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PIERCE'S DISEASE OF THE GRAPEVINE: THE ANAHEIM DISEASE AND THE CALIFORNIA VINE DISEASE



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A historical account of the long search and
final solution on the cause and nature of a
destructive disease of the grapevine.

by

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PREFACE

North American grapevine pests and diseases have plagued the European grapevine Vitis vinifera L. for a century and a quarter. First powdery mildew, better known in Europe as oidium, showed in the greenhouses of England in 1845, in France in 1848 and then spread rapidly over the rest of Europe. After oidium, Phylloxera (from Greek, that which causes) the root aphid appeared in 1865. It soon began to devastate grapevines and caused the intensive search for resistant rootstocks. Growers had to replant vineyards on the resistant American rootstocks. Only a decade later, 1878, the American grape fungus downy mildew (Peronespora viticola), appeared in the vineyards of France and has since required vigilance in its control with chemicals. This disease has not become established in California vineyards. Fortunately for European viticulture, Pierce's disease, the mysterious killer of grapevines that showed first in Anaheim, California in 1884, has not spread to the European vineyards, but there has been two epidemics of the disease in California. The first 1884-1906 destroyed some 40,000, and the second 1935-1946 some 50,000 acres of vineyards.

This volume brings together the records of two epidemics of Pierce's disease of the grapevine in California, the research that eventually led the way to the discovery of the pathogen that causes the disease, and prospects for the future control of the disease.

The first part covers the first epidemic. It is an account of the Anaheim outbreak of Pierce's disease as reflected in the agricultural and popular press of that time. The period covered is about 1884-1894, with Pierce's later work added. There is emphasis on the reaction of the

people concerned to a plant disease calamity and to the scientists who were trying to find a way to combat the disease. Of the three research agencies involved, the activities of the Board of State Viticultural Commissioners have been stressed. This early account is somewhat supplementary to the historical reviews in Pierce's Vegetable Pathology Bulletin 2, to Frazier's Ph.D. thesis, and to Hewitt's California Agricultural Experiment Station Circular 353. The second part covers the period from about 1900-1974. It is an account of the later development of the disease in the central valley that became the second epidemic. It also covers research on the disease from 1935-1974.

The first part was developed by Professor Max W. Gardner. It is thus his account and Dr. Gardner uses the personal pronoun I. The second part by Professor Wm. B. Hewitt, the use of we refers to the many associates involved in research and development of knowledge.

Professor Ralph E. Smith, who died in 1953, left an unpublished chapter on this disease, some of which has been included.

The assistance received in developing the manuscript is appreciated. Thanks are expressed to Professor W. C. Snyder, Department of Plant Pathology, University of California, Berkeley, to the University Library, especially the Bancroft Library and the Agricultural Reference Library, to the Henry E. Huntington Library at San Marino, especially Mrs. Virginia Rust, and to Mr. James De Barth Shorb of San Francisco.

INTRODUCTION

"Two events happened during the decade of 1880-1890 which made it a remarkable period in the history of plant pathology in California" said the late Prof. Ralph E. Smith in an unpublished manuscript, "One was the outbreak of the so-called California, Mysterious, or Anaheim grapevine disease, now called Pierce's disease. The other was the coming to California of Newton B. Pierce to study this disease, the first professionally trained plant pathologist to work in this state."

Anaheim Vineyards Before 1886

"Early California horticultural literature," continued Prof. Smith, "contains frequent comments on the growth and rapid expansion of the wine grape industry in both the southern and north-central parts of the state. Among the grape districts none was more promising and admired than that around Anaheim in what is now Orange County. This was started as a Cooperative wine-producing colony in 1857 by 50 German families from San Francisco, who bought a tract of land surrounding and including the present city of Anaheim for \$2 per acre. This tract was subdivided into 50 plots of 20 acres each and planted to grapes. Many other large vineyards were planted in southern California so that in 1858 there were estimated to be more than 2,000,000 vines growing in that part of the state. These vineyards

240/12 = 10, 5000 AC

and the wine industry prospered." Thirty years later, according to Pierce, Anaheim ". . . continued to be preeminently a vine-growing and wine-manufacturing town. There were, in 1886-87, about fifty wineries in Anaheim and its immediate vicinity. . . . At the close of the season of 1886 the vines . . . were to be counted by the thousands of acres in southern California."

In 1881 the Pacific Rural Press (v. 21, p. 307) stated that, "Some weeks ago we undertook the task of gathering statistics as to the numbers and varieties of vines planted in Anaheim and vicinity this season . . . no disease is observable in any of the vineyards"

Earliest Records of the Disease, 1884.

The May 8, 1886, Pacific Rural Press (v. 31, p. 457) quoted an Anaheim correspondent of the Orange Tribune, "For two or three years past it has been noticed that a few vines in our vineyards here and there would, after making an apparently healthy growth of a few inches, suddenly wither away and die This year this has been more marked than usual and a large number of vineyards have been affected to a greater or less extent. . . . This disease has done considerable damage . . . it is a very dangerous one, for no particular locality, no particular soil, no particular variety of vine is exempt from its attack." This is the earliest report of the disease I have found.

In a similar article entitled A New Vine Disease, The Rural Californian (v. 9, p. 137, June, 1886) quoted from a letter from an

Anaheim grower that, "For two or three years past it has been noticed that a few vines wither away and die."

According to Mr. Tim Carroll, of the Anaheim Evergreen Nursery (CSBH Rep. 1889, p. 440, 1890)^{1/}, the disease " started in Mr. Dryfus' vineyard on the west of Anaheim I have lived there for twenty-two years and know all about it. It started in 1883 the next year in 1884, there seemed to be a great many more dying, and in 1885 almost half of the vines were gone, and in 1886 there was not a vine to be seen; there are no vines in that part of the country." "We laid it to a fungus," said Carroll (CSBH Rep. 1889, p. 434, 1890), " the vines, after the berries got to be about half grown began to wilt the next spring they seemed to die from the tip down."

Langenberger Writes to Hilgard

The June 26, 1886, issue of the Pacific Rural Press (v. 31, p. 618) contained under the heading, Death and Disease Among Trees and Vines, a letter from A. Langenberger to Prof. E. W. Hilgard, University of California, saying, "The sickness is in all vineyards, without exception, worse on the three outside rows. A few vineyards have it all through and through in smaller or larger spots over the vineyard. The sickness, so far as I can find out, extends from Tustin City in the South to Downey in the North."

To quote from Pierce (Bul. 2, p. 61), "The Anaheim Gazette of July 24, 1886, said: Pursuant to the call published in the Gazette

^{1/} Abbreviations page 207

last week, a number of grape-growers met at Kroeger's Hall on Monday evening to organize a branch of the State Viticultural Society. . . . Following a discussion of grape-vine diseases, A. Langenberger and F. Hartung were appointed to correspond with Professor Hilgard regarding the disease which has of late shown itself in many vineyards. In commenting upon the meeting the editor says: The uppermost theme for discussion at the present time is the disease which has shown itself for the first time this year among the Mission vines. In the early part of the season large numbers of vines (and trees as well) failed to sprout at all, while others sent forth a few sickly leaves which soon died On the other hand, vines which appeared vigorous and healthy three weeks or a month ago are beginning to shrivel and dry, and the berries are dropping off."

In the Sept. 4, 1886, issue of the Pacific Rural Press (v. 32, p. 192) the Santa Ana Standard is quoted to the effect that, "The disease which has been discovered in this valley this season in the old Mission vineyards seems to be still spreading."

Hilgard Sends Morse, July, 1886

The appeal to Prof. Hilgard resulted in an inspection trip to the affected district in August, 1886, by F. W. Morse (PRP, v. 32, p. 410-411, Nov. 13, 1886), a chemist who had been investigating the grape root Phylloxera. "Mr. F. W. Morse, Assistant in the Agricultural Department of the University visited Anaheim last August under instructions from Prof. Hilgard, at the request of the Anaheim vine-growers to investigate the nature and causes of the vine trouble in that locality. The following is an abstract of Mr. Morse's report,

which will appear in full in the forthcoming viticultural report of the Department." This was followed by an account of the distribution and symptoms of the disease. "Scattered dead vines, which have made good growth last year, still have roots in good condition. A decided backwardness of starting was noticed this season . . . often six weeks later than their usual time. In many cases small shoots appeared in the early part of the year, but soon became dry . . . bush growths have formed about some of the affected spurs. In order to show the presence or absence of a fungus, specimens of all parts of the vines were collected and examined under the microscope, but in no case was there any fungus or insects to be found. In casting about for a probable cause for the trouble we were led to believe, from the general evidence given in answer to questions, that the season has been an extraordinary one, and the supposition was confirmed by meteorological data obtained later" He then called attention to the warm fall and early winter of 1885 and the cold February-April period of 1886. "There are peculiar coincidences which argue in favor of some climatic conditions as the cause of the trouble. . . . it would appear that there is no cause for alarm for the future prosperity of the vineyards. There was nothing found to indicate a true disease which might increase and spread to other vineyards. But, on the contrary, all the peculiar appearances and trouble could be traced to natural causes due to more or less accidental peculiarities of weather, soil and moisture, conditions which may not recur for many years." This was tragically erroneous diagnosis and prognosis.

Morse's Climatic Theory

Essentially the same statements appeared in Morse's official "Report of an examination into the phenomena and causes of a supposed vine disease in Los Angeles county" dated October, 1886, and appearing in the College of Agriculture Report on Viticultural Work, 1885-6, pages 176-184. Morse concluded, "From the general description of the affected vines, and the manner in which they first gave evidence of trouble, there seemed to be no reason for believing that some microscopic organism was at the bottom of the disease." In a footnote (p. 185) Hilgard stated that Morse's investigations ". . . in the southern part of the state were made by him as a volunteer, without compensation during the summer vacation, 1886."

High Rainfall, 1884

Morse supplied, however, the additional and perhaps significant information (p. 179): "Through the courtesy of the Railroad Station Agent at Anaheim I was able to obtain some records . . ." presented (p. 180) in a table showing the rainfall of the last 4 years, that for Jan. - March, 1884, being very high (20 in.), to which he attached no significance, that for 1885 rather low (5.5 in.), which he deemed important.

Pierce (CSBH Rep. 1890, p. 173, 1890) pointed out that ". . . the season of 1884 was . . . an exceptional one. The rainfall . . . was nearly three times as great as the usual . . ." In his Bulletin 2, he showed the monthly rainfall over a period of years at Anaheim and other stations and concluded (p. 119) that, ". . . rainfall has not been the direct cause of the death of the vines . . ."

The high winter rainfall of 1884 might have favored luxuriant growth of grass in the vineyards, a condition now believed important in building

up high populations of the leafhopper vectors of the pathogen in the San Joaquin Valley vineyards. However, other species of leafhoppers may have been responsible for the Anaheim outbreak. Their development would also have been favored by increased growth associated with high rainfall.

Quoting the San Francisco Evening Bulletin, the Rural California (v.9, p. 226, Oct., 1886) announced that, "Fred W. Morse, the entomological expert of the University of California, has returned from a trip to the vineyards about Los Angeles and San Diego. He attributes some alarming features recently noted in vineyards in these localities to natural or climatic causes, which may be overcome, and not to any pest or disease, as was feared." The editor, Fred J. Alles, later (RC., v. 10, p. 162, July, 1887) reviewed Morse's 1886 report under the title, Mysterious Death of Vines.

Wetmore's Sunstroke Theory

Charles A. Wetmore of the Board of State Viticultural Commissioners published an essay entitled, Sunstroke of the Vine (PRP, v. 32, p. 410, Nov. 13, 1886). He assumed the Anaheim disease was similar to the "coup de soleil" or sunstroke occurring in French vineyards and quoted from French sources about this disease and another known as "rougeot". He actually referred to ". . .the heavy wet season of two years ago" but not as a cause of the disease. He wisely commented, "In all discussion relating to disease affecting vegetation, great care should be exercised not to be misled by theory." At this time he had, presumably, not seen the Anaheim disease in the field, but this trend of thought that it was a non-parasitic disease persisted with him and he later termed it a constitutional derangement of the plant. With George Rise, he had, however, examined a so-called Muscat blight (RC, v. 7, p. 150-151, Aug. 1884) near Pasadena in 1884.

Hilgard Reports Research at Berkeley; and Reiterates

Climatic or Deficiency in Sap Flow Theory

On June 4, 1887, Hilgard (PRP, v. 33, p. 546, June 18, 1887; Anaheim Gaz., v. 17, No. 37, p. 1, June 16, 1887; SFM, v. 20, p. 140, Aug. 3, 1888) wrote, "An investigation into the cause of the mysterious decline and death of grapevines at certain points in Southern California has been in progress at the University Experiment Station for several weeks. The work was undertaken to test the results announced last year by reinvestigation, and because the loss and vexation resulting from death of vines continues in the same localities affected last year."

"Quite a large collection of vines in different stages of decline was secured from the growers The examination of this material was also much helped . . . by personal investigation in the field by Mr. F. W. Morse. The results . . . as to locating the trouble in the vine itself were mainly negative, as was the case last year. Although most careful microscopic examination of the leaves and wood of the affected vines was made, there was no parasite of either animal or vegetable nature found . . . there were clear indications of defective nutrition resulting from a stoppage of the sap supply. . . . the tissue was normal and healthy, except in the noticeable deficiency in the sap flow. . . . "

"This conclusion is a verification of the results set forth last year by field examination by Mr. Morse and by microscopic investigations in the laboratory. . . . It is altogether likely that the continued decline of vines observed this year is but the natural sequence of unfavorable conditions prevailing in the winter and spring of 1886. . . . It is possible that the evil has been aggravated by the gradual

exhaustion of the soil; pointing to fertilization as at least a partial remedy . . . enabling the vines to rally from their enfeebled condition . . ." This was dangerous speculation. Separates of the Pacific Rural Press article presumably constituted Experiment Station Bulletin 70.

The San Francisco Merchant

This Hilgard article in its Aug. 3, 1888, issue and one by F. L. Scribner in its Jan. 20, 1888, issue and a note on July 6, 1888, are apparently the first information on this disease in the San Francisco Merchant, which reflected the views and activities of the Viticultural Commissioners and now began to devote much space to the disease.

The San Francisco Merchant, later (Apr. 26, 1889) called The Merchant and Viticulturist, then (Apr. 5, 1890) The Pacific Wine and Spirit Review, will be frequently quoted. It was published fortnightly by E. C. Hughes and Co. and the editor was Charles R. Buckland until Aug. 5, 1887, after which no editor is named. It seemed to serve as an unofficial publication channel for the Viticultural Commissioners. It claimed to be "The Only Viticultural Paper in the State."

In the minutes of the 6th Annual Viticulturists' Convention, held in San Francisco, March 8, 1888, (SFM, v. 19, No. 11, p. 168, Mar. 16, 1888), there is no reference to the disease, nor in the report of the semi-annual meeting of the Board of State Viticultural Commissioners (SFM, v. 20, No. 6, p. 88, June 22, 1888). However, J. H. Wheeler, Chief Viticultural Officer, in his report for 1887 (SFM, v. 21, p. 1-3, Sept. 28, 1888), remarked that, ". . . the attention of our leading scientists and students has been repeatedly called to the unknown disease, and they have as yet failed to identify it as due to any

particular fungus or parasite, and our former impressions continue. . . viz., that it is purely the result of climatic influences." According to the editor (SFM, v. 20, p. 104, July 6, 1888), "The Los Angeles disease continues unimpeded in its course of destruction . . . an apoplexy of the vine . . . attended with fatal results."

Losses Continued: University Needed a Plant Pathologist

Unfortunatley Hilgard's and Morse's optimistic predictions that the vineyards would recover failed to materialize and the vine disease continued to increase. As recorded later by Hilgard (U.C. Agr. Exp. Sta. Rep. 1888-9, p. 47) ". . . the mysterious disease that today baffles the observers detailed by the Department of Agriculture and the State Viticultural Commission was first investigated by Assistant Morse in 1886, when, apparently, it either originated or first took a serious scope. It has been attributed by him to the extraordinary meteorological conditions which prevailed in February of that year, when thousands, not only of vines but of fruit trees, died, all over the State, apparently from the same cause. It was therefore supposed that the trouble would disappear when the damage of that season should have been done away with. This expectation has unfortunately not been realized; but the question has not been greatly advanced toward its solution since."

It was tragically unfortunate that there was no plant pathologist at the university. The university missed the opportunity afforded by this emergency to get a plant pathologist and start research in plant pathology, an event which was delayed for another decade and a half. Also the university missed the opportunity to give the vineyardists

the help that they now had to seek elsewhere and to convince them that its agricultural experiment station could and would cope with any grape disease emergency that might arise.

Pierce and Others Tell Extent of Losses

That the apprehension felt by the grape growers was fully justified is evidenced by Pierce's statement (Bull. 2, p. 15) that, "In the neighborhood east of the Santa Ana River (Orange County) it was estimated five years ago that there were 10,000 acres of vines. . . . The vines of these once fine vineyards are now almost wholly dead. Millions of them throughout the Santa Ana Valley have been removed from the ground and consumed as fuel. Land . . . has depreciated Business men feel the loss As we cross to the west of the Santa Ana river as far as Compton and Los Angeles, then east again through the San Gabriel valley as far as Pomona, the vines are nearly all dead, swelling the loss to at least \$10,000,000 The vines now incurably diseased, including those already dead, will amount to over 20,000 acres; probably to over 25,000 acres." During this time the disease did not appear in northern California nor in the San Joaquin valley, or at least not to a serious extent.

Discussing The Mysterious Vine Disease (CSBH Rep., 1890, p. 171, 1890), Pierce said, "Of all the vine affections known to science, we have here one which in the deadliness of its nature, the universality of its attack in a vineyard, and the obscurity of its workings, is nowhere surpassed. . . . There has never before been in California such a complete, such a widespread, such a continuous death of vines." Since 1884, ". . . the death of the vines has been steady, progressive, relentless and complete."

Speaking at a Farmers' Institute in San Fernando, in April, 1893 (RC, v. 16, p. 297-8, June, 1893), C. R. Rinaldo referred to ". . . the mysterious vine disease . . . which has literally ruined the growing of wine and raisin grapes throughout Los Angeles and Orange counties, and of course had its depressing effect upon viticulture in this valley."

Under the title, That Unknown Vine Disease, The California Fruit Grower (v. 3, No. 2, p. 4, Jan. 12, 1889) said, "Thousands of acres of vines have been killed and thousands more are dying. . . . It seems to be a noticeable fact, that this disease is particularly partial to vineyards and vines grown in irrigated districts."

U.S. Department of Agriculture Sends Scribner and Viala, Oct., 1887

When it became evident that the problem was beyond the limited abilities of the University, the vineyardists appealed to the U.S. Department of Agriculture at Washington. In 1887, F.L.Scribner of the U.S. Department brought Dr. Pierre Viala, the eminent vine expert of Montpellier, France, to southern California. They spent eight days early in October examining the diseased vineyards. As related in the Pacific Rural Press (v. 34, p. 299, Oct. 15, 1887), ". . . Mr. F. Lamson Scribner is now in this State, having come to study on the spot the mysterious disease which is playing such havoc in some of the vineyards in the neighborhood of Orange and Anaheim . . . specimens sent to Washington . . . did not disclose any vegetable parasite competent to compass its destruction, but that the cause of the trouble was obscure Accompanying him is Pierre Viala"

Under the title, The New Vine Disease, Fred J. Alles, editor of The Rural Californian (v. 10, p. 251, Nov., 1887), said Scribner and

Viala had visited the region". . . and report that it is something entirely new to them. . . . Mr. Scribner will recommend that a man be sent here from Washington to carefully study this disease"

Scribner described his trip in an address before the N.J. Horticultural Society, Dec. 15, 1887, entitled Fungoid Diseases of the Vine (SFM, v. 19, pp. 99, 114-115, Jan. 20, 1888) saying (p. 99), "Seven days were spent at Orange . . . investigating a disease which for the past two or three years has been devastating the vineyards . . . we arrived at no conclusion respecting the cause of the trouble. . . . We failed to detect the presence of any fungi, although careful microscopical examinations were made of root, stem and leaves. To us the disease appeared to originate in the roots, all the fibrils were dead, and many of the larger roots were dying from a species of wet-rot. . . . Some have supposed the trouble arose from certain climatic conditions and that it will pass away. . . . let us hope that this may prove true. We saw evidence of the disease in other parts of the State, especially Napa County, but its severity has not been sufficient as to cause any general alarm except in the region about Orange."

After his return to France from his trip to California, Pierre Viala published an account in his book, *Une Mission Viticole En Amerique* (p. 292-294, 1889). He described the *Maladie de Californie* which he with Scribner had studied during 8 days in October, 1887. He thought that the manner of spread of the disease seemed to indicate the existence of a parasite which, however, he had been unable to discover. The growers, he said, thought the disease was carried in scions taken from diseased vines. He collected leaves to study, dried them and then fumigated them with CS_2 so as not to introduce the disease into France (Jour. de Bot. 6:355, 378, 1892).

State Board Viticultural Commissioners Concerned

George Rice, reporting on the grape industry of Los Angeles County in 1887 to the Commissioners (BSVC Ref. 1887, p. 57-59, 1888), referred to the ". . . unknown disease that is doing some harm in the neighborhood of Anaheim and Orange . . . the vines seem to die without cause. Professor Hilgard thought it must be some climatic trouble that would pass over in a short time. Entire vines, roots and all, have been sent to scientific men in Washington, D. C., and to others but no one so far has given a name or remedy. . . . this new disease, whatever it is, should have the attention of your viticultural authorities."

In the same 1887 report of the Viticultural Commissioners (p. 87), J. H. Wheeler, Chief Executive Viticultural and Health Officer, referred to ". . . the trouble which has occurred in many of the vineyards about Orange, Anaheim, and elsewhere in Los Angeles County . . . the attention of our leading scientists and students has been repeatedly called to the unknown disease, and they have as yet failed to identify it as due to any particular fungus or parasite;" He thought it was ". . . purely the result of climatic influences."

Commissioner Shorb Employs Dowlen, Sept., 1888

The Southern California Vine Disease was discussed in the Oct. 6, 1888 (v. 2, No. 3, p. 4) issue of the California Fruit Grower, and it was announced that, "Professor E. Dowlen, a French expert on the vine and vine diseases, is now in the San Gabriel valley investigating this vine scourge, under the immediate direction of J. De Barth Shorb." Shorb, owner of large vineyards at San Gabriel, was one of the State Viticultural Commissioners.

Two questions arise: What were Dowlen's qualifications and how did Shorb discover him? Perusal of the James De Barth Shorb letters now preserved in the Henry E. Huntington Library of San Marino (which occupies land originally owned by Mrs. Shorb) disclosed that Dowlen apparently happened to be in Los Angeles and heard about the grape disease. Whereupon, giving his address as Room 76, 36 S. Main St., he wrote to Shorb on Sept. 6, 1888, as follows:

"Dear sir: Understanding that the various viticultural societies hereabouts have been considering the causes of the death of grape vines in this section, I write you to ascertain whether any steps towards an investigation of the matter have been taken. I, having been referred to you as the one best able to give me information on the matter."

"Having had considerable experience in similar work, I should be pleased to conduct, under proper auspices, an investigation into the causes referred to."

"I visited your place one day last week, with a view of consulting you regarding the matter, but learned from Mrs. Shorb that you were in San Francisco. Will you please write, or favor me with an appointment at such time and place as may be most convenient to you, and oblige."

"Yours faithfully,

"Ethelbert Dowlen."

On Sept. 22, 1888, Shorb wrote to Dowlen (HEH. Lib.), "You are hereby appointed as a special scientist to investigate the causes affecting the vines in this section, to report from week to week the result of your investigation. The State Viticultural Commission has authorized me to confer this appointment on you at a stated salary of

\$150 per month. You will put yourself in communication with our Secretary and Chief Viticultural Officer, Mr. John H. Wheeler, who will furnish you whatever may be necessary to aid you in your good work."

"Trusting your researches may eventuate in good results to the grape industry and of credit to yourself, I remain, Very truly yours,
J. De Barth Shorb, Commissioner State at Large."

Appended to this letter is a list headed, "Received the following articles from Mr. Wetmore," dated Sept. 23, 1888, and containing 1 binocular microscope, 1 Bull's eye condensing lens, 1 diaphragm for substage, 1 pair eye pieces, 1 set polarizing prisms, 1 camera lucida, 1 micrometer, 1 pair scissors, and other items used in microscopy.

At a special meeting of the Board of State Viticultural Commissioners in San Francisco on Oct. 26, 1888 (B. Lib. Ms C-A353, v. 1, p. 157), "The Chief Executive Officer reported that Mr. Shorb has consulted with the officers of the Commission in reference to employing an expert to examine into the vine disease of Southern California - that they had agreed that something should be done by the Commission at once and had employed Mr. Ethelbert Dowlen at a salary of \$150 per month to examine the disease and to report on the same. On motion the action was endorsed." Secretary C. J. Wetmore (HEH. Lib.) relayed this action in a letter to Shorb on Oct. 29.

Previously, Shorb (HEH. Lib.) wrote to C. J. Wetmore on Oct. 18, 1888, as follows: "I can see no reason for giving publicity to the reports of our Expert Mr. Dowlen until something of a definite character is reached, from which some good may come to those directly inter-

ested. To publish reports of an existing evil may belong to an enterprising Journal; but it is scarcely in line with the scientific work of a Commission charged with grave responsibilities. Already the eye of Europe is on California and her marvellous productiveness and capital is looking over this field for investment. Do not let us by our own acts drive them away from us."

Dowlen's Qualifications

As to Dowlen's qualifications, Shorb wrote (HEH. Lib.) to a friend, Mr. Newlands, on Oct. 30, 1888, that he had "employed a Prof. Dowlen (a graduate of the South Kensington School and who took a scholarship under Huxley and who taught there for four years afterwards) to investigate this new terror. He is a perfect Microscopist and Botanist, is very earnest in his work and is doing all in his power to find out the cause of this trouble it seems to be wrapped in almost an impenetrable mystery. I have him located at my ranch house and see him every day . . . he is working all the time up to 12 o'clock at nights, but still the powerful lenses fail to reveal the causes. . . . to see the work of years being destroyed day by day makes it almost intolerable to me."

Shorb Appeals to the U.S. Department of Agriculture

Shorb wrote to the Hon. Norman J. Coleman, Commissioner of Agriculture at Washington on Nov. 1, 1888 (HEH. Lib.; PRP. v. 36, p. 482-483, Dec. 8, 1888) as follows: "For the last two or three years, a disease of a very deadly character has made its appearance in the vine-

yards of this portion of the State, and up to this time the nature of the same can not be scientifically determined. . . . The investigations made by the officers of the State Viticultural Commission failed to reveal any cause for the trouble. Lately the writer, on behalf of the Commission, employed Prof. Ethelbert Dowlen, a graduate of the South Kensington School, and who took the scholarship under Prof. Huxley, and who taught botany at the same school for four years afterwards; to investigate the cause of the disease. Five weeks' patient and zealous research on his part using microscopes of the highest powers, leaves the trouble wrapped still in an impenetrable mystery. Only one thing has been proven, and that is that no insect is causing the trouble."

"Prof. Dowlen will not permit himself to adopt any theory for fear it might influence his work, but he strongly inclines to the belief that the cause, when discovered, will be found to exist in one of the forms of fungus. To produce the effect the fungus must penetrate the leaf cells and hence introduce itself into the circulation of the sap."

"As the leaves are now falling, the research in this direction must cease for the season, unless a conservatory could be established in this section, wherein the vine could be maintained in its leafy condition and the investigation proceed. The spores of the different forms of fungi could then be transplanted on to leaves of the growing vines, and their development observed under varying degrees of heat and moisture The appropriation from the State to meet the necessary expenses of the Viticultural Commission is very limited, certainly not sufficient to meet an emergency of this kind, . . . I have thought it proper to bring this matter to the attention of your Department and to invoke

its assistance, in its prosecution of this work. . . . If in your judgment the Department would be justified in giving its timely assistance, it might appropriate say \$500.00 for the establishment of an experimental conservatory, the Expert in charge to make weekly or monthly reports to your Department and our Commission jointly, of the results of the joint work"

"As I have all the best varieties of vines and varieties of soil, possibly it would be the best judgment to continue the work on my property, where I could give personal supervision to the same, and where my gardeners could look after the manual care of the conservatory without charge or expense to your Department or the Commission. . . . I question if there ever has been an emergency greater than the present one, touching one of the greatest industries of the nation. . . ."

Coleman's Reply and Galloway's Essay

Commissioner Coleman's answer (PRP, v. 36, p. 482-483, Dec. 8, 1888) was quoted to the effect that ". . . it is not within the power of the department to make such an appropriation under the conditions named in your letter If possible, arrangements will be made to send a special agent from the Section of Vegetable Pathology to your State to aid in the work which your Commission has undertaken. As matters now stand, it will be impossible to send a man before spring" He requested specimens be sent to him collect.

This correspondence in the Pacific Rural Press (v. 36, p. 483, Dec. 8, 1888) was followed by a long statement by B. T. Galloway, new chief of the Division of Vegetable Pathology, based on Viala's Les

Maladies de La Vigne and describing the obscure Mal Nero disease of Italian vineyards. He cited an imposing list of authorities - Cugini, Tozzetti, Comes, Garovaglio, Cattaneo, Fiorini, Coppala, Pirota, and Cornu.

Scibner's Letter to Benjamin Pratt; Mal Nero

Under the title, The Mysterious Vine Disease (PRP, v. 36, p. 327, Oct. 20, 1888; SFM, v. 21, p. 39, Oct. 26, 1888), was a letter from F. L. Scribner to Benjamin Pratt of Orange in which he said, "To me the disease of the vine in question is as much of a mystery as ever. In many respects it is like what the Italians name 'Mal Nero' . . . I certainly saw the same disease in Mr. Krug's vineyard at St. Helena . . . Mr. K. said he had seen similarly affected vines . . . for at least ten years past. . . . In every case examined by Prof. Viala and myself, we found the ultimate rootlets dead, often a foot or more from their tips. But what caused them to die?" Perhaps this letter was in reply to Pratt's letter to Scribner of Sept. 22, 1888, in which, as cited by Pierce (Bul. 2, p. 127), Pratt told Scribner how in early spring the growers thought the diseased vines had recovered and ". . . everyone felt encouraged. . ." but "Before midsummer the vines began to show . . . the same dying of the new growth . . . that you saw when here,"

As reported in the Oct. 26, 1888, issue of the S.F. Merchant (v. 21, p. 35), "The San Diego Sun says: It is estimated that over one half of the vines of the Mission variety in San Gabriel valley have died this year. The committee investigating the cause, by the aid of a powerful glass, has discovered a fungus growth which is believed to be the cause. .

Dowlen's First Two Weekly Reports

It was also announced (SFM, v. 21, p. 39, Oct. 26, 1888) that, "The State Viticultural Commissioners received Oct. 11th the first weekly report from Professor Ethelbert Dowlen, whom they commissioned as a specialist to inquire into the disease. . . . The first week . . . was spent in the San Gabriel Valley and the investigation confined to the branches and leaves No definite conclusion has been arrived at Many theories have been advanced by the grape-growers as to the cause, the main one being that it was the result of the early pruning;" Early pruning as a possible cause, was mentioned by a Santa Ana vineyardist quoted in the Anaheim Gazette of May 12, 1887.

The same Oct. 26, 1888, issue of the S.F. Merchant (p. 40-41) contained Dowlen's first two weekly reports (Oct. 1 and Oct. 8), and displayed editorial carelessness by misspelling his name, Dowleny and Donleny. In his first report (also in PRP, v. 36, p. 327, Oct. 20, 1888), Dowlen described the symptoms, noting that the ". . . leaves look as though they had been scorched along the outer edge. . . eventually . . . turn brown, dry up and curl in on the upper surface." He said, "A microscopic examination of the leaves shows that on the decayed portion there is a plentiful growth of a minute fungus, the spots on the surface being formed by the fructification. Considerable time has been spent in attempting to trace the fungus into the leaf tissues, but at present this attempt has not been successful. The microscopic examination of the warty patches on the branches shows they are due to the growth of a small fungus, immediately underneath the cuticle, where it has formed a network of short jointed branches, this growth has

caused the epidermal cells in contact with it to become filled with a dark brown deposit, and has caused the tissue itself to form the warty excrescences, finally the cuticle has been ruptured, and through this rupture the fungus has come to the outside. . . . the attempt to follow the fungus growth deeper into the tissues has not yet been successful."

In his second report, Oct. 8, Dowlen said, "The microscopic examination of the leaves and branches has involved the making of a large number of sections In the . . . branches, a fungus does certainly exist in . . . the epidermis, the difficulty is to determine the depth to which it penetrates." He made some observations on varietal susceptibility, ". . . the Mataro and Burger varieties have suffered most, . . ." He found no insects present. He found what he thought was the same disease on "Some wild vines in a neighboring canyon"

An accompanying editorial (p. 40) called attention to "The reports from the expert employed by the Viticultural Commission to examine into the disease . . ." and concluded, "It is to be hoped that the investigation will result in the discovery of a remedy which will promptly check the threatened plague."

Dowlen Needs Greenhouse at San Gabriel

Shorb (HEH. Lib.) sent "the Fifth weekly report of Prof. Dowlen" to Secretary Wetmore on Oct. 31, 1888, saying "I never knew anyone more faithful in his work than the Prof., burning his lamp until 12 o'clock almost every night in his examinations. He is much worried that he has not been able to have discovered the cause of this terrible scourge and seems to entertain fears that the Commission may think he

is not doing all that he might. I have calmed his fears on this score."

"Prof. D. now suggests that a small Conservatory should be erected here in which the vines could be kept growing through the winter so as to enable him or someone else to continue the examination of all fungus growth which he thinks is the cause of our trouble. In a conservatory, temperature, moisture and all climatic causes could be determined in the growth of the fungus he would have planted on the leaves."

"This little conservatory will cost \$50 to \$200.00. Will you kindly consult the other members of the Commission as to the advisability of establishing this plant which seems to be necessary, and which may result in the discovery before spring. How will I arrange to pay Prof. Dowlen his salary? . . . I do not think it would be a mistake to let the press have the most general statements of what is going on and the result of this week embraced in his report."

Shorb Fears Disease Is Statewide

Writing to C. J. Wetmore on Nov. 29, 1888 (HEH. Lib.), Shorb expressed his fear that the vine disease, . . . "threatens the entire industry of the State. I dislike very much to take the position of alarmist and yet I feel it is my duty to the State to do so. . . . I feel confident vines I saw in Sonoma Valley . . . are affected I also fear the same of some of the vineyards in Napa Valley. It certainly is at Fresno and at Riverside. . . . We are told that once a similar disease appeared in the Island of Madera and destroyed all the vines. . . . Am now building the hot house . . . Dowlen is doing all in his power to discover the causes"

Galloway's Letter About Specimens

A letter from Galloway appeared in the Santa Ana Blade (SFM, v. 21, p. 92, Dec. 7, 1888) which read as follows: "Your favor of October 30th, addressed to Professor Scribner relative to the destructive Vine disease has been referred to me. We have also received a letter from the State Viticultural Commissioner relative to this matter, in which it is stated that the agent sent to investigate the malady has discovered nothing whatever that would indicate the cause of the trouble. The specimens communicated were received, but unfortunately they were destroyed by a janitor who was ignorant of their value."

"But one examination was made of the specimens before they were destroyed, and this is not sufficient to warrant us in making a report. This disease is certainly one that should be thoroughly investigated, and we shall be glad to do all within our power to aid you and the people at large in discovering the cause and remedy for the disease, if such a thing is possible."

"I shall be greatly obliged if you will send another supply of the diseased wood and some leaves from diseased vines, if it is possible to obtain them at this season. From what I know of the disease I doubt if it is caused by a fungus, at least by any of the higher ones, such as the peronospora or uncinula. If there is sufficient interest shown it is possible that we can arrange to send an expert to your State in the spring to investigate the disease. In the meantime I should be pleased to obtain all the facts possible having a bearing upon the malady. . . ."

Denicke Thinks It A European Root Disease. Shorb Disagrees

The editor of the S.F. Merchant (v. 21, p. 104, Dec. 21, 1888) noted that, "A new disease has broken out among the grapevines of Santa Ana and San Gabriel . . . it is termed the sap-sour, and the cause of it no one knows The disease is infectious and spreads very rapidly." On the same page he printed a letter of Dec. 13, 1888, from Mr. M. Denicke of Fresno about the disease, to the effect that, "It is no doubt a sap disease or caused by diseased sap. . . . Its cause is not definitely known. The only cure is the thorough uprooting of all infected vines, as well as a double circle of unaffected vines, to starve the disease, as the mold spores reach out through the ground for fresh nourishment. (The mold is generated between the two barks) . . ." He thought it was the same as a European disease ". . . called the grape-root mold"

Denicke was promptly rebuked by Shorb (SFM, v. 21, p. 121, Jan. 4, 1889) who pointed out that if it were a European disease, Viala would have recognized it, that it was a disease of the leaves rather than the roots, and that, "The spores of fungi do not travel . . ." through the soil, but the mycelium could. However, Shorb admitted that the vine disease might be in the Fresno district, asked for specimens, and went on as follows: ". . . addressing myself to the people of this State, I would earnestly advise great caution in hasty judgments or opinions The disease . . . while now presenting apparently an impenetrable mystery, must soon give up its secret, and then the chemist and laboratory will soon supply the remedy."

Dowlen's 3rd to 14th Reports; Symptoms, Varieties, Fungi

Under the title, The Vine Rot, the first 14 of Dowlen's weekly reports, Oct. 1 to Dec. 31, 1888, were published together (SFM, v. 21, No. 8, p. 113-117, Jan. 4, 1889), the first two for the second time, but somewhat expanded. In his third report, Oct. 15, Dowlen continued his examination of leaves and branches, finding less starch in the cells of the diseased vines, and no signs of insect pests. He noted that ". . . the branches are either unripe or only partially ripened and are destitute of leaves, whilst the bunches of withered fruit still hang on." In his 4th report (Oct. 22), he had examined the roots (p. 114), which, ". . . whether dead or alive, did not show any sign of disease, . . ." and again found no evidence of insect attack on the vines.

In his 5th report, Oct. 29, Dowlen referred (p. 114) to the susceptibility of the Mission and Chasselas varieties and apparent resistance of the Blanc Elba and observed no relation of disease distribution to soil or site." . . . the vines had been attacked in an apparently capricious manner, . . . " singly or in groups.

On Oct. 25, 1888, Dowlen and Shorb sent Commissioner J. H. Wheeler (p. 114) a draft of a questionnaire to be sent to vineyardists in an attempt to learn more about the disease. The questions included nature and source of nursery stock, nature of the soil, irrigation and pruning practices, climatic relations and varietal susceptibility.

Dowlen's 6th report, Nov. 5, 1888, described (SFM, v. 21, No. 8, p. 114, Jan. 4, 1889) his studies on fungi found on the fruits, e. g. ". . . small pimples were found to arise from a thick network of mycelium under and in the epidermis of the berry. . . . A transverse section

. . . shows that each is the fructification of the fungus"

He incubated (p. 115) infected fruit tissue in moist air" . . . and by the next morning it was covered with a thick mass of white, branching mycelium" He referred to difficulty arising " . . . from the fact that on some days the atmosphere seems to be loaded with fungus spores to such an extent that it is almost impossible to make a preparation for the microscope without getting something foreign to the specimen This fact also interferes considerably in the growing of specimens under cover." He apparently made no attempt to isolate his fungi in pure culture.

Dowlen, in his 7th report, Nov. 12, (SFM, v. 21, No. 8, p. 115, Jan. 4, 1889) had made an important observation in Muscat plantings at Orange. "On the heavy ground all the vines, with the exception of one plot, were either dead, or almost so; . . . the solitary exception . . . is a piece of heavy gravel which has been planted with muscat cuttings from Riverside, a district as yet unaffected. These were put in . . . last May . . . are now particularly vigorous and healthy looking. . . . and this, too, in the midst of a tract in which all the vines have been swept off. In contrast to this, another piece, similarly situated, was also planted . . . but with muscat cuttings from Orange; this has all gone under." He wisely concluded that, "The above facts do not lend support to the idea that climatic conditions are at the bottom of the present vine trouble, though such conditions may be a factor in the case. They rather tend to the view that the trouble is the result of a disease, perhaps infectious, which is capable of being propagated by cuttings from infected areas." Dowlen should be given credit for this astute conclusion.

He continued his examination of sections of branch and root tissues in his 8th report, Nov. 19 (SFM, v. 21, No. 8, p. 115, Jan. 4, 1889) noting the presence or absence of starch in the cells. In his 9th report, Nov. 26 (p. 115), he had been in the vineyards ". . . around Tustin, Santa Ana and Orange . . ." finding among ". . . the vines left in the district, the Muscat is the one most affected. Many vineyards have been cleared out, and nearly all . . . of the few remaining . . . are affected" He observed that one planting of Muscat ". . . cuttings from Redlands put in this year . . . looked in good condition." He emphasized ". . . the yellow spots on the leaf . . ." as an early symptom.

Another symptom, the strip ". . . of unripened wood running the entire length of the cane . . . and often embraces as much as half the section of the branch . . . usually thickly spotted with the fungus . . ." was described in his 10th report, Dec. 3 (p. 116). "Whether the fungus is . . . the cause or the effect of the unripened state, can only be . . . determined by experiment." One fungus he found on the leaves with yellow spots was ". . . probably a species of cladosporium." This is the only instance I have found in which Dowlen referred to any fungus by name. He ended his report with the statement that "The examination of these leaves will be continued . . . a gentleman at Orange having kindly undertaken to forward a supply twice every week."

Dowlen's 11th report, Dec. 10 (SFM, v. 21, No. 8, p. 116, Jan. 4, 1889) was devoted to a study of the fungus he had found on Muscat leaves. "Three pieces of Muscat leaves, each containing a dead patch, which had been floated on water, were found, after a lapse of four or five

days, to have developed a considerable amount of mycelium . . . The microscope showed . . . large numbers of spores . . . " and " . . . pustules of different sizes . . . evidently perithecia . . . found to contain . . . asci . . . each ascus contained four to five spores" He warned that " . . . no deductions can be drawn until repeated experiments have produced similar results, not only on single leaves, but also on entire plants." Referring to Wheeler's questionnaire sent to vineyardists he regretted that " . . . only seventy-four replies . . . " had been received to date.

The perithecium described above, he concluded in his 12th report, Dec. 17, 1888 (p. 116), " . . . probably belongs to mildew." Continuing his study of the fungi on the leaf pieces floated on water, he found other perithecia and presumable spermagonia containing " . . . very small spores . . . locomotive . . . by what means . . . could not be seen, even under the one-twelfth inch objective"

Continuing these studies (SFM, v. 21, No. 8, p. 117, Jan. 4, 1889) in his 13th report, Dec. 24, he recognized pycnidia in his leaf preparations. He announced that, "The Experimental Conservatory has been started, rooted vines . . . having been put in for the first trial."

Dowlen, in his 14th report, Dec. 31, 1888 (p. 117), had visited " . . . a vineyard of some 300 acres at Lamanda Park" finding the disease worst in the Mission and Burger varieties, present in Mataro, Pisco, and Zinfandel, and almost absent in the Grenache, Blanc Elba, Sultana, Petit Pino, Carignan and Trousseau varieties. Examination of "A parcel of specimens from Sonoma County" led him to conclude that " . . . there can be little doubt, if any, that . . . the damage is attributable to the same disease."

Shorb's Progress Report; Commissioners' Take Action

At the Dec. 12, 1888, meeting of the State Viticultural Commissioners in San Francisco (BSVC Rep. 1889-90; p. 88-89, 1890), Shorb " . . . stated that Mr. Ethelbert Dowlen, the expert appointed by the Commission to investigate the disease, was working very hard and was studying the whole disease from a scientific standpoint, but that up to the present time he had not discovered the true cause of the disease, but that he was positive it had not been caused by any insect. Mr. Shorb further stated that thousands of acres were being destroyed by the disease, and if it was not checked that all the vineyards of the south were doomed. . . . He further stated that he had written a letter to Hon. Norman J. Coleman, Commissioner of Agriculture at Washington, D. C., asking the assistance of his department in the erection of a conservatory where the disease could be studied during the winter, and also that he send an expert to work in conjunction with the expert employed by this Commission. In answer to this letter, Mr. Coleman had stated that the department could not furnish any money for building the conservatory, but that next spring he would send out an expert to assist the Commission in its work. Mr. Shorb also stated that through instructions from the Executive Committee of this Board, he had built a small conservatory where . . . the disease could be studied in the winter."

"The Commission then indorsed the work done by Mr. Shorb, and on motion of Mr. Doyle, Mr. Shorb was appointed a committee of one to continue the investigation of the disease, and to correspond further with the Department of Agriculture at Washington, stating the importance of the work, and that the department should send on the expert at once, so that the work can be carried on during the winter."

"On motion of Mr. Krug, the Chief Executive Officer was instructed to prepare a circular describing the disease, and to send it out at once to all the vineyardists of the State, with the request that they keep a lookout for the disease, and to report it immediately to this office when discovered."

Wheeler Sends Questionnaires

Executive Officer Wheeler's letter (SFM, v. 21, p. 120, Jan. 4, 1889) appeared under the caption, The Vine Disease. Vineyardists Requested to Report Any Appearance in Their District. "I am . . . instructed," he said, ". . . to institute a special inquiry to determine if possible all localities . . . wherein the disease has made its appearance. Commissioner J. De Barth Shorb has been appointed . . . to investigate the disease . . . and under his direction a noted scientist and specialist, Prof. E. Dowlen, has been employed to identify the disease . . . and report . . . on its nature and extent. This study is being earnestly prosecuted at . . . San Gabriel . . . please forward . . . diseased vines . . . to be used for microscopic examination . . . The presence of the evil is most commonly characterized by a general turning yellow and dropping off of the leaves of the vines in the spring after they have acquired a growth of from one to three feet. . . . Other vines . . . may appear healthy . . . until the berries are . . . half grown and the canes then gradually wither back and die from the . . . ends. . . . If . . . there are any . . . who have facilities for making a microscopic examination and study of the specimens they find, I shall be pleased to send them directions for the work and the printed reports of Prof. Dowlen . . . send all . . . specimens by express . . . to Viticultural Hall, 216 Montgomery Street."

The Pacific Rural Press (v. 37, p. 80, Jan. 26, 1889) carried a notice that, "Executive Officer Wheeler of the Viticultural Commission is now sending out circulars of inquiry to all vine-growers . . . to ascertain all localities . . . in which the mysterious vine disease . . . has made its appearance." The symptoms were described, as above, and growers were asked " . . . to forward specimen canes to viticultural headquarters for microscopic examination." This emphasis on microscopic examination appears to imply that Dowlen was using a fungus as a criterion.

Shorb Asks L.A. County Supervisors for Money

Viticultural Commissioner Shorb (HEH. Lib.; L.A. Herald, Jan. 4, 1889; PRP, v. 37, p. 75, Jan. 26, 1889; SFM, v. 22, p. 6, Mar. 15, 1889) wrote a letter to the Los Angeles County Board of Supervisors on Dec. 29, 1888, requesting financial aid to support research on the disease, saying, " . . . The climatic theory is entirely disproved . . . we now think it is directly due to some form of fungi which, like some deadly mildew, settles on the leaves and by destroying their functions, which are to the economy of the plant the same as the heart, lungs and stomach . . . starves the vines to death. . . . Many spores of fungi have been observed . . . but which form is doing the deadly work cannot at this stage . . . be accurately or scientifically determined. In order to proceed . . . before the vines are again in leaf, we have built a small conservatory where . . . the vines will remain in leaf all winter, giving us the opportunity of transplanting the different forms of fungi already observed and carefully note their development and effect on the

. . . vine. Where temperature and moisture can be governed at will, the study will be rendered easier and deduction more accurate."

"The Viticultural Commission . . . appointed me a committee of one to proceed . . . and will defray expenses of the small conservatory and also the salary of Mr. Dowlen, the botanical expert. . . . the work . . . has called for a heavy correspondence, so much so as to necessitate engaging a correspondent @ . . . we cannot find room enough for the different varieties of vines We should have double the capacity The Viticultural Commission . . . appropriation is limited and I feel they have done all they should It is only by thorough scientific work that accurate or reliable conclusions can be reached . . ." He cited Pasteur's work on the silk worm disease and said, " . . . It matters not how veiled in mystery this disease is, it must give up its secret to the powerful lenses of the microscopes which we have now in use, and this discovered, the chemist will soon supply the needed remedy and save the vineyards of our country. Whatever appropriations you, in your judgment may think proper to make will be satisfactory to me. I want no compensation for my own time and services, for, as one of the Viticultural Commissioners, my time belongs to that office, unpaid as it is."

The sequel to Shorb's appeal, appeared in an editorial note (SFM, v. 21, p. 152, Feb. 1, 1889) as follows: "Recently the Hon. J. De Barth Shorb sent a letter to the Board of Supervisors of Los Angeles, describing the work he was doing in trying to find out what is causing the disease . . . and appeared before the Supervisors to explain verbally the amount of work that had been done The Supervisors decided to appropriate \$300 for assisting in the experiments and \$100 for his Secretary."

George Husmann's Warning

George Husmann, in an article on Outlook for Our Grape and Wine Interest (CFG, v. 3, No. 3, p. 9, Jan. 19, 1889), warned, " . . . I think a change will come which will decrease our production" He gave five reasons, the "First - The new, and as yet unexplained disease which has attacked and in many cases, almost annihilated vineyards in the southern portions of the State. When there only a few weeks ago, I was surprised to see the ravages which it has made, . . . and if a remedy is not found soon, grape culture there may be considered a thing of the past. . . . it seems to me to bear a strange resemblance to the Eastern pear blight both in its causes . . . and in its effects. The first may be an excess of water late in the summer, followed by sudden extreme heat, . . . which brings stagnation and vitiation of sap, and a bursting of the sap vessels which kills the vine."

An editorial in the S.F. Merchant (v. 21, p. 136, Jan. 18, 1889) seemed to aim to allay alarm. "The statement of Professor Hussmann at the Convention of Grape-growers held recently in this city, while doubtless made in good faith . . . is nevertheless couched in a tone of alarm. . . . Diseases exist in many of our vineyards, and probably will so long as vines are grown. . . . There is nothing strange or new in the development of the different types, and with the exception of the mysterious plague now raging down south, the cause and cure has been thoroughly studied"

George Husmann of Napa valley (PRP, v. 35, p. 116, Feb. 11, 1888), former professor at the University of Missouri, came to California in 1881. He was a recognized " . . . authority on grape-growing and wine-making" and was the author of a book on this subject, published

in 1888. In 1887 he observed that Langenberger's planting of the Lienoir variety at Anaheim from cuttings he had given him in 1882 had escaped infection (CFG, v. 18, p. 394, May 16, 1896).

Fresno Controversy; White and Freeman vs. Shorb and McPherson

On Jan. 9, 1889 (SFM, v. 21, p. 153, Feb. 1, 1889; L.A. Herald, Jan. 12, 1889) ". . .T. C. White and George E. Freeman of Fresno wrote the Los Angeles Herald a caustic note arraigning Mr. J. DeBarth Shorb, of this county, for having stated that the vine pest threatened the viticultural interests of the State . . ." As they said (L.A. Herald, Jan. 12, 1889), ". . .the vineyardists of Fresno County demand . . .proof of this . . . We have never heard of such a disease in this region. . . . if false . . . we demand that he should at once retract such declaration."

"Our Los Angeles viticulturist," said the S.F. Merchant (v. 21, p.153, Feb. 1, 1889) referring to Shorb, "meets the issue with visor closed and lance couchant." Shorb's reply of Jan. 12, 1889, was as follows: ". . . my authority for saying that . . .the disease was unfortunately spread all over the State is the microscopic identification of the same disease on vines and leaves sent to us by Mr. Isaac De Turk, Commission for Sonoma District . . . They were reported on by Prof. Ethelbert Dowlen, scientific expert in charge of this investigation . . .in the San Francisco Merchant of January 4th. . . . During the month of August last . . .I visited Sonoma County and observed there very suspicious signs among the vines; . . .Profs. Scribner and Viala are reported as saying the same disease is in Napa; nor does Mr. Krug, Commissioner for the Napa District, deny that a disease at least similar was located there . . ." He also referred to the disease being found at Fresno by Robert McPherson, vineyardist of Orange. ". . . This is no time, gentlemen, for the exhibition of any sectional

feeling; the common enemy and danger should unite us all; first into close examinations and investigations as to the presence of the disease in any locality, and secondly, in an earnest effort to discover its origin or nature, and thirdly, when known, in a determined effort to stamp it out, and develop means for its prevention" Referring to Wheeler's letter, above mentioned, he said, "If the aid of the microscope is invoked by anyone in making the investigation for himself, let not sectional prejudice induce him to look through the wrong end of the glass in the direction of his neighbors."

The editorial comment (SFM, v. 21, p. 152, Feb. 1, 1889) was, "In a letter to the Los Angeles Herald, on the vine disease, Mr. Shorb takes a very sensible view, in refusing to make a sectional issue of a matter of common interest to all viticulturists in the State."

Following up the same issue further (SFM, v. 21, p. 169, Feb. 15, 1889), Shorb wrote to the Los Angeles Herald: "The subjoined letter from Mr. Robert McPherson, of this county, . . . is offered as a justification of . . . the existence of the grape disease at Fresno, . . . I have an all-abiding faith that, before the vines come out in leaf again, we can name remedies which will protect all vines not affected, and, possibly, save those which are not too far gone. . . . P.S. Last week's examination of canes sent to us from Santa Clara county established the fact they they unfortunately have the same disease there,"

Under date of Jan. 28, 1889, Robert McPherson (HEH. Lib.) had written to Shorb, "Your message reading, 'Received letter from Freeman and White in today's Herald. Write me fully upon what your statement will be.' I will give you the facts briefly During the summer of 1888 several owners of vineyards from our valley took a trip into

that section and made the statement that the vine disease had extended into Fresno. . . . Near the close of the packing season I took a trip myself and with a team I spent the day among the vineyards, and I assure you that I brought specimens that no one who is an expert (and we have lots of them) would doubt their being affected similarly to our own vines. . . ." A few days later, Jan. 31, 1889, McPherson (SFM, v. 21, p. 169, Feb. 15, 1889) wrote to Shorb, "I have your favor of the 21st and note that you desire me to state what I know of the existence of the mysterious vine disease in Fresno. . . . I spent but one day among the vineyards . . . brought away specimens that showed the disease as we have it very plainly. . . . I am not going to say that the disease will cause the same destruction at Fresno as here"

Dowlen Finds Fungi

Some of Dowlen's weekly reports which I have not found were accompanied by short notes addressed to Shorb (HEH. Lib.). For example, on Jan. 14, 1889, "Sir: Herewith I beg to hand the 16th weekly Report of work done The examination of the leaves and fruit . . . has produced but small results, not at all in proportion to the time and trouble expended. It will be necessary to repeat this series of experiments"

Submitting his 17th report on Jan. 21, 1889, Dowlen (HEH. Lib.) said, "The presence of fungoid threads in the woody tissues of diseased branches is of interest, as . . . it does not at present seem that the fungus is present as the result of the decay of the tissue." Submitting his 18th report on Jan. 28, 1889, he said, "The working out of the course taken by the fungus found in the wood of infected canes is not

yet completed. The examination of specimens from Santa Clara County shows that section must now be added to the infected area." With his 19th report, of Feb. 4, 1889, he says, "The tracing of the course taken by the fungus threads . . . is proving to be somewhat difficult and the results of the week's work are not in proportion to the time expended." This 19th report was published and is referred to later. I have not found the 15th to 18th reports.

In an editorial on That Unknown Vine Disease (CFG, v. 3, No. 2, p. 4, Jan. 12, 1889), Rowley commented on Dowlen, "The expert at present investigating the matter in the San Gabriel valley . . . has made some lengthy reports, but as yet few if any conclusions have been arrived at, that throw any new light upon the subject"

Shorb's Optimistic Letter to Wetmore

Shorb wrote to Secretary C. J. Wetmore (HEH. Lib.) on Jan. 30, 1889, as follows: "Enclosed I send you Prof. Dowlen's Eighteenth weekly report. Although with his extreme caution Prof. D. is careful, very careful, in his deductions from what he sees, examines and records, still with all this caution, I am sure in his own mind there is no longer any doubt but that the fungus growth observed and reported in this and last week's report is the cause of all this trouble. . . . I believe a continuation of the examination in the directions he is now pursuing will enable him to trace this fungus to the bark and through it. . . . Then all remains to do to prove absolutely that we have aimed at the correct solution is to transplant on the growing vines in the conservatory the same forms of fungi we observe in such quantities on the bark and watch their deadly work of destruction if it does occur and the work is over. Then comes

the cure or preventive and this I believe can be quickly arrived at in time to save all threatened vines and possibly when not too far gone those already affected. I am so confident that a remedy already exists that I have ordered a number of bbls of the powder . . . and will commence to apply it now while all the buds are dormant. Until this or other remedies are tested in the Conservatory I have nothing . . . in the way of advice to give, nor will I give any information to the newspapermen that worry the life out of me for items."

Merrill's Interpretation

An explanation of the disease by Dr. S. A. Merrill was quoted from the Rural Californian by the S.F. Merchant (v. 21, p. 150, Feb. 1, 1889) as follows: "It appears from recent microscopic investigations, as reported in the public prints, that the 'vine disease' . . . is caused by a minute parasitic plant, or fungus, - probably a Cryptogam of the sub-order, Protophyte, . . . propagated by exceedingly minute sporules. . . . The disease, whatever it may be, seems to have the property of extending itself from the domestic to the wild varieties of the vine . . . will spread by germ multiplication from unhealthy to healthy vines. . . . too much sap is forced into the leaves to form healthy lung cells, . . . they become a fruitful soil for the spontaneous generation and growth of parasitic plants"

Apparently Merrill had also tried to compare the disease with Phylloxera, and Rowley criticized Dr. Merrill's New Idea (CFG, v. 3, No. 5, p. 7, Feb. 2, 1889) as misleading and inaccurate, saying, "The experts . . . are about to pronounce it a . . . fungus disease."

Considerable publicity was given to a Bordeaux spray advocated by a Pomona grape grower. In the Los Angeles Herald of Jan. 17, 1889, appeared a note as follows: "Mr. N. J. Griffith has . . . what is thought to be a remedy . . . an old French vineyardist . . . Grat Mirande, residing . . . north of Pomona . . . discovered a . . . remedy for the disease . . . (lately called Mahlner's) . . ." This was a 3-6-60 Bordeaux, applied " . . . with whisk broom or brush" According to the S.F. Merchant (v. 21, p. 168, Feb. 15, 1889), "The Pomona Progress published a review of the experiments and labors that Grat Mirande, a widely known grape-grower in this locality, has been doing during the past two years in finding a cure for the strange disease . . . all agree that Mirande has certainly found a cure . . . The remedy . . . a preparation of two pounds of bluestone, three pounds of slaked lime and fifty gallons of water. . . . He makes no secret of his cure and scores of vineyardists come to his place daily to see what he has done."

However, Pierce examined Mirande's vineyard (Bul. 2, p. 201) on September 24, 1889, after it had been sprayed ". . . for more than one year . . ." and ". . . found many of the vines had already died, and much of the vineyard was badly diseased."

The S.F. Merchant (v. 21, p. 168, Feb. 15, 1889) commented, "A vigneron in Pomona, who was born and raised in France, claims to have recognized . . . the mysterious vine disease . . . as the Mahlnew which once divested the vines in Italy." He then described Mirande's Bordeaux spray. This news in essentially the same form was repeated in subsequent issues (SFM, v. 21, p. 181, Mar. 1, 1889; v. 22, p. 8 and 9, Mar.

15, 1889). The terms, Mahlner and Mahlnew, must have meant ~~mal~~ nero, and indicate editorial carelessness.

The editor was somewhat skeptical in his Feb. 15 comment (SFM, v. 21, p. 168, 1889) saying, "If this new remedy is effective for the new plague, it will be fortunate, but in view of the scientific tests already made by Professor Dowlen, it is doubtful whether the secret has yet been discovered. Many causes have been ascribed as the source of the plague from presence of pepper trees to excessive irrigation. The most correct . . . seems to be that which suggests the presence of fungoids in the cellular tissue of the wood. Experiments are now being made with some vines in hot-houses at Los Angeles which will doubtless throw more light on this important subject."

However, a month later (SFM, v. 22, p. 9, Mar. 15, 1889), "The Los Angeles Tribune of a recent date says: Vineyardists have been at a loss to account for the new vine disease . . . The microscope failed to discover its origin . . . A vigneron in Pomona . . . remembered . . . having seen it in Europe, and also remembered the remedy . . ." The editor's comment (p. 8) was, "A remedy is reported for the mysterious disease . . . by a Monsieur Mirande . . . His relatives have been engaged in the same business in France for 130 years, and he learned from them particulars of a similar disease that had there ravaged thousands of acres of vines. . . . M. Mirande has been quietly experimenting on his diseased vines, and reports that by a system of spraying . . . he has cured thousands of vines, and some that were dying a year ago are now more healthy than at any time within five years. He has been visited by vineyardists from all parts of the State, who were anxious to see and learn for themselves,"

An article by editor B. N. Rowley on That Mysterious Vine Disease (CFG, v. 3, No. 4, p. 5, Feb. 2, 1889) referred to the Griffith-Mirande spray and stated that " . . . the Los Angeles and Southern California papers are publishing what they consider a remedy . . .", the copper-lime spray. "Mr. Griffith says that his foreman has a tank . . . on wheels, which he draws between the rows Men on either side of the tank dip a small broom in the liquid, thoroughly sprinkling each vine as they walk along." Rowley, editor of the California Fruit Grower, consistently used the name, mysterious vine disease.

Under the heading, Prescription for the Mysterious Vine Disease (PRP, v. 37, p. 171, Feb. 23, 1889), Seward Cole of Los Angeles county " . . . wrote to the Los Angeles Times as follows: . . . it is advisable to treat all vines with some wash that will destroy and protect from the fungoid germs." He was using a dormant spray of bluestone, copperas and lime.

Dowlen's 19th Report

"Expert work has been going on . . . in Los Angeles county, . . . " said Rowley, of the California Fruit Grower (CFG, v. 3, No. 7, p. 6-7, Feb. 16, 1889), " . . . from the general tone of Report No. 19, which we publish below, we are led to believe that Professor E. Dowlen, the present expert, is about to pronounce this mysterious vine disease a fungi. . . . should he be successful" in discovering the cause, he would " . . . be entitled, with the officers of the Board, . . . to the thanks and congratulations of every vineyardist in the State."

Then followed Report of Expert Dowlen, No. 19, of Feb. 4, 1889, in which he said, "The fungus itself has been found in all parts of the

cane" Specimens that had been placed in water and held for a month showed the presence of bacteria and fungi, he said.

Specimens from Santa Clara and Fresno counties (CFC, v. 3, No. 8, p. 5, Feb. 23, 1889) had been sent to Dowlen who stated that it was his opinion " . . . that the same disease is at work" Rowley, the editor, thought it was no doubt a fungus disease, and advised that, "Mr. Arpad Haraszthy's mixture . . . should be tried without wasting further time." This was a Bordeaux spray.

From its new headquarters in Platt's Hall came the news (SFM, v. 22, No. 2, p. 18, Mar. 29, 1889) that, "The Commission is now engaged in making experiments to discover a cure for the disease . . . and their efforts will probably result in the saving of many thousand acres of vines from destruction."

Dowlen's 20th Report in L. A. Herald. Advocates Fungicide

Dowlen's 20th report of Feb. 11, 1889, and its rather long letter of transmittal (HEH. Lib.) were published in full in the Los Angeles Herald of Feb. 18, 1889, under the heading, The Vine Pest. An Exhaustive Report Showing the Progress of the Investigation. Matter of Special Importance to Vignerons and Vineyardists. Shorb wrote the preface: "Appreciating fully the deep anxiety of the public in our examinations . . . and in view of the fact that the vine-planting season is on us, I herewith submit the reports of the Viticultural Commissioners' expert, Mr. Dowlen, . . . I would be obliged to the press generally if they would copy such portions of this communicated matter as their columns will permit and which the public interest would seem to justify."

Dowlen's letter of transmittal (HEH. Lib.) said, " . . . investigations are being made, not only to find out the cause of the disease, but also to ascertain the best remedy possible; to this end a series of substances, both in solution and in powder, are being tried I have thought it advisable . . . to enclose a supplementary report containing extracts from the 'Report of the Commissioner of Agriculture for 1887, pp. 328-331, Section of Vegetable Pathology' as to the use of Sulphate of Copper mixtures in combatting fungus diseases. . . . it seems probable, though the chain of evidence is not completed, that the fungus mentioned in my later reports as occurring in the bark and wood of diseased canes, is at the bottom of the present trouble. . . . full trial of the copper mixtures, as well as of various other substances will be made"

Then followed the text of his 20th report, in which he told how among apparently healthy Mission cuttings some 16% were rotted and " . . . microscopic examination showed . . . the colorless threads of fungus. . . . This decaying . . . showing that the disease is capable of spreading at almost any time of the year. . . . canes from wild vines . . . are similar . . . showing similar fungus growth The vines from which these specimens were taken are undoubtedly attacked by the same disease" Dowlen justified his inclusion of the extracts from the Section of Vegetable Pathology report on sprays, saying, " . . . in all probability the present trouble . . . is the work of a fungus, which at this time of the year is to be found in the bark of the spurs of the vines, and possibly also in the leaves, and fragments of canes lying about on the ground. . . preventive measures are the most suitable." His belief that because they rotted, the Mission cuttings had the disease, is questionable.

Commissioners' Financial Difficulties

"Please see that copies of the Herald of 18th are forwarded to speakers of both branches of Legislature, the proper Committees, and the Governor" said J. H. Wheeler in a letter to Shorb of Feb. 25, 1889 (HEH. Lib.). Wheeler was Chief Executive Viticultural Commissioner and at this period the Commission was having difficulty obtaining funds. Wheeler added, "Will you . . . kindly address an invitation - one to the Senate Committee and one to the Assembly Committee - asking them to visit and inspect the work of Prof. Dowlen? Such a courtesy will help us some at the present moment. Prof. Dowlen's last Report - comprising remedies advised - as published in your local press - has been received. The Legislature has already passed resolutions calling for aid from Dep. of Agr. at Wash. in working up the disease."

In a letter of Feb. 12, 1889 (HEH. Lib.) Charles A. Wetmore, Commissioner for San Francisco and President of the Board, told Shorb of Governor Waterman's opposition in the matter of getting expenditures allowed, saying, " . . . perhaps if you could write a letter to the Governor informing him of your progress and methods and hopes it would help"

Dowlen's Fungi; 21st Report in L.A. Herald and Orange Tribune

On Feb. 18, 1889, Dowlen (HEH. Lib.) handed Shorb his 21st weekly report, saying that specimens from Napa showed "that that district must be added to the infected areas. The presence of capsules of ripe spores in the cuticle of vine branches shows the necessity for using preventive measures before the vines start into leaf." He appeared to be accepting his fungi as diagnostic evidence of the disease.

Shorb forwarded this report to Secretary C. J. Wetmore on Feb. 21, 1889 (HEH. Lib.), saying, "I consider the present report of greater value than any previous one and in my judgment calls for a bulletin from Mr. Wheeler presenting the facts obtained to the vignerons of the State as the information therein contained is of vital importance. A portion of this report . . . I have given to the Herald for publication. . . . I believe now we thoroughly understand the nature of the malady, and will be able to name the remedies for the disease in about ten days more. . . . I suggested in view of the ripe . . . capsules carrying the spores of the fungi that something more than lime and sulphate of copper was necessary to kill the spores . . . floating in the atmosphere . . . our experiments are being made in this direction."

The Los Angeles Herald (p. 2, Feb. 22, 1889) published Dowlen's 21st report, as follows: "An extended search, through a quantity of vine cuttings has shown that . . . " some are diseased. These were presumably healthy canes planted in his hot house and some had died. He found the fungus in these bearing " . . . a large number of capsules filled with ripe spores. The destruction of these is of decided importance. Placing in the rubbish is bad practice . . . spores remain alive . . . to be blown upon the young shoots . . . where . . . they would at once germinate and continue the work of destruction. (Signed) Ethelbert Dowlen." This 21st report and a comment by Shorb were also published in the Orange Tribune, March 9, 1889.

It is obvious that Dowlen, as well as Shorb, believed at this time that the fungus, apparently a pycnidial form, that he found in the dead bark of the canes was the cause of the vine disease, and also was diagnostic evidence of the presence of the disease.

Shorb's Letter to Lieut. Gov. White

Shorb wrote to Lieutenant Governor White (HEH. Lib.) on Feb. 22, 1889, dramatically explaining that, "The cause of the vine disease is a deadly form of fungus which attacks the leaves and after deadening their functions which are precisely to the economy of a plant what the heart, lungs and stomach are to man, then penetrates into the body of the vine through the cuticle, medullary rays, the woody bundles to the very pith or heart, fructifying there and filling up the ducts so as to prevent any circulation of sap - the vine is choked to the death. . . . I feel quite sure we will be able to save all vines not affected and may save many not too far gone. I believe our work here in this direction has been more thorough than any other similar work I know of either by the French, Italian, or American botanical pathologists or microscopists. I do not claim of course for myself this credit, it is more particularly due Prof. Dowlen. . . . This is the 22nd week of unremitting examination into this curse and an average of sixteen hours out of the 24. Do not let this get into print. . . . I am informed that Gov. Watterman has threatened to veto any appropriation bill for the Viticultural Commission."

Submitting his 22nd weekly report (HEH. Lib.) on Feb. 25, 1889, Dowlen told Shorb, "The finding of both colored and colorless fungus growth together in the woody tissues promises to be one more step towards the unearthing of the vine disease."

Writing to Commissioner Wheeler on Feb. 28, 1889 (HEH. Lib.), Shorb said, "I enclose Prof. Dowlen's last report which is full of interest - there is no longer any doubt in my mind or in Prof. Dowlen's we have proven the cause of all our trouble - he still wants to verify his work"

Submitting his 25th report on Mar. 18, 1889 (HEH. Lib.), Dowlen blamed "The cold, damp weather of the past week . . . " for " . . . stopping the germination of a series of sowings of spores, necessitating a repetition of almost all the week's work."

In his letter of Mar. 25, 1889, about his 26th report (HEH. Lib.), Dowlen said, "Certain vines . . . have shown decided signs of disease, these will be examined . . . " His 27th report, April 1, 1889 (HEH. Lib.) told of his tabulating the answers to the "question circulars which were sent out during November and December" One hundred and one replies had been received, representing 21% of the circulars sent out.

Copper Sprays and Dusts Publicized

An article on The Vine Pest Remedy (SFM, v. 22, No. 2, p. 18, Mar. 29, 1889) announced, "The Los Angeles County vine disease is now in a fair way to be met and conquered. . . . The remedy . . . was stumbled upon accidentally by a Pomona man . . . a Mr. Griffith applied the ordinary blue stone and lime powder as a preventive of peronospora, and . . . the application apparently stopped the progress of the other and more dreaded disease, . . . The result is that this remedy is being extensively resorted to, some vineyardists using merely the lime and bluestone powder, and others preferring 'Ongerth's' powder which in addition contains a powerful disinfectant. . . . there is consequently much rejoicing"

"The nature of the disease . . . is well known. That it is a fungoid is amply proved by the experiments conducted under glass by Mr. J. De Barth Shorb and Ethelbert Dowlen, . . . These gentlemen have been able to propagate the fungoids at will, and thus the best means

to combat the disease itself are apparent. This is of itself a great gain, as while the nature of the disease was a mystery, the vineyardists fought it entirely in the dark."

"The southern vineyardists thus far have applied . . . " the remedy as a powder. " . . . the only proper way to apply it is in the form of a wash, . . . " commented the writer, who urged the use of a knapsack sprayer. The writer, however, seemed somewhat skeptical of success, saying, "It would not be well, however, for the Los Angeles people to put too much confidence in their remedy. Bluestone and lime . . . are to diseased vines of any sort much as brandy or generous old wine is to a sick man. . . . it is best not to be too sanguine about it."

Under the title, Treatment of the Mysterious Vine Disease, the Pacific Rural Press of Mar. 16, 1889 (v. 37, p. 252) related that at San Gabriel, " . . . experiments being made by Prof. Dowlen, under the supervision of J. De Barth Shorb, have led to a tentative conclusion very flattering to the efficacy of the powder, . . . 15,000 pounds of the powder have just been shipped to San Gabriel"

The Fresno Expositor (SFM, v. 22, No. 2, p. 21, Mar. 29, 1889) was quoted to the effect that, "The mysterious vine disease . . . has never given any trouble here, but there are persons who think they have seen scattering instances of the same thing in vineyards here. We wish that anyone in the vicinity who notices anything of the sort this year to notify this office at once for we would like to examine it promptly."

"From the testimony of those who have seen it there is little doubt but that it is a fungus trouble of some sort, . . . The trouble seems to be under ground . . . " It was suggested that the copper

lime remedy for Peronospora " . . . be sprinkled over the ground before plowing or cultivating . . . to destroy it about the roots where it seems to do its work."

B. N. Rowley in an editorial on That Mysterious Vine Disease, as he always called it, (CFG, v. 3, No. 16, p. 9, Apr. 20, 1889) said, "Investigations have progressed far enough to enable . . . the expert . . . to pronounce the vine trouble . . . a fungus disease." He recommended Arpad Haraszthy's 16-30-130 Bordeaux spray, to be applied with a spray pump and a cyclone nozzle.

However, the use of a copper spray for this disease must have received attention several years earlier, because the Anaheim Gazette of May 12, 1887 (p. 1) quoted the Santa Ana Standard that "one of the first class vineyardists . . . " when asked about the diseased vines, replied, "I don't dope them with blue vitriol or other deadly preparation to keep off a disease which I can't discover, or couldn't understand if I did."

Shorb's Vision, Optimism and Caution

Shorb's high regard for Dowlen is evidenced in his letter of March 27, 1889, to C. J. Wetmore (HEH. Lib.). He extolled Commissioner J. H. Wheeler, who was retiring, and added, "In appointing Mr. Wheeler's successor, would it not be wise to choose someone whose intimate knowledge of botany and use of the microscope would enable him to determine the causes of any new diseases . . . and . . . also study the remedies that may be called for by the discovery of any new danger. This work necessarily means the employment of an expert by the Board making it

a part of his duties to visit regularly the different sections of the State. . . . I would name Prof. Dowlen as the fittest man for this position."

The editor of the San Francisco Merchant (v. 22, No. 2, p. 20, Mar. 29, 1889) commented that "J. De Barth Shorb has been up from San Gabriel for a few days. It is impossible to get him to think or talk of anything but the Los Angeles county fungoid disease, the steps taken for its extermination, and the prospects of agriculturalists in the South. Mr. Shorb is sanguine that the ravages of the disease can now be stayed and consequently the land boom may revive somewhat."

In the news column two weeks later (SFM, v. 22, No. 3, p. 41, Apr. 12, 1889), Shorb stated that experiments made with bluestone and lime in the infested Los Angeles vineyards had been very satisfactory. . . . the remedy is effective and will cure the disease. . . . It is imprudent to use cuttings from the vines of any infested section,"

The editor commented (SFM, v. 22, No. 3, p. 33, Apr. 12, 1889), " . . . the Merchant has to congratulate the growers . . . that the vines in the northern and central districts, that were thought last year to be affected with the dreaded Los Angeles disease, are recovering . . ." The Viticultural Commission said the trouble was caused by hot weather.

Shorb's optimism and caution are expressed in his reply (HEH. Lib.) of April 13, 1889, to an inquiry from W. G. McPherson. " . . . I will say I hope we have discovered the remedy for the vine disease . . . My belief is . . . strong enough to have induced me to order 7000 lbs. . . . of the powder . . . where the powder was used . . . in the experimental hot house . . . the spores of the fungus which had been sown on

the leaves of the growing vines were so far destroyed as to prevent their further development." However, he was not sure the powder would be effective in the vineyard, saying, " . . . and until it was so proven I did not wish to publish it and possibly cause expense to those using it." W. G. McPherson of the town of McPherson was one of the numerous growers later consulted by Pierce (Bul. 2, p. 81).

Discussion and Wheeler's Speech at the 11th

Fruit Growers' Convention

At the 11th state fruit growers' convention held April 16-19, 1889, at National City, Mrs. Jeanne Carr (Off. Rep. 1889, p. 83-84) said, "I want to bring up the question of what is threatening our vineyards. Vineyards . . . are being taken out of the ground and being piled up as cordwood. The extent of this disease can hardly be imagined by those who have not seen it." Dr. J. H. Kellom of Tustin (p. 84) remarked, "Few have any idea of the calamity which is brought upon Los Angeles County. . . . a gentleman who lives across the way from me, who has a vineyard of three hundred acres, . . . should have received this fall from \$30,000 to \$40,000, but he did not get \$500. That is an indication of the calamity which is upon us."

At the same 11th state fruit growers' Convention (Off. Rep. 1889, p. 89-95), Viticultural Commissioner J. H. Wheeler, who had come down from San Francisco to Los Angeles to study the vine disease, said, "The attention of a great many prominent scientific men has been called to this subject and some elaborate investigation has been made without satisfactory results. . . . The Department of Agriculture,

in Washington, has had their agent, Professor Viala, . . . I examined the vines and reported to him and he was unable to identify the trouble or to find any appearance of fungus. . . . I wrote to Mr. Scribner . . . who took a number of the diseased vines to Washington . . . and he wrote back that he could find nothing satisfactory. . . . The Board of Viticulture appointed Mr. J. De Barth Shorb, of San Gabriel . . . to examine this trouble, and he appointed Professor . . . Dowlen, a distinguished microscopist, to . . . find whether it was truly a fungoid disease, and he has been pursuing his studies at San Gabriel for several months I have been also called upon to determine its presence in the north . . . vines . . . have . . . been sent to Mr. Dowlen and he has identified them as the same . . . as in the south. . . . " He then described the disease and discussed theories as to its cause.

Professor Dowlen, said Wheeler, " . . . has discovered on all of these vines a certain fungus . . . that seems peculiar to this disease. He is quite well satisfied that it has produced a disease, but we are not yet entirely satisfied . . . the fact that it is there, may be simply as a consequence or as a result, and not the cause of the trouble." The Board, said Wheeler, did not want " . . . to go into print until we can get a little more satisfactory work done; . . . " He recommended spraying with Bordeaux with a knapsack sprayer. Replying to questions of N. W. Motheral of Hanford, Wheeler said (p. 93) northern specimens had come from Sonoma, Santa Clara and Napa Counties, and that "vines are grafted with a clean stock and then succumb." Referring to Dowlen, Motheral asked, "In what periodicals of the State does the professor publish his researches?" and Wheeler replied, "The

San Francisco Merchant. The reports have been given to the other papers but they are so extensive and of such a technical nature that they are of little interest to the public generally." Mrs. Jeanne Carr of Pasadena asked, " . . . if Professor Dowlen found the disease in the wild vines in the immediate vicinity of Mr. Shorb's vineyard?" and was informed that " . . . he has found the disease on the Vitis Californica, . . . on old vines"

Wheeler's Report to the Commissioners

As chief executive officer, Wheeler made a similar report to the Viticultural Commissioners in San Francisco, dated April 30, 1889 (BSVC Rep. 1889-90, p. 28-30, 1890; MV, v. 22, p. 113-114, June 21, 1889) as follows: " . . . I have made inquiry and investigations to determine the existence and extent of the vine disease, . . . in the northern vineyards of the State. . . . Samples were sent from Sonoma, Napa, and Santa Clara counties, which I forwarded to Prof. Dowlen, the duly appointed specialist of the board. He found on all the specimens a fungus identical with that existing on the diseased vines of the south. My interpretation of Mr. Dowlen's reports, as a whole, leads me to understand that this fungus . . . is the agent which performs the finishing work of destruction, though, perhaps rendered more potent by antecedent causes not yet known or described. This theory is amply proven: First. In that the application of a fungicide arrests the decline of the affected vines Second . . . I have recently visited the vineyard districts of the southern counties and examined the work of Prof. Dowlen . . . This gentleman I must, in passing, commend to the Board as an earnest, conscientious student,

whose efforts are characterized, thus far, by a manifest determination to be accurate, and to sacrifice all hypotheses and theories to an absolute determination of facts by systematic analysis."

"With Professor Dowlen I visited many vineyards in Los Angeles County, and inspected other districts alone." He found none of the disease at San Diego, San Bernardino nor Riverside, but in Los Angeles County he ". . . found no vineyards exempt from the trouble, and an examination of the wild vines near San Gabriel confirmed the report of Professor Dowlen as to their perishing in like manner . . . I found that the reports of the extensive ravages . . . in Los Angeles County had not been exaggerated. The Santa Ana Valley, which once . . . had over 5000 acres of vineyards, . . . possesses less than five hundred acres today."

"In my judgment the first cause of the evil is yet to be found . . . whatever be the original cause of the vines weakening, another century may now elapse without its recurrence; . . . which is attested by the fact that the old vineyards have not, before this, suffered from its attack. . . . I can see no cause for general alarm in the north. . . . Dowlen has already given to the public the order of resistance of many varieties . . . the proprietors may safely plant the Lenoir or Isabella in the afflicted region" Parts of Wheeler's report were also published in the Pacific Rural Press (v. 37, p. 597, June 22, 1889).

Wheeler impresses me as a man of broad biological insight, keen discernment and sound judgment, with respectable stature as a plant pathologist. He was born in Oswego, N. Y., in 1857, came to California in 1868, and graduated from the University in 1879. He lived at St. Helena (PWSR, v. 28, no. 4, p. 11, Mar. 21, 1892).

Varietal Susceptibility, From Questionnaires

Dowlen's 28th report, of April 8, 1889 (MV, v. 22, p. 52-3, Apr. 26, 1889) contained " . . . replies to question circulars . . . received from thirty-six localities, referring to forty-six varieties of vines . . . " indicating that the varieties Burger (82%), Hamburg (80%), Malvoisie (76%), Carignan (40%) and Blanc Elba (21%) had suffered most. The disease was most prevalent at Orange (95%), Anaheim (93%), Alhambra (93%), Tustin (91%), and Los Angeles (81%), less so at Burbank (57%), Florence (47%) and Azusa (46%).

Dowlen's 29th Report; Fungi; Ongerth's Powder

In his widely circulated report No. 29, of April 15, 1889, (MV, v. 22, p. 52-3, Apr. 26, 1889; CFG, v. 4, No. 1, p. 5, Apr. 27, 1889; PRP, v. 37, p. 412, Apr. 27, 1889), Dowlen said, "During the past week a close lookout has been kept amongst the vines . . . a comparatively small amount of disease has appeared . . . probably due to the fact that . . . the vines . . . were freely dressed with a . . . powder, which . . . evidently has the power of stopping the development of fungus spores. Some of the diseased leaves have been submitted to examination, and in each instance they have proved to have been well supplied with fungus spores, many of which have begun to germinate, The spores are undoubtedly the same as those found on the main stems Here it may be well to recapitulate what has been done since the beginning of the present investigation. At the commencement it was an open question, as to whether the trouble was due to (a) abnormal climatic conditions, (b) to some actual disease of the tissues of the

vine, or (c) to some parasite either animal or vegetable. . . . it is evident now that the climatic conditions are not the cause, neither is there any evidence to support the theory of disease, whilst with respect to the parasite theory, there has not been found any trace whatever of animal parasites. There is thus only the vegetable parasite left, and there is but little room to doubt but that a vegetable parasite, in the shape of a microscopic fungus, is at the bottom of the present trouble. All through this investigation one particular fungus has been met with, especially on diseased vines; the more the vine is diseased, the greater is the amount of fungus present, whilst on sound and healthy vines there is very little or none." But Dowlen's hot house inoculations with spores had not been successful.

"The fungus growth," continued Dowlen, "was first noticed on the upper side or sides of the canes of diseased vines, in the shape of brown patches immediately under the cuticle, these have been watched . . . and some of the forms of fructification have been found, some of the forms are now to be found on the newly diseased leaves. . . . dead canes were found to have their tissues more or less invaded by fungus growth which had evidently grown from the outside, Spores taken from diseased canes have been found to germinate readily when kept moistened with plain water, but in contact with the powder mentioned above they will not germinate. . . . The . . . powder is composed of sulphur, lime, sulphate of copper and base of Ongerth's fungicide . . . can be applied best by bellows Those vineyardists who have already used either of the mixtures mentioned in a former report, No. 20, . . . would find it advantageous to apply another dressing now, so as to destroy the new supply of spores which has been developed during the last few weeks."

In two of the journals above cited, (PRP and MV), there was a preface to Dowlen's 29th report referring to Shorb's letter (HEH. Lib.) of April 16, 1889, to the Los Angeles Board of Supervisors as follows: "Hon. J. De Barth Shorb . . . especially intrusted with the investigation of the mysterious vine disease by both the State Commission and the Los Angeles County Supervisors, has made the following report: I have the honor of submitting herewith a report of Mr. Ethelbert Dowlen on the result of our investigations into the grapevine disease, and of the remedies to check it . . . our work and conclusions . . . leave no doubt, in my mind, that we have solved the cause of the trouble, and also discovered at least one remedy that will remove it." This was Ongerth's powder applied with " . . . the ordinary sulphur bellows familiar to all." (Also in MV, v. 22, p. 67, May 10, 1889). "Further study and experiments may enable us to find other remedies To this end, we will direct much of our future work and study, and will report from time to time any new discoveries . . . we may make." He thought the dust more penetrating than a liquid spray, recommended three applications, and warned, "This course should be pursued from year to year, until every spore of the fungus is destroyed." He ended his letter, "As your Honorable Board rendered me assistance in this investigation, I have thought it right and proper, that this report should go to you, at the same time it was forwarded to the State Board of Viticultural Commissioners."

Throughout the late spring and summer of 1889, the California Fruit Grower ran this advertisement: "For the Mysterious Vine Disease, Ongerth's Insecticide Powder No. 2. This Powder is the preparation specially recommended by Hon. J. De Barth Shorb, Viticultural Commissioner, and Ethelbert Dowlen, expert employed by the State to investigate the

Mysterious Vine Disease. All the Powder used by them in their recent experiments was the Ongerth Insecticide Powder No. 2, of which about 20,000 lbs. have been shipped to the San Gabriel Valley." The powder was manufactured in San Francisco.

Shorb sent a note on Powder for the Vines to editor Rowley (CFG, v. 4, No. 3, p. 6, May 11, 1889) saying "I am constantly in receipt of letters of inquiry regarding the powder referred to in Professor Dowlen's and my report to the Board of Supervisors of this county . . . " He told where it could be obtained, and continued, "Permit me, also, to add that I have no interest, directly or indirectly, in the manufacture or sale of the powder. Respectfully yours, J. De Barth Shorb, San Gabriel, Apr. 25, 1889."

Dowlen's 30th Report and Letter to Rowley

Dowlen's 30th weekly report of April 22, 1889 (MV, v. 22, p. 73, May 10, 1889) told that, " . . . search on the spurs of sickly vines has revealed the presence of perithecia containing asci, with ascospores. These asci and their contained ascospores agree in all respects with those developed on diseased Muscat leaves which had been floated on water, mentioned in Report No. 13, December 24, 1888, and also with those found on diseased leaves forwarded from Sonoma, Report No. 15, January 7, 1889." Dowlen was still basing his diagnosis on the presence of fungi, at least to a certain extent. Presumably he knew what powdery mildew perithecia looked like, since he referred to them in his 12th report.

There was a news item (MV, v. 22, p. 72, May 10, 1889) that " . . . samples secured from Napa and Santa Clara counties and sent to Professor

Dowlen, . . . were all found to give evidence of disease." Also (p. 68) the Livermore Herald speculated " . . . the disease . . . is confined mainly to the Mission grape . . . It has been successfully grown here for one hundred years, and is, perhaps, exhausted by age."

In a letter of April 26 to editor B. N. Rowley, (CFG, v. 4, No. 3, p. 6, May 11, 1889), Dowlen gave the extent and severity of the disease, saying, "Vines of all ages, from one hundred years to one year, are affected. The wild vines are also dying The disease sometimes makes an almost clean sweep of one variety, whilst another close by is affected in patches, or escapes altogether. The same variety may escape in one vineyard and be destroyed in another. . . . in a vineyard planted here at San Gabriel four years ago, . . . with healthy stock, a part has gone by the board, whilst other portions are in perfectly good health. Nothing has been met with to support the idea that there is any organic disease of the plant; i.e. any disease such as black knot, which is independent of the action of any parasite, either animal or vegetable."

Shorb wrote to C. J. Wetmore (HEH. Lib.) on May 4, 1889, saying he heard that the U.S. Department of Agriculture was sending an expert, " . . . to cooperate with us in any future work" He was doomed to be disappointed in expecting cooperation. Dowlen, he added, had gone to the mountains for a short vacation.

Hewes Calls on the Secretary of Agriculture

David Hewes, of Tustin, went to Washington, called on the Secretary of Agriculture and wrote this letter to him on March 18, 1889 (Orange Tribune, Apr. 20, 1889):

"Hon. J. M. Rusk, Sec. of Agriculture,"

"Sir: Several days ago I called upon you and directed your attention to a disease of the vine which, during the past four years, has destroyed hundreds of acres of vineyards in Los Angeles and adjoining Counties of California. This disease, if not speedily checked, bids fair to wipe out of existence one of the leading industries of the country. I write this therefore for the purpose of inquiring whether it will not be possible for you to send a competent man to the districts above named for the purpose of investigating the malady with the view of discovering its cause and if possible to provide a remedy. There are thousands of people in the Santa Ana and San Gabriel valleys who have their all invested in vineyards and by assisting them in this matter you will render a service not likely to be soon forgotten."

"In conclusion I would say that I have lost 600 acres of a beautiful and promising young vineyard through the action of this deadly, unknown disease and that I am now plowing out vines which, but for this scourge, would yield me from forty to fifty thousand dollars a year. Hoping to receive a favorable reply, I remain, Very respectfully yours, David Hewes,ustin City, Cal."

Secretary Rusk Writes to Hewes

Hewes received a prompt reply from the Secretary of Agriculture, (Orange Tribune, Apr. 20, 1889) as follows:

"Washington, D.C., March 21, 1889. David Hewes, Washington, D. C.

Dear Sir: In reply to your favor of March 18th, I have to say that I have directed the Chief of the Section of Vegetable Pathology in this Department to make immediate arrangements to send a competent

man to California to investigate the disease to which you refer. Owing to the very obscure nature of this malady, which so far has baffled the skill of a number of experts, it will be somewhat difficult to find a man competent to take charge of this work. I have no doubt, however, that such a person will be found and that he will be in the field prepared to begin the investigation within a few weeks. Respectfully, J. M. Rusk, Secretary."

Under the title, The Secretary of Agriculture. How He Became Interested in the California Vine Disease, The Merchant and Viticulturist (v. 22, p. 82, May 24, 1889) stated, "The credit of securing the Co-operation of the Federal Government investigating the fatal vine disease in Los Angeles county is due entirely to David Hewes, of Tustin City. While in Washington, he called on Secretary of Agriculture Rusk, told him of the devastation that had been wrought in the vineyards of Southern California during the past four years, and asked him to send a Government expert to investigate the malady . . . later he repeated the request by letter" This was followed by Secretary Rusk's letter of March 21st, to Hewes.

Galloway Writes to Benjamin Pratt

David Hewes' letter to Secretary Rusk received prompt action and within 10 days, on March 28, 1889, B. T. Galloway, Chief of the Section of Vegetable Pathology, wrote to Benjamin Pratt of Orange (Orange Tribune, Apr. 20, 1889) as follows: "Benj. Pratt, Orange, Cal., Dear sir: I have been intending to write to you for some time concerning the last package of specimens of the vine disease you sent us. We have not been able to make anything out of them."

"Realizing how useless it is to devote further time to this matter in a laboratory where it is impossible to obtain fresh material, we have made arrangements to send an expert to California to investigate the disease. He is a man in whom we have entire confidence, and one we are certain will sift the matter to the bottom. It will of course take time to do this, but we will prepare for that. Our man will be provided with the most modern apparatus and through us he will at all times be in direct communication with the most eminent European authorities on vine diseases."

"In conclusion allow me to say that in this matter we shall need the cooperation of the people and if this is granted us we know of no reason why the much talked of vine disease will not be conquered. I send herewith copies of two letters which may interest you. Respectfully, B. T. Galloway, Chief of Section."

Presumably the two letters he referred to were those from and to Hewes.

"The United States to Join in the Investigations", said the Pacific Rural Press (v. 37, p. 412, Apr. 27, 1889) and reprinted parts of Galloway's letter, stating, "A letter received by Benjamin Pratt of Orange, . . . from the Secretary of Agriculture at Washington, contains the following: . . . we have made arrangements to send an expert to California . . . " etc. Actually, of course, the letter was not from the Secretary.

Pratt Meets Pierce in Washington

The Department of Agriculture and California Problems was the title of an article in the June 15, 1889, issue of the Pacific Rural

Press (v. 37, p. 566) to this effect: "Benjamin Pratt of Orange writes the following letter from Washington to Dr. O. P. Chubb, as we learn from the Orange Tribune of June 1: . . . 'I called at the Agricultural Department to find out what was being done in relation to our grapevine disease. Mr. Galloway - the successor of Mr. Scribner as chief of the section - received me very cordially . . . the expert, a Mr. Pierce, from Michigan, whom the Department had engaged to investigate the disease, had arrived in the city the day before . . . Mr. Galloway . . . brought him in, and we had a long conversation . . . He is a young man, unassuming in his manner, and ^I/~~was~~ very favorably impressed with him. He realizes that he has a very difficult task before him When my interview ended with Mr. Pierce, Mr. Galloway said that the Assistant Secretary of Agriculture, Mr. Willets, wanted to see me, and he went with me and introduced me to Mr. Willets, who received me - as you assured me he would - with unusual cordiality. He said he felt a lively interest in the matter of the California grape disease. That he saw something of it during his visit to the Santa Ana valley and saw the discouraged feeling of the people in consequence of it. He told me that one of the first things he inquired about after assuming the duties of his office was, 'what is the Department doing about the California grape disease?' He found that arrangements had already been made to send out an expert. He assured me, and wanted me to assure the people there, that whatever can be done will be, to assist them in this emergency.' . . . Mr. Pierce started for California last Thursday, May 16, and goes direct to Los Angeles, thence to Orange, Santa Ana and Tustin. He will determine where to pursue his investigations after looking the ground over. . . . I am satisfied that you

and the public generally will do whatever can be done to assist him in his great undertaking. . . . "

"I am very truly yours, B. Pratt."

The Orange Tribune (June 1, 1889) published Pratt's letter under the heading, Mr. B. Pratt at Washington; Interviews Officials of the Agricultural Department, and said by way of introduction, "We publish below a letter just received by Dr. Chubb, which is full of interest to all our readers But the impression that it was his mission to secure the services of an expert from the Department to investigate . . . the vine disease is a mistake, Credit is due Mr. D. Hewes for securing this action, and to Mr. Pratt for the assistance and information given the Department officials"

Newton B. Pierce; Volney M. Spalding; Erwin F. Smith

Thus there was assigned to the study of the California vine trouble a man who was the first to bring to this state the best knowledge and technique of the time in the investigation of plant diseases (U.S. Sec. Agr. Rep. 1889, p. 424). Newton B. Pierce had studied entomology at Harvard University and botany with Volney Spalding and bacteriology with F. G. Novy at the University of Michigan. Writing to Erwin F. Smith, Novy said that Pierce " . . . has taken a course in bacteriology in our laboratory and is enthusiastic on applying that study in the investigation of vegetable diseases." (Rodgers, p. 177).

Spalding was in constant touch with Erwin F. Smith, his former student then with B. T. Galloway in the U.S. Department of Agriculture. Spalding wrote to Smith (Rodgers, p. 170) Nov. 27, 1888, "What you say about the . . . vine disease . . . makes me ache to have someone ready to take it up and if Galloway is not in too much of a hurry I have little

doubt that in due time he can be provided with a trained man from our laboratory" Pierce was then a student of Spalding's and, as Galloway (Phytopath. 7: 143. 1916) has said, "Largely through Dr. Spalding's influence, Mr. Pierce became intensely interested in plant pathological studies. . . . In casting about for someone to take up this work, Professor Spalding was communicated with. He recommended Mr. Pierce, and Mr. Pierce was appointed."

Pierce had no doubt heard about the vine disease and probably had seen specimens while a student at Ann Arbor because Spalding had received specimens of it from Erwin F. Smith (Rodgers, p. 171). Pierce corresponded frequently with Smith, who was working on a similar baffling virus disease, peach yellows (Rodgers, p. 232-239). This may have helped Pierce to understand the vine disease. Furthermore his association with Smith must have stimulated his interest in bacterial diseases. Pierce proceeded to California, arriving at Santa Ana on May 23, 1889. He devoted the next ten months to a survey and study of the vineyards and the vine disease.

Rodgers, when he wrote his book on Erwin Frink Smith, had access to Smith's papers which contained letters from Pierce and he presents interesting information about Pierce and the grape disease (pp. 170-171, 181-184, 205-207, 233-239).

It is worthy of note that there was one good result of the Anaheim disease. It brought to California a competent plant pathologist and a laboratory for plant disease research fourteen years before the university and agricultural experiment station were prepared to start work in this branch of science.

Pierce Writes to the Commissioners

Uncle Sam's Expert. He Begins His Study of the Mysterious Vine Disease. This was the heading of an announcement in the June 7, 1889, issue of the Merchant and Viticulturist (MV, v. 22, p. 101) which read as follows: "Newton B. Pierce, special agent of the Department of Agriculture . . . appointed by the Government to investigate the mysterious vine disease . . . is now at Santa Ana . . . He has sent to the Viticultural Commission for their annual reports and any other printed matter they may have relating to viticulture in this State. In a letter acknowledging the receipt of the reports he says:"

"For the present it shall be my purpose to work up the distribution, history and origin of the disease. Laboratory work . . . will follow later. As the papers have thought it best not to report accurately the facts . . . I am thrown almost entirely upon personal interviews for the facts"

"Mr. Pierce was notified . . . that expert Dowlen, who has been investigating the disease for several months, would be glad to afford him all the valuable information that he has gathered during that time, but in his last letter he entirely ignores the existence of Mr. Dowlen."

Rose Describes the Disease

At the June 11, 1889, meeting of the Board of State Viticultural Commissioners in Platt's Hall, San Francisco (BSVC. Rep. 1889-90, p. 92, 1890), Commissioner L. J. Rose of San Gabriel (Shorb being absent) ". . . described the manner of the spread of the disease, saying that it travelled with the wind and that its effects were very

sudden and fatal. . . . His observations convinced him that the disease does not travel in the winter, but rather when the vines are in foliage. . . . He had noticed no vines exempt when surrounded by affected vines. . . . He thought a careful examination of the fungus found on the diseased vines in Los Angeles County, and of that supposed to be the same on vines in the northern part of the State, would disclose a difference."

C. A. Wetmore Takes Harkness South

At this June 11, 1889, meeting, "Commissioner Wetmore suggested (BSVC Rep. 1889-90, p. 92, 1890) in order to better compare the disease being studied by Mr. Dowlen . . . and to identify it and to determine whether the same disease is prevalent in other parts of the State, that, in his opinion it would be important to get Dr. H. W. Harkness, who is the best authority on fungoid growths in the State, to go to Los Angeles and report on the disease. . . . Commissioner Rose and the others present fully indorsed this plan, and as Mr. Wetmore stated that he would soon go to Los Angeles County to personally inspect the infected district, it was decided that Mr. Wetmore should endeavor to get Dr. Harkness to go with him." Wetmore "was requested to visit the infected district as early as possible, which he agreed to do."

"Chief Viticultural Officer, C. A. Wetmore, went to Los Angeles yesterday," said the Merchant and Viticulturist of June 21, 1889, (MV, v. 22, p. 119), "at the request of the Viticultural Commission to investigate the vine disease. He will be gone about ten days." In the same issue (p. 121) appeared an article, Another Expert, which read as follows: "Dr. H. W. Harkness, President of the Academy of

Sciences, has gone to Los Angeles county, in the interest of the Viticultural Commission, to investigate the fungus which is one of the principal features of the mysterious disease. He is a specialist on fungoid diseases and his business will be to discover the nature of the disease and classify it." The Rural Californian (v. 12, p. 264, July, 1889), published in Los Angeles, said, " . . . and now comes Dr. H. W. Harkness, of the Academy of Science, . . . to make a study of the vine trouble."

Harkness Is Shorb's Guest at San Gabriel

With regard to the visit of Dr. Harkness, Shorb (HEH. Lib.) wrote on June 18, 1889, to Charles B. Turrill, Secretary of the Commission, that, "Dr. Harkness arrived. . . and has been my guest since his arrival here. He expresses himself as very much pleased with what he saw of the work done here and does not entertain the same views now as he evidently did before his arrival. He evidently did not believe in the fungus conclusions reached by Mr. Dowlen and myself and was at first inclined to discard all consideration as to the fungus being the cause. His visit was a very pleasant one and I am more than pleased that he was sent here. In fact the more thorough the botanist and greater familiarity with the use of the microscope he may possess is the man more than all others I am pleased to review the work done here. To intelligently understand this investigation and to read clearly what the microscope reveals one should go into it with the same spirit and intention as did we, to hold no theory and discard nothing that was seen as useless, but see all, weigh all, record all, and balance all - and this means patient and untiring study and examination for months

not days. The Dr. has expressed himself as willing and anxious to cooperate with us in all our subsequent work, and we will send him specimens from time to time. I believe all our future work will only serve to verify conclusions already reached, but this of course needs to be done and we will do it."

"As this letter is suggestive I would prefer that it should be . . . filed as a Board communication only, and not in any-wise made public I have heard nothing from Mr. Pierce although I wrote him a polite letter . . . but he remains silent. I have one request to make of the Board . . . that while I am more than anxious to have any assistance in this work, and that the reports made from time to time may be submitted to the ablest experts botanically or microscopically considered, I do not wish what we have done to be made the means of others seeing what they never found by research and investigation and successfully rob Mr. Dowlen of that he is entitled to."

Obviously Shorb had no inkling of the devastating blow to their fungus theory that Harkness was soon to deliver. Harkness must have concealed his skepticism.

Copper-Lime Dust Recommended

Dowlen's next report appeared (MV, v. 22, p. 124, June 21, 1889) under a characteristic San Francisco headline, The Los Angeles Vine Disease, and was presented in the Pacific Rural Press (v. 37, p. 618, June 29, 1889) as follows: " . . . Expert Ethelbert Dowlen, . . . who has . . . been . . . investigating and experimenting with the vine disease, . . . " wrote from San Gabriel to C. A. Wetmore, "I have this day at Mr. Shorb's suggestion, forwarded you, by express, some samples

of diseased vines . . . showing the effects produced by the powder recommended in Report No. 29 . . . it is to be noticed that the disease has made no progress since the application, . . . the vineyard . . . has been dressed three times this year, . . . now looks remarkably healthy." This was a 500-acre vineyard.

In three vineyards that had been dusted with Ongerth powder, Dowlen (MV, v. 22, p. 137, July 8, 1889) claimed that " . . . beneficial results have followed an intelligent and thorough use of the new mixture . . . " but, he added, " . . . it will be well not to build too high expectations"

Morse of Riverside Fears Spread; Rowley's Comments

Bradford Morse, inspector, announced in the Riverside Press and Horticulturist (CFG, v. 4, No. 8, p. 7, June 15, 1889) that, "Persons having vines that show signs of disease should lose no time in applying the powder that the experts . . . have recommended The disease is called by the experts a vegetable parasite in the form of a microscopic fungus which penetrates the tissues of the vine causing feebleness and death."

Editor Rowley commented, "It is to be regretted that the spread of this disease cannot be checked. So far it has worked sad havoc in the Santa Ana Valley, Los Angeles county, some five or six thousand acres of vines have been almost totally destroyed. For three years have the vineyardists of that section been fighting the spread of this disease. . . . it remains as much of a mystery as at the beginning except that Prof. Dowlen has discovered that it is accompanied with fungus, which, if not the real cause and foundation of the disease,

completed the work of destruction by some unknown agent."

Referring, no doubt, to Morse's warning, the Merchant and Viticulturist (MV, v. 22, p. 147, July 22, 1889) later noted that, "The Riverside Press and Horticulturist has sounded the alarm warning all the grape growers thereabouts to unite in preventing the spread of Mal Nero. . . . Our people are advised to apply a preventive"

L.A. Herald Tries to Allay Fear

The Merchant and Viticulturist (v. 22, p. 121, June 21, 1889) quoted from the Los Angeles Herald an optimistic account as follows: "The writer has . . . gone generally over this section . . . vineyards are generally looking as well as ever . . . even in the very midst of the worst affected, at Anaheim and Santa Ana, there are . . . small patches of vines that have shown no signs of succumbing to the Mal Nero . . . It is not pleasant to see sectional jealousy such as always exists up country against Los Angeles taking up this cry of 'wolf!' to attempt to frighten immigration away from this part of the State"

"We hope the Herald is correct . . . " commented the editor, going on to point out why the Merchant had been publishing so much about the disease.

Wetmore's Constitutional Derangement Theory

C. A. Wetmore, president of the Board of Viticultural Commissioners, writing to Shorb on July 6, 1889 (HEH. Lib.), said, "My own impression is not changed - I incline to the belief that there has been a consti-

tutional derangement of the vine with secondary diseases - and that the means of applying remedies must be through the root system - but I am in no hurry to talk - and would rather have such a statement come from you - if it pleases you after further developments." Wetmore deserves credit for being skeptical of the fungus theory. He continued to believe the disease was non-parasitic in origin (PWSR, v. 24, No. 12, p. 2, Aug.30, 1890).

Charles A. Wetmore

Charles A. Wetmore, of the Cresta Blanca vineyards at Livermore, was a graduate of the College of California in 1868, the year it became the university. He was born in Portland, Me., Jan. 20, 1847, and came to California in 1856 (PWSR, v. 27, no. 1, p. 9-10, Aug. 5, 1891).

"During the summer of 1867 . . .he canvassed the northern and central mining counties advocating the creation of the University of California." He was on the staff of the newspaper, Alta California. He was a well read man with considerable competence as a scientist. He studied grape diseases, as evidenced by his article on crown gall (PRP, v. 23, p. 83, 1882) and his knowledge of the French literature on sunstroke. It was probably his skepticism about Dowlen's fungi that prompted him to call in Harkness and restrained the Commission from vigorously recommending the fungicide for the Anaheim disease. Representing the vineyard interests he travelled widely. The Anaheim Gazette (Jan. 29, 1887) said he represented ". . .the brains and decency of the wine industry." With Matthew Cooke, he set up the state plant quarantine system (Essig, p. 470). "His very nature," said L. J. Rose, (RC, v. 7, p. 186, 1884) "impels him to be always busy in reading and observation. He seems to acquire knowledge intuitively . . .".

Harkness Refutes the Fungus Theory

C. A. Wetmore's letter of July 6, 1889, to Shorb (HEH. Lib.) continued, "Dr. Harkness showed me today the draft of his report--he is anxious for a scientific fray . . . fine . . . so much the better as he gives Pierce a scolding. He does not believe in fungus as a cause. It is a pretty scientific fight now--leaving us as ultimate judges. . . . Harkness is anxious to get in his work--and was going to be interviewed when I told him not to do so--but to send in even a report of progress when we would give it out. Then we can take time to pronounce judgments over all." This is the first intimation that Harkness disagreed with Shorb and Dowlen.

Expert Dowlen's Fungus. Dr. H. W. Harkness Says That There Is No Fungus Down South. Under this headline the editor of the Merchant and Viticulturist (MV, v. 22, p. 147, July 22, 1889) quoted from a letter from Harkness to "Chas. A. Wetmore, Esq., President, Viticultural Commission" dated July 17, 1889. The Pacific Rural Press reproduced the same letter under the title, Mysterious Vine Disease Not Fungoid. Harkness' letter (PRP, v. 38, p. 77, July 27, 1889) read as follows:

"In compliance with the request of the Commission, I have visited the southern portion of the State with the view of determining the character of the fungus discovered by your expert, Mr. Ethelbert Dowlen, to the presence of which he attributes the wholesale destruction of the vines in that region. A careful inspection of Mr. Dowlen's work was made, the infected fields visited, and examples of the diseased vines brought home for a more critical examination . . . as a result . . . I am convinced that no fungus exists, either in the root, stem, or leaves, to which the death of the vines can be attributed. All

vascular plants of whatever order, even the healthiest individuals, harbor fungi nine-tenths of the species of which do no harm, or so little as to be inappreciable to their hosts. Baron von Thümen has enumerated nearly a hundred belonging to the vine, only five or six of which are in any degree hurtful the great majority being saprophytic--that is, growing on the dead or dying host and not upon the living, healthy one. All the fungi mentioned and figured by Mr. Dowlen belong to this group and are common not only to the vines of California, but to those of Europe as well. It is perfectly safe to assert that no fungus known to science is capable of doing much injury unless it exists in such quantity as to make it perfectly visible to the unaided eye. Certain obscure diseases of plants--peach yellows for example--have been for many years the subject of investigation and experiment, yet seem no nearer a solution than at the commencement; possibly the chemical condition of the soil and disturbed nutrition may have something to do with such disorders."

Along with Harkness's letter (MV, v. 22, p. 151, July 22, 1889) appeared a note to the effect that, "A well known Los Angeles wine dealer has a good word to speak for the opinions of Dr. H. W. Harkness regarding the vine disease in the south. The gentleman does not think that the death of the vines is at all ascribable to the fungus, and he voices the view . . . that the malady is due to something in the soil. . . . The prospects for a wordy war between Dowlen on one side and Dr. Harkness and the dealer on the other are certainly promising."

Harkness Finds None of the Disease At Fresno

Fresno growers must have read with great relief (MV, v. 22, p. 135, July 8, 1889) that, "Dr. H. W. Harkness, president of the Academy of Science, after examining the vineyards of Fresno county for evidences of the mysterious vine disease said, 'The vine disease which has devastated Southern California is easily identified and I can say positively that there is not the slightest trace of the disease in the vineyards of this locality . . . your vineyards are simply magnificent'"

The July, 1889, Rural Californian (v. 12, p. 264), George Rice, editor, ventured that, "It looks encouraging to the vine growers to see the terrible unknown disease . . . at last 'letting up', and also the work that is being done by the scientific world to determine the cause of the disease, and prescribe a remedy." Reference was made to Dowlen, Harkness, and "Prof. Newton B. Pierce. . . . now at work at Santa Ana." Then on p. 269, under the heading, Latest on the Vine Disease, the report of J. H. Wheeler, Viticultural Commissioner, was referred to, indicating that a fungus was involved and suggesting the use of a fungicide. " . . . The best remedy so far is the Ongerth." The editor added, "We expect much from Mr. Pierce and his experiments."

Shorb's Letter Criticizing Pierce

On July 16, 1889, Shorb (HEH. Lib.) wrote to the Honorable Edwin Willits, Asst. Secretary of Agriculture, Washington, D.C., as follows: "Your esteemed favor of the 10th inst. has been received and in reply thereto will state that I will furnish your office with all the information at my command in relation to the vine disease and remedies."

"I have not had the pleasure of meeting Mr. Pierce . . . nor of hearing from him in answer to a letter which I addressed to him shortly after his arrival in this section. Having had some correspondence with the late Commissioner of Agriculture in relation to sending an expert here and also to use whatever influence I might have with the Representatives in Congress to aid in passing the appropriation, I thought it curious that Mr. Pierce did not at least give me an opportunity of meeting him."

"Whether our work here in this investigation was of real merit or not, still our blunders, if any there were, might guide other men to quicker conclusions."

"The expert employed by this Commission under my charge, Mr. Ethelbert Dowlen, is a graduate of South Kensington, England, where he took a scholarship under Prof. Huxley and taught there for years, would gladly have given Mr. Pierce the results of his investigations, in reaching a conclusion of this matter."

"We feel more anxious for results of practical value to our vineyardists than for any professional reputation or credit which might attach to this work or its results."

Dowlen Hints Disease Spread To San Diego by Lug Boxes

Dowlen's report No. 33 of August 1, 1889 (MV, v. 22, p. 185, Aug. 22, 1889) appeared under the heading, It Is Spreading! The Dread Vine Disease Found in San Diego. He had visited the vineyards in the El Cajon and Sweetwater valleys of San Diego county, finding two infected vineyards in the El Cajon valley. He suggested that the disease was brought in on boxes sent to market and placed near boxes from diseased Los Angeles

vineyards. He had addressed the vineyardists of El Cajon valley (p. 187) saying " . . . that the mal nero would not spread in the valley at any great rate if the vines were properly cared for and treated." The editor had announced earlier (MV, v. 22, p. 170, Aug. 8, 1889) that Dowlen had found " . . . traces of the dreaded vine disease . . . " in El Cajon valley.

A statement appeared in the California Fruit Grower (v. 5, No. 5, p. 9, Sept. 14, 1889) to the effect that "Chase's vineyard in San Diego County is reported to be showing signs of being affected by the mysterious vine disease."

However, Dowlen later said that this region was relatively free from the disease (BSVC Cir. 1892). Decker and Young of De Luz, San Diego county, advertised in the Santa Ana Herald (Jan. 4, 11, 18, 1890) their Muscat grape rootings for sale, " . . . all grown . . . in a section of country where there has been no vine disease or any symptoms of it . . . the De Luz valley."

Harkness-Shorb Controversy

Under the title, Fungus or No Fungus. Mr. Shorb Says Aye and Dr. Harkness Says Nay, the Merchant and Viticulturist (v. 22, p. 166, Aug. 8, 1889) announced that, "On Thursday afternoon of last week Commissioner Shorb, of Los Angeles, delivered a short address in the rooms of the Viticultural Commission on the vine disease There were present . . . George West, Dr. Harkness . . . Wetmore . . . Turrill" Shorb told how the dust treatment was discovered by using it against mildew. "In reply to a question by Commissioner West, Mr. Shorb stated that in three applications of the mixture the vines . . . appeared to be freed of the disease. . . ."

"While expert Dowlen had never declared the disease to be a fungus, Commissioner Shorb believed it to be such, but on the other hand Dr. Harkness had asserted emphatically that the disease was not fungoid."

"Dr. Harkness was asked by Mr. Shorb if he could tell what the disease was, and he replied that his investigation had not been in that direction, 'I am absolutely sure,' said he, 'that the disease is not a fungus. I have seen it in Alameda County, on wild vines in the East and I have specimens of the fungus from Germany. It exists in almost every vineyard in the world, and in my opinion is nothing more than the product of decay in the vines. I cannot but believe that the disease is climatic.' . . . Mr. Shorb would not accept that theory"

"President Wetmore referred to the fact that the Government expert had discovered bacteria in the sap of the diseased vines, but this fact was considered of no importance, as they could be readily found in all decaying tissue."

"Replying to a question . . . Mr. Shorb stated that Pierce, the Government expert, though offered the benefit of the experience of Expert Dowlen and himself, had ignored their invitation to come and see the result of their investigations. President Wetmore said that Pierce was sent out here chiefly through the efforts of the Viticultural Commission. But the expert had located in a section where the vines were nearly all destroyed and was making nothing more or less than a post-mortem investigation of the vines. He had failed to cooperate with the commission, and from his interviews in the southern papers was inclined to make himself personally important rather than to arrive at a conclusion regarding the disease"

"Mr. Wetmore in referring to an interview . . . in which Governor Waterman had remarked that he was 'glad some one had finally been sent down to look into the disease,' stated that the Governor's statement was entirely uncalled (for), for the reason that during the past winter the investigation of the disease had been actively going on"

Referring to the above mentioned Aug. 1, 1889, meeting of the Commissioners, the Pacific Rural Press (v. 38, p. 127, Aug. 17, 1889) quoted from " . . . an address by Hon. J. de Barth Shorb of Los Angeles county on the vine disease . . . " in which he said, "Without claiming to be a scientist or even an expert in vine diseases, I have endeavored to ascertain as nearly as an unprofessional man could, the causes of the disease and the features of its progress. . . . The disease appeared about six years ago at Anaheim, and up to the present not less than 5000 acres of vineyard have been utterly devastated . . . the rapid onward march of the common enemy compelled the Viticultural Commissioners to engage in the fight. We have at present only been able to define the disease without being able to specify a radical cure. We established a hothouse in the vicinity and transplanted some affected vines We experimented with certain washes and powders, but found only one that seemed to have a beneficial effect The effect of this powder was not only to arrest the progress of the disease, but to establish a cure as well. We have used this preparation in the vineyards with success The cause of the disease is a mystery, and as yet we have made no progress . . . one theory is that it is of fungoid origin, and another that it is a product of climatic or soil conditions. . . . We do not know much more about the disease than we did when we first started. We found in the vicinity of the diseased vines spores

to be floating in the air, and the necessity of securing a powder which would volatilize and destroy these floating spores was apparent to us at once. . . .the Viticultural Commission has secured the services of Mr. Ethelbert Dowlen, LL.D., who is busily investigating, and hopes to arrive at definite conclusions in the near future." At this meeting, "Dr. Harkness of the Academy of Sciences asserted positively that the disease was not due to a fungus. He said he was prepared to stand to that proposition and also asserted that the fungus found upon the diseased vines was only a species which was a very common one . . ."

Nowhere have I found this fungus named, nor any of the fungi that were discussed except that once, Dowlen mentioned Cladosporium. I could find no record of this Aug. 1, 1889 meeting in the biennial report of the Commissioners.

Dowlen and Harkness Attend Viticultural Convention

The 7th annual viticultural convention was to be held in San Francisco and Shorb (HEH. Lib.) wrote to President C. A. Wetmore on Aug. 11, 1889, "I have sent Professor Dowlen to attend the convention and to give . . . a history and description of the vine disease. . . .I . . .strongly advise that microscopic photos be taken . . .of the sections he has . . . and thus having them translated on glass he can use them in the magic lantern to . . .show what has been observed--if this can't be done it is possible photos of his drawings might be made and . . .used in the same manner . . . Such an evening will do more for us in this investigation than anything we can do. I would not object to all the critics being present, Harkness included. I have suggested to Professor Dowlen that possibly the Commission might wish him to go north to

Napa and Sonoma Counties or elsewhere to examine into the condition of the vines there, if so to go wherever you may want him to go. . . . On all matters connected with this investigation Prof. Dowlen will hold his own against the crowd. You see he has fair play in all things. I am coming fast to the conclusion that our disease is the Mal Nero so modified by our peculiar conditions as make it difficult of identification with the disease as described in Italy by the French scientists--and this is a fungus. I understand . . . that Mr. Pierce says he received no letter from me, and from the Ass't. Secy. of Agriculture in a letter recently received from him (July 20th), I gather Mr. Pierce is not acting under instructions from the Secy. He says 'In planning for our investigation of this disease we arranged to have Mr. Pierce go to Santa Ana where we knew he could get information which would be of great value to him. He was instructed to consult with you, and I do not understand why he has not done so. We will write to him today in regard to the matter.' All things come to him who waits."

At the 7th annual viticultural convention, held in Viticultural Hall, San Francisco, Aug. 13-17, 1889, (BSVC Rep. 1889-90: 11-15, 1890; MV, v. 22, p. 179, Aug. 22, 1889), "The Los Angeles vine disease was the subject of discussion at the (Aug. 16) evening session. Expert Ethelbert Dowlen . . . delivered an address . . . " about his work " . . . all of which has heretofore been published in this journal. Mr. Dowlen also exhibited specimens of the diseased vines with and without the microscope. He closed with the statement that he 'had a notion' that the disease was caused by a fungus growth. Dr. Harkness, President of the Academy of Sciences, who was present, most emphatically declared that the disease was not of fungoid origin." See Appendix no.2, p. 175.

This Aug. 16 meeting was also reported in the S.F. Evening Bulletin, Aug. 17, 1889, with a chapter entitled The Mysterious Vine Disease. "Mr. Dowlen . . . outlined his investigations . . ." describing the symptoms and the powder ". . . which has done a certain amount of good. . . . Experiments in killing the disease in the roots have not been very successful. No one seems to know what causes the disease. . . . the speaker had a notion, --'not an opinion'--that it is caused by a fungus growth. . . . Dr. Harkness expressed the positive conviction that the disease is not due to a fungus growth."

Commissioner De Turk's official report of this evening session (BSVC Rep. 1889-90, p. 11-15, 1890) does not mention the Harkness episode.

On Aug. 19, 1889, Dowlen (HEH. Lib.) wrote to Shorb from San Francisco, " . . . the convention is over . . . Mr. Wetmore wanted me . . . to take my turn on Tuesday evening, but . . . my specimens could not be got ready, so Friday evening was selected. The Dr. was there and of course did not agree with me, but we got along all right, he tried hard to make me say things that I did not say, and to make out that I was leading viticulturists astray but he couldn't do it. I went to see him on the following morning, and we had a pleasant half hour together. In the evening of that same day (Saturday) he came down here and began attacking me (in Mr. Wetmore's office) making just the same assertions and charges that he had on the previous evening. I again set him right and held on to my own ideas whereupon he waxed very wroth, declared he would not be put down, that the question as to fungus or not could be settled in four hours it was a question that mycologists alone could answer . . . I believe he means to try and get up a wrangel in the papers. . . ."

"I have been into the Livermore valley. . . . I found some leaves having an almost identical pattern with the regular diseased leaves, but the rest of the vine did not coincide."

"This day I intend going out to Berkeley to see Prof. Rising whom I met the other evening. I would like to talk with him on the chemical side of the question."

"Concerning the Mal Nero paper. I have had a letter from Mr. Wheeler in which he says that the piece he showed you was in Foex's work on Viticulture. It is much shorter than in Viala's work. . . ."

Harkness Criticizes Dowlen in S.F. Newspaper

A note signed Enquirer appeared in the S.F. Evening Bulletin of Aug. 22, 1889, as follows: "There seems to be a conflict of opinion between the experts, Mr. Dowlen and Dr. Harkness, as to the fungoid origin of the vine disease When doctors disagree who shall decide?"

"A note in the Bulletin of Thursday . . . signed Enquirer appears to demand an answer from me," said Dr. Harkness in a long and unnecessarily critical article, The Vine Disease. A Difference of Opinion Regarding the Nature of the Southern California Vineyard Scourge, which appeared on the front page of the S.F. Evening Bulletin, Saturday, Aug. 24, 1889. This unfortunate and not too enlightening article aroused Shorb's resentment and embarrassed Wetmore and the other Commissioners, who had reason to expect more consideration. They had sought help from Harkness and had paid him generously.

"With a view of placing the matter in its proper light," said Harkness (S.F. Evening Bul., Aug. 24, 1889), "the writer proposes

to briefly review the work accomplished by Mr. Dowlen so that those who are interested . . . may be able to form an opinion of the value of his work . . . At the late meeting . . . Mr. Dowlen exhibited specimens of leaves . . . " showing very well the symptoms of the disease. "His microscopic exhibition, upon the contrary, was far from being satisfactory . . . it was expected of him . . . he would place before us some of the fungi he had discovered." Instead, however, he showed only sections of diseased and healthy vines ". . . neatly prepared and . . . instructive . . . we . . . ask why he did not exhibit . . . some of these . . . fungi. . . . if one of these diseased vines were placed in the hands of an experienced fungologist, a few hours would prove to be amply sufficient . . . to determine the presence of a destructive fungus. . . . Mr. Dowlen states . . . he has discovered fungi . . . affecting the leaves . . . (and) the branches . . . In no instances has he given such a description of the fungus . . . as would enable a mycologist to determine as to what family it . . . belonged; neither does he make the attempt to classify them himself. . . . In diagnosis of the disease, he places great stress upon the fact that certain . . . cells . . . are . . . filled with brown matter, and . . . that the starch which is so abundant in the healthy growing plant has disappeared altogether in that which is stricken with the disease." This seems an unjust criticism. He questioned Dowlen's discovery of empty cells and ridiculed his claim that certain small spots on the canes were due to a fungus and that a fungicidal dust should, or could, be "well blown into the bark."

Commenting in *The Whistle* (later *The Vitigraph*), (v. 1, no. 15, p. 1, Sept. 21, 1889), Holmes, the editor, said Harkness was "an authority on fungus. . . . but the Doctor has allowed his anxiety to sustain his own scientific opinion to carry him too far."

Harkness Praises Shorb

Harkness more or less effectively nullified the fungus theory, but his skepticism about some of Dowlen's other findings seems in part unjustified. On the other hand, he spoke very highly of what Shorb had done: "Mr. Shorb, upon whose estate these experiments have been conducted, --is entitled to commendation from all who are interested in the welfare of our State. He has expended money and time in the endeavor to solve this mysterious problem with zeal unflagging and with his characteristic enthusiasm he has labored for long months, fighting against fearful odds to save his own property and that of his fellow men. One cannot but feel a regret that such zeal and energy . . . should not have been directed to other lines of research, when, possibly important results might have been attained had he not been misdirected by his assistant, Mr. Dowlen."

Shorb Disturbed by Harkness's Criticism of Dowlen

Reacting immediately to Harkness's article in the Evening Bulletin, Shorb (HEH. Lib.) wrote to President Wetmore on August 31, 1889, saying, "I have read in last Saturday's issue of the Bulletin an article from the pen of Dr. Harkness. The communication stamps him as ungentlemanly. . . . As he was appointed by you or the Commission to aid in the work of the investigation and . . . has conceived his orders or duties to mean simply tearing down the . . . work of other minds, I desire that my connection in this work as the committee of one of the Board herewith cease, and I may be discharged from further responsibility in the premises. I propose further to send in my resignation to the Governor as Commissioner; but will wait to do this until my associates may have

the opportunity of trying to have some agreeable party named as my successor. Will you kindly lay this matter before the Board at your and their earliest convenience and oblige."

In a similar vein, Shorb (HEH. Lib.) wrote to Commissioner George West of Stockton on Aug. 31 as follows: "Harkness' letter in the Bulletin of Saturday last suggests to my mind that he received his pay of \$500.00 not for the purpose of assisting in the investigation of the vine disease but simply to pull down the work of other conscientious minds. . . . the communication is unpardonable My answer is a request . . . that my resignation as Committee on this investigation be accepted and my responsibility in the premises cease. I shall also send in my resignation as Commissioner"

Writing on Sept. 5 about this affair to a friend, Mr. Howard (HEH. Lib.), Shorb seems to intimate that some other scientist had been appealed to, when he says, " . . . in due time a report may come back from the most prominent micrologist of the world."

Commissioners Support Shorb

Commissioner C. A. Wetmore replied to Shorb on Sept. 3, 1889 (HEH. Lib.), "Your letter relating to Harkness' . . . communication just rec'd. You are misled however by appearances."

"I have already had very stiff talks with Harkness Mr. Dowlen's opinions seem to raise an issue and place him in a disputed position. . . . I told him that the Board would no doubt feel that he had unjustly criticized Mr. Dowlen the rest of us consider that you have charge of this work"

Commissioner West's reply (HEH. Lib.) to Shorb, Sept. 4, 1889, contained some interesting side lights. "I write now to beg you not

to resign and can assure you that our Commission appreciate your work. . . . all have expressed themselves in favor of spending more money than you are doing. . . . When Harkness was requested to visit you, the question came up about an interview with Gov. Waterman by a Los Angeles or San Diego paper in which the Governor said we were doing nothing and had done nothing about the vine disease. Dr. Manlove suggested Harkness to look into the matter since he . . . believed him to be a very scientific man. Mr. De Turk favored it and said that in a talk he had with the Dr., he had expressed a wish to look into the disease and felt that our Commission had slighted him in not asking his assistance. . . . I did not know he was to receive \$500 for his work and consider it a very high price for so little work." Manlove and De Turk were Commissioners.

These letters from Commissioners Wetmore and West seemed to allay Shorb's misgivings and he replied to Wetmore, Sept. 8, 1889 (HEH. Lib.) that, "It certainly worked badly . . . to employ one . . . whose only sense of duty seemed to be discrediting . . . the work . . . " of other employees of the Board. Prof. Dowlen, he said, spoke " . . . gratefully of the consideration he received . . . " from the Board at the meeting. "As you request, I will reconsider my resignation"

Pierce at Santa Ana; Trip to San Diego; Suspects Bacteria

The Merchant and Viticulturist (v. 22, p. 170, Aug. 3, 1889) and also the Rural Californian (v.12, p. 316, Aug., 1889), from which I quote, carried this notice, "Prof. N. B. Pierce, the vine expert from the Department of Agriculture, Washington, is working away with his experiments to try and solve the mysterious vine disease; he has im-

ported two hundred healthy vines from Missouri and planted some on the Hughes ranch where he has located his experimental station."

Pierce soon made a field trip (MV, v. 23, No. 1, p. 15, Sept. 8, 1889). "Professor Newton B. Pierce . . . has, in company with County Fruit Inspector Jones, just completed the inspection of the vineyards at El Cajon, Oceanside, National City and several other points, and reports that the Santa Ana vine disease prevails in all the localities visited. The inspectors state that unless a remedy is found, San Diego County will not produce sufficient grapes for table use in two years. The Professor discovered that sap of the diseased vines is alive with bacteria, which he believes to be the cause and not the result of the vine disease." These dire and unwarranted predictions about the El Cajon vineyards aroused spirited criticism of Pierce by Shorb, as will be seen, though it is not sure that Pierce himself made the predictions. That the disease had appeared in San Diego county was reported by Dowlen in August (MV, v. 22, p. 185, Aug. 22, 1889) and by the California Fruit Grower (v. 5, No. 5, p. 9, Sept. 14, 1889).

Pierce's suspicion that bacteria might be the cause of the disease apparently appeared in print first in the Anaheim Gazette late in June, 1889. Writing to Shorb, July 6, 1889, C. A. Wetmore (HEH. Lib.) said, "I suppose you saw the statement of Pierce's ideas--in the Anaheim Gazette copied last week in the Los. A. Tribune: . . . The idea of ferment germs in a diseased wood being cause is highly improbable." (These newspapers for this period are not available in the Bancroft Library.)

Again, I should point out that Rodgers (pp. 170-171, 181-184, 205-207, 233-239) had access to Pierce's letters to E. F. Smith and Galloway

and presents interesting information about Pierce's work on the vine disease.

W. A. Henry of Wisconsin Visits San Diego Vineyards With Pierce

Secretary of Agriculture J. M. Rusk asked Dean W. A. Henry, University of Wisconsin, who was coming to California late in the summer of 1889, "to call on Mr. Pierce and canvass the matter of the vine disease with him and report." Henry reported (U.S. Sec. Agr. Rep. 1889, p. 428-429), "I had the pleasure of meeting him at San Diego and accompanying him on his visits to El Cajon, Fall Brook, and Escondido. . . . we saw ample evidence that the plague hangs like a black cloud over the whole of southern California. . . . when I remember the desolation it has wrought in Los Angeles and Orange Counties I do not wonder at the anxiety that is expressed by the vine-growers in the regions where it is just appearing. . . . Wherever we went, as soon as the people learned the object of our visit they gathered about us and asked many questions, all . . . showing deep interest and great anxiety. . . . I believe that no man could devote himself more enthusiastically to his work than Mr. Pierce has, and believe he possesses a great deal of ability for this line of investigation." It is doubtful, perhaps, whether the disease was in the vineyards they saw, since later surveys revealed very little of it in San Diego county.

Dowlen Tries Sap Inoculation

In his Sept. 1 report, Dowlen (MV, v. 23, No. 2, p. 2, Sept. 21, 1889) said that he had visited Livermore and Napa and found a

disease, which was perhaps Spanish measles or the vine disease, he was not sure which. "At the beginning of the month," he said, "a series of vines . . . in good health, were inoculated with sap from diseased vines." No symptoms had appeared as yet.

Gustav Eisen Studies the Disease

The editor of the Merchant (MV, v. 23, No. 2, p. 2, Sept. 21, 1889) proclaimed that "Great success in the treatment of diseased vines is reported by Mr. Gustav Eisen at Santa Ana. He is temporarily stopping there to study the disease and to experiment with different methods of treatment, and now reports that results are promised which will be most gratifying. As he is one of the most conservative and cautious of the men now studying the matter, such a statement will be extremely pleasing to the vineyardists of the state." I have not found any other reference to this.

Dr. Gustavus A. Eisen (Essig, p. 615) was a scientist of unusual breadth of interests and substantial stature as a biologist and horticulturist. Born in Stockholm in 1847, he received a Ph. D. from Upsala in 1872 and was now living in Fresno. He was a member of the California Academy of Sciences and was the author of about 90 publications including a monograph on the fig and one on the raisin industry. He was also a student of marine worms.

Growers' Comments and Theories

The editor of the Merchant (MV, v. 23, No. 2, p. 2, Sept. 21, 1889) announced that, "Thomas Pepper, of the El Cajon valley, has advanced a new theory in relation to the cause and cure of the disease.

He is neither a fungoid nor anti-fungoid advocate. He thinks that there is fertilizer yet to be supplied to make up a deficiency in the nourishing qualities of the soil"

The L.A. Times was quoted (MV, v. 23, No. 2, p. 7, Sept. 21, 1889) that Mr. Brighton, a grower at Twin Oaks, " . . . is positive in his opinion that the disease has done its worst and that hereafter the tide will turn and the wine industry survive."

Steward Cole (MV, v. 23, No. 3, p. 1-2, Oct. 8, 1889) of Colegrove said that " . . . The vine disease has shown its effects quite seriously and no more vineyards will be planted, in fact most . . . will be grubbed out this fall and winter. All remedies so far tried have proved worthless" Albert Brigden of Lamanda Park said, "In our own vineyards we found the disease about the same as last year. Missions are the worst affected. We used three applications of Ongerth's powder." Jeanne C. Carr, Pasadena, stated that " . . . the vine disease . . . is a great calamity. The vineyards will be turned into orange groves There is a natural disinclination to publish anything about this misfortune."

Jeanne Carr was the wife of Dr. Ezra Carr, M.D., former professor of agriculture and chemistry at the University of California, 1869-1874. She was a respected authority and writer on horticultural matters.

Referring to the vine disease, a Correspondent of the Anaheim Gazette (SFM, v. 21, p. 141, Jan. 18, 1889) thought the pepper trees " . . . have something to do with it" The third year after he had planted pepper trees 12 years ago on Palm St., his " . . . vines gradually declined" This would have been about 1879.

The May 12, 1887, Anaheim Gazette quoted a grower at Santa Ana who thought the trouble occurred " . . . where grapes were pruned too late last spring . . . pruned to death during the summer . . . drowned out with water late in the season"

Munson Finds Rot of Root Fibrils

Discussing the effects of irrigation on the disease, Pierce (Bul. 2, p. 86) quoted from T. V. Munson, noted grape expert of Denison, Texas, who " . . . made a trip through California during 1889 and observed the disease" Munson said he found " . . . the deep feeding root fibrils . . . becoming browned . . . the cuticle readily slipping off, as though the sappy cells beneath had decayed by being inhabited by bacteria, which had eaten out the starch, etc." This he attributed to saturated soil, and suggested that " . . . the ever-present bacterial scavengers enter and devour not only the dying, but, when once in, the living tissue of the plant" Death of the root "fibrils" and wet-rot of the roots were symptoms previously reported by Scribner (SFM, v. 19, p. 99, 1888). Munson was one of the speakers at the 7th Viticultural Convention in San Francisco in August, 1889. He was an authority on grape varieties, breeding and culture, and the author, later, of a book on Foundations of American Grape Culture.

The Merchant and Viticulturist Criticizes Pierce Unmercifully

Though the Commissioners were apparently not satisfied with Pierce's approach to his study of the disease and though the Merchant and Viticulturist often reflected their views, it is impossible to

believe that they approved of some anonymous articles highly critical of Pierce which appeared in the fall of 1889. The journal suffered from lack of editorial restraint. The articles contained undignified and even disgracefully scurrilous passages.

Professor Pierce's Crankism was the title of a criticism (MV, v. 23, No. 3, p. 8, Oct. 8, 1889) to the effect that, "The Commissioner of Agriculture will do a most graceful and welcome act if he will instruct Professor Pierce, his viticultural expert, to come down off his high horse and be of some assistance in finding out a remedy for the vine disease . . . The viticulturists . . . want badly . . . an infallible remedy for that disease. To that end they ask that all investigations be directed, and they ask the Commissioner to tell Pierce what is wanted in so many words."

"Pierce's course since he came to this State . . . shows that he is actuated far more to make a reputation for himself than to assist the vigneron He refused tacitly what assistance the Viticultural Commission might be to him. He never even informed the Commission, . . . what he could or would do. Much might have been gained by cooperation, but Pierce scorned it and went off by himself to Santa Ana, where the vines were all but dead, to start his investigation, while thousands of acres were only beginning to succumb elsewhere. Had he gone into a fresh field he might have been of some assistance in finding a new remedy. Up to this time, however, the only return from his being here is a miscellaneous collection of ungentlemanly utterances, and a total disregard of the requests of those who have interests at stake. His trip has, to all appearances, been totally barren of any results. The copper and lime wash proposed by J. De Barth Shorb and

Ethelbert Dowlen is the only thing which has proved at all efficacious. . . . The great body of viticulturists, while they would like to know whether the death of the vines is caused by bacteria in the sap or a fungus, do not regard the argument over this point as worth much. A man whose vines are dying does not trouble his head on that score. He . . . asks for a remedy. Will the investigators remember this? He wants a sure remedy. Will Pierce and the Commissioner of Agriculture remember it?"

"Will Dr. Harkness remember it? If he don't we will tell him something about his monetary connections with the experiments which would make rich reading. We have had access to the books at Sacramento, and can certify that it has cost something to get his . . . report."

"Mr. Shorb and Mr. Dowlen have remembered it, be it said to their credit. They have told plainly what their experiments have been, and they have succeeded in finding the only remedy which thus far has been of any material value."

Along the same line (MV, v. 23, No. 4, p. 6, Oct. 22, 1889) the Citrograph was quoted as follows: "Newton B. Pierce, government expert on the grape diseases . . . was up here a couple of days this week. He has been investigating (?) for microbes so long that he can see nothing else. . . . he pronounces our vineyards badly affected when some of the places have exactly the same appearance they have presented every summer for years. And the vineyards go right along producing bountiful crops every year." I do not know what district was referred to here.

The attack on Pierce continued. In another anonymous article entitled The Wrong Expert, (MV, v. 23, No. 6, p. 8, Nov. 23, 1889), the

readers were told that, "Newton B. Pierce, the Government expert on vines and discourtesy, has at last ceased monkeying with microbes long enough to unbossom himself to the press. . . . to escape an editorial roasting in The Rural Californian. . . . His first official break was to grossly snub the Viticultural Commission . . . this man Pierce is entirely out of his element in the pursuit of the secret of the vine disease, and we begin to mistrust that Secretary Rusk in shuffling up his experts made a mistake and got hold of an expert on Pluro-Pneumonia or a potato rot scientist instead of an expert on the vine disease. At any rate, the vine growers . . . would be grateful to Mr. Rusk if he would transpose Mr. Pierce to other fields of labor."

Rural Californian and Anaheim Gazette Defend Pierce

The editor of the Rural Californian, George Rice, championed Pierce's cause (RC, v. 12, p. 542, Nov., 1889) under the title, The Mysterious Vine Disease. Prof. Pierce and His Critics. --His Relations to the Viticultural Commission. --His Side of the Question. "The mysterious disease is still a closed book . . . nothing has been learned from any source calculated to definitely give the character of the disease, its origin, or a remedy. . . . Certain reflections both severe and unjust have been more or less printed in some of our northern contemporaries concerning the labors of the expert sent out here by the scientific branch of the Agricultural Department at Washington. . . . To get at the facts in the case, The Rural laid it before Mr. Newton B. Pierce, the government expert, and sought to learn the real facts"

Questions were asked by the editor and Pierce's answers were quoted verbatim. "'I am sorry,' said Mr. Pierce, on being informed that some

saw fit to criticize him, 'that the newspapers are doing me injustice in some quarters. I am accused of snubbing the officers of the State Viticultural Commission, which is entirely false. True, I have not co-operated with the Commission, but on no grounds of desiring to be discourteous. My instructions from the Department were silent in this regard . . . my sole duty is to work up the matter and report at the Department at Washington.'"

" . . . Mr. J. De Barth Shorb says he sent me an invitation to visit his place, and that I failed to respond. I never received any such invitation from him; if I had I should have certainly given it proper attention . . . "

"How about the assertion that you sought information from the Commission, and at the same time refusing to impart any facts . . . ?" Pierce replied he had asked only for printed matter and specimens.

"Why locate at Santa Ana?"

"Santa Ana was chosen for there it was that the disease first made its appearance. In that section there are all the conditions for study and observation . . . I am satisfied a better place could not have been chosen."

Was he indebted to the Commission for obtaining his appointment?

"This is untrue. . . . The matter had been agitated for a year and a half before Mr. Shorb, or any member of the Commission, made application to the Department for help, . . . When I discover facts upon which a definite treatment of the disease may be based, you may rest assured that they will be placed before the vine growers as soon as possible. Certainly no one is more desirous than I to solve the problem and if possible save your vineyards."

"Then how about co-operating with our people?" " . . . just what I have been doing since my arrival in the State. No stone is being left unturned to gain all the data and information possible. . . . " He said the Santa Ana people " . . . are alive to the difficulties to be overcome and can appreciate the labor of the investigations." He referred to a disease in Italy and Viala's visit and continued, " . . . I have made a great many experiments and taken observations in all sections of Southern California, tracing evidences of the disease into Lower California; . . . I am satisfied it is not wholly climatic . . . "

"Do you think there is any possible hope of preventing the spread of the disease . . . ?" " . . . When we master the cause, its nature may lead us to a remedy. It may, however, become necessary to remove all diseased vineyards, assisting the disease to die out in a natural manner." He said some Santa Ana growers were turning to other crops such as citrus and sugar beets.

George Rice, the editor (RC, v. 12, p. 543, Nov., 1889) then quoted the Anaheim Gazette under the title, More About the Disease: "Mr. Pierce last week inspected one hundred vines at Santa Ana that had been cut back in order to allow them to put forth the new growth. This was done to ascertain whether the disease was in the stump, or whether, . . . it would be removed entirely from the vine when the branches were cut away" Of the 100 vines, 65 of the 71 that produced new growth showed the disease so " . . . the disease was in the sap. Mr. Pierce is of the opinion that a solution applied strong enough to kill the bacteria will also kill the vine. The bacteria which Mr. Pierce's microscope reveals in the diseased vines is probably,

according to the expert's view, the cause of the vine disease"

"As regards the 'hard feeling' existing among members of the State Viticultural Commission towards Mr. Pierce, there is no valid reason why any should exist at all. Mr. Pierce was not sent here through Mr. J. De Barth Shorb's suggestion, as some gentlemen claim. Other gentlemen had written the Department at Washington a year before Mr. Shorb took cognizance of the disease." The Anaheim Gazette went on to assure its readers that, "Mr. Pierce is doing his best to ferret out the cause of the disease, and is working hard to accomplish that end. If he holds out no prospect for immediate relief from the disease, it is simply because in his opinion there is no ground for the assertion. . . . At present there is no solution of the mysterious malady, which is now making serious headway at Fresno and other localities throughout the State. In the opinion of many, every vine in California must succumb to the disease before the germs are killed, and vine growing becomes profitable again. On the other hand, there are persons who claim to be able to cure the disease. So far as the bacteria are concerned, it is impossible to say whether they are produced by the disease, or whether, as Mr. Pierce is inclined to think, they are the cause of it."

Reporting for the Santa Barbara County horticultural board (CSBH Rep., 1889, p. 488-489, 1890) on Oct. 26, 1889, Rowland Machin said, "We had the pleasure of meeting Newton B. Pierce, Vegetable Pathologist, . . . who gave us ocular demonstrations of the fact that the dread disease is within our borders."

Dowlen's Root Injections

Dowlen's report (No. 35) of Oct. 1, 1889 (MV, v. 23, No. 4, p. 3, Oct. 22, 1889) appeared under the heading: Benzine. Expert Dowlen Tries It on the Vine Disease. In a Muscat vineyard at Florence, entirely diseased, ". . . A hole . . . was bored . . . in the crown . . . in this a quantity of benzine . . . was poured, and the hole was then plugged with earth. Each of the vines thus treated had made some new growth, which . . . appeared to be quite healthy." On Sept. 7, two badly diseased Muscat vines were treated as follows: "A large root was . . . cut off . . . to the cut end a glass tube four feet in length . . . was attached by rubber tube . . . the tube was filled with gasoline . . . " By Sept. 16, one treated vine had a little new growth. In another vine a hole was bored and gasoline poured into the hole. By Sept. 20, this vine had continued " . . . to develop healthy leaves." He had also tried dipping young vines and cuttings in a mixture of lime and copper sulphate to no avail.

According to Dowlen's next report, No. 36, dated Nov. 1, 1889 (MV, v. 23, No. 6, p. 2, Nov. 23, 1889), the vines at Florence injected with benzine " . . . were all found to show signs of disease, though none of them showed so much as the . . . untreated vines. . . . It is certain that, for a time, the disease was checked, and a healthy growth was induced." Of a new lot of 36 vines set out in April in the experimental greenhouse, 18 " . . . were liberally dressed with . . . Ongerth's powder." By October " . . . it was found that . . . nearly every undressed cane was dead, whilst of the dressed cuttings, all but two were alive and vigorous In reports No. 29 and 32 attention was called to the benefits . . . of . . . Ongerth's powder

. . . good results followed; the disease was checked, . . . the vineyards which were treated show considerable disease though they are in decidedly better condition than . . . vineyards which had nothing done to them!' He said that the Mission and Mataro varieties had suffered most from the disease.

With regard to Dowlen's injection experiments, The Anaheim Gazette was quoted (RC, v. 12, p. 542, Nov., 1889) as follows: "The treatment is to bore a hole half an inch in diameter in the crown of each vine. In these holes a quantity of benzine . . . was poured and the hole plugged with earth. . . . The treatment appears to a certain extent rather effective, as all vines so doctored have made some new growth which is free from the markings of the disease. . . . Prof. Dowlen . . . has been experimenting . . . with gasoline. His method has been to uncover and cut off a large root. . . . glass tubes have been attached to the root by rubber tubes and the gasoline . . . placed in the glass tubes. . . . the success so far reported as quite satisfactory." Dowlen deserves credit for his pioneer work in chemotherapy.

Dowlen Notes Beneficial Effect of Shade

In his Nov. 1, 1889, report (MV, v. 23, No. 6, p. 2, Nov. 23, 1889) Dowlen also recorded that at Florence, rows of Muscats sheltered from the sun by a row of cypress trees " . . . are . . . more free from disease . . . than the vines in the rest of the vineyard. . . . wild vines . . . show some cases of disease"

Later (MV, v. 23, No. 9, p. 14, Jan. 8, 1890) Dowlen was quoted as authority for the statement that, " . . . hot weather helps the spread of the Los Angeles vine disease. . . . Some Muscat vines under

the shade of a tree are perfectly healthy, while all the other vines in the vineyard are dead."

Pierce (Bul. 2, p. 104-111) also observed a definite beneficial effect of shade in retarding the disease, as will be noted later.

Specimens Sent to Mal Nero Authorities in Europe;

Commission Approves Research

At the semi-annual meeting of the State Viticultural Commissioners at the Occidental Hotel, San Francisco, Dec. 9, 1889 (BSVC Rep. 1889-90, p. 94, 1890; MV, v. 23, No. 8, p. 2, Dec. 23, 1889), "Commissioner J. De Barth Shorb as special committee on the Anaheim vine disease, reported the progress thus far made in endeavoring to ascertain the cause of the trouble and to find a remedy. Mr. Dowlen has from time to time reported to the Commission the progress of his work under Mr. Shorb's direction. Mr. Shorb stated that specimens of the diseased vines have been sent to the best experts in Europe^{1/}, as it is feared that the complaint is Mal-Nero, a disease that has devastated the vineyards of Italy. Photographs of the disease as it appears under the microscope were being made for extensive circulation among the most noted savants of the Old World. . . .On motion of Commissioner George West, duly seconded, it was decided to vigorously continue to push the investigation of the disease in Southern California." Over \$1000 had been ". . .spent during the last four months in investigating the Los Angeles disease (MV, v. 23, No. 8, p. 2, Dec. 23, 1889) and an appropriation of \$1200 is set aside for that special work for the remainder of the year." That would have been 8 months, Nov., 1889-June, 1890, and the amount would just equal Dowlen's salary of \$150 per month. The Board was receiving a total of \$17,500 per year from the state.

^{1/} Also noted in The Vitigraph, v. 1, No. 20, p. 2, Oct. 26, 1889.

New Cures Proposed

Meantime new cures were proposed. There was a news item (RC, v. 12, p. 542, Nov. 1889) to this effect: "A Fresno man has discovered what he represents to be a cure for the mysterious vine disease, and has made a proposition to treat Riverside vines for two years with the understanding that if a cure is not effected he will make no charge. If successful he will require \$10 per acre for his services; he will not undertake the job unless he gets contracts covering 1000 acres." This must have been Richard Wheeler.

Another New Remedy was the title of an article (MV, v. 23, No. 5, p. 9, Nov. 8, 1889) as follows: "Richard Wheeler, a vineyardist of the south, . . . is taking contracts to cure affected vines at \$10 an acre, 'no cure, no pay'. . . . Wheeler guarantees a fine growth of vines . . . and future exemption from disease . . . there is one gentleman who did not take kindly to the announcement of the new discovery. That individual was, of course, Newton B. Pierce . . . he promptly denounced it as a fraud. Mr. Wheeler went to him at once, showed him the contract . . . and Pierce rather gracefully backed water."

He Cured the Vine Disease was the title of a notice (MV, v. 23, No. 5, p. 7, Nov. 8, 1889) quoted from the Riverside Press and Horticulturist relating that J. M. Alkire dug earth around the stem and, " . . . poured a pint of lime into the cavity. . . . After two years . . . the disease has not spread Rev. Chas. Button's place adjoining was treated with lime also and has likewise escaped." The neighbors suffered much more severely.

F. E. Gray, reporting on Dec. 31, 1889, for the Los Angeles county horticultural board (CSBH Rep. 1889, p. 485, 1890) said, "In many places

where vineyards have yielded to disease, orange trees will take their place."

Discussion by Carroll at Fruit Growers' Fresno Convention

At the 12th fruit growers' convention at Fresno, Nov. 5-8, 1889, President Ellwood Cooper (CSBH Rep. 1889, p. 386, 1890; CFG, v. 5, No. 14, p. 4-5, Nov. 16, 1889) said, "The raisin industry has received a check in the vine disease that is spreading with alarming rapidity, and leaves us in doubt as to the future of vine planting." At this convention, Tim. Carroll, Nurseryman of Anaheim, read a paper (CSBH Rep. 1889, p. 434-435, 1890) on the Mysterious Vine Disease. "About 1883," he said, "I first noticed a vine here and there, perhaps one in every acre, that did not look well; we laid it to the alkali. In 1884, it seemed that the alkali was taking more of them, so then we laid it to a fungus. In 1885, the vines . . . after the berries got to be about half grown . . . began to wilt . . . the next spring they seemed to die from the top down." Commenting on a paper by G. E. Freeman at the same convention (CSBH Rep. 1889, p. 442, 1890), Carroll pointed out that the disease started at Anaheim in vineyards on very good soil. Replying to a question, he said the disease did not start in Mr. Langenberger's vineyard, but in Mr. Dryfus's, as previously noted (p.4).

Pierce's Annual Report, 1889

B. T. Galloway, under the title, The California Vine Disease (U.S. Sec. Agr. Rep. 1889, p. 423-429, 1890) presented the first report by Newton B. Pierce, dated at Santa Ana, Dec. 6, 1889, where he had been working since his arrival on May 23. Pierce said, " . . . at least

one hundred vineyards . . . were inspected . . . the owners were visited, and their experience . . . carefully recorded. . . . The study . . . has resulted in a thorough diagnosis of the effects of the disease . . . upon the fruit, the vine and the vineyard as a whole." He had made a survey of the extent of the disease. He believed it was not identical with either the European mal nero or folletage. It was not caused by phylloxera, nor by root fungi, but he had found bacteria present in the diseased vines. Inoculation experiments had " . . . been inaugurated at Washington" Spraying with Bordeaux had been tried by growers but " . . . not one vine is saved by this treatment A powder recommended by individuals . . . who have been conducting experiments, and which it was claimed would master the trouble, has been extensively made and sold . . . in the infected district, and has been thoroughly tested . . . It was a part of my labor to collect records respecting the results . . . and up to date I have not found a person who has saved a vine by its use. . . . a preventive or remedy for this disease is not yet known. . . . Observations of value have been made relating to resistant stocks, . . . the grape industry . . . is receiving a heavy blow, . . . investigations are being pushed as rapidly as time and careful work will permit, and I see no reason for supposing that they will not result in a thorough understanding of the causes of the disease" In this supposition, he was, unfortunately, due to be disappointed.

Dowlen's Reports; Varietal Susceptibility; Lack of Starch

Dowlen's Jan. 1, 1890, report (MV, v. 23, No. 9, p. 2, Jan. 8, 1890, admitted that specimens of leaves from Fresno suggested, " . . .

there is very grave danger . . . " of the disease " . . . making its appearance there in the near future." He found a lack of starch in the tissues of diseased vines and " . . . unripened canes . . . " and " . . . patches of unripened bark on the canes" Hot spells made the disease worse. "The Mission and Muscat . . . "were" . . . most affected, followed by Mataro, Sultana, Burger, Chasselas, Zinfandel, Blanc Elba."

In his report dated Feb. 3, 1890, (PWSR, v. 24, No. 1, p. 1, Mar. 8, 1890), Dowlen described varietal differences in suceptibility and a microscopic study of sick canes showing that the tissues in the stripe of green wood were devoid of starch.

Albert Brigden Uses Ongerth's Powder

Albert Brigden, Lamanda Park, testified (PWSR, v. 24, No. 1, p. 9, Mar. 8, 1890) as to his gratifying experience with Ongerth's powder, saying, "I find it not only a preventive of the Mal Nero or vine disease, but a substitute for sulphur in case of mildew." Brigden had a similar testimonial in the California Fruit Grower (v. 6, p. 168, Mar. 15, 1890).

However, Dowlen, in his 1893 vineyard survey (CSBH Cir. The vineyards of S. Cal., p. 16, 1893), inspected Brigden's 75-acre vineyard and made this entry: "This vineyard is being slowly taken out and will probably not exist for more than two or three years more."

Edmiston Doubts Soil Deficiency; Doubts Microbes Swimming

in the Sap

B. Edmiston, in an article quoted (PWSR, v. 24, No. 1, p. 2, Mar. 8, 1890) from the Riverside Press " . . . refers to the theory so often

advanced, that the secret of the so-called disease in California is due to overtaxing the productive capacity But as to curing the vine disease, it is misleading, as mere theories are apt to be" Of his own vineyard, " . . . one-half . . . has never been fertilized. The other half received a heavy dressing . . . the diseased vines are nearly all on the fertilized part" Nor, he said, was the disease due to " . . . microbes in the sap . . . " because diseased and healthy shoots occurred on the same vine. " . . . Were the disease caused by microbes swimming in the sap, manifestly the vitality of the whole vine would be impaired, and not merely that of a lone branch here and there." He was a shrewd observer.

Dowlen Cites European Opinions About Mal Nero

In Dowlen's report of Mar. 1, 1890 (PWSR, v. 24, No. 2, p. 3, Mar. 22, 1890) entitled, Expert Dowlen. He Finds the Mal Nero Generally Prevalent at Riverside, he said, "The disease is apparently spread all through the district . . . there seems to be a considerable difference between the appearance of the diseased vines at Riverside and those around Los Angeles . . . one cane . . . would show disease . . . disease had not done any serious damage . . . A similar state of things exists in Napa valley . . . no serious damage" He described the diseased vines in his experimental greenhouse. "A correspondence was entered into some time ago, in order to obtain, if possible, opinions on the disease from outside this country." The Italian consul at San Francisco " . . . kindly undertook to get information from Italy regarding mal nero, and " . . . he is advised that mal nero is nothing else than the anthracnosis," The Italian Consul " . . . also

referred to Prof. L. Paparelli, a pupil of Prof. Targioni-Tozzetti, who has for several years worked upon vine diseases under the Italian government and who is now attached to the University of California at Berkeley. Prof. Paparelli has undertaken to obtain all possible information from Prof. Targioni-Tozzetti. . . . A letter has also been received from Prof. Pierre Viala of . . . Montpellier, France, in which he states that he does not think that the disease . . . is mal nero" Viala later (Ann. Ecole Agr. Montpellier, v. 7, p. 99, 1892) stated that the disease was not mal nero.

Dowlen Quotes Letter From Scribner to R. Wheeler

Dowlen quoted a letter (PWSR, v. 24, No. 2, p. 3, Mar. 22, 1890) from F. L. Scribner to Mr. R. Wheeler of Kingsburg, written at Knoxville, Tenn., Jan. 2, 1890: " . . . When in California I spent three days at Los Angeles, a week at Orange, another week in and about San Francisco, Napa valley, etc. The vine disease, so fatal in the region south of Los Angeles, I saw at Napa valley where it had been known for years, but had never been regarded as serious. I venture no explanation of the cause of this disease. Prof. Pierce may get at the cause. He is having a good opportunity to do so. To say that it is a bacterial disease and to demonstrate that it is, are two distinct propositions." Perhaps this is the Richard Wheeler of Fresno who offered a cure at \$10 per acre. Kingsburg is south of but not far from Fresno.

Cooper Reviews Theories at Fruit Growers' L.A. Convention

Hon. Ellwood Cooper, president of the California State Board of Horticulture, in his Opening Address at the 13th state fruit growers'

convention, Los Angeles, Mar. 14, 1890 (CSBH Ref. 1890, p. 37-41, 1890) discussed the vine disease: "At the Fresno Convention, held in November last, there were four distinct theories presented to account for this terrible calamity . . . poverty of soil, the vines dying from lack of sap or poisonous sap . . . by cultivation of trees and shrubs in Los Angeles County the climate was changed, and becoming more tropical was not adapted to vine growing . . . too early pruning . . . there were also many severe expressions . . . criticizing experts who were investigating this malady . . . I was extremely sorry . . . I am conscious that scientists may make mistakes, but all are not on the wrong line of investigation. To the specialist we must look for the solution. . . . it is safer for us to conclude that it is a fungous growth of a poisonous character; that the particles float and are carried through the air, and taking root in the tender leaves, grow and kill the vine, notwithstanding the fact that the particles and the fungous growth may be so minute, so subtle in their character, that they remain as yet undiscovered."

Pierce Reviews His Work at Fruit Growers' L.A. Convention

At the same Mar. 14, 1890, fruit growers' convention, Pierce, who had been in California since May 23, 1889, read his first report to the growers on The Mysterious Vine Disease (CSBH Rep. 1890, p. 169-177, 1890). He gave first a detailed account of the early history of the disease around Anaheim, saying (p. 171) "Of all the vine affections known to science, we have here one which, in the deadliness of its nature, the universality of its attack in a vineyard, and the obscurity of its workings, is nowhere surpassed. In a vineyard showing this

trouble more or less generally, it may be said that every vine will die from its effects. Of all the features . . . those of virulence of nature and eventual completeness of attack . . . are the most prominent. . . . One other related feature . . . is that of the almost or quite universal death of vines started from cuttings taken from diseased stock; thus pointing with much force to the disease as being inherent (p. 172) in every portion of the infected vine. . . . There has never before been in California such a complete, such a widespread, or such a continuous death of vines. . . . the death of the vines has been steady, progressive, relentless and complete." He said that none of the well known fungi pathogenic to grapes were involved. He described two " . . . long known but illy defined . . . " diseases of grape in Europe, folletage or sun stroke, and mal nero, which killed the vines and said (p. 175), " . . . I think that the California disease appears to be more nearly related to mal nero" He then described what he had done in studying the disease (p. 176), saying, "During perhaps two thirds of the time since my arrival in the State, I have occupied myself with active field work. . . . much of the field work has been upon the effect of the disease seen in the individual vine. Much attention has been paid to the growth of cuttings, presumably healthy . . . " showing that the trouble " . . . continues to infect vineyards set from cuttings" He had studied the fungi present, and " . . . certain parts of the vine were found more or less infected by bacteria, and in deference to the views held by some European students, we have considered it advisable to inaugurate a series of inoculation experiments with these germs." These inoculation tests were started in California, but were " . . . afterwards transferred to Washington, owing to the all-

pervading nature of the disease in this region, and the difficulty of keeping plants free from it. These experiments and numerous grafting experiments are now under way at the department. . . . it is my intention to go to Washington within two or three weeks" No remedy or preventive was yet known.

Fruit Growers' Ovation to Pierce

When Pierce had finished reading his paper at the Los Angeles meeting, Mr. Gustav Eisen (CSBH Rep. 1890, p. 177, 1890) moved, " . . . that a vote of thanks be tendered to the Department of Agriculture at Washington for what it has already done and for what it proposes to do for this disease, which all of us know is of such great importance to us in this country."

"Mr. Paine: In seconding that motion I want to congratulate ourselves upon having a man among us (Mr. Pierce) who is making such a careful and thorough study."

"A member: And to thank him for the efficient way in which he has said this, and for his kindness in coming here and telling us."

"Motion carried."

"Mr. Pierce: Gentlemen, I thank you all. I try to do my best; that is all I can say."

"Mr. Eisen: . . . I understand the department at Washington has not all the means at its command to carry on this as it should be. For instance, I think it is of great importance that an expert should be sent to Europe to study the disease there and see if it is the same thing we have got, and to find out what remedies have been used, and anything else that belongs to the disease. I beg to offer the following resolution:

" . . . Whereas, An undetermined and deathly disease of the grape-vine has already destroyed many thousand acres of our formerly most fertile and productive vineyards in the State of California; and whereas, this disease shows no abatement in destructiveness, but is constantly spreading over new territory; and whereas, the Division of Vegetable Pathology of the United States Department of Agriculture, which is now engaged in the investigation of this disease, feels the need of more liberal appropriations of funds to enable it to continue and properly maintain its work now well advanced; be it therefore,

"Resolved, By the fruit growers of California, in Convention assembled, that the Secretary of the State Board of Horticulture shall at once place these facts, in the form here presented, before each of our representatives in Congress, with the request that they will take united action in presenting and urging the great necessities of the case before the Committee on Agriculture of the Congress at Washington, D.C."

"Adopted unanimously."

Quotations from Pierce's report were published in the Pacific Wine and Spirit Review (v. 24, No. 3, p. 15, Apr. 8, 1890) under the heading, "Newton B. Pierce. The Government Expert Prattles About the Vine Disease."

Shorb Asks Rising to Look for Disease in Europe

On April 7, 1890, Shorb (HEH. Lib.) wrote to Prof. W. B. Rising, State Analyst, Berkeley, "Permit me to thank you for your kind letter . . . and proffered assistance in the investigation of the vine disease during your trip to Europe. . . . we have received but few such letters in our work here; instead of assistance and encouragement in an earnest

work from those quarters we had reason to expect it, we have had to meet unfair criticism and a spirit of jealousy which scientific men should have been ashamed of. From Berkeley, however, we have experienced nothing but considerate treatment. We shall be glad to furnish you the specimens of the diseased vines and would be under many obligations for any information you may be able to get in your researches in Europe. . . . Mr. Dowlen will write you fully in reply to your letter"

Dowlen's April and May Reports, 1890; Mal Nero Subsiding

Dowlen's report of April 1, 1890 (PWSR, v. 24, No. 4, p. 3, Apr. 28, 1890) entitled, A Progress Report, Expert Dowlen Still Wrestling With the Vine Disease, stated that 9 out of the 21 vines in his greenhouse were still healthy and referred to 1500 vines and cuttings out of doors, none ready to report on.

Dowlen's next report, dated May 1, 1890, was hailed as, An Encouraging Report. Prof. Dowlen Finds the Vines Much Improved in Condition (PWSR, v. 24, No. 7, p. 4, June 13, 1890) and " . . . is the first official information that the dread mal nero has possibly run its course." In the same issue (p. 1), under the title, Is It Dying Out? The Mal nero Seems to Have Run Its Course, The Los Angeles Times was quoted to the effect that, "The vines that had escaped the ravages of the disease up to this year are not showing the slightest sign of sickness at this date."

A few weeks earlier (PWSR, v. 24, No. 6, p. 19, May 28, 1890) the editor had said, "A San Bernardino countypaper believes that the mal nero has run its course. It says: The mysterious vine disease is believed to be a thing of the past in this section of the state. Even

in the worst affected localities in Orange and Los Angeles Counties this belief seems to be well grounded. It has never done any noteworthy damage in San Bernardino county."

In his column on Facts and Theories, the editor of the Pacific Wine and Spirit Review (v. 24, No. 4, p. 12, Apr. 28, 1890) related that, "Robert Barton . . . has been . . . among the disease-stricken vineyards of Los Angeles county and like many others has evolved a theory regarding the malady. . . . expressed the belief that frost will kill the vine disease" The editor further related that, according to an Anaheim newspaper, growers plowing up diseased vineyards found the roots alive and growing, raising the hope that " . . . the mysterious vine disease had run its course. . . . it appears to effectually dispose of the theory of Government expert Pierce that the malady is due to diseased sap caused by the presence of bacteria therein. . . . the disease comes from the extremities of the vines and . . . is the result of climatic conditions and not chargeable to the soil."

G. W. Ford of Orange wrote to the Santa Ana Blade (CFG, v. 7, p. 74, Aug. 2, 1890) that his small vineyard set out in 1889 with vines from Fresno and the East had " . . . not a trace of disease in it."

Alarm in Fresno

Fresno's Danger was the title of a news item (PWSR, v. 24, No. 5, p. 12, May 13, 1890) about a carload of Riverside vines being planted in Fresno county which read, " . . . the deadly vine disease is rampant in the Riverside district and the vines from that section are almost certain to transmit the dread malady to the healthy vineyards of Fresno. . . . these vines . . . presumably contain the germs of disease"

The vine disease has well-nigh ruined the viticultural industry of southern California"

Pierce's Annual Report, 1890

In his 1890 report (U.S. Sec. Agr. Rep. 1890, p. 405-406, 1891), Galloway said, "During the early part of March . . . Mr. Pierce was granted a leave of absence for five months without pay in order that he might visit certain parts of Europe and study there a number of vine diseases which, according to published accounts, somewhat resembled the California trouble. . . . an extended series of experiments were made by me in Washington with a view of determining the contagious or noncontagious nature of the disease. Healthy Muscat of Alexandria grapes were obtained from New York and inoculated in various ways with diseased material from California. The most common method . . . was to graft diseased Muscat wood upon healthy roots Other methods such as inarching diseased and healthy canes, planting healthy vines in soil obtained in California from around dead and dying roots, etc., were tried, but in no case was any positive evidence of transmissibility of the disease obtained. . . . Along with the foregoing there were made a series of bacteriological investigations, something over three hundred cultures being made from various parts of diseased vines"

Dowlen's 43rd Report; A Summary in the Commission Report

Dated June 1, 1890, the Report of Ethelbert Dowlen, Special Agent to Investigate the Anaheim Vine Disease, (BSVC Rep. 1889-90, p. 57-63, 1890), " . . . being one of a series of forty-three reports now on file

at the office of the State Viticultural Commissioners, . . . " was read by Secretary Turrill at the annual meeting, held June 9. It was a comprehensive summary of his work to date. "In September, 1888, the Board . . . decided upon making an investigation into the causes of the destruction of the vineyards The disease . . . has proved to be probably the most destructive . . . that has ever attacked the vines . . . quite equaling in its power for evil either black rot or phylloxera." He stated that in a survey, out of some 500 questionnaires sent out, 92 replies from actual growers were received. "The earliest date of attack reported is 1884, when it was first noticed in North Pomona and Anaheim . . . " and it appeared at Santa Ana in 1885, Orange, Tustin, Fullerton, Los Angeles, San Gabriel, Alhambra and Burbank in 1886. Native grapes were attacked, but the Lenoir and Gamay varieties escaped infection (p. 58). He described the symptoms.

"The same disease was noticed by Prof. F. L. Scribner and Prof. Pierre Viala in Napa Valley in 1887, where it was again seen in 1889; but in this district it has never done any harm."

"Altered climatic conditions were at one time somewhat strongly urged as the cause of all the trouble, the wet season of 1884 being advanced as proof. . . . Amongst the cuttings taken . . . in 1888-89, many were found to have developed disease after being put in the nursery . . . Cuttings taken from presumably healthy vines, and brought from a distance, have not always proved to be exempt from disease, but have shown the first signs in the first year of planting. . . . Threads of mycelium are also found in more or less abundance running through the various tissues. Bacteria are found more or less plentifully, and various forms of fungi are abundant upon the canes of diseased vines.

. . . No insects have been met with which could have anything to do with causing the disease . . . nothing is positively known as to the cause of the malady. . . . fungi are abundant upon and in the diseased vines, but whether as cause or effect is not yet known."

"The malady to which the Anaheim disease bears the greatest likeness is mal-nero, which has been known in Sicily and Italy for many years"

Professor L. Paparelli, then at the University of California said, "For my part, judging by samples and description of the Anaheim vine disease, I should think not the mal-nero alone is in question, but two or three maladies together, perhaps all of a non-parasitic nature."

"With respect to remedies," continued Dowlen, "partial success has been reached. In December, 1888, a small hothouse was erected by the Viticultural Commission, in which rooted vines, both healthy and diseased . . . were set out for observation and experiment. Unfortunately, soon after the vines had been set out, one end of the house was accidentally burned out, and almost all the vines were killed. . . . a second house was built onto the first, the cost being defrayed by the Los Angeles County authorities. By the middle of February, 1889, both houses were started with a fresh supply of cuttings and rooted vines. . . . Many of these were known to be diseased." Ongerth's powder was used. "In October, 1889, most of the vines were cleared out . . . it was found that of the Mission cuttings, nearly all the untreated plants were dead, whilst of the treated cuttings, only two had died. . . . The treatment has been continued this year . . . all the treated vines are in much better condition than those left untreated. In the vineyards not so much success has been reached. Last year the above mentioned powder was applied experimentally on three vineyards, having a

total of about one thousand acres. Three applications were made . . . but by the end of the season the disease had apparently reasserted itself. . . . Other substances have been tried . . . iron sulphates as a dressing to the ground, Bordeaux mixture, benzine introduced into the sap circulation, superphosphate of lime as a ground dressing. . . . The present outlook is encouraging. . . . The signs of disease in the early part of the year were very few, and there has been but little increase, and it is possible that the disease may pass away." This referred to the spring of 1890.

Dowlen's June 1 report No. 43 (PWSR, v. 24, No. 8, p. 17, June 28, 1890) was reviewed under the title, The Anaheim Disease. Interesting Extracts From Prof. Dowlen's Last Report. This report was also referred to in the California Fruit Grower (v. 6, p. 374, 1890) and was reviewed in the Pacific Rural Press (v. 40, p. 2, July 2, 1890) with these comments, "It is a fortunate thing for Fresno county that the disease has not reached there. . . . What causes the disease has not yet been discovered. . . . Present prospects are very good."

Call It Anaheim, Not California, Disease

"After the reading of Dowlen's 43rd report (BSVC Rep. 1889-90, p. 96, 1890) it was moved by John T. Doyle, that wherever in the report the word 'California' appears, as applied to the disease, the word 'Anaheim' be substituted by the Secretary. The motion was seconded and carried." At the end of the meeting, "Shorb, West, and Doyle spoke regarding the investigation of the Anaheim disease, made by Dowlen. All of the speakers agreed the work should be continued on the same plan thus far pursued."

Referring to Dowlen's June 1, 1890, report, above mentioned, the Pacific Wine and Spirit Review (v. 24, No. 7, p. 2, June 13, 1890) stated that ". . .the name . . . 'California Disease' --was objected to by Commissioner Doyle and on his motion was changed to Anaheim Disease." This journal (v. 29, No. 10, p. 24, Dec. 20, 1892) remonstrated when Pierce entitled his bulletin No. 2, The California Vine Disease, pointing out that it ". . .might lead some to think that the disease existed all over California . . ."

New York Sun Refers to the Vine Disease

The California Fruit Grower (v. 6, p. 391, 1890) noted that the St. Louis Grocer said the New York Sun had published something on the vine disease. Editor Rowley's comment was, "The whole subject has been thoroughly ventilated for the last four years and we are surprised that the New York Sun should take it up at this date as something new."

Evidence That Disease Was Subsiding

According to the Santa Ana Blade (PWSR, v. 24, No. 9, p. 4, July 15, 1890), the ". . .vines are sprouting roots which were supposed to be dead . . . the wild grape is in a healthy condition. This fact is also pointed to as an indication that the dreaded vine disease has disappeared and that it was perhaps only an epidemic . . ." On the same page of the Review it was also stated that "General E. E. Hewitt, who has recently returned from a trip through Orange county . . . announces that . . . the people grow more and more confident that the disease has got to the end of its career." Continuing in this optimistic vein the next issue (PWSR, v. 24, No. 10, p. 12, July 30, 1890) quoted from the July crop report of the U.S. Dept. of Agriculture on California grapes, ". . .from the latest reports, it seems that the mysterious

vine disease of the south has run its course." In the next issue of the Review (v. 24, No. 11, p. 12, Aug. 15, 1890) it was stated that "Superintendent Watkins of the San Gabriel Wine Company, after having inspected the vines of Riverside, Redlands and San Bernardino, concludes that the Anaheim disease has run its course, as he found vines looking healthy,"

Dowlen Tries Root Injection Again

Dowlen's report of Aug. 1, 1890, appeared (PWSR, v. 24, No. 11, p. 3, Aug. 15, 1890) under the heading, The Anaheim Disease. Every Indication That It Is At Last Dying Out. He stated that " . . . a considerable amount of time has been given to the careful inspection of vineyards in order to detect the first indications of increase of disease amongst vines which were not affected last year, but happily, no such increase has been found, . . . only those vines show disease which were affected last year, and many which were affected last year do not show any sign this year. . . . During the month some diseased vines have been experimented upon by introducing substances in solution directly into the sap by means of glass tubes attached to the roots. The tubes were about three feet in length, and one and one half inches in diameter, attachment being made by short pieces of rubber tube, all the vines treated were Muscats." The substances used were CuSO_4 , Hydro Naphthol, and K_2S . CuSO_4 burned the leaves at the margin. In the next issue (PWSR, v. 24, No. 12, p. 10, Aug. 30, 1890) was an item stating that, "Ethelbert Dowlen . . . has sent in under date of August 1st, an addition to his report read at the last annual meeting . . . in which he shows that the condition of the vines . . . is not so

encouraging as is generally supposed." This was due to heat and the disease.

Riverside Grower Asks Exorbitant Price for His Remedy

The minutes of the meeting of the executive committee of the Viticultural Commissioners (B. Lib., Ms C-A353, v. 2, p. 20) on July 28, 1890, record, "A letter from a Riverside grape grower referred by B. M. Lelong of the State Board of Horticulture offering a remedy for the Anaheim disease for \$333,333 to \$500,000. The secretary was instructed to frame an appropriate reply."

Wetmore Reviews Dowlen's Work But Favors Non-Parasitic Theory;

Arizona Evidence

Replying to an inquiry, Commissioner C. A. Wetmore wrote a letter to R. J. Creighton, Esq., New Zealand government agent in San Francisco (PWSR, v. 24, No. 12, p. 2, Aug. 30, 1890) saying, "In reference to diseases now existing in this State, I would refer you to the very able and extended reports of Prof. Ethelbert Dowlen, the viticultural expert of this Commission, which are the results of investigations conducted under the personal supervision of Hon. J. De Barth Shorb These reports have been published regularly for the last year and a half in the Pacific Wine and Spirit Review. . . . this so-called disease has resulted in the destruction during the past five years, of 10,000 or 12,000 acres of vines in the extreme southern counties of this State, The most skillfull investigations--one on the part of this Commission, and the other from the Department of Agriculture at

Washington--have, as yet, failed to discover and describe any specific parasite, as the cause of this destruction. At the present time it appears that the ravages noticeable during the past five years have, for some cause, been arrested, and it is the prevailing opinion that the disease is disappearing. . . . My own belief has been that the disease has been caused by unusual climatic conditions, affecting the soil and root vitality of the plant. I do not think that any specific bacteria or fungus has been the cause of the trouble. . . . The trouble has seemed to me . . . to be an affection of the vitality of the root-lets, brought about by abnormal soil conditions--the primary cause unusual floods and rains five years ago, more or less replicated since. . . . The fact that there has been no specific disease capable of being disseminated by infection or contagion, is partly demonstrated by the fact that . . . large numbers of cuttings . . . taken from vines then attacked, and planted in Arizona . . . " in general were healthy while those planted " . . . adjacent to the original vineyards have died."

Dowlen's Last Reports; Field Survey of Coastal Counties

A news item in the Review (PWSR, v.25, No. 1, p. 15, Sept. 15, 1890) stated that, "J. De Barth Shorb has been in the city He shares Mr. Dowlen's confidence that the Anaheim disease will soon be a thing of the past." It was also stated that, "Ethelbert Dowlen . . . has been in the Sweetwater valley, San Diego county, during the past fortnight, and reports there is considerably less disease . . . than there was one year ago. The same is true of El Cajon valley. . . . the chances are that this year will see the last of the disease."

A month later (PWSR, v. 25, No. 3, Oct. 15, 1890) the Review stated, "Ethelbert Dowlen, the Special Agent for the Viticultural Commissioners . . . has sent his forty-fourth report to the Commission through Hon. J. De Barth Shorb." Then followed his report of Oct. 1, 1890, and in it he said, "In and . . . around San Gabriel the vines have, in some vineyards, suffered considerably . . . there are some new cases. . . . after the first week in June, which was an extremely hot period, the disease began to show in the foliage" At El Cajon, Sweetwater valley and Sequan valley, ". . . when the vineyards were seen in July of last year--Report 33--the Anaheim disease had made its first appearance." It was not so widespread now. In general, "The vines throughout this district were in excellent condition, . . . Among the wild vines, there is . . . not so much disease as there was last year." He thought a loss of leaves after the hot spell might, or might not have been due to the disease. Canes were " . . . examined under the microscope and in the majority of cases, there were no indications of disease found in the tissues." There was an abundance of starch.

Dowlen's report of Dec. 1, 1890, apparently the last of the series of 45 (PWSR, v. 25, No. 7, p. 14, Dec. 15, 1890), but not his last report, was read at the Dec. 9, 1890, meeting of the Commissioners. He said he had visited San Luis Obispo, Santa Barbara, Ventura and Orange counties, and "In San Luis Obispo county . . . a few vines were noticed which showed some of the peculiarly marked foliage . . . " of the Anaheim disease, but growers had seen this every year and it had done no damage. In Santa Barbara county, " . . . no signs of the Anaheim disease were seen," and the same was true of Ventura county. In Orange county,

". . . there is an improvement in the condition of the vines. Here and there may be found vines which have lived through all the attacks of the Anaheim disease. In one vineyard some seventy acres of vines have been saved. . . . New vineyards have been set out . . . on one property fifty-six acres have been set out. The oldest of these new vines are three years of age; the youngest were set out this year. Nearly all of these new vines are Muscat. . . . The older vines show, in places a little disease, but by far the greater proportion of those set out this year show no disease. Some plots are entirely free; . . . in Orange county the Anaheim disease is evidently not so virulent as in past years . . . though the trouble has by no means passed away, the outlook for viticulture is much more hopeful than it was twelve months ago . . . Many people are looking forward to again setting out vines during the coming season."

Commissioners Terminate Dowlen's Appointment

An article in the Review (PWSR, v. 25, No. 7, p. 20, Dec. 15, 1890) under the title, Viticultural Commissioners, Business Transacted at Their Regular Semi-annual Meeting, contained the statement that, "Expert Dowlen's monthly report on the southern vine disease was read and placed on file, and it was decided to dispense with Mr. Dowlen's services as an investigator of the vine disease. Mr. Dowlen's report appears elsewhere in this issue." Another report on this meeting of the Commissioners (CFG, v. 7, p. 374, 1890) stated that "The report of Mr. Dowlen . . . was read and placed on file, and his services were discontinued, except when especially needed . . . for special investigations."

The minutes of the Dec. 9, 1890, meeting of the Commissioners show that two resolutions offered by Commissioner Doyle (BSVC Rep. 1891-92, p. 68, 1892) were adopted, as follows:

"Resolved: That the services of Ethelbert Dowlen be dispensed with after the conclusion of his current month of service . . . "

"Resolved: That the Executive Committee be authorized, if they are of the opinion that Mr. Dowlen's services should be continued for a brief period, to enable him to close pending work, to arrange with him for that purpose." On Dec. 10, 1890, Secretary Winfield Scott (HEH. Lib.) notified Shorb that the Board had voted to dispense with the services of Dowlen.

The minutes of the April 1, 1891, meeting of the executive committee of the Viticultural Commissioners (B. Lib., Ms C-A353, v. 2, p. 23) stated that "A letter was read from Commissioner J. De Barth Shorb relative to the disposal of the Greenhouse on his premises at San Gabriel, and used by Prof. Ethelbert Dowlen during the investigations of the Anaheim disease." Also, "A letter was read from Ethelbert Dowlen notifying the Board that inasmuch as the Anaheim Disease investigation had been brought to an end, Mr. Shorb would hold the Board responsible for all future expenses to which he might be put in connection with the disease."

The minutes of the next meeting of the Commissioners, June 8, 1891 (BSVC Rep. 1891-92, p. 70, 1892) showed that, "The further management of the Anaheim disease investigation was brought up by the Secretary, and, after an informal discussion, it was decided that all matters and communications pertaining to the subject should be referred to Commissioner Shorb." He had been the committee of one on the disease and now

Commissioner E. C. Bichowsky of Los Angeles County was added to the Committee on June 13, 1892.

More New Cures Claimed

The minutes of the April 1, 1890, meeting of the Commissioners' executive committee (B. Lib., Ms-c-A353, v. 2, p. 23) stated that, " . . . a letter was read from H. G. Hiett of Riverside regarding his proposed remedy for the Anaheim disease."

"On motion of Commissioner Doyle it was decided that the Secretary write Mr. Shorb, and request him (Mr. Shorb) to make inquiries and an investigation of Mr. Hiett's proposed remedy; and to request Commr. Shorb to notify the Board within what limit of expense an experimental test of the efficacy of the method can be made, on a sufficiently large scale to give satisfactory results."

A news note (PWSR, v. 26, No. 8, p. 12, May 20, 1891) announced that, "J. Cozad, of Lapresa, San Diego County, has announced to the Viti-cultural Commissioners a new and, he claims, a certain remedy and preventive of the Anaheim Disease." With regard to this, Dowlen wrote from San Gabriel on June 20 (PWSR, v. 26, No. 11, p. 23, July 6, 1891) that Cozad's treatment consisted of pruning to leave one or two buds and applying a white lead and oil paint to the freshly cut surfaces. As to its efficacy, "It is not possible to give any opinion . . . " as yet.

Reports in 1891 By Dowlen and Others

Reporting on The Anaheim Disease (PWSR, v. 26, No. 12, p. 24, July 21, 1891), Dowlen said, " . . . the proportion of vines newly affected by

the disease is not so great at present, as at the corresponding period of last year. . . Many vines . . . having died during the winter. This is a repetition of what occurred in the winter of 1889-1890 . . ." The first signs of the disease had appeared the first week in June, mostly in vines that were diseased the previous year. Cool weather had held the disease back.

Albert Brigden of the Sierra Madre vineyard stated (PWSR, v. 26, No. 1, p. 19, Jan. 26, 1891) that, "Owing to the vine disease, the Mission grape is almost a thing of the past, only a few vineyards along the mountain slopes remaining, . . . The disease has apparently gone whence it came." But later (PWSR, v. 27, No. 1, p. 15, Aug. 5, 1891) he said, "The Anaheim disease is . . . very prominent and fully equal to last year's ravages . . ."

Major H. Gardner, in a census report for Los Angeles county (PWSR, v. 26, No. 5, Mar. 30, 1891), included the fact that "A new and mysterious disease attacked the vines of the southern portion of this district about 1885, and ruined more than one-half of the acreage."

The wine report from Orange county (PWSR, v. 27, No. 8, p. 11, Nov. 20, 1891) was, "Charles Otto Rust, Anaheim, -Fifty thousand gallons will cover the entire product, the vine disease having killed nearly all the vines." The next year, Rust reported (PWSR, v. 29, No. 5, p. 15, Oct. 5, 1892), "The vines are apparently free from disease and the crop is 10 to 25 per-cent larger than last year."

Pierce in Mediterranean Region Studying Grape Diseases

Regarding Pierce's five-months trip in the Mediterranean region, while on leave without pay, Galloway said (U.S. Sec. Agr. Rep. 1890, p. 405-406, 1891), "The entire time was devoted to an active review of the workings of the vine diseases of the Mediterranean region. After

passing from the northern to the southern portion of France, the leading vine regions . . . were visited from below Bordeaux to the Italian line. . . . From France he entered Italy . . . visiting the vineyards and many of the leading scientists The diseases of the province of Naples and adjoining provinces had his attention for upwards of seven weeks. From Naples he passed to Sicily Those regions where Mal Nero had done its worst work received most of his time. . . . Some 600 or 700 miles of travel were made through the Regency of Tunis and the departments of Constantine and Algiers. . . . His trip comprises over 15,000 miles Numerous diseases not yet known in America were encountered A report embodying the results of Mr. Pierce's investigations . . . is now being prepared" Among the scientists he consulted (Bul. 2, p. 12) were Foex and Millardet in France and Briosi, Cavara, Cugini, Targioni-Tozzetti, Cuboni, Comes and Savastano in Italy.

"The investigations abroad," said Galloway later (Bul. 2, p. 9), "were carried on wholly at Mr. Pierce's expense, he at his own request being granted a leave of absence for six month's without pay, in order that he might devote his entire attention to the work."

The editor of the Rural Californian, H. W. Kruckeberg (RC, v. 15, p. 666, Dec., 1892) remarked, "There is one feature about Prof. Pierce's labors . . . which appeals to every soil tiller's sympathy and gratitude. . . . he found it expedient . . . to go abroad and visit the grape growing countries . . . where it was said a similar disease prevailed. . . . Prof. Pierce . . . spent six months in France, Italy, Sicily and Algeria at his own expense. If there ever was any question touching Prof. Pierce's ability to learn the direct cause of the disease

and possibly discover a remedy, there can be none of his sincerity and the interest he has in his work in the light of his personal expenditures in the interests of Southern California horticulture."

Pierce's classic bulletin (Bul. 2) on the California Vine Disease was based on his first ten months field work in California and his five months trip abroad. The exact dates (perhaps April-Aug., 1890) of his trip, I have not discovered. Interesting information about Pierce at this period is presented by Andrew Denny Rodgers III in his book on Erwin F. Smith. Rodgers had access to the many letters Pierce sent to Smith and Galloway from California and during his trip abroad. Late in 1890, it seems, "Smith informed Farlow concerning the return from studies abroad of Newton B. Pierce . . . " (Rodgers, p. 204-5) saying, "Pierce, our special agent at work on the California vine disease, has come back from six months in the vineyards of Mediterranean Europe and Africa--full of new facts and interesting observations. There was no money available for investigation in foreign countries. So he paid his own expenses. He is now writing a preliminary report upon the California disease. Until conversation with him this winter I had really a very inadequate notion of its extent and destructiveness. It is worse even than peach yellows in Delaware."

Pierce had written to Smith from Naples, Italy, " . . . I am not ready to speak yet relative to Mal Nero and our disease" Later he (Rodgers, p. 206) wrote from Palermo, Sicily, " . . . I am overjoyed at my opportunity to study my matter in Europe, and I feel that I will lose nothing in the end even if it will cost me about a thousand dollars besides losing several months salary."

"Returning to America," Pierce, as Rodgers (p. 206) tells us, "immediately began to prepare his report on the California vine disease, . . ." and on May 5, 1891, wrote (Rodgers, p. 207) to Smith, ". . . I am now beginning to see daylight through the other side of my report. . . . I expect to complete the ms. in two to three weeks. Have to consider non-parasitic diseases, the nature of disease, and methods of treatment tried. I have also to write the opening chapter on the 'situation'. Probably may have to speak of the hot-house experiments . . . I have said nothing of my experiments in California along that line, and don't care to until the work is more complete--hope Mr. Galloway will think the same about the hot-house work as its results were all negative."

Pierce submitted his manuscript to Galloway on June 15, 1891 (Bul.2, p. 11) saying, ". . . I have the honor to submit herewith a preliminary report of my investigations of the California vine disease," and ". . . respecting certain vine diseases of the Mediterranean region which resemble the California malady . . ."

Galloway did not submit the manuscript for publication until April 15, 1892.

This bulletin is a monograph of Pierce's most important contributions to the knowledge of this disease. As Pierce (p. 11) says in the introduction, it ". . . gives the main facts I have been able to gather . . . during something over ten months of investigation in California." He referred to his foreign work "done in France, Italy, Sicily and

Algeria . . . ", saying, " . . . my foreign notes have been freely drawn upon . . . ". "The work thus far," he said, "has been done largely in the field, extended laboratory investigations having been impossible, owing to lack of time. . . . I can say with confidence that several lines of inquiry at first important have been practically closed, others are nearly closed, and still promising lines . . . will be carefully pursued." But these lines led to nothing as important as what he had already presented in this bulletin.

He described the origin and growth of the vine industry, the symptoms of the disease in detail, its early spread in Orange county, and its disastrous consequences. Then followed a marshalling of the copious evidence he had gathered on the relation of soil, shade, rainfall, temperature, insects and fungi to the disease, on varietal differences in susceptibility, and on control methods and remedies tried. He also described the European diseases he had studied, showing how they differed from his disease. He justified his detailed description of symptoms (Bul. 2, p. 206) of his disease, saying, "To understand the value of these records we have only to note how large a percentage of human diseases are alone diagnosed by an examination of the state of the patient."

In its wealth of observational evidence convincingly presented in first person direct discourse, this bulletin is reminiscent of Darwin's writings. Though Pierce referred to the observations of Morse and of Scribner and Viala, he gathered most of his evidence in person and at first hand. It seems strange that he more or less ignored what had already been done by the Viticultural Commission, that is, by Wheeler, Shorb, Dowlen and Harkness. Some of this was in print before May 23, 1889, when Pierce arrived, and much more before he wrote his

bulletin. For example, a paper by Wheeler and the first 14 of Dowlen's weekly reports were published in the S.F. Merchant, Jan. 4, 1889, and two in the L.A. Herald in February. There were other articles in the Merchant, in the California Fruit Grower and in the Pacific Rural Press about Shorb and Dowlen's work before Pierce arrived. Dowlen had described the symptoms, discounted the climate and soil theories as to cause, observed the beneficial effect of shade, and recorded the varietal differences. In discussing the fungi, it is also strange that Pierce did not cite Harkness's negative findings, which were so well publicized.

Pierce's Conclusions

Pierce's studies nullified most, if not all, of the current theories about the cause of the disease and its remedies. The only environmental factor he found significant was shade, which appeared to offer some protection against the disease (Bul. 2, p. 111). In his opinion (p. 207) "The investigations into the effects of shade seem to be of prime importance." He suspected that bacteria might be the pathogen he was seeking. "That bacteria are present in the diseased vines," he said (p. 208), "is quite clearly established. They have been isolated and cultivated in various media. Several series of inoculation experiments with healthy vines have been conducted in California, besides others by Mr. B. T. Galloway, at Washington. . . . That the bacteria . . . bear any causal relation to the disease is not, however, established and may be very justly questioned." This last reservation proved to be prophetic, since none of the inoculations with bacteria ever produced the disease.

Pierce's main conclusions were that the disease was apparently not identical with any of the European diseases he studied; that it

was capable of spreading from vine to vine and persisting from year to year, and was not the transitory effect of weather or soil; that although vinifera grapes had been grown in California for more than a hundred years, nothing like this had ever been experienced before; that no living organism had been identified as its cause; and that (p. 209), "The observed phenomena would be in the main explained if there were a form of micro-organism within the vine capable of altering the normal physiological relations of the plant at the heat of the season, and which organism began to spread in the Santa Ana Valley about the year 1884." He found that cuttings from diseased plants (p. 152) produced diseased plants and cuttings from healthy plants planted in the affected districts lived longer than those from diseased plants but also became diseased.

Vine Disease Similar to Peach Yellows

"The mysterious grape vine disease," said the editor of the California Fruit Grower (CFG, v. 8, p. 99, Feb. 14, 1891), "belongs to the same class of diseases as the peach yellows of the Eastern States" The editor, presumably B. N. Rowley, may have gotten this idea from Pierce before he left for Europe, but he deserves credit for such accurate comparison. Pierce said in 1895 (USDA Farmers' Bul. 30, p. 8, 1895) that, "Considering its injurious nature, the obscurity of its cause, and the extent of its ravages, it may be classed with peach yellows."

Since Pierce was frequently corresponding with Erwin F. Smith, who was studying peach yellows, then very destructive in the east, he must have benefited to a considerable degree from Smith's ideas about peach yellows, when trying to understand the equally baffling and

somewhat similar grape disease. It is easy to imagine that this was one reason Pierce searched for a bacterial pathogen. Since Smith obtained graft transmission of peach yellows, Pierce must have known this but apparently made no great effort to find out if the grape disease was graft transmissible, though grafting and inarching experiments at Washington are mentioned.

Pierce Returns to Santa Ana; Negative Results With Bacteria

After completing the manuscript of his Bulletin No. 2, Pierce, according to Rodgers, returned to California in the summer of 1891 by way of the northern parts of the state, and conferred with Hilgard and Harkness. From Santa Ana (Rodgers, p. 233), Pierce wrote to Galloway on Aug. 4, 1891, as follows: "I came down to Orange and through the Santa Ana valley Monday the 3rd. The old vines throughout this valley . . . are now nearly all removed. . . ." He had " . . . perhaps 25-30 small test vineyards now already started . . . from cuttings and rooted plants procured from unaffected districts and from new vines of this district, set previously. I have already visited seven of these new vineyards. The outlook is good."

for
In his report/the year 1891 Galloway said (U.S. Sec. Agr. Rep. 1891, p. 371-2, 1892) that Pierce arrived back in California on July 15, 1891, and that, "A month was devoted to observation in various parts of the State. . . . the dreaded vine disease of California is almost wholly confined to the counties of the southern district. . . . it is advised that no cuttings be planted except those procured from districts known beyond question to be free from this malady. No cuttings should be used which have been made in Orange, Los Angeles, or San

Bernardino counties, more especially if taken from old vines. . . . After locating at Santa Ana, steps were taken to fit up a laboratory for bacteriological work. At present somewhat over two months of work has been done on the vine disease. . . .no medium tried has led to the isolation and growth of microorganisms in sufficient numbers or with sufficient constancy, from the diseased vines, to lead to a belief that such organisms could with probability be the inciting cause of the disease. . . .observations in the field . . . point strongly to a disordered state of the fluids of the vine." This is suggestive of the constitutional derangement invoked by C. A. Wetmore.

In the Nov. 19, 1892, issue of the Pacific Rural Press (v. 44, p. 420) the editor published this letter from Pierce. "To the editor:--Our preliminary bulletin on the California Vine Disease is about to appear from the Government press. Wishing it to reach those who would be most interested . . . it would give me pleasure to forward such names as you may think proper to recommend for copies in your region. The edition is limited, . . . Newton B. Pierce, Special Agent." A similar notice was in the Pacific Wine and Spirit Review (v. 29, No. 9, p. 11, Dec. 5, 1892).

This bulletin, said Kruckeberg, editor of the Rural California (v. 15, p. 666, Dec., 1892) " . . .evinces careful research and a keen analytical insight into the diverse conditions of soils and climates and methods of cultivation . . ." Pierce's former critics characterized it as " . . .a welcome addition to the viticultural literature of the state," (PWSR, v. 29, No. 10, p. 24, Dec. 20, 1892).

C. J. Wetmore Visits Southern Vineyards

An article (PWSR, v. 27, No. 9, p. 18, Dec. 5, 1891) on Viticulture in Southern California described a visit to southern California in November, 1891, By Clarence J. Wetmore, Chief Viticultural Officer. "Mr. Wetmore has made the first thorough . . . examination . . . since

the Dowlen investigation ceased Mr. Wetmore is inclined to believe that the abatement in the disease reported from time to time is more because there are few vines left to work on than that the disease is dying out. Even in the San Gabriel valley the losses have been very heavy and many of the old-time vineyardists have announced their intention of retiring for good from the wine business. . . . He says that the total acreage of vineyards cleaned out by the Anaheim disease must reach close to 20,000 acres."

C. J. Wetmore's report to the Viticultural Commissioners at their meeting on Dec. 18, 1891, was published in the Pacific Wine and Spirit Review (v. 27, No. 10, p. 9-10, Dec. 21, 1891) and later in the Commissioners' biennial report (BSVC Rep. 1891-92, p. 21-26, 1892). It read as follows: "In the Southern counties the viticultural industry has changed more during the past four years than any other portion of the State. In 1886 the counties of Los Angeles and San Bernardino produced 4,000,000 gallons of wine while during the past season but 500,000 gallons were made. This great reduction was due to the Anaheim disease, which for the past four years has destroyed all the vineyards around Orange, Santa Ana and Anaheim and a large portion of the vineyards in other parts of Los Angeles county. It is estimated that at least 20,000 acres of vines have been destroyed. Before this disease appeared the vineyards in the vicinity of Orange yielded the owners \$500,000 a year. In two years' time all of the vineyards were killed. A few small vineyards near Orange were planted last spring for the purpose of determining whether the vine disease had died out or not. The vines have made a good growth and so far show no signs of disease. If they continue to thrive next year a great many vineyards will be planted

in that neighborhood the following year. The disease has also appeared in San Bernardino county but has not done as much damage as in Los Angeles county. At Riverside, wherever it shows itself the vines are taken up and oranges planted. The area in vines around Riverside is yearly decreasing. . . . In the neighborhood of San Bernardino a great many Mission vines have been killed by the disease. This disease seems to have a liking for the Mission vines for wherever it appeared the Mission vines were among the first to go. At the Sunny Slope vineyards all of the Mission vines have been killed, while the disease has only partially killed the other varieties. It was thought that the disease had appeared in San Diego county in the El Cajon Valley. The only vines that I could find in that valley that were not doing well were those that had been planted in alkali spots."

Millardet's Soil Microorganism Theory

Pierce, when he was in France, visited Millardet at Bordeaux, who later, in an article on A New Danger for Viticulture (Jour. d'Agr. Prat. v. 54, No. 1, p. 79-80, 1890; Rev. Hort., v. 62, p. 385-390, 1890) referred to Viala's work on the Maladie de Californie, and to the recent visit from a representative (Pierce) of the U.S. Secretary of Agriculture in charge of the study of that disease. He had crossed the Atlantic to see if the disease occurred in Europe, since it seemed to resemble the mal nero of Italy. His pictures and description of the California disease made Millardet suspect that it was caused by a soil micro-organism that invaded the roots. Millardet referred to Viala's warning that the disease could be carried in cuttings and advocated strict measures to prevent the importation into France not only of vines,

cuttings and even dried grapes, but of all plants which might carry the organism in soil adhering to their roots.

French Quarantine Against American Vines

These recommendations resulted in a quarantine against importation of vines from North America. As A. de Ceris expressed it (*Jour. d'Agr. Prat.*, v. 56, No. 1, p. 406, 1892; *Rev. Hort.*, v. 64, p. 193-197, 1892), ". . . because of the new disease reported in California, vines produced in North America will not be admitted under any pretext into the territory of the French Republic."

Viala's Slime Mold Theory; Pierce's Rebuttal

Microscopic examination of the dried diseased grape leaves Viala had collected at Orange in October, 1887, led Viala and C. Sauvageau (*C. R. Acad. Sci.*, v. 115, p. 67-69, 1892; *Ann. Ecole Agr. Montpellier*, v. 7, p. 87-108, 1892; *Jour. De Bot.*, v. 6, p. 355, 378, 1892) years later to think that they saw a slime mold within the palisade and spongy parenchyma cells. This they named *Plasmodiophora californica* and claimed was the cause of the disease. They did not find spores. They thought the disease was not related to the mal nero of Italy nor the folletage and rougeot diseases of France. They pointed out that the disease was carried in the cuttings, diseased cuttings giving rise to diseased vines. They referred to Pierce's bulletin and to letters from Dowlen. False hopes were aroused. "Now that the cause is known," said the editor of the *Pacific Wine and Spirit Review* (v. 30, No. 5, p. 11, Apr. 5, 1893), "it will be less difficult to work for a cure . . ."

Pierce (*PRP*, v. 72, p. 359, 1906; *C. F. G.*, v. 34, No. 957, p. 14, Nov. 10, 1906) years later explained that Viala and Sauvageau mistook

coagulated protoplasm of the cell for a slime mold.

Pierce Recommends Use of Disease-Free Cuttings

D. N. Rowley, editor of the California Fruit Grower (v. 10, p. 154, Mar. 5, 1892) said, "Newton B. Pierce . . . claims . . . that the greatest care should be taken to make cuttings from perfectly healthy vines."

H. W. Kruckeberg, editor of the Rural Californian (v. 15, p. 129, March, 1892) quoted Pierce regarding the "mysterious vine disease": "Great pains should be taken in procuring cuttings for planting in a region where the disease does not already exist. . . . due care should always be taken to the health of the vines from which cuttings are taken."

Pierce, in his 1891 report (U.S. Sec. Agr. Rep. 1891, p. 371-2, 1892), urged that only known healthy cuttings be used, and none from the "infected districts." In his discussion of the disease in his Farmers Bulletin 30, 1895, Pierce said, " . . . the setting of healthy cuttings can now be recommended with more confidence than formerly. Numerous vineyards are growing and bearing well which were started from healthy vines, while the disease is still apparent in many vineyards set from cuttings procured within the infected district. . . . the vineyards of the great San Joaquin Valley can be recommended as a . . . source of supply for healthy cuttings."

Shorb's Final Reports; Disease Subsiding; Comment on Pierce

In his presidential report to the Viticultural Commissioners for the year ending July 1, 1892, J. De Barth Shorb (SBVC Rep. 1891-92,

p. 7-17, 1892) stated that, "The investigation into the cause and remedy for the so-called Anaheim disease has ceased. I am of the opinion that this disease has about run its course in Southern California, after having destroyed, in round numbers, from fifteen thousand to eighteen thousand acres of vines. Its origin, its nature, and its cure are still unknown and as mysterious as the day the disease was first noticed."

In a special report to the Commissioners, Aug. 8, 1892, (SBVC Rep. 1891-92, p. 39-41, 1892; PWSR, v. 29, No. 2, p. 24, Aug. 20, 1892; PRP, v. 44, p. 213-4, Sept. 10, 1892; RC, v. 15, p. 522-3, 1892) on the Present Condition of the Vineyards of the Southern Counties With Respect to the Anaheim Disease, Shorb told them that, "The vineyards . . . may be generally said to be in better condition than they were when the special investigation into the Anaheim disease was stopped at the beginning of 1891. Since that time there has been a steady decrease in the amount of disease. In some places it appears to have quite disappeared. . . . In the county of Orange, where the disease first originated, and where practically every vine was destroyed, all the young vines recently planted are in a very flourishing condition; and it may be said with confidence that the disease has there run its decimating course." The disease was never serious in the El Cajon valley ". . . where a government scientist sent out from Washington to examine into this remarkable disease saw evidence of it throughout all the vineyards and announced to the people as the result of his investigations that within another year there would not be enough grapes grown in the valley to supply the home consumption of table grapes in San Diego City and County. I was assured by one gentleman in charge of the largest vineyard there, that this ill-advised statement has cost El Cajon Valley

not less than \$200,000, by frightening away intending investors."

Shorb referred, of course, to Pierce's field trip to San Diego county in August, 1889, with Inspector Jones. The gloomy prediction above mentioned was attributed to them by the editor of the Merchant and Viticulturist (v. 23, No. 1, p. 15, Sept. 8, 1889). It is not certain, however, that Pierce, himself, made such a prediction.

Commissioners Reimburse Shorb

At their meeting, Nov. 10, 1892, the executive Committee of the Viticultural Commissioners (B. Lib., Ms. c-A253, v. 2, p. 44), "A letter from Commissioner Shorb in relation to expenses incurred in reference to the Anaheim Disease was read. A long discussion followed. The matter was settled by the adoption of the following resolution, offered by Mr. Priber:"

"Resolved: -That the Secretary be instructed to inform Commissioner Shorb, the Chairman of the Special Committee on Anaheim disease, that inasmuch as the funds now at the disposal of the Board for investigating diseases have been limited by unavoidable expenses in the counties infested by Phylloxera, he be requested to submit a statement of probable expenses to the Executive Committee before undertaking any further special investigations."

At the meeting of the Viticultural Commissioners on Dec. 12, 1892 (BSVC Rep. 1893-94, p. 64, 1894), "Commissioner Shorb brought up the matter of the expenses incurred in looking after the Anaheim disease. He said that the matter had been a source of constant and considerable expense to him, and that he should be entitled to reason-

able recompense as expert when actually engaged. Several Commissioners expressed a similar view. . . . the matter was referred to the Executive Committee with power to act"

The executive committee met on Dec. 20, 1892 (B. Lib. Ms. C-A353, v. 2, p. 46) and "The bill of Commissioner Shorb of \$62.50 for expert work in connection with the Anaheim disease was . . . brought up. The matter was settled by referring the bill to Chief Executive Officer Wetmore with instructions to so itemize the bill with Mr. Shorb's consent, that it would meet with approval by the proper authorities."

James De Barth Shorb

The Hon. James De Barth Shorb, of the Board of State Viticultural Commissioners, who directed their investigations of the grape disease, was a prominent, public spirited and energetic man. Assigned the responsibility of studying and trying to control a baffling plant disease, a task for which he had no special training nor experience, he had the wisdom to employ a man he thought was an expert, to concentrate on the problem and solve it if possible. Instead of seeking advice from agricultural or botanical scientists as to how to find a qualified plant pathologist, he apparently engaged a man who applied to him for the position. This was Ethelbert Dowlen, who happened to be in Los Angeles, and as a botanist and microscopist impressed Shorb as having the kind of ability necessary to solve the problem. Unfortunately, Shorb overestimated Dowlen's competence as a plant pathologist and this led to unpleasant and embarrassing developments.

Shorb deserves credit for providing vineyards and a hothouse for Dowlen's experiments, for whole-hearted and enthusiastic support of

Dowlen and his work, and for his broadminded grasp and understanding of this disease problem and its scientific, economic and even political aspects. He was, to be sure, too sanguine about the virtues of a fungicide as a means of control, but he had faith in the importance of research. He was noted for ". . . his sturdy honesty, executive ability and judgment. . ." (RC, v. 19, p. 212, May, 1896).

Shorb was one of the founders of the Board of State Viticultural Commissioners in 1880 and was elected its president in 1891. He was active in the Southern California Horticultural Society and was on the editorial board of its short-lived (1877-1879) journal, Southern California Horticulturist. He was the first president of the San Gabriel Valley Railroad and the Pasadena and Alhambra Railroad.

Born in Maryland, April 4, 1842, he was the son of Dr. James A. Shorb, a large landowner (PWSR, v. 26, No. 4, p. 10, 1891; RC, v. 16, p. 467-8, 1893; Studer, R.P., v. 1, p. 51-53, 83; Lewis and Co., History, L.A. county, p. 813, 1889; B. Lib., Ms. C-D 810). He graduated from St. Mary's College, Emmetsburg, Md., in 1859 and came to California in 1864, apparently as a civil engineer. He is said to have surveyed Pt. Lobos for a fort. In 1867 he married Maria Jesus Wilson, whose father, B. D. Wilson, was a prominent pioneer viticulturist at San Gabriel, and whose mother was a granddaughter of Don Bernard Yorba of the Santa Anita Rancho (HEH. Lib., Ethel Shorb autobiography). The Shorbs had 9 children and lived in a 30-room 3-storey house in San Marino. The name of one of their daughters, Ramona, was immortalized by a family friend, Helen Hunt Jackson, the author.

Shorb developed a water system for Pasadena, Alhambra and San Gabriel and surveyed and sub-divided the land for Alhambra and Pasadena. He was a far sighted man, e.g. was interested in arc lights and macadamized

roads very early, and in tree surgery. He loved nature. He was willing to experiment. For example, in 1873 he tried to control orchard tree insects by placing sulfur in holes bored in the trunk (CSBH Rep. 1891, p. 395) and was among the first to fumigate trees to control scale insects (Essig, p. 470). He died in 1896.

Commissioner Bichowsky's May, 1892, Report

In the transactions of the eighth annual viticultural convention, held in Irving Hall, San Francisco, May 18-19, 1892, Commissioner E. C. Bichowsky of San Gabriel (BSVG Rep., 1891-92, p. 129, 1892) said, "As far as the southern part of the State is concerned, . . . we have . . . suffered very much from a disease . . . Some call it Anaheim disease and some call it by other names, . . . we are aware of the effects of that disease . . . In the past year the disease has not been as bad as usual. . . . We have lost from that disease on our property about one hundred and sixty five acres. Last year several experiments were made in different parts of Southern California, of replanting vines on land which had formerly grown vineyard and which had died. I fell in line with the experiment, and set out fifty acres of Mission. They did well, and are apparently . . . healthy. . . . the seedless Sultana seems to be affected, and we have condemned two large lots the Trousseau is more affected than ever; it has lost strength, and I have come to the conclusion that the disease is not a thing that can be opposed . . . the Burger shows very little sign, and the Blanc Elba shows no sign."

It was reported (PWSR, v. 30, No. 5, p. 15, Apr. 5, 1893) that he ". . . set out about 100,000 vines . . . These are practically the only vines set out in . . . the section affected by the Anaheim Disease since the destruction of the vineyards began."

Anaheim Gazette and Vineyardists Optimistic

Under the title, Grapes to the Front, the Pacific Rural Press (v. 43, p. 484, May 21, 1892) quoted from the Anaheim Gazette that, " . . . there is a reawakening of interest in this industry, based upon the universal impression that the vine disease has run its course. . . . the last lingering trace of the disease has vanished quite mysteriously as it came. . . . On every hand prevails the opinion that we have come out of the dread scourge, and that grape-growing will soon take on again the magnificent proportions of the past."

D. Edson Smith of Santa Ana, in his paper read at the Pomological Society of Southern California meetings at Pomona, in November, 1892 (RC, v. 15, p. 651, Dec., 1892) said that in his Muscat vineyard, "This disease seems to have left us; a few two year old vines . . . are now doing well."

After Pierce had read a paper on fungus diseases at a meeting of the Pomological Society of Southern California, at Redlands, May 5, 1892 (RC, v. 15, p. 305, June, 1892), Mr. Boyd of Riverside asked, "I should like to ask if the mysterious vine disease . . . has entirely disappeared?" "Practically, yes." replied Pierce.

Herman Boettcher of the San Pedro Winery (RC, v. 16, p. 466, Sept., 1893) was of the opinion that the disease had run out or disappeared and " . . . new plantings are now being made. He himself will plant vines this coming season."

Bichowsky, Pierce and Dowlen On Field Trip, Oct., 1892

E. C. Bichowsky, Viticultural Commissioner for the Los Angeles district, in his report (BSVC Circ., The Vine in S. Cal., p. 7-10,

1892; PWSR, v. 29, No. 7, p. 25-26, Nov. 5, 1892; BSVC Rep. 1893-94, p. 51-58, 1894), Oct. 27, 1892, referred to a news item in the Los Angeles Times of Oct. 13, 1892, that the Anaheim disease ". . . had again appeared in the section from which it derived its name . . . claiming that the contagious germs remained dormant in the ground . . ." Having supposed that the new planting of healthy Muscat cuttings had remained free from the disease, Bichowsky ". . . determined to investigate the reports . . . On the morning of the 25th inst. I left for Santa Ana accompanied by Professor Ethelbert Dowlen, viticultural expert, . . . At Santa Ana we were met by Mr. E. S. Wallace . . . author of the . . . newspaper article, together with Professor Newton B. Pierce, Government pathologist. This latter gentleman is at present located in Santa Ana, and kindly accepted an invitation to join us. Ten vineyards were visited . . . four of which were entirely free . . . from any signs of disease, while six showed the apparent baneful influence of the destroyer in a greater or less degree. . . . In four of the six infected vineyards . . . the cuttings . . . were obtained from Etiwanda, in San Bernardino county, a district which, at the time of securing these cuttings, was free from disease, but which, in the past eight months, is said to have developed it." The cuttings for one of the other two infected vineyards had come from Elsinore, and for the other, Mr. Nisson's, from San Jose. The San Jose cuttings were from healthy stock, because "Professor Pierce, who has made a study of this particular tract, had written to San Jose, where the cuttings were obtained, to ascertain whether any disease had made its appearance there. He was informed that no disease of the character described by him had shown itself in that valley, and . . . they sent him leaves from the identical vines which furnished cuttings for Mr. Nisson's vineyard.

The leaves were perfectly green, being free from that spotted character so peculiar to the disease." Yet the disease occurred in Nisson's vineyard, the only evidence of "impregnated ground" that was found. Bichowsky then related his personal observation ". . . in the Sunny Slope vineyards located in the San Gabriel Valley: During the height of the disease in this vineyard, a large plot of Mataro vines had every appearance . . . of a very severe attack . . . but contrary to all expectations, the following year the vines made some new growth . . . I have watched this particular plot . . . and . . . today there is not a healthier lot of vines . . . in the valley. . . . This is a very rare case"

The editor of the Pacific Rural Press (v. 44, p. 384, Nov. 5, 1892) quoted from the Orange Post that two representatives of the Viticultural Commission, a Los Angeles Times reporter and Prof. N. B. Pierce ". . . visited ten vineyards in this county . . . all said to be diseased, and found four of them entirely free from the malady. . . . On the other places, . . . evidence of the disease was found, but it is not of the virulent type . . . and there is reason to hope that the evil will be eradicated in a few years."

Dowlen's Survey in San Diego County, 1892

Dowlen turned in a separate report, Oct. 12, 1892, on his survey in San Diego county (BSVC Cir., The Vine in S. Cal., p. 11-13, 1892, PWSR, v. 29, No. 8, p. 29, Nov. 21, 1892), which he made at Shorb's request. It seems that the disease was said to be present in a vineyard near Escondido (PWSR, v. 29, No. 4, p. 13, Sept. 20, 1892) and, "As this was a district not known hitherto as being affected by the Anaheim disease, a journey was at once made to investigate into"

it. The disease was found in the vineyard near Escondido (E. Higler's) and at Vista, but not in the El Cajon or Sweetwater valleys. At Higler's, "The disease had made its first appearance only some eight weeks previous to the visit . . . As this is an entirely new outbreak, it would be interesting to know whether the vines will follow the usual course and eventually die, or whether they will recover, as they have done elsewhere in San Diego County." Many recovered, he found on his return visit the next year. This casts doubt on his diagnosis.

Extolling the advantages of the Escondido valley, P. S. Heffleman (RC, v. 17, p. 78, Feb., 1894) wrote in 1894: " . . . the expert sent here some years ago . . . declared that our vineyards were all doomed-- that the 'vine disease' would soon wipe them out. His report discouraged those who had thought of planting vineyards and even induced some gullible individuals to root up healthy vines and quit the business. . . . Confidence has now been restored, however, and planting will go on the same as ever."

R. H. Hewitt's Report

Reporting on Orange county horticulture, R. H. Hewitt (CSBH Rep. 1892, p. 435-436, 1893) referred to "The prostration which prevailed in this section a few years ago, when a mysterious vine disease ruined every vineyard and pretty near resulted in the same way with their owners throughout the county The ruined vineyards," he said, "have comparatively all succumbed to this unknown disease, and the withered vines have been removed; . . . Anaheim was the slowest to recover . . . The shock of the ruin of vineyards was a staggering blow . . . " to Santa Ana. Referring to Los Angeles county he said

(p. 441), "The unclassified vine disease having destroyed nearly every vine in a large portion of the county, the acreage and product do not count up as in former years. . . . Evidence from all districts which have in the past been scourged with the vine disease seems to tend to the conclusion that the disease has run its course. This is alike true in Los Angeles and Orange Counties. Considerable vine planting has been done in the two years past, and in all cases the vines do well and bear freely, giving no indications that they are affected in any way ."

Hewitt was criticized (RC, v. 16, p. 30, Jan., 1893) for devoting so much space to the disease. "He must have become infatuated with the vine disease, for he gives about one-half of his space to a reference to the blight, which has long since passed out of date."

Dowlen's 1893 Survey

At the meeting of the executive committee of the viticultural commissioners, Feb. 20, 1893, the secretary was instructed (B. Lib., Ms. C-A 353, v. 2, p. 56) to write to Commissioner Bichowsky of San Gabriel "with relation to collection of statistics in the southern part of the state and particularly as to ravages of Anaheim disease." At their May 9 meeting (p. 69), Bichowsky was instructed to collect statistics in Los Angeles, Orange and San Bernardino counties "at a cost not to exceed \$400". This was presumably used to hire Dowlen who made the survey.

On Oct. 9, 1893, Dowlen reported to Bichowsky (BSVC Rep. 1893-94, p. 48-50, 1894; BSVC Cir. The Vineyards of S. Cal., p. 9-11, 1893) on his survey of the vineyards of the Los Angeles district, travelling

"by buggy". "With respect to the Anaheim, or California, disease, . . . This disease remains as vexatious as ever, so far as cause and cure are concerned, but it appears to be slowly losing its deadly power. It . . . starts a little later each year . . . is present over a larger area perhaps than it was last year, but it does not appear to be doing so much injury. . . . on the whole it seems to be slowly decreasing in virulence. In the Santa Ana district . . . although the original vineyard had been dug out some years since on account of disease; . . . some of the old roots have . . . sent out a new growth, which has never yet shown any signs of sickness. . . . In some districts, . . . there is still an inclination to take out vines and replant with citrus fruits. . . . as a rule the disease appears to be much less deadly than it was. In the Cucamonga district . . . the vines were found to be less affected than they were last year. In this connection it must be remembered that in San Diego, San Bernardino, and Riverside Counties the vines have never suffered from disease to the extent they have in some other districts. The newly set out vineyards in Orange County . . . in many instances show no signs of disease; yet many other cases could be found where the first signs of disease could be easily seen, though here, as in other districts, the disease appears to have lost much of its former destructive power. But it is still too early to venture upon any statements on this subject." He also discussed other matters than the disease.

Although Shorb said the special investigations stopped (BSVC Rep. 1891-92, p. 39, 1892) early in 1891, apparently Dowlen was temporarily re-employed in 1892 and again in 1893 by the Commissioners.

The preceding Report of Ethelbert Dowlen, as it is titled in the Commissioners' Circular, The Vineyards of Southern California, is

followed by Dowlen's Report on Vineyards (p. 13-47), his 1893 survey in which he collected statistics on acreage in over 700 vineyards. This must have been a stupendous task and attests his diligence. In E. Higler's vineyard near Escondido, he noted that, "many of the vines which showed signs of disease last year were . . . in perfect health" He also noted the disease in 4 of the 14 vineyards at Lamanda Park, where " . . . vines set out to take the places of those killed by disease in former years are doing well . . . " in two of these vineyards, the Hastings Estate and the Mountain Wine Co. However, A. Brigden's " . . . vineyard is slowly being taken out . . . " and at J. S. Kellogg's " . . . The raisin grapes are nearly extinct; cause, the Anaheim disease." P. S. Martin's vineyard at Pomona elicited this note: "Vine disease has been in this vineyard for several years; have taken out vines and set out trees with intention of pulling up the vineyard as soon as the orchard comes into bearing."

Dowlen also visited the vineyard of G. Mirande, near Pomona, who, as previously noted, was an early proponent of the copper spray control, and found this "Vineyard in very good condition. The owner has made an intelligent fight against the Anaheim disease; by constant care, and by setting out good vines whenever one was lost from disease, has managed to keep the vineyard generally in a healthy condition." Prompt replacement of diseased vines is a currently recommended control method.

Regarding the 320-acre vineyard of the San Gabriel Wine Co., where he had presumably had his headquarters for some five years, Dowlen remarked, "Vineyard in good order; vines in much better condition than for some time past. The plantings of last season doing remarkably well."

He recorded these incidental disease observations as footnote "Remarks" for a few of the vineyards he visited.

The Pacific Rural Press of Nov. 18, 1893 (v. 46, p. 344), referring to Dowlen's Oct. 9, 1893, report, stated that, "Ethelbert Dowlen, the expert of the Viticultural Commission, who has been studying the mysterious vine disease for several years, has the following in his last report, dated October, 1893: This disease remains as vexatious as ever, so far as cause and cure are concerned, but it appears to be slowly losing its deadly powers."

These reports of his 1893 survey are the last references to Dowlen that I have found. Apparently he submitted at least 48 reports on his work. Of these I have not found, or not recognized, Nos. 16, 17, 18, 22, 25, 26, 27, 31 and 32.

Ethelbert Dowlen

Ethelbert Dowlen was the first person to be employed on a full time basis in California to study a plant disease. This was from Sept. 1888, to about March, 1891, or about 2 1/2 years. Commissioner Bichowsky of San Gabriel took him with him on a vineyard survey in July, 1892. The Commissioners re-employed Dowlen to make a vineyard survey and census in the summer of 1893. He remained with Shorb at San Gabriel until at least Jan., 1894. What became of him after that I have not found out.

What credentials, if any, he had when Shorb hired him I do not know. He claimed to be a graduate of the South Kensington School, now the Royal College of Science of the University of London, to have held a scholarship under Huxley, and to have taught four years in that

school. I wrote to the University of London asking about him. The archivist informed me that he was enrolled as a student in botany in 1873-74, and was also listed as a teacher. In California he was variously referred to as a botanical expert, a French viticultural expert, a microscopist, a professor, and once (PRP, v. 38, p. 127, 1889) as an LL.D. He was apparently competent in viticulture and in microscopy and histology, but not in mycology nor plant pathology. Except for a reference to *Cladosporium*, he identified none of his fungi, and mistook common saprophytic fungi for plant pathogens. He tried leaf inoculations with spores but made no cultures. He had the true spirit of a scientific investigator, was observant, systematic, cautious, honest, well-intentioned and diligent.

Shorb referred to Dowlen as a man "of the highest probity," whose "patient and zealous research" keeps him "working all the time up to 12 o'clock at nights." (HEH. Lib.). "Prof. Dowlen," he wrote to Coleman, "will not permit himself to adopt any theory for fear it might influence his work" Dowlen impressed Commissioner Wheeler (MV, v. 22, p. 113, 1889) "as an earnest, conscientious student, whose efforts are characterized . . . by a manifest determination to be accurate, and to sacrifice all hypotheses and theories to an absolute determination of facts by systematic analysis."

Dowlen seemed to approach the problem with an open mind, seeking all pertinent information. His lack of competence consisted in attributing significance to the ubiquitous saprophytic fungi present and not to the failure of his inoculations with them. Too much was said about the fungicidal powder. But the vineyardists were desperate and both Shorb and Dowlen were under pressure to come up with a control. No

doubt Dowlen was under pressure from Shorb. Shorb was more eager than Dowlen to exploit an unproved theory. When Dowlen's fungi were recognized by Harkness as harmless saprophytes and the Ongerth powder failed to control the disease, Dowlen was unduly discredited, in part at least for claims he had not made.

Dowlen described well the effects of the disease on the vines, the lack of starch and delayed ripening of wood for example. He found the disease was not due to insects, climate or soil, was less severe in shade, was worse in some varieties than others, was present in the native grapes, and was carried in cuttings or scions. He attempted sap inoculation and tried to cure the disease by chemotherapy, that is, root injection of various chemicals. He tried to control it with fertilizers and copper dust applications. Under pressure for quick results he deserves credit for his untiring effort, his caution and his good intentions.

1893 Survey by C. J. Wetmore, Dowlen and Bichowsky

At the State Viticultural Commissioners' meeting in San Francisco, Dec. 11, 1893, C. J. Wetmore, Chief Executive Officer, reported (BSVC Rep. 1893-94, p. 23-24, 1894) on "Southern Vine Disease . . . In company with Commissioner Bichowsky, I examined the vineyards in Los Angeles County for the purpose of determining the progress of the Anaheim disease. . . . the disease did not show itself very much . . . a few vines showed the disease . . . during August and September I learned from . . . Bichowsky that the disease showed itself in a more marked degree."

Reporting on this same trip at the June 11, 1894, meeting of the Commissioners, C. J. Wetmore (BSVC Rep. 1893-94, p. 24, 1894) said, "In July, 1893, in company with Commissioner E. C. Bichowsky and Professor Ethelbert Dowlen, I made a thorough examination of the vines in the San Gabriel Valley. The vines were found to be in a very healthy condition Some few signs of the Anaheim disease were observed, but there were but few vines . . . dying. . . . In the vicinity of Anaheim and Santa Ana the disease was found among some of the two and three-year-old Muscat vines. From what I could see and learn, the disease still exists . . . but the effects . . . are not as severe as they used to be."

The Anaheim Gazette (CFG, v. 13, p. 503, Dec. 16, 1893) said, "Let us by all means revive the wine industry again."

Bichowsky's 1894 Report and One From Orange County

Commissioner Bichowsky, in his biennial report dated Aug. 18, 1894 (BSVC Rep. 1893-94, p. 31-33, 1894) said, " . . . I have come to the conclusion that the disease has about run its course. There are, here and there, however, a few sporadic cases, but the number of new cases . . . is so insignificant that . . . it would not cause comment. The vineyards as a whole in the San Gabriel Valley . . . which suffered so severely . . . are now in fairly good condition. . . . no place has been observed . . . where the disease has attacked . . . new vines It looks reasonable to me . . . that the malady has about run its course here. However, this disease has been so full of surprises . . . that I should not like to be understood as reporting its complete extinction"

The horticultural commissioner of Orange county (CSBH Rep. 1895-96, p. 143, 1896) later said, "A few years ago a mysterious disease, appeared in our vineyards that destroyed every vine. Since that time the grounds have been replanted, but the presence of the old disease is apparent."

Pierce's Annual Reports, 1892, 1893

After Pierce returned to California in July, 1891, he became interested also in other diseases. He established the Pacific Coast Laboratory of the U.S. Department of Agriculture at Santa Ana, where he worked until 1906. After his Bulletin No. 2, his published work on the grape disease was mostly on the resistance of the Lenoir variety. That the fruit growers appreciated and respected Pierce is evidenced, for example, by his election as Pathologist of the Pomological Society of Southern California (CFG, v. 12, p. 330, Apr. 22, 1893).

Galloway in his 1892 report on Pierce's work (U.S. Sec. Agr. Rep. 1892, p. 240-241, 1893) said the disease was still active, but there was less of it, and it was less virulent. "It is still an open question whether bacteria take an active part in causing the death of the vines. . . . A comparative histological and physiological study of both diseased and healthy plants is now the line being pursued" He referred to Viala's claim that he had found a slime mold in the leaf cells.

In his 1893 report (U.S. Sec. Agr. Rep. 1893, p. 273-4, 1894) Galloway stated that "A study of the root system . . . so far as throwing light on the cause of the disease . . . " was unsatisfactory and "The laboratory work has failed to reveal any organism, capable of producing the disease." Viala's Plasmodiophora had not been found. " . . . the disease has lost much of its virulence, but it remains present in most of the vine-growing sections of Los Angeles, Riverside,

San Bernardino, and Orange counties. Some of the younger vineyards showing no signs of disease in 1892 developed it to some extent in 1893."

Evidence has not been found that Galloway or Pierce or Dowlen ever transmitted the disease to a healthy rooted vine by graft inoculation, or any other means of inoculation, though it was common knowledge that cuttings or scions from diseased vines gave rise to diseased vines even when grafted on healthy roots.

Pierce's Farmers' Bulletin, 1895

In a brief popular account of Grape Diseases on the Pacific Coast, the title of Farmers' Bulletin No. 30, 1895, Pierce devoted only three pages (pp. 7-10) to the California Vine Disease, and revealed no important advancement of his understanding of the disease beyond what he had previously published. However, he now believed the disease had lost much of its virulence ". . .and the setting of healthy cuttings can now be recommended with more confidence than formerly." Husmann reprinted the chapter on the California Vine Disease (CFG, v. 18, p. 394, May 16, 1896).

Galloway Reviews Pierce's Work With Resistant Lenoir

In his 1893-94 report (U.S. Sec. Agr. Rep. 1894, p. 145, 1895) Galloway, referring to Pierce's work, said, "From previous work in the laboratory the contagious nature of the disease was settled, but so far the nature of the contagion has not been determined." Pierce referred to it in 1895 (PRP, v. 50, p. 133, Aug. 31, 1895) but there is no reference to the disease in Galloway's reports for 1894-5, 1895-6, 1896-7, or 1897-8. In his 1898-9 report (Ann. Rep. Dept. Agr. 1898, p.77, 1899), he said, "The vine disease which has been more or less prevalent in southern California for a number of years, has appeared in many new districts . . . this disease may be kept in check by grafting on certain

kinds of roots which are resistant to the disease."

No mention was found of the disease in Galloway's 1899-1900, 1900-1901, and 1901-1902 reports, but in his 1902-03 report (Ann. Rep. Dept. of Agr., 1902-03, p. 109, 1903) he announced ". . .uniform resistance . . ." of grafted vines in a 400-acre experiment in the Sacramento Valley, where ". . .none of the grafted vines has died of the disease which has killed or is killing the remainder of the 3000-acre vineyard." In this same annual report (1902-03, p. xxxii), Secretary James Wilson referred to the vine disease, ". . .the cause of which still remains unknown . . . The Lenoir vine is resistant to the disease, and its use either as a top graft or as a root . . .has been found effectual in resisting the disease. New varieties of grape, which have received Lenoir blood through hybridizing, have shown great resistance to the same disease." This referred to the disease occurring in the Sacramento Valley.

Galloway, in his 1903-04 report (Ann. Rep., Dept. of Agr., 1903-04, p. 99, 1904) said, "Positive proof is now in hand that . . .the Lenoir is almost absolutely resistant to this disease when grown upon its own roots."

Pierce Discusses Santa Clara and Sacramento Valley Outbreaks^{1/}

Pierce examined a grape disease in the Santa Clara Valley (PRP, v. 62, p. 85, Aug. 10, 1901) and was not certain it was the Anaheim disease. He gave a lecture on the disease at the twenty ninth fruit growers' convention (Off. Rep., p. 75-80, 1904) at Fresno on Dec. 9, 1903,

^{1/} As early as 1892 (PWSR, v. 29, No. 5, p. 13, Oct. 5, 1892) "The Anaheim disease is reported . . .in Santa Clara County. No alarm need be felt about it."

stating that, ". . .in 1889-90, the same disease broke out in the upper end of the Sacramento Valley . . .in Tehama, Butte, Colusa, Yuba and Sutter Counties . . . About 1898-99 the great vineyards of the Santa Clara Valley began to fail . . .the affected district includes portions of the counties of San Mateo, Santa Clara, Santa Cruz, and Alameda. . . .We have then . . .a destruction of forty thousand acres of vines by this disease in the course of the past twenty years--1884 to 1904--and a direct financial loss . . .of probably not less than \$40,000,000." He described the disease which in his opinion showed ". . .all the characteristics of a generally distributed parasitic malady." The Lenoir he found to be the most resistant variety, others with some resistance being the Malaga and the Tokay.

Referring to a Sacramento Valley vineyard Pierce said nearly 400 acres ". . .of Lenoir vines have been planted and grafted to other varieties during the past seven or eight years. . . .the Lenoir root greatly aids a more susceptible top variety in resisting the disease, . . ." He assured his audience that the disease was not around Fresno, where the vines were suffering from lowering of the water table. In 1896, he said he had ". . .wholly failed to detect any sign of the malady . . ." in the San Joaquin Valley (CFG, v. 18, p. 81, Feb. 1, 1896).

Pierce Utilizes Resistance of the Lenoir Variety

Pierce later (PRP, v. 69, p. 78, 1905) called attention to the resistance of the Lenoir grape and explained (PRP, v. 70, p. 133, 1905) that, "Vineyards eight, sixteen and twenty three years old of the Lenoir grape are now bearing eight tons of fruit to the acre in the midst of the earliest infected district in the State, and where the surrounding vineyards, tens of thousands of acres in extent, have long since perished.

...This hardiness of the Lenoir has been observed since the first studies of the disease by the writer--in 1889--in the infected center of southern California. . . .the hardiness of the Lenoir grape stands forth today as the most encouraging fact secured . . ." in his work. To obtain a good top variety to graft on the Lenoir root, ". . .the writer has been hybridizing . . .the Lenoir with all classes of wine, table and other varieties and species of grapes. . . . Hundreds of these hybrids are now growing at the Plant Improvement Gardens of the Department at Santa Ana . . ."

Husmann noted the resistance of Lenoir at Anaheim in 1887 (CFG, vol. 18, p. 394, May 16, 1896).

Pierce became deeply interested in disease control by selection and breeding for resistance (PRP, vol. 48, p. 4, July 7, 1894). In his rather philosophical paper entitled, Recent Work on Plant Diseases (RC, vol. 17, p. 277-279, June, 1894), he said, "We have . . .learned that it requires eternal vigilance and wide knowledge, supplemented by much sweat of the brow, for us to replace nature's law of the survival of the strongest by man's plan for the survival of the choicest. . . . Man's work in these sciences has brought him face to face with the weaknesses and diseases of the plants he would preserve. Here began the study of these enemies to his work, and here was founded the science of vegetable pathology."

The Disease in Santa Barbara

It was about 1906 that the California vine disease began to show its ugly face in the Santa Barbara area. By 1908 many grapevines in vineyards 30 to 40 years old were dying from the disease. The very old vines around the Santa Barbara Mission were showing symptoms of disease (PRP, vol. 76, p. 75, 1908).

The California Vine Disease in the San Joaquin Valley

The name "Mysterious Vine Disease" was again used to describe a disease killing grapevines in part of Fresno and Tulare Counties in 1916 (Jeffrey, Calif. State Comm. Hort. Bull., vol. 5, p. 416-417, 1916). The disease was stated not to be caused by Phylloxera, fungus, bacterium or the Anaheim disease. Though the cause was undetermined and it was thought at that time not to be the same as the "Anaheim disease", there is good reason to believe that indeed it was the California vine disease.

Five years later a die-back of Emperor grapes in Tulare County was described by P. A. Boncquet (Boncquet, P. A., Die-back of Emperor Grapes, Calif. Plant Pathologists, vol. 1, p. 12-20, 1921). His description of the disease agrees closely with many symptoms of the California vine disease described by Pierce in bulletin #2 (U.S.D.A. Div. of Veg. Path. Bull. #2, 1892).

About 1930 the Department of Viticulture, University of California, College of Agriculture, Davis, was asked to examine dying Emperor grapes in the area about Exeter in Tulare County, California. Professor A. J. Winkler and Mr. H. E. Jacob of the Department evaluated the disease problem at that time (Univ. of Calif. Agr. Exp. Sta. Bull. 353). Between 1930 and 1934 Mr. Jacob carried out some grafting tests to determine a possible cause of the dying Emperor grapevines. By late 1934 the results of the grafting experiments were inconclusive and the disease had spread rapidly in many vineyards. The epidemic nature of the disease was evident. The disease could be found in most any vineyard; some were losing large numbers as high as 30% of grapevines (Milbrath, State Dept. Agr. Bull., vol. 27, p. 771-772, 1938; Hewitt, Phytopathology, vol. 29, p. 10, 1939; Phytopathology, vol. 41, p. 862, 1941; Hewitt, Blue Anchor, v. 18, p. 16-21, 36, 1941).

University Assigns a Plant Pathologist to the Mysterious Vine Disease

Some 50 years after the first appearance of the Mysterious Vine Disease in Anaheim, the University assigned a student in plant pathology to work on the disease. In late 1934 the Department of Plant Pathology, the University at Davis campus, was asked to determine the cause or nature of the disease and to see what might be done in the way of its control. In 1935, a graduate student in the department, W. B. Hewitt, was invited to study the vine disease in Tulare County. It was in the spring of 1935 that H. E. Jacobs, W. B. Hewitt and Mr. W. E. Gilfillen, Director of the Extension Service in Tulare County, and A. D. Rizzi, Farm Advisor in Tulare County, reviewed dying vines in a number of vineyards about Exeter, Ivanhoe and Woodlake in Tulare County. Several different experiments were initiated to determine the nature of the disease. Symptoms of dying grapevines of varieties Emperor, Thompson Seedless, Muscat of Alexandria, white malaga, red malaga and Ribier in these areas were very similar in most all respects to those symptoms described by Pierce in the bulletin on the California Vine Disease (U.S.D.A Veg. Pathology Bull. #2, 1892).

By culturing from diseased vines and microscopic examination it was soon learned that the disease was not associated with known bacteria or fungi nor were any other obvious pathogens visible through the light microscope. These results confirmed the work of Pierce and others.

Transmissible by Grafting and Budding

Knowledge on the cause of plant diseases was increasing rapidly as the new epidemic of the California Vine Disease developed in the San Joaquin Valley. By this time it was well established that plant viruses were the cause of many such diseases. Though scientists had learned to isolate only a few viruses, criteria for determining their probable nature had become established and generally accepted. Viruses as pathogens of

diseases of fruits and other perennial plants were established by proving the transmission of the pathogen from the diseased to the healthy plant. This was done by budding or grafting pieces of the diseased plant onto a healthy plant and demonstrating that the recipient plant developed the same symptoms of the disease. It had also been demonstrated that certain sucking insects such as leafhoppers, aphids, etc., would transmit pathogens from diseased to healthy plants. They were thus the vectors of the pathogen.

It was argued that if a pathogen were introduced into a host by a bud or a graft or by an insect vector at one point and then removed by similar means from another distant point in a plant and thus transferred in sequence from plant to plant, that it was proof of the multiplication of the pathogen in the host plant. This was generally accepted as proof of the presence of the plant pathogen and that it was most likely of virus nature. Of course, it was necessary to establish that bacteria or fungi were not the pathogens.

Transmission of the Emperor Disease by Grafting

By late 1936 experiments had shown that indeed the disease would transmit from diseased grapevines to healthy grapevines by grafting pieces of roots of the diseased vine onto roots of healthy grapevines (Woods, A. F., Grape Diseases: Report of the work of Agr. Expt. Sta. Univ. of Calif. for July 1, 1937 to June 30, 1938, p. 40).

By January 1937 W. B. Hewitt had completed his studies for doctorate in plant pathology and was employed to study this disease problem on grapevines. By the fall of 1937 evidence was present in experiments to show that buds and grafts of wood from canes as well as roots of diseased vines would indeed transmit a pathogen in sequence from grapevine to grapevine and induce symptoms similar to those observed in the vineyards

of Tulare and Fresno Counties. Results of these experimental tests were reported at the annual meetings of the American Phytopathological Society in the fall of 1938 (Hewitt, W. B., A transmissible disease of grapevines, *Phytopathology*, v. 29, p. 10, 1939 and by G. D. Milbrath, Grape disease, *Calif. Dept. of Agr. Bull.*, v. 27, p. 771-772, 1938).

It is interesting to observe that during the period when the field of study on virus pathogens of plants was first opening up that A. F. Woods published a paper in which he related the cause of mosaic diseases of tobacco to an excess of peroxidase enzyme systems in the tissue causing depletion of the reserve food supply. In this paper he suggested that Peach Yellows and the California Vine Disease might be disorders of this type (Woods, A. F., Observations on the mosaic disease of tobacco, *Science*, v. 13, p. 27-28, Jan.-June, 1901).

Enter Pierce's Disease of Grapevines

In the report given before the annual meetings of the American Phytopathological Society in the fall of 1941, W. B. Hewitt named the Tulare County grape disease Pierce's disease and compared the symptomatology with the Anaheim Disease and the California Vine Disease. A development and spread of Pierce's disease of grapevines in California was also discussed in this paper.

Though not published, the reasons Hewitt named the disease after Newton B. Pierce were because of the thoroughness with which he approached and studied the disease, the information he brought forth and conclusions reached in his studies. Pierce explored most all aspects of the California Vine Disease. He demonstrated the disease was not caused by fungi or bacteria that could be cultured from the diseased vine, that it was not a nutritional disorder and that it was not the same as any other disease of grapevines known in Europe or the United

States. He also showed that the disease would carry through cuttings from diseased vines. He agreed the disease was associated with but not caused by high rainfall; that temperatures seemed also to affect the disease because grapevines growing in shade developed symptoms much slower and lived longer than grapevines exposed to the direct sun. He concluded ----"The observed phenomena would be most completely explained if we consider the disease to be due to an epidemic caused by an external parasite arising after the wet season of 1883-84 and spreading with greatest virulence from the vicinity of Anaheim. This parasite must be capable of working during the most heated portions of the year and must exist at the present time, although working with less intensity than at first."

-----"Observed phenomena would be in the main explained if there were a form of microorganism within the vine capable of altering normal physiological relations of the plant. A weakened condition in the cell contents, acquired under exceptional local conditions at some single period in the past, and which is persistent and cumulative from one hot season to another, would in part explain the observed phenomena. The objections to this explanation are: (a) the cause and nature of such a weakness are not fully apparent; (b) it does not account for the death of the vine grown from uneffected cuttings since the disease appeared; (c) it poorly harmonizes with the health and normal productiveness of old vines for several years subsequent to the death of the first vineyard."

It would be interesting to know if Pierce had considered the suggestions made by Woods (Science, vol. 13, p. 27-28, 1901), that the disease might be similar to the Peach Yellow disease.

The naming of this disease of grapevines that was killing vines in the San Joaquin Valley and information on its spread and development were

also reported in the report of work in the Agricultural Experiment Station of the University of California and in the bulletin of the State Department of Agriculture (Woods, A. F., Pierce's disease of grapevines, Rept. Work Agr. Expt. Sta. Univ. of Calif. pp 73-74, July 1, 1939-June 30, 1940; D. G. Milbrath, Pierce's disease of grapevines, Calif. Dept. Agr. Bull., vol. 28, pp 567-577, 1939).

Association with Alfalfa Dwarf Disease

Pierce's disease developed most abundantly in vineyards adjoining irrigated permanent pastures with grass and clover, adjacent to alfalfa plantings that had accessive grass, at ends of irrigation runs in vineyards where there was unusual grass and standing water for several days after irrigation. Observations and map records of vineyards on the occurrence of Pierce's disease in Tulare, Fresno and Kings Counties demonstrated that the disease was spotty throughout these areas; that it seemed to spread or radiate from the centers. Alfalfa plantings had an exceptionally high number of plants with the disease called alfalfa dwarf. Furthermore, the distribution of diseased grapevines in vineyards and its relationship to irrigated pastures, watergrass and alfalfa suggested that the disease was probably spread by some insect.

J. L. Weimer in 1931 described a disease of alfalfa which he called dwarf (Weimer, Alfalfa dwarf, a hitherto unreported disease, Phytopathology, vol. 21, pp 71-75, 1939). In 1936 Weimer reported the disease to be graft transmissible from plant to plant (Weimer, J. L., Alfalfa dwarf, a virus disease transmissible by grafting, U.S.D.A. Jour. Agr. Res., vol. 53, pp 333-347, 1936) and in 1937 presented evidence indicating the disease most likely to be insect transmitted (Weimer, J. L., The possibility of insect transmission of alfalfa dwarf, Phytopathology, vol. 27,

pp 697-702, 1937).

The association of a high incidence of Pierce's disease in grapevines in borders of vineyards adjacent to alfalfa plantings led W. B. Hewitt and B. R. Houston to examine the alfalfa more critically. In most all areas examined they found alfalfa plantings to be heavily infested with water-grass and to have high numbers of dwarf diseased alfalfa plants (Hewitt, W. R. and B. R. Houston, Association of Pierce's disease of grapevines and alfalfa dwarf in California, Plant Dis. Repr., vol. 25, pp 475-476, 1941). They concluded in this report that "The two diseases may be caused by the same virus and transmitted by the same vector or vectors. The vector or vectors may prefer to feed upon the alfalfa and grasses and only feed upon the adjacent grapes when the alfalfa is cut or the grasses became dry." They also pointed out -----"that the two diseases of alfalfa and grapes may be caused by different viruses and transmitted by the same or different vectors and that the association may have been coincidental."

Probable Insect Vector

The demonstration of a high correlation between the occurrence of Pierce's disease in vineyards and alfalfa dwarf in alfalfa plantings and that the pattern of spread in vineyards suggested the pathogen had an insect vector, was convincing evidence to encourage more intensive work on the probable vector of the pathogen. Administrators provided funds for assistance. In the spring of 1939 Mr. Norman W. Frazier, a graduate student in Entomology, University of California, Berkeley, interested in the study of virus transmission by insects, was employed to work with Hewitt and Houston.

Because there was some probable dangers in moving insect carriers of the pathogen and because it was more convenient to make the tests,

the work was started in a vineyard district in Tulare County where the disease was present. Mr. Tug Wilson volunteered the use of land on his property close to his vineyards near Woodlake in Tulare County. Cuttings from healthy grapevines from the vineyards of the University of California, Davis, were lined out in rows 12 feet apart much as a nursery would be propagated. As the vines grew in the spring insects were collected from various sources, fed on diseased vines and then caged on vines in the experimental plots. Large numbers of vines were maintained throughout the plot as control to evaluate the potential of natural spread within the plot area.

Sharpshooter Leafhopper Vectors

By the end of 1939 results of the tests showed that some 54 different insects had been collected and tested in some 94 feeding tests. Ten of the 94 test vines showed symptoms of Pierce's disease. Of the 10 vines 6 had been caged with species of Draeculacephala and 3 with species of Carneocephala leafhoppers. In 1940 and 1941 these insects and others were tested under control conditions in a specially constructed screen enclosed insectary on the Davis campus. In 1942 Hewitt, Frazier and Houston reported 3 sharpshooter leafhoppers to be vectors of the Pierce's disease pathogen. The vectors were the green sharpshooter Draeculacephala minerva Ball., the red-headed sharpshooter, Carneocephala fulgida Nott., and the blue-green sharpshooter Cicadella circellata (Baker) = (Neokolla circellata = Hordnia circellata). Developments in the transmission of the pathogen showed there were no doubt other vectors that transmitted the disease (Hewitt, W. B., N. W. Frazier and B. R. Houston, Transmission of Pierce's disease of grapevines with leafhopper, *Phytopathology*, vol. 32, p. 8, 1942). At the same annual meetings of the American Phytopathological

Society in the fall of 1941, Houston, Frazier and Hewitt reported the transmission of the alfalfa dwarf virus by the same sharpshooter leafhoppers.

A report of research on Pierce's disease carried out in 1935 to mid 1942 was published in the Agricultural Experiment Station bulletin 353 in 1942 (Hewitt, W. B., N. W. Frazier, H. E. Jacob and J. H. Freitag, Pierce's disease of grapevines, Calif. Agr. Expt. Sta. Cir. 353, pp 1-32, 1942). The authors report transmission of Pierce's disease by the green sharpshooter, Draeculacephala minerva Ball., the redheaded sharpshooter Carneocephala fulgida Nott., and the blue-green sharpshooter Cicadella circellata (Baker) = (Neokolla circellata = Hordnia circellata (Nielson, 1962). They further conclude that evidence suggests there may be additional species of sharpshooters that are vectors of the pathogen. In this same bulletin the authors described the general habitats of the three sharpshooter vectors of the Pierce's disease. They also list several host plants that seem to be favored food plants of the vectors. The results of many tests show that a grape leafhopper Arythroneura comes Say does not spread the virus.

In 1944 N. W. Frazier gave a paper pointing out the phylogenetic relationship of 9 known leafhopper vectors of Pierce's disease of grapevines. Of the 9 species referred to in this paper, only 3 of them had been previously reported (N. W. Frazier, Phytopathology, vo. 34, p. 1000, 1944). A listing of all of the known vectors of this pathogen are reported a little later in this section.

Early in the decade Dr. Julian Freitag, Department of Entomology, University of California, Berkeley, started work with Dr. Frazier on the transmission of Pierce's disease on alfalfa dwarf pathogens in many

different plants. In 1946 Hewitt, Houston, Frazier and Freitag reported that the leafhoppers D. minerva, C. fulgida, Heliochara delta Omen, and N. circellata (Baker) would transmit Pierce's disease from diseased grapevines to healthy grapevines and alfalfa dwarf from diseased plants to healthy plants and that the same vectors would transmit the disease from grape to alfalfa and from alfalfa to grape, (Leafhopper transmission of the virus causing Pierce's disease in grapevines and dwarf of alfalfa, Phytopathology, vol. 36, pp 117-128, 1946). Results in these tests demonstrated that the green sharpshooter was more efficient at transmitting the disease from alfalfa to alfalfa than from alfalfa to grape and conversely that the blue-green sharpshooter was more efficient in transmitting the disease from grape to grape than to alfalfa. The efficiency of transmission of the pathogen expressed in these data on transmission may be related to the host preferences of the leafhoppers. The green sharpshooter D. minerva commonly feeds and breeds on grasses. It is also found on many different clovers and other herbaceous plants, whereas the blue-green sharpshooter Hordnia circellata feeds and breeds on perennial shrubs, trees, brambles, and grapevines.

This paper (Hewitt, et al., Phytopath., vol. 36, pp 117-128, 1946) contains an interesting report on the effects of light traps on the incidence of disease. In an experiment by J. K. Ellsworth, Division of Entomology and Parasitology, University of California, Berkeley, the light traps were inserted in a vineyard in four positions over approximately 10 acres of grapevines. The vineyard was located at the mouth of Yokol Creek east of Exeter in Tulare County. At night the mercury vapor lights attracted large numbers of different insects. It was noted that large numbers of grapevines about the lights had Pierce's disease and that one of the very prominent insects collecting about the lights at night was the green sharpshooter D. minerva. The occurrence of insects

about these lights helped greatly in selecting leafhopper insects for testing the transmission of the Pierce's disease of grapevines.

Later in 1946 Frazier and Freitag (Phytopath., vol. 36, pp 634-637, 1946) reported 10 additional leafhopper vectors of the Pierce's disease pathogen. In 1947 H. H. P. Severin reported transmission of Pierce's disease from grape to grape by spittle insects (Phytopath., vol. 37, p. 364, 1947).

In 1949 DeLong and Severin published a paper on the characters, distribution and food plants of six leafhopper vectors of the virus causing Pierce's disease of grapevines. In this paper the authors give the outstanding characteristics for identifying some of the leafhopper vectors. Detailed descriptions were needed for identification because many of the leafhoppers were of little concern to agriculture until they were known to be vectors of the Pierce's disease and alfalfa dwarf pathogens. The leafhoppers described in the paper are Heliochara delta Oman, Carneocephala fulgida, Nottingham, Draeculacephala minerva Ball., Neokolla circulata Baker (Hordnia circulata), Neokolla confluens var., Pacifica n var., Neokolla severini DeLong, (Hilgardia, vol. 19, pp 171-181, 1949). Professor Henry Severin carried out detailed studies on the transmission of the Pierce's disease virus of grapes by leafhoppers which he (Hilgardia, vol. 19, pp 190-206, 1949) had completed on some of the vectors. He demonstrated how they could acquire the Pierce's disease pathogen from grape or alfalfa in relatively short feeding periods of an hour and may transmit the pathogen to either host for some time perhaps over much of the remaining of their lives. Not all leafhoppers, however, were found to transmit the pathogen to alfalfa and grape. Some would transmit to only one of the host plants. The paper includes black and white and color plates of some of the sharpshooter leafhoppers. In a companion paper (Hilgardia, vol. 19, pp 187-189) Severin reported work

on the life history of the blue-green sharpshooter N. circulata. This is one of the most important vectors of Pierce's disease in the north coast counties. The importance of life histories and host plants of these important vectors should not be overlooked.

In 1950 DeLong and H. H. P. Severin published a detailed account of spittle insect vectors of Pierce's disease virus, the characteristics of the vectors, their distribution and food plants (Hilgardia, vol. 19, pp 339-356, 1950). In a companion paper Severin gave a detailed account of the life histories and virus transmission of the spittle insects (Hilgardia v. 19, p. 357-380, 1950).

The ecology of the blue-green sharpshooter is presently (1972-1974) being studied in Napa Valley by graduate student Mr. A. H. "Sandy" Purcell. His major professor is Dr. Don McLean, University of California, Davis. The results of the studies, it is hoped, will provide information that may help in working out some control of the disease. Information of this nature is wanting for several of the vectors known to spread Pierce's disease of grapevines and dwarf disease of alfalfa in various parts of the state of California.

J. H. Freitag, N. W. Frazier and R. A. Flock reported 6 new leafhopper vectors of Pierce's disease virus in 1972 (Phytopathology v. 42, p. 533-534). The authors pointed out that the report in this paper brings the total of 20 leafhopper species known to transmit the Pierce's disease. They also point out that since the leafhoppers discussed in the paper have not been commonly observed in vineyards and alfalfa fields, they are not certain to be important in the dissemination of the virus to economic host plants but that the insects may be involved in the spread of the pathogen from the wild host plants and constitute a natural virus reservoir. The vectors and their most recent identification are listed below. In 1953 Warren M. Stoner reported transmission of a degeneration of

grapes in Florida by a yellow-headed sharpshooter, Carneocephala flaviceps (Riley). He demonstrated the vector would transmit the virus from grape to grape and from grape to alfalfa and there cause Pierce's disease and alfalfa dwarf respectively (Phytopathology v. 43, p. 611-614). In 1962 George H. Koloostian, H. N. Pollard and W. F. Turner reported that 3 leafhoppers, Homalodisca coagulata (Say), Oncometopia undata (F.) and Cuerna costalis (F.) were found to be vectors of Pierce's disease virus in bunch grapes in Georgia.

Many Leafhopper Vectors

Pierce's disease has been found to be transmissible by grafting and by leafhoppers and spittle insects. The numerous species of these insects reported to be vectors of Pierce's disease and alfalfa dwarf all belong to the Tettigellinae and Aphrophorinae. The various species of leafhoppers are in a synomical list by Nelson (1962, U.S.D.A. Res. Serv. Publ. 33-74, 12pp). Frazier (1965 Proc. Int. Conf. on Vir. Vect. Per Hosts, Univ. of Calif., Plant Path., Davis) has compared transmission by these vectors of xylem viruses. From these and other papers the recorded vectors are:

Carneocephala falviceps (Riley), C. fulgida Nott., C. triguttata Nott., Cuerna costalis (Fab.), C. occidentalis Oman and Beamer, C. yuccae Oman and Beamer, Draeculacephala antica (Walker), D. crassicornis Van Duzee, D. minerva Ball, D. noveboracensis (Fitch), D. portola Ball, Friscanus friscanus (Ball), Graphocephala cythura (Baker), Helochara delta Oman, Homalodisca insolita (Walker), H. liturata Ball, Hordnia circellata (Baker), Keonolla confluens (Uhler), K. dolobrata (Ball), Neokolla hieroglyphica (Say), N. severini DeLong, Oncometopia orbona (Fab.), Pagaronia confusa Oman, P. furcata Oman, P. tredecimpunctata Ball, and P. tritunata Ball.

The virus is spread naturally in California and in the Gulf coastal plains area. The primary vectors to grape in California are Carneocephala fulgida, Draeculacephala minerva, and Hordnia circellata. Reported to

transmit the virus in Florida are Carneocephala flaviceps, Draeculacephala portola, Homalodisca insolita, H. liturata, and Oncometopia orbona.

Many Host Plants of Pierce's Disease Pathogen

The pathogen of Pierce's disease can survive in many different kinds of host plants. It has been recovered from some 28 families of Monocotyledonous and Dicotyledonous plants. They include both annual and perennial plants, grasses, herbs, shrubs and trees. The host range was determined in 3 ways: plant species found to be naturally infected, plant species experimentally infected with insect vectors and plant species graft inoculated. The virus has been recovered from plants by insect vector species and transferred by feeding the vectors on indicator grapevines. J. H. Freitag contributed much of the knowledge on host range of Pierce's disease virus (Phytopathology 41:920-934, 1951). Host plants are also reported by Hewitt, Frazier, Jacob and Freitag (Univ. of Calif. Agr. Expt. Sta. Circ. 353, 32pp, 1942) and by Hewitt, Houston, Frazier and Freitag (Phytopath. 36:117-128, 1946).

A list of the known hosts for the pathogen follows. The list is classified by genus. The authors of specific names are omitted.

Gramineae - grass family: Wild oats, Avena fatura; rescue grass, Bromus catharticus; ripgut brome, B. rigidus; Russian brome, Bromus sp.; Bermuda grass, Cynodon dactylon; hairy crab grass, Digitaria sanguinalis; barnyard grass, Echinochloa crusgalli; diffuse love grass, Eragrostis diffusa; fox-tail fescue, Festuca megalura; Johnson grass, Sorghum halepense; Sudan grass, S. vulgare sudanense; common foxtail, Hordeum murinum; barley, H. vulgare; Italian rye grass, Lolium multiflorum; darnel, L. temulentum; Dallis grass, Paspalum dilatatum; Kikuyu grass, Pennisetum clandestinum; Mediterranean canary grass, Phalaris minor; gnawed canary grass, P. paradoxa; timothy, Phleum pratense; annual bluegrass, Poa annua; yellow bristlegrass, Setaria glauca.

Cyperaceae - sedge family: Yellow nutgrass or chufa, Cyperus esculentus.

Cannaceae - canna family: Canna spp.

Salicaceae - willow family: Willow, Salix spp.

Urticaceae - nettle family: Nettle, Urtica gracilis var. holosericea.

Polygonaceae - buckwheat family: Black bindweed, Polygonum convolvulus; lady's thumb, P. persicaria; rhubarb, Rheum rhaponticum; curly dock, Rumex crispus.

Chenopodiaceae - goosefoot family: Mexican tea, Chenopodium ambrosioides.

Saxifragaceae - saxifrage family: Escallonia montevidensis; Hydrangea macrophylla; mock orange, Philadelphus coronarius.

Resedaceae - mignonette family: Common mignonette, Reseda odorata.

Pittosporaceae - pittosporum family: Karo, Pittosporum crassifolium.

Rosaceae - rose family: California blackberry, Rubus vitifolius; California wild rose, Rosa californica; Cotoneaster rotundifolia lanata; toyon or Christmas berry, Heteromeles arbutifolia.

Leguminosae - pea family: Sydney golden wattle, Acacia longifolia; Scotch broom, Cytisus scoparius; chickpea or garbanzo, Cicer arietinum; Lathyrus clymenum; bur clover, Medicago hispida; white melilot, Melilotus alba; Hubam clover, M. alba annua; sour clover, M. indica; yellow sweet clover, M. officinalis; sweet clover, Melilotus sp.; strawberry clover, Trifolium fragiferum; white clover, T. repens; ladino clover, T. repens f. giganteum; alsike clover, T. hybridum; crimson clover, T. incarnatum; red clover, T. pratense; vetch, Vicia articulata; grass pea, V. sativa.

Geraniaceae - geranium family: Red-stem filaree, Erodium cicutarium; bedding geranium, Pelargonium hortorum.

Anacardiaceae - sumac family: Poison oak, Rhus diversiloba.

Vitaceae - vine family: Grape, Vitis vinifera, V. labrusca, V. californica, V. arizonica, V. rotundifolia; Boston ivy, Parthenocissus tricuspidata.

Myrtaceae - myrtle family: Australian bush cherry, Eugenia myrtifolia.

Onagraceae - evening primrose family: Willow herb or fireweed, Epilobium californicum; panicled willow herb, E. paniculatum; Clarkia (Godetia) concinna; evening primrose, Oenothera hookeri; Fuchsia magellanica.

Araliaceae - aralia family: English ivy, Hedera helix.

Umbelliferae - parsley family: Carrot, Daucus carota var. sativa; white parsley, Oenanthe sarmentosa.

Oleaceae - olive or ash family: Foothill ash, Fraxinus dipetala; lilac, Syringa vulgaris.

Apocynaceae - dogbane family: Periwinkle, Vinca major.

Boraginaceae - borage family: Buckthorn weed, Amsinckia douglasiana.

Verbenaceae - verbena family: Pigeonberry, Duranta repens (plumieri).

Labiatae - mint family: Garden balm, Melissa officinalis; mint, Mentha spp.; marjoram, Origanum majorana; rosemary, Rosmarinus officinalis.

Scrophulariaceae - figwort family: Speedwell, Veronica spp.

Rubiaceae - madder family: "Glass bush," Coprosma baueri.

Caprifoliaceae - honeysuckle family: Japanese honeysuckle, Lonicera japonica; blue elder, Sambucus caerulea; snowberry, Symphoricarpos albus.

Compositae - sunflower family: California mugwort, Artemisia vulgaris var. heterophylla; coyote bush, Baccharis pilularis; China aster, Callistephus chinensis; sand-bur, Franseria acanthicarpa; prickly lettuce, Lactuca serriola; sow thistle, Sonchus asper; cocklebur, Xanthium strumarium var. canadense.

Resistant Vitis Species. Grapes native to the Gulf coastal plains area are the only species known to have resistance (Hewitt, PDR 42:211-215, 1958); some of them are: Vitis bourquiniana Munson, V. champinii Planchon, V. coriacea Shuttleworth, V. rupestris Scheele, V. rotundifolia Michaux, and V. simpsonii Munson. The named varieties Lenoir, Hibbermont, and Iona are resistant to the disease.

The Nature of the Disease

The symptoms of Pierce's disease were found to develop in only a few of the different host plants in addition to grapevines and alfalfa. A leaf scalding symptom shows first as a shock symptom in Cotoneaster rotundifolia lanata (Photenia or Toyon, California Christmas berry). The plants recover and appear to be normal after the scald symptom show (Hewitt, U.S. D.A. Yearbook, 1950). The Toyon is one of the most common and important host plants of the Pierce's disease pathogen in the coastal areas of the Los Angeles Basin. Several of the different clover plants were found to show accumulation of gum in the vessels but express no apparent external symptoms. The leaves of Melilotus alba, white melilot and Melilotus indica, yellow melilot, developed yellow to brownish color in the leaves as the plants aged. In the greenhouse Symphoricarpos albus - the snow berry plant, usually died within a few weeks after inoculation. However, in the native habitats many of the plants live very well without showing symptoms of the disease.

It is no wonder that there were uncertainties and differences of opinion in the early days in those working with the Anaheim Disease and the California Vine Disease. We know today that the disease does express a wide variety of symptoms and that it is more severe in some varieties than in others. Furthermore, there are primary and secondary symptoms of the disease.

Though Pierce described properly many of the symptoms of the disease in grapevines, the sequence of symptom development in his report are not clear. Hewitt, 1941 (Blue Anchor, Vol. 18:16-21, 36, 1941) described symptoms found on different varieties of grapevines and the sequence of symptoms as they developed throughout and the course of disease development.

The symptoms and course of development are also described by Hewitt, Frazier, Jacobs and Freitag in Agricultural Experiment Station Bulletin 353 published in 1942.

Perhaps the most important is the sequence in symptom development. The first signs of Pierce's disease are scalding and burning of portions of the leaves. Leaf scalding is characterized by sudden drying of a part of the leaf while it is still green. Scalding usually occurs about the margin of the leaf around the primary leaf veins. The scalded areas usually turn brown and tissues bordering them turn yellowish or reddish, depending upon the fruit color of the variety. Scald and burn may develop at several points in a single leaf and on several leaves of a cane. The size of the burned area may vary from small to nearly one half of a leaf surface. Scalding and burning often progresses by zones from the margin of the leaf basally to the petiole. Symptoms usually show first on leaves of one cane but develop on additional canes as the season advances. In late season leaves with symptoms often drop leaving the petioles attached to the canes. Fruit on canes showing leaf symptoms may stop growth at any stage of development and then wilt or dry up during development.

Diseased canes often mature only irregular patches of brown bark often along one side of the cane mingled with immature green cortex tissue.

The second or later seasons of disease development is marked by secondary symptoms such as delayed growth in the spring, dwarfing of infected parts of the vine and a light green vein banding in the first 8 leaves on a shoot of an affected portion of a grapevine. Leaves may be somewhat deformed, wrinkled along the main veins. The green vein banding is usually more intense in the first few basal leaves of a shoot and less severe in later-formed leaves. In mid seasons leaves of diseased vines

showing secondary symptoms may also develop primary symptoms of the disease.

The roots of vines appear normal in early stages of the disease but as the disease advances roots die back. Decline of the root system usually follows that of the top. The last part of the vine to die is often the crown near the soil line.

The Mode of Vector Feeding

In carrying out experimental work on the transmission of the pathogen by insect vectors, W. E. Hewitt and B. R. Houston noted that the insects exuded large quantities of water. It was presumed these vectors inserted their mouth parts into the water conducting system of the host plant.

In studies on the modes of vector feeding and the tissues involved in the transmission of Pierce's disease virus in grapes and in alfalfa, Houston, Esau, and Hewitt (Phytopath. 37:247-253) reported that 4 species of leafhopper vectors studied were found to seek the xylem tissue in the processes of feeding. In a representative lot the leafhopper vector, the green sharpshooter Draeculacephala minerva 88.2% of a total of 110 feeding punctures ended in the xylem, 2.7% reached the phloem and 9.1% entered parenchyma tissue only. The penetration of mouth parts reached the xylem appeared to be made at random through the phloem or medullary ray. The mouth parts either passed through or between cells including tracheary elements. The presence or absence of the Pierce's disease pathogen in either the vectors or in the host plant appeared to have no influence on the mode of feeding. These studies further demonstrated that upon the feeding of viruleferous vectors on different parts of the grape and alfalfa stems the virus would multiply and cause the disease in the grapevine only when the xylem tissue could be reached by the vector during feeding

processes. They showed also that the rapid upward movement of the virus in the alfalfa stems indicated the virus moved rapidly in the tracheary elements.

Pathological Anatomy

Early symptoms in leaves of grapes are those usually associated with sudden acute water shortage in localized areas. Also, canes of diseased grapevines often mature unevenly with patches of brown bark and patches of green tissue.

In 1948 Professor Katherine Esau, University of California Botanist and Plant Anatomist, published a detailed account of the pathological anatomy of normal and diseased grapevine tissues. She described the effects of the disease on alfalfa and the effects of phoney disease of peach in the roots of peach (Hilgardia 18:423-464, 1948). Pierce's disease of grapevines and phoney peach were the only 2 reported cases of virus diseases where the pathogen was limited to the xylem tissue of the host plant (Houston, Esau and Hewitt, Phytopath. 37:242-253, 1947; L. M. Hutchins, Phytopath. 29:12, 1933). As discussed earlier under transmission, the pathogen of Pierce's disease was found to be xylem limited. Bark and cambium tissues from diseased vines did not transmit when grafted onto healthy vines whereas xylem tissue or buds or bark and wood tissue combined would transmit the disease. Similar phenomena had been reported for the phoney disease of peach (L. M. Hutchins, Phytopath. 29:12, 1933).

In her study Esau reported that the deposition of gum in the vessels and other xylem cells were among the first changes to be noted in disease development. In grapevine gum was found deposited in vessels some 13 to 24 days after inoculating seedlings through the leaves with leafhoppers. Gum was found first at a distance of some 750 microns from the leafhopper

feeding trace that terminated in the vessel. The xylem tissues of Pierce's diseased vines were found to have excessive quantities of tyloses in the wood. Gum and tyloses were the first and dominant symptoms to show in tissues after inoculating with insect vectors. They appeared thus to be primary responses to the presence of the pathogen. It is normal that old grape wood contain gum and tyloses, however, in the lamina of the vessels and wood of Pierce's diseased grapevines tyloses were abundant in the current and 1-year old xylem which is in reverse of the normal expected occurrence.

The green patches of grape canes were found not to form a cork cambium whereas the brown patches on diseased canes formed a normal cork cambium and cork walling of the bark. The axes of green tissue areas in the canes though it formed no cork cambium had excessive accumulation of non-functioning phloem considered by Esau to be of secondary in nature.

Alfalfa plants showed few or no tyloses but excessive accumulation of gum in the vessels of the roots characterized the effects of the pathogen on this host. The internal symptoms of phoney peach roots were found to be very similar to those of Pierce's disease of the grapevine, the formation of gum and excessive quantities of tyloses.

The studies helped materially to explain the external symptoms both primary and secondary of diseased grapevines. They show clearly that leaf scalding and burn is due to water shortage and that delayed foliation in the spring was most likely due to the plugging of water vessels with gum and tyloses, thus cutting off the water supply for early shoot growth.

The studies, however, did not explain the interveinal mottling or strong vein banding of leaves on the bases of shoots formed in the second and subsequent seasons of disease.

Later in studies on the root rot of grapevines grown in water culture Williams and Hewitt (Amer. Soc. Hort. Sci., 52:279-282, 1948) found that a similar type of veinal chlorosis of grapes as associated with a root rot caused Pythium oligandrium. In later studies Dutra and Hewitt found that the interveinal chlorosis that forms in the basal leaves of shoots on diseased grapevines is apparently a secondary effect related to the rot of roots. These effects were confirmed in experimental work on effects of mineral nutrition on susceptibility of grapevines to cortical root rot in solution-sand culture. The first few leaves that formed on new shoots of vines with root rot usually had degrees of interveinal chlorosis (J. C. Dutra, Thesis for M.S. degree, Univ. of California Dept. of Plant Path., Davis, 1968).

Since the roots of Pierce's diseased grapevines dieback it is possible that toxins formed in the roots as they stand through the winter in the soil may be involved in the development of interveinal chlorosis on the first 8 leaves that develop on new shoots of diseased vines in the spring.

Epidemics of Pierce's Disease

The first epidemic of Pierce's disease, the occurrence, distribution and sequence of development by areas in California is well documented in the early history of the disease in California (as developed by M. W. Gardner in his report).

Since the early epidemic which N. B. Pierce (California Vine Disease 1904, PRP67) estimated cost vineyardists some 40,000 acres of grapevines at a value of approximately \$40 million, there has been one more statewide epidemic of the disease and several minor outbreaks in different localities that caused equal damage to vineyards, perhaps even greater damage.

The second epidemic was recognized in its early stages in Tulare

County, California in the San Joaquin Valley about 1930 (Hewitt, Phytopath. 29:1939). By 1934 losses of grapevines had become alarming. The disease reached a peak in development about 1941 and declined to insignificant amounts by 1946 (Hilgardia 19:207-264, 1949). By 1948 it was difficult to locate diseased grapevines in vineyards in the San Joaquin Valley where the disease had been severe. However, in Napa and Sonoma Counties the disease could usually be found in some vineyards. This was especially so on Spring Mountain, Napa Valley above St. Helena and in some vineyards planted along the Napa River in the floor of the valley.

Records on the development of the disease in vineyards of California are shown in the annual reports of the California Department of Agriculture bulletin by Milbrath and by Stout in sequencive years from 1938 through 1946 (Cal. Dept. Agr. Bull. 27:771-772, 1938; 28:567-577, 1939; 29:272-273, 1940; 30:378-380, 1941; 32:134-144, 1943; 33:163-167, 1944; 34:231-237, 1945; 35:230-241, 1946). In 1943 Gilbert L. Stout, Associate Plant Pathologist, State Department of Agriculture in Sacramento, reported (State Dept. Agr. Bull, 32:134-144) a survey in 1941 showed that 45 of the 58 counties in California were surveyed for Pierce's disease. It was found in 28 of the 45 counties and that 21% of the properties surveyed showed the disease. In 1942, 23 of the 28 counties were again surveyed. Fourteen percent of the properties inspected had Pierce's disease. The disease was found in 3 additional counties, Alameda, Mendocino and Sacramento Counties where it had not been observed in 1941. A map showing the distribution of Pierce's disease in 1941 and 1942 is included in the report. These records demonstrate clearly that the 1930 epidemic of Pierce's disease was truly statewide in its distribution. The magnitude of the disease is illustrated clearly in the publication Pierce's Disease Investigations, Hilgardia 19: No. 7, June 1949. Figure 1 in this publication shows the new cases of

Pierce's disease in each season from 1937 through 1946 in vineyards which had been carefully mapped for the presence of disease through the seasons in vineyards near Woodlake, Ivanhoe, Exeter and near Delano in Tulare County, California. The disease reached its peak of development in 1941 and declined fairly rapidly thereafter. By 1946 only 0.43% disease showed in the mapped vineyards.

In 1943 M. R. Harris reported on a survey for the alfalfa dwarf disease in alfalfa plantings in California made in 1942 (Calif. Dept. Agr. Bull. 32: 163-167, 1943). Alfalfa dwarf was found only in the counties of the San Joaquin Valley and in southern California. The disease was not found in alfalfa in the Sacramento Valley or in the north coast counties.

The distribution of alfalfa dwarf would be difficult to explain solely on the occurrence of the sharpshooter vectors. The green sharpshooter, one of the more efficient in transmitting the disease to alfalfa, was found in the Sacramento Valley and north coast counties. The sharpshooter was not as abundant there, however, as it was in the San Joaquin Valley. It would be interesting and informing to know why the alfalfa disease was not found in alfalfa but was found in grapevines in the northern areas of the state.

By 1948 the incidence of Pierce's disease had dwindled to obscurity in vineyards in the San Joaquin Valley. However, in Napa Valley cases of the disease could be found most any time since.

Records of the occurrence of Pierce's disease from about 1948 through 1969 are scarce. There exists only in a few notes in the personal files of W. B. Hewitt and as memories on occurrences in vineyards were examined for diseases of various kinds and as cases were called to attention.

Pierce's Disease and Rainfall

Pierce (1892) recognized that high rainfall was associated with the development of the California Vine Disease, though he was confident the disease was not caused by wet weather.

Bioletti (Calif. Agr. Expt. Sta. Bull. 358:509-524, 1923) found crop and rainfall to be correlated with epidemics of the Anaheim disease. He pointed out the following conditions to relate to epidemics of the disease: 1. a series of years of abundant rainfall; 2. a year of very low rainfall following the series; 3. and very heavy crops in the year preceeding the drought with very rapid dying of vines in the year following the drought.

In the report on studies called "Pierce's Disease Investigations" written by W. B. Hewitt, N. W. Frazier, J. H. Freitag and A. J. Winkler, edited by Winkler (Hilgardia 19:207-264, 1949) the epidemic of Pierce's disease in the San Joaquin Valley was charted over rainfall for years 1919 through 1947 and in Napa Valley for years 1907 through 1947. In both areas the development of Pierce's disease appeared to follow about one season, a sequence of seasons of above normal rainfall.

Another Epidemic in the Making: Number Three

In Napa Valley Pierce's disease has continued to kill grapevines in vineyards on Spring Mountain west of St. Helena and along river banks on the valley floor. Spots of Pierce's disease were well identified and related to native chapparal along water streams and river banks. In addition to the endemic state of the disease there occurred outbreaks that spread into several vineyards adjacent to the "hot spot" areas, in years 1957 through 1959, 1962 through 1964 and 1968 through 1972. Annual rainfall in Napa Valley recorded at St. Helena was considerably above normal in years 1957 and 1958, 1962 and 1963 and 1967 through 1970.

In the San Joaquin Valley new cases of disease were observed occasionally between 1946 and 1960. About 1963-1964 Pierce's disease could be found in vineyards close to some irrigated pastures and alfalfa plantings. By 1968 the disease was found in isolated vineyards in most any portion of the vineyard areas on the east side of Fresno and Tulare Counties. In Visalia, Tulare County, recorded rainfall was above normal in 1955, 1958, 1963, 1967, 1969 and 1970. There was 6.8 inches of rain above normal in 1969. By 1970-1971 the incidence of Pierce's disease in a few vineyards became exceptionally high. One might refer to these increases in disease as pre-epidemic development. They compare with epidemic occurrences such as the mysterious dying of grapevines in Tulare and Fresno Counties in 1916, the dying of Emperor grapes in Tulare County in 1920 and the periodic increases of disease through 1930-1934. The similarities suggest that epidemics of Pierce's disease do indeed have pre-epidemic periods in which the pathogen builds up throughout an area and then when conditions prevail the epidemic insues. Furthermore, if one may judge from past experiences, it appears that another epidemic of Pierce's disease could develop in the San Joaquin Valley and perhaps in the north coast areas within a year or so if conditions become favorable.

There is no explanation as to why the disease is favored by seasons of high rainfall. However, it has been assumed that high rainfall favors the development of vector populations and maturity. There is need to show the relationship of high rainfall to populations of vectors and the incidence of Pierce's disease and alfalfa dwarf. Such information would be useful in planning control of the disease.

Experiments and Control

It was reasoned in early work on Pierce's disease during the last epidemic that diseased grapevines were a likely source of spread of the disease in vineyards and that rouging out diseased grapevines early in their symptom development as soon as they could be distinguished, that their removal might reduce the incidence and spread of the disease in vineyards (Hewitt, Blue Anchor 18:16-21, 36, 1941). Ten acre plots to test rouging as a means of control were first established in Tulare County in 1937. Check plots as controls against rouging were situated adjacent to or close by the rouging plots. They were of equal size and of the same variety. Diseased vines were rouged twice each season from 1937 through 1943. The annual incidence of disease in rouged and unrouged vineyards were similar in numbers and patterns of distribution (Hilgardia 19:207-264, pp220, 1949). These experiments provided evidence to show that rouging had no apparent effect on the incidence of the disease.

By 1942 Pierce's disease had taken heavily of grapevines in vineyards of the San Joaquin Valley. Labor was short during the war years and raisin grapes were among the important food crops. There was considerable pressure to work out ways and means of controlling Pierce's disease.

Rouging experiments up to 1942 indicated that the disease was introduced into vineyards by vectors moving into the vineyards from outside. It was also evident that high incidence of disease were in vineyards and/or parts of vineyards adjacent to irrigated pastures, weedy water canals and alfalfa plantings with considerable grass. The high incidence of disease in these cases was apparently due to location. The pattern of spread was also evident in Napa Valley along creeks and river banks containing native chaparral where there were found high populations of the insect vectors.

In 1943 two large plots were established to test ways of controlling the disease. The State Legislature provided special funds for the study. One plot was situated between Woodlake and Ivanhoe in Tulare County. It was called the Woodlake plot. It covered 1,000 acres of which 713 were in grapes. The remainder of the land was in citrus, walnuts, irrigated pastures, a small dairy and some land was vacant. There was a railroad through one side of the plot. The second plot was located at Cairns Corner near Lindsay in Tulare County. It was called the Lindsay plot. It contained 240 acres, all planted to grapes of different varieties. Both plots were in areas of relatively high annual incidence of disease.

Tests in the Woodlake plot were 1) to further evaluate rouging, 2) to evaluate clean culture, 3) to evaluate training of the foliage up off the ground by cutting the tips of canes to keep them from drooping into the ground, 4) high trellising, and 5) with chemicals to control leafhopper vectors in breeding areas and in areas where the vectors had reached above normal populations. The training of foliage and trellising experiments were designed to keep foliage of canes out of the grass where it had been noted the leafhoppers fed on grape canes.

It is of interest perhaps at this time to note that because of shortages of labor and assistance during the war years, various members of the staff of the Departments of Viticulture and Plant Pathology on the University campuses at Berkeley and Davis assisted in varying degrees to help carry out the task of mapping and rouging these large vineyard plots. Dean and Director of the Agricultural Experiment Station C. B. Hutchison assisted at one time. Professors M. W. Gardner, Chairman of the Department of Plant Pathology, Berkeley, and J. B. Kendrick, Head of the Department at Davis, Mr. C. E. Scott, Extension Specialist in Plant Pathology, Mr. H. E. Jacobs, Viticulturist and Professor A. J. Winkler, Chairman of the

Department of Viticulture, all helped extensively in carrying out some of the work on the plots. All of the vineyards in both plots were mapped twice a year for the occurrence of diseased grapevines. Rouging was carried out at the same time the vineyards were mapped. Blocks of grapes in the Woodlake plot were sampled regularly 1943 through 1946 for the occurrence of leafhopper vectors.

Results of the studies and experiments are recorded in the report "Pierce's Disease Investigations" (Hilgardia 19:207-264, 1949). Rouging twice each year over the four year period had no apparent effect on the incidence of Pierce's disease. Patterns on occurrence of the disease varied with the plot much as they had in 10 acre plots established elsewhere in Tulare and Fresno Counties. Distribution maps on the incidence of disease indicated that the disease was spread into the vineyards by vectors each season from outside the area and that diseased grapevines were not primary sources of inoculum for spread of the disease within the vineyard plot. The apparent benefit of rouging was to remove diseased vines early in order that the spaces could be replanted with healthy vines and in this way keep the population of healthy vines at the highest possible level.

Results of studies on insect populations, however, show that the average numbers of leafhopper vectors collected in each quarter section of the Woodlake plot correlated closely with the incidence of disease in the same area. The high correlation suggested a positive relationship between the presence of vectors in the vineyard and the development of Pierce's disease.

Results of other experiments carried out in the plots, that is, clean cultivation, shoot management, and chemical control of vectors, appeared not to influence the incidence of disease in either the Woodlake plot or Lindsay plot.

Attempts were made to control the incidence of disease with the chemical DDT in two vineyards in Napa Valley. One plot was in a vineyard along the Napa River where Pierce's disease occurred regularly and the incidence of disease each season was high. The second plot was in a vineyard near Rutherford adjacent to a small creek and near a beautiful garden with many shrubs and flowers where the disease developed regularly and in fairly large numbers. Though the treatments killed many leafhopper vectors, there appeared no differences in the incidence of disease in either of the chemical controlled plots compared with adjacent untreated blocks of grapevines (unpublished work of W. B. Hewitt, N. W. Frazier and J. H. Freitag, 1958-1959).

Pierce's Disease Found in the Gulf Plains of North America

Hewitt (U.S.D.A. Yearbook 1953, pp744-753) reported that Pierce's disease had been identified in grapevine specimens and from photographs sent to him from Carrizo Springs area, Texas in 1942. There the disease killed plantings of Thompson Seedless and other vinifera varieties of table grapes (PDR 42:211-215, 1958).

In 1951 W. N. Stoner, L. H. Stover and G. K. Parris suspected Pierce's disease to be the cause of bunch grape degeneration in Florida (PDR 35: 341-344). The authors compared symptoms of vine degeneration in Florida with those described for Pierce's disease. They also classified varieties of Vitis labrusca and Vitis vinifera and other Vitis species with respect to their longevity in the area. Most all varieties eventually died from the degeneration disease. Some hybrids of varieties with the native wild grape Vitis simpsonii, however, appeared to have resistance to vine degeneration. Stoner and Stover (Florida State Hort. Soc. 64:267-268, 1951) described the disease in field plots and pointed out vigorous growth and

longevity of hybrid selections.

In 1952 Stoner compared degeneration of grapes in Florida with Pierce's disease in California (The Florida Entomologist, 35:62-68, 1952).

In 1953 Stoner (Phytopath., 43:611-615) confirmed the presence of Pierce's disease in Florida and reported transmission of the pathogen from grapes to grapes by the leafhopper Carneocephala falviceps. In this paper Stoner reviews some history of vine degeneration in Florida and concludes that Pierce's disease had been plaguing the vineyards of the area for many years and was probably responsible for failures to culture grapes in the area.

J. M. Crawl and L. H. Stover in 1957 (Phytopath., 47:518) gave a paper at the annual meetings of the American Phytopathological Society in which they pointed out the importance and impact of Pierce's disease on problems of establishing bunch grape vineyards in Florida. They also reported transmission of the disease by 2 additional leafhoppers Homalodisca sp. and Oncometopia undata.

In 1958 Hewitt, Loomis, Overcash and Parris (PDR, 42:207-210, 1958) demonstrated the occurrence of Pierce's disease in Mississippi. In this paper it was recorded that the disease had also been observed in grapevines in Alabama and Georgia. In 1957 Hewitt and Loomis traveled in Mississippi, Alabama, Georgia and Florida and in these states they observed Pierce's disease in grape plantings.

In a companion paper 1958 (PDR, 42:211-216, 1958) Hewitt wrote about the probable home of Pierce's disease virus. In this paper he presents evidence to show that the disease had not occurred in California vineyards at any time for at least some 100 years or more prior to the 1884 epidemic of the Anaheim disease or the 1887 outbreak of the disease in the Napa Valley. In this paper Hewitt presented evidence to show that the

occurrence of the disease in Napa Valley correlated with the introduction of grapevine species from the southern and midwestern states into the Napa Valley. Cuttings of wild grapes of Vitis species were to be screened for resistance to Phylloxera and suitability as rootstocks for the culture of Vitis vinifera varieties. It was on the old home ranch of Mr. W. Sheehon, Spring Mountain above St. Helena in Napa Valley that Pierre Viala and F. L. Schribner and others observed the California vine disease in 1887 (1890, Report of E. Dowlen, Calif. Board of State Viticulture Commissioners, 1889 to 1890 and P. Viala in 1890). Evidence to show possible introduction of the disease into southern California could not be located in the literature.

Hewitt (PDR, 42:211-215, 1958) also presented evidence to indicate that the failure to culture Vitis vinifera and Vitis labrusca varieties in many of the southern and bordering states of the Gulf Plains area could be due to Pierce's disease. These and other reports (Stoner, Stover, 1951; Stoner, 1952; Stoner, 1953; Stoner, Stover and Parris, 1951) are likely indications that indeed Pierce's disease is native to the Gulf Coast Plains. Additional and perhaps the most convincing evidence is that the species of grapevines known to have resistance to Pierce's disease are native to the Gulf Coastal Plains (Hewitt, PDR, 42:211-215, 1958).

These findings indicate that Pierce's disease is apparently native to North American Gulf Coast plains. Pierce's disease was most likely introduced into southern California a few years before 1884 and into northern California and Napa Valley perhaps 2 years before 1887.

Reports of Pierce's disease in other countries, Chile and Argentina, were found by Hewitt to be incorrect. In 1964-1965 Hewitt visited vineyards in Chile and Argentina. The diseases in Chile suspected of being Pierce's disease were found to be boron deficiency and a new

disease which Hewitt named chlorotic leaf curl. There were many symptoms of both of these diseases that were similar to symptoms induced by Pierce's disease. In Argentina it was chlorotic leaf curl that was confused with Pierce's disease. Chlorotic leaf curl kills grapevines within 2 to 3 years much as does Pierce's disease (Hewitt, 1965, FAO Pub. 1962, Rome, 1965). In the summer of 1972 Hewitt visited various areas of Mexico to observe vineyards. Pierce's disease was observed only in Parras. Even there it was confused with corky bark, very similar in symptomatology with flavescente doree of France. No doubt the pathogen had been present in the area for some time. The area may also have Vitis species resistant to Pierce's disease.

These observations indicate that Pierce's disease is limited to California and the Gulf Plains area of North America, and to north central Mexico.

The Pathogen

It seems strange perhaps that the pathogen of Pierce's disease had not been identified, especially since electron microscope had become an important tool for locating viruses and virus-like pathogens in tissues of host plants. No one devoted time and effort to it. After all, except for flareups in Napa Valley, the disease had become virtually non-existent elsewhere in California until 1970 when it began to show again in the central valley.

Researchers in Florida, D. L. Hopkins and J. A. Mortensen (PDR, vol. 55, pp 610-612, 1971) were the first to point out the nature of the pathogen of Pierce's disease. They reported successful suppression of symptoms of the Pierce's disease of grapevines by application of tetracyclin antibiotics to the root zone in the soil of mature grapevines and rooted

cuttings. Based on results of other studies the successful treatment of diseased grapevines with tetracyclin to correct symptoms of Pierce's disease, they point out, suggested the pathogen to be a mycoplasma-like organism.

Earlier work of Doi, Teranaka, Yora and Asuyama (Ann. Phytopathol. Soc. Japan, vol. 33, pp 259-266, 1967) had demonstrated the association of mycoplasma-like organisms with some so-called virus diseases, mulberry dwarf, potato witches' broom, aster yellows, etc. Ishii, Doi, Yora and Asuyama were able to suppress symptoms of mulberry dwarf disease in plants by treatment with tetracycline antibiotics. Their reports have been followed by many observations of a similar nature that indeed indicate that mycoplasma-like organisms are associated with many of the leafhopper transmitted diseases so-called virus diseases of plants. These include many of the yellows type diseases transmitted by leafhoppers as well as other diseases (Davis, Whitcomb, Ann. Rev. Phytopath., vol. 9, pp 119-144, 1971). It must be recalled, however, that the mycoplasma-like organisms have not been isolated and reintroduced to cause disease. Proof of pathogenicity is lacking.

D. L. Hopkins and H. H. Mullenbauer (Science, vol. 179, pp 298-300, 1973) reported a rickettsia-like organism to be present in Pierce's diseased grapevines. They point out there remains to be proven the pathogenicity of the organism to show that it is the sole entity responsible for causing the disease. A. C. Goheen and G. Nyland (Phytopath., vol. 63, pp 341-345, 1973) also have demonstrated a rickettsia-like organism to be present in Pierce's diseased grapevines but not present in healthy grapevines. They also reported a similar pathogen to be present in dwarf diseased alfalfa. The paper contains a detailed study of the

response of grapevines to heat therapy in the control of Pierce's disease. They concluded the plant pathogen that caused Pierce's disease to be most likely a rickettsia-like organism.

One wonders had Dowlen in his chemical injection reported in 1890 (see Gardner page 121) used the right chemical he may have developed control of the disease in those early dates. E. M. Stoddard inactivated the x-disease of peach by chemotherapy in 1942 (Phytopath., vol. 32, p 17, 1942).

A Bacterial Disease

The Pierce's disease pathogen called a rickettsia-like organism by Hopkins and Mullenbauer (Science, vol. 179, pp 298-300) and Goheen and Nyland (Phytopath., vol. 63, pp 341-345) has only recently been identified to be a small bacterium. Jamie Augar, a graduate student in Plant Pathology, University of California, Davis, isolated the bacterium from the insect vector Draeculacephala minerva Ball., but not from the grapevine (Science, vol. , pp , 1974). He has grown the small bacterium in artificial culture in liquid and also on solid media. Colonies grow slowly and they are opaque whitish and smooth. Jamie Augar was able to reintroduce the bacterium into grapevines and induce the formation of Pierce's disease only by way of the vector sharpshooter. From artificial culture the bacteria were injected into the body cavity of the sharpshooter leafhoppers by micro-injection. The vectors were then caged on leaves of young healthy grapevines. After some six weeks the plants developed typical symptoms of Pierce's disease. Control plants remained healthy. His experimental procedures were all very well conducted with proper controls.

The small bacteria was proven to be the pathogen of Pierce's disease.

The bacterium was according to good procedure known as "Koch's postulates" first isolated, characterized, grown in culture, reintroduced into the host where symptoms of the disease developed. The bacterium was again isolated from a diseased grape plant by feeding pathogen-free leafhoppers on diseased tissue and then isolating the bacterium from the leafhopper. After isolation in culture the bacterium was compared with the original and shown to be the same. Proof of identity was demonstrated by characteristics in culture, morphology, and by serology.

The full circle:

For the first time since 1884 the true nature of the Pierce's disease pathogen has come to light. The story has made a complete circle, the disease was first suspected to be caused by a bacterium. Newton B. Pierce was a student and friend of Erwin F. Smith, well known and famous for his pioneering work with bacterial plant pathogens. Pierce was perhaps chosen to unravel the mysteries of the "Anaheim disease" because of his knowledge of bacterial diseases of plants. However, neither Pierce, Dowlen, nor later did Hewitt succeed in isolating bacteria from diseased grapevines. In fact, neither has Jamie Auger, but he did isolate the bacterium from the insect vector. Just why the bacterium is so difficult to culture from grape tissue will no doubt be determined as studies advance.

That the bacterium is small, that it transmits from diseased plants to healthy plants by insect vectors, and that it could not be isolated in artificial culture by the usual techniques are all facts that lead to the supposition the pathogen was virus or certainly virus-like. Pierce's disease is now known to be a bacterial disease and no longer belongs among the virul-like, mycoplasma-like or rickettsial-like diseases.

Breeding for Resistance to Pierce's Disease

Resistance to Pierce's disease occurs in the Vitis species native to the Gulf Coastal plains of North America (PDR, vol. 42, pp 211-225, 1958). Resistance may also occur in the canyons of north Mexico, especially that above Parras, Coahuila. Recently Professor H. P. Olmo of the Department of Viticulture and Enology, University of California, Davis, has transferred resistance from Vitis rutindofolia to V. vinifera L. The development of varieties resistant to the disease should move along relatively rapidly.

Viticulture in the southern states of the United States should also develop as resistant varieties of bunch grapes are produced. Professor Olmo and Mr. J. A. Mortensen of the University of Florida Experiment Station, Leesburg, Florida, are cooperating in the program. The breeding work is being done in California, and the screening for resistance at the Leesburg Station in Florida.

Summary

Appalled by the losses caused by the Anaheim disease in their vineyards, beginning in 1884, the Anaheim growers appealed to Professor Hilgard at the university for help. In July, 1886, he sent Morse to study the disease. He found it was not due to insects, fungi nor soil conditions. He and Hilgard told the growers the disease was of climatic origin and would not recur. They continued to study the disease at the university and adhered to their climatic and deficiency in sap flow theory.

But the disease did not abate and the growers, not satisfied with what Morse and Hilgard told them, turned to the U.S. Department of Agriculture and the State Board of Viticultural Commissioners to learn how to combat the disease.

The Department sent Schribner and Viala to look at the disease in the fall of 1888. They had not seen anything like it in this country or elsewhere and had no explanation.

Commissioner Shorb, whose vineyards at San Gabriel were hard hit, was delegated by the State Board to study the disease. He employed Ethelbert Dowlen, a botanist and graduate of the Royal College of Science in London, who happened to be in Los Angeles and applied for the position in September, 1888.

Dowlen made his headquarters with Shorb at San Gabriel. The Board supplied him with equipment for microscopic work and Shorb built an experimental greenhouse for him. Dowlen studied the disease diligently for over two years, submitting weekly reports. Most of these were published in the Merchant and Viticulturist, a San Francisco periodical which apparently served as an unofficial publication channel for the Board.

Shorb unsuccessfully sought the cooperation of the U.S. Department. He asked for help from the Los Angeles County board of supervisors. For awhile he feared the disease was statewide and this stirred up a controversy with the Fresno growers. Commissioner Wheeler sent out questionnaires to obtain a statewide survey.

David Hewes of Tustin called on the Secretary of Agriculture at Washington in March, 1889, asking him to send a man to study the disease. Benjamin Pratt of Orange, who had been sending specimens to Galloway, called on him in Washington in May, 1889, met the Secretary and also met Pierce who was about to leave for California.

The disease was the subject of numerous newspaper items, speeches at meetings, and articles in the Pacific Rural Press, California Fruit Grower, Rural Californian, and especially the Merchant and Viticulturist. Many

theories as to cause and control of the disease were propounded, mostly untenable.

The disease was variously known as the California vine disease, Maladie de Californie, mysterious vine disease, Los Angeles disease and Anaheim disease.

Dowlen found certain fungi on the leaves and canes and erroneously thought these might be causing the disease. Shorb publicized this too eagerly and prematurely and suggested dusting with Ongerth's copper fungicide. Growers seized upon this idea and much interest was generated and false hope engendered.

The Commissioners experienced some financial difficulties at Sacramento and were eager to discover a control for the disease.

Dowlen's weekly reports contained much new and important information about the disease, such as symptoms, varietal differences in resistance, lack of relation to soil and climate except being less severe in shade and that it was carried in the cuttings. He was never real sure of his fungus theory.

Commissioner C. A. Wetmore held to the theory of a non-parasitic cause of the disease, attributing it to constitutional derangement or impaired rootlet vitality.

Wetmore was skeptical of the fungus theory and took Dr. Harkness, the noted San Francisco mycologist, south with him to look into the fungus aspects. Harkness found that Dowlen's fungi was not pathogenic and nullified the fungus theory. But in so doing he unfortunately and unnecessarily embarrassed Shorb and Dowlen.

Dowlen's appointment was terminated early in 1891, but he was re-employed at times for vineyard surveys.

Meantime Dr. Pierce was appointed by the U.S. Department to study the disease. He had just completed graduate work in pathology at Michigan and was in close touch with Dr. Erwin F. Smith, eminent student of bacterial diseases.

Pierce arrived in Santa Ana in May, 1889, and made it his headquarters. He studied the disease in the vineyards and set up experiments. He preferred to work independently and showed so little interest in what Shorb and Dowlen were doing, that Shorb and the Commissioners were unduly critical of him. He was maligned in print. The growers, however, soon rallied to his support.

Some suspected the disease was the same as the mal nero, a non-parasitic disease of grapes in Italy, but this was never verified.

After ten months' work in California, Pierce made a five-months trip through the grape districts of France, Italy and Algiers at his own expense, to observe the mal nero and other diseases, compare them with the Anaheim disease and consult with European pathologists. Upon his return to Washington he wrote his classic Bulletin No. 2, dramatizing the California calamity and characterizing the disease that caused it. Pierce returned to Santa Ana in August, 1891, where he set up a field laboratory. He suspected bacteria might be the cause of the disease and work along this line was continued at Santa Ana and by Galloway at Washington. Though this theory eventually proved to be correct, they were never able to transmit the disease with their bacteria nor by any other means. Isolation of the causal bacterium occurred some 80 years later. The bacteria were very small ones and are yet to be identified.

Although it was common knowledge that cuttings, or scions, taken from diseased vines gave rise to diseased vines when grafted on healthy roots,

no evidence that Pierce or Galloway or Dowlen ever transmitted the disease to a healthy vine by budding or grafting was found.

Pierce demonstrated practical control of the disease by the use of disease-free cuttings obtained from regions that were free of the disease. Much of Pierce's later work on the disease had to do with the development of disease-resistant varieties based upon the resistance of the Lenoir variety.

Fortunately the disease appeared to abate in rate of spread along in about 1890. Later surveys were made by Pierce, Dowlen, C. J. Wetmore and Bischowsky.

Of the three research agencies involved in this campaign, the University missed its opportunity, the Viticultural Commissioners showed enterprise and made a great effort and considerable progress, and the U.S. Department somewhat belatedly assigned Pierce, a competent pathologist to the problem. He arrived at about as good an understanding of the disease as the scientific knowledge of that time permitted.

One good result of the Anaheim disease was to bring to California such a competent plant pathologist and a laboratory for plant disease research fourteen years before the University and its agricultural experiment station were prepared to carry on such research.

Active participants in the research on the disease were Morse, Shorb, Dowlen, Galloway and Pierce. Less important roles were played by Hilgard, Schribner, Viala, Wheeler, C. A. Wetmore, C. J. Wetmore, Harkness, and Bichowsky.

Dowlen deserves credit for his integrity, diligence, caution and certain important findings. He was handicapped by his inadequate knowledge of mycology and pathology and by being, no doubt, under pressure for

an answer as to how to control the disease.

Shorb deserves credit for his deep concern with the problem, his enterprise in bringing in a botanist whom he thought was competent to solve the problem, and his loyal and vigorous support of Dowlen and his research. Though over-confident about the efficacy of the fungicide, he did a good job of fostering research on a baffling plant disease.

Pierce's disease was first identified in the San Joaquin Valley in 1935. It was apparently observed in Tulare County about 1916, then again in 1921, and became fairly prevalent by 1930, and it was called the Emperor disease.

The second epidemic of Pierce's disease became apparent in the San Joaquin Valley about 1934 and continued to about 1946. During this time the disease showed in 28 counties and some 21% of the vineyards surveyed. Losses, though difficult to measure, were estimated to be an equivalent of some 50,000 acres of grapevines.

The disease after demonstrating that it was contagious and would spread by grafting was named after Newton B. Pierce in recognition of his appropriate diagnosis which was in line with the knowledge of his time.

Researchers during the second epidemic 1934-1946 determined the nature of the disease, transmissibility by grafting only when xylem tissue was included and natural transmission and spread by numerous sharpshooter leafhoppers. They gained much information on the modes of development of epidemics. They demonstrated the disease to be caused by the same pathogen that causes alfalfa dwarf and believed the pathogen to be a virus or virus-like because it behaved in transmission and developed in host plants as do viruses. The true identity of the causal pathogen was not discovered until 1973 and evidence published in 1974.

Records of development and spread of Pierce's disease in vineyards shows that the pathogen often spread into the vineyard from some outside sources and that diseased vines were not prime sources of the pathogen for spread in vineyards. Spread into the vineyard occurred at locations near river banks and streams lined with native plants, prominent annual pastures containing grasses and clovers, grassy alfalfa plantings, grass infested irrigation canals, exceptional home gardens well maintained with much shrubbery and lawns and also spread from some cemeteries. It was demonstrated that there were many species of sharpshooter leafhoppers and spittle insect vectors of the Pierce's disease pathogen and that the vectors and the pathogen have an unusually large host range of many monocotyledonous and dicotyledonous plants including annuals, perennials, grasses, shrubs and trees.

It has been demonstrated that epidemics of Pierce's disease are associated with a sequence of seasons of rainfall above normal. These conditions lead to the development of unusually large quantities of the sharpshooter leafhoppers which are vectors of the pathogen.

The pathological anatomy at the light microscope level as worked out by Dr. Katherine Esau demonstrated that the vector sharpshooter leafhoppers feed in the xylem tissue of the grapevine and alfalfa plants. Feeding in the xylem indicated that the vector obtained the pathogen from the wood tissues and that in feeding it would also transmit the pathogen into these tissues. It was noted in a study on the modes of vector feeding that the vector sharpshooter Draeculacephala minerva and Hordnia circellata when feeding discharged rather large quantities of water up to some 2.5 ml per leafhopper per day which is also good evidence of the vector's feeding in the wooden tissues. The cytological study showed that the effects of the

pathogen on the host were to induce early symptoms of senescence - that is, formation of gum and copious quantities of tyloses in the wood parichma and the xylem vessels. The cytological studies also explain the symptom development. The scalding and burning of leaves which is associated with gum formation in the tyloses of the wood is an expression of water shortage. Though the cytological studies demonstrated lack of cambium formation and maturity of canes and the failure of starch deposition in the green portions of canes, they did not explain why these conditions develop nor has there yet developed an explanation for this phenomenon.

Newton B. Pierce originally suspected the California vine disease of being induced by bacteria. However, neither he nor technologists at the U.S. Department of Agriculture in Washington, 1886-1889, could isolate a bacterial pathogen from diseased vine material. Later between 1936 and 1938 Hewitt attempted isolation of organisms and microorganisms from diseased tissues without success. Transmission by grafting and by insect vectors suggest the pathogen vector to be a virus or virus-like. It was therefore classed as a virus disease. Later, in 1972, after Pierce attempted isolation of a bacterial pathogen, it was demonstrated that antibiotics would alleviate the symptoms which indicated the pathogen to be either a mycoplasma-like organism or some bacterial or rickettsial-like organism. Electron microscope examination of the diseased tissues showed a rickettsial or bacterial-like organism present in the tissues. In 1973 small bacteria were isolated from the insect vector which proved later to be the pathogen of the disease. Bacteria were isolated in pure culture from the vector but they have not been isolated from the grapevine. This small bacteria has been reintroduced into grapevine by injection of the insect vector and then feeding the vector on the grapevine. After symptoms development the

bacteria was reisolated by way of the vectors and again cultured from the leafhopper. The bacteria was then compared with the original isolate and shown to be the same. Thus, finally after some 85 years the pathogen of Pierce's disease has been identified and it proves to be a bacterium as originally suspected by Pierce.

It has been demonstrated that the Pierce's disease pathogen is native to the Gulf Coast Plains states of North America and that it also occurs in Parras, Mexico. No doubt it has been there for some time. Resistance is found in Vitis species native to the Gulf Coast plains. The problem of breeding V. vinifera varieties for resistance has been that of moving genes for resistance into the V. vinifera grape. Professor H. P. Olmo of the University of California, Davis, has recently accomplished this and has been able to develop some new promising varieties resistant to the disease.

Chemical control of the vector insect has not proven effective. However, some recent work indicates that it may be possible to control the vector in its native area before it moves into the vineyard with some success in abating the spread of Pierce's disease. Cultural practices, that is the keeping of water grass from growing into ends of vineyard rows, along the irrigation canals and managing water to keep down grass has shown some promise in abating the disease in the San Joaquin Valley.

Abbreviations Used In Citations

- PRP = Pacific Rural Press
- CFG = California Fruit Grower
- RC = Rural Californian
- SFM = San Francisco Merchant (1879 - Apr. 26, 1889)
- MV = Merchant and Viticulturist (Apr. 26, 1889 - Mar. 22, 1890)
- PWSR = Pacific Wine and Spirit Review (Apr., 1890 -)
- BSVC = Board of State Viticultural Commissioners
- CSBH = California State Board of Horticulture
- Off. Rep. = Official Report of State Fruit Growers' Convention
- B. Lib. = Bancroft Library - BSVC Mss.
- HEH. Lib. = Henry E. Huntington Library - Shorb Mss.
- Bul. 2 = Pierce, N. B. The California Vine Disease. U.S. Dept. Agr.
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ANAHEIM DISEASE OF THE GRAPE

APPENDIX: REFERENCES

Abbreviations:

PRP	=	Pacific Rural Press
RC	=	Rural Californian
CFG	=	California Fruit Grower
SFM	=	San Francisco Merchant
MV	=	Merchant and Viticulturist
PWSR	=	Pacific Wine and Spirit Review (The last three are successive titles of the same periodical)
BSVC	=	Board of State Viticultural Commissioners
CSBH	=	California State Board of Horticulture
NBP	=	Re Newton B. Pierce

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Appendix No. 2

Dowlen and Harkness Attend Viticultural Convention

Abstract of verbatim account of the evening session, Aug. 16, 1889, of the 7th annual Viticultural Convention, San Francisco, published in THE WHISTLE (Later, THE VITIGRAPH) (v. 1, No. 15, pp. 6, 7, 10, 11, Sept. 21, 1889), the "Official Organ of the Grape-Growers and Wine-Makers Association of California". This was a weekly published at El Verano, Sonoma county, by G. H. Maxwell, M. K. Cady and T. B. Holmes.

Dowlen and Harkness Attend Viticultural Convention.

President C. A. Wetmore opened the Aug. 19, 1889 meeting, saying, "The special topic for this evening is the so-called Los Angeles vine disease The opinions are so diverse on this disease that no one is willing to antagonize another on the subject. . . . not only has the University of California attempted to solve the mystery, but the commission . . . has obtained the very best talent . . . and if we have not solved the mystery we are no worse off than those of other countries who have fought vine diseases and not been able to describe them. . . . This evening we propose to devote wholly to this subject. . . . When these gentlemen, Mr. Dowlen and Professor Harkness have given their opinions . . . ", questions could be asked.

Dowlen: "I hope there is nobody here that expects to hear a very scientific discourse, because I don't pretend to give them one. . . . I am going to talk as plainly and simply as I can." He then described the symptoms in considerable detail, referring (p. 7) to specimens on exhibition and to the microscope slides. "There has been a great deal of talk about remedies. Now I haven't anything very decided to say" With Ongerth's powder he had " . . . had a measure of success." As to the cause of the disease (p. 10), "Nobody seems to know I have an idea, but I don't express it as an opinion, . . . that it will turn out to be due to some fungus trouble." Dowlen gave his evidence for suspecting the disease was brought into a San Diego county vineyard on boxes that in the San Diego market " . . . came in contact with boxes from diseased areas, and on return . . . were piled up near the vines . . . " that later became diseased.

Wetmore: "Mr. Dowlen, Mr. Pierce has found millions of bacteria in San Diego."

Dowlen: "I have found them all along; but I doubt very much if they have anything to do with disease as a cause"

Dr. Harkness: "I would like to ask one question. Mr. Dowlen, you have spoken of the remedies you have applied. On what theory have you applied them?"

Dowlen: "I said I thought possibly that in the end this trouble might turn out to be connected with some fungus growth. Now because we had that opinion we applied . . . fungicides. . . . An eminent Italian named Pirotta has claimed to have found a fungus growing upon vines affected with Mal Nero. . . . It was on that ground we tried these remedies . . . we thought we should be doing wrong if we did not try them."

Dr. Harkness: "My friend Dowlen comes here before you to describe the . . . disease . . . so that each of you may determine . . . what is the trouble with your vines. I think if you followed Mr. Dowlen's description, you would be led into great error. . . . Now here is described as a pathognomonic symptom of this disease certain brown spots." Harkness had specimens from Niles showing similar spots which he called post mortem symptoms. He referred to his 9000 " . . . specimens of kindred diseases of plants . . . a collection that I have spent ten years in gathering, and I have spent ten thousand dollars in coin . . . and I say I have a right to be heard in this matter, all leaves . . . will show it. . . . The slides yonder (p. 11) don't contain the slightest sign of fungus. . . . Why talk of a fungus killing those vines? If it is a fungus, four hours time with any mycologist . . . should

determine it positively instead of nine months that my friend Dowlen has given to it. . . . aye, thirty minutes would be as much as would be required A fungus is not so hidden a plant as you may think. . . . can be determined often by the naked eye, but the microscope unfailingly will determine it. . . . There is not the slightest trace of a fungus in this disease. . . . If I can borrow the Society's microscope, I will show all who care to look at a fungus affecting a vine, growing in the wood itself, obtained from a healthy vine over at Niles. . . . I can show them these brown spots which are pathognomonic in the disease . . . which are to be found in every vineyard in this State. . . . I am sorry to disagree with my friend Dowlen, but I must tell you the facts in the case."

At this point, Wetmore asked Dr. Harkness if he had heard about Pierce's theory, presumably about bacteria. "I have no reply . . . have not investigated it"

Dowlen: "I think that Dr. Harkness has rather misunderstood me. . . . I did not claim there was any fungus on those slides The black and brown spots were inside the wood--as in Mal Nero."

Harkness: "The best mycologists have decided that Mal Nero was not a fungus."

Dowlen digressed, discussing Mal Nero and black rot.

Wetmore then ended the meeting, referring to " . . . another theory about this disease coming from Professor Pierce." San Diego county was alarmed because "Mr. Pierce has been there . . . and he has found the disease not only on the vines but on the trees. . . . Dr. Harkness, did you ever hear the word 'bacteria' applied to a vegetable?"

Dr. Harkness: "It is a vegetable."

Here the verbatim account ends. How accurate is it? Some passages are obscure. Certainly Dowlen's presentation was modest and masterful, well illustrated by specimens, and so hedged about with reservations that there seems to be little justification for Harkness's vehemence.

