James E. Teschemacher and the Cause and Management of Potato Blight in the United States

PAUL D. PETERSON, JR., Graduate Research Assistant, Department of History, C. LEE CAMPBELL, Professor, Department of Plant Pathology, and CLAY S. GRIFFITH, Former Graduate Assistant, Department of History, North Carolina State University, Raleigh 27695-7616

In the 1840s, James E. Teschemacher of Boston, a successful merchant and amateur botanist, advocated the theory that a fungus was responsible for the devastating late blight of potato. At the time, his view was very much a minority opinion. The concept that contagious, parasitic fungi could cause plant diseases had been spreading since the experiments of the Europeans Tillet and Prévost in the 18th and early 19th centuries indicated that a fungus caused wheat bunt. The theory of fungal pathogenicity did not, however, become widely known or accepted for many years. It was not until 1853 that the publication of de Bary's landmark experiments confirmed that a parasitic fungus (*Puccinia graminis*) caused a plant disease (stem rust of wheat) (1). De Bary's work proved that Teschemacher's basic premise, i.e., that a fungus caused a plant disease, had been correct. In that same year, Teschemacher died in relative obscurity (6,22). While later scientific "breakthroughs" overshadowed his work and ideas, Teschemacher did participate in the discourse on fungal pathogenicity that eventually led to the new understanding of plant diseases.

The most significant disease of crop plants in the mid-19th century was potato late blight, known colloquially as "potato rot" or "potato murrain." Although the most famous epidemic of this disease was in Ireland in 1845, it struck first in North America. The center of origin for the disease, however, was unknown (5). Poor communication or misinterpretation shrouded the time and place of its first incursion into the United States (5,9,13). In 1843, there were specific accounts of the disease in a five-state area surrounding the port cities of Philadelphia and New York (13). During 1844, potato late blight spread to other parts of the United States and to Canada (9).

The occurrence of a disease that could decimate an entire potato crop in 4 weeks (10,11) caused great public concern and spawned many theories about the cause. The agricultural press in the United States gave space to "progressive" farmers, botanists, chemists, and physicians who suggested explanations for potato rot. This was typical of scientific coverage in the agricultural press of the time. On the basis of personal experience and observation, these farmers and amateur naturalists attributed the disease to insects, the environment, poor soil, incorrect cultivation, inappropriate nutrients, and even divine intervention. Some Americans, though a small group, held that a fungus was responsible for this malady of potatoes (4,20,21). (Beginning in 1843, the commissioner of patents devoted space to summary discussions of the potato disease in his annual reports to Congress; these were largely extractions from agricultural journals.)

Teschemacher wrote in October 1844 in the *New England Farmer and Horticultural Register* (15) that his observations of potato rot led him to conclude that a fungus similar to the common mushroom was responsible for the misfortune. The peculiar odor of the diseased plants and the accounts of animals dying after eating them had led him to believe that a fungus was involved. His initial opinion was strengthened when, using the microscope, he recognized among the "grayish slimy mass" taken from the potato "the spores, or reproducing bodies of the fungus." These spores were not unlike "the seeds of other vegetables," forming and spreading in the air with "inconceivable rapidity" (15).

Teschemacher was typical of most of the "scientists" of his day. He was an amateur who carried out his studies with a simple, homemade microscope and whose life-style provided him with time to devote to his avocation of natural history and the sciences. Born in Nottingham, England, on 11 June 1790, he came to the United States in 1832, settled in Boston, and went into the mercantile trade. He joined the Boston Society of Natural History, one of the premier scientific institutions in America (6,7,22). The society published many of Teschemacher's papers on botany, mineralogy, geology, and chemistry. He also delivered numerous addresses before the Massachusetts Horticultural Society and the Harvard Natural History Society and served as coeditor of Boston's *Horticultural Register and Gardener's Magazine* in 1835 (6,22).

Also in 1844, in a subsequent issue of the *New England Farmer and Horticultural Register* (16), Teschemacher noted that since objections to his views on the cause of potato rot were not forthcoming, he had continued his investigations of the fungal theory. In this report, he declared that it was impossible for insects to be responsible for the rot, because potato decay was present before insects appeared. Teschemacher also addressed the prevailing theory that the fungus associated with the rot was the result rather than the cause of the disease. He observed parts of the plant first affected and then watched the disease spread. Teschemacher noticed the fungus originating on the skin of the potato, then traced it by the discoloration of the tuber as the fungus penetrated the healthy inside. If the fungus was the result instead of the cause, Teschemacher concluded, he would have found parts of the rotten potato without the fungus, which he asserted had not happened (16).

After reporting these observations to the editor of the *New England Farmer and Horticultural Register*, Teschemacher described experiments conducted to determine the contagious nature of the disease. He cut a diseased potato in half and placed each half on an intact, healthy potato under a bell jar in a dark, cool environment. He observed the potatoes after 5 days and found the sound potatoes "uncontaminated." He also buried a "much diseased potato" 5 cm in the soil and 6 cm away from a healthy potato, at a temperature between 13.9 and 16.6 C. Again, after 5 days, he observed that the disease had not affected the sound potato. Suggesting that maybe he had acted hastily, Teschemacher closed his letter to the editor by explaining that he intended to leave the potatoes in their locations for a longer

This paper is the first in a series of articles, to be published intermittently, presenting historical information relevant to the development of plant pathology. The goal of the series is to make information on early ideas and research on plant diseases available to plant pathologists and others interested. We encourage submission of manuscripts in this subject area, and we welcome readers' opinions of the series.—*The Editors*

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period of time and would report on his findings later (16). Teschemacher revealed the results of his lengthened analysis at a meeting in Boston convened in January 1845 to discuss potato rot. Opening the session with his fungal theory, he reported his efforts at "propagating the disorder." Potatoes that showed no contamination after 5 days were diseased after 2 weeks (2,20).

Teschemacher restated his ideas in another series of letters to the editor of the *New England Farmer and Horticultural Register* (18) beginning in October 1845. To strengthen his case, he mentioned a fungal theory held by Professor Charles Morren of Liège, Belgium (5). Although Teschemacher apparently had not read Morren's work, he knew of the Belgian's investigations from European newspapers. Teschemacher claimed that Morren's "opinion had been generally received as true by the best informed circles in Europe" (18).

Bringing in European scientific theory for support did not close the case for Teschemacher. Critics of the fungal theory continued to argue against Teschemacher's ideas in the agricultural press, maintaining that the fungus was a result of a disease, not the cause. A Mr. Webber of Charlestown, New Hampshire, wrote (21):

> A supposition of this kind [referring to Teschemacher's fungal theory] has heretofore been made in this country; but it seems possible that this may be merely a mistake of the effect for the cause. Decaying vegetables are almost uniformly the prey of parasitic or fungus growths. In the economy of Providence, it seems to be a law that there shall be no waste, and that, wherever there is nourishment, there shall be life to consume it and be supported by it, and that the decay of one race shall afford aliment to others.

Teschemacher returned fire on his critics, particularly those who favored the vague idea that atmospheric influences such as cold and wet weather held the key to the rot. He insisted that weather patterns had been too irregular to make this conclusion. The United States had experienced "a warm and dry summer . . . with more than a usual proportion of sunshine," he explained, but the disease still had devastated the potatoes. It also was difficult to claim that the cold and wet weather was totally responsible for this disease, Teschemacher added, when this type of weather was common in Europe, "without the appearance of this peculiar disease in the potato." He judged that "it is clear, therefore, that this so called atmospheric influence is mainly a name, without a distinct tangible meaning" (21).

Besides his etiological work, Teschemacher also proposed control measures for late blight. To do so, he turned to the growing field of agricultural chemistry. A small, but active clique of "progressive" agriculturalists felt increasingly that the origins of the potato disease rested in the chemical nature of the potato plant. The prevailing theorist in agricultural chemistry of the time was Justus Liebig of Germany. To those agriculturalists in the United States who were inclined to embrace science, Liebig's theories seemed to be a panacea, the perfect tools with which to define and then solve agricultural problems (12).

Teschemacher applied the concepts of agricultural chemistry to treatments for potato rot. These European ideas enhanced his level of experimentation. In his October 1844 article in the *New England Farmer and Horticultural Register*, he advocated the use of common salt, "as it destroys the fungus vegetation. Therefore, wherever the disease existed this year, I recommended a liberal supply of salt to be spread on the soil, and trust it will eradicate the evil." Teschemacher also asked that anyone with a better microscope than his study the "action of sulphate of iron, sulphate of soda, or of ammonia, or any other substance which can be cheaply applied to the soil as a preventative" (15).

Again, his opinions found opposition. In January 1845, Teschemacher attended a meeting on the potato disease held at the Massachusetts State House. State Senator Dillingham disputed the idea that salt had any effect on the blight. He had planted potatoes with seaweed and kelp, but disease still occurred (2,20).

By November 1845, Teschemacher had added to his chemical arsenal against potato blight. He suggested not only salt, but lime and several other chemical compounds. He preferred salt because "when mixed in the soil, it may get into the juices and circulate through the whole plant." Lime or limewater would perform the same function but was "far less soluble than salt" (19).

Farmers had to apply chemicals with some forethought and scientific guidance to be effective. Teschemacher (21) refuted the criticism of Senator Dillingham by explaining that the use of seaweed or planting near the sea did not deliver sufficient salt to the soil. Also, even though there were several instances of "chlorine gas" killing the blight fungus, large-scale application could cause "fatal accidents." Lime, although effective, was also problematic and could lead to failures, as Teschemacher indicated (21):

> Unslaked lime will also destroy this fungus, and must, therefore, be a most excellent addition to the soil, with salt; but lime is not so easily caused to circulate in the juices, except as lime water. Then the acids in the plant would quickly saturate it and change its nature; in addition to which, it attracts carbonic acid from the atmosphere, and becomes a carbonate of lime, in which state its powers on fungi are very questionable.

Teschemacher recognized that the potato crop of 1845 was a near total loss. He suggested specific measures to prepare the soil and the seed for the next year. Farmers should use chemical treatment in addition to the proper choice of soil and drainage area and storage of seed tubers. The key to a healthy crop the next year would be ploughing lime and salt into the soil and soaking the seed potatoes in brine. Teschemacher also added a new compound to his formula—bluestone, a common name for copper sulfate (21).

In December 1845, Teschemacher reported to the *New England Farmer and Horticultural Register* (18) that he had finally had the opportunity to study the reports of Professor Morren of Belgium. Morren advised the use of salt, lime, and bluestone to treat potato blight. Morren did not, however, give the details of experiments that substantiated his claims (21).

Neither Teschemacher nor Morren discovered the success of these compounds, particularly copper sulfate, against fungal diseases. Prévost had used bluestone on cereal smut at least as early as 1807 (8). In 1844, Judge Cheever, president of the New York Farmers' Club, aware of copper sulfate's use on cereal rust, suggested that it might have some value against potato blight (20).

Teschemacher's control recommendations never found an eager audience. Farmers largely ignored his advice to treat the tubers with chemicals, preferring instead to apply solutions to the crop in the field. The failure to follow the recommendations of Teschemacher and Morren "postponed the discovery and correct use of copper fungicides until the time of Millardet forty years later" (8).

Teschemacher's control ideas also suffered neglect because of the general lack of scientific knowledge and training in the United States during the first half of the 19th century (7,14). Most scientific agriculturalists did not yet understand or believe in his theory of fungal pathogenicity, so they failed to recognize the significance of his work. In 1844, for example, Teschemacher prepared a paper on the causes and controls of potato rot for publication by the New York State Agricultural Society. The society never published the manuscript, however, claiming that it had been lost. Thus, at an early stage of the epidemic, his fungal theory and management proposals were limited in their distribution. He later remarked that "they did me the honor not to take the slightest notice" of this paper (18).

Research and debate on potato late blight, its cause and management, marked Teschemacher's last significant public foray into science. His name became absent from the agricultural

press as the potato blight faded from a public policy crisis to an endemic irritation. In 1853, de Bary published studies that linked his name with the discovery of fungal pathogenicity. Teschemacher died that year, never having transcended the role of amateur dabbler to become one of the small, but growing society of professional scientists. Europeans such as Berkeley and de Bary receive the credit for developing and promoting the theory of fungal pathogenicity. Berkeley, incidentally, cited Teschemacher as one of the earliest scientists who recognized that a fungus caused late blight of potato (3,17). Historians and scientists credit Millardet, another European, for discovering and publicizing practical fungicides with his Bordeaux mixture in the 1880s.

James Teschemacher's work does not indicate that science in the United States equaled that of Europe in the early 1800s. It does show that Americans were participants, if only in a limited way, in contemporary scientific discourse. Teschemacher's response to potato rot contributed to the discussion of fungal pathogenicity that eventually led to a new understanding of plant diseases. More important, Teschemacher's work demonstrates that the scientific explosion of the mid-century could not have occurred without important precursors.

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