



Routing Mr. Bovine Bacillus: Eradication of Bovine Tuberculosis on Vermont Farms

At the close of the nineteenth century, there was a growing awareness that human tuberculosis was infectious and could be transmitted, in part, by milk from cattle infected with the bovine form of the disease. To address this issue and improve the health and productivity of the burgeoning dairy industry, Vermont officials initiated an innovative eradication campaign. With federal help, dedicated public health professionals, veterinarians, and dairy farmers tested hundreds of thousands of animals, promoted good farm hygiene, and, in 1936, achieved the goal of control over bovine tuberculosis.

BY BASIL P. TANGREDI

Bereavement¹

Nay, weep not, dearest, though the child be dead;
He lives again in Heaven's unclouded life,
With other angels that have early fled
From these dark scenes of sorrow, sin, and strife.

So begins one of John Godfrey Saxe's sonnets, written in 1849 in Highgate, Vermont. The sentiment expressed would have wrung the hearts of most of his vast following of readers, for the Angel of Death hovered over their cribs and nurseries in the late nineteenth century. In Vermont the death rate for urban infants and children in 1890 was 239 per 1,000 live births, and 134 per 1,000 in rural areas. By comparison, the rate for urban populations in the seven

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northeastern states averaged 288 per 1,000.² While such statistics are at best estimates, actual causes of death are even more elusive: 40 to 50 percent were laid to infectious diseases,³ with tuberculosis among the four leading causes.⁴ According to a 1917 study in New York City, 21 percent of childhood tuberculosis was caused by the bovine (cattle) form of the disease,⁵ with modern retrospective studies placing this figure closer to 40 percent.⁶ It was common knowledge in the public health community that human cases of bovine tuberculosis (bTB) were the result of the consumption of dairy products contaminated on the farm. In one study, 16 percent of milk samples in New York City yielded the tuberculosis organism.⁷ Unlike the adult disease, which most commonly involved the lungs, childhood tuberculosis was the “abdominal” type, which originated from the intestinal tract.⁸ Both forms could spread systemically. In the late nineteenth century, the eradication of bTB emerged alongside the Progressive Era pure milk movement, science-based agriculture, and such organizations as the Vermont Association for the Prevention of Tuberculosis. The goal was to take on this scourge and “have the fight out with Mr. Tubercle Bacillus.”⁹

Coincident with these public health and agricultural trends was the birth of the science of microbiology, pioneered by the work of Louis Pasteur and carried into the medical realm as the germ theory of infectious disease. It was a thirty-eight-year-old German physician, Robert Koch, who stunned the medical world on March 24, 1882, when he announced at a meeting of the Berlin Physiological Society:

On the basis of my extensive observations, I consider it as proven that in all tuberculous conditions of man and animals there exists a characteristic bacterium which I have designated as the tubercle bacillus.¹⁰

This pathogen is now known to science as *Mycobacterium tuberculosis* and is believed to have diverged from an ancestral African species as humans evolved from their hominid forebears.¹¹ The bovine species, *Mycobacterium bovis*, may have split from the early human strain around 17,000 years ago.¹² These controversial details aside, it is clear that tuberculosis is an ancient disease in both humans and cattle, and one that thrives even today as “the single most successful bacterial pathogen in human history.”¹³

While veterinarians and human physicians knew the course of the disease to be similar in both species, the average farmer would be hard pressed to detect the illness in cattle until the approach of death. Writ-

ing in 1892, this is how Daniel Salmon, DVM, and Theobald Smith, MD, described bTB:

The general effect on the body is at first slight. In fact, animals may remain in good flesh for a considerable time. Invariably, as the disease progresses, loss of flesh and appetite and paleness of mucous membranes become manifest. These are accompanied by a general diminution of milk secretion . . . The animal generally dies from exhaustion after a period of sickness that may last months and years.¹⁴

Therefore, cows could be infected and spread the disease to herd-mates while appearing to be normal and still producing milk. Even experienced veterinarians would be able to render a diagnosis of bTB in only one-third of infected animals.¹⁵ Clearly, if a herd was to be rid of bTB, a method was needed to detect the infection early.

Once again Dr. Koch made history. In 1890, he announced that he had prepared a sterilized glycerine extract of bacterial cultures which, when injected into guinea pigs, were both a prevention and a cure. He named his extract “tuberculin.” Unfortunately, further research failed to confirm the promise of a remedy. But in the process, it was found that an injection of tuberculin would consistently cause a rise in body temperature if the animal had the infection.¹⁶ At last there existed a diagnostic test that was accurate even in the early stages of infection. Working in Koch’s laboratory in 1890 and 1891 was a new graduate from the University of Pennsylvania veterinary school, Dr. Leonard Pearson.¹⁷ He returned to Pennsylvania with a supply of tuberculin and, in 1892, tested a herd of 79 cattle, of which 51 reacted positively with a fever. This was the first use of the tuberculin test in the Western Hemisphere.¹⁸ At the same time, the Bureau of Animal Industry (BAI), a division of the US Department of Agriculture, began a trial study of the test.¹⁹ By the next year, tuberculin had proven itself sufficiently reliable that the BAI Biochemic Laboratory began preparing and supplying it to state experiment stations and cattle commissions.²⁰

Vermont had a strong vested interest in these historic developments in public health and medical science. Prior to the Civil War, John Godfrey Saxe would quip, “Vermont is famous for four things—men, women, maple sugar and horses.”²¹ But with the rise of the urban centers like New York City and Boston came lucrative markets for farm products. By 1892, Vermont had become the leading dairy state in New England, with over 50,000 dairy cows and supplying the northeast market with 7.5 million pounds of butter and 650,000 pounds of cheese.²² In fact, the world’s largest creamery (a plant where butter is produced) was the Lamoille Valley Cooperative Creamery Company located in Stowe.²³

While bTB was silently smouldering in these expanding herds, three prominent veterinarians raised the awareness of the Vermont dairy community concerning the threat. In March 1877, Professor Noah Cressy, M.D., V.S. of Amherst, Massachusetts, delivered a course of lectures at the University of Vermont to “farmers, stock-raisers and medical students, numbering about a hundred persons.”²⁴ In the eighteenth lecture, he exhibited the lung of a cow from his state that had succumbed to “consumption” (a common term for tuberculosis). While the true nature of bTB was unknown, he rightly described the importance of good husbandry practices to thwart this and other diseases. For example, alluding to the effects of inbreeding, he stated,

It is high time that our farmers wake up to the dangers of breeding disease, while trying to breed high points in their cattle. By in-and-in breeding the vitality of the offspring is lowered, and the process tends to directly develop any latent disease.²⁵

A free copy of these lectures was sent to any farmer in the state upon request to the president of the Agricultural College.

Cressy confined his comments to the disease as it affects the health and well-being of a productive dairy cow. The public health implications that he failed to discuss were directly confronted by Dr. James Law, Professor of Veterinary Science at Cornell and founder of the New York State College of Veterinary Medicine. His popular book, *The Farmer’s Veterinary Adviser*, Third Edition (1879), contained these words for his lay readers:

Tubercle is communicable to healthy animals by inoculation or by eating the raw, diseased product . . . It has been transmitted by the warm, fresh milk . . . The flesh and milk of tuberculous animals are always to be regarded with suspicion.²⁶

By 1892, suspicion deepened into conviction. No one was more outspoken than the prominent Boston veterinarian, Dr. Austin Peters. Educated in Great Britain, he worked in the Harvard Medical School Microbiology Laboratory, where he and H. C. Ernst showed that transmission of bTB to animals could occur from the milk of tuberculous cows even though their udders had no obvious sign of disease.²⁷ Dr. Peters had one foot in both medical camps, being the veterinarian for the Massachusetts Society for Promoting Agriculture as well as a member of the Massachusetts Association of Boards of Health. From these pulpits he preached the gospel of eradication of bTB based on two levels of concern: protecting the health of families consuming dairy products, and protecting the health and productivity of the dairy herd.²⁸ On January 14, 1892, Dr. Peters addressed some 400 attendees of the Ver-

mont Dairymen's Association at Brattleboro's Town Hall, speaking on the subject "Tuberculosis."²⁹ Though a transcript of this lecture seems to have escaped publication, it is likely that he expressed the same ideas in a lecture on May 23, 1894, before the Massachusetts Veterinary Association, in which he advocated a government-sponsored program of test and slaughter:

I am in favor of having a State veterinarian who shall be responsible to the State Board of Health or to the State Board of Agriculture . . . Then divide the state into districts . . . and appoint the best veterinarian in that district . . . as veterinary inspector . . . Furthermore, owners of animals suffering from contagious diseases should be reimbursed.³⁰

As the public and private demand for bTB control gathered momentum, some municipalities responded with regulations requiring that dairies be tested and that local physicians guarantee their cleanliness and bTB-free status.³¹ In 1894, Massachusetts became the first state to implement a government program. It took the draconian form of compulsory testing of all cattle, starting in the east and progressing westward along a north/south line. Strict quarantine was set up behind this line, and included all imported cattle, which had to pass through specified quarantine stations. All reactors were slaughtered and their carcasses destroyed. For cattle residing in the state, they were appraised at market value up to \$60 per head and the farmer reimbursed ("indemnity"). The opposition by farmers and cattle dealers ("drovers") was vigorous, and the state soon found itself paying out enormous sums of money, mostly for the indemnity.³²

In Vermont, while the disease was known to exist, there seemed little reason for concern. After all, wasn't it Dr. Peters himself who said that bTB is found "most frequently among the dairy cows from the outskirts of large cities and towns," due to overcrowding in airless unhygienic stables?³³ This was a far cry from the rural pasture-based husbandry that made Vermont dairies so successful. In fact, the Board of Agriculture, acting as cattle commissioners, stated that, after consulting legal and medical professionals, it did not have sufficient authority to undertake any extreme measures to control bTB.³⁴ The ignorance of the true extent of the problem resided in the absence of mandated meat inspection and systematic inspection of live animals on the farm. Given also the variability in the manifestations of bTB, it is little wonder that confusion reigned regarding the true prevalence of the disease.

The turning point took place in the state's epicenter of agricultural research: the Vermont State Agricultural Experiment Station in Burl-

ington. The Station was established by an Act of the General Assembly on November 24, 1886, "for the purpose of promoting agriculture by scientific investigation and experiment," and was under the auspices of the University of Vermont and State Agricultural College.³⁵ In June 1888, the dairy research program began with the acquisition of six cows, and steadily increased to thirty-three head by 1893.³⁶ Dr. Frank A. Rich, V.S., M.D. of Burlington was hired as veterinarian for the station herd, and undertook bTB testing with tuberculin supplied by the BAI. The following is a summary of the testing and results as presented in Bulletin 42 of the Vermont Agricultural Experiment Station:³⁷

Coming in from pasture in the late autumn of 1893, the station dairy herd appeared to be in "prime condition," with their milk production described as "very satisfactory." The two exceptions were one Jersey cow ("LaViolette") and one Holstein cow ("Mercedes Jonkje"), which were described as "unthrifty." Dr. Rich's examination revealed definite lung disease in these as well as several others, so testing was undertaken of all thirty-three cows, bulls, and calves. Between 10 and 12 p.m. on December 31, 1893, Dr. Rich and his assistants recorded each cow's body temperature and administered a dose of tuberculin, also called "Koch's Lymph." On New Year's Day, temperatures were taken hourly from 8 a.m. to 11 p.m. A rise in temperature to 104° F. or better was considered a positive test or a "reactor." A total of twenty-one animals (sixteen cows, three bulls, a yearling, and a calf) reacted. The Board of Control of the station were immediately contacted, and sales of dairy products were suspended. All reactors were euthanized and post-mortem examinations were conducted. In addition, the two calves that did not react were also euthanized and examined. Lesions of bTB were found in each positive animal and there was a complete absence of lesions in the two negative calves. "La Violette" and "Mercedes Jonkje" had the most disseminated and severe disease. Most troubling of all from a public health standpoint was that evidence of bTB involvement in the udder was present in fully 73 percent of infected animals. The remaining negative animals were relocated to another barn. The infected stable was first washed with hot water, followed by a thorough washing with "corrosive sublimate" (i.e. mercuric chloride). The stable and cellar were then closed up and fumigated with burning sulfur. Next, all the wood structure of the mangers and front part of the stanchions were replaced with new wood, after which the mercury wash and sulfur fumigation were repeated. Bulletin 42 was published separately and sent to the 6,100 farmers on the station's

mailing list,³⁸ and Dr. Rich was to give lectures over the ensuing months on bTB and its dangers.

When the state legislature convened later that same year, it took up the matter of bTB. On November 27, it enacted “No. 102.—An Act to Amend Section 4021, 4022 and 4023 of the Revised Laws, Relating to Domestic Animals,” which contained the following provisions:

Section 1: The Board of Agriculture was given the authority to enforce regulations to control bTB. Specifically, it had the power to enter any farm suspected of being infected with bTB and impose a quarantine, but could not administer the tuberculin test without the consent of the owner. On the other hand, it was empowered to require testing of animals imported into the state, order the euthanasia of reactors, and dispose of the carcasses.

Section 2: Anyone knowingly selling an infected animal would face a fine or imprisonment.

Section 3: Any animal testing positive would be killed by written order of the Board. (This reflected the policy of the BAI which supplied the tuberculin to the states free of charge under the sole condition that reactors must be slaughtered and the carcass destroyed.) The value of the condemned animals would be appraised by one member of the Board and a “disinterested person selected by the owner.” If they could not agree, then they would select a third person to assist in the valuation. Here is the important clause: “such appraisal to be made just before killing, and on a basis of health.” A confirmed tuberculous animal would be worth very little compared to its value before the diagnosis. Nevertheless, the limit of the indemnity was set at \$40. No indemnity would be paid to owners of cattle that had not resided in the state for six months prior to testing. Thus, the owners of imported cattle received no compensation.

Section 4: All expenses to be paid by the State.³⁹

The crucial provisions of Vermont’s bTB control program were: the Cattle Commission was vested with the power to administer the law, testing was voluntary, and an indemnity was provided.

By the time the new law went into effect on February 1, 1895, there was already a considerable backlog of applications from dairymen seeking testing for their herds.⁴⁰ Whether or not farmers had suspicions and reservations concerning invisible germs, they faced the reality that their urban markets were requiring proof of disease-free dairy products. In the first sixteen months, 14,155 cattle were tested. A total of 6.5 percent were positive and were euthanized at a cost to the state of \$ 20,936.⁴¹ The commissioners went to great lengths to deal fairly with the farmers and give them the benefit of any doubt. For

example, though the tuberculin test was quite accurate in detecting diseased animals, there was less confidence that an animal exhibiting no temperature rise was truly free of bTB. In cases where a “negative” animal was sent to slaughter or died after testing and found to be infected, the commissioners paid an indemnity of one-half of a fair appraisal. As stated, “This has seemed to us a matter of justice from the fact that the owner had done his best to have the animal found out before and ought not to suffer through any fault of the test.”⁴² In general, they experienced “kind treatment and earnest co-operation” and found that the voluntary approach to testing was more a help than a hindrance.⁴³ The provision of an indemnity was certainly an important factor, and the commissioners usually were able to arrive at a mutually agreeable figure with the farmer without resorting to a third party.

The year 1898 found the eradication program hitting its stride. Though applications for testing were arriving on a daily basis, the commissioners were able to fulfill their obligation within a few days.⁴⁴ While no changes in the law were enacted, the commission adjusted its procedures in two ways. First, testing had to include all the animals in the herd, not merely the individuals the farmer thought might be sick. Second, thorough disinfection of the cow barns were given equal importance. For the latter policy, a case report is instructive. The fifty-seven-head herd of the Clogston brothers of Williamstown was first tested on April 29, 1896, and twenty-eight reactors were euthanized. The Clogstons purchased replacement stock that were tested before coming to the farm. Retesting took place in November, with one positive case. In December, and then twice more in 1897, the commissioners were called in to test specific animals and a total of eight more cattle were euthanized. On October 6, the owners agreed to have the entire herd retested. Twenty-nine out of forty-three (67 percent) were reactors, with the animals that were acquired sixteen months before from “clean” herds being in advanced stages of tuberculosis. The necessity of addressing the animals’ environment assumed increasing importance during these early years of the eradication process. As stated in the 1898 report,

Proper disinfection is a far more difficult matter than is the discovery of the diseased animals . . . Our Board believes that every day of delay in removing diseased animals from a herd is likely to add something to the expense of suppressing the disease.⁴⁵

Another source of information for the commission was butchers. If a tuberculous animal was slaughtered, the commission was notified and testing of the herd of origin was required. In one such instance, a farmer with twenty-five cattle was surprised to find that fifteen were

reactors.⁴⁶ Upon further investigation, it was found that these cattle were pastured adjacent to the pasture of a neighboring farm, and that “the cattle had run together occasionally in the summer (the line fence being poor and down).” This second herd yielded six cases of bTB. Here again, the Vermont commissioners were broadening their scope based on field experience with the disease.

As the cattle commissioners became more adept at tracking down infected herds, they exposed the true extent of the incidence of bTB. The proportion of reactors more than doubled between 1900 and 1902 (see graph, p. 125). The sunny optimism of 1895 was fast fading behind the gloom of reality. One reason was that, despite vigorous persuasion by the Board and the Vermont Dairymen’s Association, the officials were pressing the limits of farmer cooperation. Among the many dissenting opinions were: allow farmers the option of merely isolating infected animals (on-farm quarantine); allow carcasses to be inspected and, if no gross lesions were present, sold for food; and, of course, repeal the law or emasculate its powers.⁴⁷ There were also critics of the indemnity, averring that taxpayers should not be paying for worthless animals.

The official percentage of reactors in 1902 (8.7 percent) does not convey the variability around the state. An extreme example was the situation in the town of Williston.⁴⁸ The testing history yielded an overall 29.7 percent positive reaction. Since many of these tests were retests of the same animals, the actual rate was undoubtedly higher. Also, officials determined that fraud played a significant role: what was termed “plugging the test.”⁴⁹ This was accomplished by clandestinely injecting an infected cow with tuberculin, after which the animal would not manifest a positive reaction to a subsequent test for several weeks. That this was common practice was illustrated at a hearing held in Burlington in December 1901, at which a Williston farmer declared under oath that he had personally plugged 1,000 head of cattle in Williston, Jericho, and Starksboro.⁵⁰ In sum, the true incidence of bTB in Williston was estimated to be closer to 40 percent.

Another obstacle to eradication was the differences between the regulations of contiguous states. While New York and most New England states at least enforced regulations using the tuberculin test, New Hampshire required only a physical exam. When quarantined and tested before entry into Vermont, up to 50 percent of these cattle were turned away,⁵¹ whence they returned to their state of origin only to spread the bacillus further. How many others slipped through by plugging or with fraudulent test certificates can only be imagined.

Finally, Vermont was in the unique situation of having an exploding

population of dairy cows. By 1898, the census of cattle was some 220,000 animals.⁵² The traffic in livestock entailed not merely importations of new stock. Valuable purebred bulls were being shipped around the state to upgrade the genetics of local herds. The bacillus followed the movement of animals, presenting the commissioners with a truly daunting task.

Not all dissenting opinions were negative, however; some people pressed for more coercive policies. At the 1904 meeting of the Vermont Dairymen's Association (the oldest such association in the nation), president George Aitken of Woodstock stated:

We ought to see that wise laws are passed for the eradication of all cattle diseases by giving the Commission power to stamp out tuberculosis, so that the money expended by the State will be of some avail and not as it is now, when an obstinate or ignorant man in a community may frustrate all the efforts of his neighbors by electing to keep diseased cattle after the State has expended thousands of dollars in cleaning up the herds all around him.⁵³

No such additional powers were forthcoming, however, or even needed. The dairy markets exerted far more effective pressure on farmers than any edict handed down from the halls of Montpelier. Most of the larger municipalities (including Burlington) required dairy products coming into their jurisdictions to be derived solely from tested cows.⁵⁴

The second turning point in bTB eradication came in the next decade from the federal level. The BAI, after careful study of state eradication efforts, designed a successful pilot program in the District of Columbia.⁵⁵ This was followed by a special committee of the U.S. Livestock Sanitary Association comprising veterinarians and breeders' associations that proposed a comprehensive plan that was quickly approved by the BAI in 1917.⁵⁶ This was to be a cooperative federal-state program under the supervision of a Tuberculosis Eradication Division within the BAI and headed by Tennessee veterinarian John A. Kiernan, with the federal government providing the states with funds, tuberculin, veterinarians, clerks, and scientific support.⁵⁷ Like Vermont's regulations, it was to be voluntary, but it contained a new key concept: Herds testing free of bTB in two consecutive tests were awarded an Accreditation Certificate from the state of residence. Animals and milk could then be shipped without further encumbrance, in return for which farmers agreed to regular testing along with strict animal identification practices (ear tags, tattoo, etc.).

Vermont Commissioner of Agriculture Elbert S. Brigham enthusiastically endorsed the Sanitary Association plan and began working

with the BAI as early as July 1, 1917.⁵⁸ In 1919, the state legislature revised the original 1894 law in the following ways:

- 1) Before complying with a request for testing, the herd owner would be required to sign an agreement for retesting and taking precautions to prevent re-infection as determined by the commissioner. Failure to live up to this agreement would result in forfeiture of any further rights to testing or indemnity.
- 2) No indemnity would be paid for private testing. (This would later be amended to allow an indemnity if the private test was conducted by a state-approved veterinarian and the farmer agreed to test the entire herd within ninety days.)
- 3) The commissioner of livestock would be given greater oversight and authority over imported cattle.⁵⁹

What did all this mean to the average Vermont dairyman? Brigham answered this question at the meeting of the Vermont Dairymen's Association on January 14, 1920:

We want to enter into a partnership with you to make . . . your farm free of tuberculosis [and] here is the policy which you may follow: . . . We will test your herd, at least annually, free of charge until it has passed two annual tests without reactors, when it will be accredited, advertised as a clean herd and cattle from it may be shipped interstate for a period of a year without further tests. Furthermore, we will pay you for cattle which we condemn, 75 percent of their appraised value up to a limit in appraisal value of \$100 for a grade and \$150 for a pure bred animal.⁶⁰

During the 1920s, two important procedural changes were also effected. First was the adoption of the intradermal test, in which a minute amount of tuberculin was injected within the layers of skin at the base of the tail. If in approximately seventy-two hours there was a swelling at the injection site, the animal was classified as a reactor. This is the standard test still used today. The second change was to broaden the scope of the inspection of the farm environment. It was determined that infected cattle having access to streams and brooks could transmit the bacteria, via fecal contamination, to farms downstream.

These and other innovations came from the BAI which, in cooperation with the eastern dairy states, conducted an annual conference for continuing education and to get feedback "from government officials, veterinarians, farmers, breeders, [and] health officials."⁶¹ At the invitation of the Vermont Veterinary Medical Association, this conference was held in Burlington on June 22 and 23, 1926. Dr. John R. Mohler,

Chief of the BAI, addressed the conference with these words as reported in the *Rutland Daily Herald*:

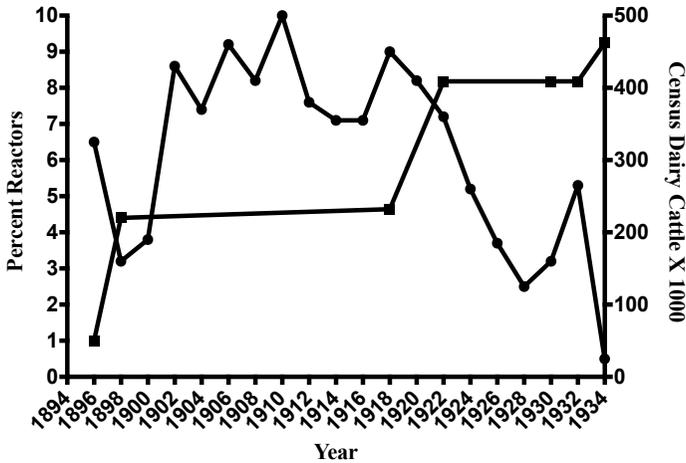
He commended Vermont as one of the pioneers in the field of bovine tuberculosis eradication. He said Vermont is in seventh place in the number of accredited herds and in third place if only eastern states are considered.⁶²

The expansion of Vermont dairy herds continued unabated, accompanied by a growing demand for testing. Unfortunately, funding was never adequate. For 1920, the expenditure was roughly \$266,000: \$100,000 from the federal appropriation, \$100,000 from the state budget, and \$66,000 from “salvage” (slaughter of condemned animals). Commissioner Brigham estimated that the state would have to supply \$250,000 annually to meet the demand from the dairy industry.⁶³ In the coming years, the federal funds increased to \$150,000, matched by a similar amount from the state.⁶⁴

The third and last turning point occurred in 1932. The commission had a sixteen-month backlog of applications while the milk-purchasing companies placed ever greater restrictions on milk they would accept. With strict regulations in neighboring states regarding importation of untested cattle, farmers found themselves in the position of being unable to sell either milk or cows. In his biennial report, Commissioner E. H. Jones described the “unrest and discontent” among the dairy farmers and made an impassioned plea to the state legislature:

Will it be more economical to spread this work over a term of years or push it to a close as vigorously and rapidly as possible? There are conditions under which the withholding of essential expenditures is as false economy as to fail to repair a leaky roof.⁶⁵

In 1933, the nadir of the Great Depression, the legislature appropriated \$675,000, and by June 30, 1934, all of Vermont’s cattle had been tested under federal/state supervision.⁶⁶ In 1935, the infection rate plummeted to 0.5 percent. Finally, on November 2, 1936, after eighteen years of cooperative eradication effort and the expenditure of \$2.6 million in state funds,⁶⁷ the BAI declared Vermont a Modified Accredited Tuberculosis Free State.⁶⁸ On December 15, an “Achievement Day” celebration was held in Montpelier. Among the guests were state officials, including those from other northeastern states, who played prominent roles in the successful outcome. In the evening, there was a “banquet, floor show and ball.” E. S. Brigham, who led the cooperative program at its outset in 1917, modestly described the eradication campaign as “one of the most significant accomplishments in the history of the state.”⁶⁹



Plot of percent reactors (circles) and census of all dairy cattle in the state (squares). All data is derived from official published annual or biennial state agricultural reports.

The triumph over the bovine form of tuberculosis was not merely a cooperative effort between federal and state public servants. It was also the result of a collaboration among dedicated public health professionals, veterinarians, university agriculturists, and progressive dairy farmers. In the first decade of the twenty-first century, the increasing associations between animal and human diseases in a rapidly changing environment has given birth to the concept of One Health.⁷⁰ As the interplay between human, animal, and environmental health deepens in the future, it is well to remember that this ground was broken a century ago in places like Vermont where Mr. Bovine Bacillus was put to rout.

NOTES

¹ John Godfrey Saxe, *The Poems of John Godfrey Saxe* (Boston, Mass.: Houghton, Mifflin and Company, 1882), 289.

² G. A. Condran and E. Crimmins, "Mortality Differentials between Rural and Urban Areas of the States in the Northeastern United States, 1890-1900," *Journal of Historical Geography* 6 (1980): 179-202.

³ K-S. Lee, "Infant Mortality Decline in the Late 19th and Early 20th Centuries," *Perspectives in Biology and Medicine* 50 (2007): 585-602.

⁴ S. T. Shulman, "The History of Pediatric Infectious Diseases," *Pediatric Research* 55 (2004): 163-176.

⁵ D. Block, "Purity, Economy, and Social Welfare in the Progressive Era Pure Milk Movement," *Journal for the Study of Food and Safety* 3 (1999): 20-27.

⁶ W. R. Waters, et al. "Relevance of Bovine Tuberculosis Research to the Understanding of Human Disease: Historical Perspectives, Approaches, and Immunologic Mechanisms," *Veterinary Immunology and Immunopathology* 159 (2014): 113-132.

⁷ Henry Shaw, "The Transmission of Bovine Tuberculosis to Children," *Journal American Medical Association* 53 (1909): 1805-1808.

⁸ *Ibid.*

⁹ Harold W. Slocum, "Routing Mr. Bacillus," *The Vermonter* 23 (1918): 84-85.

¹⁰ Robert Koch, "The Etiology of Tuberculosis," *Berliner Klinischen Wochenschrift*, No.15 (April 10, 1882): 221-230. Translation by the American Society for Microbiology, www.asm.org.

¹¹ R. Brosch, et al., "A new evolutionary scenario for the *Mycobacterium tuberculosis* complex," *Proceedings of the National Academy of Sciences* 99 (2002): 3684-3689.

¹² *Ibid.*

¹³ Sam Willcocks and Brendan Wren, "Shared Characteristics between *Mycobacterium tuberculosis* and Fungi Contribute to Virulence," *Future Microbiology* 9 (2014): 657-668.

¹⁴ Daniel E. Salmon and Theobald Smith, "Infectious Diseases of Cattle," *Special Report on the Diseases of Cattle and on Cattle Feeding* (Washington, D.C.: Government Printing Office, 1892), 404.

¹⁵ Austin Peters, "Prevalence of Tuberculosis," *The Veterinary Magazine* 1 (1894): 483-488.

¹⁶ Leonard Pearson and M. P. Ravenel, "Report on Tuberculosis of Cattle," *Fifth Annual Report of the Pennsylvania Department of Agriculture, 1899* (Harrisburg, Penn.: Wm. Stanley Ray, 1900), 422-424.

¹⁷ Clarence J. Marshall, "Biographical Sketch of Dr. Leonard Pearson," *In Memoriam Leonard Pearson, 1909* (University of Pennsylvania, 1910), 5.

¹⁸ Mitchell Palmer and W. Ray Waters, "Bovine Tuberculosis and the Establishment of an Eradication Program in the United States: Role of Veterinarians," *Veterinary Medicine International*, Vol. 2011, Article ID 816345, doi:10.4061/816345.

¹⁹ Salmon and Smith, "Infectious Diseases of Cattle," 405.

²⁰ *Fourteenth Vermont Agricultural Report of the State Board of Agriculture for the Years 1893-1894* (Burlington, Vt.: The Free Press Association, 1894), 447.

²¹ Albert Clarke, "The State of Vermont," *New England Magazine* 4 (1891): 703.

²² *Fourteenth Vermont Agricultural Report*, 315.

²³ *Ibid.*, 275.

²⁴ Noah Cressy, *Reports of a Course of Lectures on Veterinary Science Delivered at the University of Vermont and State Agricultural College* (Burlington: University of Vermont, 1877).

²⁵ *Ibid.* The term "in-and-in breeding" refers to what is now simply "inbreeding."

²⁶ James Law, *The Farmer's Veterinary Adviser*, Third Edition (Ithaca, N.Y.: Published by the Author, 1879), 48, 50.

²⁷ J. L. Hills and F. A. Rich, "Vermont Agricultural Experiment Station, July 1894, Bulletin No. 42—Bovine Tuberculosis," *Fifteenth Vermont Agricultural Report by the State Board of Agriculture for 1895-1896* (Burlington, Vt.: Free Press Association, 1896), 234.

²⁸ Alan L. Olmstead and Paul W. Rhode, "An Impossible Undertaking: The Eradication of Bovine Tuberculosis in the United States," *Journal of Economic History* 64 (2004): 734-772.

²⁹ *Rutland Herald*, 15 January 1892, 1.

³⁰ Austin Peters, "Prevalence of Tuberculosis," *Boston Medical and Surgical Journal* 131 (1894): 525-526.

³¹ Olmstead and Rhode, "An Impossible Undertaking," 750.

³² Pearson and Ravenel, "Report on Tuberculosis of Cattle," 451.

³³ Peters, "Prevalence of Tuberculosis," 526.

³⁴ *Fourteenth Vermont Agricultural Report*, 471.

³⁵ *State of Vermont, First Annual Report of the State Agricultural Experiment Station, 1887* (Rutland, Vt.: The Tuttle Co., 1888), 5.

³⁶ Hills and Rich, "Bovine Tuberculosis," 187.

³⁷ *Ibid.*, 183-248.

³⁸ J. L. Hills, "What Experiment Stations Have Done for Dairying," *Fifteenth Vermont Agricultural Report*, 65.

³⁹ "Report of the Board of Agriculture as Cattle Commissioners on Contagious Disease of Cattle and Other Domestic Animals," *Fifteenth Vermont Agricultural Report*, 42-43.

⁴⁰ *Ibid.*, 44.

⁴¹ *Ibid.*, 82-83.

⁴² *Ibid.*, 55.

⁴³ *Ibid.*, 56.

⁴⁴ "Report of the Board of Agriculture as Cattle Commissioners," *Eighteenth Vermont Agricultural Report by the State Board of Agriculture for the Year 1898* (Burlington, Vt.: Free Press Association, 1898), 170.

⁴⁵ *Ibid.*, 176-177.

⁴⁶ "Secretary's Report," *Twenty-first Annual Report of the Vermont State Board of Agriculture for the Year Ending June 30th, 1901* (Albany, N.Y.: Wynkoop Hallenbeck Crawford Co., 1901), 122.

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⁴⁷ Ernest Hitchcock "Tuberculosis in Cattle," *Twenty-second Annual Report of the Vermont Board of Agriculture for the Year Ending June 30th, 1902* (Albany, N.Y.: Wynkoop Hallenbeck Crawford Co., 1902), 98-107.

⁴⁸ *Ibid.*, 98-107.

⁴⁹ Palmer and Waters, "Bovine Tuberculosis," 7.

⁵⁰ "Cattle Commission Report," *Twenty-second Annual Report*, 110.

⁵¹ *Ibid.*, 112.

⁵² *Eighteenth Vermont Agricultural Report*, 165.

⁵³ "President's Address," *Twenty-fourth Annual Report of the Vermont State Board of Agriculture for the Year Ending June 30th, 1904* (Troy, N.Y.: Press of the Economist Co., 1904), 27.

⁵⁴ Olmstead and Rhode, "An Impossible Undertaking," 449.

⁵⁵ *Ibid.*, 450; *Twenty-second Annual Report*, 109.

⁵⁶ Palmer and Waters, "Bovine Tuberculosis," 9.

⁵⁷ *Ibid.*, 10.

⁵⁸ E. S. Brigham, "Accredited Tuberculin Tested Herds," *Agriculture of Vermont, Ninth Report for the Biennial Period July 1, 1916 to June 30, 1918* (St. Albans, Vt.: St. Albans Messenger Co., 1918), 34-40.

⁵⁹ E. S. Brigham, "Eradication of Tuberculosis from Vermont Herds," *Agriculture of Vermont, Tenth Report of the Commissioner of Agriculture for the Biennial Period July 1, 1918 to June 30, 1920* (St. Albans: Vt., St. Albans Messenger Co., 1920), 69-70.

⁶⁰ *Ibid.*, 70.

⁶¹ "Report of the Commissioner of Livestock," *Thirteenth Biennial Report of the Commissioner of Agriculture of the State of Vermont 1924-1926* (St. Albans, Vt.: St. Albans Messenger Co., 1927), 74-77.

⁶² *Rutland Daily Herald*, 23 June 1926, 12.

⁶³ E. S. Brigham, "Progress of Tuberculosis Eradication," *Eleventh Biennial Report of the Commissioner of Agriculture and the State Forester of the State of Vermont 1920-1922* (St. Albans, Vt.: St. Albans Messenger Co., 1922), 13-17.

⁶⁴ E. H. Jones, "Tuberculosis Eradication," *Sixteenth Biennial Report of the Commissioner of Agriculture of the State of Vermont 1930-1932* (n.p., n.d.), 10-12.

⁶⁵ *Ibid.*

⁶⁶ "Commissioner's Report," *Seventeenth Biennial Report of the Commissioner of Agriculture of the State of Vermont 1933-1934* (n.p., n.d.), 126.

⁶⁷ "Commissioner's Report," *Eighteenth Biennial Report of the Commissioner of Agriculture of the State of Vermont 1935-1936* (n.p., n.d.), 101.

⁶⁸ "Commissioner's Report," *Nineteenth Biennial Report of the Commissioner of Agriculture of the State of Vermont 1937-1938* (n.p., n.d.), 7.

⁶⁹ *Rutland Daily Herald*, 16 December 1936, 2.

⁷⁰ John B. Kaneene, et al., "Preventing and Controlling Zoonotic Tuberculosis: A One Health Approach," *Veterinaria Italiana* 50 (2014): 7-22.