

Barbara Orland

Federal Institute of Technology Zürich

Institute for History

History of Technology

**Cow's Milk and Human Disease
Bovine Tuberculosis and the Difficulties
Involved in Combating Animal Diseases**

In dealing with the incidence and impact of animal diseases on humans, particular attention is always devoted to the etiology. Whether, and how, a contagious disease is transmitted from animals to humans (and vice versa) is the most often highlighted question, because much hope rests on the idea that the search for and identifying of a pathogen and how this pathogen causes infection will directly lead to cogent strategies of food safety. However, several food scares in the last decades have shown that the knowledge about the ways of transmission is not enough to hold in check the danger of zoonoses to public health. Further on, the power of the scientific expertise to solve the problem sometimes seems to be very limited. Even if the cause of a disease has been clearly discovered, the transmission routes are not necessarily any clearer. Many experiments and debates are often fruitless and do not lead to clear solutions. In addition, in nearly all cases much time elapses before the right treatment is found for a pathogen, while a consensus about ways of treatment not necessarily ends up in an effective medical practice to eradicate the disease.

Animal products for human nutrition touch very different professional interests on their way to the consumer. Thus, despite evidence that animal diseases are harmful to human health, varying economic interests can hinder the formulation of effective action or give them new and unexpected directions. Taking into account these complexities, health policy makers must take action. Since measures to fight animal diseases affect special interests, day after day politicians must mediate between particular interests, find compromises and control them in form of authority régula-

tions and government legislation. Under these circumstances, food safety stands for a long and contended process of learning and decision-making. How a society selects information, sets priorities and resolves conflicts—in short, how it learns to live with epizootic diseases—is the lesson from the history of fighting bovine tuberculosis that shall be explored in this paper.

Thus, the aim of this paper is neither to explore the long-standing and in the end successful story of the eradication of bovine tuberculosis¹ nor to clarify the ways of policy making in milk hygiene.² My retelling the history of cow's milk as a carrier of bovine tuberculosis is intended to highlight the controversies that arose when bacteriology met society. Starting with Robert Koch's warning in 1882 that the tubercle bacillus can be transmitted from cattle to humans by the way of milk consumption, the paper will examine the complex web of interests that was touched by this opinion and ended up influencing the struggle against the dangers of bovine tuberculosis. Focussing on sources from Germany and Switzerland and concentrating on the period between the 1880s and about 1930 I will discuss the arguments of some of the different groups in society that exerted an influence on the question of how bacteriological findings should be interpreted and converted into a campaign against bovine tuberculosis.

Barbara G. Rosenkrantz, who has done extensive research on these controversies in the United States, mainly concentrated on the differences of opinion among physicians and veterinarians.³ In this paper I will be shown that besides the different groups of scientific experts, the economic forces of the modern milk market played a crucial role in the debate.

¹ On the history of the eradication of bovine tuberculosis in the United States now see Alan L. OLMSTEAD and Paul W. RHODE, *An Impossible Undertaking: The Eradication of Bovine Tuberculosis in the United States*, draft version, May 2003, further on W. BISPING, „Zur Geschichte der Bekämpfung der Rindertuberkulose - Beiträge aus dem Institut für Mikrobiologie und Tierseuchen der Tierärztlichen Hochschule Hannover“, *Berliner und Münchner Tierärztliche Wochenschrift*, vol. 111 n° 10 (1998), pp. 362-367, Keir WADDINGTON, "The Science of Cows" Meat, Bovine Tuberculosis and the British State 1880-1911" *History of Science* vol. 39 (2001), pp. 355-81, J. Arthur MYERS and James H. STEELE, *Bovine Tuberculosis Control in Man and Animals*, St. Louis, 1969 I wish to thank Michael Dear and Andreas Nef for their help in translation and critical readings

² For London see Peter J. ATKINS, "White Poison? The Social Consequences of Milk Consumption in London, 1850-1939", *Social History of Medicine*, vol. 5 (1992), pp. 207-228

³ See Barbara G. ROSENKRANTZ, "The Trouble with Bovine Tuberculosis", *Bulletin of the History of Medicine*, vol. 56 (1985), pp. 155-175

Thus, not only the bacteriological findings were a very contested terrain within different scientific communities, but above all the question of how to fight contaminated milk was a subject of intense debate in the economic arena. While farmers understandably were the last to be persuaded as to the radical measures to eradicate infected animals, arguments about the nutritional value of milk prevented a quick introduction of the heat-treating of milk as a prophylactic technique.

Robert Koch and the Milk Question.

On March 24, 1882, Robert Koch told an incredulous audience at the Physiological Society of Berlin what he had managed to achieve during the preceding year: the assumption of a relationship between human and animal tuberculosis.⁴ Many had suspected the existence of living pathogens that pass between different organisms, but nobody had ever seen them. The fact that now the bacillus was visible did not contradict the previous impression that humans and animals could be afflicted by one and the same disease. Long before the rise of bacteriology, it was common knowledge that house pets and humans could fall victim to similar diseases and that humans could be infected through contact with animals or by consuming animal products.⁵ Even milk was said to be a sensitive natural substance which could harbor numerous "diseases".⁶ If what veterinarians were saying in the mid-19th century was true, people were actually being

⁴ Robert KOCH, „Die Aetiologie der Tuberculose“, *Berliner Klinische Wochenschrift. Organ für praktische Ärzte*, vol. 19 n° 15 (1882), pp 221-230. He proudly reported his new methods of staining bacteria to make them visible and the likewise successful experiment in which he cultivated the tubercle bacillus in pure form. To the technically instrumentalized view of Robert Koch, see Thomas SCHLICH, “‘Wichtiger als der Gegenstand selbst’ — Die Bedeutung des fotografischen Bildes in der Begründung der bakteriologischen Krankheitsauffassung durch Robert Koch”, in Martin DINGES and Thomas SCHLICH eds., *Neue Wege in der Seuchengeschichte*, Stuttgart, 1995, pp 143-174. On the research into the causes of the various symptoms of tuberculosis, see Christoph GRADMANN, Robert Koch and the Pressures of Scientific Research Tuberculosis and Tuberculin, *Medical History*, vol. 45 (2001), pp. 1-32, especially 4-7.

⁵ See *Der Kampf gegen die Tuberkulose in Deutschland*, ed im Auftrage des Reichstuberkulose-Ausschusses Berlin, anlässlich der XI. Konferenz der Internationalen Vereinigung zur Bekämpfung der Tuberkulose, Berlin, 1939, pp 32/33.

⁶ Wilhelm FLEISCHMANN, *Das Molkereiwesen Ein Buch für Praxis und Wissenschaft*, Brunswick, 1875, p.117. The fact that official milk inspections likewise predate bacteriology by many years is also proof of this knowledge of danger. For Munich, for instance, see Uwe SPIEKER-MANN, *Milchkleinhandel im Wandel Eine Fallstudie zu München 1840-1913*, *Scriptae Mercaturae*, vol 27 (1993), pp 91-145; for London: Peter J ATKINS, *White Poison?*... , op cit., p 209.

careful—at least wherever it was under their control.⁷ The especially striking occurrence of bovine tuberculosis—tuberculosis-like inflammation of serous membranes—is alleged to have been, for centuries, a reason that already-diseased animals were never used as human food.

Thus, Koch confirmed previous empirical evidence when he wrote "*that the spillover of the tuberculous process to the milk gland has been observed by veterinarians not infrequently*" and that one is compelled to assume "*that in such cases the tubercle virus can immediately be admixed to milk (...) and is also capable of being transmitted to human beings. (...) However great or small the danger resulting from the ingestion of tuberculosis-infected meat and milk is, it is there and must therefore be avoided.*"⁸ Koch reminded his readers of the obstacles to demonstrating the transmission of tuberculosis between cattle and human populations. Nevertheless, to him it was clear how important the issue of the harmfulness of the meat and milk of infected cows was for health care. From a hygienic point of view, he concluded, the same measures must be taken against it as against the infection through human sputum.

The Euphoria and Confusion Resulting from a Discovery.

Now that a disease which had previously occurred in a variety of forms could be traced back to a single pathogen, it instantly seemed manageable. It was with great euphoria and even greater hopes that the search for pathogenic microorganisms could be commenced. There was a clearly defined "enemy", around the world the "hunt for microbes" could begin.⁹ With Koch himself having already pointed the finger at milk, this substance

⁷ What makes tuberculosis so deadly is that it is chronic and can afflict various organs. In addition, not every infection causes the disease to break out. The body needs to be weakened for the bacilli to be able to spread. General medical terminology has seen various terms for the disease due to the variety of forms in which it appears up until the pathogen was discovered: phthisis, *Lupus vulgaris*, consumption, just to name a few. And there have been various medical treatments which were sometimes contradictory, sometimes complementary or followed from one into another. An overview of the history of human tuberculosis and research on this subject can be found in: Robert BOCHALLI, *Die Entwicklung der Tuberkuloseforschung in der Zeit von 1878 bis 1958*, Stuttgart, 1958; Anne HARDY, *The epidemic streets, infectious disease and the rise of preventive medicine 1856-1900*, Oxford, 1993

⁸ Translated from Robert KOCH, *Die Aetiologie...*, op.cit., p. 230

⁹ On the war metaphors used in bacteriology see Christoph GRADMANN, "Auf Collegen, zum fröhlichen Krieg". Popularisierte Bakteriologie im Wilhelminischen Zeitalter", *Medizin, Gesellschaft und Geschichte*, vol. 13 (1994), pp. 35-54; Bruno LATOUR, *The Pasteurization of France*, Cambridge, Mass., 1988

became the first to be studied in depth. For many years milk and dairy products were to keep the international community of bacteriology researchers busy.¹⁰ And it was not difficult to detect tubercle bacilli in milk or butter samples. Numerous bacteriologists were able to detect them in the years following the discovery of the tubercle bacillus, and many considered this a clear sign that the disease was in its advanced stages. In the first years after the discovery of the bacillus, no one thought that pathogenic microorganisms could be located in a healthy body.

The focus of attention had shifted from a diffuse, infectious environment to the individual body. This meant that wherever bacilli could be detected, a manifestation of the disease had to be assumed, completely irrespective of the specific living conditions, clinical pathology or constitution of the afflicted human or animal. In its spread through the body, the bacillus did not stop at cow's milk, either. The frequency of these findings compelled Robert Koch 1899 to write a letter to the culture minister in which he told of the danger to the population of Berlin deriving in particular from the milk of cooperative dairies, which was transported over long distances.¹¹

Two years later he would do an about-face. In fact, shortly before the turn of the century, findings started to accumulate which did not quite fit into the picture. As it later turned out, different teams from Koch's institute, the laboratory of the Imperial Health Office and the Hygienic Institute of the University of Berlin, completely independently of one another, isolated a strange bacillus in butter samples which bore a marked resemblance to the tubercle bacillus but did not trigger any symptoms of disease in the animal.¹² Bacteriologists were confused, for this discovery

¹⁰ As early as in 1884 the first dissertation on this topic came out in Berlin: G. STEIN, *Experimentelle Beiträge zur Infektion der Milch perlsüchtiger Kühe*, Diss. med., Berlin, 1884. An internationally comparative report on literature covering research between 1884 and 1906 is provided by: John F. ANDERSON, "The frequency of Tubercle Bacilli in the Market Milk of the City of Washington, D.C.," *Milk and its relation to Public Health*, Washington D.C., 1908, pp. 164-173. An overview for the German Empire is provided by: Max BECK, „Experimentelle Beiträge zur Untersuchung über die Marktmilch“, *Deutsche Vierteljahresschrift für öffentliche Gesundheitspflege*, vol. 32 (1900), pp. 430-445

¹¹ Koch expected this to be bad for business, which is why the considered dairy was to be given time to solve the problem beforehand. The reaction was swift: hardly three weeks after the letter to the Ministry, the milk trader Carl Bolle informed Koch that he had asked all milk suppliers to take "tuberculin" samples. However, his offer to take over the costs was incapable of convincing anyone to take such measures. See Katharina GRAFFMANN-WESCHKE, *Lydia Rabinowitsch-Kempner (1871-1935). Leben und Werk einer der führenden Persönlichkeiten der Tuberkuloseforschung am Anfang des 20. Jahrhunderts*, Diss. med, Berlin, 1997, pp. 67/68

¹² *Ibid*, p. 64

had a devastating impact on the debate concerning dairy hygiene. It forced researchers to face the hard truth that in the past there had probably been many studies which had purported to prove the existence of TB bacilli in milk where actually only this bacillus, later named "Petri-Rabinowitsch" after its discoverers, was present. Milk studies from the past thus became worthless; this was the first discovered case of "pseudo-tuberculosis".¹³

There was another field of milk research where unambiguous results could not be uncovered. Most animal experiments, in which infected milk was injected into laboratory animals through a variety of ways, did not provide any information on the virulence of the pathogen.¹⁴ Above all, in 1896 the American bacteriologist Theobald Smith published a paper that completed the confusion within the community of bacteriologists. Smith wrote that he had observed small but identifiable differences in strains obtained from bovine, avian and human sources.¹⁵ Very soon, American veterinarians reacted to these findings with a radical criticism of Koch's "misleading" words on the bovine tubercle bacillus.

In fact, already before the end of the 19th century various studies had put the initial fears about the contagiousness of bovine tuberculosis to humans into perspective or, to put it more precisely, aroused a variety of opinions. Whereas there was no further doubt about the potential existence of pathogenic microorganisms in milk and milk products, disagreement continued as to the modes of infection, i.e. as to if and how transmission occurs. Then, when the teaching of the ubiquity of the tubercle bacillus was called into question,¹⁶ doubt about the possibility of bacteria modifying and mutating was eliminated, and secondary causes of diseases gained

¹³ See Ernst SCHÜTZ, *Untersuchung der säurefesten Pilze zur Forderung der Molkereiwirtschaft*, in: *Landwirtschaftliche Jahrbücher. Zeitschrift für wissenschaftliche Landwirtschaft und Archiv des Königlich-Preussischen Landes-Ökonomie-Kollegiums*, Berlin, 1901, pp. 223-257. This was not to be the only case. Some years later Bernhard Bang described a chronic pseudotuberculous intestinal inflammation in cattle which is now called Bang's disease. See Bernhard BANG, „Chronische pseudotuberkulöse Darmentzündung beim Rinde“, *Tierärztliche Wochenschrift*, 50 (1906): 759-763

¹⁴ See Carl Orla JENSEN, *Grundriss der Milchkunde und Milchhygiene*, Stuttgart, 1903, p. 65

¹⁵ Barbara ROSENKRANTZ, *The trouble with...*, op.cit., p.156

¹⁶ Bang is said to be the first to have pointed out that even calves born of infected cows, if separated soon after birth from their mothers and shielded from infection, can live the rest of their lives without being infected. See Eugen SEIFERLE, *Ueber die Bekämpfung der Rindertuberkulose*, Affoltern, 1929, p. 3; also: Robert BOCHALLI, *Die Entwicklung der Tuberkuloseforschung...*, op.cit., p.16

increasing prominence,¹⁷ researchers were back to square one regarding bovine tuberculosis.

What amazed Robert Koch was the fact that the frequent occurrence of the pathogens in foodstuffs was not matched by the spread of tuberculosis in the human stomach and intestinal tract. He thought that actually the involuntary daily "big-city experiment", with humans consuming contaminated meat, milk and dairy products, would have to confirm the theory of food-borne tuberculosis. But that was precisely not the case. Therefore, he felt compelled to examine the relationship between human and bovine tuberculosis once again in a laboratory experiment on cattle, sheep and pigs.¹⁸ Then, in 1901, Koch decided to drop a *bombshell*¹⁹: at the International Tuberculosis Congress in London, he told the world that human and bovine tuberculosis were not alike. According to Smith's findings, he now proclaimed that dairy products contaminated with virulent bovine tuberculosis posed little threat to humans. His conclusion was that particular measures concerning the consumption of milk from tuberculosis-infected cows were exaggerated.

Bacteriology in the "Milk War".

Koch, thinking that such a U-turn in his scientific thinking would be accepted by scientists and the public alike without much protest, was in for a rude awakening. A considerable number of his colleagues, even from his own institute, refused to go along with him. His colleague Lydia Rabinowitsch even put her career in jeopardy by assuming a radical and unyielding consumer-protection stance.²⁰ What was at stake was that the milk hygiene issue had begun to take on a public life of its own. Milk

¹⁷ In 1900, Otto Naegeli, after over 500 *autopsies* at the Zurich Pathological Institute, came to the conclusion that practically all adults had been infected, yet only some actually suffered symptoms and only a very few died of the disease. Naegeli assumed that the body's defense mechanisms prevented the outbreak of the plague or that secondary causes needed to come along. See Iris RITZMANN, *Bausordnung und Liegekur. Vom Volkssanatorium zur Spezialklinik. 100 Jahre Zürcher Höhenklinik Wald*, Zürich, 1998, p. 59

¹⁸ Rober KOCH, „Die Bekämpfung der Tuberkulose unter Berücksichtigung der Erfahrungen, welche bei der erfolgreichen Bekämpfung anderer Infektionskrankheiten gemacht sind“, Lecture held at the International Medical Congress on Tuberculosis, reprinted *Deutsche Medicinische Wochenschrift*, vol. 27 (1901), pp. 549-554

¹⁹ As remarked by one of his students: Friedrich LOEFFLER, "Robert Koch. Zum 60. Geburtstag", *Centralblatt für Bakteriologie*, vol. 35 (1904), pp. 401-415

²⁰ See Katharina GRAFFMANN-WESCHKE, *Lydia Rabinowitsch-Kempner...*, op.cit.

hygiene, as a reflection of the attempt to make a highly sensitive natural product marketable, gained much more influence than debates within the community of bacteriologists. Scientists had to take into account the forces of a completely renewed milk market.

Since the 1870s, all over Europe milk business was radically transformed from a localized system to a large-scale nationwide business. Due to a steady rise of population the processes of urbanization and industrialization provoked a dramatic increase of milk production. In Germany the number of cows increased between 1873 and 1907 from scarcely 9 million to more than 11 million while the population increased from 41 to 62,6 million people.²¹ The good milk business in the neighbourhood of cities encouraged farmers to produce as much milk as possible and to sell a great deal of it in liquid form. Although farmers successfully enhanced the milk output per cow, they faced tremendous logistical problems to guarantee the delivery of a fresh and not with dirt and disease contaminated milk. Milk and dairy products were lightyears away from meeting the conditions for sale in an anonymous mass market. Under preindustrial traffic systems it was clear that only butter and cheese could become a trading good. With the spread of railways and transport improvements, even the more remotely located farmyards were able to participate in the liquid milk boom. However, the growing distance between producer and consumer meant significant delays in delivery. Every hour of rail journey decreased the product quality and lengthened the time for the multiplication of pathogens.

Farmers, milk traders and local authorities were well aware of these problems. All efforts for a clean milk production and handling facilities were the issue of extensive public debate. Since the early 19th century local authorities had been waging a relatively fruitless campaign against debased, polluted and spoiled milk being sold in city markets.²² Cow's fae-

²¹ F MENDELSON, „Bedeutung, Lage und Aussichten der deutschen Milchwirtschaft“ in M SERING ed., *Die deutsche Landwirtschaft unter Volks- und weltwirtschaftlichen Gesichtspunkten*, (Berichte über Landwirtschaft, N F, Sonderheft Nr. 50), Leipzig, 1932, p 504 In general, see Helmut OTTENJANN and Karl-Heinz ZIESSOW eds, *Die Milch*, (Arbeit und Leben auf dem Land, no 4), Cloppenburg, 1996, Hans-Jürgen TEUTEBERG, „Anfänge des modernen Milchzeitalters in Deutschland“, in Hans-Jürgen TEUTEBERG and Gunter WIEGELMANN eds, *Unsere tägliche Kost* (Studien zur Geschichte des Alltags, no. 6), 2nd ed Munster 1986, pp 163-184

²² See G CRAMER, *Die Mängel der Milchkontrolle mit besonderer Berücksichtigung vorgekommener Fehler Praktische Winke für Polizeibehörden und für jedermann, welcher sich für gute Milchversorgung und zuverlässige Milchkontrolle interessiert*, Biel, 1882

cal water, added water or extracted cream, long distance transportation and poor storage conditions: the control of the milk business was a difficult subject. In 1876 the German Kaiserreich founded the Imperial Public Health Department which over years worked on regulations to control the urban milk market. Soon after Koch's publication, in October 1882, a commission held a meeting in order to pass „technical materials for the preparation of an imperial order, regarding the control of milk by policy“.²³ However, this like other regulations never were passed.²⁴ Until World War I it was always the same argument that hindered federal public authorities to regulate the milk market on a national level. The urban milk markets were said to be too opaque and complex to be regulated on a top-level.

Although the invention of bacteriology promised to simplify the control of contaminated milk, from the 1890s onward things became even more complicated. For several reasons, the issue of hygiene turned out to be the crucial factor in the ability of sellers to survive on the market. On the one hand, the great profits to be made with milk attracted a motley crew of self-appointed experts. Until the German milk law was passed in 1930, there existed no nationwide binding scientific definitions for "good" or "pure" or "clean" milk, nor did any standardized method of setting such norms exist. Thus, chemists, engineers, agriculturists or other entrepreneurial visionaries were just as able to set up rules for the hygienic treatment of milk as were doctors or bacteriologists. Especially the new group of milk experts, whose presence was enough to trigger structural change in agriculture with dairy farms as a hitherto unknown link between farmers and consumers, felt obliged to create a set of rules for milk hygiene.²⁵ And even the scientists working under the auspices of local authorities to control urban milk markets were competing with each other. Should the state-controlled milk analysis be done by food chemists or bacteriologists or veterinarians? Even at the end of the 1920s the collaboration between the different groups of scientific experts was a cause of conflict at some places.²⁶

²³ „Technische Materialien zum Entwurfe einer Kaiserlichen Verordnung, betreffend die polizeiliche Kontrolle der Milch“ See A REINSCH, *Die gesetzliche Regelung des Milchverkehrs in Deutschland, insbesondere in den größeren deutschen Städten*, Hamburg, 1903, pp 8/9

²⁴ The paper of the Public Health Department only served its purpose as a template that was used by several towns and communities to tighten local regulations See E G ZITZEN, „Die Milchversorgung der Städte“, *Milchwirtschaftliches Zentralblatt*, vol 44 (1915), p 294

²⁵ Wilhelm FLEISCHMANN, „Die Bedeutung der bakteriologischen Forschung für die Milchwirtschaft“, *Milch-Zeitung*, vol 18 (1889), p 183

²⁶ See Robert von OSTERTAG, *Tierärztliche Mitwirkung bei der Milchkontrolle*, Berlin, 1926, pp 4/5

On the other hand, as a result of the proliferation of types of milk trade, which often varied considerably from one town to the next, terms of business were becoming less and less transparent.²⁷ Milk markets in big cities like Berlin were a highly contested terrain, in which - at the turn of the century — all milk branches were antagonized. Big wholesalers, small milk traders, single farmers and farm cooperatives and - not to forget - more and more consumer organizations fought against each other. Berlin was on the verge of a veritable "Milk War"²⁸, a term coined at the turn of the century to denote the increasing conflict surrounding milk distribution and milk trade in the major cities. This was a battle which likewise took place all over the country. Between 1900 and 1914 Hamburg, Hannover, Dresden, Düsseldorf or Munich were affected by those battles.²⁹

Consequently, milk dealers looked for efficient tools to fight against their competitors - they found it in the issue of hygiene. Since the end of the 19th century, it became common to publish the conditions of milk delivery so that customers could get an idea about the feeding and care of cows on the farm, the milk collection system, the transportation and the processing of milk³⁰. Further on, big milk dealers, condensed milk factories as

²⁷ Up to and into the 1870s and, in some cities and regions, beyond that period, the sale of milk and dairy products was in the hands of producers, i.e. farmers' wives. They took their products, butter and cheese, to weekly markets *or* maintained other direct contacts with consumers. In major cities such as Berlin there were also, within the city limits, special "milking-only farms", which bought highly pregnant or freshly milking high-output cows, milked them for a lactation period, and then sold them for slaughter. As cities grew, the various milk producers faced competition from middlemen specializing in collecting milk from farmers, transporting them by car and increasingly by train to cities, and then either selling it as fresh milk or processing it into butter and cheese at their own facilities. In the 1890s numerous dairies, butter clubs, cheese farms or milk sales outlets owned by agricultural cooperatives were established. Directed by the farmers themselves they were built up in the countryside and functioned as collecting points for the milk of all participants. This model of dairy cooperatives has been very successful. At the end of the year 1894 beside private companies or single estates dairies all over the German Reich 1145 associations of farmer's cooperatives were registered. Private entrepreneurs followed suit, establishing their own dairy farms on the countryside. Such entrepreneurs were not always knowledgeable about agriculture, yet as prescient salespeople they smelled from afar the money to be made in milk. See DEUTSCHER MILCHWIRTSCHAFTLICHER VEREIN ed., *Beschreibung der Milchwirthschaftlichen Verhältnisse im Deutschen Reiche*, Berlin, 1895

²⁸ On the Berlin Milk War see Mathias KLENKE, *Milch für die Metropole. Zum fünfundsiebzigsten Gründungsjahr der Meierei-Zentrale GmbH*, Berlin, 1991

²⁹ See Ernst RING, Die Versorgung der Grossstädte mit Milch und der Kampf um den Milchpreis", *Vortrag gehalten in der Ökonomischen Gesellschaft im Königreiche Sachsen*, Dresden am 11. November 1904, *Mitteilungen der Ökonomischen Gesellschaft im Königreiche Sachsen*, vol. II., (1904-1905), p. 16.; Bernhard SCHOLZ, *Mein Leben für den Milchhandel*, Hamburg, 1949, p. 14

³⁰ See E.G. ZITZEN, *Die Milchversorgung...*, op.cit., p. 293

well as manufacturers of baby food started to built up their own bacteriological laboratories³¹, or they tried to get in contact with official institutes. In 1895 Lydia Rabinowitsch, at the request of the Bolle dairy farm, began to do experiments on butter offered for sale at the market in Berlin. Carl Bolle, the city's largest milk and butter dealer at that time³², expressed interest in using laboratory space at the Koch Institute when the "war on microbes" was gradually becoming a weapon in the battle for territory in Berlin's market for milk.

Finally, those who did not consider themselves competent in scientific questions sought contact with the authorities since they recognized the need for neutral coordination and regulation of the new sector of the economy. Thus, it was not long until organizations appeared which were financed by the public sector, neutral to business, and generally populated with academically trained scientists. In the Weimar Republic there were not only numerous technical dairy schools but also nine dairy teaching, research and experimental facilities or scientific institutions for milk issues in the German Empire, all of which dated back to the 1880s/1890s.³⁴

Cattle and Kids: Appendix on Children's Tuberculosis.

The already confusing situation was made even more complicated by the objections that pediatricians, representing babies—helpless bystanders yet the most sensitive customers of the milk industry—threw into the debate. Doctors had condemned the high incidence of infant mortality and

³¹ See Albert PETERS, *Das Molkereilaboratorium und die gebräuchlichen Untersuchungen der Milch und Milcherzeugnisse*, Berlin, 1930

³² On Bolle see Andreas HOFFMANN, „Meierei C. Bolle“, in *Geschichtslandschaft Berlin. Orte und Ereignisse. Tiergarten. Moabit*, edited by Hartmut ENGEL et. al., (Publikationen der Historischen Kommission zu Berlin aus Anlass der 750-Jahr Feier der Stadt Berlin 1987), Berlin, 1987, pp.174-187

³³ „Specifically the management of milk experimentation stations and laboratories are confronted with the undeniable task of studying bacteria in more detailed fashion, as well as familiarizing themselves with methods and technique, and of supplying themselves with all the necessary aids.“ Wilhelm FLEISCHMANN, *Die Bedeutung der bakteriologischen Forschung...*, op.cit., p. 183

³⁴ At the beginning those institutes only had food chemical laboratories where the chemical composition and the nutritive value of milk and milk products were analyzed. Starting in the mid-1880s they were joined by comprehensively equipped bacteriological laboratories. See W. RIEDEL, „Milchwirtschaftliche Unterrichts-, Versuchs- und Forschungsanstalten, in Willibald WINKLER ed., *Handbuch der Milchwirtschaft*, Vol. 3., *Milchwirtschaftliche Betriebslehre, Zweiter Teil: Organisationen der Milchwirtschaft*, Vienna, 1936, pp. 217-222

the tendency of mothers, particularly in the big cities, to bottle-feed their babies. Moreover, they were among the strongest criticism that accused the milk industry of being partly to blame for the death of many infants due to contaminated or infected milk.³⁵

Driven by doctors and philanthropists, many "sanitary dairy farms", children's milk or health milk institutions were established parallel to the upswing of the milk industry; in their own stalls, they held cows under extremely strict health standards and also subjected the further processing of milk to the highest quality control standards. For decades this specialized branch of the milk trade was said to sell the healthiest milk on the market. Quality control standards as defined by the children's milk institutions for decades remained the often unreachable standard model for the whole milk sector. And even in the tuberculosis question the *pédiatrie* movement for hygienic children's milk became quite important, above all because no one less than Emil von Behring put himself at the forefront of this movement by coming out with a surprising thesis about the etiology of tuberculosis in 1903.³⁶

He claimed that most adult sufferers of tuberculosis had ingested the germs during childhood with milk. All different forms of tuberculosis were supposed to be the result of a latent infection where the milk tubercle passed through the intestines into the lymph vessels and into the blood and from there to the lungs, which they then infected. Behring did not deny the possibility of infection though the sputum of infected family members or by inhaling dust containing bacilli. However, he was convinced that in most cases tuberculosis was merely "the end of the song sung to a candidate for tuberculosis while still in the cradle."

This opinion led Behring to regard cow's milk as the main cause of human tuberculosis at all. Over several years Behring experimented with vaccine sera in cow stalls specially built for this purpose; he attempted to "decontaminate" infected milk with all sorts of disinfectants, including formaldehyde. He toured agricultural associations and tried to persuade

³⁵ Barbara ORLAND, „Wissenschaft, Markt und Erfahrung *Natürliche* versus *künstliche* Säuglingsernährung im 19. Jahrhundert“, in Marguérite BOS, Bettina VINCENZ and Tanja WIRZ eds., *Erfahrung Alles nur Diskurs? Zur Verwendung des Erfahrungsbegriffes in der Geschlechtergeschichte*, Zürich, 2003 (forthcoming)

³⁶ See Emil von BEHRING, *Tuberculoseentstehung, Tuberculosebekämpfung und Säuglingsernährung*, Berlin, 1904. A more detailed description of Behring's theories is contained in H. ZEISS and R. BIELING, *Behring Gestalt und Werk*, Berlin-Grunewald, 1940, pp. 251-410

pediatricians of his theory—yet without any noticeable reaction. Most people at the time were much less afraid of contracting TB from food than through droplets and dust. After a few years Behring suddenly lost interest in tuberculosis research. His theory died just as fast. What remained was a sensitivity on the part of pediatricians to what Georg Bessau, professor of pediatrics in Leipzig, later called “feeding-tuberculosis”.³⁷ As was said, small children were the most vulnerable consumers of cow's milk.

How to fight Tuberculosis in Milk?

Those who gave thought to fighting tuberculosis prior to WWI and afterwards—whether bovine or human tuberculosis—were confronted with a dense thicket of opinions, scientific theories and competing interests. Scientific evidence of the morphological and biological characteristics of the tubercle bacillus, differences about methods of experimentation, the question of the prevalence of the disease caused by the bovine tubercle in humans — while the debate among bacteriologists on the etiology swung back and forth, public health investigators were confounded with a different type of questions.

Before the bacteriological era the dominant argument has been that farmers and milk traders were unwilling or unable to address the issue of cleanliness. The case of tuberculosis, however, could not be managed that way. There was one decisive point in which this disease was different from other contagious diseases: where cholera and typhus were concerned, it was rather probable that the pathogen entered the milk through different types of contamination after milking. One could say that the farmers and milk traders had it in their hands to reduce the danger.

However, improved stall hygiene was, in itself, completely ineffective against tuberculosis (like other animal diseases as foot and mouth disease). According to bacteriological findings, the milk was a dangerous source of infections already in the udder. The potential danger that it posed was tied to the pathology of the disease in the individual animal. Ergo, if the consumption of the meat and milk of consumptive cows was dangerous to humans—and of this the German Empire's health authorities

³⁷ See A SCHÖBEL, *Die Fütterungstuberkulose im Kindesalter*, (IX rztekonferenz veranstaltet im Rahmen der 47. Tagung der deutschen Gesellschaft für Kinderheilkunde von der deutschen Vereinigung für Säuglings- und Kleinkinderschutz, Vienna, 3. September 1940), Berlin, 1940

had no doubt³⁸—then health policy makers needed to attack the disease in the animal.

With the isolation of the bacillus, it looked as if the health authorities had a clear starting point for disease prevention measures. All that would be needed was the right medical cure to destroy the enemy within the infected animals. In 1890, when Robert Koch developed tuberculin in order to vaccinate humans and animals, for a short time this hope seemed to become reality.³⁹ But it proved wrong, the only effort of tuberculin was that it produced a reaction in animals previously exposed to the disease. Thus, it only improved the detection of tuberculosis in animals without visible symptoms.

As an irony of the story, improved diagnostics turned out to be a Pyrrhic victory. What could have previously been termed an act of God soon became an undeniable fact: bovine tuberculosis was a confirmed epidemic. Up until tuberculin came into use, information on the frequency and spread of the disease could only be obtained from public slaughterhouses, which undoubtedly did not present the whole story. Not every city had a slaughterhouse; out in the countryside, most slaughtering was still carried out on farms themselves. There were neither uniform rules for conducting surveys, nor did sanitary regulations exist. All these caveats aside, a survey taken among public slaughterhouses in Prussia in 1901 found that around 15.2% of slaughtered cattle were infected with tuberculosis as an average of the entire province. Merseburg topped the list of cities at 30.8%. The average percentage of slaughtered cattle with tuberculosis in Saxony was 29.39%.⁴⁰

Where tuberculin was used, these figures began to mount dramatically. A report from the Imperial Health Office in Berlin noted: *"Of the herds of living cattle, a large percentage is infected, and among those, up to 80% of the animals were recognized as possibly having tuberculosis due to the tuberculin test."*⁴¹ And it was obvious that the extent of bovine disease was linked to the system of animal production. Certain breeds were attacked

³⁸ In retrospect see „Denkschrift über die Tuberkulose und ihre Bekämpfung“, processed m KAISERLICHES GESUNDHEITSAMT ed., *Tuberkulose-Arbeiten aus dem Kaiserlichen Gesundheitsamte*, Heft 1 Anhang, Berlin, 1904, pp. 43-98

³⁹ See Christoph GRADMANN, *Robert Koch and the Pressures of Scientific Research* , op cit

⁴⁰ „Die Tuberkulose der Haustiere“, m KAISERLICHES GESUNDHEITSAMT ed., *Tuberkulose-Arbeiten* ..., op cit-, pp 99/100

⁴¹ *Ibid*, 100

more frequently than others. Those inhabiting wet lowlands showed a higher percentage of cases of tuberculosis than those of dry highlands. Stabled cattle and especially high-performance dairy cattle kept in the cowshed bore an increased risk of infection. Those findings, however, were utterly devastating. If every animal reacting to tuberculin tests were yanked from stalls, the economic consequences would have been unpalatable.

In any case, to eradicate the disease required radical measures, because all kinds of immunization did not prove to be a solution to the problem. After the dismal failure of tuberculin, bacteriologists resorted to vaccination as a form of immunization. Independently but simultaneously the teams headed by Koch⁴² and Behring experimented with vaccines. Both vaccines proved to be useless. They did not guarantee protection lasting longer than one year. Booster shots were out of the question because the injected bacteria remained in organs for a long time and were also excreted with milk. To put it succinctly, years of comprehensive experimentation failed to yield useful vaccine protection. Scientific progress in vaccination against tuberculosis did not begin to have an impact before the early 1930's.

Hesitancy on the Part of Veterinarians.

Veterinarians as a group had good reason to be pleased that this process had caused a mood shift from euphoria to increasing gloom. One veterinarian looked back in 1929 at the *"fearful overestimation of Koch's research findings"* in the early days. Everywhere, people attempted *"with all their might"* to *"get into the very corpus of tuberculosis..."* Everywhere there was confidence *"that the plague would be conquered rather shortly and with relatively simple means."*⁴³In the end, he wrote, veterinarians turned out to have been right from the beginning in being skeptical about the relationship between the discovery of a disease-causing agent and a cure for the disease.

Veterinarians were circumspect for reasons all of their own. It was only shortly before the unparalleled rise of bacteriology that veterinarians took

⁴² In 1905 Koch, together with animal hygienists in Berlin, developed a vaccine which contained living and completely virulent human tubercle bacilli and intravenously vaccinated around 1000 calves. See Hermann MIESSNER, *Die Bekämpfung der Tuberkulose der Haustiere, Festschrift zum 60. Geburtstag von Schlossmann*, Berlin, 1927

⁴³ See Eugen SEIFERLE, *Ueber die Bekämpfung der Rindertuberkulose* .., op cit, p 3

the major steps toward becoming professional experts on animals and epidemiology: County veterinarians had at last broken free of their colleagues in human medicine⁴⁴ when the Prussian agricultural ministry was given responsibility for veterinary medicine and the Animal Epidemics Act was passed in 1875. At the same time the training system was reformed and elevated to an academic level, and in 1887 the veterinary schools in Berlin and Hanover received the rank of veterinary college. It was precisely during this wave of professionalization that clinical findings and environmental conditions, meaning stall hygiene, were suddenly swept aside by bacteriological research findings.

In the imperial law regarding the combating and suppression of animal epidemics of 1880, veterinary requirements regarding animal husbandry, import controls, the establishment of central slaughterhouses and meat markets were the statutory measures used to stem the tide of animal epidemics. What had worked in the fight against cattle plague and anthrax, however, was not helpful regarding tuberculosis—nor was the propagation of preventive medicine and hygiene similar to the treatment of human tuberculosis able to halt the onslaught of animal contagion. The cramped conditions commonplace in most stalls was a problem without a solution; in fact, the intensive use of animals in dairies considerably increased the danger of infection.⁴⁵ Apart from that, the milk of a single infected cow could contaminate the whole daily output of a cooperative dairy.

From a veterinarian standpoint, a quick decision needed to be taken on how massive the reaction was to be. Following questions had to be answered: Should the epidemic be exterminated or only brought under control? Was the animal reacting to tuberculin to be considered sick or only the animal with clinical findings? Due to the fact that tuberculosis was characterized by its slow and chronic course, veterinarians demanded to take clinical investigations into account. However, there was a rub in it. Not only in the earliest stages of the disease but even in very advanced stages the affected animals did not always produce observable symptoms and could be in

⁴⁴ Until then the veterinary police had been under the control of the general health authorities and thus to human doctors who were civil servants. See Brigitte KROKOTSCH, *Tierhaltung und Veterinärmedizin im Berlin des 19 und 20 Jahrhunderts Eine Spurensicherung*, (Wissenschaft und Stadt, vol. 17), Berlin, 1991, pp. 210/211

⁴⁵ "The dangerous moment is in the lack of motion and the attendant superficial breathing as well as in the in many cases intolerable hygienic conditions. Dark, cramped stalls with little air and light provide an environment for tuberculous droplet and dust infection, particularly in shared feeding and drinking facilities." Samuel BALMER, *Ueber die staatliche Bekämpfung der Rindertuberkulose in der Schweiz*, Diss. vet.med. Um Bern, Muhleturnen, 1947, p. 5

good flesh. In regard to the milk question, what was the point in time to intervene?

There existed no disagreements about forms like pulmonary tuberculosis or tuberculosis of the udder. Animals with any kind of open tuberculosis should be separated or killed and no longer be used for milk production, even if the character and appearance of the milk was unchanged (in contrast with milk from animals with acute inflammations and other diseases of the udder). But what about those cases whose tuberculosis could not be diagnosed as such? While the udder tuberculosis milk nearly always contained tubercle bacilli in enormous numbers, and when fed to human or animals produced tuberculosis with the utmost probability, whereas tuberculosis in general and even at stages where the disease had existed for some time, resulted in animals producing milk that did not always contain bacilli.⁴⁶

Against this background of various combinations of all forms of tuberculosis, different possible answers could be given. Already in the 1890s there were two strategies in competition with one another. In 1899 Robert von Ostertag had taken an eponymous approach and, after intense negotiations at the International Veterinary Medicine Congress in Baden-Baden, defined it as the "German" method.⁴⁷ It stated that the openly infected animals were to be recorded and only the ascertained excretors of bacteria were to be destroyed, afterwards the cow sheds involved were to be completely disinfected. Once a year the cow herds of a farm were to be clinically tested to detect animals with externally recognizable tuberculosis of the lung, udder etc. Only those animals were then to be subjected to three bacteriological tests of the milk they yielded. The main focus lay on the breeding of healthy outcomes; thus, all milk intended for feeding cattle should be heated.

The procedure named after Bernhard Bang, professor of veterinary medicine at the Veterinary College of Copenhagen, took a more rigorous approach. Immediately after the diagnostic abilities of tuberculin had been published, Bang began time-series studies. On that basis, in 1895 he made the following methodological suggestions: first, the whole herd was to be

⁴⁶ Carl Orla-Jensen in 1903 contradicted the statement that tuberculin-reacting cows give contaminated milk. See Carl ORLA-JENSEN *Grundriss der Milchkunde* .. op cit , p 68

⁴⁷ He describes it himself in: Robert von OSTERTAG, *Die Bekämpfung der Tuberkulose des Rindes mit besonderer Berücksichtigung der klinischen und bakteriologischen Feststellung*, Berlin, 1913

injected with tuberculin regularly, and second, the separate holding of positive animals was to be introduced in connection with the gradual elimination of the infected cattle. Thirdly, it had to be ensured that calves were brought up completely free of tuberculosis, and fourth, the whole herd had to be meticulously vaccinated with tuberculin on a regular basis.

Anti-Bovine-Tuberculosis-Programs in Practice.

Leading veterinarians had long discussed the different models of fighting bovine tuberculosis. After the turn of the century, almost all European states decided to try less aggressive control programs instead of eliminating all infected animals.⁴⁸ Only the Scandinavian countries, especially Denmark and Finland, adopted the Bang method based on tuberculin testing, whereas the German Empire and Switzerland found this approach to be too radical and decided in favour of the Ostertag approach. In 1909, the Ostertag procedure was admitted to the revised German imperial law regarding the combating and suppression of animal epidemics, which meant that without tuberculin testing only animals *with* open lesions were slaughtered and infected animals were singled out in order to heat up their milk.⁴⁹

Only the already mentioned children's milk or health milk institutions that held cows in their own stalls constantly used tuberculin in order to be certified as services with a "tuberculosis-free accredited herd". Beyond this, the tuberculin testing remained a voluntary measure that was used primarily to "clean up" breeding stocks or as a marketing instrument.⁵⁰ Regions with intensive dairy husbandry, in contrast, resisted the tuberculin testing even as late as after WWII.⁵¹

⁴⁸ American public health investigators reacted much more radically. Around 1917 they set off a campaign to eradicate bovine TB that within three decades brought the disease under control across the entire United States. Already in 1941 every county in the United States was officially accredited free of bovine tuberculosis (that is with an infection rate below 0.5 percent). See Alan L. OLMSTEAD and Paul W. RHODE, *An Impossible Undertaking* . . . op.cit

⁴⁹ See H. ZWICKY, *Die Bekämpfung der Rindertuberkulose im Zusammenhang mit der Haltungs- und Milchhygiene in Dänemark, Schweden und Finnland. Ergebnisse einer Studienreise im Frühjahr 1939, beschrieben für Landwirte und Tierärzte*, Frauenfeld & Leipzig, 1939, pp. 4/5

⁵⁰ In 1928, for example, the Oldenburger dames in the northern part of Germany persuaded their farmers under contract to take part in the tuberculosis eradication program of the Oldenburger agricultural society. See Nachrichten in *Molkerei-Zeitung*, vol 42 (1928), p. 523

⁵¹ See Rudolf FRITSCHI, *Die Bekämpfung der Rindertuberkulose im Kanton Thurgau 1930-1954*, Diss. vet.med. Um Zürich, Marstetten, 1955, p. 7

Yet why were some countries more hesitant than others? In particular, why did Germany and Switzerland not implement the stricter Bang procedure before the early 1950s when they finally switched after a rancorous process? Already in the early 1930s Denmark announced that two southern islands were completely TB free, as well as a large percentage of Seeland and nearly 60% of the herds in Jutland. The Finnish government equally claimed in 1934 that TB only occurred in 0.05% of all cattle herds. This data was well-known in Germany, and criticism of the Ostertag procedure erupted rather early.⁵²

The report of the Imperial Health Office in 1904 gives a clear answer to the question by pointing out: "*A comprehensive and thorough implementation of veterinary police measures deemed effective*" must be done with the necessary care since otherwise "*the sudden devaluation of cattle herds would lead to great losses of the peoples' assets.*"⁵³ Most Europeans argued that the disease was so prevalent that eradicating all infected animals would cause unacceptable food shortages. Even Bang admitted in 1896: "*In most European states a compulsory and quick butchering of all these animals is out of the question, the number of the reacting animals being so very large.*"⁵⁴

It was particularly the inconsistency of medical diagnostics which hamstrung the authorities, as the disputes in Switzerland show. On 27 July 1889 the executive board of the *Société d'Agriculture de la Suisse Romande* sent a letter to the Swiss Department of Agriculture demanding that, in the interest of Swiss agriculture and public health, all means be used to cordon off and destroy infected animals, with the affected farmers being compensated.⁵⁵ Most of the cantons asked to comment spoke out against including TB in the list of animal epidemics required to report. In this case, as in others, the arguments were the same: it was difficult to defini-

⁵² Criticism was focused on the fact that animals were not bacteriologically examined until external signs of TB appeared. On the critics of the Ostertag method see: F. X., WEISENRIEDER, „Grundsätzliches zur Frage der Bekämpfung und der Tilgung der Rindertuberkulose. Beobachtungen und Erfahrungen über das Ostertagsche Bekämpfungsverfahren im Kanton St. Gallen“, *Schweizer Archiv für Tierheilkunde*, vol. XCH, (1950), pp. 509-528.

⁵³ „Die Tuberkulose der Haustiere“, in KAISERLICHES GESUNDHEITSAMT ed., *Tuberkulose-Arbeiten* ..., op. cit., p. 103.

⁵⁴ Cited in J. Arthur MYERS and James H. STEELE, *Bovine Tuberculosis Control*..., op. cit., pp. 245/246.

⁵⁵ Andreas NABHOLZ, *Die Bekämpfung der Rindertuberkulose im Kanton Zürich*, Zürich, 1956, p. 4.

tively prove the existence of the disease, and clinical findings were hard to assess.

However, once tuberculin had hit the market as an early warning medicine and was provided to cantons free of charge by the Swiss agricultural department beginning in 1896. It was then argued that the reaction to tuberculin was too strong and that the milk and the meat of reacting animals was not automatically infected. Only clinical symptoms could be cited as unambiguous indicators. The head was chasing the tail: only in 1934 was tuberculosis finally included in the list of epidemics for which the federal government provided compensation.

The question of how much, and by whom, the farmer should be payed compensation in case of a coercive slaughter, too, was a constant conflict for decades. Since 1891 Swiss agricultural societies searched for an exit through bovine insurance, which began as a voluntary measure and then, in 1894, became mandatory for all farmers. However, this instrument also proved to be rather inefficient since damages were only paid for animals with clinical symptoms. In addition, farmers were critical of the fact that bovine values were understated throughout; they always waited until the last minute to slaughter diseased animals.⁵⁶

Pasteurizing Milk as a Prophylactic Technique.

There was another reason why officials first believed they could avoid overly rigid measures. As said before, the flourishing milk market itself was interested in preventing damage and incited some change regarding hygiene. Whereas legislative innovation and governmental regulations were few and far between⁵⁷, the economic relevance of careful hygiene was all the more active in creating technical inventions. In 1886, four years after Koch discovered the tubercle bacillus and two years after Hueppe discovered lactic acid-producing bacteria, a household sterilization apparatus for children's milk bottles, invented by Franz von Soxhlet, a professor of agricultural chemistry in Weihenstephan, attracted major atten-

⁵⁶ See Rudolf FRITSCHI, *Die Bekämpfung der Rindertuberkulose...*, op.cit., p.11

⁵⁷ As was reported from the royal government of the province Arnsberg in 1900, only in case of an epidemic outbreak of an infectious disease official decrees were enacted that inhibited the selling of unpasteurized milk for a certain time. See Dr. HENSGEN, *Leitfaden für Desinfektoren. Anleitung zur Vernichtung und Beseitigung der Ansteckungsstoffe, in amtlichem Auftrage herausgegeben*, 2nd. ed., Berlin, 1905, appendix no. 5

tion.⁵⁸ Soxhlet assured doctors and mothers that his method would lead to completely germ-free milk, a promise which was refuted shortly thereafter by some bacteriologists.⁵⁹ All the same, Soxhlet created quite a stir,⁶⁰ and it was not long before imitators came onto the scene.⁶¹

Soon the Copenhagen professor for fermentation physiology and animal sciences Carl Orla-Jensen took up the idea and had converted the sterilization method into one of exposing milk to a constant temperature of 63°C for 30 minutes. By 1890 several mechanical engineering companies had brought a gamut of systems for batch or continuous pasteurization onto the market. All sorts of methods were tried out in order to find the right balance between time and temperature. In addition to home appliances, there were major pasteurization plants for dairies and farms, and the freezing industry also quickly developed cooling machinery since pasteurization can only function if it is directly followed by cooling.⁶²

It was the urban dairy industry that promoted the pasteurization technology, because for them it reduced the problem of controlling the farms. At the same time, urban milk traders were among the first that engaged veterinarians in order to conduct the control of the milk delivery.⁶³ For a few years it seemed as if pasteurizing milk had solved all the problems of

⁵⁸ Franz SOXHLET, „Ein verbessertes Verfahren der Milch-Sterilisierung“, *Munchner Medizinische Wochenschrift*, vol. 38 (1891), pp. 1 - 23

⁵⁹ As explained by Carl Flüggé, milk treated in this manner was by no means completely sterile. The remaining organisms were able to keep growing in a short time and to cause harm to infants. See Carl FLÜGGÉ, „Die Aufgaben und Leistungen der Milchsterilisierung gegenüber den Darmkrankheiten der Säuglinge“, *Zeitschrift für Hygiene*, vol. 17 (1894), pp. 271/2T2

⁶⁰ "To Soxhlet will ever remain the merit of having systematized and popularized the heating of milk for the special use of infants", was the praise given to Soxhlet by the director of the hygienic laboratory in the Public Health and Marine-Hospital Washington in 1908. Milton J. ROSENAU, "Pasteurization", in *Milk and its relation to the public health*..., op.cit., p. 591

⁶¹ An overview of the development of the construction of pasteurization technology is provided in: VERBAND DER INGENIEURE FÜR MILCH- UND MOLKEREI WIRTSCHAFT ed., *Die deutsche Milchwirtschaft im Wandel der Zeit. Ein Jahrhundert Molkereiwesen. Die Geschichte des technisch-ökonomischen Strukturwandels in der Milch- und Molkereiwirtschaft*, Hildesheim, 1974, pp. 150-177

⁶² See Hans-Luidger DIENEL, *Ingenieure zwischen Hochschule und Industrie. Kältetechnik in Deutschland und Amerika, 1870-1930*, Göttingen, 1995, pp. 227/228

⁶³ In Switzerland the Union of Zurich dairies ("Vereinigte Zürcher Molkereien") was the pioneer in pasteurizing milk. Soon after its founding in 1905 the chemist Nikiaus Gerber, who was engaged in all aspects of milk control technologies, introduced the pasteurization technology to the dairy. See SCHWEIZERISCHER MILCHWIRTSCHAFTLICHER VEREIN ed., *50 Jahre Schweizerische Milchwirtschaft, 1887-1937. Festschrift unter gefälliger Mitwirkung einer Anzahl von Fachleuten*, Schaffhauen, 1937, p. 236

the milk industry. Apart from the technical infancy problems of the facilities, the new technique not only helped minimize the risk of infection but also made milk last longer. Even as far as the complicated tuberculosis issue, pasteurization seemed to be a useful solution for the interplay of epidemic-policing and milking measures. On February 5, 1904, Europe's first pasteurization act entered into force in Denmark⁶⁵, which became the model for Germany's 1912 bovine epidemics act. All consolidated dairies were then given two years to acquire pasteurization or sterilization facilities. But it was not milk for human consumption which was to be heated; as a tuberculosis-preventing measure, the law only required the skim milk and buttermilk returned to farmers by dairy and intended for feeding cattle to be heated.⁶⁶

There was a decisive reason for not having all milk pasteurized immediately. In pursuit of destroying all bacilli most milk traders preferred to keep a minimum temperature of 85°C for a short moment instead of heating the milk to a constant temperature of 63°C for a longer period (about 30 minutes) which was technically more sophisticated. Around the turn of the century food chemists, nutritionists and pediatricians came out and argued that the chemical composition of milk was affected adversely.⁶⁷ The albumen would coagulate and the casein would change in a way that sensitive children were no longer able to digest the milk. Beside the fact that the milk would get rid of its nutritional value, it was said to take over a "cooked" taste. Thus, the only complete foodstuff of human nutrition would be unnatural and in the end destroyed. Using a large volume of verbiage, nutritionists and pediatricians demonstrated their support for untreated fresh milk.⁶⁸

⁶⁴ Transporting the milk, keeping the temperature constant, and not least cleaning the machines were some of the engineering feats required.

⁶⁵ It was especially the dependency of milk producers on exports which motivated the Danish government to take this step. As Europe's largest exporter of butter, the Danes generally held that not only the skim milk and buttermilk intended for feeding animals but also the cream used to make butter should be sterilized. See *Milch-Zeitung*, vol. 36 (1907), p. 412

⁶⁶ This deadline ran out precisely when WWI broke out. At that time nobody had the time to enforce the regulation. The milk market collapsed soon afterwards anyway. In 1918 the regulation needed to be extended by another six years. A dairy farm could be exempted from the regulation if all its suppliers were involved in a tuberculosis eradication program or if they could convincingly give economic reasons. See *Molkerei-Zeitung* 41 (1927), p. 1924

⁶⁷ See A. VOLLAND, *Die Entstehung, Verhütung, Behandlung und Heilung der Lungenschwindsucht*, Tübingen, 1898, p. 20

⁶⁸ A compilation of the various arguments may be found in: SÜDDEUTSCHE MOLKEREI-ZEITUNG ed., *Rohe oder pasteurisierte Milch? Eine Sammlung fachwissenschaftlicher Abhandlungen*, Kempten im Allgäu, 1927

When in 1911 vitamin research began to gain influence rapidly, the problem was shifted to the threat of killing vital vitamins. And since in actual fact all types of vitamin deficiencies in infant medicine could be traced back to milk feeding, those arguments could not be dismissed out of hand. Many laboratory experiments on heated milk were carried out. Though long lasting feeding experiments with rats showed that several vitamins, in particular vitamin C, were reduced by pasteurization, they could not clarify this difficult to prove question in general. Therefore, nutritionists began to argue that other foods like certain vegetables and citrus fruits should be used in infant feeding⁶⁹.

Again, scientific controversies and uncertainties crossed the interests of milk producers and traders. Obviously, it was a genuine interest of the industrial milk system to take reasonable precautions in order to guarantee the safety of milk without destroying its nutritional value. Because milk pasteurization supposed to be much cheaper than the extensive control of milk with its labor-intensive inspection strategies from the barn to the private household, pasteurization seemed to be the entire solution. Although numerous technical problems were quickly recognized, after WW I the amount of pasteurized milk steadily increased, especially in major cities⁷⁰.

Progress as a Convergence of Many Interests.

The dispute began again after World War II as if the issue of "milk" as a source of infection had never been mentioned in central Europe, or measures to fight bovine tuberculosis had never been passed. This time the dispute was linked up to the topics of protective vaccination methods,⁷¹ radical slaughtering (such as the US *stamping out method*)⁷² or food-borne tuberculosis in children.⁷³ It lasted another decade until most European nations

⁶⁹ See *Milk Production and Control. Communicable Diseases, Public Health Supervision, Nutritional Aspects, Economic Aspects*, Report of the Committee on Milk Production and Control, ed. By H.A. Whittaker, New York/London: The Century Co. 1932, pp. 171-172.

⁷⁰ For data about the United States, see *ibid.*, pp. 275-279.

⁷¹ The International Office of Animal Epidemics in Paris determined once again in 1948 that in the fight against TB no protective vaccination method based on previously known methods could be permitted. See Rudolf FRITSCHL, *Die Bekämpfung der Rindertuberkulose...*, *op.cit.*, p. 29

⁷² "*Between 1917 and 1940 veterinarians administered roughly 232 million tuberculin tests and ordered the destruction of about 3.8 million cattle (from a population that averaged 66.4 million animals over this period).*" Alan L. OLMSTEAD and Paul W. RHODE, *An Impossible Undertaking...*, *op.cit.*, p. 2

⁷³ Kurt Wagener, Head of the Institute for Microbiology and Animal Epidemics at the Veterinary College in Hanover, brought these subjects into headlines in the Federal Republic of Germany. See W. BISPING, *Zur Geschichte der Bekämpfung der Rindertuberkulose...*, *op.cit.*

finally copied the American model and imposed compulsory TB test-and-slaughter programs along with the mandatory pasteurization of urban milk supplies. In the end, bovine tuberculosis, and with it the risk of infection through cow's milk, was eradicated through improved milk pasteurization, test-and-slaughter, controlled hygiene in cow stalls and milk processing, effective medication and the decontamination of all cattle herds. Only in its combination the different methods discussed and explored at the various stages, helped to prevent people from contracting tuberculosis.

Looking back, nearly a century had passed since tuberculosis contaminated milk was eradicated. Thus, the main lessons to be learned are the consequences of confusion that more often follow so-called scientific breakthroughs than one would expect. Waiting for the science to be 'correct' can cause hesitancy and a delay in responding. Only in a historical perspective can one count the long-term costs in human lives that result from the prevalence of short-term interests. However, historical investigation also puts decisive interests in perspective. What appears to be a relatively constant change in a single direction turns out, at a closer glance, to be a chain of obstacles which characterized actions at every stage and at the same intensity. Seen in this light, change or even progress cannot be accredited to bacteriology or scientific research alone. The authority of scientific arguments, delivered at the time by a scientist who was famous during his lifetime, was drowned in a cacophony of opinions. In addition, since the debate only progressed step by step and without knowledge of any final outcomes, some problems had to be debated time and again. Therefore, in turbulent times of food-scares, delegating the responsibility of political action to a subsystem of society—science—will hardly yield effective measures of fighting epidemics and ensuring safe food. Only society as a whole will ultimately form the essence of what later will be called medical progress.