Preface to Brock’s *Robert Koch: A Life in Medicine and Bacteriology*

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Ten years have passed since Dr. Thomas Brock gave us this first major English-language biography of Robert Koch in 1988. Written by a distinguished microbiologist rather than a professional historian or biographer, the book has nonetheless stood the test of time. Indeed, though not working with unpublished archival sources or dissertations, Brock’s command of the published sources is extremely impressive, especially his use of the German-language biographies of Koch that are otherwise inaccessible to most English speaking readers. Thus, despite the fact that Brock did not make use of archival materials (many of which, in East Berlin, may only have become available to scholars after the fall of the Berlin Wall), his analysis in many ways opens up or foreshadows important themes that historians have since developed in more depth. His bibliography and notes are very well-arranged so that this biography is useful to the average reader and an essential starting point for any historians to work on Koch from this point on.

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In his lifetime, Robert Koch did more to single-handedly advance the world’s understanding of microbes as causes of disease than any other man, with the exception only of his great French rival Louis Pasteur. Koch and his students created almost from scratch the majority of the techniques necessary for any modern study of bacteria, including micro-photography of the organisms, staining procedures, and solid culture media, which allowed reproducible pure cultures and quantification of bacterial numbers for the first time. They also identified the causative microorganisms for anthrax, wound
infections, tuberculosis, diphtheria, cholera and many other major infectious diseases.

Koch had the talents of a first-rate researcher: he was a keen observer, an ingenious technical innovator, and was extremely persistent and single-minded in pursuit of his goal. Yet, being trained from the outset of his career as a practicing medical doctor, Koch never lost sight of the practical benefit to human health that was implicit in his work, devoting much work to the study of effective water-filtration systems, for instance, after the 1892 Hamburg cholera epidemic. This is not a mere academic point; Brock reminds us (p.3) that “water filtration has probably saved more lives than immunization and chemotherapy combined.” Brock is thorough, and his deep admiration for Koch shows, as he documents in detail all the important contributions Koch made, without which it is difficult to imagine the existence of bacteriology as we know it.

Yet this book stands out from a great many hagiographic biographies of the past. With figures of the stature of Koch or Pasteur, one rarely finds a study that can document the awesome contributions of the scientist without setting him up as a hero figure, a giant with no human qualities. Brock, more in tune with the needs of our own time, sees that Koch’s human qualities make an equally fascinating part of the story. An important thread in this narrative of Koch’s career is to show how an “eager amateur” country doctor, experimenting on microbes in his spare time, went on to become “an imperious and authoritarian father figure whose influence on bacteriology and medicine was so strong as to be downright dangerous.” And the point, Brock emphasizes, is not just to understand Koch’s personality, but to better understand science itself, including “the origins of the cult of personality in research.” (p.4) It might be added that, for a new generation of scientists in training, it is much more valuable as a model for study to have a real, complex
human being, including his mistakes and excesses. By comparison, a too-perfect hero figure will always leave most of us doubting that we can measure up, especially in the face of the messy enterprise that laboratory science can be on a day to day basis.

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I shall not attempt an exhaustive summary of the new historical work on Koch of the past decade, but will briefly indicate some of the most important works and what contribution each has made. For the reader who wants more detail, the bibliographies of those works will provide a more than adequate guide into the literature. Subjects that have received excellent and fascinating treatment include, the rivalry between the Koch and Pasteur schools (and the two men personally), the pleomorphism/monomorphism debate, the greater complexity of Koch’s postulates than at first meets the eye, the larger political and cultural resonances of the bacteriological revolution (especially in Germany), the tuberculin discovery and its relation to the creation of Koch’s Institute for Infectious Diseases, and finally, the difficulties of the historian’s task in adequately assessing a scientific giant without merely recreating the mythic hero figure that the scientist often himself began constructing during his own lifetime.

Koch disagreed with Louis Pasteur on a number of important issues in bacteriology. Brock tells us that in the Pasteur/Koch controversy, Koch could at times be so personally vicious as to be shocking. We learn, however, that the controversy “was certainly rooted, in part, in the French-German antagonism that still festered as an aftermath of the Franco-German war.” This has also been documented for Pasteur in the most recent work. Brock points out (p.176-77) that differences in style of the Koch and Pasteur schools, also “rooted in national characteristics,” but with “more deep-seated
significance” scientifically, contributed to the animosity and misunderstanding as well.
These themes have been explored and developed in great depth by Andrew Mendelsohn
(originally in his Princeton PhD dissertation, soon to appear as a book), who characterizes
the French and German schools as two fundamentally different “cultures of bacteriology.”
He argues that Pasteur’s more ecological approach to microorganisms was rooted in an
agricultural French context in which the “economy of nature” (and hence the role of
microorganisms in that big picture) was a primary cultural motif. Indeed, Pasteur’s entire
work with microbes began through fermentation, their positive functions such as
winemaking, suggesting the ecological necessity of microbes. By contrast, Koch’s view of
bacteria was medically rooted from the beginning, his surgical experience in the Franco-
Prussian war; microbes were pathogens, exclusively negative agents to be eliminated if at
all possible. This fundamental difference in “culture” produced different methods of
working with bacteria, e.g. Koch’s early insistence on working with pure cultures as
opposed to the Pastorians’ preference for working with liquid cultures that, by nature,
were mixed populations. But Mendelsohn shows that the deep philosophical difference
continued to manifest as the French and German “schools” and the new science of
bacteriology transformed over several decades.

Another important contribution to this aspect of Koch’s work has come from
University of Toronto historian Pauline Mazumdar. She shows convincingly that an
important early source of Koch’s basic opposition to the Pastorians was his deep
epistemological commitment to monomorphism, the idea that microbes, like all other
organisms, come only in discrete species. Carl von Nägeli in Munich and his students
championed the opposite theory, pleomorphism, that microbes can undergo such a wide
range of mutability under different environmental conditions that the morphologically different types are almost all interconvertible. Mazumdar shows that these views on microorganisms were manifestations of very long-standing opposed views of nature that she calls the “Linnaeans” and the “Unitarians.” Koch emulated the work of the botanist Ferdinand Cohn, with whom he shared the view that bacteria came in true Linnaean species, and thus he was opposed to Nägeli’s ideas as soon as he heard them. It was Koch’s deep _a priori_ belief in this view of nature that led him to think that photography of the organisms would be an important contribution to their study. Mazumdar suggests that Koch’s insistence, as early as 1878 (long before there was any proof of such an idea), that one bacterial species must be the cause of one and only one disease also grew out of this basic difference in beliefs about nature. In his 1878 paper on wound infections he used this as a new dimension to his definition of bacterial species: the disease that an organism caused was one of the chief features that he said could be used to define which species of microbe it must be. Brock pointed out many years ago in his book _Milestones in Microbiology_ (p.100-101) that Koch was exhibiting theory-laden observation when he emphasized tiny differences between, e.g. micrococci; indeed that the researcher was begging the question at issue in imagining “that the minor differences he saw were significant....He wanted these organisms to be different” so that his theory would be verified. Brock concludes that “fortunately Koch was right on this point, but there was no _a priori_ reason why he should have been right, and so we must conclude that he was lucky.” Thus, the widespread opposition Koch faced from other doctors and students of microbes was not at first because they were unaware of his evidence. Rather it was precisely because they saw that he did not have the evidence for his strong one
bacteria/one disease claim that his theory was opposed and the theories of Nägeli and Max von Pettenkoffer retained wide support on into the 1890s.

So why should this contribute to antagonism between Koch and the Pasteur school as well? Mazumdar points out that the pleomorphist camp used exclusively liquid cultures, as did everybody else prior to Koch’s invention of solid media. But Koch was convinced that it was that fact above all else that caused confusion between (what he was sure were) different separate species in a mixed culture and (what his opponents interpreted as) the different stages in the interconverting life cycle of pleomorphic microbes. When Pasteur first announced the discovery of attenuated virulence in a microbe in 1880, this reminded Koch all too much of the pleomorphists’ claims that such a fundamental defining property of the organism as its ability to cause a disease was a mutable thing. And since the Pasteorians, like Nägeli and his followers, still used liquid media for their cultures, this clinched the case in Koch’s mind: the Pasteur school were highly suspect of being as fundamentally misguided about stable, unchanging bacterial species as were the pleomorphists.

Of course, we now know that Koch was wrong in thinking that stable species were incompatible with quite significant genetic mutability within a species of microorganisms. Indeed, some would argue that the discovery of such important phenomena as the variation among “smooth” and “rough” forms of pneumococci (and the resultant path to the double helix) may have been held up for decades by the extent to which Koch’s monomorphist dogma held sway, once he triumphed with spectacular diseases such as cholera and tuberculosis. Bacteriologist Ludwik Fleck made such an argument in the 1930s. Brock also cites Philip Hadley and shows that disagreement over this point had
surfaced from American bacteriologists even in the last years of Koch’s life. Yet the slow waning of Koch’s dogmatically extreme monomorphist view was still to create trouble, even for American researchers, as Harris Coulter has shown in the case of Arthur Isaac Kendall. Clearly, this is a prime example of what Brock intimated when he warned of the excessive influence of the “cult of personality” that grew up around Koch. While his insights about the use of pure cultures were brilliant, his *a priori* bias led him to mistakenly think this must mean that Pasteur’s discovery of variability among microbes was illusory. For the next several decades this necessitated the creation of epistemological wastebasket categories such as “involution forms,” into which observations could be banished when they seemed at odds with the monomorphist paradigm. If an overriding commitment to his belief had the benefit of driving Koch through the years of hard work necessary to isolate the causes of major human woes, it simultaneously had the effect, proportional to his success, of calcifying the research and preserving Koch’s mistakes, at least for several decades. It also, as much as nationalistic feelings, may have contributed to driving a deep wedge of suspicion between him and the only other group of workers with whom he could have collaborated as equals. Such is a common feature of research that should give us pause.

One of the single most important new historical contributions on Koch is Richard Evans’s masterly analysis of the 1892 Hamburg cholera epidemic, in which Koch and his new bacteriology clashed with the sanitarian theory of Max von Pettenkoffer. Pettenkoffer’s theory was based on exhaustive study of local conditions of soil and climate and emphasized that the cholera germ was only one ingredient needed to produce the disease. Only when the bacterium came in contact with the soil under specific conditions
related to the underground water table could the actual cholera poison be generated. Thus in Pettenkoffer’s theory, which had enjoyed wide respect in medical circles for twenty years by 1892, the bacteria getting into drinking water could in no way transmit the disease. In the epidemic of 1892, it was noticed that the rate of cholera in the immediately adjacent, downstream city of Altona was negligible compared to Hamburg. Altona had a sand filtration system on its water supply, so to Koch and his supporters it seemed obvious that drinking water must be the main means of transmission of the disease. Historically, one of the things calling out for explanation has been, how anybody in Hamburg could have resisted such compelling epidemiological evidence and not immediately thrown out the Pettenkoffer theory, in favor of the Koch theory that bacterium = disease. Yet the epidemic reached very serious proportions indeed, claiming nearly 10,000 lives in six weeks before Koch’s views came to dominate. The power of Evans’s close-up history is in explaining what forces in the medical community and government of Hamburg lent support to Pettenkoffer’s theory and why. Furthermore, Evans shows that larger political tensions between Hamburg and the German Empire (with Prussia the dominant state), over “federal” intervention in local matters, exacerbated the reasons why local Hamburg officials would be opposed to Koch, an official of the Prussian bureaucracy.

The famous historian of medicine Erwin Ackerknecht first suggested fifty years ago that anti-contagionist, sanitarian theories of epidemic disease would tend to be supported by nineteenth century classical liberals (including free-trade advocates), while contagionist theories would be more likely to be supported by political conservatives. Why? Because contagionist theory implied the need for more centralized government authority and interference in local affairs to enforce quarantines and disinfection measures.
Free traders, especially merchants and businessmen whose livelihood depended upon the free and cheap movement of goods across state and national boundaries, stood to lose most if quarantines were imposed because of epidemics. In the nineteenth century, this group tended toward reformist, liberal politics. More extreme liberals, such as the famous pathologist Rudolph Virchow, insisted that social reforms for those living in destitute, unclean, underfed, overworked conditions were the only real cure for epidemic diseases. Virchow and his supporters would always be highly suspicious of germs as any kind of true causative agents, recognizing that the easiest way for a conservative government (such as that of Prussia or, after 1871, the Prussian-dominated Empire) to avoid expensive and democratizing social reforms was to blame epidemics entirely upon a germ from without, and so to avoid issues of poverty and inequality altogether and insist that all that was needed was quarantine and disinfection. These far-left liberals were not surprised that it was the Imperial government in Berlin that supported Koch. And they were skeptical of Pettenkoffer’s theory for allowing any role for a germ at all. Yet, compared to Koch’s Prussian State anti-germ bureaucracy, which gave the germ total causative blame, Pettenkoffer’s theory still appealed to liberals because it did at least emphasize the importance of local conditions in creating the actual poison that caused disease. Thus, it implied that local medical officials were by far the most appropriate people to decide how best to deal with epidemics, not far-off Prussian bureaucrats trying to pass sweeping uniform policies and enforce them on all German cities under all conditions. Practically speaking, sanitarian theories did actually greatly reduce overall mortality from epidemics because of their emphasis on building sewers and public water supplies (thought not necessarily with filtration), and on improving nutrition and general living conditions.
Thus, in England and in many German areas, sanitary theory was credited with actually solving the problems, without the need for germs as central players.

If all this were not enough to make Pettenkoff’s theory more popular with most local medical officials, Evans shows that Hamburg was an even more special case, and proves that this political context was a very important reason why Hamburg, alone among German cities by 1892, experienced a severe cholera outbreak that year. Hamburg’s government had been run for centuries by the mercantile class, as the merchants had basically made the wealth of this trading port since medieval times when it first became a free and independent city-state within the Hanseatic League. In its liberal, free-trade policies and culture, the city had long been known as the “most English city on the Continent,” let alone in Bismarck’s conservative German Empire. The mercantile ruling class selected the medical officials, and the doctors most likely to become public servants were those who saw their interests most closely tied to those of the wealthy merchants. Thus, the entire history and culture of the city mitigated against quarantine policies and the havoc they caused in disrupting trade, and Hamburg held out longer against centralized control of its medical policies by Berlin than any other German city. In 1892, huge numbers of eastern Europeans were passing through Hamburg, to take ship for emigration abroad, especially to America. Then, if ever, city officials would be loath to impose a lengthy quarantine, stopping the flow of this highly profitable cargo. Yet it was just the flow of these poor emigrants that was bringing the cholera bacillus from the east and depositing it in the sewers, the river and the harbor of Hamburg. Because one of the most pointed differences between the Koch and Pettenkoffer approaches was in whether epidemic disease poisons could be spread by drinking water supplies, the kind of
epidemics Hamburg (or Pettenkofer’s Munich) were most totally unprepared for, despite other intelligent sanitary measures, were water-borne diseases such as cholera and typhoid. Since centralized Berlin policy on germs, as dictated from Koch’s lab, was enforced through almost the entire remainder of the Empire, only Hamburg fell victim to cholera that year. Needless to say, Koch was sent to investigate, and his eventual triumph over the 1892 epidemic was a crippling blow to Hamburg’s continued economic and political independence from Prussian domination. It is not possible to predict simply and unequivocally that any given doctor would support or oppose contagionist theory and policy based solely on his basic political views. Nevertheless, the integral nature of political history in understanding the fortunes of the germ theory of disease never came through more clearly than in Evans’s story of *Death in Hamburg*.

Brock’s biography makes eminently clear that Koch understood how crucial the support of the Imperial and Prussian state politicians in Berlin was for the advancement of his career and the spread of his ideas. And the relationship was a true symbiosis. For, in the wake of worldwide fame for French science that came after Pasteur’s triumphs with anthrax vaccine in 1881, the prestige of German science was at stake. If the memory of the Franco-Prussian war ten years before were not still clearly in everyone’s mind, Pasteur was deeply embittered and publicly campaigned all through these years for more support for French science, insisting that France had fallen behind the state support the Germans gave to science and that this was an important reason for her defeat by the “Prussian chancre.” Thus, supporting Koch and trumpeting his triumphs as the German answer to Pasteur was a priority for Berlin. The famed “race” between the German and French teams to find the germ of cholera in 1883, and the declaration of Koch’s *Vibrio cholera* in
1884 as a triumph for German science must be seen in this context. There are two reasons: first, several other investigators had observed the cholera bacillus before Koch (the Italian Pacini is officially credited currently, with having first seen it in 1854), so presumably more conclusive proof of a causative link should account for the contemporary trumpeting of credit for Koch. But the second point is exactly this: Koch was unable to fulfill the criteria for proof of causation that were to be announced in that same year and later became enshrined in our microbiology textbooks as Koch’s postulates. The most crucial missing link was the inability to infect an animal model with the bacterium and cause the disease. Thus, the Pettenkoffer school, and many outside Germany as well, were highly skeptical of whether Koch’s bacillus was any more proven to be causative of cholera than any of the other numerous intestinal bacteria for which the claim had been made before. Anti-contagionists recalled in particular an episode in 1849 when British researchers claimed to have shown a fungus was the cause of cholera, only to have it shown within the year that the organism in question was a common mold contaminant. Why, in this context, Koch’s \textit{Vibrio} came to be so widely celebrated makes much more sense if we recall that the Berlin government was the most vocal advocate of that view, treating Koch and his team as national heroes upon their return from India and arranging for Koch to be publicly greeted by the German Emperor.

And the French were not the only intended targets of this orchestrated propaganda for the superiority of German science. As Evans points out, 1884 was the year that saw the beginning of the imperial powers’ “scramble for Africa.” And the furious competition to conquer disease in the name of science ran neck in neck over the next three decades with the race by the Germans, French, British and others to colonize territory in the name
of civilization. The link was twofold: a propaganda war to justify imperialist expansion on the one hand, combined with the need for science to get control of the aggressive tropical diseases so that large numbers of Europeans, especially troops, living in Africa could be possible. And by 1896, Koch had begun to shift his major research interest to the tropical diseases of Africa. That Koch’s scientific interest moved in this direction is not to be doubted. But again we must recall that it was only the support of the German government that made possible Koch’s intensive full time work in bacteriology after 1880. So perhaps it is not so surprising, and even may be instructive for modern high-budget science, to study the degree to which he who paid the piper chose in this case to call the tune. The racist and political roots of this, along with the science, are explored in depth in recent work by Heidelberg historian Wolfgang Eckart. Eckart shows, for instance, that trials of chemotherapeutic agents against the diseases were much easier to accomplish in the African colonial setting, with non-whites as experimental subjects, than would ever have been possible in European labs.

To return to the issue of Koch’s postulates, raised above, this is an area in which very interesting work has been done recently as well. While willing to deploy these rules in a more rigid form for publicity purposes, we learn from Brock’s discussion (p. 180-82) that, from the very beginning, Koch understood that the situation was more problematic. He was convinced that his vibrio was the cause of cholera, for example, and thus that it might still not be possible in every case to fulfill the requirement for re-infecting an animal with the pure culture and reproducing the disease. So from before they were even announced, in the mind of Koch the researcher, these rules were not the kind of dogmatic requirements that they went on to become in microbiology textbooks. Historian Victoria
Harden of the National Institutes of Health has studied the ongoing conflict in research, especially after the discovery of the viruses (which can almost never be cultivated on nonliving media), between the postulates as a helpful guideline for seeking new disease agents and simultaneously as obstacles to new breakthroughs of a fundamental nature. Virus researchers have insisted from the earliest days of their work that new versions of the rules must be continually reinvented to take into account the new properties of pathogens that differ from those of the bacteria worked with in the 1880s. Basic disagreements can be caused when two researchers insist on different versions of these postulates as bottom-line criteria, and in no case has this come out more clearly than in the objections of virologist Peter Duesberg, that the epidemiological data on HIV are insufficient to prove it causes AIDS. Harden looks at cases up to and including this one and tries to evaluate the validity of Duesberg’s arguments and those of his opponents such as William Blattner and Robert Gallo in light of past historical disputes over what form of Koch’s postulates is most reliable. In light of such a history, it is fascinating to reflect on the process by which such a scientific idea, though more flexible in the mind of its creator, can become an obstacle to new discoveries, especially if propagated in too rigid a form in science textbooks. Of course, in allowing the German state to use simplified notions of his work as propaganda tools, Koch himself must have realized his own participation in this process from the beginning.

We see this kind of double-edged nature of patronage again, when Brock shows how (p. 198-99) Koch’s German government superiors forced him to announce his discovery of tuberculin and its possible curative role for tuberculosis before he thought it scientifically appropriate. The premature announcement was forced on Koch because of
the publicity opportunity of making it at the Tenth International Medical Congress. It almost certainly also resulted from the enormous international prestige that came to the Pasteur group in the first years after the development of the rabies vaccine, leading to donations of an enormous sum of money that was used to create the Institut Pasteur in 1888. In the wake of this, Koch’s government patrons were planning to create an institute for him in Berlin that would have comparable prestige for cutting-edge research. And as soon as his work on tuberculin made it mistakenly seem that it would be an effective therapy for tuberculosis, clearly the negotiations for Koch’s new institute became bound up immediately with the potential fame and profit associated with that remedy.

In this area too, recent historical work has also brought new and interesting details to light on Koch’s negotiations with the state bureaucracy. Heidelberg scholar Christoph Gradmann has found, in East Berlin archives, detailed government documents showing that the negotiations bogged down in late 1890, but not because Koch was digging in his heels about being forced to announce the discovery prematurely. Koch was trying to strike a deal that guaranteed himself personally a large share of the profits that would accrue from tuberculin sales for the first six years. This is in striking contrast with Koch the selfless researcher whom biographers have been convinced had basically no interest in fame or profit. Over the succeeding months, when large scale trials brought out the fact that tuberculin really had very little therapeutic effect, Koch was forced to back down from his tough stance and accept the creation of the Institute for Infectious Diseases on terms mostly dictated by the German government, since he feared losing all in the public relations debacle over tuberculin. Most of all, it never became public that, as many
tuberculin critics had charged during the months of controversy, Koch hoped to personally profit from the discovery, in addition to getting his institute for the good of humanity.

Here we are faced with something harder to accept into our previous heroic vision of Koch. Despite Brock’s thoughtful comments on the larger context of science, politics and bureaucracy in which Koch worked, here is one area where Brock the microbiologist, the scientist, generously views his subject with basic faith that Koch was “strongly motivated to excel without regard to fame and fortune,” at least in his early years. And yet, working out the role of personal profit in this incredible new field, so important for humanity, is surely an important part of the history of work on human disease. The controversy that followed Selman Waksman and Albert Schatz’s discovery of streptomycin, eventually leading to a lawsuit and a court settlement over how profits from that drug were to be allocated, shows that this tension did not go away after the early days of giants like Koch and Pasteur. And surely the recent dispute between Robert Gallo and Luc Montagnier over patent rights resulting from the discovery of HIV shows that it is a matter still very relevant in research. We must realistically include these matters in our picture of Koch to see the full human being and to understand the full relevance of his story for our own times, as well as for the future of scientific research. Paraphrasing Gerald Geison from his recent scholarly and provocative biography of Pasteur, we need a Koch for our times, not only the Koch who has inspired generations of young people to become scientists, but also the more complex human that we know he must have been. This can be done while simultaneously keeping in view the important contributions in the science that Koch made so brilliantly. It is a tribute to this book that it has gone so far in
that direction without sacrificing the details that make the science itself so compelling, indeed world-changing.

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18 April 1998

Further Reading


