Article:
Stark, J orcid.org/0000-0002-0638-0804 (Cover date: September 2023) Making Microbes: Theorising the Invisible in Historical Scholarship. Isis, 114 (S1). S85-S103. ISSN 0021-1753

https://doi.org/10.1086/726982

Making Microbes: Theorising the Invisible in Historical Scholarship

James F. Stark (University of Leeds, j.f.stark@leeds.ac.uk)

Microscopic ecosystems have provided historians with myriad ways of interrogating both investigations of invisible microbial networks and their social, cultural, and political consequences. The category of "microbe" or "microorganism" has been historically flexible, encompassing originally all organisms or apparently-living beings visible only with the aid of a microscope, before becoming increasingly refined so as to cover, variously, bacteria, viruses, fungi, protozoa, and a huge swathe of unicellular prokaryotic organisms. Whilst studies unpacking the discipline of microbiology have become a touchstone for histories of medicine and the biological sciences, analyses of the public life of microbes – their power and significance – have exerted strong influence in broader understandings of social and cultural *milieus*. That is before we consider critically important work which has identified the far longer histories of microorganisms which, of course, long predates the formation of microbiology and its sub-disciplines as organised fields of investigation. There are several major themes which emerge when considering the presence of microbes within historical literature, with a clear division between pre-bacteriological conceptions of the role and nature of microscopic organisms and the later specialisms in which the microbe lifecycles and relations with society have come to predominate.

Before Bacteriology

Two names which have become synonymous with investigations of the microscopic work in the early modern period are Antonie van Leeuwenhoek (1632-1723) and Robert Hooke (1635-1703). Leeuwenhoek's characterisation of living organisms visible only with the aid of the microscope as "animalcules" provided an evidential as well as technical basis for subsequent interrogations of the invisible animate world. Robert Hooke's *Micrographia*

(1665) was itself already published by the time that Leeuwenhoek came into the field, and the two have been the subject of extensive study within the historiography. There is, however, surprisingly little historical treatment of the precise extent to which we might think of animalcules as mapping directly onto the modern, complex category of microbes, evidenced best perhaps by the ambiguous status of the terminology associated with viruses around the turn of the twentieth century. With the advent of Hooke and Leeuwenhoek's observations, however, the status of microbes as both viable and significant objects of philosophical investigation was confirmed.

The mid-eighteenth century saw an increasing focus on infusoria, with changes in microscopical technologies and techniques bringing attention to minute aquatic organisms. Detailed mapping of morphology and reproduction, as well as regeneration, was a critical endeavour, with naturalists such as Louis Joblot – who produced a major treatise on microscopic organisms in 1718 – equally interested in technical developments of the microscope and the observations thereby made possible. Indeed, historical treatments of microscopic organisms highlight the continued focus on infusoria well into the nineteenth century, noting the ongoing importance of the "gliding, teeming, whirling world" observable in water samples (Churchill, 1989, p. 189).

Other critical themes of this interstitial period between early microscopical observations and the maturation of the field of microbiology are fermentation and attempts to generate taxonomies of microbes. In the latter, historians have begun to uncover increasingly complex networks of natural historians, most recently figures such as Christian Gottfried Ehrenberg (1795-1876) for whom a description of classes of microbes and their relationships was a major goal.

These developments reinforce the fact that the more high-profile changes in late nineteenth century microbiology did not emerge *ex nihilo*. Rather, they were rather predicated

on earlier changes in technical and theoretical dimensions of microscopy and its consequences, explored within existing scholarship by the likes of Marc J. Ratcliff and Jutta Schickore. Despite this, much of the focus on their relationship with both science and society has focused on the period from the nineteenth century when debates about the causal relationship between microscopic organisms and macro-level biological phenomena assumed new significance.

In addition to technical challenges and classificatory interest in the microbial world, a similarly fundamental question about this microscopic ecology was whether microbes themselves could arise spontaneously. Drawing on the legacies of ancient thought about the nature of reproduction and the origins of life, regional-specific studies have demonstrated that a multiplicity of explanatory frameworks for the supposed spontaneous generation of microbes circulated through growing transnational networks of scholarly exchange in the eighteenth century, though experimental testing of microbial origins was not a new phenomenon. Amongst the architects of such inquisition were Francisco Redi (1626-1697), John Needham and Lazzaro Spallanzani. The characterisation of Redi as the originator of experimental biology has been complexified, yet it is still the case that as a contemporary of Hooke and Leeuwenhoek his early empirical work on the supposed spontaneous generation of insects, published in 1668, provided a framework for an experimental challenge to the doctrine of *creatio ex nihilo*.

This was followed by nearly two centuries of claim and counter-claim, as experiments were replicated with widely different results, leading to the characterisation of the period as marking a "slow death" of spontaneous generation. Archetypal of the disputes between proponents and opponents was that between John Needham (1713-1781) and Lazzaro Spallanzani (1729-1799), explored by historians Shirley Roe and Iris Sandler respectively.

The *experimentum crucis* in this ongoing debate has frequently been held up as Louis Pasteur's 1859 intervention, in which a novel experimental configuration around the swan-necked flask appeared to provide decisive proof against spontaneous generation. His method built on prior work by Needham, Spallanzani and others, yet was equally a product of the social, economic and intellectual environment of the age: an intervention in debates about religion and creation as much as science (and showing that very discourse to be to a large extent inseparable). It is, however, a mistake to regard the matter as closed, since debate continued about the veracity and replicability of Pasteur's supposedly decisive proof, and even the interventions of John Tyndall in refining the methods and acting as a vocal critic of spontaneous generation in subsequent decades provided the foundation for only a gradual and incomplete shift in bacteriological modes of thought.

Microbiology as Discipline and Mode of Thought

As a concrete scientific discipline, bacteriology has proved a fertile ground for historical enquiry. William Bulloch's much-cited 1938 treatise, *The History of Bacteriology*, is arguably the foundational work in this area. As well as the key developments in medico-scientific perspectives on disease causation which characterised the late nineteenth century, Bulloch also surveyed earlier developments in theories of disease, including contagion, spontaneous generation, and miasma. Subsequent investigations at the level of specific diseases – including Margaret Pelling's account of cholera in England (Pelling, 1978) - Since social histories of medicine came to prominence, such approaches have undergone extensive revision, with accounts by Nancy Tomes and Michael Worboys, published in consecutive years, accounting for major developments in both germ theories and, critically, practices, in the United States and Britain respectively.

The events of the late nineteenth century, and the totemic figures of Pasteur and Koch have been increasingly contextualised against a backdrop of existing change and

flux in microbial thought. For example, whilst the miasmatic theory of disease causation was earlier thought to be the principal idea which the so-called "Bacteriological Revolution" sought to displace, it was arguably Justus von Liebig's zymotic framework of the 1840s which predominated at the time. The zymotic account of disease causation rested heavily on analogies between disease and the putrefactive processes seen in fermentation, and provided a compelling account of how a wide range of so-called "zymotic" diseases – including typhoid, typhus and scarlet fever, measles, cholera and diphtheria – were induced. As numerous studies of the period from 1850-1900 have shown, zymotic disease theory was a central driving force in shaping public health interventions and medical treatment long after its assumed displacement by bacteriological disease causation mechanisms.

Indeed, the very concept of a revolution in bacteriological thought and practice in the decades around 1870 – once a lynchpin of the historiography – has over the last twenty years been shown to exist merely as a mirage. It is now well established that whilst the field of bacteriology became concretised across Europe and North America in this period, the consequences of this major disciplinary entity were in many cases reinforcement, rather than disruption, of existing sanitary practices. That is not to say that historians have downplayed the significance of a causal relationship between microbes and diseases; rather that the appreciation for the work of Pasteur, Koch, and others has been tempered by recognition that its impact was not as immediate and far-reaching as might have been expected. In some ways, the welcome expansion of English-language scholarship addressing the topic from a non-Eurocentric perspective has accelerated this transformation in our understanding. For example, the Imperial ambitions evidenced by the rapid expansion of the global network of Pasteur Institutes in the late nineteenth century did not yield (as those responsible expected) a transformation of medical practice along the lines of the new bacteriology. Instead, these efforts interfaced in diverse ways with existing forms of indigenous knowledge and practices,

with bacteriology serving in many cases as another arm of colonisers' attempted influence and control.

Disease Biography

The relationship between microbes and specific diseases and disease processes is perhaps nowhere more evident than a number of biographies of (infectious) disease, many of which trace the development of experimental and theoretical interrogation of the role of microbes. Straddling pre- and post-bacteriological thought, these have demonstrated conclusively that practices, perceptions, and experiences of specific conditions have persisted even long after the so-called "nature" of the disease has been successfully challenged in specialist circles. Whilst these tended originally to adopt something of an organism's eye view, tying disease definitions closely to the identity of the causative organism, increasingly biographical accounts of disease are more detached from the relevant microbes, focusing instead on a sympathetic recreation of disease histories which are in tune with shifting actors' categories. Microbes, though, are far from peripheral in such narratives, and the engagement at the level of disease serves to highlight their significance in accounts of disease experience.

One critical aspect of microbes which this genre of academic study serves to highlight most, perhaps, is the necessity of thinking of an organism as distinct from the disease for which it is responsible. Microbes, to be sure, have social as much as biological properties, yet the diseases to which they lead in higher organisms are themselves much more than the mere presence of a microorganism and the physiological consequence of its incursion into the body.

Microbes in Social, Environmental and Industrial Contexts

As an influential experimental discipline, understanding laboratory practices and clinical consequences associated with bacteriology and, latterly, microbiology, has been a

cornerstone of the history of medicine and science. However, with the advent of social histories of medicine and science, the field has also uncovered a crucial place for microbes within broader society and culture. They functioned as objects of fear and key components in the process of "othering" served to reinforce racial, national, and geographical prejudices, as well as deeply resonant public health messaging. Alan Kraut's exploration of the intersection between threats of germs and the so-called 'immigrant menace' showed how this manifested in a range of national contexts, with common themes clearly visible in a broad range of socio-cultural settings and time periods.

The relative impact of germs according to class, race, gender, and age, has also provided inspiration for a range of studies exploring the so-called "politics" of microbes and their social consequences. This also includes an increasing body of scholarship which, over the past fifteen to twenty years, has highlighted the significance of the interactions between humans and non-human animals, particularly those organisms which serve as vectors for disease transmission. Historical accounts of intra- and cross-species exchange of disease-causing microbes have been framed at the level of both individuals and populations, the latter tending to focus on major outbreaks, epidemics, and pandemics in which microbes are all-too-often implicated.

Alongside the fascination with microbes as agents of disease, historians have been equally attentive to their roles as beneficial agents in a range of industrial contexts. Here, research has revealed a dynamic tension between pathogens and microbes' critical presence within valuable industrial processes. Much of this foundational work has centred on investigations of brewing and fermentation in the nineteenth century, and represents a significant instantiation of the nexus between practical and theoretical dimensions of microbiology, a distinction which historians have steadily eroded. Indeed, the recognition that microbes are a critical feature not just of laboratory configurations or human-microbe

interactions, but of a broader ecology has marked out important recent scholarship, highlighting the origins and continuity of the systematic interrogation of microbe-environment relationships from the late nineteenth century onwards.

In addition to applications within the scientific-industrial complex, historians have also highlighted how the conceptual premises of microbiology have also provided a platform for key interventions across a range of other disciplines, including in early genetic research (exploring heredity and heritability in microbes), evolution, and cellular biology (though investigations of purity and cultures). It is equally important to recognise that microbiology – the successor discipline to bacteriology – has continued to remake the category of "microbe" itself, providing fertile ground for philosophies of microbial action, identity and relations such as those outlined in recent years by O'Malley, Dupré and Sapp.

Vaccination and Resistance

The practical benefits of a more mature field of microbiology – encompassing previously disparate disciplines of bacteriology, virology, and parasitology – have largely been manifest in two ways: through the expansion of mass vaccination programmes, and in the hunt for new classes antibiotics to treat infection. At the heart of these enterprises lies a clear understanding of microbial lifecycles, yet both are inseparable from socio-political considerations such as the democratisation of healthcare, vaccine scepticism, and the now-dominant threat of antimicrobial resistance (AMR). The origins of the antivivisection movements in multiple social contexts are the focus of much work in this area, though there are doubtless many histories of AMR to be written in the coming decades from the perspective of scientific investigation and everyday medical practice through to transnational political and economic regulation and veterinary practices.