

1 One Health in History

Michael Bresalier,* Angela Cassidy and Abigail Woods
Department of History, King's College London, UK

Introduction

The purpose of this chapter is to outline the history of One Health. This task immediately raises the question of how to approach the history of a subject that only became known as 'One Health' a few years ago, and is still evolving conceptually under the influence of health challenges, scientific advances, and political, economic, environmental and professional priorities. While there were many precedents to One Health, they did not go by this term, and they occurred at times when health problems, scientific ideas and the wider world were very different to today. This state of affairs makes it impossible to impose a simple structure on to past events, or to link them, in linear fashion, to present-day One Health.

It is important to highlight this problem because existing histories of One Health usually gloss over it. These accounts are structured around key historical figures and scientific advances, whose contributions to health are used to argue for the importance of pursuing a One Health approach today. The achievements of Rudolf Virchow, Robert Koch, William Osler, John McFadyean, James Steele and Calvin Schwabe are routinely celebrated, along with the health benefits of vaccination, the germ

theory and zoonosis control. While the importance of these individuals and activities cannot be denied, their roles within the history of One Health require more critical consideration. The accounts in which they feature are neither politically neutral nor historically well-grounded and have been assembled not for the purpose of understanding the past but for advancing the case for One Health today. While this strategy may be useful in justifying and winning support for One Health, it has resulted in an extremely partial and selective reading of the past.

Rather than analysing history retrospectively from the perspective of present-day agendas, this chapter adopts a neutral, prospective, evidence-based approach that pays due regard to historical context.¹ Drawing on an extensive body of historical literature and source material, we aim to effect a fundamental shift in the way that the history of One Health is popularly conceived. We take as our subject matter the constellation of ideas, practices and circumstances that brought human and animal health (and to a lesser extent, the environment) into alignment, the people and institutions involved and the reasons for change over time. This chapter will demonstrate that while at certain points in history, particular individuals

*E-mail: michael.bresalier@kcl.ac.uk

made deliberate attempts to rally people and resources in support of an integrated agenda, there were often many people already working along these lines, in accordance with established scientific ideas and practices.

This account makes no claim to completeness, in part, due to space constraints. Only a brief summary is offered of very recent events as these are well described elsewhere (Lebouef, 2011; Cassidy, 2014). It also reflects the fact that many aspects of One Health history have yet to be subjected to the sort of systematic, contextualized analysis needed to make sense of individual observations. Amongst the neglected areas is the history of One Health in non-western contexts. Owing to the fragmentary state of this field, this chapter focuses overwhelmingly on western medical and veterinary traditions. However, it does acknowledge the importance of cross-cultural exchanges, which were often facilitated by international health organizations concerned with human and animal disease control.

The first section analyses intersections between human and animal health in the pre-modern era. It will reveal how deeply animals and animal health were embedded within human medicine and the importance of the environment to health ideas and practices. The second section extends from the late 18th-century foundation of the veterinary profession until the turn of the 20th century. It tracks the evolving relationship between the veterinary and medical professions, and how, as scientific ideas and practices changed, new links were forged between humans, animals and the environment. The third section extends this analysis into the 20th century, focusing particularly on the changing status of animals within medical research, and on international efforts to develop comparative medicine and veterinary public health. The conclusion reflects on the importance of these findings for history, and for One Health today.

Pre-Modern Connections

Looking back on the pre-modern era, commentators often highlight the existence of a fundamental, well-entrenched distinction between

humans and animals, which derived from the Christian belief that only humans had souls (Hardy, 2003). In fact, this divide has been overstated, for the perceived boundaries between humans and animals were often blurred and unstable (Fudge, 2000). In health and medicine there existed historically three key points of intersection: (i) animals were used to work out the anatomy and physiology of human bodies; (ii) they were studied in comparison to humans in order to work out the relations between them; and (iii) the theory and practice of animal medicine attracted the attention of human doctors, usually as an end in itself, but occasionally as a basis for comparison with human medicine. Aspects of these connections can be identified in very ancient civilizations (Gordon and Schwabe, 2004). However, as all three featured in Ancient Greek thought, which exerted a powerful influence in the west until the 17th century, this will form the starting point of our survey.

Around one-quarter of the surviving works produced by the Greek philosopher Aristotle in the 4th century BC are devoted to animals, most importantly *History of Animals*, *Parts of Animals* and *Generation of Animals*. While Aristotle distinguished humans from animals through their possession of a rational soul, he also sought to relate them, by documenting differences and similarities in the form, function and purpose of their parts and drew up a taxonomic system. The numerous dissections he conducted in the course of this work illustrated the possibility of learning about humans from animals (Clutton-Brock, 1995). Taboos on the use of human bodies led the famous Greek doctor, Galen, working in 2nd-century Rome, to follow Aristotle's lead. In an extensive and influential body of writing, he documented the results of his numerous observations and experiments on animals. The errors he made in extrapolating from animal to human anatomy were not discovered until Andreas Vesalius (1514–1564) revived human dissection at Padua University in the 16th century (Guerrini, 2003).

Vesalius, and several of his contemporaries and successors, also vivisected animals in their attempts to work out the differences between living and dead bodies and to describe and explain how body parts functioned

(Shotwell, 2013). Vivisection was problematic: debates surrounded the value of knowledge drawn from animals and the suffering involved (Guerrini, 2003). Nevertheless, it enabled Realdo Columbo (1516–1559) and Fabricius (1537–1619) to identify the pulmonary transit of the blood and the function of the venous valves, respectively. After studying under Fabricius, William Harvey took up an Aristotelian programme of research on animals that resulted in his novel and, at the time, controversial proposal that the blood circulated. Meanwhile, as part of the wider investigation of nature, medical doctors followed Aristotle in dissecting dead animals, for example at the elite Paris Academy Royale des Sciences during the 1660s and 1670s. This activity, described as ‘comparative anatomy’, drew on animals derived from colonial conquests that were contained within European leaders’ menageries (Cunningham, 2010).

The health of humans and animals were defined by the same medical theory: humoralism. This awarded a significant role to the environment in maintaining, disturbing and restoring health status. Drawing on the ideas of Hippocrates and Galen, humoralism formed the dominant system of medical thought until the 18th century. It held that all bodies were composed of four humours, influenced by factors such as feeding, climate, ventilation, exercise and sexual behaviour. Disease of individual bodies resulted from an imbalance between the humours (Curth, 2002). In addition, the rise and fall of epidemics was attributed to changes in the wider environment, as described by the Hippocratic text, *Airs, Waters, Places* (Wilkinson, 1992; Nutton, 2004). These theories implied that similar interventions, such as bleeding, purging, lifestyle changes and improvements in air quality could restore or maintain the humoral balance in both human and animal bodies. Formally trained healers usually focused on one or the other. Physicians, surgeons and apothecaries treated humans, while animals received dedicated attention from medieval veterinarians at the Mamluk courts and from British farriers, French marechals, Spanish beitaras and their equivalents in other countries (Conrad *et al.*, 1995; Shehada, 2012). However, such healers were expensive and

few in number. Consequently, most humans and animals relied on self-help, clergymen, gentry and the various self-styled healers that made up the ‘medical marketplace’. Here, the division between species was less well defined (Curth, 2002).

The 17th and 18th century movement away from ancient Greek thought brought humans and animals into even greater proximity. The new experimental philosophy of nature, and Rene Descartes’ (1596–1650) conception of animals as ‘automata’ (self-operating machines), resulted in the more extensive use of animal vivisection in medical research and teaching (Guerrini, 2003). For example, Swiss physiologist Albrecht von Haller (1708–1777) used live animals to work out human neurological functions (Eichberg, 2009). At Leiden in the Netherlands, and later in Edinburgh, Scotland, anatomy lecturers vivisected dogs and dissected humans simultaneously, in order to demonstrate to students the structure and the function of body parts (Guerrini, 2006). A new scheme of classifying animals, drawn up by Swedish naturalist Carolus Linnaeus (1707–1778), placed humans, apes, monkeys and bats within the same order of primates and brought humans and orang-utans together in the genus *Homo*, thereby challenging notions of a human–animal divide (Ritvo, 1995). Subsequently, in Paris, additional classification schemes were drawn up using dissected animals from the Versailles menagerie. Here, the key figures were George Buffon (1739–1788), the medically trained comparative anatomist, Louis Daubenton (1716–1799) and Georges Cuvier (1769–1832) (Cunningham, 2010).

One of Daubenton’s pupils, the physician Vicq d’Azyr (1749–1794), went beyond comparative anatomy to develop a truly comparative form of medicine. His initial concern was cattle plague or rinderpest. This disease was prevalent throughout Europe in the 18th century. It inspired much medical comment and attempts to control it by quarantine, modelled on responses to bubonic plague in humans (Wilkinson, 1992). After reporting upon this disease to the French government, d’Azyr was made secretary to a Royal Commission of Enquiry into epidemics and epizootics and steered its 1778 evolution into the Société Royale de Médecine. His investigations

demonstrate the continuing importance of the environment in thinking about human and animal health and disease. Drawing on medical meteorology and topology, D'Azyr correlated human and animal epidemics with climatic and geographical conditions. D'Azyr also performed animal experiments. He believed that by understanding the functioning of organs in health, it was possible to make sense of their dysfunction in disease (Hannaway, 1994). Perceiving no dividing line between human and animal medicine, he argued that 'considerations on the diseases which attack man are applicable without any exception to those which attack animals. Medicine is one: and its general principles, once set out, are very easy to apply to different circumstances and species' (Hannaway, 1977).

A similar stance was adopted by a number of British surgeons, who became actively involved in equine health care during the second half of the 18th century. Arguing that 'physic' (conventional medicine) was the same whether practised on humans or horses, they wrote manuals of farriery and established infirmaries for the treatment of horses and tuition of pupils. For them, farriery was part of natural history or comparative anatomy. It was therefore a polite practice, suitable for a gentleman (MacKay, 2009). Comparative anatomy was consolidated as a medical practice by the surgeon John Hunter (1728–1793). He established his own menagerie and spent hours each day dissecting and experimenting upon animals. He incorporated their bodies into his museum, which numbered over 500 species with 13,000 specimens at his death in 1793 (Chaplin, 2008). Hunter's influence on the field of surgery and its growing profile kept animals at the forefront of medical research in subsequent years (Lawrence, 1996). It was one of his pupils, Edward Jenner, who showed in 1796 that cowpox inoculation could protect humans from smallpox (Fisher, 1991).

Enter the Vets

The connections outlined above reveal that in many ways, pre-modern medicine really was 'one'. So how did the creation of the veterinary

profession impact this situation? The first schools were established in Lyons (1762) and Alfort (1777). By 1791, they existed throughout much of Europe: in Dresden, Freiburg, Karlsruhe, Berlin and Munich in Germany; Turin, Padua and Parma in Italy; as well as Vienna, Budapest, Copenhagen, Sweden and London (Cotchin, 1990). Historical accounts often portray their creation as a significant break with the past, which led to a new enlightened approach to animal healing (Schwabe, 1978, 1984, 2004; Wilkinson, 1992). However, this interpretation is deeply flawed, for as shown above, animal bodies and their treatment in health and disease had already attracted substantial attention from medical doctors.

It is perhaps more accurate to view the veterinary schools as an expression of pre-existing medical interest in animals, because although circumstances varied from school to school, doctors often played important roles in driving and shaping veterinary education. The doctors' commitment to studying the health and medicine of animals is shown by the fact that they did not automatically cede this field to the new veterinary profession. Rather, as shown below, they intensified their investigations during the first half of the 19th century and drew on vets as collaborators. Therefore, although in time the connections between human and animal health lessened, this was not an immediate or inevitable consequence of the veterinary profession's formation.

In the 1780s, against the wishes of founder Claude Bourgelat, the physician Vicq d'Azyr refashioned the Alfort veterinary school into a research institution and assumed the chair of comparative anatomy. Teaching was extended to human fracture care and midwifery to enable vets to offer an extended service to rural communities. For political reasons, these changes were reversed in 1788 (Hannaway, 1977, 1994). However, from the 1790s, a number of Alfort veterinary and medical staff, including Francois Magendie in the 1820s, engaged in the systematic vivisection of horses, making this one of the first contexts for the development of experimental physiology in France (Elliott, 1987). The subsequent expansion of this field within Germany, France and,

later in the century, Britain, in the face of anti-vivisectionist opposition, considerably enhanced the use of animals as experimental tools within medicine (Bynum, 1994). For proponent Claude Bernard these uses were entirely justified, for 'to learn how man and animals live, we cannot avoid seeing great numbers of them die' (Bernard, 1957).

In London, surgeons and, less commonly, physicians acted as governors for the Veterinary College (est. 1791), ran examinations for students and were well represented on the student body: 130 surgeons had qualified as veterinarians by 1830. Edward Coleman, principal of the college from 1796 to 1839, was also a surgeon, appointed on the strength of his research on animals and ability to teach learned farriery. He modelled veterinary education on that of human surgery. Veterinary students were encouraged to attend lectures in the London medical schools, while medical students had the opportunity to attend lectures on veterinary topics. However, little research was undertaken at the college. This drew criticism from the medical press, which campaigned with disaffected vets for the reform of the school. In 1844, vets replaced doctors in the control of student examinations. Concurrently, reforms in medical education restricted the courses on offer. These shifts enhanced the institutional separation of the professions.

However, as shown by the many reports on animal health issues that appeared in the medical press, doctors retained their interest in this topic to the extent that veterinary surgeons sometimes accused them of stealing their patients. Doctors also conducted numerous investigations into animal disease pathology and epidemiology. Their infrequent use of the term 'comparative' to describe such investigations suggests that they regarded them as part of mainstream medicine. Their aims were to document animal diseases, to describe their analogies with human diseases and to learn about the nature of disease in general. These investigations featured a remarkable and formerly unrecognized degree of collaboration between doctors and veterinary surgeons. Vets drew doctors' attention to interesting cases and outbreaks, facilitated their access to live animals and dead bodies

and offered personal insights based on clinical experience. Less frequently, doctors assisted vets in their animal disease investigations. Grass-roots collaboration between the professions was therefore important to the development of mid-19th-century understandings of human and animal disease.

Medical interest in animals was promoted further by two key scientific developments. First, investigations during the 1830s suggested that glanders in horses, rabies in dogs and anthrax in animals were causally connected to the equivalent diseases in humans (Wilkinson, 1992). Second, there emerged a Romantic or philosophical form of comparative anatomy, which suggested that humans and animals were formed on the same general plan. In their efforts to comprehend this plan, doctors compared the anatomy and pathology of the bodies and embryos of multiple animal species (Jacyna, 1984; Hopwood, 2009). Humans and animals were thereby brought together in ways that are usually attributed to Darwinism and the germ theory, 30 years later. This finding reveals that contrary to popular belief, the latter events did not spell a complete break with the past. Rather, they formed part of an ongoing process of making and remaking links between human and animal bodies and diseases.

Veterinary education emerged later in North America than in Europe. While some of the earliest qualified vets were European émigrés, physicians were also extremely active. In the period 1820–1870 they investigated and reported on livestock diseases, campaigned for veterinary education and established and taught at early veterinary schools that were mostly short-lived (Smithcors, 1959). In 1863, Scottish vet Duncan McEachran founded the Montreal Veterinary College. Believing that veterinary medicine was a branch of human medicine, he modelled teaching on that of the McGill medical school. One of his best known collaborators was William Osler, a former student of Virchow's and lecturer in medicine at McGill, 1874–1884. Osler taught veterinary students, undertook research (mostly unpublished) into the diseases of animals and asserted the value of comparative medicine to medical audiences. Although today

he is often heralded as a figurehead of One Health, he was not unusual at the time. His predecessors and successors at McGill also taught veterinary students, and several, such as J.G. Adami, produced more extensive and significant research in comparative medicine (Teigen, 1984, 1988).

The late-19th century saw a number of important developments within science and medicine that had mixed implications for the history of One Health (Wilkinson, 1992; Hardy, 2002). The 1859 publication of Darwin's *Origin of the Species* claimed that all living organisms descended by evolution from a common ancestor. It inspired some doctors to trace the evolutionary history of disease by examining its manifestations in different animal species. The most famous participant was Eli Metchnikoff, whose Nobel prize-winning theory of phagocytosis was inspired by evolutionary thinking (Tauber, 1994).

The 1860s and 1870s saw the development of the notion that diseases were caused by germs. In Britain, the acceptance of this theory was precipitated by the devastating 1865–1867 epidemic of cattle plague, whose pathology and epidemiology was subjected to scientific investigation by medical doctors (Worboys, 1991). Elsewhere, seminal insights into germs derived from studying the nature, prevention and spread of animal diseases. In France, Louis Pasteur produced vaccines against chicken cholera, anthrax and rabies. His German counterpart, Robert Koch, investigated anthrax and tuberculosis, as well as tropical animal diseases, which inspired his concept of the carrier state.

Vets made important contributions to all these investigations, which used a myriad of animals for the purposes of research, diagnosis and the production of vaccines and sera (Bynum, 1990; Wilkinson, 1992; Gradmann, 2009, 2010). Existing aetiological connections between human and animal diseases were re-defined in terms of germs. A new category of diseases, the zoonoses, emerged to incorporate these and parasitic diseases like trichinellosis, whose life cycle and spread via the meat trade were worked out from the mid-1850s to 1870s by Virchow, amongst others. They formed the focus of a new field of veterinary public health (VPH).

However, while in some ways, germ theory served to promote One Health approaches, in other ways it undermined them. Up to this point in time, the environment had played a central role in explaining patterns of health and disease. However, it was marginalized by germ theories that explained disease in much narrower terms, as the straightforward product of infectious agents invading susceptible bodies (Worboys, 2000). While the appearance of VPH led many individuals, particularly veterinary surgeons, to advocate closer veterinary-medical relations, in practice, collaborative working patterns became more competitive as the two professions battled for control over research and policy (Waddington, 2006; Woods, 2014).

Medical and veterinary perspectives on zoonoses often differed because doctors prioritized human health and vets prioritized the health of animals and agriculture. In 1901, Robert Koch famously reversed his earlier opinion that human and bovine tuberculosis were not alike, adding to a climate of uncertainty about the nature, extent and even existence of transmission pathways. Doctors and vets clashed over the health threats posed by meat and milk, the regulation of these foodstuffs and how to define a healthy animal. The stakes were raised by western governments' growing assumption of responsibility for health and their increasing reliance on experts. Veterinary and medical disciplinary differences were given structural and political expression by their employment in separate government departments. Doctors generally had the upper hand, because their profession possessed a higher status and had forged a public role years before the creation of state veterinary services. Throughout Europe and North America, dissatisfied vets organized and lobbied for state recognition and legal protection.² They gained some ground towards the end of the century, in inspecting meat at slaughterhouses and regulating the supply of clean milk. However, the nature and extent of these roles varied considerably between and within nations (Schmaltz, 1936; Koolmees, 2000; Hardy, 2002; Jones, 2003; Orland, 2003; Brantz, 2005; Waddington, 2006; Berdah, 2014).

Animals and Humans in 20th-Century Medicine

The 20th century was characterized by considerable ambiguity in the perceived relations between humans and animals in health and disease. This was particularly apparent in the status of animals within medical research, which underwent an important epistemological shift around the turn of the 20th century. Earlier, scientists had drawn on a diversity of species, including but not confined to earthworms, horses, birds, frogs, pets, zoo animals, horses, livestock and fish. They were usually familiar with these animals, having encountered them in farming, field sports, natural historical pursuits, zoos, and urban streets populated with horse-drawn transport, stray dogs and livestock for sale and slaughter (Kete, 2007). The sheer ubiquity of animals made it easy to acquire them for experiment in life, and dissection after death. The resulting research was truly comparative. It sought to build general truths through examination of similarities and differences between animals. Acknowledging, with a nod to evolution, that species' differences were to be expected, researchers did not assume that a finding was true of all animals until they had demonstrated it in a host of different species (Logan, 2002).

Subsequently, however, scientists moved away from demonstrating generality to presuming its existence. Animal diversity became a confounding factor rather than a research strength. It can be no coincidence that as towns grew larger, as animals disappeared from the streets and urban upbringings became the norm, scientists began to restrict their gaze to a handful of animal species that could be kept within the laboratory. Paralleling the rise of standardization and mass production within industry, scientists entered into the mass production of standardized laboratory animals whose features could be quantified or mechanically assessed. By the interwar period, with diversity reduced further through standardized husbandry and environments, these animals formed the mainstay of scientific work on cancer, genetics and drug standardization. Their uses

continued to expand throughout the second half of the century. By then, however, biomedical scientists were no longer engaging with them as animals, but as functional equivalents or 'models' of the human body whose scientific legitimacy was underpinned by the theory of evolution (Clause, 1993; Logan, 2002; Löwy, 2003; Rader, 2004; Kirk, 2008).

One interesting inversion of this state of affairs occurred in the context of veterinary medicine in the late 20th century. The increasing importance of human relationships with pets, and owners' greater willingness to invest financially in this relationship, resulted in the growing veterinary use of insulin treatment, orthopaedic surgery and transplant surgery. Originally these technologies were trialled on animal models before entering human medical practice. Now, their use in animal patients was informed by clinical trials and experiences in humans, who effectively became the models (Degeling, 2009; Gardiner, 2009; Schlich *et al.*, 2009).

The increasing use of standardized animals within medical research caused some vets in Europe and North America to carve out a new role in caring for them. In the light of continuing public concerns about animal experimentation, they guided medical scientists on how to maximize experimental outcomes while minimizing animal welfare costs (Kirk, 2009). Such work was reminiscent of how vets had facilitated medical research on animal diseases during the mid-19th century, but the science, the setting and the animals were now very different. However, not all vets embraced the changing status of the laboratory animal. Starting in the 1920s, some voiced criticisms of animal models and called instead for the study of spontaneous disease events in zoo, farm, wild and pet animals (Allbutt, 1924). They argued, as in the 19th century, that diversity was important to the creation of scientific knowledge, and they perceived disease problems in different species as analogous rather than identical. They referred to this form of investigation as 'comparative medicine' (although confusingly, the use of this term today applies to the care of laboratory animal models as well).

Interwar comparative medicine advocates included O. Charnock Bradley (1871–1937),

Principal of the Royal (Dick) Veterinary College, Edinburgh, and T.W.M. Cameron, professor and director of parasitology at McGill University (Bradley, 1927; Cameron, 1938a,b). Investigation of comparative medicine gathered momentum in the decades after the Second World War. Meetings at the New York Academy of Medicine, University of Michigan, Rockefeller Foundation, University of Pennsylvania and the London Zoological Society aimed to demonstrate its practical value and to debate its incorporation within medical, veterinary and graduate school curricula (Jones, 1959). In 1958, a joint Washington meeting of medical and veterinary experts attached to the World Health Organization (WHO) and the Pan-American Sanitary Bureau (PASB) proposed the creation of a new programme in comparative medicine, with the aim of expanding the kinds of animals and animal diseases used in basic medical research (WHO, 1958a; WHO, Chronicle, 1961). W.I.B. Beveridge, director of the Institute of Animal Pathology at Cambridge University, was the lead consultant (Beveridge, 1969). Initially concentrating on cardiovascular disease and cancer, the official task of this programme expanded in the early 1960s to include comparative virology, neuropathology and mycoplasmaology, as well as work on the welfare of primates in medical research centres (Kaplan, 1961; Cotchin, 1962).

From the 1920s onwards, advocates of this form of enquiry adopted an almost identical refrain. They argued that comparative medicine could tackle a wider range of diseases than could be experimentally induced and would produce fundamental insights common to all species. Although it required knowledge of species' similarities and differences, veterinary surgeons already possessed such insights. Moreover, the approach would help to bridge professional, epistemological and practical divisions between veterinary and human medicine (Bradley, 1927; Cameron, 1938a,b; Beveridge, 1972). Renewed calls for unifying veterinary and human medicine were made within this context, on the assumption that these were the two strands of 'one' medicine.

Today, the coining of the term 'One Medicine' is usually attributed to Calvin Schwabe, a vigorous proponent of comparative medicine,

who employed the term frequently in the third edition of his volume *Veterinary Medicine and Human Health* (1984). However, it was used on many earlier occasions to illustrate the nature and value of comparative medicine (Bradley, 1927, p. 129; Shope, 1959; Beveridge, 1969). During the mid-20th century, it was particularly associated with authors from the University of Pennsylvania veterinary school (Schmidt, 1962; Allam, 1966; Cass, 1973) and the University of Minnesota.³ It is likely that Schwabe adopted the term 'One Medicine' from mid-20th century currents of thinking within comparative medicine.

By the 1970s the results of comparative medical research into chronic human disease were still rather uneven. It seems that the skills required for conducting this research were rather difficult to obtain and that few scientists were convinced by its claimed superiority over other methods or by broader visions of 'One Medicine'. The failure to advance comparative medicine was indicative of the growing differences between the professions in their research orientation and in the status they awarded to animals. Such differences were consolidated by 20th-century research and development infrastructures, which allocated human and animal health to different funding streams, research institutions and international organizations.

Yet at the same time, certain individuals, working in specific settings on particular disease problems, brought human and animal health into closer alignment. One key institution was the Rockefeller Foundation, which made the study of animal pathology central to many of its medical, scientific and public health programmes (Corner, 1964). Theobald Smith, the first director of its Department of Animal Pathology at Princeton (established in 1915), had made his name at the Bureau of Animal Industry, where he applied a comparative, ecological approach to the study of Texas fever (Méthot, 2012). Both he and his successor, Richard E. Shope, who discovered the influenza virus of pigs and proposed its role in human influenza, were medically trained, yet they saw animal pathology as the necessary foundation of *all* medicine (Shope, 1959). One particularly productive line of work, begun by Peyton Rous on chickens and

continued later on rabbits in collaboration with Shope, was the role of viruses in cancer causation (Rous, 1910; Shope, 1933). Elsewhere in the USA, the University of Pennsylvania, the Mayo Clinic at the University of Minnesota (incorporated in 1915) and the Hooper Foundation for Medical Research at the University of California (established in 1913), were among a cluster of institutions that supported medical-veterinary interactions in research and post-graduate education (Steele, 1991). In France and Germany, the Pasteur and Koch institutes remained committed to a comparative approach, as did other medical research centres in Europe (Gradmann, 2010). In Britain, the Medical Research Council established a programme of research into dog distemper, which helped scientists to discover the human influenza virus in 1933 (Bresalier and Worboys, 2014).

Twentieth-century relations between health and the role of the environment in ideas of human and animal health also varied by time. As noted above, the acceptance of germs as causal agents diverted attention away from the environmental factors that influenced the emergence, spread and clinical impacts of disease. This shift was accentuated by development of vaccines and antibiotics. These were so successful in the West that, despite a few opposing voices, by the 1960s and 1970s it was widely believed the conquest of infectious disease was in sight. From the 1980s, this optimism was dashed by the emergence and re-emergence of infectious diseases like AIDS, Ebola and BSE, which reinforced the connections between the health of humans, animals and the environment (Anderson, 2004). A different disease trajectory occurred in certain colonial and post-colonial settings where infectious diseases remained a problem and the role of the environment could not be ignored. Investigations were approached in a more ecological fashion, as seen in the study of trypanosomiasis during the first half of the century. A highly ecological set of investigations resulted which drew on entomology, medicine, veterinary medicine and agricultural science to generate a dynamic picture of the disease (Tilley, 2011).

The integration of human and animal health within colonial and post-colonial settings

was further driven by the elevation of development as an economic and political priority (Staples, 2006). In 1948, as part of an international drive to improve human health through disease control and better nutrition, the WHO set up a Veterinary Public Health (VPH) unit within its Division of Communicable Diseases (WHO, 1958b). Headed by the American Martin Kaplan, who had degrees in veterinary medicine and public health, it developed close relations with the Food and Agriculture Organization (FAO), other UN agencies and the World Organisation for Animal Health (OIE) (Kaplan, 1953). A series of joint WHO/FAO meetings in the 1950s led to collaborative programmes on zoonoses, meat hygiene and veterinary education. It also brought a working definition of VPH as comprising 'all the community efforts influencing and influenced by the veterinary medical arts and sciences applied to the prevention of diseases, protection of life and promotion of the well-being and efficiency of man' (WHO/FAO, 1951).

In framing animal health as a crucial problem of human health and development, the FAO and WHO positioned veterinarians, trained and working within public health, as vital to realizing these goals. However, most countries lacked such personnel (WHO/FAO, 1956), therefore establishing new education and training programmes became a key focus. Through the 1950s and 1960s, WHO and FAO acted to support and fund veterinary and VPH education in the developing world (WHO/FAO, 1975). These activities relied on expertise drawn from the USA, which led the post-war development of VPH at national, state and local levels, as well as internationally through the Pan-American Health Bureau (PAHB). The leading figure in these initiatives was James H. Steele (Steele, 2008). Trained in both veterinary medicine and public health, he was a prodigy of the Swiss-American veterinary pathologist Karl F. Meyer, himself a vocal proponent of the integration of human and animal medicine. It was Meyer who established the Hooper Foundation as a world-leading research centre on zoonoses and food safety.

As is evident from the above, post-colonial and international health contexts were very important in shaping the careers

and ideas of many of the key figures who aligned themselves with a 'One Medicine' agenda. Their work within developing countries also enabled them to engage in cross-cultural encounters and exchanges with pastoral and agricultural peoples, which informed their thinking about the relationship between human and animal health, disease and medicine (Kaplan, 1966; Green, 1998; Beinart and Brown, 2013). The influence of these experiences and contexts can, for example, be detected in Calvin Schwabe's frequently cited work, *Veterinary Medicine and Human Health* (Schwabe 1964, 1969, 1984). More generally, this history indicates that many of the roots of present-day One Health lie in earlier currents of veterinary thought and practice that were deeply entangled with projects of development, international health, aid and post-colonial reconstruction.

Conclusion: From One Medicine to One Health

In analysing the changing relations between the health of humans, animals and the environment, this chapter has demonstrated the many and varied links between them. Human medicine, in particular, has a rich history of engagement with animals, their diseases and the people and institutions dedicated to animal health. Correspondingly, since the late 18th-century creation of their profession, vets have supported, collaborated and sometimes competed with this medical programme. These interconnections can be explained, in part, by reference to prevailing scientific ideas, practices and disease problems, but they can only be fully understood by examining the people involved, their institutional settings and the wider professional, political, economic and environmental contexts. The historical specificity of these factors, as well as the variability of the health activities they influenced, make it impossible to construct a simple, linear narrative linking past to present. Nor is it possible to draw direct lessons from history, or to claim – as do many existing histories – that the work of certain historical figures demonstrates the importance of pursuing One Health today.

This does not mean, however, that the past is completely irrelevant to the present. One key finding to emerge from this account is that while they varied over time and place, the historical links between the health of humans, animals and the environment were multiple and profound. Embedded within scientific concepts and practices, they shaped the way in which doctors and vets approached the problem of disease. For the most part, these individuals did not feel the need to articulate their activities, self-consciously, within a 'veterinary public health', 'comparative medicine' or 'One Medicine' agenda. These terms were only adopted at certain historical junctures by advocates who aimed to validate or win wider support for operationalizing their activities. Pushing beyond these labels and the rhetoric that surrounded them, and looking at what individuals on the ground were actually thinking and doing, reveals that integrated approaches to health were much more widespread and more significant than previously realized. It is no understatement to say that health and medicine today are heavily shaped and underpinned by the many precursors to One Health.

One Health itself, as a self-consciously labelled set of activities and agendas, has emerged very recently out of a complex and rapidly shifting coalition of international health bodies, veterinary associations, academic advocates, environmental organizations and pharmaceutical companies. While its history has been fully explored elsewhere (e.g. Lebouf, 2011; Chien, 2013; Cassidy, 2014), this chapter concludes by sketching out the broad contours of these developments in order to put the rest of this volume into context. During the 2000s, elements of the ongoing traditions of comparative medicine and VPH came together into a rearticulated vision of 'One Medicine, One Health'. This involved the alliance or convergence of veterinary and human medical research and/or clinical practice, including collaborative research, and shared clinics, vaccination strategies, equipment and drug development (e.g. King *et al.*, 2008).

In parallel, a different (albeit overlapping) set of actors and agendas came together around the term 'One World, One Health™' (OWOH). In contrast to the veterinary-medical focus of One Medicine, OWOH tended to address

a broader range of disciplines across the life and environmental sciences while maintaining a relatively tight focus on issues such as zoonotic diseases. The idea of 'One World' (OW) has its origins in mid-20th-century debates about international relations and the formation of UNESCO (Sluga, 2010). It was taken up by health actors during the 1990s, when the global scale and potential wildlife origins of the HIV/AIDS pandemic were recognized (Whiteside, 1996; King, 2004), alongside the emergence and re-emergence of many other infectious diseases (Anderson, 2004). In 2004, the first of a series of meetings between human public health, conservation and infectious disease experts was organized by the US-based Wildlife Conservation Society on the theme of OWOH. The idea then found strong purchase in international responses to the outbreak of highly pathogenic avian influenza (HPAI), and was adopted by WHO, FAO, OIE and others in a shared statement of cooperative intent (FAO *et al.*, 2008) following the HPAI crisis (Scoones and Forster, 2008). These disease events, alongside reconfigurations of the organizations which deal with them, have contributed to a renewed awareness of the environmental causes of disease. This has taken on new forms, combining with late-20th-century understandings of 'the environment', to be rearticulated in (for example) arguments for understanding and preserving 'ecosystem health' (Zinsstag *et al.*, 2012).

Over this decade the 'One Medicine' and 'One World' agendas have become more and more intertwined, increasingly sharing the broader, snappier and more widely used banner of One Health (e.g. Zinsstag *et al.*, 2005; FAO *et al.*, 2010). The recent adoption of the language of One Health by key organizations across the worlds of veterinary and human medicine, international health, national governments and research funding bodies,

represents the integration of these various agendas. Advocates based particularly in the USA and Switzerland have organized workshops, conferences, reports, websites and journal publications to promote it. As an organizing concept, it has proved flexible enough to encompass very different languages, ideas and working practices, yet coherent enough to enable communication across disciplinary and organizational divides (Lebouef, 2011; Chien, 2013). However, questions remain about the long-term viability and practical utility of One Health (Lee and Brumme, 2013; Cassidy, 2014), as well as how it can engage productively with questions of colonial and post-colonial legacies, power, and ongoing tensions between local and 'global' approaches to health (Scoones and Forster, 2008; Bonfoh *et al.*, 2011; Beinart and Brown, 2013; Green, 2012).

Like its predecessors, the rise of One Health cannot be explained solely by advocacy, internal scientific logic, or as the natural and inevitable outcome of long-standing efforts to bring humans, animals and the environment closer together. A product of 21st-century concerns, it forms part of a wider cluster of research and policy agendas, including 'food security', 'biosecurity', 'global health' and 'translational medicine', which also aim to break down barriers between disciplines. Rather than competing for resources or legitimacy, arguments for these agendas tend to be mutually reinforcing. Jointly, they could be described as part of a collective response to a (re)emerging set of highly complex concerns which extend across traditional disciplinary boundaries – over environmental damage, scarce resources, food availability and disease/health (Rushton, 2011; Cassidy, 2014). This is the arena in which the future of One Health will be forged. However, in looking ahead, we must also remember to look back, in order to understand how today's rapidly changing situation has been shaped by its past.

Notes

¹ For another balanced historical perspective on this topic, see Kirk and Worboys (2011).

² Numerous papers on this topic were delivered to the 2012 Congress of the World Association for the History of Veterinary Medicine. For a summary see Woods (2012).

³ Today Pennsylvania Vet School has its own trademarked slogan, 'Many Species, One Medicine'TM, attributed broadly to another 19th-century 'founding father', Benjamin Rush MD (Hendricks *et al.*, 2009).

References

- Allam, M.W. (1966) The M.D. and the V.M.D. *Pennsylvania Medicine* 69(8), 57–60.
- Allbutt, C. (1924) The integration of medicine. *Proceedings of the Royal Society of Medicine* (Section of Comparative Medicine) 17, 1–3.
- Anderson, W. (2004) Natural histories of infectious disease: ecological vision in 20th century biomedical science. *Osiris* 19, 39–61.
- Beinart, W. and Brown, K. (2013) *African Local Knowledge and Livestock Health: Diseases and Treatments in South Africa*. Boydell & Brewer Ltd, Woodbridge, UK.
- Berdah, D. (2014) Meat, public health and veterinary expertise: eating beef from tuberculous bovines in France, late 19th century (in preparation).
- Bernard, C. (1957) *An Introduction to the Study of Experimental Medicine* (English translation of 1865 text). Courier Dover Publications, 1957.
- Beveridge, W.I.B. (1969) Comparative medicine in theory and practice. *WHO Chronicle* 23(12), 547–553.
- Beveridge, W.I.B. (1972) *Frontiers in Comparative Medicine*. Oxford University Press, London.
- Bonfoh, B., Raso, G., Koné, I., Dao, D., Girardin, O., Cissé, G., Zinsstag, J., Utzinger, J. and Tanner, M. (2011) Research in a war zone. *Nature* 474(7353), 569–571.
- Bradley, O.C. (1927) What is Comparative Medicine? *Proceedings of the Royal Society of Medicine* 21(1), 129–134.
- Brantz, D. (2005) Animal bodies, human health, and the reform of slaughterhouses in 19th century Berlin. *Food and History* 3, 193–215.
- Bresalier, M. and Worboys, M. (2014) ‘Saving the lives of our dogs’: the development of canine distemper vaccine in interwar Britain. *British Journal for the History of Science* 47(173 Pt 2), 305–334.
- Bynum, W. (1990) ‘C’est un malade’: animal models and concepts of human diseases. *Journal of the History of Medicine* 45, 397–413.
- Bynum, W. (1994) *Science and the Practice of Medicine in the 19th Century*. Cambridge University Press, Cambridge.
- Cameron, T.W.M. (1938a) Veterinarians and medicine. *Canadian Journal of Comparative Medicine* 2, 119–120.
- Cameron, T.W.M. (1938b) Diseases common to animals and man. *Canadian Journal of Comparative Medicine* 2, 121–128.
- Cass, J. (1973) One Medicine - human and veterinary. *Perspectives in Biology and Medicine* 16(3), 418–426.
- Cassidy, A. (2014) One Medicine? Cross-disciplinary advocacy for animal and human health (in preparation).
- Chaplin, S. (2008) Nature dissected, or dissection naturalized? The case of John Hunter’s museum. *Museum and Society* 6, 135–151.
- Chien, Y.-J. (2013) How did international agencies perceive the avian influenza problem? The adoption and manufacture of the ‘One World, One Health’ framework. *Sociology of Health & Illness* 35(2), 213–226.
- Clause, B. (1993) The Wistar rat as a right choice: establishing mammalian standards and the ideal of a standardized mammal. *Journal of the History of Biology* 26, 329–349.
- Clutton-Brock, J. (1995) Aristotle, the scale of nature, and modern attitudes to animals. *Social Research* 62, 421–440.
- Conrad, L., Neve, M., Nutton, V., Porter, R. and Wear, A. (1995) *The Western Medical Tradition, 800BC to AD1800*. Cambridge University Press, Cambridge.
- Corner, G.W. (1964) *The Rockefeller Institute: Origins and Growth, 1901–1953*. Rockefeller Institute Press, New York.
- Cotchin, E. (1962) The problems of comparative oncology. *Bulletin of the World Health Organisation* 26, 633–648.
- Cotchin, E. (1990) *The Royal Veterinary College London: A Bicentenary History*. Barracuda, Buckingham, UK.
- Cunningham, A. (2010) *The Anatomist Anatomis’d: An Experimental Discipline in Enlightenment Europe*. Ashgate, Farnham, UK.
- Curth, L. (2002) The care of the brute beast: animals and the 17th century marketplace. *Social History of Medicine* 15, 375–392.
- Degeling, C. (2009) Negotiating value. Comparing human and animal fracture care in industrial societies. *Science, Technology and Human Values* 34, 77–101.
- Eichberg, S. (2009) Constituting the human via the animal in eighteenth-century experimental neurophysiology: Albrecht von Haller’s sensibility trials’. *Medizinhistorisches Journal* 44(3–4), 274–295.

- Elliott, P. (1987) Vivisection and the emergence of experimental physiology in 19th century France. In: Rupke, N. (ed.) *Vivisection in Historical Perspective*. Croom Helm, London.
- FAO, OIE, WHO, UN System Influenza Coordination, World Bank & UNICEF (2008) Contributing to One World, One Health: A Strategic Framework for Reducing Risks of Infectious Diseases at the Animal-Human-Ecosystems Interface. Available at: <http://www.fao.org/docrep/011/aj137e/aj137e00.htm> (accessed 18 July 2014).
- FAO, OIE and WHO (2010) The FAO-OIE-WHO Collaboration. Sharing Responsibilities and Coordinating Global Activities to Address Health Risks at the Animal-Human-Ecosystems Interfaces. A Tripartite Concept Note. Geneva: World Health Organization. Available at: http://www.who.int/influenza/resources/documents/tripartite_concept_note_hanoi/en (accessed 18 July 2014).
- Fisher, R.B. (1991) *Edward Jenner 1749–1823*. André Deutsch, London.
- Fudge, E. (2000) *Perceiving Animals: Humans and Beasts in Early Modern English Culture*. Macmillan/St Martin's Press, Basingstoke, UK.
- Gardiner, A. (2009) The animal as surgical patient: a historical perspective on the 20th century. *History and Philosophy of the Life Sciences* 31, 355–378.
- Gordon, A.H. and Schwabe, C.W. (2004) *The Quick and the Dead: Biomedical Theory in Ancient Egypt*. Brill, Leiden.
- Gradmann, C. (2009) *Laboratory Disease: Robert Koch's Medical Bacteriology*. Johns Hopkins University Press, Baltimore, Maryland.
- Gradmann, C. (2010) Robert Koch and the invention of the carrier state: tropical medicine, veterinary infections and epidemiology around 1900. *Studies in History and Philosophy of Biological and Biomedical Sciences* 41, 232–240.
- Green, E.C. (1998) Etiology in human and animal ethnomedicine. *Agriculture and Human Values* 15, 127–131.
- Green, J. (2012) 'One health, one medicine' and critical public health. *Critical Public Health* 22(4), 377–381.
- Guerrini, A. (2003) *Experimenting with Humans and Animals: From Galen to Animal Rights*. John Hopkins University Press, Baltimore, Maryland.
- Guerrini, A. (2006) Alexander Monro primus and the moral theatre of anatomy. *The Eighteenth Century* 47, 1–18.
- Hannaway, C. (1977) Veterinary medicine and rural health care in pre-Revolutionary France. *Bulletin of the History of Medicine* 51, 431–447.
- Hannaway, C. (1994) Vicq d'Azyr, anatomy and a vision of medicine. In: La Berge, A. and Feingold, M. (eds) *French Medical Culture in the 19th Century*. Rodopi, Clio Medica 25, Amsterdam, the Netherlands.
- Hardy, A. (2002) Pioneers in the Victorian provinces: veterinarians, public health and the urban animal economy. *Urban History* 29(3), 372–387.
- Hardy, A. (2003) Animals, disease and man: making connections. *Perspectives in Biology and Medicine* 46, 200–215.
- Hendricks, J., Newton, C.D. and Rubenstein, A. (2009) 'One Medicine - One Health' at the School of Veterinary Medicine of the University of Pennsylvania - the first 125 years. *Veterinaria Italiana* 45(1), 183–194.
- Hopwood, N. (2009) Embryology. In: Bowler, P.J. and Pickstone, J.V. (eds) *The Cambridge History of Science*, vol. 6: *The Modern Biological and Earth Sciences*. Cambridge University Press, pp. 285–315.
- Jacyna, S. (1984) The Romantic programme and the reception of cell theory in Britain. *Journal of the History of Biology* 17, 13–48.
- Jones, S.D. (2003) *Valuing Animals: Veterinarians and Their Patients in Modern America*. Johns Hopkins University Press, Baltimore, Maryland.
- Jones, T.L. (1959) Comparative medicine - the half-open door. *Canadian Journal of Comparative Medicine and Veterinary Science* 22(12), 416–419.
- Kaplan, M.M. (1953) The concept of veterinary public health and its application in the World Health Organization. *Bulletin of the World Health Organization* 7(9), 227–236.
- Kaplan, M.M. (1961) Comparative medical studies of chronic degenerative diseases as a veterinary public health activity. *Journal of the American Medical Women's Association* 16, 296–299.
- Kaplan, M.M. (1966) Social effects of animal diseases in developing countries. *Bulletin of the Atomic Scientists* 22(9), 15–21.
- Kete, K. (2007) Introduction: animals and human empire. In: Kete, K. (ed.) *A Cultural History of Animals in the Age of Empire, 1800–1920*, Vol. 5. Berg, Oxford/New York.
- King, L.J., Anderson, L.R., Blackmore, C.G., Blackwell, M.J., Lautner, E.A., Marcus, L.C., et al. (2008) Executive summary of the AVMA One Health Initiative Task Force report. *Journal of the American Veterinary Medical Association* 233(2), 259–261.

- King, N.B. (2004) The scale politics of emerging diseases. *Osiris* 19, 62–76.
- Kirk, R.G.W. (2008) ‘Wanted – standard guinea pigs’: standardisation and the experimental animal market in Britain ca. 1919–1947. *Studies in the History and Philosophy of the Biological and Biomedical Sciences* 39, 280–291.
- Kirk, R.G.W. (2009) Between the clinic and the laboratory: ethology and pharmacology in the work of Michael Robin Alexander Chance, c.1946–1964. *Medical History* 53, 513–536.
- Kirk, R.G.W. and Worboys, M. (2011) Medicine and species: one medicine, one history? In: Jackson, M. (ed.) *The Oxford Handbook of the History of Medicine*. Oxford University Press, Oxford.
- Koolmees, P. (2000) Veterinary inspection and food hygiene in the twentieth century. In: Smith, D. and Phillips, J. (eds) *Food Science, Policy and Regulation in the Twentieth Century*. Routledge, London, pp. 53–68.
- Lawrence, S. (1996) *Charitable Knowledge: Hospital Pupils and Practitioners in 18th Century London*. Cambridge University Press, Cambridge.
- Leboeuf, A. (2011) Making Sense of One Health. Cooperating at the Human-Animal-Ecosystem Health Interface. Institut Français des relations internationales (Ifri), Paris. IFRI Health and Environment Reports 7.
- Lee, K. and Brumme, Z.L. (2013) Operationalizing the One Health approach: the global governance challenges. *Health Policy and Planning* 28(7), 778–785.
- Logan, C. (2002) Before there were standards: the role of test animals in the production of empirical generality in physiology. *Journal of the History of Biology* 35, 329–363.
- Löwy, I. (2003) Experimental bodies. In: Cooter, R. and Pickstone, J.V. (eds) *Companion to Medicine in the Twentieth Century*. Routledge, London, pp. 435–450.
- MacKay, M. (2009) The rise of a medical speciality: the medicalization of elite equine medical care, 1680–1800. PhD thesis, University of York, chapters 1,4.
- Méhot, P.-O. (2012) Why do parasites harm their hosts? On the origin and legacy of Theobald Smith’s ‘law of declining virulence’ - 1900–1980. *History and Philosophy of the Life Sciences* 34(4), 561–601.
- Nutton, V. (2004) *Ancient Medicine*. Routledge, London.
- Orland, B. (2003) Cow’s milk and human disease: bovine tuberculosis and the difficulties involved in combating animal diseases. *Food and History* 1, 179–202.
- Rader, K. (2004) *Making Mice: Standardizing Animals for American Biomedical Research, 1900–1955*. Princeton University Press, Princeton, New Jersey.
- Ritvo, H. (1995) Border trouble: shifting the line between people and other animals. *Social Research* 62, 481–500.
- Rous, P. (1910) A transmissible avian neoplasm (sarcoma of the common fowl). *Journal of Experimental Medicine* 12, 697–705.
- Rushton, S. (2011) Global health security: security for whom? Security from what? *Political Studies* 59(4), 779–796.
- Schlich, T., Mykhalovsky, E. and Rock, M. (2009) Animals in surgery – surgery in animals: nature and culture in animal-human relationship and modern surgery. *History and Philosophy of the Life Sciences* 31, 321–354.
- Schmaltz, R. (1936) *Entwicklungsgeschichte des tierärztlichen Berufes und Standes in Deutschland*. Verlagsbuchhandlung von Richard Schoetz, Berlin.
- Schmidt, C.F. (1962) Editorial: One Medicine for more than one world. *Circulation Research* 11(6), 901–903.
- Schwabe, C.W. (1964, 1969, 1984) *Veterinary Medicine and Human Health*. Williams and Wilkins, Baltimore, Maryland.
- Schwabe, C.W. (1978) *Cattle, Priests and Progress in Medicine*. University of Minnesota Press, Minneapolis.
- Schwabe, C.W. (2004) Keynote address: The calculus of disease – importance of an integrating mindset. *Preventive Veterinary Medicine* 62, 193–205.
- Scoones, I. and Forster, P. (2008) The International Response to Highly Pathogenic Avian Influenza: Science, Policy and Politics (STEPS Working Paper No. 10). Available at: <http://steps-centre.org/publication/the-international-response-to-highly-pathogenic-avian-influenza-science-policy-and-politics> (accessed 18 July 2014).
- Shehada, H.A. (2012) *Mamluks and Animals: Veterinary Medicine in Medieval Islam*. Brill, Leiden.
- Shope, R.E. (1933) Infectious papillomatosis in rabbits. *Journal of Experimental Medicine* 58, 607–624.
- Shope, R.E. (1959) *Comparative Medicine*. Rockefeller Institute, New York.
- Shotwell, R.A. (2013) The revival of vivisection in the sixteenth century. *Journal of the History of Biology* 46, 171–197.
- Sluga, G. (2010) UNESCO and the (One) World of Julian Huxley. *Journal of World History* 21(3), 1–18.
- Smithcors, J. (1959) Medical men and the beginnings of veterinary medicine in America. *Bulletin of the History of Medicine* 33, 330–341.

- Staples, A.L.S. (2006) *The Birth of Development: How the World Bank, Food and Agriculture Organization, and World Health Organization Changed the World, 1945–1965*. Kent State University Press, Kent, Ohio.
- Steele, J. (1991) History of veterinary public health in the United States of America. *Rev. Sci. Tech. Off. Int Epiz. [Scientific and Technical Review of the OIE]* 10(4), 951–983.
- Steele, J. (2008) Veterinary public health: past success, new opportunities. *Preventive Veterinary Medicine* 86, 224–243.
- Swabe, J. (1998) *Animals, Disease and Human Society*. Routledge, London.
- Tauber, A. (1994) *The Immune Self: Theory or Metaphor?* Cambridge University Press, Cambridge.
- Teigen, P. (1984) William Osler and comparative medicine. *Canadian Veterinary Journal* 25, 400–405.
- Teigen, P. (1988) The establishment of the Montreal Veterinary College 1866/67-1874/75. *Canadian Veterinary Journal* 29, 185–189.
- Tilley, H. (2011) *Africa as a Living Laboratory: Empire, Development and the Problem of Scientific Knowledge 1870–1850*. University of Chicago Press, Chicago, Illinois.
- Waddington, K. (2006) *The Bovine Scourge: Meat, Tuberculosis and Public Health, 1850–1914*. Boydell Press, Woodbridge, UK.
- Whiteside, A. (1996) Vancouver AIDS conference: special report. A verdict on the conference: sadly, not one world or one hope. *AIDS Analysis Africa* 6(4), 2.
- WHO (1958a) WHO Document MHO/PA/71.59 (unpublished).
- WHO (1958b) *The First Ten Years of the World Health Organization*. World Health Organization, Geneva, pp. 211–227.
- WHO Chronicle (1961) *Comparative Medicine*, vol. 15. No. 11 (November), pp. 399–405.
- WHO/FAO (1951) Joint WHO/FAO Expert Committee on Zoonoses. *WHO Technical Report Series*, No. 40. World Health Organization, Geneva.
- WHO/FAO (1956) Advisory group on veterinary public health. *WHO Technical Report Series*, No. 111. World Health Organization, Geneva.
- WHO/FAO (1975) The Veterinary Contribution to Public Health Practice, Report of a Joint FAO/WHO Expert Committee on Veterinary Public Health. *WHO Technical Report Series*, No. 573. World Health Organization, Geneva.
- Wilkinson, L. (1992) *Animals and Disease: An Introduction to the History of Comparative Medicine*. Cambridge University Press, Cambridge.
- Woods, A. (2012) Vets and historians gain from joint approach to international subjects. *Veterinary Times* 15 October, 14.
- Woods, A. (2014) Animals and their doctors in Victorian Britain (in preparation).
- Worboys, M. (1991) Germ theories of disease and British veterinary medicine, 1860–1890. *Medical History* 35, 308–327.
- Worboys, M. (2000) *Spreading Germs: Disease Theories and Medical Practice in Britain, 1865–1900*. Cambridge University Press, Cambridge.
- Zinsstag, J., Schelling, E., Wyss, K. and Mahamat, M.B. (2005) Potential of cooperation between human and animal health to strengthen health systems. *Lancet* 366(9503), 2142–2145.
- Zinsstag, J., Meisser, A., Schelling, E., Bonfroh, B. and Tanner, M. (2012) From ‘two medicines’ to ‘One Health’ and beyond. *Onderstepoort Journal of Veterinary Research* 79(2), 1–5.