ONE HEALTH ATLAS

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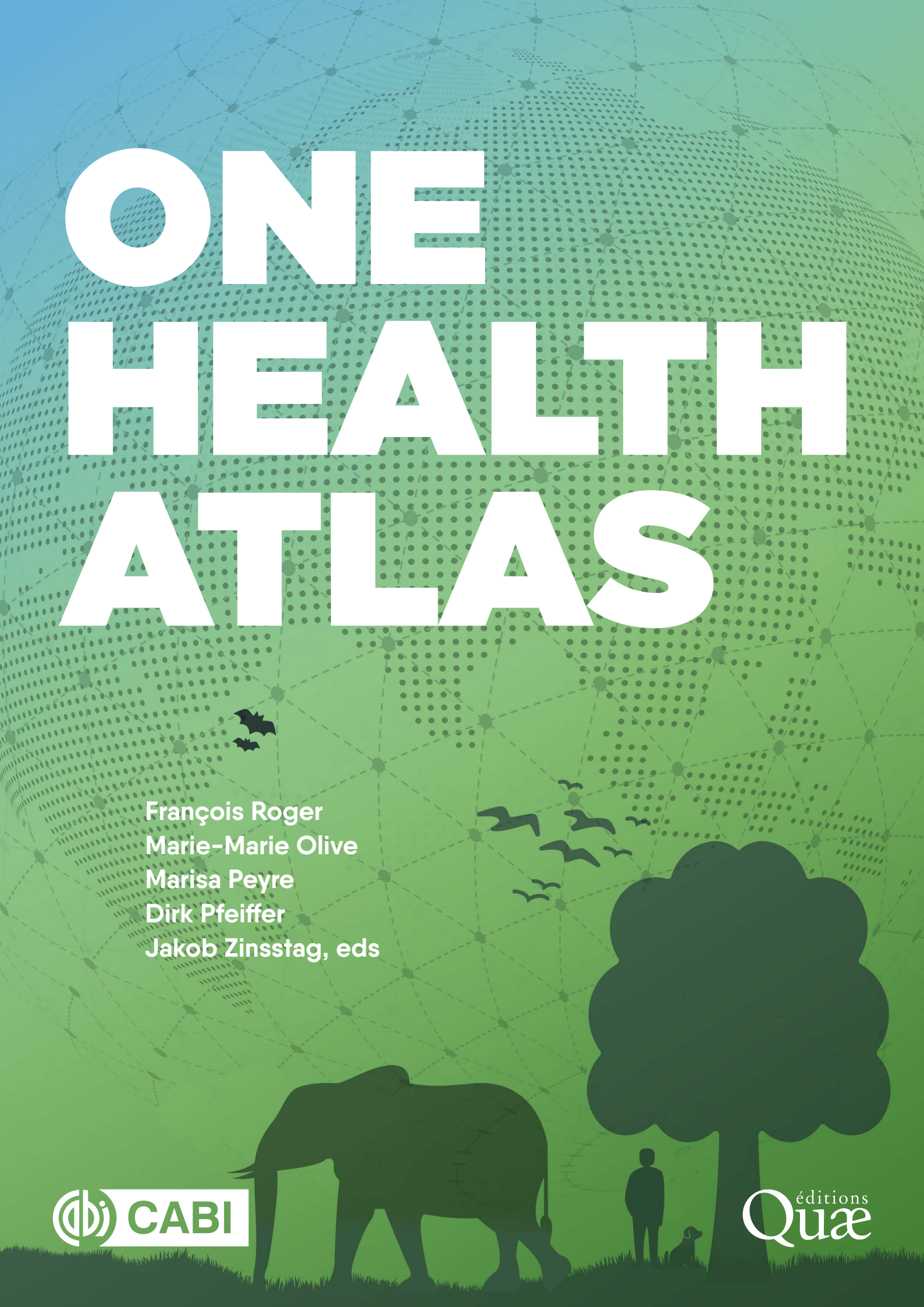

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The historical context of the human plague: from miasmas to One Health

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Human plague, caused by the bacterium *Yersinia pestis*, is an example of an ancient zoonotic disease. Pandemics occurred from the tenth century (Figure 1). Ancient European and Chinese ideas about disease transmission were sketchy at best and lacked the precise data on germs and vector transfer that modern science is able to provide. For example, scientists demonstrated in the nineteenth century that fleas spread the plague from infected animals to humans after the disease initially appeared in Central Asian rodent populations (Figure 2).

China had always prioritized public health in its response to epidemics. The Chinese may not have understood the plague specifically, but they were familiar with the general principles of disease transmission. Traditional philosophical ideas, such as the harmony of yin and yang and qi (meaning "life force energy"), had a significant impact on their health-care practices. Despite not knowing how the plague spreads from animals, they instituted quarantines and other health measures to limit infections more generally.

A third of the European population perished during the second plague pandemic. The epidemic was blamed on miasmas, or polluted air emissions, or seen as a divine punishment. Since transmission by vectors and animal reservoirs remained unclear, the miasmatic idea prevailed. Neither the significance of the environment nor the possibility of transmission from animals was considered during the plague's early stages.

Human plague cases still occur around the world (Figure 3). The current understanding of plague dynamics shows how the human–animal–environment interfaces are essential for disease development and transmission. Environmental variations, such as changes in natural habitats, biodiversity and climate, influence rodent populations and the behaviours of vectors like fleas, which in turn could increase the risk of transmission to humans. Thus, a One Health strategy is necessary to manage and prevent the plague, and includes monitoring rodent populations, studying disease carriers and educating communities. Understanding the environmental factors that affect transmission of the plague is also crucial for preventing future epidemics of the same type.

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First pandemic: 6th–8th centuries	Second pandemic: 14th–18th centuries	Third pandemic: 1855–mid-20th
The Plague of Justinian began in 541 CE, primarily affecting the Byzantine Empire and Mediterranean port cities. It killed millions of people before subsiding in the 700s.	The second plague pandemic started with the Black Death in 1347. This pandemic overwhelmed Europe and Asia (and possibly Africa), resulting in the death of 75 to 200 million people. Recurrences of this plague were reported until the 18th century.	Originating in China before spreading to India and then other parts of the world, the third plague pandemic stimulated advances in scientific understanding (reservoirs and vectors). It led to significant casualties, particularly in India and China, until its decline in the mid-20th century.

Figure 1. Timeline covering the three major human plague pandemics. Two major advances were made during the third plague pandemic: first, in 1894, when Alexandre Yersin, considered by some to be a forefather of One Health, discovered the pathogen responsible for epidemics; and second, in 1898, when Paul-Louis Simond discovered the role of the rat flea, *Xenopsylla cheopis*, as a vector of *Yersinia pestis*.

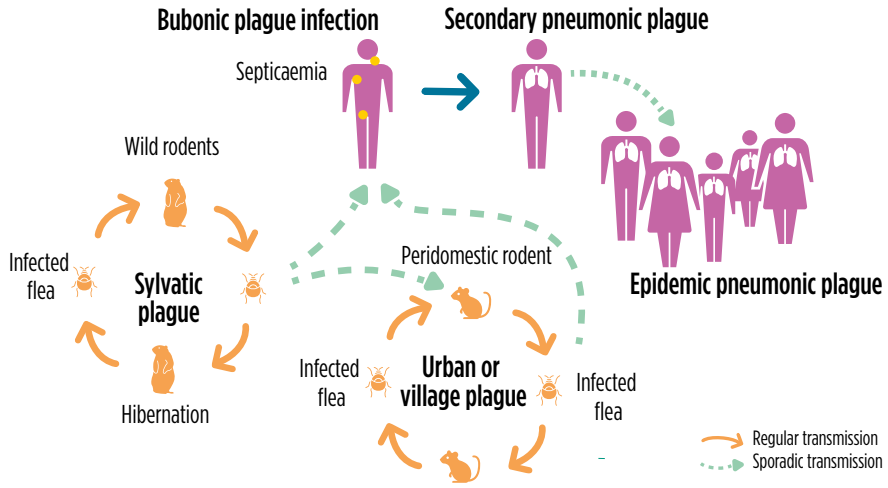

Figure 2. Transmission cycle. Primary hosts are black and brown rats. Sylvatic plague circulates in wild rodents via fleas, which can hibernate, sustaining the infection cycle. Urban plague spreads to domestic rodents, transmitting to nearby humans through fleas, leading to outbreaks. If human bubonic plague evolves, it can become pneumonic plague, spreading directly between humans via respiratory droplets. From: Lachenal and Thomas 2023.

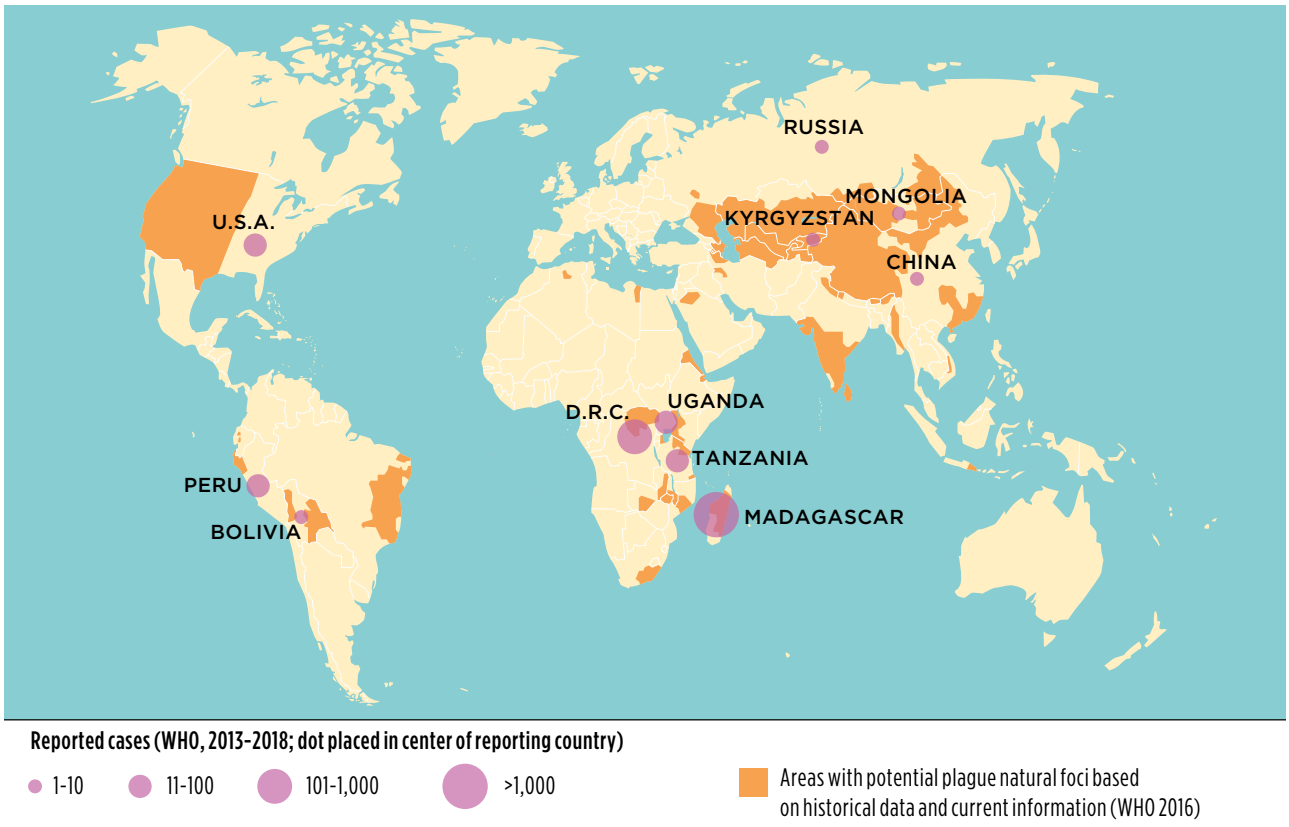

Figure 3. Plague remains endemic in parts of South and North America, Africa, and Central Asia, where rodent reservoirs persist. Outbreaks still occur, notably in Madagascar, Peru, and the D.R. of Congo. Sources: WHO and CDC.