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Abstract of the dissertation

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学位論文題名
The title of the doctoral dissertation

Serological and spatio-temporal analysis of anthrax in Mongolia
(モンゴルにおける炭疽の血清学的解析と時空間分析)

Anthrax is a zoonotic disease caused by a Gram-positive endospore-forming bacterium, *Bacillus anthracis*, which possesses two virulent plasmids; pXO1 and pXO2. It infects a wide range of mammals including livestock, wildlife, and humans. Anthrax is globally distributed and occurs worldwide. After the invention of an effective animal vaccine, outbreaks declined in many parts of the world; however, anthrax remains endemic in some regions of Africa and Asia. In Mongolia, anthrax cases are frequently reported in livestock with occasional transmission to humans, causing serious public health and socioeconomic problems. Effective control measures against anthrax require composite serological and epidemiological information, which is hindered by the lack of robust serological tools and studies. Accordingly, the purpose of this dissertation was to provide two different entry points, which are serological tool development and epidemiological analysis, important to guide the policy and public health intervention of anthrax in Mongolia and other countries.

To support confident and accurate serosurveillance data collection on anthrax infection in animals, a new enzyme-linked immunosorbent assay (ELISA) that is able to specifically detect naturally acquired antibodies against virulent *B. anthracis* was established. Based on the difference between virulent *B. anthracis* (pXO1⁺, pXO2⁺) and anthrax vaccine strains (pXO1⁺, pXO2⁻), potential antigen candidates were searched through *in silico* analyses, targeting the pXO2. In this study, the C-terminus region of capsule biosynthesis protein CapA (GBAA_RS28240), named CapA322 was identified to be immunoreactive, soluble, and specific to *B. anthracis*. CapA322-ELISA was established and validated that it can detect the antibodies in sera of horses infected with virulent *B. anthracis* but was non-cross-reactive to sera from horses vaccinated with *B. anthracis* Sterne

34F2 strain live spores. Therefore, this serological tool can be used to improve the anthrax serosurveillance in Mongolia and beyond.

Furthermore, to provide insight into the anthrax epidemiology in Khuvsgul Province, Mongolia, spatio-temporal patterns of anthrax in livestock between 1986 and 2015 were analyzed based on the carcass burial sites of animals that died of anthrax. The results showed that the spatial distribution of carcass sites had not changed over the 30 years, indicating the recurrence of anthrax in the same area. There was one stable hotspot of anthrax carcass sites around the southern and an emerging new one in the northern region of the province. These hotspots exist in low-lying areas with abundant rivers, lakes, and ponds. Further, the burden of anthrax was higher in cattle than in other livestock species, and the cattle anthrax prevalence was high in some districts. Finally, the size of outbreaks in livestock was influenced by the annual summer mean air temperature (June to August) of Khuvsgul Province. The findings emphasize the historical hotspots of carcass sites that need to be prioritized in public health interventions and the factors that precipitate the recurrence of anthrax outbreaks. Moreover, the study provided essential epidemiological data that will inform policy for controlling anthrax in Mongolia.

Overall, the work presented here highlights approaches for investigating anthrax from serological and epidemiological aspects.