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A rapid risk assessment of African swine fever introduction and spread in Japan based on expert opinions

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ABSTRACT. A rapid risk assessment was conducted using a questionnaire composed of 10 questions asking experts in African swine fever (ASF) to identify and rank the potential risk factors associated with the introduction and spread of ASF in Japan. The experts participating in this risk assessment considered illegal food import, followed by transport routes and foreign workers, to be the most relevant pathway of ASF introduction into Japan. Kanto and Kyushu were identified as the most likely regions for ASF introduction. All experts agreed that China is the most likely source of ASF introduction into Japan. Most Japanese experts were of the view that the risk of ASF spread if introduced into Japan would be low, while foreign experts considered the risk to be moderate or high. Most experts answered that wild boars would play an important role in the persistence of ASF if the disease were to spread in Japan.

KEY WORDS: African swine fever, expert opinion, risk assessment, risk factor

African swine fever (ASF) is a highly contagious disease that affects pigs. It is caused by the African swine fever virus (ASFV) that belongs to the genus *Asfivirus* of the *Asfarviridae* family [1]. ASF can spread through direct or indirect contact and causes high mortality. The ASFV persists for a long time in the environment and in a variety of pig products. Wild boar can harbor the virus, and ASF may become endemic with or without an added transmission cycle through *Ornithodoros* ticks [16].

ASF was first recognized in Kenya in 1921 [8]. Since then, ASF has been found to be endemic in sub-Saharan African countries, where it persists in a sylvatic cycle between warthogs and *Ornithodoros* ticks [8]. It arrived in Portugal from Africa in 1957 and again in 1960. From there it spread to Spain, Caribbean countries (Cuba, Dominican Republic and Haiti), and then to Brazil [19, 20]. In the Iberian Peninsula, ASF was eradicated after 30 years; however, it remains endemic in the Italian island of Sardinia and most sub-Saharan African countries [2, 17]. In 2007, the disease was introduced into Georgia, a Caucasus country, and quickly spread to neighboring countries, including Armenia the Russian Federation in 2007, and Azerbaijan in 2008. From the Caucasus, the disease continued to spread northward and westward to Ukraine and Belarus in 2013, in Poland, Latvia, Estonia and Lithuania in 2014, and in Czech Republic and Romania in 2017. During this period, there were additional outbreaks to the east of the Russian Federation in domestic pig and wild boar populations [3, 17, 18]. In March 2017, ASF was reported in Irkutsk, approximately 1,000 km from the Chinese border [5].

ASF appeared in China, the largest pig producer and pig meat consumer in the world, with the first outbreak reported on a farm near Shenyang City in Liaoning Province on 3 August 2018 [10, 21]. The pigs on this farm had been fed with table scraps and suffered from acute clinical and pathological signs since mid-June 2018 [21]. The second outbreak was reported on 17 August 2018 in a slaughterhouse in Zhengzhou, a city of Henan Province. The infected pigs had been legally transported from a live swine market in Heilongjiang Province [11]. The disease continued to spread in mainland China. By 7 September 2018 six additional widely separated outbreaks had been reported in Jiangsu, Zhejiang, Anhui, and Heilongjiang Provinces [12–15]. There is no sign that the epidemic will cease in the near future despite the disease control measures being in place, which includes culling of affected and susceptible animals. ASFV was suggested to be circulating in the area since at least March 2018 [9]. There is some evidence to support the view that the source of the Chinese epidemic is Russia. Genetic testing has shown that the sequencing of the Chinese virus is consistent with the corresponding sequence of the Russian Irkutsk 2017 strain [21].

In response to the rapid geographic expansion of the disease, the Japanese government has tightened quarantine operations at airports and seaports, especially for travelers from China, and has called for domestic pig farmers to adopt a higher level of

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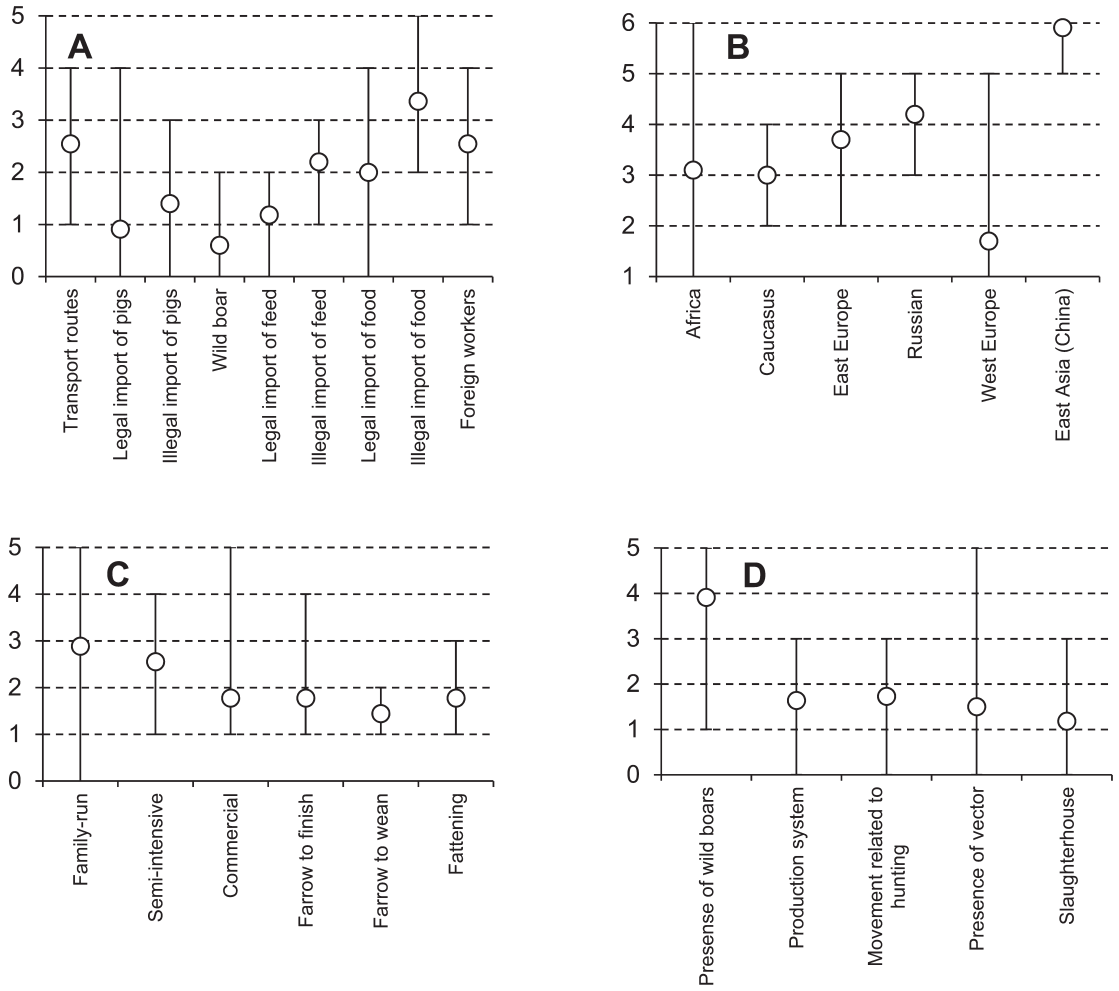

Fig. 1. Most likely way of ASF introduction into Japan (A); most likely source of ASF introduction into Japan (B); production system mostly affected (C); and risk factors associated with the persistence of ASF in Japan (D). The scale on the vertical axis indicates the risk: 0 (negligible risk); 1 (very low risk); 2 (low risk); 3 (moderate risk); 4 (high risk) and 5 (very high risk). Open circles indicate the average and error bars indicate the range of expert opinions.

biosecurity measures [7]. However, no systematic risk assessment has been made to identify the risk factors associated with the introduction of ASF to Japan and factors that would assist the spread of the disease in Japan.

We conducted a rapid risk assessment to identify and rank potential risk factors for the introduction and spread of ASF in Japan using a questionnaire comprising 10 questions asking ASF experts to rank potential risk factors associated with the introduction, spread, and persistence of the disease in Japan. This questionnaire was similar to the one used by the FAO to identify and rank risk factors associated with the introduction, spread, and persistence of ASF in China [4], but modified to accommodate the Japanese situation. The questionnaire was sent to 15 experts by e-mail on 31 August 2018 (See Supplementary material 1 for the questionnaire used).

As a proxy for the data required for their assessment, the experts were provided with background information on: Japanese pig production; the number of international flights, boats, and vehicles arriving in Japan; import data of live pigs, pig meat, and heat-processed pig meat products to Japan; import data of feed and feed ingredients to Japan; data on the illegal import of animal product to Japan; the number of international travelers and workers in Japan; the habitats of wild boars and soft ticks in Japan; and biosecurity measures of pig farms in Japan (See supplementary material 2 for the details of the background information).

Responses were received by 14 September 2018 from 12 experts: Silvia Bellini, Istituto Zooprofilattico Sperimentale Della Lombardia E Dell'Emilia, Italy; Samuel Connell, Pirbright Institute, U.K.; Klaus Depner, Friedrich-Loeffler-Institute, Germany; Linda Dixon, Pirbright Institute, U.K.; Chris Netherton, Pirbright Institute, UK; Hua-ji Qiu, Harbin Veterinary Research Institute, China; Helen Roberts, Defra, U.K.; Mitsugu Shimizu, Japan; Masuo Sueyoshi, Miyazaki University, Japan; Tomoyuki Tsuda, KM Biologics, Co., Ltd., Japan; and two experts who did not want their names disclosed. Three of the experts did not respond to all the questions, having reported a lack of information for some of the questions. Responses from all experts are summarized as follows:

Most likely pathway of ASF introduction into Japan: Experts widely agreed that the most likely way of ASF introduction into Japan was the illegal import of food, followed by transport routes and foreign workers in Japan (Fig. 1A). They considered the

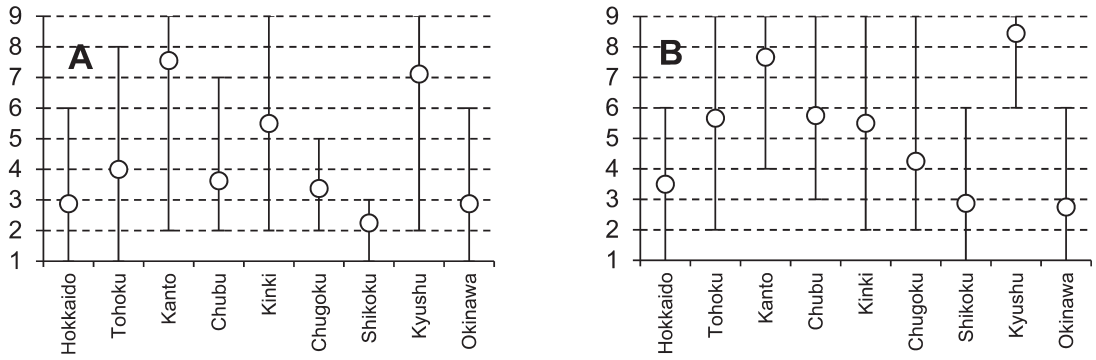

Fig. 2. Regions where ASF is most likely to be introduced (A); and regions where ASF is most likely to spread (B). The scale on the vertical axis indicates the rank of regions in terms of the likelihood of introduction, from 1 (least likely to be introduced/spread) to 9 (most likely to be introduced/spread). Open circles indicate the average and error bars indicate the range of expert opinions.

risk of introduction through these pathways to be moderate, while they ranked all other pathways negligible or low risk. One expert was of the view that the risk of ASF introduction through legally imported pig meat products is high given the large amount being imported into Japan, even if the heat treatment condition still applies. Most experts were of the view that the risk of ASF introduction through wild boars and the legal or illegal import of pigs is negligible or very low because of Japan's geographical advantage; i.e., that it is surrounded by the sea and does not share borders with any country. Among various transport-associated routes, most experts believed that waste from international ships and planes can contribute to the introduction of the disease, and that this was more of a concern than contamination from international vehicles. One expert was of the view that if ASF is introduced to Korea, the risk of introduction to Japan through contaminated vehicles would increase dramatically.

Japanese regions where ASF is most likely to be introduced: Most experts considered Kanto and Kyushu, followed by Kinki region, as the two regions where ASF would most likely to be introduced. (Fig. 2A). They considered the presence of large international airports, the number of foreign tourists, wild boar habitats, and pig population density as key risk factors in ranking the regions.

Source of ASF introduction into Japan: All experts agreed that East Asia (China) would be the most likely source of ASF introduction into Japan (Fig. 1B). Most experts considered Africa to be a less likely source of introduction into Japan compared to a similar risk assessment previously conducted for China [4]. This is likely because Japan's economic relationship with Africa is not as strong as China's economic relationship with Africa in terms of movement of people, ships, and aircrafts.

Risk of ASF spread in Japan once introduced: Most Japanese experts considered that the spread of ASF in Japan is very unlikely (1–10%), while most foreign experts answered that it is as likely as not (30–60%). Some foreign experts believed that in the presence of a wild boar habitat, particularly with poorer biosecurity levels, there is a chance that ASF could spread without being detected at an early stage.

Relevance of ticks to the spread of ASF in Japan: Most experts answered that the relevance of ticks to the spread of ASF in Japan is extremely unlikely (<1%). One Japanese expert was of the view that the soft ticks (*Ornithodoros* spp.) that exist in Japan are unlikely to become a vector of ASF.

Japanese regions where ASF is most likely to spread: Most experts believed that Kyushu and Kanto are the regions where ASF would be most likely to spread, while Shikoku is the region where the disease would be least likely to spread (Fig. 2B). Some experts were of the view that an epidemic would be prevented if the infection remained contained in domestic pigs.

Production systems to be affected after the spread of ASF in Japan: Most experts answered that family-run or semi-intensive pig farms, rather than commercial farms, would be most affected if the disease were to spread in Japan (Fig. 1C).

Risk of ASF persistence: Most experts were of the view that the persistence of ASF is extremely or very unlikely (<10%).

Risk factors involved in ASF persistence: Most experts answered that the presence of wild boars would play the largest role in the persistence of the disease once spread in Japan (Fig. 1D).

Until a more refined risk assessment is conducted, these results can provide policy makers, veterinarians and pig farmers with useful information in developing quarantine and biosecurity programs to protect Japanese pig herds from the introduction and spread of ASF. In conducting our risk assessment, we identified information gaps in the following areas:

Amount of pig meat products illegally imported from China and other countries: Illegally imported pig meat products might not be properly heat-treated, and thus have a greater chance of becoming a source of infection compared to legally imported products. Assuming that the amount of animal products actually seized by the Animal Quarantine Service (83 tons in 2017) is the tip of the iceberg, there is a possibility that a much larger amount is being imported illegally from China and other countries for personal consumption or commercial purposes.

Frequency of swill feeding in pig farms: Though swill feeding is not a common practice on Japanese pig farms, it is not prohibited. Data on the frequency of swill feeding, as well as the treatment procedures applied, are needed for a more accurate risk assessment.

Level of biosecurity measures on pig farms: Many experts stressed the importance of biosecurity on pig farms in preventing the introduction and spread of ASF. In accordance with the Domestic Animal Infectious Diseases Control Law, all pig farmers are supposed to observe biosecurity measures to protect their pig herds from the introduction of infectious diseases including ASF. As of 13 August 2018, there are only 107 pig farms certified for the Farm HACCP which includes control points for biosecurity measures [6]. For other pig farms, the compliance level of biosecurity measure is not really known.

Given the fact that there are many foreigners who visit Japan after visiting ASF-affected countries or after working on pig farms, the pig farms should assure that their biosecurity measures are sufficiently high to protect their farms from the introduction of ASF.

According to many experts, while the spread and persistence of ASF by ticks is unlikely, there is a significant risk by the wild boar habitat in Japan, particularly if early detection is delayed. Japanese pig farmers should be on alert, not just to protect their farms from the introduction of ASF, but to ensure early notification of the disease should it be introduced.

This rapid risk assessment has identified key knowledge gaps and thus a need for the collection of further data to perform a more refined qualitative or quantitative risk assessment.

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