

## SHORT PAPER

# Serological survey of parapoxvirus infection in wild ruminants in Japan in 1996–9

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## SUMMARY

The prevalence of parapoxvirus infection was examined in free-ranging wild ruminants in Japan, Japanese serow (*Capricornis crispus*) and Japanese deer (*Cervus nippon centralis*), in 1996–9. We collected a total of 151 serum samples from 101 Japanese serows and 50 Japanese deer and tested for antibodies against parapoxvirus by an enzyme-linked immunosorbent assay and an agar gel immunodiffusion test. Overall seroprevalences among Japanese serows were 5/25 (20·0%) in 1996, 4/14 (28·6%) in 1997, 5/32 (15·6%) in 1998 and 2/30 (6·7%) in 1999, respectively. The seroprevalence increased with age but was not affected by sex. No antibodies were detected from any of 50 serum samples taken from Japanese deer. Our results in this study suggest that parapoxvirus infection is widespread among the population of Japanese serows, however, Japanese deer appear to be still free of the disease.

Parapoxviruses (Family *Poxviridae*) are the aetiological agents of contagious pustular dermatitis in domestic ruminants such as cattle, sheep and goats, and are often transmissible to humans, causing, for example, ‘milker’s nodule’ [1, 2]. Parapoxvirus infections have also been described in free-ranging and captive wild ruminants (Ruminantia and Tyropoda) including thar (*Hemitragus jemlahicus*), bighorn sheep (*Ovis canadensis*), Dall sheep (*Ovis dalli*), mountain goats (*Oreamnos americanus*), musk oxen (*Ovibos moschatus*), gazelles (*Gazella gazella*) and camels (*Camelus dromedarius*) [3–14].

Two wild ruminants are found in Japan, Japanese serows (*Capricornis crispus*) and Japanese deer (*Cervus nippon centralis*). Several studies have reported para-

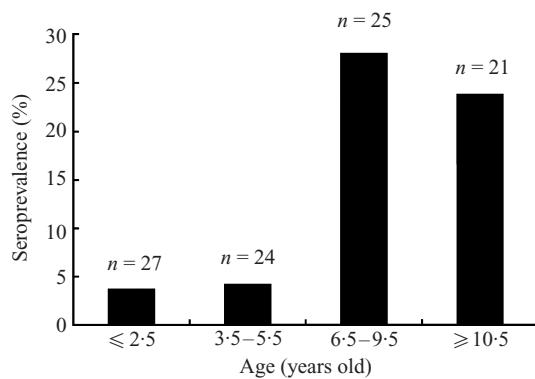
poxvirus infections among Japanese serows [15–22], in which the disease is occasionally severe: affected animals can become lame and anorexic because of lesions around the mouth or pastern joint, and consequently die from debilitation [15, 17, 19]. Serows are a protected species in Japan, and a better understanding of the epidemiology of parapoxvirus infection is therefore important for their management and conservation. By contrast, there have been no reports of parapoxvirus infections in Japanese deer, despite the foraging ranges of wild and domestic ruminants sometimes overlapping, and the potential for the virus to move between domestic and wild animals.

We therefore undertook a serological survey for parapoxvirus infection in Japanese serows and

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Table 1. Prevalence of antibodies to parapoxvirus in Japanese serows

Year	No. of seropositive serows/ no. tested (%)		
	Male	Female	Total
1996	1/12 (8.3)	4/13 (30.8)	5/25 (20)
1997	1/4 (25)	3/10 (30)	4/14 (28.6)
1998	3/16 (18.8)	2/16 (12.5)	5/32 (15.6)
1999	0/18 (0)	2/12 (16.7)	2/30 (6.7)
Total (1996–9)	5/50 (10)	11/51 (21.6)	16/101 (15.8)



**Fig. 1.** Age-distributions of seropositive Japanese serows. The positive reactors were 1 of 27 in the  $\leq 2.5$  years old group, 1 of 24 in the 3.5–5.5 group, 7 of 25 in the 6.5–9.5 group and 5 of 21 in the  $\geq 10.5$  group. Data from three serows were not included because their ages could not be determined. Of the three serows, two were seropositive for parapoxvirus.

Japanese deer, making use of culls permitted by the Agency of Cultural Affairs to collect samples. Serum samples were collected during February–March over the period from 1996–9 from 101 free-ranging Japanese serows in Yamagata Prefecture and 50 Japanese deer in Gunma Prefecture in Japan. The age of each animal was determined at the Japan Wildlife Research Center (Tokyo, Japan) from the number of rings on a horn in Japanese serows [23] and the number of lines in an incisor in Japanese deer [24]. Sera were tested by ELISA and agar gel immunodiffusion (AGID). The Chiba strain of parapoxvirus, originally isolated from a cow [25], was used as antigen in both assays as described previously [22, 26, 27]. The significance of the serological test results in relation to age and sex was analysed using  $\chi^2$  and Fisher's exact tests.

Parapoxvirus antibodies were detected only in Japanese serows by ELISA (Table 1), and confirmed by the AGID test. No antibodies were detected in

samples from the 50 Japanese deer. Of the 101 samples from Japanese serows tested, 5 of 25 (20.0%) in 1996, 4 of 14 (28.6%) in 1997, 5 of 32 (15.6%) in 1998 and 2 of 30 (6.7%) in 1999 were positive for the antibody (Table 1). Thus a total of 16 of the 101 (15.8%) serows had antibodies. The prevalence of antibody increased with age (Fig. 1), as is also the case for cattle in Japan [25, 27], but there was no difference in prevalence between males and females (Table 1).

In domestic animals such as cattle, sheep and goats, morbidity rates can be very high, approaching 100% in sheep and goats [28], while serological surveys suggest lower rates of infection in wild animals from various countries. Thus, antibody has been reported in 80% of 10 bighorn sheep (*Ovis canadensis*) [6], 41% of 17 Dall sheep (*Ovis dalli*) and 10% of 53 reindeer (caribou) (*Rangifer tarandus*) [9]. The prevalence of antibody in Japanese serows is towards the lower end of this range, and this may be because they are largely solitary animals, with few opportunities for close contact with each other except during the breeding season.

In this study, no antibodies were detected from free-ranging wild Japanese deer and there have been no clinical observations among Japanese deer so far. Parapoxvirus infections have been observed elsewhere in other members of the deer family, including reindeer [9, 11, 29] and red deer (*Cervus elaphus*) [30]. In New Zealand, farmed red deer are susceptible to an apparently novel parapoxvirus [30, 31]. Moreover, experimental infections with parapoxvirus have been reported in mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*) and wapiti (*Cervus elaphus nelsoni*) [32]. The foraging ranges of wild Japanese deer overlap those of wild Japanese serows and pastures of cattle and sheep in certain areas, and since the infectivity of parapoxvirus is extremely stable under natural conditions [1, 33], it is likely that Japanese deer have been exposed to the virus. Furthermore, infection with several other bovine viral pathogens, including bovine coronavirus, bovine rotavirus, Akabane disease virus, bluetongue virus, parainfluenza virus-3, bovine viral diarrhoea-mucosal disease virus and bovine herpesvirus 1, has been reported in Japanese deer [34]. Thus it may be that Japanese deer are relatively unsusceptible to infection with the prevalent parapoxviruses.

This study indicates a possible role for Japanese serows in the epidemiology of parapoxvirus infection in Japan. It is likely that serows can transmit the virus to domestic animals, although the converse cases

would probably occur more frequently. Further studies of parapoxvirus infection epidemiology will therefore be important not only for the management of serows, but also for the hygiene of both domestic and other wild animals.

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