NOTE *Virology*

Serological survey of caprine arthritis-encephalitis virus infection in Japan

Misako KONISHI[1)]*, Yoko HAYAMA[1)], Hiroaki SHIRAFUJI[2)], Ken-ichiro KAMEYAMA[1)], Kenji MURAKAMI[3)], Toshiyuki TSUTSUI[1)] and Hiroomi AKASHI[4)]

[1)]*National Institute of Animal Health, 3–1–5 Kannondai, Tsukuba, Ibaraki 305–0856, Japan*
[2)]*National Institute of Animal Health (Kyushu Research Station), 2702 Chuzan, Kagoshima, Kagoshima 891–0105, Japan*
[3)]*Iwate University, 3–18–8 Ueda, Morioka, Iwate 020–8550, Japan*
[4)]*Emeritus Professor, The University of Tokyo, 1–1–1 Yayoi, Bunkyo, Tokyo 113–8657, Japan*

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ABSTRACT. A serological survey of caprine arthritis-encephalitis virus (CAEV) infection was conducted from September 2006 to February 2007 in Japan. A total of 857 serum samples were collected from 113 herds in 28 prefectures and were analyzed for the presence of CAEV antibodies using agar gel immunodiffusion test. The seroprevalence of CAEV infection at the herd and animal levels was 15.0% (17/113) and 10.0% (86/857), respectively. Large farms with more than 10 goats and with animals for dairy and breeding purposes had higher seroprevalence ($P<0.05$). The results of this study provide useful information to consider effective control programs against CAEV infection in Japan.

KEY WORDS: caprine arthritis-encephalitis virus, epidemiological survey, seroprevalence

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Caprine arthritis-encephalitis virus (CAEV), an RNA virus belonging to the genus *Lentivirus* in the family Retroviridae, is the causative agent of CAE, which is characterized by progressive degenerative inflammatory lesions in multiple regions [4, 18]. Infected animals develop antibodies against CAEV and shed the virus for life in colostrum/milk, blood and respiratory tract secretions [6].

CAEV and maedi-visna virus (MVV), which infect sheep, share a high sequence homology and genomic organization, and antigenic cross-reactions occur between the structural proteins of these viruses [10, 18]. Thus, both CAEV and MVV are designated as small ruminant lentiviruses (SRLVs) [4, 16–18]. SRLVs have been identified in most countries that rear sheep and goats, including Japan [12, 14, 16]. Because SRLVs cause both direct and indirect economic losses owing to decreased productivity and delayed maturity, diagnostic methods and programs to control the transmission of SRLVs have been established in countries with large goat and sheep industries [16, 17]. Global surveys and epidemiological studies to identify the risk factors associated with SRLV infection have been conducted in the same countries [1–3, 5–9, 13, 15, 19–22]. These previous studies revealed that ingestion of infected colostrum/milk or direct contact with infected animals is the main risk factor for the transmission of SRLVs within a herd [4]. In addition, large herd size, increased age, high stocking density, prolonged duration of exposure to infected animals and extensive rearing systems have also been indicated as risk factors [4, 13, 16, 17].

In Japan, CAE was first detected in 2002 at one of the largest dairy goat farms in the country [12]. Because the infected farm was one of the largest suppliers of live goats to other farms throughout Japan, a nationwide survey of CAEV infection was required to elucidate the prevalence of CAE. However, the goat industry in Japan is not very large, with only approximately 19,000 goats throughout the country in 2014, according to the Japan Livestock Technology Association (Statistics of number of goats in each prefecture; http://jlta.lin.gr.jp/sheepandgoat/goat/toukei.html), and thus, information on goat herd operations is limited. In this study, a serological survey of goat herds was conducted to reveal the seroprevalence of CAEV among goat populations. In addition, information on herd management practices was collected to understand farming practices of goats in Japan.

A voluntary survey of goat herds was conducted in 28 Japanese prefectures from September 2006 to February 2007. Veterinary officers of each prefectural government visited herds and collected a total of 857 blood samples from 113 herds. The Animal Ethical Committee and the Animal Care and Use Committee of National Institute of Animal Health (NIAH) approved the sampling. Sera were separated at prefectural laboratories and sent to NIAH for antibody detection by the agar gel immunodiffusion (AGID) test, as previously described [12]. On the day of blood sampling, the owners of the herds were asked to answer a questionnaire prepared by the authors. The questionnaire was designed to get information regarding herds and individual animals. The questions regarding herds included the number of goats in the herd, the purpose of farming (breeding, dairy or other), grazing practices, introduction of goats from other herds, housing conditions, breeding and rearing methods, and feed-

*CORRESPONDENCE TO: KONISHI, M., Viral Disease and Epidemiology Research Division, National Institute of Animal Health, National Agriculture and Food Research Organization (NARO), 3–1–5 Kannondai, Tsukuba, Ibaraki 305–0856, Japan.
e-mail: mkonishi@affrc.go.jp

Table 1. Comparison of seroprevalence of CAEV at the herd level

Variable	Categories	Number of herds	Positive herds (%)	*P*
Number of goats in herd	<10	54	9.3	0.016
	≥10	31	32.3	
Purpose of farming	Breeding	11	45.5	<0.001
	Dairy	11	45.5	
	Other	63	7.9	
Grazing	Yes	31	29	0.073
	No	54	11.1	
Presence of purchased goats	Yes	57	22.8	0.128
	No	28	7.1	
Goats were reared	Separately	61	19.7	0.54
	Together	24	12.5	
Breeding	Natural mating	73	20.5	0.224
	Artificial Insemination	2	0	
	No breeding	10	0	
Rearing	Naturally	74	20.3	0.258
	Artificially	1	0	
	No breeding	10	0	
Use of milk replacer	Yes	2	50	0.157
	No	73	19.2	
	No breeding	10	0	
Feeding pooled milk	Yes	3	33.3	0.245
	No	72	19.4	
	No breeding	10	0	

ing of milk replacer or pooled milk. The questionnaire also included information regarding gender, age, breed, purpose/use, origin (purchased or born to the herd), field grazing, parturition number (for female goats) and health status (including case histories) of the animals. Infection was defined as a seropositive animal identified by the AGID test, and herds were defined as infected if at least one goat in the herd was infected. Collected data were stored and analyzed using commercially available spreadsheet software (Excel 2007; Microsoft Corp., Redmond, WA, U.S.A.). Descriptive analysis was performed to examine features of goat farming and the prevalence of CAEV infection in Japan. Statistical analyses were performed using SPSS statistical software (IBM SPSS Statistics 19; IBM Japan, Tokyo, Japan).

Of 857 goats, 86 were seropositive, resulting in a seroprevalence of 10.0% at the animal level [95% confidence interval (CI), 8.0–12.1%], whereas 17 of 113 herds were found to be infected, resulting in a seroprevalence of 15.0% at the herd level (95% CI, 8.5–21.6%). No goat examined in this study exhibited clinical symptoms of CAE, such as pneumonia, arthritis or mastitis. Approximately 60% of the 107 herds that answered the total number of goats, consisted of fewer than 10 goats. Only three herds had more than 100 goats. The average herd consisted of 15 goats (range, 1–216). The primary reasons for rearing goats were dairy production (37.9%), pets (19.6%), experimental animals (14.1%), breeding (6.8%) and other uses (21.6%). No farm reared goats for meat purposes. In most herds, goats were bred by natural mating, and kids were naturally reared with their dams. The use of milk replacer and pooled milk was very rare (2/113 herds). The following breeds of goat (635) were observed in this study: Saanen (428), Alpine (57), Nubian (7), Toggenburg (6), Angora (4), Shiba (85), Tokara (35) and Yakushima (13). The remaining goats were crossbreeds (114) or unknown breeds (108). The seroprevalence of Saanen, Alpine, Nubian and crossbreed goats in Japan was 14.3% (61/428), 24.6% (14/56), 14.3% (1/7) and 8.8% (10/114), respectively. Among the crossbreeds, all infected animals were crosses between Saanen and Alpine breeds. All other breeds (including those unknown) were seronegative based on the AGID test. The age of the examined goats ranged from 1 month to 12 years (average age, 2.6 years).

Excluding those data with missing values in one or more fields, data concerning 85 herds and 678 goats were used for statistical analyses. At the herd level, the seroprevalence of goats reared for breeding and dairy uses was significantly higher than that for other purposes ($P<0.01$, χ^2-test) (Table 1). At the animal level, gender, age, breed, purpose/use, acquisition (purchased or born to the herd) and grazing (yes or no) significantly influenced the seroprevalence ($P<0.05$, χ^2-test) (Table 2).

This is the first epidemiological study of CAEV infection in Japan. Although participation in this study was voluntary, we believe that our results reasonably reflect current herd management practices and the prevalence of CAEV among the goat population in Japan, as prefectures with large numbers of goat herds were covered by this survey. In this study, overall seroprevalence at the animal level was 10%, and that

Table 2. Comparison of seroprevalence of CAEV at the animal level

Variables	Categories	Number of goats	Positive goats (%)	*P*
Gender	Female	485	11.3	0.014
	Male	193	5.2	
Age (years)	<1	208	5.3	0.001
	1–2	192	6.8	
	≥3	278	14.7	
Breed	Saanen	369	11.7	0.046
	Others	309	7.1	
Purpose/use	Breeding	53	22.6	<0.001
	Dairy	278	15.1	
	Others	347	3.2	
Acquisition	Purchased	162	16	0.001
	Born on the herd	516	7.6	
Grazing	Yes	339	6.2	0.003
	No	339	13	
Number of goats in herd	<10	128	7	0.276
	≥10	550	10.2	

at the herd level was 15%. Previous studies indicated that countries with large-scale goat farms and intensive dairy farming generally had a high seroprevalence of CAEV (>65.0% at the animal level), whereas those with small-scale farms had a low seroprevalence (approximately 10% at the animal level) [2, 6]. Considering that most goat herds in Japan are small, our results conform to these studies. In addition, herds with more than 10 goats appeared to have a higher seroprevalence of CAEV than smaller herds. These results also indicate that herd size influences seroprevalence of CAEV in goat herds.

Our results revealed that goats were mainly reared for personal use, with large-scale commercial farms being relatively rare in Japan. Our results also showed that farms keeping goats for breeding and dairy purposes had higher seroprevalence than those for other purposes. This finding appears reasonable, because CAE primarily occurs in dairy herds [17], and these farms often introduce goats from other herds for the genetic improvement of animals. The spread of SRLVs via live animal trade has been confirmed epidemiologically and phylogenetically. This practice was accordingly identified as a major risk factor for the spread of SRLVs between herds in previous studies [4, 16]. The frequent movement of animals among breeding and dairy farms might increase the risk of introduction of infected goats and cause higher seroprevalence in those farms.

Our results showed that local Japanese breeds (Shiba, Tokara and Yakushima) are rarely reared with goats acquired from abroad, and instead, they are usually reared on small-scale farms as pets or experimental animals (data not shown). In contrast to “non-native” breeds, goats of local Japanese breeds are rarely transferred to other herds, and all goats of local Japanese breeds in this study were seronegative for CAEV. Although further studies, including molecular epidemiological studies of viral genes, are required, our findings suggest that the spread of CAEV throughout Japan may occur via trading infected goats.

Several studies have reported a correlation between the breed of goat and risk of CAEV [9, 19, 20]. In the present survey, Saanen was the most common breed and was reared for many purposes, including breeding, dairy and experimental uses or as pets, throughout Japan. The results of the statistical analysis showed that seroprevalence in Saanen was significantly higher than that in other breeds. However, caution should be exercised as Alpine and Nubian breeds were also found to have a high seroprevalence and all were reared with Saanen goats in the same herd. Considering both the high seroprevalence of these dairy goats and absence of seropositive goats in the Japanese local breeds, the risk for CAEV infection may be related to herd management, and not the type of breed.

The results of the present study provide useful information on the seroprevalence of CAEV and herd management practices of goats in Japan. Considering the seroprevalence observed in this study, disease management should be prioritized by large-scale dairy farms, because of the frequent on/off movements of animals at such goat farms. Control measures may include use of milk-deprived rearing, periodical testing and isolation of infected animals [11]. Implementation of control measures targeting highly affected herds will contribute to the eradication of CAEV in Japan.

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