BRIEF NOTE

Latent Infection of *Toxoplasma* in Sheep and Goats

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The latent infection of *Toxoplasma* in human beings, swine, dogs and cats was proved parasitologically by the authors previously [6-9]. In sheep and goats no parasitological surveys have been conducted in Japan, except two performed by Maitani [11] and Tateyama et al. [14]. A large number of these animals are suspected to be infected latently with *Toxoplasma* on the basis of serological evidence [3, 12, 13]. In this experiment, therefore, sheep and goats kept on a farm located in Chiba Prefecture were examined parasitologically, as well as serologically, for the latent infection of *Toxoplasma*.

Apparently healthy animals, consisting of 26 sheep and 3 goats, were examined. They were sacrificed by bleeding from the common carotid artery. Immediately after death, autopsy was performed and the diaphragm was collected from all the animals for parasitological examination. From 4 sheep, the abdominal muscle, heart, brain, lung, liver, spleen, kidney, gastrointestinal tracts and contents, gastric, hepatic, pulmonary, small intestinal and large intestinal lymph nodes, chorioretinal coat, and humor vitreous were also obtained for isolation of *Toxoplasma*. These materials were

treated and inoculated into mice in the same manner as described previously [6, 9]. The serum of sheep and goats, and sheep blood absorbed to filter paper strips were submitted to serological examination. The former was examined by modified Sabin-Feldman's dye test [10] and hemagglutination test (HA test-2) [2], and the latter by the HA test (HA test-1) [2].

Toxoplasma organisms were isolated from 7 (26%) of the 26 sheep and 1 (33%) of the 3 goats (Table 1). Of the 7 sheep, 5 were among 22 in which only the diaphragm had been examined and 2 among 4 in which the diaphragm and other organs had been examined. Of the latter 2, one harbored *Toxoplasma* in the diaphragm, heart and brain, and the other in the abdominal muscle and lung (Table 2). No organisms were isolated from the liver, spleen, kidney, lymph nodes, gastrointestinal tracts or contents, or eyes. All the strains isolated from the 7 sheep and a strain from a goat were avirulent to mice, forming cysts in the brain even after serial passages.

At postmortem examination, lesions ascribed to *Toxoplasma* infection were not observed.

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Table 1. Isolation of *Toxoplasma* from sheep and goats

Animal	Specimen for isolation	Number examined	Number positive	%
Sheep	Diaphragm	22	5	22
	Diaphragm and other tissues*	4	2	50
	Total	26	7	26
Goat	Diaphragm	3	1	33

Remarks.

*: See Table 2 and text.

The results of serological tests are shown in Table 3. Of the 26 sheep, 17 (65%) were positive for the dye test, 11 (42%) for the HA test-1, and 18 (69%) for the HA test-2. All the sheep found to be infected were positive for both dye and HA tests. The recovery rate of organisms from serologically positive cases, however, varied depending upon the method of serological test. *Toxoplasma* organisms were isolated from 41% of the cases positive for the dye test, and 63% and 38% of the cases positive for the HA test-1 and -2, respectively. The recovery rate was rather high in the cases positive for the HA test-1. All the goats were positive for the HA test-2, but only one of them was positive for the dye test and proved to be infected parasitologically.

The presence of latent infection with

Table 2. Distribution of *Toxoplasma* in tissues of 2 sheep

Tissue	Sheep No.	
	149	70-31
Diaphragm	+	—
Abdominal muscle	—	+
Heart	+	—
Brain	+	—
Lung	—	+
Others*	—	—

Remarks.

*: See text.

Toxoplasma among apparently healthy sheep and goats kept on a farm was confirmed parasitologically in this experiment. Maitani [11] performed parasitological examination on the diaphragms of 26 sheep and 37 goats, all apparently healthy, and isolated *Toxoplasma* from 3 sheep (11.5%) and 10 goats (27.0%). Tateyama et al. [14] also isolated the organism from 4 (20%) of 20 apparently healthy goats in which the diaphragm had been examined. These results indicate that the infection rate is rather high among sheep and goats. The authors suggested in the previous paper [6] that the latent infection in swine is of importance from the viewpoint of meat hygiene in Japan. Although the ovine and caprine population or the number of

Table 3. Results of serological tests on sheep and goats

Animal	Number examined	Number infected	Number negative	Number positive					% positive {DT ≥ 1 : 16} {HA ≥ 1 : 64}		% infected among DT- or HA-positive cases		
				16*	64	256	1,024	4,096					
Sheep	26	7	Dye test	9	3	5 (1) **	6 (5)	2	1 (1)	65	17/26	41	7/17
			HA test-1	15	•	6 (3)	2 (1)	3 (3)	42	11/26	63	7/11	
			HA test-2	8	•	9 (1)	5 (4)	4 (2)	69	18/26	38	7/18	
Goat	3	1	Dye test	2			1 (1)			33	1/3	100	1/1
			HA test-2	0	•	1		2 (1)		100	3/3	33	1/3

Remarks.

*: Titer expressed as a reciprocal of the highest dilution appeared positive.

**: Figure in parentheses indicates the number of cases infected.

slaughtered sheep and goats is significantly smaller than that of swine in Japan, it seems that the role of sheep and goats cannot be disregarded in the epidemiology of toxoplasmosis, since the infection rate is rather high in the animals.

The authors showed previously that the most favorite site of localization of *Toxoplasma* was the striated musculature in the latent infection of cats, dogs and swine [6, 7]. In sheep, the striated musculature may also serve as a favorite site of localization of the organism. In fact, Jacobs et al. [4] performed a survey on sheep and reported that the diaphragm was the most consistently parasitized tissue, the psoas muscle the second, and the brain the least.

Although all the infected animals were positive for the dye and HA tests, the recovery rate of *Toxoplasma* from serologically positive animals varied depending upon the method of the serological test. Of the methods used for the serological diagnosis of the latent infection in apparently healthy cats, dogs and swine [1, 5], the dye test is regarded as the most reliable method. In the case of sheep, however, the organism was isolated most frequently from animals positive for the HA test-1 under this experimental condition. The reliability of the serological test in goats could not be evaluated, since the number of animals examined was limited in this study.

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