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Prevalence of *Cryptosporidium* in *Rattus rattus* and *R. norvegicus* in Japan

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Abstract

Fecal samples from 171 *Rattus rattus* (roof rats) and 47 *Rattus norvegicus* (brown rats) captured in Tokyo, Osaka, and Chiba, Japan, were examined for the presence of oocysts of *Cryptosporidium*. These animals were mainly obtained in department stores and buildings equipped with restaurants and grocery shops. Eighty-three (48.5%) of 171 roof rats and 10 (21.3%) of 47 brown rats were positive. The oocysts detected from the roof rats and brown rats were about 4.6 × 3.9 μm in size. The prevalence of *Cryptosporidium* in the roof rats decreased according to the body weight of animals. Male roof rats had a higher incidence than females. Recurrent discharging of oocysts was found in 4 of 7 naturally-infected roof rats kept in captivity. One naturally-infected roof rat discharged oocysts for more than 6 weeks. Roof rats and brown rats may be reservoir hosts for the transmission of *Cryptosporidium* to domestic animals, and possibly to man.

Key words: *Cryptosporidium, Rattus norvegicus, Rattus rattus,* natural infections, Japan

Introduction

Cryptosporidium is a coccidian protozoan recognized as a cause of gastroenteritis and diarrhea in man and animals (Fayer and Ungar, 1986; Tzipori, 1988). In immunocompetent humans the illness is self limiting and symptoms may be short-lived or persist for some weeks. However, in immunocompromised individuals, such as AIDS patients, the infection may cause a persistent, life-threatening diarrhea (Soave and Armstrong, 1986).

It has been suggested that domestic and wild animals play a role in the transmission of this parasite to humans or other mammalian species (Anderson *et al.*, 1982; Blagburn and Current, 1983; Klesius *et al.*, 1986). From this point of view, there have been many reports about the prevalence of *Cryptosporidium* in wild animals (Heuschele *et al.*, 1986; Iseki, 1986; Klesius *et al.*, 1986; Synder, 1988; Uga *et al.*, 1989).

Rattus rattus (roof rats) and *Rattus norvegicus* (brown rats) are significant wild animals that are common in urban environments, and they may become the source of fecal contamination affecting humans. This study was undertaken to determine the prevalence of *Cryptosporidium* in roof rats and brown rats in Tokyo, Osaka, and Chiba, Japan. Also, the pattern of oocyst shedding in roof rats naturally infected, which is an important factor in the ecology and epidemiology of *Cryptosporidium*, is reported.

Materials and Methods

One hundred and seventy-one roof rats and 47 brown rats were obtained from 9 districts in Tokyo, Osaka, and Chiba, Japan, from October 1988 to January 1989. They were mainly captured in buildings equipped with restaurants and grocery shops. Each animal was kept separately in a wire-cage placed on a tray containing water, and wet feces were collected respectively within 5 days after capture. Fecal examination was

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carried out for the presence of cryptosporidial oocysts by a centrifugal-flotation technique using a sugar solution (sp. gr. 1.20). Fresh oocysts floating on the surface of the sugar solution were examined at a magnification of ×600.

Seven roof rats that were positive for cryptosporidial oocysts at the first examination were examined for the pattern of oocyst shedding in the feces. Fecal samples from the 7 roof rats were collected at designated intervals of 3 to 5 days for 65 days, and fecal examinations were carried out.

Results

The prevalence of *Cryptosporidium* among roof rats and brown rats is shown in Table 1. All regions surveyed were positive for *Cryptosporidium* except for one location, F, where only 5 roof rats were captured. The prevalence in roof rats ranged from a high of 65.0% to a low of 14.3%, and that in brown rats ranged from 30.0% to 8.3%. In total 83 of 171 roof rats (48.5%) and 10 of 47 brown rats (21.3%) were positive for *Cryptosporidium*. As shown in Fig. 1, the prevalence of *Cryptosporidium* in roof rats decreased according to the body weight of rats. Furthermore, the mean body weight of positive rats (64.8 g) was lower than that of negative rats

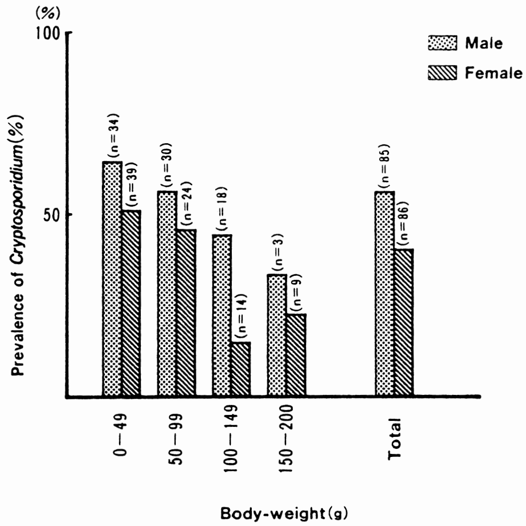

Fig. 1 Relationship between prevalence of *Cryptosporidium* and body weight and sex of *Rattus rattus*.

Table 1 The prevalence of *Cryptosporidium* among *Rattus rattus* and *R. norvegicus* in Japan

Hosts	Locality*	No. of rats examined	No. of rats infected (%)
Rattus rattus	A	51	22 (43.1)
	B	7	1 (14.3)
	C	31	18 (58.1)
	D	11	6 (54.5)
	E	20	13 (65.0)
	F	5	0 (0.0)
	G	46	23 (50.0)
	Total	171	83 (48.5)
Rattus norvegicus	B	12	1 (8.3)
	H	25	6 (24.0)
	I	10	3 (30.0)
	Total	47	10 (21.3)

* A, C, D : Department stores in Tokyo.
B : A department store in Osaka.
E, F, G : Buildings equipped with restaurants in Tokyo.
H : A reclaimed land in Tokyo Harbor.
I : A fish market in Chiba.

Table 2 The pattern of oocyst shedding in *Rattus rattus* naturally infected with *Cryptosporidium*

Host	Number of days after first examination and infection status.															
No.	0	4	7	11	15	20	25	30	34	39	43	47	51	55	60	65
1	+	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+
2	+	−	−	−	−	+	+	+	+	−	−	−	−	−	−	−
3	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−
4	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−
5	+	−	−	−	−	−	−	−	−	−	−	+	−	+	+	+
6	+	+	−	−	−	−	−	−	−	−	−	−	−	−	+	+
7	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−

+ : Positive of oocysts in the feces

−: Negative of oocysts in the feces

(82.2 g) ($p<0.01$; t-test). Male roof rats had a higher incidence than females. Oocysts from the roof rats and the brown rats were about $4.6 \times 3.9\,\mu m$ in size, and there were no morphological differences.

Seven roof rats that were positive for cryptosporidial oocysts were kept longer to determine the pattern of oocyst shedding (Table 2). Recurrent shedding of oocysts was observed in 4 of the 7 roof rats. One roof rat (No. 1) discharged oocysts for more than 6 weeks.

Discussion

Cryptosporidium is widespread in nature throughout the world. In Japan it has been reported in cats (Iseki, 1979), chickens (Itakura *et al.*, 1984; Nishikawa *et al.*, 1984), brown rats (Iseki, 1986), calves (Itakura *et al.*, 1985), guinea pigs (Muto *et al.*, 1984), swine (Yoshinaga *et al.*, 1988), and human (Suzuki *et al.*, 1986). Iseki (1986) reported cryptosporidial oocysts in brown rats. However, he could not detected cryptosporidial oocysts in three roof rats. The present study is the first report of *Cryptosporidium* in roof rats.

Many species have been reported in the genus *Cryptosporidium,* but the taxonomic status of genus *Cryptosporidium* is still confused. Tzipori *et al.* (1980) suggested that *Cryptosporidium* should be regarded as a single-species genus. Levine (1984) concluded that only 4 species of *Cryptosporidium* should be considered valid. Many other suggestions about species of *Cryptosporidium* have been made (Upton and Current, 1985; Current *et al.*, 1986). Upton and Current (1985) and Iseki (1986) reported large and small forms of oocysts of *Cryptosporidium* in calves and brown rats. In the present reports, a large form of oocysts was not detected in either rat species.

Many epidemiological studies of *Cryptosporidium* in wild animals have been carried out. Iseki (1986) reported that a small form of cryptosporidial oocyst was detected in 6 of 61 brown rats, and a large form of oocyst was detected in 3 out of the 61 brown rats. Klesius *et al.* (1986) reported that in wild mice, 30% of 115 mice shed oocysts. Synder (1988) reported that 13% of 100 fecal samples from raccoons (*Procyon lotor*) were positive for *Cryptosporidium* by indirect immunofluorescent detection. Uga *et al.* (1989) reported the incidence of *Cryptosporidium* in dogs and cats in Japan. Compared with previous reports, the incidence of *Cryptosporidium* is higher in the roof rats of the present report.

As shown in Fig. 1, the prevalence of *Cryptosporidium* in the roof rats decreased according to body weight, and male rats had a higher incidence than females. Such an age-related susceptibility to *Cryptosporidium* is generally well known (Fayer and Ungar, 1986; Sherwood *et al.*, 1982). Thomson *et al.* (1987) reported that the boy/girl ratio in 48 cases of human cryptosporidiosis was 1.6: 1. However, Soave *et al.* (1989) reported that of 18 patients found to have *Cryptosporidium,* 7 were male and 11 were female. Further investigations and experimental infections are needed to elucidate a sex dependent susceptibility.

Four of 7 roof rats examined for patterns of oocyst shedding showed recurrent shedding of oocysts, and one shed oocysts for more than 6 weeks. Iseki (1979) and Iseki *et al.* (1989) reported a similar long period of oocyst discharge in naturally-infected cats, and in mice experimentally infected with *Cryptosporidium*. Furthermore, in immunodeficient humans, such as AIDS patients, persistent infection by *Cryptosporidium* is common (Soave and Armstrong, 1986). In immunocompetent individuals, the duration of oocyst shedding is reported to range from 8 to more than 50 days (Stehr-Green *et al.*, 1987) or 9 to 50 days (Shepherd *et al.*, 1988). Recurrent discharging of oocysts has been reported in experimentally-infected wild mice (Klesius *et al.*, 1986). The immune status of the host appears to be an important factor in such phenomena.

In this study the roof rats and brown rats examined were mainly captured in buildings equipped with restaurants and grocery shops, so that the role of roof rats and brown rats as potential reservoirs for cryptosporidiosis in humans may be very important. The pathogenicity of isolates of *Cryptosporidium* from roof rats and brown rats to other mammalian species, including humans, is not known. Additional information is needed on the infectivity of isolates of *Cryptosporidium* from roof rats and brown rats.

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