Helminth Survey of Wildcats in Japan

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ABSTRACT. Two Iriomote cats (Felis iriomotensis) and 2 Tsushima leopard cats (Felis bengalensis eupilura) killed probably by traffic accidents were submitted to the helminthological examination. In Iriomote cats, 8 species of parasites (Spirometra erinacei, Toxocara cati, Molineus springsmithi, Uncinaria maya, Capillaria aerophila, C, felis-cat, larvae of an unidentified lung worm and one species of Acanthocephala) were found. In Tsushima leopard cats, 10 species of parasites (Pharyngostomum cordatum, Spirometra erinacei, Toxocara cati, Molineus springsmithi, Arthrostrongylus duodenalis, Uncinaria felidis, Capillaria felis-cat, larvae of an unidentified lung worm, and two species of Acanthocephala) were detected.—KEY WORDS: Felis bengalensis eupilura, Felis iriomotensis, helminthological survey.


There are two species of wildcats in Japan; Iriomote cats (Felis iriomotensis) and Tsushima leopard cats (Felis bengalensis eupilura). Both wildcats are the natural monument of Japan. They are assumed now small in population and currently represent endangering species. Although infectious diseases are supposed to be one of endangering factors for the wild animals, only a little information could be available on the diseases of these wildcats. Ten species of helminth parasites have been reported from Iriomote cats (5 trematodes, 2 cestodes, and 3 nematodes) [1, 7–10]. On the other hand, in Tsushima leopard cats were found 15 species of helminths (2 trematodes, 3 cestodes, 9 nematodes and 2 acanthocephala) [13, 15, 17]. This paper presents the results of surveys on helminths of Iriomote cats and Tsushima leopard cats that died probably from traffic accidents.

MATERIALS AND METHODS

Two Iriomote cats were examined parasitologically. One mature male (No. 1), 3,320 g in body weight, was found dead in February, 1993, with a fracture of the mandibular bone and a rupture of the abdominal wall. The other mature male (No. 2), 3,000 g in body weight, was captured in April, 1993, with a fracture of the mandibular bone and died a few days later.

Two Tsushima leopard cats were examined. One mature female (No. 1), 2,590 g in body weight, was found dead in April, 1993, with serious bleeding at the right hip bone. The other mature male (No. 2), 2,890 g in body weight, was found dead in June, 1993, with a rupture of the lung.

Nematodes, acanthocephala and cestodes from the 4 wildcats were fixed in 5% phosphate buffered saline formalin solution and cleared in lactophenol solution. Trematodes and some of cestodes were flattened and stained with potassium alum solution, and observed under the light microscope.

Measurements are given as the mean with the ranges in parentheses.

RESULTS

From Iriomote cats, 8 species of parasites were found; 1 cestode, 6 nematodes, and 1 acanthocephala. From Tsushima leopard cats, 10 species of parasites were found; 1 trematode, 1 cestode, 6 nematodes and 2 acanthocephala (Table 1).

Trematode: Pharyngostomum cordatum found in the jejunum of Tsushima leopard cat No. 1 was white and looked like sesame seeds. One specimen flattened with a coverslip, 1.97 mm long by 1.24 mm in maximum width. Anterior oral sucker, at the anterior extremity with 0.171 mm long and 0.109 mm wide.

Cestode: Spirometra erinacei was found from the small intestine of two Iriomote cats and Tsushima leopard cat No. 2. The worms from Iriomote cats (n=19), 181 (135–248) mm long, number of proglottids 195 (105–277), scolex 1.14 (0.781–1.38) mm long, ventrodorsal thickness 0.39 (0.34–0.53) mm and maximum proglottid 2.21 (1.51–2.45) mm long by 2.52 (1.78–3.01) mm wide. S. erinacei from Iriomote cats (n=1) was 309 mm long, number of proglottids 377, scolex 1.38 mm long, ventrodorsal thickness 0.42 mm and maximum proglottid 1.63 mm long by 3.39 mm wide.

Nematodes: Toxocara cati was obtained from two Iriomote cats and from Tsushima leopard cat No. 1. Most of T. cati from both wildcats were immature, and many of them were found in the stomach.

Uncinaria maya was obtained from the intestine and colon of Iriomote cat No. 2. U. felidis was found in the intestine and colon of two Tsushima leopard cats.

Molineus springsmithi was obtained from the intestine of Iriomote cat No. 1, and from the stomach, small intestine and colon of two Tsushima leopard cats. Measurements of M. springsmithi from Iriomote cat No. 1

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Table 1. Species, number and sex of helminths obtained from wildcats in Japan

<table>
<thead>
<tr>
<th>Helminths</th>
<th>Sex of helminths</th>
<th>Irionote cats</th>
<th>Tsushima leopard cats</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. 1</td>
<td>No. 2</td>
<td>No. 1</td>
</tr>
<tr>
<td>Trematode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharyngostomum cordatum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cestode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spioroeca erinacei</td>
<td>12(152)*</td>
<td>7*</td>
<td></td>
</tr>
<tr>
<td>Nematodes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toxocara cati</td>
<td>1(1)</td>
<td>1(3)</td>
<td></td>
</tr>
<tr>
<td>Uncinaria maya</td>
<td>16(12)</td>
<td>11</td>
<td>199</td>
</tr>
<tr>
<td>Uncinia fieldii</td>
<td>(4)</td>
<td>14</td>
<td>221</td>
</tr>
<tr>
<td>Molnus springsmithi</td>
<td>3</td>
<td>48</td>
<td>649</td>
</tr>
<tr>
<td>Arthrostrongylus humanensis</td>
<td></td>
<td>246</td>
<td>261</td>
</tr>
<tr>
<td>Capillaria aerophila</td>
<td>1</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Capillaria felis-catii</td>
<td>27</td>
<td>47</td>
<td>222</td>
</tr>
<tr>
<td>Unidentifiable larvae</td>
<td>many</td>
<td>many</td>
<td>many</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acanthocephala</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polymorphidae gen. sp. 1</td>
<td>(2)</td>
<td>(4)</td>
<td></td>
</tr>
<tr>
<td>Polymorphidae gen. sp. 2</td>
<td>(5)</td>
<td>(2)</td>
<td></td>
</tr>
<tr>
<td>Polymorphidae gen. sp. 3</td>
<td>(3)</td>
<td>(3)</td>
<td></td>
</tr>
</tbody>
</table>

In parentheses are shown the number of immature larvae.

* Numbers of trematodes and cestodes are shown midway between males and females because of their hermaphroditism.

were as follows: Male (n=3), 3.31 (3.20–3.43) mm long by 0.062 (0.058–0.066) mm wide. Female (n=8), 4.46 (4.00–4.68) mm long by 0.070 (0.066–0.074) mm wide.

*M. springsmithi* was obtained in greater numbers from Tsushima leopard cats than from one Irionote cat. Measurements were as follows: Male (n=20), 2.72 (2.11–3.11) mm long by 0.053 (0.041–0.075) mm wide. Female (n=20), 3.77 (3.11–4.57) mm long by 0.056 (0.047–0.086) mm wide.

*Arthrostrongylus humanensis* was obtained from Tsushima leopard cat No. 2 in the bile duct and also in the stomach, small intestine and colon. Measurements were as follows: Male (n=20), 5.54 (4.82–6.41) mm long by 0.181 (0.158–0.213) mm wide. Female (n=20), 6.10 (5.78–6.67) mm long by 0.206 (0.179–0.229) mm wide.

*Capillaria aerophila* was found in the trachea of two Irionote cats. Most of the worms were decomposed. Measurements were as follows: Male (n=1), 15.63 mm long by 0.054 mm wide. Ratio of esophageal to intestinal length 0.95. Female (n=9), 23.39 (20.49–27.06) mm long by 0.111 (0.092–0.126) mm wide. Ratio of esophageal to intestinal length 0.54 (0.50–0.61).

*Capillaria felis-catii* occurred only in the bladder. Measurements of worms from Irionote cats were as follows: Male (n=20), 10.24 (8.63–11.23) mm long by 0.055 (0.048–0.070) mm wide. Ratio of esophageal to intestinal length 0.70 (0.54–0.84). Female (n=20), 10.90 (9.37–12.66) mm long by 0.074 (0.051–0.087) mm. Ratio of esophageal to intestinal length 0.63 (0.53–0.75). Measurements of *C. felis-catii* from Tsushima leopard cats were as follows: Male (n=2), 11.58 (10.73–12.43) mm long by 0.054 (0.053–0.055) mm wide. Ratio of esophageal to intestinal length 0.69 (0.65–0.73). Female (n=6), 13.86 (12.56–14.08) mm long by 0.062 (0.056–0.065) mm wide. Ratio of esophageal to intestinal length 0.45 (0.37–0.49).

Unidentifiable nematode larvae were found in the trachea and feces in the rectum of all the wildcats examined. The larvae (n=20), 0.358 (0.340–0.369) mm long by 0.016 (0.015–0.018) mm wide, tail length 0.024 (0.022–0.027) mm with a characteristic S-shaped tip and length of genital primordium 0.028 (0.025–0.030) mm.

*Acanthocephala*: One species (Polymorphidae gen. sp. 1) and two species (Polymorphidae gen. sp. 2 and Polymorphidae gen. sp. 3) were obtained from the small intestine of Irionote cat No. 1 and of Tsushima leopard cat No. 1, respectively. Polymorphidae gen. sp. 1 (Fig. 1) from Irionote cat No. 1, white and like a pin of bowling game. Hooks, orderly arranged on the elliptical proboscis in 20–22 rows with 9–11 each, crown-shaped in the first 5–7th rows and small spine in more posterior rows. Proboscis sheath composed of two layers of slender membrane arising from the last quarter of proboscis. Measurements of worms were as follows: Male (n=2), 1.86 (1.57–2.15) mm long by 0.66 (0.63–0.69) mm in maximum width, thicker in posterior body. Proboscis sheath 0.83 (0.75–0.97) mm long by 0.31 (0.25–0.37) mm.
Fig. 1. Polymorphidae gen. sp. 1. A juvenile female from the small intestine of Iriomote cat No. 1. Bar = 200 μm
Fig. 2. Proboscis of the worm in Fig. 1. Bar = 100 μm
Fig. 3. Polymorphidae gen. sp. 2. A juvenile female from the small intestine of Tsushima leopard cat No. 1. The worm is nearly the same in size that in Fig. 1. Bar = 200 μm
Fig. 4. Proboscis of the worm in Fig. 3. Bar = 100 μm
Fig. 5. Polymorphidae gen. sp. 3. A juvenile female from the small intestine of Tsushima leopard cat No. 1. The worm is larger in size than the other 2 species. Bar = 400 μm
Fig. 6. Proboscis of the worm in Fig. 5. Bar = 200 μm
wide. Female (n=4), 2.34 (2.08–2.43) mm long by 0.51 (0.50–0.53) mm in maximum width. Proboscis sheath 0.74 (0.67–0.79) mm long by 0.16 (0.13–0.18) mm wide. 

Polymorphidae gen. sp. 2 (Fig. 2) from Tsushima leopard cat No. 1, small. Hooks, orderly arranged on the elliptical proboscis in 22–26 rows with 12–14 each. Trunk smooth without spine. Proboscis sheath composed of two layers of slender membrane. Measurements of worms were as follows: Male (n=5), 2.25 (1.95–2.32) mm long by 0.72 (0.67–0.74) mm in maximum width. Proboscis sheath 0.62 (0.56–0.64) mm long by 0.18 (0.13–0.25) mm wide. Two testes elliptical, separated from each other. Cement glands long. Female (n=2), 2.42 (2.25–2.59) mm long by 0.96 (0.87–1.05) mm in maximum width. Proboscis sheath 0.64 (0.59–0.69) mm long by 0.22 (0.19–0.25) mm wide. 

Polymorphidae gen. sp. 3 (Fig. 3) from Tsushima leopard cat No. 1. All the worms were female. Hooks, orderly arranged on the elliptical proboscis in 34 rows with 8–9 each. Measurements of worms were as follows: (n=3) 3.92 (3.64–4.10) mm long by 0.94 (0.90–0.96) mm in maximum width. Proboscis sheath 1.24 (1.19–1.27) mm long by 0.33 (0.28–0.37) mm wide. Uterus containing no eggs.

**DISCUSSION**

*P. cordatum* was the only one species of trematode from Tsushima leopard cat No. 1. Most worms were decomposed and the ventral sucker, testis, ovary and eggs could not be observed. While fine structures were difficult to be measured, morphological findings and the body size almost agreed with those of *P. cordatum* [12]. This species of parasite had been obtained from Tsushima leopard cats [13, 18], and immature worms were also found in Iriomote cats [8]. *P. cordatum* is widely distributed from Southeast Asia to Europe and is also seen mainly in the western area of Honshu, Japan. Recently wide range of the infestation was known among Japanese domestic cats.

*S. erinacei* was the only cestode found in this survey except in Tsushima leopard cat No. 1. Detection of this parasite might suggest the wide distribution among the wildcats. The body size of *S. erinacei* found in this study agreed with those having been reported [8, 13, 18].

The nematodes detected included 8 species. Although *T. cati* and *Toxascaris leonina* are prevalent among felines, *T. cati* has been the only species from the wildcats in Japan.

*Molineus springsmithi* was also found in both species of wildcats and found in one Tsushima leopard cat in large numbers. Especially in the case of Tsushima leopard cats, worms were distributed in the whole length of intestine. *M. springsmithi* was first reported from East Nepal wildcats (*Felis bengalensis horsfieldi*) [11]. The subspecies, *M. s. yayeyamanus*, has been also obtained from Iriomote cats [18]. A nematode from Iriomote cats was almost morphologically similar to *M. s. yayeyamanus* except for a subtle difference in the length of ventral ray of male worms. A nematode from Tsushima leopard cats was different in the smaller size and the longer spicule from *M. s. yayeyamanus*, and in the shorter esophagus and longer spicule from *M. springsmithi* [18]. More study is necessary to identify whether this nematode is the subspecies or not. There is no document on this parasite from Japanese domestic cats, and the wildcat seems to be a predilection host.

*Anystostoma tubaeforme* prevails among Japanese domestic cats and has been detected in both Iriomote cats and Tsushima leopard cats [8, 18]. However, it was not detected in the present study. *Arthrostrongylus hunanensis* belonging to the family Ancylostomatidae was first found from Chinese wildcats [3] in the bile duct as definitive infection site. Many worms were found in the bile duct, pancreatic duct, stomach, small intestine and colon of Tsushima leopard cats. This worm has been found only in Tsushima leopard cats in Japan [17, 18]. Peroral experimental infection of domestic cats revealed *A. hunanensis* to be parasitic in the pancreatic duct [18].

Two species of *Uncinaria* spp. were detected in this survey. One from Tsushima leopard cats was identified as *U. felidis* based on the shape of preupal flat according to Olsen’s documentation on *Uncinaria* spp. [14]. The other from Iriomote cats was similar to *U. maya* reported by Hasegawa from Iriomote cats [10].

Capillaria aerophila and *C. felis-catii* have been detected from Tsushima leopard cats [18]. In Iriomote cats, however, no worm of *Capillaria* spp. has been found except some eggs of the genus in previous reports. Therefore, species of these eggs has not been determined [7]. In the present study, the nematode found in the trachea of Iriomote cats was recognized as *C. aerophila* from their infection sites and morphology.

*Capillaria* worms found in the bladder of the 4 wildcats were recognized as *C. felis-catii* on the basis of their morphology and size.

Detection of larvae but not eggs of nematode from the bronchi and feces in the rectum of all 4 wildcats suggests ovoviviparity of the nematodes. Parasitism in the lung, ovoviviparity and a characteristic S-shaped tail of the larvae indicated that they are those of *Filarioidea* sp. or a closely related species [6]. The species of the worms, however, was unable to be identified because of the absence of intact mature worms. Nematode larvae have been found in feces of Iriomote cats [7], that were the same in size and shape as those in this study. The nematode seemed to be prevalent among the Japanese wildcats.

Three species of Acanthocephala could not be identified more precisely because of poor preservation of the internal structures in addition to their immaturity. One species from one Iriomote cat and another species from one Tsushima leopard cat were similar to each other in size and morphology. The differences between these two species were the number of longitudinal rows of hooks, the number of hooks in each row, and the shape of gonopore in females. Another species from one Tsushima leopard cat was larger in size than the other 2 species and
slightly different in shape. Acanthocephala was classified into 3 classes and 8 orders by Cheng [4]. *Centrotrynchus* sp. [15] and the family Oligacanthorhynchidae [2] have been obtained from domestic cats and immature larvae of *Porrorchis* sp. [13] from Tsushima leopard cats in Japan. It is probable that Acanthocephala is accidentally detected in domestic cats that ingested birds, the predilection host of this worm. Three species of Acanthocephala detected in the study were considered those of the order Polymorphida [4, 5, 16]. They were unidentifiable to the level of species on account of poor preservation of the inner structures of the parasites by freezing the host animals. The worms seemed to have high pathogenicity because the worms attached themselves firmly to the mucosa.

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