Zoonotic Intestinal Trematodes in Stray Cats (Felis catus) from Riverside Areas of the Republic of Korea

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Abstract: The present study was performed to survey the infection status of zoonotic intestinal trematode (ZIT) in stray cats from 5 major riverside areas in the Republic of Korea. Total 400 stray cats were captured with live-traps in riverside areas of Seomjingang (‘gang’ means river) (203 cats) from June to October 2010, and of Yeongsangang (41), Nakdonggang (57), Geumgang (38), and Hangang (61 cats) from June to October 2011, respectively. Small intestines dissected from cats were opened with a pair of scissors in a beaker with 0.85% saline and examined with naked eyes and under a stereomicroscope. More than 16 ZIT species were detected in 188 (92.6%) cats from Seomjingang areas, and the number of worms recovered was 111 per cat infected. In cats from riverside areas of Yeongsangang, Nakdonggang, Geumgang, and Hangang, more than 9, 8, 3, and 5 ZIT species were recovered, and the worm burdens were 13, 42, 11, and 56 specimens per infected cat, respectively. As the members of family Heterophyidae, more than 10 species, i.e., Metagonimus spp., Pygidiopeps summa, Heterophyes nocens, Stellantchasmus falcatus, Heterophyopsis continua, Acanthotrema felis, Centrocestus armatus, Procerovum varium, Cryptocotyle concava, and Stictodora larj, were recovered. More than 5 species of echinostomes, i.e., Echinostoma hortense, Echinochasmus japonicus, Echinochasmus sp., Echinoparyphium sp., and unidentified larval echinostomes, were collected. Plagiorchis spp. were detected in cats from areas of Seomjingang and Yeongsangang. From the above results, it has been confirmed that stray cats in 5 major riverside areas of Korea are highly infected with various species of ZITs.

Key words: Metagonimus spp., Pygidiopeps summa, Heterophyes nocens, Stellantchasmus falcatus, zoonotic intestinal trematode, stray cat, riverside area, Korea

INTRODUCTION

The stray cat (Felis catus), a powerful predator, actively consumes the wide-ranged foodstuff, which originated from various kinds of prey animals. That’s why this predator animal is highly infected with various species of parasites, and act as the important reservoir host of human and veterinary parasites. Surveys on intestinal parasite infections in stray or feral cats have been conducted in various regions of the world including the Republic of Korea (Korea) [1-14]. Especially, in Korea, more than 21 species of zoonotic intestinal trematodes (ZITs) from cats have been reported in the literatures [7,8,11-14].

On the other hand, soil-transmitted nematodiases are no longer public health problems in these days in Korea. Meanwhile, infections with zoonotic trematodes including Clonorchis sinensis are important parasitic diseases in endemic areas, especially in riverside areas [15-18]. Moreover, these trematodes show the low host-specificity, and then many kinds of reservoir hosts can contribute to the maintenance of their life cycles. Therefore, we have been trying to survey on the infection status of ZITs in stray cats from the Riverside areas of 5 major rivers in Korea, and to estimate these predator animals as the potential reservoir hosts for ZITs.

MATERIALS AND METHODS

We captured total 203 stray cats with live-traps in Riverside areas of Seomjingang (‘gang’ means river) from June to October 2010. We also collected with the same manner 41, 57, 38, and 61 stray cats in Riverside areas of Yeongsangang, Nakdonggang, Geumgang, and Hangang from June to October 2011 respectively. Their small intestines were isolated and longitudi-
nally opened with a pair of scissors in a beaker with 0.85% saline, and washed with saline until the supernatant is cleared. The sediment of intestinal content was carefully examined with naked eyes and under a stereomicroscope. The collected worms were fixed with 10% neutral buffered formalin under the slight pressure of cover glass, stained with Semichon's acetocarmine and observed under a light microscope with a micrometer (OSM-4, Olympus Co.). The stained specimens of ZITs were identified based on the appropriate systematic keys with morphological characteristics and dimensions. Then, each ZIT species identified was counted to get hold of infection rates and densities per cat infected.

**RESULTS**

**Overall infection status of ZITs**

Among the total 400 cats examined, 178 (44.5%) were negative for ZITs, and 222 (55.5%) were positive for more than 1 ZIT species (Table 1). Among the positive cats, 121 (30.0%) was infected with 1 species of ZIT. Only 1 cat from a riverside area of Nakdonggang was infected with more than 7 species of ZIT. The ZIT prevalence by the surveyed area is presented in Table 1.

**Infection status of ZIT in cats from Seomjingang areas**

More than 16 species of ZIT were recovered in 188 (92.6%) cats from the Seomjingang area (Table 1). The most prevalent species was Metagonimus spp. followed by Pygidiopsis summa and Heterophyes nocens. The overall worm recovery in the small intestines of 203 stray cats from riverside areas of Seomjingang (= Seomjin River) is shown in Table 2. The total number of worms recovered was 20,821, of which Echinochasmus spp. accounted for 10,768 (566.7). Among the unidentified larval echinostome, Cryptocotyle concava (2) and Centrocestus armatus (4) were the most common. The infection rate of unidentified species was 1.7.

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**Table 1.** Recovery of intestinal trematodes by the number of species detected in cats from riverside areas of 5 major rivers, Korea

| No. of species detected | No. (%) of cats positive from riverside areas of | SJG | YSG | NDG | GG | HG | Total |
|------------------------|-----------------------------------------------|-----|-----|-----|----|----|-------|
| Negative               | 94 (46.3)                                    | 16 (39.0) | 25 (43.9) | 20 (52.6) | 23 (37.7) | 178 (44.5) |
| 1 sp.                  | 59 (29.1)                                    | 13 (31.7) | 15 (26.3) | 14 (36.8) | 20 (32.6) | 121 (30.0) |
| 2 spp.                 | 35 (17.2)                                    | 5 (12.2) | 7 (12.3) | 4 (10.5) | 7 (11.5) | 58 (14.5) |
| 3 spp.                 | 9 (4.4)                                      | 5 (12.2) | 5 (8.8) | - | 7 (11.5) | 26 (6.5) |
| 4 spp.                 | 5 (2.3)                                      | - | 2 (3.5) | - | 2 (3.3) | 9 (2.3) |
| 5 spp.                 | -                                           | 1 (2.4) | - | - | 2 (3.3) | 3 (0.75) |
| 6 spp.                 | 1 (0.5)                                      | 1 (2.4) | 2 (3.5) | - | - | 4 (1.0) |
| 7 spp.                 | -                                           | - | 1 (1.8) | - | - | 1 (0.25) |
| Total                  | 203 (100)                                    | 41 (100) | 57 (100) | 38 (100) | 61 (100) | 400 (100) |

SJG, Seomjingang (=Seomjin River); YSG, Yeongsangang; NDG, Nakdonggang; GG, Geumgang; HG, Hangang.

**Table 2.** Results of worm recovery in the small intestines of 203 stray cats from riverside areas of Seomjingang (= Seomjin River)

| Trematode recovered | No. (%) of cats positive | No. of worms recovered |
|---------------------|--------------------------|-----------------------|
| Total               | 188 (92.6)*              | 20,821                |
| Metagonimus spp.    | 61 (30.0)                | 6,446                 |
| Pygidiopsis summa   | 33 (16.3)                | 2,734                 |
| Heterophyes nocens  | 29 (14.3)                | 375                   |
| Stellantchasmus falcatus | 6 (3.0) | 216                   |
| Heterophyopsis continua | 5 (2.5) | 37                   |
| Acanthotrema fels    | 5 (2.3)                  | 35                    |
| Centrocestus armatus | 4 (2.0) | 2                     |
| Cryptocotyle concava | 2 (1.0) | 1                     |
| Stictodora lari      | 1 (0.5)                  | 1                     |
| Echinochasmus spp.  | 19 (9.4)                 | 10,768                |
| Echinostoma hortense | 2 (1.0) | 28                    |
| Echinoparyphium sp. | 1 (0.5)                  | 63                    |
| Unidentified larval echinostome | 9 (4.4) | 85                    |
| Plagiorchis spp.    | 8 (3.9)                  | 11                    |
| Unidentified spp.   | 3 (1.5)                  | 5                     |

*Cumulative positive rate.

* Mixed-infection including a dominant species, *Echinochasmus japonicus*. 

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cats from Seomjingang areas. The number of worms recovered was 111 per cat infected. *Metagonimus* spp. (30.0%) were the most prevalent, followed by *P. summa* (16.3%), *H. nocens* (14.3%), and *Echinochasmus* spp. (9.4%). A cat was extraordinarily infected with about 9,600 *Echinochasmus* spp. The infection status of each ZIT species is shown in Table 2.

**Infection status of ZIT in cats from riverside areas of 4 major rivers**

More than 9 species of ZIT were recovered in 25 (61.0%) cats from Yeongsangang areas. The average number of worms recovered was 12.5 per cat infected. *H. nocens* was most highly prevalent and recovered from 8 (19.5%) cats. Total 45 (79.0%) cats from Nakdonggang areas were infected with ZITs (more than 8 species), and the average number of specimens recovered per cat was 42.2. *H. nocens* (21.1%), *Metagonimus* spp. (17.5%), and *P. summa* (17.5%) were prevalent in cats from Nakdonggang areas. Only 3 cats (7.9%) from Geumgang areas were infected with a total of 33 ZIT specimens. More than 5 species of ZIT were recovered in 22 (36.1%) cats from Han-gang areas. The number of worms recovered was 56 per infected cat. *Metagonimus* spp. was most highly prevalent and recovered from 13 (21.3%) cats. The infection status of each ZIT species by surveyed areas is shown in Table 3.

**DISCUSSION**

Studies on ZIT infections in cats have been done by several workers in Korea. Lee [7] reported 5 species of ZIT, i.e., *H. nocens*, *M. yokogawai*, *Centrocestus sp.*, *Echinococbus perfoliatus*, and *Echinoparyphium* sp., from cats captured in Geungosang-buk-do. Eom et al. [8] described 3 species of ZIT, *H. continua*,
H. nocens, and P. summa, collected in domestic cats from Seoul. Sohn et al. [11] recorded Ananthotrema felis, as a new species, from the small intestines of stray cats from a market in Busan. Sohn and Chai [12] added more than 15 species of ZITs in the fauna of cat trematodes, and Shin et al. [13] reported Gymnophallioles soei found in feral cats from Shinan-gun, Jeollanam-do. Chai et al. [14] clarified species names of some ZITs recorded by Sohn and Chai [12] in the faunistic point of view. Thus far, more than 23 species, i.e., Metagonimus spp., Heterophyes nocens, Heterophyopsis continua, Pgydiopsis summa, Stellantchasmus falcatus, Stictodora fuscat, Stictodora lari, Ananthotrema felis, Centrocestus armatus, Procerovum variurn, Cryptocotyle conca-
vum, Echinostoma hortense, Echinostoma revolutum, Echinocococcus japonicus, Echinocococcus perfoliatus, Echinocococcus sp., Echinoparyphium sp., Stephanoprora sp., Neodipllostomum seoulense, Plagiorchis muri, Plagiorchis sp., Gymnophallioles soei, and Eurytrema pancreati
tum, have been reported as the ZITs recovered from cats in Korea [7,8,11-14].

In the present study, 178 (44.5%) out of 400 stray cats ex
amined were negative for ZIT, while the remaining 222 (55.5%) were infected with 1-7 species of ZITs. The cumulative positive rate of ZIT was the highest in cats from Seomjingang areas (92.6%), and lowest in cats from Geumgang areas (7.9%). The worm burden (intensity of infection) was also the highest in cats from Seomjingang areas (111 worms per cat infected), and lowest in cats from Geumgang areas (11 worms). However, direct comparison of ZIT endemicity by the surveyed areas in the present study seems unreasonable. The survey in the Seomjingang areas was performed from June to October 2010, and a total of 203 stray cats were captured and examined. Whereas, the surveys in the adjacent areas of 4 rivers, Yeongsangang, Nakdonggang, Geumgang, and Hangang, were conducted from June to October 2011, and only 38-61 cats (total 197) were captured and examined. The number of cats examined was relatively high in the areas of Seomjingang, but it is considered not enough in the other 4 river areas for evaluation of the ZIT endemicity. More than 9 species of heterophyid flukes, i.e., Metagonimus spp., P. summa, H. nocens, S. falcatus, H. continua, A. felis, C. armatus, C. concava, and S. lari, were detected in 146 (72.0%) cats from Seomjingang areas. Among these, Metagonimus spp. were the most frequently detected (in 61 cats: 30.0%), and P. summa and H. nocens were found from 33 (16.3%) and 29 (14.3%) cats, respectively. These findings are in accordance with those of previous studies; the adjacent areas of Seomjin-
gang and the coastal areas of Namhae (the southern sea) are endemic areas of heterophyidiases including metagonimiasis [19-22]. Sohn and Chai [12] surveyed stray cats from a local market of Busan and found that H. nocens was the most prevalent ZIT (from 24.2% cats), and P. summa, Metagonimus spp., and H. continua were detected in 21.0%, 17.8%, and 13.2% of cats, respectively. The most prevalent ZIT, Metagonimus spp. comprised 3 species, i.e., M. yokogawai, M. takahashii, and M. miyatai, distributed in Korea [23]. Although the distribution pattern of the uterine tubule of M. yokogawai is different from those of the latter 2 species, they are difficult to distinguish from each other in fresh worm samples.

Three species of heterophyid flukes, A. felis, C. concava, and S. lari, were found only in cats from Seomjingang areas. P. vari
um, described with only 2 adults by Chai et al. [14] for the first time in Korea, was detected in cats from the areas of Yeongsangang and Nakdonggang. Whereas, Metagonimus spp. were found in cats from all surveyed areas. P. summa, H. nocens, and S. falcatus were detected in cats from 4 surveyed areas except Geumgang areas.

An echinostomatid fluke, E. hortense, the dominant species in Korea, was found in cats from the areas of Seomjingang, Yeongsangang, and Nakdonggang. Also Echinocococcus spp. (including E. japonicus), Echinoparyphium sp., and unidentified larval echinostomes were detected in a small number of cats. Extraordinarily, about 9,600 Echinocococcus spp. specimens (including E. japonicus) were recovered in a cat from Seomjin
gang area, and 63 Echinoparyphium sp. were collected in another cat from Seomjingang area. Two species of Echinocococcus, i.e., E. japonicus and E. perfoliatus, and Echinoparyphium sp. were already reported as cat trematodes in Korea [7,12,14]. However, E. perfoliatus and Echinoparyphium sp. were poorly and erro
neously described with 2 and 1 worm samples, respectively, and the genus- and/or species-specific characteristics are not obvious to approve their taxonomic validities. Therefore, in faunistic points of view, these obscure problems should be solved in the near future with the worm samples of Echinococ
coccus spp. and Echinoparyphium sp. recovered in the present study.

Nowadays, fishborne trematode (FBT) infections are the most important parasitic diseases in the riverside areas of Korea. People in the endemic areas have been subjected to the control projects by the Korea CDCP (Centers for Disease Control and Prevention), and human excrements have been hy
gienically dealt with in the sewage disposal plant in Korea [15-
17]. However, the endemicity of FBT infections is continuously maintained in these areas. If it is so, what kind of animals (definitive hosts) are acting as the egg-supplier in the ecological environment? In the present study, we could confirm that stray cats from riverside areas are infected with various species of ZITs. It is suggested strongly that stray cats play an important role of a reservoir host for ZITs.

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Conflict of Interest

We have no conflict of interest related to this work.

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