

Intestinal Parasites among Wild Rodents in Northern Gangwon-do, Korea

Young-Il Lee¹, Hee-Jang Pyeon¹ and Min Seo^{2,*}

Departments of ¹Anatomy, ²Parasitology, College of Medicine, Dankook University, Cheonan 330-714, Korea

Abstract: To determine geographical patterns of natural parasite infections among wild rodents, a total of 46 wild rodents from 3 different localities in northern Gangwon-do (Province), Korea were examined for intestinal parasite infections. Along with nematodes such as hookworms and *Syphacia* spp., *Plagiorchis muris* (2 specimens) (Trematoda) were collected from striped field mice, *Apodemus agrarius*. In a Korean wood mouse, *Apodemus peninsulae*, the overall nematode infections were similar to *A. agrarius*, but an adult worm of *Echinostoma hortense* (Trematoda) was collected. In addition, 2 species of cestodes, i.e., *Hymenolepis nana* and *Hymenolepis diminuta*, were collected from *A. agrarius*. Through this survey, *A. agrarius* and *A. peninsulae* were confirmed as the natural definite hosts for zoonotic intestinal helminths, i.e., *P. muris*, *E. hortense*, *H. nana*, and *H. diminuta*, in northern Gangwon-do, Korea. Considering increased leisure activities around these areas, seasonal and further comprehensive surveys on wild rodents seem to be needed to prevent zoonotic parasite infections.

Key words: *Plagiorchis muris*, *Echinostoma hortense*, *Apodemus agrarius*, *Apodemus peninsulae*, Gangwon-do

Since rodents can be natural final hosts of intestinal trematodes, several studies have been performed on parasitic infections among rodents. For example, *Neodiplostomum seoulense*, originally recovered from a house rat in 1964, was subsequently discovered in a man with epigastric pain, suggesting the role of rodents as a reservoir host for this trematode infection [1]. Moreover, echinostomes were reported in rats collected in Seoul, Yangyang-gun (Gangwon-do), Goyang-gun (Gyeonggi-do), Iksan-gun (Jeollabuk-do), and northern Gyeonggi-do near the demilitarized zone (DMZ), the Republic of Korea (= Korea) [2-5].

The prevalence of *Plagiorchis muris*, recently proved to be a human intestinal trematode, had also been surveyed in endemic areas. The adult worms of *P. muris* were discovered in rodents from Hadong-gun (Gyeongsangnam-do), Yongin-si (Gyeonggi-do), and Yangyang-gun (Gangwon-do), and 5.3% of *Apodemus agrarius* were infected with *P. muris* in northern Gyeonggi-do, near the demilitarized zone [3,6,7]. Outside of Korea, it

was reported that the overall prevalence of *P. muris* was 16.9% in the wood mouse of North Yorkshire, UK [8]. However, most Korean studies were performed on house rodents except for some studies performed from DMZ [5,7]. Considering the importance of sylvatic rodents as the reservoir host for intestinal flukes, more surveys should be performed on wild rodents in Korea. This study was initiated to determine the geographical patterns of natural parasite infections among small mammals and focused on the patterns and rates of intestinal parasite infections among the wild rodents from northern Gangwon-do (Province).

A total of 56 rodents were live-captured from 3 sites of northern Gangwon-do, i.e., Gaojak-2-ri, Nam-myon, Yanggu-gun (site 1), Jukgok-ri, Yanggu-eup, Yanggu-gun (site 2), and Gari, Inje-eup, Inje-gun (site 3) by using Sherman traps (3×3.5×9 folding traps; H.B. Sherman, Tallahassee, Florida, USA) baited with peanut butter between saltine crackers. The captured rodents included the striped-field mouse, *A. agrarius* (n=43), Korean wood mouse, *Apodemus peninsulae* (n=11), Red-backed vole, *Myodes regulus* (n=1), and squirrel (n=1). Animal trapping was performed during the summer season (July and August) of the year 2011. Captured animals were euthanized in accordance with the approved animal use protocol under biosafety level 3 (BSL-3) laboratory conditions. The

•Received 5 July 2013, revised 21 August 2013, accepted 4 September 2013.

*Corresponding author (bbbenji@naver.com)

© 2013, Korean Society for Parasitology and Tropical Medicine

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

whole intestine to the end of the rectum was removed and preserved in 70% alcohol till the time of examination. The gastrointestinal contents were opened in a Petri dish containing distilled water, and all helminths were collected under a dissecting microscope ($\times 10$). Finally, worms were examined under a light microscope for species identification.

In site 1 (Yanggu-gun, Gaojak-ri), 7 out of 9 (77.8%) captured *A. agrarius* were found to be infected with helminths. In site 2 (Yanggu-gun, Jukgok-ri), all captured 11 *A. agrarius* and 7 *A. peninsulae* were found to be infected with helminths. In site 3 (Inje-gun, Gaa-ri), 15 out of 23 (65.2%) *A. agrarius* were found to be infected with helminths. No parasite was recovered from the red-backed vole and the squirrel. The infection rates of each intestinal parasite in *A. agrarius* and *A. peninsulae* are summarized in Table 1. Briefly, 72.1% of *A. agrarius* and 63.6% of *A. peninsulae* were found to be infected with various species of intestinal parasites. In *A. agrarius*, hookworm infection rate (41.9%; 18/43) was the highest, followed by *Syphacia* spp. (14.0%) and ascarids (11.6%) among the nematodes. In case of trematodes, 2 specimens of *P. muris* were collected and no other species of trematodes were found (Fig. 1). In addition, 2 species of cestodes, i.e., *Hymenolepis nana* and *Hymenolepis diminuta*, were collected from *A. agrarius*. The species of 2 nematodes and 2 cestodes were unable to identify. In *A. peninsulae*, the overall nematode infection rate (63.6%) was similar to that of *A. agrarius* except the fact that the proportion of hookworms among the nematodes was relatively higher in *A. peninsulae* than in *A. agrarius* because of the absence of ascarids and small numbers of *Syphacia* spp. in *A. peninsulae*. Unlike *A.*

agrarius, only 1 *Echinostoma hortense* was collected as a trematode and no other species were found. Whereas *H. nana* was also collected from *A. agrarius*, *H. diminuta* was the only cestode found in *A. peninsulae*.

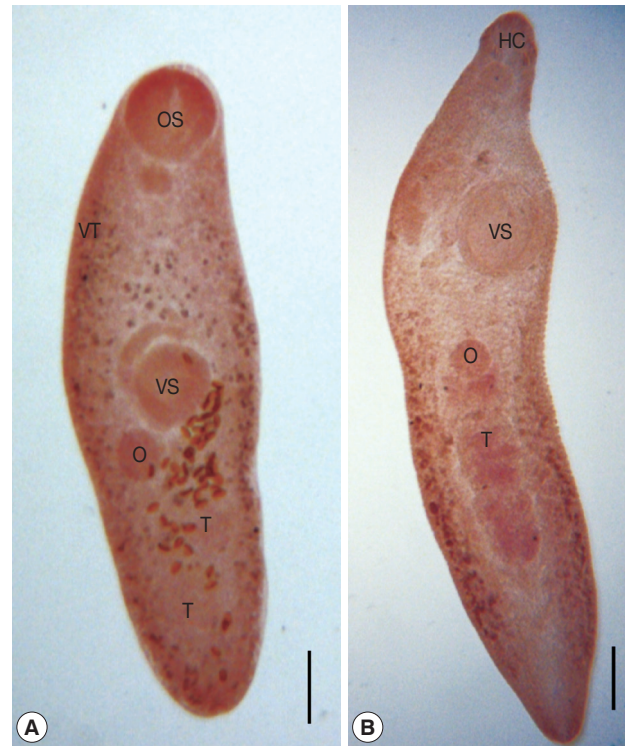


Fig. 1. (A) An adult worm of *Plagiorchis muris* recovered from a striped field mouse, *Apodemus agrarius*. Bar = 200 μ m. (B) An adult of *Echinostoma hortense* recovered from a Korean wood mouse, *Apodemus peninsulae*. Bar = 200 μ m. OS, oral sucker; VS, ventral sucker; O, ovary; T, testis; VT, vitellaria; HC, head crown.

Table 1. Infection rates of intestinal parasites in *Apodemus agrarius* and *Apodemus peninsulae* caught from 3 sites of Yanggu-gun and Inje-gun in northern Gangwon-do, Republic of Korea

Species of helminths	<i>A. agrarius</i> (n = 43) ^a		<i>A. peninsulae</i> (n = 11) ^b	
	No. positive (%)	No. worms	No. positive (%)	No. worms
Nematodes	22 (51.2)	713	7 (63.6)	516
<i>Ascaris</i> sp.	5 (11.6)	51	0 (0.0)	0
<i>Syphacia</i> sp.	6 (14.0)	160	2 (18.2)	4
Hookworms	18 (41.9)	502	7 (63.6)	512
Trematodes	2 (4.7)	2	1 (9.1)	1
<i>Plagiorchis muris</i>	2 (4.7)	2	0 (0.0)	0
<i>Echinostoma hortense</i>	0 (4.7)	0	1 (9.1)	1
Cestodes	16 (37.2)	49	6 (54.5)	14
<i>Hymenolepis nana</i>	4 (9.3)	19	0 (0.0)	0
<i>Hymenolepis diminuta</i>	12 (27.9)	30	6 (54.5)	14
Total ^c	31 (72.1)	764	7 (63.6)	531

^aParasite infections were identified from all 3 sites of Yanggu-gun (16) and Inje-gun (15).

^bParasite infections were identified from only 1 site of Inje-gun (7).

^c4 unknown helminths (2 nematodes and 2 cestodes) from *A. agrarius* were excluded from counting.

This is the first report on intestinal parasites among wild rodents in Gangwon-do, suggesting that wild rodents might play a role in maintaining the sylvatic cycle of some trematodes. Among them, *P. muris* is a small intestinal fluke (2.9-3.0 mm long) and there have been several reports on human infections [9,10]. According to a previous survey performed in a northern part of Korea, the majority (83.3%) of *A. agrarius* were infected with *P. muris* [2]. *A. agrarius* is still strongly suggested as an important reservoir of *P. muris* in northern parts of Korea [7] and in this survey, *P. muris* was also collected from *A. agrarius* although the infection rate was relatively low. In addition, an adult worm of *E. hortense* was recovered from *A. peninsulae*, proving the potential of *A. agrarius* as the natural definitive host in northern Gangwon-do.

H. nana, a dwarf tapeworm, is most common in temperate zone including the Korean peninsula. For a long time, it had been a relatively common cestode infection in Korea, especially in children. The nationwide survey in 1986 revealed that the egg positive rate of *H. nana* was 0.22%, but a review of zoonotic parasites in Korea also indicated very low prevalence of *H. nana* infection in comparison to other zoonotic cestodes like *Taenia* spp. [11,12]. However, the possibility of *H. nana* infection has still been present as seen in the case of a 40-year-old man [13], and symptoms can attend heavy worm burdens. Although *H. diminuta* is also known as a zoonotic cestode like *H. nana*, human infection cases by *H. diminuta* was almost absent in Korea after the first case report in 1966 [12,14]. However, in this survey, considerable infection rates of *H. diminuta* were shown in both *A. agrarius* (27.9%) and *A. peninsulae* (54.5%), still implying the possibilities of zoonotic infection by this cestode along with *H. nana*.

Taken together, the increased demands for leisure activities in northern Gangwon-do, Korea might provide the chance of opportunistic parasite infections around the areas of this survey. Furthermore, 2 major lakes (Paro-ho and Soyang-ho) which provide many attractive basins for freshwater fishing are located near from the survey sites. Therefore, seasonal and further comprehensive surveys on natural parasite infections in these areas are needed for an effective control of human infections by intestinal flukes and tapeworms.

ACKNOWLEDGMENTS

We thank to Dr. Ok-Sik Chung, Division of Ecology and Environment, Chungnam Development Institute, for his effort in

collecting the wild rodents. This work was supported by the research fund of Dankook University in 2011.

Conflict of interest

We have no conflict of interest related to this study.

REFERENCES

- Seo BS, Lee SH, Hong ST, Hong SJ, Kim CY, Lee HY. Studies on intestinal trematodes in Korea V. A human case infected by *Fibricola seoulensis* (Trematoda: Diplostomatidae). Korean J Parasitol 1982; 20: 93-99.
- Seo BS, Rim HJ, Lee CW. Studies on the parasitic helminths of Korea. I. Trematodes of rodents. Korean J Parasitol 1964; 2: 20-26.
- Lee SH, Sohn WM, Chai JY. *Echinostoma revolutum* and *Echinoparyphium recurvatum* recovered from house rats in Yangyang-gun, Kangwon-do. Korean J Parasitol 1990; 28: 235-240.
- Yong TS, Chung KH, Ree HI. Infection status of intestinal parasites of field rodents in Korea. Yonsei Reports Trop Med 1991; 22: 55-59.
- Chai JY, Park JH, Jung BK, Guk SM, Kim JL, Shin EH, Klein TA, Kim HC, Chong ST, Baek LJ, Song JW. Echinostome infections in the striped-field mouse, *Apodemus agrarius*, and the Ussuri white-toothed shrew, *Crocidura lasiura*, caught near the demilitarized zone, Gyeonggi-do (Province), Republic of Korea. Korean J Parasitol 2009; 47: 311-314.
- Seo BS, Cho SY, Hong ST. Studies on parasitic helminths of Korea. V. Survey on trematodes of house rats. Korean J Parasitol 1981; 19: 131-136.
- Chai JY, Park JH, Guk SM, Kim JL, Kim HJ, Kim WH, Shin EH, Klein TA, Kim HC, Chong ST, Song JW, Baek LJ. *Plagiorchis muris* infection in *Apodemus agrarius* from northern Gyeonggi-do (Province) near the demilitarized zone. Korean J Parasitol 2007; 45: 153-156.
- Rogan MT, Craig PS, Hide G, Heath S, Pickles A, Storey DM. The occurrence of the trematode *Plagiorchis muris* in the wood mouse *Apodemus sylvaticus* in North Yorkshire, UK. J Helminthol 2007; 81: 57-62.
- Radomyos P, Bunnag D, Harinasuta T. A new intestinal fluke, *Plagiorchis harinasutai* n. sp. Southeast Asian J Trop Med Public Health 1989; 20: 101-107.
- Hong SJ, Woo HC, Chai JY. A human case of *Plagiorchis muris* (Tanabe, 1922: Digenea) infection in the Republic of Korea: freshwater fish as a possible source of infection. J Parasitol 1996; 82: 647-649.
- Min DY. Cestode infections in Korea. Korean J Parasitol 1990; 28(suppl.): 123-144.
- Youn HJ. Review of zoonotic parasites in medical and veterinary fields in the Republic of Korea. Korean J Parasitol 2009; 47(suppl): S133-S141.
- Cho SC, Lee HL, Lee OY, Yoon BC, Choi HS, Hahm JS, Ryu JS,

Ahn MH. *Hymenolepis nana* infection of the colon in an adult male. *Gastrointest Endosc* 2009; 70: 784-785.

14. Lee CS, Lee JK. Case report on human infection of *Hymenolepis diminuta*. *Korean J Parasitol* 1966; 4: 41-44.