



Case Report

Detection of sarcocystic infection in a wild rodent (*Apodemus agrarius chejuensis*) captured on Jeju island

Tae-Hyoun Kim¹, Ju-Hee Han¹, Seo-Na Chang¹, Dong-Su Kim¹, Tamer Said Abdelkader¹, Seung-Hyeok Seok², Jong-Hwan Park³, Hong-Shik Oh⁴, Jong-Taek Kim⁵, Byoung-Hee Lee⁶, Jeong-Hwa Shin⁷, Jung-Hyun Kim⁷, Jong-Min Kim⁷, Jae-Hak Park^{1*}

¹Department of Laboratory Animal Medicine, College of Veterinary Medicine, Seoul National University, Seoul, Korea

²Department of Microbiology and Immunology, Seoul National University College of Medicine, Seoul, Korea

³Department of Biochemistry, College of Medicine, Konyang University, Daejeon, Korea

⁴Department of Science Education, Jeju National University, Jeju, Korea

⁵College of Veterinary Medicine, Kangwon National University, Chuncheon, Korea

⁶Biological Resources Coordination Division, National Institute of Biological Resources, Incheon, Korea

⁷Biosafety Research Team, Environmental Health Research Department, National Institute of Environmental Research, Incheon, Korea

Sarcocystis spp is a causative agent of sarcocystosis. They have a characteristic life cycle infecting both prey and predator. *Sarcocystis* can cause myositis, atrophy of the adjacent cells and abortion in cattle. In mice, sarcocystosis causes mild cellular reactions without clinical disease. Severe haemorrhage and abortion were also reported. For monitoring the disease in wild rodents of the Korean peninsula, we captured *Apodemus agrarius chejuensis* on Jeju island and examined the specimen histopathologically. Intramuscular cysts were found and diagnosed as *Sarcocystis*. Sarcocystic infection has been reported in worldwide. There have been many reported infections in cattle and pigs in Korea. To our knowledge, this is the first report of *Sarcocystis* in *Apodemus agrarius chejuensis* captured in Korea.

Key words: *Sarcocystis*, *Apodemus agrarius chejuensis*, Jeju island

Received 10 November 2011; Revised version received 9 December 2011; Accepted 12 December 2011

Sarcocystosis is a parasitic disease caused by *Sarcocystis* spp [1]. In 1843, cystic intramuscular inclusions were first reported by Miescher, who found 'Miescher's tubes' in the skeletal muscles of the house mouse *Mus musculus* caught in his home in Switzerland [2,3]. Miescher's tubules are late generation meronts or sarcocysts, and, when mature, are filled with bradyzoites [2].

Genus *Sarcocystis* belongs to the Family *Sarcocystidae*. They have a two-host life cycle involving mainly herbivores and omnivores as intermediate hosts and carnivores as the definitive host [4]. When a predator eats an animal, the bradyzoites become gamonts in the cells of their intestinal wall, which form gametes, and fertilization takes place resulting in zygotes

from oocysts. The oocysts sporulate in the host's intestine and sporulated sporocysts are passed in the feces. Then, the sporocysts are eaten by the prey animals and the sporozoites enter the bloodstream and become first generation meronts in the endothelial or subendothelial cells of the blood vessels. The meronts produce first generation merozoites, which enter new endothelial or subendothelial cells and become second generation meronts. The latter, second generation merozoites enter the muscle and become third generation meronts [2]. *Sarcocystis* can cause myositis, pressure atrophy of the adjacent cells, abortion, clinical illness and even death [3,5]. Human beings act as the definitive host for two zoonotic species, namely *Sarcocystis hominis* and *Sarcocystis suisheimi* and

*Corresponding author: Jae-Hak Park, Department of Laboratory Animal Medicine, College of Veterinary Medicine, Seoul National University, 1 Gwanakro, Gwanak-gu, Seoul 151-742, Korea
Tel: +82-2-880-1256; Fax: +82-2-887-125; E-mail: pjhak@snu.ac.kr

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.

can be the intermediate host for *Sarcocystis lindemanni* [4,6].

For diagnosis of *sarcocystis*, microscopic examination using the muscle squash method, peptic digestion and histological tests are used for surveillance in slaughtered cattle or farmed elk [7,8]. Serological tests using enzyme-linked immunosorbent assay (ELISA) and indirect fluorescent antibodies (IFAT) have also been used for humans [9]. For the investigation in wild rodents and laboratory mice, identification of cysts with macroscopic and microscopic examination in tissue has usually been used [3,10].

Sarcocystis have been found in various animals including moose, roe deer (*Capreolus capreolus*), coyotes (*Canis latrans*), mule deer (*Odocoileus hemionus hemionus*), sheep, horse and Corvid birds [11-14]; it is distributed worldwide including Korea, Norway, Canada, Iraq and the United states [8,10,13-16].

In the past, *sarcocystis* was found in 4% of wild mice in a laboratory area in 1978 and commonly observed in laboratory mice [17,18]. Cat was known to have shed sporocysts of *Sarcocystis muris* and coprophagous insects (cockroaches) as transport hosts [3].

In August 2010, we performed a surveillance project to monitor the disease of wild rodents in the Korean peninsula. Brain, heart, lung, liver, spleen, stomach, intestine and kidney were collected and fixed in 10% neutral buffered formalin for 48 h. After embedding in paraffin, sections were prepared at 4 μ m thickness were stained with haematoxylin and eosin, and observed microscopically.

We found cyst in muscle tissue of a female *Apodemus agrarius chejuensis* captured in Jeju island (N33°20'33.8", E126°20'12.1", body weight 37.3 g, body length 107.84 mm) after histopathological examination. At necropsy, a gross lesion was not detected.

Cysts were oval or elongated, being 64-98 μ m wide (mean 84 μ m) and 201-346 μ m long (mean 255 μ m: Figure 1). Cysts were well demarcated with adjacent muscular tissue. There were no inflammatory reactions or migration of leukocytes in the surrounding tissue. We diagnosed this as *Sarcocystis* based on the shape and size of cysts.

Many kinds of *Sarcocystis* including *Sarcocystis proechimyo*s, *Sarcocystis oryzomyos*, *Sarcocystis azevedoi*, *Sarcocystis marmosae*, *Sarcocystis garnhami* and *Sarcocystis muris* infect rodents [8]. In the mouse, *Sarcocystis* has been found in the skeletal muscle and less commonly in the cardiac, oesophageal and diaphragmatic muscle and it usually causes only a mild cellular reaction and no clinical disease. Histologically, infected *Sarcocystis muris* cysts were either elongated or circular with a mean measuring size of 254 \times 24.5 μ m. The wall is 2.5 μ m in thickness [3]. There was no

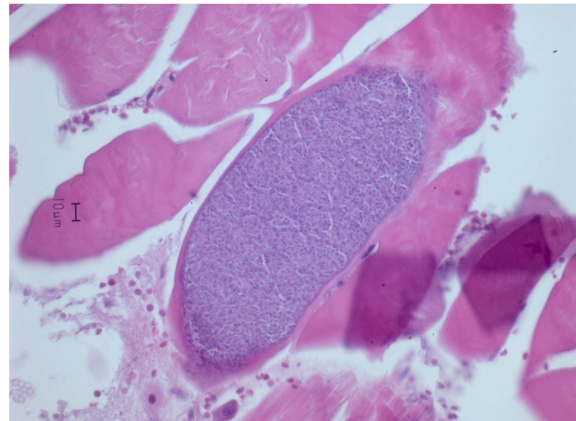


Figure 1. *Sarcocystis* in skeletal muscle of *Apodemus agrarius chejuensis*. Elongated cysts were found in muscle tissue. No inflammatory reaction was induced surrounding the cyst.

leukocytic infiltration present in the adjacent muscle tissue [1,8]. For differential diagnosis, other intramuscular parasites can be easily distinguished by size of the cyst, structures and induced inflammatory reactions histologically [3]. To our knowledge, this is the first report of *Sarcocystis* in *Apodemus agrarius chejuensis* captured in Korea.

Acknowledgments

All authors appreciate support from the National Institute of Environmental Research. This study was partially supported by the Research Institute for Veterinary Science, Seoul National University.

References

1. Latif B, Vellayan S, Omar E, Abdullah S, Mat Desa N. Sarcocystosis among wild captive and zoo animals in Malaysia. *Korean J Parasitol* 2010; 48(3): 213-217.
2. Levine ND. The taxonomy of *Sarcocystis* (protozoa, apicomplexa) species. *J Parasitol* 1986; 72(3): 372-382.
3. Tillmann T, Kamino K, Mohr U. *Sarcocystis muris*-a rare case in laboratory mice. *Lab Anim* 1999; 33(4): 390-392.
4. Noh JW, Jang DH, Kang YB, Jang H, Wee SH. Effects of temperature on viability of sarcocysts of *Sarcocystis cruzi* in cardiac muscle of cattle. *Kor J Vet Pub Health* 1988; 12(2): 151-155.
5. Wee SH, Shin SS. Experimental induction of the two-host life cycle of *Sarcocystis cruzi* between dogs and Korean native calves. *Korean J Parasitol* 2001; 39(3): 227-232.
6. Owen IL. Parasitic zoonoses in Papua New Guinea. *J Helminthol* 2005; 79(1): 1-14.
7. Gjerde B. Ultrastructure of the cysts of *Sarcocystis grueneri* from cardiac muscle of reindeer (*Rangifer tarandus tarandus*). *Z Parasitenkd* 1985; 71(2): 189-198.
8. Kang SS, Yi YJ, Cui XS, Kwon YB, Cho SK, Choi SH. *Sarcocystis* infection in farmed elk (*Cervus canadensis*). *Korean J Vet Clin Med* 1999; 16(2): 529-532.
9. Habeeb YS, Selim MA, Ali MS, Mahmoud LA, Abdel Hadi AM, Shafei A. Serological diagnosis of extraintestinal

- sarcocystosis. J Egypt Soc Parasitol 1996; 26: 393-400.
10. Shaw JJ, Lainson R. Sarcocystis of rodents and marsupials in Brazil. Parasitology 1969; 59(1): 233-244.
 11. Davis CR, Barr BC, Pascoe JR, Olander HJ, Dubey JP. Hepatic sarcocystosis in a horse. J Parasitol 1999; 85(5): 965-968.
 12. Dubey JP, Lindsay DS, Speer CA, Fayer R, Livingston CW Jr. *Sarcocystis arieticanis* and other *Sarcocystis* species in sheep in the United States. J Parasitol 1988; 74(6): 1033-1038.
 13. Colwell DD, Mahrt JL. Ultrastructure of the cyst wall and merozoites of *Sarcocystis* from moose (*Alces alces*) in Alberta, Canada. Z Parasitenkd 1981; 65(3): 317-329.
 14. Gjerde B, Dahlgren SS. Corvid birds (*Corvidae*) act as definitive hosts for *Sarcocystis ovalis* in moose (*Alces alces*). Parasitol Res 2010; 107(6): 1445-1453.
 15. Atkinson CT, Wright SD, Telford SR Jr, McLaughlin GS, Forrester DJ, Roelke ME, McCown JW. Morphology, prevalence, and distribution of *Sarcocystis* spp. in white-tailed deer (*Odocoileus virginianus*) from Florida. J Wildl Dis 1993; 29(1): 73-84.
 16. Moon MH. *Sarcocystis* infection and identification of *Sarcocystis* species in pigs in Korea. Korean J Vet Res 1989; 29(3): 325-331.
 17. Smith DD, Frenkel JK. Cockroaches as vectors of *Sarcocystis muris* and of other coccidia in the laboratory. J Parasitol 1978; 64(2): 315-319.
 18. Ruiz A, Frenkel JK. Recognition of cyclic transmission of *Sarcocystis muris* by cats. J Infect Dis 1976; 133(4): 409-418.