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Paragonimiasis Due to the Consumption of Wild Boar Meat in Japan: Contamination Levels of Lung Fluke Larvae in Muscle Samples of Wild Boars Caught in Kagoshima Prefecture

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In Japan, wild animals such as Sika deer (*Cervus nippon*) and wild boar (*Sus scrofa*) are exempt from the Slaughterhouse Act. Accordingly, they are not inspected by official veterinary experts at slaughterhouses to determine whether their internal organs and muscles are contaminated with zoonotic foodborne pathogens. There have been only a few studies on the prevalence of certain pathogens in these animals (1,2).

Wild boars serve as paratenic hosts of the lung fluke, *Paragonimus westermani*. Their meat is a principal source of human infection in Western Japan, particularly, the two Southern prefectures of Kyushu Island (Fig. 1), where 135 (30.5%) of the 443 cases of

paragonimiasis in Japan in 2001–2012 occurred (3). In this region, hunters eat undercooked wild boar meat harboring the larval stage of *P. westermani* and are infected with the lung flukes. This mode of infection has not attracted sufficient attention with regard to food hygiene, and little is known about the prevalence of *Paragonimus* larvae in wild boar meat (4,5).

We therefore purchased fresh chilled meat samples (140–340 g; average, 256 g) of 7 wild boars from a local supplier in Kagoshima Prefecture between October 2013 and February 2014. The samples were examined for the presence of lung fluke larvae using a method described elsewhere (6). All boars were caught near the supplier's location. *Paragonimus* larvae were detected in the meat samples of 3 of the 7 wild boars (43%), and the number of larvae per positive sample was 1–8 (average 4.3; total, 13). Surprisingly, as little as 215 g of one sample contained up to 8 larvae (Table 1).

The isolated larvae were allowed to actively crawl in physiological saline at 37°C. They were pale brown in color and had I-shaped excretory bladders filled with excretory granules in the centers of their bodies (Fig. 2). Although we did not prepare stained and mounted specimens of the isolated larvae for morphometric analysis, the length of the living larvae ranged between 1 and 2 mm. Via restriction fragment length polymorphism analysis and sequencing (6), all larvae were identified as the triploid form of *P. westermani*. Previous studies

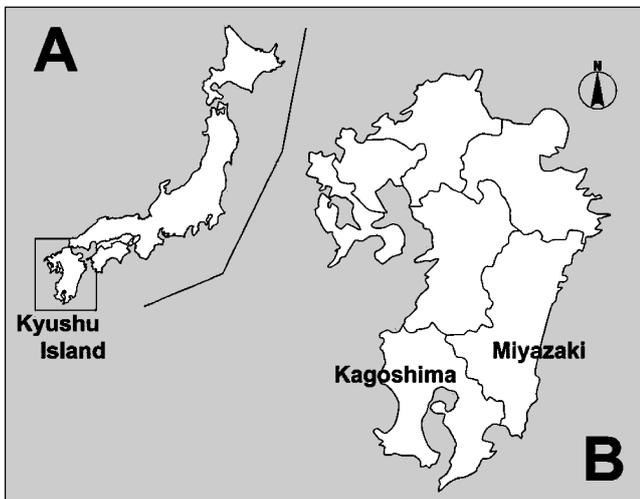


Fig. 1. Maps of Japan (A) and Kyushu Island (B), showing Kagoshima Prefecture where the wild boars were caught for examination. Kagoshima Prefecture neighbors Miyazaki Prefecture, where wild boars were previously reported to be infected with *Paragonimus westermani* larvae in their muscle tissue.

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Table 1. Number and species of *Paragonimus* larvae in muscle samples of wild boars caught in Kagoshima Prefecture, Japan

No. ¹⁾	Wild boar			Muscle sample weight (g)	No. of larvae detected	Species (form)
	Date of purchase (mo, yr)	Sex	Body weight (kg)			
1	Oct. 2013	NR ¹⁾	NR	285	0	—
2	Oct. 2013	NR	NR	222	0	—
3	Dec. 2013	Female	65	140	0	—
4	Feb. 2014	Male	39	340	0	—
5	Feb. 2014	Male	44	270	1	Pw(3n) ²⁾
6	Feb. 2014	Male	35	215	8	Pw(3n)
7	Feb. 2014	Male	59	320	4	Pw(3n)

¹⁾: No., sample number; NR, not recorded.

²⁾: Triploid form of *Paragonimus westermani*.



Fig. 2. (Color online) *Paragonimus* larva isolated from the muscle sample of a wild boar. EB, excretory bladder; Bar = 0.2 mm.

have shown that wild boars from Miyazaki Prefecture are infected with *P. westermani* larvae in their muscle tissue (4,5). Herein, we demonstrate that *P. westermani*-positive animals are also prevalent in Kagoshima Prefecture. The two prefectures neighbor each other in the Southern part of Kyushu Island (Fig. 1).

Another key source of human infections is the freshwater crab, the second intermediate host of *P. westermani*. Freshwater crabs harbor encysted larvae known as metacercariae. Our previous study demonstrated that *P. westermani* metacercariae in the host crabs lost morphological integrity and infectivity in recipient mice (the experimental paratenic hosts of *P. westermani*) after freezing at -18°C for 2 h (7). This finding indicates that deep freezing wild boar meat before consumption can effectively prevent human infection. In fact, the supplier freezes wild boar meat at -27°C for at least 24 h before distribution.

The consumption of Sika deer and wild boar meat has become increasingly popular in Japan, and the meat is even served in some restaurants. It can also be pur-

chased via mail order from metropolitan areas such as Tokyo. Therefore, public health government agencies should inform the public, especially wild boar meat suppliers, of the risk of paragonimiasis from consumption of wild boar meat without prior deep freezing. A health education program for boar hunters whose dietary habits include the consumption of undercooked wild boar meat should also be conducted. It is said that habit is second nature; however, it is never too late to change dietary habits to eliminate the risk of paragonimiasis via an effective health education campaign.

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Conflict of interest None to declare.

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