PRESENT STATUS OF TRICHINELLOSIS IN JAPAN

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Abstract. There have been three mass outbreaks of human trichinellosis in Japan. The first was in 1974 in Iwasaki, Aomori Prefecture, involving a group of hunters who ate raw meat of a black bear they had shot. Of the 20 people who ate the bear meat raw, 15 showed clinical symptoms of trichinellosis. The second outbreak was experienced in Sapporo, Hokkaido, in 1980. The patients had eaten the raw meat of a brown bear served in a local restaurant. Twelve people were diagnosed positive on the basis of clinical symptoms and the results of serological tests. The third outbreak was reported in 1982. Of the 434 people who had eaten raw black bear meat at a local restaurant in Yokkaichi, Mie Prefecture in December 1981, 60 were diagnosed as positive for trichinellosis.

The first finding of *Trichinella spiralis* in Japan was in 1957, when the parasite was detected in a formalin-preserved specimen of an indigenous dog in Sapporo, Hokkaido. Since then *T. spiralis* infection has been reported in imported animals, such as mink (1957), polar bears (1960, 1969, 1986), tiger (1986), and black leopard (1986). To date, spontaneous infection of *T. spiralis* in wildlife in Japan has been reported in sables (in Hokkaido, 1963), Japanese black bear (in Aomori, 1974, 1975), brown bear (in Hokkaido, 1980) and raccoon dog (in Yamagata, 1984).

INTRODUCTION

Trichinellosis is still a major health problem in the world and is one of the most important and dreadful zoonotic parasitic diseases. In Japan, however, little attention has been given to this disease until 1974 when the first human trichinellosis occurred in Aomori Prefecture.

In this report, the author presents the records of the incidence of *Trichinella* in animals and three outbreaks of human trichinellosis in Japan. The materials used were the literature published to date on the epidemiological aspect of trichinellosis in Japan.

RESULTS

Case reports before 1974

Human cases: Although there is no authentic record of human trichinellosis before 1974, the following few reports have been published from Japan.

Takemura (1930) reported trichinellosis in a 26–year-old woman, based on leukocytosis and eosinophilia and her clinical symptoms of rheumatic pain of the muscles, edema in eye lids and skin rash. Although he stated that he found the worm in the feces, he did not describe the organism in his report.

Mashita and Tsukamoto (1933) reported clinical trichinellosis in a 41-year-old male American traveler. The patient travelled by the Siberian Railway and by ship before arriving in Kyoto, Japan, on May 23, 1933. On the next day he was admitted to the Kyoto University Hospital with high fever, skin rash, loss of consciousness, and abundant sweating. He died 2 weeks later, on June 6, 1933. He had no facial edema and eosinophilia. He had been fond of sausage which he had eaten often during his travels.

Hamanaka and Umizumi (1934) reported a 28-year-old man whose symptoms suggested trichinellosis with clinical symptoms of fever, skin rash, edema in eyelids, sweating, and myalgia with leukocytosis and marked eosinophilia. But, since then they declared that this case was not trichinellosis but a patient poisoned by acridine dye.

Gould *et al* (1968) examined human diaphragms for *T. spiralis* in a series of 149 autopsies in Hiroshima and 37 in Nagasaki, by means of the digestion and compression methods and microscopic sections. Although

they failed to find trichina infection, they emphasized that a possibility of outbreak of human trichinellosis in Japan was caused by, not only consumption of pork, but also bear, dog, cat, rat, and sea mammals.

Animal cases: Up to 1974, trichinellosis in animals in Japan has been found only in Hokkaido.

The first finding of *T. spiralis* in animal in Japan was reported by Satoh *et al* (1957) and Ohbayashi and Satoh in 1957. They found *Trichinella* larvae in the muscles of formalin-preserved specimen of an indigenous dog which had died four years earlier in Sapporo, Hokkaido.

Satoh *et al* (1960) found trichina larvae in the muscles of a male polar bear which had been brought from the Netherlands to the Maruyama Zoo of Sapporo, Hokkaido, in 1957 and had died in 1959. The polar bear had been fed dog meat daily for 3 months during the winter before its death. The authors stated that the infection must have occurred after the animal arrived in Japan, basing their finding on relatively young cysts present in the muscles.

Makita *et al* (1963) reported the discovery of *T. spiralis* larvae in the muscles of 4 sables, *Martes zibellina brachyma* Temminck, which were caught in a mountainous area in central Hokkaido and kept in the Maruyama Zoo of Sapporo. They stated that the infection was probably contracted within a period of some months before death, as indicated by the histopathological findings. Although no evidence of *Trichinella* infection has yet appeared among voles in Japan, they stated that the infection may be traced to that animal. Sakamoto *et al* (1969) found trichina larvae in the muscle of a polar bear, *Thalarctos maritimus*, which was imported from Scandinavia to the Maruyama Zoo of Sapporo in April 1968 and had died in July of same year. It was thought that this polar bear was infected outside Japan.

Case reports after 1974

Human cases: There have been three mass outbreaks of human trichinellosis in Japan (Fig 1).

The first occurred in June 1974 in Iwasaki, a small village on the west coast facing the Japan Sea of Aomori Prefecture. A group of hunters contracted trichinellosis after eating raw Japanese black bear meat, *Selenarctos thibetanus japonicus* Schlegel, that they shot on April 30. This is the first recorded outbreak of human trichinellosis in Japan. The Iwasaki village is situated in the southwest of Aomori Prefecture and was recently designated as a national park since it is well known for its beautiful coast. Many wild mammals, such as Japanese black bear, Japanese monkey, weasel, Japanese marten, and Japanese serow dwell in the region and it is presumed that about 200 black bears live in the mountainous range of the village (Fig 2).

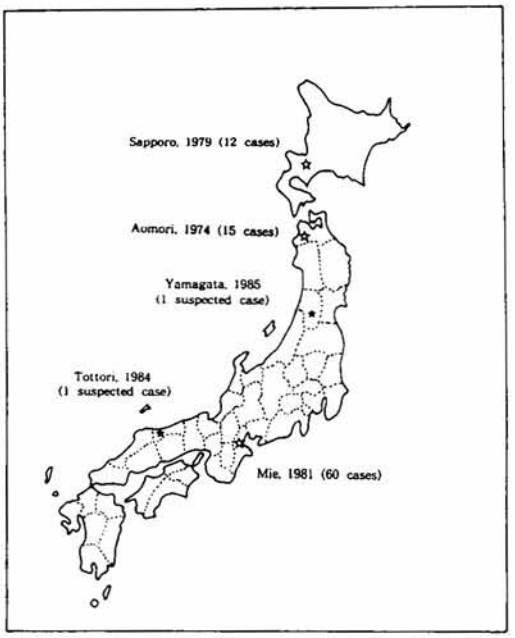

Fig 1 – Human trichinellosis reported from Japan (1974–1985).

Of the 20 people who ate the bear meat raw, 15 showed clinical symptoms of trichinellosis which included fever, muscle pain, malaise, periorbital edema, skin rash and marked eosinophilia up to 70% of the WBC. Subjective symptoms of acute trichinellosis chiefly consisted of thirst, chillness, fever, headache, fatigue, weakness, sweating, prostration, loss of body weight and skin itching. Muscle pain was seen in all patients (Table 1).

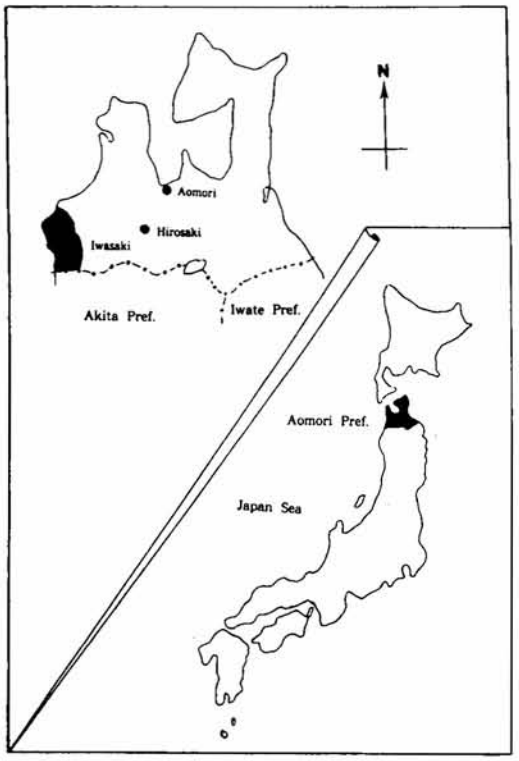

Fig 2 – Situation map of Iwasaki Village.

The second outbreak of human trichinellosis was experienced in Sapporo, Hokkaido. The patients had eaten the raw brown bear meat, *Ursus arctos yesoensis*, at a local restaurant in Sapporo in November, 1979. One of the patients was diagnosed in Chiba, and was infected during a tour of Sapporo. This is the only patient who was positive for the larvae in muscle biopsy. Twelve were diagnosed positive on the basis of clinical symptoms and the results of serological tests (Ohbayaski and Yamaguchi, 1980).

In January, 1982, the third outbreak of human trichinellosis was reported from Mie Prefecture. The patients had ingested the raw meat of black bear at a local restaurant in Yokkaichi in December, 1981. Of the 437 people who had eaten raw bear meat in the restaurant, 60 were diagnosed as trichinellosis (Yamaguchi, 1985).

Animal cases: Since 1974 spontaneous infections of *T. spiralis* among wildlife in Japan have been reported in Japanese black bears, *Selenarctos thibetanus japonicus* (in Iwasaki, Aomori, 1974

Table 1

Symptoms frequently encountered in 14 acute trichinellosis cases.

Appetite, loss of	4	Weakness	7
Taste, disagreeable	4	Sweating	10
Thirst	8	Prostration	10
Smell, alteration of	2	Dizziness	3
Dyspnea	5	Fainting	8
Talking, difficulty	1	Palpitation	2
Hoarseness	3	Chokling sensation	4
Eys, photophobia	3	Body weight, loss of	10
Eys, burning sensation of	3	Skin, itching	12
Eys, sensation of pressure	3	Skin, numbness	4
Urination, burning of	1	Skin, sensation of crawling of insects	4
Polyuria	1	Diarrhea	1
Dysuria	5	Muscle pain	14
Epistaxis	2	Abdominal wall	3
Chills	9	Lower extremities	11
Feverishness	9	Neck and back	4
Insomnia	3	Chest	2
Headache	7	Shoulder	2
Fatigue	13	Waist	3
Irritability	2	Upper extremities	3

and 1975); brown bear, *Ursus arctos yesoensis* (in Sapporo, Hokkaido, in 1980) and in a raccoon dog, *Nyctereutes procyonoides viverinus* (in Yamagata in 1984). The infections in the black bear and the brown bear were responsible for the outbreak of human trichinellosis in Iwasaki and Sapporo, respectively (Fig 3).

Trichina larvae were first found in a piece of frozen bear meat in 1974, part of which the patients had eaten in Aomori Prefecture, and this became the diagnostic clue of the disease. The size of trichina cysts in the bear meat was about 0.4 mm in length and 0.24 mm in width. The wall was thickened and all of the enclosed larvae were dead from being stored frozen. The number of the cysts in the bear meat was only 5.1 per gram, and this might be one reason why the clinical symptoms of the patients were relatively mild (Yamaguchi *et al*, 1975; 1978).

On June 19, 1974, living trichina larvae were obtained from the muscle of dog in Iwasaki village, Aomori Prefecture. The dog had eaten a piece of bear meat which caused human trichinellosis. Attempts were made to maintain this parasite line as an established strain. It is designated as "Iwasaki strain", after the village where the outbreak occurred.

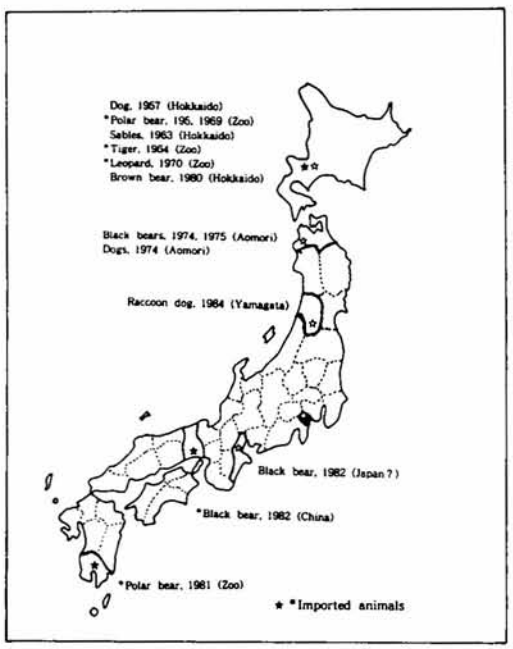

Fig 3 — Records of *Trichinella spiralis* infection among domestic and wild animals in Japan (1957-1984).

On February 22, 1980, the meat of a brown bear at the restaurant in Sapporo was examined in the laboratory. This brown bear had been bred in Kimobetsu Town in the suburb of Sapporo. The meat was bought by the restaurant in July 1979 and was kept refrigerated at –30° C for about 4 months. The meat was examined by the compression and digestion methods, and muscle trichina larvae were found. By the digestion method, 146 larvae per gram were detected. Infection experiments using laboratory mice gave negative results (Ohbayashi and Yamaguchi, 1980).

In January 1982, the remains of the bear meat from the restaurant in Yokkaichi, Mie Prefecture, was examined. The bear meat had been stored at -20°C. The numbers of trichina larvae discovered were 60.7 per gram of muscle by compression method and 41.3 by digestion method. All larvae were dead. The source of the bear meat was doubtful because the restaurant owner obtained it from a wholesaler in Osaka. This wholesaler, in turn, obtained bear meat, wild boar, venison, etc, from various sources including local hunters and also his father in the Hyogo Prefecture.

The Quarantine Section of the Kobe Port Authority, Hyogo Prefecture, detected *Trichinella* infected bear meat imported from mainland China. Of 10 blocks examined in the laboratory, 3 were positive for *Trichinella* infection, and the numbers of the larvae in the muscles were from 86.3 to 166.2 per gram. However, all of the larvae were dead (Table 2).

Further investigation revealed that the importer of the infected bear meat was the father of the aforementioned wholesaler. Therefore, imported bear meat from mainland China might be involved in the outbreak but there is no definite proof of this.

On March 24, 1984, a male raccoon dog was killed in a traffic accident on the mountain road named Kitsunegoe-road, which leads from the southwest border of Yamagata City to Shirataka Town. About 50 g of muscles were collected from each part of the body, minced

Table 2

Results of examination of imported bear meat from mainland China.

Block no.	Weight (g)	No. of larvae found	No. of larvae per gram muscle
1	0.310	0	–
2	0.500	0	–
3	1.739	150	86.3
4	1.840	273	148.4
5	1.450	241	166.2
6			
7			
8	2.500	0	–
9			
10			

and digested by artificial gastric juice. *Trichinella* larvae were found in every part of the muscles and the numbers of encysted larvae per gram were 59 to 412 (Saito and Yamaguchi, 1985).

As the Japanese black bear is usually not a carnivorous animal, it is presumed that carnivorous or omnivorous animals should exist. The author and his coworkers have captured and examined wild animals in Japan from June, 1974 to March, 1985. Of 1,244 wild mammals consisting of 32 species only 2 of 161 Japanese black bears and 1 of 64 raccoon dog were found to be infected. A survey of trichina infection among dogs revealed 3 out of 4 infected. They had eaten bones or paws of the black bear which caused human trichinellosis in Aomori Prefecture (Table 3).

DISCUSSION

No fatal cases of trichinellosis have ever been reported in Japan. Among the 87 patients who were diagnosed for trichinellosis in all 3 mass outbreaks, one larva was found in a muscle biopsy of one case. Suspected sera samples were usually sent to universities to be tested with different methods. Serological tests included the countercurrent electrophoresis, latex agglutination, circumlarval precipitation, and indirect fluorescent antibody test, and the ELISA.

In all three mass outbreaks of human trichinellosis in Japan, the source of infection can be traced to the bear meat. It is also interesting to note that the frozen bear meat can give rise to infection with severe clinical symptoms. Since resistance to cold has been used as a criterion for the identification of variant strains, such as *Trichinella spiralis* var. *nativa*, we cannot rule out the possibility that such a variant might be responsible for the outbreaks.

Although its epidemiology is still inconclusive, and the number of patients is insignificant, trichinellosis is now considered as an important parasitic zoonoses in Japan. Recent outbreaks of human trichinellosis have been from wild animals rather than pigs. Also, it is suggested that the trichina worm is more widely distributed than we expected among wild animals in Japan.

Consequently, caution should be paid to the consumption of undercooked meat of wild animals, including imported meat, in this country.

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Table 3

Results of investigation of *Trichinella spiralis* infection among mammalian hosts in Japan (1974-1985).

Order	Species	No. examined	No. positive	Locality
Insectivora	*Crocidura horsfieldi watasei*	3	0	Okinawa
	Suncus murinus riukuanus	2	0	Okinawa
	Dymecodon pilirostis	1	0	Aomori
	Urotrichus talpoides hondonus	53	0	Aomori, Kyoto
Primates	*Macacca fuscata fuscata*	2	0	Ishikawa
Lagomorpha	*Lepus brachyurus angustidens*	1	0	Aomori
Rodentia	*Sciurus lis*	4	0	Aomori
	Petaurista leucogenys nikkonis	10	0	Aomori
	Clethrionomys rufocanus bedfordiae	40	0	Hokkaido
	Eotheonomys smithi smithi	12	0	Kyoto
	Microtus montebelli montebelli	63	0	Aomori, Kyoto
	Apodemus speciosus speciosus	189	0	Aomori, Akita
	Apodemus speciosus ainu	24	0	Hokkiado
	Apodemus argenteus argenteus	24	0	Aomori
	Apodemus argenteus hokkaidi	40	0	Hokkaido
	Mus carloi	7	0	Okinawa
	Rattus norvegicus	17	0	Aomori
Carnivora	*Ursus arctos yesoensis*	74	0	Hokkaido
	Selenarctos thibetanus japonicus	161	2	Aomori, Akita, Iwate, Ishikawa, Yamagata, Tottori,
	* *Canis familiaris*	4	3	Aomori
	Nyctereutes procyonoides viverrinus	64	1	Aomori, Kyoto, Ishikawa, Yamagata, Tottori
	Vulpes vulpes japonica	16	0	Aomori, Tottori
	Vulpes vulpes schrencki	198	0	Hokkaido
	Martes melampus melampus	134	0	Aomori, Ishikawa, Tottori
	Mustela sibirica itatsi	39	0	Aomori, Yamagata, Tottori
	Meles meles anakuma	1	0	Aomori
	Phoca fasciata	6	0	Hokkaido
	Phoca vitlina f. kurilensis	29	0	Hokkaido
Artiodactyla	*Sus sacrofa leucomystax*	9	0	Kyoto, Tottori
	Sus murinus riukiuanus	11	0	Okinawa
	Cervus nippon centralis	5	0	Ishikawa, Kyoto
	Capricornis crispus crispus	1	0	Ishikawa

* : Fed bear meat that the patients had eaten.

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