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MOST PROBABLE ROUTE OF INTRODUCTION OF *ECHINOCOCCUS* INTO THE ISLAND OF REBUN

By

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(With 2 Figures)

About 30 cases of the serious disease known as echinococcosis or hydatid disease which is caused by the parasite *Echnicoccus granulosus* (BATSCH 1786) RUDOLPHI 1805, have been reported from Rebun Island, the northernmost small island off Hokkaido with an area of 80 square km and around 10,000 inhabitants. As the disease is of rare occurrence in Japan, it is very likely considered as one of the endemic diseases of the island. However, nothing concerning the disease had been known among the inhabitants until 1937 when the first patient was found on the island. Different to the inland area of Hokkaido the settlement of this island was commenced in relatively old days; government officials had been despatched since 1786 in order to control the fisheries of the island which afforded a rich fishing ground of crabs and herrings. If there had occurred such fatal dicease of such comparatively high infection rate as 1–2%, some facts would have been left in the written records or in the tradition of the people. It is highly probable that the disease is not endemic to the island but has been introduced from outside in recent years.

The people of Rebun are not as particular in living and in general customs as the usual Japanese. There is no evidence of direct communication with people living in places where the disease is of common occurrence such as Australia. A question arises naturally whether the parasite might have been transmitted by some animals which are in close contact with man.

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As is well known this cestode parasite establishes its life cycle in mammals. The adult worm harbors in the small intestine of the dog, the fox, the cat etc. and the egg delivered is evacuated in the excreta of the host animal. The egg upon being swallowed by intermediate hosts, including cattle, sheep, rats, humans etc. as a contamination, passes into the small intestine and the embryo emerges which penetrates the intestinal wall until it reaches the circulatory system. The largest proportion of the embryos lodge in the liver and become implanted there to develop into a hydatid cyst. This causes echinococcosis in the liver presenting various symptoms according to the animal infested.

The mammalian fauna of Rebun is very poor, the known species being only rodents and insectivores. From the historical evidence as mentioned above it is clear that these endemic animals are not responsible for the disease. Then the transmitter of the parasite might be the animals which have been introduced from outside of the island. As new comers to the island there can be enumerated the cattle, the horse, the pig, the sheep, the goat, the rabbit, the cat and the dog which have been brought in as domestic animals mostly from Hokkaido. Among them the cattle, the horse, the pig, the sheep, the goat and the rabbit are very few in number and are out of the question as YAMASHITA has mentioned (1955).

After a careful survey of the host animals in the island ANBO, ICHIKAWA et al. found in 1953 that the cat is a host animal of *Echinococcus*, having recovered an adult worm from the duodenum of a cat raised by a fisherman out of 57 cats collected in the island (ANBO, ICHIKAWA et al. 1954). At that time they failed to obtain any evidence of the parasitism of the cestode from more than 70 dogs they dissected. However, another survey party in 1954 including YAMASHITA, OHNO, TAKAHASHI and HATTORI discovered that the dog is also a host animal of the parasite. The latter party recovered adult worms from 2 dogs respectively out of 154 heads, including 13 street dogs which they dissected.

It is noted that the dogs and cats of the island have been introduced mostly from Hokkaido where no evidence of epidemic of the echinococcosis has been reported. Therefore, the above-mentioned host animals might have been infected within the island from other sources. Then the most important animal responsible for the transmission of the parasite might be wild animals which

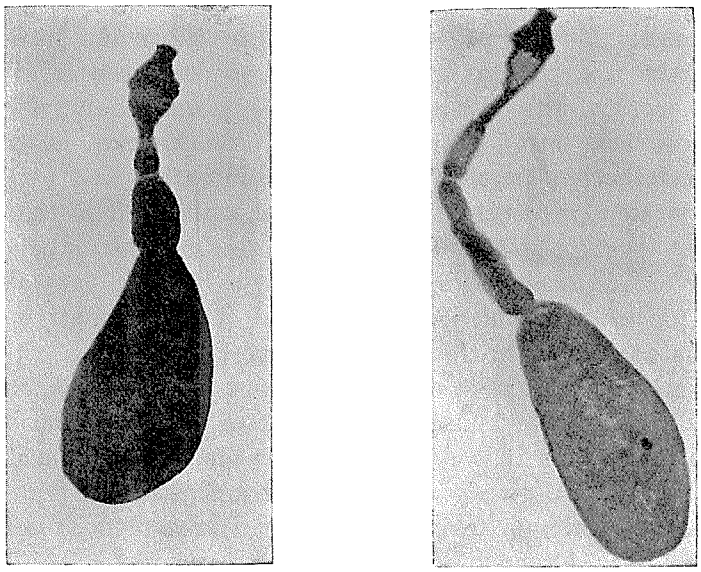

Fig. 1. Adult worms of *Echinococcus* recovered from the dog.

have been transferred from other places.

The mammals which are new to the island are the Japanese mink and the red fox. The Japanese mink of the island was introduced from Hokkaido during 1940–1944 in order to control the voles and rats which had been a plague infesting the forest (INUKAI 1949). The number of the mink originally sent totaled 88 and they increased successfully to become very common in the island. The Japanese mink in Hokkaido is very popular producing annually more than 50,000 pieces of fur though it was introduced by chance only about 80 years ago from Honshu. As there is no sign of the epidemic of the disease in Hokkaido, the mink of the island could not be the transmitter of the parasite. Concerning this, one must not overlook the experience of Rishiri Island close to Rebun. Into the Island of Rishiri minks totaling 44 in number were sent alive from Hokkaido prior to the introduction on Rebun Island. They have quite increased in number in Rishiri but no case of the disease has been reported from there.

Then attention should be paid to the fox of Rebun. Before the introduction of the Japanese mink the people of Rebun es-

tablished a plan of raising foxes allowing them free range in the island for the double purpose of controlling the vole damage on the one hand, and on the other of producing fox skins which might be financially remunerative to the villages.

In the years from 1924 to 1926 twelve pairs of red fox were sent to the island from the Middle Kuriles and released there. The red fox inhabiting the Middle Kuriles is of fine quality furnishing deep red-coloured pelts with rich wool, the price being three times as much as that for the ordinary red fox. The Middle Kurile area was at that time administratively closed and under the control of the Bureau of Fisheries of the National Government for the purpose of protection of foxes in the island and the sea otters in the surrounding seas. Neither communication with the other places nor enterprise of any kind was allowed. Besides the red fox, the black fox and the blue fox were distributed in the island of the Kurile Chain. The blue fox which is originally an arctic animal was not native to the Kuriles but transferred from the Commander Islands off Kamchatka. In 1916 five pairs of blue fox native to those islands were sent to Ushishir of the Middle Kuriles, having been presented by the Russian Government. Another ten pairs of blue fox were added from the same source in 1917. The raising of the blue fox free in the Kurile was successful and the increased ones were distributed to the neighbouring islands. They feed mostly on wild mice in the islands (ISHINO 1925).

It is well authenticated that in 1935 ISHINO who was chief inspector of the animals in the Middle Kuriles discovered *Echinococcus* from the blue fox (ISHINO 1941). He has found the hydatid cyst in the fox-liver. At the same time he collected one specimen of wild mouse which had been infected by the parasite. Recently YAMASHITA has examined carefully the specimen collected by ISHINO and preserved in our university, and identified the parasite as the hydatid cyst. In this respect the work of BARABASH-NIKIFOROV (1938) is very important as he has proved that about 50% of the field mice of the Commander Islands are infected by *Echinococcus*. This is naturally a very high percentage of infection of the parasite. The blue fox of the Commander Islands might be the most common host of *Echinococcus* under such circumstance.

Fig. 2. Sketch map showing the route of transference of foxes.

It is highly probable that the infested blue foxes were transferred into the Middle Kuriles and the parasite became epidemic among the field mice which again transmitted it to the native red foxes. Fortunately, the Middle Kurile region was almost uninhabited except by a few inspectors and watchmen, being quite separated from the Japanese community. However, 2 human echinococcosis patients discovered in Japan were originated from the Middle Kuriles, having been there in their career.

There remains little doubt that the red foxes which were sent from the Middle Kuriles to Rebun Island were infested by *Echinococcus* and played the role of the transmitter of the parasite to that island.

Let attention next be turned to the fate of the red foxes which were introduced and released in Rebun Island. According to the plan of increase, fox killing was prohibited for 10 years by village ordinance. At first the production plan progressed very steadily and after 5 years wild foxes began to appear in the villages sometimes accompanied by cubs. Some foxes made their lairs under the floor of the fisherman's home. Drying fishes were occasionally stolen by the fox outdoors and some invaded the house to take people's food. They roamed everywhere in the daytime. At that time they seemed to be at their prime in the island.

Since that time some foxes have begun to look poorer than before. Moreover, at about 10 years after the original introduction some poachers began to approach to the island and some are said to have taken away with them more than 600 fox skins. Then the decline of the fox in number and in general state has become very apparent. In addition to this, the dogs have increased in number in the island and many have begun roaming as street dogs attacking the fox. Thus the foxes have almost disappeared before the plan of fur production could be carried into complete excecution. Instead of the fur the fox has bequeathed to the inhabitants of the island only a tedious disease. The symptoms of the echinococcosis appear clearly in general about 10 years after infection. The introduction of the fox occurred in the years from 1924 to 1926 and the hydatid disease among man has begun to appear since 1937. This seems to be more than mere coincidence.

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