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The visual recognition of parasitic helminths  
in Japan before the introduction of parasitology  
from Germany-A preliminary note  
on the confirmation from Jomon Period onward

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## RESEARCH NOTE

# The visual recognition of parasitic helminths in Japan before the introduction of parasitology from Germany-A preliminary note on the confirmation from Jomon Period onward

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## ABSTRACT

1. A hypothesis on parasitic worms (helminths) traditionally recognized in Japan

The present authors postulate and discuss a hypothesis that parasitic helminths traditionally recognized in Japan from the Jomon Period through the end of the Edo Era (before Meiji Restoration) were no more than the 3 kinds, roundworms, the pinworm and tapeworms. All of these worms can be seen naturally out of the human body.

2. Paleoparasitological evidences showing the occurrence of parasitic diseases

It is true that paleo-parasitological evidences have been presented showing the occurrence of parasitic diseases in Japan. Eggs of parasitic worms, for instances,

Chinese liver fluke (*Clonorchis sinensis*), Yokogawa's liver fluke (*Metagonimus yokogawai*) and the whipworm (*Trichuris trichiura*), found in what are considered to be toilets in remains during Jomon Period onward before Meiji Restoration show that Japanese people were infected with these parasites. However, no evidence has been presented showing that people recognized them as parasitic worms in their body. Their morphological recognition is impossible unless the worms are successfully expelled with modern excellent anthelmintics.

### 3. The 3 kinds of real parasitic worms included in medical books compiled in Heian Period

"Ishimpou", one of the oldest medical books in Japan compiled and edited in Heian Period, describes 9 kinds of parasitic worms in the human body. Based on a close inspection into the description, the 3 parasites out of the 9 worms are thought to be the real parasitic worms, **roundworms, the pinworm and tapeworms**. The other 6 worms are mostly imaginary parasites.

### 4. A speculation for what the 3 parasitic worms are like in a traditional superstition

In the traditional society of Japan, there used to be a special superstition in which **3 parasitic worms** called "sanshichyu" inhabiting the human body have the habit of leaving the body during sleeping hours of the host at a special night to tell the heaven that the person is so wicked that he (or she) is destined to the immediate death. In those days no more than 3 kinds of parasitic worms were known that might go out through the anus. They are the traditionally recognized parasitic worms roundworms (*A. lumbricoides*), the pinworm (*E. vermicularis*) and tapeworms. Whether "sanshichyu" belong to the 3 kinds of parasitic worms merits further studies.

## 5. The blood fluke formerly endemic and undiscovered until 1904 in Japan

The blood fluke (*Schistosoma japonicum*) parasitic in the portal vein was traditionally endemic in Japan, responsible for the severe parasitosis and hygienic problems in endemic areas. However, it was impossible to find them in feces in those days without excellent anthelmintics and the magnifying glass. **The parasitic worms themselves had not been recognized for many years until the worm recovery from the portal vein of a patient** autopsied in 1904. In other words, Japanese people had been suffering from this infection for a long period without recognizing the morphology of the parasite.

## 6. Newly recognized *Anisakis* spp presumably having afflicted people

The fact that *Anisakis* spp belonging to the parasitic nematode are responsible for a severe abdominal pain was never been reported before the World War II. No parasites called anisakis can be found in the feces. In former days, therefore, modern Japanese as well as ancient people could not morphologically recognize the parasite even when they were grievously afflicted with the infection. In man, anisakis parasites at their larval stage could be found in the stomach and intestine with a good manipulation of the endoscope. When people are infected with *Anisakis* spp following raw ingestion of many kinds of the marine fish, for instance, the fresh mackerel, it is responsible for the severe abdominal pain. There must have been patients suffering from the infection in Edo Period or earlier in Japan. Many Japanese people are daily infected with *Anisakis* spp after eating many kinds of the sea fish raw. Most of the sea fish eaten in Japan will often harbor the larvae of the anisakis. When they are ingested, the larvae will parasitize in the stomach or intestine of patients for less than a week.

## 7. Introduction of parasitology from Germany after Meiji Restoration

A zoologist Isao IJIMA (1861~1921), Imperial University of Tokyo, interested in parasites went to Germany to study parasitology under the direction of Prof. Dr. Leuckart in Leipzig University after Meiji Restoration. At that time, many kinds of parasitic helminths had already been identified in Europe since the study by Linnaeus (1758) who had established the binominal classification. For instances, roundworms, the pinworm and some kinds of tapeworms were given scientific names in 1758.

## 8. A conclusion drawn provisionally in the present study

It is probable that a very small number of species of parasitic worms (helminths) were recognized in Japan before Meiji Restoration. Japan learned many species of parasitic helminths that had been identified and studied biologically and medically in Europe whereas the parasitic worms recognized visually in Japan had been no more than **roundworms, the pinworms and tapeworms.**

# INTRODUCTION

Parasitology was first introduced into Japan by a zoologist Isao IJIMA (飯島魁, 1861~1921), Imperial University of Tokyo, after Meiji Restoration. He found some kinds of parasitic helminths (worms), and his Japanese followers identified other species of them.

Before the introduction of parasitology into Japan, the recognition of parasitic helminths (worms) seems to be obscure, not to say that of parasitic protozoa invisible to the naked eye.

The present research has been carried out in an attempt to draw a sound conclusion as to whether no more than 3 kinds of parasitic worms (helminths) were

recognized in Japan from the Jomon Period to the end of Edo Era (before Meiji Restoration).

Such a conclusion has never been drawn elsewhere to the present authors' knowledge.

## MATERIALS AND METHODS

All the information and publications thought to have something to do historically with parasites in Japan has been collected through libraries and Internet. They were perused. Parts of them that are thought to be directly related are cited in this paper.<sup>1~28)</sup> Scientific names for parasites are expressed according to newer nomenclatures.

## RESULTS AND DISCUSSION

### 1. A hypothesis on parasitic worms (helminths) traditionally recognized in Japan

The present authors postulate and discuss a hypothesis that parasitic worms (helminths) which were recognized in Japan traditionally from the Jomon Period through the end of the Edo Period (before Meiji Restoration) are no more than the 3 kinds, roundworms, the pinworm and tapeworms according to the following facts.

**Roundworms** (including 2 species, *Ascaris lumbricoides*, *A. suum*), parasitic in the intestine, are expelled naturally when the worm burden (the number of worms parasitic in the intestine) is high. They are sometimes vomited through the mouth. According to Faust et al.,<sup>13)</sup> fever due to intercurrent infection or disturbed digestion may cause the worms to be passed spontaneously *per anum* (through the anus: a comment by the present authors Maki et al.) or to be vomited. Needless to say, the

worms expelled or vomited are readily recognizable to the naked eye. The adult roundworms flesh-color in appearance measure about 30 cm and 5 mm (female) and 20 cm and 4 mm (male) in length and width,<sup>2)</sup> respectively. Publications in the Edo Period<sup>12)</sup> described them biologically and pathologically.

**The pinworm** (just one species in man : *Enterovius vermicularis*) inhabiting the cecum, appendix and adjacent portions has the nature of going out through the anus with the anal sphincter relaxed at night to deposit eggs onto the perianal parts and die there. Though the adult females distinguished with white color are not so large, measuring 8~13 mm and 0.3~0.5 mm in length and width, respectively,<sup>2)</sup> they have been noticed by people since ancient times. An interesting picture in Edo Period is "Shinsenbyosoushi" 『新撰病草紙』,<sup>2)</sup> showing a person observing the worms probably crawling on the skin near the perianal parts.

**Tapeworms** including several species scientifically named *Diphyllobothrium* spp, *Taenia* spp and so on are daily expelled at least partly through the anus. The drawing "Shinsenbyosoushi"<sup>2)</sup> in the Edo Period depicts such a tapeworm pulled out through the anus carefully by hands with the use of chopsticks. According to the explanation it must be a fish tapeworm *Diphyllobothrium* sp with which the patient was infected following ingestion of raw salmon. It is no exaggeration to say that these worms have been observed by ancient people, too.

## 2. Paleo-parasitological evidences showing the occurrence of parasitic diseases

It is true that parasitic eggs have been found in what are considered to be toilets in remains during Jomon Period and later ages such as Edo Period.<sup>2-4, 15-17, 23, 25, 27, 28)</sup> The tendency is that they are the eggs covered with thick shells, for examples, those of the liver fluke (*Clonorchis sinensis*) and the whipworm (*Trichuris trichiura*) found in archaeological sites as follows. The descriptions on periods in parentheses



are based on the information in the dictionary.<sup>6)</sup>

(1) **Jomon Period (lasting about 10,000 years until 5 century BC)**

Sannai-Maruyama Iseki 三内丸山遺跡 (Aomori Prefecture) : Whipworm (*Trichuris trichiura*)

(2) **Fujiwara & Nara Periods (694 AD~794 AD)**

Fujiwara-Kyo Iseki 藤原京遺跡 (Nara Prefecture) : Roundworms (*Ascaris lumbricoides*, *A. suum*), Whipworm (*Trichuris trichiura*), Chinese liver fluke (*Clonorchis sinensis*), Yokogawa's fluke (*Metagonimus yokogawai*), Tapeworms (*Diphyllobothrium* sp)

(3) **Heian Period (794 AD~1192)**

Yanagi-no-goshyo-ato Remains 柳之御所跡 (Iwate Prefecture) : Roundworms (*Ascaris lumbricoides*, *A. suum*), Whipworm (*Trichuris trichiura*), Tapeworms (*Diphyllobothrium* sp)

(4) **Edo Period (1603~1867)**

Matsue-jyo Castle 松江城 (Shimane Prefecture) : Roundworms (*Ascaris lumbricoides*, *A. suum*), Whipworm (*Trichuris trichiura*), Chinese liver fluke (*Clonorchis sinensis*), Yokogawa's fluke (*Metagonimus yokogawai*)

Based on the archeological fact, people in those days were infected surely with some kinds of parasitic helminths and probably with more kinds of them including hookworms *Ancylostoma* spp, the egg shells of which are thin and hardly preserved for a long period in feces excreted from patients. On the other hand, the eggs of **Chinese liver fluke** (*Clonorchis sinensis*), **Yokogawa's fluke** (*Metagonimus*

*yokogawai*) and the **whipworm** (*Trichuris trichiura*) have well been preserved in the remains because of their thick coverage.

An attention has to be paid to the fact that no evidence has been presented showing that people in Jomon Period or later era before Meiji Restoration recognized them as parasitic worms except the 3 kinds of parasitic helminthes, **roundworms**, **the pinworm** and **tapeworms** as above mentioned. Their morphological recognition is impossible unless the worms are successfully expelled with modern excellent anthelmintics.

It is possible that they administered herbal medicines to expel them as African monkeys.<sup>27, 28)</sup> However, no such kinds of crude drugs including medicinal plants have been found in the remains belonging to Jomon Period and later era. It is worthwhile to investigate whether any medicinal plants were used as anthelmintics in those days. If it is indeed the case, it is possible that they may have observed other parasitic worms as well as the 3 kinds of parasitic worms, roundworms being put out, pinworms going out and tapeworms expelled automatically.

### 3. The 3 real parasitic worms included in medical books compiled in Heian Period

In Heian Period, famous medical text books were compiled including the description of parasitic worms in the human body. This is called "Ishimpo" (『医心方』), one of the oldest medical books that have been considered to be important traditional medical ones in Japan.<sup>1, 2, 26)</sup>

The medical textbook, "Ishimpo" was compiled and edited in Japan by a nobleman and traditional doctor TAMBA-NO-Yasuyori (丹波康頼, 912~995 AD) in Heian Period (982 AD). It was mostly transcribed in Japan from the original medical textbooks called "Shyo-byogen-kou-ron" 『諸病源候論』(abbreviated like "Byogenkouron") (50 volumes). This book on "pathology and symptomatology"

was compiled in 610 AD during the Sui Dynasty (581–618 AD). Unfortunately, the texts have disappeared even in China as far as present authors know. The 2 famous medical books are related according to Ogawa.<sup>1)</sup>

A chapter of “Ishimpou”<sup>2, 8, 26)</sup> describes 9 kinds of parasitic helminths. What they meant has intrigued historians and parasitologists so far. The 3 out of the 9 parasites are thought to be the **roundworm, the pinworm and tapeworms** when we believe in the statement (the literal expression or the length described).<sup>2, 8, 26)</sup> Kaichu (蛔虫, the roundworm) : 1 *shaku* (about 30 cm), Gyochyu (蟯虫 the pinworm) and Hakuchyu (白虫, the white worm) : 1 *sun* (about 3 cm).

The other worms, Nikumushi (肉虫, the flesh worm), Haichu (肺虫, the lung worm), Ichu (胃虫, the stomach worm), Jyakuchu (弱虫, the weak worm) and Akamushi (赤虫, the red worm) are thought to be rather imaginary except the possible real worm apparently measured in length; Fushimusi (伏虫, the hiding worm) : 4 *bu* (about 1.2 cm)

The possibility is that the candidates for the rest 6 kinds of worms are hookworms, whipworms (*Trichuris trichiura*), Chinese liver fluke (*Clonorchis sinensis*), sheep liver fluke (*Fasciola hepatica*), *Fasciolopsis buski*, the lung flukes and one of the schistosomes (*Schistosoma japonicum*). Patients with *S. japonicum* are found in even today. The other worms are all present in China and Japan now.

#### 4. A speculation for what the 3 parasitic worms are like in a traditional superstition

In the traditional society of Japan there used to be a special superstition “KouShinShinkou (庚申信仰)” in which 3 parasitic worms called “**sanshichyu**” inhabiting the human body have the habit of leaving the body during sleeping hours of the host at a special night to tell the heaven that the person is so wicked that he (or she) is destined to the immediate death.<sup>26~28)</sup>

The present authors are now inclined to think over the 3 parasitic worms in question. In those days no more than 3 kinds of parasitic worms were known that would go out through the anus as discussed in the present paper. They are the 3 traditionally recognized parasitic worms, **roundworms** (*A. lumbricoides*), **the pinworm** (*E. vermicularis*) and **tapeworms**. Whether “**sanshichyu**” or 3 parasitic worms belong to the visually recognized parasites is interesting and merits further studies as a working hypothesis.

##### 5. The blood fluke formerly endemic and undiscovered until 1904 in Japan

The blood fluke (*Schistosoma japonicum*) still nowadays distributed in China and the Philippines is responsible for the severe parasitic and hygienic problems in the endemic areas. This parasitizes in the portal vein. This specimen of the worm has been recovered from a mummy in China [湖南省, 長沙, 馬王堆第一号墓].<sup>2,4)</sup> However, it is hard to find the adult worms in the feces in those days when excellent anthelmintics and the magnifying glass were not available as today.

Japanese people used to suffer from this parasite infection in former days. New infection has not been recorded for about 40 years. Katayama District (Hiroshima Prefecture), Kofu Basin (Yamanashi Prefecture) and Chikugo River Basin (Fukuoka Prefecture) were the 3 endemic areas in Japan.

In 1847, the syndromes and symptoms of the endemic disease were accurately observed and described by a traditional herb doctor Yoshinao FUJII (藤井好直, 1815~1895) in the area (Hiroshima Prefecture), who described a memoir called “Katayama-ki 『片山記』(1847)”. Nevertheless, the pathogenic agent remained still obscure until the discoveries of the adult blood fluke *S. japonicum* from human and animal hosts in 1904.<sup>2,4,24,27,28)</sup>

May 26, 1904 adult *S. japonicum* was discovered in the portal vein of an infected cat by Dr. Fujirou KATSURADA 桂田富士郎 (1867~1946) in Yamanashi

Prefecture where one of the areas endemic with *S. japonicum* is located. The parasite was given a scientific name of *Schistosoma japonicum* (Katsurada, 1904).

Adult *S. japonicum* was recovered also from a human case only 4 days later in Hiroshima Prefecture. Dr. Akira FUJINAMI (藤浪鑑, 1871~1934), Professor of Pathology, Kyoto Imperial University, dissected the murdered human case in 1904. He discovered and recovered the adult *S. japonicum* responsible for this disease in the portal vein of the patient.

Japanese had been suffering from this infection. However, the parasitic worms in question had not been recognized for long periods until 1904.

## 6. Newly recognized *Anisakis* spp presumably having afflicted people

It was not indicated before the World War II that *Anisakis* spp belonging to the parasitic nematode are responsible for a severe abdominal pain. They were recognized as a causative agent responsible for the syndrome and symptoms after the World War II in Japan, too. The first case report in Japan was published by Asami, K (Am. J. Trop. Med. Hyg. 14, 119–123, 1965).

No parasites called anisakis are detected in the feces. In man, anisakis parasites at their larval stage could be found in the stomach and intestine with a good manipulation of the endoscope. The adult worms dwell in the stomach of sea mammals including the whale.

It is therefore no wonder that ancient people could not morphologically recognize the parasite even when they were grievously afflicted with the infection. Did they dissect the parasitized organs? The answer is “no” in a usual sense except a kind of dissection during wars, for examples those in Edo Period like “Shimabara-no-ran” (島原の乱) or earlier. This research belongs to the fields of war medicine, meriting further studies.

When man is infected with *Anisakis* spp following ingestion of raw marine fish,

it is responsible for the abdominal pain. There must have been patients suffering from the infection in Edo Period or earlier in Japan.

Many Japanese people are daily infected with *Anisakis* spp belonging to the parasitic nematode after eating some kinds of the sea fish raw. Most of the sea fish eaten in Japan will often harbor the larvae of the anisakis. For instance Japanese are often infected with the larval anisakis on raw ingestion of the mackerel, a kind of sea fish popular in Japan. Although the fish is fresh from the sea, people suffer occasionally from the abdominal pain, which is compared to the syndrome as if it were a kind of “poisonous” pain. This pain has been notorious as “poisonous” pain caused by the fresh mackerel having larval *Anisakis* spp parasitized in the muscle.

## 7. Introduction of parasitology from Germany after Meiji Restoration

A zoologist Isao IJIMA, (飯島魁, 1861~1921), Imperial University of Tokyo, interested in parasites, went to Germany to study parasitology under the direction of Prof. Dr. Leuckart in Leipzig University in Meiji Era. At that time, many kinds of parasitic helminths had already been identified in Europe since the study by Linnaeus (1758) who had established the binominal classification. For instances, **roundworms, the pinworm and some kinds of tapeworms** mentioned in this paper so far were given scientific names in 1758.

The **whipworm** above mentioned had been named scientifically (Linnaeus, 1771) (the present academic name: *Trichuris trichiura*). The **liver fluke** (so-called Chinese liver fluke) had been given the academic name (*Distoma sinense*, Cobbold, 1875). The present academic name is *Clonorchis sinensis*.

## 8. A conclusion drawn provisionally in the present study

In conclusion, it is probable that a very small number of species of parasitic worms (helminths) were recognized in Japan before Meiji Restoration. Japan learned

many kinds of parasitic worms (helminths) that had been studied biologically and medically in Europe. Contrarily, the recognized kinds of parasitic worms familiar to Japan had been probably no more than **round worms, the pin worm and tapeworms**. This is rather a tentative conclusion. Studies from the viewpoint of war medicine in the history of Japan are worthy of being carried out.

## 要 約

1. 日本で縄文時代から明治維新に至るまでの長い間、回虫（蛔虫）、ギョウチュウ（蟯虫）、サナダムシ（いわゆる真田虫、学問的には条虫）は貴族の階層ならびに庶民の間で、その形態が認識されていた寄生蠕虫類（一応肉眼で判別のつく多細胞の寄生虫）である。江戸時代の書物にも紹介されている回虫は、小腸から自然に駆出されることもある。時に「逆虫現象」といって口から吐き出されることもある。盲腸・虫垂に寄生するギョウチュウは、夜間肛門から出て周囲に付着していることがあるので視認される。腸管に寄生するサナダムシ（条虫）は日常的に肛門から一部が出てくるので、古代人にも認識されたはずである。江戸時代の絵画に、肛門から条虫（サナダムシ）が人の手により引き出される様子を描いたものが残っている。

2. 確かに、縄文時代から江戸時代まで、トイレ跡であったと考えられる遺跡・遺構から他の寄生虫卵、例えば肝吸虫、横川吸虫、鞭虫などの虫卵も発掘されている。このような寄生虫病が当時存在していたことは疑いの余地がなく、近年の考古寄生虫学の成果として受け入れられている。この事実に異論はないが、これら寄生虫が体外に駆出されて認識されていたという証拠はあげられていない。現代でも形態を損なわない成功裏の駆虫を行わない限り、これらの寄生虫の形態認識は困難である。したがって肝吸虫、横川吸虫、鞭虫の視認はなかったと判断される。

3. 平安時代から伝わる『医心方』には、上記の回虫（蛔虫）、ギョウチュウ

ウ（蟯虫）、サナダムシ（真田虫）3種を含めて9種類の“寄生虫類”の記載がある。長さの記載のある回虫（蛔虫）、サナダムシ（真田虫）、伏虫（特定できず）の3種、および長さの記載がないギョウチュウ（蟯虫）以外の寄生虫も体内にいるものと想定していた可能性が高い。しかし、伝統的に日本に9種類の寄生蠕虫類が視覚認識されていたと考えるのは早計である。

これらをはじめとして多種多様の寄生虫がヒトに寄生することで、激しい腹痛に悩まされる感染者たちは、体内に異様なものがうごめいていると想像するものごとく自然なことであり、必ずしも視覚認識されていたわけではない。

4. 江戸時代に盛んに信奉された迷信の一種「庚申信仰」では、人体内には3匹の虫が寄生していて定期的に夜間肛門より這い出して天に向かい、その人間はよからぬ者であると告げ口する結果その人はまもなく死ぬという。この回避のために、その夜は眠らずに過ごすことで、このような天からの罰は防げると信じられてきた。肛門より這い出すことが古より知られているのは、上記3種の寄生虫、回虫（蛔虫）、ギョウチュウ（蟯虫）、サナダムシ（真田虫）である。とりわけ、ギョウチュウは夜間睡眠中、肛門括約筋が緩んでいるときに這い出して肛門周囲に産卵する。「庚申信仰」の3匹の虫が、これらの3種類の寄生虫と関係があるとなれば大変興味深いですが、現時点では「作業仮説」として記しておく。

5. 腹水、粘血便など重篤な症状をもたらす日本住血吸虫は、江戸時代も含め長い間全国のいくつかの流行地で住民を苦しめてきた寄生虫である。しかし、患者の死後剖検によりその虫体が発見されたのは20世紀になってからであるから、それ以前にこの虫体は視認されていない。

6. 海産魚の生食を好む日本人で大いに問題となってきたアニサキスは現在の日本で最も多い寄生虫であり激しい腹痛をもたらすが、胃腸内に生存するのは1週間程度で、その後消化されるので体外での視覚確認は困難である。「サバの生き腐れ」として昔よりアニサキス様の症状は知られていたが、日本における最初のヒトのアニサキスの症例で、内視鏡による胃内の虫体の確認は



1960年代のことである。

7. 時は明治となり、近代科学が欧米から移入された。寄生虫学も当時ドイツに留学した東京大学の動物学者飯島魁により導入された。明治維新前には回虫、ギョウチュウ、サナダムシの形態認識はあったが、体内の未知の寄生虫に対してはその重篤な症状に苦しみつつも想像するに過ぎなかった日本に、多種多様の寄生虫に関する科学的な知見がもたらされた。

8. 一応の結論として、縄文時代より江戸時代末期に至るまでの間、日本人がその形態を視認していた寄生虫は回虫（蛔虫）、ギョウチュウ（蟯虫）、サナダムシ（真田虫、学問的名称は条虫）の3通りに過ぎないと考えられる。軍陣医学分野等における極めて特殊な例に関しては、今後の検討に俟ちたい。

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