**Abstract:**

Human diplogonoporiasis caused by the tapeworm *Diplogonoporus balaenopterae* has been rarely reported in Japan in the last decade. A 38-year-old man complained of a fever, diarrhea, intermittent abdominal pain, and worm excretion. He had a history of consuming raw juvenile Japanese anchovy one month earlier. On admission, the patient had acute enteritis and received intravenous fluids. During hospitalization, he excreted a white worm in his stool. On a macroscopic examination, the worm was found to be a tapeworm with scolexes. His health improved spontaneously without taking anthelmintic agents. Based on the genetic analysis, the tapeworm was identified as *Diplogonoporus balaenopterae*.

**Key words:** parasitic disease, tapeworm, *Diplogonoporus balaenopterae*, raw juvenile Japanese anchovy, genetic analysis

(Intern Med Advance Publication)  
(DOI: 10.2169/internalmedicine.8881-21)

**Introduction**

Human diplogonoporiasis is caused by the tapeworm *Diplogonoporus balaenopterae*, which is closely associated with the food custom of eating raw fish. Although most cases have been reported in Japan, only a few cases have been reported in the last decade.

We herein report a case of human diplogonoporiasis that occurred after the consumption of raw juvenile Japanese anchovy.

**Case Report**

The patient, a previously healthy 38-year-old Japanese man, visited our hospital with a 2-day history of a fever, diarrhea, and intermittent abdominal pain. He had also found white cord-like segments in his stool immediately before the visit. He had a history of eating raw juvenile Japanese anchovy one month earlier. His stool was watery and not bloody or mucoid. His bowel movement frequency was approximately more than 5 times per day. On arrival at the hospital, his body temperature was 37.0 °C, and he was too sick to eat. A peripheral blood analysis showed a white blood cell count of 9,000 cells/μL with 2.8% eosinophils and a C-reactive protein level of 2.44 mg/dL. Computed tomography of the abdomen revealed thickening of the ascending colon wall and enlarged mesenteric lymph nodes. He was admitted with a diagnosis of acute enteritis and treated with intravenous fluids.

On day 2 of admission, he again found a white cord-like segment in his stool. This segment was then collected on a Petri dish. Macroscopic examinations indicated that it was a tapeworm (Fig. 1). The tapeworm was 1,100 mm in length and 2 mm in width, with a slender and spatulated scolex (20 mm in length and 2 mm in width). After observations, the tapeworm was stored in a formalin bottle. Other causative organisms associated with acute enteritis were not identified in stool cultures. His gastrointestinal symptoms improved spontaneously after the worm was excreted, and he was dis-
charged on day 7 of hospitalization without the need for anthelmintic agents. Since then, no additional tapeworms were found in the stool samples.

One month later, a fecal microbial ova-parasite examination showed negative results. The tapeworm stored in the formalin bottle was further tested at the Division of Medical Zoology, Department of Infection and Immunity, Jichi Medical University, Tochigi, Japan. The tapeworm appeared to have a scolex and immature proglottids, lacking mature and gravid proglottids (Fig. 2). Reproductive organs were not confirmed by carmine staining. Based on the morphology of the scolex, the cestode was identified as a family Diphyllobothriidae. Since the tapeworm was fixed in formalin for a taxonomic analysis, DNA was extracted from a section of the formalin-fixed proglottids using the QIAamp DNA FFPE Tissue Kit (QIAGEN, Tokyo, Japan), and the parasite species was identified by a sequence analysis of cestode ribosomal RNA region containing the internal transcribed spacer 1 (ITS-1)-5.8S rRNA gene. Polymerase chain reaction (PCR) amplification with a pair of primers-tapeworm F (5’-AACCTGCGGAAGGATCATTAC-3’) and tapeworm R (5’-AATTCACACAGTTGGCTGCG-3’) was performed with 30 cycles of denaturation (95 °C, 1 min), annealing (55 °C, 1 min), and polymerization (72 °C, 1 min) using the AmpliTaq Gold 360 Master Mix (Applied Biosystems, Foster City, CA, USA). The PCR product was purified using the FastGene Gel/PCR Extraction Kit (Nippon Genetics, Tokyo, Japan), and the nucleotide sequence was analyzed by direct sequencing using the BigDye Terminator v3.1 Cycle Sequencing Kit (Applied Biosystems). A BLAST analysis of the obtained sequence revealed 99%-100% homology with those of D. balaenopterae in the GenBank register, indicating that the parasite was D. balaenopterae. The reported nucleotide sequence data are available in the DDBJ databases under the accession number LC653146.

**Discussion**

Cases of human diplogonoporiasis, caused by the tapeworm D. balaenopterae (Syn. of D. grandis), have been reported almost exclusively in Japan. To date, more than 200 cases of diplogonoporiasis have been recorded in Japan (1, 2), with only 3 cases in humans having been reported outside of Japan (3-5). In Japan, the incidence of diplogonoporiasis ranged from one to four cases each year from 2001 to 2011; however, only one case of human diplogonoporiasis has been reported in the last decade (6). Thus, diplogonoporiasis has become a rare disease in clinical practice; in particular, cases diagnosed by a genetic analysis are extremely rare. The sample in the present case was fixed in formalin for a taxonomic analysis. Alcohol fixation is generally preferred for genetic analyses, but for this case, a genetic analysis using a formalin-fixed sample was successful.

The definitive host of D. balaenopterae is the Baleen whale. D. balaenopterae usually enters the human body through the consumption of raw fish, such as sardine, bonito, Japanese horse mackerel, mackerel, tuna, and yellowtail. In addition, previous case reports have shown that

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**Figure 1.** Macroscopic observation of the tapeworm in a Petri dish.

**Figure 2.** The scolae (a) and strobilae (b) of Diplogonoporus balaenopterae.
Diplogonoporiasis occurs after the consumption of raw juvenile Japanese anchovy (6, 7). Notably, in 1996, as many as 46 new cases of diplogonoporiasis were reported in Shizuoka Prefecture, Japan (7). Shizuoka Prefecture is located in Central Japan, where juvenile Japanese anchovy is caught off the Pacific coast in spring. In a previous report, the occurrence of diplogonoporiasis after the consumption of raw juvenile Japanese anchovy was most common (7). Similarly, in the present case, the patient lived in Shizuoka Prefecture and had a history of raw juvenile Japanese anchovy consumption one month earlier; therefore, the consumption of the raw juvenile Japanese anchovy may have caused diplogonoporiasis.

*D. balaenopterae* grows to a size of 3-6 m in length and 10-45 mm in width in the small intestine of humans after parasitism. One to two months later, white cord-like segments of the parasite are excreted in the stool. However, the tapeworm found in the present case was smaller and finer than the mature *D. balaenopterae*. In addition, the uterus was not observed on staining, and a fecal microbial ova-parasite examination showed negative results. We therefore speculated that the tapeworm had parasitized alone and been excreted from the body in an immature state. Thus, we did not administer any anthelmintic agent. A patient with diplogonoporiasis is generally asymptomatic, and the condition is often noticed only on worm excretion in the stool. However, several previous studies have reported cases involving gastrointestinal symptoms, such as diarrhea and abdominal pain, as seen in the present case (2, 7).

Improvements in environmental health have reduced the frequency at which physicians encounter cases of parasitic diseases in clinical practice in developed countries. However, even today, physicians may encounter cases of diplogonoporiasis in areas where raw fish, especially raw juvenile Japanese anchovy, is consumed; therefore, further awareness concerning diplogonoporiasis may aid in making a correct diagnosis.

**The authors state that they have no Conflict of Interest (COI).**

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