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Cause of Increase in Notifications of Anisakiasis in Japan

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ABSTRACT

Anisakiasis in humans is a disease accompanied by severe pain and urticaria as a result of *Anisakis* larvae infesting the stomach and intestines. *Anisakis* uses marine mammals such as whales as end hosts, and people were not originally part of its life cycle. However, by eating raw fish such as mackerel - which is an intermediate host - infection is established when one or several invade the consumer. In recent years, the number of reports of anisakiasis has increased dramatically in Japan. We studied the possible causes, which include effects resulting from revision of the Food Sanitation Act, improvements in fish transportation technique, a rise in seawater temperature, increasing numbers of end hosts such as whales, and increases in numbers of *Anisakis* itself. We concluded that the first of these was the main cause.

INTRODUCTION

In recent years, the number of notifications of anisakiasis has increased in Japan (Fig. 1).

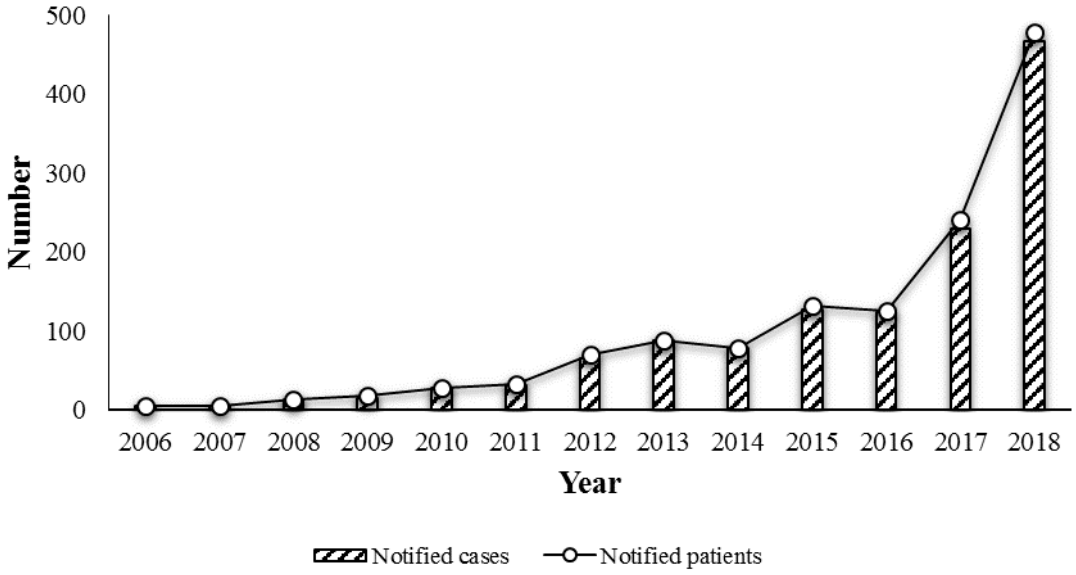

Fig. 1 Changes in the number of notifications of anisakiasis cases and patients in Japan, 2006–2018. Based on the data in references (1)–(5)

Anisakiasis is a type of food poisoning caused by larvae of *Anisakis* – a parasitic nematode – remaining in the human stomach and intestines[6]. According to the definition of the Ministry of Health, Labor and Welfare, the genus includes the species *A. simplex*, which often parasitizes dolphins as its end hosts; *A. physeteris*, which parasitizes whales as its end hosts; and *Pseudoterranova decipiens*, which often parasitizes seals as its end hosts. It is an infectious disease that occurs when sashimi or salty fish is eaten. Symptoms include severe pain, internal bleeding, nausea, vomiting and urticaria. According to the life cycle, adult *Anisakis* lay eggs, which enter microorganisms such as krill. *Anisakis* moves through hosts in the food chain from small fish → larger fish (horse mackerel, mackerel, bonito, saury, sardines, squid, etc.) → marine mammals. In the meantime, the process of growing into eggs → larvae → adults is inherent, and this process does not normally include humans. It is thought that one or several animals invade irregularly into the human body when raw fish and shellfish are eaten. Adult *Anisakis* are earthworm-like, about 3–20 cm long and 5–8 mm wide. Larvae are long, translucent white filaments 2–3 cm long and 0.5–1 mm wide; eggs are short, oval in shape, and have a diameter of 50 μm[2,6]. In this study, we examined why the number of notified anisakiasis cases in Japan is increasing.

Why do people get anisakiasis?

It is thought that the main cause is eating seafood, an intermediate host. Japanese culture includes the eating of raw fish, and it is easy to establish a human infection by eating raw fish and shellfish infested with *Anisakis*. However, both heat and freezing can kill *Anisakis*: the larvae die in a few seconds at 60°C and instantly above 70°C[1)], and if frozen below −20°C for 24 h or more. If you chew the fish properly, the living *Anisakis* are cut up and cannot survive in the human body. It has been said that infection can be prevented by using wasabi, vinegar, salt, etc. when eating raw fish but this is a false rumor.

Anisakis larvae move on the surface of the viscera and often take nutrients from the intestine when the infested fish is alive or fresh. However, sometime after the host fish dies, decay begins and the storage temperature rises. As a result, the larvae encyst on the visceral surface and become immobile (becoming globular and covered with a membrane) as in hibernation, or migrate into the muscle. Since this fish muscle is what is a human would eat, it is easy to become infected.

History of anisakiasis

Although the parasite species responsible for anisakiasis in Japan was first identified in 1963, it is believed that the disease had been present before that time[2)]. Before the 1950s, when a surgically resected diseased area was used as a specimen, later pathological examination always revealed anisakiasis. In other words, although cases that were often cured in the hospital could be diagnosed with anisakiasis, it was difficult to be recognized during the affliction and to take appropriate measures. In Japan, as endoscopic examination became widespread from the 1970s, extraction of worms with forceps for biopsy became possible and it became clear that many cases of anisakiasis could be identified. The incidence of *Anisakis* is particularly high in Japan in comparison with the rest of the world, and it is estimated that more than 2,000 infections occur annually. However, even if the infection is established, the *Anisakis* larvae often die spontaneously in about 2–3 weeks, and so there are many natural cures. This seems to be reflected in the difference between the actual number of notifications and the estimated number of cases.

Reason for increase in anisakiasis notifications in Japan

Although the number of notifications is increasing, this does not mean there has been an

increase in anisakiasis or in numbers of *Anisakis* larvae. Reasons for notifications include:

(1) Partial revision of the Ordinance for Enforcement of the Food Sanitation Act on 28 December 2012, when *Anisakis* was newly added to the list of Food Poisoning Incidents as a type of food poisoning substance (Article 58 in Food Sanitation Act, Report on Poisoning)[7]. A doctor who has diagnosed an *Anisakis* patient needs to notify the nearest public health center within 24 h[3)]. Prior to this, there was no detailed classification of parasites in the notification contents, so there was no need to identify the presence of *Anisakis*. Statistical data on infections reported as anisakiasis are now individually classified and so more visible to the general public. It is thought that an increase in the opportunity for doctors to examine whether anisakiasis is a candidate for the cause of disease has also led to an increase in notification.

(2) Improved transport and storage techniques: seafood that was not previously eaten, and seafood formerly eaten only in specific areas, can now be widely eaten[3)]. In the past, fresh fish were rarely available in many areas, and it was commonplace to simmer and bake them. Fish can now be transported for a long distance in a short time, either alive or soon after being killed. As a result, opportunities to eat fresh (not frozen) fish are increasing. In the past, saury sashimi was generally only eaten in areas near the harbor during its peak season in the fall. However, although this may have been the case, it seems to be an insufficient reason for the rapid increase in the number of notifications in recent years. Transportation technology has been developing for more than 20 years, and not particularly recently. However, new dishes have been devised (for example, sauces mixed with liver and salty fish that have not been used conventionally) and have been increasing in recent years; they may be part of the reason for rising notifications.

(3) The increase in fish and shellfish parasites caused by the rise in seawater temperature, which is thought to be distantly related to global environmental problems. It is said that *Kudoa septempunctata*, which infests flounder, also tends to increase as the seawater temperature rises. We are skeptical about this, as the rise in seawater temperature is also related to the quality of the growing environment, and it is thought that migratory (and other) fish will move to an area with lower, more tolerable water temperatures if the environment becomes uninhabitable. Since the parasite needs to coexist with its host, it seems to naturally adapt to the livable environment of the host fish.

(4) Increased numbers of whales and dolphins as the final hosts of *Anisakis*[3]. We cannot judge this because there seems to be expert opinion.

(5) Marine pollution, which may lead to increased numbers of parasites. However, considering the life cycle of *Anisakis*, the number of marine mammals should not be irrelevant, so it is strange that only parasites increase. If it is increasing in conjunction with (4), it may be considered a reason for increased notifications.

CONCLUSION

We believe that the main reason for the increase in reported cases of anisakiasis is revision of the Food Sanitation Act, which was reported on television[8]. According to published data on the history of the Food Sanitation Act revision[9], the number of patients per incident differs dramatically in the case of food poisoning due to parasites compared with food poisoning due to bacteria and viruses (Table 1)[3].

Table 1 Poisonings notified in Japan according to etiological substance, 2018

No.	Name of etiological substance	Total		
		Incident	Patient	Dead
1	*Salmonella* bacteria	18	640	0
2	*Staphylococcus*	26	405	0
3	Botulinus	0	0	0
4	*Vibrio parahaemolyticus*	22	222	0
5	Enterohemorrhagic *E. coli*	32	456	0
6	Other pathogenic *E. coli*	8	404	0
7	*Clostridium perfringens*	32	2319	0
8	*Bacillus cereus*	8	86	0
9	*Yersinia enterocolitica*	1	7	0
10	*Campylobacter jejuni / coli*	319	1995	0
11	Nagubiburio	0	0	0
12	Cholera bacteria	0	0	0
13	*Shigella*	1	99	0
14	*Salmonella typhi*	0	0	0
15	Paratyphoid A bacteria	0	0	0
16	Other bacteria	0	0	0
17	Norovirus	256	8475	0
18	Other viruses	9	401	0
19	Kudor	14	155	0
20	Sarcocystis	1	8	0
21	*Anisakis*	468	478	0
22	Other parasites	4	6	0
23	Chemical substances	23	361	0
24	Natural plant poisons	36	99	3
25	Natural animal poisons	25	34	0
26	Others	3	15	0
27	Unknown	24	617	0
	Total	1330	17282	3

Based on the data in reference (5).

The pathogens numbered 19–22 were newly established in the Food Sanitation Act revision in December 2012.

Bacterial or viral infections often lead to more than 100 patients in a single incident, but anisakiasis not uncommonly affects only one patient (Table 1 and Fig. 1). Bacterial food poisoning often occurs in summer, and more viral infections tend to occur in winter. Anisakiasis is said to be abundant in winter[2], but that does not mean there is a big difference compared with summer (Fig. 2),

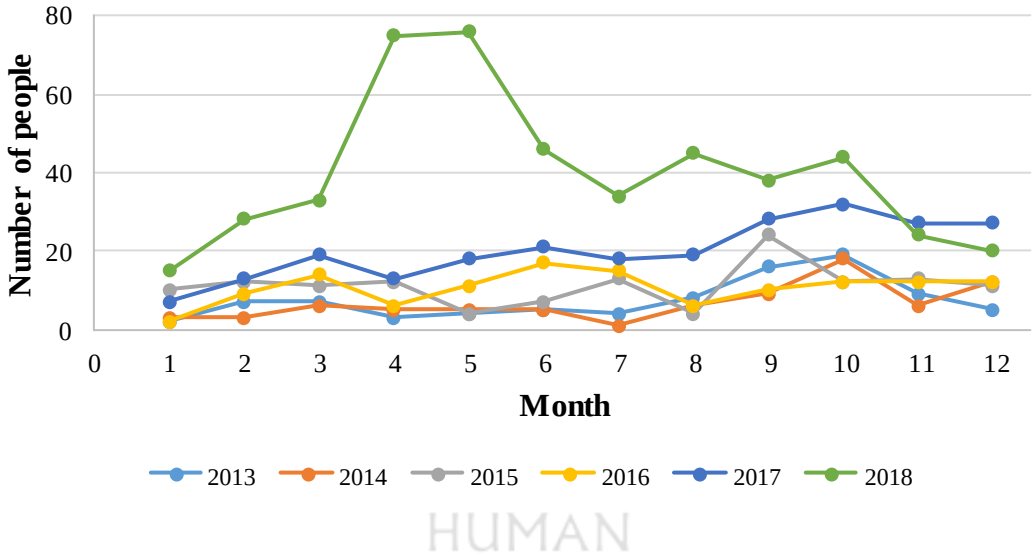

Fig. 2 Number of notifications of anisakiasis patients in Japan in 2013–2018, by month.

Based on data in reference (5).

Owing to the stable supply of fresh fish everywhere in Japan as a result of transportation and aquaculture technology. In the case of parasitic disease, it seems to be that the amount of fish being eaten increases when the fish representing the food material reaches its peak season. At this time, the disease may be related to a decrease in the rate of frozen storage, a decrease in market prices and an increase in the quantities of fish available in the market. Furthermore, although bacteria and viruses grow quickly (*Vibrio parahaemolyticus* doubles every 10 min), parasites grow much more slowly (*Anisakis* larvae do not increase in the human body). This is reflected in the difference in incubation period (2–3 h in *V. parahaemolyticus* and 1 h to 2 weeks in *Anisakis*)[1]. Also, host specificity is stricter in parasites than in bacteria and viruses. A characteristic of parasites is that growth is controlled by the infected host (in the

intermediate host, only a certain period of larval growth is tolerated). In view of such differences, it is considered that they have been treated separately.

The focus on anisakiasis is welcome in terms of improving disease prevention and treatment. However, it seems that it makes no sense to avoid eating raw fish you want to eat by knowing such information. Just as small amounts of pesticides may persist in vegetables, it may be necessary to keep in mind that food has certain risks, but also enjoy eating. It may also be necessary to put a precautionary measure (heating or freezing of the fish) in one corner of the head. Food eating has more meaning than just taking nutrition, and it is thought that it can be a purpose of enriching life and living.

Trainee doctors only study parasitosis for a short time, and it is thought that the number of doctors in Japan who can properly diagnose this condition – including recognizing anisakiasis – is still small[10]. In particular, current clinical examination methods mainly determine the presence or absence of a disease state or disease from numerical values such as antibody titer. This differs from parasitic disease in which the detection of an insect body by microscopic examination, for example, often becomes a definite diagnosis. Thus, in line with the current situation in Japan where the number of notified parasitic diseases is increasing, we expect doctors to improve their diagnostic ability and hope that treatment will be properly performed as a result.

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