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Stomach Contents and Nematode Infection of Two Deep-water Catsharks, *Apristurus fedorovi* and *A. japonicus*, from Northern Japan

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Abstract

Two deep-water catsharks, *Apristurus fedorovi* and *A. japonicus*, from the western North Pacific Ocean off northern Japan were examined for stomach contents and gastrointestinal nematode infection. A variety of prey (myctophids, bathylagids, other teleosts, crustaceans, cephalopods, asteroids) was discovered from the stomachs of *A. fedorovi*, whereas only myctophids were found in those of *A. japonicus*. This difference suggests that *A. fedorovi* feeds on nektic and benthic animals in mid- and bottom waters but *A. japonicus* takes myctophids in mid-waters. The gnathostomatid nematode *Metaleptus rabuka* was found in the alimentary tract of the two shark species, and the nematode was the most abundant in the cardiac stomach. *Apristurus fedorovi* had higher infection levels than *A. japonicus*, indicating that *A. fedorovi* is a preferred host. In *A. fedorovi*, high intensity of infection was recorded from large fish captured mainly in waters deeper than 1,000 m. *Apristurus japonicus* represents a new host record for *M. rabuka*. Myctophids and bathylagids may play a role as intermediate or paratenic hosts for *M. rabuka*.

Key words: Deep-water catsharks, *Apristurus fedorovi*, *Apristurus japonicus*, Stomach contents, Parasitic nematode, *Metaleptus rabuka*, Western North Pacific

Introduction

The deep-water catsharks (genus *Apristurus*) are members of the family Scyliohinidae, and six species has been reported from Japanese waters (Nakaya, 1975: Nakaya and Sato, 1999). Information on their ecology and life cycles is very sparse because they usually inhabit deep benthic waters and catches are limited. To understand their biology, the present study was undertaken to elucidate the feeding habits of two species, *Apristurus fedorovi* Dolganov and *A. japonicus* Nakaya, which were collected in the western North Pacific Ocean off northern Japan. In addition, Moravec and Nagasawa (2000) recently reported the gnathostomatid nematode, *Metaleptus rabuka* Machida, Ogawa and Okiyama from the intestine of *A. fedorovi* collected in the same region. This finding also promoted us to study the occurrence of the parasite in the two deep-water catsharks.

Materials and Methods

Specimens of *Apristurus fedorovi* and *A. japonicus* were collected using trawl nets at depths ranging from 650 to 1,505 m in the western North Pacific Ocean off the east coast of Honshu and Hokkaido, Japan (between 36° 29′ to 41°15′N and 141°09′ to 144°15′E) from 1978 to 1999. They were fixed in 10% formalin solution and have been deposited at the Laboratory of Marine Zoology, Faculty of Fisheries, Hokkaido University in Hakodate, Hokkaido. In the present study, 154 specimens of *A. fedorovi* and 41 specimens of *A. japonicus* were used: they were measured (total length), weighed, sexed, and examined for stomach contents. Of these specimens, 48 *A. fedorovi* and all *A. japonicus* were examined for the presence of *Metaleptus rabuka* in two parts (cardiac stomach and pyloric stomach) of the stomach and also in the intestine (spiral valve). Definitions on infection level of *M. rabuka* follows Bush et al. (1997): prevalence is a percentage of infected host, intensity is the number of parasite in an infected host, and mean intensity is a mean number of parasite per infected host.

Voucher specimens of *M. rabuka* have been deposited in the National Science Museum, Tokyo (NSMT-As

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2975 from *A. fedorovi* and NSMT-As 2976 from *A. japonicus*).

Results and Discussion

Stomach contents

The two deep-water catsharks examined mostly had an empty stomach (85.1% in *A. fedorovi* and 87.8% in *A. japonicus*). Prey organisms were often found in the mouth region of the sharks, and it is likely that stomach contents were discharged during capture. There was a big difference in prey composition between the two species (Table 1). A variety of prey (myctophids, bathylagids, other teleosts, crustaceans, cephalopods, asteroids) was discovered from the stomachs of *A. fedorovi*, whereas only myctophids were found in those of *A. japonicus*. Some of the fish were identified as *Leuroglossus schmidti* Rass (family Bathylagidae), *Stenobrachius nannochir* (Gilbert) and *S. leucopsarus* (Eigenmann and Eigenmann) (both in the family Myctophidae). The difference in stomach contents suggests that *A. fedorovi* feeds on nektic and benthic animals in mid- and bottom waters but *A. japonicus* rather takes myctophids in mid-waters.

Nematode infection

Metaleptus rabuka was found in the stomach and intestine of *A. fedorovi* and only in the stomach of *A. japonicus*. Infection levels markedly differed between the two shark species. All of 48 *A. fedorovi* were usually heavily infected (prevalence=100%, intensity=4-494 [mean=230]) but only two of 41 *A. japonicus* were infected with 7 or 37 worms (prevalence=4.9%, mean intensity=22).

A total of 11029 *M. rabuka* was collected from *A. fedorovi*. They were most abundantly found in the cardiac stomach (68.1%), followed by the pyloric stomach (25.3%) and the intestine (6.6%). In *A. japonicus*, all worms ($N=44$) were found in the cardiac stomach. These results indicate that *M. rabuka* prefers the pyloric stomach as infection site. Although the pyloric stomach is a slender tube, it was swollen when heavily infected.

In *A. fedorovi*, higher intensity of infection was recorded from larger fish, although there was marked variations (Fig. 1). There was a trend that the fish caught at depths of more than 1,000 m were more heavily infected (N=29, mean intensity=250) than those from waters less than 1,000 m ($N=19$, mean intensity=199), but this difference was caused by a difference in fish size between the two depth zones: the fish from $\geqq$1,000 m were larger (mean total length=586 mm) than those from $<$1,000 m (511 mm) (Fig. 1).

Metaleptus rabuka was originally described as a new genus and species in the family Physalopteridae from the stomach and intestine of the deep-sea frill shark, *Chlamydoselachus anguineus* Garman, from off Choshi, central Japan (Machida et al., 1982). Subsequently, Moravec and Nagasawa (2000) found *M. rabuka* in *A. fedorovi* taken off northern Honshu, Japan. The authors transferred the species to the family Gnathostomatidae and established a new subfamily Metaleptinae to accommodate it as a type species. The known definitive hosts are only two sharks, *C. anguineus* and *A. fedorovi*, and *A. japonicus* represents a new host record for *M. rabuka*. Based on the observed difference in infection level between the two species of deep-water catsharks, *A. fedorovi* is thought to be a preferred host.

Table 1. Stomach contents of *Apristurus fedorovi* and *A. japonicus* from the western North Pacific off northern Japan.

Shark species	Taxon	Prey species or group	No. of sharks (%)
A. fedorovi	Teleostei	*Leuroglossus schmidti*	1(0.65)
$N=154$		*Stenobrachius nannochir*	1(0.65)
		Myctophidae spp.	3(1.95)
		Unidentified	7(4.55)
	Crustacea	Decapoda spp.	3(1.95)
		Eucarida spp.	3(1.95)
		Euphausiacea sp.	1(0.95)
	Cephalopoda	Celeoidea spp.	2(1.30)
	Asteroidea	Unidentified	2(1.30)
	Empty stomach		131(85.1)
A. japonicus	Teleostei	*Stenobrachius leucopsarus*	1(2.44)
$N=41$		Myctophidae spp.	4(9.76)
	Empty stomach		36(87.8)

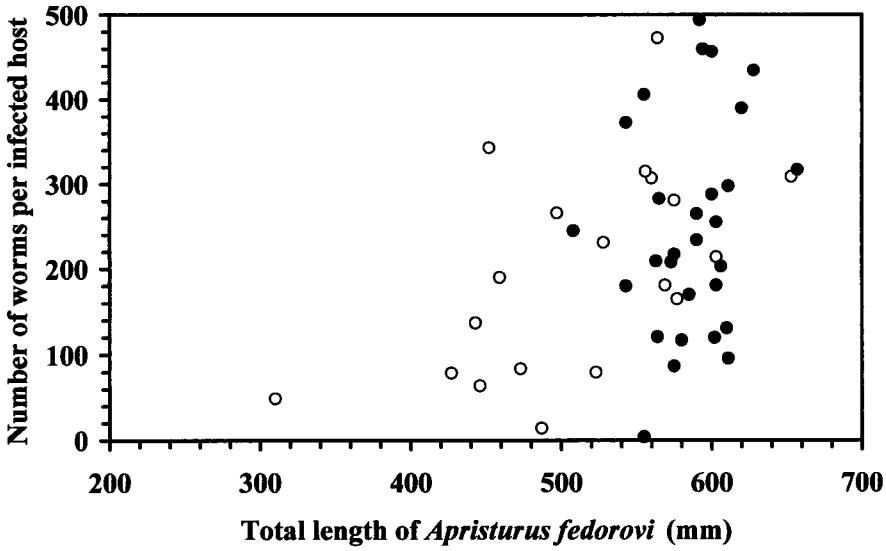

Fig. 1. Relationship between total length of *Apristurus fedorovi* and number of *Metaleptus rabuka* from each infected host.
○: fish collected at depths of less than 1,000 m, ●: fish collected at depths of more than 1,000 m.

No information is available on the parasite's infection level in *C. anguineus*.

Machida et al. (1982) suggested that copepods and mid-water gonostomids (*Cyclothone* spp.) are involved in the life cycle of *M. rabuka*. They actually found larval *M. rabuka* (13-22 mm long) from the top of the brain of *C. atraria* Gilbert caught at depths between 500 to 1,000 m off Sanriku District, which is nearly the same as our sampling locations. Myctophids and bathylagids are important prey of *A. fedorovi* and *A. japonicus*, and it is thus likely that they play a role as intermediate or paratenic hosts for *M. rabuka*, as suggested by Machida et al. (1982) for gonostomids.

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