

Infection Status of *Todarodes pacificus* (Mollusca: Cephalopoda) with Anisakid Larvae in the South Sea, Korea

KAE SIK CHUN AND SE-WHA KIM*

Department of Environmental Health,

*Department of Life Science, Yongin University, Yongin 449-714, Korea

한국 남해산 살오징어(*Todarodes pacificus*)의 아니사키스 유충 감염상

전계식 · 김세화*

용인대학교 자연과학대 환경보건학과, *생명과학과

A total of 272 specimens of *Todarodes pacificus* purchased during the period from July 1 to August 30, 1994 in the southern sea off Pusan were examined for their infection status with larval anisakids. Larvae in squids were encapsulated and appeared to remain active. Fifty five larval anisakids sorted from *T. pacificus* (7.72% of infection rate) were classified based on morphological and morphometric observations as follows; Anisakis type I larvae (23 larvae, 51.0%: positive rate), *Contraecaecum* type A (9, 20.0%), *Contraecaecum* D (4, 9.0%), *Anisakis* II (3, 6.7%) and unknown type (6, 13.3%).

1994년 7월과 8월에 구입한 남해산 살오징어(*Todarodes pacificus*) 272개체로부터 45개체의 아니사키스 유충이 채집되어 7.72%의 유충 감염을 보였다. 형태 및 크기를 바탕으로 유충의 종류 및 내장, 근육 등 어체 부위별 감염상황을 조사한 결과 유충의 길이는 7.0~22.8 mm이었으며 *Anisakis* type I 23개체(51.0%: 회수율), *Anisakis* type II 3개체 (6.7%), *Contraecaecum* A 9개체(20.0%), *Contraecaecum* D 4개체(9.0%) 및 불명 6개체(13.3%)로 분류되었다. 아니사키스 유충은 남해산 *T. pacificus*의 근육과 내장에 주로 기생하고 있었다.

INTRODUCTION

Anisakiasis caused by *Anisakis* larvae was first reported by Van Thiel (1960). The third stage larval ascaridoid nematodes such as the genera *Anisakis*, *Terranova*, *Contraecaecum*, *Raphidascaris*, *Thynnascaris* are often found in the visceral cavity and muscle of marine fishes and squids (Margolis, 1970; Smith and Wootten 1975).

Nematod larvae might encyst within the muscles of the fish host. In cases of raw or inadequately cooked fishes being eaten, these larvae seemed to be introduced into the human gastrointestinal tract, then could cause an eosinophilic granuloma at the

gut wall and abdominal pain (Jung *et al.*, 1974; Chang *et al.*, 1978; Shiraki, 1974).

Eelworms found from marine fishes were first identified as that belonged to the genus *Anisakis* in Holland (Van Thiel, 1960) and afterwards, nematodes in the family Anisakidae are found throughout the world. Especially, human anisakiasis is most common and more than 1200 cases have been reported in Japan (Koyama, 1982). In Korea, only 13 cases were reported (Kim *et al.*, 1971; Cho *et al.*, 1980; Seo *et al.*, 1984; Paik *et al.*, 1984; Lee *et al.*, 1985; Rim *et al.*, 1988; Sohn *et al.*, 1994). With the wide spread habit of eating raw fish among the Korean, however, it is easily assumed

Table 1. The prevalence rate for the infection of *Todarodes pacificus* with anisakid larvae in the southern sea, Korea.

Presumed species	Case	%
<i>Anisakis</i> I	23	51.0
<i>Contracaecum</i> A	9	20.0
<i>Contracaecum</i> D	4	9.0
<i>Anisakis</i> II	3	6.7
Unknown	6	13.3
Total	45	100



Fig. 1. *Anisakis* type II. The anterior part, left lateral view of larvae from *Todarodes pacificus* is characterized by the directed anteriorly boring tooth (↑). mag. X100.

that the cases of anisakiasis could be encountered in this country.

With regard to taxonomy of larval anisakids in squids from northern coastal waters of Japan, four larval types were recognized in the genus *Anisakis*; viz., *Anisakis* larva I, II, III and IV along with other larval types representing genera, *Terranova*, *Contracaecum*, *Raphidascaris* and *Thynnascaris* (Shiraki, 1974). There are, however, no reports being available on the taxonomy of larval anisakids of squids in Korea yet.

The objective of this study was to investigate the infection status of the larval anisakids found in the muscle and intestinal organs of squids.

MATERIALS AND METHODS

A total of 45 larvae from 272 specimens of squids (*Todarodes pacificus*) were purchased during the period from July 1 to August 30, 1994 in the



Fig. 2. *Anisakis* type II. The ventral part of larvae showing a short ventriculus (↑). mag. X100.

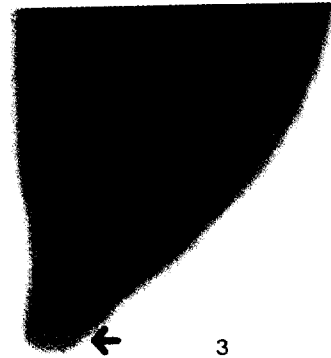


Fig. 3. *Anisakis* type II. The posterior part, left lateral view of larvae is a conical (↑), tapering tail lacking amucron. mag. X100.

south sea off Pusan. Alive specimens of squids were fixed with 10% formalin, then transported to the laboratory. The muscle and viscera of squids, then were carefully dissected. Anisakid larvae were isolated from the muscle and viscera.

Larval individuals were sorted with a micropin under stereomicroscope. Fixed larvae with 10% formalin were cleared with lactophenol (lactic acid 85% : phenol:glycerol:distilled water at 1:1:1:2) and mounted with glycerin jelly.

The body length and width were measured with ocular micrometer and the presence of the pre-ventriculus (muscular esophagus), ventriculus (glandular esophagus) and tail were recorded. Morphological characteristics for the identification of the larval types are distinguished with the third stage larvae reported by Koyama *et al.* (1969).

Table 2. Number of positive cases of anisakid larvae sorted from the various parts of the body of *Todarodes pacificus*.

Body part	<i>Anisakis</i> type I	<i>Anisakis</i> type II	<i>Contracaecum</i>		Unknown	Total
			A	D		
Muscle	14	3	6	3	4	30
Viscera	9	0	3	1	2	15
Total	23	3	9	4	6	45

Table 3. Comparative morphological features of anisakid larvae collected from *Platysepio* sp.

Body organs	<i>Anisakis</i> type I	<i>Contracaecum</i> type		<i>Anisakis</i> type II
		A	D	
Boring tooth	+	+	+	+
Excretory pore	between subventral libs	behind	nerve ring	between subventral libs
Ventricular appendage	-	+	+	-
Genital organ	-	short	long	-
Tail	short, round	long, slender	long, slender	long pointed
Mucron	+	+	+	-
	small, spines	small, spines		

+: present -absent

RESULTS

A total of 45 *Anisakis* larvae were sorted from 272 specimens of squids (*Todarodes pacificus*). The positive cases for the total number of anisakid larvae were 7.72%. Namely, the infection with *Anisakis* was revealed to be common in the southern sea, Korea.

The anisakid larval types on this study consisted of *Anisakis* type I, *Anisakis* type II, *Contracaecum* type A, and *Contracaecum* type D. Among the 45 specimens of larval anisakids, *Anisakis* type I was most frequently observed (23 specimens: 51.0% of total collected anisakids), followed order by *Contracaecum* A type (9 specimens: 20.0%), *Contracaecum* D type (4 specimens: 9.0%) and *Anisakis* type II (3 specimens: 6.7%) (Table 1). Six specimens (13.3%) remained to be unknown type.

Anisakis type I was detected from muscle (14 cases) and viscera (9 cases). With *Contracaecum* type A, 6 positive cases from muscle and 3 cases

from viscera and with *Contracaecum* type D, 3 from muscle and only 1 in viscera were discriminated. Three *Anisakis* type II showed positive cases from muscle and were not observed from viscera (Table 2).

Due to no reported cases caused by *Anisakis* type II from Korean squids, morphological characteristics of larval *Anisakis* type II were briefly described (Table 3). The *Anisakis* type II larvae were between 12.4 and 22.8 mm long and a maximum width laid between 0.45 and 0.55 mm.

Figs. 1-3 showed the pictures of the anterior and posterior ends of an *Anisakis* type II larva. In the anterior extremity, larva has prominent boring tooth directing anteriorly with the ventrolateral lip mass. The mouth opening is more or less triangular (Fig. 1). The excretory system has a large renette cell at ventral side of the anterior body. Esophagus is cylindrical and ventriculus is short (Fig. 2). No recognizable genital organ in the posterior portion is observed. Tail is conical but lacks the terminal por-

tion (Fig. 3)

DISCUSSION

Smith (1971) gave a brief account of larval nematodes. Lindley (1977) recorded the parasites associated with squids in 1966–1967; apart from two specimens of larval anisakids and *Thalassomyces fagei* from *Thysanoessa inermis*, a larval *Ascarophis* was found in a *T. inermis* caught off the Norwegian coast.

Taxonomic studies on the larval types of anisakids such as *Anisakis*, *Terranova*, *Contracecum* and *Raphidascaris* were reported in Japan (Yamaguchi, 1935, 1941; Koyama *et al.*, 1969; Kagei *et al.*, 1970; Myers, 1975)

In Korea, the majority of studies on anisakid larval types have been concerned with the *Anisakis*, *Contracecum* and *Raphidascaris* (Kim *et al.*, 1988; Chai *et al.*, 1990). The predominant larval type of *Anisakis* type I in this study (cf. Berland, 1961) from *Todarodes pacificus* agrees with the description of *Anisakis simplex* larvae (Beverly-Burton *et al.*, 1977). Then, infection with larval anisakiasis seems to be virtually restricted to *Anisakis* type I in Korea.

The distribution of infection appeared to be markedly continuous in the south sea and there showed a patchy distribution. Larval *Anisakis* type I occurred in 23 individuals (51.0%), which showed the highest prevalence rate. Rare occurrence of *Anisakis* type II from squids was also remarkable. Namely there were three cases of *Anisakis* type II only in muscle of squids. Infection of the yellow corvina with several kinds of anisakid larvae such as *Anisakis* type I, some types of *Contracecum* sp. and *Rapidascaris* sp. was recorded (Chai *et al.*, 1986, 1990). The surveyed species on this study were similar to those reported by Chai *et al.* (1986, 1990) except *Anisakis* type II.

The positive rate of larval anisakids was recorded as *Anisakis* I 80.4%, *Contracecum* A 1.2%, *Contracecum* C 1.7% and *Contracecum* D 7.2% from the yellow corvina (Chai *et al.*, 1986). In this study, the prevalence rate of *Anisakis* I was much lower

than that of the yellow corvina reported by Chai *et al.* (1986). The difference seems to be due to the host specific character of anisakid larvae.

The anisakid larvae from muscle of squids were revealed to have higher prevalence rates than those from viscera. This tendency suggests that the anisakid larvae could deeply penetrate into the muscle of fresh squids.

The morphology of anisakid larvae was similar to that of described in *Anisakis* type I of Shiraki *et al.* (1974). *Anisakis* type I was described by Shiraki (1974), Oshima (1972) and Koyama *et al.* (1969) as possessing a relatively long ventriculus with an oblique ventricular-intestinal junction and a rounded tail bearing a mucron. The three lips which surround the mouth opening may be termed as inconspicuous complex or protruded as having been reported by previous workers (Gibson, 1970; Pippy and Van Banning, 1975; Grabda, 1976). In the form of a transverse slit situated between the ventrolateral lips, the excretory pore opens from a single excretory duct. An asymmetrical system with the excretory duct and "ribbon-like" excretory gland were described by previous workers (Beverly-Burton *et al.*, 1977; Cannon, 1977). The preventriculus is followed by the ventriculus, the posterior margin of which meets the intestine obliquely such that the ventral side is longer than the dorsal side. The rectum opens the anus and is associated with three rectal glands including two dorsal and one ventral.

With *Contracecum*, very young larvae show a single caecum extending anteriorly from the front of the intestine (type A) and another extending posteriorly from the glandular part of the oesophagus (type D) (Dollfus, 1953). The *Contracecum* type C has a very short tail without a mucron (Koyama *et al.*, 1969).

Anisakis type II is characterized by a short ventriculus with horizontal ventricular intestinal junction, and a long conical, lacking mucron, and the head is similar to that of *Anisakis* I. Intensive sampling would be required to ascertain the extent of anisakid infection in squids in Korean waters as well as the southern sea. More attention should also be paid for the detection of the anisakiasis in Korea.

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