A Case of *Contracaecum spiculigerum* (Ascaroidea: Anisakinae) Infection in a Cormorant (*Phalacrocorax carbo*)

Takao SARASHINA, Hiroyuki TANIYAMA¹⁾, and Junzo YAMADA²⁾

Department of Veterinary Internal Medicine, ¹⁾Department of Veterinary Pathology, and ²⁾Department of Veterinary Anatomy, Obihiro University of Agriculture and Veterinary Medicine, Obihiro 080, Japan

(Received 13 May 1986/Accepted 4 October 1986)

ABSTRACT. An infection of *Contracaecum spiculigerum* was seen in the proventriculus of a cormorant (*Phalacrocorax carbo*) kept for fishing at Leshan, Sichuan Province, People's Republic of China, in April 1985. Erosions with hemorrhages were seen in areas of the mucosa where many worms burrowed. Many nodes with worms were seen in the muscular layer and projected from the serosal surface. Most worms in the muscular layer were surrounded by cell infiltration and granulation tissue, and showed regressive changes. The tissue response was characterized by the presence of homogeneous eosinophilic substance by the degenerating worms which surrounded by the foreign-body giant cells. The 4th stage larvae of the species were thought to invade the glandular lumen and muscular layer of the proventriculus. Following development, most of the larvae may return to the lumen of the proventriculus, but some larvae may remain in the muscular layer and succumb to degeneration after maturity.—**KEY WORDS:** *Contracaecum spiculigerum*, nematodiasis, *Phalacrocorax carbo*, proventriculus.

—Jpn. J. Vet. Sci. 49(1): 15–21, 1987

Contracaecum spiculigerum has been detected in many piscivorous birds in various parts of the world [1, 3, 5–8]. The species was described by Yamaguti [9] in cormorants at Ise Province, Japan, 1941. However, the infection of cormorant with *C. spiculigerum* in Sichuan Province, People's Republic of China has not been reported, and pathological involvement of this species in the avian host has not been fully understood. In April 1985, a cormorant (*Phalacrocorax carbo*) kept for fishing at Leshan, Sichuan Province, People's Republic of China, was necropsied for the purpose of an immunohistochemical study of gastro-entero-pancreatic endocrine cells. Upon necropsy macroscopic changes were observed in the proventriculus of the cormorant and a large number of nematodes were recovered. The worms were morphologically identified; pathological involvement of parasite development were studied.

MATERIALS AND METHODS

The female cormorant, 18 years old (1.7 kg), kept for fishing at Leshan, Sichuan Province, was killed and dissected in April 1985. The macroscopic changes were limited to the proventriculus. Tissue samples from the proventriculus were fixed in Bouin's fluid and embedded in paraffin. Histological sections were stained with hematoxylin and eosin. Nematodes were fixed in Bouin's fluid and cleared in lactophenol (Amann method).

RESULTS

A large number of worms were found in the proventriculus with heads burrowed within the mucosa; some were seen in the lumen of the proventriculus and gizzard. Erosions with hemorrhages were observed in many areas of the mucosa where worms attached themselves to the mucosa. Also

Fig. 1. *C. spiculigerum* (arrows) in the muscular layer of the proventriculus. $\times 1.2$.

Fig. 2. Histologic section of the muscular layer in the proventriculus, showing *C. spiculigerum* and tissue reaction. HE stain. $\times 17$.

Fig. 3. Histologic section of the muscular layer in the proventriculus, showing degenerated nematodes (DN) absorbed by granulation tissue containing the foreign-body giant cells. HE stain. $\times 200$.

many nodes (Fig. 1), 0.3–0.6 mm diameter, containing coiled worms were seen in the subserosa and projected from the serosal surface.

Histologically, many worms invaded the proventricular gland and muscular layer of the proventriculus (Fig. 2). Most of these worms in the muscular layer were adult and showed regressive changes, surrounded by cell infiltration consisting of many foreign-body giant cells, lymphocytes, eosinophils and granulation tissue. Following the degeneration and death of worms, prominent tissue response was absorption of degenerating worms by granulation tissue containing the foreign-body giant cells (Fig. 3). Tissue response was characterized by the presence of homogeneous eosinophilic substance by the degenerating worms which surrounded by the foreign-body giant cells (Fig. 4).

While many juvenile worms were found

Fig. 4. Histologic section of the muscular layer in the proventriculus, showing the presence of the homogeneous eosinophilic substance (ES) by the nematode (upper part) and surrounded by the foreign-body giant cells (lower part). HE stain. $\times 200$.

in the glandular lumen, there was no visible change in the glandular epithelium lining. Some of the juvenile worms burrowed in the mucosa, but necrotic focus and desquamation of the epithelium were rarely observed (Fig. 5).

Number of worms recovered were 45 males, 71 females and 29 juveniles. The body of adult worms was yellowish and coiled, tapering slightly at each extremity. The head (Fig. 6) consisted of 3 round lips and 3 hook-shaped interlabia, with thick transparent cuticle, bearing radial striations. The lips each had two ear-shaped anterior projections. The projections each had a small blunt-conical barb on the outer side. The dorsal lip had two large single papillae, and the subventral lips each had one. The incurved interlabia, only slightly shorter

Fig. 5. Histologic section of the mucosa in the proventriculus, showing many juvenile *C. spiculigerum* in the necrotic focus (NF). HE stain. $\times 100$.

than the lips, were triangular with broad bases. The opening of excretory pore (Fig. 7) at the base of the ventral interlabium was seen. The body cuticle showed numerous and fine transverse folds which were deepest just behind the head. The nerve ring surrounding the esophagus laid about halfway between the head and the end of the intestinal caecum. A pair of cervical papillae were present laterally at about the same level as the nerve ring. The cylindrical esophagus (Fig. 8) had a short ventriculus connected to a posterior ventricular appendix. The intestinal caecum (Figs. 6, 8) extended as a gradually tapering pouch along the dorsal side of the posterior four-fifths of the esophagus length. The intestine (Fig. 8), bearing distinct folds, extended from the ventriculus to the rectum.

Male. Measurements are given in Table 1. The conical tail with round point curved

Fig. 6. Anterior end of the female *C. spiculigerum*, showing the head, esophagus (E), and anterior end of the intestinal caecum (IC). $\times 40$.

ventrally. The elongate alate spicules were equal. Caudal papillae consisted of 31–42 pairs of preanal and 7 pairs of postanal papillae. The first four pairs of postanal papillae laid subventrally and the second three pairs laterally. On the 4 subventral papillae, the two larger anterior ones laid close together immediately posterolateral to the cloacal aperture. The two smaller posterior ones were lined up parallel with each other. Of the 3 lateral postanal papillae, the middle one was much smaller than the others.

Female. Measurements are given in Table 2. The vulva was in the anterior third of the body, dividing the body length into a ratio of 1:2.4. The ovejector was filiform and sinuous, dividing into the 2 uteri. The conical tail with rounded end had a pair of lateral papillae. The subglobular thick-shelled eggs contained ova that were not yet segmented. The above morphological

Fig. 7. Anterior end of the female *C. spiculigerum*, showing the excretory pore (EP). $\times 130$.

Fig. 8. The posterior end of esophagus (E) in the female, showing ventriculus (V) with posterior ventricular appendix (VA), anterior intestinal caecum (IC), and intestine (I). $\times 40$.

Table 1. Measurements (mm) of male *Contracaecum spiculigerum*

	Yamaguti (1941)	Mozgovoi (1953)	Present findings
Body length	29.000–40.000	20.000–40.000	16.208–22.401
width	0.750– 0.950	0.614– 1.001	0.688– 0.909
Head diameter	0.170– 0.260		0.185– 0.248
Lip length	0.075– 0.120	0.075– 0.139	0.079– 0.148
Interlabia length	0.075– 0.110	0.061– 0.120	0.062– 0.103
Cervical papillae	0.570– 0.820	0.440– 0.811	0.492– 0.640
Nerve ring	0.520– 0.650	0.400– 0.640	0.423– 0.541
Esophagus length	3.000– 5.200	3.033– 4.450	2.580– 3.391
width	0.180– 0.250	0.213– 0.320	0.221– 0.307
Ventriculus length	0.250– 0.310	0.226– 0.375	0.148– 0.266
width	0.200– 0.230	0.210– 0.320	0.148– 0.276
Ventricular appendix length	0.900– 1.300	0.714– 1.266	0.512– 0.964
width	0.120– 0.250	0.076– 0.192	0.128– 0.207
Intestinal caecum length	2.300– 3.300	2.030– 2.833	1.572– 2.506
width			0.246– 0.369
Intestine length			13.229–18.858
width			0.433– 0.561
Cloaca	0.180– 0.200	0.201– 0.241	0.177– 0.216
Spiculus length	7.200– 9.100	6.200– 7.800	6.833– 8.267
width			0.040– 0.057

a) All values derived from 20 specimens.

b) Width based on maximum value.

Table 2. Measurements (mm) of female *Contracaecum spiculigerum*

	Yamaguti (1941)	Mozgovoi (1953)	Present findings
Female adult			
Body length	40.000–51.000	36.000–85.000	24.618–30.581
width	1.000– 1.400	0.960– 1.400	0.946– 1.229
Head diameter	0.240– 0.300		0.238– 0.291
Lip length	0.110– 0.150	0.148– 0.151	0.113– 0.153
Interlabia length	0.110– 0.150	0.111	0.091– 0.125
Cervical papillae	0.660– 0.960	0.820	0.581– 0.689
Nerve ring	0.620– 0.760	0.630	0.541– 0.640
Esophagus length	3.500– 5.300	4.600– 5.300	3.194– 4.128
width	0.200– 0.310	0.237	0.283– 0.405
Ventriculus length	0.320– 0.450	0.370	0.216– 0.374
width	0.250– 0.330	0.310	0.246– 0.374
Ventricular appendix length	1.000– 1.500	0.840– 1.200	0.738– 1.279
width	0.140– 0.210	0.148	0.148– 0.246
Intestinal caecum length	2.700– 4.400	2.400– 3.100	2.334– 3.170
width			0.356– 0.491
Vulva		13.000	6.575– 9.098
Intestine length			20.713–26.108
width			0.600– 0.758
Anus	0.300– 0.410	0.412	0.374– 0.443
Eggs			
length	0.057– 0.072	0.068	0.054– 0.065
width	0.045– 0.075	0.063	0.044– 0.055

a) All values derived from 20 specimens.

b) Width based on maximum value.

findings agreed fairly well with the description of *Contracaecum spiculigerum* (Rudolphi, 1909) by Mozgovoi [3] and Yamaguti [8].

DISCUSSION

Yamaguti [9] described two new species: *Contracaecum himeu* from *Phalacrocorax pelagicus* and *C. umiu* from *P. capillatus*. Present specimens closely resemble to *C. umiu* in the length of spicules. Yamaguti [9] stated that the two new species differed from *C. spiculigerum* in the length of spicules and thickness of egg shell. However, Mozgovoi [4] reported the considerable variations in the length of spicules and egg size of *C. spiculigerum*, and speculated *C. himeu* and *C. umiu* to be synonymous with *C. spiculigerum*. Subsequently, Yamaguti [10] cited Mozgovoi's opinion [4] in his book, *Systema Helminthum*. It seems therefore that the present species can be identified as *C. spiculigerum* (Rudolphi, 1909).

The body length of the present specimens was shorter than the descriptions of Yamaguti [9] and Mozgovoi [4]. The distances of cervical papillae, nerve ring and vulva from the head end were also shorter than those of the previous investigators. However, the numbers of preanal papillae in the present specimens were approximately equal to those of Mozgovoi [4], 31–42 and 32–40 pairs, respectively. The ratio of the vulva divided body length in the present specimens also approximately equaled those of Yamaguti [9] and Mozgovoi [4], 1:2.4, 1:1.3–2.2 and 1:2.08, respectively. The present shorter specimens may have been caused by the heavy infection with numbers more than 50 individuals harbored [1] or the repetitive *C. spiculigerum* infections by the long-living cormorant.

According to the Mozgovoi's illustration [4] of *C. spiculigerum*, the excretory pore opened ventrally at about the same level as

the nerve ring. However, Hartwich [2] indicated that the excretory pore in *Contracaecum* opened at the base of the ventral interlabium as seen in the present findings. Accordingly, the position of the excretory pore in Mozgovoi's figure is thought to be erroneous.

C. spiculigerum has wide host specificity; cormorants, ducks, fulmars, geese, grebes, gulls, mergansers, pelicans, shags, swans and a wide variety of other piscivorous birds. This worm has an indirect life cycle. Eggs pass in the bird's feces; the larvae undergo two molts within the egg before hatching, which takes place within 5–7 days. Host specificity of the 3rd stage larvae also appears to be broad. The larvae are ingested by many marine or freshwater fishes and encyst in the fish's musculature, mesentery or viscera. When infected fish are ingested by the avian hosts, the larvae undergo two additional molts and become mature worms in the proventriculus, gizzard or intestine [1, 3, 5–8].

However, the development of *C. spiculigerum* in avian hosts has not been fully examined. Present worms were seen separately in the mucosa and the muscular layer of the proventriculus. Consequently, this finding suggests the following development of this species. The 3rd stage larvae ingested by the avian host may invade the proventricular gland and undergo the third molt. The 4th stage larvae may wander into the granular lumen and muscular layer. Following development, most of the larvae may return to the lumen of the proventriculus and develop there into adults. However, some of larvae may remain in the muscular layer of the proventriculus and succumb to degeneration after maturity.

ACKNOWLEDGEMENTS. The authors wish to express their appreciation to Prof. M. Ohbayashi, Department of Parasitology, Faculty of Veterinary Medicine, Hokkaido University, for his continuing guidance, and Dr. B. LI and Dr. Z. Deng, Department of Veterinary

Anatomy, School of Veterinary Medicine, Beijing Agriculture University, for supplying samples.

REFERENCES

1. Dubinin, V. B. 1949. Experimental investigation on the cycle of development of several parasitic worms of animals of the Volga district. *Parazitol. Sb. Akad. Nauk USSR Zool. Inst.* 11: 126 (in Russian).
2. Hartwich, G. 1957. Zur Systematik der nematoden-Superfamilie Ascaridoidea. *Zool. Jb. Syst.* 85: 211-252.
3. Huizinga, H. W. 1965. Studies on the life cycle and histopathology of the nematode parasite, *Contracaecum spiculigerum* in fish eating birds. Northeast Fish Wildlife Conf., Harrisburg, Pennsylvania, Jan. 1965, p. 17.
4. Mozgovoi, A. A. 1953. Essentials of Nematodology Vol. III. Acad. Sci. USSR. Moscow (Russian text).
5. Mozgovoi, A. A., Shakhmatova, V. I., and Semenova, M. K. 1968. Life-cycle of *Contracaecum spiculigerum* (Ascaridata: Anisakidae), a parasite of domestic and economically important birds. *Trudy gel'mint. Lab.* 19: 129-136 (in Russian).
6. Thomas, L. J. 1937. On the life cycle of *Contracaecum spiculigerum* (Rud.). *J. Parasitol.* 23: 429-431.
7. Thomas, L. J. 1937. Further studies on the life cycle of *Contracaecum spiculigerum*. *J. Parasitol.* 23: 572.
8. Thomas, L. J. 1940. Life cycle studies on *Contracaecum spiculigerum*, a nematode from the cormorant, *Phalacrocorax auritus*, and other fish-eating birds. *3rd Intern. Congr. Microbiol. Rep. Proc.* 458-460.
9. Yamaguti, S. 1941. Studies on the helminth fauna of Japan. Part 36. Avian nematodes. II. *Jpn. J. Zool.* 9: 441-480.
10. Yamaguti, S. 1961. *Systema Helminthum* Vol. III, The nematodes of vertebrates. Interscience, New York.

要 約

鵜 (カワウ *Phalacrocorax carbo*) の *Contracaecum spiculigerum* (蛔虫目: アニサキス科) 寄生例: 更科孝夫・谷山弘之¹⁾・山田純三²⁾ (帯広畜産大学家畜内科学教室, ¹⁾家畜病理学教室, ²⁾家畜解剖学教室)——1985年4月に中国四川省眉山市で鵜飼いのため飼育されていた1羽のカワウの前胃に多数の *C. spiculigerum* の寄生を認めた。前胃粘膜には多数の虫体が刺入し, 出血を伴う糜爛がみられ, 筋層には虫体を含む結節が多発し, 漿膜面より隆起していた。筋層の虫体は, 浸潤細胞層と肉芽組織に囲まれ, 多くは退行性変化を示した。虫体とそれを取り囲む異物巨細胞との間にエオジン好性の均質物質が介在する部位が多く, 同部の組織反応は物質を欠く部位よりも強かった。本種の第4期子虫は前胃の腺腔または筋層に侵入し, 発育に伴って腺腔の子虫は前胃腔へ戻るが, 筋層ではそのまま成熟後死滅するものと考えられた。