Discovery of *Pharyngostomum cordatum* (Diesing, 1850) in cats from Kyushu, Japan

(Trematoda ; Strigeoidea ; Diplostomidae)

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In the surveys on the intestinal helminths of ownerless dogs and cats captured in Chikugo District covering the southern parts of Fukuoka and Saga prefectures, Kyushu, the present authors found an unfamiliar trematode parasitizing in the small intestines of two cats. Those parasites were counted more than 500 from the two cats together. The examinations of the specimens flattened and stained *in toto* and of several series of sections in the three elementary dimensions revealed that these are all identical to *Pharyngostomum cordatum* (Diesing, 1850) Ciurea, 1922, which has not yet been found in Japan though it has been recorded from European, Asian, and African continents.

In the present paper, the authors report the results of measurements and some new informations obtained from the above-mentioned Japanese materials. Usage of the term is followed La Rue (1926) and Yamaguti (1958).

Materials and Methods

Materials

All materials of the trematode were obtained from 2 female cats captured in Okawa city and Kurume city, Fukuoka prefecture. These two cities are situated along the main stream of the river Chikugo, and the distance between them is about 17 km. Two female cats were infected with 89 and 440 of the parasites, respectively (Table 1). Since 1964, about 30 cats have been captured in Chikugo district and autopsied for the research of the intestinal parasites. No other cats were infected with this trematode.

The existence of the present parasites was noticed first by the discovery of several unfamiliar large eggs in faeces of the cats. By autopsy of the hosts, many adult worms of the trematode were found attaching tightly to mucosa of the small intestines. They sticked in mucosa so firmly that it was unable to separate them from mucosa by shaking of a piece of the intestine in saline. The worms separated from mucosa by forceps held generally a piece of mucosa around the tribocytic (=holdfast) organ. The worms attached almost perpendicularly to the substratum (Figs. 1 and 2). Their distribution in the intestine was not so characteristic but almost all of them were found in duodenum and jejunum in both of the hosts. The worms naturally showed a beer-barrel-like form, and the

Table 1 Data of host animals parasitized by *Pharyngostomum cordatum*

Host number	Host species	Sex	Weight	Locality	Date of examination	Number of parasites
1	cat	♀	2,500 g.	Okawa city	20. Jan. 1965	89
3	cat	♀	845 g.	Kurume city	15. Dec. 1964	440

vitelline glands were recognized as a dark-coloured band (Fig. 3). In natural condition, the tribocytic organ is almost enclosed by the foliate portion of the fore-body. The organ, however, appeared clearly between depressed foliate portions when the worm was flattened (Fig. 4). In the flattened specimen, the outlines of the ovary, testes, and vitellaria were recognizable.

Preparation of materials for examination

Less than 100 worms were separated from the host intestine and immediately flattened and fixed with Bouin's fluid. The rest worms were fixed together with a piece of the basal intestinal tissue. Some of these flattened materials were stained with borax carmine and made into mounted specimens *in toto*. Some of unflattened materials were embedded into paraffin, and sectioned in three elementary dimensions. The sectioned materials were stained with Delafield's haematoxylin and eosin. Eggs were collected from the faeces by repetitive washing with tap water.

Method of measurements

Measurements were performed by two different methods. Oral sucker and pharynx of the adult and eggs were measured by the microscopic micrometer. Other organs were directly measured on the accurate 100 X images enlarged by a shadowgraph (Nippon Kogaku, No. 6C).

Results

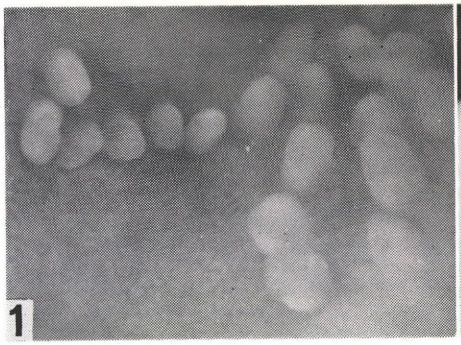
Measurements of the adult worms were performed on 20 flattened specimens. The eggs were measured on 10 samples taken from the faeces of the cat No. 3. Results of the measurements are shown in Table 2. As the acetabulum was not recognizable in the mounted specimen *in toto* (Fig. 4), it was measured in a sectioned specimen. Internal structures of the adult worm were observed on the serially sectioned specimens, and were shown in Fig. 5.

The results of measurements and the organization of the internal structures showed a quite identity of the present trematode with *Pharyngostomum cordatum* (Diesing, 1850) Ciurea, 1922. The descriptions on the internal structures of *P. cordatum* made by La Rue (1926) were so excellent that no important additional informations were obtained from the present materials. Some new findings, however, were obtained as follows.

1) Form of ovary: According to the figures shown by La Rue (1926), Faust (1927), etc., ovary seemed to be simply elliptical in the ventral view. In the present ma-

Table 2 Results of measurements of *Pharyngostomum cordatum* with comparisons to those described by previous authors (mm)

Characters	No. of specimens examined	Minimum	Maximum	Average	Previous data described by			
					Ciurea	La Rue	Dubois	Baer & Dubois
Adult (flattened)								
Body length	20	1.37	2.26	1.79	2.60–3.82	—	1.8–2.37	1.8–3.2
Body width Fore-body	20	0.79	1.57	1.22	1.58–1.98	—	0.85–1.26	1.6–2
Body width Hind-body	20	0.66	1.38	1.05	—	—	0.78–1.16	
Oral sucker Length	20	0.061	0.095	0.083	0.19	0.131	0.040–0.096	0.136
Oral sucker Width	20	0.081	0.138	0.116		0.207	—	
Pharynx Length	20	0.105	0.137	0.117	0.21–0.23	0.225–0.244	0.160–0.207	0.144–0.192
Pharynx Width	20	0.109	0.155	0.132	0.21–0.22	0.22–0.244	0.175–0.245	0.136–0.176
Acetabulum	1	0.06		—	0.066	0.058–0.061	—	0.046
Tribocytic organ Length	20	0.61	1.19	0.81	0.99–1.32	—	0.63–0.84	1.200–1.500
Tribocytic organ Width	20	0.64	1.17	0.88	1.15–1.78	—	0.70–1.08	1.350–1.800
Ovary Longitudinal length	20	0.12	0.24	0.17	—	0.3	0.17	—
Ovary Transverse length	20	0.21	0.43	0.34	—	0.4	0.25	—
Egg (found in host faeces)								
Length	10	0.104	0.121	0.114	0.118–0.132	—	0.089–0.117	0.120
Diameter	10	0.070	0.089	0.078	0.074–0.088	—	0.055–0.069	0.072



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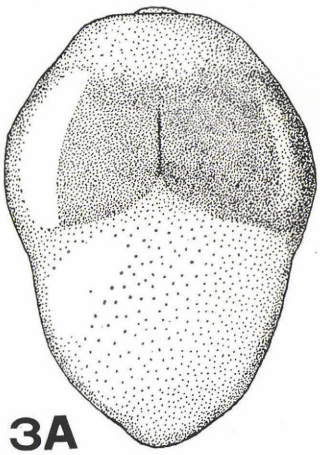

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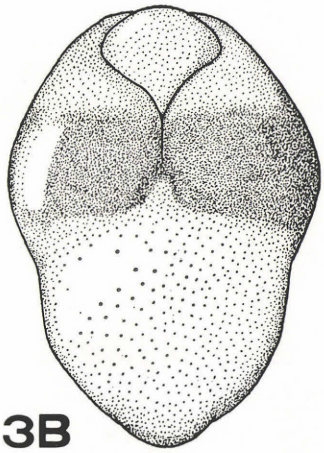

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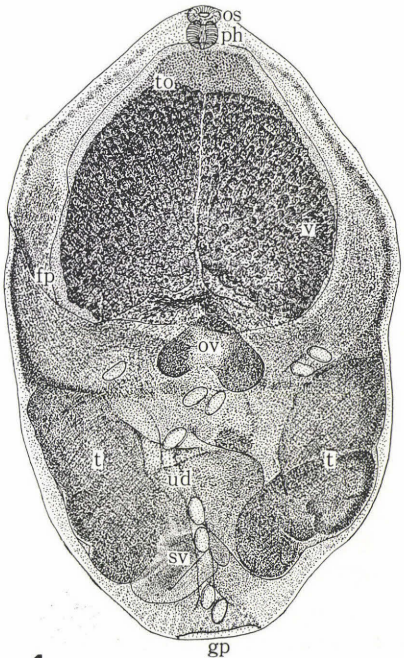

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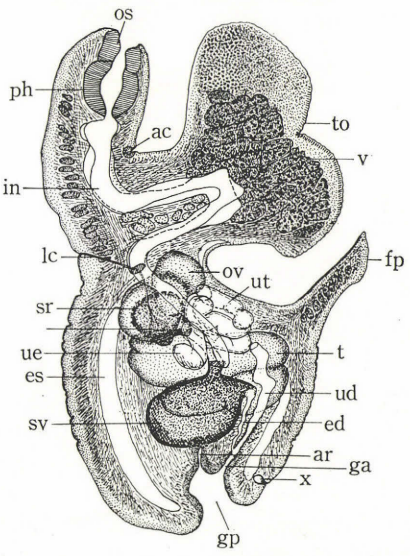
1 mm



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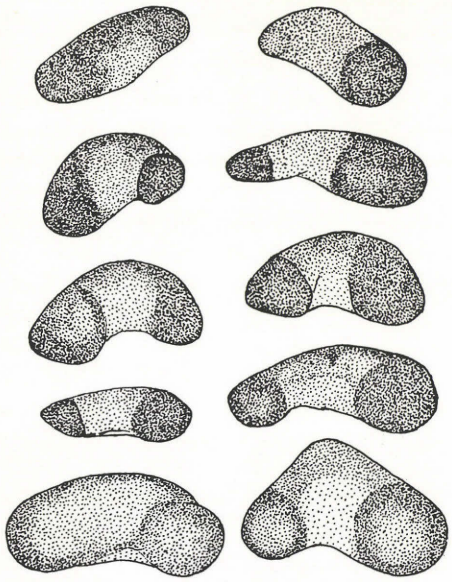
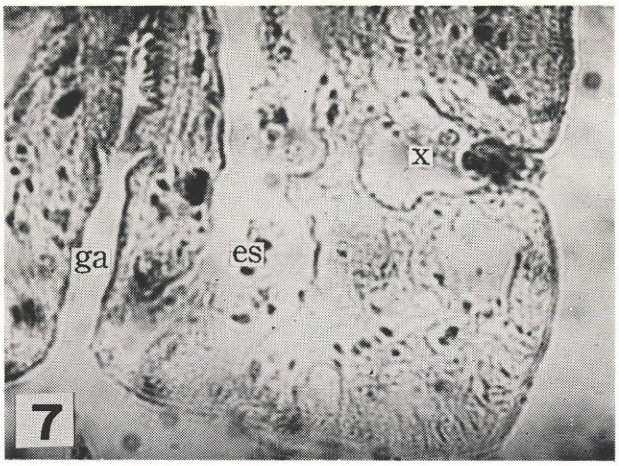


6 0,3 mm



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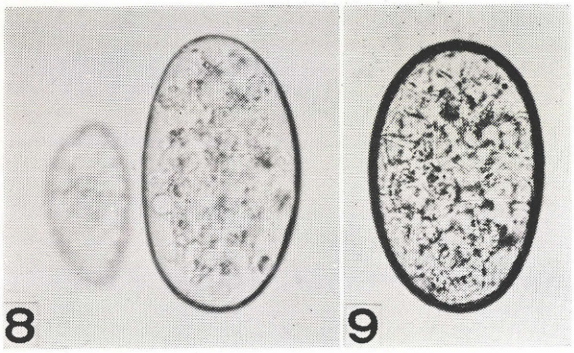

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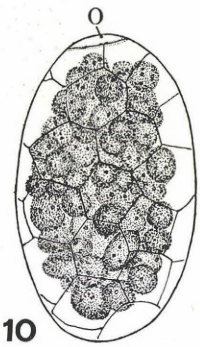

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Explanations of figures

Figs. 1 and 2 Features of *Pharyngostomum cordatum* attaching to the intestines of the host cats.
Fig. 3 External aspect of an unflattened adult of *P. cordatum*. A : Dorsal aspect B : Ventral aspect
Fig. 4 Ventral aspect of a flattened adult of *P. cordatum*. Drawn from the specimen No. 75.
Fig. 5 Combined optical section and partial reconstruction of an unflattened adult of *P. cordatum*, seen from right side. Right testis and a part of uterus and left intestine are omitted. Drawn from several series of sectioned specimens.
Fig. 6 Variation of ovary of *P. cordatum* (ventral view).
Fig. 7 Enlarged section of *P. cordatum* showing X-organ. Cf. Fig. 5.
Fig. 8 Comparison with egg of *Diphyllobothrium mansoni* (left, soft-focussed).
Fig. 9 Surfacial pattern on egg-shell of *P. cordatum*.
Fig. 10 Schema showing coarse network pattern on egg-shell of *P. cordatum*.

Abbreviations used in figures

ac : acetabulum ar : atrial recess ed : ejaculatory duct es : excretory space fp : foliate portion ga : genital atrium gp : genital pore in : intestine lc : Laurer's canal o : operculum os : oral sucker ov : ovary ph : pharynx sr : seminal reservoir sv : seminal vesicle t : testis to : tribocytic organ ud : uterine duct ue : uterine eggs ut : uterus v : vitellaria x : X-organ

terials it is rather variable in form but generally shows a dumb-bell-form or a telephone-receiver-form. Its variations are shown in Fig. 6. It is transversely elongated and the both terminal ends swell somewhat spherically.

2) Existence of a minute organ: No one has described a small gland-like structure situating near the genital pore on the ventral side (Figs. 5 and 7, x). The organ is measured 0.046 mm in depth from the cuticular surface and 0.028 mm in diameter. The organ seemed to be connecting to the excretory space with a narrow duct. The function of this organ is unknown. The organ is tentatively named as "X-organ".

3) Number of eggs found in uterus: La Rue described that the coils of the uterus were numerous and contained, for Strigeidae, a large number of eggs, and that in some specimens the convolutions extended well into the stalk of the holdfast organ. In the present specimens, however, less than 20 eggs were found and no convolution extended into the stalk of the tribocytic organ (Fig. 5).

4) Surfacial network pattern on egg-shell: The worm produces extremely large eggs (Fig. 8). On the surface of the egg-shell a characteristic network pattern was observed (Fig. 9). This pattern is much more coarse than that of the liver fluke (*Clonorchis sinensis*) and is apparently polygonal and covers uniformly almost all of the egg-shell except the operculum (Fig. 10, o).

Discussion

The worm now belonging to the genus *Pharyngostomum* Ciurea, 1922, was first recorded by Diesing (1850) under the name of *Diplostomum cordatum*, based on the materials from a wild cat captured in Steiermark, Germany. This species was frequently cited by many authors such as Diesing (1855), Brandes (1890), and Krause (1915), but none of them added on the distribution or on the biological information of the species.

In 1922, Ciurea recorded the species from a wild cat captured in Braïla, Roumania, and established a new genus *Pharyngostomum* for this peculiar species. Using Ciurea's materials, La Rue (1926) presented an excellent morphological study on the internal structures of this monotypical species. Distributional and host records were added by Faust (1927, 1930), Chen (1934), Tang (1935), and Wallace (1937) from the domestic cats collected in China, by Rao (1943) from a tiger in India, and by Baer and Dubois (1951) from a cheetah in Tanganyika.

On the other hand, the second species of the genus, *P. fausti*, was described by Skrjabin and Popow (1930) from the domestic cat captured in Astrakhan, U. S. S. R., and the third, *P. congolense*, by van den Berghe (1939) from a genet collected in Belgian Congo. These two species were synonymized to *P. cordatum* by Baer and Dubois (1951), but Sudarikov (1960) considered that *P. fausti* is independent though *P. congolense* is synonymous to the type species. Yamaguti agreed to Baer and Dubois' opinion.

The Japanese materials discussed here are closely identical with *P. cordatum* though some minute difference are found as mentioned above. Those differences from the descriptions of *P. cordatum* made by La Rue seem to be depending on the simplicity of his descriptions and figurations. Comparing carefully his descriptions with the characters of the present specimens, the present authors considered the latter was identical to the former.

Summary

The occurrence of a strigeid trematode, *Pharyngostomum cordatum* (Diesing, 1850) Ciurea, 1922, is reported. It was found from the upper half of the intestines (duodena and jejuna) of 2 female cats captured in Okawa city and Kurume city, Fukuoka prefecture, Kyushu, Japan. Results of the

measurements of the adults and the eggs and the observation on the internal structures showed the identity with those made by La Rue (1926). Some minute differences are discussed. The form of the ovary is not simply elliptical but somewhat elongated transversely and terminally swollen making a dumb-bell-like form. The number of uterine eggs are counted less than 20. A small gland-like (tentatively named as X-organ) structure is discovered on the ventral cuticle near the genital pore. A coarse network pattern is observed on the surface of the egg-shell.

This is the first record of *Pharyngostomum cordatum* from Japan.

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Pharyngostomum 属吸虫の日本からの発見

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福岡県大川市および久留米市で捕獲したネコ（2匹，何れも雌）より吸虫の1種を見出し，調査した結果，本邦未記録の有襞吸虫類に属する *Pharyngostomum cordatum* (Diesing, 1850) Ciurea, 1922 であることが判明した．寄生部位は小腸上半（十二指腸および空腸）で，それぞれ89隻および440隻の虫体を保有していた．圧平染色標本および連続切片標本を検して，今までの報告に見られなかったつぎの諸点について新しい知見を得た．

1） 卵巣の形（腹面より見て）は単純な楕円形ではなく，むしろ亜鈴形で，立体的にも両端が球状に膨大すること．

2） 体後端の生殖孔に近く，腹側に1個の開孔を有する機能不明の小器官があり，これは小管で排泄腔と連絡していること．

3） 卵は大型，その表面には肝吸虫卵にくらべてはるかに粗大な，多角形の集合より成る紋理が一様に認められること，この紋理は小蓋部にはない．

このほか若干の部位，器官について計測を行い，国外における過去の記録との比較を行ったが大差は認められなかった．あわせて本種に関する研究史をまとめた．

本種の和名としては，その特異な体形からツボガタキュウチュウ（壺形吸虫）を提唱したい．