

Two Blood Flukes from Deep-sea Fishes of Suruga Bay, Japan

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Abstract Two species of blood flukes (Digenea, Sanguinicolidae) were obtained from deep-sea fishes of Suruga Bay, on the Pacific coast of central Japan: *Chimaerohemecus trondheimensis* van der Land, 1967 from the dorsal aorta and postcardinal vein around the kidney of *Hydrolagus mitsukurii* (Chimaeridae), and *Aporocotyle garciai* Tantalean & Martinez, 1990 from the atrium and branchial arteries of *Hoplobrotula armata* (Ophidiidae). Morphological description on our material and some discrepancies between the original description and ours are given.

Key words: Digenea, Sanguinicolidae, *Chimaerohemecus trondheimensis*, *Aporocotyle garciai*, deep-sea fish, Japan

Two species of blood flukes (Digenea, Sanguinicolidae) were obtained from deep-sea fishes of Suruga Bay, on the Pacific coast of central Japan. This is the first record of blood flukes from chimaerid and ophidiid fish in Japanese waters. The flukes were fixed in AFA under slight pressure, stained with Heidenhain's hematoxylin or alum carmine and mounted in balsam. The specimens are deposited in the Meguro Parasitological Museum (MPM) and the National Science Museum, Tokyo (NSMT). Measurements are given in millimeters unless otherwise stated.

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Family Sanguinicolidae

Chimaerohemecus trondheimensis

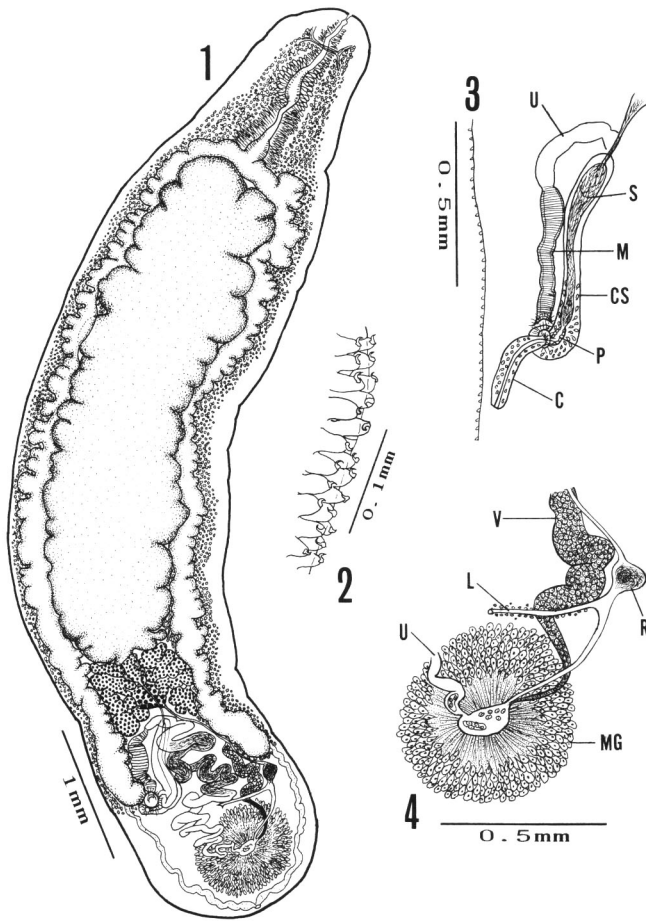
van der Land, 1967

(Figs. 1–4)

Material. From dorsal aorta and postcardinal vein around kidney of *Hydrolagus mitsukurii* (Chimaeridae), 285–480 m in depth in Suruga Bay, Japan, 12-XI-1996 (MPM Coll. No. 18806) and 14-XI-1996 (MPM Coll. No. 18807 & NSMT-PI 5163).

Description. Based on 15 specimens. Body lanceolate, slightly tapering anteriorly and rounded posteriorly, 4.17–7.49 long by 1.19–1.92 wide; 3–5 times longer than wide. Lateral margin of tegument covered with spines; spine 15–23 μm long, parapodium-like with chitinous hook on the tip, in 2–3 longitudinal rows at midlevel of body. Mouth small, ventro-subterminal, followed by short buccal cavity up to 50 μm long. Esophagus divided into two portions. Anterior portion with thin wall, 0.54–0.81 long, lined with microvillous projections. Buccal cavity and anterior esophagus surrounded by relatively short glandular cells. Posterior portion with thick wall, 0.18–0.43 long, lined with longitudinal rugae and enclosed by relatively tall glandular cells. Nerve

¹ Deceased February 5, 2001



Figs. 1–4. *Chimaerohemecus trondheimensis* van der Land, 1967. —1. Entire worm, dorsal view (MPM Coll. No. 18807). 2. Tegument spines. 3. Terminal genitalia, dorsal view. 4. Ovarian complex, dorsal view. C, everted cirrus; CS, cirrus sac; L, Laurer's canal; M, metraterm; MG, Mehlis' gland; P, prostatic vesicle; R, seminal receptacle; S, seminal vesicle; U, uterus; V, vitelline reservoir.

commissure 0.20–0.27 from head end. Intestinal bifurcation 15–19% of body length from head end. Caeca corrugated, terminating near midlevel of posttesticular space.

Testis single, immediately posterior to intestinal bifurcation, intercaecal, bounded posteriorly by ovary, $1.88\text{--}3.90 \times 0.63\text{--}1.34$, 3–4 times longer than wide, 47–58% of body length. Posttesticular space 25–34% of body length. Spermduct passing midventral to ovary. Cirrus sac tubular, $0.46\text{--}0.75 \times 0.08\text{--}0.13$, beginning from just posterior to mid-posterior border of ovary, sinistral, thin-walled; containing seminal vesicle which is tubular, occasionally sinuous and occupies the greater

part of the sac, small prostatic vesicle 0.08 long and eversible cirrus. Male pore opening into sub-lateral common genital pore just posterior to left caecal termination.

Ovary two-winged, multilobed, bounded anteriorly by testis and laterally by caeca, $0.43\text{--}0.56 \times 0.55\text{--}0.80$ as a whole. Oviduct arising from mid-posterior border of ovary, extending along inside of right caecum and entering into small seminal receptacle $45\text{--}80\text{ }\mu\text{m}$ in diameter, immediately posterior to right caecal termination. Laurer's canal arising from posterior edge of seminal receptacle, running transversely to left and opening middorsally. The canal is surrounded by

small rounded gland cells. Ootype 0.38–0.69 from tail end, enclosed by well-developed Mehlis' glands. Uterus postovarian, loops anteriorly along posterior border of ovary and joining metraterm between left caecum and cirrus sac. Distal portion of uterus filled with sperm. Metraterm thin-walled, sinistral to cirrus sac, 48–98% length of cirrus sac; pore just anterior to male pore. Vitellaria extensive, exterior to esophageal glands and caeca, reaching anteriorly near nerve commissure and posteriorly caecal termination. Vitelline duct running backward along right border of ovary ventrad, uniting with oviduct close to ootype. Excretory vesicle V- or Y-shaped with very short stem. Numerous eggs are observed in gill filaments, $86\text{--}120 \times 43\text{--}52\ \mu\text{m}$, containing ciliated miracidium $64 \times 47\ \mu\text{m}$ with a pair of eyespots.

Remarks. Our specimens are tentatively identified as *Chimaerohemecus trondheimensis* van der Land, 1967 from *Chimaera monstrosa* from Norway because general morphology and measurements of the worms closely resemble each other. However, our specimens have some discrepancies from the original description such as the esophagus being divided into two portions, the presence of prostatic vesicle, metraterm and common genital pore, and the ovary being more posteriorly. Our request to borrow the type-material of *C. trondheimensis* had met with no reply, we could not clarify the above respects in the type-material.

Aporocotyle garciai Tantalean & Martinez, 1990
(Figs. 5–8)

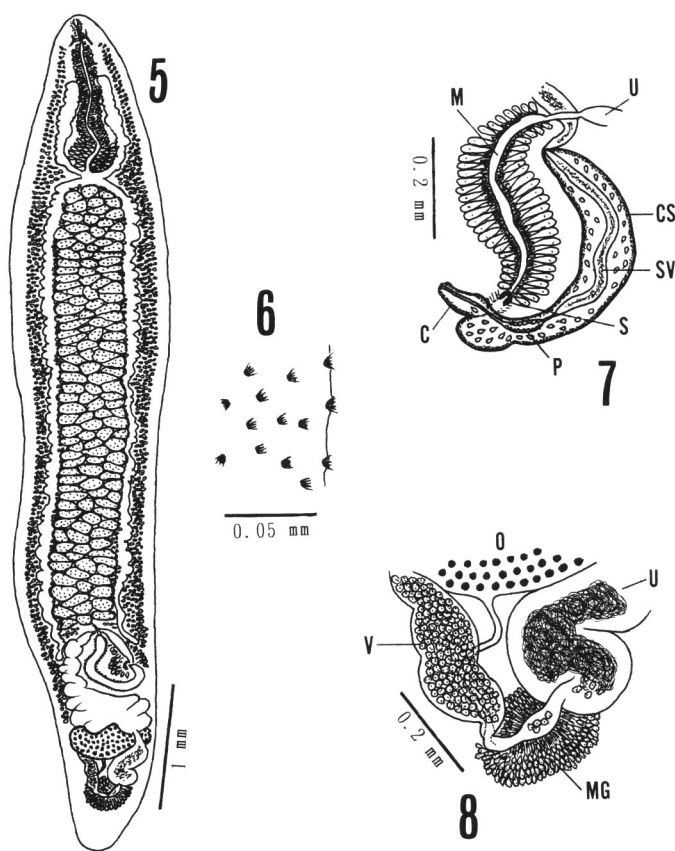
Material. From atrium and branchial arteries of *Hoplobrotula armata* (Ophidiidae), 285–480 m in depth in Suruga Bay, Japan, 18-XI-1993 (MPM Coll. No. 18808), 26-X-1994 (NSMT-PI 5164) and 27-X-1994 (MPM Coll. No. 18809).

Description. Based on 10 specimens. Body lanceolate, with slightly pointed anterior end and rounded posterior end, 3.72–6.60 long by 0.62–1.23 wide; 4–8 times longer than wide. Lateral and posterior margin of tegument covered with

fan-shaped cluster of spines, each cluster consisting of 7–18 spines, 8–11 μm long, in 9–11 zigzag longitudinal rows at midlevel of body. Mouth ventro-subterminal. Buccal cavity small, fusiform, $37\text{--}64 \times 15\text{--}31\ \mu\text{m}$. Esophagus divided into two portions: anterior portion with thin wall, 0.63–1.31 long, lined with microvillous projections; and posterior portion with thick wall, 0.23–0.49 long, lined with longitudinal rugae. Buccal cavity and anterior esophagus surrounded by short, fine glandular cells, and posterior esophagus enclosed by tall, large glandular cells. Nerve commissure 0.12–0.19 from head end. Esophago-intestinal junction 19–29% of body length from head end. Caeca X-shaped, undulating. Anterior caecal branches 0.45–1.27 long, about 2/3 as long as esophagus. Posterior caecal branches terminating a little posterior to testes, not extending tail end. Length ratio of anterior to posterior caecal branch 1:2.8–5.1.

Testes irregularly ovoid, wider than long, 60–140 in number, arranged in two or three longitudinal zigzag rows, occupying entire intercaecal region, $1.78\text{--}3.50 \times 0.33\text{--}0.70$ as a whole, 42–55% of body length. Posttesticular space 20–31% of body length. Spermduct joining to cirrus sac at median, just posterior to posteriormost testes. Cirrus sac tubular, curved in the shape of a fish-hook, $0.57\text{--}0.94 \times 0.08\text{--}0.15$, with thick wall of inner longitudinal and outer circular muscles, in anterior third or anterior half of posttesticular space. Cirrus sac containing straight or slightly convoluted seminal vesicle which occupies most of cirrus sac, prostatic vesicle $65 \times 25\ \mu\text{m}$, and eversible cirrus. Occasionally proximal portion of seminal vesicle is swollen with a large quantity of sperm. Male pore sinistral, 0.70–1.43 from tail end. Shallow genital atrium and common genital pore may be present.

Ovary wider than long, $0.15\text{--}0.30 \times 0.38\text{--}0.72$, pan-shaped with convex posterior surface, from midlevel to posterior 1/3 in posttesticular region. Oviduct arising from mid-posterior margin of ovary, descending, slightly curved, joining to vitelline reservoir immediately in front of ootype. Ootype near middle of postovarian region, sur-



Figs. 5–8. *Aporocotyle garciai* Tantalean & Martinez, 1990. — 5. Entire worm, ventral view (NSMT-PI 5164). 6. Tegument spines. 7. Terminal genitalia, dorsal view. 8. Ovarian complex, ventral view. C, everted cirrus; CS, cirrus sac; M, metraterm; MG, Mehlis' gland; O, ovary; P, prostatic vesicle; S, sphincter; SV, seminal vesicle; U, uterus; V, vitelline reservoir.

rounded by well-developed Mehlis' glands. Uterus extending from posterosinistral to ovary, passing left side of ovary and right side of cirrus sac, to mid-posterior to posteriormost testes, near proximal end of cirrus sac. Proximal portion of uterus filled with sperm. Metraterm almost straight with thin muscular wall, enclosed by glandular cells, sinistral to cirrus sac, 0.30–0.45 long, 37–77% length of cirrus sac. Female pore with muscular sphincter, a little apart from male pore. Vitellaria extensive, exterior and partially interior to caeca, reaching anteriorly near nerve commissure and posteriorly caecal termination on left, near ovary on right. Vitelline reservoir posterodextral to ovary. Eggs in metraterm $25\text{--}30 \times 17\text{--}21 \mu\text{m}$. Excretory vesicle V- or Y-shaped with

very short stem; pore subdorsal.

Remarks. Five species of *Aporocotyle* which have posterior caecal branches terminating slightly beyond the testes have been described: *Aporocotyle smithi* Parukhin & Tkachuk, 1980 from *Genypterus capensis* from the Indian Ocean, *A. ymakara* Villalba & Fernandez, 1986 from *G. blacodes* from Chile, *A. kuri* Villalba & Fernandez, 1986 from *G. maculatus* from Chile, *A. keli* Villalba & Fernandez, 1986 from *G. chilensis* from Chile, and *A. garciai* Tantalean & Martinez, 1990 from *Genypterus* sp. from Peru. These five species have been obtained from the same ophidiid fishes as our material host.

According to Villalba and Fernandez (1986) and Tantalean and Martinez (1990), the five

Table 1. Measurements of five species of *Aporocotyle* with posterior caeca terminating slightly beyond testes

	<i>A. smithi</i>	<i>A. ymakara</i>	<i>A. kuri</i>	<i>A. keli</i>	<i>A. garciai</i>	
Author	Parukhin & Tkachuk (1980)	Villalba & Fernandez (1986)	Villalba & Fernandez (1986)	Villalba & Fernandez (1986)	Tantalean & Martinez (1990)	Present authors
Host	<i>Genypterus capensis</i>	<i>G. blacodes</i>	<i>G. maculatus</i>	<i>G. chilensis</i>	<i>Genypterus</i> sp.	<i>Hoplobrotula armata</i>
Locality	Cape Agulhas, Indian Ocean	Chile	Chile	Chile	Peru	Japan
Body	4×0.396–0.468	1.58–2.74 ×0.26–0.41	1.50–3.19 ×0.26–0.52	3.00–4.69 ×0.41–0.53	3.119–3.332 ×0.562–0.590	3.72–6.60 ×0.62–1.23
Esophagus length	0.828	0.75–1.18	0.50–0.92	0.75–1.30	0.685–0.874	0.85–1.37
Esophagus length: Body length	1 : 4.8	1 : 2.10–2.61	1 : 2.84–3.80	1 : 3.50–4.10	1 : 4.3?	1 : 3.8–5.2
Length of anterior caeca:	1 : 2.6–3.2	1 : 1.28–1.35	1 : 1.84–2.32	1 : 2.77–2.98	1 : 4.1	1 : 2.8–5.1
Length of posterior caeca						
No. of testes	36	18–21	28–32	35–38	96–100	60–140
Cirrus sac	–	0.04–0.13 ×0.12–0.24	0.06–0.12 ×0.20–0.24	0.12–0.19 ×0.29–0.42	0.25–0.3 ×0.05–0.07	0.57–0.94 ×0.08–0.15
Ovary	0.621×0.414	0.04–0.12 ×0.09–0.15	0.07–0.15 ×0.18–0.27	0.16 ×0.24–0.30	0.18–0.22 ×0.15–0.17	0.15–0.30 ×0.38–0.72
Folds of caecal extremities	–	+	–	–	–	–
Muscular sphincter of genital pore	–?	–	+	+	–	+

species were differentiated from each other by the number of testes, the proportion of the esophagus to the body length, the presence or absence of a muscular sphincter at the genital pore, etc (Table 1). Our specimens are larger worms with correspondingly larger organs, and show considerable variation in characteristics and measurements. For example, the testes vary from 60 to 140 in number, and the proportion of the testes to the body length is expanded as the testes increase in number, at the same time, the proportion of the esophagus to the body length is shortened.

Thulin (1980) examined *Aporocotyle simplex* in detail and described morphological variation associated with size and host species. According to him, the specimens of *A. simplex* were 0.89 to 10.3 mm long and 0.11 to 1.52 mm wide. The number of testes ranged between 110 and 203. The tegument bore clusters of 13 to 36 spines. The ratio between the length of forebody, that is, the head end to the end of the posterior esophagus, and the total length of the body changed allometrically during the life span. In 1 mm long specimen this ratio was 1:3 while it was less than 1:6 in specimens longer than 9 mm.

As shown in Table 1, five species of *Aporocotyle* from ophidiid fishes are very like each other and they might be rather variations than different species. We are provisionally placing our specimens in *A. garciai*. Compared with the original description of *A. garciai*, a few differ-

ences are observed in that our specimens have a prostatic vesicle in the cirrus sac and a muscular sphincter at the female pore, and vitellaria extending posteriorly to the caecal termination on the left side and near the ovary on the right side. We could not check these respects with the type-material of *A. garciai*, because the type-material was not lent to us despite our request. Reexamination of the five species is required to confirm their validity.

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