広島大学総合博物館研究報告 Bulletin of the Hiroshima University Museum 10: 37–52, December 25, 2018

論文 Article

Four species of acanthocephalans parasitic in freshwater gobies *Rhinogobius* spp. in western and central Japan, with a list of the known parasites of *Rhinogobius* spp. of Japan (1935-2018)

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Abstract: Four species of acanthocephalans are reported from gobies of the genus *Rhinogobius* in western and central Japan: *Acanthocephalus gotoi* Van Cleave, 1925 from *Rhinogobius similis* in the Kamo River (Hiroshima Prefecture) and *Rhinogobius* sp. OR (=orange type) in the Sōja River (Ehime Prefecture) and the Hiwatashi River (Kōchi Prefecture); *Acanthocephalus longiacanthus* Katahira and Nagasawa, 2014 from *Rhinogobius nagoyae* and *Rhinogobius* sp. OR in the Tenchi River (Hiroshima Prefecture), *Rhinogobius fluviatilis* in the Kamo River, and *Rhinogobius* sp. OR in the Sōja and Hiwatashi rivers; *Acanthocephalus minor* Yamaguti, 1935 from *Rhinogobius flumineus* in the Aruji River (Hiroshima Prefecture); and *Southwellina hispida* (Van Cleave, 1925) from *Rhinogobius flumineus* in the Aruji River and the Shika River (Kyōto Prefecture). All these collections represent new host records for the acanthocephalans. New prefecture records are *A. gotoi* and *A. longiacanthus* from Hiroshima and Kochi prefectures, and *A. minor* and *S. hispida* from Hiroshima Prefecture. Based on the previous and present papers published between the years 1935 and 2018, 48 nominal and some unidentified species of the parasites have been reported from the Japanese *Rhinogobius* spp. The nominal species include: 3 species in the Myxozoa (Cnidaria); 1 species in the Monogenea; 16 species in the Trematoda; 4 species in the Cestoda (all Platyhelminthes); 3 species in the Nematoda; 5 species in the Acanthocephala; 15 species in the Bivalvia (Mollusca); and 1 species in the Copepoda (Arthropoda).

Keywords: fish parasites, Acanthocephala, *Acanthocephalus*, *Southwellina*, *Rhinogobius*

Ⅰ. Introduction

Gobies of the genus *Rhinogobius* Gill, 1859 (Perciformes: Gobiidae) are widely distributed in fresh waters in East and Southeast Asia, including Japan. Recent studies on the taxonomy of *Rhinogobius* spp. from Japan have revealed that the genus consists of morphologically and genetically distinguished species (e.g., Akihito et al., 2013; Yamasaki et al., 2015; Hosoya, 2015). The number of the Japanese *Rhinogobius* species increased from three in the 1970's (Miyadi et al., 1976) to 17 and 18 species in 2013 (Akihito et al., 2013) and 2015 (Hosoya, 2015), respectively, and most of these species are endemic to Japan (Suzuki and Chen, 2011; Akihito et al., 2013; Yamasaki et al., 2015). Recently, Takahashi and Okazaki (2017) described *Rhinogobius biwaensis* from Lake Biwa, central Japan, which had been reported as *Rhinogobius* sp. BW (=Biwa type) (cf. Hosoya, 2015) from the lake.

Based on their life history and migration patterns, the Japanese *Rhinogobius* spp. are classified into three groups: amphidromous, fluvial, and lentic types (Mizuno, 1960, 1961; Tsunagawa and Arai, 2008). Larvae of the amphidromous type go to the sea immediately after the eggs hatch in fresh waters, and juveniles return to rivers for further growth and reproduction (Mizuno, 1960, 1961), while individuals of the fluvial and lentic types remain throughout their life in rivers and ponds/lakes, respectively (e.g., Takahashi and Okazaki, 2002; Tsunagawa et al., 2010a, 2010b; Suzuki et al., 2011). In addition to their high species diversity, these complex life histories of the Japanese *Rhinogobius* spp. have the potential to understand the parasite fauna of freshwater fishes including those gobies inhabiting different types of habitats in Japan.

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The Acanthocephala are a group of the intestinal parasites of vertebrates including fishes (Yamaguti, 1963). The acanthocephalan fauna of *Rhinogobius* spp. in Japan remains poorly studied. Only two species, *Southwellina hispida* (Van Cleave, 1925) and *Echinorhynchus cotti* Yamaguti, 1935, have so far been reported from an unidentified species of *Rhinogobius* (Yamaguti, 1935; Amin et al., 2007). This paper describes four species of acanthocephalans from five species of *Rhinogobius* collected in western and central Japan. Three of these acanthocephalan species were collected for the first time from the gobies of the genus.

In 1935, the first paper on the parasites of the Japanese *Rhinogobius* spp. was published by Yamaguti (1935), who found a cystacanth (reported as "larva") of *S. hispida* in *Rhinogobius* sp. from Toyama Prefecture. Subsequently, various species of parasites have been reported from the gobies of the genus. In this paper, based on the literature published for 84 years between 1935 and 2018, a list of the known parasites of the Japanese *Rhinogobius* spp. is also provided.

Ⅱ. Materials and Methods

Gobies were collected from November 2014 to September 2016 using a hand net in the following six rivers in western and central Japan (Fig. 1, Table 1 for detailed information on the sampling sites and dates): the Tenchi River, the Kamo River (site 1 [middle reaches] and site 2 [lower reaches]), the Aruji River (site 1 [upper reaches], site 2 [middle reaches], and site 3 [lower

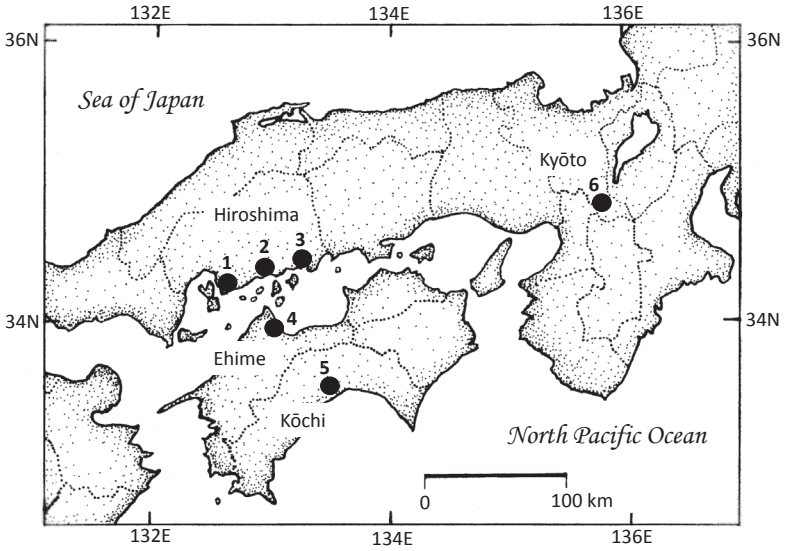

Fig. 1. A map of western and central Japan, showing the sampling localities of *Rhinogobius* spp. examined in this study. Numerals 1, 2, 3, 4, 5, and 6 are: the Tenchi, Kamo, and Aruji rivers in Hiroshima Prefecture; the Sōja River in Ehime Prefecture; the Hiwatashi River in Kōchi Prefecture; and the Shika River in Kyōto Prefecture, respectively. Prefectural boundaries are indicated by dotted lines.

Table 1. Sampling localities and dates for *Rhinogobius* spp. examined in this study.

River	No. in Fig. 1	Site	Prefecture	Latitude, longitude	Date
Tenchi River	1	Koyaura, Saka	Hiroshima	34°18'12" N, 132°30'39" E	30 September 2015, 6 July 2016
Kamo River	2		Hiroshima		
site 1: middle reaches		Nishino, Takehara		34°23'42" N, 132°52'58" E	28 May 2015
site 2: lower reaches		Shimono, Takehara		34°20'58" N, 132°54'03" E	22 June 2016, 12 September 2016
Aruji River	3		Hiroshima		
site 1: upper reaches		Taruma, Fukuyama		34°31'19" N, 133°14'24" E	4 June 2016
site 2: middle reaches		Shimoaruji, Fukuyama		34°31'35" N, 133°16'22" E	4 June 2016
site 3: lower reaches		Fukuda, Fukuyama		34°32'00" N, 133°17'03" E	4 June 2016
Sōja River	4	Igarashi, Imabari	Ehime	34°02'12" N, 132°58'31" E	5 July 2016
Hiwatashi River	5	Funakoshi, Tosa	Kōchi	33°30'09" N, 133°24'26" E	26 July 2015
Shika River	6	Nishikobayashi, Kizugawa	Kyōto	34°43'45" N, 135°48'35" E	29 November 2014

reaches]), a tributary of the Ashida River, Hiroshima Prefecture; the Sōja River, Ehime Prefecture; the Hiwatashi River, a tributary of the Hage River, Kōchi Prefecture; and the Shika River, a tributary of the Kizu River, Kyōto Prefecture. The gobies were transported alive to the laboratory of Hiroshima University, where they were measured for standard length in millimeters and identified using a key given by Akihito et al. (2013). In their work, these authors did not include "*Rhinogobius* sp. OR", but it is adopted herein because Hosoya (2015) later listed it as a valid taxon. The gobies were dissected under an Olympus SZX7 stereo microscope. All acanthocephalans found were fixed in 70% ethanol with slight cover-slip pressure, then stained with Heidenhain's iron hematoxylin or alum carmine, dehydrated through a graded ethanol series, cleared in xylene, and mounted in Canada balsam. These specimens were examined under an Olympus BX51 light microscope. Drawings were made with the aid of a drawing tube. Measurements taken with an ocular micrometer are shown in millimeters unless otherwise stated. Prevalence, intensity, and mean intensity of infection are those defined by Bush et al. (1997). The scientific names of fishes mentioned in this paper follow Akihito et al. (2013), Hosoya (2015), and Takahashi and Okazaki (2017) for *Rhinogobius* spp. and Nakabo (2013) for other fishes, and the Japanese names of fishes are adopted from Hosoya (2015). The scientific names of bivalves follow Kondo (2008) for unionids except for two genera *Nodularia* and *Sinanodonta* and Sano et al. (2017) for the species of these genera. Voucher specimens of the acanthocephalans have been deposited in the Aschelminthes (As) collection of the National Museum of Nature and Science, Tsukuba, Ibaraki Prefecture, Japan (NSMT-As).

Ⅲ. Results

Four species of acanthocephalans, *viz.*, *Acanthocephalus gotoi* Van Cleave, 1925, *Acanthocephalus longiacanthus* Katahira and Nagasawa, 2014, *Acanthocephalus minor* Yamaguti, 1935, and *Southwellina hispida* (Van Cleave, 1925), were collected in this study. The infected gobies were five species: *Rhinogobius similis* Gills, 1859 [Japanese name: gokuraku-haze]; *Rhinogobius fluviatilis* Tanaka, 1925 [ō-yoshinobori]; *Rhinogobius flumineus* (Mizuno, 1960) [kawa-yoshinobori]; *Rhinogobius nagoyae* Jordan and Seale, 1906 [shima-yoshinobori]; and *Rhinogobius* sp. OR (=orange type) [no Japanese name, but tō-yoshinobori was used in the past] (Table 2). No acanthocephalan was collected at site 1 in the Aruji River, but at least one species of acanthocephalan was found in other localities.

Table 2. Occurrence of acanthocephalans in *Rhinogobius* spp. examined in this study.

River	Host	Standard length (mean) in mm	Acanthocephalan	No. of fish infected/ examined (percent prevalence)	Intensity (mean)	Date
Tenchi River	*Rhinogobius nagoyae*	33.5–60.5 (48.5)	*Acanthocephalus longiacanthus*	1/7 (14.3)	1 (1.0)	30 September 2015
	Rhinogobius nagoyae	57.5–60.3 (58.9)	*Acanthocephalus longiacanthus*	1/4 (25.0)	2 (2.0)	6 July 2016
	Rhinogobius sp. OR	57.5–69.6 (62.2)	*Acanthocephalus longiacanthus*	2/3 (66.7)	1–2 (1.5)	6 July 2016
Kamo River						
site 1: middle reaches	*Rhinogobius fluviatilis*	32.7–72.4 (52.5)	*Acanthocephalus longiacanthus*	1/12 (8.3)	1 (1.0)	28 May 2015
site 2: lower reaches	*Rhinogobius similis*	47.1–67.4 (54.6)	*Acanthocephalus gotoi*	1/3 (33.3)	1 (1.0)	22 June 2016
	Rhinogobius similis	70.0–86.8 (76.8)	*Acanthocephalus gotoi*	1/3 (33.3)	3 (3.0)	12 September 2016
Aruji River						
site 1: upper reaches	*Rhinogobius flumineus*	28.5–47.0 (38.2)	No acanthocephalan	0/4 (0)	–	4 June 2016
site 2: middle reaches	*Rhinogobius flumineus*	35.0–46.2 (40.3)	*Acanthocephalus minor*	1/11 (9.1)	6 (6.0)	4 June 2016
			Southwellina hispida	1/11 (9.1)	2 (2.0)	
site 3: lower reaches	*Rhinogobius flumineus*	35.1–47.5 (39.9)	*Acanthocephalus minor*	1/5 (20.0)	2 (2.0)	4 June 2016
Sōja River	*Rhinogobius* sp. OR	36.5–57.2 (45.3)	*Acanthocephalus gotoi*	1/5 (20.0)	1 (1.0)	5 July 2016
			Acanthocephalus longiacanthus	1/5 (20.0)	1 (1.0)	
Hiwatashi River	*Rhinogobius* sp. OR	48.4–64.3 (55.4)	*Acanthocephalus gotoi*	1/7 (14.3)	2 (2.0)	26 July 2015
			Acanthocephalus longiacanthus	3/7 (42.9)	1–2 (1.7)	
Shika River	*Rhinogobius flumineus*	25.1–42.5 (32.5)	*Southwellina hispida*	1/11 (9.1)	1 (1.0)	29 November 2014

Phylum **Acanthocephala** Kohlreuther, 1771
Class **Palaeacanthocephala** Meyer, 1931
Order **Echinorhynchida** Southwell and Macfie, 1925
Family **Echinorhynchidae** Cobbold, 1876
Subfamily **Echinorhynchinae** Cobbold, 1876
Genus ***Acanthocephalus*** Kohlreuther, 1771

Acanthocephalus gotoi Van Cleave, 1925
(Fig. 2A–C)

Material examined. One male (NSMT-As 4575) and 1 male and 2 females (NSMT-As 4576–4578) from *Rhinogobius similis* at site 2 in the Kamo River on 22 June and 12 September 2016, respectively; 1 male (NSMT-As 4579) from *Rhinogobius* sp. OR in the Sōja River on 5 July 2016; and 2 males (NSMT-As 4580–4581) from *Rhinogobius* sp. OR from the Hiwatashi River on 26 July 2015.

Description. *General*. Trunk elongate, cylindrical, aspinose. Proboscis cylindrical, armed with 15–17 (usually 15 in males and 17 in females) longitudinal rows; maximum number of hooks per row 9–12 (usually 11 in males and 12 in females). Hook blade longer than root. Proboscis receptacle double-walled, with cephalic ganglion near its posterior end. Lemnisci elongate.

Male (based on 3 specimens: 1 specimen from *Rhinogobius similis* at site 2 in the Kamo River; 1 specimen from *Rhinogobius* sp. OR in the Sōja River; and 1 specimen from *Rhinogobius* sp. OR in the Hiwatashi River). Trunk 2.35–3.18 (2.86) long, 0.43–0.69 (0.59) wide. Proboscis 0.43–0.61 (0.53) long, 0.15–0.31 (0.21) wide. Maximum length of hook blade 48–53 (50) μm long, root 28–33 (30) μm long. Proboscis receptacle 0.45–0.59 (0.52) long, 0.18–0.23 (0.20) wide. Longer lemniscus 0.39–0.64 (0.50) long, 0.10–0.18 (0.13) wide; shorter lemniscus 0.38–0.55 (0.46) long, 0.06–0.11 (0.09) wide. Testes rounded, slightly oblique. Anterior testis 0.31–0.40 (0.35) long, 0.25–0.29 (0.27) wide; posterior testis 0.26–0.37 (0.32) long, 0.26–0.30 (0.28) wide. Cement glands 6, in 3 pairs, 0.09–0.15 (0.12) wide in maximum diameter. Saefftigen's pouch bulb-shaped, 0.14–0.18 (0.16) wide in maximum diameter. Penis conical, 53–58 (55) μm wide.

Female (based on 2 specimens from *Rhinogobius*

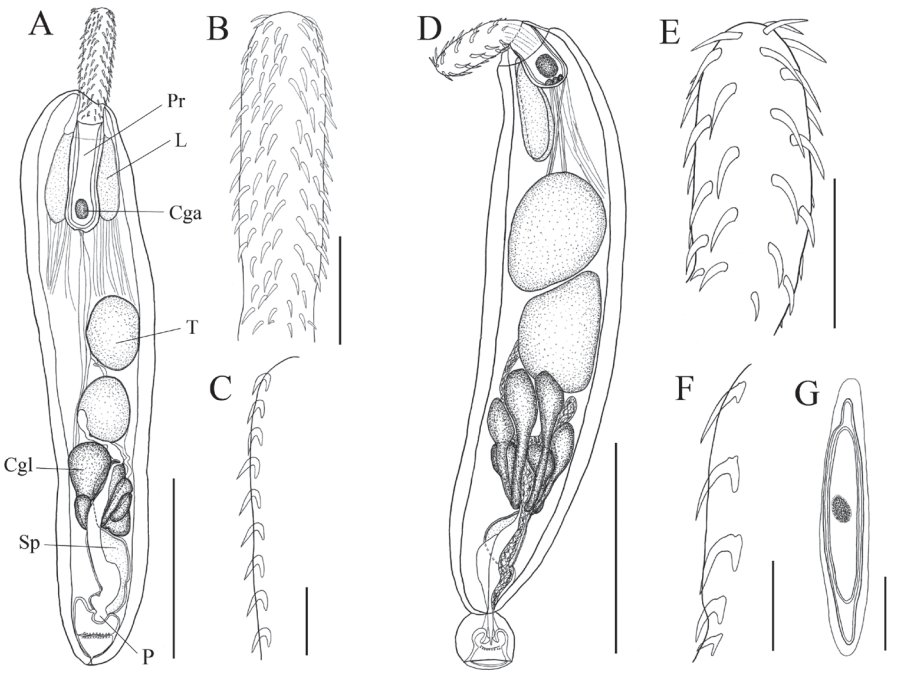

Fig. 2. *Acanthocephalus gotoi* Van Cleave, 1925 (A–C) from *Rhinogobius similis* at site 2 in the Kamo River, Hiroshima Prefecture, western Japan; and *Acanthocephalus longiacanthus* Katahira and Nagasawa, 2014 (D–F) from *Rhinogobius* sp. OR in the Sōja River, Ehime Prefecture, western Japan. The egg (G) was taken from a gravid female of *A. longiacanthus* from *Rhinogobius nagoyae* in the Tenchi River, Hiroshima Prefecture. A, D, entire body of male; B, E, proboscis of male; C, F, proboscis hooks; G, egg. Abbreviations: Cga, cephalic ganglion; Cgl, cement gland; L, lemniscus; P, penis; Pr, proboscis receptacle; Sp, Saefftigen's pouch. Scale bars: A, D, 1 mm; B, E–F, 200 μm; C, 100 μm; G, 20 μm.

similis at site 2 in the Kamo River). Trunk 3.10–3.63 (3.37) long, 0.66–0.71 (0.69) wide. Proboscis 0.58–0.67 (0.63) long, 0.18–0.19 (0.19) wide. Maximum length of hook blade 45–48 (47) μm long, root 18–35 (27) μm long. Proboscis receptacle 0.52–0.60 (0.56) long, 0.20–0.22 (0.21) wide. Longer lemniscus 0.72–0.75 (0.74) long, 0.09–0.15 (0.12) wide; shorter lemniscus 0.69–0.70 (0.70) long, 0.11–0.15 (0.13) wide. Uterus cylindrical, 0.19–0.20 (0.20) long, 0.06–0.08 (0.07) wide. Vagina with single sphincter.

Hosts and localities. *Rhinogobius similis* from site 2 in the Kamo River (Hiroshima Prefecture); and *Rhinogobius* sp. OR from the Sōja River (Ehime Prefecture) and the Hiwatashi River (Kōchi Prefecture).

Site of infection. Intestine.

Prevalences and intensities. See Table 2.

Remarks. The present specimens correspond to the morphology of *A. gotoi* described by Van Cleave (1925) and the subsequent authors (Yamaguti, 1935, 1939a; Fukui and Morisita, 1936; Katahira and Nagasawa, 2014), except for the number of hooks per longitudinal row. In the present specimens, it ranges from 9–12 (usually 11–12) hooks, which nearly overlap with the previously reported counts (12 and 11–12 in Yamaguti [1935, 1939a], respectively; 12 in Fukui and Morisita [1936]; and 12 in Katahira and Nagasawa [2014]), but 9 and 10 hooks per row were observed for the first time in this study. Van Cleave (1925) found "about 15 hooks" per row in the original description of *A. gotoi*, but no similar count has been reported to date.

Acanthocephalus gotoi has so far been reported from five species of Japanese freshwater fishes: *Anguilla japonica* Temminck and Schlegel, 1847 (type host) [Japanese name: nihon-unagi], *Anguilla marmorata* Quoy and Gaimard, 1824 [ō-unagi] (Anguilliformes: Anguillidae); *Silurus asotus* Linnaeus, 1758 (reported as *Parasilurus asotus*) [namazu] (Siluriformes: Silruridae); *Odontobutis obscura* (Temminck and Schlegel, 1845) (reported as *Mogurnda obscura* [donko] (Perciformes: Odontobutidae); and *Gymnogobius urotaenia* (Hilgendorf, 1879) (reported as *Chaenogobius annularis urotaenia*) [ukigori] (Perciformes: Gobiidae) (Van Cleave, 1925; Yamaguti, 1935, 1939a; Fukui and Morisita, 1936; Katahira and Nagasawa, 2014). *Rhinogobius similis* and *Rhinogobius* sp. OR are new hosts of *A. gotoi*.

The known localities of *A. gotoi* are a fish market in Tokyo (Van Cleave, 1925), Lake Ogura in Kyōto Prefecture, unspecified "various localities" (Yamaguti, 1935), an unspecified locality in Aichi Prefecture (Fukui and Morisita, 1936), Lake Suwa in Nagano Prefecture, Lake Biwa in Shiga Prefecture (Yamaguti, 1939a), and the Renjōji River in Ehime Prefecture (Katahira and Nagasawa, 2014). The collections of *A. gotoi* from Hiroshima and Kōchi prefectures in this study represent new prefectural records for the species.

Acanthocephalus longiacanthus Katahira and Nagasawa, 2014
(Fig. 2D–G)

Material examined. One male (NSMT-As 4582) and 2 females (NSMT-As 4583–4584) from *Rhinogobius nagoyae* in the Tenchi River on 30 September 2015 and 6 July 2016, respectively; 1 female (NSMT-As 4585) from *Rhinogobius fluviatilis* at site 1 in the Kamo River on 28 May 2015; 3 males (NSMT-As 4586–4588) from *Rhinogobius* sp. OR in the Tenchi River on 6 July 2016; 1 male (NSMT-As 4589) from *Rhinogobius* sp. OR in the Sōja River on 5 July 2016; and 2 males and 2 females (NSMT-As 4590–4592) from *Rhinogobius* sp. OR in the Hiwatashi River on 26 July 2015.

Description. *General*. Females larger than males. Trunk elongate, cylindrical, aspinose. Proboscis cylindrical, slightly ventrally directed. Proboscis hooks arranged in 8–9 (usually 9 in both sexes) longitudinal rows; number of hooks per row 5–6 (usually 5 in both sexes). Hook blade longer than root. Root with pair of lateral alar processes at anterior end. Longest-bladed hook found on anterior part of proboscis. Neck short. Proboscis receptacle double-walled, with cephalic ganglion near its posterior end. Lemnisci elongate, longer than proboscis receptacle.

Male (based on 4 specimens: 1 specimen from *Rhinogobius* sp. OR in the Sōja River; and 3 specimens from *Rhinogobius nagoyae* in the Tenchi River). Trunk 2.15–3.70 (2.98) long, 0.65–0.88 (0.72) wide. Proboscis 0.34–0.45 (0.41) long, 0.12–0.15 (0.14) wide. Second anterior hook largest in a row; maximum length of hook blade 70–88 (79) μm long, root 40–45 (43) μm long, protrusion 6–8 (8) μm long. Basal hook smallest in a row; maximum length of hook blade 25–48 (36) μm

long, root 20–28 (24) μm long, protrusion 4–8 (5) μm long. Proboscis receptacle 0.34–0.42 (0.39) long, 0.16–0.18 (0.18) wide. Longer lemniscus 0.47–0.76 (0.61) long, 0.12–0.14 (0.13) wide; shorter lemniscus 0.47–0.54 (0.51) long, 0.12–0.18 (0.15) wide. Testes rounded, in tandem or slightly oblique, located at mid-length of trunk; anterior testis 0.39–0.75 (0.62) long, 0.34–0.50 (0.41); posterior testis 0.43–0.74 (0.59) long, 0.28–0.45 (0.36). Cement glands usually 6, in 3 pairs, oval, 0.07–0.23 (0.14) wide in maximum diameter. Saefftigen's pouch bulb-shaped, 0.13–0.34 (0.24) long, 0.12–0.15 (0.13) wide in maximum diameter. Penis conical, 20–50 (38) μm wide.

Female (based on 4 specimens: 3 specimens from *Rhinogobius nagoyae* in the Tenchi River; 1 specimen from *Rhinogobius fluviatilis* at site 1 in the Kamo River). Trunk 3.63–7.63 (5.31) long, 0.73–1.38 (1.06) wide. Proboscis 0.53–0.81 (0.67) long, 0.16–0.25 (0.20) wide. Second anterior hook largest in a row: hook blade 145–175 (157) μm long, root 40–65 (55) μm long, protrusion 10–13 (12) μm long. Basal hook smallest in a row; maximum length of hook blade 30–65 (50) μm long, root 23–38 (29) μm long, protrusion 4–5 (5) μm long. Proboscis receptacle 0.57–0.70 (0.62) long, 0.18–0.28 (0.23) wide. Longer lemniscus 0.45–0.84 (0.65) long, 0.21–0.32 (0.25) wide; shorter lemniscus 0.45–0.73 (0.58) long, 0.18–0.32 (0.24) wide. Uterus cylindrical, 0.16–0.29 (0.23) long, 0.06–0.07 (0.07) wide. Vagina with single sphincter. Egg 83 μm long, 13 μm wide (n = 1).

Hosts and localities. *Rhinogobius nagoyae* from the Tenchi River (Hiroshima Prefecture); *Rhinogobius fluviatilis* from site 1 in the Kamo River (Hiroshima Prefecture); and *Rhinogobius* sp. OR from the Tenchi River (Hiroshima Prefecture), the Sōja River (Ehime Prefecture), and the Hiwatashi River (Kōchi Prefecture).

Sites of infection. Intestine (exceptionally, 1 worm was found ensheathed in the mesentery, see Remarks).

Prevalences and intensities. See Table 2.

Remarks. The specimens collected in this study fit the morphology of *A. longiacanthus* described by Katahira and Nagasawa (2014). This acanthocephalan was recently described from *Anguilla marmorata* (type host) [Japanese name: ō-unagi] in the Renjōji River, Ehime Prefecture, and this fish is the only known host (Katahira and Nagasawa, 2014). The present collection of *A. longiacanthus* represents the second record of the species and also the first record from Hiroshima and Kōchi prefectures. *Rhinogobius nagoyae*, *Rhinogobius fluviatilis*, and *Rhinogobius* sp. OR are new host records for *A. longiacanthus*.

One female of *A. longiacanthus* was found ensheathed in the mesentery of *Rhinogobius* sp. OR from the Tenchi River. Since *Acanthocephalus* spp. are intestinal parasites of fishes and other aquatic vertebrates, the observed site of infection is unusual: the worm probably penetrated the intestinal wall and became ensheathed.

Acanthocephalus minor Yamaguti, 1935
(Fig. 3A–C)

Material examined. Five males and 3 females (NSMT-As 4593–4600) from *Rhinogobius flumineus* from site 2 and 3 in the Aruji River on 4 June 2016.

Description. *General*. Trunk subcylindrical, unarmed. Body wall thick. Proboscis cylindrical, armed with 13 longitudinal rows with 5–6 (usually 5 in both sexes) hooks per low. Second or third anterior hook largest and basal hook smallest in each row. Hook blade longer than root. Neck short. Proboscis receptacle double-walled, with cephalic ganglion situated distally. Lemnisci saccular, usually longer than proboscis receptacle.

Male (based on 4 specimens from *Rhinogobius flumineus* in the Aruji River). Trunk 2.04–3.18 (2.38) long, 0.65–1.13 (0.83) wide. Proboscis 0.33–0.43 (0.37) long, 0.17–0.23 (0.20) wide. Second or third anterior hook largest in a row; maximum length of hook blade 75–85 (82) μm long. Neck 0.13–0.19 (0.17) long. Proboscis receptacle 0.23–0.37 (0.27) long, 0.15–0.18 (0.16) wide. Longer lemniscus 0.20–0.37 (0.29) long, 0.07–0.17 (0.11) wide; shorter lemniscus 0.19–0.35 (0.27) long, 0.05–0.16 (0.11) wide. Testes rounded, in tandem or slightly oblique, located at mid-length of trunk; anterior testis 0.20–0.36 (0.28) long, 0.24–0.30 (0.27); posterior testis 0.23–0.44 (0.26) long, 0.17–0.26 (0.22). Cement glands usually 6, in 3 pairs, oval, 0.11–0.16 (0.13) wide in maximum diameter. Saefftigen's pouch bulb-shaped, 0.15–0.34 (0.24) long, 0.09–0.16 (0.12) wide in maximum diameter.

Female (based on 2 specimens with ovarian balls

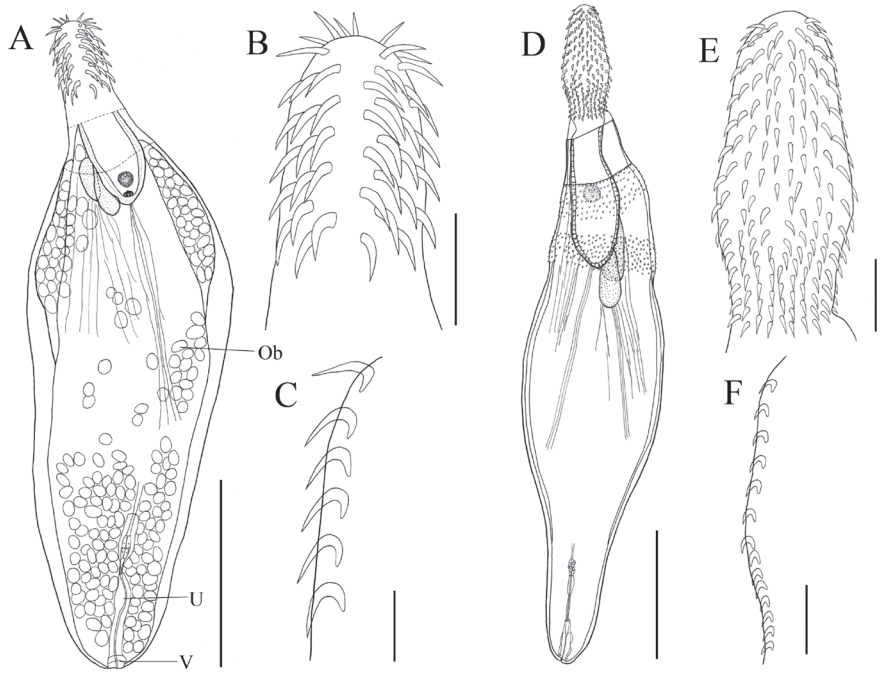

Fig. 3. *Acanthocephalus minor* Yamaguti, 1935 (A–C) from *Rhinogobius flumineus* at site 3 in the Aruji River, Hiroshima Prefecture, western Japan; and *Southwellina hispida* (Van Cleave, 1925) (D–F) from *Rhinogobius flumineus* in the Shika River, Kyōto Prefecture, central Japan. A, D, entire body of female; B, E, proboscis of female; C, F, proboscis hooks. Abbreviations: Ob, ovarian ball; U, uterus; V, vagina. Scale bars: A, 1 mm; B, E–F, 200 μm; C, 100 μm; D, 2 mm.

from *Rhinogobius flumineus* in the Aruji River). Trunk 1.98–2.57 (2.28) long, 0.92–1.08 (1.00) wide. Proboscis 0.46–0.54 (0.50) long, 0.27–0.29 (0.28) wide. Second or third anterior hook largest in a row: hook blade 95–98 (97) μm long. Neck 0.18–0.27 (0.23) long. Proboscis receptacle 0.35–0.49 (0.42) long, 0.26–0.28 (0.27) wide. Longer lemniscus 0.28–0.31 (0.30) long, 0.10–0.15 (0.13) wide; shorter lemniscus 0.24–0.28 (0.26) long, 0.08–0.13 (0.11) wide. Reproductive system 0.53–0.85 (0.69) long.

Host and localities. *Rhinogobius flumineus* from site 2 and 3 in the Aruji River (Hiroshima Prefecture).

Site of infection. Rectum.

Prevalences and intensities. See Table 2.

Remarks. The specimens collected in this study are identified as *Acanthocephalus minor* which was originally described by Yamaguti (1935) from *Silurus asotus* (type host, reported as *Parasilurus asotus*) [Japanese name: namazu] in Toyama Prefecture. The acanthocephalan has been reported from *Odontobutis obscura* [donko] in Lake Biwa, Shiga Prefecture (Fukui and Morisita 1936); *O. obscura* and *Carassius* sp. (reported as *Carassius carassius*) [funa] Cypriniformes: Cyprinidae) in Obama, Fukui Prefecture (Yamaguti, 1939a); *Oncorhynchus masou masou* (Brevoort, 1856) (reported as *O. masou*) [yamame], *Oncorhynchus mykiss* (Walbaum, 1792) (reported as *Salmo gairdneri irideus* and *S. g. gairdneri*) [nijimasu], *Salvelinus malma kraschenninnikovi* Taranetz, 1933 (reported as *S. malma*) [oshorokoma] (all Salmoniformes: Salmonidae), and *Gasterosteus aculeatus aculeatus* Linnaeus, 1758 [itoyo] (Gasterosteiformes: Gasterosteidae) at a trout culture experimental station in Hokkaido (Awakura, 1972); *Gymnogobius urotaenia* (reported as the freshwater type of *Chaenogobius annularis*) [ukigori] and *Gymnogobius opperiens* Stevenson, 2002 (reported as the middle-reach type of *C. annularis*) [shima-ukigori] (Perciformes: Gobiidae) in the Ryūkei River, Hokkaido (Nagasawa et al., 1982); and *O. obscura* in an irrigation canal, Shiga Prefecture (Nagasawa and Nitta, 2015). The present collection of *A. minor* from *Rhinogobius flumineus* from Hiroshima Prefecture represents a new host and a new prefectural record for the acanthocephalan.

The blade length of the largest hook in the specimens from this study ranges from 75–85 μm in male and 95–98 μm in female, which are bigger than those previously reported in both sexes of the same species (e.g., 60–72 and 68–87 μm in Yamaguti [1935];

60–75 and 85 μm in Yamaguti [1939a]; and 65–75 and 65–75 μm in Awakura [1972]).

All the specimens of *A. minor* reported herein were found in the rectum of the fish. Such site specificity by the species has been noticed by Nagasawa et al. (1982) and Nagasawa and Nitta (2015).

Order **Polymorphida** Petrochenko, 1956
Family **Polymorphidae** Meyer, 1931
Genus ***Southwellina*** Witenberg, 1932

Southwellina hispida (Van Cleave, 1925)
(Fig. 3D–F)

Material examined. Two females (NSMT-As 4601–4602) from *Rhinogobius flumineus* at site 2 in the Aruji River on 4 June 2016; and 1 female (NSMT-As 4603) from *Rhinogobius flumineus* in the Shika River on 29 November 2014.

Description. *Female* (based on 2 specimens: 1 specimen from *Rhinogobius flumineus* at site 2 in the Aruji River; and 1 specimen from *Rhinogobius flumineus* in the Shika River). Cystacanth encapsulated in mesentery. Trunk fusiform, 2.58–4.00 (3.29) long, 1.13–1.28 (1.21) wide, with 2 bands of spines in anterior part. Proboscis 0.88–1.03 (0.96) long, armed with 20 longitudinal rows of 15 hooks per row. Maximum length of middle hook blade 63–65 (64) μm long, root 48–53 (51) μm long; anterior hook blade 50–53 (52) μm long, root 39–40 (40) μm long; basal hook blade 43–48 (46) μm long, root 30–35 (33) μm long. Neck wider than long; 0.40 long, 0.58 wide (n = 1). Proboscis receptacle 0.86–1.53 (1.20) long, 0.39–0.40 (0.40) wide. Leminsci 0.80–1.00 (0.90) long. Uterus cylindrical, 0.34 long, 0.09 wide (n = 1). Vagina 100 μm long (n = 1).

Host and localities. *Rhinogobius flumineus* from site 2 in the Aruji River (Hiroshima Prefecture) and the Shika River (Kyōto Prefecture).

Site of infection. Mesentery.

Prevalences and intensities. See Table 2.

Remarks. The female specimens collected in this study are cystacanths encapsulated in the mesentery and identified as *Southwellina hispida*. This acanthocephalan uses amphipods and long-armed freshwater prawns as the intermediate hosts, amphibian, reptile and freshwater fishes as the paratenic hosts, and piscivorous birds as the definitive hosts to complete its life cycle (Schmidt and Kunz, 1967; Schmidt, 1985; Lisitsyna, 2011). In Japan, *S. hispida* has been found from the following freshwater fishes in different locations: *Rhinogobius* sp. [Japanese name: yoshinobori] and a cyprinid (reported as "*Cyprinus carassius*" but probably *Carassius* sp. [funa], see Amin et al. [2007]) in Namerikawa, Toyama Prefecture (Yamaguti, 1935); *Odontobutis obscura* (reported as *Mogurnda obscura*) [donko] in Obama, Fukui Prefecture (Yamaguti, 1939a); *Tanakia lanceolata* (Temminck and Schlegel, 1846) [yaritanago], *Tanakia limbata* (Temminck and Schlegel, 1846) [aburabote], *Candidia sieboldii* (Temminck and Schlegel, 1846) (reported as *Zacco sieboldii*) [numamutsu] (all Cypriniformes: Cyprinidae), *Lefua echigonia* Jordan and Richardson, 1907 [hotoke-dojō] (Cypriniformes: Cobitidae), *Coreoperca kawamebari* (Temminck and Schlegel, 1843) [oyanirami] (Perciformes: Sinipercidae), and *Micropterus salmoides* (Lacepède, 1802) [ōkuchibasu] (Perciformes: Centrarchidae) in Lake Biwa and its rivers, Shiga Prefecture (Amin et al., 2007); *Cottus reinii* Hilgendorf, 1879 [utsusemi-kajika] (Perciformes: Cottidae) in Lake Biwa, Shiga Prefecture (Nagasawa and Grygier, 2011); *Anguilla marmorata* [ō-unagi] in the Renjōji River, Ehime Prefecture (Katahira and Nagasawa, 2014); and *A. marmorata* on Okinoerabu-jima Island in Kagoshima Prefecture (Nagasawa and Kan, 2017). In this study, the specimens of *S. hispida* were collected from *Rhinogobius flumineus* in Hiroshima and Kyōto prefectures. There are two records of *S. hispida* from bird hosts, *Nycticorax nycticorax* (Linnaeus, 1758) [goisagi] (Pelecaniformes: Aedeidae) and *Tachybaptus ruficollis* (Pallas, 1764) (reported as *Podiceps ruficollis japonicus*) [kaitsuburi] (Podicipediformes: Podicipedidae), in the latter prefecture (Yamaguti, 1935, 1939a). The acanthocephalan is reported herein for the first time from Hiroshima Prefecture. *Rhinogobius flumineus* is a new host of *S. hispida.*

Ⅳ. Discussion

Prior to the present study, only two species of acanthocephalans (*Southwellina hispida* and *Echinorhynchus cotti*) have been reported from the gobies of *Rhinogobius* in Japan (Yamaguti, 1935; Amin et al., 2007). Three of the four acanthocephalans

described in this paper, viz., *Acanthocephalus gotoi*, *A. longiacanthus*, and *A. minor*, were newly collected from the gobies of the genus, and five species of acanthocephalans are now known to parasitize *Rhinogobius* spp. in Japan (Table 1).

Based on the previous and present papers published between the years 1935 and 2018, 48 nominal and some unidentified species of the parasites have been reported from *Rhinogobius* spp. in Japan (Table 3). The nominal species of these parasites include: 3 species in the Myxozoa (Cnidaria); 1 species in the Monogenea; 16 species in the Trematoda; 4 species in the Cestoda (all Platyhelminthes); 3 species in the Nematoda; 5 species in the Acanthocephala (including the 3 species reported in this paper); 15 species, of which 1 species includes 2 subspecies, in the Bivalvia (Mollusca); and 1 species in the Copepoda (Arthropoda). The gobies reported as the hosts of the parasites are 10 species, which consist of 7 nominal species (*Rhinogobius biwaensis*, *R. brunneus*, *R. flumineus*, *R. fluviatilis*, *R. kurodai*, *R. nagoyae*, and *R. similis*) and 3 species without a specific name (*Rhinogobius* sp. CO [=cobalt type], *R.* sp. OR [=orange type], and *R.* sp. TO [=Tokai type]) (Table 3). Among the parasites reported, as many as 15 species of bivalves are known to infect the gobies when they are larvae (as glochidia) (Table 3), and all these species belong to the family Unionidae. The Japanese *Rhinogobius* spp. are considered to serve as important hosts for the Japanese unionids.

Despite the above information accumulated for more than 80 years, our knowledge of the parasites of the Japanese *Rhinogobius* spp. is definitely not enough yet, because 1) only 10 of the 18 species in the genus (cf. Hosoya, 2015) have been examined for their parasites; 2) the gobies of the genus widely occur in the Japanese Archipelago ranging from Hokkaido in the north to the Ryūkyū Islands in the south (Akihito et al., 2013; Yamasaki et al., 2015; Hosoya, 2015) but the past parasitological works to examine these fishes were conducted mainly in central and western Japan; and 3) the taxonomy of the Japanese *Rhinogobius* spp. have currently been revised (see Akihito et al., 2013; Hosoya, 2015) and it is often difficult to specify the species of the gobies reported as the hosts in the past papers (see Table 3).

Recently, a new dactylogyrid genus, *Gobioecetes*, was described for the monogenean from *Rhinogobius biwaensis* and *Rhinogobius* sp. in central Japan (Ogawa and Itoh, 2017). More species in different parasite groups would be discovered from *Rhinogobius* spp. in various locations from Hokkaido to the Ryūkyū Islands. We need more work to clarify the parasite fauna of the Japanese *Rhinogobius* spp.

Information on the ecology of the parasites of the Japanese *Rhinogobius* spp. is also very limited. For example, acanthocephalans need intermediate hosts to complete their life cycles (Schmidt, 1985) but, among the four acanthocephalan species reported herein, only *A. minor* is known for its intermediate host *Asellus hilgendorfii* Bovallius, 1886 (Crustacea: Isopoda: Asellidae) (Awakura, 1972; Nagasawa et al., 1982). Crustaceans also have been reported to serve as the intermediate hosts for *S. hispida* (Schmidt, 1985; Lisitsyna, 2011), but no paper on the intermediate host of the acanthocephalan has been published in Japan. Further, no information is available on the seasonal dynamics and maturation of the four species of acanthocephalans reported in this paper.

It is interesting to note that *A. gotoi* and *A. longiacanthus* were found infecting *Rhinogobius similis* and *R. fluviatilis* in the lower (site 2) and middle (site 1) reaches of the Kamo River, respectively. This may indicate that the acanthocephalans show different distributional patterns and use different fish host species within the river. In contrast to this, these two acanthocephalan species were found in *Rhinogobius* sp. OR sampled at a single site in the Sōja and Hiwatashi rivers, which suggests that both acanthocephalans co-occur in the same region in each river. The distribution of acanthocephalans within a river appears to be affected by longitudinal differences in the fauna and abundance of fishes and aquatic invertebrates. Thus, it is desirable to collect and examine many fishes and possible intermediate hosts from different sites of the rivers for clarifying the distribution patterns of the acanthocephalans.

As stated in the Introduction section, the Japanese *Rhinogobius* spp. are classified, based on their life history and migration patterns, into three groups: amphidromous, fluvial, and lentic types (Mizuno, 1960, 1961). The gobies of the latter two types inhabit rivers and ponds/lakes, respectively (e.g., Takahashi and

Table 3. The parasites reported from *Rhinogobius* spp. in Japan between the years 1939 and 2018. The scientific names of the hosts follow Akihito et al. (2013), Hosoya (2015), and Takahashi and Okazaki (2017).

Parasite	Stage	Host	Prefecture*	Reference
Ciliophora				
Trichodinidae sp.		*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Ciliophora sp.		*Rhinogobius flumineus*	Nara	Nakamura et al. (2000)
Cnidaria: Myxozoa				
Henneguya rhinogobii Lee and Nie in Chen, 1973		*Rhinogobius* sp. OR	Gifu	Kageyama et al. (2009)
Henneguya pseudorhinogobii Kageyama, Yanagida, Ohara and Yokoyama, 2009		*Rhinogobius* sp. OR	Gifu	Kageyama et al. (2009)
Myxobolus nagaraensis Yokoyama, Kageyama, Ohara and Yanagida, 2007		*Rhinogobius* sp. OR	Gifu	Yokoyama et al. (2007)
Myxozoa sp.		*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Platyhelminthes: Monogenea				
Dactylogyrus sp.		*Rhinogobius flumineus*	Nara	Nakamura et al. (2000)
Gobioecetes biwaensis Ogawa and Itoh, 2017		*Rhinogobius biwaensis* (as *Rhinogobius* sp. BW), *Rhinogobius* sp.	Shiga, Kyōto	Ogawa and Itoh (2017)
Gyrodactylus sp.		*Rhinogobius flumineus*	Nara	Nakamura et al. (2000)
Monopisthocotylea sp.		*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Platyhelminthes: Trematoda				
Apharyngostrigea sp.	metacercaria	*Rhinogobius* sp. OR (as *Rhinogobius* sp.)	Tōkyō	Shimazu et al. (2000)
Azygia gotoi Shimazu, 1979		*Rhinogobius* sp. OR (as *Rhinogobius brunneus*)	Nagano	Shimazu (1979, 2007 as *Azygia anguillae*, 2014b)
Azygia rhinogobii Shimazu, 2007		*Rhinogobius* sp. OR (as *Rhinogobius* sp.)	Ibaraki, Nagano	Shimazu (2007, 2014b)
Coitocaecum plagiorchis Ozaki, 1926		*Rhinogobius* sp. (including *Gobius similis*), *Rhinogobius flumineus, Rhinogobius biwaensis* (as *Rhinogobius* sp. BW)	Shiga, Kyōto, Ōita	Yamaguti (1942b), Yoshida and Urabe (2005, as *Coitocoecum plagiorchis*), Shimazu et al. (2011), Shimazu (2016)
Dimerosaccus oncorhynchi (Eguchi, 1931)		*Rhinogobius flumineus, Rhinogobius nagoyae* (as *Rhinogobius* sp. CB), *Rhinogobius brunneus* (as *Rhinogobius* sp. DA), *Rhinogobius fluviatilis* (as *Rhinogobius* sp. LD), *Rhinogobius* sp. CO, *Rhinogobius* sp. OR, *Rhinogobius* sp.	Nara, Wakayama, Tokushima, Kōichi, Ōita	Nakamura et al. (2000), Shimazu and Urabe (2005), Shimazu (2008, 2016)
Diplostomatidae gen. sp.	metacercaria	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius* sp. OR (as *Rhinogobius* sp.)	Tōkyō, Gifu	Anonymous (2002), Shimazu et al. (2000)
Echinostomatid with 22 collar spines	metacercaria	*Rhinogobius* sp. (as *Gobius similis*)	Kyōto	Yamaguti (1942a)
Echinostomatid with 24 collar spines	metacercaria	*Rhinogobius* sp. (as *Gobius similis*)	Kyōto	Yamaguti (1942a)
Genarchopsis chubuensis Shimazu, 2015		*Rhinogobius* sp. (as *Gobius similis*), *Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius flumineus*, *Rhinogobius kurodai*, *Rhinogobius* sp. OM, *Rhinogobius* sp. OR	Ibaraki, Saitama, Nagano, Shiga, Kyōto, Nara	Yamaguti (1942b), Shimazu (1995, as *Genarchapsis goppo*, 2007 as *Genarchopsis goppo*, 2015), Nakamura et al. (2000, as *Genarchopsis goppo*), Urabe (2001, as *Genarchopsis goppo*), Shimazu and Urabe (2005, as *Genarchopsis goppo*), Shimazu et al. (2011, as *Genarchopsis goppo* [in part]), Urabe et al. (2012, as *Genarchopsis goppo* [in part])
Genarchopsis fellicola Shimazu, 1995		*Rhinogobius* sp. OR (as *Rhinogobius brunneus*), *Rhinogobius kurodai*	Ibaraki, Nagano	Shimazu (1995, 2007, 2015), Urabe et al. (2012)
Genarchopsis gigi Yamaguti, 1939		*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius kurodai*, *Rhinogobius biwaensis* (as *Rhinogobius* sp. BW)	Shiga (Lake Biwa only)	Shimazu (1995, as *Genarchapsis goppo*, 2015), Shimazu et al. (2011, as *Genarchopsis goppo* [in part]), Urabe et al. (2012, as *Genarchopsis goppo* [in part])

Table 3. continued.

Parasite	Stage	Host	Prefecture*	Reference
Genarchopsis goppo Ozaki, 1925		*Rhinogobius flumineus*, *Rhinogobius similis* (as *Rhinogobius giurinus*), *Rhinogobius nagoyae* (as *Rhinogobius* sp. CB)	Kōchi	Shimazu (2008)
Isoparorchis eurytremus (Kobayashi, 1915)		*Rhinogobius biwaensis* (as *Rhinogobius* sp. BW), *Rhinogobius fluviatilis*, *Rhinogobius* sp. OR (as *Rhinogobius* sp.)	Shiga, Hiroshima	Shimazu et al. (2011, as *Isoparorchis hypselobagri*), Nagasawa et al. (2013, as *I. hypselobagri*)
Metagonimus miyatai Saito, Chai, Kim, Lee and Rim, 1997	metacercaria	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Metagonimus otsurui Saito and Shimizu, 1968	metacercaria	*Rhinogobius flumineus*	Nara	Shimazu and Urabe (2002)
Metagonimus takahashii Suzuki in Takahashi, 1929	metacercaria	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Metagonimus sp.	metacercaria	*Rhinogobius flumineus*	Nara	Nakamura et al. (2000)
Neoplagioporus elongatus (Goto and Ozaki, 1930)		*Rhinogobius flumineus*, *Rhinogobius biwaensis* (as *Rhinogobius* sp. BW)	Shiga, Kyōto	Shimazu and Urabe (2005), Shimazu et al. (2011)
Parabucephalopsis parasiluri Wang, 1985	metacercaria	*Rhinogobius* sp. OR (as *Rhinogobius kurodai*)***	—**	Baba and Urabe (2011a, 2011b, 2015)
Phyllodistomum mogurndae Yamaguti, 1934		*Rhinogobius* sp. OR (as *Rhinogobius* sp.)	Nagano	Shimazu (2007, 2014a)
Urorchis goro Ozaki, 1927		*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius flumineus*, *Rhinogobius* sp. OR	Shiga, Nara	Shimazu (1990a, 2007), Shimazu and Urabe (2005, as *Urorchis* sp.), Shimazu et al. (2011)
Platyhelminthes: Cestoda				
Bothriocephalus sp.		*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Gangesia parasiluri Yamaguti, 1934	plerocercoid	*Rhinogobius* sp. (as *Rhinogobius bruneus*), *Rhinogobius similis* (as *Rhinogobius giurinus*), *Rhinogobius* sp.	Nagano, Gifu, Shiga, Kochi	Shimazu (1999), Anonymous (2002), Ash et al. (2015)
Nippotaenia chaenogobii Yamaguti, 1939		*Rhinogobius* sp. (as *Gobius similis* and *Rhinogobius brunneus*)	Nagano	Yamaguti (1939b), Shimazu (1997)
Proteocephalus plecoglossi Yamaguti, 1934		*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Shiga	Shimazu (1990b)
Schyzocotyle acheilognathi (Yamaguti, 1934)		*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002, as *Bothriocephalus acheilognathi*)
Cestoda sp.		*Rhinogobius flumineus, Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu, Nara	Nakamura et al. (2000, as Cestoidea sp.), Anonymous (2002)
Nematoda				
Camallanus cotti Fujita, 1927		*Rhinogobius* sp. (as *Rhinogobius similis*), *Rhinogobius brunneus*	—, Okinawa	Yamaguti (1941), Hasegawa and Yoshimura (2003)
Contracaecum sp.	larva	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Eustrongylides sp.	larva	*Rhinogobius* sp. (as *Rhinogobius similis*), *Rhinogobius* sp. OR (as *Rhinogobius* sp.)	—, Tōkyō	Yamaguti (1941), Shimazu et al. (2000)
Philometra sp.	larva	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Gifu	Anonymous (2002)
Rhabdochona coronacauda Belouss, 1965		*Rhinogobius flumineus*	Nara	Nakamura et al. (2000), Hirasawa (2000, 2002), Hirasawa et al. (2004)
Rhandochona denudata honshuensis Moravec and Nagasawa, 1989		*Rhinogobius flumineus*	Nara	Nakamura et al. (2000, as *Rhabdochona denudata*), Hirasawa et al. (2004)
Rhabdochona sp.		*Rhinogobius* sp.	Okinawa	Hasegawa and Yoshimura (2003)
Spinitectus sp.		*Rhinogobius brunneus*	Okinawa	Hasegawa and Yoshimura (2003)
Acanthocephala				
Acanthocephalus gotoi Van Cleave, 1925		*Rhinogobius similis*, *Rhinogobius* sp. OR	Hiroshima, Kōchi	This paper
Acanthocephalus longiacanthus Katahira and Nagasawa, 2014		*Rhinogobius fluviatilis*, *Rhinogobius nagoyae*, *Rhinogobius* sp. OR	Hiroshima, Kōchi	This paper
Acanthocephalus minor Yamaguti, 1935		*Rhinogobius flumineus*	Hiroshima	This paper
Echinorhynchus cotti Yamaguti, 1935		*Rhinogobius* sp.	Shiga	Amin et al. (2007)

Table 3. continued.

Parasite	Stage	Host	Prefecture*	Reference
Southwellina hispida (Van Cleave, 1925)	cystacanth	*Rhinogobius* sp., *Rhinogobius flumineus*	Toyama, Shiga, Kyōto, Hiroshima	Yamaguti (1935), Amin et al. (2007), this paper
Mollusca: Bivalvia				
Anemina arcaeformis (Heude, 1877)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius flumineus****	—	Kondo (2008), Kondo et al. (2015)
Cristaria plicata (Leach, 1815)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius similis* (as *Rhinogobius giurinus*)***, *Rhinogobius nagoyae****, *Rhinogobius* sp. ***	—	Kondo (2008), Miyamoto et al. (2015), Itoh et al. (2016)
Cristaria tenuis (Lea, 1834)	glochidium	*Rhinogobius similis* (as *Rhinogobius giurinus*)***, *Rhinogobius* sp.	Okinawa	Itoh et al. (2014, 2017)
Hyriopsis schlegeli (Martens, 1861)	glochidium	*Rhinogobius* sp. (as *Gobius similis*, *Rhinogobius brunneus*), *Rhinogobius* spp.	Aomori, Shiga	Mizumoto and Tanabe (1954), Mizumoto and Kobayashi (1956), Furukawa and Kobayashi (1966), Kondo (2008), Itoh et al. (2015)
Inversiunio jokohamensis (Ihering, 1893)	glochidium	*Rhinogogobius* sp. (as *Rhinogobius brunnes*), *Rhinogobius* sp. OR	Tochigi, Mie	Kondo (1997, as a species being similar to "nise-matsukasa-gai"; 2008), Itoh et al. (2010)
Inversiunio reinianus (Kobelt, 1879)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	—	Kondo (2008)
Inversiunio yanagawensis (Kondo, 1982)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	—	Kondo (1989, as *Inversidens yanagawensis*; 2008)
Lanceolaria grayana (Lea, 1834)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)***	—	Kondo (1989, 2008)
Nodularia douglasiae Griffin and Pidgeon, 1834	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)***	—	Kondo (1989, as *Unio douglasiae*)
Nodularia douglasiae biwae (Kobelt, 1879)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Shiga	Kondo (1997, as "tategoshi-gai"; 2008, as *Unio douglasiae biwae*)
Nodularia douglasiae nipponensis (Martens, 1877)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius* sp. OR***	Ōsaka	Kondo (2008, as *Unio douglasiae nippoensis*), Kimura (2009), Ishida et al. (2010, as *Unio douglasiae nippoensis*), Itoh (2013, as *Unio douglasiae nippoensis*), Kondo et al. (2013, as *Unio douglasiae nippoensis*)
Obovalis omiensis (Heimburg, 1884)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Shiga, Okayama	Kondo (1997, as "kataha-gai"; 1989, as *Pseudodon omiensis*; 2008), Nakagawa et al. (1998, as *Pseudodon omiensis*)
Pronodularia japanensis (Lea, 1834)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius* sp. OR	Tochigi	Itoh et al. (2003), Kondo (2008)
Sinanodonta calipygos (Kobelt, 1879)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	Shiga, Ōsaka	Kondo (2008, as *Anodonta calipygos*)
Sinanodonta lauta (Martens, 1877)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	—	Kondo (2008, as *Anodonta lauta*)
Sinanodonta japonica (Clessin, 1874)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius* sp. OR	Shiga	Kondo (2008, as *Anodonta japonica*), Akiyama (2011, as *Anodonta japonica*)
Sinanodonta ogurae (Kuroda and Habe, 1987)	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*)	—	Kondo (2008, as *Oguranodonta ogurae*)
Sinanodonta spp.****	glochidium	*Rhinogobius* sp. (as *Rhinogobius brunneus*), *Rhinogobius flumineus, Rhinogobius* sp. OR	Gifu, Shiga, Ōsaka, Hyōgo	Fukuhara et al. (1986, 1990, as *Anodonta woodiana*), Kondo (1989, as *Anodonta woodiana*; 1997, as "dobu-gai"), Kondo et al. (1996, as *Anodonta woodiana*), Anonymous (2002, as *Anodonta woodiana*), Kimura (2009), Ishida et al. (2010, *Anodonta* spp.)
Arthropoda: Copepoda				
Lernaea cyprinacea Linnaeus, 1758		*Rhinogobius* sp. TO	Aichi	Nagasawa and Torii (2015)
Arthropoda: Branchiura				
Argulus sp.		*Rhinogobius* sp. TO	Aichi	Nagasawa and Torii (2015)

* The prefectures are listed from the north to the south.
** Not reported.
*** These hosts became infected by laboratory experiments.
**** Include *Sinanodonta japonica* and *S. lauta*.

Okazaki, 2002; Tsunagawa et al., 2010a, 2010b; Suzuki et al., 2011). This difference in their habitat appears to cause a difference in their parasite fauna, and a study is needed to assess the effects of environmental and biological factors on the parasite faunas of the gobies in the two habitats (rivers and ponds/lakes).

【Acknowledgements】

We thank Masato Nitta, Yusuke Aoto, and Kohei Ito, Laboratory of Aquaculture, Graduate School of Biosphere Science, Hiroshima University, for their cooperation during the study. We are grateful to Misako Urabe, University of Shiga Prefecture, and Takuya Sato, National Research Institute of Far Seas Fisheries, for their help with the literature. Thanks also go to Toshiaki Kuramochi, National Museum of Nature and Science, for his cooperation to deposit the voucher specimens at the museum and an anonymous reviewer for useful comments to improve the manuscript of this paper.

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(Received: 31 August 2018)
(Accepted: 5 Desember 2018)