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日本新記録4種および沖縄県新記録1種を含む沖縄県産単生類の目録 (1936-2017年)

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An annotated checklist of the monogeneans (Platyhelminthes) reported from Okinawa Prefecture, southern Japan (1936–2017), with four new Japanese records and one new prefectural record for fish monogeneans

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Abstract. Parasite-Host and Host-Parasite lists were compiled based on the information on the monogeneans parasitic on or in animals of Okinawa Prefecture published between the years 1936 and 2017, including four new Japanese records and one new prefectural record for fish monogeneans. A total of 36 nominal species of the following six families have been reported: Capsalidae (7 species), Gyrodactylidae (2), Dactylogyridae (2), Ancyrocephalidae (20), Diplectanidae (3), and Polystomatidae (2). Thirty-nine records of unidentified monogeneans are also included. As the reported hosts, 51 species of fishes, one species of amphibian, and one species of reptile are listed. Four fish monogeneans, *Gyrodactylus bullatarudis*, *G. turnbulli*, *Haliotrema epinepheli*, and *Heteronchocleidus buschkieli*, are briefly described herein as new records from Japan, and one fish monogenean, *Dactylogyrus minutus*, is reported for the first time from Okinawa Prefecture.

Introduction

Okinawa Prefecture (Fig. 1), comprising about 360 islands, is located in the southernmost and subtropical climate region of Japan and has high biodiversity (JODC 1987, Ikehara 1996). About 500 species of freshwater fishes are known in this prefecture (Yoshigou 2014), and almost all native reptiles and amphibians present are endemic (Toyama & Ota 1991, Toyama & Azama 2003).

The class Monogenea van Beneden, 1858 (Platyhelminthes) is commonly parasitic on or in aquatic or amphibious vertebrates, mainly fishes, but rarely also on aquatic invertebrates (Yamaguti 1963). The first record of a monogenean from Okinawa Prefecture was provided by Ozaki (1936), who found *Polystomoides megaovum* Ozaki, 1936 (Polystomatidae) from the Ryukyu black-breasted leaf turtle *Geoemyda japonica* Fan, 1931 (Reptilia: Geoemydidae) in Kunigami District of Okinawa-jima Island. Yamaguti (1942) described three monogenean species from marine fishes collected from the same island off Naha. Subsequently, however, no study had been conducted on monogeneans until the 1970s, when the staff of the Okinawa Prefectural Fisheries Research and Extension Center (formerly the Okinawa Prefectural Fisheries Experiment Station) reported monogenean-causing diseases of cultured fishes (e.g. Inoha 1974), and Machida (1979) described two monogenean species from wild marine fishes. Dyer et al. (1989) provided new host and locality records of monogeneans from marine fishes from Okinawa Prefecture and suggested conduct more extensive research on monogeneans infecting marine fishes was needed. Monogeneans of the freshwater fishes from Okinawa Prefecture were identified for the first time by Maneepitaksanti & Nagasawa (2012), who found three species of *Cichlidogyrus* Paperna, 1960 from two species of introduced tilapias, *Oreochromis mossambicus* (Peters, 1852) and *O. niloticus* (Linnaeus, 1758) (Perciformes: Cichlidae).

Okinawa Prefecture hosts a number of endemic animal species. These species are sometimes negatively impacted by introduced species, and some of endemic species are on the verge of extinction (Takehara 1997; Ikehara 1996). Introduced species sometimes bring alien parasites, which can cause negative impacts on native species (Lymbery et al. 2014). Thus, it is important and necessary to understand the native and alien parasite fauna of this prefecture in terms of conservation of biodiversity. Since there has been no review thus far

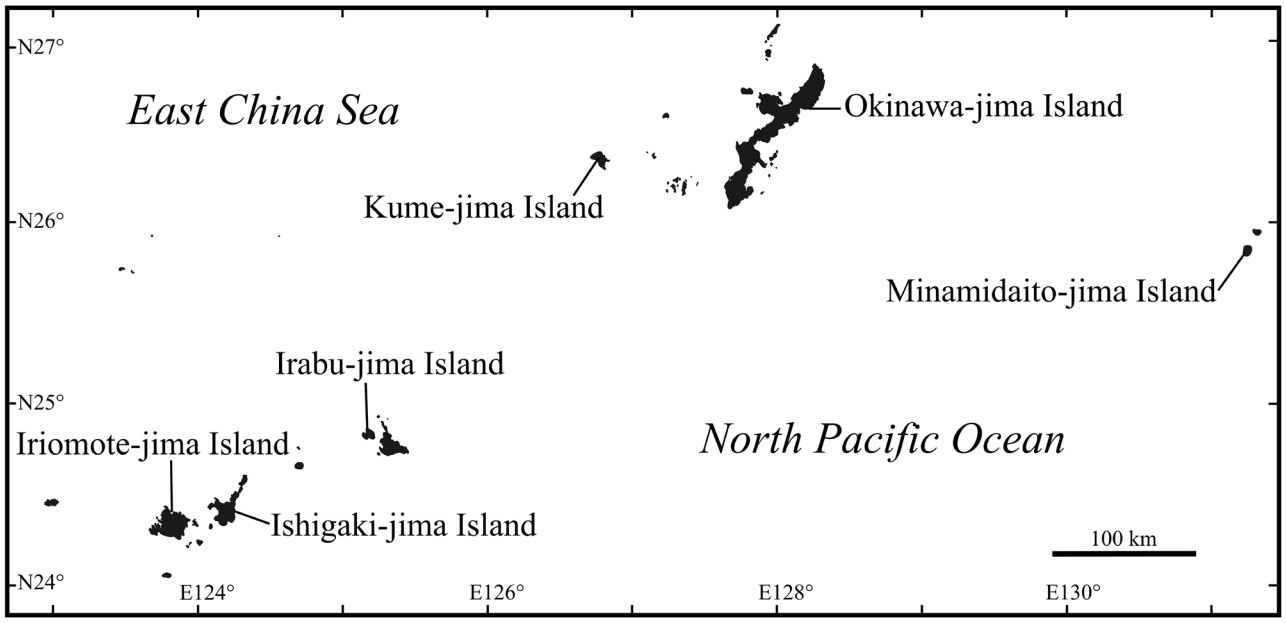

Fig. 1. Name and location of islands from which monogeneans were recorded in Okinawa Prefecture, southern Japan.
図 1. 単生類の記録がある沖縄県の島嶼の名称と位置 .

on the monogenean fauna of Okinawa Prefecture, the present study collected the literature on the monogeneans of Okinawa Prefecture and compiled information as two lists provided herein. The lists include five species of monogeneans newly found by our current investigation as well as four new records from Japan and one new record from this prefecture. This paper contains information on 36 nominal species of monogeneans belonging to the following six families: Capsalidae (7 species), Gyrodactylidae (2), Dactylogyridae (2), Ancyrocephalidae (20), Diplectanidae (3), and Polystomatidae (2). Information on the monogeneans not identified to species level is also given.

Material and Methods

A list of monogeneans from Okinawa Prefecture was prepared based on the literature published between 1936 and 2017, and our monogenean specimens were collected from the common carp *Cyprinus carpio* Linnaeus, 1758, the paradisefish *Macropodus opercularis* (Linnaeus, 1758), the guppy *Poecilia reticulata* Peters, 1859, and the white-edged lyretail *Variola albimarginata* Baissac, 1953 in Okinawa Prefecture from 2013 to 2015. Monogeneans were flattened under coverslip pressure, fixed in 70% ethanol, and stained with Heidenhain's iron hematoxylin, or fixed in ammonium picrate glycerin (APG, Nitta & Nagasawa 2018). All specimens were dehydrated in a graded ethanol series, cleared in xylene, and mounted in Canada balsam. Drawings were made with the aid of a drawing tube fitted on an Olympus BX51 compound microscope. Specimens are deposited in the Platyhelminthes collection of the National Museum of Nature and Science (NSMT-Pl), Tsukuba City, Ibaraki Prefecture, Japan.

In the checklist herein, information on the monogeneans is assembled as Parasite–Host and Host–Parasite lists. In the Parasite–Host List, the higher classification of monogeneans follows WoRMS (2018). For each species of monogenean, the following information is provided:

1) the current scientific name, including the original author(s), date with the source of the combination, and collection water (fresh or marine as F or M, respectively) in parentheses, followed by any recognized synonym(s) used in establishing the record(s) from Okinawa Prefecture.

2) Site(s) of occurrence of the parasite on its host(s).

3) Host(s), in which currently accepted scientific names with original author(s) and date are given: for hosts, the names recommended by Froese & Pauly (2018) and the Herpetological Society of Japan (2017) are used. The scientific names used in the original reports are shown in parentheses. A Japanese common name is also given in Japanese for each host species after its scientific name. Numbers in square brackets correspond to those listed in the Record(s) section.

4) Record(s), in which the references responsible for the records are listed in chronological order. When only one reference was published for a

particular parasite, such reference is not numbered. Each reference is followed by the locality (localities) from which the parasite was reported given in two parts (detailed collection locality (localities), and island(s) shown in Fig. 1). If the monogenean was collected from fish farm(s) or cage(s), this information is shown in square brackets followed by detailed collection locality.

5) Remarks, where explanatory comments are offered on parasite's nomenclature and questionable host and/or parasite identifications in original reports.

In the Host–Parasite list (Appendix 1), the genera and species of hosts are listed in alphabetical order within each of higher taxa of animals (Elasmobranchii, Actinopterygii, Amphibia, and Reptilia).

Parasite–Host List

Class Monogenea van Beneden, 1858

Unidentified species of Monogenea (M)

Site: Gills.

Hosts: *Epinephelus malabaricus* (Bloch & Schneider, 1801) ヤイトハタ [1, 2, 3, 4, 5, 6, 7, 8, 9]; *Lethrinus nebulosus* (Forsskål, 1775) ハマフエフキ [3, 6]; *Pagrus major* (Temminck & Schlegel, 1843) マダイ [2].

Records: 1, Sugiyama & Kurashita 2000 (- [fish farm], -); 2, Sugiyama & Nakamura 2001 (- [fish farm], -); 3, Tamaki & Nakamura 2006 (- [fish farm], -); 4, Tamaki & Nakamura 2007a (- [fish farm], -); 5, Tamaki & Nakamura 2007b (- [fish farm], -); 6, Tamaki & China 2011 (- [fish farm], -); 7, Nakamori & Sugiyama 2012 (- [fish farm], -); 8, Nakamori & Sugiyama 2013 (- [fish farm], -); 9, Nakamori 2017 (-. -).

Remarks: The parasites were reported simply as "monogeneans (単生類)" or "gill flukes (エラムシ)".

Subclass Monopisthocotylea Odhner, 1912
Order Capsalidea Lebedev, 1988
Family Capsalidae Baird, 1853

***Benedenia seriolae* (Yamaguti, 1934)** Price, 1939 (M)

Site: -.

Host: *Cantherhines pardalis* (Rüppell, 1837) アミメウマヅラハギ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

***Benedenia synagrls* Yamaguti, 1953** (M)

Site: -.

Host: *Arothron mappa* (Linnaeus, 1758) ケショウフグ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

***Benedenia* sp.** (M)

Site: Skin.

Host: *Seriola rivoliana* Valenciennes, 1833 ヒレナガカンパチ .

Record: Yamamoto et al. 1995 (Kabira Bay [fish cages], Ishigaki-jima Island).

Remarks: This is the only record of *Benedenia* species identified from the longfin yellowtail *S. rivoliana*.

***Capsala* sp.** (M)

Site: -.

Syn.: *Caballerocotyla* sp.

Host: *Grammatorcynus bilineatus* (Rüppell, 1836) ニジョウサバ .

Record: Dyer et al. 1989 (off Taketomi Town, Iriomote-jima Island).

Remarks: *Caballerocotyla* was synonymized as *Capsala* by Chisholm & Whittington (2007). This is the only record of a capsalid identified from the double-lined mackerel *G. bilineatus*.

***Encotyllabe spari* Yamaguti, 1934** (M)

Site: Gills.

Hosts: *Lethrinus nebulosus* ハマフエフキ ; *Plectorhynchus pictus* (Thunberg, 1792) コロダイ ; *Upeneus tragula* Richardson, 1846 ヨメヒメジ .

Record: Iwata 1990 (coastal waters of Amitori Bay, Iriomote-jima Island).

***Entobdella squamula* (Heath, 1902)** Johnston, 1929 (M)

Site: Skin.

Host: *Taeniura meyeni* Müller & Henle, 1841 (as *T. melanospila*) マダラエイ .

Record: Dyer et al. 1989 (Okinawa Churaumi Aquarium, Okinawa-jima Island).

***Entobdella* sp.** (M)

Site: -.

Host: *Plectropomus leopardus* (Lacepède, 1802) スジアラ .

Record: Dyer et al. 1989 (off Motobu Town,

Okinawa-jima Island).

Remarks: This is the only record of *Entobdella* species identified from the leopard coralgrouper *P. leopardus*.

***Metabenedeniella hoplognathi* (Yamaguti, 1942)** Yamaguti, 1963 (M)

Site: -.

Host: *Plectorhinchus chaetodonoides* Lacepède, 1801 チョウチョウコショウダイ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

***Neobenedenia melleni* (MacCallum, 1927)** Yamaguti, 1963 (M)

Synonyms: *Neobenedenia girellae* (Hargis, 1955) Yamaguti, 1963 [1, 2, 4, 5]; *Neobenedenia* sp. [3].

Site: Skin.

Hosts: *Seriola rivoliana* ヒレナガカンパチ [1, 3]; *Epinephelus malabaricus* ヤイトハタ [4, 5].

Records: 1, Bondad-Reantaso et al. 1995 (-, Ishigaki-jima Island); 2, Ogawa et al. 1995 (off Motobu Town, Okinawa-jima Island; Kabira, Ishigaki-jima Island); 3, Yamamoto et al. 1995 (Kabira Cove [fish cages], Ishigaki-jima Island); 4, Yamauchi & Imamichi 2017 (-, -); 5, Yamauchi & Shirakashi 2017 (Tonoshiro [fish farm], Ishigaki-jima Island).

Remarks: The Japanese species of *Neobenedenia* has so far been identified as *N. girellae* (Hargis, 1955) (e.g. Ogawa et al. 1995, 2014) and regarded as an alien parasite introduced from China to Japan (Ogawa et al. 1995, Ogawa 2015). *Neobenedenia girellae* was originally described from opaleye *Girella nigricans* (Ayres, 1860) from California, USA, but Whittington & Horton (1996) regarded it as a junior synonym of a widespread species, *N. melleni* (MacCallum, 1927) [type locality: New York Aquarium]. Later, Whittington et al. (2004) conducted a phylogenetic analysis of capsalids based on the large subunit ribosomal DNA and showed that *N. melleni* forms a species complex. Recently, *N. girellae* has been regarded as a junior synonym of *N. melleni* (e.g. Miao et al. 2012, Zhang et al. 2014, Shin et al. 2015, Reyes-Becerril et al. 2017). Indeed, morphologically identified *N. melleni* and *N. girellae* from China, are genetically similar to each other (Miao et al. 2012). This paper refers to the previously recorded *Neobenedenia* from Okinawa as *N. melleni*.

Despite the situation concerning the scientific name of *N. melleni*, Japanese fish pathologists so far have followed Ogawa *et al*. (1995) and used the name *N. girellae* (see the above synonyms and records). While Ogawa et al. (2014) indicated that *Neobenedenia* species cannot be identified at the species level only by morphological characteristics, they continued to use *N. girellae* because their study focused on reproductive biology.

Ogawa et al. (1995) reported 14 fish species as hosts from western Japan including Okinawa Prefecture, but these species are not listed here, as the localities of the recorded hosts were not given.

***Trilobiodiscus lutiani* Bychowsky & Nagibina, 1967** (M)

Site: Gills.

Host: *Lutjanus argentimaculatus* (Forsskål, 1775) ゴマフエダイ .

Record: Iwata 1990 (coastal waters of Amitori Bay, Iriomote-jima Island).

Unidentified species of Capsalidae (M)

Sites: Skin, eyes.

Hosts: *Acanthopagrus latus* (Houttuyn, 1782) キチヌ [1]; *Epinephelus lanceolatus* Bloch, 1790 タマカイ [9]; *Epinephelus malabaricus* ヤイトハタ [2, 3, 5, 6, 11, 12, 13, 14, 15]; *Gnathanodon speciosus* (Forsskål, 1775) コガネシマアジ [1]; *Pagrus major* マダイ [1]; *Rachycentron canadum* (Linnaeus, 1766) スギ [4, 5, 7, 8, 10, 12]; *Seriola dumerili* (Risso, 1810) カンパチ [1].

Records: 1, Katsumata 1993 (- [fish farm], -); 2, Kanashiro et al. 1998 (Yaeyama Branch of Okinawa Prefecture Fisheries Experiment Station, Ishigaki-jima Island); 3, Kanashiro et al. 1999 (Yaeyama Branch of Okinawa Prefecture Fisheries Experiment Station, Ishigaki-jima Island); 4, Sugiyama & Kurashita 2000 (- [fish farm], -); 5, Sugiyama & Nakamura 2001 (- [fish farm], -); 6, Tawada et al. 2004 (Yaeyama Branch of Okinawa Prefecture Fisheries Experiment Station, Ishigaki-jima Island); 7, Nakamura et al. 2007 (Okinawa Prefectural Fisheries and Ocean Research Center [fish cages], Okinawa-jima Island); 8, Tamaki & Nakamura 2007b (- [fish farm], -); 9, Karimata & Kimura 2008 (Okinawa Prefectural Sea Farming Center, Ishigaki-jima Island); 10, China et al. 2009) (-, -); 11, China et al. 2010 (-, -); 12, Tamaki & China 2011 (- [fish farm], -); 13, Nakamori & Sugiyama 2012 (- [fish farm], -); 14, Nakamori & Sugiyama 2013 (- [fish farm], -); 15, Nakamori 2017 (-, -).

Remarks: All of the above records were reported simply as “skin flukes (ハダムシ)”. These are the

only records of a capsalid identified from the giant grouper *Epinephelus lanceolatus* and the golden trevally *G. speciosus*. One of the host species, *E. lanceolatus*, reported by Karimata & Kimura (2008), was imported from Taiwan.

The following capsalids have been reported from the above host species in other countries and regions of Japan outside Okinawa Prefecture, except *N. melleni* from *E. malabaricus* (Yamauchi & Shirakashi 2017): *Allobenedenia epinepheli* (Bychowsky & Nagibina, 1967) from the Malabar grouper *E. malabaricus* in China and Australia (Bychowsky & Nagibina 1967, Lester & Sewell 1989, Yang et al. 2004); *N. melleni* from *E. malabaricus* in Brazil and Okinawa, Japan (Roumbedakis et al. 2013, Yamauchi & Shirakashi 2017); *Pseudomegalocotyla* sp. from *E. malabaricus* in New Caledonia (Justine & Sigura 2007); *Benedenia acanthopagri* (Hussey, 1986) from the yellowfin seabream *A. latus* in Kuwait (Hussey 1986); *Benedenia madai* (Ishii and Sawada, 1938), *Benedenia pagrosomi* (Ishii & Sawada, 1937), and *Benedenia sekii* (Yamaguti, 1937) all from the red seabream *P. major* in Japan (Yamaguti 1937, Ishii & Sawada 1937, 1938a, b); *N. melleni* from the cobia *R. canadum* in Taiwan (Ogawa et al. 2006); and *Benedenia seriolae* and *N. melleni* from the greater amberjack *S. dumerili* in Japan (e.g. Ogawa et al. 1995, Whittington et al. 2001).

Order Gyrodactylidea Bychowsky, 1937
Family Gyrodactylidae Van Beneden & Hesse, 1863

***Gyrodactylus bullatarudis* Turnbull, 1956** (F)

Sites: Gills, fins.

Host: *Poecilia reticulata* Peters, 1859 グッピー .

Record: This paper (Senbaru Reservoir, Okinawa-jima Island).

Remarks: *Gyrodactylus bullatarudis* was originally described by Turnbull (1956) from the guppy *Poecilia reticulata* (as *Lebistes reticulatus*) in an aquarium (no information about the country sampled). The monogenean is considered to be native to Latin America because Kritsky & Fritts (1970) and Harris & Lyles (1992) recorded this monogenean from wild-caught molly *P. sphenops* (Valenciennes, 1846) and wild-caught guppy *P. reticulata* in Costa Rica and Trinidad, respectively.

The specimens of *G. bullatarudis* (Fig. 2, NSMT-Pl 6358–6359, n=13) examined in this study were collected from the gills and fins of guppies at Senbaru Reservoir (26°15'03.2"N, 127°45'57.7"E) within the Senbaru Campus of the University of the Ryukyus, Nishihara Town, on 24 and 27 June 2015, and the Asatomata River (26°12'24.7"N, 127°44'18.7"E), Miyagusuku, Haebaru Town, on 23 June 2015, both on Okinawa-jima Island. The dorsal bar has two expansions on both sides and a notch at the mid-point (Fig. 2A), the point of the marginal hook sickle does not extend as far as the toe (Fig. 2B, C), and the male copulatory organ has one large spine with the base on each side curved behind and joined five to six small spines (Fig. 2D). The morphological features and measurements (Table 1) of the specimens examined conform to the descriptions by Turnbull (1956), Kritsky & Fritts (1970), Harris & Lyles (1992), and Richards et al. (2000). This represents a new record of *G. bullatarudis* from Japan.

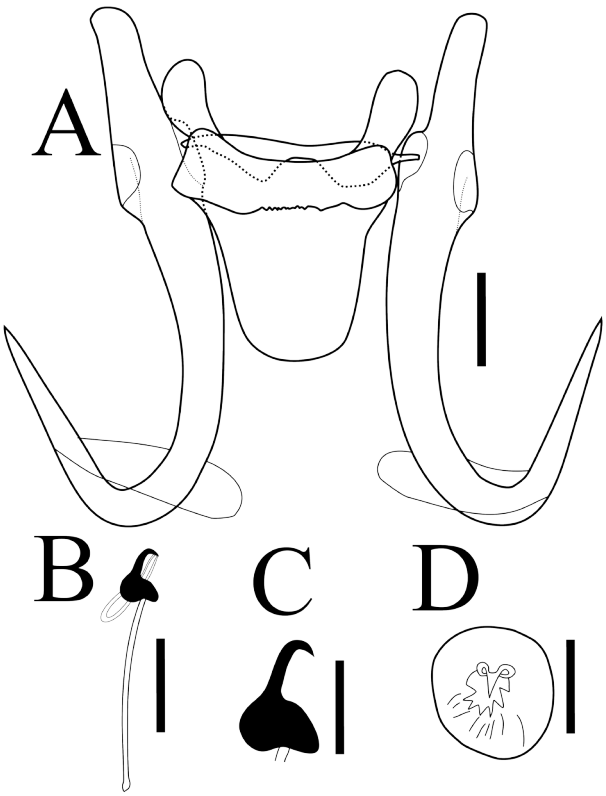

Fig. 2. *Gyrodactylus bullatarudis* Turnbull, 1956. NSMT-Pl 6359. A, hamulus and bars; B, marginal hook; C, marginal hook sickle; D, male copulatory organ. Scale bars: A–B, D, 10 µm; C, 5 µm.
図 2. *Gyrodactylus bullatarudis* Turnbull, 1956. NSMT-Pl 6359. A, 鉤および支持棒 ; B, 周辺小鉤 ; C, 周辺小鉤の鉤 ; D, 雄交接器 .

According to Richards et al. (2000), guppies infected by *G. bullatarudis* were imported from a fish farm in Singapore to the UK. A large number of guppies cultured at fish farms in Singapore were introduced into Japan as aquarium fish in the 1960s.

Those guppies have established their populations on Okinawa-jima Island through the release from aquaria during the 1970s (Takehara et al. 1997; Tachihara et al. 2002).

***Gyrodactylus turnbulli* Harris, 1986** (F)

Sites: Gills, fins.

Host: *Poecilia reticulata* グッピー .

Record: This paper (Senbaru Reservoir, Asatomata River, Okinawa-jima Island).

Remarks: *Gyrodactylus turnbulli* were originally described from the guppy *Poecilia reticulata* imported into the UK from Singapore (Harris 1986). Later, this monogenean was reported from the same fish species in Trinidad which is the native habitat of the host fish (Harris & Lyles 1992).

The specimens of *G. turnbulli* (Fig. 3, NSMT-Pl 6360, n=8) examined in this study were collected from the gill and fins of *P. reticulata* at Senbaru Reservoir (26°15'03.2"N, 127°45'57.7"E) within the Senbaru Campus of the University of the Ryukyus, Nishihara Town, Okinawa-jima Island, on 24 and 27 June 2015. This collection represents the first record of *G. turnbulli* from Japan. The dorsal bar is rod-shaped (Fig. 3A), the process of the ventral bar is smaller than that in *G. bullatarudis* (Table 1), and the point of the marginal hook sickle overhangs its toe (Fig. 3B, C). The morphological features and measurements (Table 1) of the specimens examined correspond to those of the species reported by Harris (1986) and Harris & Lyles (1992). As with the case of *G. bullatarudis*, *G. turnbulli* is considered to be an alien species co-introduced along with *P. reticulata* via Singapore.

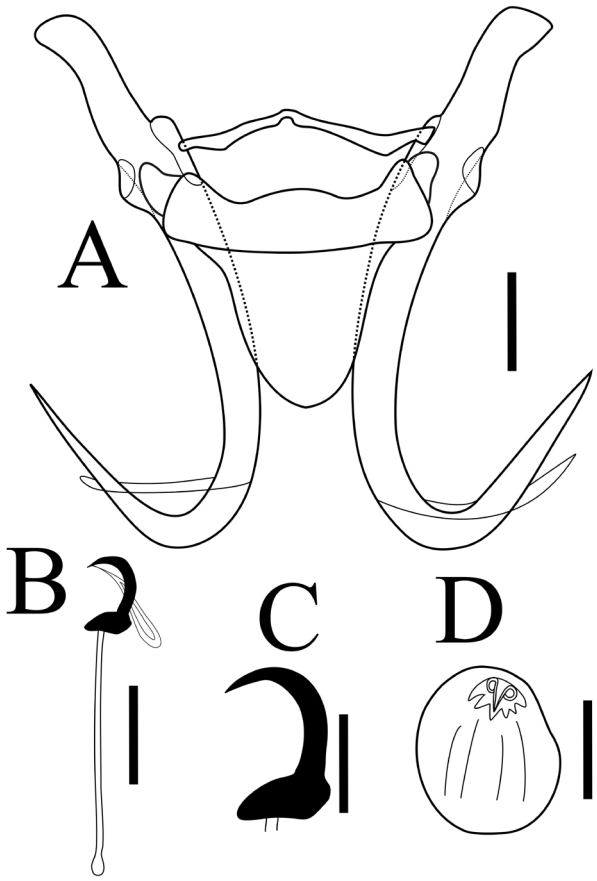

Fig. 3. *Gyrodactylus turnbulli* Harris, 1986. NSMT-Pl 6360. A, hamulus and bars; B, marginal hook; C, marginal hook sickle; D, male copulatory organ. Scale bars: A–B, D, 10 µm; C, 5 µm.

図 3. *Gyrodactylus turnbulli* Harris, 1986. NSMT-Pl 6360. A, 鉤および支持棒; B, 周辺小鉤; C, 周辺小鉤の鉤; D, 雄交接器 .

Order Dactylogyridea Bychowsky, 1937
Family Dactylogyridae Bychowsky, 1933

***Dactylogyrus extensus* Mueller & Van Cleave, 1932** (F)

Site: Gills.

Host: *Cyprinus carpio* Linnaeus, 1758 コイ .

Records: 1, Nitta & Nagasawa 2015 (Hija River, Okinawa-jima Island); 2, this paper (Asatomata River, Okinawa-jima Island).

Remarks: This monogenean is an alien species co-introduced along with the common carp *Cyprinus carpio* into Okinawa Prefecture from an unknown locality in Japan and/or China (Nitta & Nagasawa 2015). The species is newly recorded herein from the gills of the same host species caught in the Asatomata River (26°12'24.7"N, 127°44'18.7"E), Miyagusuku, Haebaru Town on 27 June 2015 (NSMT-Pl 6361, n=7).

***Dactylogyrus minutus* Kulwieć, 1927** (F)

Site: Gills.

Host: *Cyprinus carpio* コイ .

Record: This paper (Asatomata River, Okinawa-jima Island).

Remarks: *Dactylogyrus minutus* was originally described from *Cyprinus carpio* in Poland (Kulwieć 1927). This monogenean has been reported from Europe, Eurasia, North America, and Africa (Hoffman 1998, Crafford et al. 2014) and is known to occur in four prefectures of Japan (Tokyo, Nagano, Shiga, and Hiroshima) (Nakatsugawa & Muroga 1977; Ogawa & Egusa 1977, 1982). The present paper represents a new prefectural record for *D. minutus*.

The specimens of *D. minutus* (Fig. 4, NSMT-Pl 6363, n=13) examined in this study were collected

Table. 1. Morphological measurements (in micrometers) of *Gyrodactylus bullatarudis* and *G. turnbulli*. The method of measuring sclerotized structures follows Shinn et al. (2004).
表 1. *Gyrodactylus bullatarudis* および *G. turnbulli* の計測値 (単位 : マイクロメートル). 計測方法は Shinn et al. (2004) に従った .

Species 種		*Gyrodactylus bullatarudis*	*Gyrodactylus turnbulli*
Number of samples mesured 計測個体数		13	8
		range (mean) 範囲 (平均)	range (mean) 範囲 (平均)
Male copulatory organ 雄交接器		11–12 (11.4)	10–12 (11.2)
Hamulus 鉤	total length 全長	52–57 (53.7)	53–57 (55.3)
	shaft length 基部長	32–38 (34.2)	34–38 (35)
	proximal shaft width 基部根幅	8–10 (8.7)	7–9 (7.6)
	point length 尖頭長	24–27 (25.6)	24–26 (25.2)
	aperture angle (°) 開口角	33–42 (35.3)	40–44 (41.5)
	inner aperture angle (°) 内開口角	38–50 (40.8)	45–50 (46.6)
	point curve angle (°) 尖頭角	3–15 (10.4)	2–19 (13.4)
	inner curve length 内曲長	1–5 (3.4)	2–9 (4.8)
	aperture distance 開口長	16–23 (17.6)	21–24 (22)
	distal shaft width 基部先幅	4–6 (5)	4–5 (4.1)
	root length 突起長	15–18 (16.7)	17–19 (18.2)
Dorsal bar 背側支持棒	length 長	12–26 (19.7)	22–28 (24.2)
	width 幅	1–2 (1.4)	1–2 (1.4)
Ventral bar 腹側支持棒	total length 全長	27–38 (32.6)	29–35 (32.4)
	total width 全幅	26–33 (28.6)	27–36 (30.7)
	process length 突起長	6–8 (6.9)	2–4 (2.8)
	process–to–mid length 突起 – 中央部長	8–10 (9)	3–6 (4.5)
	median width 中間幅	4–7 (5.6)	5–7 (5.6)
	membrane length 膜様突起長	16–21 (18.6)	17–22 (19.8)
Hooks length 周縁小鉤長	total length 全長	23–27 (25.3)	31–34 (32.1)
	shaft length 柄長	17–23 (20.1)	23–28 (24.8)
	sickle length 尖頭長	4.2–5.9 (5.2)	7.5–8.2 (7.8)
	sickle proximal width 尖頭根幅	3.1–4.4 (3.6)	4–4.7 (4.4)
	sickle distal width 尖頭先幅	1.6–2.4 (2.1)	3.4–4.2 (3.9)
	toe length 尖頭突起長	1–2 (1.3)	1.2–2.3 (1.7)
	aperture 開口長	3.4–5.3 (4.3)	5.9–7.2 (6.7)
	instep/arch heigth 尖頭突起曲高	0.2–0.5 (0.3)	0.3–0.5 (0.4)
	firament length 連結糸長	9–13 (10.5)	11–16 (13.3)

from the gills of *C. carpio* in the Asatomata River (26°12'24.7"N, 127°44'18.7"E), Miyagusuku, Haebaru Town, Okinawa-jima Island on 27 June 2015. The haptoral structure consists of two pairs of anchors (Fig. 4A), one dorsal bar (Fig. 4B), seven pairs of marginal hooks (Fig. 4C–I), and a pair of the needles (Fig. 4J). The penis is a tapering tube with the accessory piece having a bifurcated tip and a short process distally rounded at mid-length (Fig. 4K). The morphological characters and measurements (Table 2) of the specimens examined correspond to those of the species reported by Kulwieć (1927), Ogawa & Egusa (1977), Long (2000), and Gussev et al. (2010). As earlier suggested for *D. extensus* (Nitta & Nagasawa 2015), it is likely that *D. minutus* was also co-introduced along with *C. carpio* into Okinawa Prefecture from an unknown locality in Japan and/or China.

***Dactylogyrus* sp./spp.** (F)

Site: -.

Host: *Cyprinus carpio* コイ .

Record: Tamaki & Nakamura 2007a (-, -).

Remarks: Tamaki & Nakamura (2007a) reported a disease caused by worms of *Dactylogyrus* in cultured koi carp. As the fish is not native in Okinawa Prefecture (Kochi 2003), the monogeneans were perhaps introduced into Okinawa Prefecture along with the koi carp. In total, 19 species of *Dactylogyrus* have been reported from *C. carpio* in the Palaeartic region (Gussev et al. 2010), suggesting the possibility that the record of Tamaki & Nakamura (2007a) may contain more than one *Dactylogyrus* species.

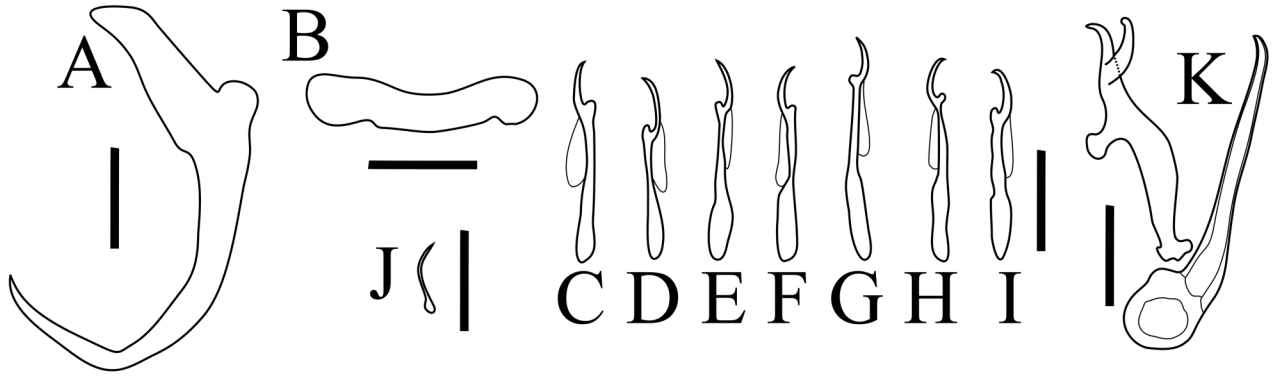

Fig. 4. *Dactylogyrus minutus* Kulwieć, 1927. NSMT-Pl 6362. A, anchor; B, dorsal bar; C, marginal hook of pair I; D, marginal hook of pair II; E, marginal hook of pair III; F, marginal hook of pair IV; G, marginal hook of pair V; H, marginal hook of pair VI; I, marginal hook of pair VII; J, needle; K, male copulatory organ. Scale bars: 10 µm.
図 4. *Dactylogyrus minutus* Kulwieć, 1927. NSMT-Pl 6362. A, 鉤 ; B, 背側支持棒 ; C, 周縁小鉤第 1 対 ; D, 周縁小鉤第 2 対 ; E, 周縁小鉤第 3 対 ; F, 周縁小鉤第 4 対 ; G, 周縁小鉤第 5 対 ; H, 周縁小鉤第 6 対 ; I, 周縁小鉤第 7 対 ; J, 針状鉤 ; K, 雄交接器 .

Family Ancyrocephalidae Bychowsky & Nagibina, 1968, sensu lato

Ancyrocephalus sp. (M)

Site: -.

Host: *Pterois lunulata* Temminck & Schlegel, 1843 ミノカサゴ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

Remarks: This is the only record of a monogenean species identified from the Luna lion fish *P. lunulata*.

***Ancyrocephalus* sp.** (M)

Site: -.

Host: *Tylosurus crocodilus* (Péron & Lesueur, 1821) (as *T. c. crocodilus*) オキザヨリ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

Remarks: There is no previous record of ancyrocephalids identified from the hound needlefish *T. crocodilus*.

***Cichlidogyrus halli* (Price & Kirk, 1967)** Paperna, 1979 (F)

Site: Gills.

Hosts: *Oreochromis mossambicus* (Peters, 1852) カワスズメ ; *O. niloticus* (Linnaeus, 1758) (as *O. n. niloticus*) ナイルティラピア .

Record: Maneepitaksanti & Nagasawa 2012 (Miyara River, Nagura River, an irrigation canal in Uratabaru, Ishigaki-jima Island).

Remarks: This monogenean is an alien species co-introduced with its cichlid hosts from South Africa to Okinawa Prefecture (Maneepitaksanti & Nagasawa 2012).

***Cichlidogyrus sclerosus* Paperna & Thurston, 1969** (F)

Site: Gills.

Hosts: *Oreochromis mossambicus* カワスズメ ; *O. niloticus* (as *O. n. niloticus*) ナイルティラピア .

Record: Maneepitaksanti & Nagasawa 2012 (Haebaru Reservoir, Ohshiro Reservoir, Kinjo Reservoir, Hija River, Okubi River, Okinawa-jima Island; Yamakura Reservoir, Kume-jima Island; Miyara River, Nagura River, an irrigation canal in Uratabaru, Ishigaki-jima Island; Hyotan Pond, Tansui Pond, Minamidaito-jima Island).

Remarks: This monogenean is an alien species co-introduced with its cichlid hosts from South Africa to Okinawa Prefecture (Maneepitaksanti & Nagasawa 2012).

***Cichlidogyrus tilapiae* Paperna, 1960** (F)

Site: Gills.

Host: *Oreochromis niloticus* (as *O. n. niloticus*) ナイルティラピア .

Record: Maneepitaksanti & Nagasawa 2012 (Hija River, Okinawa-jima Island; Yamakura Reservoir, Kume-jima Island; Miyara River, Nagura River, Ishigaki-jima Island).

Remarks: This monogenean is an alien species co-introduced with its cichlid hosts from South Africa into Okinawa Prefecture (Maneepitaksanti & Nagasawa 2012). Maneepitaksanti & Nagasawa (2012: 116) listed the Mozambique tilapia *O. mossambicus* as the hosts of *Cichlidogyrus tilapiae*, but this fish record is most likely an error (see Maneepitaksanti & Nagasawa 2012: table 2).

Table 2. Morphological measurements (in micrometers) of *Dactylogyrus minutus*, *Haliotrema epinepheli* and *Heteronchocleidus buschkieli*. The method of measuring sclerotized structures follows Nitta & Nagasawa (2015).
表 2. *Dactylogyrus minutus*, *Haliotrema epinepheli* および *Heteronchocleidus buschkieli* の計測値 (単位 : マイクロメートル). 計測方法は Nitta & Nagasawa (2015) に従った .

Species 種		*Dactylogyrus minutus*	*Haliotrema epinepheli*	*Heteronchocleidus buschkieli*
Number of samples mesured 計測個体数		5	8	9
		range (mean) 範囲 (平均)	range (mean) 範囲 (平均)	range (mean) 範囲 (平均)
Body 体	length 長	421–554 (506)	479–738 (586)	259–359 (296)
	width 幅	79–92 (86)	110–175 (144)	48–99 (67)
Pharynx 咽頭	length 長	18–24 (22)	40–54 (45)	18–31 (25)
	width 幅	21–24 (23)	28–34 (31)	17–23 (20)
Penis 陰茎	length 長	33–36 (35)	47–50 (49)	20–28 (23)
Accesssory piece 付属片	length 長	24–26 (25)		7–8 (7)
Haptor 固着器	length 長	60–93 (72)	65–92 (72)	47–70 (58)
	width 幅	90–142 (116)	97–107 (101)	63–94 (76)
Dorsal anchor 背側鉤	total length 全長	37–42 (40)	45–51 (48)	36–42 (39)
	length to notch 基部長	30–34 (32)	33–36 (35)	28–34 (31)
	outer root length 外側突起長	3–5 (4)	2–5 (4)	2–5 (4)
	innner root length 内側突起長	13–15 (14)	19–22 (21)	10–14 (12)
	point length 尖頭長	12–14 (13)	13–17 (15)	11–14 (12)
Ventral anchor 腹側鉤	total length 全長		47–50 (48)	31–34 (32)
	length to notch 基部長		32–36 (34)	27–31 (29)
	outer root length 外側突起長		5–7 (6)	2–4 (3)
	innner root length 内側突起長		20–23 (22)	7–11 (9)
	point length 尖頭長		15–17 (16)	10–13 (11)
Dorsal bar 背側支持棒	total length 全長	24–25 (24)	35–40 (37)	23–29 (26)
	total width 全幅	5–6 (6)	12–16 (14)	4–7 (6)
	median width 中間幅	3–4 (4)	4–6 (5)	3–5 (4)
Ventral bar 腹側支持棒	total length 全長		34–37 (36)	27–37 (32)
	total width 全幅		14–17 (15)	6–8 (7)
	median width 中間幅		7–8 (7)	4–5 (4)
Hooks length 周縁小鉤長			11–13 (12)	11–14 (12)
	Pair I 第 1 対	20–22 (21)		
	Pair II 第 2 対	18–19 (18)		
	Pair III 第 3 対	20–21 (20)		
	Pair IV 第 4 対	20–22 (21)		
	Pair V 第 5 対	21–23 (22)		
	Pair VI 第 6 対	20–23 (22)		
	Pair VII 第 7 対	19–21 (20)		
Needle 針状鉤	length 長	7–8 (7)		

***Euryhaliotrematoides* sp.** (M)

Synonym: *Ancyrocephalus* sp.

Site: -.

Host: *Heniochus singularius* Smith & Radcliffe, 1911 シマハタタテダイ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

Remarks: *Ancyrocephalus* sp. reported by Dyer et al. (1989) has been regarded as *Euryhaliotrematoides* sp. (Plaisance & Kritsky 2004).

***Haliotrema alatum* Yamaguti, 1942** (M)

Site: Gills.

Hosts: *Acanthurus bariene* Lesson, 1831 カンランハギ [2]; *Parupeneus cyclostomus* (Lacepède, 1801) (as *P. chrysedros*) マルクチヒメジ [1], *P. multifasciatus* (Quoy & Gaimard, 1825) オジサン [1].

Records: 1, Yamaguti 1942 (Naha, Okinawa-jima Island); 2, Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

***Haliotrema epinepheli* Young, 1968** (M)

Site: Gills.

Host: *Variola albimarginata* Baissac, 1953 オジロバラハタ .

Record: This paper (Hatoma Strait, Iriomote-jima Island).

Remarks: *Haliotrema epinepheli* was originally described from the gills of the blacktip grouper *Epinephelus fasciatus* (Forsskål, 1775) and the honeycomb grouper *E. merra* (Bloch, 1793) in Australia (Young 1968). Subsequently, the following fishes have been reported as its hosts (see Justine 2007): the Hong Kong grouper *E. akaara* (Temminck & Schlegel, 1842), the areolate grouper *E. areolatus* (Forsskål, 1775), the yellow grouper *E. awoara* (Temminck & Schlegel, 1842), the brownspotted grouper *E. chlorostigma* (Valenciennes, 1828), the sixbar grouper *E. sexfasciatus* (Valenciennes, 1828), the Hawaiian grouper *Hyporthodus quernus* (Seale, 1901), the yellow-edged lyretail *Variola louti* (Forsskål, 1775), the red seabream *Pagrus major*, and the goldlined seabream *Rhabdosargus sarba* (Forsskål, 1775).

We collected *H. epinepheli* from the gills of the white-edged lyretail *V. albimarginata* captured by angling in Hatoma Strait (24°26'N, 123°49'E) off the northern coast of Iriomote-jima Island on 10 October 2013. The specimens of *H. epinepheli* (Fig. 5, NSMT-Pl 6363, n=8) have a cone-shaped penis with a distal flap (Fig. 5 F), the dorsal anchors (Fig. 5A) similar to the ventral anchors (Fig. 5B), a broadly V-shaped dorsal bar (Fig. 5C), and a straight ventral bar with two projections at each end (Fig. 5D). The morphological features and measurements (Table 2) of the specimens examined conform to the descriptions and illustrations of *H. epinepheli* given by Young (1968) and Justine (2007). The present collection represents a new Japanese record for *H. epinepheli*, and *V. albimarginata* is a new host record for *H. epinepheli*.

Haliotrema japonense **Yamaguti, 1934** (M)

Site: -.

Host: *Zanclus cornutus* (Linnaeus, 1758) ツノダシ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

Haliotrema ornatum **Yamaguti, 1942** (M)

Site: Gills.

Host: Unidentified Apogonidae テンジクダイ科の一種 .

Record: Yamaguti 1942 (Naha, Okinawa-jima Island).

Haliotrema recurvatum **Yamaguti, 1942** (M)

Site: Gills.

Host: *Parupeneus cyclostomus* (as *P. chrysedros*) マルクチヒメジ .

Record: Yamaguti 1942 (Naha, Okinawa-jima Island).

Haliotrema spinicirrus **(Yamaguti, 1953)** Bychowsky & Nagibina, 1970 (M)

Synonym: *Ancyrocephalus spinicirrus* Yamaguti, 1953.

Site: -.

Host: *Variola albimarginata* オジロバラハタ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

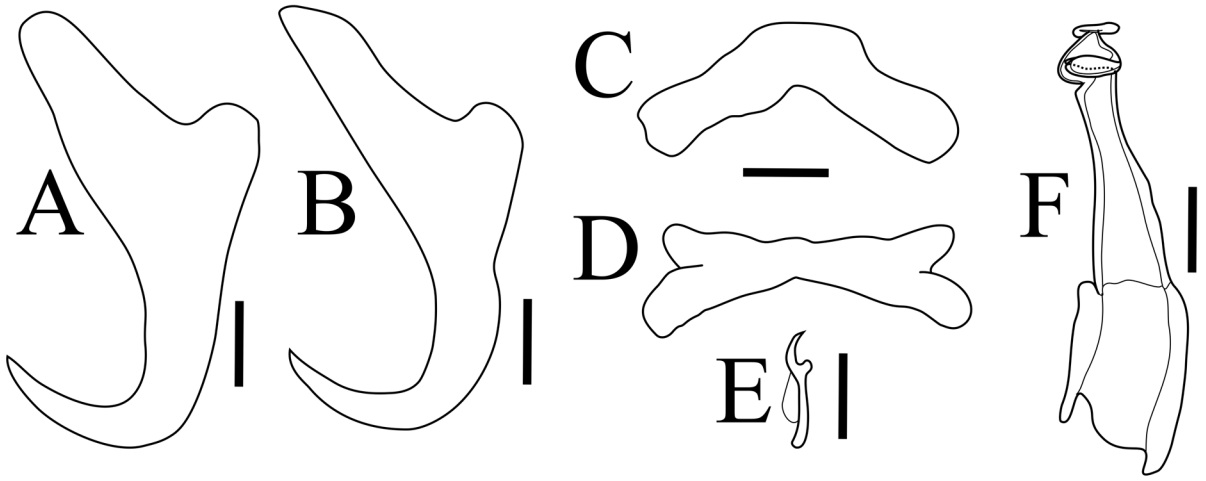

Fig. 5. *Haliotrema epinepheli* Young, 1968. NSMT-Pl 6363. A, dorsal anchor; B, ventral anchor; C, dorsal bar; D, ventral anchor; E, marginal hook F, penis. Scale bars: 10 µm.

図 5. *Haliotrema epinepheli* Young, 1968. NSMT-Pl 6363. A, 背側鉤 ; B, 腹側鉤 ; C, 背側支持棒 ; D, 腹側支持棒 ; E, 周縁小鉤 ; F, 陰茎 .

Haliotrema upenei **Yamaguti, 1953** (M)

Site: -.

Host: *Acanthurus nigrofuscus* (Forsskål, 1775) ナガニザ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

Heteronchocleidus buschkieli **Bychowsky, 1957** (F)

Site: Gills.

Host: *Macropodus opercularis* (Linnaeus, 1758) タイワンキンギョ .

Record: This paper (Kan-na-Fukuchi River, Okinawa-jima Island).

Remarks: *Heteronchocleidus buschkieli* was originally described by Bychowsky (1957) from the gills of the paradisefish *M. opercularis* in aquaria of St. Petersburg, Russia. The monogenean has since been reported from the following osphronemids in different localities of the world: the same host in Brno (aquaria), the Czech Republic (Lucky 1958) and the Pearl River system (Tchang & Ji 1980), Guangdong, China (Ding & Liao 2005; Li & Xiang 2006); the banded gourami *Trichogaster fasciata* Bloch & Schneider, 1801 in Lucknow, India (Agrawal et al. 2010) and Mymeningh, Bangladesh (Chandra & Yasumin 2003); the dwarf gourami *T. lalius* (Hamilton, 1822) in Raipur, India (Majumdar et al. 1988, as *Heteronchocleidus stunkardi* Majumdar, Ramchandrula, Gor & Agrawal, 1988) and Iran where the fish species was imported from Southeast Asia (Shoaibi Omrani 2014); the croaking gourami *Trichopsis vittata* (Cuvier, 1831) in Pahang, Malaysia (Lim 1986); and the Siamese fighting fish *Betta splendens* Regan, 1910 and the threestripe gourami *Trichopsis schalleri* Ladiges, 1962 in the Czech Republic (aquaria) (Gelnar 2006).

The specimens of *H. buschkieli* (Fig. 6, NSMT-Pl 6365, n=9) examined in this study were collected from the gills of *M. opercularis* in the Kan-na-Fukuchi River, Ginoza Village, Okinawa-jima Island on 14 January 2013 and 26 June 2015. These collections represent new records of *H. buschkieli* from Japan. The body is elongate (Fig. 6A), one of the two dorsal anchors is vestigial (Fig. 6C), and a J-shaped penis articulates an accessory piece proximally (Fig. 6H). These morphological features and measurements (Table 2) of the specimens examined correspond to those of the species reported by Lucky (1958), Lim (1986), and Agrawal et al. (2010).

Macropodus opercularis is the only osphronemid

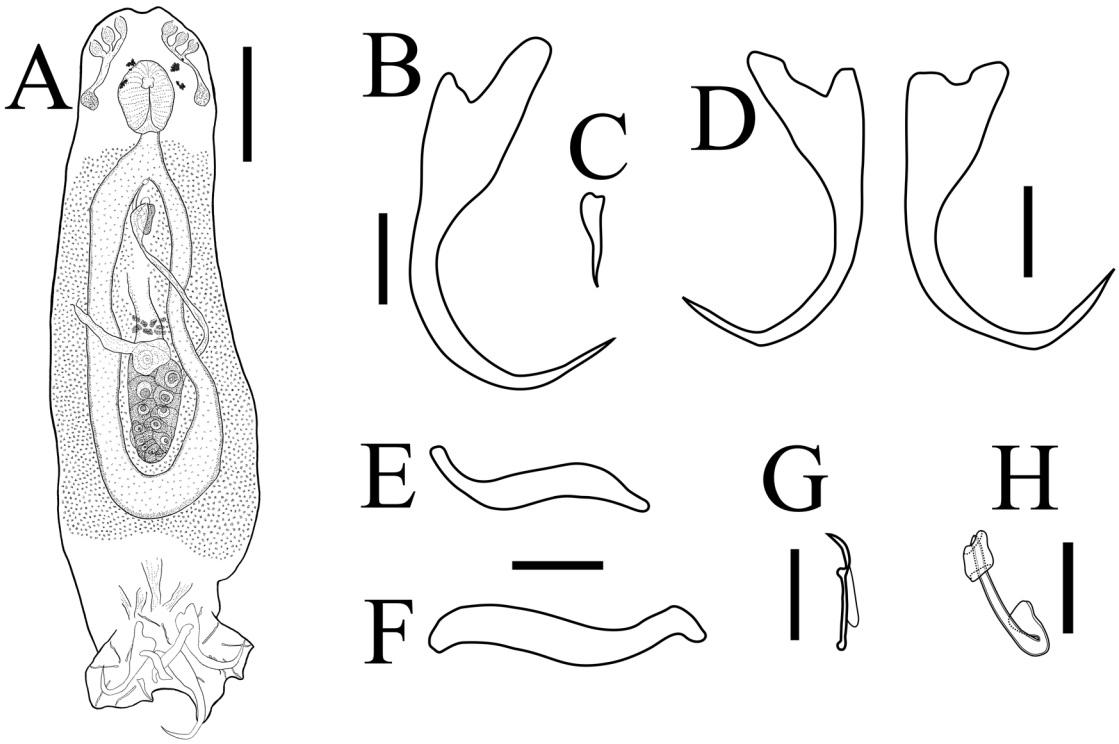

Fig. 6. *Heteronchocleidus buschkieli* Bychowsky, 1957. NSMT-Pl 6364. A, whole mount (ventral view); B, dorsal anchor; C, reduced dorsal anchor; D, ventral anchors; E, dorsal bar; F, ventral bar; G, marginal hook; H, male copulatory organ. Scale bars: A, 50 µm; B–H, 10 µm.

図 6. *Heteronchocleidus buschkieli* Bychowsky, 1957. NSMT-Pl 6364. A, 全体 (腹面図); B, 背側鉤 ; C, 退縮した背側鉤 ; D, 腹側鉤 ; E, 背側支持棒 ; F, 腹側支持棒 ; G, 周縁小鉤 ; H, 雄交接器 .

species occurring on Okinawa-jima Island (Shimadzu 2010), and the Okinawan population of the species was previously speculated to have been introduced from Taiwan or China (Tachihara 2005). However, recent studies on the reproductive characters and literature survey have suggested that the population of the species is native to the island (Kitagawa et al. 2013, Kitagawa & Hosoya 2016). If this suggestion is verified, *H. buschkieli* is likely a native parasite because the species is highly host specific to osphronemids.

***Heteropriapulus heterotylus* (Jogunoori, Kritsky & Venkatanarasaiah, 2004)** Kritsky, 2007 (F)

Site: Gills.

Host: *Pterygoplichthys disjunctivus* (Weber, 1991) マダラロリカリア [1, 2].

Records: 1, Nitta & Nagasawa 2013 (Senbaru Reservoir, Okinawa-jima Island); 2, Nitta & Nagasawa 2016 (Asatomata River, Hija River, Senbaru Reservoir, Okinawa-jima Island).

Remarks: This monogenean is an alien species co-introduced with the host, which was probably from the Amazon River basin (Nitta & Nagasawa 2013).

***Nasoancyrocephalus diorchis* Machida, 1979** (M)

Site: Gills.

Host: *Naso unicornis* (Forsskål, 1775) テングハギ .

Record: Machida 1979 (-, Irabu-jima Island).

***Protancyrocephalus strelkowi* Bychowsky, 1957** (M)

Site: -.

Host: *Dactyloptena orientalis* (Cuvier, 1829) セミホウボウ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

***Pseudohaliotrema sphincteroporus* Yamaguti, 1953** (M)

Site: -.

Hosts: *Acanthurus lineatus* (Linnaeus, 1758) ニジハギ ; *Acanthurus olivaceus* Bloch & Schneider, 1801 モンツキハギ ; *Cephalopholis urodeta* (Forster, 1801) ニジハタ ; *Gerres oyena* (Forsskål, 1775) ミナミクロサギ ; *Heniochus chrysostomus* Cuvier, 1831 オニハタタテダイ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

***Salsuginus seculus* (Mizelle & Arcadi, 1945)** Murith & Beverley-Burton, 1985 (F)

Site: Gills.

Host: *Gambusia affinis* (Baird & Girard, 1853) カダヤシ .

Record: Nitta & Nagasawa 2014 (irrigation canal flowing into Urauchi Bay, Iriomote-jima Island).

Remarks: This monogenean is an alien species co-introduced with its host from Texas, USA, through Hawaii and Taiwan into Japan (Nitta & Nagasawa 2014).

***Tetrancistrum nasonis* Young, 1967** (M)

Synonym: *Pseudancyrocephalus duplicatus* Yamaguti, 1968.

Site: Gills.

Host: *Naso unicornis* テングハギ .

Record: Machida 1979 (-, Irabu-jima Island).

Remarks: *Pseudancyrocephalus duplicatus* has been regarded as a junior synonym of *T. nasonis* by Kritsky et al. (2007).

***Trinigyrus peregrinus* Nitta & Nagasawa, 2016** (F)

Site: Gills.

Host: *Pterygoplichthys disjunctivus* (Weber, 1991) マダラロリカリア .

Record: Nitta & Nagasawa 2016 (Hija River, Sembaru Reservoir, Okinawa-jima Island).

Remarks: This monogenean is an alien species co-introduced with the host, which was probably from the Amazon River basin (Nitta & Nagasawa 2016).

***Unilatus brittani* Mizelle, Kritsky & Crane, 1968** (F)

Site: Gills.

Host: *Pterygoplichthys disjunctivus* (Weber, 1991) マダラロリカリア .

Record: Nitta & Nagasawa 2016 (Hija River, Okinawa-jima Island).

Remarks: This monogenean is an alien species co-introduced with the host, which was probably from the Amazon River basin (Nitta & Nagasawa 2016).

***Unilatus unilatus* Mizelle & Kritsky, 1967** (F)

Site: Gills.

Host: *Pterygoplichthys disjunctivus* (Weber, 1991) マダラロリカリア .

Record: Nitta & Nagasawa 2016 (Hija River, Sembaru Reservoir, Okinawa-jima Island).

Remarks: This monogenean is an alien species

co-introduced with the host, which was probably from the Amazon River basin (Nitta & Nagasawa 2016).

Family Pseudodactylogyridae Ogawa, 1986

***Pseudodactylogyrus* sp./spp.** (F)

Synonym: *Dactylogyrus* sp./spp. [1].

Site: Gills.

Hosts: *Anguilla anguilla* (Linnaeus, 1758) ヨーロッパウナギ [1]; *Anguilla japonica* Temminck & Schlegel, 1846 ニホンウナギ [1, 2].

Records: 1, Inoha 1974 (fish farm, Okinawa-jima Island); 2, Tamaki & Nakamura 2007b (fish farm, -).

Remarks: The hosts, the European eel *Anguilla anguilla* and the Japanese eel *A. japonica*, reported by Inoha (1974), were imported from France and Taiwan, respectively. These fishes are known to be infected by three species of *Pseudodactylogyrus* in Japan: *P. anguillae* (Yin & Sproston, 1948), *P. bini* (Kikuchi, 1929), and *P. kamegaii* Iwashita, Hirata & Ogawa, 2002 (Ogawa & Egusa 1976, Iwashita et al. 2002).

Family Protogyrodactylidae Johnston & Tiegs, 1922

***Protogyrodactylus* sp.** (M)

Site: -.

Host: *Parupeneus spilurus* (Bleeker, 1854) オキナヒメジ .

Record: Dyer et al. 1989 (-, -).

Remarks: This is the only record of a protogyrodactylid identified from the blackspot goatfish *P. spilurus*.

Family Diplectanidae Monticelli, 1903

***Diplectanum* sp.** (M)

Site: Gill.

Host: *Epinephelus malabaricus* ヤイトハタ .

Record: Yamauchi & Imamichi 2017 (Tonoshiro [fish farm], Ishigaki-jima Island).

Remarks: The Malabar grouper *E. malabaricus* is known to be infected by *Diplectanum maa* Justine & Sigura, 2007 in New Caledonia (Justine & Sigura 2007).

***Lamellodiscus elegans* Bychowsky, 1957** (M)

Site: -.

Host: *Acanthopagrus sivicolus* Akazaki, 1962 ミナミクロダイ .

Record: Dyer et al. 1989 (Okinawa Prefectural Sea Farming Center [fish farm], Okinawa-jima Island).

***Lamellodiscus spari* (Yamaguti, 1958)** Oliver, 1987 (M)

Site: Gills.

Host: *Acanthopagrus sivicolus* Akazaki, 1962 ミナミクロダイ .

Record: Katsumata & Tamaki 1988 (Itoman City [fish farm], Okinawa-jima Island).

***Lepidotrema* sp.** (M)

Site: -.

Host: *Epinephelus fasciatus* アカハタ .

Record: Dyer et al. 1989 (-, -).

Remarks: This is the only record of a *Lepidotrema* species from the blacktip grouper *E. fasciatus*.

***Protolamellodiscus convolutus* (Yamaguti, 1953)** Oliver, 1987 (M)

Site: -.

Host: *Lethrinus harak* (Forsskål, 1775) マトフエフキ .

Record: Dyer et al. 1989 (off Motobu Town, Okinawa-jima Island).

Unidentified species of Diplectanidae (M)

Synonym: *Diplectanum* cf. *epinepheli* Yamaguti, 1938.

Site: Gills.

Host: *Epinephelus coioides* (Hamilton, 1822) チャイロマルハタ .

Record: Katsumata 1993 (Okinawa Prefecture Fisheries Experiment Station, Okinawa-jima Island).

Remarks: The host fish was imported from the Philippines (Katsumata 1993). Since the past records of *D. epinepheli* (currently *Pseudorhabdosynochus epinepheli*) from the orange-spotted grouper *E. coioides* have been recognized as unreliable (Justine 2009), the monogenean reported as *Diplectanum* cf. *epinepheli* by Katsuyama (1993) is herein treated as an unidentified diplectanid.

Subclass Polyopisthocotylea Odhner, 1912
Order Polystomatidea Lebedev, 1988
Family Polystomatidae Gamble, 1896

***Polystoma rhacophori* Yamaguti, 1936** (F)

Site: -.

Host: *Rhacophorus viridis viridis* (Hallowell, 1861) オキナワアオガエル .

Record: Hasegawa 2002 (-, -).

***Polystomoides megaovum* Ozaki, 1936** (F)

Site: Urinary bladder.

Host: *Geoemyda japonica* Fan, 1931 (as *Geoemyda spengleri*) リュウキュウヤマガメ.

Record: Ozaki 1936 (Kunigami District, Okinawa-jima Island).

Order Mazocraeidea Bychowsky, 1937
Family Diclidophoridae Fuhrmann, 1928

***Heterobothrium* sp.** (M)

Site: -.

Host: *Takifugu rubripes* (Temminck & Schlegel, 1850) トラフグ.

Record: Tamaki & Nakamura 2007b (- [fish farm], -).

Remarks: Since *Heterobothrium okamotoi* Ogawa, 1991 is the only monogenean species to parasitize the Japanese pufferfish *Takifugu rubripes* (Ogawa 1991), the monogenean causing "heterobothriosis" reported by Tamaki & Nakamura (2007b) may be *H. okamotoi*.

Family Microcotylidae Taschenberg, 1879

Unidentified species of Microcotylidae (M)

Synonym: *Bivagina* sp. (as a causative agent of bivaginasis).

Site: gills.

Hosts: *Acanthopagrus chinshira* Kume and Yoshino, 2008 (as *A. australis*) オキナワキチヌ [3]; *A. sivicolus* ミナミクロダイ [1, 2].

Records: 1, Katsumata 1983 (Kabira Bay [fish cages], Ishigaki-jima Island); 2, Katsumata & Tamaki 1988 (Itoman City [fish farm], Okinawa-jima Island); 3, Katsumata 1993 (Okinawa Prefecture Fishery Experiment Station, Okinawa-jima Island).

Remarks: The monogenean was reported to cause bivaginasis, but no species of *Bivagina* has been described from *Acanthopagrus* species in Japan, where species of the microcotylid genera *Polylabris* and *Polylabroides* infect *Acanthopagrus* spp. (e.g. Ogawa and Egusa 1980, Roubal 1981, Byrnes 1985). Thus, we treat the monogeneans as unidentified species of Microcotylidae.

Discussion

Monogeneans can induce diseases and mortality of fishes in aquaculture systems as well as in natural waters such as lakes, rivers, and seas (Ogawa 2004, Hayward 2005, Whittington 2005, Buchmann & Bresciani 2006). In this paper, 16 species of cultured fishes are listed as the hosts of monogeneans, and some species of monogeneans caused diseases and were found from the following cultured fishes imported from other countries: the European eel *Anguilla anguilla* from France (Inoha 1974); the Japanese eel *A. japonica* and the giant grouper *Epinephelus lanceolatus* from Taiwan (Inoha 1974, Karimata & Kimura 2008); and the orange-spotted grouper *E. coioides* from the Philippines (Katsumata 1993). Some alien monogeneans co-introduced with their hosts are known to cause negative impacts on closely related hosts (e.g. Petrushevski & Shulman 1970, Johnsen & Jensen 1986, Ogawa 2002, Yoshinaga et al. 2009), although most monogeneans are strictly specific to their hosts. For example, *Neobenedenia melleni* demonstrated a very low host specificity and caused fish diseases in Okinawa Prefecture (Yamamoto et al. 1995). In addition, subtropical fishes have been suggested to be shifting their distribution northward to the Japanese main islands with climate change (Kuwahara et al. 2006), and research on monogeneans should be more intensively conducted in southern Japan to monitor their distributional changes. As pointed out by Sano et al. (2001), no monogenean, except for the diplectanid *Lamellodiscus spari* from the Okinawa seabream *Acanthopagrus sivicolus* (Katsumata & Tamaki 1988) and the capsalid *N. melleni* from *Seiola riveliana* and *E. malbaricus* (Bondad-Reantaso et al. 1995, Yamauchi & Shirakashi 2017 as *N. girellae*), has been identified to species level. It is necessary to identify monogeneans for control and risk management of fish diseases in Okinawa Prefecture.

Ten species of monogeneans have been reported from freshwater fishes in Okinawa Prefecture, nine of which are alien species. The common carp *Cyprinus carpio* was transplanted to this prefecture before the 19th century (Kochi 2003), and two species of dactylogyrids, *Dactylogyrus extensus* and *D. minutus*, were co-introduced with it (Nitta & Nagasawa 2015, this paper). The mozambique tilapia *Oreochromis mossambicus* and the Nile tilapia *O. niloticus* were introduced as new fisheries resources into Okinawa Prefecture (Takehara et al. 1997) and were accompanied by three ancyrocephalid species, *Cichlidogyrus halli*, *C. sclerosus*, and *C. tilapiae* (Maneepitaksanti & Nagasawa 2012). Another ancyrocephalid, *Salsuginus seculus*, was

co-introduced with the mosquitofish *Gambusia affinis* transplanted to control mosquitos (Nitta & Nagasawa 2014). Four species of Latin American native monogeneans have been reported from the vermiculated sailfin catfish *Pterygoplichthys disjunctivus* in Okinawa Prefecture: *Heteropriapulus heterotylus*, *Trinigyrus peregrinus*, *Unilatus brittani*, and *U. unilatus*. These species were co-introduced to Okinawa Prefecture through the release of ornamental pet fish (Nitta & Nagasawa 2013, 2016). A similar co-introduction is suggested in this paper for the two species of gyrodactylids, *Gyrodactylus bullatarudis* and *G. turnbulli*, parasitic on the guppy *Poecilia reticulata*, which is native to Latin America. About 20 species of ornamental fishes have been recorded from the inland waters of Okinawa-jima Island (Ishikawa et al. 2013). It is obvious that the ornamental fish trade is one of the major invasion routes of alien fish monogeneans to Okinawa Prefecture.

Heteronchocleidus buschkieli (Ancyrocephalidae) is considered in this paper to be the only native monogenean so far reported from freshwater fishes in Okinawa Prefecture. It is also probable that *Polystomoides megaovum* (Polystomatidae) is specific to its host, the Ryukyu black-breasted leaf turtle *Geoemyda japonica*, which is endemic to Okinawa Prefecture and has been designated for special protection by the Japanese Government (Nakachi & Hasegawa 1992, Yasukawa et al. 1992). To clarify whether *P. megaovum* is endemic to Okinawa Prefecture, it is desirable to investigate the parasites of the related turtle *G. spengleri* (Gmelin, 1789) occurring in South China and Viet Nam (Yasukawa et al. 1992). On the other hand, two species of diplectanids, *Lamellodiscus elegans* and *L. spari*, were collected from the Okinawa seabream *Acanthopagrus sivicolus*, an endemic fish in coastal waters of the Ryukyu Islands (Dyer et al. 1989, Katsumata & Tamaki 1988), but these monogeneans are not endemic to this region because they have been reported from other fish hosts in other regions (e.g. Bychowsky 1957, Zhukov 1970, Ogawa & Egusa 1978). Similarly, the remaining other nominal species of monogeneans reported from marine fishes in Okinawa Prefecture are not likely to be endemic here because of the wide geographical distributions of the host fishes (Nakabo 2013).

A total of 36 nominal monogenean species and 44 unidentified monogenean records from Okinawa Prefecture are listed herein. These monogeneans have been reported from 51 fish species (one elasmobranch and 50 actinopterygian species), one amphibian species, and one reptile species. Machida (2003) studied the helminth fauna of coastal fishes of the Ryukyu Islands and found that the number of nominal monogenean species was about one-third of that of digeneans (129 species). Dyer et al. (1989) found monogeneans from only 21 (13.6 %) out of 154 marine fish species from Okinawa Prefecture, and based on this data, Williams et al. (1996) suggested that the marine fish monogeneans from this prefecture were less abundant than those occurring on Caribbean marine fishes. However, Dyer et al. (1989) collected from only shallow waters and only examined a few individuals of each fish species (range: 1–45, mean: 2.2 individuals), and considering the large number of marine fish species (about 1,200 species) distributed around the Ryukyu Islands (Nakabo 2013), many undescribed monogeneans are likely distributed in Okinawa Prefecture. Further, only a small number of freshwater fish species have been examined for their parasites in the prefecture (Hasegawa 2002), and there is no study on the monogeneans of brackish-water fishes. As about 500 species of fishes occur in the inland waters of the prefecture (Yoshigou 2014), more studies are needed to clarify the monogenean fauna of Okinawa Prefecture and the Ryukyu Islands.

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日本新記録 4 種および沖縄県新記録 1 種を含む沖縄県産単生類の目録 (1936–2017 年)

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要旨 . 1936–2017 年に出版された文献および新記録に基づき , 沖縄県産単生類（扁形動物）の寄生虫 – 宿主リストと宿主 – 寄生虫リストを整理した . その結果 , 下記新記録 5 種を含む 36 名義種が沖縄県から記録され , その内訳はハダムシ科 7 種 , サンダイチュウ科 2 種 , シセンチュウ科 2 種 , ヨツメイカリ科 20 種 , オウギエラムシ科 3 種 , ポリストマ科 2 種であった . 種まで同定されていない単生類の 44 記録を含めると , これまでに報告された単生類の宿主は魚類 51 種 , 両生類 1 種 , 爬虫類 1 種であった . 魚類寄生性の *Gyrodactylus bullatarudis*, *G. turnbulli*, *Haliotrema epinepheli*, *Heteronchocleidus buschkieli* の 4 種を日本新記録種 , 同じく魚類寄生性の *Dactylogyrus minutus* を沖縄県初記録種として本目録に収録した .

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Appendix 1. Host–Parasite list of monogeneans reported from Okinawa Prefecture, southern Japan (1936–2017).
附録 1. 沖縄県産単生類の宿主 — 寄生虫リスト (1936–2017).

Host scientific name (Japanese name) 宿主の学名 (和名)	Monogenean parasite 単生類の種	Site of infection 寄生部位	Island 島
Elasmobranchii (板鰓亜綱)			
Taeniura meyeni (マダラエイ)	*Entobdella squamula*	-	Okinawa-jima
Actinopterygii (条鰭綱)			
Acanthopagrus chinshira (オキナワキチヌ)	Unidentified species of Microcotylidae	-	-
Acanthopagrus latus (キチヌ)	Unidentified species of Capsalidae	-	-
Acanthopagrus sivicolus (ミナミクロダイ)	*Lamellodiscus elegans*	-	Okinawa-jima
	Lamellodiscus spari	Gills	Okinawa-jima
	Unidentified species of Microcotylidae	-	Okinawa-jima
Acanthurus bariene (カンランハギ)	*Haliotrema alatum*	-	Okinawa-jima
Acanthurus lineatus (ニジハギ)	*Pseudohaliotrema sphincteroporus*	-	Okinawa-jima
Acanthurus nigrofuscus (ナガニザ):	*Haliotrema upenei*	-	Okinawa-jima
Acanthurus olivaceus (モンツキハギ)	*Pseudohaliotrema sphincteroporus*	-	Okinawa-jima
Anguilla anguilla (ヨーロッパウナギ)	*Pseudodactylogyrus* sp./spp.	Gills	Okinawa-jima
Anguilla japonica (ニホンウナギ)	*Pseudodactylogyrus* sp./spp.	Gills	Okinawa-jima
Arothron mappa (ケショウフグ)	*Benedenia synagrls*	-	Okinawa-jima
Cantherhines pardalis (アミメウマヅラハギ)	*Benedenia seriolae*	-	Okinawa-jima
Cephalopholis urodeta (ニジハタ)	*Pseudohaliotrema sphincteroporus*	-	Okinawa-jima
Cyprinus carpio (コイ)	*Dactylogyrus extensus*	Gills	Okinawa-jima
	Dactylogyrus minutus	Gills	Okinawa-jima
	Dactylogyrus sp./spp.	-	-
Dactyloptena orientalis (セミホウボウ)	*Protancyrocephalus strelkowi*	-	Okinawa-jima
Epinephelus coioides (チャイロマルハタ)	Unidentified species of Diplectanidae	Gills	-
Epinephelus fasciatus (アカハタ)	*Lepidotrema* sp.	-	-
Epinephelus lanceolatus (タマカイ)	Unidentified species of Capsalidae	Skin	Ishigaki-jima
Epinephelus malabaricus (ヤイトハタ)	*Neobenedenia melleni*	Skin	Ishigaki-jima
	Unidentified species of Capsalidae	Skin, eye	Ishigaki-jima
	Unidentified species of Monogenea	Gills	-
Gambusia affinis (カダヤシ)	*Salsuginus seculus*	Gills	Iriomote-jima
Gerres oyena (ミナミクロサギ)	*Pseudohaliotrema sphincteroporus*	-	Okinawa-jima
Gnathanodon speciosus (コガネシマアジ)	Unidentified species of Capsalidae	-	-
Grammatorcynus bilineatus (ニジョウサバ)	*Capsala* sp.	-	Iriomote-jima
Heniochus chrysostomus (オニハタタテダイ)	*Pseudohaliotrema sphincteroporus*	-	Okinawa-jima
Heniochus singularius (シマハタタテダイ)	*Euryhaliotrematoides* sp.	-	Okinawa-jima
Lutjanus argentimaculatus (ゴマフエダイ)	*Trilobiodiscus lutiani*	Gills	Iriomote-jima
Lethrinus harak (マトフエフキ)	*Protolamellodiscus convolutus*	-	Okinawa-jima
Lethrinus nebulosus (ハマフエフキ)	*Encotyllabe spari*	Gills	Iriomote-jima
	Unidentified species of Monogenea	Gills	-
Macropodus opercularis (タイワンキンギョ)	*Heteronchocleidus buschkieli*	Gills	Okinawa-jima
Naso unicornis (テングハギ)	*Nasoancyrocephalus diorchis*	Gills	Irabu-jima
	Tetrancistrum nasonis	Gills	Irabu-jima
Oreochromis mossambicus (カワスズメ)	*Cichlidogyrus halli*	Gills	Ishigaki-jima
	Cichlidogyrus sclerosus	Gills	Ishigaki-jima
Oreochromis niloticus (ナイルティラピア)	*Cichlidogyrus halli*	Gills	Ishigaki-jima
	Cichlidogyrus sclerosus	Gills	Okinawa-jima, Ishigaki-jima, Minamidaito-jima
	Cichlidogyrus tilapiae	Gills	Okinawa-jima Kume-jima, Ishigaki-jima
Pagrus major (マダイ)	Unidentified species of Capsalidae	-	-
	Unidentified species of Monogenea	-	-

Appendix 1 (Continued). 附録 1 (続き).

Host scientific name (Japanese name) 宿主の学名 (和名)	Monogenean parasite 単生類の種	Site of infection 寄生部位	Island 島
Parupeneus cyclostomus (マルクチヒメジ)	*Haliotrema alatum*	Gills	Okinawa-jima
	Haliotrema recurvatum	Gills	Okinawa-jima
Parupeneus multifasciatus (オジサン)	*Haliotrema alatum*	Gills	Okinawa-jima
Parupeneus spilurus (オキナヒメジ)	*Protogyrodactylus* sp.	-	-
Plectorhinchus chaetodonoides (チョウチョウコショウダイ)	*Metabenedeniella hoplognathi*	-	Okinawa-jima
Plectorhynchus pictus (コロダイ)	*Encotyllabe spari*	Gills	Iriomote-jima
Plectropomus leopardus (スジアラ)	*Entobdella* sp.	-	Okinawa-jima
Poecilia reticulata (グッピー)	*Gyrodactylus bullatarudis*	Gills, fins	Okinawa-jima
	Gyrodactylus turnbulli	Gills, fins	Okinawa-jima
Pterois lunulata (ミノカサゴ)	*Ancyrocephalus* sp.	-	Okinawa-jima
Pterygoplichthys disjunctivus (マダラロリカリア)	*Heteropriapulus heterotylus*	Gills	Okinawa-jima
	Trinigyrus peregrinus	Gills	Okinawa-jima
	Unilatus brittani	Gills	Okinawa-jima
	Unilatus unilatus	Gills	Okinawa-jima
Rachycentron canadum (スギ)	Unidentified species of Capsalidae	Skin, eye	Okinawa-jima
Seriola dumerili (カンパチ)	Unidentified species of Capsalidae	-	-
Seriola rivoliana (ヒレナガカンパチ)	*Benedenia* sp.	Skin	Ishigaki-jima
	Neobenedenia melleni	Skin	Okinawa-jima, Ishigaki-jima
Takifugu rubripes (トラフグ)	*Heterobothrium* sp.	-	-
Tylosurus crocodilus (オキザヨリ)	*Ancyrocephalus* sp.	-	Okinawa-jima
Upeneus tragula (ヨメヒメジ)	*Encotyllabe spari*	Gills	Iriomote-jima
Variola albimarginata (オジロバラハタ)	*Haliotrema spinicirrus*	-	Okinawa-jima
Zanclus cornutus (ツノダシ)	*Haliotrema japonense*	-	Okinawa-jima
Unidentified Apogonidae (テンジクダイ科の一種)	*Haliotrema ornatum*	Gills	Okinawa-jima
Amphibia (両生綱)			
Rhacophorus viridis viridis (オキナワアオガエル)	*Polystoma rhacophori*	-	-
Reptilia (爬虫綱)			
Geoemyda japonica (リュウキュウヤマガメ)	*Polystomoides megaovum*	Urinary bladder	Okinawa-jima