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Additional Monorchiid Digeneans (Trematoda) from Fishes of Japanese and Adjacent Waters

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Abstract Six species of monorchiid digeneans are reported from fishes of Japanese and adjacent waters. Two new species are described: *Lasiotocus okinawaensis* sp. nov. from *Plectorhinchus gibbosus* (Haemulidae) from Japan, and *Opisthomonorchis orwidal* sp. nov. from *Carangoides* sp. (Carangidae) from Palau, western Caroline Islands. One new combination is made: *Lasiotocus sparui* (Shen, 1990) comb. nov. from *Acanthopagus* sp. (Sparidae) from Palawan, the Philippines. Three previously known species are shortly redescribed: *Alloproctotrema gerres* Machida, 1973 from *Gerres oyena* (Gerreidae) from Japan and Palawan, *Opisthomonorcheides decapteri* Parukhin, 1966 from *Rastralliger kanagurta* (Scombridae) from Palawan, and *Pseudoproctotrema parupenei* Yamaguti, 1942 from *Mulloidichthys vanicolensis* (Mullidae) from Japan. The relationship between *Anamonorchis ulua* Yamaguti, 1970 and *Hurleytrema carangoidis* Machida, 2005 is briefly discussed.

Key words : Digenea, Monorchiidae, new species, new combination, marine fish, Japan, Palau, Philippines.

Following the previous paper (Machida, 2005), six monorchiid species (Trematoda, Digenea) are reported from fishes of Japanese and adjacent waters. In addition, the relationship between *Anamonorchis ulua* and *Hurleytrema carangoidis* is briefly discussed. Digeneans obtained were washed in saline, fixed in AFA under slight pressure, stained with Heidenhain's hematoxylin and mounted in Canada balsam. The specimens are deposited in the National Museum of Nature and Science, Tokyo (NSMT) and the Meguro Parasitological Museum (MPM). Measurements are given in millimeters unless otherwise stated.

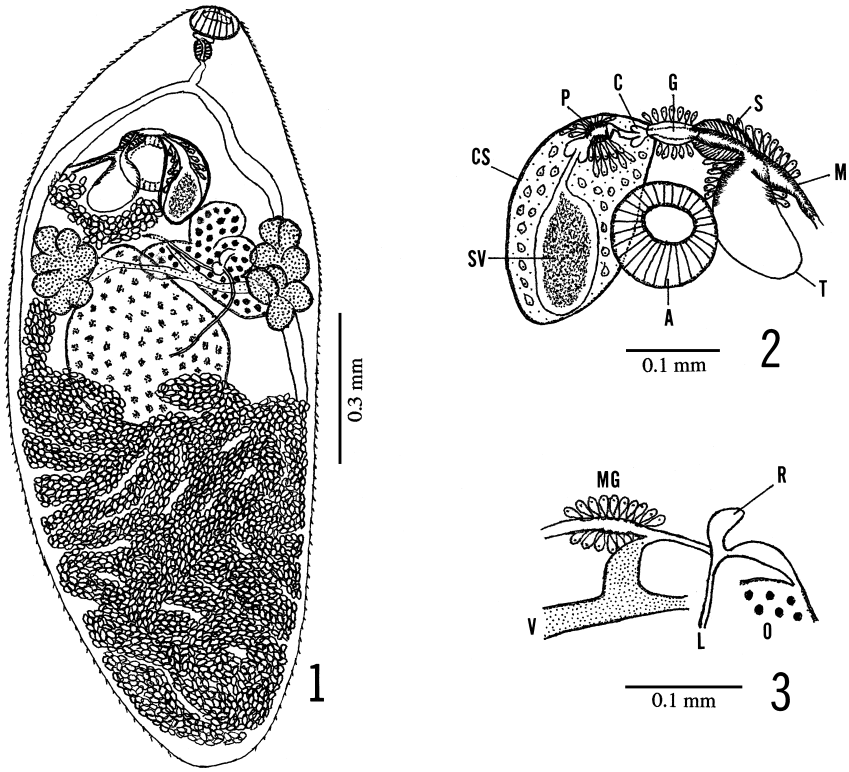
Alloproctotrema gerres Machida, 1973

Alloproctotrema gerres Machida, 1973, pp. 432–435, figs. 4–6.

Material. Four specimens from the intestine of *Gerres oyena* (Forsskål) (Gerreidae), Kushimoto, Wakayama Pref., 21-X-1979, NSMT-Pl 2224; and three specimens from the lower intestine and rectum of *G. oyena*, Palawan, the Philippines, 17-XI-1988, NSMT-Pl 3593.

Additional measurements. Seven specimens 0.97–1.47 long by 0.28–0.59 wide. Oral sucker 53–87×76–105 μm; prepharynx 10–43 μm long; pharynx 40–46×33–41 μm. Acetabulum 71–110×89–128 μm. Sucker ratio 1 : 1.12–1.25. Forebody 23–32% of body length. Testis 0.32–0.56×0.15–0.25. Cirrus sac 0.24–0.45×0.09–0.17. Ovary 0.18–0.24×0.10–0.17. Eggs 10–12×7−8 μm. Terminal organ 0.17–0.24×0.06–0.14.

Remarks. Madhavi (2008) regarded *Alloproctotrema* Machida, 1973 as a synonym of *Postmonorchis* Hopkins, 1941. *Alloproctotrema* is valid, distinguishable from *Postmonorchis* by possessing an unarmed genital atrium and a unipartite terminal organ. Both these features do not fit the generic diagnosis of *Postmonorchis* by Madhavi (2008).



Figs. 1–3. *Lasiotocus okinawaensis* sp. nov. — 1, Entire worm, dorsal view (holotype, MPM Coll. No. 20661); 2, terminal genitalia, ventral view; 3, ovarian complex, dorsal view. Abbreviations: A, acetabulum; C, cirrus; CS, cirrus sac; G, genital pore; L, Laurer's canal; M, metraterm; MG, Mehlis' gland; O, ovary; P, pars prostatica; R, seminal receptacle; S, sphincter; SV, seminal vesicle; T, terminal organ; V, vitelline duct.

Lasiotocus okinawaensis sp. nov.

(Figs. 1–3)

Type host. *Plectorhinchus gibbosus* (Lacepède) (Haemulidae).

Site. Pyloric caeca.

Type locality. Nago, Okinawa Pref., 6-III-1966 and 4-III-2009.

Specimens. Holotype, MPM Coll. No. 20661 and 11 paratypes NSMT-Pl 4855 and MPM Coll. No. 20661.

Etymology. The specific name *okinawaensis* is from the type locality.

Description. Based on 12 specimens. Body plump with bluntly pointed ends, 1.26–2.35 long by 0.58–0.78 wide. Tegument spinose. Oral sucker subterminal, 63–107×102–158 μm; prepharynx inconspicuous in most specimens, but 40 μm long in well-extended specimen; pharynx 38–64×33–48 μm; esophagus 25–135 μm long, bifurcating approximately midway between suckers; caeca terminating anterior 1/3 to middle of posttesticular space. Acetabulum 109–135×109–140 μm. Sucker ratio 1 : 0.78–1.82. Forebody 21–40% of body length.

Testis ovoid, 0.28–0.62×0.18–0.33, submedian, with its anterior border in touch with vitelline duct. Posttesticular space 35–50% of body length. Two vasa efferentia arising from anterior edge of testis, entering posterior end of cirrus sac. Cirrus sac thick-walled, 0.19–0.38×0.10–0.22, passing dextral to or partly overlapping acetabulum, ending near or at preovarian level; containing seminal vesicle 81–133×51–77 μm, pars prostatica with prostatic cells, and cirrus

50–95 μm long. Cirrus spines not observed. Genital pore immediately preacetabular. Genital atrium without spines.

Ovary four-lobed, 0.13–0.36×0.06–0.11, dextral, sometimes partly overlapping testis or right vitelline follicles. Oviduct arising from center of ovary, connecting small seminal receptacle 30–33×23–25 μm, receiving vitelline reservoir, and entering Mehlis' gland. Mehlis' gland near posterior edge of cirrus sac. Laurer's canal originating from base of seminal receptacle, opening dorsally from pre- to midtesticular level. Uterus descending to near posterior end of body, sperm in proximal end, then ascending sinistral to testis; metraterm swollen, lined with fluff-like spines, entering terminal organ near middle of anterior spiny portion. Eggs 24–30×15–18 μm. Terminal organ 0.16–0.21×0.06–0.11; posterior vesicular portion unspined; anterior tubular portion with fluff-like spines, surrounded by well-developed muscular sphincter 43–56×46−56 μm at distal end. Anterior portion of terminal organ and genital pore enclosed by glandular cells. Vitelline follicles in lateral groups, 7–9 on each side, between levels of acetabulum and testis. Vitelline duct distinct. Excretory vesicle saccular, anterior extent not determined; pore terminal.

Remarks. This species is most similar to *Lasiotocus macrorchis* (Yamaguti, 1934), which is found in the same genus of host from Japan. It differs from *L. macrorchis* by having an oral sucker that is not funnel-shaped, and a cirrus without spines. In *L. macrorchis*, the cirrus has long spines like those of the anterior portion of the terminal organ. My observation of the type series of *L. macrorchis* (a holotype and three paratypes; MPM Coll. No. 22108) reveals the genital atrium to be unarmed as in the present new species.

Lasiotocus sparui (Shen, 1990) comb. nov.

Genolopa sparui Shen, 1990, pp. 46–47, fig. 37.

Material. Twenty-five specimens from the intestine of *Acanthopagrus* sp. (Sparidae), Palawan, the Philippines, 15-XI-1988, NSMT-Pl 3580.

Brief description on 10 specimens. Body 0.99–1.60 long by 0.38-0.61 wide. Oral sucker cup-shaped, 0.14–0.20×0.19–0.29; prepharynx up to 36 μm long; pharynx 43–64×35–53 μm; esophagus 18–51 μm long; caeca ending slightly beyond testis. Acetabulum 0.10–0.15×0.11–0.16. Sucker ratio 1 : 0.50–0.60. Forebody 33–44% of body length. Testis 0.11–0.28×0.15–0.26. Posttesticular space 26–37% of body length. Cirrus sac 0.27–0.43×0.08–0.11, containing ovoid seminal vesicle, saccate pars prostatica 25–40×30–45 μm, prostatic cells, cirrus with slender spines 15–35 μm long. Genital atrium unarmed. Genital pore immediately anterior to acetabulum. Ovary trilobed, 0.12–0.23×0.10–0.18, immediately anterodextral to testis. Laurer's canal opening middorsally at ovarian level. Uterus entering terminal organ at junction of its spiny and unarmed portions. Eggs 18–22×10–12 μm. Terminal organ 0.13–0.19×0.05–0.09; anterior portion with spines 12–20 μm long. Vitelline follicles in two lateral clusters, acetabular to ovarian level.

Remarks. This species was initially described by Shen (1990) from *Sparus berda* (=*Acanthopagrus berda*) of Hainan Island, China. The genital pore is located midway between the caecal bifurcation and acetabulum in his description and illustration, but it is immediately anterior to the acetabulum in my specimens. He did not describe whether the genital atrium is spined or unspined. In my specimens the genital atrium is unspined, therefore, this species is to be transferred to the genus *Lasiotocus* as a new combination.

Opisthomonorcheides decapteri Parukhin, 1966

Opisthomonorcheides decapteri Parukhin, 1966, pp. 1465–1466, fig. 4.—Shen, 1990, p. 48, fig. 39.

Material. Twenty-nine gravid specimens from the intestine of *Rastrelliger kanagurta* (Cuvier) (Scombridae), Palawan, the Philippines, 10-XI-1988, NSMT-Pl 3547.

Brief description on 14 specimens. Body slender, 2.35–3.55 long by 0.32–0.46 wide, tapering toward both ends. Eyespot pigment at prepharyngeal-pharyngeal level. Oral sucker 46–66×53–69

μm; prepharynx 51–128 μm long; pharynx 97–112×63–84 μm; esophagus 35–110 μm long, bifurcating approximately midway between pharynx and acetabulum; caeca terminating near end of body. Acetabulum 99–128×119–150 μm. Sucker ratio 1 : 1.7–2.6. Forebody 16–29% of body length.

Testis ovoid, 0.27–0.43×0.10–0.28. Posttesticular space 10–17% of body length. Cirrus sac 0.48–0.67×0.14–0.19, extending midway between acetabulum and ovary; containing seminal vesicle that tapers anteriorly, 0.30–0.45 long, pars prostatica, cirrus 0.13–0.26 long. Cirrus with spines 16–20 μm long. Genital atrium tubular, thin-walled, 0.18–0.58 long, without spines. Genital pore immediately anterior to acetabulum.

Ovary ovoid, sometimes divided irregularly, 0.09–0.18×0.14–0.24, midway between posterior border of cirrus sac and testis. Uterus extending to posterior end of body; metraterm very short, entering terminal organ near its anterior margin. Eggs 22–26×13–16 μm. Terminal organ 0.20–0.31×0.05–0.11, with spines all over; spines 11–13 μm long, those on border with genital atrium slender, 30 μm long. Vitelline follicles small, filling most area between posterior border of cirrus sac and anterior border of testis.

Remarks. Concerning the synonymy of *Longimonorchis* Mamaev, 1970 and *Retractomonorchis* Madhavi, 1977 with *Opisthomonorcheides* Parukhin, 1966, refer to Hafeezullah (1984) and Madhavi (2008). Two species of *Opisthomonorcheides*, *O. decapteri* Parukhin, 1966 and *O. ovacutus* (Mamaev, 1970), have been recorded from carangid fishes in the Gulf of Tonkin (Parukhin, 1966; Mamaev, 1970). Mamaev (1970) did not aware of Parukhin's (1966) work. The morphological details of the terminal genitalia were well described and illustrated by Mamaev (1970). The only difference between the two species is the posterior extent of the vitelline follicles: *O. decapteri* has vitelline follicles extending to the anterior border of the testis, whereas in *O. ovacutus* they reach to near the posterior end of the body. Shen (1990) reported two species of *Opisthomonorcheides, O. decapteri* and *O. indicus* Karyakarate, 1976, from carangid fishes of Hainan Island, China. The vitelline follicles in the latter species were described by Shen (1990) as extending from the middle of the cirrus sac to the anterior edge of the testis. I place my specimens in *O. decapteri* on the basis of their vitelline distribution.

Opisthomonorchis orwidal sp. nov.

(Figs. 4–6)

Type host. Carangoides sp. (Carangidae).

Site. Intestine.

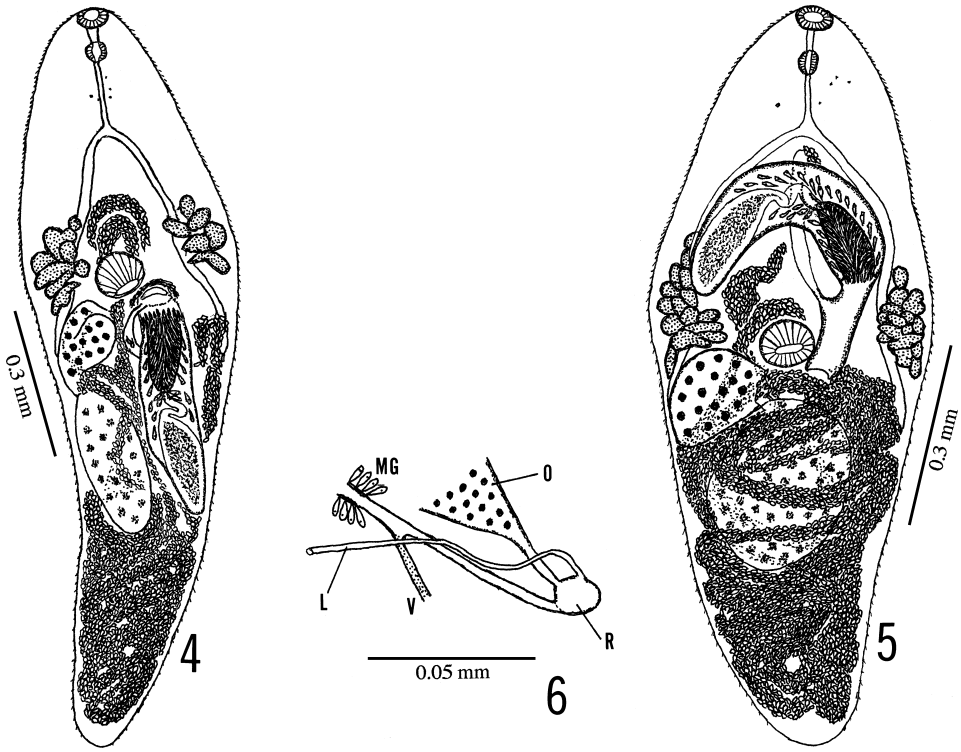
Type locality. Palau, western Caroline Is., 10-VII-1980.

Specimens. Holotype and 19 paratypes, NSMT-Pl 2448.

Etymology. The specific name *orwidal* is from the Palauan local name of the host.

Description. Based on 20 specimens. Body lanceolate, blunt-pointed anteriorly, tapering posteriorly, 1.08–1.46 long by 0.32–0.44 wide at preacetabular level. Tegument spinose. Eyespots or dispersed pigment granules mostly in esophageal region. Oral sucker subterminal, 41–61×51–72 μm; prepharynx 18–56 μm long; pharynx 30–43×30–46 μm; esophagus 84–156 μm long, bifurcating midway between suckers; caeca slender, terminating some distance posterior to acetabulum, not extending beyond testis. Acetabulum 68–92×89–115 μm. Sucker ratio 1 : 1.4–2.0. Forebody 34–46% of body length.

Testis ovoid to longitudinally elongate, 0.22–0.35×0.12–0.20, near middle of hindbody or more anteriorly. Posttesticular space 16–32% of body length. Cirrus sac subcylindrical, straight or arcuate, 0.11–0.26×0.06–0.09, slightly sinistral to median line, extending around left of ovary and testis to near middle of hindbody; containing elliptical seminal vesicle 0.11–0.26 long, curved duct leading to pars prostatica, small pars prostatica 16–45 μm long, well-developed prostatic cells, cylindrical cirrus 0.13–0.22×0.05–0.08. Cirrus with slender thorn-like spines which are largest 25–30 μm long at distal end, smallest 15 μm long at proximal end. Occasionally cirrus sac



Figs. 4–6. *Opisthomonorchis orwidal* sp. nov. — 4, Entire worm, ventral view (holotype, NSMT-Pl 2448); 5, specimen with inverted cirrus sac, ventral view; 6, Ovarian complex, dorsal view. Abbreviations: L, Laurer's canal; MG, Mehlis' gland; O, ovary; R, seminal receptacle; V, vitelline reservoir.

changing its position, inverted straight or arcuate between caecal bifurcation and acetabulum (Fig. 5). Genital atrium shallow, occasionally tubular, unarmed. Genital pore immediately posterosinistral to acetabulum.

Ovary subglobular, 0.13–0.20×0.06–0.12, posterodextral to acetabulum, occasionally changeable in position, anterodextral to acetabulum or immediately posterior to caecal bifurcation; in such a case testis also changes its position to posterior to ovary. Oviduct arising from posterior or lateral edge of ovary, connecting vitelline reservoir by way of small saccular seminal receptacle. Laurer's canal originating from base of seminal receptacle, opening middorsally near level of posterior border of ovary. Uterus filling almost available space of hindbody, sometimes intruding forebody, near caecal bifurcation; entering genital atrium by metraterm 40–60 μm long. Eggs 14–18×9–10 μm, with a filament 15–18 μm long at antiopercular pole. Vitelline follicles in lateral fields, mostly extracaecal, from midway between caecal bifurcation and acetabulum to posterior border of acetabulum. Excretory vesicle short, saccular, maybe extending to posterior 1/3 of posttesticular space; pore terminal.

Remarks. This species differs from the type and only species of the genus, *Opisthomonorchis carangis* Yamaguti, 1952, from *Caranx* sp. of Macassar (=Ujung Pandang), Indonesia, by having short caeca that terminate some distance posterior to the acetabulum, and vitelline follicles that lie from midway between the caecal bifurcation and acetabulum to the posterior border of the acetabulum. Variation in the position of the cirrus sac, testis and ovary in my specimens suggests caution in evaluating these characters.

Pseudoproctotrema parupenei Yamaguti, 1942

Pseudoproctotrema parupenei Yamaguti, 1942, pp. 371–373, figs. 21–22.

Material. Eleven specimens from the intestine of *Mulloidichthys vanicolensis* (Valenciennes) (Mullidae), Ishigaki-jima, Okinawa Pref., 5-III-1973, NSMT-Pl 1322b.

Brief description on seven specimens. Body 0.88–1.12 long by 0.41–0.48 wide. Oral sucker 84–107×109–140 μm; prepharynx 25–51 μm long; pharynx 43–64×40–51 μm; esophagus 43–64 μm long. Acetabulum 68–82×76–85 μm. Sucker ratio 1 : 0.62–0.77. Forebody 37–48% of body length. Testis 0.17–0.30×0.15–0.28. Posttesticular space 20–41% of body length. Cirrus sac 0.23–0.30×0.07–0.11, including seminal vesicle 89–166×58–95 μm, pars prostatica with prostatic cells, and spiny cirrus 71–97 μm long. Genital atrium unarmed. Genital pore immediately anterior to acetabulum. Ovary ovoid or uneven on surface, 0.15–0.19×0.09–0.18, dextral or anterodextral to acetabulum. Terminal organ bipartite, 0.13–0.23×0.05–0.11; proximal vesicle 66–153×56–107 μm. Uterus entering terminal organ near middle of distal spiny portion. Eggs 19–22×14–16 μm. Vitellaria consisting of two compact masses; right 0.10–0.19×0.05–0.10; left 0.12–0.18×0.07–0.11; from pre- to postacetabular zone.

Remarks. This species was originally described by Yamaguti (1942) from *Parupeneus chrysedros* (Mullidae) from Naha, Okinawa Pref. His specimens (type series consists of a holotype and two paratypes; MPM Coll. No. 23230) are all macerated, so that his description is somewhat unclear in detail. For example, he said of his specimens: "there is no usual pars prostatica. This fact leads one to conclude that the vesicula seminalis may function as pars prostatica too" (Yamaguti, 1942). My observation reveals that the holotype seems to have a pars prostatica at the distal end of the duct from the seminal vesicle inside the everted cirrus (corresponding to a slightly swollen part of the duct in Fig. 22, Yamaguti, 1942). In my specimens, the pars prostatica is clearly visible at the distal end of the duct from the seminal vesicle. I briefly redescribed this species based on my non-macerated specimens.

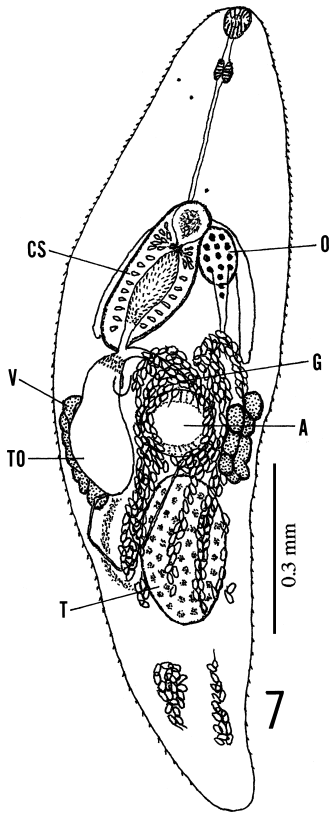


Fig. 7. *Hurleytrema carangoidis* Machida, 2005. Specimen with cirrus sac extending forward and terminal organ extending backward (NSMT-Pl 2407). Abbreviations: A, acetabulum; CS, cirrus sac; G, genital pore; O, ovary; T, testis; TO, terminal organ; V, vitelline follicle.

Anamonorchis ulua Yamaguti, 1970 and ***Hurleytrema carangoidis*** Machida, 2005

(Fig. 7)

Anamonorchis ulua Yamaguti, 1970, pp. 26–27, fig. 29 and *Hurleytrema carangoidis* Machida, 2005, pp. 125–126, figs. 4–6.

Material. Five specimens of *Anamonorchis ulua* from *Carangoides ferdau* (Carangidae), Hawaii, MPM Coll. No. 15259 and 25 specimens

from *C. orthogrammus*, Palau, western Caroline Is., NSMT-Pl 2407.

Remarks. Yamaguti (1970) described *Anamonorchis ulua* as a new genus and species from *Carangoides ferdau* of Hawaii. This species is characteristic in that the internal organs including the gonads and terminal genitalia, are inverted in arrangement in contrast to members of the Monorchiidae. Hence he proposed a new subfamily Anamonorchiinae with this genus as a type.

Five specimens of *A. ulua* (one of them may be a paratype) collected by Yamaguti are preserved in the MPM (MPM Coll. No. 15259). They are all macerated and in poor condition. Yamaguti (1970) incorrectly stated: "uterus ..... opening directly into genital atrium" and "terminal organ ..... covered inside with spines." My examination of his specimens shows that the terminal organ is bipartite, the anterior spined and posterior unspined portions, and the uterus enters the terminal organ near the junction of the spiny and unspined portions. These features agree with those of *Hurleytrema carangoidis* given below. His five specimens can be placed in three groups owing to the extending patterns of the male (cirrus sac) and female (terminal organ) terminal genitalia: one specimen (paratype?) has 1) both male and female terminal genitalia extending forward, in front of the acetabulum as described in *A. ulua*; another one specimen possesses 2) both male and female terminal genitalia extending backward, behind the acetabulum. This feature coincides with that of *Hurleytrema carangoidis;* and in the remaining three specimens, 3) one of the terminal genitalia extends forward, but the other extends backward or transeversely.

Three slides with many specimens labeled as "*Hurleytrema carangoidis* Machida, 2005 and *Lasiotocus*-like species" collected by Machida from *Carangoides orthogrammus* of Palau are deposited in the NSMT (NSMT-Pl 2407). *H. carangoidis* was described by Machida (2005) as having an above 2) extending pattern of the terminal genitalia which is a feature in common with members of the Monorchiidae. In the specimens "*H. carangoidis*", the extending patterns 1) 2) 3) of the terminal genitalia are also observed. The specimens with 1) and 2) correspond to *A. ulua* and *H. carangoidis*, respectively. The specimens with 3) appear to be intermediate between the two species (Fig. 7). Generally, in specimens having an acetabulum near the midbody, the patterns 1) 2) 3) of the terminal genitalia are recognized. In specimens possessing an acetabulum in the posterior half of the body, usually the pattern 1) but occasionally 2) or 3) is observed. In any case, the caeca extend near the acetabulum, the ovary is located near the posterior margin of the cirrus sac, and the vitelline follicles lie posterolateral to the acetabulum. *Lasiotocus*-like species mixed with *H. carangoidis* on the three slides (NSMT-Pl 2407) also shows the same extending patterns 1) 2) 3) of the terminal genitalia. These facts suggest that the position of the terminal genitalia is a variable character in certain monorchiids.

Anamonorchis ulua and *Hurleytrema carangoidis* may be the same species, in which various extending patterns of the terminal genitalia occur. Molecular data will be necessary to confirm the relationship between the two species.

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