

Some Species of the Genus *Bivesicula* (Digenea: Bivesiculidae),
Including Three New Species, from Marine Fishes
of Japan and Palau

By

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Abstract Six species of the genus *Bivesicula* YAMAGUTI, 1934 (Digenea: Bivesiculidae) are reported from marine fishes of Japan and the Palau Islands. *B. gymnothoracis* sp. nov. found in the intestine of *Gymnothorax kidako* (Muraenidae) from Japan is different from the most closely allied *B. ostichthydis* SHEN, 1982 in having a broader body and smaller eggs. *B. obovata* sp. nov. found in the pyloric ceca of *Sargocentron rubrum* (Holocentridae) from Japan is different from the most closely allied *B. hepsetiae* MANTER, 1947 in having a larger and broader body and more anteriorly distributed vitellaria. *B. palauensis* sp. nov. found in the intestine of *Variola louti* (type host) and *Epinephelus microdon* (both Serranidae) from the Palau Islands is different from the most closely allied *B. tarponis* SOGANDARES-BERNAL et HUTTON, 1959 in having a larger pharynx, a shorter esophagus, a smaller testis, a much more spacious pars prostatica, a very short ejaculatory duct and larger eggs. Specimens found in the intestine of *Brotula multibarbata* (Ophidiidae) from Japan are provisionally assigned to *B. ostichthydis*. Specimens (*Bivesicula* spp. 1 and 2) found in the intestine of *G. kidako* and the pyloric ceca of *E. fasciatus*, respectively, both from Japan remain unidentified. Data are given on other members of the genus previously known from Japanese waters.

Digeneans of the genus *Bivesicula* YAMAGUTI, 1934 in the family Bivesiculidae YAMAGUTI, 1934 have been recorded as intestinal parasites from marine fishes (YAMAGUTI, 1971; SHEN, 1982; GU & SHEN, 1983; CRIBB *et al.*, 1994) except unidentified specimens from a freshwater fish in Japan (SHIMAZU, 1994). This paper deals with six species of the genus found in marine fishes from Japan and the Palau Islands. Data are also given on museum specimens, hosts and localities of, and some taxonomic notes on, other members previously known from Japanese waters.

Materials and Methods

Worms were slightly flattened, fixed in AFA, stained with HEIDENHAIN'S iron hematoxylin and mounted in Canada balsam. They have been deposited in the collection of the National Science Museum, Tokyo (NSMT). Some other museum specimens were borrowed from the collection of the Meguro Parasitological Museum (MPM), Tokyo.

Measurements (length by width) are given in millimeters unless otherwise stated. The body ratio means the ratio of body width to body length.

Digenea: Bivesiculidae

Bivesicula gymnothoracis sp. nov.

(Fig. 1)

Material examined. Three gravid whole-mounts (NSMT-PI 983 and 1132) found in intestine of *Gymnothorax kidako* (Muraenidae) landed at Fukaura, Ehime Prefecture, Japan, on 24 May and 19 December 1972.

Description. With characters of *Bivesicula*. Body obovate, large, 3.08–4.56 by 1.74–2.50; body ratio 1: 1.7–1.8; distance between anterior end of body and genital pore 1.56–2.50, occupying 51–55% of total body length. Tegument thin; tegumental spines fine. Eyespot pigment fine, dispersed between pharynx and intestinal bifurcation. Mouth opening ventral. Pharynx globular, subterminal, 0.16–0.22 in diameter. Esophagus 0.20–0.43 long. Intestinal bifurcation slightly anterior to junction of first and second sixths of body; intestines terminating blindly at about level of anterior border of testis.

Testis globular to elliptical, to left of midline, in anterior half of body posterior to genital pore, 0.68–1.10 by 0.61–0.90. Sperm ducts 2, diverging from anterolateral edge of testis, running dorsal to cirrus pouch. External seminal vesicle cordate or oblong, anterodorsal to cirrus pouch, 0.31–0.35 by 0.12–0.13. Cirrus pouch elliptical, thin-walled, slightly anterior to midlevel of body, 0.82–1.19 by 0.62–0.75. Internal seminal vesicle pyriform, 0.20–0.39 by 0.17–0.33; pars prostatica thick, 0.23–0.39 long, with 2 diverticula, surrounded by numerous prostatic cells; ejaculatory duct thick, 0.23–0.35 long, surrounded by numerous gland cells. Genital atrium fairly large. Genital pore median, on posterior margin of cirrus pouch; sphincter fairly well developed around its aperture. A number of fine, fiberlike (muscular?) structures radiating around genital pore in shallow ventral parenchyma, but not extending into sphincter of genital pore (see also Fig. 3). Ovary spherical, to right of genital pore, 0.27–0.31 by 0.24–0.29. Ootype-complex postovarian; oviduct ciliated; LAURER'S canal long, opening dorsal to anterior part of testis. Uterus extending posteriorly to posterior end of body,

folded several times in posttesticular region, descending and ascending on right side of testis; uterine seminal receptacle large; metraterm short. Eggs yellowish brown, numerous, 76–92 by 48–56 μm . Vitellaria more dendritic than follicular, distributed forward to pharyngeal level beyond anterior ends of arms of excretory vesicle and backward to midlevel of testis beyond posterior ends of intestines, present dorsal and ventral to intestines and excretory vesicle, confluent medially in front of cirrus pouch. Excretory vesicle V-shaped, in ventral parenchyma; arms reaching to midlevel of esophagus; excretory pore terminal.

Type host: *Gymnothorax kidako* (Muraenidae).

Site of infection: Intestine.

Type locality: Fukaura, Ehime Prefecture, Japan.

Specimens: Holotype (NSMT-Pl 1132); 2 paratypes (983 and 1132).

Discussion. The genus *Bivesicula* comprises 15 proposed species (YAMAGUTI, 1971; SHEN, 1982; GU & SHEN, 1983; CRIBB *et al.*, 1994). We recognize 13 of them as valid, following CRIBB *et al.* (1994) who regarded *B. epinepheli* YAMAGUTI, 1938, and *B. xishaensis* GU et SHEN, 1983 as synonyms of *B. claviformis* YAMAGUTI, 1934 (type species), as will be discussed later again in this paper.

In the following 9 of the 13 valid species, neither intestines nor vitellaria extend posterior to the testis: *B. claviformis* (= *B. epinepheli*, *B. xishaensis*); *B. synodi* YAMAGUTI, 1938; *B. hepsetiae* MANTER, 1947; *B. caribbensis* CABLE et NAHHAS, 1962; *B. megalopsis* SHEN, 1982; *B. ostichthydis* SHEN, 1982; *B. auxisae* GU et SHEN, 1983; *B. lutiani* GU et SHEN, 1983; and *B. unexpecta* CRIBB, BRAY et BARKER, 1994 (YAMAGUTI, 1934, 1938; MANTER, 1947; CABLE & NAHHAS, 1962; SHEN, 1982; GU & SHEN, 1983; CRIBB *et al.*, 1994). However, both intestines and vitellaria extend posterior to the testis in *B. tarponis* SOGANDARES-BERNAL et HUTTON, 1959; and so do the intestines alone in *B. australis* CROWCROFT, 1947, *B. fistulariae* SHEN, 1982, and *B. congeri* YAMAGUTI, 1970 (SOGANDARES-BERNAL & HUTTON, 1959; CROWCROFT, 1947; SHEN, 1982; YAMAGUTI, 1970).

The new species is closely similar in general to the description by SHEN (1982) for *B. ostichthydis* from *Ostichthys japonicus* (Holocentridae) at Ningbao, Zhejiang Province, China. However, it is different from *B. ostichthydis* in having a broader body (body ratio, 1: 1.7–1.8 vs. 1: 2.1, calculated from fig. 3) and smaller eggs (76–92 by 48–56 μm vs. 99–105 by 57–66 μm).

SHEN (1982) described and figured, in *B. fistulariae* and *B. ostichthydis*, the ovary on the left side of the cirrus pouch and the uterus descending and ascending on the left side of the testis. This relative situation of the reproductive organs suggests that SHEN wrongly determined the ventral or dorsal side of the body in the species.

According to SHEN (1982) and GU and SHEN (1983), circular and longitu-

dinal muscle fibers form a genital sucker around the genital pore in the their species (see above). We presume that the circular and longitudinal muscle fibers correspond to the sphincter muscle of the genital pore and the radial (muscle?) fibers in the parenchyma around the genital pore, respectively (this paper). If so, the structure that they form cannot be interpreted as a sucker because the sphincter muscle and radial fibers are independent on each other in structure, even though they are connected externally to each other; and because the radial fibers

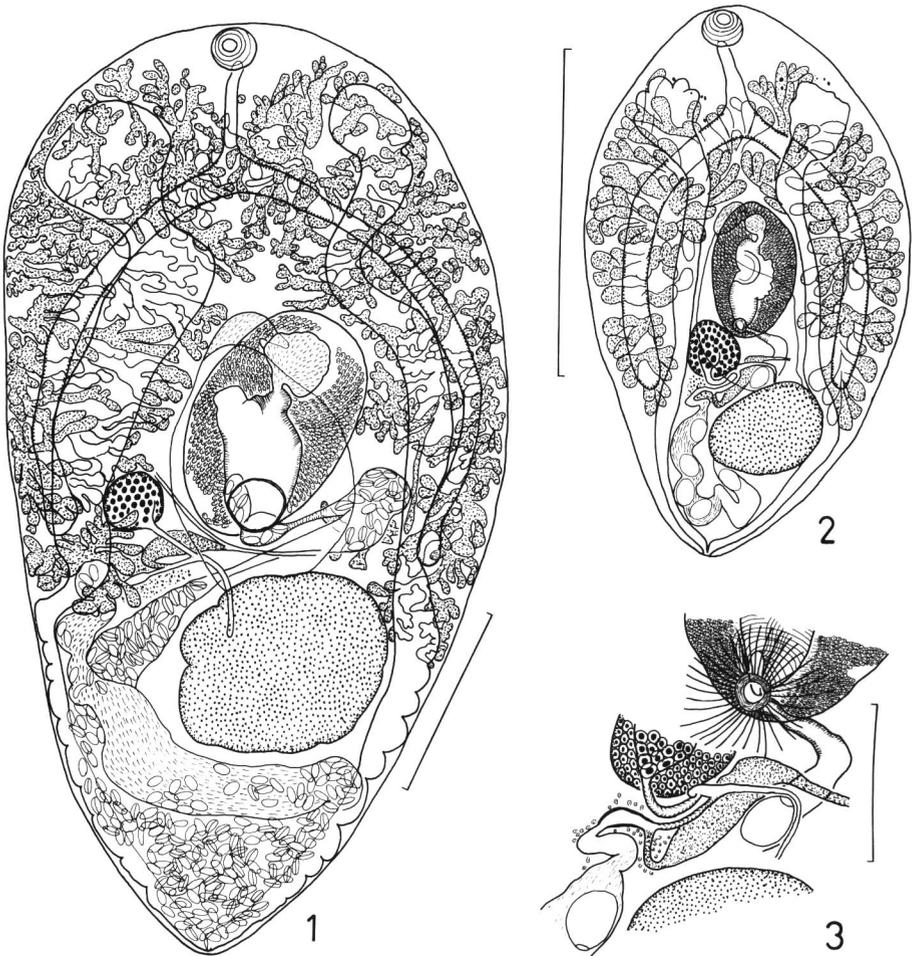


Fig. 1. *Bivesicula gymnothoracis* sp. nov. found in *Gymnothorax kidako* at Fukaura, Ehime Prefecture, Japan, holotype, entire body, ventral view. (Scale bar: 1 mm.)

Figs. 2, 3. *B. obovata* sp. nov. found in *Sargocentron rubrum* at Nago, Okinawa Prefecture, Japan, holotype, ventral view.—2. Entire body. 3. Posterior part of terminal genitalia and ovarian complex, terminal part of LAURER'S canal obscure. (Scale bars: 1 mm in Figs. 2; 0.2 mm in Fig. 3.)

lack any tissue which delineates a sharp boundary between them and the parenchyma (see Fig. 3).

Bivesicula obovata sp. nov.

(Figs. 2, 3)

Material examined. One immature and 2 gravid whole-mounts (NSMT-PI 3427) found in pyloric ceca of *Sargocentron rubrum* (Holocentridae) landed at Nago, Okinawa Prefecture, Japan, on 6 June 1988.

Description. With characters of *Bivesicula*. Body broad obovate, 1.40–1.75 by 0.94–1.01; body ratio 1: 1.4–1.9; distance between anterior end of body and genital pore 0.78–1.05, occupying 55–60% of total body length. Tegument thin; tegumental spines fine. Eyespot pigment dispersed between pharynx and intestinal bifurcation. Mouth opening ventral, terminal or dorsal (probably, anterior end of body mobile). Pharynx globular, subterminal or terminal, 0.09–0.12 in diameter. Esophagus 0.13–0.31 long. Intestinal bifurcation slightly anterior to junction of first and second quarters of body; intestines terminating blindly at midlevel of testis.

Testis globular to elliptical, to left of midline, in middle third of body posterior to genital pore, 0.26–0.33 by 0.23–0.26. Sperm ducts 2, diverging from anterolateral edge of testis, running dorsal to cirrus pouch. External seminal vesicle oblong, anterodorsal to cirrus pouch, 0.12–0.14 by 0.04–0.08. Cirrus pouch elliptical, thin-walled, in midbody, 0.33–0.43 by 0.22–0.31. Internal seminal vesicle pyriform, 0.09–0.12 by 0.07–0.10; pars prostatica 0.12–0.16 long, with 2 diverticula, surrounded by numerous prostatic cells; ejaculatory duct 0.08–0.12 long, surrounded by numerous gland cells. Genital atrium small. Genital pore median, on posterior margin of cirrus pouch; sphincter and radial fibers (see *B. gymnothoracis*) well developed. Ovary spherical to subtriangular, to right of midline, just posterolateral to cirrus pouch, 0.13–0.17 by 0.12–0.16. Ootype-complex postovarian; oviduct ciliated, with a very small pouch (for this structure, see LE ZOTTE [1954]) a short distance toward ovary from its connection to LAURER's canal; LAURER's canal fairly long, opening dorsal to testis. Uterus extending posteriorly to near bifurcation of excretory vesicle, descending and ascending on right side of testis; uterine seminal receptacle present; metraterm well developed, short. Eggs yellowish brown, few (3–6), 76–88 by 50–60 μm . Vitellaria more dendritic than follicular, distributed forward slightly beyond anterior ends of arms of excretory vesicle and backward slightly beyond posterior ends of intestines, present dorsal and ventral to intestines and excretory vesicle, confluent medially in front of cirrus pouch. Excretory vesicle V-shaped, in ventral parenchyma; arms reaching to midlevel of esophagus; excretory pore terminal.

Type host: *Sargocentron rubrum* (Holocentridae).

Site of infection: Pyloric ceca.

Type locality: Nago, Okinawa Prefecture, Japan.

Specimens: Holotype and 2 paratypes (NSMT-Pl 3427).

Discussion. In posterior extent of the intestines and vitellaria and in number and size of the uterine eggs, this new species resembles *B. hepsetiae*. However, it differs from *B. hepsetiae* as described by MANTER (1947) from *Hepsetia stipes* (Atherinidae) at Tortugas, Florida, in having a larger and broader body, 1.40–1.75 by 0.94–1.01 (body ratio 1: 1.4–1.9) vs. about 0.59–0.62 by 0.32–0.40 (body ratio 1: 2.1, calculated from fig. 93); and more anteriorly distributed vitellaria, to the midlevel of the esophagus vs. to the bifurcal level. Further, the new species is distinguishable from *B. hepsetiae* as described by LE ZOTTE (1954) from *H. stipes* at Puerto Rico by that the vitellaria end posteriorly slightly beyond, instead of at a good distance in front of, the posterior ends of the intestines.

Bivesicula palauensis sp. nov.

(Fig. 4)

Material examined. Two gravid whole-mounts (NSMT-Pl 2428 and 4681) found in intestine of *Variola louti* and *Epinephelus microdon* (both Serranidae) landed at Ngeremlengui and Koror, the Palau Islands, on 7 July 1980 and 13 August 1994, respectively.

Description. With characters of *Bivesicula*. Body elongate obovate, 2.03–3.08 by 1.02–1.21; body ratio 1: 2.0–2.5; distance between anterior end of body and genital pore 1.09–1.56, occupying 51–54% of total body length. Tegument thin; tegumental spines fine. Eyespot pigment dispersed between pharynx and intestinal bifurcation. Mouth opening terminal or dorsal (probably, anterior end of body mobile). Pharynx globular, terminal or subterminal, 0.09–0.12 by 0.10–0.14. Esophagus 0.20–0.38 long. Intestinal bifurcation at about junction of first and second sixths of body; intestines terminating blindly at midlevel of post-testicular region.

Testis almost globular, median, in middle third of body region situated posterior to genital pore, 0.29–0.33 by 0.23–0.27. Sperm ducts 2, diverging from anterior end of testis, running dorsal to cirrus pouch. External seminal vesicle oblong, anterodorsal to cirrus pouch, 0.13–0.20 by 0.04–0.06 (some of its contents squeezed out anteriorly in holotype). Cirrus pouch elliptical, thin-walled, in midbody, 0.35–0.44 by 0.29–0.30. Internal seminal vesicle pear-shaped, 0.12–0.16 by 0.08–0.13; pars prostatica 0.20 long, with 2 laterally expanded diverticula, surrounded by numerous prostatic cells; ejaculatory duct very short (or practically absent). Genital atrium fairly large. Genital pore median, some distance anterior to posterior margin of cirrus pouch; sphincter and radial fibers (see *B.*

gymnothoracis) present. Ovary spherical, posterolateral to cirrus pouch, 0.16–0.18 by 0.12–0.17. Ootype-complex postovarian; oviduct ciliated; LAURER's canal short, opening between cirrus pouch and testis. Uterus reaching bifurcation of excretory vesicle posteriorly, descending and ascending on right side of testis; uterine seminal receptacle present; metraterm well developed, short. Eggs reddish

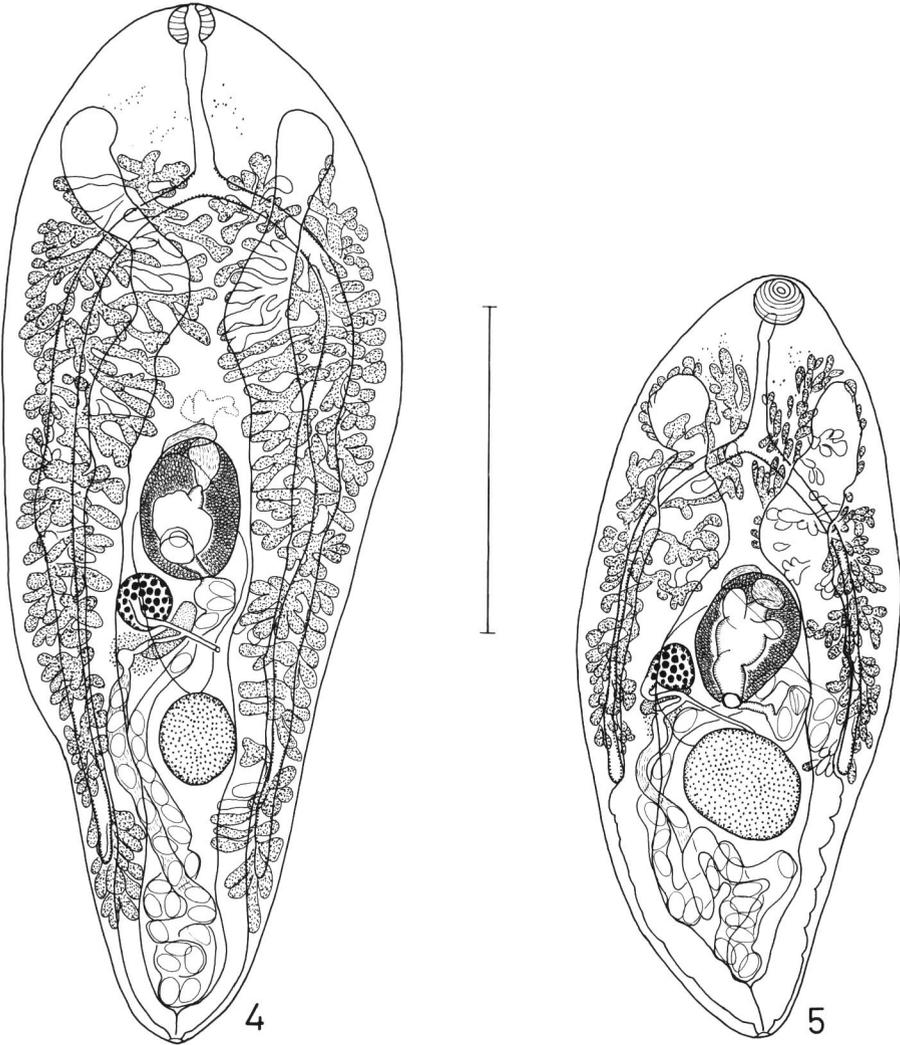


Fig. 4. *Bivesicula palauensis* sp. nov. found in *Variola louti* at Ngeremlengui, the Palau Islands, holotype, entire body, some of contents of external seminal vesicle squeezed out anteriorly, ventral view. (Scale bar: 1 mm.)

Fig. 5. *B. ostichthydis* SHEN, 1982, found in *Brotula multibarbata* at Kushimoto, Wakayama Prefecture, entire body, ventral view. (Scale bar: 1 mm.)

brown, fairly numerous, 80–92 by 48–56 μm . Vitellaria more dendritic than follicular, distributed forward to near anterior ends of arms of excretory vesicle and backward slightly beyond posterior ends of intestines, present dorsal and ventral to intestines and excretory vesicle, confluent medially behind intestinal bifurcation. Excretory vesicle V-shaped, in ventral parenchyma; arms reaching to midlevel of esophagus; excretory pore terminal.

Hosts: *Variola louti* (type host) and *Epinephelus microdon* (both Serranidae).

Site of infection: Intestine.

Localities: Ngeremlengui (type locality) and Koror, the Palau Islands.

Specimens: Holotype (NSMT-PI 2428); 1 paratype (4681).

Discussion. This new species is closely similar to the description by SOGANDARES-BERNAL and HUTTON (1959) for *B. tarponis* from *Megalops atlanticus* (Megalopidae) from the Gulf of Mexico not only in posterior extent of the intestines and vitellaria but also in an elongate obovate or elliptical body and an equatorial genital pore. However, it is distinguished from *B. tarponis* by having a larger pharynx (=oral sucker of the authors), 0.09–0.12 by 0.10–0.14 vs. about 0.06–0.08 by 0.06–0.07; a shorter esophagus, 2–4 vs. about 7 times as long as the pharynx; a smaller testis, 0.29–0.33 by 0.23–0.27 vs. about 0.32–0.57 by 0.36–0.46; a much more spacious pars prostatica; a very short ejaculatory duct; and larger eggs, 80–92 by 48–56 μm vs. 57–74 by 42–50 μm .

Bivesicula ostichthydis SHEN, 1982

(Fig. 5)

Material examined. Six gravid whole-mounts (NSMT-PI 2280) found in first part of intestine of *Brotula multibarbata* (Ophidiidae) landed at Kushimoto, Wakayama Prefecture, Japan, on 27 October 1979.

Description. With characters of *Bivesicula*. Body elongate obovate or nearly fusiform, 1.44–2.42 by 0.86–1.17; body ratio 1: 1.5–2.4; distance between anterior end of body and genital pore 0.82–1.35, occupying 53–59% of total body length. Tegument thin; tegumental spines fine. Eyespot pigment dispersed between pharynx and intestinal bifurcation. Large (glandular?) cells prominent in parenchyma especially of prebifurcal region. Mouth opening ventral, terminal or dorsal (probably, anterior end of body mobile). Pharynx globular, subterminal or terminal, 0.12–0.14 by 0.11–0.16. Esophagus 0.19–0.36 long. Intestinal bifurcation slightly anterior to junction of first and second quarters of body; intestines terminating blindly at about midlevel of testis.

Testis globular to elliptical, almost median, slightly posterior to cirrus pouch, 0.31–0.47 by 0.27–0.35. Sperm ducts 2, diverging from anterolateral edge of testis, running dorsal to cirrus pouch. External seminal vesicle oblong, antero-

dorsal to cirrus pouch, 0.13–0.16 by 0.05–0.09. Cirrus pouch elliptical, thin-walled, in midbody, 0.37–0.47 by 0.25–0.35. Internal seminal vesicle pyriform, 0.08–0.12 by 0.06–0.12. Pars prostatica 0.12–0.19 long, with 2 diverticula, surrounded by numerous prostatic cells; ejaculatory duct 0.12–0.16 long, surrounded by numerous glandular cells. Genital atrium small. Genital pore on posterior margin of cirrus pouch; sphincter and radial fibers (see *B. gymnothoracis*) well developed. Ovary almost spherical, dextral to posterior part of cirrus pouch, 0.12–0.17 by 0.08–0.14. Ootype-complex postovarian; oviduct ciliated, with a very small pouch (see *B. obovata*); LAURER's canal fairly long, opening dorsal to anterior part of testis. Uterus reaching bifurcation of excretory vesicle posteriorly, descending and ascending on right side of testis, coiled a few times; uterine seminal receptacle present; metraterm short. Eggs reddish brown, fairly numerous, 80–106 by 40–60 μm (2 specimens which apparently had just begun egg formation contained only a few eggs measuring 80–86 by 40–50 μm). Vitellaria more dendritic than follicular, distributed forward slightly beyond anterior ends of arms of excretory vesicle and backward to posterior ends of intestines, present dorsal and ventral to intestines and excretory vesicle, nearly confluent medially in front of cirrus pouch. Excretory vesicle V-shaped, in ventral parenchyma; arms reaching to midlevel of esophagus; excretory pore terminal.

Discussion. These specimens are provisionally identified as *B. ostichthydis*. Although they agree fairly well with the description by SHEN (1982) for this species from *Ostichthys japonicus* (Holocentridae) at Ningbao, Zhejiang Province, China, slight differences are seen between the two in length of the body, less than 2.5 vs. over 3.5; condition of the eyespot pigment, dispersed vs. a pair of large solid bodies; position of the ovary, on the right vs. left side of the cirrus pouch; and position of the genital pore, postequatorial vs. equatorial. As already stated, SHEN's original description and figure are apparently incomplete. A more detailed and adequate redescription of the type material is necessary.

Bivesicula sp. 1

(Fig. 6)

Material examined. Fourteen immature and 1 just mature whole-mounts (NSMT-P1 983) found in intestine of *Gymnothorax kidako* landed at Fukaura, Ehime Prefecture, Japan, on 24 May 1972. These specimens, together with one specimen of *B. gymnothoracis* (see above), were obtained from the same host.

Description. With characters of *Bivesicula*. Body elongate obovate, 1.56–2.61 by 0.82–1.40; body ratio 1: 1.6–2.1; distance between anterior end of body and genital pore 0.94–1.64, occupying 60–63% of total body length. Tegument thin; tegumental spines fine. Eyespot pigment fine, dispersed between pharynx and intestinal bifurcation. Large (glandular?) cells prominent in parenchyma

especially of prebifurcal region. Mouth opening ventral or dorsal (probably, anterior end of body mobile). Pharynx globular, subterminal, 0.13–0.20 by 0.16–0.25. Esophagus 0.16–0.43 long. Intestinal bifurcation at about junction of first and second fifths of body; intestines terminating blindly at about anterior border of testis.

Testis almost globular, almost median, slightly posterior to cirrus pouch, 0.25–0.55 by 0.21–0.51. Sperm ducts 2, diverging from anterolateral edge of testis, running dorsal to cirrus pouch. External seminal vesicle oblong, anterodorsal to cirrus pouch, 0.12–0.16 by 0.05–0.07. Cirrus pouch elliptical, thin-walled, in midbody, 0.31–0.65 by 0.19–0.37. Internal seminal vesicle pyriform or

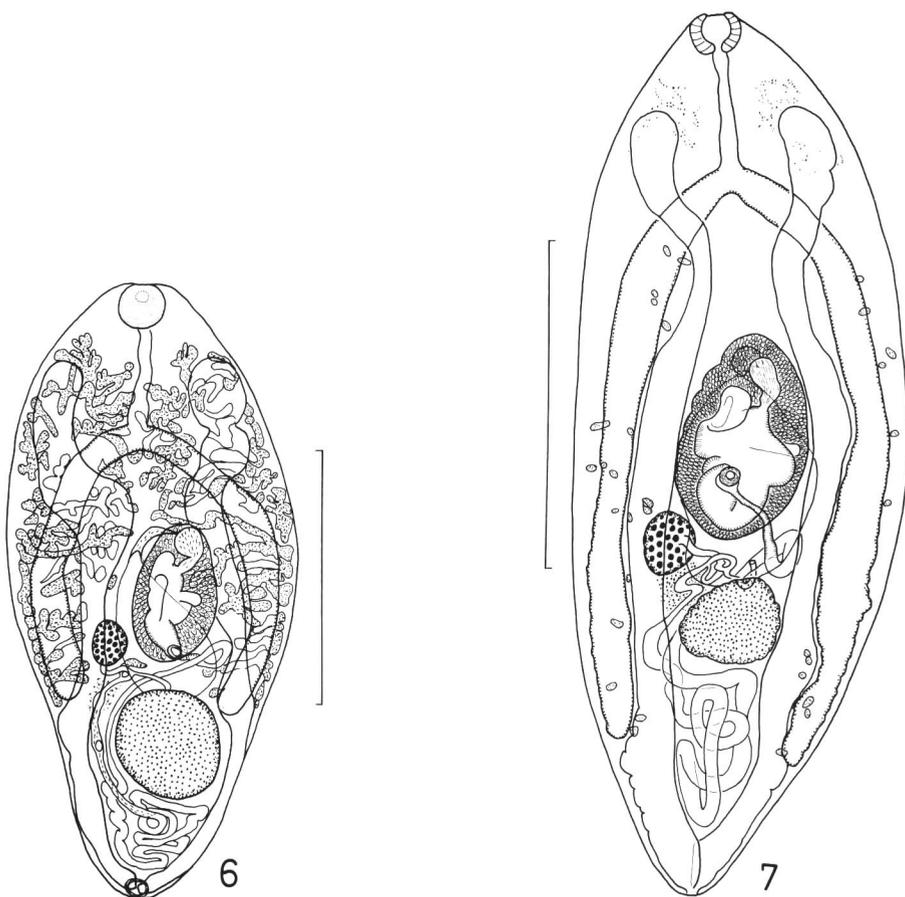


Fig. 6. *Bivesicula* sp. 1 found in *Gymnothorax kidako* at Fukaura, Ehime Prefecture, Japan, entire body, ventral view. (Scale bar: 1 mm.)

Fig. 7. *Bivesicula* sp. 2 found in *Epinephelus fasciatus* at Nishinoomote, Tanegashima, Kagoshima Prefecture, Japan, entire body, ventral view. (Scale bar: 1 mm.)

retort-shaped, 0.08–0.20 by 0.08–0.16. Pars prostatica 0.13–0.21 long, with 2 diverticula, surrounded by numerous prostatic cells; ejaculatory duct 0.13–0.23 long, surrounded by numerous glandular cells. Genital atrium small. Genital pore on posterior margin of cirrus pouch; sphincter and radial fibers (see *B. gymnothoracis*) well developed. Ovary almost spherical, dextral to posterior part of cirrus pouch, 0.10–0.22 by 0.08–0.16. Ootype-complex postovarian; oviduct ciliated, with a very small pouch (see *B. obovata*); LAURER's canal fairly long, opening at about anterior border of testis. Uterus reaching bifurcation of excretory vesicle posteriorly, descending and ascending on right side of testis, coiled several times in posttesticular region; uterine seminal receptacle present; metraterm short. Just mature specimen containing one egg measuring 44 by 36 μm . Vitellaria more dendritic than follicular, distributed forward to pharyngeal level slightly beyond anterior ends of arms of excretory vesicle and backward to posterior ends of intestines, present dorsal and ventral to intestines and excretory vesicle, confluent medially in front of cirrus pouch. Excretory vesicle V-shaped, in ventral parenchyma; arms reaching to midlevel of esophagus; excretory pore terminal, with a well-developed sphincter around it.

Discussion. In general morphology, these specimens somewhat resemble the foregoing specimens and accordingly to *B. ostichthydis*. They remain unidentified because (1) they slightly differ in having a smaller body, a larger pharynx, a slightly posterior genital pore and a more convoluted uterus; (2) they lack eggs; and (3) the original description and figure by SHEN (1982) for *B. ostichthydis* are apparently incomplete.

Bivesicula sp. 2

(Fig. 7)

Material examined. Two whole-mounts (NSMT-PI 1753) found in pyloric ceca of *Epinephelus fasciatus* (Serranidae) landed at Nishinoomote, Tanegashima, Kagoshima Prefecture, Japan, on 25 November 1974.

Description. With characters of *Bivesicula*. Body broad fusiform, 2.45–3.00 by 0.94–1.17; body ratio 1: 2.6; distance between anterior end of body and genital pore 1.32–1.52, occupying 50–54% of total body length. Tegument thin; tegumental spines fine. Eyespot pigment dispersed between pharynx and intestinal bifurcation. Mouth opening terminal. Pharynx globular, terminal, 0.11–0.12 by 0.14. Esophagus 0.33–0.40 long. Intestinal bifurcation slightly anterior to junction of first and second fifths of body; intestines terminating blindly at midlevel of posttesticular region.

Testis almost oval, slightly indented, median, slightly posterior to cirrus pouch, 0.29–0.35 by 0.26–0.33. Sperm ducts 2, diverging from anterior edge of testis, running dorsal to cirrus pouch. External seminal vesicle oblong, dorsal to

cirrus pouch, 0.08 by 0.06–0.08, containing a small number of spermatozoa. Cirrus pouch elliptical, thin-walled, in midbody, 0.58–0.60 by 0.35–0.37. Internal seminal vesicle pyriform or retort-shaped, 0.12–0.19 by 0.08, containing a small number of spermatozoa; pars prostatica expanded, with 2 diverticula, surrounded by numerous prostatic cells; ejaculatory duct fairly long, curved anteriorly, surrounded by numerous glandular cells. Genital atrium small. Genital pore at about junction of middle and posterior thirds of cirrus pouch; sphincter and radial fibers (see *B. gymnothoracis*) well developed. Ovary almost globular, to right of midline, just posterolateral to cirrus pouch, 0.18–0.19 by 0.15–0.16. Ootype-complex between ovary and testis; oviduct ciliated, with a very small pouch (see *B. obovata*); LAURER'S canal fairly long, opening in front of testis. Uterus descending and ascending on right side of testis, coiled a few times between testis and bifurcation of excretory vesicle, containing only disintegrated vitelline cells in one specimen figured but a few spermatozoa in the other specimen, thus forming a weakly developed uterine seminal receptacle; metraterm fairly long. No eggs present in uterus. Small vitelline follicles scattered along intestines between near intestinal bifurcation and posterior ends of intestines. Excretory vesicle V-shaped, in ventral parenchyma; arms reaching to midlevel of esophagus; excretory pore terminal.

Discussion. These specimens, though it is uncertain whether they are immature or senescent, are somewhat similar to *B. tarponis* and *B. palauensis* sp. nov. in that both intestines and vitellaria extend into the posttesticular region. They are different from the adult of *B. tarponis* as described by SOGANDARES-BERNAL and HUTTON (1959) from *Megalops atlanticus* from the Gulf of Mexico in having a larger body, a larger pharynx (=oral sucker of the authors), a larger cirrus pouch and a much more spacious pars prostatica. They are also different from the adult of *B. palauensis* (this paper) in having a larger pharynx, a larger cirrus pouch, a prominent ejaculatory duct and a longer LAURER'S canal. They may well be a new species. Fully gravid worms must be studied.

Other members of *Bivesicula* previously known from Japan

1. *B. claviformis* YAMAGUTI, 1934

(Syn. *B. epinepheli* YAMAGUTI, 1938; *B. xishaensis* GU et SHEN, 1983)

Material examined. 1) Paratypes of *B. claviformis* of YAMAGUTI (1934): 1 gravid whole-mount (MPM Coll. No. 22798) from small intestine of *Seriola quinqueradiata* (Carangidae) (type host); and 4 gravid whole-mounts (MPM Coll. No. 22799) from small intestine [and pyloric ceca] of *Parapristipoma trilineatum* (Pomadasyidae) at Tarumi [now in Kobe, Hyogo Prefecture], on 11 and 17 August 1931, respectively. The holotype has not been located. SHIMAZU (1994) was wrong in locating Tarumi in Okayama Prefecture.

2) One immature and 10 gravid whole-mounts (MPM Coll. No. 22800) of *B. claviformis* of YAMAGUTI (unpublished) from pyloric ceca of *Scomber japonicus* (Scombridae) or *Epinephelus akaara* (Serranidae) at Tarumi on 12 August 1931. YAMAGUTI seems to have been unable to specify the exact host name because he wrote an arrow directed from *S. japonicus* to “?”*E. akaara* on the label. (New host record?)

3) Two gravid whole-mounts (holotype and 1 paratype, MPM Coll. No. 22802) of *B. epinepheli* of YAMAGUTI (1938) from small intestine of *E. akaara* from the Inland Sea [at Tarumi] on 10 August 1935.

4) Twenty-three gravid whole-mounts (MPM Coll. No. 22803) of *B. epinepheli* of YAMAGUTI (1939) from small intestine of *E. akaara* from the Inland Sea [at Tarumi on 6 and 17 August 1938].

5) One gravid whole-mount (NSMT-PI 306) of *B. epinepheli* of MACHIDA *et al.* (1970) from [pyloric cecum of] *E. fario* from the sea north of the Tsushima Islands, Nagasaki Prefecture [on 1 August 1968].

6) Three gravid whole-mounts (NSMT-PI 1953) found in intestine of *Epinephelus* sp. at Chichijima, the Ogasawara Islands, Tokyo, on 27 June 1976 (see also CRIBB *et al.*, 1994). (New locality record.)

7) Thirty-nine gravid whole-mounts (NSMT-PI 1964 and 1981) found in pyloric ceca and first part of intestine of *E. tauvina* at Chichijima on 30 June and 5 July 1976 (see also CRIBB *et al.*, 1994). (New host and locality records.)

Discussion. CRIBB *et al.* (1994) provisionally considered *B. epinepheli* and *B. xishaensis* to be synonymous with *B. claviformis*. We agree to this synonymy because these species are practically indistinguishable from one another in morphology (see also SHIMAZU, 1994) and because it might be that both *B. claviformis* and *B. epinepheli* were obtained by YAMAGUTI himself from the same host species (*E. akaara*) at the same locality (Tarumi). For other previous records of the species, see CRIBB *et al.* (1994).

2. *B. synodi* YAMAGUTI, 1938

Material examined. 1) One gravid whole-mount (holotype, MPM Coll. No. 22801) of *B. synodi* of YAMAGUTI (1938) from small intestine of *Synodus japonicus* [= *S. ulae*] (Synodontidae) at Numazu [in Shizuoka Prefecture] on 12 April 1935. YAMAGUTI described this species on three gravid specimens, but the two others (paratypes?) have not been located.

2) One gravid whole-mount (NSMT-PI 1125) found in intestine of *S. ulae* at Fukaura, Ehime Prefecture, on 18 December 1972. (New locality record.)

Discussion. SHIMAZU (1994) redescribed the structure of the male terminal genitalia in the cirrus pouch on the holotype.

3. *Bivesicula* sp. of MACHIDA *et al.*, 1970

Discussion. MACHIDA *et al.* (1970) obtained a single specimen from intestine of *Sebastiscus marmoratus* (Scorpaenidae) from the sea north of the Tsushima Islands, Nagasaki Prefecture. This specimen has been deposited in the MPM and is being described by ICHIHARA there (ICHIHARA, pers. comm.).

During this study, we found that MACHIDA *et al.* (1970) had erroneously listed *Bivesicula* sp. from the intestine of *Scorpaenopsis cirrhosa* (Scorpaenidae) from the same sea area. Actually, they did not collect any *Bivesicula* specimen from this host.

4. *Bivesicula* sp. of SHIMAZU, 1994

Material examined. Two gravid whole-mounts (MPM Coll. No. 30206) of *Bivesicula* sp. of SHIMAZU (1994) from intestine of a freshwater fish, *Monopterus albus* (Synbranchidae), at Naha, Okinawa Prefecture.

Discussion. Morphologically, these unidentified specimens resemble *B. synodi* to a considerable extent (SHIMAZU, 1994).

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References

- CABLE, R. M., & F. M. NAHHAS, 1962. *Bivesicula caribbensis* sp. n. (Trematoda: Digenea) and its life history. *J. Parasitol.*, 48: 536–538.
- CRIBB, T. H., R. A. BRAY, & S. C. BARKER, 1994. Bivesiculidae and Haplospolychnidae (Digenea) from fishes of the southern Great Barrier Reef, Australia. *Syst. Parasitol.*, 28: 81–97.
- CROWCROFT, P. W., 1947. Some digenetic trematodes from fishes of shallow Tasmanian waters. *Pap. Proc. R. Soc. Tasmania*, 1946: 5–25.
- GU, C.-d., & SHEN, J.-w., 1983. Digenetic trematodes of fishes from the Xisha Islands, Guangdong Province, China. I. *Stud. Mar. Sinica*, (20): 157–184. (In Chinese, with English summary.)
- LE ZOTTE, L. A., Jr., 1954. Studies on marine digenetic trematodes of Puerto Rico: the family Bivesiculidae, its biology and affinities. *J. Parasitol.*, 40: 148–162.
- MACHIDA, M., A. ICHIHARA, & S. KAMEGAI, 1970. Digenetic trematodes collected from the fishes in the sea north of the Tsushima Islands. *Mem. Natn. Sci. Mus., Tokyo*, (3): 101–112. (In Japanese, with English summary.)
- MANTER, H. W., 1947. The digenetic trematodes of marine fishes of Tortugas, Florida. *Am. Midland Natural.*, 38: 257–416.
- SHEN, J.-w., 1982. Three new species of genus *Bivesicula* YAMAGUTI, 1934 (Trematode [sic]: Bivesiculidae) from marine fishes of China. *Oceanol. Limnol. Sinica*, 13: 570–576. (In Chinese, with English summary.)
- SHIMAZU, T., 1994. A species of *Bivesicula* (Digenea: Bivesiculidae) from a freshwater fish of Japan.

J. Nagano Pref. Coll., (49): 17-20.

- SOGANDARES-BERNAL, F., & R. F. HUTTON, 1959. *Bivesicula tarponis*, a new trematode in the tarpon, *Megalops atlanticus* (CUV. & VAL.), from the west coast of Florida. *J. Parasitol.*, 45: 114-118.
- YAMAGUTI, S., 1934. Studies on the helminth fauna of Japan. Part 2. Trematodes of fishes, I. *Jpn. J. Zool.*, 5: 249-541.
- 1938. Studies on the Helminth Fauna of Japan. Part 21. Trematodes of Fishes, IV. Author's publication, Kyoto, 139 pp., 1 pl.
- 1939. Studies on the helminth fauna of Japan. Part 26. Trematodes of fishes, VI. *Jpn. J. Zool.*, 8: 211-230, pls. 29-30.
- 1970. Digenetic Trematodes of Hawaiian Fishes. Keigaku Publishing Co., Tokyo, 436 pp.
- 1971. Synopsis of Digenetic Trematodes of Vertebrates. Keigaku Publishing Co., Tokyo, 2 vols., 1074 pp., 349 pls.

