

Digenetic trematodes of marine fishes from the Arabian Gulf off the coast of Kuwait. Family Bucephalidae Poche, 1907, and the description of a new species

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Summary

Six species of Bucephalidae are reported: Subfamily Bucephalinae: *Bucephalus sphyraenae* Yamaguti, 1952 from *Sphyraena obtusata* and *S. chrysoaenia* (Sphyraenidae) (new host records); *Bucephalus margaritae* Ozaki and Ishibashi, 1934 from *Atropus atropus*, *Scomberoides commersonianus*, *Carangoides malabaricus* (Carangidae), *Gerres filamentosus* (Gerreidae) (new host record) and *Sphyraena jello* (new host record); *Rhipidocotyle pseudorhombi* n. sp. from *Pseudorhombus arsius* is characterized by and differs from its congeners by several characteristics including an elongate body, a rhynchus with 7 thin papillae, a long tular caecum extending posteriorly to the ovarian level, gonads in the posterior half of the body, and contiguous testes not separated by uterine coils. More specifically it differs from *R. heptathelata* and *R. septapapillata* by having a long cirrus sac relative to body length, tandem and more anterior testes. Subfamily Proisorhynchinae: *Proisorhynchus pacificus* Manter, 1940 from *Epinephelus tauvina* (Serranidae) and *Gnathonodon speciosus* (Carangidae) (new host record); *P. epinepheli* Yamaguti, 1939 from *Epinephelus areolatus*; *P. manteri* Srivastava, 1938 from *Trichiurus lepturus* (Trichiuridae). All species, except *Proisorhynchus epinepheli* represent new records from the Arabian Gulf.

Key words: Arabian Gulf; Kuwaiti coast; marine fishes; digenetic trematodes; Bucephalidae; Bucephalinae; *Bucephalus*; *Rhipidocotyle*; Proisorhynchinae; *Proisorhynchus*

Introduction

This is the eighth paper in a series on digenetic trematodes of marine fishes obtained by the second author from fishes captured off the Kuwaiti coast of the Arabian Gulf (see Sey & Nahhas, 1997). It reports 6 species belonging to family Bucephalidae Poche, 1907, one of which is new.

Materials and Methods

Fishes were obtained from a local fish market and kept on ice or in the refrigerator until examined under a dissecting microscope. The digeneans were washed in saline, fixed in cold AFA (alcohol-formalin-acetic acid) under slight coverglass pressure, rinsed in 70 % ethanol, stained with alum carmine, destained in diluted HCl, dehydrated in ascending concentrations of ethanol, cleared in clove oil, and mounted in Canada balsam. Prevalence, mean intensity and mean abundance are calculated according to definitions given by Bush *et al.* (1997). Measurements are expressed in micrometers and indicated as a range, length followed by width; the mean in parentheses is calculated for those species with measurements done on 3 or more specimens; numbers are rounded to the nearest decimal. Drawings were prepared by micro-projection or tracing of photographs taken by a Kodak digital camera (CX 7300) or a Nikon eclipse E800 microscope and captured with an Optronics DEL-750 camera coupled with Image-Pro Plus Software (Media Cybernetics). Details were filled in through microscopic observations. The holotype is deposited with voucher specimens of other species in the United States Parasite Collection (USNPC), Beltsville, MD, USA; others in the Parasitology Collection of the University of the Pacific (UOP), Stockton, CA, USA. Identification of the bucephalids to the generic level is based on Overstreet and Curran (2001). Fishes were identified using Kuronuma and Abe (1986), reference to Randall (1995) and names updated by Froese and Pauly (2005).

Family Bucephalidae Poche, 1907

Subfamily: Bucephalinae Poche, 1907

Genus: *Bucephalus* Baer, 1827

Bucephalus sphyraenae Yamaguti, 1952 (Fig. 1)

Taxonomic summary

Hosts: *Sphyraena obtusata* Cuvier, 1829 (Sphyraenidae-

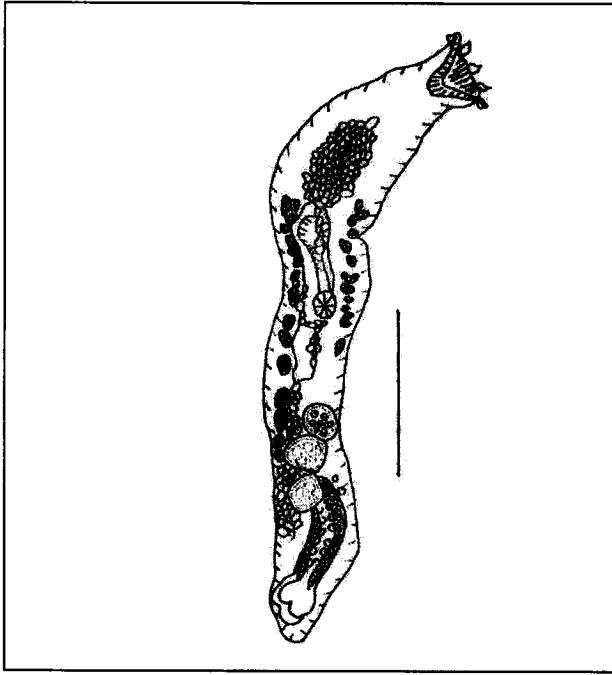


Fig. 1. *Bucephalus sphyraenae*: Whole mount from *Sphyraena chrysotaenia*-ventral view

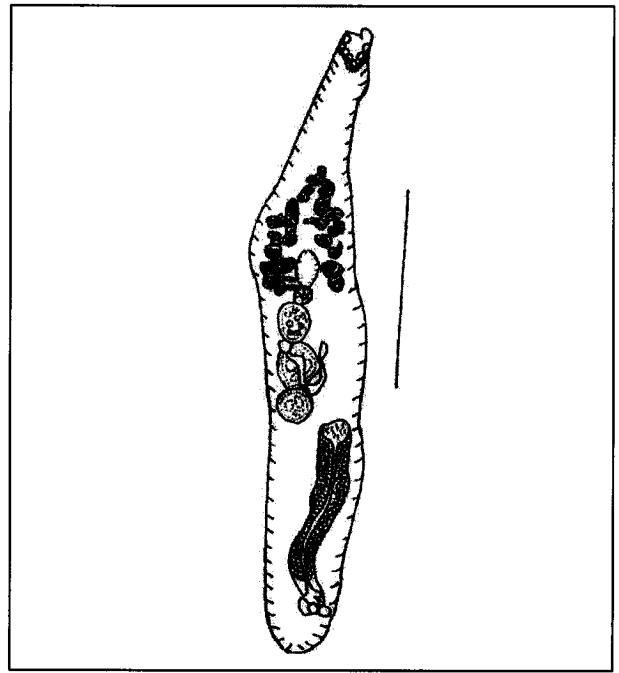


Fig. 2. *Bucephalus margaritae*: Whole mount from *Atropus atropos*-ventral view

new host record); *S. chrysotaenia* Klunzinger, 1884 (*Sphyraenidae*-new host record)

Dates of collection: *S. obtusata* 20 July 1993; *S. chrysotaenia* 25 January 1994

Locality: Arabian Gulf (fish market-Kuwait)

Sites of infection: caeca; intestine

Levels of infection: *S. obtusata*: prevalence: 1/6 = 17 %, mean intensity 2, mean abundance 0.33; *S. chrysotaenia*: prevalence 1/5 = 20%, mean intensity 4, mean abundance 0.8.

Specimens deposited: *S. obtusata*: USNPC 96465, UOP K-59; *S. chrysotaenia*: USNPC 96466, UOP K-133

Description

Description is based on 6 specimens from 2 host species: Body 1 500 – 2 175 x 180 – 325 (1 821 x 255). Tegument spinose, spines extending to posterior end of body. Rhynchus 80 – 137 x 75 – 150 (109 x 134), with 7 tentacles, 3 in the middle, and 2 on each lateral side; each tentacle with a single unbranched prong. Pharynx 40 – 65 x 50 – 75 (51 x 63), slightly postequatorial; oesophagus 123 – 195 (142); intestine ovoid sac, directed anteriorly. Gonads in posterior third of body, tandem, contiguous or slightly separated; anterior testis 95 – 135 x 75 – 123 (122 x 102); posterior testis 90 – 130 x 93 – 120 (108 x 103). Cirrus sac 350 – 550 x 75 – 95 (454 x 85), containing spherical to ovoid seminal vesicle, 63 – 100 x 38 – 60 (79 x 54), pars prostatica 287 – 387 x 35 – 60 (342 x 43), surrounded by prostatic cells, and cirrus 90 and 125 long in 2 specimens. Ovary pretesticular, 100 – 123 x 88 – 105 (110 x 100). Vitellarium in 2 rows, 15 – 20 follicles each, extending laterally from junction of gonads to about anterior third of body.

Uterus extending to anterior fourth of body, and posteriorly to near genital atrium, rarely intruding between gonads. Eggs 13 – 20 x 10 – 18. Genital atrium 68 – 150 x 63 – 125 (107 x 95), with 2 – 3 genital lobes, opening by short duct at posterior end of body. Excretory vesicle tubular, extending to anterior level of uterus or slightly more anterior.

Remarks

Yamaguti (1952) described this species from 2 specimens obtained from the intestine of *Sphyraena* sp. from Celebes and noted that "so far as the body size and the topography of the internal organs are concerned the present species represents an intermediate form between *Bucephalus uranoscopi* Yamaguti 1934, and *B. varicus* Manter, 1940. From either of these it can easily be distinguished by the apical tentacles being devoid of side branches or tubercles. Further, it is to be noted that the intestine lies in the species in question ventral to the uterus by which it is separated from the dorsal wall of the body, whereas it extends to near this wall in *B. uranoscopi* and *B. varicus*." Our material is generally smaller but agrees with the original description in the topography of the internal organs. The rhynchus in one of our specimens shows 7 short and pointed tentacles, 3 in the middle and a pair on each lateral side that seem to be attached at their base. We accept the synonymy of *B. varicus* with *B. margaritae* Ozaki and Ishibashi, 1934. *Bucephalus sphyraenae* and *B. margaritae* can be distinguished from each other by the structure of the fully protruded tentacles, which are devoid of side branches in the former but present in the latter. *B. sphyraenae* was reported from the Red Sea and Bay of Aden fishes by Parukhin (1970). He found 3 – 174 specimens in the pyloric caeca of 5 of 6

Table 1. Range of measurements, mean in parentheses of *Bucephalus margaritae* from 5 host species; n = number of specimens measured/number found

		<i>Atropus atropos</i> n = 10/20	<i>Scomberoides commersonianus</i> n = 9/9	<i>Carangoides malabaricus</i> n = 10/20	<i>Gerres filamentosus</i> n = 10/14	<i>Sphyraena jello</i> n = 5/5
Body	L	890 – 1750	625 – 825	675 – 2,175	1,300 – 1,650	950 – 2,100
	W	225 – 375 (1 320 x 292)	210 – 250 (695 x 228)	125 – 350 (1 231 x 238)	200 – 350 (1 421 x 297)	150 – 250 (1 531 x 182)
Rhynchus	L	63 – 163	123 – 150	60 – 190	75 – 150	70 – 110
	W	35 – 113 (118 x 81)	110 – 140 (139 x 124)	52 – 129 (110 x 115)	73 – 125 (124 x 103)	110 – 130 (86 x 120)
Pharynx	L	30 – 75	45 – 55	38 – 60	63 – 113	48 – 60
	W	30 – 75 (53 x 55)	38 – 40 (52 x 44)	45 – 60 (45 x 50)	70 – 100 (84 x 85)	33 – 50 (54 x 44)
Anterior testis	L	110 – 230	75 – 90	100 – 140	92.5 – 150	88 – 135
	W	115 – 210 (152 x 156)	50 – 100 (83 x 82)	83 – 150 (118 x 111)	80 – 200 (137 x 146)	75 – 120 (129 x 96)
Posterior testis	L		50 – 85	103 – 150	120 – 150	83 – 113
	W	87.5 – 200 (141 x 144)	50 – 100 (70 x 69)	75 – 150 (126 x 116)	120 – 163 (130 x 119)	75 – 110 (96 x 90)
Cirrus sac	L	238 – 620	183 – 220	203 – 450	387 – 455	260 – 375
	W	47.5 – 110 (382 x 81)	50 – 60 (200 x 56)	38 – 120 (284 x 67)	57.5 – 100 (440 x 80)	48 – 75 (314 x 58)
Seminal Vesicle	L	40 – 103	50 – 75	53 – 70	80 – 112.5	58 – 88
	W	40 – 88 (70 x 60)	42 – 68 (64 x 49)	35 – 63 (63 x 47)	55 – 75 (88 x 70)	30 – 48 (68 x 40)
Pars Prostatica	L	175 – 390	98 – 130	140 – 380	275 – 400 (322)	187 – 300
	W	20 – 38 (263 x 24)	38 – 40 (116 x 39)	36 – 44 (244 x 40)	23 – 40 (322 x 30)	20 – 28 (234 x 24)
Cirrus	L	Coiled	15 – 25 (23)	Coiled	Coiled	22 (up to 22)
Ovary	L	80 – 130	50 – 73	80 – 140	50 – 162.5	78 – 120
	W	70 – 160 (105 x 112)	45 – 85 (61 x 68)	70 – 138 (107 x 109)	42 – 132.5 (112 x 103)	80 – 113 (97 x 93)
Vitelline follicles		16 – 18	12 – 16)	14 – 17	15 – 18	16 – 18
Eggs LxW		(16x12)	(18 x 13)	(18 x 12)	(15 x 11)	(17 x 14)
Genital atrium	L	78 – 135	55 – 93	53 – 160	112 – 137	63 – 83
	W	63 – 125 (103 x 91)	38 – 93 (67 x 61)	57 – 120 (92 x 82)	90 – 112.5 (123 x 104)	58 – 93 (70 x 71)
Post-testicu-lar space		210 – 630 (429)	150 – 225 (184)	250 – 700 (538)	550 – 630 (596)	250 – 375 (296)

Sphyraena tessera (now *S. genie*) but gave no description or illustrations. *Sphyraena obtusata* was found to harbour *Bucephalus varicus* by Zaidi and Khan (1977) in the Bay of Bengal, and by Bilqees (1981) in the Karachi coast. The former's agrees with that of *B. margaritae*. The latter did not compare her specimens with those of Yamaguti (1952). *Bucephalus margaritae* was found in the present Kuwaiti study in *S. jello* Cuvier, 1829 (and several other fish hosts) and compared with specimens from *S. chrysotaenia*.

Bucephalus margaritae Ozaki & Ishibashi, 1934 (Fig. 2)

Taxonomic summary

Synonyms: *Prosorhynchus margaritae* (Ozaki & Ishibashi, 1934) Ozaki, 1960; *Bucephalus polymorphus* von Baer in

Nagaty (1937); *B. varicus* Manter, 1940; *B. pseudovaricus* Velasquez, 1959; *B. retractilis* Yamaguti, 1959; *B. carangoides* Yamaguti, 1970; *B. ulua* Yamaguti, 1970

Hosts: *Atropus atropos* (Bloch & Schneider, 1801) (Carangidae); *Scomberoides commersonianus* Lacépède, 1801 (Carangidae); *Carangoides malabaricus* (Bloch & Schneider, 1801) (Carangidae); *Gerres filamentosus* Cuvier, 1829 (Gerreidae - new host record);

Sphyraena jello Cuvier, 1829 (Sphyraenidae - new host record).

Dates of collection: *A. atropos* 26 April 1995; *S. commersonianus* 21 June 1993; *C. malabaricus* 29 July 1993, 18 April 1996; *G. filamentosus* 10 October 1995; *S. jello* 15 October 1993.

Locality: Arabian Gulf (fish market-Kuwait)

Sites of infection: caeca; intestine

Levels of infection: *A. atropos*: prevalence 1/5 = 20 %, mean intensity 20, mean abundance 4; *S. commersonianus*: prevalence 1/9 = 11 %, mean intensity 9, mean abundance 1; *C. malabaricus*: prevalence 2/11 = 18 %, mean intensity 11, mean abundance 2; *G. filamentosus*: prevalence 1/4 = 25 %, mean intensity 14, mean abundance 3.5; *S. jello*: prevalence 1/3 = 33 %, mean intensity 5, mean abundance 1.67.

Specimens deposited: *A. atropos*: USNPC 96467, UOP K-212; *S. commersonianus*: USNPC 96468, UOP K-212; *C. malabaricus*: USNPC 96469-96470, UOP K-69, K-313; *G. filamentosus*: USNPC 96471, UOP K-240; *S. jello*: USNPC 96472; UOP K-82.

Description (measurements of *B. margaritae* from 5 host species are listed in Table 1).

The characteristics of *B. margaritae*, based on 44 specimens from 5 host species include body length to width ratio of about 4 – 7:1. Tegument spinose, spines along entire body. Rhynchus with 7 tentacles, each with a large basal and a small distal prong. Pharynx pre- or post-equatorial; oesophagus short; intestine sac-like, directed anteriorly. Gonads contiguous or slightly separated, tandem, chiefly in mid body third. Cirrus sac one fifth to one third body length; seminal vesicle oval or spherical; pars prostatica usually 3 – 6 times length of seminal vesicle. Cirrus short, often coiled. Ovary pretesticular, unlobed. Vitelline follicles preovarian, lateral, 13-20 on each side, occasionally confluent anteriorly. Uterus extending posteriorly beyond genital atrium and anteriorly to level of follicles, rarely more anterior. Eggs in our specimens are of smaller size, 15 – 18 x 11 – 14 compared with literature reports of 14 – 27 x 10 – 23. Excretory vesicle tubular, extending halfway between anterior level of vitellaria and rhynchus.

Remarks

Figure 2 shows a whole mount of this species from *A. atropos*. The tentacles are withdrawn into the rhynchus, a feature seen in many of our specimens from different hosts. *Bucephalus margaritae* can be suspected from the topography of its internal structures but definitive identification depends on finding specimens with 7 tentacles, one of which at least, shows a protruded tentacle. When the tentacles are withdrawn into the rhynchus, their number can be determined by the number of “knobs” on the surface of the rhynchus; the characteristic tentacle with a large basal and a small distal prong must be evident in some specimens. The length of the pars prostatica, compared with the seminal vesicle, is usually about 3 – 5 times longer, but in one specimen from *C. malabaricus*, it is about 6 times. The pars prostatica is usually straight but in some it is slightly curved.

Table 1 compares the range of measurements and the mean of *Bucephalus margaritae* from the 5 host species found in this study. In general, the specimens from *S. commersonianus* are smaller in body size and in most internal organs; the location of the pharynx in specimens from the various host species is at 35 % to 53 % of body length

from anterior end. The bucephalids from all these hosts meet the diagnosis given for *B. margaritae*. The differences in measurements, in our opinion, suggest that differences in size and internal structures, as a major and only criterion, to distinguish among species of the same genus developing in different host species should be carefully evaluated.

Except for somewhat larger pharynx and seminal vesicle, the specimens from *Gerres filamentosus* fit well within the characteristics of *B. margaritae*. This finding represents a new host record.

Sphyraena jello is also a host for *Bucephalus kaku* Yamaguti, 1970. Toman (1989) reported it from the Seychelles. His specimens were a little smaller than those of Yamaguti (1970) from *Sphyraena barracuda* (Walbaum) and *S. helleri* Jenkins from Hawaii. Chief characteristic of *B. kaku*, according to Yamaguti (1970), is a “strongly muscular, fan-shaped (rhynchus) in dorsoventral view, 0.1 – 0.26 x 0.1 – 0.35 mm, with 11 horn-like tentacular appendages along its anterior margin, each with a nodular or denticular process.”

A historical review of *B. margaritae* and its relationship to *B. varicus*, Manter, 1940 and to *B. polymorphus* from marine fishes is discussed in Bray (1984). *B. varicus* has been recorded “in the Caribbean Sea, Pacific coast of Panama and Mexico, Brazil, Guinea-Bissau, China, South China Sea, Mediterranean coast of Israel, Red Sea, Arabian Sea, Hawaii, India and Japan” (Bray, 1984), and now from the Arabian Gulf (new locality record). *Caranx* and *Carangoides* spp. are the most common hosts of *B. margaritae*. Other carangid genera include “*Alectis*, *Atropus*, *Chloroscombrus*, *Chorinemus*, *Lichia*, *Palometa*, *Selar*, *Seriola*, *Trachinotus*, *Zonichthys*” (Bray, 1984). These infections are not restricted to Family Carangidae. “Other families are represented by *Scomberomorus* (Scombridae), *Menticirrhus* (Sciaenidae), *Pomatomus* (Pomatomidae), *Terapon* (Teraponidae), *Polynemus* (Polynemidae), *Scolopsis* (Nemipteridae), *Sphyraena* (Sphyraenidae), *Pomadasys* (Pomadasyidae) and *Centropomus* (Centropomidae)” (Bray, 1984). The characteristics of *B. varicus* as reported by various authors are variable especially as they relate to egg size, the range of which is 14 – 27 x 10 – 23. Another variable feature is the anterior extent of the uterus described by some as reaching the level of the vitelline follicles, more anteriorly by others. Bray (1984) considered the Hawaiian species of Yamaguti *B. carangoides* and *B. ulua* from *Carangoides* sp. and *Carangoides ferdau* (Forsskål), respectively, as synonyms of *B. margaritae* “as they fit comfortably into the variation exhibited by this species”. The same is true of *B. pseudovaricus* Velasquez, 1959 and *B. retractilis* Yamaguti, 1959. Our large collection of specimens from 5 host species confirms this synonymy. It should be noted, however, that Yamaguti (1971) does not seem to recognize the synonymy of *B. varicus* with *B. margaritae* as both are listed among the species of *Bucephalus*.

Genus: *Rhipidocotyle* Diesing, 1858

Rhipidocotyle pseudorhombi n.sp. (Figs 3a – d)

Taxonomic summary

Host: *Pseudorhombus arsius* (Hamilton, 1822) (Paralichthyidae)

Locality: Arabian Gulf (fish market-Kuwait)

Sites of infection: intestine

Levels of infection: prevalence: $1/38 = 2.6\%$; mean intensity 10; mean abundance 0.26; Holotype and one paratype: USNPC 96481-96482; paratypes UOP K-346

Etymology: The species name is derived from that of the host

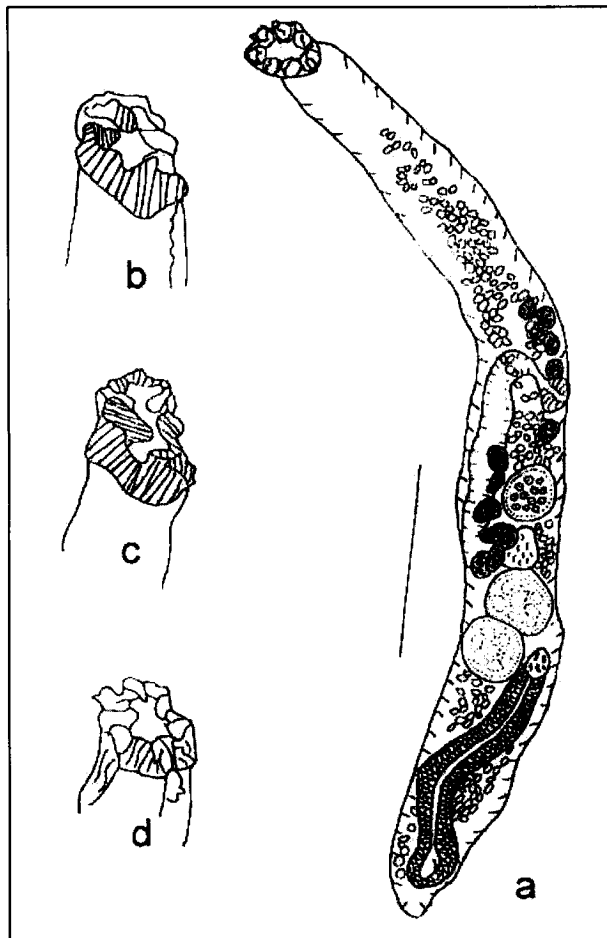


Fig. 3. *Rhipidocotyle pseudorhombi* n. sp.: a – Whole mount from *Pseudorhombus arsius* - ventral view; b - d – rhynchus at various depths as seen by a Nikon Eclipse E800 microscope

Differential diagnosis

Identification of these specimens to the generic level is based on the key to Family Bucephalidae Poche, 1907 by Overstreet and Curran (2001) who placed the genus *Rhipidocotyle* Diesing, 1858 in Subfamily Bucephalinae Poche, 1907 and characterized it as follows: "Rhynchus a simple feeble sucker with dorsal hood; hood with or without associated lateral and/or frontal fleshy lobes. Mouth near midbody. Caecum sac-like, variably directed from

pharynx. Testes oblique. Seminal vesicle spherical to slightly ovoid. Pars prostatica curved, never straight. Ovary pretesticular. Vitellarium in two fields, anterior to ovary. Excretory vesicle variable in length". Overstreet and Curran (2001) considered *Nannoenterum* Ozaki, 1924 and *Pararhipidocotyle* Kohn, 1970 synonyms of *Rhipidocotyle*. In their key to the genera of Subfamily Bucephalinae, the rhynchus of *Rhipidocotyle* is described as a simple sucker covered by simple muscular hood or hood with three to five large fleshy lobes". Several species of *Rhipidocotyle*, however, are characterized by 7 fleshy lobes or papillae. The hood in *R. pseudorhombi* n. sp. seems to be poorly developed in most and not seen in some.

Description

Description is based on 10, measurements partial on some: Body 2 050 – 2 500 x 200 – 260 (2 250 x 234). Tegument spinose, spines extending to posterior end of body, lost partially or completely in some. Rhynchus 80 – 130 x 75 – 125 (108 x 93), with a smooth poorly developed hood and 7 thin papillae, 2 lateral, one dorsal, one ventral and 3 median. Pharynx 33 – 53 x 38-68 (44 x 47), near midbody; distance of pharynx from anterior end 1 125 in 2 specimens; oesophagus short directed anteriorly, diagonally in some; caecum tubular, 410 – 550 x 50 – 90 (483 x 63), anterior portion curves posteriorly, extending to junction of ovary and anterior testis. Gonads in posterior half of body. Testes 2, tandem, spherical; anterior testis 75 – 180 x 60 – 160 (130 x 113); posterior testis 113 – 180 x 130 – 160 (148 x 145). Cirrus sac 20 – 31 % (25 %) of body length, 410 – 763 x 73 – 100 (556 x 85) exclusive of genital atrium; seminal vesicle ovoid, 88 – 113 x 50 – 93 (102 x 69); pars prostatica 350 – 650 x 55 (471 x 55), surrounded by prostatic cells; cirrus short, often coiled. Ovary pretesticular, 100 – 150 x 80 – 138 (128 x 113); seminal receptacle (?) 38 – 118 x 75 – 100 (78 x 88). Vitelline follicles lateral, 14 – 21 on each side, in midbody third. Uterus extending to posterior level of genital atrium and anteriorly to about 15 – 20 % from anterior extremity. Eggs 18 – 20 x 10 – 13 (19 x 12). Genital atrium 68 – 100 x 65 – 75 (81 x 70), genital lobes 3. Excretory vesicle tubular, extending to about anterior level of follicles.

Remarks

These specimens were not in the best condition when recovered from the intestine of their host. They stained well, however, and their internal organs clearly visible. *Rhipidocotyle pseudorhombi* n. sp. is characterized by an elongate body, a rhynchus with 7 thin papillae, a long tubular caecum extending posteriorly to the ovarian level. The gonads are in the posterior half of the body; the testes contiguous, not separated by uterine coils. The vitelline follicles are lateral in midbody third. Among the more than 50 nominal species in the genus *Rhipidocotyle*, several are characterized by a long body, and an elongated tubular caecum. However, species with 7 papillae or fleshy lobes include *R. longlei* Manter, 1934 from *Hypoclydonia bella* (Good & Bean) (now *Synagrops*

bellus, Good & Bean) (Apocropomatidae) at depths of 256 – 457 meters; *R. septapapillata* Krull, 1934 from *Eupomatous gibbosus* (Linnaeus) (now *Lepomis gibbosus*, Linnaeus) (Centrarchidae) and *Fundulus diaphanus* (Lesueur) (Fundulidae) in Virginia; *R. laruei* Velasquez, 1959 from *Psettodes erumei* (Bloch & Schneider) in the Philippines; *R. ghanensis* Fishcthal and Thomas, 1968 from *Psettodes belcheri* Bennett (Psettodidae) from Ghana; *R. karthai* Hafeezullah and Siddiqi, 1970 from *Psettodes erumei* in Visakhapatnam, near Bay of Bengal; *R. heptathelata* (Nagaty, 1937) Stunkard, 1974 for *R. septapapillata* of Nagaty, 1937 from *Thunnus thunina* (Linnaeus) (Scombridae) from the Red Sea; *R. indicus* Gupta and Ahmad, 1976 from *Cynoglossus lida* (Bleeker) (Cynoglossidae) from Puri, Orissa, India; *R. theraponi* Gupta and Tandon, 1985 from *Terapon therap* (Cuvier & Valenciennes) (Teraponidae) also from Puri, Orissa, Bay of Bengal. Some of these species have also been reported by other investigators: *R. ghanensis* from *Psettodes erumei* by Madhavi (1974) who suggested that *R. karthai* Hafeezullah and Siddiqi, 1970 from the same host species is probably a synonym; *R. septapapillata* by Chauhan (1943) from *Chrysopshrys berda* (Forsskål) (now *Acanthopagrus berda*, Forsskål) from Bombay; *R. laruei* was found in *Psettodes erumei* by Reimer (1985) in the Seychelles, and *R. longleyi* in *Telescopias* sp. (Scombridae) in Japan according to Yamaguti (1971), and by Reimer (1985) in *Cubiceps natalense* (Lloyd) (now *Cubiceps squamiceps*) (Nomeidae) in the Seychelles. Among this group, the only species with an elongate tubular caecum are *R. septapapillata* and *R. heptathelata*. All the others have an ovoid or saccular caecum. A long and tubular caecum is a characteristic of species of Dolichoenterinae Yamaguti, 1958 and Paurorhynchinae Dickeman, 1954 but members of these genera have intertesticular ovary. A tubular caecum is also found in *Prosorhynchoides ovatus* (Linton, 1910) according to Overstreet and Curran (2001).

R. heptathelata, described from one immature specimen, has a very small cirrus sac relative to body length and occupies the posterior seventh of the worm; its gonads are diagonal and in the posterior sixth of the body; its body is 3 times larger than *R. septapapillata*. The rhynchus and pharynx are also about two times larger (Gupta & Ahmad, 1976). *R. septapapillata* is from fresh and brackish water fish of unrelated families from Virginia, USA. Chauhan's (1943) report of *R. septapapillata* was very brief. His specimens "were very much longer than those obtained by Krull in Virginia from *Fundulus diaphanus*, the rest of the anatomy was practically identical". In a key to species of *Rhipidocotyle*, Chauhan (1943) described the cirrus sac as "comparatively small, pear-shaped, not extending anteriorly up to testes". He was aware of Nagaty's work on bucephalids evident by including the latter's species in the key, but he did not compare his "specimens" with Nagaty's. The Kuwaiti material has a longer cirrus sac compared with that of *R. heptathelata* and *R. septapapillata*; it also differs in its tandem testes and its host affiliation. Except for its 7 papillae, *R. pseudorhombi* n.sp. has a

strong resemblance in the topography of the internal organs to *R. khalili* Nagaty, 1937, a species with 5 papillae from the milkfish *Chanos chanos* (Forsskål, 1775) (Channidae) in the Red Sea. Nagaty (1937) described the anterior sucker as having "a constant shape of a rounded posterior, truncate anterior, and an average diameter of 122; the anterior sucker is crown-shaped with 2 processes and 3 small conical papillae, one median and 2 lateral." Other similarities to *R. khalili* are evident in the location of the pharynx near the midbody, and the course of the oesophagus which extends anteriorly and then bends backward to form a long tubular caecum reaching the anterior level of the ovary. *R. khalili* was also reported by Yamaguti (1953) from *Sphyræna* sp. from Celebes, by Madhavi (1974) from *Sphyræna obtusata* from the Arabian Sea, and by Reimer (1985) from *Sphyræna japonica* from the Seychelles. All 3 reports more or less confirm the characteristics of the rhynchus. The various Kuwaiti specimens show different orientations of the rhynchus suggesting the presence of as many as 7 thin papillae. In several specimens the papillae are "invaginated" or "folded" inside the rhynchus. The holotype was observed using the Nikon Eclipse E800 microscope which allows visualization of the structures and taking photomicrographs at various depths (Figs 3b – d) thus revealing the presence of a central round depression and 7 thin papillae, 2 lateral, one dorsal, one ventral, and 3 median. The illustrations in figures 3b-d were difficult to draw to show depth, and they do not clearly show the true arrangement of the 7 papillae.

A seminal receptacle is not a characteristic of bucephalids in general (Overstreet & Curran, 2001), although *Neobucephalopsis bagarius* Dayal, 1948 from a freshwater fish was described as having one. A "seminal receptacle" in *R. khalili* described by Nagaty (1937), according to Yamaguti (1953), is the "initial portion of the uterus, containing abundant sperm" that is "convoluted between the ovary and the anterior testis." Such a structure was not mentioned by Madhavi (1974) or Reimer (1985). Nagaty (1937) also suspected its presence in *R. heptathelata* (his figure 38) in the form of a "premordium". In most of our specimens, a large, spherical structure containing sperm that is lodged between the ovary and the anterior testis is consistent with the morphologic characteristics of a true seminal receptacle. A connection to the oviduct or to the ootype was difficult to demonstrate, even in one specimen that was "squashed". Purely on morphologic grounds, we suspect this structure as a seminal receptacle even though we agree that a true (canalicular) seminal receptacle should be demonstrated by sectioning. Overstreet and Curran (2001) do not list a seminal receptacle as a characteristic of *Rhipidocotyle*.

Subfamily: Prosorhynchinae Nicoll, 1914

Genus: *Prosorhynchus* Odhner, 1905

Prosorhynchus pacificus Manter, 1940

(Figs 4a – d and 5)

Taxonomic summary

Synonyms: *Prosorhynchus atlanticus* (Manter, 1940) Hanson, 1950

P. luzonicus (Velasquez, 1959) Madhavi, 1974

Hosts: *Epinephelus tauvina* (Forsskål, 1775) (Serranidae)

Gnathonodon speciosus (Forsskål, 1775) (Carangidae - new host record)

Dates of collection: *E. tauvina* 8 January 1994, 15 January 1994, 16 March 1994; *G. speciosus* 15 January 1994.

Locality: Arabian Gulf (fish market- Kuwait)

Site of infection: intestine

Levels of infection: prevalence: *E. tauvina* 3/12 = 25 %, mean intensity 25, mean abundance 6.3; *G. speciosus*: prevalence 1/21 = 5 %, mean intensity 1, mean abundance 0.05.

Deposited specimens: *E. tauvina* USNPC 96473-96475, UOP K-108, K-117, K-145; *G. speciosus* USNPC 96476, UOP K-123.

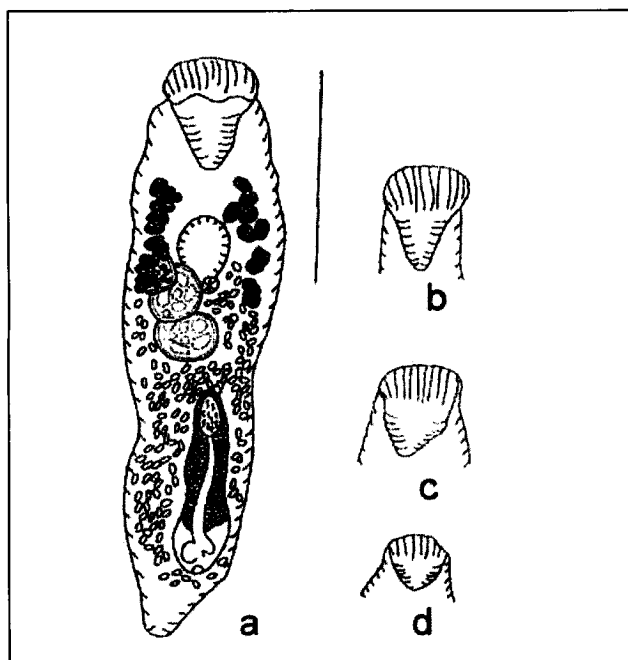


Fig. 4. *Prosorhynchus pacificus*: 4a - Whole mount from *Epinephelus tauvina* - ventral view; 4b-d - variations in the shape of the rhynchus; free-hand drawing

Description

Description and measurements are based on 9 specimens from 3 *Epinephelus tauvina*: Body 1 040 - 1 800 x 260 - 550 (1 319 x 357). Rhynchus 210 - 360, greatest width 130 - 250 (244 x 196). Pharynx 45 - 88 x 63 - 83 (70 x 69), near testicular junction; distance of pharynx from anterior end 310 - 570 (496); oesophagus 0 - 50; intestine sac-like, directed anteriorly. Gonads near midbody. Anterior testis 108 - 160 x 113 - 140 (140 x 133); posterior testis 100 - 170 x 88 - 160 (129 x 125). Cirrus sac 280 - 400 x 78 - 150 (360 x 94); seminal vesicle 99 - 190 x 25 - 55 (126 x 38); seminal duct about half length of seminal vesicle; pars prostatica 150 - 350 (228); cirrus short, mostly coiled in-

side genital atrium. Ovary 98 - 140 x 78 - 140 (111 x 98), contiguous with anterior testis. Vitellarium in 2 lateral groups of 15 - 20 follicles each, extending from near level of testicular junction to about midway between caecum and base of rhynchus. Uterus extensive extending anteriorly to mid-level of caecum, and posteriorly to posterior end of genital atrium. Eggs 20 - 30 x 15 - 24 (26 x 21). Genital atrium 58 - 180 x 67 - 200 (96 x 111).

Measurements on one from *Gnathonodon speciosus*: Body 1 075 x 275. Rhynchus 290 x 180; Pharynx 55 x 63, near junction of testes; distance of pharynx from anterior end 580; oesophagus 45; intestine elongated sac, directed anteriorly. Gonads near midbody. Testes tandem; anterior testis 138 x 148; posterior testis 133 x 145. Cirrus sac 325 x 80; seminal vesicle 100 x 30; seminal duct 25; pars prostatica 160; cirrus short, coiled inside genital atrium. Ovary 120 x 63, preovarian contiguous with anterior testis. Vitellarium in 2 lateral groups of 15 and 20 follicles, extending from near level of testicular junction to about midway between caecum and base of rhynchus. Uterus containing few eggs. Eggs 22 - 25 x 18 - 20. Genital atrium 100 x 75.

Remarks

The shape of the rhynchus in our specimens from *E. tauvina* shows some variations, especially with respect to its base. In the majority of specimens, the rhynchus is as shown in figure 4a; some variations (4b - d) are seen in a few from the same host.

A number of investigators had suggested that *P. atlanticus* is a synonym of *P. pacificus*. Hanson (1950) was the first to suggest such synonymy on the grounds that egg size of her specimens from Bermuda was variable. Several authors including Winter (1960) and Overstreet (1969) agreed, but Siddiqi and Cable (1960) and Nahhas and Cable (1964) did not. Both species have been reported from the Indian Ocean and related waters. *Prosorhynchus pacificus* was reported by Madhavi (1974) from the Bay of Bengal from *E. tauvina* and Hafeezullah and Siddiqi (1970) reported *P. atlanticus* from *E. malabaricus* (Bloch & Schneider). Madhavi (1974) listed an egg size of her specimens as 27 - 33 x 16 - 20; she agreed with the synonymy of *P. atlanticus* and added *P. luzonicus* Velasquez, 1959 from *Lates calcarifer* (Bloch) (Centropomidae) as another. She calculated the range of eggs of *P. pacificus* as reported by the various investigators to be 24 - 36 x 12 - 24. The eggs of *P. pacificus* from *Caranx* sp. from Panama, according to Manter (1940), are smaller (17 - 20 x 11 - 14); those from *Mycteroperca* spp. from the Galapagos Islands are "light yellow, fairly thin shelled, 24 to 27 by 12 to 17 μ , usually about 25 by 17 μ ". Eggs of *P. atlanticus* from *Mycteroperca* spp. from Tortugas, Florida are "ovoid, thick-shelled, brown, 27 to 34 by 14 to 22 microns; average about 30 by 17 microns" (Manter, 1942). Those of *P. atlanticus* from Puerto Rico, reported by Nahhas and Cable (1964), are 31 - 36 x 21 - 24 and 29 - 36 x 18 - 24 for those from Curaçao and Jamaica. Eggs of the Kuwaiti specimens average 26 x 21 and are within the range cited by Madhavi (1974). Hafeezullah and Siddiqi (1970) reported *P. atlanticus*, but gave

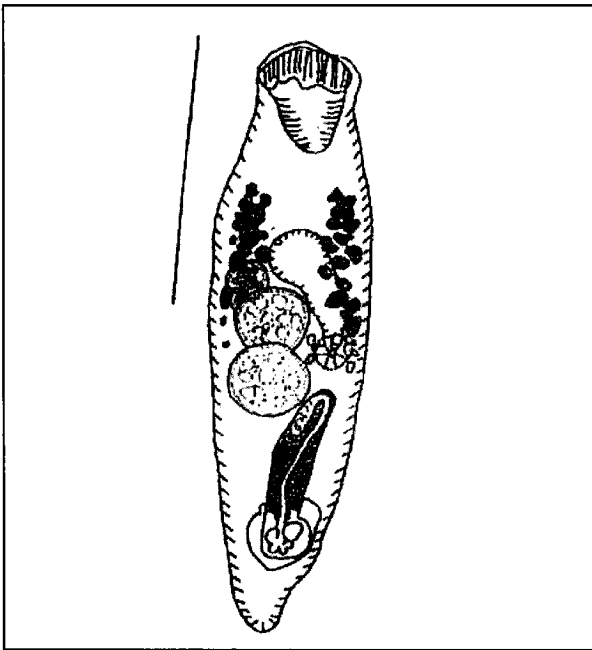


Fig. 5. *Prosorhynchus pacificus*: Whole mount from *Gnathonodon speciosus* - ventral view

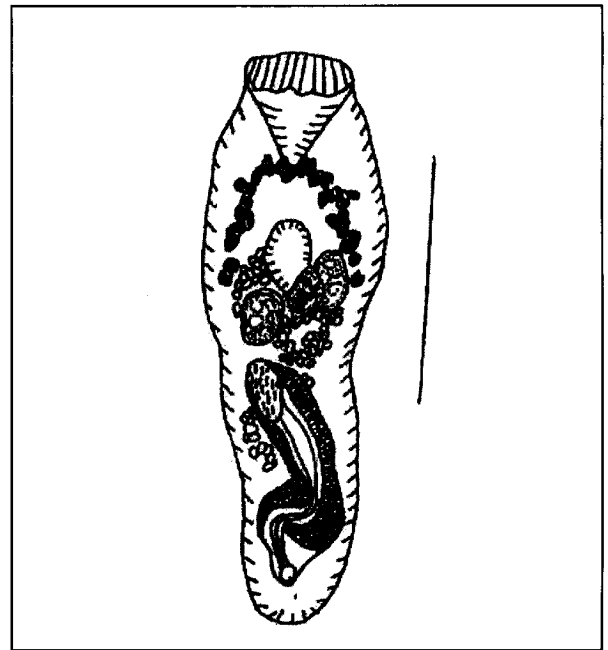


Fig. 6. *Prosorhynchus epinepheli*: Whole mount from *Epinephelus areolatus* - ventral view

no measurements or discussion of its relationship to *P. pacificus*. Madhavi (1974) considered *P. atlanticus* of Hafeezullah and Siddiqi (1970) from *E. tauvina* as *P. pacificus*. *P. pacificus* was originally described from *Mycteroperca* spp. from the Galapagos Islands and neighbouring waters, and later from *Sebastopyr ruberrimus* in Bermuda, (Han-son, 1950). Other reports are those of Sogandares-Bernal (1959) from *Mycteroperca v. venenosa* from Bimini; Winter (1960) from *Epinephelus analogus* from Baja California, Mexico; Nahhas and Short (1965) as *P. atlanticus* from *M. bonaci* from Apalachee Bay, Gulf of Mexico; Overstreet (1969) from *M. bonaci* and *M. microlepis* from Biscayne Bay, Florida; Fischthal (1977) from *M. bonaci* from Belize; Amato (1982) from *M. microlepis* and *M. in-terstitialis* from Southern Brazil.

Parukhin (1970) reported *Prosorhynchus ozakii* Manter, 1934, another Atlantic-Pacific species, from *Epinephelus areolatus* and *E. orientalis* from the Red Sea but gave no illustration or measurements. Gupta and Miglani (1976) reported it from *Rastrelliger brachyosoma* (Bleeker) (Scombridae) from Andaman and Nicobar Islands, India. *P. ozakii* can be distinguished from *P. pacificus* by its diagonal testes, intertesticular ovary, a small reticulate rhynchus with a small funnel-shaped base, and lateral vitelline follicles in the anterior half of the body rather than near midbody third.

Prosorhynchus epinepheli Yamaguti, 1939 (Fig. 6)

Taxonomic summary

Host: *Epinephelus areolatus* (Forsskål, 1775) (Serranidae)
 Dates of collection: 10 December 1993; 25 January 1995;
 29 March 1996.

Locality: Arabian Gulf (fish market – Kuwait)

Sites of infection: intestine

Levels of infection: prevalence: 3/7 = 43 %, mean intensity 8, mean abundance 3.43.

Specimens deposited: USNPC 96477-96479; UOP K-130, K-300, K-304.

Description

Description is based on 13 specimens. Body 875 – 1400 x 325 – 800 (1 145 x 465). Rhynchus 125 – 350 (249), greatest width 190 – 280 (230). Pharynx 53 – 88 x 48 – 85 (67 x 63), near junction of testes; distance of pharynx from anterior end 470 – 730 (575). Gonads near midbody, anterior to cirrus sac. Testes slightly diagonal; anterior testis 113 – 150 x 75 – 150 (128 x 111); posterior testis 100 – 150 x 88 – 140 (127 x 108); Cirrus sac 290 – 550 x 75 – 170 (418 x 121); seminal vesicle 145 – 158 x 38 – 83 (121 x 56); seminal duct 100 – 120; pars prostatica 170 – 288 (211); cirrus coiled. Ovary 80 – 138 x 53 – 138 (112 x 94), at level of anterior testis, occasionally intertesticular. Vitellarium in 2 lateral groups of 18 – 23 follicles extending from level of testicular junction, forming an arch in region between caecum and rhynchus. Uterus extending anteriorly to midlevel of caecum. Eggs 25 – 33 x 13 – 18 (29 x 16). Genital atrium 85 – 175 x 100 – 175 (125 x 135). Excretory vesicle tubular, extending to level of gonads.

Remarks

Prosorhynchus epinepheli Yamaguti, 1939 was described from *Epinephelus akaara* (Temminck & Schlegel) from the Inland Sea, Japan. It was later found in *Epinephelus* sp. by Yamaguti (1970) in Hawaii, and by Hafeezullah & Siddiqi (1970) from *Epinephelus undulosus* (Quoy & Gai-

mard), *E. chlorostigma* (Valenciennes), *E. diacanthus* (Valenciennes), and *Serranus waandersii* Bleeker (Serranidae). In the Arabian Gulf, it was also reported by Saoud *et al.* (1988) from *E. chlorostigma* and by Kardousha (2003) from *E. areolatus*.

Prosorhynchus manteri Srivastava, 1938 (Fig. 7) (Table 2)

Taxonomic summary

Host: *Trichiurus lepturus* (Linnaeus, 1758) (Trichuridae)

Date of collection: 16 March 1994

Locality: Arabian Gulf (fish market-Kuwait)

Site of infection: intestine

Levels of infection: prevalence: 1/8 = 0.13, mean intensity 1, mean abundance 0.13.

Specimen deposited: USNPC 96480

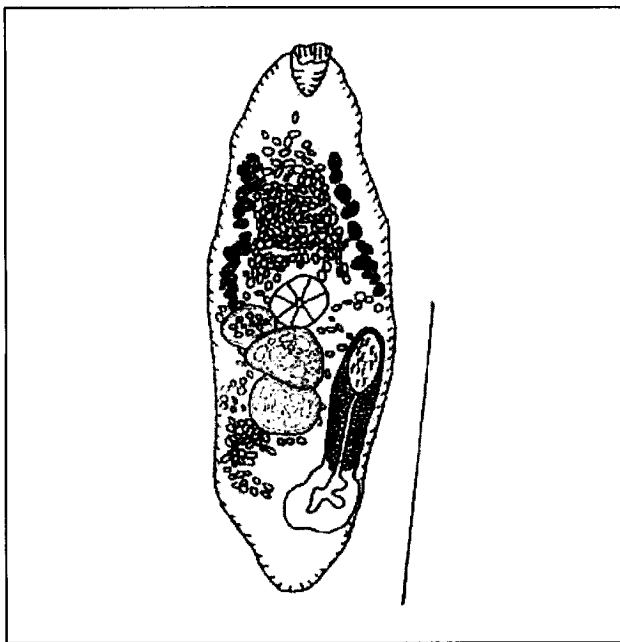


Fig. 7. *Prosorhynchus manteri*: Whole mount from *Trichiurus lepturus* - ventral view. Scale = 0.5 mm

Description

Description is based on one specimen: Body elongated oval, 900 x 310. Tegument spinose, spines relatively long anteriorly, smaller posteriorly. Rhynchus 75 x 63 in greatest width anteriorly, 50 near base. Pharynx 68 x 75, 400 from anterior end at 44 % of body length; oesophagus short; intestine sac-like, directed posteriorly, dorsal to gonads, extending to junction of testes. Testes at level of anterior half of cirrus sac; anterior testis 95 x 133; posterior testis 80 x 100; cirrus sac 260 x 68, exclusive of genital atrium, relatively thick-walled; seminal vesicle oval, 113 x 55; seminal duct 115; pars prostatica 137 x 40; cirrus coiled. Ovary 65 x 78, dextral to and contiguous with anterior testis; Mehlis' gland and ootype dorsal to junction of ovary and anterior testis; Laurer's canal not seen. Vitellarium lateral, in anterior half of body, 15 on left side and 18 on

right side. Uterus extending to near posterior level of genital atrium and anteriorly to 63 from base of rhynchus. Eggs thick-walled, 20 – 25 x 13 – 15; eggs infected by a microsporidian. Genital atrium 115 x 125; pore ventral, subterminal. Excretory vesicle tubular, extending anteriorly to junction of anterior testis with ovary. Posttesticular space 250.

Remarks

Prosorhynchus manteri was described from the intestine of *Tetraodon oblongus* (now *Takifugu oblongus* (Bloch) (Tetraodontidae) by Srivastava (1938) from Puri, Bay of Bengal. Madhavi (1974) found 27 specimens in 4 of 9 *Trichiurus haumela* (Forsskål) (now *T. lepturus*) from Waltair coast, Bay of Bengal, but gave no measurements, illustration or description of her specimens except that "the excretory vesicle extends to level of the ovary rather than to the level of anterior limit of the vitellaria as originally described." Gupta and Ahmad (1976) recovered "numerous" specimens from *Trichiurus muticus* (Griffith) from Puri, Orissa, Bay of Bengal, gave detailed description and 3 illustrations, noting variable extent of the cirrus sac from just posterior to the posterior testis to near the anterior level of the anterior testis; they described the location of the mouth "pre-equatorial, at 0.37 – 0.43 from anterior extremity". Their figure, however, shows a pharynx at the junction of the first and second fourths of the body. Reimer (1985) recovered several specimens from *T. lepturus* from Madras, Bay of Bengal, gave a brief description, an illustration, and compared his measurements with those of Srivastava (1938). All illustrations show a pharynx near the junction of the first and second quarters of the body. Compared with these descriptions and illustrations, our specimen has a slightly different shape, is wider and bulging in the middle; the pharynx is at 44 % from anterior end of the body; the gonads are contiguous and are located chiefly parallel to the cirrus sac instead of being mostly anterior to it; the uterus extends anterior to the vitelline follicles. There might be some justification in naming the Kuwaiti specimen a new species but we are hesitant to do so on the basis of a single specimen. Furthermore, the extent of the uterus depends on the maturity of the worm. The method of fixation can lead to a change in shape, (the bulge in the middle) and consequent dislocation of internal organs (gonads and pharynx). Gupta & Ahmad's (1976) description of the location of the pharynx but not its illustration also suggests variations in position. Gupta and Gupta (1986) described *P. vinodae* from 2 specimens from a related host, *T. muticus*, from the Puri coast. Their illustration shows a close similarity to those of Srivastava's and Reimer's. They distinguished their species from Srivastava's by the "anterior extent of the cirrus sac", a distinction not evident to us in either its description or illustration. Measurements of the various organs in Table 2 show a great deal of overlap and gradations. Table 2 also compares the measurements of the Kuwaiti specimen with those of the 2 species as reported in the literature. Based on literature reports, host affiliation and distribution, and the discrepancy in the

Table 2. Measurements comparing of *Proisorhynchus manteri* and *P. vinodae*

		<i>P. manteri</i> Srivastava, 1938 n = several	Reimer's (1985) <i>P. manteri</i> n = several	Gupta and Ahmad's (1976) <i>P. manteri</i> n = numerous	This paper n=1	<i>P. vinodae</i> Gupta & Gupta, 1986 n = 2
Body	L	860 – 2 260	720 – 1 600	1 460 – 1 600	900	1 160 – 1 310
	W	300 – 64	163 – 313	330 – 450	310	250 – 260
Rhynchus	L	100 – 120	48 – 98	110 – 190	75	110 – 120
	W	80 – 100	42 – 70	58 – 90	63	50
Pharynx	L	50 – 100	76 – 125	80 – 90	68	100 – 110
	W	50 – 100	76 – 112	80 – 90	75	90 – 100
Location of pharynx in body/ distance of pharynx from anterior end/		Junction of first and second fourth	Junction of first and second fourth	at 37 % – 43 % of body length	400; at 44 % of body length	330 – 360 junction of first and second fourth
Anterior testis	L	120 – 500	76 – 125	120 – 186	95	100 – 110
	W	180 – 560	76 – 112	120 – 170	133	90 – 100
Posterior testis	L			126 – 160	80	80 – 100
	W			126 – 170	100	90 – 110
Cirrus sac	L	280 – 600	240 – 326	530 – 632	260	400 – 410
	W	80 – 140	62 – 90	90 – 110	68	60 – 70
Seminal vesicle	L	50 – 100	61 – 107	91 – 105	113	50 – 70
	W	34 – 40	43 – 75	60 – 70	55	30 – 40
Seminal duct	L	Not given	Not given	Not given	115	Not given
Pars prostatica.	L				137	190 – 280
	W				40	
Cirrus	L				50	
Ovary	L	160 – 440	61 – 88	90 – 120	65	80 – 90
	W			70 – 110	78	60 – 70
Eggs	L	19 – 20	20 – 25	18 – 24	20 – 25	18 – 21
	W	11 – 13	12 – 15	12 – 15	13 – 15	14 – 15
Intestine	L	120 – 360	92 – 145	190 – 240		
	W	60 – 340	69 – 73	138 – 165		
Post – testicular space	L				250	360 – 410

location of the pharynx in Gupta and Ahmad's description and illustration, we suspect that *P. vinodae* and the Kuwaiti material represent variations rather than new taxa. We are, however, hesitant to synonymize *P. vinodae* with *P. manteri*.

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