Taxometric analysis of helminthes of marine fishes. 1. *Pedunculacetabulum spinatum* n.sp., from *Chorinemus mandetta* and *Wenyonia rhincodonti* n.sp., from *Rhincodon typus*

Anshu Malhotra · Neeshma Jaiswal ·
H. R. Singh · V. N. Capoor · Sandeep K. Malhotra

Received: 22 January 2011 / Accepted: 3 June 2011 / Published online: 24 June 2011
© Indian Society for Parasitology 2011

Abstract The investigations include report of two new worms from marine fishes of Central West Coast of Goa in Arabian Sea. A trematode, *Pedunculacetabulum spinatum* n.sp. from *Chorinemus mandetta* and *Wenyonia rhincodonti* n.sp. from sharks, *Rhincodon typus* have been described and compared with closer species. The systematics of genus *Pedunculacetabulum* Yamaguti (Japan J Zool 6:1–112, 1934) has been discussed with detailed evidence of taxometric significance to reinstate this genus.

Keywords *Pedunculacetabulum spinatum* n.sp. · *Wenyonia rhincodonti* n.sp. · Synonymy · Taxometry

Abbreviations

A Acetabulum
C Caecum
E Egg
EV Excretory vessel

Part of D.Phil. thesis of Anshu Malhotra awarded by the Allahabad Central University, Allahabad.

A. Malhotra (✉) · N. Jaiswal · V. N. Capoor · S. K. Malhotra
Parasitology Laboratory, Department of Zoology, University of
Allahabad, P.O. Box 2010, Allahabad 211 002, UP, India
e-mail: anshu.malhotra@hotmail.com

S. K. Malhotra
e-mail: emsandip@rediffmail.com

H. R. Singh
College of Fisheries, G.B. Pant University of Agriculture &
Technology, Pantnagar, Uttaranchal, India

Present Address:

A. Malhotra
Department of Biochemistry & Cancer Biology, Meharry
Medical College, Nashville, TN 37208, USA

HD Hermaphroditic duct
OS Oral Sucker
P Pharynx
PL Polar plug
PP Pars Prostatica
Pp Pre-pharynx
Vg Vitelline follicles

Introduction

The dilemma on the systematic position of genus *Pedunculacetabulum* Yamaguti (1934) was highlighted after it was synonymized by Bray and Cribb (1989) on grounds of rejection of criteria based on extension of excretory vesicle to establish their separate identity, as “flimsy” by the latter authors. Therefore, an attempt has been made to provide critical morphological details of characters of this genus that demonstrate taxonomic significance to reinstate *Pedunculacetabulum* as a distinctly separate taxonomic entity. The study also deals with the taxometric description of the cestode, *Wenyonia rhincodonti* n.sp. from deep sea fishes, *Rhincodon typus*.

Materials and methods

10 fishes out of a total 75 *Chorinemus mandetta* examined at Karveddo beach and 22 out of 189 sharks, *Rhincodon typus* at Dona Paula beach, Goa in Central West Coast of India during September 2006 to September 2007 onboard trawlers, were found infected with trematodes and tape-worms, respectively. The collections were a part of investigations conducted during MoU with National Institute of Oceanography, Goa. The fishes were dissected on the spot, the helminthes fixed in Davidson’s fluid and

transported to the Parasitology Laboratory of the University of Allahabad, Allahabad, U.P. The worms were washed till they became transparent, and permanent Haemalum stained preparations of the cestodes were prepared by the usual method (Gairola et al. 1987). The trematodes were dehydrated after staining in Borax Carmine, cleared in xylene to mount in Canada balsam for microscopic examinations. Permanent preparations were examined to keep record of measurements in mm which are mentioned as range with mean $\pm$ S.E. given in parentheses, unless otherwise stated. Camera lucida drawings were prepared. Drawings were made with camera lucida and photomicrographs were prepared from MOTIC Binocular Microscope with BIOVIS Image Plus facility. Polythetic Divisive Classificatory System (Malhotra Sandeep et al. 1981) was applied for taxometric assessment.

Results

Pedunculacetabulum spinatum n.sp. (Figs. 1, 2, 3, 4, 5, 6, 7, 8)

Body medium-sized, narrower, elongate, measuring 4.76–5.92 (5.871 ± 0.001) $\times$ 0.10–0.37 (0.30 ± 0.002). The anterior extremity of body bifurcated with the arm bearing acetabulum at right angles to the one bearing oral sucker (Fig. 1). The minute cuticular spines, 0.001–0.006 (0.004 ± 0.001) long, covered the whole body surface. The internal organs in stained specimens were obscured by the intensely stained gland cells throughout the length of body. Oral sucker terminal (Figs. 1, 4), measured 0.14–0.25 (0.18 ± 0.003) $\times$ 0.17–0.36 (0.22 ± 0.006), and was smaller in size than ventral sucker that measured, 0.16–0.23 (0.19 ± 0.001) $\times$ 0.23–0.41 (0.26 ± 0.005). Acetabulum (Figs. 1, 4) located on a separate pedicel, 0.25–0.31 (0.29 ± 0.004) $\times$ 0.18–0.20 (0.19 ± 0.002) in size. The pre-pharynx small (Fig. 1), measure (0.03 ± 0.003) $\times$ (0.039 ± 0.005), and follows oral sucker which quite often is overlapped by the former in permanent preparations. It continues into a small pharynx, 0.097–0.10 (0.09 ± 0.002) $\times$ 0.11–0.14 (0.12 ± 0.003), after which oesophagus, 0.30–0.90 (0.74) $\times$ 0.02–0.06 (0.11) leads into a bifurcated intestine into two narrow intestinal caecae, 0.02–0.2 (0.1 $\pm$ 0.03) in dia and running parallel at a short distance from each other along the two lateral margins of the body of the worm and measure, 0.02–0.20 (0.03 ± 0.001) in dia. The intestine bifurcates at the level of the meeting point of pedicel of acetabulum with the arm bearing oral sucker at the anterior terminus shortly behind the anterior end of body. These two caecae unequal; end blindly after running up to a short distance before the posterior end of body of the worms.

The male genital pore opened along lateral margin of the body of the worm at the level of pharynx, but female genital pore medially placed at the same level. Testes 2 (Figs. 2, 3), post-ovarian, oval, unequal in size, located in middle to posterior half of body one after the other. The larger testes measure, 0.013–1.4 (0.49 ± 0.002) $\times$ 0.020–1.33 (0.497 ± 0.001), while the anterior smaller testes measure, 0.13–1.0 (0.44 ± 0.002) $\times$ 0.151–1.5 (0.595 ± 0.004), placed a short distance anterior to posterior testes behind ovary. The large elongated cirrus pouch is enlarged antero-medially, measures, 0.09–0.53 (0.091 ± 0.002) $\times$ 0.02–0.09 (0.063 ± 0.002), and tapers down posteriorly to join vas deferens, 0.004–0.007 (0.005 ± 0.0001) in dia and opens through a narrower male genital pore, 0.015–0.026 (0.019 ± 0.004) and 0.005–0.20 (0.06 ± 0.001) wide. Cirrus pouch follows a tortuous course from behind the junction of the pedicel with terminal acetabulum and the stalk possessing oral sucker at the tip, till it opens into male genital pore, located 0.05–0.29 (0.28 ± 0.005) behind anterior end of body. The pedicel with terminal acetabulum measure, 0.50–0.62 (0.59 ± 0.03) $\times$ 0.21–0.42 (0.39 ± 0.04). The stalk possessing oral sucker at the tip measure, 0.39–0.46 (0.43 ± 0.01) $\times$ 0.30–0.36 (0.35 ± 0.002). An elongated bipartite vesicula seminalis (Figs. 1) occupies most of the space inside cirrus pouch, measure, 0.025–0.031 (0.029 ± 0.001) $\times$ 0.151–0.22 (0.156 ± 0.004). The distinct pars prostatica, ductus ejaculatorius and a thinner but quite longer protrusible cirrus are enclosed within cirrus pouch. The equidistant receptaculum seminis, ovary and the smaller and larger testes occupy varied positions from medial to near the lateral margin of the body of the worm. Ovary smooth, small, oval to spherical, measure, 0.07–0.15 (0.09 ± 0.001) $\times$ 0.12–0.19 (0.15 ± 0.006). Vagina measure, 0.006–0.01 (0.009 ± 0.0005) in dia. The receptaculum seminis small oval, preovarian, measured, 0.01–0.054 (0.04 ± 0.002) $\times$ 0.09–0.133 (0.124 ± 0.005). Uterine tube 0.04–0.08 (0.057 ± 0.007) in dia emerging from near the ovary and extended anteriorly, intercaecal. Eggs small, oval to spherical, measure, 0.011–0.013 (0.012 ± 0.001) $\times$ 0.013–0.2 (0.022 ± 0.002) with embryo, 0.004–0.006 (0.0053 ± 0.003) $\times$ 0.008–0.01 (0.009 ± 0.004). Uterine duct, 0.015–0.028 (0.025 ± 0.006) in dia. Vitelline follicles (Figs. 5, 6, 7) smaller, measure, 0.002–0.008 (0.004 ± 0.001) $\times$ 0.002–0.008 (0.004 ± 0.002) and occupy the field extending from just behind pharynx in the arm bearing oral sucker up to almost nearer the excretory vesicle (Fig. 7) at the terminal end of the worm. Vitellaria also extend up to 1/3rd into the basal part of the arm bearing acetabulum in forebody. Eggs (Figs. 7, 8), oval to spherical, measure, 0.011–0.013 (0.012 ± 0.001) $\times$ 0.013–0.20 (0.018 ± 0.002). Eggs small, embryonated containing cleaved embryo showing morula stage. Eggs with polar

Figs. 1–8 *Pedunculacetabulum spinatum* n.sp. **1** Anterior end of worm ($\times 60$), **2** Part of body of adult worm ($\times 60$), **3** Middle part of body to show testes ($\times 60$), **4** Anterior end of worm (magnified $\times 60$), **5** Middle part of body ($\times 60$), **6** Posterior end of body of worm to

show excretory vessels ($\times 60$), **7** Posterior end of worm to show uterus filled with eggs ($\times 60$), **8** Eggs with polar plug and embryonated ova ($\times 240$)

plug at one end, measured, $0.003\text{--}0.007$ (0.004 ± 0.0002) $\times$ $0.004\text{--}0.10$ (0.0053 ± 0.0001). Excretory pore, terminal, $0.02\text{--}0.04$ (0.03 ± 0.002) in dia. Excretory vessels, measured, $0.007\text{--}0.02$ (0.009 ± 0.001) in dia. The

extensions of excretory vesicle reached beyond the junction of intestinal caeca, and pharynx in forebody, entering into the pedicel bearing acetabulum at its extremity.

Discussion

Yamaguti (1970) emphatically asserted to include the worms with characters of Opecoelinae (Ozaki 1925) and with acetabulum placed on a long peduncle that projected at right angles to the body of the worm under genus *Pedunculacetabulum* as per key provided. But Aken'Ova (2003) rightly referred to the location of ventral sucker on a protuberance, used as a matter of convenience by several earlier authors, who dealt with the synonymy of genera under Opecoelinae, particularly of *Pedunculacetabulum*, *Podocotyloides* and *Podocotyle*. Therefore, instead of focusing on details of extensions of excretory vesicle in worms of genus *Pedunculacetabulum* in light of distribution of vitellarian follicles in forebody and other characters highlighted for this genus by Yamaguti (1970), hurried attempts were made to synonymize *Pedunculacetabulum* by undermining the significance of excretory system and distribution of vitellaria in concluding discussion on systematics. Yadav (1982) referred to the revision of the genus *Podocotyle* to split it into genera that were based on characters, such as stalked or unstalked acetabulum, lobed or unlobed ovary, and sinistral or medial genital pore. She synonymized *Pedunculacetabulum* Yamaguti (1934) with *Podocotyloides*. Bray and Cribb (1989) commented that, “Yamaguti (1971) retained *Podocotyloides* and *Pedunculacetabulum* as separate genera based on the length of the excretory vesicle, which is said to reach into the preovarian region nearer to the intestinal bifurcation in the former genus, but its extent is unknown in the latter. This seems a rather flimsy pretext for retaining the genus.” Interesting contradictions have appeared in the report of Bray and Cribb (1989), who themselves declined to accept inclusion of *P. manteri* under *Podocotyloides* with whom *Pedunculacetabulum* was proposed by them to be synonymized, mainly because of extension of vitellaria in the fore body. It was stated by them that, “Two other species also have vitelline fields extending into the forebody and should not, therefore, be placed in *Podocotyloides*. These are *Pedunculacetabulum manteri* (this was pointed out by Pritchard 1966b) and *Podocotyloides pentavitellosus*.”

Bray and Cribb (1989) quoted Manter (1954) and Cribb (1985) to assert varying distribution of vitellarium as the most satisfactory series of characters. Simultaneously, the importance of excretory sac and the related infrastructure of excretory tubules in classification of digenean trematodes has been given due weightage by Yamaguti (1970) and several other earlier authors (Prudhoe and Bray 1973).

Therefore, due consideration was given by Yamaguti (1970) to establish key to genera of Plagioporinae that was, however, disregarded by Pritchard (1966a) to synonymize

Pedunculacetabulum with *Podocotyloides*. Aken'Ova (2003) emphasized to uphold synonymy of *Pedunculacetabulum* with *Podocotyloides*, mainly because of lack of knowledge on the extension of excretory ducts in the anterior part of body beyond ovary.

The distribution of vitelline follicles has been distinctively considered as a character of significant taxonomic value by several earlier authors (Aken'Ova, 2003). Aken'Ova (2003) also emphasized that there is no possibility of distribution of vitellaria to be induced by fixation or the state of the worms prior to fixation. Therefore, the irrational emended generic diagnosis proposed by Aken'Ova (2003) to discard Pritchard's (1966a) and Yamaguti's (1971) concept of distribution of vitelline follicles in hindbody in *Pedunculacetabulum* who also gave weightage to the extension of excretory vesicle in the key proposed by latter author can not be accepted to synonymize *Pedunculacetabulum* with *Podocotyloides*. Accordingly, a preovarian uterus in *Podocotyloides*, excretory vesicle reaching beyond pharynx in the arm bearing oral sucker, and well into the arm bearing acetabulum, unequal intestinal caecae, bipartite seminal vesicle and vitellarian follicles extending into fore body, as far as well into the arm bearing acetabulum and up to pharynx in the arm bearing oral sucker, and up to excretory vesicle in hind body were the distinctive features that established separate identity of *Pedunculacetabulum* separate than *Podocotyloides*. Besides these characters, the extensions of excretory vesicle into the pedunculate arm bearing ventral sucker at its extremity are reported in the current study.

It is worth mentioning that though Aken'Ova (2003) accepted the synonymy of *Pedunculacetabulum* with *Podocotyloides*, as proposed by Bray and Cribb (1989), yet she was very well convinced about the separate taxonomic status of *P. manteri* in which vitelline follicles are distributed in the forebody, contrary to the location of vitellaria in other genera of *Podocotyloides*. On identical grounds, Bray and Cribb (1989) were doubtful about its inclusion as a species under *Podocotyloides*. On this basis too the key proposed by Bray and Cribbs (1989) to assign separate status of *Allopodocotyle epinepheli* Yamaguti (1942) and *Podocotyloides stenometra* Pritchard (1966a) with *Pedunculacetabulum* as its junior synonym cannot be considered valid because its status has been considered on the criteria of distribution of vitellaria in forebody, while other 8 genera with vitellaria distributed in the hind body have been separately placed in the key. It is noteworthy that Aken'Ova (2003) was inclined to retain *P. stenometra* closer to *A. epinepheli* wherein the ventral sucker was not pedunculate, caeca not unequal and body not notably elongate. She also insisted inclusion of *P. stenometra* in the Plagioporinae despite it being consistent with Gibson

Revised Key to genera of
Plagioporinae

-
1. Excretory vesicle unusually long, reaching to near intestinal bifurcation, or beyond it
 Acetabulum pedunculate, overlapped by puckered margin of its stalk;
 Excretory vesicle not reaching intestinal bifurcation*Podocotyloides*
 Excretory vesicle extends through excretory tubules far beyond intestinal bifurcation to cross past pharynx.....*Pedunculacetabulum*
 Acetabulum sessile
 Excretory vesicle reaching to pharynx; oral sucker funnel-shaped; ovary unlobed.....*Choanostoma*
 Excretory vesicle reaching to intestinal bifurcation; oral sucker simple; ovary lobed or not
 Genital pore submedian; excretory vesicle simple; vitellaria extending into forebody
 Genital pore prebifurcal.....*Plagioporus* (*Paraplagioporus*)
 Genital pore postbifurcal.....*Haemacreadium*
 Genital pore median; excretory vesicle branched anteriorly.....*Pacificreadium*
 Excretory vesicle not so long; acetabulum pedunculate or not..... 2
 2. Testes divided into 9 or 10 follicles; vitellaria in fore- and hindbody
 Genital pore submedian; eggs not filamented.....*Decemtestis*
 Genital pore median; eggs filamented.....*Helicometrina*
-

Note: Rest of the key to be retained as per Yamaguti (1971)

and Bray's (1982) concept of the Stenakrinae which showed a predominant vitelline extension in the post-testicular region. Such contradictory interpretations are contrary to acceptance of convincing taxonomic traits, particularly because the detailed study of extensions of excretory vesicle have not been worked out by these authors after Yamaguti (1970, 1971) relied upon the characters of vitellaria distribution and extension of excretory vesicle within Plagioporinae. Therefore, in this light the revised key proposed by Bray and Cribbs (1989) does not hold ground.

Under this inexplicable situation, on the basis of characteristic extension of excretory ducts well beyond junction of intestinal caeca and pharynx, and the smooth ovary and bipartite seminal vesicle further supporting its distinctive status from *Podocotyloides*, therefore, the distinct generic status of *Pedunculacetabulum* Yamaguti (1971) is reinstated. The authors have already begun the processing of materials in hand for DNA sequencing to show further light on the firm taxonomic status of genus *Pedunculacetabulum* in near future. The portion of the key to genera of Plagioporinae given by Yamaguti (1970) has been revised to accommodate genus *Pedunculacetabulum* as per newer knowledge of this genus.

It is now obvious that the precise information on the extension of excretory vesicle and distribution of vitellaria in species under the genus *Pedunculacetabulum* are critical for species under the genus (Yamaguti 1970). Bray and Cribbs (1989) contemplated some of the additions to the list of species of *Pedunculacetabulum* and *Podocotyloides* including the two species, namely, *P. gwaliorensis* and *P. papillatum* described by Bhadauria and Dandotia (1984) to be so poorly described that these should be considered *species inquirendae*. Thus the authors are inclined to uphold the opinion of Bray and Cribbs (1989) that unless complete information on the extension of excretory vesicle is available, these two species are recommended to be *species inquirendae*.

The worms of the new species have shown features typical of the genus *Pedunculacetabulum*, particularly the bifurcated anterior extremity to accommodate acetabulum on a distinct pedicel that was separated from arm on which a terminal oral sucker was located. However, the presence of minute cuticular spines all over the body of the worm brings them closer to the Indian species *P. pedicellata* Srivastava (1938) from which the newer worms have shown distinctive characteristic morphological attributes. It could further be compared with *P. pedicellata* in possessing larger body of

the worms, possessing larger oral sucker, equal oral and ventral suckers (vs. 3 times larger oral sucker than acetabulum), longer arm bearing oral sucker, larger anterior and posterior testes, wider ovary and wider eggs.

The current worms resembled closely with *P. manteri* Nagaty (1942) in the specific characteristics of distribution of vitelline follicles in the forebody. However, the newer worms differed from *P. manteri* in possessing larger body, oral and ventral suckers, unequal intestinal caecae, larger testes, bipartite vesicula seminis, larger pedicels bearing oral sucker as well as acetabulum at their extremities, respectively, genital pore located at lesser percentage distance from anterior extremity, and larger eggs with polar plug at one end. The worms of the new species could also be differentiated from *P. opisthorchis* (Yamaguti 1934) in having larger worms with larger arms bearing larger oral and ventral suckers at their extremities, respectively, unequal intestinal caecae, distribution of vitellaria in forebody as well (Vs restricted to hindbody), bipartite vesicula seminis, smaller distance of larger testes from posterior extremity, genital pore located at lesser percentage distance from anterior extremity, and wider eggs with polar body at one end.

Therefore, based on characteristic differences of the present worms with closer species it is suggested to accommodate these as a newer species, *P. spinatum* n.sp. Three other species namely *P. manteri*, *P. opisthorchis* and *P. pedicellata* have been retained under the genus after Yamaguti (1970).

Wenyonia rhincodoni n.sp. (Figs. 9, 10, 11)

The unsegmented tapeworms possessed typical bothria at the anterior end with vitellaria practically covering the whole body length extending from preovarian region up to the posterior end of bothria in the anterior region. Body, 1.48–2.07 (1.91 ± 0.01) $\times$ 0.062–0.61 (0.43 ± 0.04), with maximum breadth in the region of genital atrium. The flatworms are oval in appearance but not with pointed extremities. Scolex, undifferentiated from rest of the body, measure, 0.04–0.08 (0.07 ± 0.001) $\times$ 0.21–0.25 (0.23 ± 0.02). Bothria 2, small, measure, 0.08–0.13 (0.11 ± 0.02) $\times$ 0.07–0.14 (0.017 ± 0.001). Intestine 0.02–0.03 (0.027 ± 0.006) in diameter. Testes numerous, 173–201 (187 ± 14) in number, scattered from pre-ovarian region up to the region a short distance behind bothria. Testes round to oval, measure, 0.02–0.37 (0.32 ± 0.08) $\times$ 0.02–0.62 (0.42 ± 0.01). The testicular region extends from almost anterior extremity just behind bothria to a distance of 0.29–0.41 (0.38 ± 0.004). Cirrus pouch, broader anteriorly that gradually tapers posteriorly before the vas deferens joins it at the hind end. Cirrus pouch measure, 0.19–0.26 (0.205 ± 0.003) $\times$ 0.03–0.15 (0.136 ± 0.015). Internal seminal vesicle small, measure, 0.0144–0.018 (0.016 ± 0.003) $\times$

Figs. 9–11 *Wenyonia rhincodontii* n.sp. 9 Anterior end of worm ($\times 60$), 10 Posterior end of worm ($\times 60$), 11 Female genitalia of the worm magnified to show association of organs ($\times 240$)

0.019–0.023 (0.02 ± 0.004). Cirrus 0.005–0.008 (0.007 ± 0.001) in dia. Genital pore situated 0.053–0.08 (0.068 ± 0.014) from anterior extremity. Ovary bilobed, in the posterior half of body near hinder extremity, measure, 0.058–0.34 (0.29 ± 0.003) $\times$ 0.11–0.42 (0.265 ± 0.09). Post-ovarian region measure, 0.158 $\times$ 0.19–0.26 (0.24 ± 0.001). Receptaculum seminis small, measure, 0.01–0.054 (0.04 ± 0.002) $\times$ 0.09–0.133 (0.124 ± 0.005). Vagina is a relatively wider tube running medially, almost straight, from ovary to genital pore. Uterine duct, 0.018–0.04 (0.03 ± 0.001) in dia. Uterine region extending up to a space of 0.69–0.75 (0.729 ± 0.002) occupying principally medial region of body. Vitelline follicles, 0.005–0.02 (0.018 ± 0.007) $\times$ 0.02–0.20 (0.14 ± 0.003). Vitellaria are peculiarly assembled into two groups near the excretory pore, each of these bunches measure, 0.19–0.28 (0.25 ± 0.001) and 0.17–0.27 (0.23 ± 0.005) in dia., respectively. Eggs small, measure, 0.02–0.006 (0.035 ± 0.002) $\times$ 0.015–0.062 (0.05 ± 0.009). The Excretory sac medial receiving multiple numbers of excretory vessels, that join to form 3 excretory vessels

Table 1 Polythetic divisive classificatory system applications to substantiate morphometric differences between body organs of *Pedunculacetabulum spinatum* n.sp. vis-a-vis *P. pedicellata*

Characters	<i>Pedunculacetabulum pedicellata</i>		
	C.Dis.	M.C.D.	C.D.
Body			
L	0.13*	0.17*	2.20*
W	0.61	0.02*	2.02*
Oral sucker			
L	0.34	0.03*	2.02*
Acetabulum			
L	0.35	0.34	2.52
Pedicel			
L	0.13*	0.20*	2.30
Oesophagus			
L	0.54	0.30	2.43
Testes			
Anterior			
L	0.82	0.30	2.42
W	0.88	0.40	2.62
Posterior			
L	0.02*	0.23*	2.31
W	0.04*	0.40*	2.55
Cirrus pouch			
L	0.78	0.09*	2.22*
W	0.89	0.18*	2.22*
Receptaculum seminis			
L	0.33	0.03*	2.03*
W	0.66	0.30	2.33
Ovary			
L	0.69	0.004*	2.04*
Eggs			
L	0.16*	0.42	2.69
W	10.75	0.30	2.43

* Non-significant

that open into medial excretory sac. The excretory sac opens outside through a wider excretory pore.

Discussion

The newer tapeworms differed from *W. virilis* Woodland (1923) in possessing smaller body, smaller scolex and smaller eggs. The anterior extremity of the newer worms was not differentiated from the rest of the body in any form, neither expansion nor muscular differentiation. The morphological differences in the distribution of internal organs were conspicuous in that the testicular region extended to as posterior as up to anterior part of ovary, virtually occupying the whole width of worm anterior to genital pore as well as anterior to ovary. In comparison, the testes were restricted up to genital pore in *W. virilis*. The uterine region was not so extensive as seen in *W. virilis*. The vitellaria formed two conspicuous bunches at the hinder extremity, one on each side of the median line, contrary to the scattered vitellarian follicles in the post-ovarian region of the latter species. These worms also differed from *W. acuminata* Woodland (1923) in possessing smaller body, smaller scolex and smaller eggs. Their anterior end did not taper into a finer point as observed in *W. acuminata*, but was quite broadly blunt. In the similar fashion the posterior end of body also did not end in a blunt point but was flatter. The testicular region, the uterine region and the post-ovarian region were smaller in comparison to the closer species. The expansion of uterus region was restricted to a smaller portion in relation to the body size. The extension of vitellaria was recorded well beyond testicular extension nearer the anterior extremity. Posteriorly the compact arrangement of vitellaria into two distinct groups differed significantly from the marginal strand arrangement of vitellaria in the closer species. The worms of the new species could also be differentiated from

Table 2 Polythetic Divisive Classificatory System applications to substantiate morphometric differences between body organs of *Wenyonia rhincodonit* n.sp. vis-a-vis *W. acuminata*, *W. minuta* and *W. virilis*

Characters	<i>Wenyonia acuminata</i>			<i>Wenyonia minuta</i>			<i>Wenyonia virilis</i>		
	C.Dis.	M.C.D.	C.D.	C.Dis.	M.C.D.	C.D.	C.Dis.	M.C.D.	C.D.
Body									
L	0.50	0.50	2.71	0.20*	0.20*	2.23*	0.789	0.50	2.87
W	0.40	0.40	2.52	0.40	0.24*	2.31*	0.58	0.01*	2.01*
Testicular region	0.23*	0.50	2.88	–	–	–	0.78	0.50	2.90
Post-ovarian region	0.08*	0.40	2.53	0.10*	0.50	2.86	0.06*	0.40	2.70
Uterine region	0.41	0.50	2.96	0.41	0.50	2.96	0.13*	0.04*	2.65
Eggs									
L	0.50	0.50	2.99	0.58	0.50	2.99	0.53	0.50	2.99
W	0.41	0.50	2.32*	0.50	0.50	2.99	0.50	0.50	2.99

* Non-significant

W. minuta Woodland (1923) in the absence of bluntly pointed extremities, and possessing a smaller body, smaller scolex and smaller eggs. The uterus in the newer worms is smaller than the testicular region, and does not occupy two-thirds of the entire body length while the former region was nearly twice the length of testicular region in *W. minuta* (Table 1).

Therefore, on the basis of characteristic differentiation of the newer worms with the closer species under the genus, that have been taxometrically substantiated (Table 2), the worms under study are proposed to be accommodated as a new species, *W. rhincodoni* n.sp.

Acknowledgments AM is thankful to Department of Biotechnology, Govt. of India for a Fellowship under Major Research Project no. BT/PRPR4402/SPD/09/350/2003. NJ is grateful to PADI Foundation, California, USA for Research Grant No. 39.

References

- Aken'Ova TO (2003) A new species of *Podocotyloides* Yamaguti (1934) (Digenea: Opecoelidae) from a Western Australian temperate marine fish. *Syst Parasitol* 55:127–133
- Bhadauria S, Dandotia MR (1984) Studies on the trematode parasites of fresh water fishes with special reference to Gwalior region. II: On one new genus and some unknown and known species. *Riv di Parassit* 45:341–383
- Bray R, Cribb TH (1989) Digeneans of the family Opecoelidae Ozaki (1925) from the southern Great Barrier Reef, including a new genus and three new species. *J Nat Hist* 23:429–473
- Cribb TH (1985) The life cycle and biology of *Opecoelus variabilis* sp. nov. (Digenea: Opecoelidae). *Austr J Zool* 33:715–728
- Gairola D, Malhotra Sandeep K, Sukul NC (1987) Bionomics and taxometry of *Cephalobothrium gangeticus* n. sp. parasitizing Indian freshwater and marine fishes. *Riv di Parassit* 4:361–367
- Gibson DI, Bray RA (1982) A study and reorganization of *Plagioporus* Stafford, 1904 (Digenea: Opecoelidae) and related genera, with special reference to forms from European Atlantic waters. *J Nat Hist* 16:529–559
- Malhotra Sandeep K, Dixit S, Capoor VN (1981) A contribution to the study of taxa differentiation in cestode taxonomy. *Proc Indian Acad Sci (Anim Sci)* 90(3):343–349
- Manter HW (1954) Some digenetic trematodes from fishes of New Zealand. *Trans R Soc New Zealand* 82:475–568
- Nagaty HF (1942) Trematodes of fishes from the Red Sea Part 2 The genus *Hamacreadium* Linton, 1910 (Faro Allocreadiidae) with a description of two new species. *J Egypt Med Assoc* 24:300–310
- Ozaki Y (1925) On *Harmostomum horizawai* and its life history. *Tokyo Iji Shinshi* 2434:12–15
- Pritchard MH (1966a) Studies on digenetic trematodes of Hawaiian fishes: Family Opecoelidae. *Jahrb Abt Syst Okol Geog* 93:173–202
- Pritchard MH (1966b) A revision of the genus *Podocotyle* (Trematoda: Opecoelidae). *Zool Jahrb Abt Syst Okol Geog* 93:158–172
- Prudhoe S, Bray RA (1973) Digenetic trematodes from fishes. Reports BANZ Antarct Res Exped Ser B 8:195–225
- Srivastava HD (1938) New allocreadiids from Indian marine food fishes. III. *Pedunculacetabulum pedicellata* 1938 n.sp. from the gut of *Chiloscyllium indicum*. *Ind J Vet Sci Anim Husb* 8:403–405
- Woodland WNF (1923) On some remarkable new forms of Caryophyllaeidae from the Anglo-Egyptian Sudan, and a revision of the families of the Cestodaria. *Quart J Micr Sc* 67:435–472
- Yadav BB (1982) *Podocotyloides pentavitellus* n. sp. (Trematoda: Opecoelidae) from the marine fish *Chirocentrus dorab* (Ruppell), in India. *Proc Indian Acad Parasitol* 2:67–70
- Yamaguti S (1934) Studies on the helminth fauna of Japan. Pt. 4. Cestodes of Fishes. *Japan J Zool* 6:1–112
- Yamaguti S (1942) Studies on the helminth fauna of Japan. Part 39. Trematodes of fishes mainly from Naha. *Biogeographica Tokyo* 3:329–397
- Yamaguti S (1970) Synopsis of digenetic trematodes of vertebrates. 1. Keigaku Publication Company, Tokyo
- Yamaguti S (1971) Synopsis of digenetic trematodes of vertebrates. 1. Keigaku Publication Company, Tokyo