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Rediagnosis of *Ichthyotrema* Caballero & Bravo-Hollis, 1952 (Digenea: Gyliauchenidae Fukui, 1929), including the redescription of *I. vogelsangi* Caballero & Bravo-Hollis, 1952

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Abstract

Recent studies on the Gyliauchenidae Fukui, 1929 have lead to our reinterpretation of the morphology of the group. Here we emend the generic diagnosis of *Ichthyotrema* Caballero & Bravo-Hollis, 1952 to reflect current understanding of the morphology of the digestive system and male terminal genitalia. We redescribe the type-, and only, species, *Ichthyotrema vogelsangi* Caballero & Bravo-Hollis, 1952, based on our examinations of paratype material from the intestine of *Prionurus punctatus* Gill, 1862, caught in Pacific waters off Mexico. Specimens of *I. vogelsangi* are distinctive because of their massive bodies, and *Ichthyotrema* is distinguished among the Gyliauchenidae by the position of the cirrus-sac entirely posterior to the caeca, the possession of a post-testicular ovary and the coiling of the uterus between the diagonal testes. The ventral sucker of *Ichthyotrema* is close to the posterior extremity of the body, supporting placement of the genus within the Gyliaucheninae Fukui, 1929. Here we recognise *Ichthyotrema* as a monotypic genus within the Gyliauchenidae, which is restricted to acanthurid fishes in the Eastern Pacific Ocean.

Key words: *Ichthyotrema vogelsangi* Caballero & Bravo-Hollis, 1952; *Ichthyotrema* Caballero & Bravo-Hollis, 1952; Gyliauchenidae; Digenea; *Prionurus punctatus* Gill, 1862; Acanthuridae; East Pacific

Introduction

Ichthyotrema Caballero & Bravo-Hollis, 1952 was originally proposed as a monotypic genus within the Pronocephalidae Looss, 1902. These authors designated the genus within a new subfamily, Ichthyotreminae Caballero & Bravo-Hollis, 1952, based on the presence of a "prepharynx", short caeca, a post-testicular ovary, the structure of the male terminal genitalia, the restriction of the vitelline follicles and the shape of the excretory vesicle. Yamaguti (1958) reassigned *Ichthyotrema* to the Gyliauchenidae Fukui, 1929; Winter (1960) agreed with this placement and recognised the Ichthyotreminae within this family based on the post-testicular position of the ovary. Manter & Pritchard (1962) described a second species, *I. chaetodontis* Manter & Pritchard, 1962, which was subsequently reassigned to *Flagellotrema* Ozaki, 1936 by Yamaguti (1970); we have previously recombined this species as *Hadrobolbus chaetodontis* (Manter & Pritchard, 1962) Hall & Cribb, 2005 (see Hall & Cribb 2005a). Currently, we recognise *Ichthyotrema* as a monotypic gyliauchenid genus, within the subfamily Gyliaucheninae Fukui, 1929, distinguished from other gyliauchenines by the combination of the massive fusiform body, sigmoid oesophagus, cirrus-sac entirely posterior to the caeca, post-testicular ovary and the uterine coils winding between the diagonal testes. Recently, we have been investigating extensively the taxonomy and biodiversity of the Gyliauchenidae in the Indo-West Pacific. As part of that investigation, we have reinterpreted much of the morphology of gyliauchenids, particularly with respect to the gastrointestinal and male reproductive systems (see Hall & Cribb 2005a, b). Here we clarify the generic diag-

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nosis and redescribe the type-, and only, species, *I. vogelsangi* Caballero & Bravo-Hollis, 1952 in the light of our new interpretations of the morphology of the group.

Materials and methods

Paratype specimens from the Institute of Biology Collection, Universidad Nacional Autonoma de Mexico (UNAM), Mexico were examined using a compound microscope fitted with Nomarski differential interference contrast optics, and a drawing tube was used to draw sketches of the material. Measurements were made with the assistance of a calibrated eyepiece micrometer, except for the length of the body, which was impossible to measure with a micrometer because of the curvature; the body was drawn and measured along the midline using a calibrated planometer. A table of all measurements, in micrometres (µm), is provided. Terminology used in this paper is consistent with Hall & Cribb (2005b).

Results

Family Gyliauchenidae Fukui, 1929

syn. Dissotrematidae Goto & Matsudaira (1918)
Robphildollfusiidae Paggi & Orecchia, 1963

Subfamily Gyliaucheninae Fukui, 1929

syn. Apharyngogyliaucheninae Yamaguti, 1958
Ichthyotreminae Caballero & Bravo-Hollis, 1952

Genus *Ichthyotrema* Caballero & Bravo-Hollis, 1952

Emended diagnosis: Body large, elongate, fusiform. Tegument smooth, with few posterior annulations. Ventral sucker elongate, posterior, close to posterior extremity. Pharynx barrel-shaped, ventrosubterminal, surrounds mouth, smaller than ventral sucker; pre-oral lip reduced. Oesophagus long, sigmoid, lining developed, invested with glands along entire length. Oesophageal bulb well-developed, spheroid, distinct, smaller than pharynx. Intestinal bifurcation immediately posterior to oesophageal bulb; caeca 2, blind, extend to midpoint of body length. Testes 2, entire, ovoid, diagonal, in posterior third of body. Cirrus-sac prominent, entirely posterior to caeca, globular; ejaculatory duct short, eversible. Seminal vesicle partially external to cirrus-sac. *Pars prostatica* large, cylindrical, surrounded by dense prostate gland cells which partially penetrate cirrus-sac. Genital atrium regular. Genital pore posterior to caeca, equatorial, median, strongly muscular, laterally elongate. Ovary entire, post-testicular, median. Seminal receptacle prominent, canalicular. Vitellarium follicular; follicles dense, extend from level of pharynx to immediately anterior to testes; dorsal, ventral and lateral fields confluent. Uterus entirely pre-ovarian, coiled between testes, enters genital atrium sinistral to cirrus-sac. Eggs large, tanned, apparently unembryonated *in utero*. Excretory pore subterminal; papilla virtually absent. Excretory vesicle saccular, short. Primary collecting ducts arise anterolaterally. Parasites of intestine of herbivorous East Pacific marine teleosts (Acanthuridae, *Prionurus* only). Type species *Ichthyotrema vogelsangi* Caballero & Bravo-Hollis, 1952.

Ichthyotrema vogelsangi Caballero & Bravo-Hollis, 1952 (Fig. 1)

Type-host: *Prionurus punctatus* Gill, 1862 (as *Xesurus punctatus*), Acanthuridae.
Site: Intestine.
Type locality: Puerto Vallarta, Mexico.

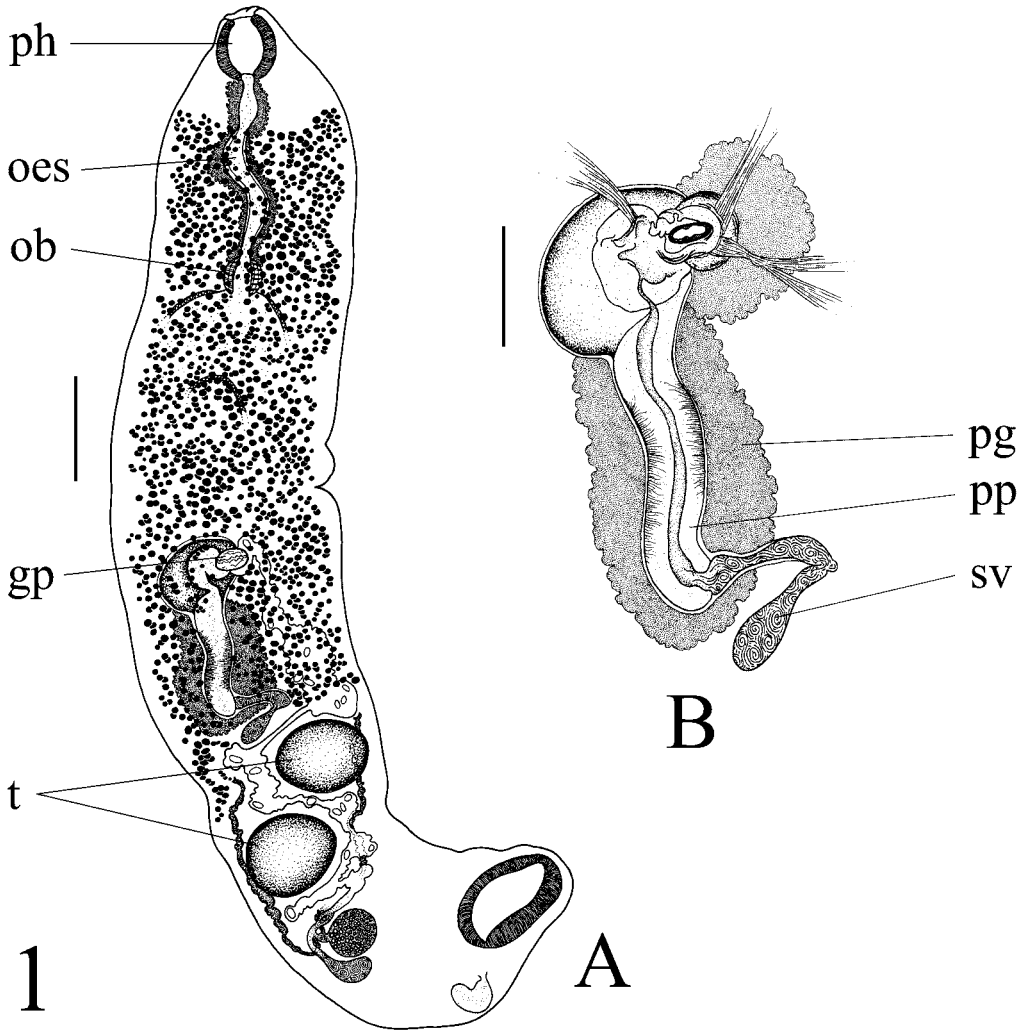

FIGURE 1. *Ichthyotrema vogelsangi* Caballero & Bravo-Hollis, 1952 from the intestine of *Prionurus punctatus*. Paratype (UNAM 001051.09). **A.** View of entire worm. Note that the path of the caeca is obscured by the extensive vitellarium and that the specimen is distorted; the anterior of the body is presented dorsoventrally, whereas the posterior extremity is mounted laterally. Scale bar = 500 µm. Legend: gp, genital pore; ob, oesophageal bulb; oes, oesophagus; ph, pharynx; t, testes. **B.** Detail of cirrus-sac. Note that the muscular capsule surrounding the globular proximal portion of the cirrus-sac, which contains the ejaculatory duct, is contiguous with the capsule surrounding the *pars prostatica* and the proximal portion of the seminal vesicle. In addition, the prostate glands are external to the cirrus-sac wall, and the tails of these glands penetrate the wall laterally. Scale bar = 250 µm. Legend: pg, prostate glands; pp, *pars prostatica*; sv, seminal vesicle.

Records: 1. Caballero & Bravo-Hollis (1952). 2. Winter (1960).

Hosts: *Prionurus punctatus*, Acanthuridae (1, 2).

Localities: Mexico, Pacific Coast (1, 2).

Redescription: Based on the examination of 3 paratype specimens (UNAM 001051.03, 001051.06, 001051.09). Measurements in Table 1. Body large, elongate, slender, fusiform; width equal along length of body. Tegument smooth, with few posterior annulations. Ventral sucker elongate, posterior, ventrosubterminal. Pharynx barrel-shaped, ventrosubterminal, surrounds mouth, smaller than ventral sucker; pre-oral lip reduced. Oesophagus long, sigmoid, lining developed, invested with glands along entire length. Oesophageal bulb well-developed, spheroid, distinct, smaller than pharynx. Intestinal bifurcation immediately posterior to oesophageal bulb; caeca 2, blind, extend to midpoint of body length; gastrodermis thick.

Testes 2, entire, ovoid, diagonal, in posterior third of body (Fig. 1a). Cirrus-sac prominent, entirely posterior to caeca, globular, encased in muscular capsule (Fig. 1b); ejaculatory duct short, eversible; everted cirrus

not observed. Seminal vesicle partially external to cirrus-sac, bipartite; proximal and distal portions globular, separated by narrow constriction; proximal portion internal and encased in muscular capsule contiguous with cirrus-sac, distal portion external. *Pars prostatica* large, cylindrical, surrounded by dense prostate gland cells which partially penetrate cirrus-sac. Genital atrium regular, muscular. Genital pore posterior to caeca, equatorial, median, strongly muscular, laterally elongate.

Ovary entire, post-testicular, median; oviduct with insemination chamber immediately proximal to ovary (Fig. 1a). Seminal receptacle prominent, canalicular, posterodorsal to ovary. Mehlis' gland not observed. Laurer's canal not observed. Oötype anterior to insemination chamber and seminal receptacle. Uterus entirely preovarian, coiled between testes, proceeds sinistral to male terminal genitalia. Opening of uterus unspecialised, enters genital atrium sinistral to cirrus-sac. Vitellarium follicular; follicles dense, extend from level of pharynx to immediately anterior to testes; dorsal, ventral and lateral fields confluent; vitelline ducts pass posterolateral to testes, unite to form globular vitelline reservoir dorsal to ovary. Eggs large, tanned, apparently unembryonated *in utero*, opercula not observed.

Excretory pore subterminal; papilla virtually absent. Excretory vesicle saccular, short. Primary collecting ducts arise anterolaterally. Lymph system not observed.

Comments. Specimens of *I. vogelsangi* are massive, reaching lengths greater than 7.5 mm. There have been 2 records of this species (Caballero & Bravo-Hollis 1952; Winter 1960), both from *Prionurus punctatus* from Mexico (East Pacific). The measurements and illustrations of both records are broadly congruent. We are confident, from our examination of the paratype material deposited by Caballero & Bravo-Hollis and reviews of the literature, that the specimens obtained by Winter (1960) represent a second record of this species. The paratypes are in fair condition, although the caeca were difficult to observe because of the density of the vitelline follicles, and the specimens have been mounted somewhat askew, with the anterior end of the body presented dorsoventrally and the posterior extremity mounted laterally. The curved morphology of gyliauchenids makes them often difficult to mount, and despite the differences in presentation anteriorly and posteriorly, the internal structures of these specimens is clear. In particular, the morphology of the female reproductive system is able to be well observed; we were able to discern the forked junction of the seminal receptacle, insemination chamber and oötype. The ventral sucker of paratype specimen UNAM 001051.06 (see Figure 52.1 in Hall & Cribb 2005a) was retracted deep within the body and was contiguous with the seminal receptacle; powerful retractor muscles were observed associated with the ventral sucker of this specimen.

Discussion

Taxonomy

Ichthyotrema was originally proposed within the Pronocephalidae Looss, 1902; Yamaguti (1958) and Winter (1960) recognised this genus as belonging within the Gyliauchenidae. Winter recognised the Ichthyotreminae Caballero & Bravo-Hollis, 1952 on the basis of the post-testicular position of the ovary; we do not recognise this subfamily, and have listed it here as a junior synonym of Gyliaucheninae Fukui, 1929. The inclusion of *Ichthyotrema* within the Gyliaucheninae is supported by the posterior position of the ventral sucker, the presence of an elongate oesophagus surrounded by dense glands and a well-developed oesophageal bulb. In addition, *I. vogelsangi* displays the characteristic gyliauchenid morphology of the cirrus-sac, which has a partially external seminal vesicle and a large cylindrical *pars prostatica*, and which is penetrated laterally by the dense, external prostate glands. *Ichthyotrema* is similar in morphology to species of *Affecauda* Hall & Chambers, 1999, but differs in having short caeca, which terminate far anterior to the gonads, diagonally arranged testes and the position of the cirrus-sac entirely posterior to the caeca. In species of *Affecauda*, the caeca reach to the level of the gonads, the testes are tandem and the cirrus-sac is intercaecal (Hall & Cribb 2004). Although the body of *I. vogelsangi*, in common with species of *Affecauda*, is elongate with tegumental annulation, it maintains a similar width throughout the entire length. In contrast to the shape of *I. vogelsangi*,

species of *Affecauda* are extremely slender; species of *Affecauda* are widest at the level of the genital pore, and the posterior body conforms to the outline of the gonads. Further, the ovary of *I. vogelsangi* is consistently post-testicular and the uterus winds anteriorly from the ovary, between the testes. This condition is not seen in *Affecauda* or any other species of gyliauchenid. Specimens of *I. vogelsangi* may be immediately recognisable because of their sheer massive size, however, the uniqueness of the positions of the cirrus-sac and ovary and the unusual pattern of uterine coiling justify recognition of *Ichthyotrema* as a distinct genus within the Gyliauchenidae.

TABLE 1. Measurements of *Ichthyotrema vogelsangi* Caballero & Bravo-Hollis, 1952 in micrometres (µm).

	Voucher Material			Caballero & Bravo-Hollis (1952)			Winter (1960)	
Variable	Mean	Min	Max	Mean	Min	Max	Min	Max
body length	6560	5888	7680	6068	5130	7463	5876	6391
body width	1211	1136	1344	868	675	1014	1079	1212
pharynx length	325	308	347	298	246	360	282	299
pharynx width	323	321	327	264	208	294	–[1]	299
oesophageal bulb length	199	180	218	181	165	208	95	114
oesophageal bulb width	215	199	231	138	104	173	–	–
ventral sucker length	642	584	706	540	480	585	581	614
ventral sucker width	430	398	469	349	300	428	398	432
oesophagus length	1122	918	1429	–	–	–	–	–
caeca length	1355	1310	1400	1258	900	1613	1627	1793
length from pharynx to oesophageal bulb	830	777	886	954	713	1298	–	–
anterior testis length	366	308	404	284	233	338	332	432
anterior testis width	464	411	539	344	278	390	349	581
posterior testis length	415	392	443	315	255	383	365	498
posterior testis width	490	449	546	384	300	443	398	598
ovary length	225	193	257	188	128	234	266	282
ovary width	306	270	347	213	135	178	232	249
seminal receptacle length	323	244	417	222	113	311	199	266
seminal receptacle width	120	109	135	119	87	147	116	249
cirrus-sac length	449	347	546	375	260	467	–	–
cirrus-sac width	347	308	398	289	208	332	–	–
egg length	68	67	71	70	68	72	–	68
egg width	49	45	51	38	34	43	–	38
ratio of pharynx to oesophageal bulb (length)[2,3]	1.67	1.41	1.93	–	–	–	–	–
ratio of pharynx to ventral sucker (length)	0.51	0.45	0.55	–	–	–	–	–
ratio of oesophageal bulb to ventral sucker (length)	1.67	1.41	1.93	–	–	–	–	–
ratio of caeca to body (length)	0.23	0.22	0.23	–	–	–	–	–

[1]unavailable measurements are indicated by a dash (–); [2]ratios are calculated to 2 decimal places; [3]ratios not calculated for previously published measurements.

Biogeography and host associations

Ichthyotrema vogelsangi is known only from 1 species of the Acanthuridae, *Prionurus punctatus*, from the East Pacific. It is the only species of gyliauchenid known to occur in these waters, and only species of *Ichthyotrema* and *Hadrobolbus* Hall & Cribb, 2005 are found in waters other than the Indo-West Pacific; species of *Hadrobolbus* have been recorded only from Hawaii in the central Pacific (Manter & Pritchard, 1962; Yamaguti, 1970). During our studies on gyliauchenids from the Indo-West Pacific, 3 individual *Prionurus* (from 2 species) from the Great Barrier Reef and Moreton Bay have been examined, however, no specimen of *Ichthyotrema* has been recovered. It should be noted that, although this sample size is very small, 2 other species of gyliauchenids from the genera *Flagellotrema* Ozaki, 1936 (Hall & Cribb, unpublished data) and *Petalocotyle* Ozaki, 1934 (*P. adenometra* Hall & Cribb, 2000) have been identified from this sample. In addition, we have also examined more than 750 individual acanthurid fishes throughout the Indo-West Pacific, but no specimen of *Ichthyotrema* has been recovered. The absence of *Ichthyotrema* from the Indo-West Pacific can not be asserted with certainty, however, our collecting suggests that the distribution of *Ichthyotrema* is indeed restricted to species of *Prionurus* in the Eastern Pacific Ocean.

Acknowledgments

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