Research Article

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Two new species of *Euryhaliotrema* Kritsky et Boeger, 2002 (Monogenea: Dactylogyridae) from *Lutjanus russellii* (Bleeker) and *L. argentimaculatus* (Forsskal) (Teleostei: Lutjanidae) in the South China Sea

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Abstract: *Euryhaliotrema russellum* sp. n. and *Euryhaliotrema tenuiaccessorium* sp. n. are described from the gills of *Lutjanus russellii* (Bleeker) and *L. argentimaculatus* (Forsskal), respectively, in the South China Sea. *Euryhaliotrema russellum* sp. n. differs from all other members of *Euryhaliotrema* Kritsky et Boeger, 2002 by its unique male copulatory organ, a straight tube with a bulbous base and without an accessory piece. *Euryhaliotrema tenuiaccessorium* sp. n. differs from its congeners by having a copulatory organ with a bulbous base, a meandering copulatory tube with clockwise coil having less than one complete ring, and a slender accessory piece along the middle length of the copulatory tube. All species of *Euryhaliotrema* are listed and divided to three groups based on morphology of the male copulatory organ.

Keywords: *Euryhaliotrema russellum* sp. n., *Euryhaliotrema tenuiaccessorium* sp. n., lutjanid, China

Lutjanus russellii (Bleeker) and *L. argentimaculatus* (Forsskal) are common lutjanids (Teleostei: Perciformes) in the tropical and subtropical waters of the Indo-West Pacific (Froese and Pauly 2014). To date, five species of *Euryhaliotrema* Kritsky et Boeger, 2002 have been reported from *L. russellii*, including *E. anguiformis* Kritsky, 2012, *E. chrysotaeniae* Kritsky, 2012, *E. johni* Kritsky, 2012, *E. seyi* Kritsky, 2012 and *E. spirobifurum* Wu, Zhu, Xie et Li, 2006 (see Wu et al. 2006, Kritsky 2012). Six *Euryhaliotrema* spp. have been recorded from *L. argentimaculatus*, i. e. *E. cryptophallus* Kritsky et Yang, 2012, *E. diplops* Kritsky, Yang et Justine, 2012, *E. guangdongense*, Li, Yan, Yu, Lan et Huang, 2005, *E. hainanense* Pan et Zhang, 2006, *E. nanaoense* Kritsky, 2012 and *E. xinyingense* Pan et Zhang, 2006 (see Li et al. 2005, Pan and Zhang 2006, Kritsky 2012).

During a survey of monogeneans of marine fishes in the South China Sea, two undescribed species of *Euryhaliotrema* were found on the gills of *L. russellii* and *L. argentimaculatus*, respectively. In this paper, the new species are described.

MATERIALS AND METHODS

Fish hosts were collected by local fishermen from off Huzhou, Guangdong Province, South China Sea (114°69'E;

22°45'N) and off Zhanjiang, Guangdong Province, South China Sea (110°40'E; 21°19'N). Gills of each fish were isolated and placed in Petri dish with seawater and dactylogyrids were collected from the gills with a fine needle under a dissecting microscope. Specimens were slightly flattened under a coverslip, fixed and mounted in ammonium picrate-glycerine for examination of the sclerotised structures. After drawings and measurements of the sclerotised structures were completed, the worms were removed from the slides, stained with Gomori's trichrome and mounted in Canada balsam for studies of their soft anatomy and permanent preservation (Yang et al. 2004). Drawings were made using an Olympus BX41 microscope with the aid of a drawing apparatus, scanned and redrawn on a computer with Adobe Illustrator CS6. Measurements, all in micrometres, are expressed as the range followed by the mean and the number (n) of structures measured in parentheses. The measurement of the copulatory organ represents an approximation of the total length obtained by means of a CV-9 Jr map meter (Koizumi Sokki Mfg. Co., Ltd., Nagaoka, Japan). All dimensions of other internal structures represent straight-line distances between extreme ends; body width is that of the greatest width of the trunk; body length includes that of the haptor. Numbering and distribution of hook pairs follow recommendations of Mizelle (1936) and Mizelle and Price (1963). Type and voucher specimens are deposited in the School of Life Sciences, Sun Yat-sen University (SYSU). Paratypes are

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also deposited in the Helminthological Collection of the Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, České Budějovice (IPCAS) and the Natural History Museum, London, UK (NHMUK).

RESULTS

Euryhaliotrema russellum sp. n.

Fig. 1

ZooBank number for species:

urn:lsid:zoobank.org:act:75E8B3FF-3856-42BE-BB54-437B46331788

Description (based on 30 specimens): Body fusiform, 281–488 (391; $n = 14$) long; greatest width 88–146 (110; $n = 14$) usually at middle length of body. Cephalic region broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; bilateral pair of cephalic glands at level of pharynx. Pigmented eyespots 4; eyespots of posterior pair with lenses, slightly bigger and more closely located than those of anterior pair. Pharynx subspherical, 25–35 (30; $n = 30$) in greatest width; oesophagus inconspicuous; intestinal bifurcation close to postpharyngeal glands; intestinal caeca unite posteriorly to gonads, lacking posterior diverticula. Peduncle broad, short.

Haptor subhexagonal, 45–82 (62; $n = 30$) long, 63–107 (84; $n = 28$) wide, moderately differentiated from body proper; ventral and dorsal extrinsic adductor muscles (see Kearn 1971) well developed, connecting to tips of superficial roots of ventral and dorsal anchors, respectively.

Ventral anchor 31–36 (34; $n = 30$) long, with robust, elongate superficial root, poorly defined deep root, short shaft; point and shaft with longitudinal superficial grooves; anchor base 10–17 (14; $n = 30$) wide. Dorsal anchor 29–35 (34; $n = 30$) long, with elongate superficial root, poorly developed deep root, short shaft; point and shaft with longitudinal superficial grooves; anchor base 11–17 (14; $n = 28$) wide. Ventral bar 27–32 (30; $n = 30$) long, slightly bow-shaped, with lateral knobbed extremities arched anteriorly. Dorsal bar 31–36 (34; $n = 30$) long, rod-shaped, with large and intermediate anterior expansion. Hooks similar, 10–12 (11; $n = 58$) long, each with upright acute thumb, slender shaft and delicate, entire point; filamentous hooklet loop about shaft length.

Testis 70–128 (99; $n = 30$) long, 60–125 (89; $n = 30$) wide, spherical, postequatorial. Vas deferens loops around left intestinal caecum, wriggles anteriorly, then forms small reniform seminal vesicle before entering base of male copulatory organ. Male copulatory organ 25–38 (29;

Fig. 1. *Euryhaliotrema russellum* sp. n. from *Lutjanus russellii* (Bleeker). **A** – whole worm (ventral view); **B** – copulatory complex (ventral view); **C** – ventral bar; **D** – dorsal bar; **E** – ventral anchor; **F** – dorsal anchor; **G** – hook.

Fig. 2. *Euryhaliotrema tenuiaccessorium* sp. n. from *Lutjanus argentimaculatus* (Forsskal). **A** – whole worm (ventral view); **B** – copulatory complex (ventral view); **C** – ventral bar; **D** – dorsal bar; **E** – ventral anchor; **F** – dorsal anchor; **G** – hook. Abbreviation: AP – accessory piece.

$n = 14$) long, with bulbous base, simple and straight tube; accessory piece absent. Prostatic reservoirs 2; one small, subspherical, dextral, another large, ovate, sinistral. Ovary 31–75 (56; $n = 28$) long, 29–65 (42; $n = 28$) wide, elliptical, pretesticular, tandem with testis; oviduct passes immediately to ootype; ootype large, surrounded by Mehlis' gland, opening into uterus. Vaginal aperture dextromarginal, vaginal vestibule funnel-shaped; vagina canal narrow, arising from distal region of vestibule, joining ovate seminal receptacle in region of uterus. Vitellarium follicular; follicles dense from level of intestinal bifurcation to postintestinal region, absent in regions of reproductive organs.

Type host: *Lutjanus russellii* (Bleeker).

Type locality: Off Huizhou, Guangdong Province, South China Sea (114°69'E; 22°45'N).

Site of infestation: Gills.

Specimens studied: Holotype (SYSU20050529-1), 27 paratypes (SYSU20050529-2–28), 1 paratype (IPCAS M-594), 1 paratype (NHMUK 2015.6.29.1).

Ety m o l o g y : The specific epithet refers to the specific name of the host.

Remarks. *Euryhaliotrema russellum* sp. n. belongs to the group of congeners in *Euryhaliotrema* that lack an

accessory piece, including *E. adelpha* Kritsky et Justine, 2012, *E. cribbi* Kritsky, 2012, *E. kurodai* Kritsky, 2012, *E. monoporosum* Kritsky, 2012, *E. nanaoense*, *E. paululum* Kritsky et Justine, 2012, *E. spirotubiform* and *E. youngi* Kritsky, 2012. The male copulatory tube of *Euryhaliotrema russellum* sp. n. is straight, serving to differentiate it from *E. adelpha*, *E. cribbi*, *E. kurodai*, *E. monoporosum*, *E. paululum*, *E. spirotubiform* and *E. youngi*, which have coiled copulatory tube with more than one or half (in *E. kurodai*) ring. *Euryhaliotrema russellum* sp. n. is most similar to *E. nanaoense* described from the same host by the straight copulatory tube, but differs in having straight distal portion of the copulatory tube (S-shaped in *E. nanaoense*). Besides, the copulatory organ of the new species is remarkably shorter than that of *E. nanaoense* (25–38 μm vs 125–146 μm).

***Euryhaliotrema tenuiaccessorium* sp. n.**

Fig. 2

ZooBank number for species:

url:lsid:zoobank.org:act:70645255-3ABD-4B25-A126-6781E49DF19D

Description (based on 29 specimens): Body fusiform, 331–475 (411; $n = 13$) long; greatest width 83–156 (116;

Table 1. Characters of the male copulatory organ (MCO) of *Euryhaliotrema* spp. from six families of fish hosts.

Hosts family/ Characters of MCO	Lacking accessory piece	Having accessory piece	
		with articulation process attached to base of MCO	without articulation process attached to base of MCO
Ambassidae	-	-	<i>E. ambassisi</i> Pan et Lu, 2005
	-	-	<i>E. zhangjiangyini</i> Pan et Lu, 2005
Chaetodontidae	<i>E. cribbi</i> Kritsky, 2012	<i>E. annulocirrus</i> Kritsky, 2012	<i>E. microphallus</i> Kritsky, 2012
	<i>E. monoporosum</i> Kritsky, 2012	<i>E. aspistis</i> Kritsky, 2012	-
	-	<i>E. berenguelae</i> Kritsky, 2012	-
	-	<i>E. grandis</i> Kritsky, 2012	-
	-	<i>E. pirulum</i> Kritsky, 2012	-
	-	<i>E. triangulovagina</i> Kritsky, 2012	-
Haemulidae	-	-	<i>E. bychowskyi</i> Kritsky et Boeger, 2002
Lutjanidae	<i>E. adelpha</i> Kritsky et Justine, 2012	<i>E. anecorhizion</i> Kritsky et Mendoza-Franco, 2012	<i>E. anguiformis</i> Kritsky, 2012
	<i>E. nanaoense</i> Kritsky, 2012	<i>E. cardinale</i> Kritsky et Justine, 2012	<i>E. chrysotaeniae</i> Kritsky et Boeger, 2002
	<i>E. paululum</i> Kritsky et Justine, 2012	<i>E. cognatus</i> Kritsky et Galli, 2012	<i>E. cryptophallus</i> Kritsky et Yang, 2012
	<i>E. spirobifurum</i> Wu, Zhu, Xie et Li, 2006	<i>E. diplops</i> Kritsky, Yang et Justine, 2012	<i>E. fastigatum</i> Kritsky et Boeger, 2002
	<i>E. youngi</i> Kritsky, 2012	<i>E. distinctum</i> Kritsky et Galli, 2012	<i>E. fatuum</i> Kritsky et Justine, 2012
	<i>Euryhaliotrema russellum</i> sp. n.	<i>E. fajerae</i> Kritsky et Mendoza-Franco, 2012	<i>E. ferocis</i> Kritsky et Yang, 2012
	-	<i>E. guangdongense</i> Li, Yan, Yu, Lan et Huang, 2005	<i>E. johnei</i> Kritsky et Boeger, 2002
	-	<i>E. hainanense</i> Pan et Zhang, 2006	<i>E. lisae</i> Kritsky et Diggles, 2014
	-	<i>E. longibaculoides</i> Kritsky et Diggles, 2014	<i>E. lutiani</i> Kritsky et Boeger, 2002
	-	<i>E. longibaculum</i> Kritsky et Boeger, 2002	<i>E. lutjani</i> Li, 2006
	-	<i>E. mehen</i> Kritsky, 2012	<i>E. perezponcei</i> García-Vargas, Fajer-Ávila et Lamothe-Argumedo, 2008
	-	<i>E. paracanthi</i> Kritsky et Boeger, 2002	<i>E. seyi</i> Kritsky, 2012
	-	<i>E. ramulum</i> Kritsky et Galli, 2012	<i>Euryhaliotrema tenuiaccessorium</i> sp. n.
	-	<i>E. simplicis</i> Kritsky et Justine, 2012	<i>E. torquecirrus</i> Kritsky et Boeger, 2002
	-	<i>E. tormocleithrum</i> Kritsky et Galli, 2012	<i>E. tubocirrus</i> Kritsky et Boeger, 2002
	-	<i>E. xinyingense</i> Pan et Zhang, 2006	-
Sciaenidae	-	<i>E. atlanticum</i> Kritsky et Boeger, 2002	<i>E. chaoi</i> Kritsky et Boeger, 2002
	-	<i>E. dontykoleos</i> Fehlaue et Boeger, 2005	<i>E. lovejoyi</i> Kritsky et Boeger, 2002
	-	<i>E. paralanchuri</i> Kritsky et Boeger, 2002	<i>E. monacanthus</i> Kritsky et Boeger, 2002
	-	<i>E. potamocetes</i> Kritsky et Boeger, 2002	<i>E. sagmatum</i> Kritsky et Boeger, 2002
	-	-	<i>E. succedaneus</i> Kritsky et Boeger, 2002
	-	-	<i>E. thatcheri</i> Kritsky et Boeger, 2002
Sparidae	<i>E. kurodai</i> Kritsky, 2012	<i>E. carbunculus</i> Kritsky et Boeger, 2002	<i>E. amydrum</i> Kritsky et Bakenhaster, 2011
	-	<i>E. dunlapae</i> Kritsky et Bakenhaster, 2011	<i>E. carbuncularium</i> Kritsky et Bakenhaster, 2011
	-	<i>E. guangzhouense</i> Li, 2005	<i>E. eukurodai</i> Kritsky, 2012
	-	-	<i>E. johnei</i>
	-	-	<i>E. lutjani</i>
	-	-	<i>E. spirulum</i> Kritsky et Bakenhaster, 2011

n = 29) usually at level of testis. Cephalic region broad; cephalic lobes moderately developed; 3 bilateral pairs of head organs; bilateral pair of cephalic glands at level of pharynx. Pigmented eyespots 4; eyespots of posterior pair with lenses, slightly bigger and more closely located than anterior pair. Pharynx subspherical, 23–36 (30; n = 29) in greatest width; oesophagus short; intestinal caeca united posteriorly to gonads, lacking posterior diverticula. Peduncle broad, short.

Haptor subhexagonal, 35–63 (50; n = 29) long, 60–107 (82; n = 27) wide, moderately differentiated from body proper; ventral and dorsal extrinsic adductor muscles (see Kearn 1971) well developed, connecting to tips of superficial roots of ventral and dorsal anchors, respectively; ventral and dorsal transverse muscles present, between superficial roots of ventral and dorsal anchors, respectively.

Anchors 4, with fine wings. Ventral anchor 21–25 (23; n = 28) long, with elongate robust superficial root, poorly defined deep root, short shaft, elongate point; shaft and point with longitudinal superficial grooves; anchor base 10–15 (13; n = 28) wide. Dorsal anchor 20–23 (22; n = 27) long, with elongate slender superficial root, poorly developed deep root, short shaft, elongate point; shaft and point with longitudinal superficial grooves; anchor base 9–14 (12; n = 26) wide. Ventral and dorsal bar similar in shape, broadly V-shaped, with knobbed ends; ventral bar 29–35 (32; n = 29) long, dorsal bar 25–30 (29; n = 29) long. Hooks similar, 12–14 (13; n = 47) long, with upright acute thumb, slender shaft and delicate, entire point; filamentous hooklet loop about shank length.

Testis 50–120 (86; n = 27) long, 39–95 (69; n = 28) wide, spherical, intercecal, postequatorial. Vas deferens

loops around left intestinal caecum, wriggles anteriorly, then forms small reniform seminal vesicle before entering base of male copulatory organ. Male copulatory organ 33–58 (43; $n = 12$) long, comprising bulbous base and clockwise curving tube with coil forming less than one complete ring, frequently as C-shaped; accessory piece 11–16 (13; $n = 4$) long, wire-like, present along middle portion of male copulatory tube. Prostatic reservoir 2; one small, subspherical, dextral, another larger, cucurbit-shaped, sinistral; prostatic glands conspicuous, radiating around prostatic reservoir. Ovary 48–88 (66; $n = 24$) long, 26–70 (45; $n = 26$) wide, subelliptical, pretesticular but slightly overlapping testis; oviduct passes immediately to ootype; ootype large, surrounded by Mehlis' gland, opening into uterus. Vaginal aperture dextromarginal, vaginal vestibule inconspicuous; vagina canal narrow, arising from distal region of vestibule, joining an ovate seminal receptacle close to sinistral intestinal caecum at level of ootype. Vitellarium follicular; follicles dense from level of intestinal bifurcation to postintestinal region, except in region of reproductive organs.

Type host: *Lutjanus argentimaculatus* (Forsskal).

Type locality: Off Zhanjiang, Guangdong Province, South China Sea (110°40'E; 21°19'N).

Site of infestation: Gills.

Specimens studied: Holotype (SYSU20040713-1), 26 paratypes (SYSU20040713-2-27), 1 voucher (IPCAS M-593), 1 voucher (NHMUK 2015.6.29.2).

Etymology: The specific name refers to the slender accessory piece of the male copulatory organ.

Remarks. *Euryhaliotrema tenuiaccessorium* sp. n. belongs to the group of 29 *Euryhaliotrema* spp. whose accessory piece does not have articulation to attach to the base of the male copulatory organ (Table 1). Based on the morphology of the haptor sclerotised structures, *Euryhaliotrema tenuiaccessorium* is similar to *E. cryptophallus* and *E. lisae* Kritsky et Diggles, 2014. However, the copulatory tube of *E. tenuiaccessorium* is C-shaped and represented by less than one clockwise ring, rather than J-shaped in *E. lisae* and a counterclockwise ring in *E. cryptophallus*. Moreover, the wire-like accessory piece locates the middle portion of the male copulatory tube in the new species, but the accessory piece in *E. lisae* and *E. cryptophallus* is a sheath and a sleeve, respectively, and encloses distal end of the male copulatory organ. The coiled copulatory tube with less than one complete clockwise ring makes *E. tenuiaccessorium* similar to *E. johnei* and *E. lutiani* Kritsky et Boeger, 2002, but can be differentiated by its smaller anchors and bars. Moreover, *E. tenuiaccessorium* has ventral bars longer than dorsal bars, whereas both *E. johnei* and *E. lutiani* have ventral bars shorter than dorsal bars. The most distinctive feature of *E. tenuiaccessorium* is the slender, wire-like accessory piece along the middle length of the copulatory tube, which can actually discriminate the new species from all other congeners.

DISCUSSION

Euryhaliotrema was established by Kritsky and Boeger (2002) for species of dactylogyrids possessing a coiled counterclockwise copulatory organ with a bulbous base and accessory piece present, and parasitising Haemulidae, Lutjanidae, Sciaenidae and Sparidae. *Euryhaliotrematoides* Plaisance et Kritsky, 2004 and *Aliatrema* Plaisance et Kritsky, 2004 were subsequently erected by Plaisance and Kritsky (2004) for species from chaetodontid hosts, both of which possess male copulatory organ comprising a coiled counterclockwise tube with a funnel-shaped base. The accessory piece present in *Euryhaliotrematoides* spp. but absent in *Aliatrema* spp. was adopted to differentiate these two genera. Based on comprehensive surveys of dactylogyrids from lutjanids, Kritsky (2012) made a revision of *Euryhaliotrema*. Species previously assigned to *Euryhaliotrematoides* and *Aliatrema* plus three other *Haliotrema* spp. were transferred to *Euryhaliotrema*. *Euryhaliotrema* is now diagnosed mainly by possessing a coiled or meandering male copulatory organ with bulbous or funnel-shaped base, with or without accessory piece serving as guide for the copulatory tube (Kritsky 2012). So far, including the two new taxa described in the present paper, *Euryhaliotrema* contains 67 species from fish hosts of the Ambassidae, Chaetodontidae, Haemulidae, Lutjanidae, Sciaenidae, and Sparidae (Kritsky 2012, Kritsky and Diggles 2014).

Based on the features of the accessory piece in the male copulatory organ, species of *Euryhaliotrema* could be classified into three groups (Table 1). The first group comprises nine *Euryhaliotrema* species including *Euryhaliotrema russellum* sp. n. lacking an accessory piece in the male copulatory organ, being found on fishes of the Chaetodontidae, Lutjanidae and Sparidae. Except for *E. russellum* and *E. nanaoense* having a straight copulatory tube, the other congeners in this group possess a coiled copulatory tube. The copulatory organ of *E. russellum* is remarkably shorter than that of *E. nanaoense*, and the distal portion of the copulatory tube in *E. russellum* is straight, instead of S-shaped in *E. nanaoense*.

The second group contains 29 species with an accessory piece attached to the base of the male copulatory organ by articulation, described from fishes of the Chaetodontidae, Lutjanidae, Sciaenidae and Sparidae. The remaining 29 species of *Euryhaliotrema* constitute the third group whose members have an accessory piece without articulation in its connection to the base of the male copulatory organ. *Euryhaliotrema tenuiaccessorium* sp. n. belongs to the third group, but differs from its congeners in this group by its peculiar accessory piece, a slender, wire-like-shaped, along the middle portion of the copulatory tube.

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