***Trianchoratus longianchoratus* sp. n. (Monogenea: Ancyrocephalidae: Heteronchocleidinae) from *Channa lucius* (Osteichthyes: Channidae) in Peninsular Malaysia**

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Abstract: One new and three previously described species of *Trianchoratus* Price et Berry, 1966 were collected from the gills of *Channa lucius* (Cuvier) and *Channa striata* (Bloch) from the Bukit Merah Reservoir, Perak and Endau-Rompin, Pahang, Peninsular Malaysia. They are *Trianchoratus longianchoratus* sp. n., *T. malayensis* Lim, 1986 and *T. pahangensis* Lim, 1986 from *C. lucius*, and *T. ophicephali* Lim, 1986 from *C. striata*. The new species differs from the *Trianchoratus* species hitherto described from channids and anabantoids in having two ventral anchors with a long curved inner root and one dorsal anchor with a curved inner root and lacking an outer root. A table summarizing the known species of heteronchocleidins (*Trianchoratus*, *Eutrianchoratus* and *Heteronchocleidus*) and *Sundanonchus* reported from fish hosts of different families (Channidae, Helostomatidae, Anabantidae and Osphronemidae) is provided.

Key words: *Trianchoratus*, Ancyrocephalidae, Heteronchocleidinae, *Channa lucius*, *Channa striata*, Anabantoidei, Channoidei, Malaysia

There are 26 species of *Channa* (Scopoli) (syn. *Ophicephalus*) and three species of *Parachanna* (Teugels et Daget) (syn. *Ophicephalus*) within the Channidae (see Li et al. 2006). In Peninsular Malaysia, channids are represented by seven *Channa* spp., namely *C. lucius* (Cuvier), *C. striata* (Bloch), *C. maruloides* (Bleeker), *C. bankanensis* (Bleeker), *C. gachua* (Hamilton-Buchanan), *C. micropeltes* (Cuvier et Valenciennes) and *C. melasoma* (Bleeker) (see Lee 1997). The channids are hosts to monogenean species belonging to *Trianchoratus* Price et Berry, 1966, *Eutrianchoratus* Paperna, 1969 and *Sundanonchus* Lim et Furtado, 1985 (see Lim 1997). *Trianchoratus*, *Eutrianchoratus* and *Heteronchocleidus* Bychowsky, 1957 have been assigned to the subfamily Heteronchocleidinae Price, 1968 (Ancyrocephalidae Bychowsky, 1937) (see Lim 1986, 1998). To date, there are 29 species of heteronchocleidine monogeneans (10 *Trianchoratus* spp., 9 *Eutrianchoratus* spp. and 10 *Heteronchocleidus* spp.) described from 16 freshwater fish species of channids (3 species) and anabantoids (13 species); the information is summarized in Table 1. A recent investigation on monogeneans from freshwater fish species of Peninsular Malaysia revealed the presence of one new and three previously described species of *Trianchoratus* on *Channa lucius* from the Bukit Merah Reservoir, Perak (7 individuals) and Endau-Rompin, Pahang (4 individuals) and also on *C. striata* from the Bukit Merah Reservoir (9 indi-

viduals). Examinations of recently collected specimens of *T. malayensis* Lim, 1986, *T. pahangensis* Lim, 1986 and *T. ophicephali* Lim, 1986 revealed discrepancies in the latter two species which prompted the re-examinations of the type specimens of these three described species present in the parasite collection of the Zoological Department, University of Malaya (UMZD).

MATERIALS AND METHODS

Two species of *Channa* were obtained from the Bukit Merah Reservoir (*Channa lucius* and *C. striata*) and Endau-Rompin (*C. lucius*), Peninsular Malaysia. These fish were caught using hook and line. The monogeneans were removed from the gills and prepared for investigations of their soft and hard parts. Some specimens were flattened to varying degrees to best expose the soft anatomical structures and stained in Gomori's triple stain, following Lim (2006). Some specimens were flattened and mounted in modified ammonium picrate glycerine (Lim 1991) and later made into unstained permanent mounts in Canada balsam. The stained and unstained parasites were examined using both bright field and phase contrast optics. Images of the hard and soft body parts were captured using a Leica digital camera (Leica DFC320) and image analysis software (QWin Plus) and were drawn using a digitising tablet (WACOM) and Adobe Illustrator software. Measurements of the sclerotized hard-parts (both haptor and reproductive) were made on flattened stained or unstained specimens cleared in ammonium picrate glycerine. The basic measurements taken are as indicated in Fig. 1 and are

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given as the mean and range (within parentheses) in micrometres. Illustrations of the hard-parts and a composite figure of the whole body of the new species are given.

The following type specimens of the three previously described *Trianchoratus* species from the parasite collection of the University of Malaya (UMZD) were re-examined: *T. malayensis* [31 specimens: UMZD(P)28, UMZD(P) 99(P)–129(P)], *T. pahangensis* [50 specimens: UMZD(P)27, UMZD(P) 130(P)–179(P)], and *T. ophicephali* [79 specimens: UMZD(P)26, UMZD(P) 180(P)–258(P)]. The haptor hard-parts of the type specimens were measured using Leica QWIN imaging software for comparison.

Type specimens of the new species are deposited in the Natural History Museum, London (BMNH), the Helminthological Collection, Institute of Parasitology, Biology Centre of the Academy of Sciences of the Czech Republic, České Budějovice (HCIP) and the Muzium Zoologi Universiti Malaya, Kuala Lumpur (MZUM). Voucher specimens of the three previously described *Trianchoratus* species collected during the present study are deposited in the Natural History Museum, London (BMNH) and the Muzium Zoologi Universiti Malaya, Kuala Lumpur (MZUM).

RESULTS

A total of 101 specimens of *Trianchoratus malayensis* [vouchers MZUM(P)763(V)–863(V)], 136 specimens of *T. pahangensis* [vouchers MZUM(P)864(V)–872(V), MZUM(P)875(V)–999(V), BM(NH)2008.12.22.3], 250 specimens of *T. ophicephali* [vouchers MZUM(P)1000(V)–1185(V), MZUM(P)1187(V)–1249(V), BM(NH)2008.12.22.2], and 29 specimens of *T. longianchoratus* sp. n. [1 holotype BM(NH)2008.12.22.1, 2 paratypes HCIP (M-481) and 26 paratypes MZUM(P)737(P)–762(P)] were collected from *C. lucius* in Endau-Rompin (7 individuals) in 2002 and from *C. lucius* (4 individuals) and *C. striata* (9 individuals) in the Bukit Merah Reservoir in 2006 and 2008. Re-examinations of the type specimens of *T. malayensis*, *T. pahangensis* and *T. ophicephali* from *C. lucius* and *C. striata* revealed errors in the labelling of the figures in the original description of *T. pahangensis* and *T. ophicephali*. On page 39 of Lim (1986), figs. 50–55 and fig. 56 should have been labelled as *T. pahangensis* and figs. 57–62 as *T. ophicephali*.

Trianchoratus longianchoratus sp. n. Fig. 1A–F

Description. Body size 524 (371–677) × 137 (72–167). Eyespots 4. Alimentary system consists of pharynx, short oesophagus and caeca confluent just anterior to haptor. Haptor slightly longer than wide, 119 (96–134) × 98 (81–114) in size. Dorsal anchors unequal: 1 vestigial anchor, comma-shaped, length 15 (13–19); 1 well-developed anchor, with indistinct outer root and long curved inner root 36 (33–38), inner length 44 (41–46), outer length 23 (21–26), point 23 (20–24) long, recurved. Two ventral anchors equally developed, inner length 54 (50–58), outer length 26 (25–27), long curved inner root 54 (50–57), outer root

4 (4–6) long, point 21 (20–23) long, recurved. Connecting bars absent. Marginal hooks 14 in number, length 15 (12–17). Testis dorsal to ovary; vas deferens arises from anterior margin of testis, crosses diagonally along dorsal field of body, loops around left caecum to ventral field. Copulatory organ 39 (36–43) long, consisting of large rounded initial part, coiled tube and accessory piece with proximal rod and more complex broad distal part. Ovary median; uterus extends anteriorly to uterine pore close to copulatory organ. Vitelline follicles co-extensive with intestinal caeca, confluent anteriorly, medially and posteriorly. Vagina comprising short tube with sclerotized, cup-like, dextral opening.

Type host: *Channa lucius* (Cuvier) (Channidae).

Type locality: Bukit Merah Reservoir, Perak, Malaysia.

Material studied: 29 specimens; 20 specimens measured.

Type specimens: Holotype BM(NH)2008.12.22.1; 2 paratypes HCIP(M-481) and 26 paratypes MZUM(P)737(P)–762(P).

Etymology: The specific appellation is derived from the long inner roots of the three well-developed anchors.

Differential diagnosis. There are 10 previously described species of *Trianchoratus* from channids and anabantoids (Table 1). This new species is very different from *T. malayensis* and *T. pahangensis* from *C. lucius* and *T. ophicephali* from *C. striata* in having anchors with long curving inner roots. In the three previously described species from channids, the inner roots of the developed anchors do not curve as distinctly. The vestigial dorsal anchor in the new species [15 (13–19) long, n = 20] is similar in shape and size to that of *T. pahangensis* [16 (11–18), n = 114] but smaller than that of *T. ophicephali* [19 (17–21), n = 95] and *T. malayensis* [20 (15–25), n = 83]. The marginal hooks of the new species [15 (12–17) long, n = 20] are similar in size to those of *T. pahangensis* [15 (13–16), n = 114] but smaller than those of *T. ophicephali* [19 (18–19), n = 95] and *T. malayensis* [20 (16–22), n = 91].

The shape of the developed anchors with long curving inner roots also distinguishes this new species from the *Trianchoratus* species found on the anabantoids (Table 1). For example, the anchors of *T. longianchoratus* are different from those of *T. acleithrium* Price et Berry, 1966 from *Helostoma temminckii* (Cuvier), which are almost C-shaped with gently curved points, and from the almost C-shaped anchors with sharply recurved points of *T. grandis* Lim, 1986 from *Anabas testudineus* (Bloch). Basically, in the *Trianchoratus* spp. from other anabantoids, the roots of the ventral anchors are broad compared to the narrow slender roots of those species, including the new species, from channids.

The soft anatomical parts, particularly the reproductive organs, of this new species are similar to those of the three known species from channids but with minor differences,

Fig. 1. *Trianchoratus longianchoratus* sp.n. **A** – composite drawing, dorsal view; **B** – dorsal anchor; **C** – vestigial dorsal anchor; **D** – ventral anchors; **E** – marginal hook; **F** – copulatory organ. Abbreviations: il – inner length; ir – inner root length; ol – outer length; or – outer root length; pt – point length.

particularly in the vagina, which is not as conspicuous as in the others. *Trianchoratus* spp. from channids possess larger vaginal opening and a longer vagina tube than the *Trianchoratus* spp. from anabantoids (see Lim 1986).

DISCUSSION

Including *Trianchoratus longianchoratus* there are now 11 species of *Trianchoratus* from channids (4 *Trianchoratus* spp.) and anabantoids (7 *Trianchoratus* spp.)

(Table 1). With the exception of *T. kearni* Agrawal et Bhatnagar, 1994, from the Indian *Anabas testudineus*, the other 10 species are from Southeast Asian anabantoids and channids (Table 1). Of the seven species of *Channa* in Peninsular Malaysia, monogeneans have been only recorded on *C. micropeltes*, *C. lucius* and *C. striata* (Table 1), although our field records reveal that *C. gachua*, *C. maruloides* and *C. bankanensis* have all been examined (Lim, personal observations). The presence of

Table 1. List of monogenean (*Trianchoratus*, *Eutrianchoratus*, *Heteronchocleidus* and *Sundanonchus*) species from channid and anabantoid fishes.

	Host species ¹	Monogenean species	Locality	Reference
Channoidei				
Channidae	<i>Channa striata</i> (<i>Ophicephalus striatus</i>)	<i>T. ophicephali</i> Lim, 1986	Malaysia	Lim 1986
	<i>Channa lucius</i> (<i>Ophicephalus lucius</i>)	<i>T. pahangensis</i> Lim, 1986	Malaysia	Lim 1986
	<i>C. lucius</i> (<i>O. lucius</i>)	<i>T. malayensis</i> Lim, 1986	Malaysia	Lim 1986
	<i>C. lucius</i>	<i>T. longianchoratus</i> sp. n.	Malaysia	Present study
	<i>Parachanna obscura</i> (<i>Ophicephalus obscurus</i>)	<i>E. magnum</i> Paperna, 1969	Ghana, Africa	Paperna 1969
	<i>P. obscura</i> (<i>O. obscurus</i>)	<i>E. minutus</i> Paperna, 1969	Ghana, Africa	Paperna 1969
	<i>P. obscura</i> (<i>O. obscurus</i>)	<i>E. imbachi</i> Dossou et Euzet, 1984	Benin, Africa	Dossou and Euzet 1984
	<i>P. obscura</i>	<i>E. chibami</i> Bilong Bilong, Euzet et Birgi, 1994	Cameroon, Africa	Bilong Bilong et al. 1994
	<i>P. obscura</i>	<i>E. malleus</i> Bilong Bilong, Euzet et Birgi, 1994	Cameroon, Africa	Bilong Bilong et al. 1994
	<i>Channa micropeltes</i>	<i>S. micropeltis</i> Lim et Furtado, 1985	Malaysia	Lim and Furtado 1985
	<i>C. micropeltes</i>	<i>S. foliaceus</i> Lim et Furtado, 1985	Malaysia	Lim and Furtado 1985
	<i>C. micropeltes</i>	<i>S. tomanorum</i> Kritsky et Lim, 1995	Malaysia	Kritsky and Lim 1995
Anabantoidei				
Helostomatidae	<i>Helostoma temminckii</i> (<i>H. rudolfi</i>)	<i>T. acleithrium</i> Price et Berry, 1966	Southeast Asia ²	Price and Berry 1966
	<i>H. temminckii</i>	<i>T. acleithrium</i> Price et Berry, 1966	Malaysia	Lim 1986
Anabantidae	<i>Anabas testudineus</i>	<i>T. grandis</i> Lim, 1986	Malaysia	Lim 1986
	<i>A. testudineus</i>	<i>T. gussevi</i> Lim, 1986	Malaysia	Lim 1986
	<i>A. testudineus</i>	<i>T. parvulus</i> Lim, 1986	Malaysia	Lim 1986
	<i>A. testudineus</i>	<i>T. kearnii</i> Agrawal et Bhatnagar, 1994	India	Agrawal and Bhatnagar 1994
	<i>Ctenopoma kingsleyae</i>	<i>H. ctenopomae</i> Paperna, 1969	Ghana, Africa	Paperna 1969
	<i>C. kingsleyae</i>	<i>H. ouemensis</i> Euzet et Dossou, 1975	Africa	Euzet and Dossou 1975
	<i>C. kingsleyae</i>	<i>H. tuzetae</i> Euzet et Dossou, 1975	Africa	Euzet and Dossou 1975
	<i>C. kingsleyae</i>	<i>H. adjanohouni</i> Euzet et Dossou, 1975	Africa	Euzet and Dossou 1975
	<i>C. kingsleyae</i>	<i>H. ouemensis</i> Euzet et Dossou, 1975	Africa	Euzet and Dossou 1975
	<i>C. kingsleyae</i>	<i>H. tuzetae</i> Euzet et Dossou, 1975	Africa	Euzet and Dossou 1975
	<i>C. kingsleyae</i>	<i>H. adjanohouni</i> Euzet et Dossou, 1975	Africa	Euzet and Dossou 1975
Osphronemidae				
Belontiinae	<i>Belontia hasselti</i>	<i>E. cleithrium</i> Lim, 1989	Malaysia	Lim 1989
	<i>B. hasselti</i>	<i>E. distensigenitalis</i> Lim, 1989	Malaysia	Lim 1989
	<i>B. hasselti</i>	<i>E. fusiformis</i> Lim, 1989	Malaysia	Lim 1989
	<i>B. hasselti</i>	<i>E. inequalis</i> Lim, 1989	Malaysia	Lim 1989
Macropodinae	<i>Trichopsis vittata</i>	<i>H. buschkielli</i> Bychowsky, 1957	Malaysia	Lim 1986
	<i>Macropodus opercularis</i>	<i>H. buschkielli</i> Bychowsky, 1957	China	Bychowsky 1957
	<i>Macropodus chinensis</i>	<i>H. buschkielli</i> Bychowsky, 1957	China	Tchang and Ji 1980
	<i>M. chinensis</i>	<i>H. magnihamatus</i> Tchang et Ji, 1980	China	Tchang and Ji 1980
Luciocephalinae	<i>Trichogaster leerii</i>	<i>T. leerium</i> Lim, 1986	Malaysia	Lim 1986
	<i>Trichogaster trichopterus</i>	<i>T. trichogasterium</i> Lim, 1986	Malaysia	Lim 1986
	<i>Colisa labiosa</i>	<i>H. gracilis</i> Mizelle et Kritsky, 1969	India	Mizelle and Kritsky 1969
	<i>Colisa lalius</i>	<i>H. asymmetricus</i> Majumdar, Ramchandrla, Trupati et Agrawal, 1988	India	Majumdar et al. 1988
	<i>C. lalius</i>	<i>H. stunkardi</i> Majumdar, Ramchandrla, Trupati et Agrawal, 1988	India	Majumdar et al. 1988
	<i>Colisa fasciatus</i>	<i>H. lucknowensis</i> Agarwal et Bhatnagar, 1997	India	Agarwal and Bhatnagar 1997

¹ Valid names following FishBase (Froese and Pauly 2008); in parentheses, synonym names used in the original sources.² Fish specimens were obtained from Cordell Farm Supply Co., Milledgeville, Georgia, USA and listed as from Sumatra, Borneo, Java, Malaya and Thailand.

T. longianchoratus on *C. lucius* from Bukit Merah, Perak, but not on this host from Endau-Rompin or Tasek Bera (the type locality for *T. malayensis* and *T. pahangensis*) (Lim 1986), indicates that the habitat is an important factor in parasite distribution.

All of the *Trianchoratus* species described to date have morphologically similar copulatory organs and differ mainly in the shapes and sizes of their haptor arms, particularly in the three well-developed anchors (Lim 1986). Basically, those species from the anabantoids and channids can be distinguished by the general shape of the developed anchors. Some species from anabanto-

ids have comparatively longer and more sharply recurved anchor points in comparison to those from channids. The vestigial dorsal anchor in all species of *Trianchoratus*, *Heteronchocleidus* and *Eutrianchoratus* is comma-shaped.

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