MONOGENEAN GILL PARASITES OF THE KINGFISH *SERIOLA GRANDIS* CASTLENAU (CARANGIDAE) FROM THE GREAT BARRIER REEF

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With Text-figures 1–3 and Tables 1–2

Abstract. 15 *Seriola grandis* (Carangidae) from near Heron Island, Great Barrier Reef, Australia, were examined for gill parasites. The Monogenea *Zeuxapta seriolae* (Meserve, 1938) and *Paramicrocotyloides reticularis* gen. et sp. nov. are described. The new species differs from other genera of the Microcotylidae in its caecal reticulum found in most of the body, in its body proper which is divided into three parts, and in its opisthaptor, which is symmetrical and has two equal rows of clamps. The clamps are of two types, the most anterior ones are symmetrical of a typical *Microcotyle*-type, all others are asymmetrical of a modified *Microcotyle*-type. The unarmed common genital atrium is ventral and close to the pharynx, the unarmed vagina is mid-dorsal, a short distance behind the genital atrium. *Zeuxapta japonica* is synonymized with *Z. seriolae*. The distribution of the two Monogenea species and of two copepod species on the gills is described.

This paper is one of a series dealing with monogenean ectoparasites of fish on the Australian east coast.

Material and Methods

Fish were caught by trolling at Heron Island, Great Barrier Reef (23°27′ S, 151°55′ E). The gills were removed and fixed by pouring hot 10% formalin over them. The distribution of the various monogenean and copepod species on the gills was mapped on natural size drawings of the gills. Monogenea were either stained in Grenacher's carmine alum and mounted in Canada balsam, or they were mounted unstained, often with parts of the gill filaments to which they were attached. Drawings were made with the aid of a camera lucida. Measurements of a number of specimens of different size are given separately to permit an evaluation of allometric trends.

Description

Zeuxapta seriolae (Meserve, 1938) Price, 1962.

(syn. *Axine seriolae* Meserve, 1938; *Heteraxine meservei* Sproston, 1946; *Microcotyle seriolae* Yamaguti, 1940 and *Zeuxapta japonica* (Yamaguti, 1940) Yamaguti, 1963; *Z. zyxivaginata* Unnithan, 1957).

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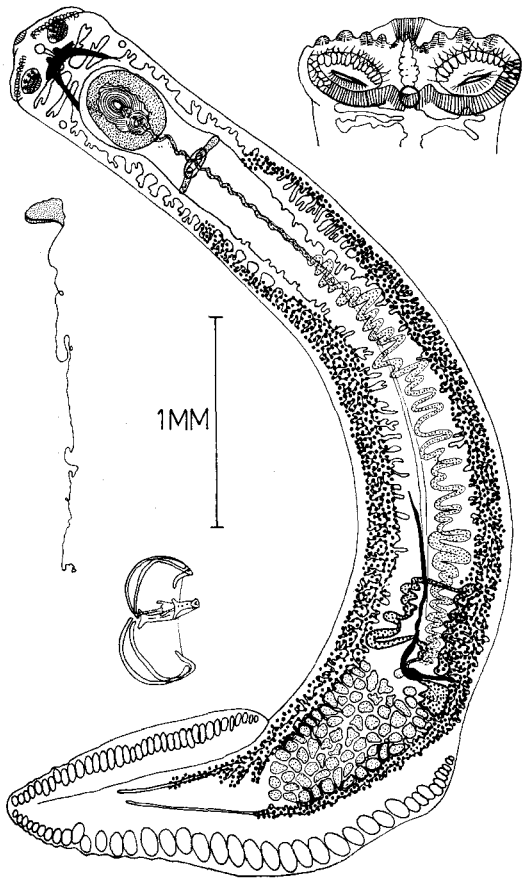

Fig. 1. *Zeuxapta seriolae* from *Seriola grandis* at Heron Island. Top right: anterior end expanded.

105 specimens on 15 of 15 *Seriola grandis* Castlenau (Carangidae) at Heron Island.

Body flat, smooth, widest at anterior margin of opisthaptor, continuous with opisthaptor. Pharynx between 2 buccal suckers, oesophagus with long diverticula, caeca with medial and lateral diverticula except for most posterior parts, extending deep into opisthaptor; not joined posteriorly. Testes numerous in median field from behind ovary to first clamps of short clamp row; vas deferens strongly winding, ejaculatory duct in ejaculatory bulb consisting of meridional fibres; no cirrus pouch, very small papilla-like cirrus unarmed, genital atrium with weak circular muscle fibres forming sphincter. Gonopore midventral short distance behind caecal bifurcation. Germinal part of ovary on side of longer clamp row a short distance in front of most anterior clamps, anterior loop crossing to other side and back, terminal part of ovary directed posteriorly. Ootype and yolk reservoir medial to germinal part of ovary. Common yolk duct very long, transverse yolk ducts unite approximately in middle of body. Small follicular vitellaria in lateral fields from behind vaginal

opening to end of caeca. Uterus opens with male gonoduct through common gonopore. Vaginal opening median and dorsal some distance behind gonopore, surrounded by muscles and lined with small irregular spines(?), sometimes divided by median ridge into two openings.

Opisthaptor asymmetrical, 1 row of clamps with smaller (occasionally equal) number of smaller clamps. Clamps of *Microcotyle*-type, with 2 pairs of marginal sclerites and median sclerite. Shorter part of median sclerite with median prolonga-

Table 1. *Zeuxapta seriolae*. (Measurements in mm)

Total length	5.3	7.5	5.6	4.6	approx. 5.0	approx. 3.2
Max width of main body	0.85	0.95	0.78	1.27	0.75	—
Buccal suckers	0.068×0.126 0.079×0.129	0.090×0.158 0.086×0.152	0.083×0.143 0.090×0.150	0.083×0.144 0.054×0.119	0.076×0.145 0.074×0.148	—
Pharynx	0.047×0.036	0.043×0.041	0.040×0.040	—	0.039×0.039	—
Distance middle of gonopore-ant. end	0.52	0.75	0.61	0.43	0.57	—
Distance vaginal opening-ant. end	0.91	1.32	1.02	0.75	1.02	—
No. of testes	approx. 105	—	approx. 100	approx. 110	approx. 115	approx. 110
No. of clamps	35+42	48+48	43+46	30+31	36+40	26+31
Largest clamp in short row (width)	0.102	0.116	0.112	0.129	0.130	—
Largest clamp in long row (width)	0.156	0.191	0.182	0.195	0.170	—

Total length	approx. 7.2	approx. 6.2	4.9	4.1—8.5	7.8—18.7
Max width of main body	—	—	0.92	0.9—0.95	0.98
Buccal suckers	—	—	0.076×0·120 0.075×0.112	0.060—0.075 ×0.080—0.093	—
Pharynx	—	—	0.039×0.040	0.042—0.063 ×0.033—0.036	—
Distance middle of gonopore-ant. end	—	—	0.61	0.4—0.63	—
Distance vaginal opening-ant. end	—	—	1.01	0.78—0.95	—
No. of testes	95	approx. 125	approx. 120–140	80—110	80—90
No. of clamps	46+55	43+53	32+40	39—42+45—47 (in 1 case 26+26)	45—50+43—52
Largest clamp in short row (width)	—	—	0.108	—	0.15×0.09
Largest clamp in long row (width)	—	—	0.165	—	0.29×0.23
			Axine seriolae Meserve, type U.S.N.M. Helm. Coll. No. 9169	*Microcotype seriolae*=*Zeuxapta japonica* acc. to Yamaguti (1940)	*Z. seriolae australica* Acc. to Lebedev, 1968.

tion. Terminal lappet and hamuli absent. Eggs with a long filament at one pole.

Remarks. The Australian specimens are practically identical with those originally described as *Axine seriolae*. The specimen of Meserve's material examined by me (USNM. Helm. Coll. No. 9169) has a slightly greater number of testes than found in most Australian specimens, but this character is strongly variable. My measurements of Meserve's specimen also differ slightly from the ranges given by Meserve.

Unnithan (1957) established the genus *Zeuxapta* for *A. seriolae*. It differs from the other genera of the subfamily Heteraxininae Unnithan, 1957 in the presence of a vagina (absent in *Heteraxinoides*), in the presence of an ejaculatory bulb (absent in *Heteraxine*), and in the absence of a seminal vesicle and the presence of a single dorsal vaginal pore (*Kannaphallus* with seminal vesicle and paired submedian vaginal openings). The differences are slight and the vaginal pore of the Australian specimens of *Zeuxapta* is sometimes divided into two halves by a median ridge. The examination of more species of the various genera may well show that the characters used for establishing genera in this group indicate differences at the species level only.

I could not examine material of *Zeuxapta japonica* Yamaguti, 1963 (=*Microcotyle seriolae* Yamaguti, 1940), but the drawings, measurements, and counts given in Yamaguti (1940) (see table 1) indicate that this species is a synonym of *Z. seriolae*, as suggested earlier by other authors (compare discussion by Lebedev, 1968). For a discussion of the other synonyms compare Yamaguti (1963, p. 263–264).

Zeuxapta seriolae has been found on *Seriola dorsalis* at the Galapagos Islands, on *Seriola grandis* in the Tasman Sea (Lebedev, 1968) and on the Great Barrier Reef (this paper), and on *Caranx hippos* on the Mexican Pacific coast (Lamothe-Argumedo,

Table 2. *Paramicrocotyloides reticularis*. (Measurements in mm)

Total length	approx. 9.0	8.0	approx. 7.0
Max. width of body proper	3.1	2.9	2.1
Length of opisthaptor	3.2	2.7	approx. 2.2
Max. width of opisthaptor	—	0.8	—
Buccal suckers	0.069×0.108 0.072×0.115	—	0.068×0.108 0.070×0.091
Pharynx	0.076×0.050	0.068×0.054	0.054×0.043
Distance gonopore-ant. end	0.46	—	0.22
Distance vaginal pore-ant. end	—	—	0.40
No. of testes	—	> 150	> 100
No. of left clamps	65	60	approx. 53
No. of right clamps	64	56	approx. 55
Largest clamp	0.155 (width)	0.162 (width)	0.140 (length)
Anterior clamp	0.064 (width) 0.040×0.040	0.025×0.043	0.028×0.043
Posterior clamp	0.071 (width)	0.050×0.058	0.054×0.061
Eggs	—	0.180×0.102 0.173×0.102 0.160×0.098 0.180×0.093 0.180×0.090	0.180×0.091

1970). *"Z. japonica"* has been found on *Seriola aureovittata* in the Inland Sea of Japan.

Lebedev (1968) established a new subspecies *Zeuxapta seriolae australica* for specimens from *Seriola grandis* in the Tasman Sea on the basis of their larger maximum size, their smaller difference in the number of clamps on both sides of the opisthaptor (see table), and their geographical distribution. He distinguished the subspecies *Z. s. japonica* and *Z. s. seriolae* for the Japanese and Galapagos forms respectively. Only a statistical evaluation of many specimens from the various areas can show whether distinct subspecies exist. The larger size of the Tasmanian form may be due to environmental factors (for instance temperature) and not to genetic factors indicative of a difference at the subspecific level. Furthermore, specimens from Mexico also reach a relatively large size (max. length 9.9 mm, Lamothe-Argumedo, 1970).

Specimens deposited in the Australian Museum, Sydney W. 9163–9165; USNM. Helm. Coll. No. 74123 and in the British Museum (Natural History).

Description

Paramicrocotyloides reticularis gen. nov., sp. nov.

6 specimens on 2 of 15 *Seriola grandis* (Castlenau) at Heron Island.
Habitat: gills.

Body smooth, consisting of 3 parts: narrow anterior part with buccal suckers, pharynx, gonopore, vaginal opening and terminal part of uterus; wide main part with most of uterus, ovary and testes; narrow posterior part bearing the opisthaptor. Intestine consists of reticulum of narrow interconnected canals which fills all of body including the median part of the opisthaptor. Testes numerous from behind ovary to anterior margin of opisthaptor, vas deferens winding in midline; no cirrus pouch, unarmed muscular cirrus, unarmed genital atrium, mid-ventral gonopore posterior to pharynx and surrounded by muscular sphincter. Germinal part of ovary lobed, submedian; large ovarial loop directed anteriorly; terminal part of ovary just in front of germinal part. Vitellaria small follicular, in lateral fields of main body part. Transverse and common yolk ducts in the shape of a Y; common yolk duct at level of germinal part of ovary. Uterus in median field, may contain many eggs, opens (probably) with male duct through common gonopore. Single dorsal vaginal opening short distance behind gonopore.

Opisthaptor on ventral side of a tapering posterior extension of the body proper, symmetrical, with 2 equal rows of clamps which are bent medioposteriorly at anterior end. No hamuli and larval hooks. Clamps largest in middle part of opisthaptor. Most clamps asymmetrical; median sclerite with one row of thorns, one end winged, the other with a bifurcated appendage; one pair of marginal sclerites U-shaped, one pair more or less straight on one side and curved outwards on the other. Anterior clamps symmetrical, of typical *Microcotyle*-type (median sclerite, 2 pairs of symmetrical marginal sclerites; marginal sclerites of 1 pair with incisions but apparently not clearly jointed); clamps formed at anterior end of opisthaptor. Eggs oval, with a long filament at each pole.

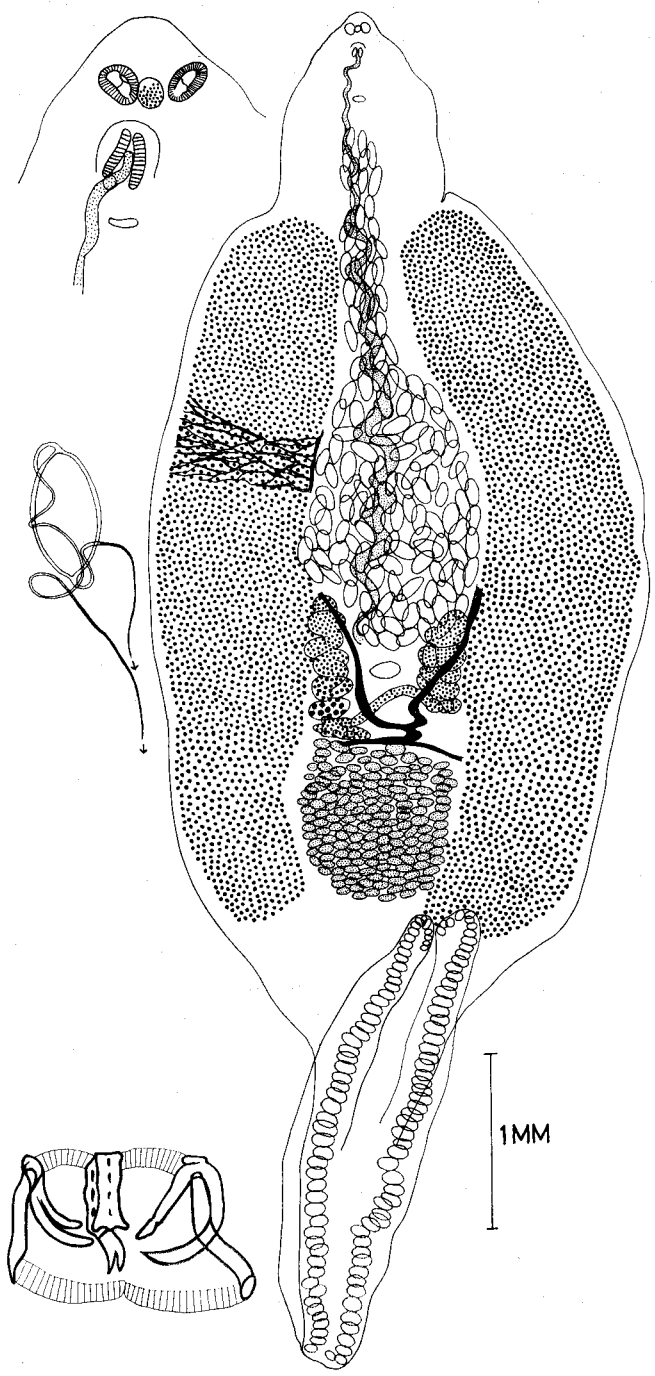

Fig. 2. *Paramicrocotyloides reticularis* from *Seriola grandis* at Heron Island. Intestinal reticulum drawn only in small part on left side of body.

Remarks. The species described here must be included in the famliy Microcotylidae Taschenberg, 1879, because the opisthaptor is not "fishtail"-shaped and has numerous clamps on both sides, which are of an unmodified or a modified *Microcotyle*-type and do not have accessory sclerites. Of the 3 subfamilies comprising this family in Yamaguti's (1963) system, the Metamicrocotylinae differ mainly in the posteriorly lacking or poorly developed vitellaria, in the structure of the opisthaptor and in the absence of a vagina, and the Prosomicrocotylinae in the structure of the opisthaptor, which forms two separate marginal frills along much of the body proper. All genera of the third subfamily, Microcotylinae Monticelli, 1892, differ in a number of important characters from the species described above. None has an extensive caecal reticulum, a body divided into 3 distinct parts, and in all genera the opisthaptor has a different structure and there are no modified *Microcotyle*-clamps of the kind described here.

In Unnithan's (1971) system, the Microcotylinae has unequal clamp rows, the Bradyhaptorinae has usually fewer than 12 (in *Gamacallum* up to 25) clamps on each side and the clamps are not significantly modified in shape, and in the Caenomicrocotylinae the clamps are formed in the middle of the rows. In these characters, the three subfamilies differ clearly from the form described here. The fourth subfamily, the Bychowskicotylinae was established by Unnathan for *Bychowskicotyla mormyri* (Lorenz, 1878) originally described as *Microcotyle mormyri* on *Pagellus mormyrus*, Mediterranean. Like the Australian species it has clamps with lateral asymmetry. However, the structure of the clamps is different and the posterior clamps are unmodified. Furthermore, the genital atrium has a circle of spines of two types and there are only 16–18 testes.

The differences justify the establishment of a new genus, for which I propose the name *Paramicrocotyloides* because of its closeness to *Microcotyle*. I name the species *reticularis* because of the reticular structure of its intestine.

Generic diagnosis

Paramicrocotyloides gen. nov.

Microcotylidae with body proper divided into anterior and posterior narrow and middle wide parts. Common genital atrium unarmed, ventral behind pharynx; vagina unarmed, dorsal behind common gonopore. Vitellaria in lateral fields of middle part of body proper. Ovary looped anteriorly, numerous postovarian testes. Intestine forms reticulum of narrow interconnected canals throughout body. Opisthaptor narrow, without hamuli, with two symmetrical rows of clamps. Anterior clamps symmetrical of *Microcotyle*-type, other clamps asymmetrical of modified *Microcotyle*-type.

Type species: *P. reticularis.*

Type host: *Seriola grandis* (Castlenau).

Holotype and one paratype deposited in USNM. Helm. Coll. No. 74124 and 74125. One paratype deposited in the British Museum (Natural History).

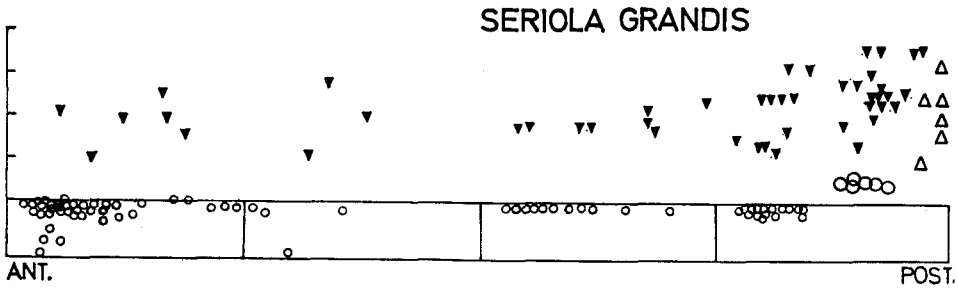

Fig. 3. Distribution of mongeneans and copepods on the gills of 6 *Seriola grandis*. Rectangles at bottom of drawing represent 1st-4th longitudinal quarters of gill arches; gill filaments are represented above the arches (affer Rohde, 1977).

▼ *Zeuxapta seriolae*
△ *Paramicrocotyloides reticularis*
∘ *Caligus spinosus*
○ *Brachiella* sp.

Distribution of ectoparasites on the gills (Fig. 3).

Fig. 3 shows that all four species of ectoparasites found on the gills of the kingfish examined have well defined microhabitats with practically no overlap.

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LITERATURE CITED

Lamothe-Argumedo, R. 1970. Monogéneos de peces II. Reporte de tres especies de Monogenea parásitas de las branquias de *Caranx hippos* del Pacífico mexicano y redescripción de *Zeuxapta seriolae* (Meserve, 1938) Price, 1962. Rev. Biol. Trop. **16**: 153–169.

Lebedev, B.I. 1968. Monogeneans of commercial fish of the Pacific Basin. Family Heteraxinidae Price, 1962. In: Skrjabin, K.I. and Mamaev, Yu. L. ed. Helminths of animals of the Pacific Ocean. Akad. Nauk SSSR, Isd. "Nauka," Moscow (in Russian), 38–45.

Rohde, K. 1977. Species diversity of monogenean gill parasites of fish on the Great Barrier Reef. Proc. 3rd Int. Coral Reef Symp. Miami-Florida, 585–591.

Sproston, N.G. 1946. A synopsis of the monogenetic trematodes. Tr. Zool. Soc. London **25**: 185–600.

Unnithan, V. 1957. On the functional morphology of a new fauna of Monogenea on fishes from Trivandrum and environs. Part. I. Axinidae fam. nov. Bull. Centr. Res. Inst. Univ. Kerala **5**: 27–122.

Unnithan, V. 1971. On the functional morphology of a new fauna of Monogenea on fishes from Trivandrum and environs. Part IV. Microcotylidae sensu stricto and its repartition into subsidiary taxa. Amer. Midland Naturalist **85**: 366–398.

Yamaguti, S. 1940. Studies on the helminth fauna of Japan. Part 31. Trematodes of fishes. VII. Jap. J. Zool. **9**: 35–108.

Yamaguti, S. 1963. Systema Helminthum. IV. Monogenea and Aspidocotylea. Interscience Publ. New York-London-Sydney.