Research Article

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Five monogenean species (Allodiscocotylidae, Heteromicrocotylidae, Microcotylidae) from the Pacific seabream *Acanthopagrus pacificus* (Perciformes: Sparidae) in the Gulf of Tonkin off Vietnam, with descriptions of three new species

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Abstract: A total of 52 specimens of the Pacific seabream *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino from the Gulf of Tonkin off Vietnam were examined for monogeneans. Twenty fish were parasitised by 101 individuals of five monogenean species, including two known species *Allodiscocotyla diacanthi* Unnithan, 1962 and *Heterapta chorinemi* (Tripathi, 1956), as well as three new species, *Polylabroides tienyenensis* sp. n., *Polylabroides tonkinensis* sp. n. and *Metacamopia lebedevi* sp. n. *Polylabroides tienyenensis* and *P. tonkinensis* are morphologically more similar to *Polylabroides guangdongensis* Zhang et Yang, 2001 in comparison with other species within the genus, based on the absence of small spines on the cirrus. However, *P. tonkinensis* is distinguished from *P. guangdongensis* by fewer clamps on the haptor and by the different shapes of the large spines on the cirrus. Similarly, *P. tienyenensis* differs from *P. guangdongensis* by vaginal ducts with fewer branches, fewer clamps and smaller egg size. *Metacamopia lebedevi* is distinguished from *Metacamopia chorinemi* (Yamaguti, 1953) by the arrangement of testes (one row vs two rows), diverticula absent in the oesophagus, and the number of anchor pairs (one vs two); it differs from *Metacamopia oligoplites* Takemoto, Amato et Luque, 1996 by the smaller haptor, shape and absence of small sclerotised hooks, the number of ribs in their clamps, and the position of the testes; it can be separated from *Metacamopia indica* (Unnithan, 1962) by having fewer testes and lacking sclerotised structures in the vagina. The present study also provides the measurements for *A. diacanthi*, *H. chorinemi*, and proposes a new key to all species of *Polylabroides*.

Keywords: Polyopisthocotylea taxonomy, Monogenea, marine parasites, sparids, western Pacific

The Pacific seabream, *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino (Perciformes: Sparidae), is distributed throughout the western Pacific (Iwatsuki et al. 2010). Hitherto, there are no records of monogeneans from *A. pacificus*. However, 37 monogenean species have been recorded from fishes of *Acanthopagrus* spp., including one species of *Haliotrema* Johnston et Tiegs, 1922 (Johnston and Tiegs 1922, Roubal 1981, Byrnes 1986a); one species of *Murraytrema* Price, 1937 (Zhang and Yang 2001); one species of *Encotyllabe* Diesing, 1850 (Yamaguti 1934, Nitta and Nagasawa 2015); one species of *Lobotrema* Tripathi, 1959 (Yamaguti 1958, Roubal 1981, Byrnes 1986a, Nitta and

Nagasawa 2015); one species of *Pseudaxine* Parona et Perugia, 1890 (Chauhan 1945); one species of *Aspinatrium* Yamaguti, 1963 (Yamaguti 1963); one species of *Microcotyle* van Beneden et Hesse, 1863 (Ko and Chan 2002); one species of *Udonella* Johnston, 1835 (Byrnes 1986a); two species of *Euryhaliotrema* Kritsky et Boeger, 2002 (Ogawa and Egusa 1978a, Kritsky and Boeger 2002, Kritsky 2012); two species of *Anoplodiscus* Sonsino, 1890 (Yamaguti 1958, Ogawa and Egusa 1981, Roubal 1981, Byrnes 1986a, Maran et al. 2014); two species of *Benedenia* Diesing, 1858 (Byrnes 1986a, Hussey 1986); four species of *Polylabris* Euzet et Cauwet, 1967 (Mamaev and Parukhin

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Zoobank number for article: [urn:lsid:zoobank.org:pub:29F9A993-A9EF-4074-8524-B5E3BEF45337](http://zoobank.org/pub:29F9A993-A9EF-4074-8524-B5E3BEF45337)

1976, Ogawa and Egusa 1980, Hussey 1986, Al-Daraji et al. 2010); eight species of *Polylabroides* Mamaev et Parukhin, 1976 (Murray 1931, Yamaguti 1963, Mamaev and Parukhin 1976, Roubal 1981, Byrnes 1985, Dillon et al. 1985, Mamaev 1988, Zhang and Yang 2001) and one species of *Lamellodiscus* Johnston et Tieg, 1922 (Johnston and Tieg 1922, Ogawa and Egusa 1978b, Roubal 1981, Byrnes 1986b, Kritsky 2012, Nitta and Nagasawa 2015, Zhang et al. 2018). Species of the polyopisthocotylean genera *Metacamopia* Lebedev, 1972, *Allodiscocotyla* Yamaguti, 1953, and *Heterapta* Unnithan, 1961, have never been reported from fishes of the genus of *Acanthopagrus* Peters.

Among the monogenean fauna of marine fishes in Vietnam, *Metacamopia* and *Allodiscocotyla* have been found infecting different carangid hosts, e.g. *Metacamopia indica* (Unnithan, 1962) in *Scomberoides lysan* (Forsskal) (Lebedev 1972, 1986); *Metacamopia chorinemi* (Yamaguti, 1953) in *S. lysan* and *Selar crumenophthalmus* (Bloch) (Lebedev 1970, 1986); *Allodiscocotyla chorinemi* Yamaguti, 1953 in *S. lysan*, *Caranx* sp., and *Decapterus* sp. (Lebedev 1970); *Allodiscocotyla diacanthi* Unnithan, 1962 in *Decapterus* sp. (Lebedev 1970). There are no previous records of species of *Heterapta* and *Polylabroides* Mamaev et Parukhin, 1976 from the coast of Vietnam.

This study is the first survey of monogeneans from the Pacific seabream, *A. pacificus*, in the Gulf of Tonkin, off Vietnam. Herein, we present the description of one new species of *Metacamopia* and two new species of *Polylabroides*, as well as new host records and measurement for *A. diacanthi* and *H. chorinemi* (Tripathi, 1956).

MATERIAL AND METHODS

During a survey of the helminth fauna of marine fishes off the coast of Vietnam between March 2012 and May 2018, we examined 52 individuals of *Acanthopagrus pacificus* collected from five locations in the Gulf of Tonkin, e.g. off Mong Cai (21.4463N, 107.9438E), Tien Yen (mangrove forest) (21.3052N, 107.4736E), Quat Lam (20.2016N, 106.3888E), Do Son (20.7211N, 106.7980E), and Cat Ba (20.7252N, 107.0463E).

Fish were purchased alive from fishermen, placed in an ice box and carried fresh to the laboratory. All fishes were euthanised using benzocaine (100 mg/l) within 12 hours before examination. Gills were cut out and gill lamellae were placed separately in Petri dishes with seawater and checked for the presence of monogeneans under an Olympus SZ61 stereomicroscope. Monogeneans were removed from gill filaments and debris with the aid of fine brushes and needles, fixed in hot (70°C) AFA (a mixture of 70% ethanol-formalin-acetic acid in the ratio of 90 : 7 : 3), and preserved in 70% ethanol. After one month, half of samples was stained with Mayer's carmine while the other half was stained with Gomori's trichrome. Then all samples were dehydrated using an ethanol series (80–100%), cleared in xylene and mounted in Canada balsam.

The morphological characters of monogeneans were studied using an Olympus BX53 light microscope at magnifications ranging from 40 × to 1,000 ×; and drawings were made with the aid of a camera lucida. All measurements are given in micrometres

presenting the range followed by the mean and the number of individuals or structures measured in parentheses.

Type specimens and vouchers are deposited at the Department of Parasitology, Institute of Ecology and Biological Resources, and in the Vietnam National Museum of Nature, Hanoi, Vietnam.

RESULTS

Twenty individuals of *Acanthopagrus pacificus* were infected by a total of 101 monogenean specimens. The intensity of infection varied from 1 to 16 worms per fish. Morphological examination of all 101 monogenean specimens revealed that they represented five species. Among them, one dominant species consisted of 95 specimens, while the other four species consisted of only one or two specimens each/species. The details of each species are presented below.

Polylabroides tienyenensis sp. n.

Figs. 1, 2

ZooBank number for species:

[urn:lsid:zoobank.org:act:38F13E50-5B5E-413A-AD0A-3BA560F57545](https://zoobank.org/act:38F13E50-5B5E-413A-AD0A-3BA560F57545).

Description (based on one specimen stained in Mayer's carmine and one specimen stained in Gomori's trichrome)

Body elongate, subcylindrical, tapering anteriorly and posteriorly, 3.362–3.875 in length, maximum width at level of ovary 205–287. Anterior extremity with three slight protuberances in which cephalic glands open. Haptor symmetrical, distinctly delineated from body proper, armed with 31–36 pairs of clamps (Fig. 1A). Clamps of typical *Microcotyle*-type without accessory sclerite (Figs. 1E, 2C,D), similar in shape, dissimilar in size; the largest clamps in anterior region of haptor, 66–68 × 30–43 (67 × 37) (n = 8); middle clamps 64–66 × 31–37 (65 × 34) (n = 8); posterior clamps 41 × 25–31 (41 × 28) (n = 8).

Buccal suckers two, muscular, oval, without septa, 53–57 × 47–49 (55 × 48) (n = 4). Mouth ventro-subterminal; pharynx subglobular, 39–41 in width (Fig. 1B). Oesophagus slender, 230 in length, bifurcating at posterior end of cirrus, about 272 from anterior extremity. Intestinal caeca two, extending posteriorly but does not enter haptor; right and left caeca equal in length.

Testes 13, postovarian, globular or elongate-oval, large, dissimilar in size, 62–102 × 66–120 (88 × 92) (n = 24); arranged in longitudinal intracaeca row (Fig. 1A). Vas deferens dilating with sperm at base, winding sinuously forward along midline of body, entering at posterior end of cirrus. Genital atrium at prebifurcal, thin walled, oval, 62 × 51 and 68 × 51 in size. Cirrus spherical, 37 × 41 and 41 × 49 in size, armed with two large spines, 39–41 (40) long (n = 4). Cirrus spines elephant's tusk-shaped with rounded base (Figs. 1C, 2A,B).

Ovary pretesticular, question mark-shaped, intercaecal, equatorial. Seminal receptacle well-defined, round, lies close to distal end of ovary. Oötype mid-ovarian, oval, surrounded by Mehlis' glands, two times smaller than seminal receptacle, connected with genito-intestinal canal (Fig. 1D). Vaginal aperture median, ventral, postbifurcal, about 328 from anterior margin of body. Two narrow vagi-

Type material: Holotype (NMH–Microcotylid–2015–1)

Fig. 2. *Polylabroides tienyenensis* sp. n. from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – clampecirrus (specimen stained with Mayer's carmine); **B** – cirrus (specimen stained with Gomori's); **C** – clamp (specimen stained with Gomori's); **D** – clamp (specimen stained with Mayer's carmine). *Abbreviations:* c – muscular base; csp – cirrus spines.

is deposited in the Department of Parasitology, Institute of Ecology and Biological Resources and one paratype (NMH–Microcotylid–2015–2) is deposited in the Vietnam National Museum of Nature, Hanoi, Vietnam.

E t y m o l o g y : The specific name refers to the type locality of the parasite (Tien Yen District).

Remarks. *Polylabroides* consists of eight species and can be divided into two groups based on the number of large spines on the cirrus (Zhang and Yang 2001). The first group comprises two taxa with numerous large spines on the cirrus; i.e. *Polylabroides quadruspinosus* Byrnes, 1985 (4 large spines) and *Polylabroides longispinosus* Byrnes, 1985 (40–67 large spines). The second group comprises taxa with only two large spines on the cirrus and includes *P. tienyenensis* sp.n. The new species differs from *Polylabroides australis* (Murray, 1931), *Polylabroides biungulatus* Mamaev et Parukhin, 1976, *Polylabroides mylionis* Dillon, Hargis et Hargises, 1985, *Polylabroides multispinosus* Roubal, 1981, and *Polylabroides zini* Mamaev, 1988 by the absence of small spines on the cirrus. *Polylabroides tienyenensis* most resembles *Polylabroides guangdongensis* Zhang et Yang, 2001 in the structure of the

genital atrium and cirrus (no small spines; two large spines are straight, curved only at distal end), as well as the number of testes (approximately 13). However, *P. tienyenensis* can be distinguished from the latter species by the narrower body (width 246 µm vs 453 µm), fewer clamps (62–72 vs 96–106) and smaller eggs much (50 × 25 µm vs 205 × 68 µm). This is the first *Polylabroides* species described from *A. pacificus* in the coast of Vietnam.

Polylabroides tonkinensis sp. n.

Figs. 3, 4

ZooBank number for species:

[urn:lsid:zoobank.org:act:B9B48B88-5BF9-4F54-9903-E9FE10D53207](https://zoobank.org/act:B9B48B88-5BF9-4F54-9903-E9FE10D53207).

Description (based on selected, stained and measured 36 specimens, from totally collected 95 specimens, including 18 specimens stained in Mayer's carmine and other 18 specimens stained in Gomori's trichrome).

Body elongate, subcylindrical, 2.38–2.81 mm (2.63 mm; n = 12) in length, maximum width 233–394 (310; n = 20) at level of ovary, tapering anteriorly and posteriorly. Haptor symmetrical, distinctly delineated from body proper, armed with 30–40 (36; n = 12) pairs of clamps.

Fig. 3. *Polylabroides tonkinensis* sp. n. from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – holotype (total view); **B** – paratype, (total view); **C** – cirrus and vagina (ventral view); **D** – cirrus (lateral view); **E** – reproductive system; **F** – vaginal aperture; **G** – cirrus spines; **H** – egg; **I** – clamp. *Abbreviations:* gi – genito-intestinal canal; ö – oötype; ov – ovary; sr – seminal receptacle; t – testis; u – uterus; vas – vas deferens; vi – duct of vitelline reservoir.

Clamps of typical *Microcotyle*-type without accessory sclerite (Figs. 3I, 4C), similar in shape, dissimilar in size; largest clamps in middle region of haptor, $54\text{--}63 \times 29\text{--}31$ (58×30 ; $n = 12$); anterior clamps $38\text{--}50 \times 26\text{--}28$ (46×29 ; $n = 12$); posterior clamps $25\text{--}36 \times 23\text{--}25$ (29×24 ; $n = 12$).

Two buccal suckers, muscular, oval, without septa, $38\text{--}58 \times 36\text{--}52$ (50×46) ($n = 38$). Mouth ventrosubterminal; pharynx subglobular, $30\text{--}40$ (36 ; $n = 20$) in diameter. Oesophagus slender, without lateral diverticula, $115\text{--}212$ (171 ; $n = 16$) in length, bifurcating at posterior end of cirrus, about $186\text{--}282$ (254 ; $n = 16$) from anterior extremity. Intestinal caeca two, extending posteriorly but not entering haptor; right and left caecum equal in length.

Testes $7\text{--}14$ (10 ; $n = 16$), postovarian, globular or elongate-oval, large, dissimilar in size, biggest testis in middle of testicular region $87\text{--}220 \times 68\text{--}120$ (145×95) smallest testis in posterior or anterior end of testicular region $64\text{--}123 \times 56\text{--}101$ (87×77); arranged in longitudinal row. Vas deferens dilating with sperm at base, winding sinuously forward along midline of body, and entering posterior end of cirrus. Genital atrium situated near intestinal bifurcation, thin-walled, oval, $62\text{--}72 \times 40\text{--}47$ (68×44 ; $n = 16$). Cirrus spherical, $27\text{--}40 \times 27\text{--}41$ (35×31 ; $n = 16$) armed with two large spines, $28\text{--}43$ (34 ; $n = 16$) in length. Each cirrus spine sickle-shaped, with a noticeable knob and forked base forming two deep roots (Figs. 3G, 4A).

Ovary pretesticular, question mark-shaped, intercaecal, just equatorial; distal end leading to rounded seminal recep-

tacle, and short duct to genito-intestinal canal connecting with oötype. Oötype posterior to ovary, oval, surrounded by Mehlis' glands (Fig. 3E). Vaginal aperture oval, median, ventral, post-bifurcal, $54\text{--}56 \times 30\text{--}32$ (55×31 ; $n = 12$). Two vaginal ducts from lateral regions of vaginal aperture extending backwards and embracing intestinal caeca, connecting dorsally, travelling backward and opening into branches of vitelline duct; part of vaginal ducts connected with vaginal aperture sclerotised, about 14 in width; vaginal aperture armed with small sclerotised spine (Figs. 3F, 4B). Vitellarium follicular, coextensive with caeca; vitelline reservoir Y-shaped, common duct joins oötype. Uterus arising from dextral margin of oötype, extending sinuously forward and opening at vaginal aperture. Eggs ovoid, $179\text{--}235 \times 56\text{--}80$ (200×68 ; $n = 8$), with filaments at both ends; filament at one end extremely long and coiling in a knot (Figs. 3H, 4D).

Type host: *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino.

Type locality: Gulf of Tonkin, off Mong Cai district, Quang Ninh province, Vietnam, 21.446389°N , 107.943889°E .

Site of infection: Gills.

Prevalence and intensity of infection: 35% (18 of 52 examined fish); and 1–16, specimens fish.

Type material: Holotype (NMH-Microcotylid-2018-3) and 10 paratypes (NMH-Microcotylid-2018-4-6; NMH-Microcotylid-2013-16-17; NMH-Microcotylid-2015-26-29; NMH-Microcotylid-2017-36-37) are deposited in the Depart-

Fig. 4. *Polylabroides tonkinensis* sp. n. from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – cirrus spines (specimen stained with Mayer's carmine); **B** – vaginal aperture (specimen stained with Mayer's carmine); **C** – clamps (specimen stained with Gomori's trichrome); **D** – egg (specimen stained with Mayer's carmine).

ment of Parasitology, Institute of Ecology and Biological Resources; other paratypes (NMH – Microcotylid – 2018 – 7–15; NMH – Microcotylid – 2013 – 18 – 25; NMH – Microcotylid – 2015 – 30 – 35; NMH – Microcotylid – 2017 – 38) are deposited in the Vietnam National Museum of Nature, Hanoi, Vietnam.

E t y m o l o g y : The specific name refers to the typelocality of the parasite (Gulf of Tonkin).

Remarks. *Polylabroides tonkinensis* differs from *P. quadruspinosus* and *P. longispinosus* by the presence of two large spines on its cirrus, whereas the other two species have four or more spines. Similarly, *P. tonkinensis* can be distinguished from *P. australis*, *P. biungulatus*, *P. mylionis*, *P. multispinosus* and *P. zini* by the absence of small spines on its cirrus. *Polylabroides tonkinensis* is similar to *P. guangdongensis* in size, structure of the genital atrium and cirrus (no small spines; two large spines), as well as the number, size and arrangement of the testes, and size and shape of the eggs. However, *P. tonkinensis* differs in the following characteristics: slender oesophagus lacking lateral diverticula, haptor with fewer clamps (60–80 vs 96–106), and large spines of the cirrus sickle-shaped with a noticeable knob and two deep roots.

Polylabroides tonkinensis also differs from *P. tienyensis* by the broader body (310 vs 246 µm), shape of the large spines on the cirrus (sickle-shaped, noticeable knob, and two deep roots vs straight), fewer testes (10 vs 13) and larger eggs (200 × 68 µm vs 50 × 25 µm). This is the second

Polylabroides species described in *A. pacificus* from the coast of Vietnam.

Metacamopia lebedevi sp. n.

Figs. 5, 6

ZooBank number for species:

[urn:lsid:zoobank.org:act:31149169-BDD8-4160-BCBF-211160AD1009](https://zoobank.org/act:31149169-BDD8-4160-BCBF-211160AD1009).

Description (based on one specimen stained in Mayer's carmine and one specimen stained in Gomori's trichrome)

Body L- or V-shaped, comprises four defined regions, namely forebody consisting of buccal cavity and genital apertures, twisted bulb region in middle, hindbody consisting of reproductive system, and haptor bearing clamps and hooks (Figs. 5A, 6B). Total length 1.89–2.34 mm, maximum width at twisted bulb 205–279. Elongate forebody tapering anteriorly, 918–943 long, 41–45 wide at anterior end, and enlarged at level of posterior end of cirrus, 66–98 wide. Twisted bulb region 370–451 long, abruptly distends at level of its junction with forebody, and its posterior constriction. Hindbody almost same length as forebody, slightly tapering posteriorly.

Haptor asymmetrical, with two dissimilar rows of four gastrocotylid type clamps. Shorter right row 98–123 long, with equidistant pedunculate clamps, clamp size 26–40 × 21–30 (34 × 27; n = 8). Left row 131–213 long, with sessile clamps, clamp size 23–29 × 29–31 (26 × 30; n = 8). Each clamp has one pair of anterolateral sclerites, one

Fig. 5. *Metacamopia lebedevi* sp. n. from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – anchor; **B** – cirrus; **C** – clamp; **D** – holotype total view. *Abbreviations:* c – clamp; o – ovary; acs – accessory sclerite; ams – anterior mid-sclerite; ats – anterolateral sclerite; $\bar{o}$ – oötype; pts – posterolateral sclerite; t – testis; u – uterus; v – vaginal aperture; v – duct of vitelline reservoir; vtr – ventral transverse rib.

Fig. 6. *Metacamopia lebedevi* sp. n. from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – cirrus; **B** – posterior part. *Abbreviations:* c – small spines on the cirrus; cl – clamp; h – anchor; o – ovary;

pair of posterolateral sclerites, one anterior mid-sclerite and one pair of accessory sclerites. All clamps with eight pairs of ventral transverse ribs (Fig. 5C). One pair of Haptor anchors, 30–39 (35) long ($n = 4$), sickle-shaped, with rounded base (Fig. 3D), located at terminal end of haptor.

Buccal suckers two, muscular, oval, 20–25 $\times$ 22–26 (22 $\times$ 24; $n = 4$). Mouth ventro-subterminal; prepharynx absent; pharynx globular, 25 and 29 wide. Oesophagus slender, without diverticula, 492 and 496 long. Intestinal caeca two, diverticular, running along each side of body, extending posteriorly into haptor and confluent at level of the base of caudal hooks.

Testes 12, smooth, globular, 32–34 (33; $n = 16$), arranged in two longitudinal intercaecal rows in anterior region of hindbody. Vas deferens winding forward in median field, slightly dilating anteriorly and joining cirrus; seminal vesicle not observed. Cirrus tubular, muscular, eversible and protrusible, 185 $\times$ 16 and 189 $\times$ 41 in size; entirely lined with numerous closely arranged conical spines (Figs. 5B, 6A), 4.8–5.2 (5; $n = 60$) in length. Median ventral genital pore unarmed, at 189–215 from anterior end of body.

Ovary post-testicular, question mark-shaped, placed in anterior second half of hindbody. Oötype surrounded by Mehlis' glands. Vaginal aperture two, wide, tubular, unarmed, opening laterally about 310 from anterior end of body. Two vaginal ducts leading from vaginal pores dilate into small receptacle on each side and extend posteriorly to meet in median line of intestinal bifurcation. Vitellarium follicular, co-extensive with intestinal caeca; follicles in two lateral non confluent fields extending from posterior end of cirrus to distal end of caeca. Vitelline reservoir T-shaped; median vitelline duct extending posteriorly, bending and joining oötype. Uterus arising from anterior margin of oötype, extending forwards ventrally to vas deferens and opening at common genital pore. Genitointestinal canal and eggs not observed.

Type host: *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino.

Type locality: Gulf of Tonkin, off Mong Cai District, Quang Ninh Province, Vietnam, 21.446389°N, 107.943889°E.

Site of infection: gills.

Prevalence and intensity: 4% (2 of 52 examined fish); 1 specimen/fish.

Type material: The holotype (NMH–Allodiscocotylid–2012–1) is deposited in the Department of Parasitology, Institute of Ecology and Biological Resources and paratype (NMH–Allodiscocotylid–2012–2) is deposited in the Vietnam National Museum of Nature, Hanoi, Vietnam.

Etymology: The species is named in honour of Boris Lebedev from Vladivostok, Russia, for his great contribution to the classification of the Camopiinae.

Remarks. The new species is considered a member of *Metacamopia* due to the presence of the generic characteristics proposed by Lebedev (1972), i.e. haptor has two rows of four clamps, including pedunculated on one row and without peduncles on another row; one pair of anchors; testes preovarian in the posterior half of the body; paired

dorsolateral vaginae; vaginal ducts dilated into vaginal seminal receptacles.

Only three species of *Metacamopia*, *M. indica*, *Metacamopia oligoplites* Takemoto, Amato et Luque, 1996, and *Metacamopia chorinemi* (Yamaguti, 1953), are known. The new species differs from *M. chorinemi* in the arrangement of its testes (two longitudinal rows vs one row), number of anchors (one pair vs three pairs) and in having an unbranched oesophagus. *Metacamopia lebedevi* is smaller in size and its haptor does not have a large heel-like area, and sclerites compared with *M. oligoplites*. In addition, each clamp of *M. lebedevi* has eight pairs of ribs whereas *M. oligoplites* has only three pairs. *Metacamopia lebedevi* can be distinguished from *M. indica* in having fewer testes (12 vs 20–50) and vagina lacking sclerotised structures.

***Allodiscocotyla diacanthi* Unnithan, 1962** Figs. 7, 8

Measurements (based on one specimen stained in Mayer's carmine).

Total length 927; maximum width across the haptor 221. Buccal suckers 19 $\times$ 20; pharynx 16 $\times$ 18; oesophagus length 152; distance from anterior extremity to intestinal bifurcation 198. Number of testes 20, testis diameter 30; cirrus length 78, width at the anterior end 14 and maximum width at base 21 (Fig. 7A). Distance from anterior end of body to genital atrium 121. Vaginal size 52 $\times$ 16. Number of clamps 8; size of clamps on the left side 49–59 $\times$ 33–35; size of clamps on the right side 55–57 $\times$ 43 (Figs. 7A,D, 8). Anchor length 43 (Figs. 7A, 8).

Type host: *Chorinemus sanctipetri* (Cuvier) (syn. of *Scomberoides lysan* [Forsskal]) (Perciformes: Carangidae).

Other hosts: *Decapterus* sp., *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino (new host)

Type locality: Trivandrum, India.

Other localities: Trivandrum, India; Madras, India, Gulf of Tonkin, Vietnam.

New locality: Gulf of Tonkin, off Do Son District, Hai Phong Province, Vietnam (20.721111°N, 106.798056°E).

Site of infection: Gills.

Prevalence and intensity in Vietnam: 2% (1 of 52 examined fishes); 1 specimen.

Material: one voucher specimen (NMH–Allodiscocotylid–2012–3).

Remarks. According to the description of Unnithan (1962), *Allodiscocotyla diacanthi* can be identified by the presence of the morphological characteristics, such as the symmetrical haptor bearing four pairs of gastrocotylid clamps and one pair of anchors; caecal branches not confluent; testes preovarian, 15–21 in number, arranged in two intercaecal longitudinal rows; eversible cirrus Z-shaped, armed with numerous closely arranged spines; ovary inverted U-shaped; seminal receptacle and genitointestinal canal present; vitellarium follicular, coextensive with caeca; vagina muscular, unarmed.

In Vietnam, *A. diacanthi* was first recorded by Lebedev (1970) from *Decapterus* sp. (Carangidae). The Pacific seabream *A. pacificus* (Sparidae) is a new host of *A. diacanthi*.

Fig. 7. *Allodiscocotyla diacanthi* Unnithan, 1962 from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – total view; **B** – cirrus; **C** – reproduce system; **D** – clamp.

***Heterapta chorinemi* (Tripathi, 1956) Unnithan, 1961**

Figs. 9, 10

Measurements (based on one specimen stained in Mayer's carmine).

Total length 5.21 mm; maximum width 369; length of haptor 2,808; clamps 39 pairs including 30 anterior pairs and nine posterior pairs. The biggest and smallest size of an anterior clamp 86×52 and 53×49 , respectively; pos-

terior clamp size $35\text{--}37 \times 15\text{--}17$. Buccal suckers 20×18 ; pharynx 22×16 . Number of testes 13, testes size $22\text{--}24 \times 25\text{--}27$; large cirrus spines 2, 96 in length; small cirrus spines 15 pairs, the biggest spine 24 in length. Distance from anterior end of body to genital atrium 140. Egg size $120\text{--}180 \times 50\text{--}90$; $n = 8$.

Type host: *Scomberoides tala* (Cuvier) (Perciformes: Carangidae).

Fig. 8. *Allodiscocotyla diacanthi* Unnithan, 1962 from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. Haptor (specimen stained with Mayer's carmine)

New host: *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino

Type locality: Mahanadi estuary, Bay of Bengal, India.

Other localities: Mahanadi estuary, Bay of Bengal, India; Motupore Island, Papua New Guinea.

New locality: Gulf of Tonkin, off Giao Thuy district, Nam Dinh province, Vietnam (20.207778°N, 106.413611°E).

Site of infection: Gills.

Prevalence and intensity in Vietnam: 2% (1 of 52 examined fishes); intensity: 1.

Material: one voucher specimen (NMH–Heteromicrocotylid–2012–1)

Remarks. *Heterapta chorinemi* was described by Tripathi (1956) based on the following generic characteristics: body very long, haptor accounting for more than half of the total length of the body, bearing 39 pairs of clamps of microcotylid type, including 30 anterior pairs (opening-type) and nine posterior pairs (closing-type); testes 13 in number, arranged in two intercecal longitudinal rows, situated in the middle region of the body; the cirrus spinous with two long central spines and surrounded by 15 pairs of small spines; ovary convoluted; the vagina muscular, unarmed; the vitellarium confluent in the end of the haptor region; eggs oval with a long coiled filament at the posterior end.

The Pacific seabream is a new host record for *A. diacanthi*, being this study the first record of a species of *Heterapta* from the coast of Vietnam.

DISCUSSION

Metacamopia, which was proposed by Lebedev (1972), includes three species, i.e. *Metacamopia indica*, *M. chorinemi* and *M. oligoplites*. Takemoto et al. (1996) re-examined the type specimen of *M. chorinemi* and confirmed the presence of sclerotised structures in the vaginal ducts. The same authors described a new species, *M. oligoplites* without these structures within the vagina. In addition, they described several pairs of hooks in this species, thus greatly expanding the diagnostic characteristics of the genus. Moreover, the host of *M. lebedevi* belongs to the Sparidae, whereas the hosts of other species of *Metacamopia* belong to the Carangidae.

The related *Vallisia* Parona et Perugia, 1890 have an oesophagus with poorly differentiated diverticula as is seen in *M. chorinemi*. However, since there is still no satisfactory description of it, details of the distal parts of the genital ducts are unclear. However, in the figures of *Vallisia striata* Parona et Perugia, 1890 it is seen that the proximal parts of the vaginal ducts are markedly expanded. *Metacamopia oligoplites* and *M. lebedevi* both lack armament of the vaginal ducts. The only character that distinguishes *V. striata* from species of *Metacamopia* remains the rounded shape of the copulatory organ, which also needs confirmation.

Allodiscocotyla diacanthi was first described by Unnithan (1962) from the gills of *Chorinemus sanctipetri* (syn. of

Fig. 9. *Heterapta chorinemi* (Tripathi, 1956) from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – total view; **B** – cirrus; **C** – egg; **D** – anterior clamp; **E** – posterior clamp.

Scomberoides lysan) in Trivandrum, India. Ramasamy et al. (1995) also collected *A. diacanthi* from *Scomberoides tol* (Cuvier) in Madras, India. The first report of *A. diacanthi* outside the Indian Ocean was made by Lebedev et al. (1970), who found this species in the Gulf of Tonkin, Vietnam, from the gills of *Decapterus* sp. However, the authors did not provide measurements. Remarkably, all previous host species of *A. diacanthi* belong to the Carangidae, whereas our present study found it in a new host species, *Acanthopagrus pacificus*, a member of the Sparidae.

Heterapta chorinemi was first described as *Diplasiocotyle chorinemi* by Tripathi (1956) from *Scomberoides tala* in the Bay of Bengal, India. This species was transferred

to another genus, *Tripathia*, by Yamaguti (1963) and finally to *Heterapta* by Unnithan (1961). Rohde (1979) found *H. chorinemi* on the gills of the same host species from Motupore Island, Papua New Guinea. Later Ramasamy and Hanna (1986) collected this species from the gills of *Scomberoides commersonianus* Lacépède. Both recorded host species belong to the Carangidae. In the present study, *H. chorinemi* was collected for the first time from *A. pacificus* (Sparidae) in Vietnam.

Both families, Sparidae and Carangidae, belong to the superorder Actinopterygii, and both used to belong to the Perciformes. However, Carangidae was moved to a separate order Carangiformes. Additionally, according to a

Fig. 10. *Heterapta chorinemi* (Tripathi, 1956) from *Acanthopagrus pacificus* Iwatsuki, Kume et Yoshino. **A** – cirrus; **B** – egg; **C** – posterior end. Abbreviations: ap – anterior clamps; pp – posterior clamps).

phylogenetic analysis based on cytochrome b mtDNA sequences, the sparidae and Carangidae are fairly divergent from each other (Nelson 2006). Although these two fish families are phylogenetically distant from each other, it is possible that they share some similarities. The host in our study, *A. pacificus*, is widely distributed and shows region- and site-specific ecology, especially associated with its diet. Given that we only found two specimens of *M. lebedevi* and one specimen each of *A. diacanthi* and *H. chorinemi* on *A. pacificus* in our study, it cannot be ruled out that these are incidental infections. However, in each circumstance, the parasites were fully mature adults. Future sampling efforts focused on *A. pacificus* are needed to further clarify these host associations.

The present study is the first record a species of *Polylabroides* on *A. pacificus* from the coast of Vietnam with the description of two new species, increasing the number of species in the genus to ten. All *Polylabroides* spp. are currently found to only infect members of the Sparidae. A key to five known species of *Polylabroides*

was first proposed by Byrnes (1985). The key was expanded to include seven taxa when Mamaev (1988) described a new species, *P. zini*, and, included *P. mylionis* which was described by Dillon et al. (1985). The major characters for identification were the shape and number of the small and large spines on the cirrus. Subsequently, Zhang and Yang (2001) added *Polylabroides guangdongensis* from three fish species; *Sparus macrocephalus* (Basilewsky), *Acanthopagrus latus* (Houttuyn), and *Acanthopagrus berda* (Forsskal) off Guangdong, China. According to the description of *P. guangdongensis*, small spines on the cirrus are absent, as well as in the new species *Polylabroides tienyenensis* and *Polylabroides tonkinensis* described herein. Zhang and Yang (2001) suggested that the reference to small spines on the cirrus in the diagnosis of *Polylabroides* should be changed to present or absent. Based on the old key and characters of the species recently described, we propose a new key for all species of *Polylabroides*:

1. Cirrus armed with two large spines..... 3
- Cirrus armed with four or more large spines 2

2. Large spines four; small spines 35–36 *P. quadruspinosus*
Large spines 40–67; small spines 25–35 *P. longispinosus*
3. Small spines on the cirrus absent 4
Small spines on the cirrus present 6
4. Large spines sickle-shaped with a noticeable knob and
forked base *P. tonkinensis*
Large spines two, straight, curving at the distal end 5
5. Clamps 96–106 in number; eggs large $205 \times 68 \mu\text{m}$
..... *P. guangdongensis*
Clamps 62–72 in number; eggs small $50 \times 25 \mu\text{m}$
..... *P. tienyenensis*
6. Genital atrium and vagina with strong musculature; cir-
rus armed with a pair of large claw-like spines and 6–7
small triangulate spines; testes 13–17 in number
..... *P. biungulatus*
Genital atrium and vagina with no developed musculature;
testes up to 13 in number 7
7. Large spines shaped as roe-deer antlers; one pair of
small sharp spines between them *P. zini*
Large spines claw-like 8
8. Small spines 8–10, different in size and shape
..... *P. australis*

- Small spines similar in size and form 9
9. Small spines eight in number, 9–13 μm long; large
spines 23–33 μm long; testes 6–9
..... *P. mylionis*
Small spines 30–45 in number; large spines 18–26 μm
long; testes 10–13 *P. multispinosus*

Acknowledgements. We would like to thank Klaus Rohde from University of New England, Australia, Alex V. Ermolenko, Department of Parasitology, Federal Scientific Center of the East Asia Terrestrial Biodiversity, Far Eastern Branch, Russian Academy of Sciences, Vladivostok, Russia and Huy Phong Dang, Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology for providing literature; Delane C. Kritsky from Idaho State University for providing useful comments. We also appreciate the valuable contributions of the anonymous reviewers. This study was funded by the National Programs (VAST.DA47.DA.12/16–19) with the project title “Investigation and evaluation of the parasites and microorganisms in the marine areas of Vietnam with the aims to protect marine ecosystems and public health”. One part of samples provided by the project “Research on developing a model of green economy for some typical island communes in Vietnam coastal areas – KC.08.09/16–20”.

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Received 13 April 2020

Accepted 16 July 2020

Published online 21 October 2020

Cite this article as: Nguyen H.V., Nguyen H.M., Ha N.D., Ngoc C.N., Ngoc T.B., Le S.X., Tatonova Y., Greiman S.E. 2020: Five monogenean species (Allodiscocotylidae, Heteromicrocotylidae, Microcotylidae) from the Pacific seabream *Acanthopagrus pacificus* (Perciformes: Sparidae) in the Gulf of Tonkin off Vietnam, with descriptions of three new species. Folia Parasitol. 67: 028.