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A new species of *Ergasilus* von Nordmann, 1832 (Copepoda: Cyclopoida) from the gills of a dasyatid ray, *Himantura oxyrhyncha* (Sauvage, 1878) from West Kalimantan, Indonesia

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Abstract

A new species of the cyclopoid copepod genus *Ergasilus* von Nordmann, 1832 is described based on material collected from the gills of an elasmobranch, *Himantura oxyrhyncha* (Sauvage, 1878), collected in the Java Sea off the coast of West Kalimantan, Indonesia. To justify the establishment of the new species, *Ergasilus kimi* **sp. nov.**, detailed comparisons are made with the 28 congeneric species that share the combination of a 3-segmented leg 1 endopod and the presence of 2 setae on the free exopodal segment of leg 5. This is the fourth report of an *Ergasilus* species infecting an elasmobranch and it is concluded that each represents an independent colonization event of elasmobranchs as hosts.

Key words: parasitic copepod, elasmobranch host, *Ergasilus kimi* **sp. nov.**, taxonomy

Introduction

The Ergasilidae is an unusual family of podoplean copepods in which only the adult females are parasitic, typically on fishes, while the developmental stages and males are never found on a host and are considered to be free-living (Alston *et al.* 1996; Boxshall & Halsey 2004). The family currently comprises 28 genera (Boxshall & Halsey 2004; Tang & Kalman 2008; Rosim *et al.* 2013), although one of these, *Anklobranchius* Thatcher, 1999 is based only on males and was treated as a *genus inquirendum* by Boxshall & Halsey (2004) because the existing classification system for genera is based only on morphological characters of females. The largest genus is *Ergasilus* von Nordmann, 1832, consisting of 153 valid species (Boxshall & Walter 2014), virtually all of which utilise actinopterygian fishes as hosts and occur in marine, brackish and freshwater habitats around the world. Only three species have been reported from elasmobranch hosts: *E. myctarothes* Wilson, 1913; *E. ogawai* Kabata, 1992; and, *E. trygonophilus* Domingues & Marques, 2010. The first of these was reported from the nasal tubes of a hammerhead shark, *Sphyrna zygaena* (Linnaeus, 1758) caught off Jamaica (Wilson 1913). The second was reported from the sawfish *Pristis microdon* Latham, 1794 and from an actinopterygian host, *Lates calcarifer* (Bloch, 1790), both collected in the Daly River, Northern Territories, Australia (Kabata 1992). The last was described from the gills of at least three species of freshwater stingrays belonging to *Potamotrygon* Garman, 1877 in Amazonia, Brazil (Domingues & Marques 2010).

During a survey of metazoan parasites of elasmobranchs in waters around Borneo, Janine Caira and her colleagues collected four adult females of a small *Ergasilus* from the gills of the dasyatid ray, *Himantura oxyrhyncha* (Sauvage, 1878), from the Java Sea, off the coast of West Kalimantan (Indonesia). This material is described below as a new species.

Material and methods

The copepods were immersed and dissected in lactophenol on a glass slide before microscopic observation. All drawings were made on a Leitz Diaplan microscope equipped with differential interference contrast, using a

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drawing tube. Morphological terminology follows Huys & Boxshall (1991) and host nomenclature was checked against the World Register of Marine Species (WoRMS, www.marinespecies.org). The holotype and one paratype are deposited in the collections of the Museum Zoologicum Bogoriense (MZB) in Bogor, Indonesia, one paratype is deposited in the Natural History Museum, London (NHMUK), and one in the collections of the US National Museum (USNM).

Systematic account

Order Cyclopoida Rafinesque, 1815

Family Ergasilidae Burmeister, 1835

Genus *Ergasilus* Müller, 1785

Ergasilus kimi sp. nov.

(Figs. 1–3)

Type material. Holotype ovigerous ♀ from gills of *Himantura oxyrhyncha* (KA 229) caught in the Java Sea off the coast of West Kalimantan, Indonesia, near Sungai Kakap (00°03'42.38"S, 109°10'37.68"E) on 18 July 2007; registration number MZB Cru Cop 113. Paratype ♀ from gills of *H. oxyrhyncha* (KA 186) caught in the Java Sea off the coast of West Kalimantan, Indonesia, near Jungkat (00°03'46.00"N, 109°12'10.40"E) on 13 July 2007; registration number MZB Cru Cop 114. Paratype ♀ from gills of *H. oxyrhyncha* (KA 236) caught in the Java Sea off the coast of West Kalimantan, Indonesia, near Sungai Kakap (00°03'42.38"S, 109°10'37.68"E) on 18 July 2007; registration number USNM 1266274. Paratype ♀ from gills of *H. oxyrhyncha* (KA 186) caught in the Java Sea off the coast of West Kalimantan, Indonesia, near Jungkat (00°03'46.00"N, 109°12'10.40"E) on 13 July 2007, partly dissected; registration number NHMUK 2014.661.

Etymology. The species is named in honour of Professor Il-Hoi Kim in recognition of his contributions to our knowledge of the Ergasilidae of the Northern Indo-Pacific.

Description of adult female. Body cyclopiform (Fig. 1A), comprising prosome consisting of cephalosome and first pedigerous somite, separated dorsally by functional articulation but fused ventrally, and three free pedigerous somites (bearing legs 2 to 4), and urosome consisting of fifth pedigerous somite, genital double-somite and three free abdominal somites. Cephalosome elongate, covered by dorsal shield; with oral region located ventrally near posterior border and separated from antennary bases by distinct gap. Rostrum (Fig. 1C) weakly developed, ornamented with median pore and two pairs of sensillae. First pedigerous somite elongate, narrower than cephalosome. Second pedigerous somite narrower than first, bearing paired, weakly defined integumental windows laterally on tergite (arrowed in Fig. 1A). Third pedigerous somite narrower than second, and fourth narrower than third; tergite of fourth pedigerous somite completely concealing fifth pedigerous somite in dorsal view (Fig. 1A). Fifth pedigerous somite very small, concealed in both dorsal and ventral views. Genital double somite, 1.2 times wider than long, with rounded lateral margins, bearing paired, slit-like genital apertures dorsally, ornamented with transverse rows of spinules on ventral surface (Fig. 1B). First and second free abdominal somites broad and short, both ornamented with posterior spinule row along ventral margin. Anal somite deeply incised in midline; about 2.5 times broader than long: ornamented with paired spinule rows on ventral surface (Fig. 1B). Caudal rami about 1.4 times longer than wide: armed with four setae, all naked (Fig. 1B). Mean body length from anterior margin of cephalothorax to posterior margin of caudal rami 619 μm (range 614–625 μm, based on three specimens). Egg sacs multiseriate, length 575 and 606 μm in holotype.

Antennule 6-segmented (Fig. 2A), setal formula: 3, 12, 5, 4 + ae, 2 + ae, 7 + ae. Antenna 4-segmented (Fig. 2B) comprising robust coxobasis armed with short naked seta distally, 3-segmented endopod and curved terminal claw. Second segment (first endopodal segment) unarmed but with small swelling near middle of medial margin carrying tiny sensilla. Third segment (second endopodal segment) shorter and narrower than preceding segment, curved distally and bearing small tooth-like process on medial margin about one third of length from base. Fourth segment (third endopodal segment) reduced, bearing minute seta externally. Claw curved, without fossa on concave margin; length of claw about equal to length of second endopodal segment.

Labrum weakly defined, with slightly concave posterior margin (Fig. 2C). Mandible (Fig. 2D) with three blades; proximal blade carried on posterior margin, ornamented with 12 blunt teeth increasing in size distally; subapical blade ornamented with row of about 12 large pointed spinules on posterior margin and isolated spinules on anterior margin; apical blade slender, tapering, with fine spinules. Maxillule (Fig. 2E) lobate, armed with two unequal distal setae and produced into small process medially. Maxilla (Fig. 2F) comprising large tapering syncoxa and basis; syncoxa ornamented with patch of spinules and single pore; basis spatulate and ornamented with dense array of acute spinules. Maxilliped absent, as in all female ergasilids.

Legs 1–4 (Figs. 3A–D) biramous, each with 3-segmented endopod and 3-segmented exopod, except for 2-segmented exopod of leg 4. Intercoxal sclerites slender, interpodal plates well developed between legs 1 and 2, legs 2 and 3 and legs 3 and 4; each ornamented with row of large spinules posteriorly (Fig. 1D). Spine and seta formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	1-0	I-0; 0-1; II,5	0-1; 0-1; II,4
Leg 2	0-0	1-0	I-0; 0-1; 6	0-1; 0-2; I,4
Leg 3	0-0	1-0	I-0; 0-1; 6	0-1; 0-2; I,4
Leg 4	0-0	1-0	I-0; 5	0-1; 0-2; I,3

Legs 1–4 with outer margins of all endopodal and exopodal segments ornamented with row of spinules; inner margin of first exopodal segment with row of long spinules. Legs 1 to 4 each with row of spinules on basis, near inner posterior margin (Figs. 3A–D); leg 1 with additional row of minute spinules adjacent to origin of endopod (Fig. 3A).

Fifth leg (Fig. 1E) located dorso-laterally and visible in dorsal view; indistinctly 2-segmented; first segment with single (protopodal) seta located and directed dorsally, second (exopodal) segment about 1.4 times longer than wide, ornamented with minute spinules distally, and armed with two long setae; apical seta reaching beyond posterior margin of caudal ramus.

Taxonomic remarks. The new species has 153 congeners and recent studies have shown the genus *Ergasilus* to be very heterogeneous and in need of revision (El-Rashidy 1996; Song *et al.* 2008). The current classification is based almost entirely on characteristics of the adult females, so species such as *E. divergens* (Kokubo, 1914), which is known only from the male (Ohtsuka *et al.* 2004), cannot be compared with the new species. The combination of a 3-segmented endopod for leg 1 and the presence of two setae on the free exopodal segment of leg 5, is relatively unusual within the genus, and the new species thus belongs in an assemblage of 28 nominal species of *Ergasilus* which share these two character states: *E. batai* Karamchandani, 1952; *E. borneoensis* Yamaguti, 1954; *E. cochlearius* Kuang & Liu, 1991; *E. flaccidus* Fryer, 1965; *E. genuinus* (Kokubo, 1914); *E. glyptothoracis* Kuang & Qian, 1983; *E. hemibagri* Zhang & Ma, 1994; *E. iraquensis* Amado, in Amado, da Rocha, Piasecki, Al-Daraji & Mhaisen, 2001; *E. jiangxiensis* Liu, 1998; *E. lamellifer* Fryer, 1961; *E. leiocassi* Xu, 1987; *E. longicaudatus* Kuang & Li, 1984; *E. manicatus* Wilson, 1911; *E. mendisi* Fernando & Hanek, 1973; *E. mirabilis* Oldewage & van As, 1987; *E. orientalis* Yamaguti, 1939; *E. pararostralis* Amado, in Amado, da Rocha, Piasecki, Al-Daraji & Mhaisen, 2001; *E. peregrinus* Heller, 1865; *E. philippinensis* Velasquez, 1951; *E. rostralis* Ho, Jayarajan & Radhakrishnan, 1992; *E. rotundicorpus* Jones & Hine, 1983; *E. shehyangensis* Wang, 1961; *E. sieboldi* von Nordmann, 1832; *E. sittangenesis* El-Rashidy & Boxshall, 2002; *E. synanceiensis* Amado, in Amado, da Rocha, Piasecki, Al-Daraji & Mhaisen, 2001; *E. uniseriatus* Ho, Jayarajan & Radhakrishnan, 1992; *E. xenomelanirisi* Carvalho, 1955 and *E. xinjiangensis* Kuang & Qian, 1985.

This list excludes *E. cunningtoni* Capart, 1944 because of uncertainty about the setation of leg 5. In the original description leg 5 was illustrated as carrying two terminal setae, but Capart (1944: 15) stated that this limb also had a lateral seta which was not figured - “une soie latérale (non figurée)”. Subsequently, after examining new material from the type locality, Fryer (1964, 1965) raised doubts about the existence of this third seta on the free exopodal segment. Irrespective of the form of leg 5, this species differs from the new species in the possession of an outer margin spine on the second exopodal segment of leg 1, and in the form of the second endopodal segment of the

antenna, which in *E. cunningtoni* has a marked indentation proximally on its convex outer margin, and in the very short antennary claw.

This assemblage of 28 species (Table 1) can be subdivided by reference to the segmentation pattern of the female antennules. Descriptions of antennule segmentation are generally reliable in the Ergasilidae, although details of antennulary setation are not, particularly in the older literature, because setae are easily broken or overlooked, and the aesthetascs can be difficult to see. The new species possesses a 6-segmented antennule, in common with 24 of the species listed, but the remaining four species, *E. flaccidus, E. pararostralis, E. rostralis* and *E. uniseriatus*, all exhibit a 5-segmented antennule and can be eliminated from further comparisons.

TABLE 1. Comparisons of character states exhibited by species of *Ergasilus* with a 3-segmented endopod of leg 1, plus 2 setae on the free exopodal segment of leg 5. Abbreviations: A1 = number of antennule segments; P2 = number of inner setae on second endopodal segment of leg 2; CR (L:W) = length to width ratio of caudal rami.

Species	Body length (mm)	A1	Antenna	P2	CR (L:W)	Data source
E. batai	09–1.25	6	slender	2	7:1	Karamchandani (1952)
E. borneoensis	0.9–1.1	6	slender	2	1.3:1	Yamaguti (1954)
E. cochlearius	0.54–0.65	6	slender	2	1.5:1	Kuang & Liu (1991)
E. flaccidus	0.6–0.9	5	slender	1	1:1	Fryer (1965)
E. genuinus	0.72–0.84	6	slender	2	1.3:1	Ohtsuka *et al.* (2004)
E. glyptothoracis	0.85–1.01	6	inflated	2	1.2:1	Kuang & Qian (1983)
E. hemibagri	0.66–0.93	6	slender	1	1.3:1	Zhang & Ma (1994)
E. iraquensis	1.08	6	slender	1	1:1	Amado *et al.* (2001)
E. jiangxiensis	0.55	6	slender	2	6:1	Liu (1998)
E. kimi **sp. nov.**	0.61–0.63	6	slender	2	1.4:1	present account
E. lamellifer	0.85	6	lamella	2	1.6:1	Fryer (1961)
E. leiocassi	0.78–0.96	6	slender	1	1.1:1	Xu (1987)
E. longicaudatus	0.95–0.99	6	slender	2	6:1	Kuang & Li (1984)
E. manicatus	0.75	6	inflated	?	1:1	Wilson (1911)
E. mendisi	0.8–0.9	6	slender	2	3.5:1	Fernando & Hanek (1973)
E. mirabilis	0.93	6	slender	1	2:1	Oldewage & van As (1987)
E. orientalis	0.7	6	inflated	2	1.2:1	Yamaguti (1939)
E. pararostralis	0.71	5	slender	1	1:1	Amado *et al.* (2001)
E. peregrinus	0.79	6	slender	2	1.2:1	Kim & Choi (2003)
E. philippinensis	0.86	6	slender	2	2.7:1	Velasquez (1951)
E. rostralis	0.80–0.86	5	slender	2	1.5:1	Ho *et al.* (1992)
E. rotundicorpus	0.60	6	inflated	2	1:1	Jones & Hine (1983)
E. shehyangensis	0.91–1.15	6	slender	2	1.5:1	Wang (1961)
E. sieboldi	1.0–2.0	6	slender	2	2.1:1	Kabata (1979)
E. sittangenesis	0.78	6	slender	1	1.7:1	El-Rashidy & Boxshall (2002)
E. synanceiensis	0.89	6	slender	2	1.3:1	Amado *et al.* (2001)
E. uniseriatus	0.56–0.60	5	slender	2	1.2:1	Ho *et al.* (1992)
E. xenomelanirisi	0.6–0.7	6	slender	1?	1:1	Carvalho (1955)
E. xinjiangensis	0.89–0.98	6	slender	2	3:1	Kuang & Qian (1985)

A second group of species can be separated from within the remaining 24 species by the gross morphology of the antenna, which forms the attachment apparatus securing the adult female to the gill filaments of its fish host. In *E. glyptothoracis, E. manicatus, E. orientalis* and *E. rotundicorpus* the antenna is a relatively short and compact limb, and the joint between the coxobasis and the first endopodal segment is inflated to form a distinctive lateral swelling (Table 1). In the new species and in the remaining 20 species, the antenna is a relatively slender limb and the joint between the two proximal segments is not inflated. One other species, *E. lamellifer*, also has a distinctive antenna. When first describing this species Fryer (1961) highlighted the presence of a ridge-like lamella along the margin of the first endopodal segment; indeed, this feature was sufficiently remarkable to be alluded to in the name of the species. No other species listed in Table 1 has a lamella along the margin of this segment.

The proportions of the caudal rami, as indicated by the length to width ratio (L:W), has proven a useful

character for species discrimination in many different copepod families, and there are marked differences between some of the species listed in Table 1. The most elongate ramus is found in *E. batai* in which the L:W ratio is 7:1 (Karamchandani 1952), whilst in several species the ramus is about as long as wide (Table 1). It is convenient to divide the species into two categories, those with an elongate caudal ramus (*i.e.*, L:W ratio of 3:1 or greater) and those with a relatively short caudal ramus (*i.e.*, a L:W ratio of less than 3:1). The elongate category includes *E. batai*, *E. jiangxiensis*, *E. longicaudatus*, *E. mendisi* and *E. xinjiangensis*. Elimination of species listed in Table 1 on the basis of gross differences in antennulary segmentation, in the form of the antenna and in the proportions of the caudal rami, leaves 14 species for comparison with the new species in greater detail.

Descriptions of swimming leg setation in the family Ergasilidae are sometimes unreliable. In *E. jiangxiensis*, for example, leg 2 and leg 4 are both described as bearing two inner setae on the second endopodal segment, while leg 3 is shown with only one seta on the equivalent segment (Liu 1998). Such a pattern is almost certainly incorrect since reductions in leg setation along the leg series in copepods typically follow an antero-posterior sequence. The original description of the legs of *E. xenomelanirisi* by Carvalho (1955) is similarly problematic, with many setae missing and spines drawn as present where spines never occur in other members of this family. Given such confusion, it is necessary to exercise caution when interpreting some of the older published descriptions of leg setation in small species. However, the recent detailed description of *E. sittangenesis* by El-Rashidy & Boxshall (2002) revealed an unusual feature of leg setation: the second endopodal segment of leg 2 has only one inner seta while this segment on each of legs 3 and 4 carries two setae. Four other species, all described relatively recently, share this unusual setation pattern, *E. hemibagri*, *E. iraquensis*, *E. leiocassi* and *E. mirabilis*. The new species differs in the possession of two setae on this segment in leg 2. All five of these species also have markedly larger body size than the new species which, with a mean body length of 0.62 mm, is one of the smallest of those listed (Table 1).

The inadequate description of *E. xenomelanirisi* from Brazil (Carvalho 1955) also shows a single seta on the second endopodal segment of leg 2, but none on the same segment of leg 3; further evidence that it cannot be considered accurate. For this species comparisons can be restricted to the largest and easiest limb to observe, the antenna, which provides several key differences from the new species. In *E. xenomelanirisi* the antennary claw is small, only about half the length of the second endopodal segment, whereas in the new species claw and segment are similar in length. The first endopodal segment is about twice as long as wide in *E. xenomelanirisi*, whereas in the new species it is about 4.2 times longer than wide.

Yamaguti (1954) described *E. borneoensis* from the gills of "an unknown fish, probably of the Coridae" caught at Bandjermasin, Borneo, close to the type locality of the new species. The Coridae is not a valid family but the genus *Coris* Lacepède, 1801 is currently included within the actinopterygian family Labridae. The new species can be distinguished by its smaller body size (see Table 1), relatively long antennary claw (*cf.* about 60% length of second endopodal segment in *E. borneoensis*), and the presence of five setal elements on the distal exopodal segment of leg 4 (*cf.* 6 in *E. borneoensis*). The unusual form of the mandible in *E. borneoensis*, with four blades, would be unique in the genus and requires confirmation.

Both sexes of *E. genuinus* were redescribed in detail by Ohtsuka *et al.* (2004) and it shares the identical leg setation pattern with the new species, but significant differences are found in the antennae. *Ergasilus genuinus* has a rather robust antenna with the first endopodal segment about 2.2 times longer than wide and bearing two spiniform sensillae in the distal half, whereas in the new species this segment is about 4.2 times longer than wide and carries a knob-like sensilla close to the middle of the medial margin (Fig. 2B). The interpodal plates are more heavily ornamented in *E. genuinus*, with spinules scattered over the entire surface of each plate, not just a single spinule row along its posterior border (Fig. 1D).

Kim & Choi (2003) redescribed *E. peregrinus*, a widespread species reported from China, Korea and Russia (far eastern zone of Siberia). Again, the setation pattern is identical to that of the new species and the main differences can be found in the antennae. *Ergasilus peregrinus* has a robust antenna with the first endopodal segment about twice longer than wide, bearing a single sensilla in the distal third, and the second endopodal segment lacks sensillae. In contrast, the first endopodal segment is slender in the new species (about 4.2 times longer than wide) and carries a knob-like sensilla close to the middle of the medial margin, while the second segment has a prominent marginal sensilla proximally (Fig. 2B).

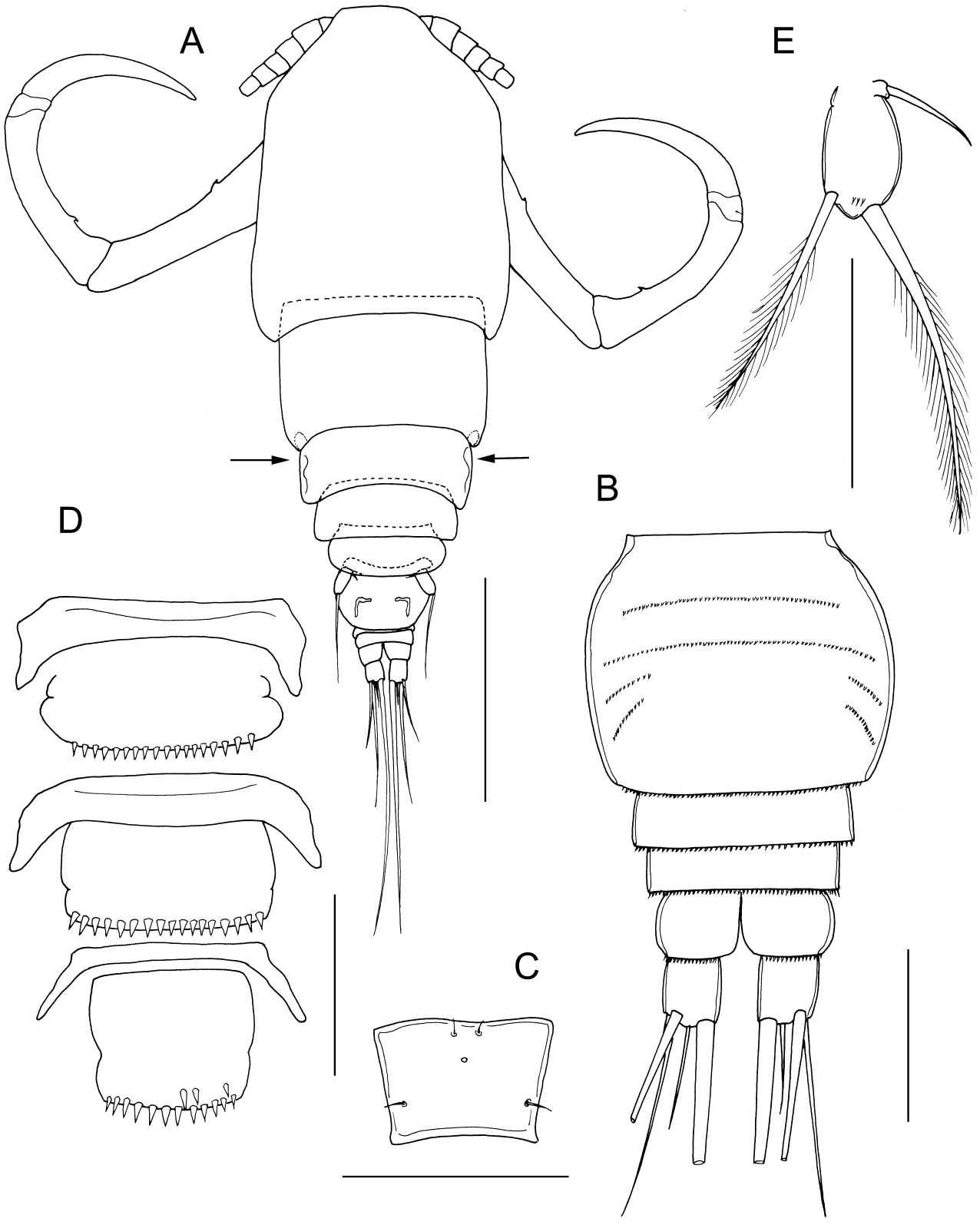

FIGURE 1. *Ergasilus kimi* **sp. nov.** (paratype adult female). A, habitus, dorsal; B, genital double-somite, free abdominal somites and caudal rami, ventral; C, rostrum, ventral; D, intercoxal sclerites of legs 1 to 3 and associated interpodal plates, ventral; E. left fifth leg, lateral. Scale bars: A = 200 μm, B–E = 50 μm.

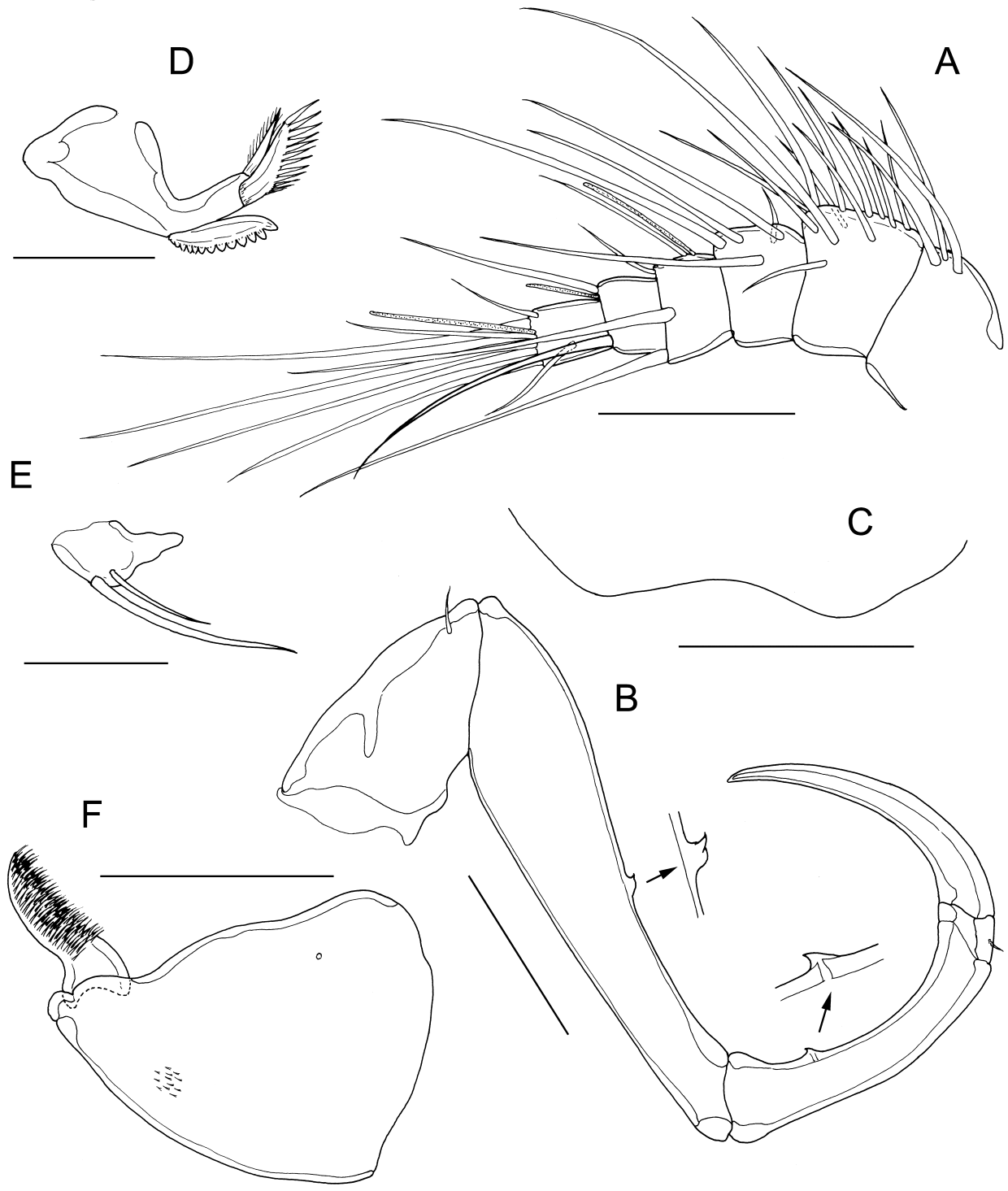

FIGURE 2. *Ergasilus kimi* **sp. nov.** (paratype adult female). A, antennule, ventral; B, antenna, lateral, with insets showing detail of sensillae on first and second endopodal segments; C, labrum, ventral; D, mandible, ventral in situ; E, maxillule, ventral in situ; F, maxilla, ventral in situ. Scale bars: A, C, F = 50 μm, B = 100 μm, D–E = 25 μm.

The type species, *E. sieboldi*, is one of the largest in the genus, with a body length of between 1 and 2 mm (Kabata 1979), two to three times larger than the new species. The detailed redescription of this species by Kabata (1979) shows differences in leg setation: leg 1 carries an outer spine on the second exopodal segment (absent in the new species), and legs 2 and 3 each carry an outer spine on the third exopodal segment (absent in the new species). *Ergasilus cochlearius* (see Kuang & Liu 1991) shares the same leg setation pattern as *E. sieboldi*, and thus also differs from the new species. In addition the antennary claw is distinctly shorter than the second endopodal segment in both *E. sieboldi* and *E. cochlearius*, but about the same length in the new species.

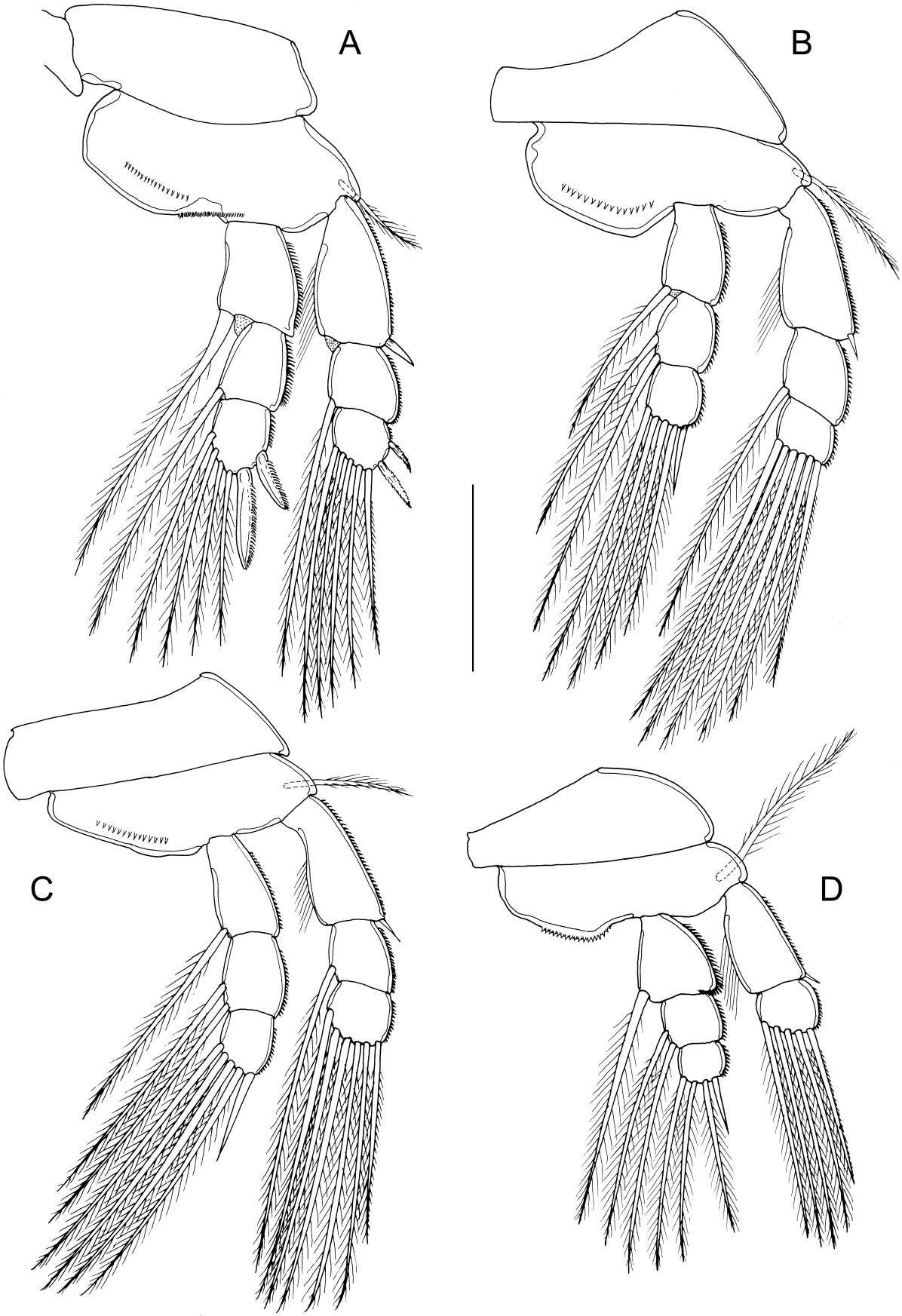

FIGURE 3. *Ergasilus kimi* **sp. nov.** (paratype adult female). A, leg 1, anterior; B, leg 2, anterior; C, leg 3, anterior; D, leg 4, anterior. Scale bar = 50 µm.

Ergasilus synaceiensis has the same leg setation pattern as the new species (see Amado *et al*. 2001) but differs in having a much more swollen prosome than the new species, and its genital double-somite is just longer than wide whereas in the new species it is wider than long. In addition, the antennary claw is only half the length of the second endopodal segment in *E. synaceiensis* and bears two sensillae (one at mid-length, the other distally), while in the new species the claw and segment are similar in length and only a single, proximally-located sensilla is present.

The antenna of *E. philippinensis* is long and slender but the claw is only about half the length of the second endopodal segment (Velasquez 1951) whereas in the new species the claw and segment are about equal in length. The caudal rami are also more elongate in *E. philippinensis* than in the new species (Table 1).

Finally, the new species can be distinguished from *E. shehyangensis* (see Wang 1961) by differences in the antenna and there are also apparent differences in leg setation. The antenna of *E. shehyangensis* has sensillae located in the distal third of the first endopodal segment and in the middle of the second, whereas in the new species the former is located mid-segment and the latter is located in the proximal third. Also the claw is only half the length of the second endopodal segment in *E. shehyangensis*, but about the same length in the new species. Outer spines are shown as present on the terminal exopod segment of legs 2 and 4 of *E. shehyangensis* by Wang (1961). No such spines are present in the new species but the lack of this spine on Wang's figure of leg 3 raises some concern over the accuracy of the description.

Discussion

Wilson (1913) was the first to describe a member of the Ergasilidae from an elasmobranch host, *E. myctarothes* from the nasal tubes of *Sphyrna zygaena*. This species has not been reported since and the host record was overlooked by most subsequent authors. Ogawa (1991) initially reported on the material subsequently described as *E. ogawai* by Kabata (1992), who referred to this as the first record of the genus from an elasmobranch host. As noted by Domingues & Marques (2010), *E. ogawai* appears to have low host specificity as it was also found on an actinopterygian host (*Lates calcarifer*) at the original locality (Kabata 1992). The third record of an *Ergasilus* species infecting an elasmobranch host was by Domingues & Marques (2010) who described *E. trygonophilus* from the gills of at least three *Potamotrygon* species collected in brackish waters in Brazil. The new species is thus the fourth *Ergasilus* species reported from an elasmobranch, but it does not appear to be closely related to any of the other three previously reported species. *Ergasilus myctarothes* is a robust species, about 0.95 mm in length, with squat rather than slender antennae and with outer spines on the second exopodal segments of legs 1 to 3 (unlike the new species). *Ergasilus trygonophilus* shares a 2-segmented endopod on leg 1 with a large cluster of Neotropical species and was considered to be closely related to *E. foresti* Boxshall, Araújo & Montú, 2002 and *E. youngi* Tavares & Luque, 2005, by Domingues & Marques (2010) because all three species share the presence of a rosette of blunt spinules on the compound second endopodal segment of leg 1. Kabata (1992) did not explicitly compare *E. ogawai* with any particular congeners but it appears, from the presence of three setae on the free exopodal segment of leg 5 and the presence of one outer spine on the distal exopodal segment of legs 2, 3 and 4 in *E. ogawai*, that this species is not closely related to the new species described here. This leads to the inference that the presence of a fourth *Ergasilus* species infecting an elasmobranch is likely the result of a fourth independent host colonization event, rather than pointing to the existence of a clade of species using elasmobranchs as hosts.

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References

Alston, S., Boxshall, G.A. & Lewis, J.W. (1996) The life-cycle of *Ergasilus briani* Markewitsch, 1933 (Copepoda: Poecilostomatoida). *Systematic Parasitology*, 35, 79–110. http://dx.doi.org/10.1007/bf00009818

Amado, M.A.P. da Motta, da Rocha, C.E.F., Piasecki, W., Al-Daraji S.A.M. & Mhaisen, F.T. (2001) Copepods of the family Ergasilidae (Poecilostomatoida) parasitic on fishes from Khor al-Zubair Lagoon, Iraq. *Hydrobiologia*, 459, 213–221. http://dx.doi.org/10.1023/a:1012511716677

Bloch, M.E. (1790) *Naturgeschichte der ausländischen Fische, Volume 4.* Berlin, xii + 128 pp., plates 217–252.

Boxshall, G.A., Araújo, H.M.P. & Montú, M. (2002) A new species of *Ergasilus* Nordmann, 1832 (Copepoda, Ergasilidae) from Brazil. *Crustaceana*, 75, 269–276. http://dx.doi.org/10.1163/156854002760095381

Boxshall, G.A. & Halsey, S.H. (2004) *An Introduction to Copepod Diversity.* The Ray Society, London, xv + 966 pp.

Boxshall, G.A. & Walter, T.C. (2014) *Ergasilus* von Nordmann, 1832. *In*: Walter, T.C. & Boxshall, G.A. (Eds.) *World of Copepods Database.* Accessed through World Register of Marine Species. Available from: http://www.marinespecies.org/aphia.php?p=taxdetails&id=128641 (accessed 30 September 2014)

Burmeister, H. (1835) Beschreibung einiger neuen oder weniger bekannten Schmarotzerkrebe, nebst allgemeinen Betrachtungen uber die Gruppe; welcher sie angehoren. *Nova Acta Physico-Medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum (Acta der Kaiserlichen Leopoldinisch-Carolinischen Deutschen Akademie der Naturforscher), Halle*, 17, 269–336, plates XXIII, XXIV, XXIVA, XXV.

Capart, A. (1944) Notes sur les Copépodes parasites. III. – Copépodes parasites des poissons d'eau douce du Congo Belge. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, 20 (24), 1–24.

Carvalho, J. de P. (1955) *Ergasilus xenomelanirisi* n. sp. parasite de peixe-rei - *Xenomelaniris brasiliensis* (Quoy & Gaimard) (Copepoda – Cyclopoida – Pisces – Mugiloidei). *Boletim do Instituto Oceanográfico, Sao Paulo*, 6, 215–224. http://dx.doi.org/10.1590/S0373-55241955000100007

Domingues, M.V. & Marques, T.M. (2010) *Ergasilus trygonophilus* sp. nov. (Copepoda: Ergasilidae) a branchial parasite of freshwater stingrays (Potamotrygonidae) from the state of Pará, Brazil. *Zoologia*, 27, 829–833. http://dx.doi.org/10.1590/S1984-46702010000500020

El-Rashidy, H.H. (1996) *Ergasilid copepods and grey mullet*. PhD thesis, University of London, 468 pp.

El-Rashidy, H.H. & Boxshall, G.A. (2002) New species and new records of *Ergasilus* (Copepoda: Ergasilidae) from the gills of grey mullet (Mugilidae). *Systematic Parasitology*, 51, 37–58. http://dx.doi.org/10.1023/A:1012998327834

Fernando, C.H. & Hanek, G. (1973) Two new species of the genus *Ergasilus* Nordmann, 1832 (Copepoda, Ergasilidae) from Ceylon. *Crustaceana*, 25, 13–20. http://dx.doi.org/10.1163/156854073X00452

Fryer, G. (1961) The parasitic Copepoda and Branchiura of the fishes of Lake Victoria and the Victoria Nile. *Proceedings of the Zoological Society of London*, 137, 41–60. http://dx.doi.org/10.1111/j.1469-7998.1961.tb06160.x

Fryer, G. (1964) Further studies on the parasitic Crustacea of African freshwater fishes. *Proceedings of the Zoological Society of London*, 143, 79–102.

Fryer, G. (1965) Crustacean parasites of African freshwater fishes, mostly collected during the expeditions to Lake Tanganyika, and to Lakes Kivu, Edward and Albert by the Institut Royal des Sciences naturelles de Belgique. *Bulletin du Musée royal d'Histoire naturelle de Belgique*, 51 (7), 1–22.

Garman, S.W. (1877) On the pelvis and external sexual organs of selachians, with especial references to the new genera *Potamotrygon* and *Disceus* (with descriptions). *Proceedings of the Boston Society of natural History*, 19, 197–214.

Heller, C. (1865) Crustaccen. *In*: *Reise der Österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859. Zoologie*, 2, 1–280, plates 1–25. http://dx.doi.org/10.5962/bhl.title.1597

Ho, J.-S., Jayarajan, P. & Radhakrishnan, S. (1992) Copepods of the family Ergasilidae (Poecilostomatoida) parasitic on coastal fishes of Kerala, India. *Journal of natural History*, 26, 1227–1241. http://dx/doi.org/10.1080/00222939200770691

Huys, R. & Boxshall, G.A. (1991) *Copepod Evolution*. The Ray Society, London, 468 pp.

Jones, J.B. & Hine, P.M. (1983) *Ergasilus rotundicorpus* n. sp. (Copepoda: Ergasilidae) from *Siganus guttatus* (Bloch) in the Philippines. *Systematic Parasitology*, 5, 241–244. http://dx.doi.org/10.1007/BF00009158

Kabata, Z. (1979) *Parasitic Copepoda of British Fishes*. The Ray Society, London, xii + 468 pp. + figures 1–2031.

Kabata, Z. (1992) Copepoda parasitic on Australian fishes, XV. Family Ergasilidae (Poecilostomatoida). *Journal of natural History*, 26, 47–56. http://dx.doi.org/10.1080/00222939200770031

Karamchandani, S.J. (1952) A new species of *Ergasilus* from the gills of *Labeo bata* (Hamilton). *Records of the Indian Museum*, 50, 287–293.

Kim, I.-H. & Choi, S.-K. (2003) Copepod Parasites (Crustacea) of Freshwater Fishes in Korea. *The Korean Journal of systematic Zoology*, 19, 57–93.

Kokubo, S. (1914) Emendation of the scope of the family Oncaeidae with description of one new genus and three new species. *Zoological Magazine, Tokyo*, 16, 533–541. [in Japanese]

Kuang, P. & Li, H. (1984) A new parasitic copepod of the genus *Ergasilus*. *Zoological Research*, 5, 385–390. [in Chinese with English summary]

Kuang, P. & Liu, D.S. (1991) A new species of the family Ergasilidae and SEM observation (Crustacea: Copepoda). *Acta zootaxonomica sinica*, 16, 403–406. [in Chinese with English summary]
Kuang, P.-R. & Qian, J.-H. (1983) The distribution of Parasitic Copepoda in Yunnan, China, with descriptions of four new species. *Acta zootaxonomica sinica*, 8, 354–365. [in Chinese with English summary]
Kuang, P. & Qian, J. (1985) Two new species of Ergasilidae (parasitic Copepoda) from China. *Zoological Research*, 6, 271–276. [in Chinese with English summary]
Lacepède, B.G.E. (1801) *Histoire naturelle des Poissons. Vol. 3.* Plassan, Paris, lxvi + 558 pp., plates I–XXXIV.
Latham, J.F. (1794) An essay on the various species of sawfish. *Transactions of the Linnean Society of London*, 2, 273–282, plates XXVI–XXVII.
Linnaeus, C. (1758) *Systema naturae per Regna tria naturae, secundum Classes, Ordines, Genera, Species, cum Characteribus, Differentiis, Synonymis, Locis. Tomus I. Editio decima, reformata*. *Vol. 1. 10th Edition.* Impensis Direct. Laurentii Salvii, Holmiae, ii + 824 pp.
Liu, J. (1998) A nwe [*sic*] species of the parasitic copepod from freshwater fishes of China. *Acta hydrobiologica sinica*, 22 (Supplement), 208–210. [in Chinese with English summary]
Müller, O.F. (1785) *Entomostraca seu Insecta Testacea quae in aquis Daniæ et Norvegiæ reperit, descripsit et iconibus illustravit.* F.W. Thiele, Lipsiæ & Havniæ, 134 pp., index, plates 1–21.
http://dx.doi.org/10.5962/bhl.title.14414
Nordmann, A. von (1832) *Mikrographische Beiträge zur Naturgeschichte der wirbellosen Thiere*. *Vol. 1 & 2.* G. Reimer, Berlin, x + 118 pp., plates 1–10 & xviii + 150 pp.
Ogawa, K. (1991) Ectoparasites of sawfish, *Pristis microdon,* caught in fresh waters of Australia and Papua New Guinea. *University Museum, University of Tokyo, Nature and Culture*, 3, 91–101.
Ohtsuka, S., Ho, J.-S. & Nagasawa, K. (2004) Ergasilid copepods (Poecilostomatoida) in plankton samples from Hokkaido, Japan, with reconsideration of the taxonomic status of *Limnoncaea* Kokubo, 1914. *Journal of natural History*, 38, 471–498.
http://dx.doi.org/10.1080/0022293021000034778
Oldewage, W.H. & van As, J.G. (1987) A new ectoparasitic ergasilid copepod from the Pongola River system. *South African Journal of Zoology*, 27, 62–65.
Rafinesque, C.S. (1815) *Analyse de la Nature ou Tableau de l'Univers et des Corps organises*. Imp. Jean Barravecchia, Palermo, 224 pp.
Rosim, D.F., Boxshall, G.A. & Ceccarelli, P.S. (2013) A novel microhabitat for parasitic copepods: A new genus of Ergasilidae (Copepoda: Cyclopoida) from the urinary bladder of a freshwater fish. *Parasitology International*, 62, 347–354.
http://dx.doi.org/10.1016/j.parint.2013.03.003
Sauvage, H.-E. (1878) Sur une *Himantura* de Cochinchine. *Bulletin de la Société philomathique de Paris*, 7e Série, 2, 90–91.
Song, Y., Wang, G.T., Yao, W.J., Gao, G. & Nie, P. (2008) Phylogeny of freshwater parasitic copepods in the Ergasilidae (Copepoda: Poecilostomatoida) based on 18S and 28S rDNA sequences. *Parasitology Research*, 102, 299–306.
http://dx.doi.org/10.1007/s00436-007-0764-8
Tang, D. & Kalman, J.E. (2008) A new genus and species of mesoparasitic ergasilid (Copepoda: Cyclopoida) from brackish water pufferfishes collected in northern Australian waters. *Systematic Parasitology*, 69, 89–99.
http://dx.doi.org/10.1007/s11230-007-9109-3
Tavares, L.E.R. & Luque. J.L. (2005) *Ergasilus youngi* sp. nov. (Copepoda: Poecilostomatoida: Ergasilidae) parasitic on *Aspistor luniscutis* (Actinopterygii: Ariidae) from off the State of Rio de Janeiro, Brazil. *Acta Parasitologica*, 50, 150–155.
Thatcher, V.E. (1999) *Anklobrachius marajoensis* gen. et sp. nov. (Copepoda, Poecilostomatoida, Ergasilidae) described from male specimens taken in plankton samples from the Amazon River. *In*: Schram, F.R. & Vaupel Klein, J.C. von (Eds.), *Crustaceans and the biodiversity crisis. Proceedings of the Fourth International Crustacean Congress, Amsterdam, The Netherlands, July 20–24, 1998.Vol. 1.* Brill, Leiden, Boston & Köln, pp. 231–237.
Velasquez, C.C. (1951) An unreported Philippine species of parasitic copepod. *Natural and applied Science Bulletin*, 11, 243–255.
Wang, K.-N. (1961) Two new species of parasitic copepods from *Mugil* sp. *Acta zoologica sinica*, 13, 1–8, plates I–II. [in Chinese with English summary]
Wilson, C.B. (1911) North American parasitic copepods belonging to the family Ergasilidae. *Proceedings of the United States National Museum*, 39, 263–400, plates 41–60.
http://dx.doi.org/10.5479/si.00963801.39-1788.263
Wilson, C.B. (1913) Crustacean parasites of West Indian fishes and land crabs, with descriptions of new genera and species. *Proceedings of the United States National Museum*, 44, 189–227, plates 18–53.
http://dx.doi.org/10.5479/si.00963801.44-1750.189
Xu, G. (1987) A faunistic survey of parasitic crustaceans on fishes in Lake Hongzehu, with description of a new species. *Acta hydrobiologica sinica*, 11, 152–160. [in Chinese with English summary]
Yamaguti, S. (1939) Parasitic copepods from fishes of Japan. Part 4. Cyclopoida II. *In*: *Volumen Jubilare pro Prof. Sadao Yoshida*, 2, 391–415, plates I–XIII.
Yamaguti, S. (1954) Parasitic copepods from fishes of Celebes and Borneo. *Publications of the Seto marine biological Laboratory*, 3, 375–398, plates I–VI.
Zhang, Q.-Z. & Ma, C.-L. (1994) A new species of the genus *Ergasilus* parasitizing freshwater fish in Sichuan Province, China (Cyclopoida: Ergasilidae). *Acta zootaxonomica sinica*, 19, 139–143.