

Catoessa boscii (Crustacea, Isopoda, Cymothoidae) parasitic on *Carangoides malabaricus* (Pisces, Carangidae) from India. Taxonomy and host-parasite relationships

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Abstract

Catoessa boscii (Bleeker, 1857) (Crustacea, Isopoda, Cymothoidae), is redescribed according to the type specimen observed by Schioedte and Meinert (1884) extant in the Rijksmuseum von Natuurlijke Historie, Leiden (RMNH) and from many additional specimens recently collected in India from *Carangoides malabaricus* (Pisces, Carangidae). This study allows an updating of the diagnosis of the genus *Catoessa* and of the species *Catoessa boscii*. Some parasite-host relationships were studied during the year. Prevalence and sex ratio of parasites varied according to the month, and the sex and size of hosts.

Keywords

Isopoda, Cymothoidae, *Catoessa boscii*, redescription, host-parasite relationships

Introduction

Livoneca boscii (Livonèze de Bosc) (Crustacea, Isopoda, Cymothoidae) was originally poorly described by Bleeker (1857) from different fish species unidentified of the Batavia Sea. This species was redescribed by Schioedte and Meinert (1884) from a single Bleeker's specimen, scarcely typical according to the Danish authors and from an unknown host. However, their Latin redescription was incomplete by modern standards. Following these original description and redescription, this species was sometimes recorded (Miers 1880; Nierstrasz 1915, 1931; Trilles 1979, 1994; Bruce 1990) but has not received an accurate redescription. However, it was transferred from the genus *Livoneca* Leach, 1818 to the genus *Catoessa* Schioedte et Meinert, 1884 by Bruce (1990). Until now, the male was unknown and its host was not accurately identified. Indeed, a single host, *Stolephorus indicus* (van Hasselt, 1823), was reported by Trilles (1979) from a single specimen held in the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands (RMNH).

As the original description and the Latin redescription of this species are poor, an accurate and detailed redescription was necessary with precise drawings particularly on the mouth

parts and other appendages. This contribution redescribes and describes the female and male adult isopods respectively using the type material and fresh material from India. Some precise details about the host-parasite relationships are also supplied. The opportunity to perform such study was provided by finding many female and male specimens parasitizing an Indian Carangidae, *Carangoides malabaricus* (Bloch et Schneider, 1801).

Materials and methods

Carangoides malabaricus were collected monthly directly from the trawlers landed at Parangipettai, Southeastern coast of India, during the period December 2008 to November 2009 (Table I). The mouth and branchial cavities of each fish were examined under a dissecting stereomicroscope for the presence of parasites. Isopods were removed alive from the buccal cavity of the fish hosts and immediately placed into 70% ethanol. The parasites of each fish were counted and their sex was determined. The total length of the fish hosts and isopods was measured and all measurements are in millimetres. Mouthparts and appendages were carefully dissected using

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dissecting needles and forceps. Drawings were made with the aid of a camera lucida.

Specimens 243 were collected (Table I). Additional samples were obtained from the RMNH. The type materials for *Catoessa scabricauda* Schioedte et Meinert, 1884 and *Livoneca boscii* (Bleeker, 1857) were obtained respectively from the Museum für Naturkunde Leibniz Institute for researchs on Evolution and Biodiversity at the Humbolt University of Berlin, Germany (ZMHU) and from the Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands (RMNH).

The host-parasite relationships were analyzed for female and male isopods separately and for both sexes combined, according to the month, and the sex and size of hosts. Prevalence (P) and the mean intensity were calculated according to Bush *et al.* (1997). Host nomenclature and fish taxonomy are according to FishBase (Froese and Pauly 2011). Voucher specimens are deposited at the National Museum of Natural History of Paris, France (MNHN).

Abbreviations used: MNHN – National Museum of Natural History of Paris, France; RMNH – Rijksmuseum van Natuurlijke Historie te Leiden, Netherlands; ZMHU – Museum für Naturkunde Leibniz Institute for Researchs on Evolution and Biodiversity at the Humbolt University of Berlin, Germany.

Taxonomy

Suborder: Cymothoidea Wägele, 1989.

Superfamily: Cymothoidea Leach, 1814.

Family: Cymothoidea Leach, 1814.

Genus: *Catoessa* Schioedte et Meinert, 1884.

Catoessa Schioedte and Meinert (1884): 309–310. Nierstrasz (1931), 137. Bowman and Tareen (1983), 17–18. Bruce (1990), 251. Trilles (1994), 136.

Type species: *Catoessa scabricauda* Schioedte et Meinert, 1884 by monotypy.

The genus *Catoessa* was proposed by the Danish authors for a single specimen ovigerous female of the species *Catoessa scabricauda* collected at the Adonara Island, one of the Lesser Sunda Islands east of the Flores Island, Indonesia, from an unknown host. This specimen, now very fragile, is held in the ZMHU (no. 3642).

Diagnosis of female: Body more or less vaulted, weakly twisted to the left or the right side, sometimes scarcely symmetrical, about 2.5–3 times as long as wide. Cephalon weakly immersed in pereonite 1, with an acute or truncate rostral margin. Pleon narrow, not immersed into pereon; all pleonites visibles, pleonite 1 narrower than rest of pleon, more or less overlapped by pereonite 7; pleonites 2–5 subequal in width, slightly wider than pereonite 7, lateral margins twisted or directed laterally, leaving gaps between some pleonites.

Antennule (8 articulated) and antenna (10–11 articles) subequal or antennule shorter than antenna, slightly or strongly stouter than antenna; bases set wide apart. Mandible palp slender, incisor usually acute, elongate. Maxilliped without oostegial lobe. Pereopods without anterolateral carina on basis or with only slender carina on basis 6 or 6–7, articles not dilated or expanded. Brood pouch arising from sternites 2–4 and 6. Pleopods all lamellar, endopods of pleopods 3–5 with not folded proximomedial lobe. Uropods rami not extending posterior of pleotelson or exceeding more or less posterior margin of pleotelson; endopod shorter than exopod.

Composition: *Catoessa scabricauda* Schioedte et Meinert, 1884 (type species), *Catoessa boscii* (Bleeker, 1857), *Catoessa gruneri* (Bowman et Tareen, 1983) and *Catoessa ambassae* (Bruce, 1990).

Distribution: According to the species now included in this genus, the genus *Catoessa* is known from the Pacific and Indian Oceans (Australia, Indonesia, India and Kuwait).

Hosts: Host of the type species is still unknown. The other species currently included in the genus *Catoessa* were collected respectively from Pisces, Perciformes Leiognathidae

Table I. Infestation of *Carangoides malabaricus* by *Catoessa boscii* according to different months (December.08 – November.09)

Months	No. of fishes examined	No. of fishes infested (prevalence)	No. of parasites collected (mean intensity)
December.08	46	20 (43.5)	21 (1.1)
January.09	38	24 (63.2)	27 (1.1)
February.09	52	14 (26.9)	15 (1.1)
March.09	86	46 (53.5)	58 (1.3)
April.09	72	43 (59.7)	44 (1.0)
May.09	28	–	–
June.09	32	–	–
July.09	64	15 (23.4)	16 (1.1)
August.09	26	9 (34.6)	10 (1.1)
September.09	35	11 (31.4)	13 (1.2)
October.09	57	20 (35.1)	22 (1.1)
November.09	49	16 (32.7)	17 (1.1)
Total	585	218 (37.3)	243 (1.1)

and Terapontidae (*C. gruneri*); Ambassidae (*C. ambassae*) or Carangidae (*C. boscii*) and from Pisces, Clupeiformes, Pristigasteridae (*C. gruneri*) and Engraulidae (*C. boscii*).

Remarks: As already reported by Bowman and Tareen (1983) and Bruce (1990), the Latin diagnosis of the genus *Catoessa* contains almost nothing of generic value. On the basis of this diagnosis by Schioedte and Meinert (1884) and in the light of their study on *Catoessa gruneri*, Bowman and Tareen (1983) reported that there was little justification for separating *Catoessa* from *Livoneca* Leach, 1818 and recognized the little known genus *Catoessa* as valid. While Bruce (1990), studying the genera *Catoessa*, *Elthusa* Schioedte et Meinert, 1884 and *Livoneca*, and particularly according to new data on the genera *Elthusa* and *Livoneca* presented in its study, reported that there is a great deal of difference between these three genera. However, the genus *Catoessa* has been only provisionally redefined by the author because the type species was still not well known.

An updated diagnosis of the genus *Catoessa* is given here, on the basis of a careful study of the type specimen of *Catoessa scabricauda* and according to the new data on *Catoessa gruneri* (Bowman and Tareen 1983), *Catoessa ambassae* (Bruce 1990) and *Catoessa boscii* (this study). It is clear that the genera *Catoessa* is very different from the genus *Livoneca*. However, it is closely allied to the heterogeneous genus *Elthusa* as redefined by Bruce (1990) and later by Trilles and Randall (2010). *Catoessa* is still best identified by the pleonite 1 narrower than 2 and pereopods 1–7 without carina on basis and dilated merus, or with slender carina on basis 6–7 only. However, further studies on fresh material belonging to the species *Catoessa scabricauda* will be very useful.

Catoessa boscii (Bleeker, 1857)

Livoneca boscii Bleeker, 1856: 21, 29–30, pl. 1, fig. 9. – Schioedte and Meinert 1884: 365–367, pl. 15 (Cym. XXXIII), figs 7–8.

Livoneca boscii – Miers 1880: 466–467.

Livoneca boscii – Nierstrasz 1915: 100. Trilles 1979: 265–266.

Trilles 1994: 174.

Livoneca boscii – Nierstrasz 1931: 143, 145.

Catoessa boscii – Bruce 1990: 251, 254.

Material examined

Type material: A single specimen ovigerous female, total length 15 mm, held at the RMNH (No. I. 67), from the Batavia Sea (= Java, Indonesia). As for the most species collected by Bleeker (1857) the type host and the site of attachment was not clearly identified (“Habite la peau de diverses especes de poissons”, “Living on the skin of different host species”).

Non-type material examined: All from *Carangoides malabaricus* and deposited in the MNHN. Two females (ovigerous 19 mm and non-ovigerous 12.5 mm), attached in the buccal cavity of *Carangoides malabaricus*, from Nagapattinam

(10°46'N, 79°50'E), Southeast coast of India, 23 October 2010 (MNHN – Is 6303); 3 ovigerous females (20 mm, 15 mm and 15 mm), Parangipettai, Southeast coast of India, from *Carangoides malabaricus*, 28 December 2008, 8 February 2009 and 21 November 2009, respectively (MNHN – Is 6304); 3 non-ovigerous females (16 mm, 16 mm and 15 mm), Parangipettai, Southeast coast of India, from *Carangoides malabaricus*, 18 December 2008, 24 February 2009 and 24 April 2009, respectively (MNHN – Is 6305); 6 males (1 mm, 14 mm, 13 mm, 13 mm, 13 mm and 11 mm), Parangipettai, Southeast coast of India, from *Carangoides malabaricus*, 15 March 2009, 24 April 2009, 17 January 2009, 8 April 2009, 3 September 2009 and 8 October 2009, respectively (MNHN – Is 6306).

Additional material: Several specimens from the RMNH, already reported by Trilles (1979), i.e. female (ovigerous, 15 mm), Indian Archipelago, from the branchial cavity of *Stolephorus indicus*, leg. P. Bleeker (RMNH No. 100) – 2 females (ovigerous and non-ovigerous, 20 mm each), Belawan Deli, Medan Harbour, Northwest coast of Sumatra to the Malacca Strait, Janvier 1929, P. Buitendijk (RMNH No. 28) – 7 females (ovigerous, 16, 15, 15, 14.5, 14.5, 14.5, 14 mm) and 1 female (non ovigerous, 13.5 mm), Bay of Djakarta (Batavia), November 1926, May 1927 and October 1928, leg. P. Buitendijk (RMNH No. 58, 62 and 44) – 2 females (ovigerous, 16 and 13.5 mm), Tandjong Priok (= Djakarta Harbour), November 1925 and May 1927, leg. P. Buitendijk (RMNH No. 63 and 25) – 1 female (ovigerous, 13 mm), Tegal, North coast of Java about 109°8'E, August 1926, leg. P. Buitendijk (RMNH No. 26) – 1 female (ovigerous, 12 mm), Semarang Roads, North coast of Java about 110°25'E, November 1925, leg. P. Buitendijk (RMNH No. 13).

Description of female (Figs 1, 2 and 3): Body about 2.5–3 times as long as wide, widest at pereonite 4–5, twisted to the left (about 60% of specimens) or the right side (about 40% of specimens), dorsum moderately vaulted.

Cephalon not deeply immersed in pereonite 1, anterior margin truncate, reflexed ventrally into triangular lobe separating antennules. Eyes well developed, conspicuous, with distinct margins, but small, about 0.2 times width of cephalon. Coxae visible in dorsal view; coxae of pereonite 2 as long as segment, coxae 3–7 not extending beyond posterior of pereonites. Pereonite 1 longest, 2–4 increasing and 5–7 decreasing in width and length. Posterior margin of pereonite 7 slightly indented. All pleonites visible, pleonite 1 narrower than rest of pleon, partly overlapped by pereonite 7. Pleonites 2–5 subequal in length. Epimera slightly directed posteriorly, narrower than central parts of pleonites, with gaps between some pleonites. Pleotelson subtriangular, slightly wider than long.

Antennule extending to anterior margin of pereonite 1, stouter than antenna, composed of 8 articles, with small setae on article 8, basal segments widely separated. Antenna subequal in length to antennule, extending to pereonite 1, more slender, 10 segmented, with small setae on article 10. Mandible incisor acute, elongate; palp article 3 with 4–7 and

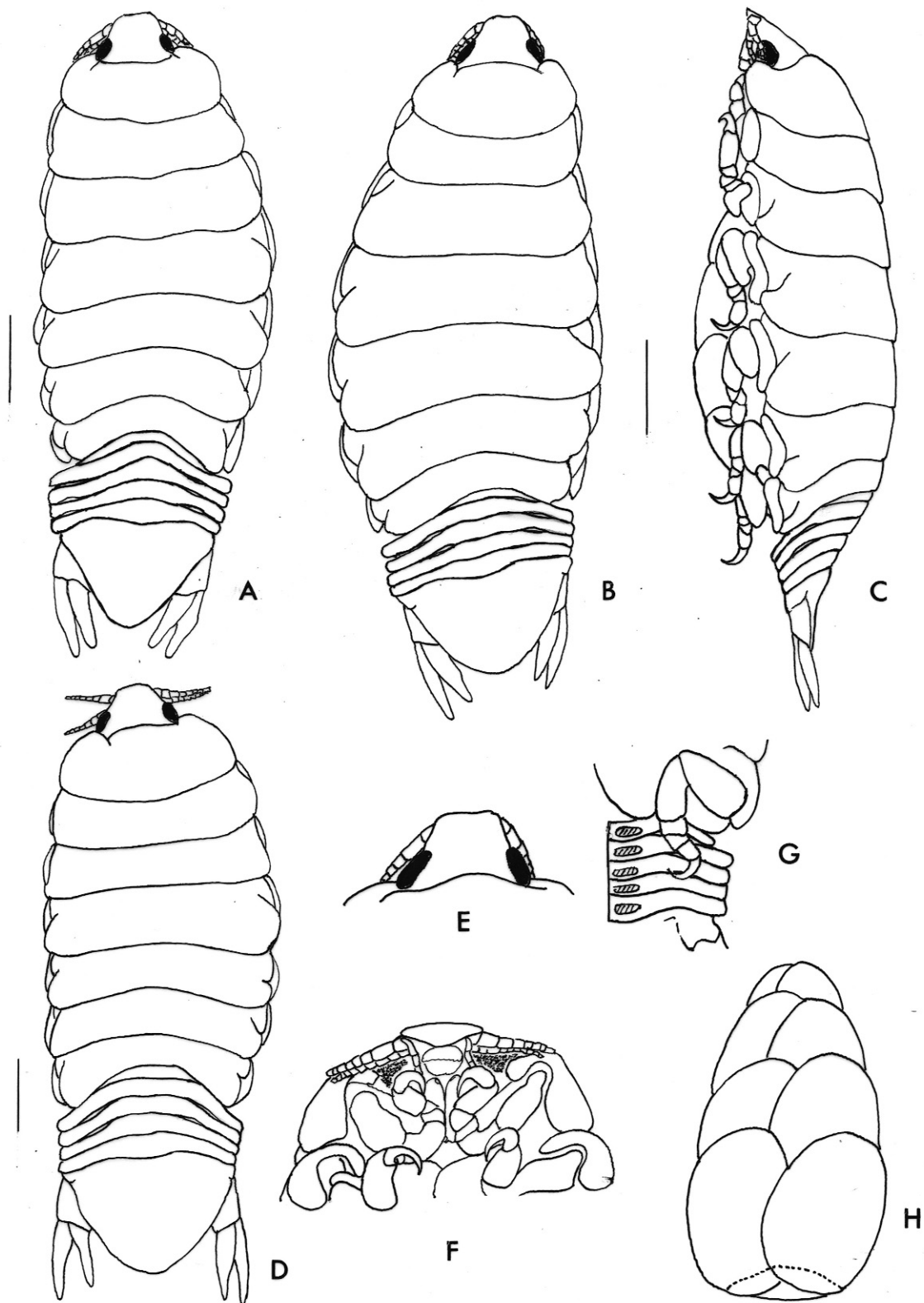


Fig. 1. *Catoessa boscii* (Bleeker, 1857). **A** – ovigerous female (RMNH No. I. 67); **B** – ovigerous female (MNHN – Is 6303), dorsal view; **C** – ovigerous female (RMNH – Is 6303), lateral view; **D** – non-ovigerous female (MNHN – Is 6305), dorsal view; **E–H** – ovigerous female (RMNH – Is 6304): **E** – cephalon; **F** – frons, ventral view; **G** – left pleonites, ventral view; **H** – brood pouch. Scale bars represent 2.0 mm (A), 3.0 mm (B-C), 2.0 mm (D)

article 2 with 0–2 more or less long setae on distolateral margin. Maxillule with 4 apical spines slightly recurved. Maxilla with 2 spines on the inner, medial lobe and a single spine on the outer, lateral lobe. Maxilliped with 3 recurved spines on article 3. Pereopods with rather broad basis, elongate ischium and short propodus. Pereopod 1 shortest and pereopod 7 longest, 1–5 similar but ischium increasing in width progressively; pereopods 6–7 with a slender anterolateral carina on basis. Brood pouch made up of 4 pairs of overlapping oostegites arising from sternites 2–4 and 6. Pleopods all lamellar,

without folding and accessory lobes, endopods of pleopods 3–5 with proximomedial lobe but not folded; protopod of pleopods 1–4 with 4–5 coupling hooks on medial margin; all pleopods with exopod longer than endopod. Uropod rami extending beyond posterior margin of pleotelson; endopod slightly shorter than exopod, apices of both rami narrow, subacute.

Description of male (Fig. 4): Body 3–3.5 times as long as wide, similar to female but bilaterally symmetrical. A pair of penes on posterior of sternite 7.

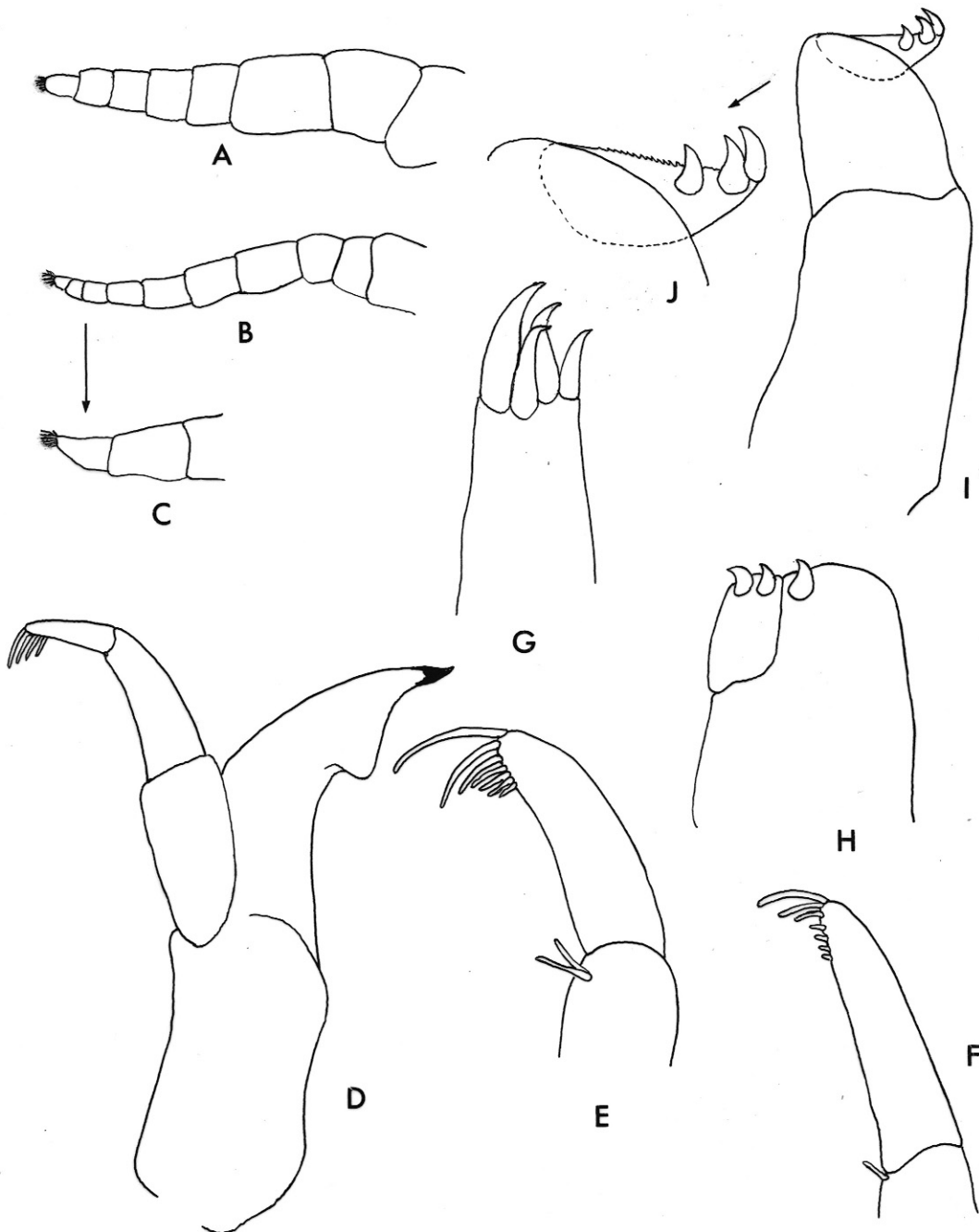


Fig. 2. *Catoessa boscii* (Bleeker, 1857) ovigerous female (MNHN – Is 6304). **A** – antennule; **B** – antenna; **C** – antenna detail; **D** – mandible; **E-F** – mandible palp, variations; **G** – maxillule; **H** – maxilla; **I** – maxilliped; **J** – maxilliped article 3, detail

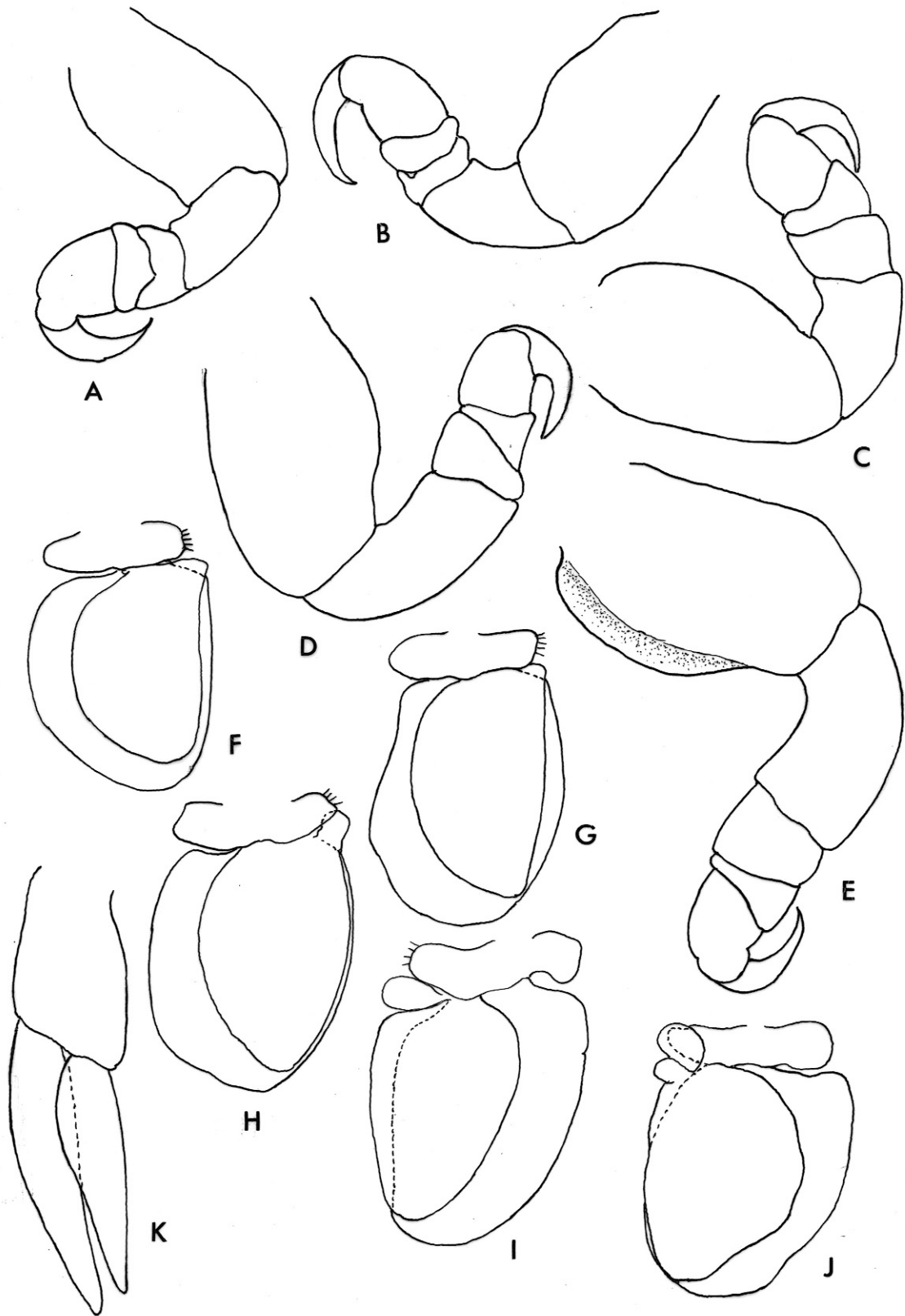


Fig. 3. *Catoessa boscii* (Bleeker, 1857). Ovigerous female (MNHN – Is 6304). **A–D** – left pereopods 1, 2, 5 and 6 respectively, lateral view; **E** – pereopod 7, medial view; **F–J** – pleopods 1–5: **F, G, H**, right pleopods 1, 2, 3, posterior view; **I–J** – left pleopods 4–5, posterior view; **K** – uropod

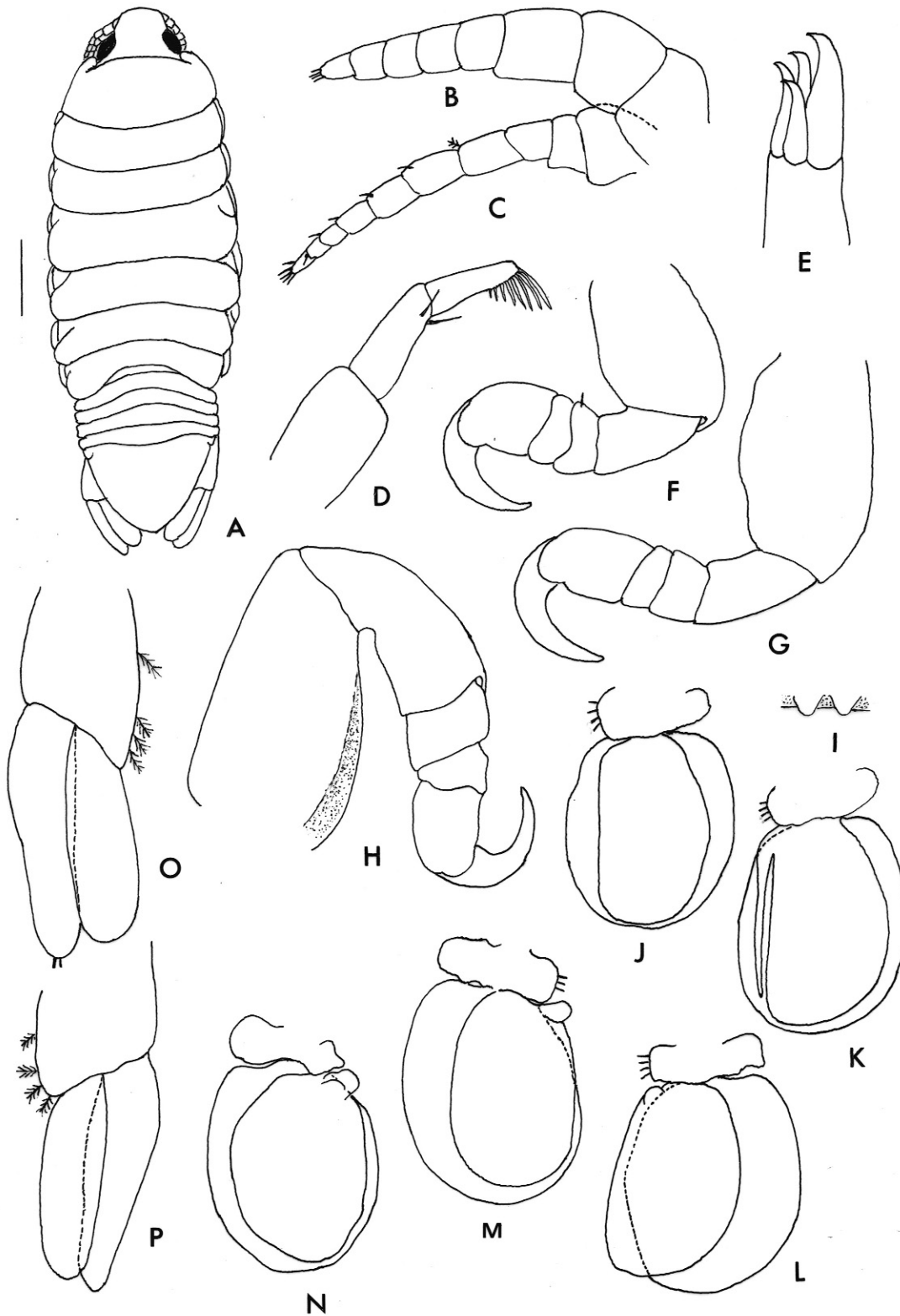


Fig. 4. *Catoessa boscii* (Bleeker, 1857). Male (MNHN – Is 6306). **A** – dorsal view; **B-C** – antennule and antenna, respectively; **D** – mandible palp; **E** – maxillule apex; **F-G** – left pereopods 1, 3 respectively, lateral view; **H** – left pereopod 7, medial view; **I** – penes; **J-L** – left pleopods 1–3 respectively, posterior view; **M-N** – right pleopods 4–5, posterior view; **O-P** – uropods. Scale bar represent 1.5 mm (A)

Table II. Morphological comparison of species of the genus *Catoessa*

Species	Cephalon	Antennae	Pereopods	Pleonites	Pleotelson	Uropods
<i>Catoessa scabricauda</i>	pointed anteriorly	2 longer than 1	without carina on basis*	5 narrower than 2–4	much wider than long	reaching mid-length of pleotelson
<i>Catoessa ambassae</i>	truncate rostrum	1 and 2 subequal or 1 slightly longer than 2	pereopod 7 basis with carina	2–5 subequal in width	broadly rounded	reaching about $\frac{3}{4}$ length of pleotelson
<i>Catoessa boscii</i>	truncate rostrum	1 and 2 subequal	pereopods 6–7 with carina on basis	2–5 subequal in width	subtriangular, slightly wider than long	extending beyond of pleotelson
<i>Catoessa gruneri</i>	rounded anteriorly	1 and 2 subequal	without carina on basis	2–5 subequal in width, epimera directed laterally	subtriangular, slightly wider than long	reaching posterior end of pleotelson

*Not accurately observable given the actual condition of the type specimen.

Appendages similar to females, except for antenna slightly longer than antennule, with setae on articles 4–10; mandible palp with 2 setae on article 2 and 8 setae on article 3; maxillule with 4 more recurved spines. Pereopod 1 with a single setae on carpus; pleopods 2 with appendix masculine; uropod rami wider, with apices rounded, with plumose setae.

Size: Ovigerous females 12–24 mm, non-ovigerous females 12–18 mm, males 8–14 mm.

Colour: Alive females pale tan (about 70% of specimens) or pale brown with visible chromatophores (about 30% of specimens); all alive males pale tan.

Remarks: *Catoessa boscii* is readily distinguished from all other species of the genus. *Catoessa ambassae* and *Catoessa boscii* are chiefly distinguished from two others of the genus by the presence of a truncate rostrum and carina on basis of the posterior pereopods while *Catoessa scabricauda* and *Catoessa gruneri* have an acute rostral point or a rounded rostral point, respectively and all pereopods without carina on basis. *Catoessa boscii* is characterized by the presence of uropods extending beyond of a subtriangular pleotelson while *Catoessa ambassae* has a broadly rounded pleotelson with uropods not reaching posterior margin of pleotelson.

The most obvious differences between the species now included in the genus *Catoessa* are summarized in Table II.

Host: Present Indian material is all from *Carangoides malabaricus*, an Indo-West Pacific species, occurring in the continental shelf, near rocks and coral reefs. Until now, a single specimen was reported by Trilles (1979) from *Stolephorus indicus* in Indonesia.

Distribution: Now recorded from Indonesia (Bleeker 1857) and Southeast coast of India (present study).

Host-parasite relationships: *Catoessa boscii* was until now collected from the buccal cavity of *Carangoides malabaricus*. During the study period *Catoessa boscii* was recorded throughout the year except in May and June 2009. The parasites occur

in the buccal cavity of the host fish and their position is highly specific. Sometimes they are observed protruding through the host mouth.

The parasite was normally attached in such a way that its broader posterior part was lodged in the wider portion of the floor of the buccal cavity and the narrow anterior part was either facing the opening of the mouth or protruding out through the mouth. In some fish, two *Catoessa boscii* are found, a large ovigerous female in the mouth and a small active male in the buccal cavity. Most of the females were attached on the fish tongue, rarely on the roof of the buccal cavity. Such mode of attachment was also reported by Bruce (1990) for *Catoessa ambassae*, while *Catoessa gruneri* was collected on gills by Bowman and Tareen (1983) and *Catoessa scabricauda* doubtfully on the skin by Bleeker (1857).

During the sampling period, 585 *Carangoides malabaricus* were examined including 51.1% of males and 48.9% of females. Among them, 218 specimens were found to carry 243 parasites corresponding to an overall prevalence of 37.3% (Table I). Infestation rate was higher in male fishes (38.1%) than in female fishes (36.4%) (Table III).

The monthly prevalence showed marked variations throughout the year (Table I). The highest percentage of infestation occurred in January 2009 and the lowest in July 2009. The mean intensity ranged from a minimum (1.0) in April 2009 to a maximum (1.3) in March 2009.

The parasite incidence regarding the host's sex was 36.4% and 38.1% in host females and males, respectively. The prevalence was maximum in males during January 2009 (77.8%) and minimum (28.6%) in February, July and August, with an intensity ranging from 1 in February, July and November to 1.3 in March 2009. In female hosts the prevalence was maximum (57.9%) in April 2009 and minimum (19.4%) July 2009. The higher intensity (1.2) was observed in January, February, March and September 2009 and the minimum intensity (1) in December 2008, April and August 2009 (Table III).

Table III. Infestation of *Carangoides malabaricus* by *Catoessa boscii* according to the fish sex at different months (December.08 – November.09)

Months	Male fishes			Female fishes		
	No. of fishes examined	No. of infested fishes (% prevalence)	Parasites collected (mean intensity)	No. of fishes examined	No. of infested fishes (% prevalence)	Parasites collected (mean intensity)
December.08	22	9 (40.9)	10 (1.1)	24	11 (45.8)	11 (1)
January.09	18	14 (77.8)	15 (1.1)	20	10 (50)	12 (1.2)
February.09	28	8 (28.6)	8 (1)	24	6 (25)	7 (1.2)
March.09	52	28 (53.8)	36 (1.3)	34	18 (52.9)	22 (1.2)
April.09	34	21 (61.8)	22 (1.0)	38	22 (57.9)	22 (1)
May.09	12	–	–	16	–	–
June.09	18	–	–	14	–	–
July.09	28	8 (28.6)	8 (1)	36	7 (19.4)	8 (1.1)
August.09	14	4 (28.6)	5 (1.2)	12	5 (41.7)	5 (1)
September.09	19	6 (31.6)	7 (1.2)	16	5 (31.3)	6 (1.2)
October.09	31	9 (29.0)	10 (1.1)	26	11 (42.3)	12 (1.1)
November.09	23	7 (30.4)	7 (1)	26	9 (34.6)	10 (1.1)
Total	299	114 (38.1)	128 (1.1)	286	104 (36.4)	115 (1.1)

Table IV. Sex ratio of *Catoessa boscii* in relation to different months

Months	Male fishes			Female fishes			Total		
	Male parasites	Female parasites	Female/male ratio	Male parasites	Female parasites	Female/male ratio	Male parasites	Female parasites	Female/male ratio
December.08	1	9	9.0	2	9	4.5	3	18	6.0
January.09	3	12	4.0	2	10	5.0	5	22	4.4
February.09	1	7	7.0	1	6	6.0	2	13	6.5
March.09	6	30	5.0	4	18	4.5	10	48	4.8
April.09	4	18	4.5	3	19	6.3	7	37	5.2
May.09	–	–	–	–	–	–	–	–	–
June.09	–	–	–	–	–	–	–	–	–
July.09	2	6	3.0	1	7	7.0	3	13	4.3
August.09	1	4	4.0	1	4	4.0	2	8	4.0
September.09	1	6	6.0	2	4	2.0	3	10	3.3
October.09	2	8	4.0	3	9	3.0	5	17	3.4
November.09	1	6	6.0	3	7	2.3	4	13	3.2

Table V. Sex ratio of *Catoessa boscii* in relation to size of *Carangoides malabaricus*

Length class (mm)	Male fishes			Female fishes			Total		
	Male parasites	Female parasites	Female/male ratio	Male parasites	Female parasites	Female/male ratio	Male parasites	Female parasites	Female/male ratio
80–90	–	2	–	–	1	–	–	3	–
90–100	–	2	–	–	2	–	–	4	–
100–110	–	1	–	–	2	–	–	3	–
110–120	5	19	3.8	3	16	5.3	8	35	4.3
120–130	6	29	4.8	5	21	4.2	11	50	4.5
130–140	5	26	5.2	7	27	3.8	12	53	4.4
140–150	2	12	6.0	2	11	5.5	4	23	5.7
150–160	2	8	4.0	1	7	7.0	3	15	5.0
160–170	1	4	4.0	2	3	1.5	3	7	2.3
170–180	1	3	3.0	2	3	1.5	3	6	2.0

Table VI. Infestation of *Catoessa boscii* in relation to size and sex of *Carangoides malabaricus*

Length class (mm)	No. of fishes examined	No. of fishes infected (prevalence)	Total no. of parasites collected (mean intensity)	Male			Female		
				No. of fishes examined	No. of fishes infected (prevalence)	Total no. of parasites collected (mean intensity)	No. of fishes examined	No. of fishes infected (prevalence)	Total no. of parasites collected (mean intensity)
80–90	33	3 (9.1)	3 (1)	22	1 (9.1)	2 (1)	11	1 (9.1)	1 (1)
90–100	45	4 (8.9)	4 (1)	26	2 (7.7)	2 (1)	19	2 (10.5)	2 (1)
100–110	59	3 (5.1)	3 (1)	32	1 (3.1)	1 (1)	27	2 (7.4)	2 (1)
110–120	73	36 (49.3)	43 (1.2)	42	19 (45.2)	24 (1.2)	31	17 (54.8)	19 (1.1)
120–130	96	54 (56.3)	61 (1.1)	51	31 (60.8)	35 (1.1)	45	23 (51.1)	26 (1.1)
130–140	99	57 (57.6)	65 (1.1)	52	28 (53.8)	31 (1.1)	47	29 (61.7)	34 (1.1)
140–150	53	26 (49.1)	27 (1.0)	24	14 (58.3)	14 (1)	29	12 (41.4)	13 (1.1)
150–160	65	8 (27.7)	18 (1)	24	10 (41.7)	10 (1)	41	8 (19.5)	8 (1)
160–170	34	9 (26.5)	10 (1.1)	16	4 (25)	5 (1.2)	18	5 (27.8)	5 (1)
170–180	28	8 (28.6)	9 (1.1)	10	3 (30)	4 (1.3)	18	5 (27.8)	5 (1)
Total	585	218 (37.2)	243 (1.1)	299	114 (38.1)	128 (1.1)	286	104 (36.4)	115 (1.1)

The sex-ratio of male and female parasites in relation to the sex of hosts was calculated according to the different months. The highest sex-ratio (9.0) was observed in male fishes during December 2008 and the lowest (3.0) in July 2009 (Table IV). In female fishes, the sex-ratio was maximum (7.0) in July 2009 and the minimum (2.0) was observed in September 2009. Usually the sex-ratio of parasites was higher in male fish than in female fish (Table IV).

However, the sex-ratio showed also significant differences in relation to the host's size. In male fishes, it was maximum (6.0) for the length class of fishes 140–150 mm and minimum (3.0) for the length class 170–180 mm. In female fishes, the maximum value (7.0) was observed for the size group 150–160 mm and the minimum for the length class 160–180 mm (Table V). The prevalence showed significant differences according to the host's size. It was higher (57.6%) in the length group of fishes 130–140 mm than in the size class 100–110 mm (5.1%). In male fishes, the prevalence of infestation was maximum (60.8%) for the length class 120–130 mm and minimum (3.1%) for the 100–110 mm size group of fishes. In female fishes, it was maximum (61.7%) for the length class 130–140 mm and minimum (7.4%) for the length class 100–110 mm (Table VI).

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