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Redescription of *Lernaeenicus stromatei* Gnanamuthu, 1953 (Copepoda: Siphonostomatoida: Pennellidae) infesting the Black Pomfret *Parastromateus niger* (Bloch) from Indian waters

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Abstract

The parasitic copepod *Lernaeenicus stromatei* Gnanamuthu, 1953 infecting black pomfret, *Parastromateus niger* (Bloch) (Carangidae) is redescribed based on a neotype and additional fresh material obtained from hosts collected at different fish landing centers on the Chennai Coast (Tamil Nadu), Malabar Coast (Kerala), and from West Bengal, India. A female *L. stromatei* obtained from the Chennai Coast has been designated as a neotype and deposited in the National Zoological Collections of Zoological Survey of India (NZC-ZSI). *Lernaeenicus stromatei* can be identified based on the following features: A long and slender body; head anteriorly rounded, dorso-ventrally flattened and slightly longer than broad; presence of three posterior horns on the head, one median and two lateral, all sub-similar and apically rounded; and an anterior neck with an indistinct partition on the dorsal side, indicating thoracic segments, and a three-jointed antennule.

Key words: Parasitic copepod, redescription, neotype designation, *Parastromateus niger*, India

Introduction

The family Pennellidae Burmeister, 1835 (Copepoda: Siphonostomatoida) contains 26 valid genera (Boxshall & Halsey 2004; Walter & Boxshall 2018; Ohtsuka *et al.* 2018; Hogans 2018). Pennellids are widely reported from both wild and cultured fishes (Castro Romero 2014; Ohtsuka *et al*. 2018; Hogans 2018). In India, Pillai (1985) reported seven genera from the family Pennellidae, including species from the genus *Lernaeenicus* Le Sueur, 1824. Thirty-two species of *Lernaeenicus* have been reported worldwide and ten species have so far been reported from India (Pillai 1985; Raja *et al.* 2016). *Lernaeenicus* can be differentiated from other pennellid genera based on a cephalothorax with simple holdfasts and a labium surface bearing a row of spines or row of scale-like plates (Raja *et al.* 2016).

Pillai (1985) listed and described the parasitic copepods of black pomfret *Parastromateus niger* (Bloch), which is an economically important food fish in Indian waters and a potential host for a number of parasitic crustaceans. The host *P. niger* is the only known species of its genus. This pelagic fish species occurs in large schools at depths of 15–40 m, generally over muddy bottoms. It is distributed across the Persian Gulf and Oman Sea in tropical, subtropical and temperate seas of the world, including the Indian and Pacific Oceans, China and the Malay Archipelago and is most abundant on the west coast of India and Indonesia (Froese & Pauly 2018). The

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information regarding parasitic infestations on fish in open waters, especially the swift-swimming, pelagic fishes, is limited. Few reports are available on the parasitic crustaceans infesting *P. niger* although the buccal cavity, operculum, gill apparatus and body surface of *P. niger* are a common habitat for ectoparasites (Aneesh 2014).

Gnanamuthu (1953) described *L. stromatei* based on the material obtained from the same host *P. niger* from Chennai, India, and the holotype was deposited in the Indian museum, Kolkata. Based on available literature and a recent museum search, the type material of *L. stromatei* is lost. The present paper redescribes *L. stromatei* based on a designated neotype and additional specimens collected from the Bay of Bengal (Chennai Coast), Malabar Coast, and West Bengal.

Materials and methods

Lernaeenicus stromatei was collected from the host fish (*Parastromateus niger*) obtained from three different fish landing centers, the Chennai Coast (Marina Beach, Chennai, India, 13.0500° N, 80.2824° E, the Bay of Bengal); Malabar Coast (Azhikkal, 11^0 94′ 18″ N; 75^0 30′ 48 E″, Bekal, 12° 25' 14 N", 75° 1' 23 E", and Ayyikkara, 11^0 51′33″ N, 75^0 22′ 30 E″; the Arabian Sea), and Behala fish market, West Bengal. The collected copepods were removed from the host and preserved in 75% ethanol (after Aneesh *et al.* 2017). Species identification follows Gnanamuthu (1953) and Pillai (1985). Mouthparts and appendages of the *L. stromatei* were carefully removed using dissecting needles and fine forceps, and observed using a Leica DM-750 and Leica M-205A microscopes at various magnification (40x, 200x, 400x and 1000x). Drawings of observed mouthparts and appendages were completed using a phase contrast microscope (Leica M-205A) and drawing tube. Drawings were inked using Adobe Illustrator and WACOM CTL-472/K0-c drawing pad. Morphological details of the parasite were also examined using a scanning electron microscope (Zeiss EVO 18 SEM). The host nomenclature and fish taxonomy are according to Fish Base (Froese & Pauly 2018). The neotype and voucher specimens are deposited at the National Zoological Collections of Zoological Survey of India (NZC-ZSI), Kolkata (C-7146/2, C-7162/2, C-7163/2, C-7164/2).

Results

Order Siphonostomatida Burmeister, 1835

Family Pennellidae Burmeister, 1835

Genus *Lernaeenicus* Le Sueur, 1824

Lernaeenicus Le Sueur, 1824–Wilson, 1932, p. 480; Yamaguti, 1963, p. 185; Pillai, 1985, p. 716, Aneesh, 2014, p. 168.
Syn. Foroculum Thompson W, 1844
Lernaeonema H Milne-Edwards, 1840
Lerneoceropsis Fowler, 1912.
Type species: *Lernaeenicus radiatus* Le Sueur, 1824

Generic diagnosis: The genus *Lernaeenicus* Le Sueur, 1824, has been distinguished from other pennellids by the following characteristic features, (1) cephalon with two or more simple, nodular or branched cephalic processes projecting outwards or obliquely backwards, (2) antennule 2–5 segmented, Antenna three segmented and chelate, proboscis with three chitinous rings, (3) neck, narrow and usually bent, with four pairs of small swimming legs; first two pairs of legs placed close together, biramous, 3–4, uniramous, 4) enlarged, straight and cylindrical trunk and a narrow abdomen, 5) caudal rami present or absent and the egg strings long and slender with strongly flattened eggs.

Neotype designation for *Lernaeenicus stromatei* Gnanamuthu, 1953: The original description of *Lernaeenicus stromatei* was accompanied by six figures of the adult female and six figures of metamorphosed larvae. Even though the original description contains some species-specific details, it needs to be updated according to the modern taxonomic standard. Fortunately, the type locality (Madras, Tamil Nadu, India), and the

type hosts of *L. stromatei* were clearly mentioned, namely *Stromateus niger* (=*Parastromateus niger*). Gnanamuthu (1953) mentioned that the holotype was deposited in Indian museum, Kolkata and the paratypes were in the author's personal collection, but the author did not include registration numbers. Later, Pillai (1985) clearly stated that all materials, including the type, are lost, and this statement is supported by our present museum search. Enquiries at the Indian museum, failed to reveal any material that could be identified as the type material for *L. stromatei*.

There are few subsequent records of the species. Pillai (1985) provided a description based on the original description but didn't provide drawings and stated that the species closely resembled *L. hemiramphid.* According to Gnanamuthu, the head of *L. stromatei* is asymmetrical, but figures in the original description do not show this asymmetry. Pillai (1985) also doubted the presence of incomplete divisions on the neck. If true, it would be a useful distinguishing character of this species.

The new material of *Lernaeenicus stromatei* Gnanamuthu, 1953 described here was recovered from the type host *Parastromateus niger*. The present materials were collected from three different localities in India (Chennai Coast, Bay of Bengal; Ayyikkara fish landing Centre, Malabar Coast; Behala fish market, West Bengal) and Madras (=Chennai) the type locality.

Remarks. The present material is slightly larger (70 mm) than the size range of adult females (14–63 mm) of *L. stromatei* given by Gnanamuthu (1953) and the host was also smaller in size. However, the present neotype is from a large- sized host fish (*P. niger* = 41.5 cm). The correlation between sizes of the host and parasite has been previously reported (Helna *et al.* 2016). We confirm that both are the same species of *Lernaeenicus* and we designate a neotype in order to conserve Gnanamuthu's (1953) authority and description of this species.

Lernaeenicus stromatei Gnanamuthu, 1953

(Figs 1–4)

Lernaeenicus stromatei Gnanamuthu, 1953, p. 3, figs. 17–22; Pillai, 1985, p, 722; Aneesh, 2014, p.168, fig.2.14g, Raja, Saravanakumar, Gopalakrishnan, Vijayakumar, Hwang & Venmathi Maran, 2016, p. 192–211, fig. 7.

Material examined. 23 ♀♀

Type material. **Neotype**—here designated, ♀ (70 mm), Marina Beach fish landing centre, Chennai, India (13.0500° N, 80.2824° E, Bay of Bengal) Reg. No. C-7146/2 from *Parastromateus niger* (Bloch), coll. P.T. Aneesh.

Non type material. All from *Parastromateus niger* (Bloch) coll. Aneesh and Helna, 1♀ (66 mm), Bekal fish landing centre (12° 25' 14 N", 75° 1' 23 E″, Malabar Coast) Reg. No C-7162/2; 1♀ (69 mm), Ayyikkara fish landing centre (11^0 51′33″ N, 75^0 22′ 30 E″, Malabar Coast, India) Reg. No C-7163/2; 1♀ (47 mm), Marina Beach fish landing centre (13.0500° N, 80.2824° E, Bay of Bengal) Reg. No C-7164/2.

Description. *Female. Body* (41–79 mm), long and slender; *Cephalon* attached at right angles to neck, anteriorly rounded and somewhat dorso-ventrally flattened and 1.5–1.6 mm longer than wide, with three posterior horns, one median directed backwards and two lateral directed outwards and backwards, all sub-similar and apically rounded. Elongated, tubular neck, gradually enlarging into the trunk, about 3.6–5.4 mm. Anterior neck with indistinct partition on dorsal side, indicating thoracic segments. Abdomen very narrow, 0.27–0.36 mm as the length of neck. Genital part of trunk (8–11 mm) forming a step-like projection from which the egg strings are attached.

Egg string longer than abdomen; eggs uniserriate. *Caudal rami* absent. Number of eggs per string ranged from 110 to 160, dependent on length of the string.

Antennule slender, 3- segmented; all segments with many setae. Article 2 with a cluster of long setae. *Antenna* stouter than antennule, 3- articled, terminal segment chelate, with sharp and strongly curved claw. Oral appendages situated in the proboscis. Proboscis a retractile, chitinous tube, situated at the ventral side of the cephalon, armed with an outer saclike plate and an inner ring like cephalosome bearing a single row of recurved spines. In the upper part of the proboscis a fork like buccal style is present. *Mandibles* within the oral tube. *Maxillules*, small and situated on side of the proboscis, inner lobes with few long setae, outer lobe with one short seta. *Maxillae* 3-articled, third article narrow, as long as second, ventral border of article 2 and 3 denticulated.

Swimming Legs, 4 pairs, located just behind the head, successively decreasing in size from L1–L4. L1 and L2 biramous, 3–4 uniramous. Rami of all legs 2- articled, setose. L1 almost on the head, L2–L4 on the neck.

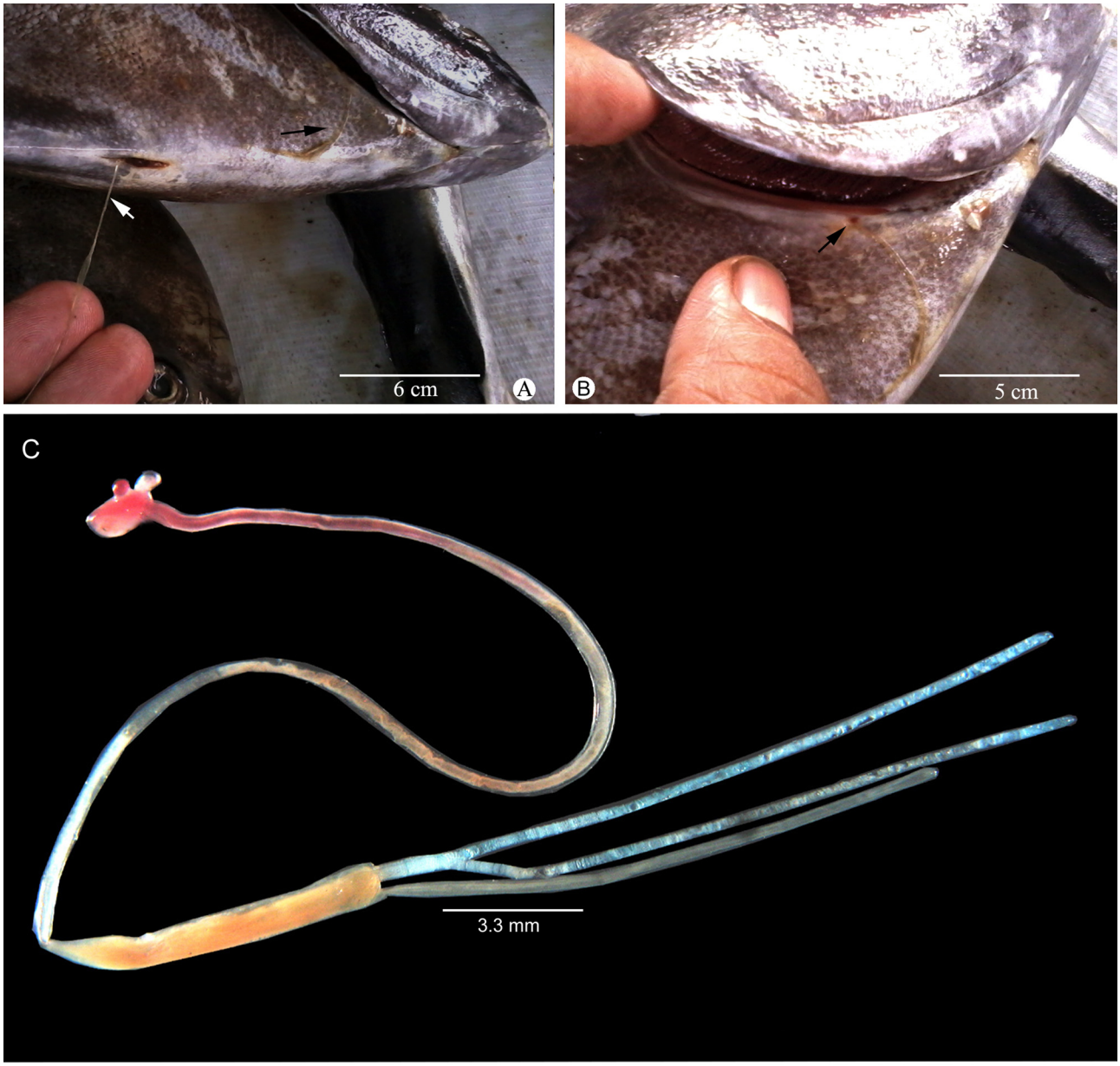

FIGURE 1. *Lernaeenicus stromatei* Gnanamuthu, 1953 ovigerous female ex *Parastromateus niger* (Bloch): **A**–**B.** sites of infestation (arrow); **C.** habitus dorsal.

Size. Ovigerous female: 41–79 mm **(**total length excluding egg strings**)**

Colour. Live specimens are translucent with light red colour anteriorly.

Host. Reported only from *Parastromateus niger* (Bloch) (Gnanamuthu 1953; Pillai 1985; Aneesh 2014; Raja *et al.* 2016)

Distribution. Chennai (type locality) (Gnanamuthu, 1953; present study), Malabar Coast (Aneesh 2014; present study), West Bengal (present study), South east coast (Raja *et al.* 2016).

Remarks. *Lernaeenicus stromatei* is one of ten species of *Lernaeenicus* known from India (Pillai 1985; Raja *et al.* 2016) and is very distinct within the genus. *Lernaeenicus stromatei* can be identified by the following characteristic features: (1) long and slender body; (2) head anteriorly rounded, dorso-ventrally flattened and slightly longer than broad; (3) presence of three posterior horns on the head, one median and two lateral, all sub-similar and apically rounded; and (4) anterior part of neck with indistinct partition on dorsal side, indicating thoracic segments**,** and a three-jointed antennule. *Lernaeenicus stromatei* closely resembles *L. hemirhamphi* Kirtisinghe, 1932, but the head is asymmetrical in *L. stromatei* (Pillai 1985). *Lernaeenicus stromatei* has so far been reported only from black pomfret of the family Carangidae, however, *L. hemirhamphi* is apparently restricted

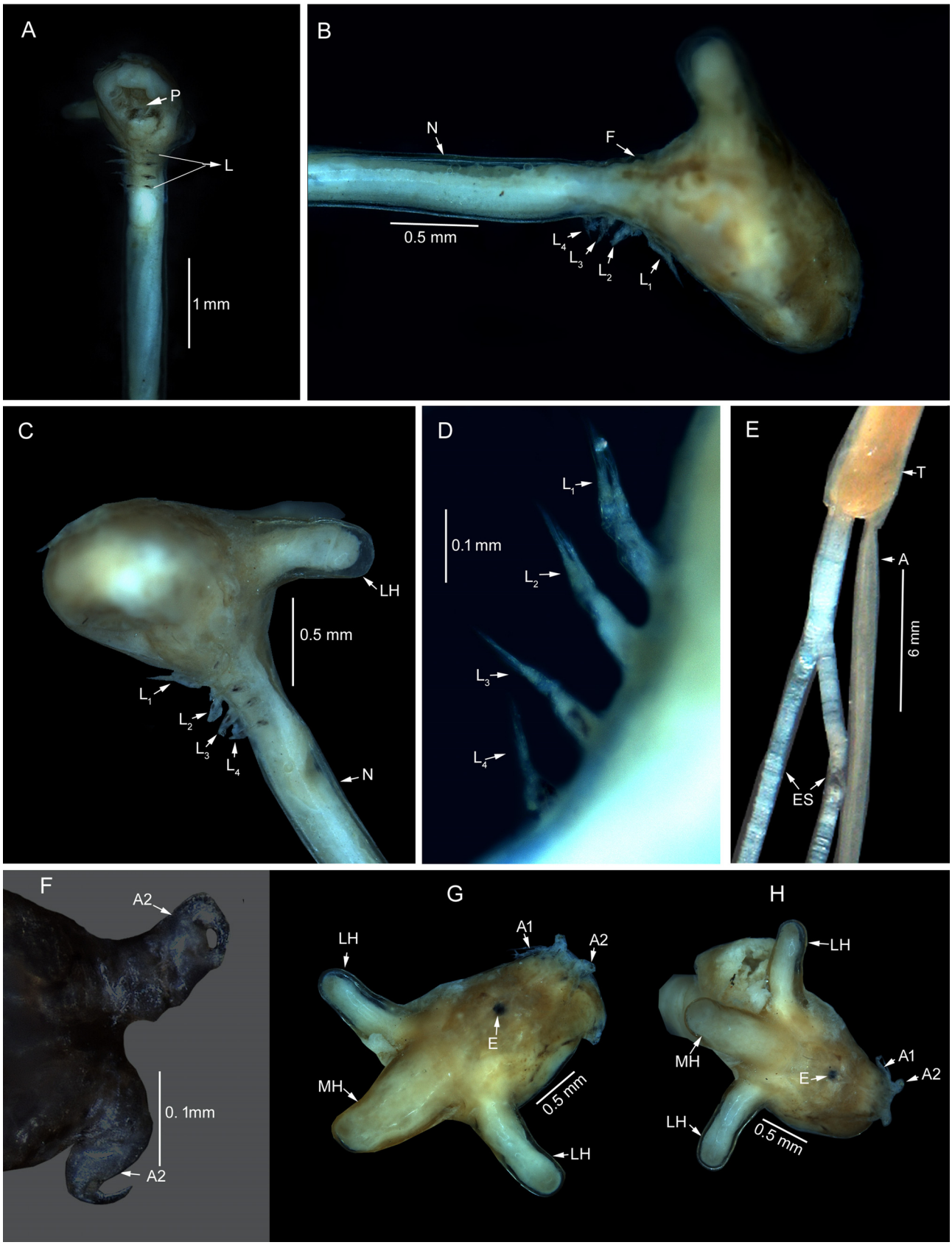

FIGURE 2. *Lernaeenicus stromatei* Gnanamuthu, 1953 ovigerous female ex *Parastromateus niger* (Bloch): **A.** ventral view of head and neck; **B**–**C.** lateral view of head and neck; **D.** neck region showing legs 1–4; **E.** trunk with egg sacs and hind end; **F.** head with antenna; **G**–**H.** head dorsal view. P—proboscis, L_1–L_4—legs 1–4, F—furrows in the dorsal thorax, N—neck, LH—lateral horn, MH—median horn, A—abdomen, T—trunk, ES—egg sacs.

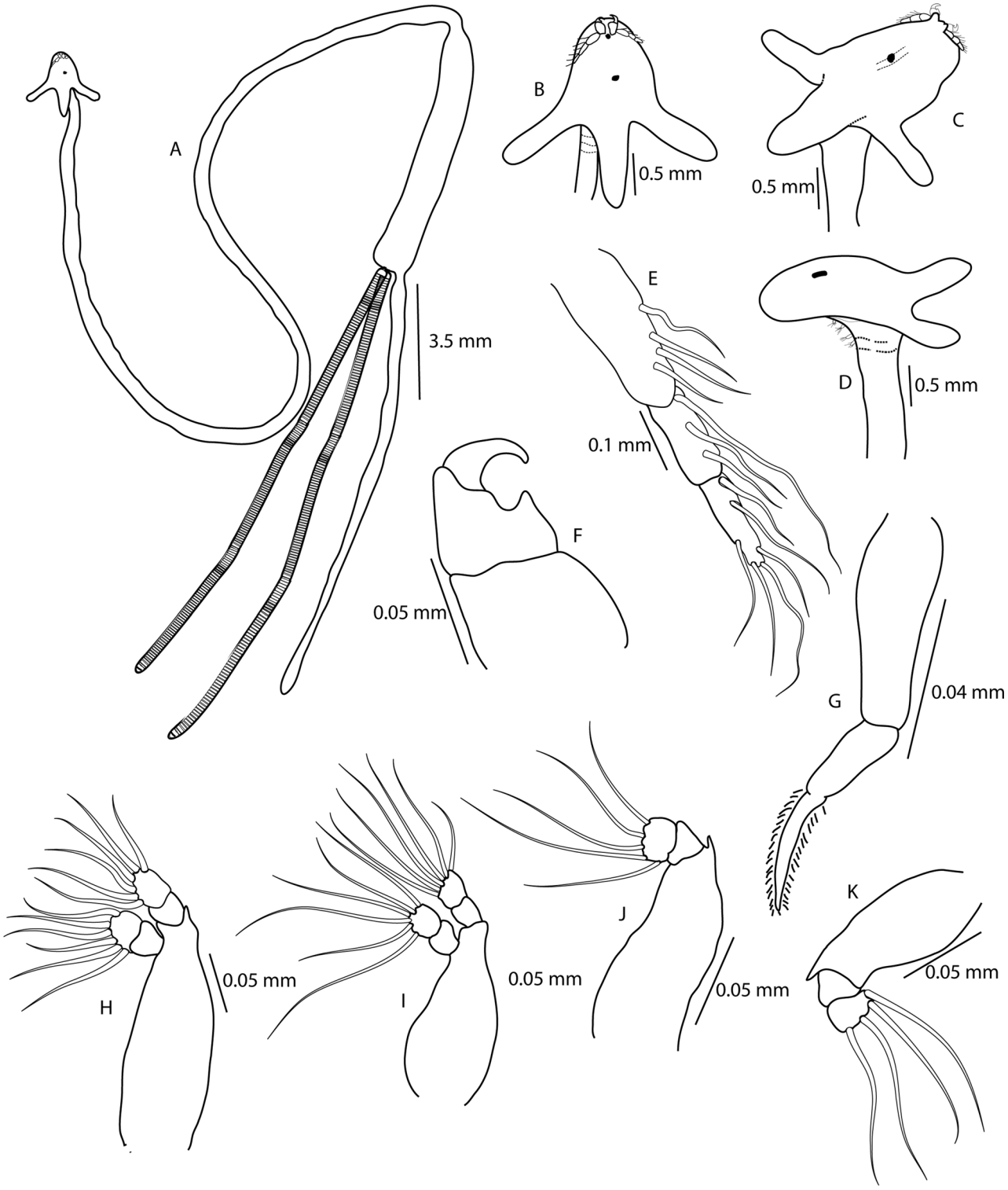

FIGURE 3. *Lernaeenicus stromatei* Gnanamuthu, 1953 ovigerous female ex *Parastromateus niger* (Bloch) Neotype (Reg. No. C-7146/2): **A.** habitus dorsal; **B**–**C**. head dorsal view; **D.** head dorso-lateral view; **E.** antennule; **F.** antenna; **G.** maxilla; **H**–**K.** leg 1–4.

to hosts in the family Hemirhamphidae (Pillai 1985; Aneesh 2014; Raja *et al.* 2016). Till date most of the studies including the present work is based only on morphological data and the molecular analysis (ex: DNA profiling) may show different species distinctness amongst *Lernaeenicus.* Recently Hogans (2018) documented the functional morphology and structural variations among the three species of *Lernaeenicus* infesting the fishes from Atlantic Coast of North America. Akin to that of recent study by Hogans (2018), the functional morphology of the anchoring appendages of *L. stromatei* was influenced by site of attachment and feeding. Except few recent studies (for instance Hogans 2018), most of the species of *Lernaeenicus* need to be clarified with its detailed redescription, since many of them are not adequately documented.

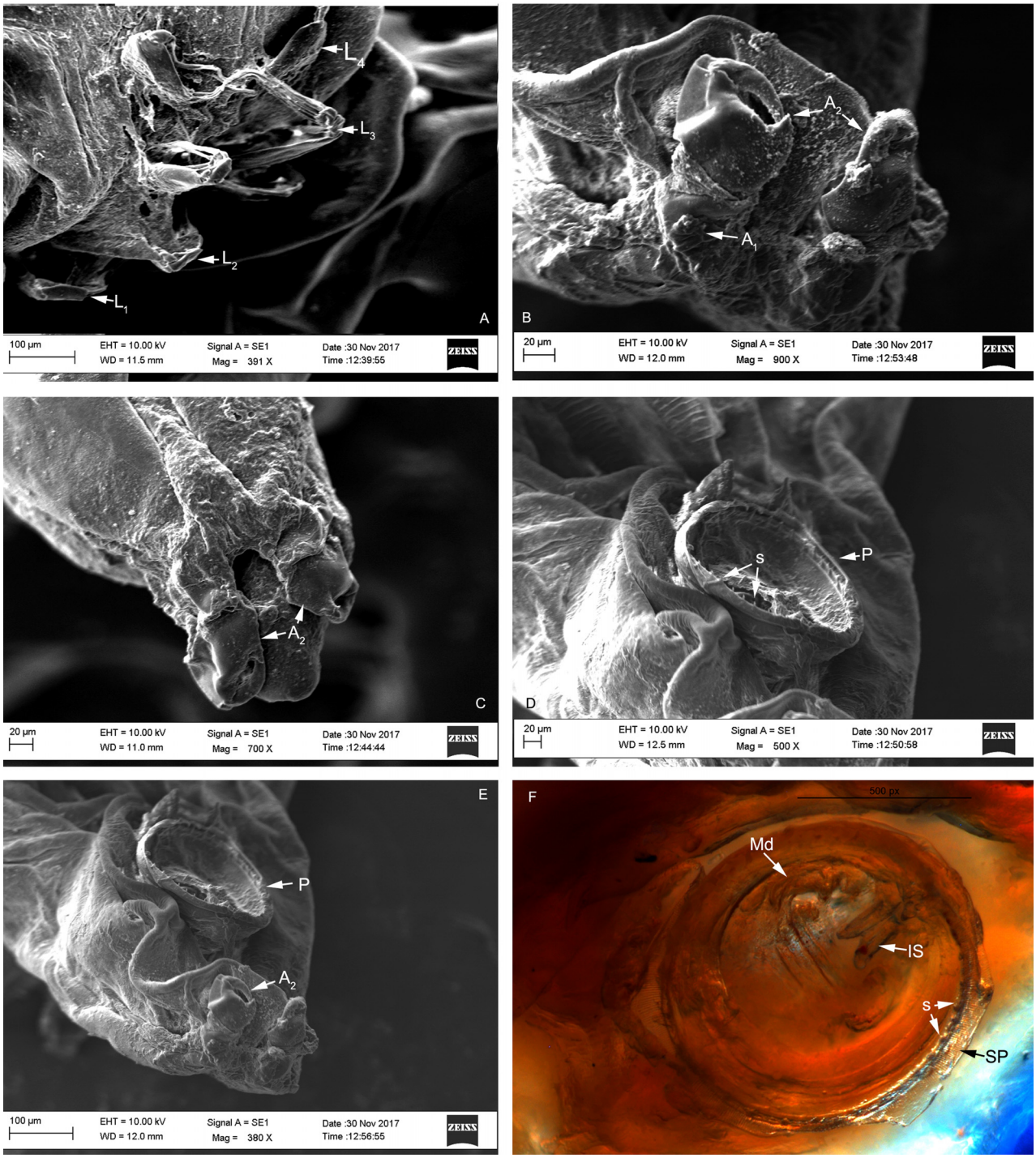

FIGURE 4. Scanning electron micrographs of *Lernaeenicus stromatei* Gnanamuthu, 1953 ovigerous female ex *Parastromateus niger* (Bloch), **A–E: A.** leg 1–4; **B**–C. head dorsal view showing antennule and antenna; **D**–**E.** proboscis; **F.** light microscopic view of proboscis; P—proboscis, L_1–L_4—legs 1–4, A_1—antennule, A_2—antenna, S—spines on ventral surface of cephalosome, Md—mandible, SP—sac like plate, IS—intrabuccal style.

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