Parabrachiella jarai sp. nov. (Crustacea: Copepoda: Siphonostomatoida) parasitic on Sillago sihama (Actinopterygii: Perciformes: Sillaginidae)

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A B S T R A C T

The presently reported study provides a detailed morphological description of the female and the male of a new species of the genus Parabrachiella—Parabrachiella jarai sp. nov. The parasites were sampled from marine fish, silver sillago, Sillago sihama (Perciformes: Sillaginidae), captured in Malaysia in 1994 and Hong Kong in 1995. The new species bears some resemblance to Parabrachiella lata (Song et Chen, 1976) but differs from it in details of second antenna, mandible, and maxilliped.

The genus Parabrachiella currently covers 67 species including those recently transferred from Neobrachiella Kabata, 1979. An amended generic diagnosis is proposed for Parabrachiella and Thysanote. Some members of Parabrachiella are herewith transferred to Thysanote and some Thysanote are now placed in Parabrachiella.

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1. Introduction

Lernaeopodid copepods (Copepoda: Lernaeopodidae) are parasites of predominantly marine fishes, but they also infect freshwater and brackish water species. They are one of the largest families of parasitic copepods (some 250 valid species) and most extensively adapted to parasitism (Kabata, 1986). Lernaeopodids are also very host specific.

Only recently the genus Parabrachiella regained its senior position. Twenty years ago Kabata (1979) established the genus Neobrachiella, to accommodate selected species of the genus Brachiella, as well as species previously assigned to other genera such as Parabrachiella, Probrachiella, Epibrachiella, Branchiellina, Lernaeopoda, and Isobranchia. Boxshall and Halsey (2004) noticed that the name Parabrachiella Wilson, 1915 should have priority over the name Neobrachiella Kabata, 1979. Therefore all of the former Neobrachiella species require a transfer to Parabrachiella.

One of us (CJH) surveyed fish, in the frames of his PhD studies, and collected a number of parasite specimens, including crustaceans. The presently reported study focuses on one of those parasite species, which turned out to be a new species. One of the host fishes studied (Sillago sihama) hosted two species of the genus Parabrachiella. One of them was P. sihama, while the other represented species hitherto unknown to science. The latter species is described below as Parabrachiella jarai sp. nov.

Another, closely related, genus is Thysanote Krøyer, 1863. Females belonging to this genus have distinct fimbriate posterior and maxillary processes (Piasecki et al., 2008). The structure of the male body is the same as in the genus Parabrachiella. Surprisingly, some species without maxillary processes traditionally belonged to Thysanote and vice versa—species with maxillary processes have been assigned to Neobrachiella. The need for preparing a checklist for species of Parabrachiella prompted us to propose the species transfers, between two above-mentioned genera, where necessary.

2. Materials and methods

The parasites were sampled from the operculum of a marine fish, silver sillago, Sillago sihama (Forskål) (Perciformes: Sillaginidae), captured in Malaysia (40 fish) and Hong Kong (38 fish) in 1994 and 1995, respectively. Examination of specimens of related sillaginids occurring in South-East Asia (Sillago parvisquamis, ...
S. soringa, S. aeolus, S. chondropus, and Sillaginopsis panjus) and Middle East (Sillago arabica, S. attenuata) did not reveal those copepods, and nor was the species present on S. sihama sampled from any other localities in South-East Asia, Middle East, eastern Africa, Australia, and islands in the western Pacific Ocean, or on any of a total of 25 other sillaginid species examined. The study material consisted of ovigerous- and non-ovigerous females and males attached to females. The material studied were 10 copepod females and 3 males from Hong Kong and 1 female from Malaysia. The copepods were studied under a compound microscope using a modified “wooden slide” method of Humes and Gooding (1964). Details of all appendages were illustrated and described. The types are deposited in the Museum für Naturkunde in Berlin, Germany.

Terminology of the body parts is consistent with that proposed by Kabata (1979) (with some exceptions). Appendage abbreviations used throughout the text are as follows: first antenna = A1, second antenna = A2, mandible = Mdb, first maxilla = Mx1, second maxilla = Mx2, maxilliped = Mxp.

The siphonostomatoid mandibular dental formula (Siphonostomatoida including Lernaeopodidae) used here was first introduced by Kurtz (1877). Kabata (1979) proposed its Anglicized version which has been widely used ever since. The tip of mandible has a row of denticles on one edge. The anterior section is occupied by larger, primary teeth (P) with distinct interdenticular spaces. Sometimes those spaces feature much smaller, secondary (S) teeth. Posterio denticles are smaller, usually uniform in size and shape (sometimes diminishing posteriorly) and they are called basal teeth (B). The dental formula shows the sequence of those teeth starting from distalmost tooth (e.g., P2, S1, P1, S1, B4). Valid scientific names of host fishes were determined using FishBase (Froese and Pauly, 2009).

3. Results

3.1. Parabrachiella jarai sp. nov. (Figs. 1–22)

FEMALE (Figs. 1–14). Body typically lernaeopodid (Figs. 1–4), consisting of three distinct parts: cephalosome, genital trunk, and maxillary “trunk” (fused Mx2). Cephalosome elongate, 2.11 mm long (1.96–2.25 mm), regularly cylindrical; on fixed specimens flexed dorsally. Genital trunk sub-spherical, or drop-shaped, 2.25 mm long (1.88–2.39 mm), 1.5 mm wide (1.37–1.68 mm); its length slightly exceeding length of cephalosome. Posterior part outfitted with two pairs of digitiform posterior processes, one of which possibly representing caudal rami. Relative length of processes variable, approximating trunk width or even length (Fig. 4). Small but distinct genital process present between posterior processes. Egg sacs multisieriate, twice as long as genital trunk. Maxillary “trunk” relatively short. Appendages (except Mx2) situated at distal end of cephalosome. Anteriormost second antennae followed by first antennae and mouth cone with inserted mandibles and flanked by first maxillae. Second maxillae displaced anteriorly in front of maxillipeds and located closely behind mouth cone.

First antenna (Fig. 5) sub-cylindrical; three-segmented. Basal segment almost as long as two other segments combined, and armed subterminally with single seta (whip). Terminal segment with well developed terminal armature, consisting of three long setae and three tubercles.

Second antenna (Figs. 6 and 7) biramous. Robust, cylindrical sympod unarmed. Bulbous, one-segmented, unarmed exopod distinctly longer and thicker than endopod. Endopod two-segmented with small, almost straight claw 1, aligned with long axis of endopod, small seta 2, seta 5 and prominent denticulate pad 4 (Figs. 6 and 7).

Mandible (Fig. 8) typically siphonostome with 9 teeth. Dental formula: P2, S1, P1, S1, B4.

First maxilla (Fig. 9) biramous with small endopod and prominent tripartite exopod. Endopod composed of short digitiform process surmounted with two setae: small terminal and larger subterminal. Exopod tripartite with two big digitiform processes and short third one. Processes ending with conical elongate setiferous processes.

Second maxillae (Fig. 10) completely fused together and forming “maxillary trunk”. In fixed specimens contracted and wrinkled. Paired openings of maxillary glands visible at base, ventrally. Small, mushroom-shaped bulb partly hidden inside terminal collar (Figs. 3, 4, and 10).

Maxilliped (Figs. 11 and 12) subchelate with robust corpus and long slender subchela. Corpus robust, covered by thick, wrinkled cuticle. On its medial side single process with seta and denticulate, semipedal pad. Subchela sub-cylindrical with single ventral seta. Claw large (constituting almost 1/3 of subchela) with secondary tooth. Large auxiliary seta at base of claw, medially.

Thoracic appendages not observed.

Caudal rami (Figs. 1–4) probably represented by ventral pair of posterior processes. Genital process (Fig. 13) consisting of two conical parts partly fused together with attached spermatophores (Fig. 14) in some females examined.

MALE (Figs. 3 and 15–22) distinctly smaller than female (Fig. 15); representing male structural type A (Kabata, 1979); consisting of two major parts: cephalosome (0.57 mm long) and genital trunk (0.65 mm long). Long axis of genital trunk inclined at almost right angle to long axis of cephalosome. Appendages arranged in undisturbed order: A1, A2, Mdb, Mx1, Mx2, Mxp.

First antenna (Fig. 16) three-segmented. Basal segment longest with small seta (whip). Terminal segment with well developed armature consisting of 4 setae and 1 tubercle.

Second antenna (Fig. 17) biramous, elongate. Sympod cylindrical, unarmed. Bulbous, one-segmented, unarmed exopod distinctly shorter than endopod. Endopod two-segmented with basal segment with denticulate pad. Terminal segment with well developed lernaeopodid armature consisting of big, curved claw 1, big seta 2, tubercle 3 (at base of seta 2), denticulate pad 4, and big seta 5.

Mandible (Fig. 18) typical siphonostome with 9 teeth. Dental formula: P2, S1, P1, S1, B5 (last basal tooth small).

First maxilla (Fig. 19) similar as in female, although more slender. Endopod terminating with 2 equal small setae.

Second maxilla (Fig. 20) subchelate (made of strong thick cuticle) with robust pyriform corpus and strong subchela. Corpus unarmed. Subchela with well delimited, powerful claw, and slightly shorter cylindrical shaft. Subchela closing against large bulbous outgrowth of corpus.

Maxilliped (Fig. 21) subchelate, similar in structure to second maxilla but stronger in appearance. Subchela very robust with claw positioned at right angle to shaft. Closed subchela partly hiding tip of claw behind medial outgrowth of corpus.

Thoracic appendages not observed.

Caudal rami (Fig. 22) partly hidden in depression of cuticle; consisting of paired conical outgrowths with obscure segmentation and no additional setation.

Type host: Sillago sihama (Forsskål).
Site of infection: Inner surface of operculum.
Type locality: Sai Kung, Hong Kong.

Prevalence and intensity: 40 host fish from Sai Kung, Hong Kong. (December 1995) were infected by 10 females (and 3 males attached to them) from; 38 host fish from Cendering, Malaysia (April 1994) yielded 1 parasite female.

Etymology: The specific name of the new species is intended to honour Professor Zbigniew J. Jara (1918–2008)—a renowned Polish
fish pathologist and parasitologist (Lonc, 2004; Olech and Piasecki, 2009).

Deposition of types: Holotype, allotype, and 5 paratypes have been deposited in the Museum für Naturkunde in Berlin (ZMB 27689) (all type specimens under a single number).

4. Discussion

The morphology of the presently described new species bears the closest resemblance (in overall appearance) to P. lata (Song et Chen, 1976). The differences, however, in the structure of append-
ages of both males and females are distinct and explicit (Song and Chen, 1976; Roubal, 1981; Ho et al., 2007) and they cover: (1) shape of “torso” (base of Mx2) (plain in *P. jarai* female vs. distinct lateral lobes/inflations in *P. lata*); (2) unarmed A2 exopod in *P. jarai* female (vs. denticulate area in *P. lata*); (3) different dental formulas of female Mdb (P2, S1, P1, S1, B4 in *P. jarai* vs. P1, S1, P1, S1, B5 in *P. lata*); (4) single denticulate pad on medial side of Mxp corpus of female in *P. jarai* (vs. two denticulate pads in *P. lata*); (5) unarmed exopod of male A2 in *P. jarai* (vs. two spiniform setae and denticulate pad in *P. lata*); (6) different dental formulas of male Mdb (P2, S1, P1, S1, B5 in *P. jarai* vs. P4, S1, B5 in *P. lata*). Moreover, *P. lata* was found on “*Sparus latus*” = *Acanthopagrus latus* (Houttuyn, 1782) (family Sparidae), while *P. jarai* parasitized *Sillago sihama* (family Sillaginidae).

*Parabrachiella jarai* n. sp. is very host specific. Of 26 sillaginid species examined by one of the authors (CJH) throughout the Indo-West Pacific, ranging from East Africa to Australia, New Caledonia and Japan, it parasitized only one: *Sillago sihama*, and was only found at two locations that this species was examined, both in South-East Asia.

The presently described new species has been assigned to Group 2. This group is the largest, consisting of 35 members (including the new species): *P. albida*, *P. anisotremi*, *P. auriculata*, *P. bera*, *P. brevicapita*, *P. chavesii*, *P. dentici*, *P. dispar*, *P. elegans*, *P. fasciata*, *P. gracilis*, *P. gulosa*, *P. hoi*, *P. hostilis*, *P. indica*, *P. insidiosa*, *P. jarai* sp. nov., *P. johnii*, *P. lutani*, *P. menticirrhi*, *P. merlucci*, *P. multifimbriata*, *P. oralis*, *P. otolithi*, *P. paralichthyos*, *P. regia*, *P. richiardii*, *P. rotunda*, *P. sciaenae*, *P. seriolae*, *P. sihama*, *P. trichiuri*, and *P. yongxingensis*.

The identity of a number of *Parabrachiella* species should be reconsidered. Some specimens used for redescriptions, especially those found on different hosts should be re-examined. Among them are “*Neobrachiella pillai* Kabata et Tareen, 1987” (=*Parabrachiella lutiani* Tripathi, 1962), the “short form” of “*Neobrachiella rostrata*” found by Rubec (1988) on Greenland halibut, *Reinhardtius hippoglossoides*, and the long-armed form of *P. annulata* (Markewitsch, 1940) sensu Ho (1975).

*P. chevreuxii* (van Beneden, 1891), described from an unconfirmed and unlikely host (“*Squalus sp.*”) is certainly not a species described from sciaenid fishes by Brian (1906) and Kabata (1966, 1979). It has differing structure and body proportions. The sciaenid
parasite should be referred to as *P. sciaenae* (Brian, 1906) comb. nov.

"Neobrachiella sp.", described by Piasecki (1993) from a California halibut, *Paralichthys californicus*, from southern California, probably represents an unknown species. New specimens are needed, however, to describe missing details of its morphology.

As mentioned earlier, some representatives of the genus *Thysanozoon* bear a close resemblance to those of the genus *Parabrachiella*.
Table 1

List of all valid species of *Parabachiella* with their principal data (host data for original record only).

<table>
<thead>
<tr>
<th>Valid name</th>
<th>Original name</th>
<th>Type host</th>
<th>Host family</th>
<th>Type locality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>P. albida</em> (Rangnekar, 1956)</td>
<td>Charopinus albidus</td>
<td>&quot;Pseudosciema albida&quot; = <em>Daysciaena albida</em> (Cuvier, 1830)</td>
<td>Sciænidae</td>
<td>Indian Ocean, Bombay</td>
</tr>
<tr>
<td>3. <em>P. anisostemni</em> (Castro Romero et Baeza Kuroki, 1985)</td>
<td>Brachiella anisostemni</td>
<td>Anisotremus scapularis (Tschudi, 1846)</td>
<td>Haemulidae</td>
<td>Pacific S., Chile, Antofagasta</td>
</tr>
<tr>
<td>4. <em>P. annulata</em> (Markewitsch, 1940)</td>
<td>Brachiella annulata</td>
<td>Ereunias grallator Jordan et Snyder, 1901</td>
<td>Ereunidiidae</td>
<td>Pacific N., Japan, Misaki</td>
</tr>
<tr>
<td>5. <em>P. annulata</em> (Wilson, 1908)</td>
<td>Brachiella annulata</td>
<td>&quot;Sebastodes glaucus&quot; = <em>Sebastes glaucus</em> Hilgendorf, 1880</td>
<td>Sebastidae</td>
<td>Pacific N., off Bering Island</td>
</tr>
<tr>
<td>7. <em>P. bera</em> (Yamaguti, 1939)</td>
<td>Brachiella bera</td>
<td>&quot;Halichoeres paeoletrepus&quot; = <em>Paragilos paeoletrepus</em> (Tennmink et Schlegel, 1845)</td>
<td>Labridae</td>
<td>Pacific N., Japan, Tokara Island</td>
</tr>
<tr>
<td>8. <em>P. bispinosa</em> (von Nordmann, 1832)</td>
<td>Neobrachiella bispinosa</td>
<td>&quot;Gads sp.&quot; (misidentification possible)</td>
<td>Triglidae</td>
<td>Atlantic N. ???</td>
</tr>
<tr>
<td>17. <em>P. elegans</em> (Richardi, 1880)</td>
<td>Brachiella elegans</td>
<td>Lichia amia, L. gauca, Seriola lalandi</td>
<td>Carangidæ</td>
<td>Atlantic N., Mediterranean Sea</td>
</tr>
<tr>
<td>18. <em>P. exigua</em> (Brian, 1906)</td>
<td>Brachiella exigua</td>
<td>Pagellus erythrinus (L.)</td>
<td>Sparidæ</td>
<td>Atlantic N., Mediterranean Sea, off Napoli</td>
</tr>
<tr>
<td>21. <em>P. genypiteri</em> (Capart, 1959)</td>
<td>Brachiella genypiteri</td>
<td>Genypeterus caeni (Smith, 1847)</td>
<td>Ophidiidæ</td>
<td>Atlantic S., Namibia, Fort Rock Point</td>
</tr>
<tr>
<td>23. <em>P. gula</em> (Wilson, 1915)</td>
<td>Brachiella gula</td>
<td><em>Sciænops ocellatus</em> (Linnaeus, 1766)</td>
<td>Sciænidae</td>
<td>Atlantic N., USA East coast</td>
</tr>
<tr>
<td>24. <em>P. gymnobrachiata</em> (Kabata, 1968)</td>
<td>Neobrachiella gymnobrachiata</td>
<td>Epinephelus merra Bloch, 1793</td>
<td>Serranidæ</td>
<td>Pacific S., Australia, Heron Island</td>
</tr>
<tr>
<td>25. <em>P. ho</em> (Piasceki, 1993)</td>
<td>Neobrachiella ho</td>
<td>Chiara taylori (Garard, 1858)</td>
<td>Ophidiidæ</td>
<td>Pacific N., California S.</td>
</tr>
<tr>
<td>27. <em>P. hostiliis</em> (Heller, 1868)</td>
<td>Anchorella hostiliis</td>
<td>Umbrina cirrosa (L.)</td>
<td>Sciænidae</td>
<td>Atlantic N., Mediterranean Sea</td>
</tr>
<tr>
<td>31. <em>P. insidiosa</em> (Heller, 1868)</td>
<td>Brachiella insidiosa</td>
<td>&quot;Gads sp.&quot;</td>
<td>Gadidæ</td>
<td>Atlantic N., Mediterranean Sea, Adriatic</td>
</tr>
<tr>
<td>32. <em>P. intermedius</em> (Bere, 1936)</td>
<td>Brachiella intermedius</td>
<td>Sciænops ocellatus (Linnaeus, 1766)</td>
<td>Sciænidae</td>
<td>Atlantic N., Gulf of Mexico</td>
</tr>
<tr>
<td>33. <em>P. jarai</em> sp. nov.</td>
<td>Brachiella jarai</td>
<td>Silago sthama (Forsskal, 1775)</td>
<td>Sillaginidæ</td>
<td>Pacific N., Hong Kong</td>
</tr>
<tr>
<td>34. <em>P. johnii</em> (Yamaguti, 1939)</td>
<td>Clavellopsis johnii</td>
<td>&quot;Johnius goma&quot; = <em>Protonibea diaconitus</em> (Lacepède, 1802)</td>
<td>Sciænidae</td>
<td>Pacific N., East China Sea</td>
</tr>
<tr>
<td>35. <em>P. katabai</em> (Luque et Farfan, 1991)</td>
<td>Neobrachiella katabai</td>
<td>Isacia conceptionis (Cuvier, 1830)</td>
<td>Haemulidæ</td>
<td>Pacific S., Peru, Chorrillos</td>
</tr>
<tr>
<td>36. <em>P. lata</em> (Song et Chen, 1976)</td>
<td>Neobrachiella lata</td>
<td>&quot;Sparus latus&quot; = <em>Acanthopagrus latus</em> (Houttuyn, 1782)</td>
<td>Sparidæ</td>
<td>Pacific N., China, Hainan Dao, Sanya</td>
</tr>
<tr>
<td>37. <em>P. lutianii</em> (Pillai, 1968)</td>
<td>Brachiella indica</td>
<td>&quot;Lutianus sp.&quot; = <em>Lutianus sp.</em></td>
<td>Lutjanidæ</td>
<td>Indian Ocean, India</td>
</tr>
<tr>
<td>38. <em>P. menticirrhi</em> (Luque et Farfan, 1990)</td>
<td>Brachiella menticirrhi</td>
<td>Menticirrhus hippocrepaleus (Jenyns, 1840)</td>
<td>Sciænidae</td>
<td>Pacific S., Peru, Chorrillos</td>
</tr>
<tr>
<td>40. <em>P. microdigitata</em> (Kabata, 1992)</td>
<td>Neobrachiella microdigitata</td>
<td>&quot;Helicolenus papillosus&quot; = <em>Scorpaena papillosa</em> (Schneider et Forster, 1801)</td>
<td>Scorpaenidæ</td>
<td>Pacific S., Australia, New South Wales</td>
</tr>
</tbody>
</table>
Thysanote retaining impractical. According to those authors the principal reason for the diagnosis of the genus Thysanote is the pattern of mandibular denticulation, once or twice. Many descriptions contain inadequate (or non-reliable) data on the mandible. Consequently, if the mandibular criterion is preserved, the status of many species will remain unresolved. We propose, herewith, to disregard the mandibular criterion, not being caudal rami, are not present at the last moult.

The males in both genera look alike. We believe that the existing species to the genus Thysanote as Thysanote papillosa (Pearse, 1952) comb. nov. Consequently, also Neobrachiella impudica (von Nordmann, 1832) should become Thysanote papillosa (von Nordmann, 1832) comb. nov.

Many researchers referring to the posterior processes of Parabrachiella tend to treat one of the pairs as caudal rami (“uropods”). Such reasoning may not always be reliable. According to Ho et al. (2007), who first studied a complete life cycle of a Parabrachiella, the posterior processes, not being caudal rami, are not present at any of the chalimus stages and they are apparently formed after the last moult.

Copepods of the genus Parabrachiella seem to be highly host specific, infecting single fish species (or only a few closely related hosts). They have been recorded from various teleost fishes, representing an extensive set of the families. The most frequently infected family is the Sciaenidae, hosting as many as 16 species, followed by Sparidae with 3 species. Three Parabrachiella species have been found in representatives of Moridae, Ophidiidae, and Triglidae. Two species have been recorded in Carangidae, Haemulidae, Kyphosidae, Macrouridae, Labridae, Sebastidae, Serranidae,
Sillaginidae, Tetraodontidae, whereas a number of families (such as Acropomatidae, Congiopodidae, Ereunidae, Gadidae, Hoplichthysidae, Lampridae, Lethrinidae, Lutjanidae, Malacanthidae, Merlucciiidae, Mugilidae, Oplegnathidae, Paralichthyidae, Paraulopidae, Pleuronectidae, Psychrolutidae, Scorpaenidae, and Trichiuridae) have been associated with a single Parabrachiella species. Parabrachiella seems to be parasites of exclusively teleost fishes, and the finding of “Brachiella chavesii” by van Beneden (1891) on a “Ceratopterus sp.” = Manta birostris (Walbaum) (Elasmobranchii: Rajiformes: Myliobatidae) seems to be an error. Similarly, P. chievreuxi (van Beneden, 1891) was allegedly found on a “Squalus sp.”, which is also doubtful.

The narrow host specificity of Parabrachiella species seems to be their important characteristic feature. Therefore, cases of finding (allegedly) the same species of copepod from fishes representing different families must be treated with caution (Kempter et al., 2006). For example: Markewitsch (1940) described P. annulata from the skin of a fish representing family Ereunidae, while Kabata and Gusev (1966), Noble (1973), and Ho (1975) recorded it from fishes representing family Macrouridae. Also P. exilis (Shiino, 1956) was originally described from Kyphosus vaigiensis (Kyphosidae) but Castro Romero and Baeza Kuroki (1986) re-described it from Mugil cephalus (Mugilidae).

The majority of Parabrachiella species were found in the Pacific Ocean (37 species: 22 in North Pacific and 15 in South Pacific). Some 23 species come from the Atlantic (18 form the North and 5 from the South), while the Indian Ocean is the type locality for only 7 species.

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References


