DOI: 10.1515/ap-2018-0043

Acta Parasitologica, 2018, 63(2), 375–385; ISSN 1230-2821

DE GRUYTER

A new species of *Chondracanthus* (Cyclopoida: Chondracanthidae) parasitic on deep-sea *Dibranchus spongiosa* (Lophiiformes: Ogcocephalidae) from the Eastern Central Pacific

Samuel Gómez[1], Hugo Aguirre-Villaseñor[2] and Francisco Neptali Morales-Serna[3]

[1]Universidad Nacional Autónoma de México, Instituto de Ciencias del Mar y Limnología, Unidad Académica Mazatlán, Sinaloa, México;
[2]Instituto Nacional de Pesca y Acuacultura. Centro Regional de Investigación Pesquera, Mazatlán, Sinaloa, México;
[3]CONACyT, Centro de Investigación en Alimentación y Desarrollo, A.C. Unidad Mazatlán en Acuicultura y Manejo Ambiental, Mazatlán, Sinaloa, México

Abstract

A total of 228 sampling stations were visited for benthic fauna during a series of oceanographic cruises in the Gulf of California, west coast of the Baja California Peninsula, and Eastern Central Pacific from year 1991 to 2014. Among others, three fish species of the genus *Dibranchus* were caught in 28 stations. Of these, *D. spongiosa* was the most common and abundant. Close inspection of this fish revealed the presence of a new species of parasitic copepod, *Chondracanthus dibranchi* sp. nov., found in the gill cavity of seven specimens of *D. spongiosa*. *Chondracanthus dibranchi* sp. nov. seems to be morphologically related to *C. psetti* and *C. janebennettae*. The female of *C. janebennettae* can be separated from these other two congeners by the general shape of the head and abdomen, by the number of teeth on the mandibular blade, and by the general body shape. *Chondracanthus psetti* and *C. dibranchi* sp. nov. share the relative lengths of legs 1 and 2, the relative size and shape of the genito-abdomen, and the conical attenuating lateral processes on the trunk of the female. The females of these two species can be separated by the shape and armature of the antennule, shape of the antenna, the claw of the maxilliped, the rami of leg 1 and 2 and posterior processes, the head region, and by the position of the lateral processes of the trunk. An amendment to Tang's (2007) key to the species of *Chondracanthus* is proposed.

Keywords

Copepoda, Cyclopoida, *Chondracanthus*, parasite, taxonomy, Mexico, batfish, deep sea

Introduction

There are approximately 30 families of copepods with parasitic species using fishes as hosts (Boxshall 2005). Of those, the Sphyriidae, the Lernaeopodidae and Chondracanthidae are the most common families on deep-sea demersal fishes (Boxshall 1998). Chondracanthidae currently consists of 51 valid genera, of which *Acanthochondria* Oakley, 1930 is the largest genus with 50 valid species, followed by *Chondracanthus* Delaroche, 1811 with 39 valid species (Walter and Boxshall 2017). The chondracanthid fauna on fishes from Mexico is poorly known, only two species, *Acanthochondria galerita* (Rathbun, 1886) and *Pseudochondracanthus diceraus* Wilson C. B., 1908, have so far been reported on coastal fishes (Causey 1960, Morales-Serna *et al*. 2011, 2012), and nothing is known about this fauna on deep-sea fishes from the Mexican Pacific and Gulf of California.

Fourteen oceanographic cruises were carried out off the west coast of the Baja California Peninsula, Gulf of California and Eastern Central Pacific from August 1991 to May 2014 aiming to improve the knowledge of the diversity of deep-sea fauna including deep-sea macro- and meiofauna, and fishes. Among the latter, specimens of the batfish, *Dibranchus* Peters, 1876 (Lophiiformes: Ogcocephalidae) were caught in 28 stations (see also Cruz-Acevedo *et al*., 2017). Like most of ogcocephalids members, the genus *Dibranchus* are bottom fishes with large, strongly depressed heads reminiscent of skates (Bradbury 1999). Present in the Atlantic, Pacific

*Corresponding author: samuelgomez@ola.icmyl.unam.mx

and Indian oceans, *Dibranchus* occurs in tropical and subtropical latitudes in depths from 200 to over 2200 meters. Four species of *Dibranchus* have been reported in the Mexican Pacific Ocean, *D. hystrix* Garman, 1899, *D. nudivomer* (Garman, 1899), *D. spinosus* (Garman, 1899), and *D. spongiosa* (Gilbert, 1890) (Castro-Aguirre and Moncayo-Lopes 1976, Bradbury 1999, Cruz-Acevedo *et al*., 2017). *Dibranchus spongiosa* can be separated from *D. nudivomer* and *D. spinosus* by the absence of teeth on palate, and from *D. hystrix* by differences in tubercle spines which are shorter in *D. spongiosa* than in *D. hystrix* (Bradbury 1999).

The fish gathered during the oceanographic cruises were identified as *D. hystrix*, *D. spongiosa* and *D. spinosus*. External examination of the fish revealed seven specimens of a parasitic copepod of the family Chondracanthidae in the gill cavity of seven individuals of *D. spongiosa* collected at five stations. The chondracanthids recovered belong to a new species of *Chondracanthus*, *C. dibranchi* sp. nov., whose description is given. Also, some amendments to Tang's *et al*. (2007) key to the species of *Chondracanthus* are proposed to include *C. hoi* Braicovich, Lanfranchi, Incorvaia et Timi, 2013, and the new species proposed herein.

Materials and Methods

Specimens of the genus *Dibranchus* were collected at 28 stations visited during 11 out of 14 Talud cruises throughout the Eastern Central Pacific (Figs. 1A, B). The material was collected at depths from 479 to 1,626 m with an epibenthic sledge (2.35 m wide, 0.90 m high) equipped with a collecting net of about 5.5 cm stretched mesh size. Each trawl lasted about 30 min at a speed of 2 knots. Sampling depth was estimated with an analogue Edo Western echo sounder. Temperature and dissolved oxygen concentrations (see Table I) were measured approximately 10 m above the bottom with a Seabird 19 CTD (Sea Bird Scientific, Bellevue, Washington, USA). Specimens were fixed with a 4% formaldehyde seawater solution for at least one week, washed with tap water and preserved in 70% ethanol. Fishes were identified using Bradbury's (1999) key.

A total of 178 fish were examined for parasites, of which 6, 21 and 151 specimens belonged to *D. hystrix*, *D. spinosus*, and *D. spongiosa*, respectively. Seven parasitic copepods were removed from the gill openings of seven specimens of *D. spongiosa* found at five stations visited during Talud V, IX, XII, and XV cruises (Fig. 1, Table I).

Both the copepods and their fish hosts, were fixed with a 4% formaldehyde–seawater solution for at least 1 week, washed with tap water and preserved in 70% ethanol until further inspection. Observations of the copepods were made from whole and dissected animals previously cleared in lactophenol. Dissected parts were mounted with lactophenol as mounting medium, and slides were sealed using nail varnish. Measurements were made using an ocular micrometer and drawings were made using a Leica DMLB microscope equipped with a drawing tube.

The term "oligoseriate" is used here to refer in general to the tri-, bi-, or uniseriate, elongated egg sacs with comparatively fewer eggs than in the multiseriate, sausage-shaped or cylindrical egg sacs of most species of *Chondracanthus*.

The type material and its host were deposited in the Copepoda Collection of the Instituto de Ciencias del Mar y Limnología at Mazatlán, Sinaloa, Mexico (ICML-EMUCOP).

The terms prevalence and mean intensity of the infection follow Bush *et al*. (1997).

Results

Family Chondracanthidae Milne Edwards, 1840
Genus *Chondracanthus* Delaroche, 1811
Chondracanthus dibranchi sp. nov. Figs. 2–11

Diagnosis (based on one ovigerous female)

Female: Body (Figs. 2A, B, 3A, B, D-F) divided into head, short neck and trunk. Total body length measured from anterior margin of head to distal end of posterior processes on trunk, ranging from 5.3 mm (holotype) to 3.6 mm (mean = 4.5 mm; n = 6). Head composed of cephalosome only, well-demarcated from first pedigerous somite, broader posteriorly,

Table I. Basic information of sampling stations where specimens of *Chondracanthus dibranchi* sp. nov. were found on *Dibranchus spongiosa* in the west coast of the Baja California Peninsula, Gulf of California and Eastern Central Pacific. Starting position of trawls: Latitude (Lat N) and Longitude (Long W). Bottom conditions: Dissolved oxygen concentration [O2] and Temperature (T °C). Occurring area (OA): Gulf of California (GC); west coast of the Baja California Peninsula (BC); Mexican Central Pacific (MCP). Examined fish per station: total (NT) and infected fish (NI)

Talud Cruise	Date	St	Lat N	Long W	[O2] (ml/l)	Depth (m)	T °C	OA	NT	NI
V	13/Dec/2000	3	21°59′14″	106°28′30″	0.13	730	5.5	GC	6	1
IX	13/Nov/2005	17	25°19′54″	110°47′42″	0.03	736	5.8	GC	1	1
XII	01/Apr/2008	23	18°33′43″	103°57′45″	0.22	1073	4.4	MCP	15	2
XV	05/Aug/2012	5D	23°17′28″	110°22′00″	0.08	677	6.2	BC	80	2
XV	02/Aug/2012	20	26°32′35″	113°50′20″	0.15	479	8.4	BC	4	1

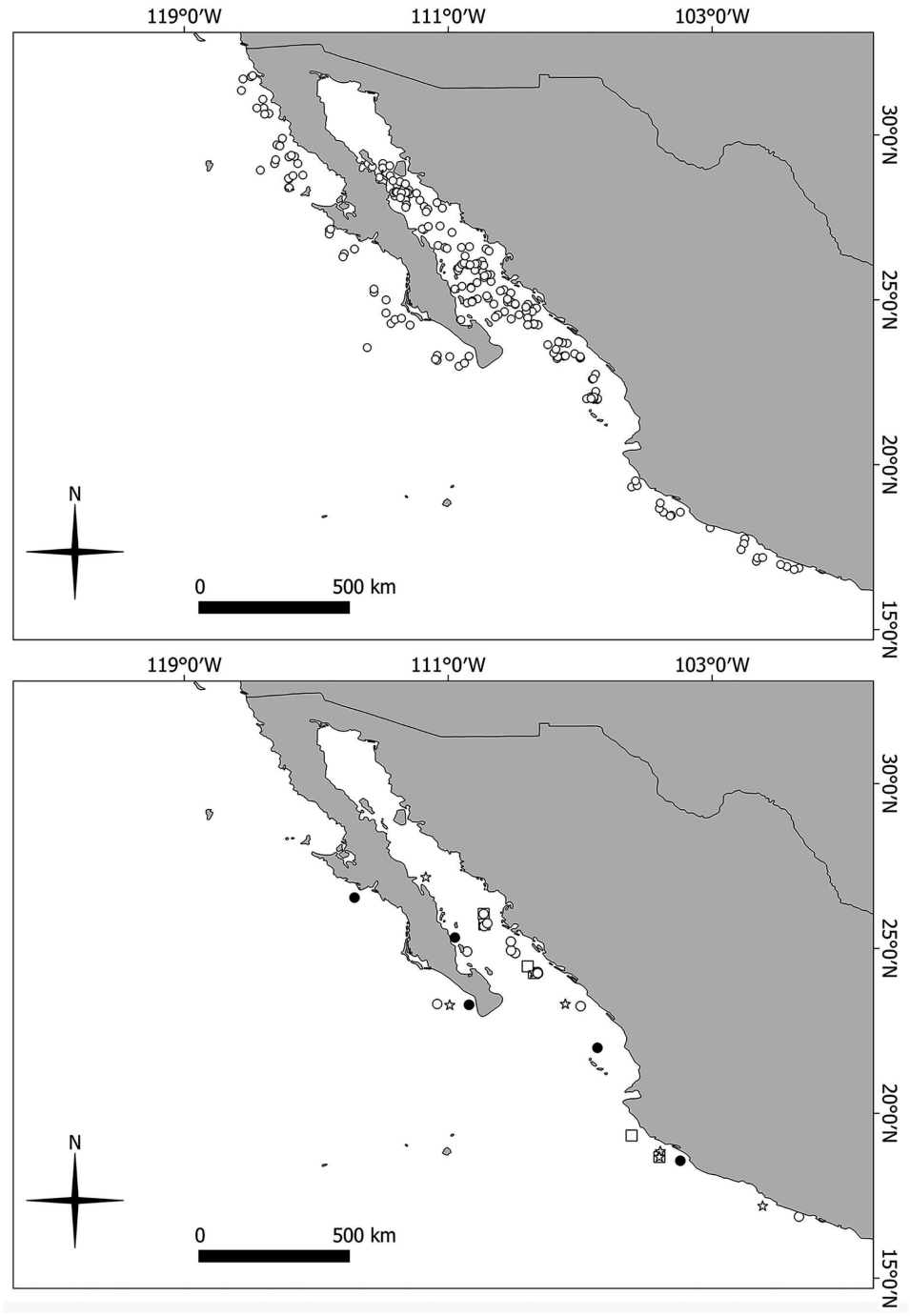

Fig. 1. A – sampling stations visited during Talud III-XII, and XIV-XVIB; **B** – sampling stations where specimens of *Dibranchus spongiosa* (circles), *D. spinosus* (star), and *D. hystrix* (square) were caught, and where *Chondracanthus dibranchi* sp. nov. was found (black circles). Map courtesy of Edgar Cruz Acevedo

nearly twice as wide as long. Neck region composed of first pediger only, without dorsal outgrowths. Trunk composed of fused pedigerous somites 2, 3 and 4, with 1 pair of conical lateral outgrowths, and 1 pair of elongate posterior processes nearly as long as leg 2 from dorsal view. Genito-abdomen (Figs. 2A, B, 4A, B) clearly divisible as 2 tagmata; anterior tagma broadened posteriorly, noticeably wider than posterior tagma, without sensilla; posterior tagma suboval, with 2 dorsal sensilla medially, with small patches of minute spinules dorsally (Fig. 4A), and continuous transverse patch of minute spinules ventrally (Fig. 4B), with posteroventral pair of caudal rami. Caudal rami (Figs. 4A-C) elongate, spiniform, about 4 times as long as wide, with minute spinules in proximal half ventrally, and distally; with 1 dorsal (Fig. 4A), and 2 ventral

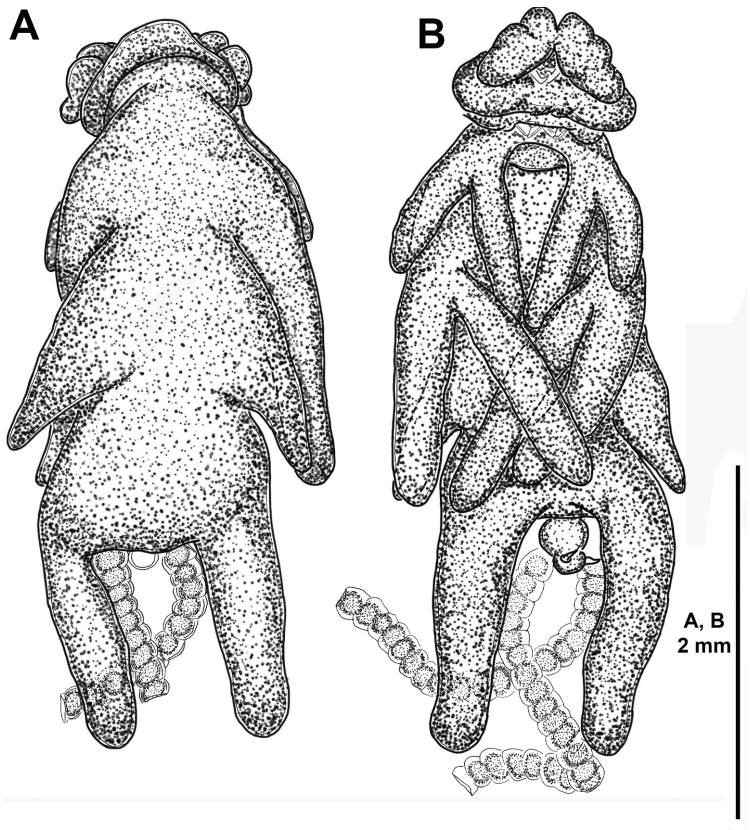

Fig. 2. *Chondracanthus dibranchi* sp. nov. Female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – habitus, dorsal view; **B** – habitus, ventral view

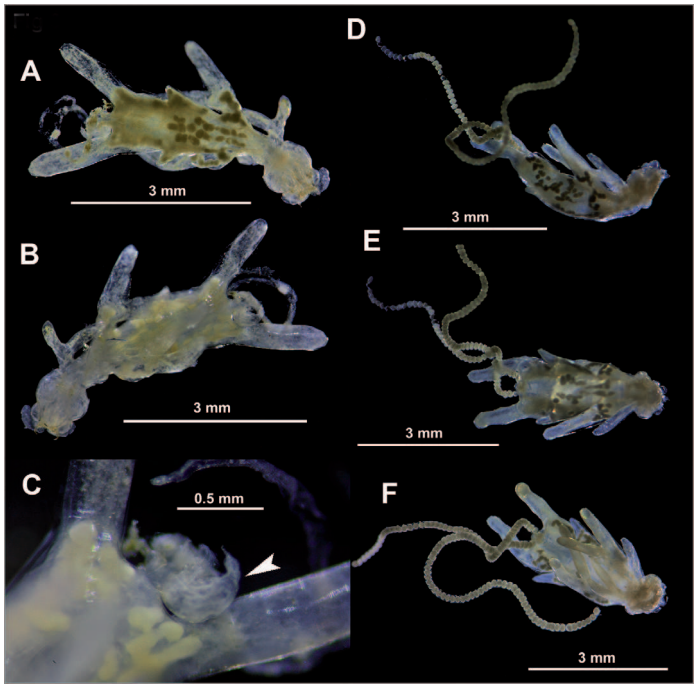

Fig. 3. *Chondracanthus dibranchi* sp. nov. Microphotographs, **A-C** – female holotype with attached male allotype (ICML-EMUCOP-050812-03); **D-F** – female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – female holotype, habitus, dorsal view; **B** – female holotype, habitus, ventral view; **C** – male allotype attached to female holotype, ventral view; **D** – female paratype, habitus, lateral view; **E** – female paratype, habitus, dorsal view; **F** – female paratype, habitus ventral view

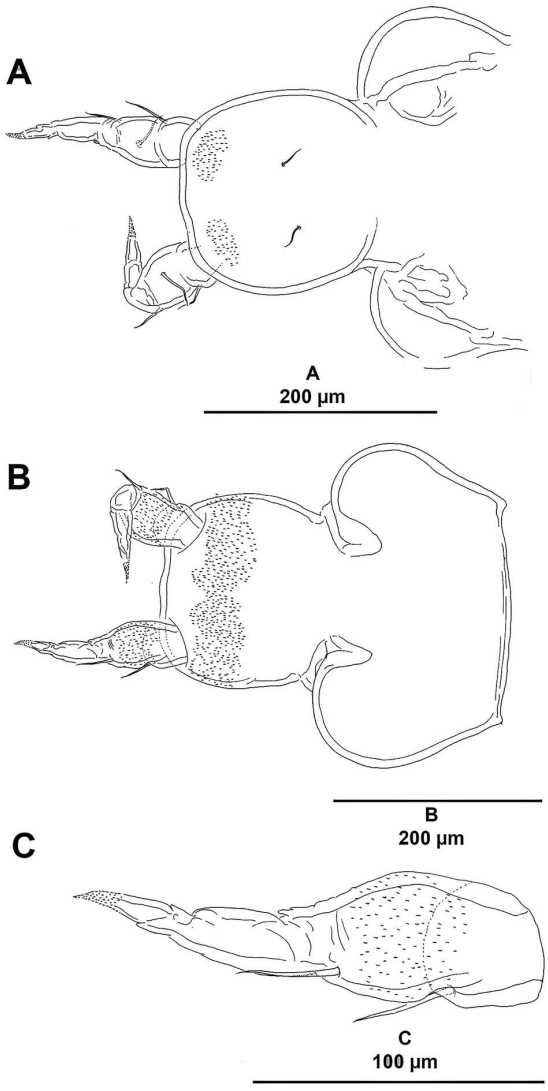

Fig. 4. *Chondracanthus dibranchi* sp. nov. Female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – genito-abdomen, dorsal view; **B** – genito-abdomen, ventral view; **C** – left caudal ramus, ventral view

setae (Figs. 4B, C). With paired oligoseriate egg sacs, longer than total body length.

Antennule (Fig. 5A, B) small, suboval. Armature formula, 1-1-3-8-.

Antenna (Fig. 6A) two-segmented; distal segment elongate, recurved distally.

Mandible (Fig. 6B) one-segmented; apical falcate blade with longitudinal row of teeth along convex and concave margins.

Maxillule (Fig. 6C) lobate, with subapical patch of spinules, and 2 unequal elements.

Maxilla (Fig. 6D) comprised of syncoxa and basis; the former robust, unarmed; the latter drawn out into claw-like process, with 2 unequal setae, and with longitudinal row of teeth.

Maxilliped (Fig. 6E) with syncoxa seemingly naked, longer than following segments combined. Basis stout, with spinular patches as figured. Endopod drawn-out into strong claw; claw conical, short, stout with 1 accessory tooth.

Leg 1 (Figs. 2B, 3B, F, 7A, B) fleshy, with outer protopodal seta (the latter indicated with an asterisk and shown in insert in Fig. 7A). Outer (exopodal) and inner (endopodal) lobes elongate, slender, cylindrical. Exopodal lobe visibly shorter than endopodal lobe (Figs. 2B, 3B, F), with minute spinules on distal part, with 3 apical fleshy elements (Figs. 7A, B). Endopodal lobe unarmed.

Leg 2 (Figs. 2B, 3B, F, 8A-C) fleshy, with outer protopodal seta (the latter indicated with an asterisk and shown in insert in Fig. 8A). Outer (exopodal) and inner (endopodal) lobes elongate, slender, cylindrical, subequal (Figs. 2B, 3B, F). Exopodal lobe with minute spinules on distal part, with 1 subapical and 2 apical fleshy elements (Figs. 8A, B). Endopodal lobe with 1 apical fleshy element only (Fig. 8C).

Male: Body pyriform (Fig. 9A, C); segmentation indistinct. Total body length measured from anterior margin of head to

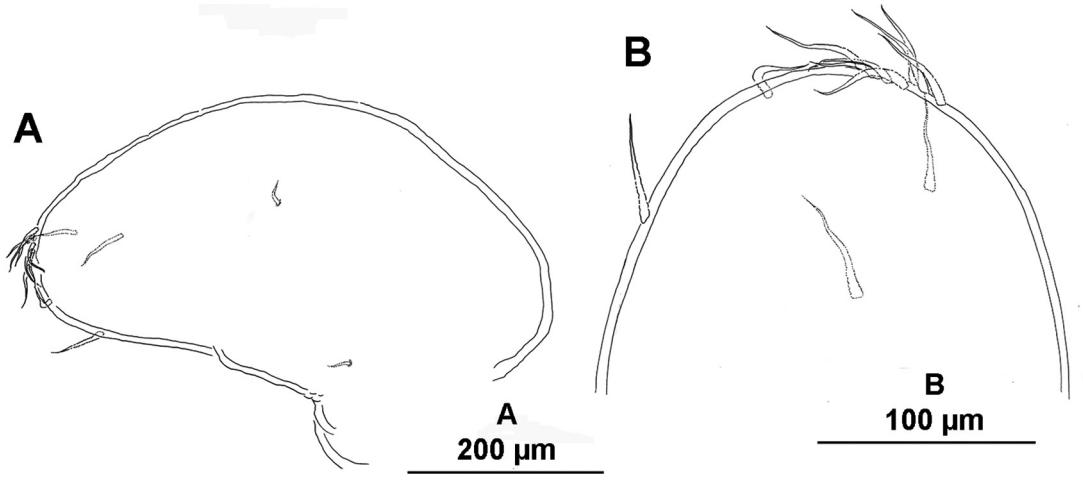

Fig. 5. *Chondracanthus dibranchi* sp. nov. Female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – antennule; **B** – distal part of antennule

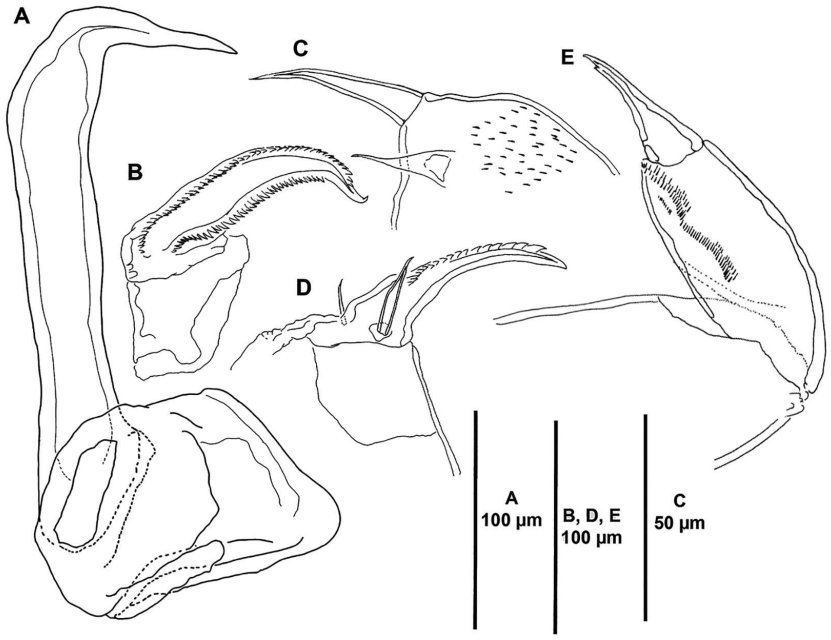

Fig. 6. *Chondracanthus dibranchi* sp. nov. Female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – antenna; **B** – mandible; **C** – maxillule; **D** – maxilla; **E** – maxilliped

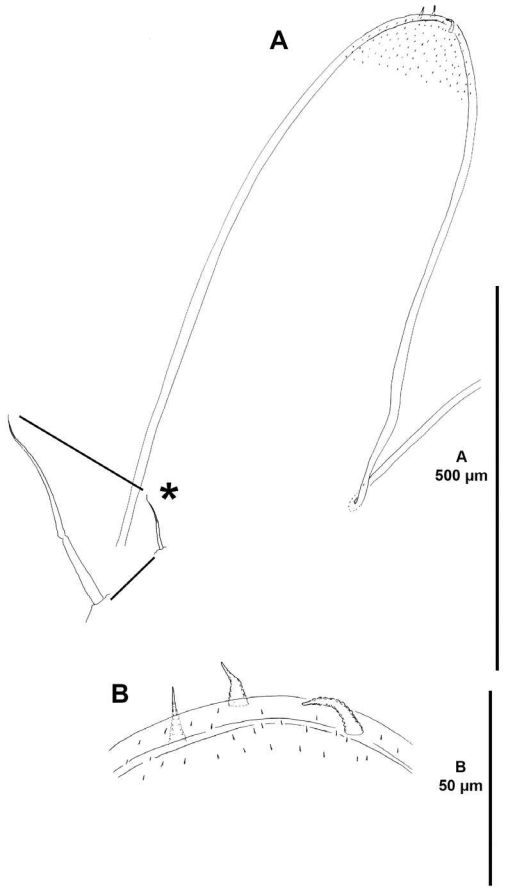

Fig. 7. *Chondracanthus dibranchi* sp. nov. Female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – exopod of P1; **B** – tip of exopod of P1

distal end of caudal rami, 0.6 mm (mean = 0.6 mm; n = 3). Cephalothorax globose, about half total body length. Abdomen and genital somite fused; genital opercula unarmed. Caudal rami (Fig. 9B) spiniform, each with 2 outer and 1 inner seta, and ornamented with minute spinules apically.

Antennule (Fig. 10A) fleshy, elongate. Armature formula, 1-1-1-8.

Antenna (Fig. 10B) short, stout, seemingly unarmed.

Mandible (Fig. 10C) one-segmented; apical falcate blade with longitudinal row of teeth along convex and concave margins.

Maxillule (Fig. 10D) as in female.

Maxilla (Fig. 10E) with robust unarmed syncoxa. Basis drawn out into claw-like process with 2 teeth, with 2 unequal setae.

Maxilliped (Fig. 10F) as in female.

Leg 1 (Fig. 11A) with outer protopodal seta, and 3 apical (exopodal) elements. Endopod represented by inner small protrusion.

Leg 2 (Figs. 11B, C) with outer protopodal seta, and 1 subdistal and 1 apical (exopodal) setae. Endopod represented by inner protrusion.

Type host: Batfish, *Dibranchus spongiosa* (Lophiiformes: Ogcocephalidae).

Site of infection: Gill cavity; the copepods were found detached inside the gill cavity; they were probably attached to the gill filaments and after detaching they were trapped by the gill rakers.

Type locality: West coast of the Baja California Peninsula (23°17′28″N, 110°22′00″W; Talud XV cruise, stn. 5D); 677 m depth.

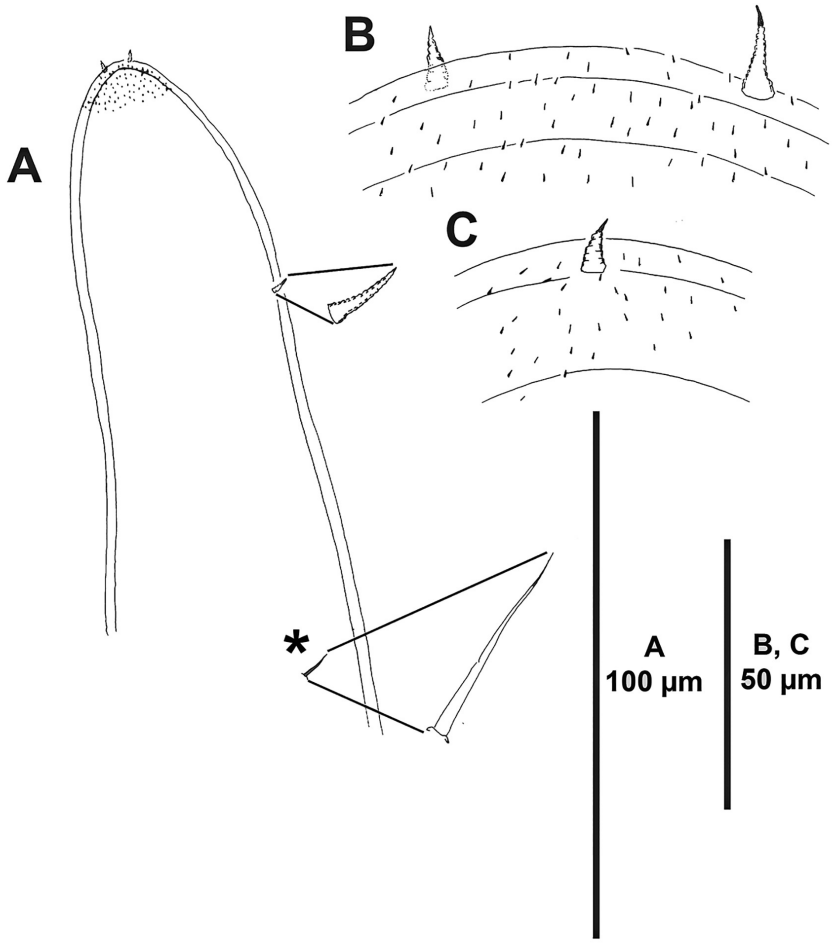

Fig. 8. *Chondracanthus dibranchi* sp. nov. Female paratype (ICML-EMUCOP-131105-01, 131105-02). **A** – exopod of P2; **B** – tip of exopod of P2; **C** – tip of endopod of P2

Date of collection: August 5, 2012.
Prevalence: 4.6% (7 fish infected out of 151 specimens of *D. spongiosa* examined).
Mean intensity: 1.

Specimens deposited:

- 1 female holotype with male allotype attached (ICML-EMUCOP-050812-03) preserved in alcohol; Talud XV cruise, stn. 5D; 23°17′28″N, 110°22′00″W; 677 m depth; August 5, 2012; coll. Hugo Aguirre-Villaseñor;
- 1 female paratype as follows: genito-abdomen and caudal rami preserved in alcohol (ICML-EMUCOP-131105-01), pair of antennules, mandibles, maxillules, maxillae and maxillipeds, left and right leg 1 and 2 dissected and mounted onto six slides (ICML-EMUCOP-131105-02); Talud IX cruise, stn. 17; 25°19′54″N, 110°47′42″W; 736 m depth; November 13, 2005; coll. Hugo Aguirre-Villaseñor;
- 1 female paratype as follows: body preserved in alcohol (ICML-EMUCOP-050812-01), both antennae dissected (ICML-EMUCOP-050812-02); Talud XV cruise, stn. 5D; 23°17′28″N, 110°22′00″W; 677 m depth; August 5, 2012; coll. Hugo Aguirre-Villaseñor;
- 1 female paratype (ICML-EMUCOP-010408-01) preserved in alcohol, with detached male paratype dissected (ICML-010408-02); Talud XII cruise, stn. 23; 18°33′43″N, 103°57′45″W; 1073 m depth; April 1st, 2008; coll. Hugo Aguirre-Villaseñor;
- 1 female paratype with attached male paratype (ICML-EMUCOP-010408-03) preserved in alcohol; Talud XII cruise, stn. 23; 18°33′43″N, 103°57′45″W; 1073 m depth; April 1st, 2008; coll. Hugo Aguirre-Villaseñor;
- 1 female paratype (ICML-EMUCOP-131200-01) preserved in alcohol; Talud V cruise, stn. 3; 21°59′14″N, 106°28′30″W; 730 m depth; December 13, 2000; coll. Hugo Aguirre-Villaseñor.
- 1 female paratype (ICML-EMUCOP-020812-01) preserved in alcohol; Talud XV cruise, stn. 20; 26°32′35″N, 113°50′20″W; 479 m depth; August 2, 2012; coll. Hugo Aguirre-Villaseñor.

Etymology: The specific epithet refers to the genus *Dibranchus* (Lophiiformes: Ogcocephalidae) to which the new species was found to be associated.

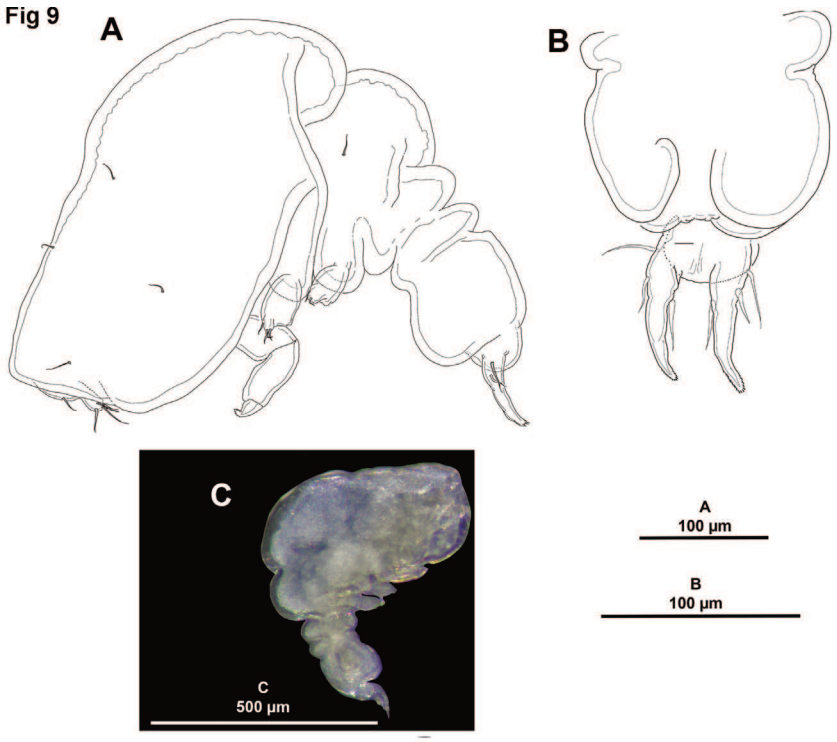

Fig. 9. *Chondracanthus dibranchi* sp. nov. Male paratype (ICML-EMUCOP-010408-02). **A** – habitus, lateral view; **B** – genito-abdomen and caudal rami, ventral view; **C** – microphotograph of habitus, lateral view

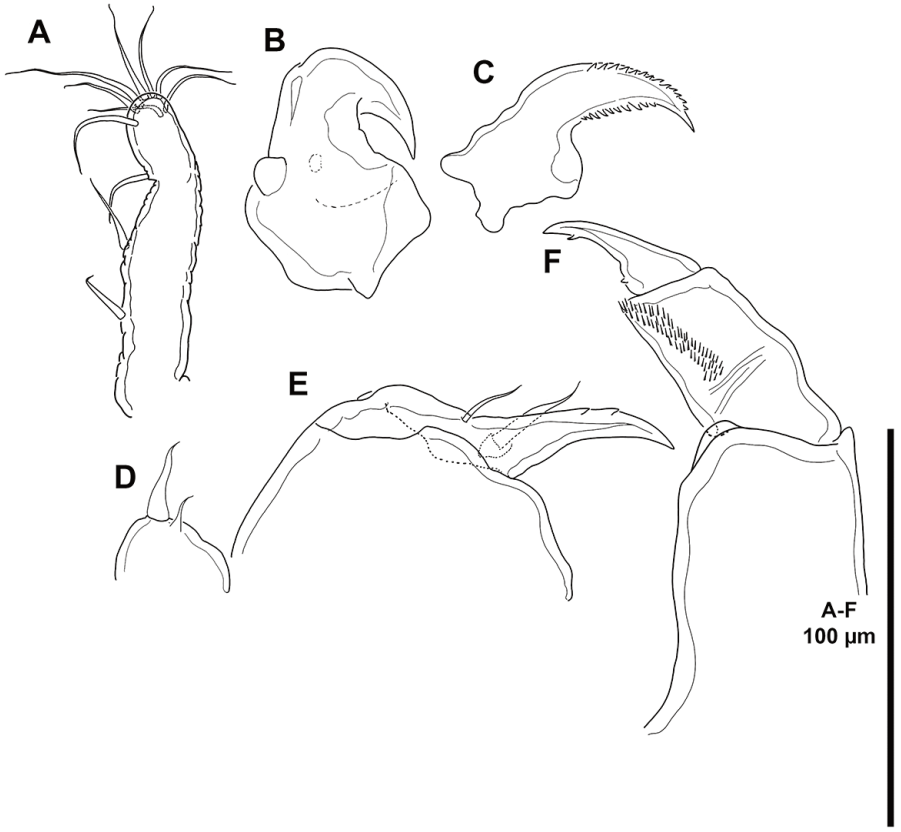

Fig. 10. *Chondracanthus dibranchi* sp. nov. Male paratype (ICML-EMUCOP-010408-02). **A** – antennule; **B** – antenna; **C** – mandible; **D** – maxillule; **E** – maxilla; **F** – maxilliped

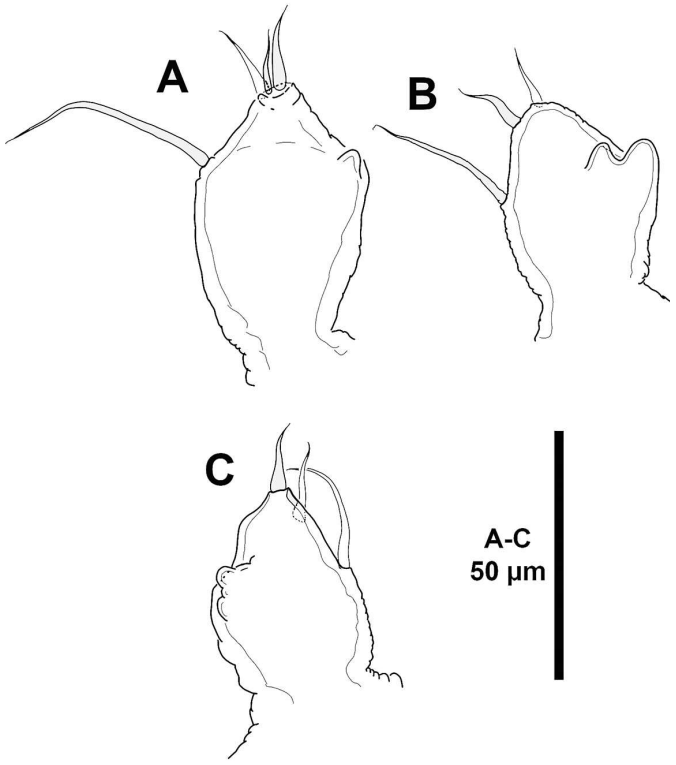

Fig. 11. *Chondracanthus dibranchi* sp. nov. Male paratype (ICML-EMUCOP-010408-02). **A** – leg 1; **B-C** – pair of legs 2

Discussion

The new species proposed herein was unequivocally placed within the genus *Chondracanthus* on account of the lack of an atrophied tip on the antenna, presence of a cephalosomic head region, presence of outgrowths or processes on the trunk, and two pairs of modified legs in the female (Kabata 1979, 1992, Boxshall and Halsey 2004). With the addition of *C. dibranchi* sp. nov., the genus *Chondracanthus* is now composed of 40 described species parasitic on an ample variety of fish hosts (see Boxshall and Halsey 2004). The species of *Chondracanthus* are typically separated on account of the uni-, bi-, or trilobed condition of legs 1 and 2, presence/absence of dorsal/lateral outgrowths or processes either on the trunk or head, size of the antennule, relative length of the rami of legs 1 and 2, and relative length of posterior processes, in the female (Ho 1991, Kabata 1979, 1992, Boxshall and Halsey 2004, Tang *et al*. 2007). *Chondracanthus dibranchi* sp. nov. seems to be more closely related to *C. psetti* Kröyer, 1863, parasitic on flatfish species from Valparaiso, Chile, as redescribed by Ho (1977). Following Ho (1977) these two species are also similar to *C. janebennettae* Causey, 1953, parasitic on flounders of the genus *Paralichthys* Girard, 1858 (Pleuronectiformes: Paralichthyidae) as redescribed by Ho (1971) from northern Gulf of Mexico and Florida. As noted in the keys to the species of *Chondracanthus* by Ho (1991) and Tang *et al*. (2007), and as can be seen in Ho's (1971) figures, the female of *C. janebennettae* can be readily separated from the other two congeners by the presence in the former, of a crest-like outgrowth on the posterodorsal portion of the head, pair of conspicuous lateral processes on the head, the greatly elongated abdomen, exceedingly high number of teeth on the mandibular blade, and general body shape (relatively more compact in *C. janebennettae* than in the other two species). On the other hand, the females of *C. janebennettae* and *C. psetti* share the attenuating posterior processes and rami of legs 1 and 2. A closer relationship between *C. psetti* and *C. dibranchi* sp. nov. is herein hypothesized since these two species share leg 1 relatively shorter than leg 2, the relative size and shape of the genito-abdomen, and above all, the conical attenuating lateral processes on the trunk in the female. The females of these two species can be separated mainly by the shape and armature of the antennule (pear-shaped, and with seven apical and one subapical seta in *C. psetti*, but suboval, and with one proximal, one medial, three subapical and eight apical elements in *C. dibranchi* sp. nov.), by the shape of the antenna (a strongly recurved hook in *C. psetti*, but distal segment elongate and recurved distally in *C. dibranchi* sp. nov.), by the shape of the claw of the maxilliped (with two teeth in *C. psetti*, but with one tooth only in *C. dibranchi* sp. nov.), and above all, by the general shape of the rami of leg 1 and 2, and posterior processes (attenuating in *C. psetti*, but cylindrical in *C. dibranchi* sp. nov.), general shape of the head region (longer than wide in *C. psetti*, but wider than long in *C. dibranchi* sp. nov.), position of the lateral processes of the trunk (situated posterior to leg 2 in *C. psetti*, but leg 2 and lateral processes aligned in *C. dibranchi* sp. nov.), and by the shape of the egg sacs (multiseriate sausage-shaped in *C. psetti*, but elongate, oligoseriate in *C. dibranchi* sp. nov.).

In the present study, *C. dibranchi* sp. nov. has been found on the gill cavity of *D. spongiosa* only (7 fish infected out of 151). The other two fish species analysed, *D. spinosus* (21 fish) and *D. hystrix* (6 fish), were not infected. The above could be an evidence of host specificity (Yuniar *et al*. 2007, Rameshkumar *et al*. 2014), although sample sizes differed.

Given the above, the following amendment to Tang's (2007) couplets 11 and 29 of his key to the species of *Chondracanthus* is suggested:

11. Anterior end of head distinctly narrower than its posterior end; posterior end of trunk with a ventral swelling 12
    Anterior end of head as wide as or slightly wider that its posterior end; posterior end of trunk without ventral swelling; posterior processes of the trunk and rami of leg 1 and leg 2 attenuating; lateral process on the trunk posterior to leg 2; with one egg sac, not coiled, sausage-shaped, multiseriate ..... *psetti* (Ho 1977, 164–165)
    Anterior end of head as wide as or slightly wider that its posterior end; posterior end of trunk without ventral swelling; posterior processes of the trunk and rami of leg 1 and leg 2 cylindrical; lateral process on the trunk and leg 2 aligned; with two egg sacs, elongate, oligoseriate... *dibranchi* sp. nov.

29. Trunk with dorsal outgrowths; abdomen extended posteriorly ..... *neali* (Ho 1972, 152–155)
Trunk lacking dorsal outgrowths; abdomen not extended posteriorly; second pediger with one single and one bifurcated process on each side .... *distortus* (Shiino 1955, 71–74)
Trunk lacking dorsal outgrowths; abdomen not extended posteriorly; second pediger with one single process on each side ..... *hoi* (Braicovich *et al*. 2013, 360–363)

Acknowledgements. This study was financed by the Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT) of the Dirección General de Asuntos del Personal Académico of the Universidad Nacional Autónoma de México (PAPIIT-DGAPA-UNAM), project IN202116. Ship time of the research cruises Talud III-XV on board R/V "El Puma" was supported by the Universidad Nacional Autónoma de México and CONACyT (Talud XV). Sampling campaigns were partly supported by CONACyT (Projects 31805-N and 179467) and PAPIIT-DGAPA-UNAM (Project IN-217306-3). We are grateful to Edgar Cruz Acevedo and Carolina Salas Singh for their invaluable assistance during Talud XV and XVI cruises, and to all scientists, students and crew members for their help and support during the Talud III-XII, and XV.

References

Boxshall G.A. 1998. Host specificity in copepod parasites of deep-sea fishes. *Journal of Marine Systems*, 15, 215–223. DOI: 10.1016/S0924-7963(97)00058-4

Boxshall G.A. 2005. Copepoda (copepods). In: (Ed K. Rohde) Marine Parasitology. CSIRO Publishing, Collingwood, pp. 123–138

Boxshall G.A., Halsey S.H. 2004. An introduction to copepod diversity. The Ray Society, London, pp. 966

Bradbury M.G. 1999. A review of the fish genus *Dibranchus* with descriptions of new species and a new genus, *Solocisquama*. *Proceedings of the California Academy of Sciences*, 51, 259–310

Braicovich P.E., Lanfranchi A.L., Incorvaia I.S., Timi J.T. 2013. Chondracanthid copepod parasites of dories (Zeiformes: Zeidae) with the description of a new species of *Chondracanthus* from waters off northern Argentina. *Folia Parasitologica*, 60, 359–364. DOI: 10.14411/fp.2013.037

Bush A.O., Lafferty K.D., Lotz J.M., Shostak A.W. 1997. Parasitology meets ecology on its own terms: Margolis *et al*. revisited. *Journal of Parasitology*, 83, 575–583. DOI: 10.2307/3284227

Castro-Aguirre J.L., Moncayo-López M.E. 1976. Sobre la presencia de *Dibranchus nudivomer* (Garman) (Pis.: Ogcocephalidae) en la Costa Occidental de México, con notas y observaciones biológicas. *Revista de la Sociedad Mexicana de Historia Natural*, 37, 307–322. (In Spanish)

Causey D. 1953. Parasitic Copepoda from Grand Isle, Louisiana. *Occasional papers of the Marine Laboratory*, *Louisiana State University*, 7, 1–18

Causey D. 1960. Parasitic Copepoda from Mexican coastal fishes. *Bulletin of Marine Science of the Gulf and Caribbean*, 10, 323–337

Cruz-Acevedo E., Salas-Singh C, Aguirre-Villaseñor H. 2017. Distribution of *Dibranchus* species (Pisces: Ogcocephalidae) from the Eastern Central Pacific and their relationship with environmental factors. *Marine Biodiversity*, https://doi.org/10.1007/s12526-017-0808-y

Delaroche F. 1811. Sur des animaux vivant sur les branchies des poissons. *Nouveau Bulletin des Sciences*, *Société Philomatique de Paris*, 2, 270–272.

Garman S. 1899. Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands, in charge of Alexander Agassiz, by the U.S. Fish Commission Steamer Albatross, during 1891, Lieut. Commander Z.L. Tanner, U.S.N., commanding. 26. The fishes. *Memoirs of the Museum of Comparative Zoology*, *at Harvard College*, *Cambridge*, *Mass.*, 24, 1–431.DOI: DOI.org/10.5962/bhl.part.27494

Gilbert C.H. 1890. A preliminary report on the fishes collected by the steamer Albatross on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. *Proceedings of the United States National Museum*, 13, 49–126

Girard C. F. 1854. Observations upon a collection of fishes made on the Pacific coast of the United States, by Lieut. W. P. Trowbridge, U.S.A., for the museum of the Smithsonian Institution. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 7, 142–156

Ho J.–S. 1971. Parasitic copepods of the family Chondracanthidae from fishes of Eastern North America. *Smithsonian Contributions to Zoology*, 87, Smithsonian Institution Press, Washington, pp. 39

Ho J.–S. 1972. Copepods of the family Chondracanthidae (Cyclopoida) parasitic on South African marine fishes. *Parasitology*, 65, 147–158

Ho J.–S. 1977. Parasitic copepods of the family Chondracanthidae from fishes of the South–Eastern Pacific (Crustacea, Copepoda). *Steenstrupia*, 4, 157–165

Ho J.–S. 1991. Redescription of *Chondracanthus zei* Delaroche (Copepoda, Poecilostomatoida) parasitic on *Zeus faber* L. in the Sea of Japan, with a preliminary review of the genus. *Report of the Sado Marine Biological Station*, 21, 49–79

Kabata Z. 1979. Parasitic Copepoda of British fishes. The Ray Society, London, pp. 468

Kabata Z. 1992. Copepods parasitic on fishes. In: (Eds D.M. Kermack, R.S.K. Barnes and J.H. Crothers) Synopses of the British Fauna (New Series). Universal Book Services/Dr. W. Backhuys, The Netherlands, pp. 1–264

Kröyer H. 1863. Bidrag til Kundskab om Snyltekrebsene. *Naturhistorisk tidsskrift*, 3, 75–426

Milne Edwards H. 1840. Ordre des copépodes. In: (Ed H. Milne Edwards) Histoire naturelle des crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux. Vol. 3. Imprimerie de Fain et Thunot, Paris, pp. 411–529

Morales–Serna F.N., Gómez S., Pérez–Ponce de León G.P. 2012. Parasitic copepods reported from Mexico. *Zootaxa*, 3234, 43–68

Morales–Serna F.N., Rubio–Godoy M., Gómez S. 2011. Seasonality of parasitic copepods on bullseye puffer, *Sphoeroides annulatus* (Pisces: Tetraodontidae), from the northwestern coast of Mexico. *Journal of Parasitology*, 97, 565–573. DOI: 10.1645/GE-2638.1

Oakley C.L. 1930. The Chondracanthidae (Crustacea: Copepoda); with a description of five new genera and one new species. *Parasitology*, 22, 182–201

Peters W. 1876. Über eine neue, mit *Halieutaea* verwandte Fischgattung, *Dibranchus*, aus dem Atlantischen Ocean. *Monatsberichte der Königlichen Pereussischen Akademie der Wissenschaften zu Berlin*, 1875, 736–742

Rameshkumar G., Ravichandran S., Venmathi Maran B.A. 2014. Occurrence of parasitic copepods in Carangid fishes from Parangipettai, Southeast coast of India. *Journal of Parasitic Diseases*, 38, 317–323. DOI: 10.1007/s12639-013-0251-3

Rathbun R. 1886. Description of parasitic Copepoda belonging to the genera *Pandarus* and *Chondracanthus* (with seven plates). *Proceedings of the Unites States National Museum*, 9, 310–324

Shiino S.M. 1955. Copepods parasitic on Japanese fishes. 9. Family Chondracanthidae, subfamily Chondracanthinae. *Report of the Faculty of Fisheries*, *Prefectural University of Mie*, 2, 70–111

Tang D., Andrews M., Cobcroft J.M. 2007. The first chondracanthid (Copepoda: Cyclopoida) reported from cultured finfish, with a revised key to the species of *Chondracanthus*. *Journal of Parasitology*, 93, 788–795. DOI: 10.1645/GE-1121R.1

Walter T.C., Boxshall G. 2017. World of copepods database. Accessed at http://www.marinespecies.org/copepoda on 2017-02-09

Wilson C.B. 1908. North American parasitic copepods: a list of those found upon the fishes of the Pacific coast, with descriptions of new genera and species. *Proceedings of the United States National Museum*, 35, 431–481

Yuniar A., Palm H.W., Walter T. 2007. Crustacean fish parasites from Segara Anakan Lagoon, Java, Indonesia. *Parasitology Research*, 100, 1193–1204. DOI: 10.1007/s00436-006-0391-9

Received: July 28, 2017
Revised: February 12, 2018
Accepted for publication: February 15, 2018