TWO NEW SPECIES OF *PSEUDOCHRISTIANELLA* CAMPBELL & BEVERIDGE, 1990 (CESTODA: TRYPANORHYNCHA) FROM ELASMOBRANCH FISHES FROM THE GULF OF CALIFORNIA, MEXICO

CAMPBELL R.A.* & BEVERIDGE I.**

Summary:

Pseudochristianella elegantissima sp. nov. (Cestoda: Trypanorhyncha) is described from the spiral valves of the rays *Dasyatis brevis* (Garman, 1880) and *D. longus* (Garman, 1880), from the Gulf of California, Mexico. Also described is *P. nudiscula* sp. nov. from rays *Rhinobatos productus* Ayres, 1854, *D. longus*, *Myliobatis longirostris* Applegate & Fitch, 1964 and *Zapteryx exasperata* (Jordan & Gilbert, 1880) from the same location. The species are distinguished from one another and from the only existing species within the genus, *P. southwelli* Campbell & Beveridge, 1990, by differences in the arrangement of bill-hooks on the external surface of the basal swelling of the tentacle and by the number of hooks in each row of the metabasasl armature.

KEY WORDS : *Pseudochristianella*, Cestoda, Trypanorhyncha, new species.

Résumé : DEUX NOUVELLES ESPÈCES DE *PSEUDOCHRISTIANELLA* CAMPBELL & BEVERIDGE, 1990 (CESTODA : TRYPANORHYNCHA), PARASITES D'ÉLASMOBRANCHES DANS LE GOLFE DE CALIFORNIE, MEXIQUE

Description de Pseudochristianella elegantissima *sp. nov. (Cestoda : Trypanorhyncha) parasite de la valvule spirale des raies* Dasyatis brevis *(Garman, 1880) et* D. longus *(Garman, 1880), et de* P. nudiscula *sp. nov., parasites des raies* Rhinobatos productus *Ayres, 1854,* D. longus, Myliobatis longirostris *Applegate & Fitch, 1964 et* Zapteryx exasperata *(Jordan & Gilbert, 1880) provenant du Golfe de Californie, Mexique. Les nouvelles espèces se distinguent de* P. southwelli *Campbell & Beveridge, 1990 par la distribution des crochets serpe-à-bec sur la surface externe du renflement basal de la trompe.*

MOTS CLÉS : Pseudochristianella, *Cestoda, Trypanorhyncha, nouvelle espèce.*

INTRODUCTION

The eutetrarhynchid trypanorhynch genus *Pseudochristianella* Campbell & Beveridge, 1990 is currently represented by a single species, *P. southwelli* Campbell & Beveridge, 1990, known from sharks and rays from the Indian Ocean (Campbell & Beveridge, 1990). The new genus was erected because this cestode shared an armature pattern similar to that of the genus *Parachristianella* Dollfus, 1946 in possessing a heteroacanthous, heteromorphous armature with solid hooks and with the initial file of hooks of the principal rows the largest, but differing in having a basal tentacular swelling and a distinctive basal armature on the external surface of the tentacle.

The genus has remained monotypic despite the description of a number of new eutetrarhynchids in the intervening years (Beveridge, 1990; Beveridge *et al.*, 2004; Palm, 2004). Recent collections of cestodes from elasmobranchs from the Gulf of California, Mexico by Dr Janine N. Caira of the University of Connecticut, have revealed the existence of two new species belonging to this genus. The two new species are described herein.

MATERIALS AND METHODS

Elasmobranchs were collected in the Gulf of California, Mexico (local name Baja California) (also known as the Sea of Cortez) by local fisherman. Cestodes were fixed in 10 % formalin *in situ* or were removed from the hosts and were relaxed in water or water containing 5 % lidocaine prior to fixation in AFA (Pritchard & Kruse, 1982).

Whole mounts were prepared by staining in Harris' haematoxylin or Mayer's paracarmine, dehydrated in a graded ethanol series, cleared in methyl salicylate and mounted in Canada balsam.

Morphological terminology for trypanorhynch cestodes follows Campbell & Beveridge (1994) except that the attachment organs are referred to as bothria following Jones *et al.* (2004).

Drawings were made with the aid of a drawing tube attached to an Olympus BH microscope. Measurements were made with an ocular micrometre. All measurements are presented in micrometres, unless otherwise stated, as the range followed, in parentheses, by the mean and the number of specimens measured (n =). Specimens have been deposited in the Instituto de Bio-

* Department of Biology, University of Massachusetts Dartmouth, North Dartmouth, Massachusetts, USA; current address: 415 Highfield Road, Salem Virginia 24153, USA.
** Department of Veterinary Science, University of Melbourne, Veterinary Clinical Centre, Werribee, Victoria 3030, Australia.
Correspondence: Ian Beveridge.
Tel.: 61 3 97312285 – Fax 61 3 97312263.
E-mail: ibeve@unimelb.edu.au

logía, Universidad Nacional Autonoma de México, Mexico City, Mexico (IBUNAM) and the United States National Parasite Collection, Beltsville (USNPC).
Host nomenclature follows Eschmeyer (1998) except that the family names Dasyatididae and Myliobatididae follow Last & Stevens (1994).

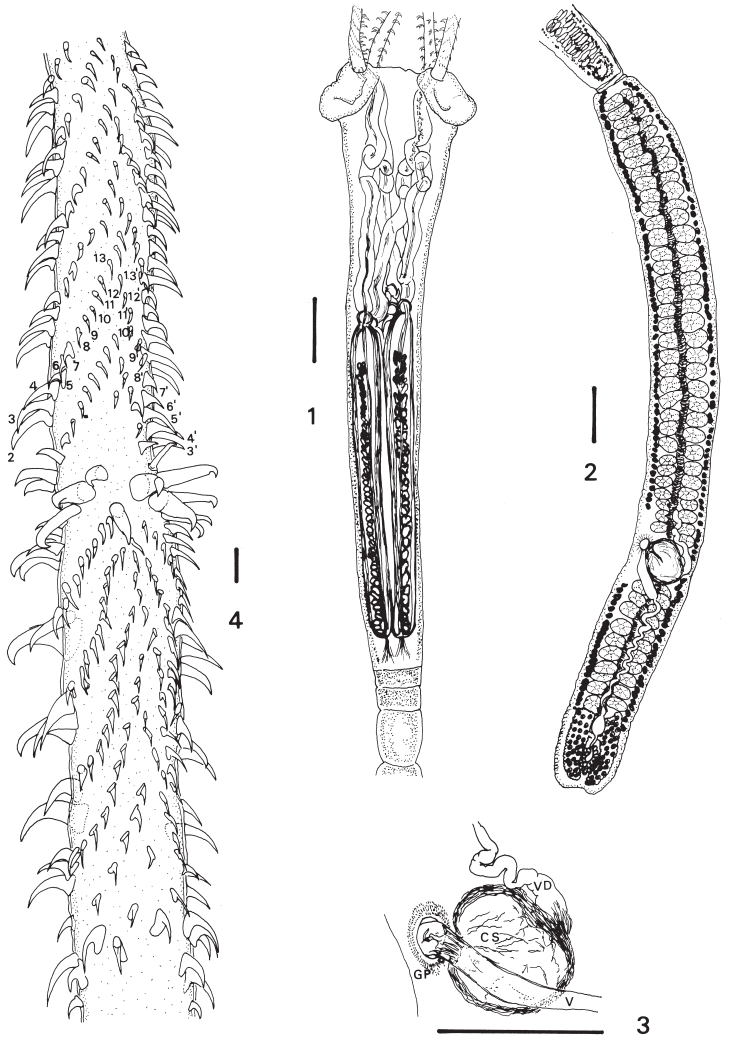
RESULTS

PSEUDOCHRISTIANELLA ELEGANTISSIMA SP. NOV. (Figs 1-8)

DESCRIPTION

Small cestodes, mature specimens 3.40-4.36 (3.89, n = 5) mm long, maximum width in region of pars vaginalis 260-390 (330, n = 5), with 2-6 (4, n = 8) segments. Scolex acraspedote, 1050-1550 (1270, n = 5) long, maximum width in region of pars vaginalis 260-390 (360, n = 5). Tegument of scolex smooth. Two oval bothria; pars bothrialis 140-230 (190, n = 5). Pars vaginalis longer than pars bothrialis, 450-830 (640, n = 5) long; sheaths slightly sinuous. Bulbs 550-620 (580, n = 5) long, 40-75 (63, n = 5) wide; retractor originates at base of bulb; gland cells present within bulb; prebulbar organ present; pars post bulbosa present or absent, 0-45 (30, n = 5).

Everted tentacle up to 450 long, 30 (30, n = 5) wide in metabasal region; with basal swelling, 40-45 (41, n = 5) in diameter at base. Armature heteroacanthous typical, heteromorphous; hooks solid. Distinctive basal armature present; initial two rows of hooks uncinate to falciform with elongated bases, 11-20 (15, n = 5) long, base 9-11 (10, n = 5); on remainder of base, hooks arranged in five ascending rows beginning on internal surface, terminating on external surface; prominent space between hook files 1 and 1'; hooks 1 (1') uncinate, diminishing in size along row, becoming spiniform with approx. 15 hooks per row; terminal hook of fifth row and terminal 2-3 hooks of sixth row enlarged, cylindrical, 16-24 (22, n = 5) long, circular base 5-8 (6, n = 5) in diameter, projecting perpendicularly from surface of tentacle; terminal 2-3 hooks of row 6 on bothrial



Figs 1-4. – *Pseudochristianella elegantissima* sp. nov. from *Dasyatis brevis* (Dasyatididae). Fig.1. Scolex, lateral view. Fig. 2. Mature segment. Fig. 3. Terminal genitalia, ventral view. Fig. 4. Tentacle, external surface, basal and metabasal regions, bothrial surface on right hand side. Scale-lines: Figs 1-3, 0.1 mm; Fig. 4, 0.01 mm. Abbreviations: CS, cirrus sac; GP, genital pore; V, vagina; VD, vas deferens.

surface enlarged, elongate, bill-hooked, 18-21 (20, n = 5) long, base 4-7 (5, n = 5). Metabasal armature with distinct space between hooks 1 and 1'; with 13 hooks per row; hooks 1 (1') large, uncinate with broad base, 17-21 (19, n = 5) long, base 14-20 (17, n = 5); hooks 2 (2') uncinate, slightly smaller but with much shorter base, 15-19 (17, n = 5) long, base 6-12 (8, n = 5); hooks 3 (3') spiniform, 8-11 (10, n = 5) long, base 3-4 (3, n = 5); hooks 4 (4') spiniform, longer, 14-16 (15, n = 5), base 4-5 (5, n = 5); hooks diminish in size gradually along row, hooks 13 (13') spiniform, 3-8 (5, n = 5) long, base 2-3 (2, n = 5); hook rows overlap and alternate on external surface of tentacle.

Mature segments acraspedote, 1000-2100 (1480, n = 5) long, 130-260 (200, n = 5) wide; genital pore in posterior part of segment margin, 400-1000 (620, n = 5) or 37-59 (47, n = 5) % from posterior end. Testes aligned in two columns; testes 40-90 long by 20-30 wide; total number of testes 79-112 (96, n = 5) distributed as 8-12 (11, n = 5) post-vaginal, 30-46 (36, n = 5) pre-vaginal and 41-55 (49, n = 5) anti-poral. Cirrus sac globular with thick wall, 80-175 (118, n = 5) long by 50-100 (77, n = 5) wide; cirrus unarmed; internal and external seminal vesicles absent. Vagina enters genital atrium posterior to cirrus sac, passes posteriorly to a distinct seminal receptacle. Ovary four lobed, lobes 120-240 (140, n = 5) by 45-110 (68, n = 5); Mehlis' gland posterior to ovarian isthmus, 40 in diameter. Uterus tubiform, extends from Mehlis' gland almost to anterior extremity of segment. Osmoregulatory canals: ventral canal sinuous, 50 in diameter, dorsal canal 20 in diameter. Gravid segments absent.

Type host: *Dasyatis brevis* (Garman, 1880) (Dasyatididae).

Other host: *Dasyatis longus* (Garman, 1880) (Dasyatididae).

Site in host: spiral valve.

Material examined: from *D. brevis*: holotype, La Paz, Gulf of California, Mexico (24º 10' N, 110º 17' W), coll. J. Caira, 10.ix.1993 (IBUNAM 5468); 19 paratypes, same data (IBUNAM 5469, USNPC 97913, 97914); one specimen, Puertecitos, Gulf of California, Mexico, coll. J. Caira, 22.vii.1993 (USNPC 97915); from *D. longus*: three specimens, San Jose del Cabo, Gulf of California, Mexico, coll. J. Caira, 17.ix.1993 (USNPC 97916).

Etymology: latin, meaning, most elegant, referring to the basal armature.

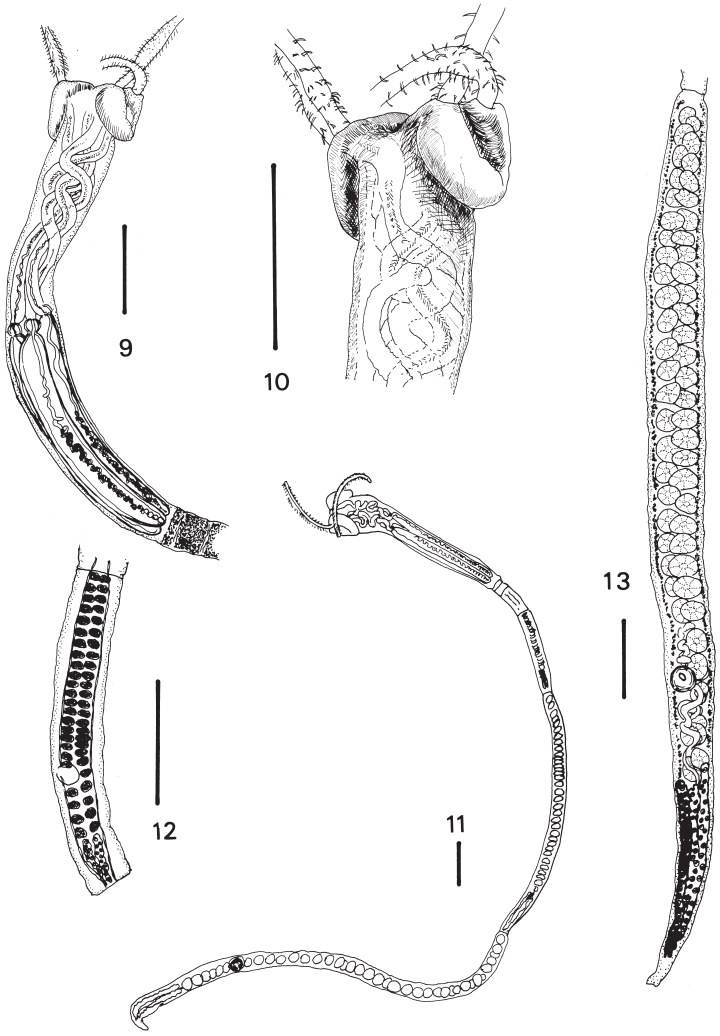
Figs 5-8. – *Pseudochristianella elegantissima* sp. nov. from *Dasyatis brevis* (armature) and *D. longus* (Dasyatididae) (entire cestode). Fig. 5. Tentacle, antibothrial surface, basal and metabasal armature. Fig. 6. Tentacle, antibothrial surface, internal surface on right hand side, metabasal armature. Fig. 7. Tentacle, internal surface, bothrial surface on right hand side, basal and metabasal armature. Fig. 8. Entire cestode. Scale-lines: Figs 5,6, 0.01 mm; Figs 7,8, 0.1 mm.

PSEUDOCHRISTIANELLA NUDISCULA SP. NOV. (Figs 9-16)

DESCRIPTION

Small cestodes, mature specimens 2.13-2.93 (2.48, n = 5) mm long, maximum width 100-130 (120, n = 5), with 3-5 (4, n = 5) segments. Scolex acraspedote, 730-870 (810, n = 5) long, maximum width in region of pars bulbosa 90-130 (120, n = 5). Tegument of scolex smooth. Two oval bothria; pars bothrialis 100-130 (120, n = 5), width 100-140 (120, n = 2). Pars vaginalis longer than pars bothrialis, 300-420 (380, n = 5) long; sheaths slightly sinuous. Bulbs 320-430 (380, n = 5) long, 40-50 (46, n = 5) wide; retractor originates at base of bulb; gland cells present within bulb; prebulbar organ present; pars post bulbosa present or absent, 0-50 (20, n = 5).

Everted tentacle up to 525 long, 15-20 (18, n = 5) wide in metabasal region; with basal swelling, 23-28 (25, n = 5) in diameter at base. Armature heteroacanthous typical, heteromorphous; hooks solid. Distinctive basal armature present on external surface only; initial two rows of hooks uncinate to falciform with elongated bases, 10-20 (14, n = 5) long, base 5-10 (7, n = 5); on remainder of base, hooks arranged in ascending rows beginning on internal surface, terminating on external surface; prominent space between hook files 1 and 1'; hooks 1 (1') uncinate, diminishing in size along row; initial rows incomplete; hooks becoming spiniform along row with 4-7 hooks per row; terminal 2-3 hooks of third and fourth rows enlarged, cylindrical, 10-17 (14, n = 5) long, circular base 3-6 (5, n = 5) in diameter, projecting perpendicularly from surface of tentacle; bill-hooks arranged on external surface as alternating pairs with small spiniform hooks interspersed. Metabasal armature with distinct space between hooks 1 and 1'; 10 hooks per row; hooks diminish gradually in size along row, hooks 1 (1') large, uncinate with broad base, 16-20 (18, n = 5) long, base 10-14 (12, n = 5); hooks 2 (2') falcate, slightly longer but with much shorter base, 18-21 (20, n = 5) long, base 6-7 (7, n = 5); hooks 3 (3') falcate, 16-20 (18, n = 5) long, base 5-7 (6, n = 5); hooks 4(4') spiniform, 12-17 (14, n = 5), base 3-4 (4, n = 5); hooks 5 (5') spiniform, 4-14 (11, n = 5) long, base 3 (3, n = 5); hooks 6 (6') spiniform



Figs 9-13. – *Pseudochristianella nudiscula* sp. nov. from *Rhinobatos productus* (Rhinobatidae). Fig. 9. Scolex. Fig. 10. Bothria. Fig. 11. Entire cestode. Fig. 12. Premature segment. Fig. 13. Mature segment. Scale-lines: 0.1 mm.

8-11 (9, n = 5) long, base 2-3 (3, n = 5); hooks 7 (7') spiniform, 4-7 (5, n = 5) long, base 1-2 (2, n = 5); hooks 8 (8')-10 (10') tiny, spiniform, 4-5 (4, n = 5) long, base 1-2 (2, n = 5); hook rows overlap and alternate on external surface of tentacle.

Mature segments acraspedote, 1100-1800 (1370, n = 5) long, 110-120 (110, n = 5) wide; genital pore in posterior part of segment margin, 350-700 (550, n = 5) or 27-49 (41, n = 5) % from posterior end. Testes arranged in two columns; testes 45-75 (60, n = 10) by 28-43 (35, n = 10); total number of testes 41-57 (46, n = 5) distributed as 3-5 (4, n = 5) post-vaginal, 16-22 (18, n = 5) pre-vaginal and 20-30 (23, n = 5) anti-poral. Cirrus sac globular with thick wall, 50-55 (53, n = 3) by 35-45 (40, n = 3); cirrus unarmed; internal and external seminal vesicles absent. Vagina enters genital atrium posterior to cirrus sac, passes posterior to ovary. Ovary four lobed, lobes 188-350 (270, n = 3) by 25-33 (30, n = 5); Mehlis' gland not seen. Uterus tubiform, extends from ovary almost to anterior extremity of segment. Osmoregulatory canals not seen. Gravid segments absent.

Type host: *Rhinobatos productus* Ayres, 1854 (Rhinobatidae).

Other hosts: *Dasyatis longus* (Garman, 1880) (Dasyatididae); *Myliobatis longirostris* Applegate & Fitch, 1964 (Myliobatididae); *Zapteryx exasperata* (Jordan & Gilbert, 1880) (Rhinobatidae).

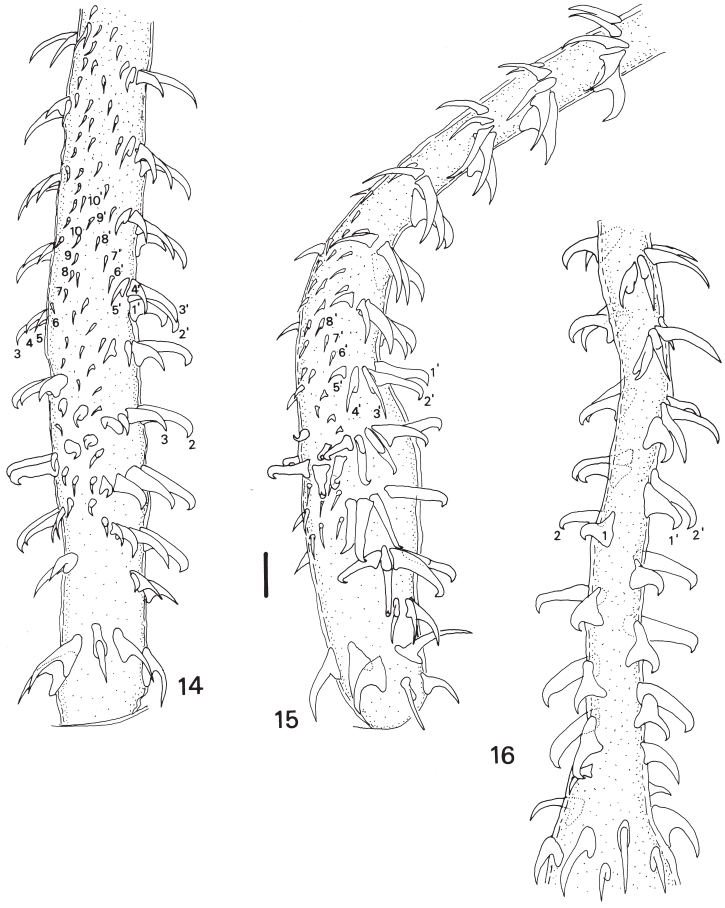
Site in host: spiral valve.

Material examined: from *Rhinobatos productus*: holotype, Santa Rosalia, Gulf of California, Mexico (29º 17' N, 112º 17' W), coll. J. Caira, 15.viii.1993 (IBUNAM 5470); four paratypes, same data (IBUNAM 5471, USNPC 97918); one specimen, Bahía de Los Angeles, Gulf of California, Mexico, coll. J. Caira, 7.viii.1993 (USNPC 97917); from *D. longus*: two specimens, San José del Cabo, Gulf of California, Mexico, coll. J. Caira, 18, 20.ix.1993 (USNPC 97919-20); from *Myliobatis longirostris*: one specimen, Bahía de Los Angeles, Gulf of California, Mexico, coll. J. Caira, 28.ix.1993 (USNPC 97921); from *Zapteryx exasperata*: one specimen, Santa Rosalia, Gulf of California, Mexico, coll. J. Caira, 22.viii.1993 (USNPC 97922).

Etymology: Latin, somewhat naked, referring to the external surface of the base of the tentacle.

DISCUSSION

Pseudochristianella elegantissima is distinguished from *P. southwelli* primarily on the basis of the arrangement of hooks on the external surface of



Figs 14-16. – *Pseudochristianella nudiscula* sp. nov. from *Rhinobatos productus* (Rhinobatidae). Fig. 14. Tentacle, external surface, bothrial surface on right hand side, basal and metabasal armature. Fig. 15. Tentacle, bothrial surface, internal surface on right hand side, basal and metabasal armature. Fig. 16. Tentacle, internal surface, bothrial surface on right hand side, basal and metabasal armature. Scale-line: 0.01 mm.

the base of the tentacle. In *P. elegantissima*, anterior to the two rows of hooks which encircle the base are five ascending hook rows with approximately 11 hooks per row (Fig. 4). These ascending rows are absent in *P. southwelli*. The bill hooks on the external surface of the tentacle are larger (16-24 long) in *P. elegantissima* than in *P. southwelli* (9-13) and are confined to the termination of one pair of hook rows, with a single bill hook posterior to these rows, at the apex of two hook rows. In *P. southwelli*, the bill hooks are present at the termination of several hook rows (Campbell & Beveridge, 1990, Fig. 2). The scolex of *P. elegantissima* (1050-1550) is also slightly larger than that of *P. southwelli* (920-1000). In addition, the two species differ in the number of hooks in each row of the metabasal armature with 13 in *P. elegantissima* and 11 in *P. southwelli*.

P. nudiscula is a smaller species (2.1-2.9 mm compared with 3.4-4.4 mm in *P. elegantissima* and *P. southwelli*), with bulbs (320-430) shorter than those of *P. elegantissima* (550-620) and *P. southwelli* (450-580). The principal distinguishing feature of the species lies in the arrangement of hooks on the external surface of the base of the tentacle. In *P. nudiscula* anterior to the two rows of hooks encircling the very base of the tentacle, there is a space devoid of hooks (Figs 14, 15). In *P. southwelli*, a small space exists, but is not bounded on either side by principal rows of hooks (Campbell & Beveridge, 1990, Fig. 2), while in *P. elegantissima*, this region is occupied by ascending hook rows (Fig. 4). In addition, the number of testes per segment is lower in *P. nudiscula* (41-57) than in either *P. southwelli* (80) or *P. elegantissima* (79-112). *P. nudiscula* is also distinguishable from *P. elegantissima* by the number of hooks in rows of the metabasal armature, with 10 in *P. nudiscula* and 13 in *P. elegantissima*. For these reasons, both species described herein are considered to be new.

The addition of two new species to the genus *Pseudochristianella* allows a more precise definition of the genus. Campbell & Beveridge (1990) differentiated the genus from the closely-related *Parachristianella* Dollfus, 1946 based on the existence of a basal swelling of the tentacle and a distinctive armature on the external surface of the base. In all three species of *Pseudochristianella*, a slight basal swelling is present, and the distinctive basal armature is composed of symmetrically-arranged bill-hooks at the termination of one or more hook rows. Bill hooks exist at the termination of hook rows in the basal armature of *Parachristianella baverstocki* Beveridge, 1990 and *Para. indonesiensis* Palm, 2004, but on one side of the tentacle only and both lack a basal tentacular swelling. Thus the presence of a basal swelling and the symmetrical arrangement of bill hooks at the base differentiate *Pseudochristianella* from *Parachristianella*.

The description of *P. southwelli* was based on material from an unidentified species of *Carcharhinus* and from *Rhinobatos halavi* (Forsskål, 1775) from India (Campbell & Beveridge, 1990). Current collections of *Pseudochristianella* extend the known distribution of the genus to the west coast of north America and indicate a host range of dasyatid, myliobatid and rhinobatid rays. It therefore seems likely that rays are the usual host of cestodes of this genus and that the collection of *P. southwelli* from a species of *Carcharhinus* may have been a chance finding. Little is known of the life cycles of eutetrarhynchid cestodes (Palm, 2004) although all known plerocerci have been collected from crustaceans, molluscs and occasionally teleosts. It may be that the definitive host range of the parasites is determined as much by prey availability than by phylogenetic or physiological constraints imposed by the elasmobranch host.

ACKNOWLEDGEMENTS

We wish to thank Dr J. Caira of the University of Connecticut for making this material available for study and also to K. Jensen, S. Curran, G. Tyler, P. Cislo, T. Ruhnke, V. McKenzie and P. Olson for assistance with the collection of specimens. J. McEachran is thanked for host identification. Collecting was funded by National Science Foundation grant DEB 9300796 to J. Caira and collections were undertaken under permit number 120496-213-03 issued by the Secretaria de Medio Ambiente Recursos Naturales y Pesca, Mexico.

REFERENCES

Beveridge I., Neifar L. & Euzet L. Eutetrarhynchid cestodes from Atlantic and Mediterranean elasmobranch fishes, with the description of two new species of *Dollfusiella* Campbell & Beveridge, 1994 and redescriptions of *Prochristianella papillifer* (Poyarkoff, 1909) Dollfus, 1957 and *Parachristianella trygonis* Dollfus, 1946. *Systematic Parasitology*, 2004, *59*, 81-102.

Campbell R.A. & Beveridge I. Order Trypanorhyncha Diesing, 1863. *In*: Keys to the Cestode Parasites of Vertebrates. Khalil L.F., Jones A., Bray R.A. (eds), CAB International, Wallingford, 1994, 51-148.

Campbell R.A. & Beveridge I. *Pseudochristianella* (Cestoda: Trypanorhyncha), a new genus for *Tentacularia minuta* (Van Beneden, 1849) *sensu* Southwell, 1929 and its relationships within the family Eutetrarhynchidae. *Transactions of the Royal Society of South Australia*, 1990, *114*, 219-222.

Eschmeyer W.N. Catalog of fishes. California Academy of Sciences, Anaheim, California, 1998, 2905 pp.

Jones M.K., Beveridge I., Campbell R.A. & Palm H.W. Terminology of the sucker-like organs of the scolex of trypa-

norynch cestodes. *Systematic Parasitology*, 2004, *59*, 121-126.

LAST P.R. & STEVENS J.D. Sharks and rays of Australia. CSIRO, Australia, 1994, 513 p.

PALM H.W. The Trypanorhyncha Diesing, 1863. PKSPL-IPB Press, Bogor, 2004, 710 p.

PRITCHARD M.H. & KRUSE G.O.W. The Collection and Preservation of Animal Parasites. University of Nebraska Press, Lincoln, 1982, 141 p.

Reçu le 22 juin 2006
Accepté le 29 septembre 2006