

A New Deep-sea Eelpout, *Pachycara moelleri* (Perciformes: Zoarcidae) from Japan

Gento Shinohara

Department of Zoology, National Museum of Nature and Science,
4–1–1 Amakubo, Tsukuba, Ibaraki 305–0005, Japan
E-mail: s-gento@kahaku.go.jp

Abstract A new zoarcid fish, *Pachycara moelleri*, is described from a single 318 mm specimen collected from off Kii Peninsula, Japan in 4,093 m. The new species is distinguished from its congeners in having following characters: vertebrae $31 + 78 = 109$; lateral line configuration with mediolateral branch originating at posterior quarter of trunk; pelvic fins absent; palatine teeth in two rows; no pseudobranch filaments; tricuspid and bicuspid rakers present on first gill arch; interorbital space wide; nostril tube short, not reaching to upper lip; branchiostegal rays 7; suborbital pores 6, postorbital pores 2 (positions 1 and 4), preoperculomandibular pores 8 (4 + 4); whitish horseshoe-shaped blotches on dorsal fin. This record is the first occurrence of *Pachycara* from the Western North Pacific.

Key words: Abyssal zone, Deep-sea fishes, Kii Peninsula, New species, Western North Pacific.

The zoarcid genus *Pachycara* Zugmayer, 1911 includes 24 deep-sea species, all inhabiting the upper bathyal to abyssal zones (Anderson and Fedorov, 2004; Anderson, 2006; Møller and King, 2007). The species of *Pachycara* have been described and/or reported from the Atlantic, Indian, southwestern and eastern Pacific, and Southern oceans. No specimens of *Pachycara* have been collected from the Western North Pacific.

In 2008, one specimen of a species belonging to *Pachycara* was collected from the abyssal zone of the Pacific side of Japan during a deep-sea organism survey made by the R/V *Soyo-maru* of the National Fisheries Research Institute. This species is similar to some known species from the Indian Ocean in its lateral line configuration, lack of pelvic fins and/or absence of pseudobranch filaments. The new species differs from its congeners in having unique lateral line configuration and is described here as new to science.

Materials and Methods

Methods for taking counts and measurements

follow Peden and Anderson (1978) and Anderson (1982). Vertebrae and other osteological elements were examined from radiographs and computed tomography. Terminology of head pores follows Anderson (1994). Total length (TL), standard length (SL), and head length (HL) are used throughout. Gill raker shape was examined by the versatile staining with Cyanine Blue (Saruwatari *et al.*, 1997).

The specimen is deposited in the Department of Zoology, National Museum of Nature and Science, Tsukuba (NSMT).

Pachycara Zugmayer, 1911

(New Japanese name: Bouzugenge-zoku)

Remarks. The latest diagnosis of the genus was proposed by Anderson (1994) as follows: suborbital bones 6–8, canal with 5–7 pores; submental crests absent; parasphenoid wing below mid-height of trigeminofacial foramen; palatopterygoid series well developed; flesh firm; scales, pyloric caeca, lateral lines, vomerine and palatine teeth present; pseudobranch filaments, and pelvic fins present or absent; vertebrae $21–32 + 67–94 =$

93–122. When Geistodoerfer (1994) originally described *Pachycara thermophilum* from the Mid-Atlantic Ridge, he incorrectly diagnosed this species as having no lateral lines on the body (see Anderson and Bluhm, 1996). On the other hand vertebral number should be slightly broadened to $21-34 + 67-94 = 93-123$ by the recent discovery of *Pachycara saldanhai* Biscoito and Almeida, 2004.

Anderson (1989) noted that *Pachycara* may be closely related to *Lycodes* Reinhardt, 1831 phylogenetically and gave as example one apomorphic character (=reduced parasphenoid wing) and three plesiomorphic characters, i.e., retention of oral valve, retention of small head pores, and lack of submental crests. Møller and Anderson (2000) demonstrated morphological differences among *Lycenchelys* Gill, 1884, *Lycodes*, and *Pachycara*. Although it is possible to separate *Pachycara* by external characters (e.g., no submental crests, head pores not well developed) from its close congeners, the monophyly and phylogenetic position are thought to be still in question. More anatomical and molecular data on species of *Pachycara* are strongly needed to

resolve these problems.

Importantly, for identification of species of *Pachycara*, gill raker morphology and lateral line configuration were shown to be highly valuable (Anderson, 1989, 1994).

The new Japanese name comes from the word that appears in each of the three Japanese names proposed by Nakaya *et al.* (2009) for eelpout specimens collected off Peru during a joint Japanese-Peruvian trawl survey 1998–2003.

***Pachycara moelleri* sp. nov.**

(New Japanese name: Souyou-bouzugenge)

(Figs. 1–5, Table 1)

Holotype. NSMT-P 105631, female, 312.0 mm SL (318.0 mm TL), Pacific off Kii Peninsula, Wakayama, Honshu, Japan (32°0.7'N, 135°57.2'E–32°0.3'N, 136°2.7'E), 4,093 m, 5 August 2008, crab trap “Kanikago” (=crab baskets), R/V *Soyo-maru*, coll. by K. Fujimoto and M. Okanishi.

Diagnosis. Vertebrae $31 + 78 = 109$; lateral line configuration with mediolateral branch originating at posterior quarter of trunk; pelvic fins



Fig. 1. Fresh condition (top), formalin fixed condition (middle), and drawing (bottom) of *Pachycara moelleri* sp. nov., holotype, NSMT-P 105631, female, 312.0 mm SL.

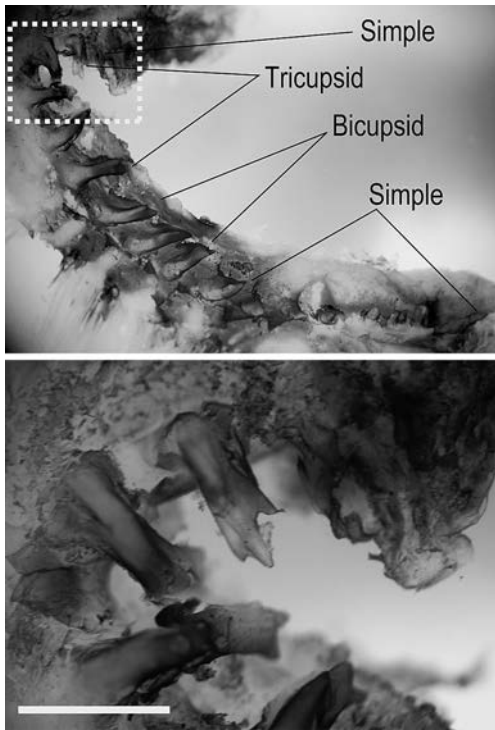


Fig. 2. Gill rakers on first gill arch (right side) of *Pachycara moelleri* sp. nov., holotype, NSMT-P 105631, female, 312.0 mm SL. Upper, distribution three types of gill rakers; lower, magnified square part with white dot lines in upper figure. Stained by Cyanin Blue. Bar = 1 mm.

absent; palatine teeth in two rows; no pseudo-branch filaments; tricuspid and bicuspid gill rakers present on first arch; interorbital space wide; nostril tube short, not reaching to upper lip; branchiostegal rays 7; suborbital pores 6, postorbital pores 2 (positions 1 and 4), and preoperculo-mandibular pores 8 (4 + 4); whitish horseshoe-shaped blotches on dorsal fin.

Description. Counts and measurements are shown in Table 1. Flesh firm, not gelatinous (Fig. 1). Body moderately elongate; trunk robust, tail laterally compressed. Head ovoid, robust. Snout broad, rounded, anterior profile vertical. Eye small, almost rounded, not reaching dorsal profile of head. Interorbital space broad, its width more than half of snout length. Mouth subterminal; upper lip continuous across snout; lower lip with thin labial lobe. Upper jaw not protruding,

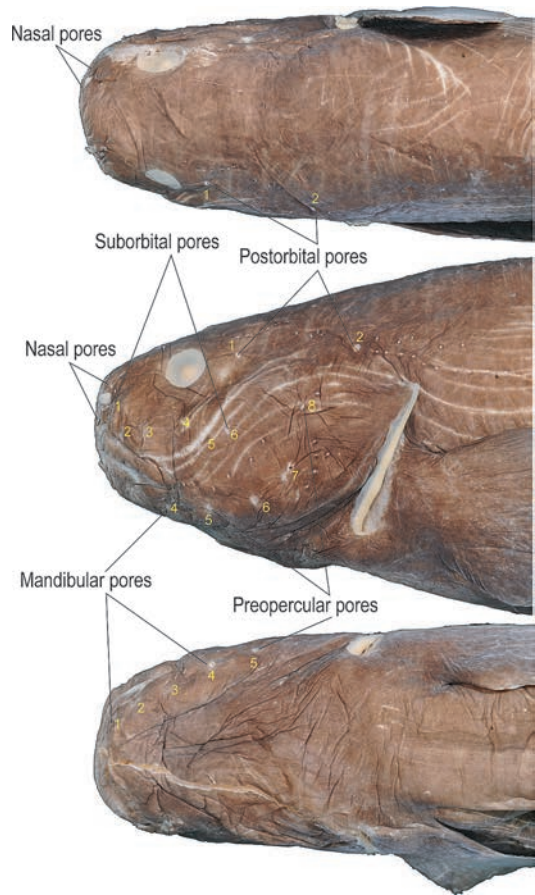


Fig. 3. Head pores of *Pachycara moelleri* sp. nov., holotype, NSMT-P 105631, female, 312.0 mm SL.

extending posteriorly to middle of eye. Nasal tube very short, not reaching upper lip. Gill slit extending ventrally and reaching base of 17th pectoral fin ray. Opercular lobe at dorsal margin of gill slit developed. Tricuspid, bicuspid and single-tip gill rakers on first arch (Fig. 2). Branchiostegal rays 7. Upper origin of pectoral fin at level of body midheight. Pelvic fins absent.

Jaw, vomer and palatine teeth small, conical. Premaxilla with two rows of teeth anteriorly and single row posteriorly. Dentary with 4–5 rows of teeth anteriorly blending to single row posteriorly. Vomerine teeth in irregular patch. Palatine teeth in 2 rows.

Head pores developed (Fig. 3). Postorbital pores 2, located at positions 1 and 4 (*sensu*

Table 1. Comparison of meristic and morphometric characters among species of *Pachycara* with 3 rows body neuromasts.

	<i>P. moelleri</i> sp. nov.	<i>P. andersoni</i> ^a	<i>P. shcherbachevi</i> ^a
	Holotype	<i>n</i> = 31	<i>n</i> = 2
	312 mm SL	123–250 mm SL	236–272 mm SL
Counts			
Dorsal fin rays	103	92–97	112
Anal fin rays	83	76–80	94
Pectoral fin rays	19 ^b	18–20	16
Caudal fin rays	12	12	12
Precaudal vertebrae	31	24–26	29–32
Caudal vertebrae	78	73–77	90–91
Total vertebrae	109	98–102	120
First dorsal fin pterygiophore associated with vertebra	7	5–6	7
Last precaudal vertebra associated with dorsal fin ray	28	20–23	24
Gill rakers	15	16–17	16
Pseudobranch filaments	0	3–4	3
Dentition			
Teeth on premaxilla	19–20 ^b	9–18	13–27
Teeth on vomer	10	4–8	2–6
Teeth on palatine	18 ^b	5–8	3–4
Teeth on dentary	39–40 ^b	16–26	14
% SL			
Head length	14.7	15.9–18.9	11.4–12.0
Head width	8.7	8.0–13.4	7.7–7.8
Head height	11.2	9.5–12.1	7.2
Snout length	4.1	4.4–5.4	3.5
Nostril tube length	0.7	0.6–1.0	0.5
Eye diameter	1.8	2.0–3.7	1.7
Pupil diameter	1.1	1.5–2.2	1.0
Interorbital width (hard)	2.4	1.1–1.9	1.2
Upper jaw length	5.3	6.1–7.9	4.6–4.8
Lower jaw length	7.6	5.6–7.6	4.0–4.3
Preanal length	44.0	37.2–44.3	34.0
Predorsal length	22.4	18.6–23.0	16.6–20.6
Dorsal fin height above anal fin origin	1.9	2.7–3.7	N/A
Body height at anal fin origin	13.9	8.9–12.7	7.7–8.1
Pectoral fin length	10.9	12.0–15.5	9.2–10.0
Pectoral fin base height	5.2	4.1–5.4	2.6
Gill slit length	6.2	5.2–6.5	4.6
Opercular lobe length	0.9	0.7–1.3	0.8
Isthmus width	7.0	3.9–7.3	4.4
%HL			
Head width	59.2	45.5–76.7	65.0–67.7
Upper jaw length	36.2	34.6–45.1	38.6–39.0
Pectoral fin length	74.2	67.8–89.8	76.4–87.7
Snout length	27.7	23.9–30.6	16.0–29.5
Eye diameter	12.3	12.7–19.9	14.4–23.8
Interorbital width	16.4	7.0–10.5	9.8–13.8
Pectoral base/length ratio	0.48	0.30–0.40	0.28

^aData from Möller (2003)^bBoth sides

Anderson, 1994). Nasal pores 2, one set antero-ventrally to nostril, another posterodorsally. Sub-orbital pores 6. Preoperculomandibular pores 8, 4 arising from dentary (4 mandibular pores) and 1

from anguloarticular and 3 from preopercle (4 preopercular pores). Interorbital and occipital pores absent. Free neuromasts scattered on dorsal and lateral side of head, nape, and above upper

lip.

Lateral line configuration with 3 rows of body neuromasts and short predorsal branch on nape (Fig. 4). Predorsal branch very short, with 7 neuromasts (5 in right side). Dorsolateral branch with 27 neuromasts (23), originating above gill opening and continuing to posterior half of caudal region. Mediolateral branch with 62 neuromasts (67), originating at posterior quarter of trunk and continuing to caudal fin base. Ventral branch with 55 (49).

Body covered with small cycloid scales. Predorsal area, abdomen and pectoral fin base naked. Vertical fins naked anteriorly, 1/3 to 1/2 scaled posteriorly. Caudal fin scaled.

Osteology. Suborbital bones 6: first bone largest, articulating with palatine; others small, tube-like. Maxilla long, slender. Premaxilla with developed ascending process. Dentary with prominent knob anteroventally. No submental crests. Palatopterygoid series (= palatine, mesopterygoid and ectopterygoid) well developed (Fig. 5). Quadrate with developed notch posteriorly for symplectic. Opercle with a single projection on anterodorsal margin. Parasphenoid wing reduced, articulating with pterosphenoid and frontal dorsally. Ceratohyal-epihyal articulation smooth. Branchiostegal rays 4 on ceratohyal, 1 on ceratohyal-epihyal junction, and 2 on epihyal. Lower pharyngeal teeth well developed. Three pharyngeals with tooth patch. Pectoral actinosts 4. Scapular foramen enclosed by bone. Postcleithrum single, slender. No pelvis. Epurals 1, upper hypural plate fused to preural centra 1. Lower hypural plate fused to parhypural. Epineurals from vertebra 1 and pleural ribs from vertebra 4 (3 in left) and continuing posteriorly (positions of the last epineural and the last pleural rib were impossible to be determined from radiographs). Vertebral centra symmetrical. Anal fin pterygiophore 5 inserted anterior to haemal spine of first caudal vertebra. Caudal fin with 2 epural, 5 upper and 5 lower hypural rays.

Color. Fresh condition just after capture is shown in Fig. 1; following description based on recently formalin fixed and alcohol preserved

specimen. Head and body dark brown. Nasal tube white. Pectoral fin dark purple. Two whitish horseshoe-shaped blotches on middle of dorsal fin (Figs. 1, 4). Roof of oral cavity with melanophores. Peritoneum black.

Etymology. The specific name is adopted in honor of Peter Rask Møller, University of Copenhagen, in recognition of his valuable contributions to systematics on deep-sea eelpouts including *Pachycara*.

Distribution. Known only from the Western North Pacific off Kii Peninsula, Honshu, Japan at 4,093 m depth.

Comparison. *Pachycara moelleri* sp. nov. appears to be distinct from all species in having 7 branchiostegal rays (4–5 in *Pachycara rimae* Anderson, 1989 and 6 in the other species), although the original description of *Pachycara cousinsi* Møller and King, 2007 lacks the branchiostegal ray count.

In having 4 rows of neuromasts in lateral lines, *P. moelleri* sp. nov. is the most similar to *Pachycara schcherbachevi* Anderson, 1989 and *Pachycara andersoni* Møller, 2003, both species known from the Indian Ocean. The new species is distinguished from them in having a shorter mediolateral branch of the lateral line system, no pseudobranch filaments, no pelvic fins, slightly larger interorbital width and double tooth rows with higher numbers of teeth on the palatines and dentary which are dependent on the different tooth-row numbers (Table 1). *Pachycara moelleri* sp. nov. is further distinguished from *P. schcherbachevi* in having a larger head length (14.7% SL vs. 11.4–12.0% SL) and higher pectoral fin ray counts (19 vs. 16). The new species is similar to *P. andersoni* in having a robust body, but it is further separated from the latter species in having tricupsid and bicupsid gill rakers (Fig. 2).

Five species were described from the Indian Ocean including the above two (Anderson, 1989; Møller, 2003; Møller and King, 2007). The remaining species, i.e., *Pachycara arabica* Møller, 2003, *P. cousinsi* and *Pachycara priedei* Møller and King, 2007, are somewhat similar to

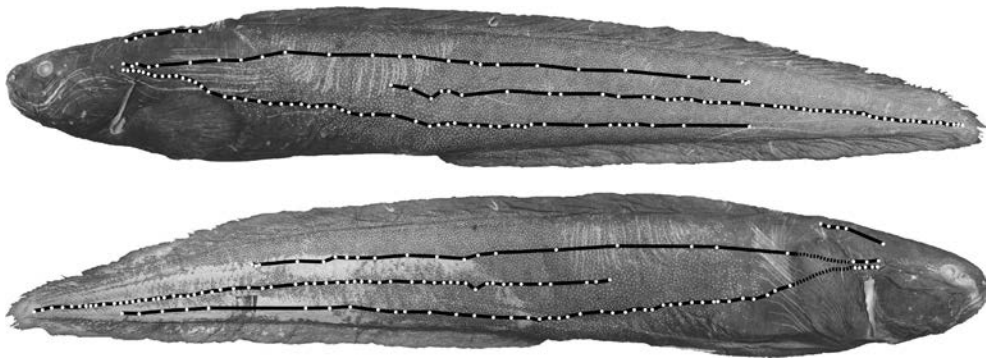


Fig. 4. Lateral line system of *Pachycara moelleri* sp. nov., holotype, NSMT-P 105631, female, 312.0 mm SL.

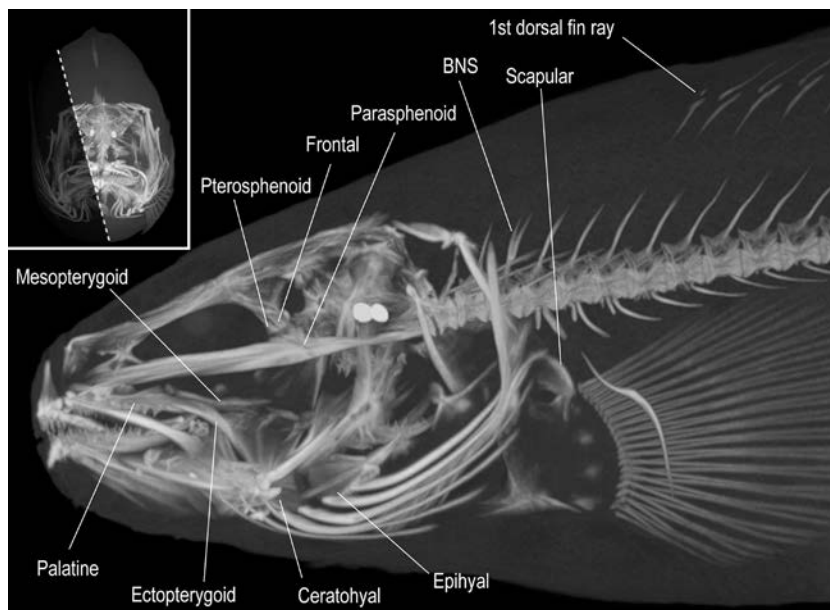


Fig. 5. Computed tomography for head of *Pachycara moelleri* sp. nov., holotype, NSMT-P 105631, female. BNS, branched neural spine. Inset showing frontal view of head and captured part (lighter area).

P. moelleri sp. nov. in having no pelvic fins, 0–3 pseudobranch filaments and a pectoral fin base/length ratio of 0.33–0.50. In addition to the different number of neuromast rows (= branches) in the lateral lines (3 in *P. arabica* and 2 in *P. cousinsi* and *P. priedei*), *P. moelleri* sp. nov. is further distinguished from *P. arabica* in having a shorter pectoral fin length (10.9% SL vs. 13.3% SL in the latter species), from *P. cousinsi* in its shorter predorsal length (22.4% SL vs. 26.5% SL), and from *P. priedei* in its different body coloration

(dark brown vs. pale pink).

Among nine species recorded from the Pacific Ocean (Anderson, 2006, 2009; Anderson and Fedorov, 2004), *P. moelleri* sp. nov. resembles *Pachycara bulbiceps* (Garman, 1899), some individuals of *Pachycara mesoporum* Anderson, 1989, and *Pachycara nazca* Anderson and Bluhm, 1997 in lacking pelvic fins. The new species can be separated from *P. bulbiceps* by the presence of predorsal and dorsolateral lateral line branches and from *P. nazca* in having predorsal, dorsolat-

eral, and ventral branches. It can be distinguished from *P. mesoporum* by its lack of a single, medial occipital pore (vs. presence) and presence of 2 postorbital pores (vs. 3–4).

Two species are known from the Southern Ocean (Anderson, 1990, 1991) and eight (including above *P. bulbiceps*) from the Atlantic (Anderson, 1989; Biscoito and Almeida, 2004; Anderson and Mincarone, 2006). The new species differs from all Antarctic and Atlantic species, except *P. bulbiceps*, in lacking pelvic fins and pseudobranch filaments.

Taxonomic notes. A branched neural spine (Fig. 5: BNS) has not been reported among the Zoarcidae. It is considered abnormal and was not included to the diagnostic characters.

Acknowledgments

I express my sincere thanks to the following persons: Ken Fujimoto (National Research Institute of Fisheries Science, Yokohama), Masanori Okanishi (University of Tokyo), and all officers and crew of the R/V *Soyo-maru* for supplying the specimen. Thanks to Toshihiko Fujita and Kaoru Kuriwa (NSMT) for pictures of holotype and Yutaro Inoue (NSMT) for drawing of holotype. M. Eric Anderson (South African Institute of Aquatic Biodiversity) read an early draft manuscript critically and helped with English language adjustments.

Literature Cited

- Anderson, M. E. 1982. Revision of the fish genera *Gymnelus* Reinhardt and *Gymnelopsis* Soldatov (Zoarcidae), with two new species and comparative osteology of *Gymnelus viridis*. National Museum of Canada Publications in Zoology, (17): i–iv + 1–76.
- Anderson, M. E. 1989. Review of the eelpout genus *Pachycara* Zugmayer, 1911 (Teleostei: Zoarcidae), with description of six new species. Proceedings of the California Academy of Sciences, 46: 221–242.
- Anderson, M. E. 1990. Zoarcidae eelpouts. Pages 256–276 in Gon, O. and P. C. Heemstra, eds. Fishes of the Southern Ocean. J. L. B. Smith Institute of Ichthyology, Grahamstown.
- Anderson, M. E. 1991. Studies on the Zoarcidae (Teleostei: Perciformes) of the Southern Hemisphere. V. Two new species from the Weddell Sea, Antarctica. Cybium, 15: 151–158.
- Anderson, M. E. 1994. Systematics and osteology of the Zoarcidae (Teleostei: Perciformes). Ichthyological Bulletin of the J. L. B. Smith Institute of Ichthyology, (60): 1–120.
- Anderson, M. E. 2006. Studies on the Zoarcidae (Teleostei: Perciformes) of the Southern Hemisphere. XII. Two new lycodine species. Species Diversity, 11: 183–190.
- Anderson, M. E. 2009. Zoarcidae eelpouts. Pages 287–289 in Nakaya, K., M. Yabe, H. Imamura, M. Romero Camarena, and M. Yoshida, eds. Deep-sea fishes of Peru. Japan Deep Sea Trawlers Association, Tokyo.
- Anderson, M. E. and H. Bluhm. 1996. Description of a new species of *Pachycara* Zugmayer, 1911 from the abyssal South-eastern Pacific and redescription of *P. thermophilum* Geistdoerfer, 1994, with a new keys to the species. Transactions of the Royal Society of South Africa, 51: 219–227.
- Anderson, M. E. and V. V. Fedorov. 2004. Family Zoarcidae Swainson 1839 eelpouts. California Academy of Sciences Annotated Checklists of Fishes, (34): 1–58.
- Anderson, M. E. and M. M. Mincarone. 2006. Studies on the Zoarcidae (Teleostei: Perciformes) of the southern hemisphere. IX. A new species of *Pachycara* from the southwestern Atlantic. Zootaxa, 1177: 21–26.
- Biscoito, M. and A. J. Almeida. 2004. New species of *Pachycara* Zugmayer (Pisces: Zoarcidae) from the Rainbow hydrothermal vent field (Mid-Atlantic Ridge). Copeia, 2004: 562–568.
- Garman, S. 1899. Reports of 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. XXVI. The fishes. Memoirs of the Museum of Comparative Zoology, 24: 1–431.
- Geistdoerfer, P. 1994. *Pachycara thermophilum*, une nouvelle espèce de poisson Zoarcidae des sites hydrothermaux de la dorsale médio-atlantique. Cybium, 18: 109–115.
- Gill, T. N. 1884. On the anacanthine fishes. Proceedings of the Academy of Natural Sciences of Philadelphia, 36: 167–183.
- Peden, A. E. and M. E. Anderson. 1978. A systematic review of the fish genus *Lycodapus* (Zoarcidae) with descriptions of two new species. Canadian Journal of Zoology, 56: 1925–1961.
- Møller, P. R. 2003. Two new species of *Pachycara* Zugmayer (Teleostei: Zoarcidae) from the Indian Ocean, with redescription of *Pachycara shcherbachevi* Anderson. Copeia, 2003: 357–365.
- Møller, P. R. and M. E. Anderson. 2000. Assignment of

- Lycodes microcephalum* Jensen, 1902 to *Pachycara* Zugmayer, 1911 (Teleostei: Zoarcidae). *Cybiurn*, 24: 61–65.
- Møller, P. R. and N. King. 2007. Two new species of *Pachycara* (Teleostei: Zoarcidae) from the Sub-Antarctic southern Indian Ocean, and range extension of *Lycenchelys antarctica*. *Copeia*, 2007: 586–593.
- Nakaya, K., M. Yabe, H. Imamura, M. Romero Camarena, and M. Yoshida, eds. 2009. Deep-sea fishes of Peru. Japan Deep Sea Trawlers Association, Tokyo. 356 pp.
- Reinhardt, J. C. H. 1831. Bidrag til vor Kundskab om Grønlands Fiske. Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandling og dets Medlemmers Arbejder (Kjøbenhavn), 1830–1831: 18–24.
- Saruwatari, T., J. A. López and T. W. Pietsch. 1997. Cyanine Blue: A versatile and harmless stain for specimen observation. *Copeia*, 1997: 840–841.
- Zugmayer, E. 1911. Diagnoses de poissons nouveaux provenant des campagnes du yacht “Princesse-Alice” (1901 à 1910). Bulletin de l’Institut Oceanographique (Monaco), (193): 1–14.

Manuscript received 10 November 2011; revised 26 February 2012; accepted 5 March 2012.

Associate editor: S. Kimura