Zootaxa 3367: 1–4 (2012)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

ZOOTAXA

3367

Scientific Results of the Kumejima Marine Biodiversity Expedition—KUMEJIMA 2009

Tohru NARUSE, Tin-Yam CHAN, Heok Hui TAN, Shane T. AYHONG & James Davis REIMER

Magnolia Press
Auckland, New Zealand

Accepted: 31 Jan. 2012; published: 4 Jul. 2012

Tohru NARUSE, Tin-Yam CHAN, Heok Hui TAN, Shane T. AYHONG & James Davis REIMER (ED.)
Scientific Results of the Kumejima Marine Biodiversity Expedition—KUMEJIMA 2009
(*Zootaxa* 3367)

280 pp.; 30 cm.

4 Jul. 2012

ISBN 978-1-86977-953-5 (paperback)

ISBN 978-1-86977-954-2 (Online edition)

FIRST PUBLISHED IN 2012 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: zootaxa@mapress.com

http://www.mapress.com/zootaxa/

ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

Scientific Results of the Kumejima Marine Biodiversity Expedition—KUMEJIMA 2009

Tohru NARUSE, Tin-Yam CHAN, Heok Hui TAN, Shane T. AYHONG & James Davis REIMER (ED.)

Table of contents

Zootaxa 3367: 5–7 (2012)
www.mapress.com/zootaxa/

Editorial

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Scientific Results of the Kumejima Marine Biodiversity Expedition—KUMEJIMA 2009—Editorial*

TOHRU NARUSE[1, 2], TIN-YAM CHAN[3], HEOK HUI TAN[4], SHANE T. AHYONG[5]
& JAMES DAVIS REIMER[1]

[1] *Transdisciplinary Research Organization for Subtropical and Island Studies, University of the Ryukyus, 1 Senbaru, Nishihara, Okinawa 903-0213, Japan*

[2] *Current affiliation: Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan. E-mail: naruse@lab.u-ryukyu.ac.jp*

[3] *Institute of Marine Biology and Center of Excellence for Marine Bioenvironment and Biotechnology, National Taiwan Ocean University, Keelung 20224, Taiwan, R.O.C.*

[4] *Raffles Museum of Biodiversity Research, Department of Biological Sciences, National University of Singapore, 6 Science Drive 2, #03-01, Singapore 117546, Republic of Singapore*

[5] *Australian Museum, College Street, Sydney, NSW 2010, Australia*

* *In*: Naruse, T., Chan, T.-Y., Tan H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

This special issue of Zootaxa is dedicated to scientific results of a marine biodiversity workshop, Kumejima Marine Biodiversity Expedition — KUMEJIMA 2009. The idea of this expedition was conceived at the end of the year 2008. Following major successes of several Franco-Taiwanese-Singaporean marine biodiversity expeditions in the Philippines (Bouchet *et al.* 2009; Richer de Forges *et al.* 2009), two key participants of these surveys (Drs. Peter K. L. Ng and Tin-Yam Chan) had various discussions on potential future exploration sites in Asia. During that period, the first author was working on an enormous amount of important brachyuran material collected from the Philippine expeditions and realised the potential of such explorations. He expressed a strong interest in conducting similar expeditions at his own field site, the Ryukyu Islands in southwestern Japan. In 2008, together with Dr. Yoshihisa Fujita, he subsequently formally proposed Kumejima (= Kume Island) to Drs. Chan and Ng as the next exploration site. This culminated in a joint Japanese-Singaporean-Taiwanese expedition to Kumejima, which also received full support from the Biodiversity Research Center, Academia Sinica, Taiwan.

FIGURE 1. Group photograph of the KUMEJIMA 2009 expedition (9 Nov. 2009) (Photograph courtesy of Yoshihisa Fujita)

Accepted by Z.Q. Zhang: 31 Jan. 2012; published: 4 Jul. 2012

Kumejima is located about 100 km west of Okinawa Island. The land area of the island is approximately 59.1 km^2, and the highest point is about 310 m above sea level. Although the island is not large or high, it has a number of relict terrestrial species. For example, Kikuzato's stream snake, *Opisthotropis kikuzatoi* (Okada & Takara, 1958) (Reptilia) and the Kumejima firefly, *Luciola owadai* M. Satô & Kimura, 1994 (Coleoptera), are iconic species, and have received much attention from biologists. Kumejima is also surrounded by a wide variety of different marine habitats, e.g., intertidal mudflats and rocky shores, beautiful coral reefs, muddy/sandy substrates, submarine limestone caves, and very deep water just offshore. These rich environments attract recreational divers and nature lovers, especially scientists, and this has led to some interesting and exciting discoveries by Japanese biologists. For example, Mr. Shinji Ogawa, a local field guide and skilful diver, has contributed to many new discoveries of mollusc and crustacean species from the island. Mr. Seiji Nagai, an avid crab collector, in the 1990s found several crabs not previously known from Japan (Marumura & Kosaka 2002). Mr. Syou Hirayama, an amateur carcinologist and skilled diver, together with Mr. Keiichi Nomura (Kushimoto Marine Park) reported on some interesting decapod crustaceans from the island (Hirayama 1997; Hirayama & Nomura, unpublished data). Research activities on the island's marine fauna became more active in the 2000s with frequent reports of new species. For example, *Neoliomera cerasinus* Ng, 2002, *Atoportunus dolichopus* Takeda, 2003 (both Brachyura), *Odontozona fasciata* Okuno, 2003 (Stenopodidea), *Pagurixus longipes* Osawa, Fujita & Okuno, 2006, and *Pylopaguropsis bellula* Osawa & Okuno, 2007 (both Anomura) were described as new from Kumejima's submarine caves. Dr. Junji Okuno, together with Mr. Tsuyoshi Kawamoto, has also published a beautiful photo-guidebook on the decapod crustaceans of Kumejima (Kawamoto & Okuno 2003). In addition, a new taxon and a range extension of several fish species were recorded by Senou & Kawamoto (2002) and Suzuki *et al.* (2008, 2009). Another group of scientists, led by Dr. Takashi Kuramochi and the Okinawa Prefectural Deep Sea Water Research Center, have also recorded many rare deepwater Pleurobranchomorpha, crustaceans, cephalopods, echinoderms and fishes from the island (e.g., Kuramochi *et al.* 2002a, b, 2003a, b, 2007).

The KUMEJIMA 2009 expedition was conducted from 8 November 2009 for approximately two weeks. This expedition also became one of the largest international biodiversity surveys held in Japan in recent years; involving more than 50 scientists and students from 17 research institutions from seven countries. The expedition was very successful, resulting in the discovery of more than 50 new taxa (T. Naruse, unpublished data) — and this number is increasing steadily with on-going studies of the collected specimens.

This special issue contains 23 papers on crustaceans, echinoderms and fishes by 28 authors, validates two new genera and 24 new species. This special issue provides a large amount of new information on the marine fauna of Kumeijima and the Ryukyus, and hopefully, will attract more people to conduct similar faunistic studies to enhance our knowledge of the area's rich biodiversity.

Acknowledgements

We sincerely thank all authors and reviewers for their contributions and support. Thanks are also due to all the scientific participants as well as the local people who have supported the expedition in various ways. We could not have published this issue without their help. We also thank Martyn E. Y. Low (University of the Ryukyus) and Ng Ngan Kee (National University of Singapore) for their help in editing this issue and Junji Okuno (Coastal Branch of Natural History Museum and Institute, Chiba) and Yoshihisa Fujita (University of the Ryukyus / Marine Learning Center) for providing us with information on earlier research at Kumejima. The expedition was supported by Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, Center of Excellence for Marine Bioenvironment and Biotechnology of the National Taiwan Ocean University, Raffles Museum of Biodiversity Research of the National University of Singapore, and Academia Sinica (Taiwan).

References

Bouchet, P., Ng, P. K. L., Largo, D. & Tan, S. H. (2009) PANGLAO 2004 — Investigations of the marine species richness in the Philippines. *Raffles Bulletin of Zoology*, Supplement 20: 1–19.

Hirayama, S. (1997) Some interesting crustacean species found in Kume-jima Island, the Ryukyus. *I.O.P. Diving News*, 8(10), 2–7. [in Japanese with English abstract and figure caption]

Kawamoto, T. & Okuno, J. (2003) *Shrimps and crabs of Kume Island, Okinawa*. First printing. Hankyu Communications, Tokyo. 173 pp. [in Japanese.]

Kuramochi, T., Sudou, Y., Ogawa, M., Tamaki, E., Toma, T. & Naganuma, T. (2002a) A record of *Pleurobranchella nicobarica* Thiele, 1925 : (Pleurobranchomopha : Pleurobranchidae) from off Kume Island, Ryukyu Islands, Southwestern Japan. *Chiribotan*, 33(1/2), 27–29. [in Japanese with English abstract and figure caption]

Kuramochi, T., Sudou, Y., Ogawa, M., Tamaki, E., Toma, T. & Naganuma, T. (2002b) A record of *Thaumastocheles japonicus* Calman, 1913 (Decapoda: Thaumastochelidae) from off Kume Island, Ryukyu Islands, Western Japan. *Nankiseibutsu*, 44(2), 147–148. [in Japanese with English figure captions]

Kuramochi, T., Sudou, Y., Ogawa, M., Tamaki, E. & Naganuma, T. (2003a) Record of *Cryptopsara couesii* Gill (Lophiiformes: Ceratiidae) from off-Kume Island, Ryukyu Islands, Western Japan. *Journal of the Graduate School of Biospere Science, Hiroshima University*, 42, 11–14. [in Japanese with English abstract and figure caption]

Kuramochi, T., Sudou, Y., Ogawa, M., Tamaki, E., Toma, T. & Naganuma, T. (2003b) A record of *Enypniastes eximia* (Elasipoda: Holothuroidea) from Kume Island, Ryukyu Islands, Western Japan. *Nankiseibutsu*, 45(2), 134–135. [in Japanese with English figure captions]

Kuramochi, T., Sudou, Y., Shiroma, K. Ogawa, M., Tamaki, E. & Naganuma, T. (2007) Record of *Octopus tenuicirrus* (Mollusca, Cephalopoda) collectef from off Kume Island, Ryukyu Islands, south western Japan. *Nankiseibutsu*, (1), 53–54. [in Japanese with English figure captions]

Marumura, M. & Kosaka, A. (2003) *Catalogue of Brachyuran and Anomuran crabs Collection Donated by the late Mr. Seiji Nagai to the Wakayama Prefectural Museum of Natural History.* Wakayama Prefectural Museum of Natural History, Wakayama. 74 pp. [in Japanese.]

Ng, P. K. L. (2002) On a new species of cavernicolous *Neoliomera* (Crustacea: Decapoda: Brachyura: Xanthidae) from Christmas island and Ryukyus, Japan. *Raffles Bulletin of Zoology*, 50, 95–99.

Okada, Y. & Takara, T. (1958) A new species of *Liopeltis* (Ophidia, Colubridae) from Ryukyu Islands. *Bulletin of the Biogeographical Society of Japan*, 20(3), 1–3.

Okuno, J. (2003) A new species of the genus *Odontozona* Holthuis, 1946 (Crustacea: Decapoda: Stenopodidae) from submarine caves in southern Japan. *Natural History Research*, 7, 167–180.

Osawa, M. & Okuno, J. (2007) A new species of the genus *Pylopaguropsis* (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, southwestern Japan, with notes on two poorly known species. *Species Diversity*, 12(1), 29–46.

Osawa, M., Fujita, Y. & Okuno, J. (2006) Two new species of *Pagurixus* (Crustacea: Decapoda: Anomura: Paguridae) from submarine caves of the Ryukyu Islands, southwestern Japan. *Zootaxa*, 1148, 27–45.

Richer de Forges, B., Tan, S. H., Bouchet, P., Ng, P. K. L., Chan, T.-Y. & Saguil, N. (2009) PANGLAO 2005 — Survey of the deep-water benthic fauna of the Bohol Sea and adjacent waters. *Raffles Bulletin of Zoology*, Supplement 20, 21–38.

Satô, M. & Kimura, M. (1994) Discovery of a new firefly of the genus *Luciola* (Coleoptera, Lampyridae) from Kume-jima of the Ryukyu Islands. *Elytra*, 22(1), 159–162.

Senou, H. & Kawamoto, T. (2002) First record of a frogfish, *Antennarius randalli* from Japan. *I.O.P. Diving News*, 13(4), 2–6. [in Japanese with English abstract and figure caption]

Suzuki, T., Senou, H., Yano, K., Kato, S. & Yunokawa, K. (2008) First records of three gobiid fish Genus *Trimma* Japan. *Bulletin of the Osaka Museum of Natural History*, 62, 1–12. [in Japanese with English abstract and figure caption]

Suzuki, T. & Senou, H. (2009) Two new species of the genus *Trimma* (Perciformes: Gobiidae). *Bulletin of the Kanagawa Prefectural Museum (Natural Sciences)*, 38, 107–112.

Takeda, M., 2003. *Atoportunus dolichopus*, a new cavernicolous crab of the family Portunidae (Crustacea: Decapoda) from the Ryukyu Islands. *Bulletin of the National Science Museum*, Tokyo, Series A, 29(3), 141–146.

Zootaxa 3367: 8–20 (2012)
www.mapress.com/zootaxa/

Editorial

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

The KUMEMEJIMA 2009 Expedition: station data and collecting sites*

TOHRU NARUSE[1, 2]

[1] *Transdisciplinary Research Organization for Subtropical and Island Studies, University of the Ryukyus, 1 Senbaru, Nishihara, Okinawa 903-0213, Japan*

[2] *Current affiliation: Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan. E-mail: naruse@lab.u-ryukyu.ac.jp*

* *In*: Naruse, T., Chan, T.-Y., Tan H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. Zootaxa, 3367, 1–280.

Abstract

The present paper introduces the sampling methods employed during the Marine Biodiversity Expedition — KUMEJIMA 2009. Data of all sampling stations are listed.

Key words: KUMEJIMA 2009 Expedition, methodology, sampling, station data

Introduction

The present expedition was originally planned with the idea of a biodiversity rich area of the Ryukyu Islands. Kumejima (= Kume Island) in the central Ryukyus (Fig. 1) selected as exploration site, as it is a relatively small

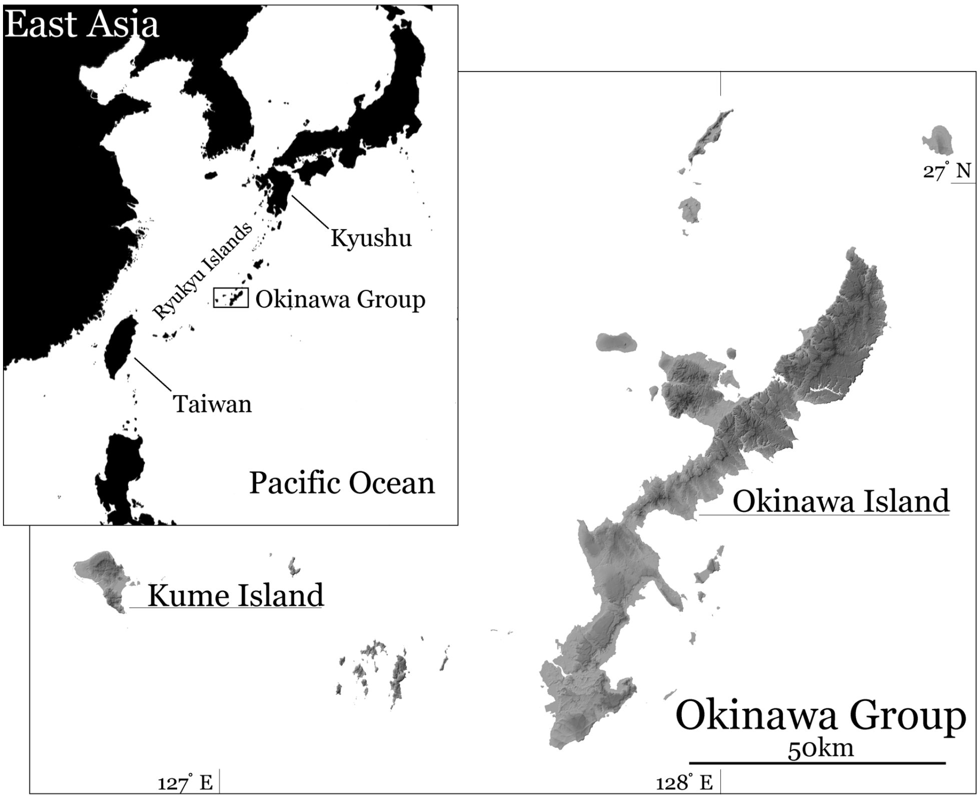


FIGURE 1. Map of Kumejima in the Ryukyu Islands, and East Asia.

Accepted by Z.Q. Zhang: 31 Jan.2012; published: 4 Jul. 2012

island with a rich diversity of marine environments. During the two-week expedition, more than 150 stations were surveyed by various methods. The present paper briefly introduces the sampling methods employed during the expedition and lists the data for the various sampling stations.

Methodology

Trawling and dredging. The trawling and dredging team was led primarily by Bertrand Richer de Forges and Tin-Yam Chan. A fisherman's boat, "*Daisan-Emi-maru*" (3.8 t), was used to operate bottom trawling and dredging (Fig. 2). Two sets of 1.2 m beam trawls and triangular dredges (90 cm-long rods) were constructed in Taiwan. These trawls and dredges were equipped with 3.1 m and 1.5 m nets, respectively. The mesh size of the net was 0.8 cm (Fig. 3). Oblong metal dredges with finer mesh-sized nets were also used (Fig. 3). A total of 35 trawling and 49 dredging stations, with a maximum depth of 225 m, were sampled (Table 1, Fig. 4). Stations of trawling and dredging were coded as "Trawl #" and "Dredge #", respectively.

FIGURE 2. Trawl/dredge team in operation on "*Daisan-Emi-maru*".

Scuba diving. The scuba diving team was led by primarily by Yoshihisa Fujita and Daisuke Uyeno. A total of 43 dives with normal air were conducted. These included three night and several cave dives; the maximum surveyed depth was 55 m (Table 2, Fig. 5). The diving activities were supported by local fishermen, as well as by local diving instructors and dive operators. Specimens were collected by hand, yabbie pumping, gill netting, etc. (Fig. 6). Diving stations were coded as "Dive #". Specimens collected by small bait traps set during these dives were also included in the diving collections.

TABLE 1. Trawl and dredge stations of KUMEJIMA 2009.

Station	Date	Starting point			Ending point			Remarks
		Coordinate		Depth (m)	Coordinate		Depth (m)	
Trawl 1	9 Nov. 2009	26.37625	126.72935	69.3				
Trawl 2	9 Nov. 2009	26.37823	126.73388	90.7				Seaweed, cnidarians, fishes.
Trawl 3	9 Nov. 2009	26.38062	126.7395	94.7				Cnidarians.
Trawl 4	9 Nov. 2009	26.3871	126.74625	113				Rubbles, crinoids.
Trawl 5	9 Nov. 2009	26.39353	126.75447	116				Rubbles.
Dredge 1	9 Nov. 2009	26.38252	126.74505	70.7				No material.
Dredge 2	9 Nov. 2009	26.38578	126.74885	70				Shells, rubbles.
Trawl 6	10 Nov. 2009	26.38407	126.7954	64	26.38322	126.79835	81.3	Rubbles.
Trawl 7	10 Nov. 2009	26.38483	126.7972	82	26.38277	126.79895	81.3	Rubbles.
Trawl 8	10 Nov. 2009	26.38467	126.79967	98	26.38197	126.8022	102	
Dredge 9	10 Nov. 2009	26.38192	126.80265	118	26.37933	126.8046	131	
Dredge 10	10 Nov. 2009	26.3797	126.80335	101	26.3777	126.80625		
Dredge 11	10 Nov. 2009	26.3801	126.80058	68	26.37783	126.80545		
Dredge 12	11 Nov. 2009	26.29097	126.85172	88	26.28973	126.85767	105	
Trawl 13	11 Nov. 2009	26.28973	126.85885	105	26.28725	126.86005	112	
Trawl 14	11 Nov. 2009	26.28158	126.85467	116	26.27338	126.85808		
Trawl 15	11 Nov. 2009	26.3055	126.82883	27	26.30585	126.8289	28	
Dredge 16	11 Nov. 2009	26.30348	126.82728	32	26.30125	126.82848	32	
Dredge 17	11 Nov. 2009	26.30122	126.82518	40	26.30028	126.82563	30	
Dredge 18	11 Nov. 2009	26.32252	126.82788	14	26.32175	126.82947	14	
Dredge 19	11 Nov. 2009	26.32535	126.83038	5	26.32435	126.83173	5	Sand, seaweed.
Dredge 20	11 Nov. 2009	26.32382	126.78193	5.5	26.32342	126.8322	6	
Dredge 21	11 Nov. 2009	26.32803	126.83692	3	26.32597	126.8358	3	Sand, seaweed.
Dredge 22	11 Nov. 2009	26.31452	126.84097	13	26.31482	126.84085	12	Sand.
Dredge 23	12 Nov. 2009	26.273	126.85837	147	26.26637	126.85507	125	
Trawl 24	12 Nov. 2009	26.27203	126.86052	150	26.26237	126.857	168	
Trawl 25	12 Nov. 2009	26.2759	126.87857	151	26.27758	126.89145	160	
Dredge 26	12 Nov. 2009	26.27667	126.88893	157	26.27332	126.88472	166	
Trawl 27	12 Nov. 2009	26.28268	126.87513	136	26.2838	126.86587	126	
Trawl 28	13 Nov. 2009	26.28093	126.888	142	26.2836	126.90072	149	Sponges, cnidarians.
Trawl 29	13 Nov. 2009	26.29375	126.88233	90	26.29617	126.89677	91.3	Sponges, sea urchins, crinoids, rocks, rubbles.
Dredge 30	13 Nov. 2009	26.2945	126.89073	90.7	26.29747	126.89813	93.3	Rocks, rubbles.
Trawl 31	13 Nov. 2009	26.31308	126.88748	75.3	26.31507	126.89272	70.4	Sponges, corals.
Trawl 32	13 Nov. 2009	26.27958	126.80083	67.3	26.27932	126.79683	73.3	Iron ancor, dead coral blocks, rubbles.
Dredge 33	13 Nov. 2009	26.2785	126.78512	91	26.27495	126.79403	88	Blocks.
Trawl 34	13 Nov. 2009	26.26307	126.7832	115	26.2545	126.79463	114	
Trawl 35	14 Nov. 2009	26.32667	126.73725	62	26.32253	126.74598	73.3	Shells, cnidarians, crabs.
Dredge 36	14 Nov. 2009	26.3288	126.7392	45	26.32827	126.73902	46	No material.
Dredge 37	14 Nov. 2009	26.32722	126.74292	36.3	26.3266	126.7438	39.8	No material.
Trawl 38	14 Nov. 2009	26.32623	126.73708	65	26.32137	126.74727	69.7	One shell and one fish only.
Dredge 39	14 Nov. 2009	26.32635	126.73785	60	26.32348	126.74345	94	Sand.
Trawl 40	14 Nov. 2009	26.32617	126.73757	62.4	26.32278	126.74373	111	Sponges, blocks.

..... *continued*

TABLE 1 (continued)

Station	Date	Starting point			Ending point			Remarks
		Coordinate		Depth (m)	Coordinate		Depth (m)	
Dredge 41	14 Nov. 2009	26.32585	126.73912	68	26.32307	126.74392	99.3	Sand.
Dredge 42	14 Nov. 2009	26.32872	126.7607	17.7	26.32677	126.76102	23.6	Sand, mud.
Dredge 43	14 Nov. 2009	26.32675	126.76055	24.6	26.32408	126.75822	35.4	Rubbles.
Dredge 44	14 Nov. 2009	26.32857	126.76082	17.9	26.32632	126.76178	42.5	Rubbles.
Trawl 45	16 Nov. 2009	26.33178	126.71985	67.5	26.33427	126.71037	76	Dead coral blocks, rubbles.
Trawl 46	16 Nov. 2009	26.31083	126.75255	76.7	26.31168	126.74487	85	Dead coral blocks, rubbles, sponges.
Trawl 47	16 Nov. 2009	26.31588	126.74833	64.7	26.31738	126.74695	69.3	Sponges, rubbles.
Dredge 48	16 Nov. 2009	26.32175	126.74537	103	26.32393	126.74193	99.3	No material.
Dredge 49	16 Nov. 2009	26.32503	126.7595	50	26.3249	126.76327	11.4	Dead coral branches, rubbles.
Dredge 50	16 Nov. 2009	26.32528	126.76328	9.6	26.32522	126.76303	13.2	Dead coral branches, rubbles.
Dredge 51	16 Nov. 2009	26.32415	126.76247	8.9	26.32463	126.76333	9.3	Dead coral branches, rubbles.
Dredge 52	17 Nov. 2009	26.34015	126.82792	5.1	26.33363	126.8204	4.5	Dead coral branches, rubbles.
Dredge 53	17 Nov. 2009	26.32688	126.82012	4.1	26.32525	126.8196	5	Dead coral branches, rubbles.
Trawl 54	17 Nov. 2009	26.32427	126.82417	4.5	26.32333	126.8197	9	Dead coral blocks.
Dredge 55	17 Nov. 2009	26.32403	126.82018	4.7	26.32297	126.81997	9.5	Sand; Stns Trawl 54 & Dredges 55 mixed.
Dredge 56	17 Nov. 2009	26.32267	126.82007	7.5	26.32157	126.81987	4.7	Dead coral blocks, rubbles.
Dredge 57	17 Nov. 2009	26.32703	126.82518	9.4	26.32373	126.82417	12.5	Rubbles, seaweeds.
Dredge 58	17 Nov. 2009	26.32588	126.82517	9.1	26.32438	126.82485	13.3	Sand.
Trawl 59	18 Nov. 2009	26.33845	126.82267	5.1	26.33597	126.82223	6.4	Large rounded rock in net.
Dredge 60	18 Nov. 2009	26.32337	126.838	6.5	26.3205	126.83722	7.5	Rubbles, sand.
Dredge 61	18 Nov. 2009	26.32982	126.86838	18.7	26.32888	126.86783	20.5	Some rubbles.
Dredge 62	18 Nov. 2009	26.33075	126.86768	10.5	26.3278	126.86503	19.4	Some rubbles.
Dredge 63	18 Nov. 2009	26.32985	126.86722	11.7	26.3274	126.86288	19.5	Seaweeds.
Dredge 64	18 Nov. 2009	26.33047	126.86625	10.2	26.32877	126.86275	17.1	Shells.
Dredge 65	18 Nov. 2009	26.33063	126.86688	10.4	26.32875	126.86117	13.6	Shells, rubbles.
Dredge 66	18 Nov. 2009	26.32625	126.86103	20.7	26.3238	126.86045	27.1	Rubbles.
Dredge 67	18 Nov. 2009	26.33233	126.866	6.4	26.3313	126.8631	6.5	Sand.
Dredge 68	18 Nov. 2009	26.31825	126.8168	10.7	26.31497	126.81615	17.1	Sand, mud.
Dredge 69	18 Nov. 2009	26.31757	126.8117	5.6	26.31597	126.81207	13.1	Mud.
Trawl 70	19 Nov. 2009	26.39718	126.76142	95.5	26.39317	126.75353	123	Blocks, rubbles, fish, decapods, cnidarians.
Trawl 71	19 Nov. 2009	26.37427	126.70387	66	26.37257	126.70085	81	Blocks, rubbles, fish, crinoids.
Trawl 72	19 Nov. 2009	26.36203	126.6891	86	26.36047	126.68762	97.3	Few material.
Trawl 73	19 Nov. 2009	26.35692	126.6887	96.4	26.34737	126.68857	186	Gravels
Trawl 74	19 Nov. 2009	26.32515	126.70853	183	26.33043	126.69792	225	Some rubbles.
Trawl 75	19 Nov. 2009	26.32643	126.70755	156	26.3333	126.70023	137	Some cnidarians.
Dredge 76	19 Nov. 2009	26.32787	126.72213	101	26.3283	126.71595	93.2	Rubbles.
Trawl 77	20 Nov. 2009	26.26548	126.83308	90.9	26.2601	126.8234	105	Sponges, cnidarians, echinoderms.

..... *continued*

TABLE 1 (continued)

Station	Date	Starting point			Ending point			Remarks
		Coordinate		Depth (m)	Coordinate		Depth (m)	
Dredge 78	20 Nov. 2009	26.24723	126.86585	192	26.2451	126.85728	179	Shells, rubbles.
Dredge 79	20 Nov. 2009	26.24477	126.82705	165	26.24542	126.81745	141	Shells, rubbles.
Trawl 80	20 Nov. 2009	26.245	126.82333	153	26.24655	126.81615	123	A few material including sponges & echinoderms.
Dredge 81	20 Nov. 2009	26.25452	126.79432	116	26.25792	126.78707	125	Shells, rubbles.
Dredge 82	20 Nov. 2009	26.25633	126.78205	175	26.26227	126.7748	195	Shells, rubbles.

TABLE 2 Diving stations of KUMEJIMA 2009.

Station	Date	Starting time	Site	Coordinate		Depth (m)	Operator	Remarks
Dive 1	9 Nov. 2009	11:31	Umagai	26.34615	126.85843	5-50	I. Nakayoshi	
Dive 2	9 Nov. 2009	14:09	East of North Line	26.35385	126.88522	5-50	I. Nakayoshi	
Dive 3	9 Nov. 2009	16:25	Entrance of Port	26.34628	126.827	< 20	I. Nakayoshi	
Dive 4	10 Nov. 2009	09:40 (09:48)	East of North Line	26.35385	126.88522	5-50	I. Nakayoshi	Less than 10 m away from Dive 2; coral, sand.
Dive 5	10 Nov. 2009	12:15 (12:21)	Tonbarazashi	26.34582	126.85013	5-55	I. Nakayoshi	Drop-off, depth 70 m.
Dive 6	10 Nov. 2009	15:00	near Aka-Todai	26.35375	126.82713	15-30	I. Nakayoshi	Dead coral rubbles.
Dive 7	11 Nov. 2009	9:21	Crasher-shita	26.31322	126.81138	8-20	I. Nakayoshi	Mud, dead coral rubbles.
Dive 8	11 Nov. 2009	11:45	Nanguchi	26.30893	126.84003	< 25	I. Nakayoshi	Dead coral rubbles, reef-end.
Dive 9	11 Nov. 2009	14:34	Suna Point	26.3	126.8374	< 9	I. Nakayoshi	Sand, rubbles.
Dive 10	12 Nov. 2009	9:35	Shogakko-mae (off elementary school)	26.33353	126.73268	< 36	I. Nakayoshi	Submarine cave.
Dive 11	12 Nov. 2009	11:56	Entrance of Gima Port	26.32368	126.81713	< 20	I. Nakayoshi	Dead coral rubbles, mud.
Dive 12	12 Nov. 2009	15:00	Off Torishima Islet	26.32805	126.74375	< 20	I. Nakayoshi	
Dive 13	13 Nov. 2009	9:31	Off Torishima Islet	26.32028	126.74378	< 40	I. Nakayoshi	
Dive 14	13 Nov. 2009	11:41	Ebi-ana	26.29245	126.79618	10	I. Nakayoshi	
Dive 15	13 Nov. 2009	19:23	Ebi-ana	26.29245	126.79618	10	I. Nakayoshi	
Dive 16	14 Nov. 2009	10:39	Koukou-mae (off high school)	26.33142	126.76027	< 4	I. Nakayoshi	Mud, dead coral rubbles, rocks; yabby pump.
Dive 17	14 Nov. 2009	13:40	Off Kenjo	26.32515	126.75173	< 30	I. Nakayoshi	
Dive 18	14 Nov. 2009		Shogakko-mae (off elementary school)	26.33353	126.73268	18-39	S. Ogawa	Below dropp-off, overhang.
Dive 19	14 Nov. 2009		Shogakko-mae (off elementary school)	26.33353	126.73268		S. Ogawa	Submarine cave; traps set.
Dive 20	15 Nov. 2009	11:24	Shogakko-mae (off elementary school)	26.33273	126.73177	38	I. Nakayoshi	50 m inside submarine limestone cave.
Dive 21	16 Nov. 2009	9:45	In front of Torishima Islet, westside	26.32867	126.74322	50	I. Nakayoshi	Drop-off.
Dive 22	16 Nov. 2009		Shogakko-mae (off elementary school)	26.33273	126.73177	< 40	S. Ogawa	Submarine limestone cave.
Dive 23	16 Nov. 2009	11:50	Nanguchi	26.31245	126.766	< 20	I. Nakayoshi	Inner bay-like environment.
Dive 24	16 Nov. 2009							
Dive 25	16 Nov. 2009	14:40	Twin Rock	26.3311	126.73693	< 40	I. Nakayoshi	Drop-off.

..... continued

TABLE 1 (continued)

Station	Date	Starting time	Site	Coordinate		Depth (m)	Operator	Remarks
Dive 26	17 Nov. 2009	9:25	Crasher-shita	26.31312	126.81093	< 20	I. Nakayoshi	Mud.
Dive 27	17 Nov. 2009	11:53	Oyako-iwa	26.2909	126.79817	< 20	I. Nakayoshi	Submarine cave, dead coral rubble area.
Dive 28	17 Nov. 2009	15:15	Oyako-iwa	26.2909	126.79817	< 20	I. Nakayoshi	Submarine hole, dead coral rubble area.
Dive 29	17 Nov. 2009		Shogakko-mae (off elementary school)	26.33305	126.73223		S. Ogawa	
Dive 30	17 Nov. 2009		Off Garasa				S. Ogawa	
Dive 31	18 Nov. 2009	9:23	Shogakko-mae (off elementary school)	26.33305	126.73223	< 50	I. Nakayoshi	
Dive 32	18 Nov. 2009	11:31	Off Torishima Islet	26.32777	126.81713	< 40	I. Nakayoshi	Gill net and small traps set.
Dive 33	18 Nov. 2009							
Dive 34	18 Nov. 2009							
Dive 35	18 Nov. 2009	20:38	Aka-todai	26.32085	126.7559	about 15	I. Nakayoshi	
Dive 36	19 Nov. 2009	9:30	Off Torishima Islet	26.32777	126.81713	15-40	I. Nakayoshi	
Dive 37	19 Nov. 2009	11:50	Tengoku-to-Zigoku	26.32368	126.76222	6-8	I. Nakayoshi	
Dive 38	19 Nov. 2009	before noon	Hidenchigama			35-40	S. Ogawa	Submarine limestone cave.
Dive 39	19 Nov. 2009	after noon	Hidenchigama			35-40	S. Ogawa	Submarine limestone cave.
Dive 40	20 Nov. 2009	10:10	Hidenchigama			40	I. Nakayoshi	Submarine limestone cave.
Dive 41	20 Nov. 2009	13:20	Shogakko-mae (off elementary school)	26.33305	126.73223		I. Nakayoshi	
Dive 42	20 Nov. 2009	13:45	Ara	26.31667	126.775	18	S. Ogawa	
Dive 43	20 Nov. 2009	20:15	Aka-todai	26.32085	126.7559	30	I. Nakayoshi	

FIGURE 3. Beam trawls and dredges used in KUMEJIMA 2009.

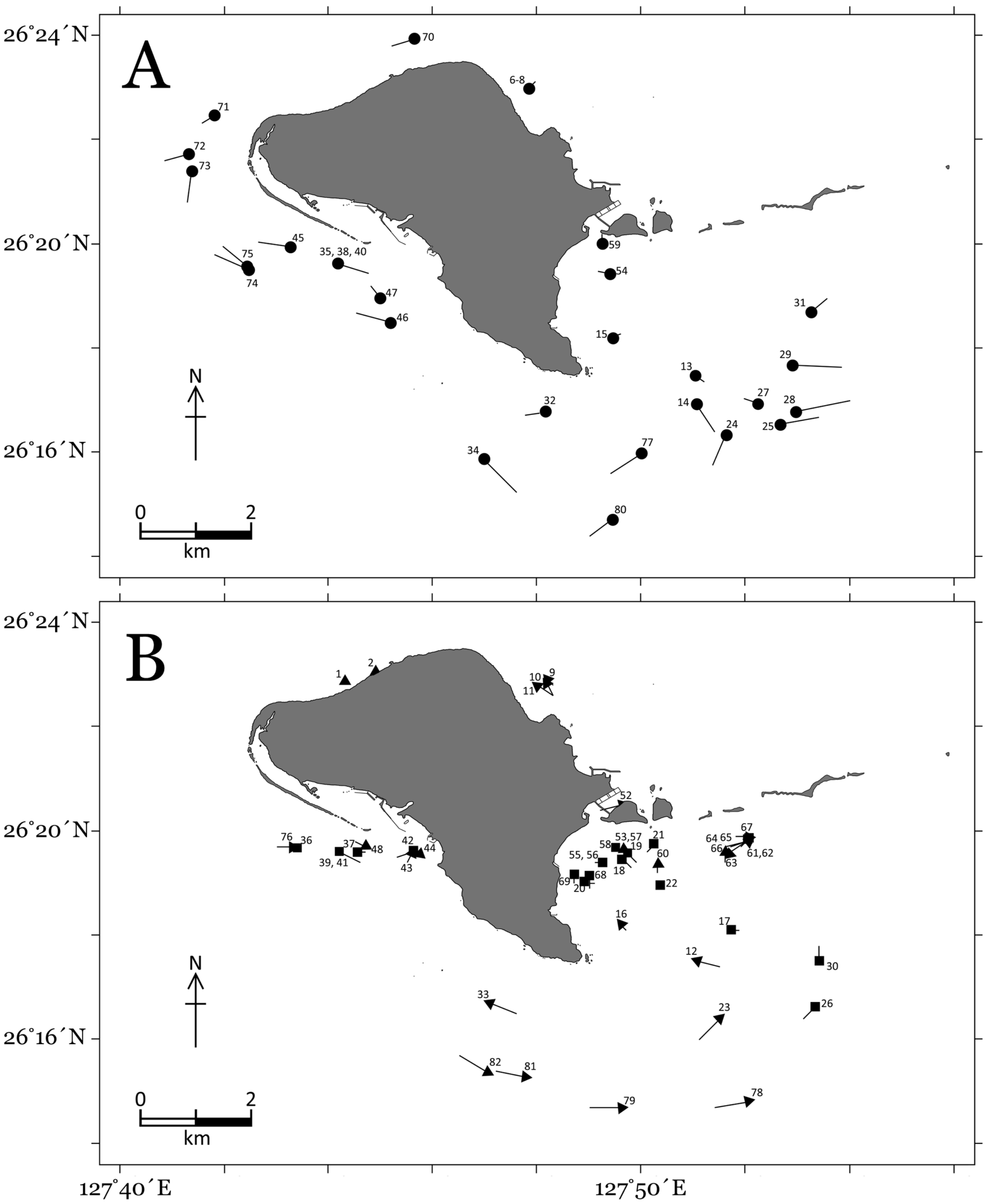


FIGURE 4. Trawl and dredge stations of KUMEJIMA 2009.
A, Trawl stations (closed circle, trawl); B, dredge stations (closed triangle, triangular dredges; closed square, oblong dredge). Symbol indicates starting points of each operation.

Traps. Three types of bait traps were used (Fig. 7). The rectangular "*Kanikago*" (= crab trap) usually targets *Scylla* spp. or other swimming crabs. Traps are made of metal and fordable frames, and are covered with nets of a mesh size of about 1 cm. A flexible slit is placed at each end of lateral sides. The ellipsoidal mesh trap is also metal-framed, with a pair of cylindrical openings laterally. These two types of traps were set by the Churaumi Aquarium team. Pipe traps, made of cylindrical PVC, were designed to collect mainly carnivorous gastropods, but small crustaceans were also obtained. The pipe traps were set by Hirofumi Kubo. The traps were set individually or connected in lines of up to 20 traps resembling a bottom long line to a maximum depth of 547 m (Table 3, Fig. 8). All traps were baited with dead fishes or Pacific saury (*Cololabis saira*; "Sanma" in Japanese). Stations of trapping were coded as "Trap #".

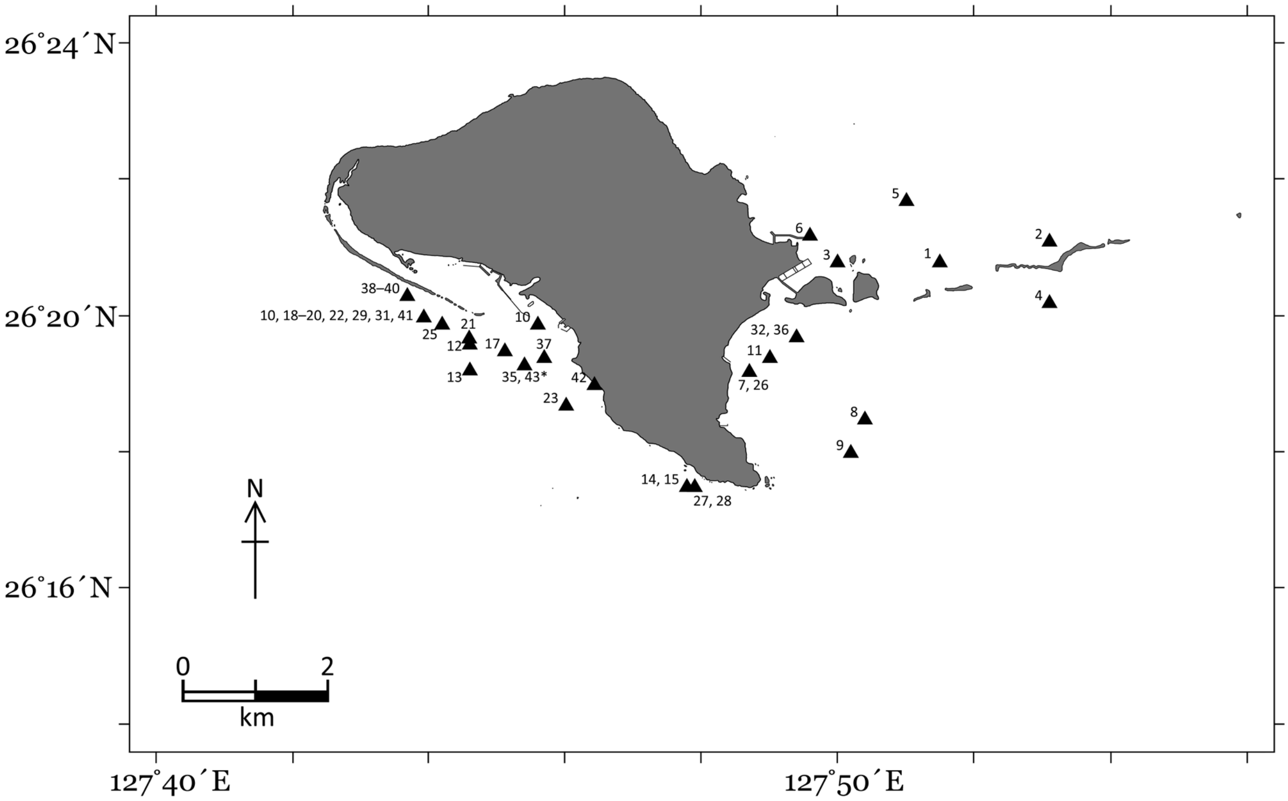


FIGURE 5. Diving stations of KUMEJIMA 2009.

Intertidal work. The intertidal team was led primarily by Takashi Nagai. Sampling was conducted at both day and night during the second half of the expedition (Table 4, Fig. 9). Specimens were collected by hand, digging, yabbie pumping, etc. Stations of trapping were coded as "Intertidal #".

ROV. The Churaumi Aquarium team attempted to take sample and video from deep water environments around Kumejima utilizing the ROV "LEO" (KOWA Co., Ltd.). However, due to mechanical problems, it operated just the first day.

Operational program

Day 01 — 8 Nov. 2009. Gathering and preparation of sampling; base camp set up. Briefing and welcome banquet at the Prefectural Deep Sea Water Research Center, Kumejima.
Day 02 — 9 Nov. 2009. Start of sampling. Trawling/dredging, diving and ROV teams' operation begins.
Day 03 — 10 Nov. 2009. Trawling/dredging and diving teams' operation.
Day 04 — 11 Nov. 2009. Trawling/dredging and diving teams' operation.
Day 05 — 12 Nov. 2009. Trawling/dredging, diving and trapping teams' operation.
Day 06 — 13 Nov. 2009. Trawling/dredging, diving and trapping teams' operation.
Day 07 — 14 Nov. 2009. Trawling/dredging and diving teams' operation. Trapping team could not operate due to bad sea conditions. Midterm banquet at base camp.
Day 08 — 15 Nov. 2009. Holiday.

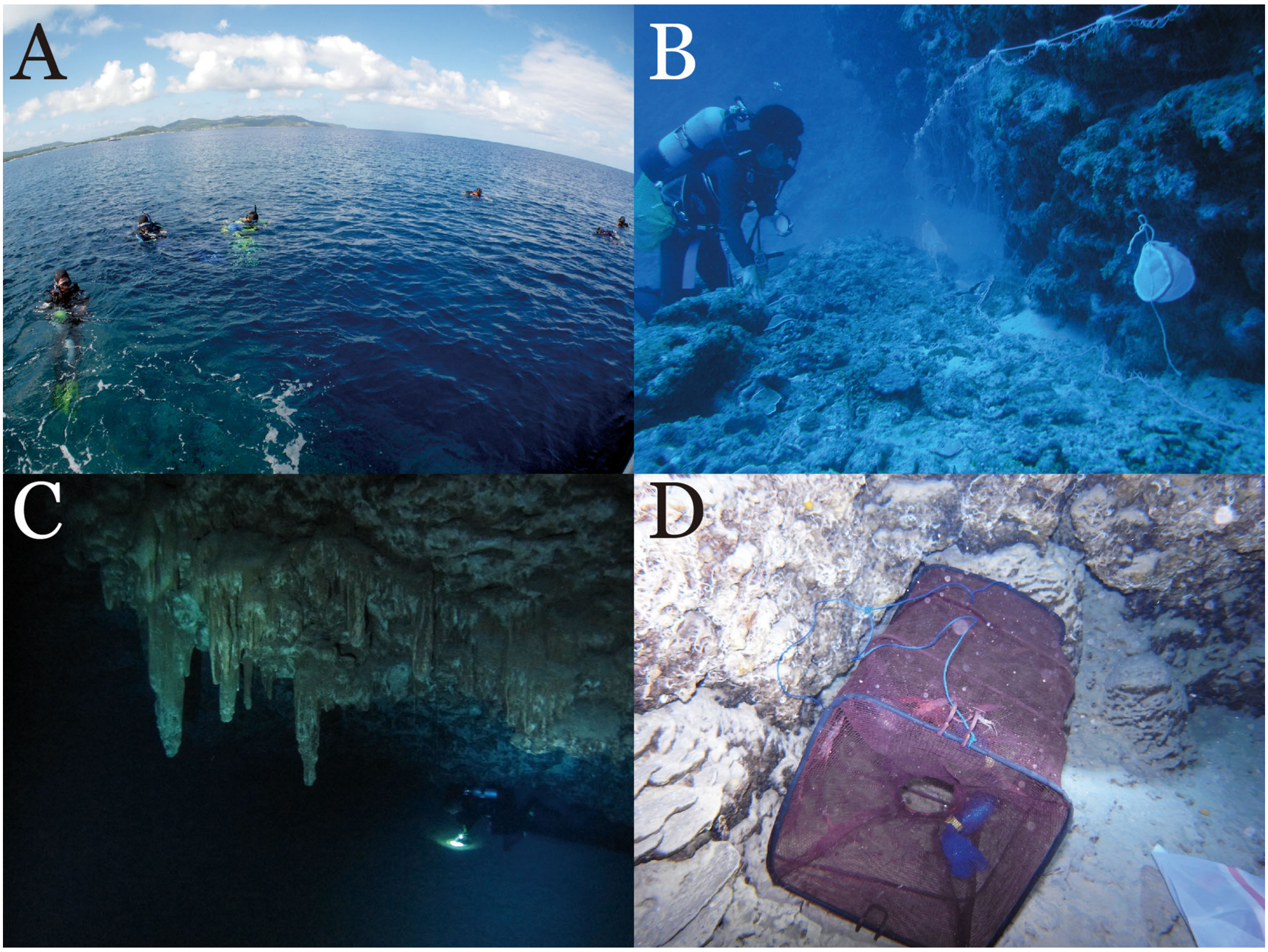


FIGURE 6. Various methods of sampling employed for SCUBA diving in KUMEJIMA 2009.
A, diving operation; B, gill netting; C, submarine limestone cave, Hidenchigama; D, small bait trapping during SCUBA diving. Photograph courtesies of Yoshihisa Fujita (A), Daisuke Uyeno (B), Azusa Sakaguchi (C), and Takuma Fujii (D).

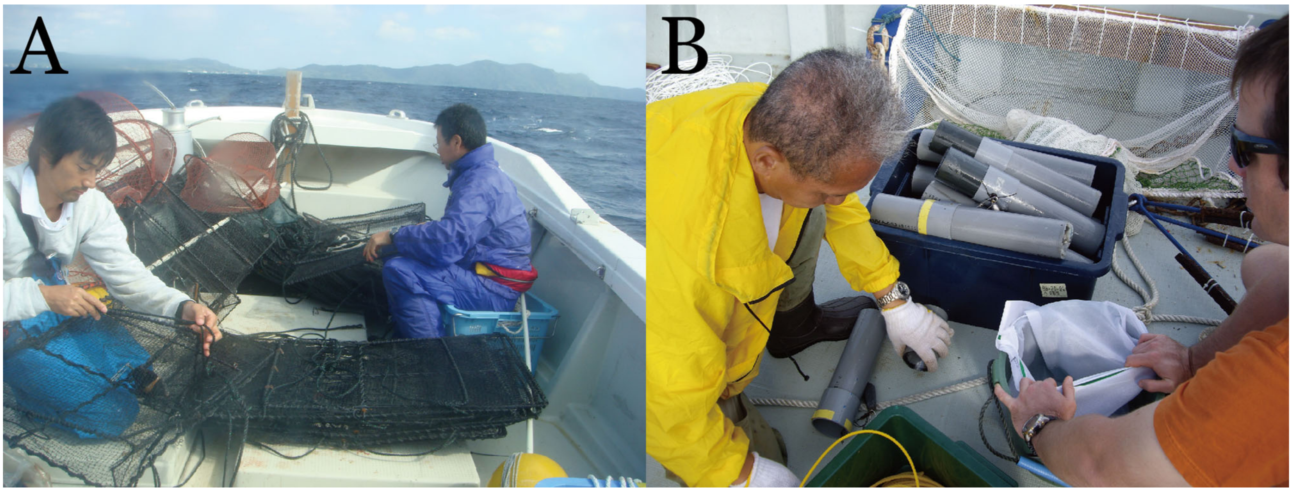


FIGURE 7. Bait traps used in KUMEJIMA 2009.
A, rectangular and ellipsoidal traps; B, pipe traps. courtesy of Yuzo Ota (A).

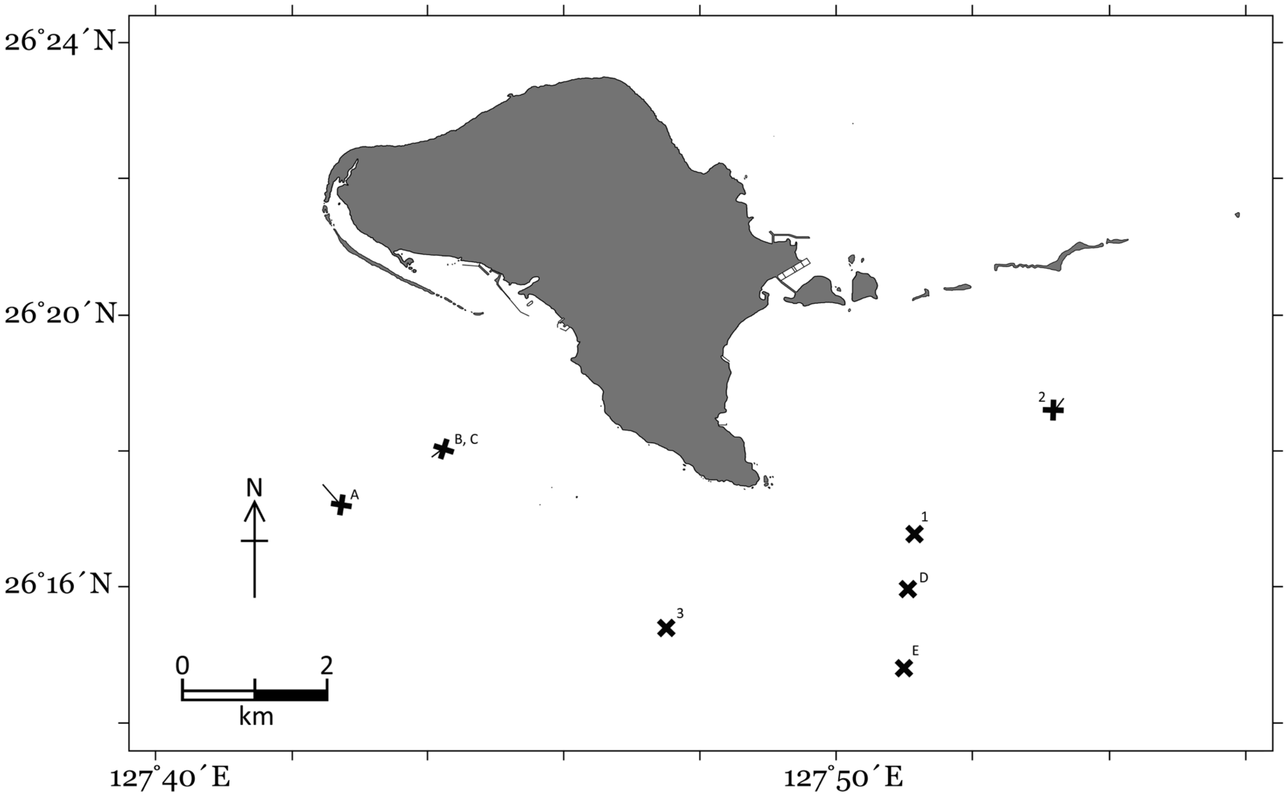


FIGURE 8. Trap stations of KUMEJIMA 2009.

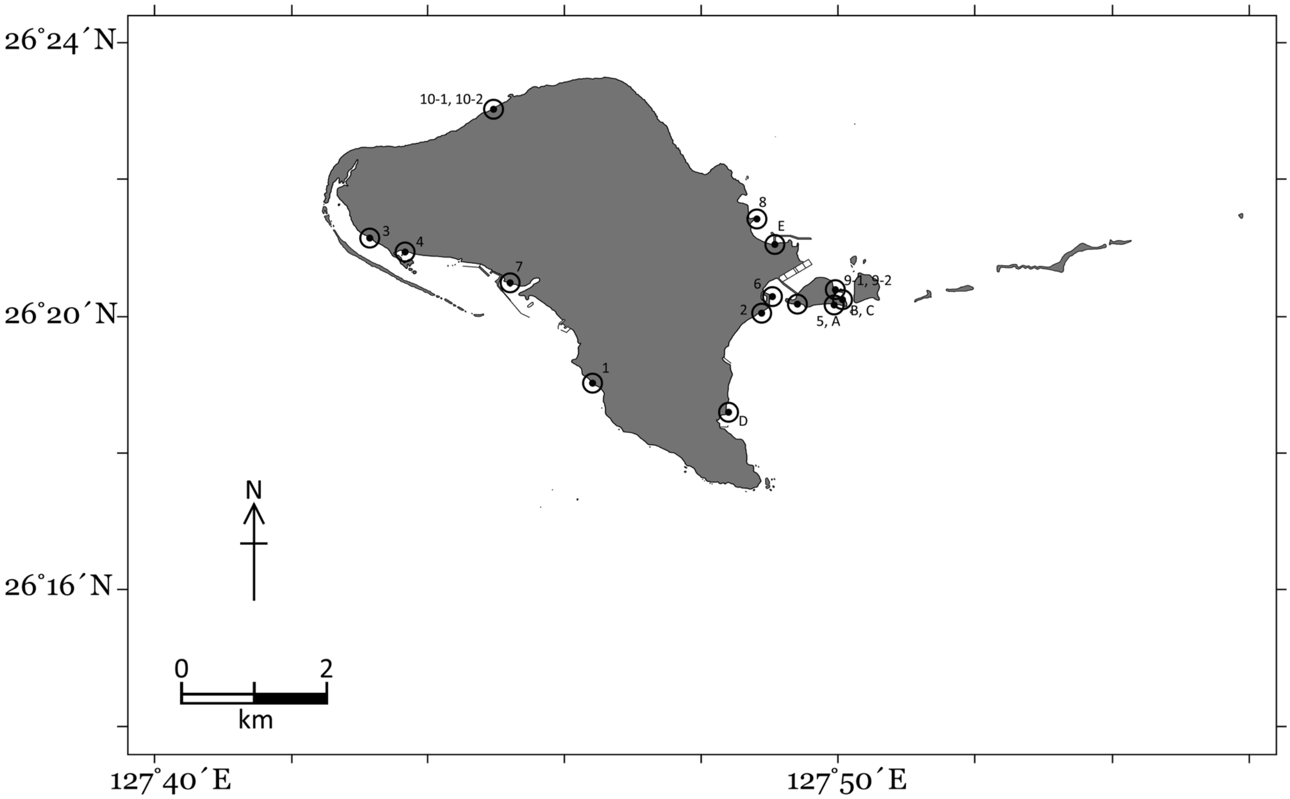


FIGURE 9. Intertidal stations of KUMEJIMA 2009.

TABLE 3. Trap stations of KUMEJIMA 2009.

Station	Date (set)	Date (collected)	Starting point			Ending point			Remarks
			Coordinate		Depth (m)	Coordinate		Depth (m)	
Trap D	12 Nov. 2009, 11:45	13 Nov. 2009, 9:00	26.26562	126.85407	150				fishes including sharks, decapod crustaceans
Trap E	12 Nov. 2009, 15:00	13 Nov. 2009, 9:45	26.24767	126.84827	280				fishes including sharks, decapod crustaceans
Trap A	19 Nov. 2009, 11:30	20 Nov. 2009, 11:05	26.28667	126.71220	457	26.29163	126.70812	547	20 traps
Trap B	19 Nov. 2009, 12:14	20 Nov. 2009, 10:05	26.30123	126.73800	350	26.29910	126.73457	430	20 traps
Trap C	19 Nov. 2009, 12:45	20 Nov. 2009, 9:15	26.30187	126.74217	260	26.29997	126.73990	355	8 traps
Trap 1	11 Nov. 2009, 10:55	12 Nov. 2009, 9:27	26.27473	126.85827	130				Trap
Trap 2	12 Nov. 2009, 9:35	13 Nov. 2009, 9:50	26.27962	126.88677	147	26.28125	126.88788	143	Trap, cylindrical bottles
Trap 3	13 Nov. 2009, 15:21	14 Nov. 2009, 10:03	26.25618	126.79150	120				Trap, arge net, cylindrical bottles

TABLE 4. Intertidal stations of KUMEJIMA 2009.

Station	Date	Starting time	Ending time	Site	Coordinate	
Intertidal 1	16–17 Nov. 2009	23:20	2:00	Ara Beach	26.31636	126.77389
Intertidal 2	17—18 Nov. 2009	0:00	2:00	Ifu Beach	26.33556	126.81597
Intertidal 3	18 Nov. 2009	12:45	14:00	Shinri Beach	26.35372	126.71656
Intertidal 4	18 Nov. 2009	14:15	16:30	Ohara	26.34939	126.72608
Intertidal 5	19 Nov. 2009	0:30	2:30	Ishidatami, Oh-jima Islet	26.33600	126.82478
Intertidal 6	19 Nov. 2009	2:45	4:00	West of Oh-jima Islet	26.33936	126.82339
Intertidal 7	19 Nov. 2009	13:45	16:40	Rivermouth of Shirase River	26.34158	126.75917
Intertidal 8	20 Nov. 2009	1:00	3:30	Madomari	26.35661	126.81403
Intertidal 9-1	20 Nov. 2009	13:30	14:45	East of Oh-jima Islet	26.34017	126.83153
Intertidal 9-2	21 Nov. 2009	1:30	3:30	East of Oh-jima Islet	26.34017	126.83153
Intertidal 10-1	20 Nov. 2009	15:30	17:30	Nakama-gumui	26.38258	126.74828
Intertidal 10-2	21 Nov. 2009	0:00	1:00	Nakama-gumui	26.38258	126.74828
no stn # (A)	17 Nov. 2009	12:45	13:15	Ishidatami, Oh-jima Islet	26.33600	126.82478
no stn # (B)	17 Nov. 2009	13:30	14:00	East of Oh-jima Islet	26.34017	126.83153
no stn # (C)	17 Nov. 2009	14:30	15:30	Madomari-Une	26.35328	126.81525
no stn # (D)	21 Nov. 2009			Shimajiri	26.31011	126.80531
no stn # (E)	21 Nov. 2009			Madomari fishing port	26.35122	126.82017

Day 09 — 16 Nov. 2009. Trawling/dredging, diving and intertidal teams' operation. Trapping team could not operate due to bad sea conditions.

Day 10 — 17 Nov. 2009. Trawling/dredging, diving and intertidal teams' operation. Trapping team could not operate due to bad sea conditions.

Day 11 — 18 Nov. 2009. Trawling/dredging, diving and intertidal teams' operation. Trapping team could not operate due to bad sea conditions.

Day 12 — 19 Nov. 2009. Trawling/dredging, diving, trapping and intertidal teams' operation. Local children paid a visit to base camp to observe collected animals and scientists' activities.
Day 13 — 20 Nov. 2009. Trawling/dredging, diving, trapping and intertidal teams' operation.
Day 14 — 21 Nov. 2009. Packing specimens and field gear. Final banquet at the Prefectural Deep Sea Water Research Center, Kumejima.

Stations

Sampling stations are listed by methods in Tables 1–4 and mapped in Figs. 4, 5, 8, 9. All GPS coordinates are indicated by decimal degrees.

Acknowledgements

I would like to thank all institutions and individuals who supported the expedition in various ways. The expedition was financially supported by the Biodiversity Research Center, Academia Sinica, Taiwan; Raffles Museum of Biodiversity Research and Tropical Marine Science Institute, National University of Singapore; Center of Excellence for Marine Bioenvironment and Biotechnology, National Taiwan Ocean University, Taiwan, and Research Organization for Subtropical and Island Studies, University of the Ryukyus, Japan. The very strong support from the following local institutions is greatly appreciated: Fisheries Cooperative, Deep Sea Water Research Center, Okinawa Prefecture and Kumejima Education Board. I sincerely thank all participants and local supporters of the expedition, especially Kazuhito Shiroma, Yutaka Fujimoto (Sea Water Research Center), Isamu Nakayoshi, Yuji Tabata, Eizo Tabata (Fisheries Cooperative), and Arisa Izeki (Blue Dome, Kumejima), who made the expedition possible.

Appendix

Participants of the KUMEJIMA 2009

Japan
Tohru NARUSE University of the Ryukyus
Yoshihisa FUJITA University of the Ryukyus / Marine Learning Center
Ryuji ASAMI University of the Ryukyus
Masayuki OSAWA University of the Ryukyus
Noriko KIDERA University of the Ryukyus
Yuzo OTA University of the Ryukyus
Takuma FUJII University of the Ryukyus
Shoko TOMIMOTO University of the Ryukyus
Kazuhito SHIROMA Deep Sea Water Research Center, Okinawa Prefecture
Masahiro NONAKA Ocean Exposition Commemorative Park Management Foundatation
Atsushi KANEKO Ocean Exposition Commemorative Park Management Foundatation
Hiroko TAKAOKA Ocean Exposition Commemorative Park Management Foundatation
Eiji OUCHI Ocean Exposition Commemorative Park Management Foundatation
Takuo HIGASHIJI Ocean Exposition Commemorative Park Management Foundatation
Miyako TANIMOTO Ocean Exposition Commemorative Park Management Foundatation
Kenta YAMADA Ocean Exposition Commemorative Park Management Foundatation
Yukiko MURABAYASHI Ocean Exposition Commemorative Park Management Foundatation
Noboru KATAKI Ocean Exposition Commemorative Park Management Foundatation
Hirofumi KUBO Fisheries Development Center, Fisheries Division, Okinwa Prefecture
Takashi NAGAI Okinawa Environment Science Center
Tadafumi MAENOSONO Tsudoi Company

Tomofumi SAEKI Tsudoi Company
Daisuke UYENO Hiroshima University
Tomoyuki KOMAI Natural History Museum and Institute, Chiba
Junji OKUNO Natural History Museum and Institute, Chiba
Michitaka SHIMOMURA Kitakyushu Museum of Natural History & Hiuman History
Keiichi KAKUI Hokkaido University

Taiwan
Tin-Yam CHAN National Taiwan Ocean University
I-Shiung CHEN National Taiwan Ocean University
Chai-Wai LIN National Taiwan Ocean University
Teng-Wei WANG National Taiwan Ocean University
Shih-Pin HUANG National Taiwan Ocean University
Chih-Kuei KAO National Taiwan Ocean University
Ruei-Yi LEE National Taiwan Ocean University
Shih-Hua SU National Taiwan Ocean University
Benny K. K. CHAN Academia Sinica
Yun-Chih LIAO Academia Sinica
Mao-Ying LEE Academia Sinica
Pei-Chen TSAI Academia Sinica
Ching-Yi CHEN Academia Sinica
Tung-Yung CHENG Academia Sinica
Chia-Hao CHENG Academia Sinica

Singapore
Peter K. L. NG National University of Singapore
TAN Heok Hui National University of Singapore
TAN Koh Siang National University of Singapore
Zeehan Bte JAAFAR National University of Singapore
SIN Tsai Min National University of Singapore
TAN Siong Kiat National University of Singapore
LEE Ai Chin National University of Singapore
LOW Ern Yee, Martyn National University of Singapore

France
Bertrand RICHER DE FORGES KIWA Enterprise
Mathilde RICHER DE FORGES KIWA Enterprise

Indonesia
Dwi Listyo RAHAY UIndonesian Institute of Science

UK
Paul F. CLARK The Natural History Museum

USA
Frederic SINNIGER Florida State University

Zootaxa 3367: 21–48 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Epibiotic barnacles (Crustacea: Cirripedia: Thoracica) collected by the Kumejima 2009 Expedition, with descriptions of two new species*

BENNY K.K. CHAN[1,4] & RYOTA HAYASHI[2,3]
[1]*Biodiversity Research Center, Academia Sinica, Taipei 115, Taiwan*
[2]*International Coastal Research Center, Atmosphere and Ocean Research Institute, University of Tokyo, Kashiwa, Chiba 277-8564, Japan*
[3]*Marine Biology and Ecology Research Program, Extremobiosphere Research Center, Japan Agency for Marine-Earth Science and Technology, Natsushimacho, Yokosuka 237-0061, Japan*
[4]*Corresponding author (chankk@gate.sinica.edu.tw)*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

The present study reports on the epibiotic barnacles collected by the Kumejima 2009 Expedition. Six cirripede species from five genera within four families were identified: *Oxynaspis celata* Darwin, 1852, *Euscalpellum* c.f. *squamosum* Hiro, 1937, *Poecilasma obliqua* (Hoek, 1907) and *Platylepas hexastylos* (Fabricius, 1798), all of which had been recorded previously from Japanese waters, and two new taxa, *Calantica arcuata* **n. sp.** and *Oxynaspis ryukyuensis* **n. sp.** The hosts of the barnacles collected included antipatharian corals, gorgonian corals, a decapod crustacean and a sea turtle.

Introduction

Thoracican cirripedes exhibit high diversity and live in a wide range of habitats, including rocky shores, mangroves, deep-sea hydrothermal vents and cold seeps. Some are epibiotic, attaching to the outer surfaces of a variety of marine species including corals, turtles and decapod crustaceans (Darwin 1854; Anderson 1994).

The cirripede fauna of Japanese waters has been studied extensively by Utinomi/Hiro (Hiro & Utinomi were the same person, see Newman 1981) and Hiro described 26 new cirripede taxa (cf. Newman 1981). Hiro (1937b) recorded 16 continental shelf species (< 300 m depth) from the Pacific Ocean and the Japan Sea. Kumejima Island in the Ryukyus Islands (Fig. 1) is located close to the Okinawa Trough in the East China Sea, which has a different oceanographic current pattern compared to the Philippine Basin in the Pacific Ocean (Chaen *et al*. 1993; Kawabe 1993). Ryukyu waters and the Okinawa Trough house endemic marine species as they are one of the refugia during the Last Glacial Maxima (Voris 2000). For example, the sand bubbler crabs *Scopimera ryukyuensis* Wong, Chan & Shih, 2010, the soldier crabs *Mictyris guinotae* Davie, Shih & Chan, 2010, and the ocypoid crab *Tmethypocoelis choreutus* Davie & Kosuge, 1995, are endemic in Ryukyu waters.

The Kumejima 2009 Expedition conducted a series of trawling and tangle net samples in shallow and deep waters around Kumejima Island, Japan, which yielded a variety of crustaceans, antipatharians, gorgonian corals and a dead sea turtle, some of which had associated epibiotic barnacles. The present paper reports on these barnacles, which includes two undescribed stalked barnacle species of the genera *Calantica* Gray, 1825 and *Oxynaspis* Darwin, 1852. Further studies should focus on the geographical distribution of these two new species to ascertain whether they are endemic in Ryukyu waters.

The undescribed *Calantica* species in the present study has 13 capitular plates and belongs to the Group I species of *Calantica* following Newman & Jones (2011). Previous taxonomic studies on barnacles of the Oxynaspididae have received scant attention (see Zevina 1982; Ren 1983; Foster & Buckeridge 1995). Recently, Van Syoc &

Accepted by Tohru Naruse: 22 Jan. 2012; published: 4 Jul. 2012

Dekelboum (2011) conducted an extensive review of the Oxynaspadidae, erecting three new genera in addition to *Oxynaspis* Darwin, 1852 and identifing six new species. Currently, 30 Oxynaspidid species (including extinct species) are recorded by Van Syoc & Dekelboum (2011). The type species of *Oxynaspis*, *Oxynaspis celata*, was identified by Darwin (1852) from Madeira and, subsequently, four sub-species of *Oxynaspis celata* (Annandale 1909; Broch 1922; Totton 1940) were identified. *Oxynaspis celata* is a cryptic species complex whose taxonomy is confused and should receive further attention. The undescribed *Oxynaspis* species in the present study exhibited diagnostic morphological characters that differed from the *O. celata* cryptic species group and other described *Oxynaspis* species. We paid careful attention to compare the undescribed species in the present study with all allied species in the genus *Oxynaspis* to confirm its new species status.

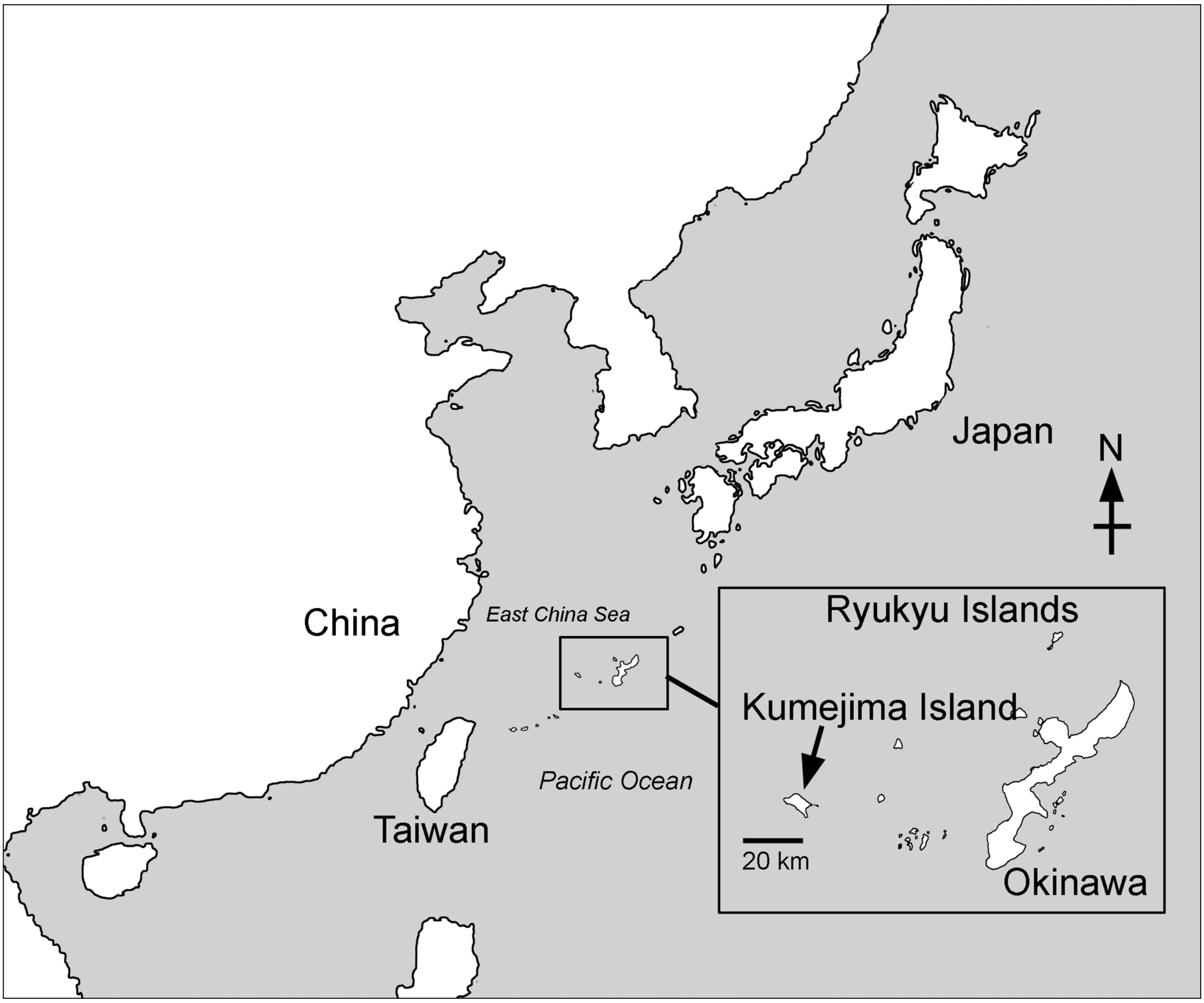


FIGURE 1. Location of Kumejima Island in the Ryukyus Islands.

Materials and Methods

Specimens were examined and dissected using stereomicroscopy. Cirri and mouth parts were further examined using inverted light microscopy (Zeiss Scope A1). Observations of setal types on cirri and mouth parts were under magnification of 400x (Zeiss Plan APOChromat 40X/0.95) and 1000x (ZEISS Plan APO Chromat 100x/1.4 oil). Dwarf males of *Calantica* species were observed using scanning electron microscopy, following the methods of Chan *et al.* (2008). The terminology used in describing stalked barnacles follows Jones (1992, 1993) and Newman (1987, 1996) and setal terminology follows Chan *et al.* (2008). Calanticid barnacles have two whorls of capitular plates and the pattern of plate arrangement can be described using the formula and abbreviations of Jones (1998) and Newman & Jones (2011): S—Scutum, T—Tergum, R—Rostrum, RL—Rostrolatus, L—Latus, CL—Carinolatus, C—Carina, SR—Subrostrum, SC—Subcarina.

Types of the new species are deposited in the Ryukyu University Museum, Fujukan, Japan (RUMF), and paratypes in the National Museum of Natural Science, Taiwan (NMNS) and the Biodiversity Research Museum of Academia Sinica, Taiwan (ASIZCR). Capitular length (CL) of stalked barnacles and rostral-carinal basal diameter (BD) of sessile barnacle were measured using vernier calipers to 0.1 mm.

Systematics

Order Scalpelliformes Buckeridge & Newman, 2006

Family Calanticidae Zevina, 1978

Genus *Calantica* Gray, 1825

Calantica arcuata n. sp.

(Figs. 2A, 3, 4)

Material examined. Holotype: RUMF-ZC-1554, one specimen (CL 7.9 mm) attached to a gorgonian coral, trawl 45, 26°19.907´N, 126°43.191´E, 16 Nov. 2009, depth 67.5–76.0 m. Paratypes: RUMF-ZC-1555, two specimens (CL 8.2, 7.8 mm), same data as holotype. NMNS-6690-001, four specimens (CL 8.3, 8.5, 7.6, 5.1 mm), same data as holotype.

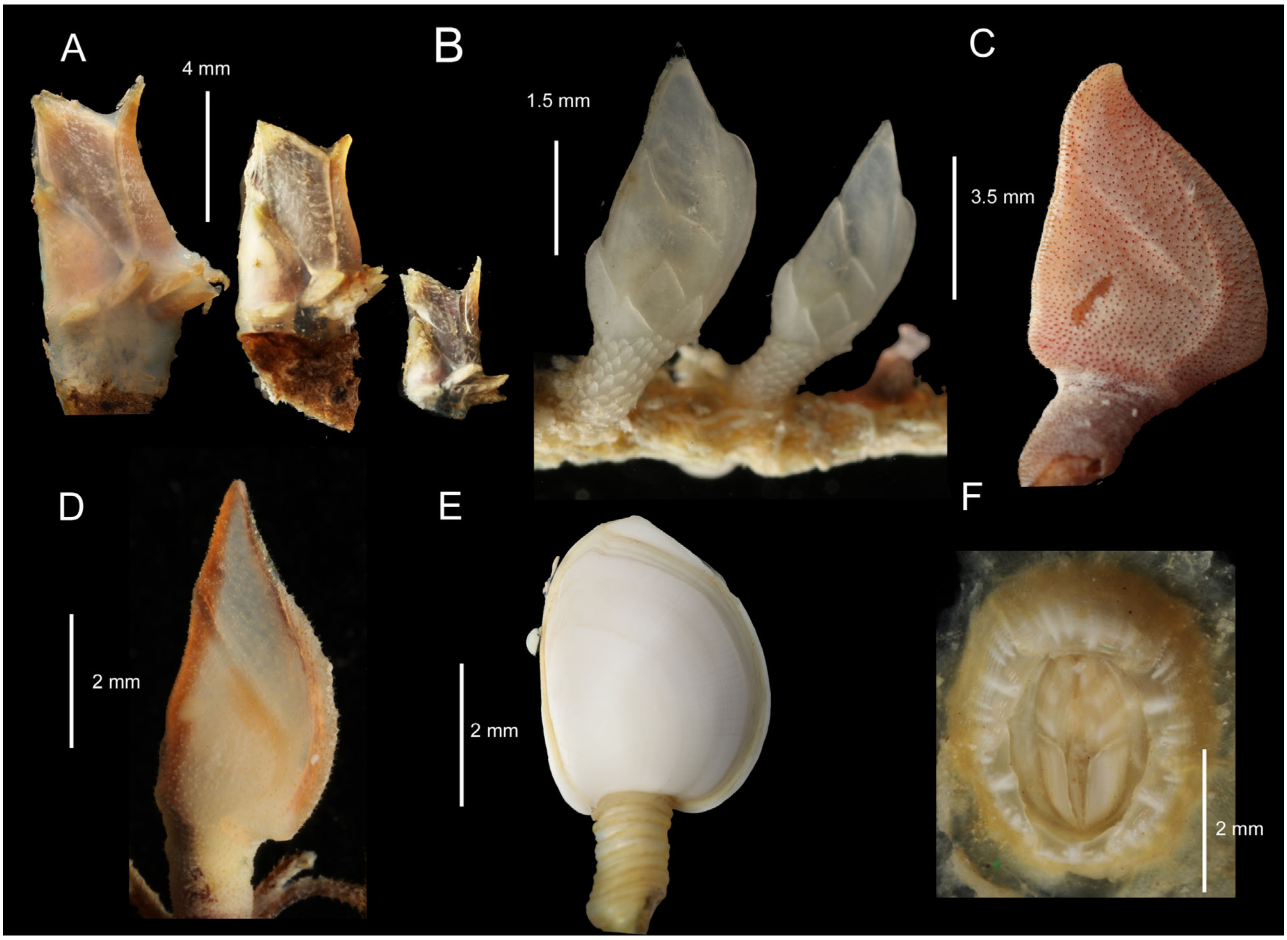


FIGURE 2. Kumejima epibiotic barnacles. A, *Calantica arcuata* **n. sp.** (Left, holotype, RUMF-ZC-1554, middle, paratype, RUMF-ZC-1555, note the tip of carina was broken, right, paratype, NMNS-6690-001); B, *Euscalpellum* c.f. *squamoum* Hiro, 1937 (left, RUMF-ZC-1556, right ASIZCR-000225); C, *Oxynaspis celata* Darwin, 1852 (RUMF-ZC-1557); D, *Oxynaspis ryukyuensis* **n. sp.** (holotype, RUMF-ZC-1558); E, *Poecilasma obliqua* (Hoek, 1907) (RUMF-ZC-1560); F, *Platylepas hexastylos* (Fabricius, 1798) (RUMF-ZC-1561). A-E, lateral view for stalked barnacles; F, anterior view for *Platylepas hexastylos*. Scale bars in mm to indicate the size of specimens.

Diagnosis. Hermaphrodite capitulum with 13 capitular plates arranged in 2 horizontal whorls, with capitular armourment of S-T surrounded by R-RL-L-CL-C-SC. Carina with apex acute, one third of carina extending beyond carinal margin of tergum, curving outward. Mandible with 3 large teeth, cutting margin convex, small pectinations between teeth. Maxillule rectangular, cutting margin convex, without notch, cutting margin with simple setae. Basipodite of cirri IV and V with extension of 2 lobes on inner margin, all lobe margins with simple and serrulate setae.

Description. Hermaphrodite capitulum trapezoid, with 13 plates (Figs 2A, 3A) arranged in 2 whorls, with capitular armourment of S-T surrounded by R-RL-L-CL-C-SC (Figs 2A, 3A). Capitular plates covered by thick, chitinous coating (Figs 2A, 3A). Carina long, one third of carina extending beyond carinal margin of tergum, umbo apical, apex acute, curving outward (Figs 2A, 3A). Tergum pentagonal, umbo apical, basal margin shortest. Scutum almost equilateral triangular, umbo apical (Figs 2A, 3A). Rostrolatus triangularly pyramidal, umbo apical, apex extending outward (laterally) and downward (Figs 2A, 3A, B). Latus triangularly pyramidal, umbo apical, apex extending outward (laterally) and upwards (Figs 2A, 3A, B). Carinolatus triangularly pyramidal, umbo apical, apex extending beyond carinal margin (Figs 2A, 3A). Sub-carina pyramidal, umbo apical, apex extending beyond carinal margin (Fig. 3A). Rostrum globular, small, located at base of junction between paired scuta (Fig. 3B).

Peduncle covered by thick cuticle with scattered setae (Figs 2A, 3A).

Maxilla rectangular, covered with simple setae (Fig. 4A). Maxillule rectangular, cutting margin without notch, margin convex with 15 simple setae (Fig. 4B, C). Mandible with 3 large, sharp teeth, cutting margin convex, pectinations between large teeth, lower margin short, straight, with 6 pectinations, inferior angle with 2 sharp pectinations (Fig. 4D, E). Mandibular palps triangular, with dense serrulate setae distally (Fig. 4F). Labrum concave, without notch, 6–8 sharp teeth on each side of cutting margin (Fig. 4G).

Gap between cirri I and II absent. Cirrus I shortest of all cirri, anterior ramus 11–segmented, posterior ramus 14-segmented (Fig. 3C), rami with simple setae. Cirrus II with anterior ramus 8-segmented, posterior ramus 9-segmented (Fig. 3D), setae of distal portion of rami fine serrulate, those of mid and proximal portions simple. Cirrus III, anterior ramus 9-segmented, posterior ramus 8-segmented (Fig. 3E), setae simple. Cirrus IV with both anterior and posterior rami 11-segmented (Fig. 3F), inner margin of basipodite with 2 extended lobes, margin around lobes covered with simple and serrulate setae (Fig. 3F). Cirrus V with both anterior and posterior rami 11-segmented, inner region of basipodite with 2 extended lobes, margins around lobes covered with simple and serrulate setae (Fig. 3G). Cirrus VI with anterior and posterior rami 12-segmented, posterior region of basipodite without lobe. Caudal appendage non-segmented, leaf-shaped; caudal appendage about 1.5 times height of proximal segment of pedicel of cirrus VI (Fig. 3H). Penis short, non-segmented, length similar to height of proximal segment of pedicel of cirrus VI. Complemental males found on inner margin of scutum, composed of carina, rostrum and paired scuta and terga (Fig. 4H).

Etymology. Derived from the Latin *arcuata*, indicating the strongly curved carina, which is a diagnostic character of this new species.

Distribution. At present only recorded from Kumejima Island, Ryukyu Islands, Japan.

Remarks. The current species is classified in *Calantica* as it has 13 capitular plates arranged in two whorls, with the lower whorls not overlapping the upper whorl. Newman & Jones (2011) reviewed the morphological groupings of *Calantica* and classified the genus into four groups, based on the number of capitular plates. Group I contains nine species with 13 capitular plates. Group II has one species, which sometimes has an extra second carinolatus. Group III contains two species having 14 capitular plates, including a sub-rostrum. Group IV contains three species with 14 capitular plates, including an additional second latus located at the rostral midline of the first latus. In the present study, *C. arcuata* **n. sp.** has 13 capitular plates and thus belongs to Group I. At present, Group I contains *C. affinis* Broch, 1922, *C. eos* (Pilsbry, 1907), *C. darwini* Jones & Hosie, 2009, *C. graphica* Rosell, 1991, *C. kruegeri* Hiro, 1932, *C. pusilla* Utinomi, 1970a, *C. studeri* (Weltner, 1922), *C. trispinosa* (Hoek, 1883) and *C. arcuata* **n. sp.** (Fig. 16A–I).

Calantica arcuata **n. sp.** differs from all members Group I (Newman & Jones 2011) by having a diagnostic long (one third of carina extending beyond the tergum) and outward curving carina (Figs 2A, 16I). The long carina is also present in juvenile specimens (CL 5.1 mm, NMNS-6690-001; Fig.2A), suggesting this character has been developed at an earlier stage of ontogeny (Fig. 2A). Mandibles of both *C. arcuata* **n. sp.** and *C. graphica* are three toothed, but *C. arcuata* differs from *C. graphica* in the morphology of the capitulum. Compared to *C. arcuata* **n. sp.,** the carinal margin of the tergum in *C. graphica* is slightly convex, whilst the carinal margin of the tergum of *C. arcuata* **n. sp.** is bent and forms a distinct obtuse angle (Fig. 16C, I). In addition, *C. arcuata* **n. sp.** is distinct from the members of Group I by its rectangularly shaped maxillule with a convex cutting margin, and the presence of extended lobes in the basal region of cirri IV and V (Fig. 4B, C). Such features have not been reported in other *Calantica* species.

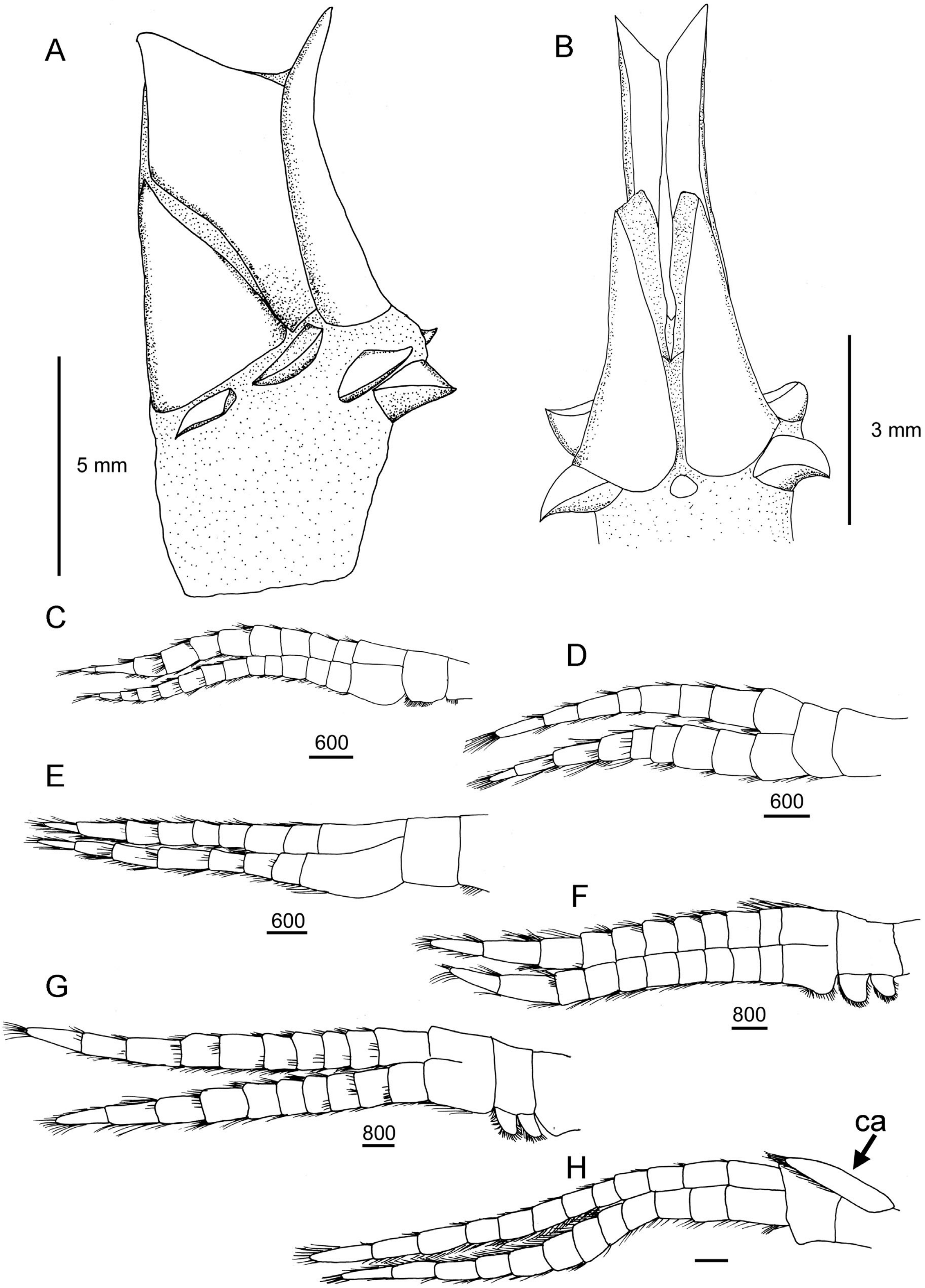


FIGURE 3. *Calantica arcuata* **n. sp.** (holotype, RUMF-ZC-1554) A, left view of capitulum; B, rostral view of capitulum, showing rostrum; C, cirrus I; D, cirrus II; E, cirrus III; F, cirrus IV; G, cirrus V; H, cirrus VI. ca, caudal appendage. Scale bars in μm, except A and B in mm. ca indicates the caudal appendage.

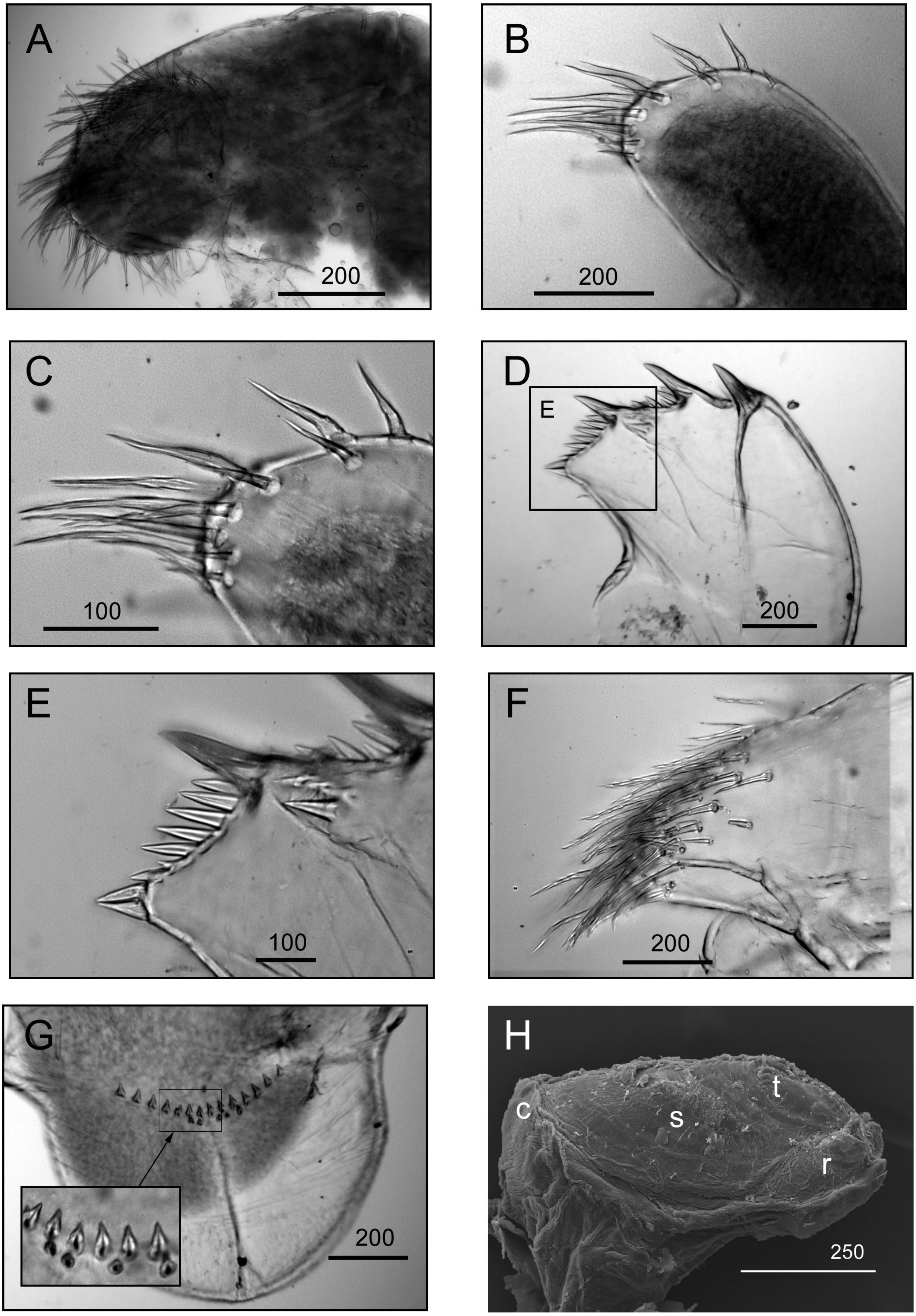


FIGURE 4. *Calantica arcuata* **n. sp.** (holotype, RUMF-ZC-1554). A, maxilla; B, maxillule; C, magnified view of cutting margin of maxillule; D, mandible; E, lower margin and inferior angle of mandible; F, mandibular palp; G, labrum; H, scanning electron microscopy image of complemental male showing carina (c), rostrum (r), scutum (s) and tergum (t). Scale bars in µm.

Genus *Euscalpellum* Hoek, 1907

Euscalpellum c.f. *squamosum* Hiro, 1937

(Figs. 2B, 5, 6)

Euscalpellum squamosum Hiro, 1937b: 391. — Zevina 1981: 89, fig 59.
Euscalpellum stratum. — Hiro 1933: 18, text figs 2, 3, pl. 1, fig. 4, 4a [non *E. stratum* (Aurivillius, 1894)].

Material examined. RUMF-ZC-1556, one specimen (CL 3.4 mm) on antipatharians, trawl 24, 26°16.322´N, 126°51.631´E, 12 Nov. 2009, depth 150.0–168.0 m. ASIZCR-000225, one specimen (CL 3.8 mm) on antipatharians; trawl 24, 26°16.322´N, 126°51.631´E, 12 Nov. 2009, depth 150.0–168.0 m.

Diagnosis. Capitulum with 15 white, smooth capitular plates. Tergum quadrangular, umbo apical, inframedian latus rhombic, umbo apical. Rostrolatus and carinolatus triangular, umbos apical.

Description. Hermaphrodite capitulum white, elongated, 15 smooth capitular plates, including carina, subcarina, rostrum, paired tergum, scutum, upper latus, inframedian latus, rostrolatus and carinolatus (Fig. 2B). Tergum quadrangular, umbo apical, occludent margin straight. Scutum quadrangular, umbo at middle of occludent margin. Upper latus almost square to parallelogram. Inframedian latus quadrangular, longitudinal diameter longer than lateral. Carinolatus and rostrolatus triangular, margins straight. Rostrum rhomboid, large, incurved, apex reaching half scutal occludent margin (Fig. 2B).

Maxilla bi-lobed, distally setose on each lobe (Fig. 5A). Maxillule slightly notched, region below notch slightly protuberant, 2 large setae above notch, 7 setae below, cutting margin short (Fig. 5B). Mandible with 4 large teeth excluding inferior angle, 1 small seta present between third and fourth large teeth, lower margin very short, inferior angle ending in sharp seta (Fig. 5C, D)

Cirrus I with anterior and posterior rami subequal, both rami 12-segmented (Fig. 6A), setae simple (Fig. 6B) and serrulate with very fine setules (Fig. 6C). Cirri II–VI ctenopod, all with simple setae in medial and proximal regions (Fig. 6D, E), serrulate setae distally (Fig. 6F). Cirrus II with anterior and posterior rami 9- and 10-segmented, respectively. Cirrus III with anterior and posterior rami 13-segmented. Cirri IV and V with anterior and posterior rami 12- and 13-segmented, respectively. Cirrus VI with anterior and posterior rami 13- and 12-segmented, respectively; intermediate segment of posterior ramus of cirrus VI with 3 pairs of long simple setae and 1 pair of short simple setae. Caudal appendage short, about half height of proximal segment of pedicel of cirrus VI (Fig. 5E), inner and outer margins with small pectinations, bundle of setae distally (Fig. 5E). Penis short, half length of cirrus VI (Fig. 5F).

Complemental males absent in present specimens.

Distribution. Japanese waters, including the Kii Channel, Wakayama Prefecture and Kumejima Island, Ryukyu Islands.

Remarks. The capitular morphology of the current species fits the description of *Euscalpellum squamosum* by Hiro (1933; 1937b). The mandible described by Hiro (1933) had four teeth, with a small setae between the third and fourth teeth, which is similar to the mandible morphology of the present specimen. The descriptions of Hiro (1933; 1937b) were based on the same, single specimen and recorded no penis. However, we found our specimen has a short penis (Fig. 4F). The reasons for the absences of a penis in *E. squamosum* in Hiro (1933; 1937b) is uncertain and could be due to the preservation status of the samples, and Hiro (1937b: 391) claimed “A further investigation on more materials may settle the question whether the present specimen is a pure female or not”. In Zevina‘s (1981) revision of the scalpellid barnacles, the description of *E. squamosum* was based on Hiro’s (1933; 1937b) original descriptions and no further specimens were examined to clarify the absence of a penis in *E. squamosum*. Some species of balanomorph barnacles (e.g. *Semibalanus balanoides*) lose the penis after the reproductive season (Barnes, 1992) but such loss has not been recorded in species of the stalked barnacle genus *Pollicipes* (Barnes, 1992). However, information on the relationship of the penis condition and the reproductive cycle of a large number of stalked barnacle species is still very limited (Barnes, 1992).

In the present study, we assigned the present species as *Euscalpellum* c.f. *squamosum* because the hard and soft parts of the specimens well matched with Hiro’s (1933; 1937b) descriptions. The only discrepancy between the present specimen and Hiro’s description is the absences of a penis in Hiro’s specimen. It is essential to locate and check the type specimen of *E. squamosum* (information and location of type specimen were not mentioned in Hiro 1933 and 1937b) and further collect samples from the type locality, to confirm the species identity of the current species.

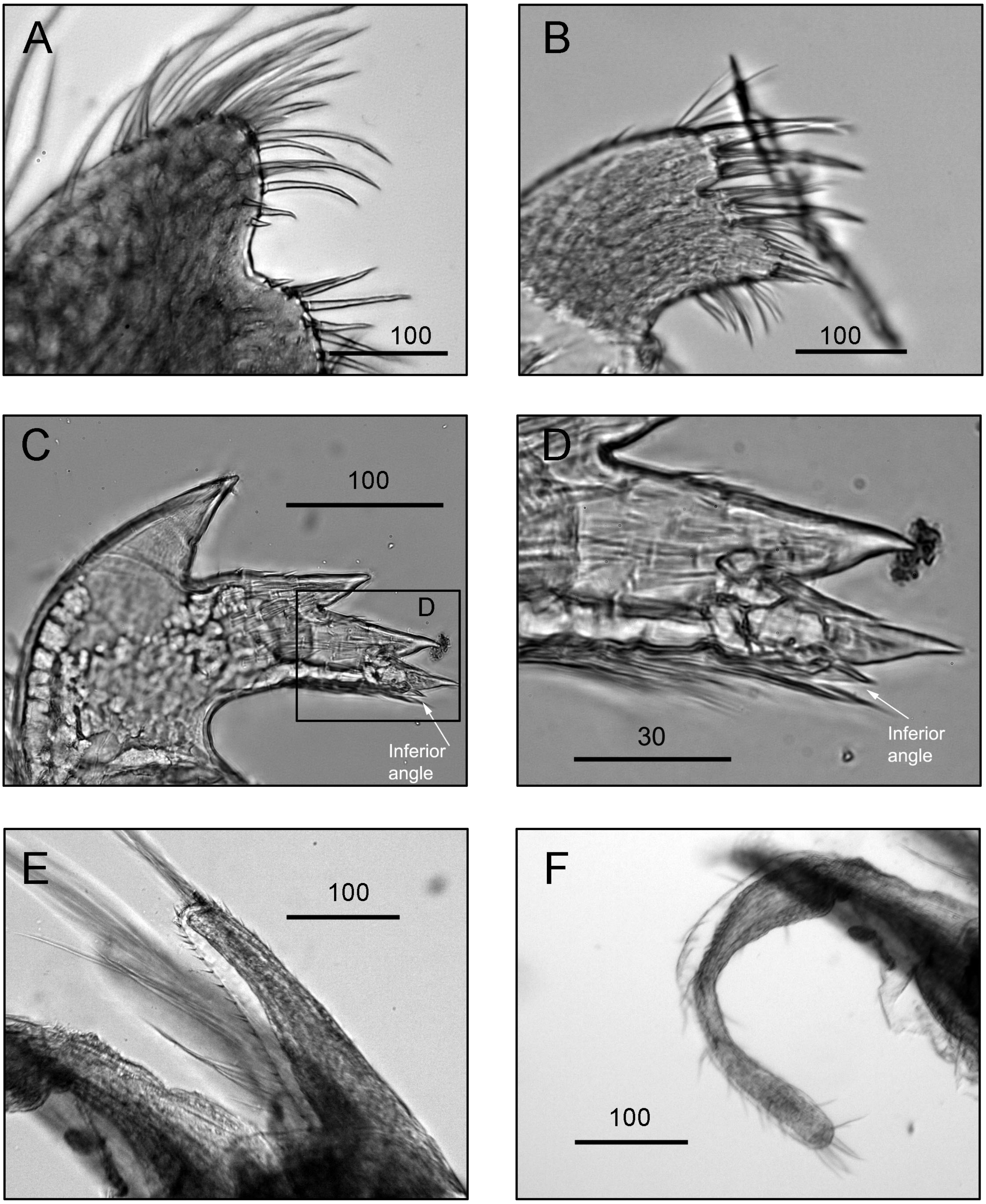


FIGURE 5. *Euscalpellum* c.f. *squamosum* Hiro, 1937 (RUMF-ZC-1556). A, maxilla; B, maxillule; C, mandible; D, lower margin and inferior angle of mandible; E, caudal appendage; F, penis. Scale bars in μm.

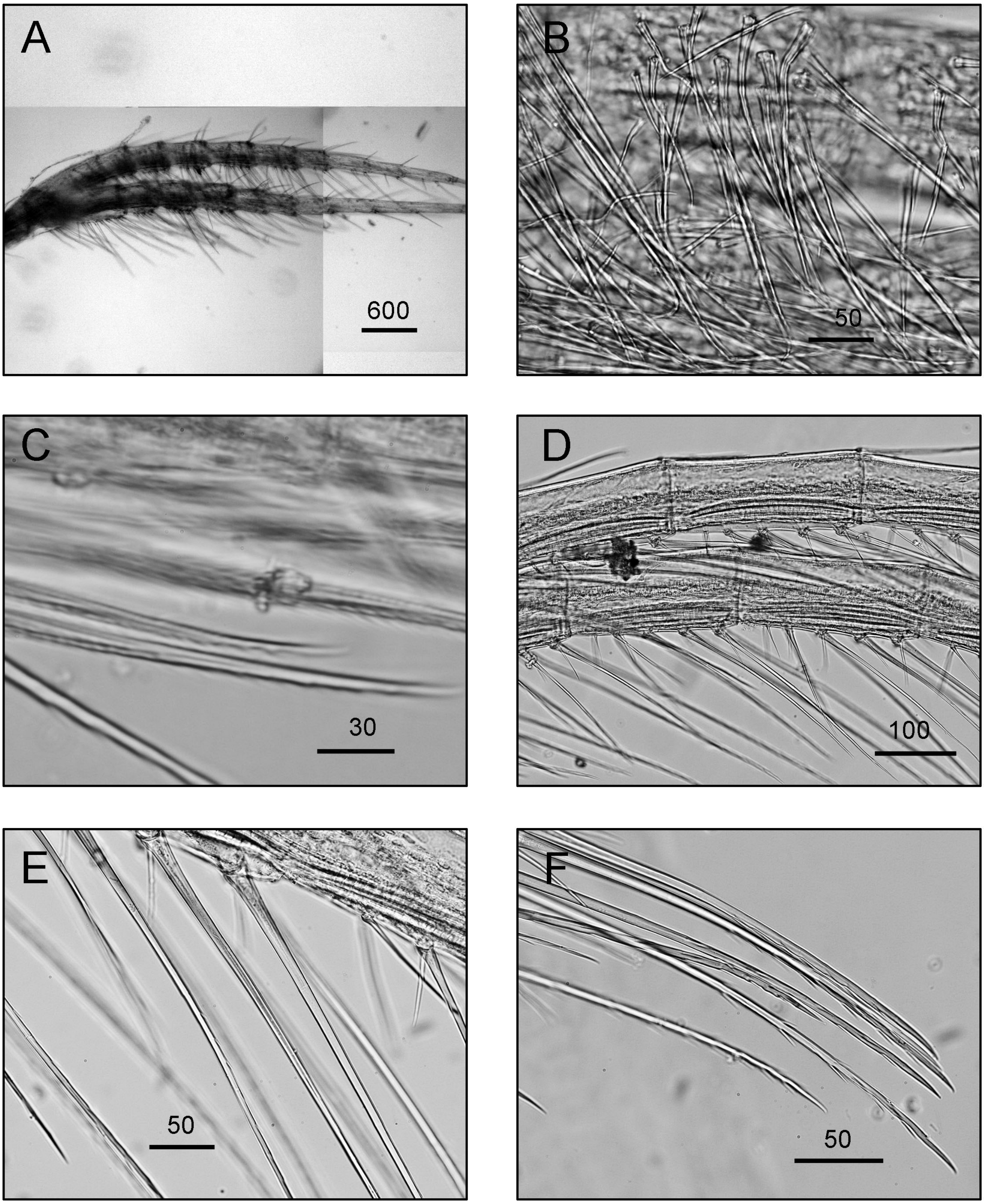


FIGURE 6. *Euscalpellum* c.f. *squamosum* Hiro, 1937 (RUMF-ZC-1556). A, cirrus I; B, simple type setae on cirrus I; C, serrulate setae with fine setules on cirrus I; D, intermediate segment of posterior ramus of cirrus VI; E, simple type setae on cirrus VI; F, serrulate type setae on distal region of cirrus VI. Scale bars in µm.

Order Lepadiformes Buckeridge & Newman, 2006

Suborder Lepadomorpha Darwin, 1852

Family Oxynaspididae Pilsbry, 1907

Genus *Oxynaspis* Darwin, 1852 (Van Soyc & Dekelboum, 2011 emend)

Oxynaspis celata Darwin, 1852

(Figs. 2C, 7, 8)

Oxynaspis celata Darwin, 1852: 134, pl. 3, fig. 1. — Gruvel 1905: 103, fig. 114. — Nilsson-Cantell 1921: 226, fig. 37. — Nilsson Cantell 1937: 94. — Hiro 1937a: 51, fig. 42. — Totton 1940: 473, fig. 9. — Zevina 1968: 35. — Zevina 1982: 31, fig. 18. — Van Soyc & Dekelboum 2011: 5.

Material examined. RUMF-ZC-1557, one specimen (CL 7.9 mm) on an antipatharian coral, trawl 31, 26°18.785´N, 126°53.249´E, 13 Nov. 2009, depth 70.4–75.3 m.

Diagnosis (emended). Capitulum completely or nearly covered by 5 thin, fragile plates; surfaces often overgrown by antipatharian corals. Tergum with apex distally recurved; length of occludent margin half length of scutal margin. Umbo of scutum located in middle portion of occludent margin. Carina bowed; umbo located in proximal one third of carina, length of distal arm of carina about twice length of basal arm. Filamentary appendages absent. Caudal appendages minute, oval shaped, bundles of setae apically.

Description. Capitulum covered by 5 fully calcified, thin, fragile plates - carina, paired tergum and scutum (Fig. 2C); surface of plates overgrown by antipatharian corals. Tergum narrow, occludent margin half length of scutal margin, occludent margin slightly convex, apex of tergum recurved distally. Scutum trapezoid, umbo at middle of occludent margin, basal margin perpendicular to occludent margin, carinal margin convex. Carina bowed, umbo located in proximal one third of carinal margin, length of distal arm twice length of basal arm (Fig. 2C). Maxilla rounded, simple setae on all margins (Fig. 7A, B). Maxillule slightly notched, 2 large simple setae above notch, notch shallow with several fine simple setae, more than 10 longer, simple setae below notch (Fig. 7C, D). Mandible with 4 teeth, first well separated from remainder (Fig. 7E), lower margin very short, smooth (Fig. 7F), inferior angle terminating in 1 pectination (Fig. 7F). Mandibular palps elongated (Fig. 7G, H); dense, simple setae distally (Fig. 7H).

Cirrus I with anterior and posterior rami subequal, setae simple, anterior and posterior rami 12-and 8-segmented, respectively (Fig. 8A, B). Cirri II–VI ctenopod. Cirrus II with anterior and posterior rami 9-and 13-segmented, respectively (Fig. 8C), setae simple (Fig. 8D) and serrulate with very fine setules (Fig. 8E). Cirrus III with anterior and posterior rami 14- and 15-segmented, respectively, both rami with simple and serrulate setae. Cirrus IV with anterior and posterior rami 17-segmented, setae simple and serrulate. Cirrus V with both rami 16-segmented, setae simple and serrulate. Cirrus VI with anterior and posterior rami 16- and 17-segmented, setae simple and serrulate; intermediate segment of posterior ramus of cirrus VI with 3 pairs of long serrulate setae and 2 pairs of short simple setae (Fig. 8F). Caudal appendage oval uniarticulate, short (one third height of proximal segment of pedicel of cirrus VI), 4 simple setae distally (Fig. 8G). Penis long, half length of cirrus VI, pedicel of penis without basi-dorsal point (Fig. 8H).

Distribution. Atlantic Ocean (Madeira); Indian Ocean (Bay of Bengal); South China Sea (Beibu Gulf); Taiwan Strait; Japan; New Zealand,

Remarks. Darwin (1852) identified *Oxynaspis celata* from an antipatharian coral, *Aphanipathes woollastoni*, from Madeira, Atlantic Ocean (Totton 1940). Subsequently, it has been widely recorded as four sub-species in the world's oceans (*O. celata indica* Annandale, 1909; also see Foster 1978; *O. c. novazelandica* Broch, 1922; *O. c. japonica* Broch, 1922; *O. c. hirtae* Totton 1940). Zevina (1982) revised the genus *Oxynaspis* and grouped *O. c. japonica* and *O. c. indica* as synonyms of *O. celata*, due to similarities in their external capitular morphology. Newman (1972) and Van Syoc and Dekelboum (2011) retained *O. c. japonica, O. c. novazelandica, O. c. indica* and *O. c. hirtae* as distinct sub-species of *O. celata*. *Oxynaspis celata* may be a cryptic species complex with high morphological variations in the world oceans and the taxonomy of this cryptic species group is unclear (see Foster 1978). Further studies should focus on the taxonomic status and population genetics of *O. celata* from different oceans in the world, using a combination of morphological and molecular approaches. In the present study we tentatively follow Van Syoc & Dekelboum (2011).

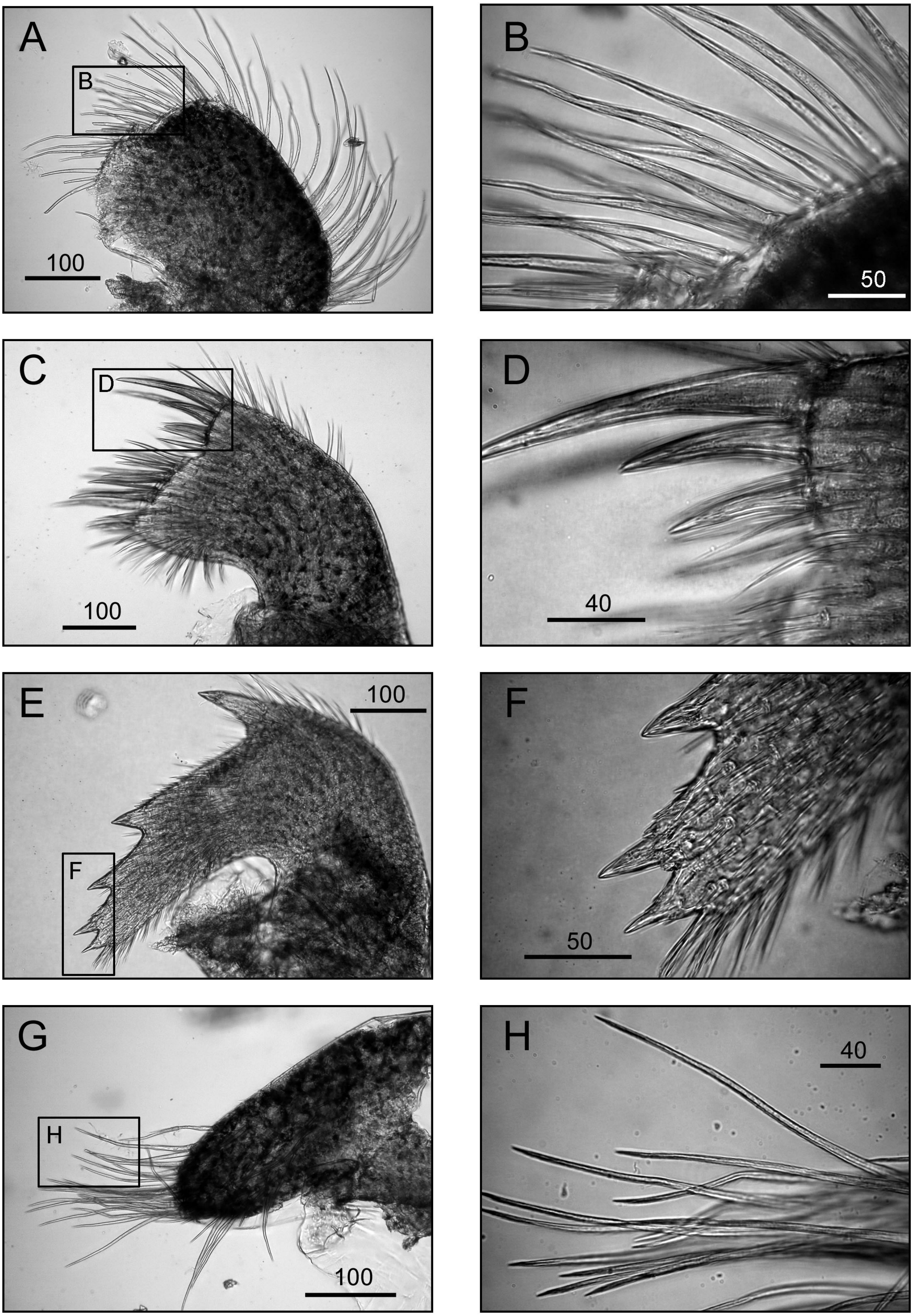


FIGURE 7. *Oxynaspis celata* Darwin, 1852 (RUMF-ZC-1557). A, maxilla; B, magnified view of setae of maxilla; C, maxillule; D, cutting margin of maxillule; E, mandible; F, lower margin and inferior angle of mandible; G, mandibular palp; H, setae on the of mandibular palp. Scale bars in µm.

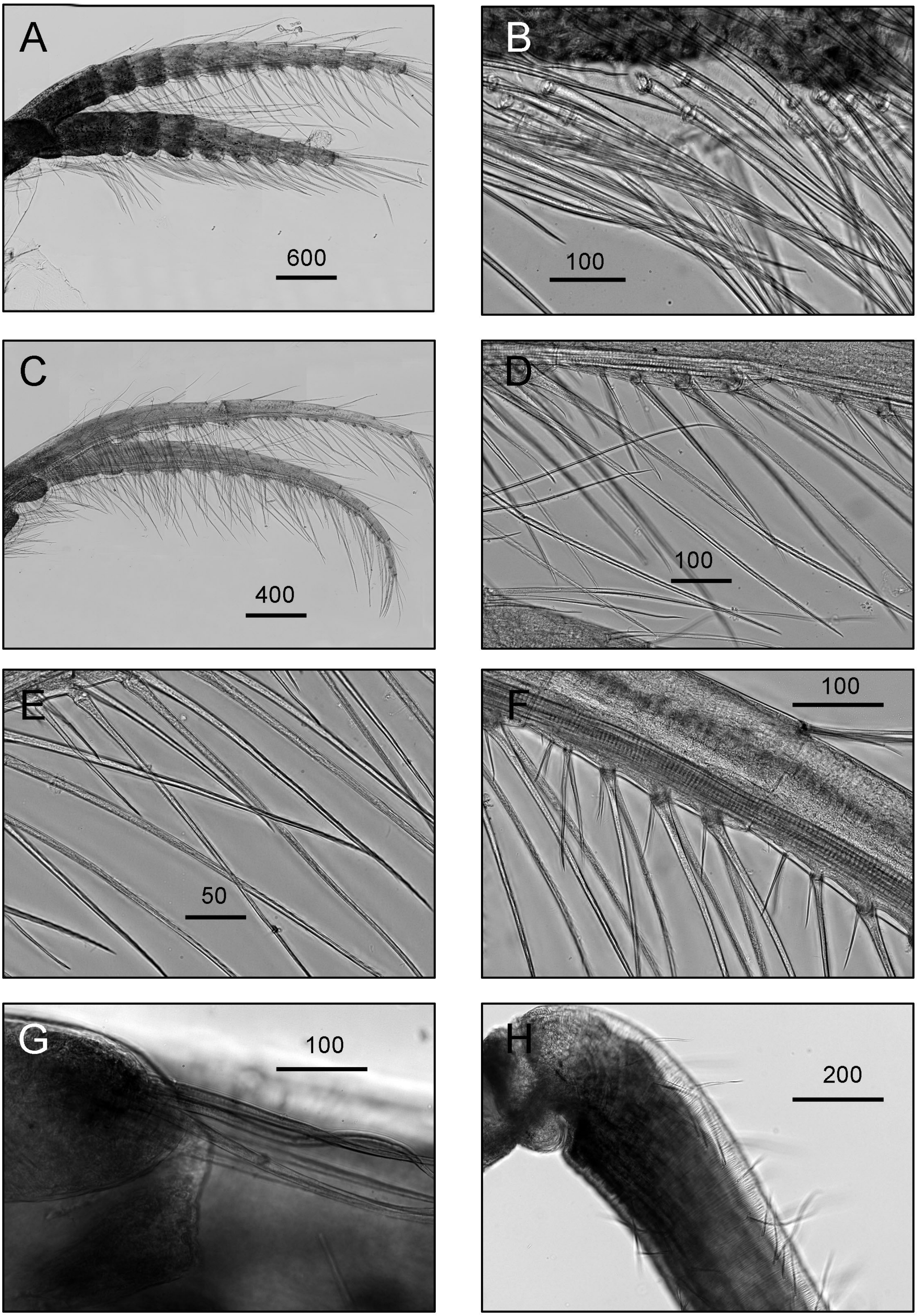


FIGURE 8. *Oxynaspis celata* (RUMF-ZC-1557). A, cirrus I; B, simple type setae on cirrus I; C, cirrus II; D, simple type setae on cirrus II; E, simple type setae on cirrus IV; F, intermediate segment of posterior ramus of cirrus VI; G, caudal appendage; H, pedicel of penis. Scale bars in µm.

Oxynaspis c. japonica Broch, 1922 was collected from Nagasaki, Japan. The capitular morphology and the arthropodal characters (cirri and mouth parts) of the present specimen fit the descriptions of *O. celata* Darwin,1852. Comparing the present specimen with *O. c. japonica* collected in Nagasaki, Japan (Broch 1922), most of the morphology described for *O. c. japonica* is similar to the present specimen except for morphological differences exhibited by the labrum. Broch (1922) described the labrum of *O. celata japonica* as follows - "a deep and broad median furrow extends from between the palpi and its extreme top and makes the projecting end of the labrum appear a little cleft". Such a deep and broad median burrow is absent from the labrum in the present specimen. Darwin (1852) did not mentioned the existence of such a furrow in the labrum of *O. celata*. The present specimen differs from *O. c. indica* as the opercular plate margins are smooth whereas those of *O. c. indica* have serrated margins (Table 1). The present specimen also differs from *O. c. hirtae* as the latter has an additional pair of filamentary appendages at the base of cirrus I (Table 1). *Oxynaspis celata* collected in the present study also differs from *O. c. novazelandica*, as the maxillule of *O. c. novazelandica* is strongly notched. Broch (1922: 278–279) described the maxillule of *O. c. novazelandica* as having "only three spines above the excavation (= notch) and the excavation is very broad, occupying almost half of the cutting edge….". In the present study, the maxillule of the *O. celata* is slightly notched (Fig. 7C), differing from *O. c. novazelandica* which has a broad maxillular notch.

Oxynaspis ryukyuensis n. sp.

(Figs 2D, 9–11)

Material examined. Holotype: RUMF-ZC-1558, one specimen (CL 5.4 mm) on an antipatharian coral; trawl 75, 26°19.586´N, 126°42.453´E, 19 Nov. 2009, depth 137–156 m. Paratypes: RUMF-ZC-1559, one specimen (CL 5 mm), same data as holotype. NHMS-6690-002, one specimen (CL 5.8 mm), same data as holotype.

Diagnosis. Capitulum elongated, with 5 completely calcified, thin plates. Tergum triangular, apex acute, high. Scutum quadrangular, occludent margin almost parallel with carinal margin. Carina slightly concave, umbo of carina located very close to basal region of carina, length of distal arm of carina about 7.5 times length of basal arm. Two filamentary appendages on dorsal side of somatic body.

Description. Hermaphrodite, capitulum narrow, surface covered by antipatharian; 5 fully calcified' thin plates, covering whole capitulum (Figs 2D, 9A). Carina slightly concave, apex reaching middle of carinal margin of tergum, umbo located very close to basal region of carinal margin, base non-forked (Fig. 11C, D), length of distal arm 7.5 times length of basal arm (Figs 2D, 9A). Tergum triangular, narrow, apex acute, umbo apical, occludent margin shortest, umbo apical (Figs 2D, 9A, 11B). Scutum trapezoid, umbo at middle portion of occludent margin, basal margin straight, perpendicular to occludent margin, carinal margin shortest (Figs 2D, 9A, 11A).

Maxilla rounded, simple setae on all margin (Fig. 10A, B). Maxillule strongly notched (Fig. 10C), 2 large spines above notch, region below notch protuberant, several short, simple setae in notch, approximately 8 setae below notch (Fig. 10D). Mandible with4 teeth, first separated from remainder, fourth smallest, lower margin short, with 3 short pectinations, inferior angle with 1 sharp pectination (Fig. 10E, F). Mandibular palps elongated, simple setae distally and on exterior margin (Fig. 10G, H).

Cirrus I with anterior and posterior rami 6-segmented, anterior ramus slightly longer (Fig. 9B); setae on both rami simple (Fig. 11E). Cirrus II with anterior and posterior rami 13- and 12-segmented, respectively (Fig. 9C); setae on both rami simple (Fig. 11F, G). Cirri III and IV with anterior and posterior rami 11-segmented (Fig. 9D, E). Cirrus V with anterior and posterior rami 12- and 11-segmented (Fig. 9F). Cirrus VI with anterior and posterior rami 15- and 14-segmented, respectively (Fig. 9G). Intermediate segments of posterior rami of cirri III to VI with 3 pairs of long simple setae and 1 pair of short simple setae (Fig. 11H). Caudal appendages absent. Penis half length of cirrus VI (Fig. 11J). Dorsal margin of somatic body with 2 narrow, long filamentary appendages (Fig. 11I).

Distribution. Currently only known from Kumejima Island, Ryukyu Islands.

Etymology. The name *ryukyuensis* denotes the type locality, the Ryukyu Islands.

Remarks. Previous studies on the diversity of *Oxynaspis* have received very scant attention. A recent revision of the Oxynaspididae (Van Syoc & Dekelboum 2011) erected two new genera, *Pycnaspis* Van Syoc & Dekelboum, 2011 and *Minyaspis* Van Syoc & Dekelboum, 2011, in addition to *Oxynaspis*. *Pycnaspis* is a monotypic genus, containing the thick and strong plated *P. connectens* (Broch, 1931, = ex *Oxynaspis connectens*). *Miyaspis* contains 15 species, all of which have a capitulum partially covered by plates and a basally forked carina (Van Syoc & Dekelboum 2011). *Oxynaspis* presently contains nine species (*Oxynaspis celata* Darwin, 1852, *O. gracilis* Totton, 1940, *O. alatae* Totton, 1940, *Oxynaspis cancellatae* Totton, 1940, *Oxynaspis pacifica* Hiro, 1931, *Oxynaspis rossi* Newman, 1972, *O. perekrestenkoi* Van Syoc & Dekelboum, 2011, *O. joankovennae* Van Syoc & Dekelboum, 2011 and *O. joandianeae* Van Syoc & Dekelboum, 2011) and four sub-species of *O. celata* (see remarks on *O. celata* above; Van Syoc & Dekelboum 2011). In Zevina's (1982) revision of the poecilasmatid barnacles, *Oxynaspis cancellatae* Totton, 1940 was considered a junior synonym to *O. connectens* Broch, 1931, while Newman (1972) considered them two separate species. Even Van Syoc & Dekelboum (2011) erected a new genus *Pycnaspis* to accommodate *O. connectens*, due to its distinctly strong and thick capitular plates. In the present study, we adopt the classification of Van Syoc & Dekelboum (2011). No other *Oxynaspis* species are reported to be junior synonyms of *O. gracilis* and *O. alatae* (see Zevina, 1982).

Oxnaspis pacifica, *O. rossi*, *O. perekrestenkoi*, *O. joankovennae* and *O. joandianeae* have large uncalcified spaces between the scutum and carina, differing from *O. ryukyuensis* **sp. n.**, which has the capitulum completely covered by the capitular plates.

The location of the umbo on an opercular plate is an important taxonomic character in identifying stalked barnacles (see Zevina, 1982). In *Oxynaspis*, the umbo of the scutum is located at the occludent margin; the location of the umbo on the carina, located at the middle or below the middle portion of the carinal margin, is a morphological characteristic used to identify *Oxynaspis* species (Newman, 1972; Van Syoc & Dekelboum 2011). Annandale (1909) and Totton (1940) measured the length ratio of the distal arm (carinal length above the umbo) and basal arm (carinal length below the umbo) of the carina of *Oxynaspis* for species comparisons. Comparing the present specimen with *Oxynaspis celata* collected in the present study (see *O. celata* in the previous section), the location of the umbo on the carina exhibited great differences between *O. celata* and *O. ryukyuensis* **n. sp.** The umbo of the carina of *O. celata* was located in the proximal one third of the carina and the length of the distal arm was about twice the length of the basal arm. In *O. ryukyuensis* **n. sp.,** the location of the carinal umbo was located very close to the basal region, with the length of the distal arm 7.5 times greater than the basal arm (Table 1). Both specimens of *O. celata* and *O. ryukyunesis* **n. sp.** were adults with mature egg masses and thus such differences in the locations of the umbones should not be due to age variation.. In addition, the dorsal side of the somatic body of *O. ryukyuensis* **n. sp.** has two filamentary appendages, whereas filamentary appendages were absent from *O. celata*, suggesting that *O. ryukyuensis* **n. sp.** differs from *O. celata* (Table 1).

The location of the carinal umbo has been described and clearly illustrated for *O. celata* Darwin, 1852, *O. celata japonica* Broch, 1922, *O. celata hirtae* Totton, 1940, *O. celata indica* Annandale, 1902 (illustrated in figs 12–14 in Totton 1940; redrawn in Fig. 16), *O. cancellatae* Totton, 1940, *O. gracilis* Totton, 1940, and *O. alatae* Totton, 1940. The umbo of the carina in *O. celata* (see pl. 3 in Darwin 1852; Fig. 16L), *O. celata hirtae* (see figs 10, 11 in Totton 1940; Fig. 16N), *O. celata japonica* (see fig. 32 in Broch 1922; Fig. 16M), *O. celata indica* (see figs 12–14 in Totton 1940; Fig. 16O), *O. gracilis* (see fig. 8 in Totton 1940; Fig. 16K) and *O. alatae* (see fig. 3 in Totton 1940; Fig. 16J) are expanded, forming a distinct angle and are located at the middle or proximal one third of the carina, differing from the specimens of *O. ryukyuensis* **n. sp.**, which have the umbo located very close to the basal region of the carina (Fig. 16Q; Table 1). Measuring the type illustration of *Oxynapsis* species mentioned above (except *O. indica* illustrated in Totton 1940), the length ratio of the distal arm to basal arm was 1.9 in *O. alatae*, 1.5 in *O. gracilis*, 1.9 in *O. celata*, 2.1 in *O. celata japonica*, 2.4 in *O. c. hirtae*, 1.7 in *O. c. indica*, obviously differing from 7.5 in *O. ryukyuensis* **n. sp.** (Table 1). The basal location of the carinal umbo of *O. ryukyuensis* **n. sp.** is consistent in the holotype and the two paratypes. The length ratio of the distal arm to the basal arm is 7.9 and 8.0 for the two paratypes. There is no detailed description of *O. c. novazelandica* in Broch (1922) but *O. c. novazelandica* was described as morphologically very close to *O. c. indica*, with only the maxillule differing between the two species. In the present study, we believe the external morphology of *O. c. novazelandica* is close to that of *O. c. indica* and thus morphologically differs from *O. ryukyuensis* **n. sp.**, therefore confirming that *O. ryukyuensis* **n. sp.** does not belong to the *O. celata* cryptic species group.

Oxynaspis cancellatae (see fig. 1 in Totton 1940; Fig. 16P) and *O. ryukyuensis* **n. sp.** have the carinal umbo located close to the basal region (see Fig. 16Q). The carinal umbo of *O. cancellatae* is located higher than in *O. ryukyuensis* **n. sp.**, resulting in the length ratio of the distal arm to the basal arm in *O. cancellatae* as 5.7, shorter than that of *O. ryukyuensis* **n. sp.**, which is 7.5. The base of cirrus I of *O. cancellatae* has a single filamentary appendage (see fig. 13b in Broch 1931) but a filamentary appendage is absent from the base of cirrus I of *O. ryukyuensis* **n. sp.** (Fig. 9B). The capitulum with completely calcified plates, the location of the carinal umbo and the absence of a filamentary appendage at the base of cirrus I define *O. ryukyuensis* **n. sp.**.

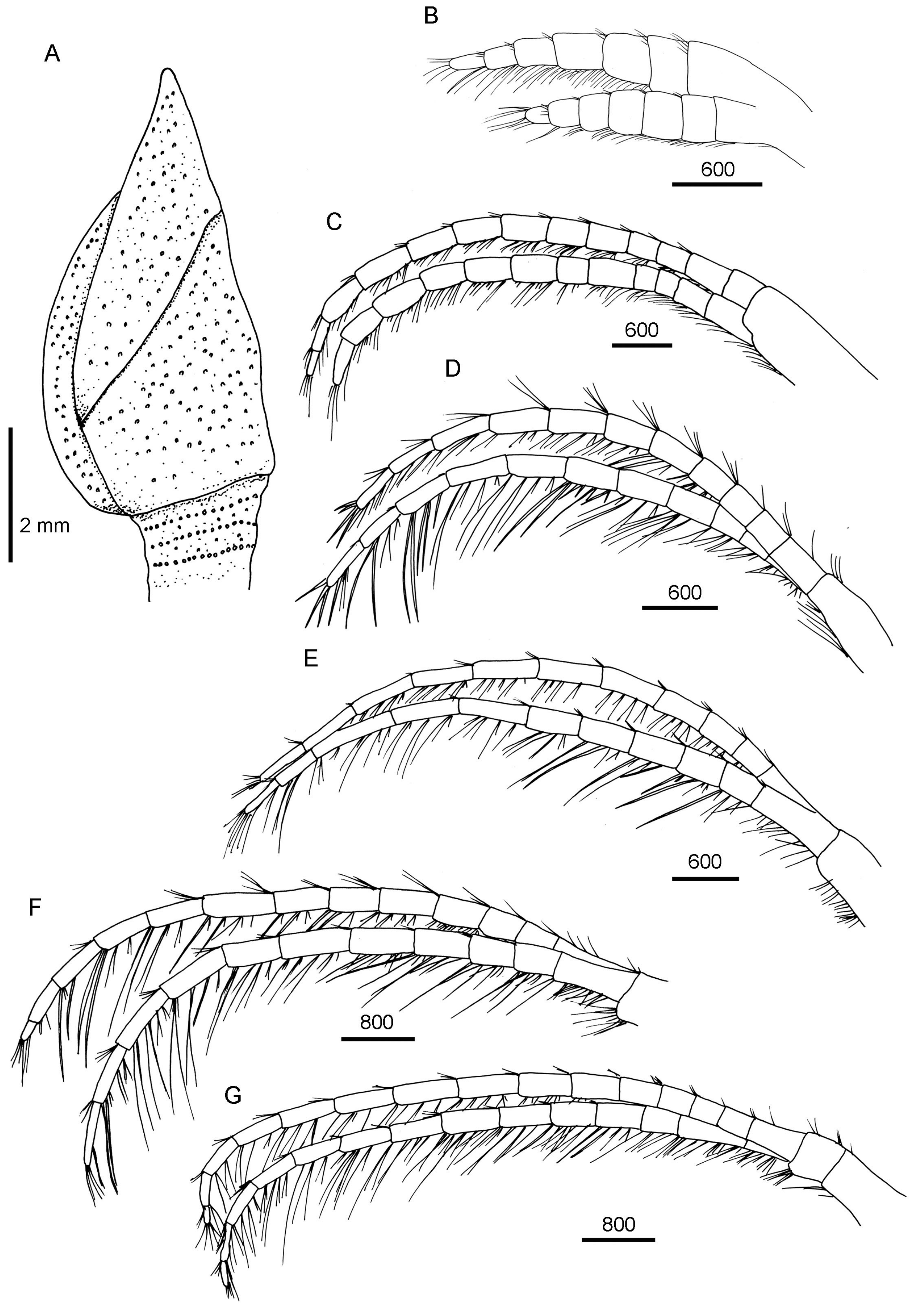


FIGURE 9. *Oxynaspis ryukyuensis* **n. sp.** (holotype, RUMF-ZC-1558). A, right view of capitulum; B, cirrus I; C, cirrus II; D, cirrus III; E, cirrus IV; F, cirrus V; G, cirrus VI. Scale bars in μm, except A in mm.

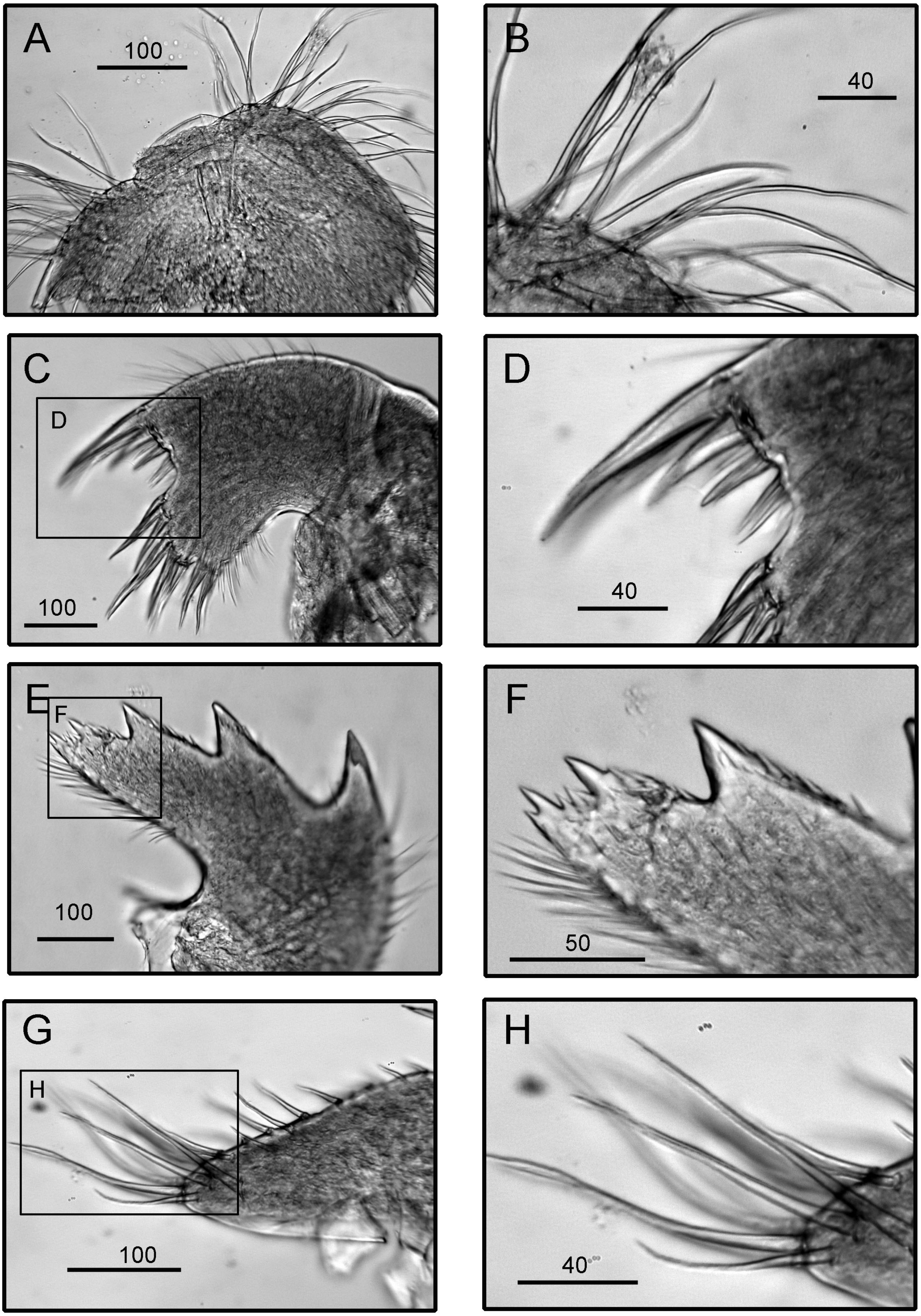


FIGURE 10. *Oxynaspis ryukyuensis* **n. sp.** (holotype, RUMF-ZC-1558). A, maxilla; B, magnified view of maxilla, showing setae; C, maxillule; D, cutting margin of maxillule; E, mandible; F, lower margin and inferior angle of mandible; G, mandibular palp; H, setae at tip of mandibular palp. Scale bars in µm.

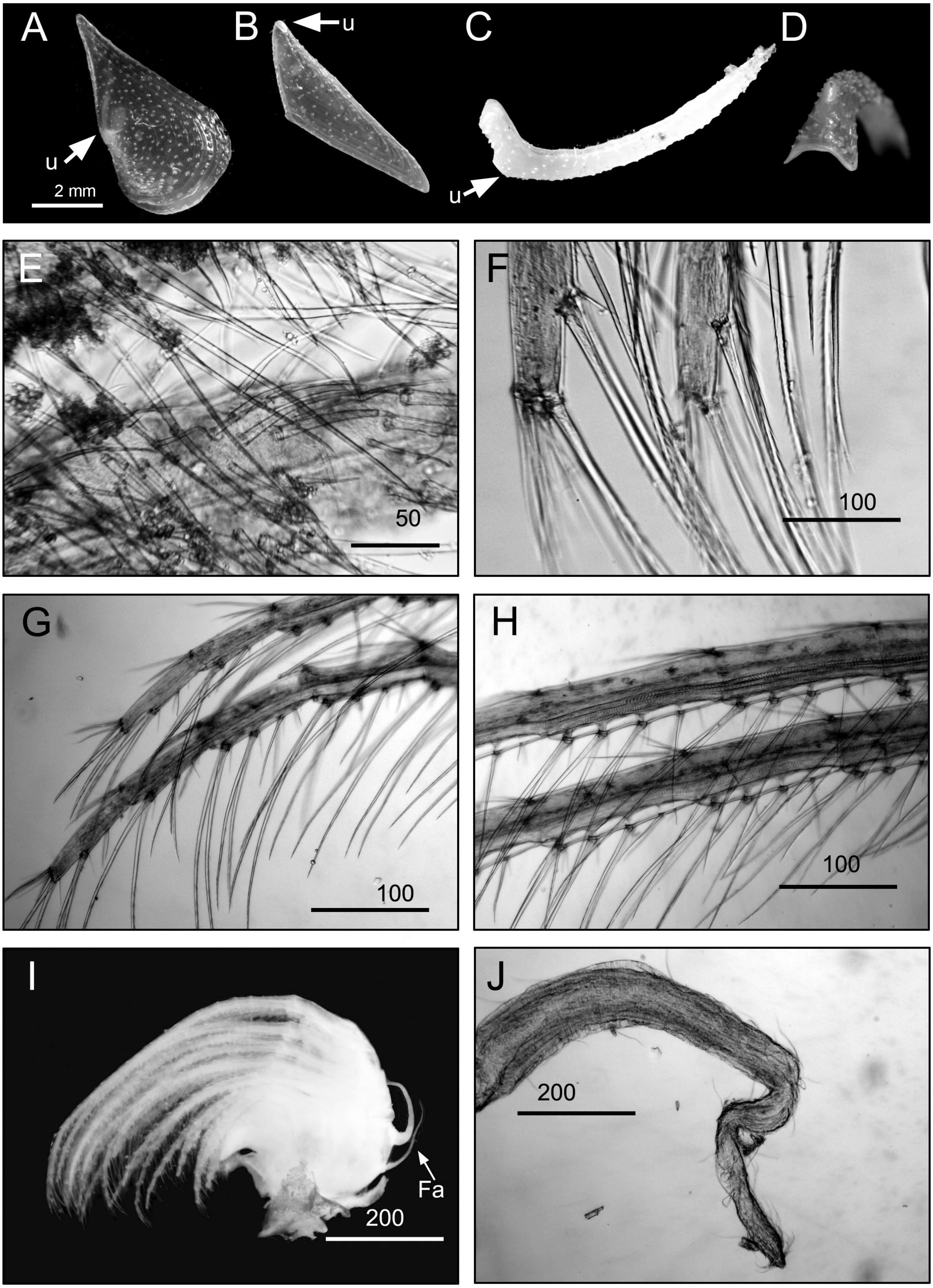


FIGURE 11. *Oxynaspis ryukyuensis* **n. sp.** (holotype, RUMF-ZC-1558). A, scutum, dorsal view, B, tergum, dorsal view, C, carina, lateral view, D, carina, basal view showing non-forked base, u—umbo, E, simple type setae on cirrus I; F, distal region of cirrus II; G, distal region of cirrus III; H. intermediate segment of posterior ramus of cirrus VI; I, somatic body, showing location of two filamentary appendage (Fa); J, penis. Scale bars in μm, except E in mm.

TABLE 1. Comparison of the diagnostic characters among *Oxnaspis* species (species with capitulum fully covered by capitular plates). There was no detailed description of *O. c. novazelandica* Broch, 1922 and it was not included in the table below (see remarks in *O. ryukyuensis* **n. sp.** for details). FA—Filamentary appendages, CA—Caudal appendages. NA—no information available in the literature.

	O. celata Darwin, 1852	*O. c. japonica* Broch, 1922	*O. c. hirtae* Totton, 1940	*O. c. indica* Annandale, 1909	*O. gracilis* Totton, 1940	*O. alatae* Totton, 1940	*O. cancellatae* Totton, 1940	*O. celata* (present study)	*O. ryukyuensis* **n. sp.** (present study)
FA	Absent	Absent	1 pair at base of cirrus I	Absent	NA	2 at dorsal side of body, 1 at base of cirrus I	2 at dorsal side of body, 1 pair at base of cirrus I	Absent	2 at dorsal side of the body
CA	1 pair	1 pair	NA	1 pair	NA	Absent	Absent	1 pair	Absent
Location of umbo of carina	Proximal one third portion of carina	Proximal one third portion of carina	Proximal one third portion of carina	Proximal one third portion of carina	Approximate middle portion of carina	Proximal one third portion of carina	Close to basal region of carina	Proximal one third portion of carina	Very close to basal region of carina
Length ratio of distal arm to basal arm of carina	1.88	2.1	2.4	1.7	1.5	1.88	4.4	2	7.5
Opercular plate margin	Smooth	Smooth	Smooth	Serrated	Smooth	Smooth	Smooth	Smooth	Smooth

Family Poecilasmatidae Annandale, 1909

Genus *Poecilasma* Darwin, 1852

Poecilasma obliqua (Hoek, 1907)

(Figs. 2E, 12, 13)

Poecilasma oblequum Hoek, 1907: 12, pl. 1, figs. 11–22.— Liu & Ren 1985: 231, fig 27: pl. 6: 17.
Poecilasma (*Trilasmis*) *oblequum*.— Krüger, 1911: 39.
Temnaspis obliqua.— Broch, 1931: 128.
Trilasmis (*Poecilasma*) *oblique*.— Hiro 1937b: 408, figs. 8–9.—Hiro 1937a: 83, fig. 68.

Material examined. RUMF-ZC-1560, one specimen (13.2 mm) on *Chaceon granulatus* (Sakai) (Brachyura, Geryionidae RUMF-ZC-1093); collected by a bait trap off Kumejima, 26°17.433´N 126°43.142´E–26°17.498´N 126°42.487´E, 19–20 Nov. 2009, depth 457–547 m.

Diagnosis. Capitulum globular, white, plates smooth. Tergum very narrow, occludent margin very short.

Description. Capitulum globular, white; 5 capitular plates - 1 carina, paired tergum and scutum. Tergum triangular, very narrow; occludent margin shortest (Fig. 2E). Scutum D-shaped; tergal and carinal margins convex; occludent margin straight, vertical; basal margin perpendicular to occludent margin (Fig. 2E). Peduncle yellow, with concentric rings (Fig. 2E).

Maxilla globular; all margins setose; setae simple. Maxillule strongly notched; two large setae above notch, one large setae in notch; region below notch protuberant; short setae below (Fig. 12A, B). Mandible with 4 teeth, first separated from remainder; cutting margin smooth; inferior angle acute (Fig. 12C, D). Mandibular palps subtriangular, tapering distally (Fig. 12E); serrulate setae distally (Fig. 12F) and on exterior margin. Labrum concave with numerous (>100) small, sharp teeth (Fig. 12G, H).

Cirrus I with 1 oval shaped filamentary appendage at base (Fig. 13B); anterior and posterior rami 8- and 6-segmented, respectively (Fig. 13A); large, robust, short simple setae at tip of both rami and on segment junction of greater curvature of ramus (Fig. 13E); serrulate setae along mid and proximal region of lesser curvature of ramus (Fig. 13C, D). Setal type of cirri II–VI simple. Cirrus II, anterior and posterior rami 10- and 17-segmented, respectively. Cirri III and IV with anterior and posterior rami 13- and 14-segmented, respectively. Cirrus V with anterior and posterior rami 12- and 13-segmented, respectively. Cirrus VI with anterior and posterior rami 14-segmented; intermediate segment of lesser curvature of posterior ramus with 7 to 10 serrulate setae at junction of each segment (Fig. 13F). Caudal appendage short, length similar to height of proximal segment of pedicel of cirrus VI; serrulate setae distally (Fig. 13G). Penis setose, large bundle of setae distally (Fig. 13H).

Distribution. Pacific Ocean, South China Sea.

Remarks. This species has been recorded previously in Japanese waters (Hiro 1937b).

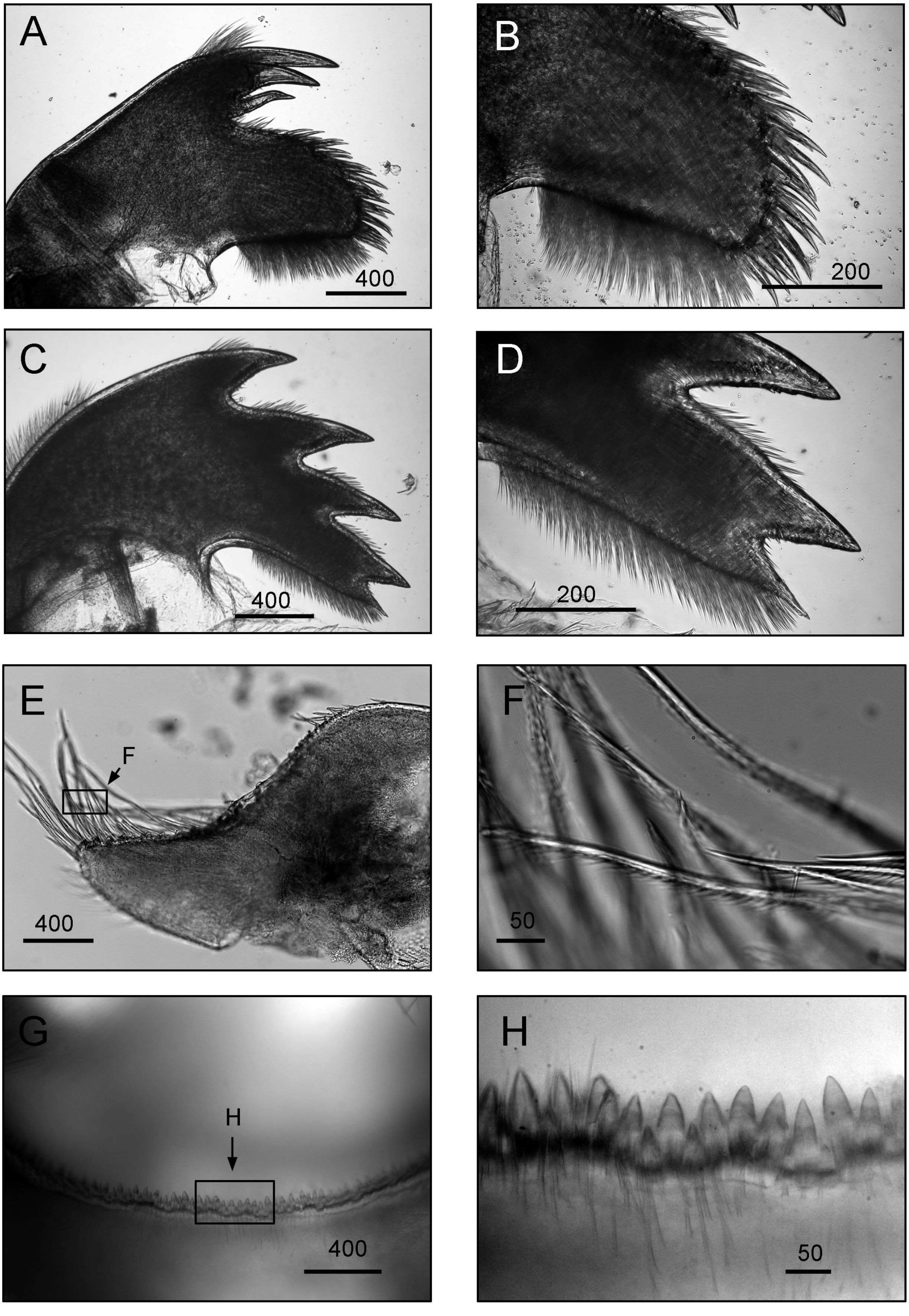


FIGURE 12. *Poecilasma obliqua* (Hoek, 1907) (RUMF-ZC-1560). A, maxillule; B, protuberant portion of maxillule below the notch; C, mandible; D, cutting margin and inferior margin of mandible; E, mandibular palp; F, serrulate setae on distal region of mandibular palp; G, labrum; H, teeth on cutting margin of labrum. Scale bars in µm.

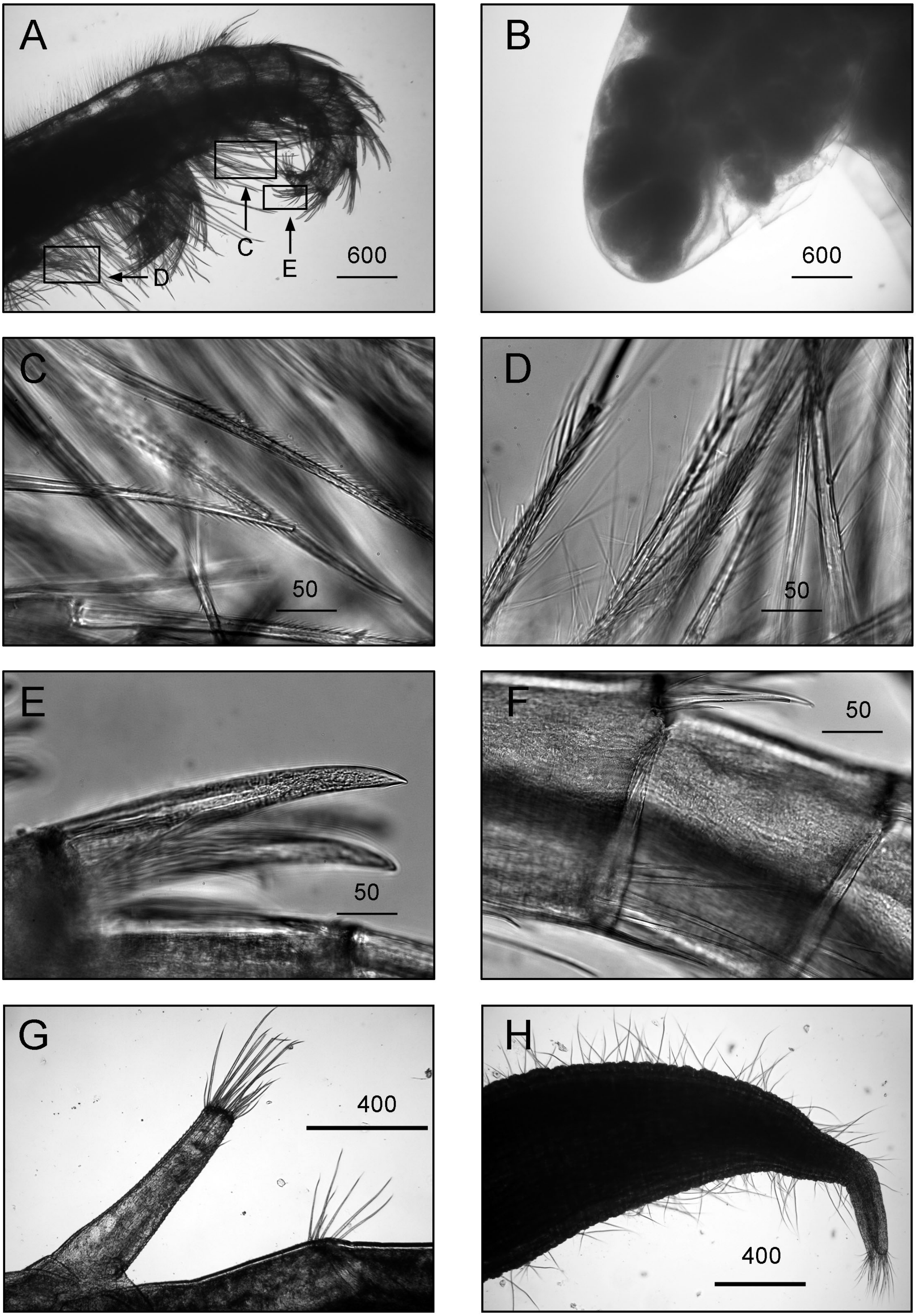


FIGURE 13. *Poecilasma obliqua* (Hoek, 1907) (RUMF-ZC-1560). A, cirrus I; B, filamentary appendage at basal region of cirrus I; C, serrulate setae at mid-region of ramus in cirrus I; D, serrulate setae at proximal region of ramus of cirrus I; E, sharp robust simple setae at distal region of cirrus I; F, intermediate segment of posterior ramus of cirrus VI; G, caudal appendage; H, penis. Scale bars in µm.

Order Sessilia Lamarck, 1818

Suborder Balanomorpha Pilsbry, 1916

Superfamily Coronuloidea Leach, 1817

Family Platylepadidae Newman & Ross, 1976

Platylepas hexastylos (Fabricius, 1798)

(Figs. 2F, 14, 15)

Lepas hexastylos Fabricius, 1798: 35, pl. 10, figs 1–2. (not seen)
Coronula bissexlobata De Blainville, 1824: 379, tab 117, fig. 1.
Platylepas bissexlobata.— Darwin 1854: 428, pl. 17, figs. 1a–d. — Weltner 1897: 253. — Gruvel 1905: 276, fig. 300.
Platylepas hexastylos.— Pilsbry 1916: 285, pl. 67, figs. 1–1c. — Broch 1924: 18, fig. 6. — Hiro 1936: 319. — 1937b: 472, fig. 43. — Kolosvàry 1943: 101. — Henry 1954: 444. — Stubbings 1967: 300. — Utinomi 1959: 384. — 1970: 360. — Newman & Ross 1976: 44. — Ren 1980: 188, fig. 2 pl. 1. — Liu & Ren 2007: 312, fig. 138. — Ross & Frick, 2011: 62. — Hayashi 2012: 117: fig. 7.

Material examined. RUMF-ZC-1561, ten specimens (BD 3.08–5.38 mm); collected from a dead sea turtle, *Chelonia mydas*, in a gill net, Tomari Port, 19 Nov. 2009.

Diagnosis. Shell white; 6 tubiferous plates, externally with horizontal growth ridges, internally with median longitudinal sulcus.

Description. Shell white, conical, low, outer margin of plates serrated, surfaces with horizontal growth ridges (Fig. 2F, 14A), plates tubiferous, with median longitudinal sulcus of inner surface visible from basal view (Fig. 14A, B), line of median longitudinal sulcus obvious, dividing each plate into two main lobes (Fig. 14A); radii narrow. Orifice narrow, oval shaped (Fig. 2F). Scutum rectangular, wider than high. Tergum triangular, occludent margin and basal margin forming obtuse angle.

Maxilla sub-triangular, serrulate setae apically (Fig. 14C). Maxillule without notch, cutting margin straight, 2 large setae at upper margin followed by 8 smaller, simple setae (Fig. 14D). Mandible with 5 main teeth, second, third and fourth bifid, secondary tooth between second and third, and third and fourth; inferior angle pectinated, covered with fine pectinations (Fig. 14E, F). Mandibular palp oval; lateral margin covered with long, fine setae; upper margin with short, fine setae (Fig. 14G). Labrum notched, 3 large teeth on either side of cutting margin (Fig 14H).

Cirrus I with rami unequal, anterior and posterior rami 7- and 10-segmented, respectively, both rami with serrulate setae (Fig. 15A, B). Cirrus II with anterior and posterior rami 7-segmented (Fig. 15C); both rami with serrulate setae. Cirrus III with anterior and posterior rami 9- and 12-segmented (Fig. 15D). Cirri IV to VI long, slender (Fig. 15E), intermediate segments of posterior ramus of cirrus IV (Fig. 15F) and cirrus VI (Fig. 15G) with 3 pairs of long serrulate setae with very fine setules and 1 pair of shorter, simple setae.

Penis long, length about 1.5 times length of cirrus VI; pedicel with small basi-dorsal point (Fig. 15H).

Distribution. Cosmopolitan in temperate and tropical waters; attached to the carapace, plastron, head, flipper, legs and soft skin of sea turtles.

Remarks. In Japanese waters, *P. hexastylos* has been recorded on the Loggerhead turtle *Caretta caretta* (Linnaeus, 1758) in Niigata (Utinomi 1970b), Iwate, Fukui, Okinawa, Kagoshima, Hachijojima Island and Chiba (Hayashi 2012), on the Green turtles *Chelonia mydas* (Linnaeus, 1758) in Okinawa, Ogasawara Island, Wakayama and Kanagawa (Hayashi 2012), on the Black turtle *Chelonia mydas agassizii* (Bocourt, 1868) in Iwate (Hayashi *et al.* 2011), on the Hawksbill turtles Eretmochelys imbricata (Linnaeus, 1766) in Chiba, Fukui and Okinawa (Hayashi 2012) and on the Leatherhead turtle *Dermochelys coriacea* (Vandelli, 1761) in Niigata and Ishikawa (Utinomi 1970b).

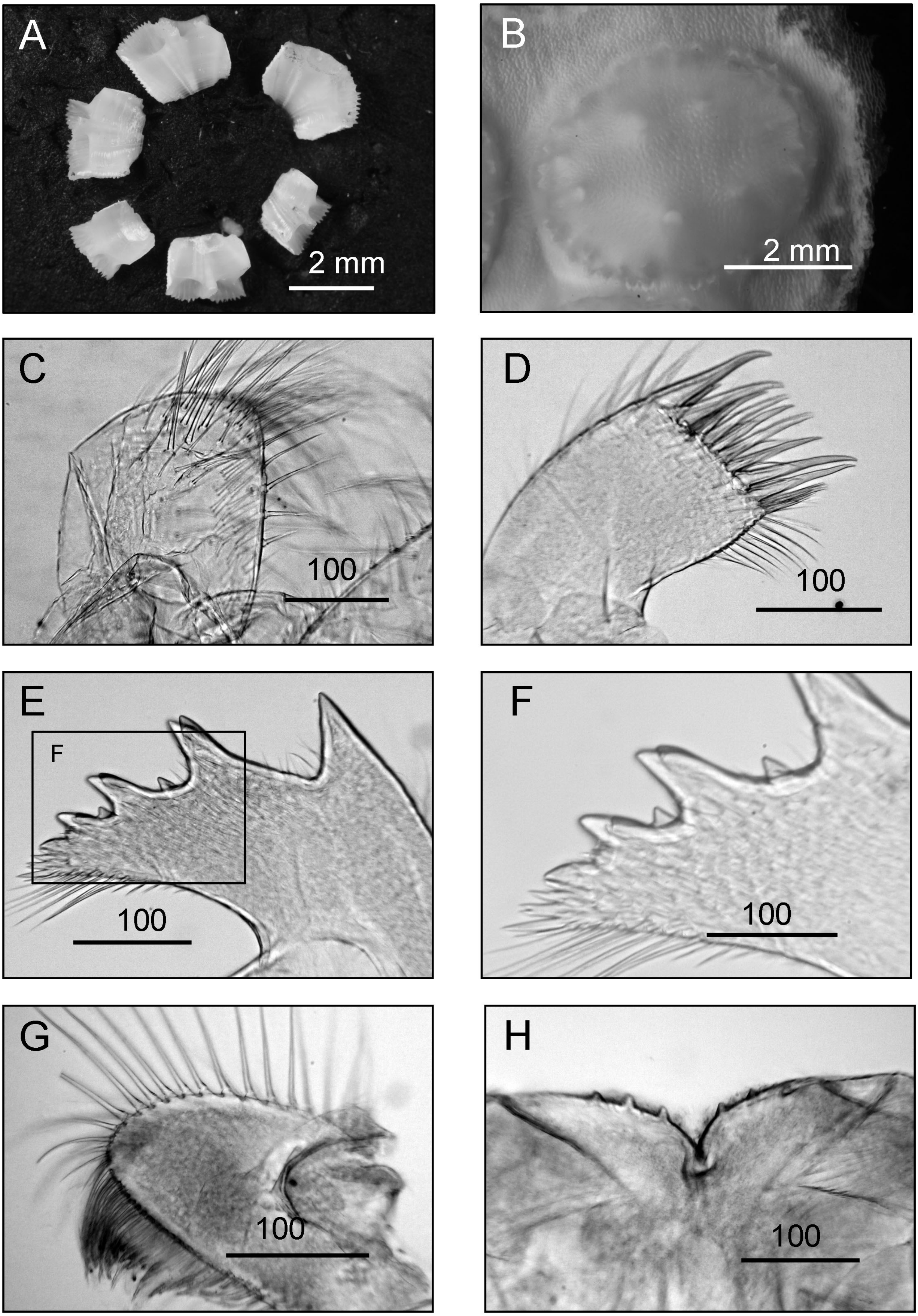


FIGURE 14. *Platylepas hexastylos* (Fabricius, 1798) (RUMF-ZC-1561). A, basal view of shell plates; B. basal view of whole barnacles; C, maxilla; D, maxillule; E, mandible; F, lower margin and inferior angle of mandible; G, mandibular palp; H, labrum. Scale bars in µm, except A, B in mm.

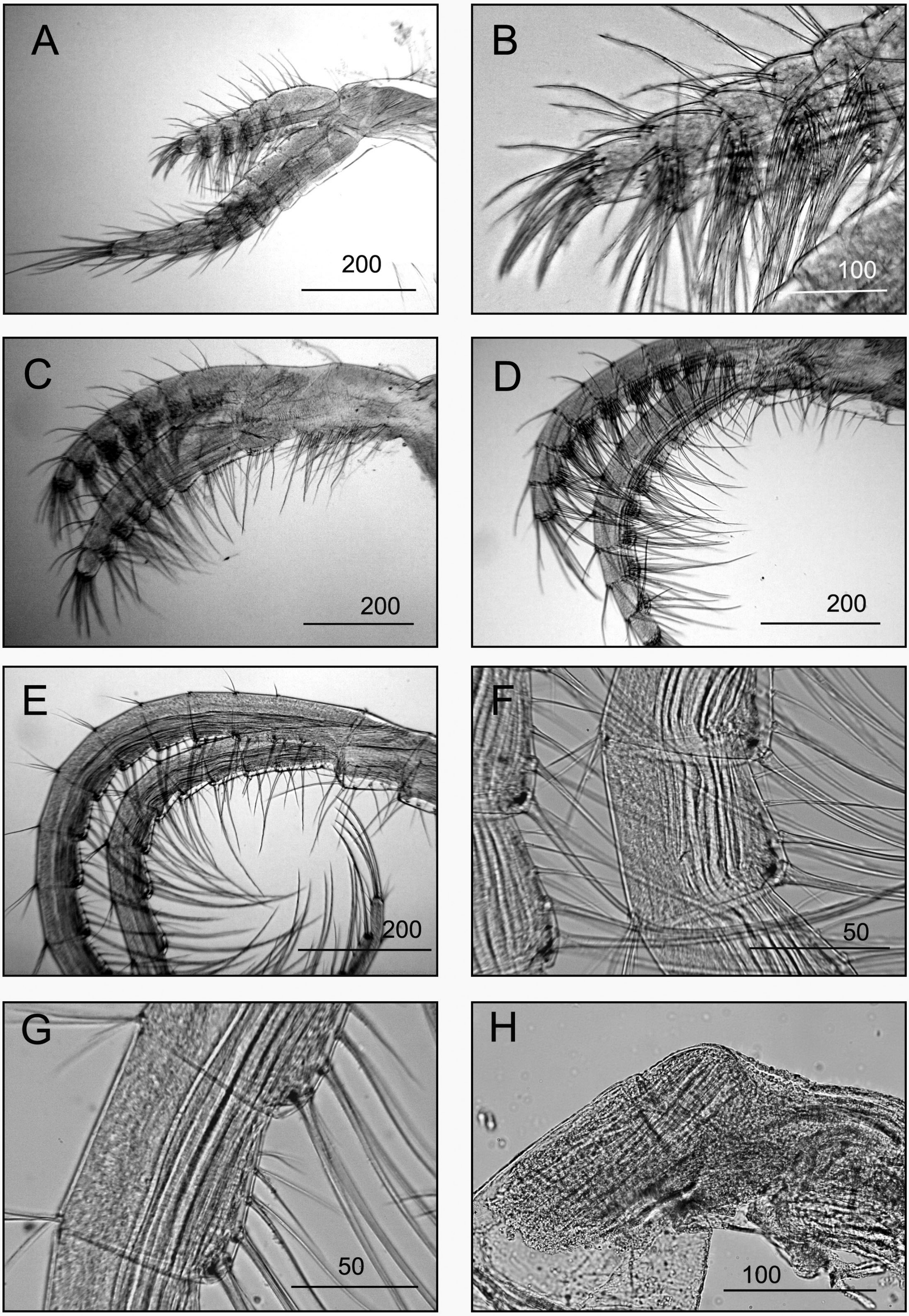


FIGURE 15. *Platylepas hexastylos* (Fabricius, 1798) (RUMF-ZC-1561). A, cirrus I; B, anterior ramus of cirrus I; C, cirrus II; D, cirrus III; E, cirrus IV; F, intermediate segment of posterior ramus of cirrus IV; G, intermediate segment of posterior ramus in cirrus VI; H, pedicel of penis Scale bars in µm.

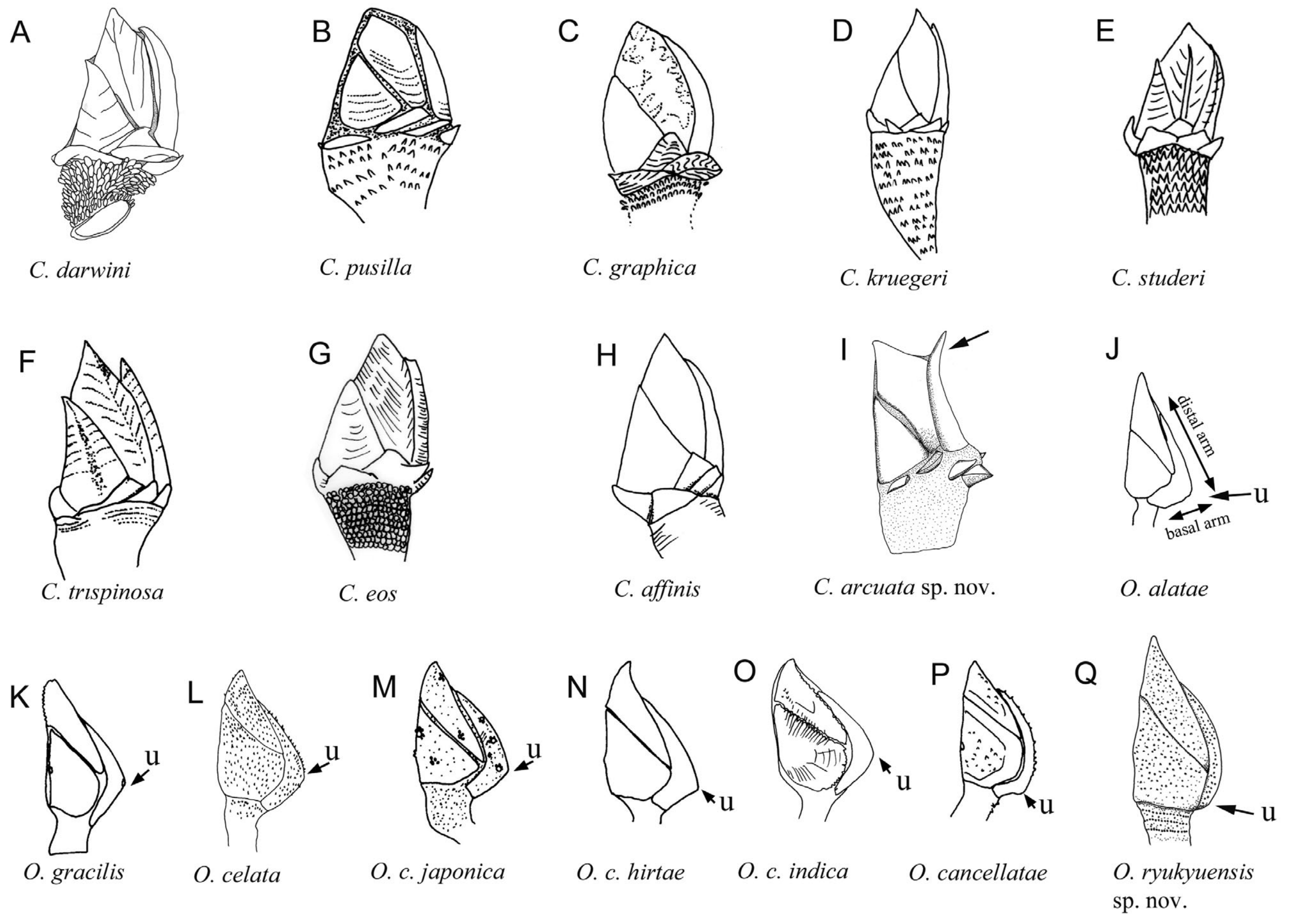


FIGURE 16. Comparisons between *Calantica arcuata* **n. sp.** (I) and allied species (Group I sensu Newman & Jones, 2011), and between *Oxynaspis ryukyuensis* **n. sp.** (N) and allied congeners. A, *C. darwini* Jones & Hoise, 2009 (redrawn from Jones &Hoise 2009); B, *C. pusilla* Utinomi, 1970a (redrawn from Utinomi 1970a); C, *C. graphica* Rosell, 1991 (redrawn from Rosell 1991); D, *C. kruegeri* Hiro, 1932 (redrawn from Hiro 1932); E, *C. studeri* (Weltner, 1922) (redrawn from Zevina 1978); F, *C. trispinosa* Hoek, 1883 (redrawn from Hoek 1883); G, *C. eos* (Pilsbry, 1907) (redrawn from Pilsbry 1907); H, *C. affinis* (Broch, 1922) (redrawn from Broch 1922); I, *C. arcuata* **n. sp.** (present study, RUMF-ZC-1554); J, *Oxynaspis alatae* Totton, 1940 (redrawn from Totton 1940); K, *Oxynaspis gracilis* Totton, 1940 (redrawn from Totton 1940); L, *O. celata* Darwin, 1852 (redrawn from Darwin 1852); M. *O. celata japonica* Broch, 1922 (redrawn from Broch 1922); N, *O. c. hirtae* Totton, 1940 (redrawn from Totton, 1940); O, *O. c. indica* Annandale, 1909 (redrawn from Totton 1940); P, *O. cancellatae* Totton, 1940 (redrawn from Totton 1940); Q, *O. ryukyuensis* **n. sp.** (present study, (RUMF-ZC-1558). Arrow in I indicates the diagnostic carina in *C. arcuata* **n. sp.,** u indicates the location of the umbo of the carina in *Oxynaspis* species. The distal arm indicates the length of carinal margin above the umbo, basal arm indicate length of carinal margin below the umbo (see J). The length ratio of the distal arm to basal arm is a diagnostic character to identify *Oxynaspis* species.

Acknowledgements

The material examined was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience and Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition operated under a permit granted to Dr T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. The authors would like to thank Dr Diana Jones (Western Australian Museum), Prof. John Buckeridge (RMIT University, Australia) and Dr Tohru Naruse (Ryukyus University, Japan) and Prof. Tin-Yam Chan (National Taiwan Ocean University) for the constructive comments on the manuscript, Ms Li Ruei-yi and Dr Lin Cha-wei (National Taiwan Ocean University) for collecting a part of the samples and Mr Chen I-Han (Academia Sinica) for helping in barnacle dissections. This project is supported by the Thematic grant from Academia Sinica, Taiwan (AS-98-TP-B01)

References

Anderson, D.T. (1994) *Barnacles: structure, function, development and evolution.* Chapman and Hall, London.

Annandale, N. (1909) An account of the Indian Cirripedia Pedunculata Part 1. Family Lepadidae (sensu stricto). *Records of the Indian Museum*, 2(2), 61–137.

Aurivillius, C.W.C. (1894) Studien uber Cirripeden. I. Morphologie und Sysematik neuer oder wenig bekannter cirripeden. *Kungliga Svenska Vetenskaps-akademiens Handlingar,* 26, 1–89.

Barnes, M. (1992) The reproductive periods and condition of the penis in several species of common cirripedes. *Oceanography and Marine Biology,* 30, 483–525.

Broch, H. (1922) Papers from Dr. Th. Mortensen's Pacific Expedition 1914–1916, X. Studies on Pacific Cirripedes. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening I Kobenhavn,* 73, 215–358.

Broch, H. (1924) Cirripedia Thoracica von Norwegen und dem norwegischen Nordmeere. Eine Systematische und Biologische-Tiergeographische Studie. *Videnskapsselskapets Skrifter, I. Matematisk-naturvidenskabelig klasse* (17), 1–121.

Broch, H. (1931) Papers from Dr. Th. Mortensen's Pacific Expedition 1914~1916, LVI. Indomalayan Cirripedia. *Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening i Kobenhavn*, 91, 1–146.

Buckeridge, J.S. & Newman, W.A. (2006) A revision of the Iblidae and the pedunculate barnacles (Crustacea: Cirripedia: Thoracica), including new ordinal, familial and generic taxa, and two new species from New Zealand and Tasmanian waters. *Zootaxa*, 1136, 1–38.

Chaen, M., Fukasawa, M., Maeda, A., Sakurai, M. & Takematsu, M. (1993) Abyssal boundary current along the Northwestern Perimeter of the Philippine Basin. *In*: Teramoto, T. (Ed.), *Deep Ocean Circulation, Physical and Chemical Aspects.* Elsevier Science Publisher, pp. 51–68.

Chan, B.K.K., Høeg, J.T. & Garm, A. (2008) Setal morphology and setation patterns of barnacle cirri: adaptations and implications for thoracican evolution. *Journal of Zoology (London)* 275, 294–306.

Darwin, C. (1852) *A monograph on the sub-class Cirripedia with figures of all species. The Lepadidae: or pedunculated barnacles.* Ray Society, London. 400 pp. (1851, published 1852)

Darwin, C. (1854) *A monograph on the sub-class Cirripedia with figures of all the species. The Balanidae the verrucidae etc.* Ray Society, London, 684 pp.

Davie, P.J.F. & Kosuge, T. (1995) A new species of *Tmethypocoelis* (Crustacea: Brachyura: Ocypodidae) from Japan. *Raffles Bulletin of Zoology*, 43, 207–215.

Davie, P.J.F., Shih, H.-T. & Chan, B.K.K. (2010) A new species of *Mictyris* (Decapoda, Brachyura, Mictyridae) from the Ryukyu Islands, Japan. *Crustaceana*, Monographs 11, 83–105.

De Blainville, M.D. (1824) *Dictionnaire des Sciences Naturelles. Vol. 32, Mollusques*. 567 pp.

Fabricius, O. (1798) Tillaeg-til Conchylie-Slaegterne *Lepas*, *Pholas*, *Mya og Solen*. *Skrivter af Naturhiítorie Selskabet Kobenhavn*, 4, 34–51.

Foster, B.A. (1978) The marine fauna of New Zealand: barnacles (Cirripedia: Thoracica). *New Zealand Oceaographic Institute Memoir*, 69, 1–160.

Foster, B.A. & Buckeridge, J.S. (1995) Barnacles (Cirripedia: Thoracica) of seas off the Straits of Gibraltar. *Bulletin du Muséum national d'Histoire naturelle, Paris, Série 4*, 17, 163–192.

Gray, J.E. (1825) A synopsis of the genera of Cirripedes arranged in natural families, with a description of some new species. *Annals of Philosophy,* 10, 97–107.

Gruvel, A. (1905) *Monographie des Cirrhipèdes ou Thecostracés*. Masson et Cie, Paris, 472 pp.

Hayashi, R., Takuma, S., Narazaki, T. & Sato, K. (2011) *Chelonia mydas agassizii* (Black [Pacific] sea turtle). Epibiont barnacles. *Herpetological Review,* 42(2), 264-265.

Hayashi, R. (2012) Atlas of the barnacles on marine vertebrates in Japanese waters including taxonomic review of superfamily Coronuloidea (Cirripedia: Thoracica). *Journal of the Marine Biological Association of the United Kingdom*, 92, 107–127.

Henry, D.P. (1954) Cirripedia: The barnacles of the Gulf of Mexico. *Fishery Bulletin* (*United States*), 55, 443–446.

Hiro, F. (1931) Notes on some new Cirripedia from Japan. *Memoirs of the College of Science, Koyoto Imperial University,* Series B., 7(3), 143–158.

Hiro, F. (1932) Report on the Japanese species of the genus *Calantica* (Cirripedia). *Annotationes Zoologicae, Japon*, 13(5), 467–482.

Hiro, F. (1933) Report on the Cirripedia collected by the surveying ships of the Imperial Fisheries Experimental Station on the continental shelf bordering Japan. *Records of the Oceanographic Works in Japan,* 5, 11–84.

Hiro, F. (1936) Occurrence of the cirripede *Stomatolepas elegans* on a loggerhead turtle found at Seto. *Annotationes Zoologicae Japoneses*, 15, 312–320.

Hiro, F. (1937a) Order Thoracica I. (Cirripedia Pedunculata) Subclass Cirripedia (Class Crustacea). *Fauna Nipponica,* 9, 1–116. (In Japanese)

Hiro, F. (1937b) Studies on the cirripedian fauna of Japan. II. Cirripeds found in the vicinity of the Seto Marine Biological Laboratory. *Memoirs of the College of Science*, *Kyoto University, Series B,* 12, 385–478.

Hoek, P.P.C. (1883) Report on the Cirripedia collected by H.M.S. Challenger during the years 1873–1876. *In*: Thomson, W. and Murray, J. (Eds.), *Report of the Scientific Results of the Voyage of H.M.S. Challenger, Zoology,* 8(25), 1–169 + pls. 1–13.

Hoek, P.P.C. (1907) Pedunculata. The Cirripedia of the Siboga Expedition. A. Cirripedia Pedunculata. *Siboga-Expeditie*

Monographe, 31a, 1–127.

Jones, D.S. (1992) Scalpellid barnacles (Cirripedia: Thoracica) from the northeastern and central eastern Australian continental shelf and slope. *Memoirs of the Queensland Museum*, 32, 145–178.

Jones, D.S. (1993) Techniques to investigate the structure of Scalpellomorph barnacles (Thoracica: Pedunculata). *Journal of Crustacean Biology*, 13, 343–348.

Jones, D.S. (1988) New genus and species of Calanticidae (Cirripedia, Thoracica, Scalpellomorpha) from Australian waters. *Zoosystema*, 20, 239–253.

Jones, D.S. & Hosie, A.M. (2009) A new species of *Calantica* from Western Australian waters (Thoracica: Scalpellomorpha: Calanticidae). *Records of the Western Australian Museum*, 25, 239–246.

Kawabe, M. (1993) Deep water properties and circulation in the western north Pacific. *In*: T. Teramoto (Ed.) *Deep Ocean Circulation, Physical and Chemical Aspects.* Elsevier Science Publisher, pp. 17–37.Kolosvary, G. (1943) Cirripedi thoracica in der Sammlung des Ungarischen National-Museums. *Annales Historico-Naturales Musei Nationalis Hungarici* 36, 67-120.

Krüger, D.P. (1911) Beitrage zur Cirripedienfauna ostasien. Beitrage zur Naturgeschichte ostasiens herausgegeben von F. Doflein. *Kongelige Bayerische Akademie der Wissenschaften, Munich Mathematische-physikalische Klasse. Abhandlungen Supplement Band*, 2, 1–72.

Lamarck, J.B. P.A. de M., ch. De (1818) *Histoire naturelle des animaux san vertèbres*, 5. Deterville, Paris, 612 pp.

Leach, W.E. (1817) Distribution, sysématique de la class Cirripèdes: par la même. *Journal de Physique, de Chimie et d'Histoire naturelle et des Arts, Paris*, 85, 67–69.

Linnaeus, C. (1758). *Systema Naturae. Holmiae, Editio Decima, Reformata* 1, 1–824.

Liu, R.Y. & Ren, X.Q. (1985) Studies on Chinese Cirripedia (Crustacea). VI. Suborder Lepadomorpha. *Studia Marina Sinica*, 25, 179–281.

Liu, R.Y. & Ren, X.Q. (2007) *Fauna Sinica. Invertebrata. Vol. 42 Crustacea Cirripedia Thoracica.* Science Press, Beijing, China. 633 pp.

Newman, W.A. (1972) An Oxynaspid (Cirripedia, Thoracica) from the Eastern Pacific. *Crustaceana*, 23, 202–208

Newman, W.A. (1981) Huzio Utinomi 24 February 1910–19 June 1979. *Crustaceana*, 40, 100–101.

Newman, W.A. (1987) Evolution of Cirripedes and their major groups. *In:* Southward, A.J. (Ed.), Barnacle Biology. *Crustacean Issues*, 5, 3–42. Balkema, Rotterdam.

Newman, W.A. (1996) Cirripedia; Suborders Thoracica and Acrothoracica. *In*: Forest, J. (Ed.), *Traité de Zoologie*, Tome VII, Crustacés, Fascicule 2, 453–540, Masson, Paris.

Newman, W.A. & Jones, W.J. (2011) Two Northeast Pacific deep-water barnacle populations (Cirripedia: Calanticidae and Pachlasmatidae) from seamounts of the Juan de Fuca Ridge; "Insular" endemics stemming from Tethys, or by subsequent dispersal from the Western Pacific center of distribution? *Zootaxa*, 2789, 49–68.

Newman, W.A. & Ross, A. (1976) A revision of the balanomorph barnacles: including a catalog of the species. *Memoirs of the San Diego Society of Natural History*, 9, 1–108.

Nilsson-Cantell, C.A. (1921) Cirripeden-Studien. Zur Kenntnis der Biologie, Antomie und Systematic dieser Gruppe. *Zoologiska Bidrag Fran Uppsala*, 7, 75–390.

Nilsson-Cantell, C.A. (1937) On a second collection of Indo-Malayan Cirripedes from the Raffles Museum. *Bulletin of the Raffles Museum*, 13, 93–96.

Pilsbry, H.A. (1907) The barnacles (Cirripedia) contained in the collections of the U.S. National Museum. *Bulletin of the United States National Museum*, 60, 1–122.

Pilsbry, H.A. (1916) The sessile barnacles (Cirripedia) collected in the collections of the U.S. National Museum: Including a monograph of the American species. *Bulletin of the United States National Museum*, 93, 1–366.

Ren, X.Q. (1980) Turtle barnacles of the Xisha islands, Guangdong Province, China. *Studia Marina Sinica*, 17, 187–197.

Ren, X.Q. (1983) Five new species of the Suborder Lepadomorpha (Cirripedia: Thoracica) from Chinese waters. *Oceanologia et Limnologia Sinica*, 14, 74–87.

Rosell, N.C. (1991) Crustacea Cirripedia Thoracica: MUSORSTOM 3 Philippine collection. *In*: A Crosnier (Ed.) Resultants des Campagnes MUSORSTOM. Vol. 9 *Mémoires du Muséum national d'Histoire naturelle*, 152, 9–16.

Ross, A. & Frick, M. (2011) Nomenclatural emendations of the family-group names Cylindrolepadinae, Stomatolepadinae, Chelolepadinae, Cryptolepadinae, and Tubicinellinae of Ross & Frick, 2007—including current definitions of family-groups within the Coronuloidea (Cirripedia: Balanomorpha). *Zootaxa*, 3106, 60–66.

Stubbings, H.G. (1967) West African Cirripedia fauna of tropical West African. *Bulletin of the British Museum (Natural History) Zoology*, 15(6), 229–319.

Totton, A.K. (1940) New species of the cirripede genus *Oxynaspis* commensal with Antipatharia. *The Annals and Magazine of Natural History, Series, 11*, 6, 465–487.

Utinomi, H. (1959) Thoracic Cirripeds from the environs of Banyuls. *Vie et Milieu, tome X, fasc.* 4, 379–399.

Utinomi, H. (1970a) New and rare commensal pedunculate cirripeds from Amakusa Islands, Western Kyusyu, Japan. *Publications of the Seto Marine Biological Laboratory*, 18(3), 157–167.

Utinomi, H. (1970b) Studies on the cirripedian fauna of Japan. IX. Distributional survey of thoracic cirripeds in the southeastern part of Japan Sea. *Publications of the Seto Marine Biological Laboratory*, 17, 339–372.

Van Syoc, R. & Dekelboum, A. (2011) Oxynaspididae (Crustacea, Cirripedia): phylogenetic and evolutionary ecology, with description of three new genera and six new species. *Zootaxa*, 3103, 1–32.

Voris, H.K. (2000) Maps of Pleistocene sea levels in Southeast Asia: shorelines, river systems and time durations. *Journal of Biogeography*, 27, 1153–1167.

Weltner, W. (1897) *Verzeichnis der bisher beschriebenen recenten Cirripedienarten*. *Archiv für Naturg*, Jahrg., Jahrg. 1897, Bd. I. Berlin, pp 227–280.

Weltner, W. (1922) *Cirripedia der Deutschen Tiefsee-Expedition, Wissenschafteliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898-1899*, 23(2), 69–113 + pls. 2–4. Jena.

Wong, K.J.H., Chan, B.K.K. & Shih, H.-T. (2010). Taxonomy of the sand bubbler crabs *Scopimera globosa* De Haan, 1835, and *S. tuberculata* Stimpson, 1858 (Crustacea: Decapoda: Dotillidae) in East Asia with description of a new species from the Ryukyus, Japan. *Zootaxa*, 2345, 43–59.

Zevina, G.B. (1968) New species of Lepadomorpha (Cirripedia, Thoracica) from the Bay of Tonkin. *Crustaceana*, 15, 35–40.

Zevina, G.B. (1978) A new classification of the family Scalpellidae Pilsbry (Cirripedia, Thoracica). 1. Sub-families Lithotryinae, Calanticinae, Pollicipinae, Scalpellinae, Brochiinae and Scalpellipsinae. *Zoologicheskii Zhurnal*, 57(7), 998–1007. (in Russian).

Zevina, G.B. (1981) Barnacles of the suborder Lepadomorpha (Cirripedia, Thoracica) of the world oceans. I: Family Scalpellidae. *Opredeliteli Faune SSSR*, 127, 1–406. (in Russian).

Zevina, G.B. (1982) Barnacles of the suborder Lepadomorpha (Cirripedia, Thoracica) of the world oceans. II. *Opredeliteli Faune SSSR*, 133, 1–221. (in Russian).

Zootaxa 3367: 49–59 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Two new species of the copepod *Hatschekia* Poche, 1902 (Siphonostomatoida: Hatschekiidae) from angelfishes (Pisces: Perciformes: Pomacanthidae) collected during the KUMEJIMA 2009 Expedition*

DAISUKE UYENO[1, 2, 3] & KAZUYA NAGASAWA[1]

[1]*Graduate School of Biosphere Science, Hiroshima University, 1-4-4 Kagamiyama, Higashi–Hiroshima, Hiroshima 739–8528, Japan.*
[2]*Marine Learning Center, 2–95–101 Miyagi, Chatan, Nakagami, Okinawa 901-0113, Japan.*
[3]*Corresponding author*
E–mails: DU, daisuke.uyeno@gmail.com; KN, ornatus@hiroshima–u.ac.jp

* *In*: Naruse, T., Chan, T.-Y., Tan H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Two new species of *Hatschekia* Poche, 1902 (Siphonostomatoida: Hatschekiidae) are described based on specimens collected during the KUMEJIMA 2009 Expedition carried out at Kumejima Island, Ryukyu Islands, an area getting strong Kuroshio current influence in the East China Sea, Japan. Female *Hatscekia triannuli* **n. sp.** and female and male *H. sumireyakko* **n. sp.** were removed from *Centropyge heraldi* Woods & Schultz and *C. venusta* (Yasuda & Tominaga), respectively. The two new species shares a unique dorsal frame on the cephalothorax that is absent on other congeners. These two species can be differentiated from each other by the shape and proportion of the cephalothorax, trunk, and leg 2.

Key words: parasitic Copepoda, new species, the Ryukyu Islands, angelfish

Introduction

Hatschekia Poche, 1902, is one of the major genera of Copepoda parasitic on actinopterygian fishes (Boxshall & Halsey 2004). In 1985, Jones recognized 68 species as valid. Since then 41 new species have been described as new (Castro & Baeza 1986; El-Rashidy & Boxshall 2011; Ho & Kim 2001; Jones & Cabral 1990; Kabata 1991; Pillai 1985; Uyeno & Nagasawa 2009b, 2010a–c; Villalba 1986;). Currently, in addition to the shape of the dorsal frame of the cephalothorax, the ratios of body parts and appendages have been established as valuable characters to distinguish morphologically similar species in the genus (Uyeno & Nagasawa 2009b, 2010a–c). Several peculiar morphological features (i.e., parabasal papilla and rostral process) also have been used to identify *Hatschekia* species. In this paper, two new species are described based on differences observed among these characters.

Materials and Methods

Angelfishes were collected by gillnets set along coral reef with a depth of 40 m, off Kumejima Island, the Ryukyu Islands, Japan, during the KUMEJIMA 2009 Expedition. Copepods were removed from the hosts' gills by rinsing in freshwater and preserved in 80% ethanol. Specimens were kept in lactophenol for 24 hours before dissection. Appendages were dissected and observed using the method of Humes & Gooding (1964). Drawings were made with the aid of a drawing tube. The terminology followed Huys & Boxshall (1991). Specimens were measured according to the method used in Uyeno & Nagasawa (2009a, 2010b). Measurements in micrometers are shown as ranges with means and standard deviations in parentheses. Ratios of length of body parts and appendages are calculated based on Uyeno & Nagasawa (2009a) and shown in Table 1. Type specimens are deposited in the

Accepted by T. Naruse: 14 Aug. 2011; published: 4 Jul. 2012

crustacean collection of the National Museum of Nature and Science, Tokyo (NSMT) and the University of the Ryukyus Museum, Fujukan (RUMF), Okinawa.

TABLE 1. Ratios of body parts of females of *Hatschekia triannuli* **n. sp.** and both sexes of *H. sumireyakko* n. sp. The data are shown as the mean ± standard deviation.

	H. triannuli	***H. sumireyakko***	
	female (n = 4)	**female (n = 5)**	**male (n = 6)**
CeL/BL	0.15 ± 0.01	0.32 ± 0.02	0.30 ± 0.02
CeW/BL	0.25 ± 0.01	0.33 ± 0.02	0.31 ± 0.01
TL/BL	0.83 ± 0.04	0.72 ± 0.02	0.70 ± 0.02
TW/BL	0.30 ± 0.04	0.35 ± 0.02	0.21 ± 0.01
UL/BL	0.02 ± 0.01	0.04 ± 0	0.08 ± 0.01
UW/BL	0.04 ± 0.01	0.09 ± 0.02	0.11 ± 0.00
CaL/BL	0.02 ± 0	0.03 ± 0	0.09 ± 0
CaW/BL	0.01 ± 0	0.01 ± 0	0.03 ± 0
CeW/CeL	1.64 ± 0.07	1.05 ± 0.05	1.03 ± 0.04
UW/UL	2.26 ± 0.62	2.13 ± 0.28	1.42 ± 0.17
A1L/BL	0.08 ± 0.01	0.19 ± 0.02	0.61 ± 0.10
A2L/BL	0.13 ± 0.04	0.36 ± 0.05	0.42 ± 0.05
A2TL*/A2ML	0.18 ± 0.05	0.18 ± 0.05	0.31 ± 0.07
L1L/BL	0.08 ± 0.01	0.13 ± 0.01	0.28 ± 0.05
L1ExL/L1EnL	1.01 ± 0.07	1.47 ± 0.16	1.44 ± 0.12
L2 L/BL	0.07 ± 0	0.11 ± 0.01	0.26 ± 0.04
L2ExL/L2EnL	1.09 ± 0.14	1.16 ± 0.11	1.19 ± 0.07
A1L/A2L	0.63 ± 0.16	0.53 ± 0.08	1.45 ± 0.11

Abbreviations: BL = body length; CeL, cephalothorax length; CeW = cephalothorax width; TL = trunk length; TW = trunk width; UL = urosome length excluding caudal ramus; UW = abdomenurosome width; CaL = caudal ramus length; CaW = caudal ramus width; A1L = antennule length; A2L = antenna length; A2ML = middle segment length of antenna; A2TL = terminal claw length of antenna*; L1L = Leg 1 length; L1ExL = exopod length of leg 1; L1EnL = endopod length of leg 1; L2L = Leg 2 length; L2ExL = exopod length of leg 2; L2EnL = endopod length of leg 2.

*This length was expressed as the "terminal segment length" in Uyeno & Nagasawa (2009a, b).

Taxonomic account

Order Siphonostomatoida Burmeister, 1835

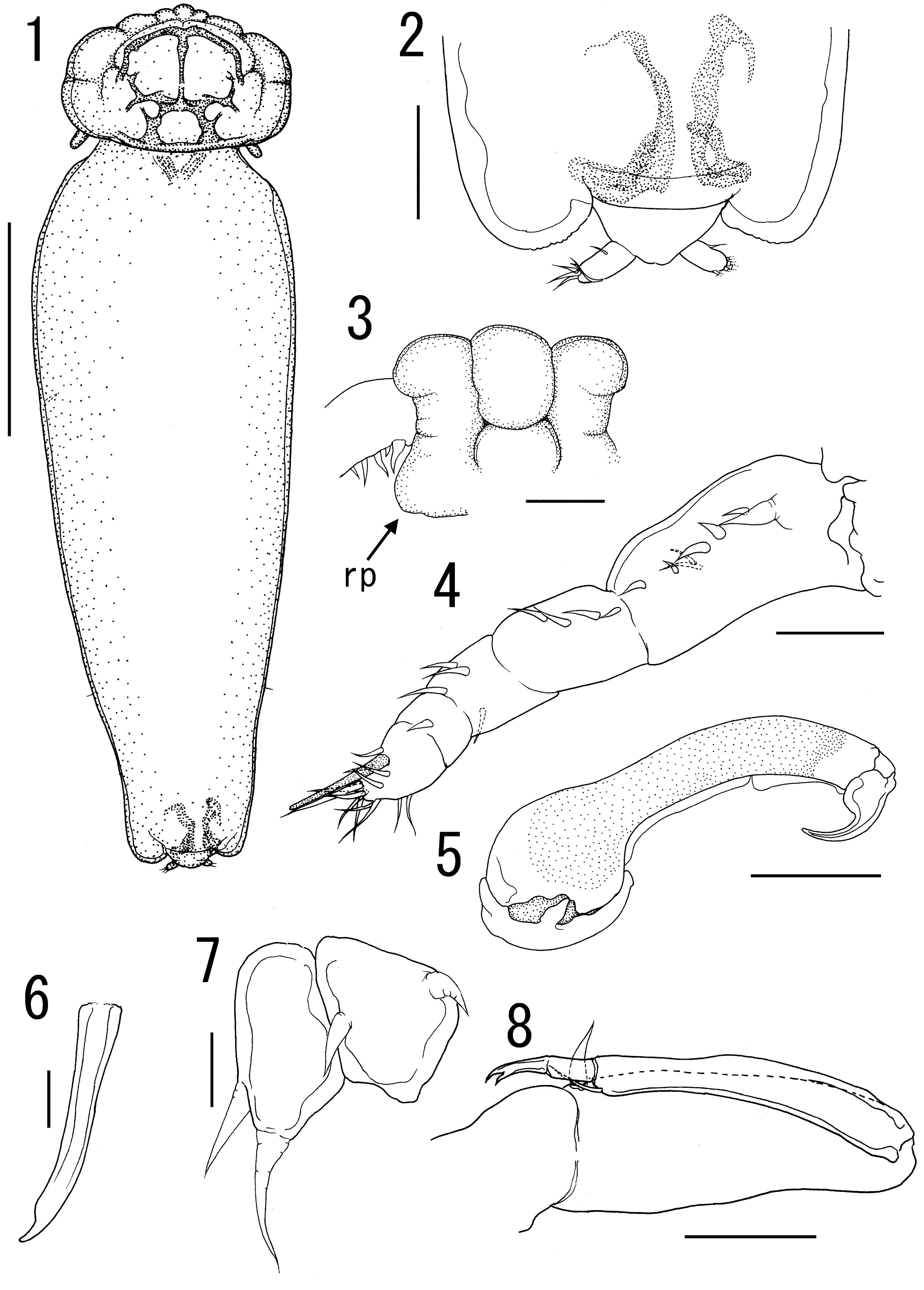
Family Hatschekiidae Kabata, 1979

Genus *Hatschekia* Poche, 1902

Hatschekia triannuli n. sp.

(Figs. 1–14)

Material examined. Holotype, female (NSMT–Cr 21660), ex *Centropyge heraldi* Woods & Schultz (Perciformes: Pomacanthidae), off Torishima Islet (26°19′N, 126°44′E), Kumejima Island, the Ryukyu Islands, East China Sea, Japan. 12 November, 2009. Paratypes: 2 females (NSMT–Cr 21661) and 1 female (RUMF–ZC–1502), same collection data as the holotype.



FIGURES 1–8. *Hatschekia triannuli* n. sp., holotype female NSMT–Cr 21660. 1, habitus dorsal; 2, posterior part of trunk, dorsal; 3, rostrum, ventral, rp = rostrum process; 4, right antennule, posterior; 5, left antenna, anterior; 6, mandible; 7, right maxillule, posterior; 8, left maxilla, posterior. Scales: 1 = 300 µm; 2, 5, 8 = 50 µm; 3 = 30 µm; 4 = 20 µm; 6 = 5 µm; 7 = 10 µm.

Description of female holotype. Body (Fig. 1) 1204 long, excluding caudal rami, on holotype. Cephalothorax ellipsoidal, shorter than wide (208 × 319), widest at middle; dorsal frame with partly lacking double-semicircle with posterior complete ring and lateral bar along posterior margin of cephalothorax. Trunk elongated, fusiform bearing posterolateral lobe, longer than wide (1010 × 370), widest anteriorly, narrower posteriorly. Urosome (Fig. 2), excluding caudal rami, shorter than wide 25 × 60. Caudal ramus (Fig. 2) longer than wide 26 × 12, bearing 6 naked setae.

Rostrum (Fig. 3) with 3 round processes along anterior margin and rostrum process. Antennule (Fig. 4) indistinctly 5-segmented, 107 long; armature formula: 8, 4, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 5) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw unarmed; proximal segment length 34; middle segment length 157; terminal claw length 24; total length 215. Parabasal papilla absent. Oral cone robust. Mandible (Fig. 6) slender, with sharp tip. Maxillule (Fig. 7) bilobate; both lobes armed with 2 tapering elements. Maxilla (Fig. 8) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, bifid claw, presence of additional seta on terminal claw uncertain. Maxilliped absent.

Legs 1 and 2 (Figs 9–10) biramous; both rami 2–segmented, except for 1-segmented endopod of leg 2; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 6
Leg 2	1–0	1–0; 5	6

Leg 1 (Fig. 9) 93 long; protopod length 48; exopod length 21 similar to endopod length 24. Leg 2 (Fig. 10) length 97; protopod length 60; exopod length 37; endopod length 29. Protopods and rami of leg 2 ornamented with rows of blunt spinules on posterior margin of anterior surface.

Intercoxal sclerite of legs 1 and 2 (Figs 11–12) rod like, unarmed.

Leg 3 (Fig. 13) represented by 2 simple setae on anterior 1/3 surface of trunk. Leg 4 (Fig. 14) represented by 1 simple lateral seta on posterior 2/3 of trunk.

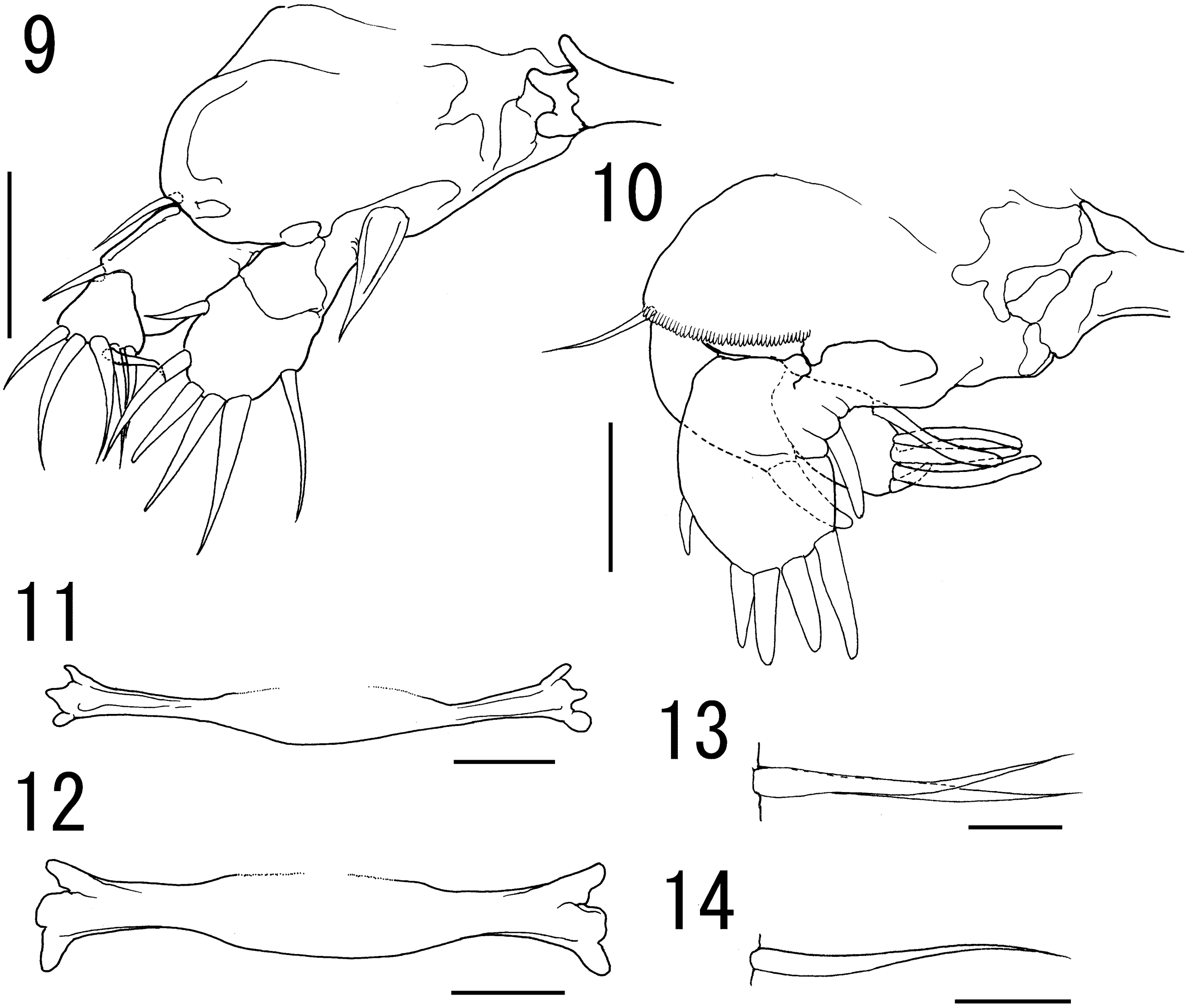
Variability of measurements. Paratype females share all important morphological characters with the holotype. Measurement range of their body parts and appendages of type series (n = 4) was as follows: body (excluding caudal rami) length 1204–1492 (1338 ± 118), cephalothorax length 200–208 (204 ± 4), cephalothorax width 319–343 (334 ± 10), trunk length 1010–1147 (1107 ± 65), trunk width 370–453 (396 ± 38), urosome length (excluding caudal rami) 21–41 (27 ± 9), urosome (excluding caudal rami) width 43–67 (58 ± 10), caudal ramus length 25–30 (28 ± 3), caudal ramus width 11–12 (11 ± 1), antennule length 103–114 (107 ± 5), antenna proximal segment length 18–34 (26 ± 6), antenna middle segment length 94–157 (128 ± 29), antenna terminal segment length 20–24 (22 ± 2), antenna total length 135–215 (176 ± 36), leg 1 length 93–112 (101 ± 8), leg 1 protopod length 48–52 (49 ± 2), leg 1 exopod length 21–30 (26 ± 4), leg 1 endopod length 24–29 (26 ± 3), leg 2 length 97–107 (100 ± 5), leg 2 protopod length 58–62 (60 ± 2), leg 2 exopod length 37–46 (39 ± 4), leg 2 endopod length 29–40 (36 ± 5).

Attachment site. Gill filaments.

Remarks. Among its congeners *Hatschekia triannuli* **n. sp.** shares a posterior ring at the dorsal frame of the cephalothorax with *H. monacanthi* Yamaguti, 1939, and *H. khahajya* Uyeno & Nagasawa, 2010. *Hatschekia triannuli* **n. sp.** differs from these 2 species in the following chareacters: the presence of a vertical bar with a short horizontal bar on the anterior tip of the dorsal frame, the presence of 2 to 3 apical teeth on the mandible, and the possession of 4 processes at the intercoxal sclerites of legs 1 and 2 (vs. dorsal frame with partly lacking double-semicircle on anterior part; the mandible bearing only apical tip; the intercoxal sclerites of legs 1 to 2 unarmed) (Yamaguti 1939; Uyeno & Nagasawa 2009a, 2010b). Four species, *H. crenata* Hewitt, 1969, *H. nohu* Villalba, 1986, *H. pacifica* Cressey, 1970, and *H. pagellibogneravi* (Hesse, 1878) have been insufficiently described or illustrated with respect to the dorsal frame on the cephalothorax. *Hatschekia crenata* differs from *H. triannuli* **n. sp.** by having the following two characters: complex crenate frontal margin and posterolateral lobe of the cephalothorax (vs. the frontal margin of cephalothorax with the rostrum representing three round processes in *H. triannuli* **n. sp.**); and the presence of a small, sub-acute posterolateral process on the abdomen (vs. no such structures on the abdomen in *H. triannuli* **n. sp.**). *Hatschekia nohu* is easily distinguishable from *H. triannuli* **n. sp.**

by an ellipsoidal trunk, which is widest in the middle, and lacking a posterolateral lobe. *Hatschekia pacifica* is separated from *H. triannuli* **n. sp.** by having a vermiform trunk. *Hatschekia pagellibogneravei* is demarcated from *H. triannuli* **n. sp.** by having the cephalothorax with a pointed conical protuberance on the posterior margin.

Etymology. The specific name of the new species, *triannuli*, is derived from an arbitrary combination of "tri-" and the noun "annuli" which refers to dorsal frame forming three rings on the cephalothorax.



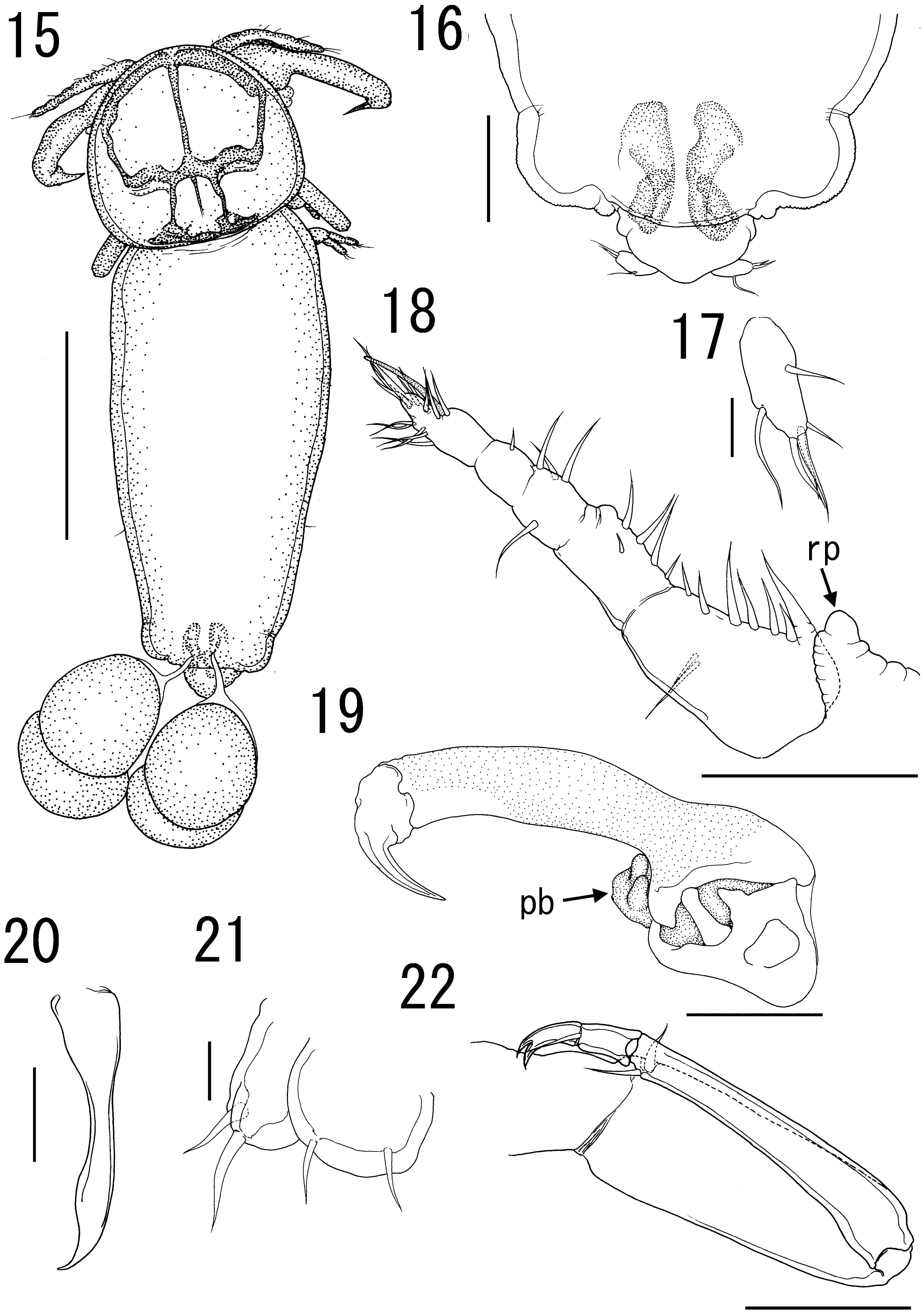
FIGURES 9–14. *Hatschekia triannuli* **n. sp.**, holotype female NSMT–Cr 21660. 9, right leg 1, anterior; 10, right leg 2, anterior; 12, intercoxal sclerite of leg 1, anterior; 13, intercoxal sclerite of leg 2, anterior; 14, right leg 3, ventral; 15, right leg 4, ventral. Scales: 9–12 = 20 µm; 13, 14 = 5 µm.

Hatschekia sumireyakko n. sp.

(Figs. 15–36)

Material examined. Holotype, female (NSMT–Cr 21662), ex *Centropyge venusta* (Yasuda & Tominaga) (Perciformes: Pomacanthidae), off Torishima Islet (26°19′N, 126°49′E), Kumejima Island, the Ryukyu Islands, East China Sea, Japan. 19 November, 2009. Allotype: a male (NSMT–Cr 21663) and Paratypes: 3 females and 3 males (NSMT–Cr 21664); 1 female and 2 males (RUMF–ZC–1503), Collection data of allotype and paratypes same as that of holotype.

Description of female holotype. Body (Fig. 15) 624 long, excluding caudal rami, on holotype. Cephalothorax round, slightly shorter than wide (190 × 210); dorsal chitinous frame with double semicircle with posterior ring and lateral bar along posterior margin of cephalothorax. Trunk fusiform, longer than wide (466 × 208), widest anteriorly, gradually narrowed posteriorly. Urosome (Fig. 16), excluding caudal rami, shorter than wide 23 × 52. Caudal ramus (Fig. 17) slightly longer than wide 22 × 9, bearing 6 naked setae.

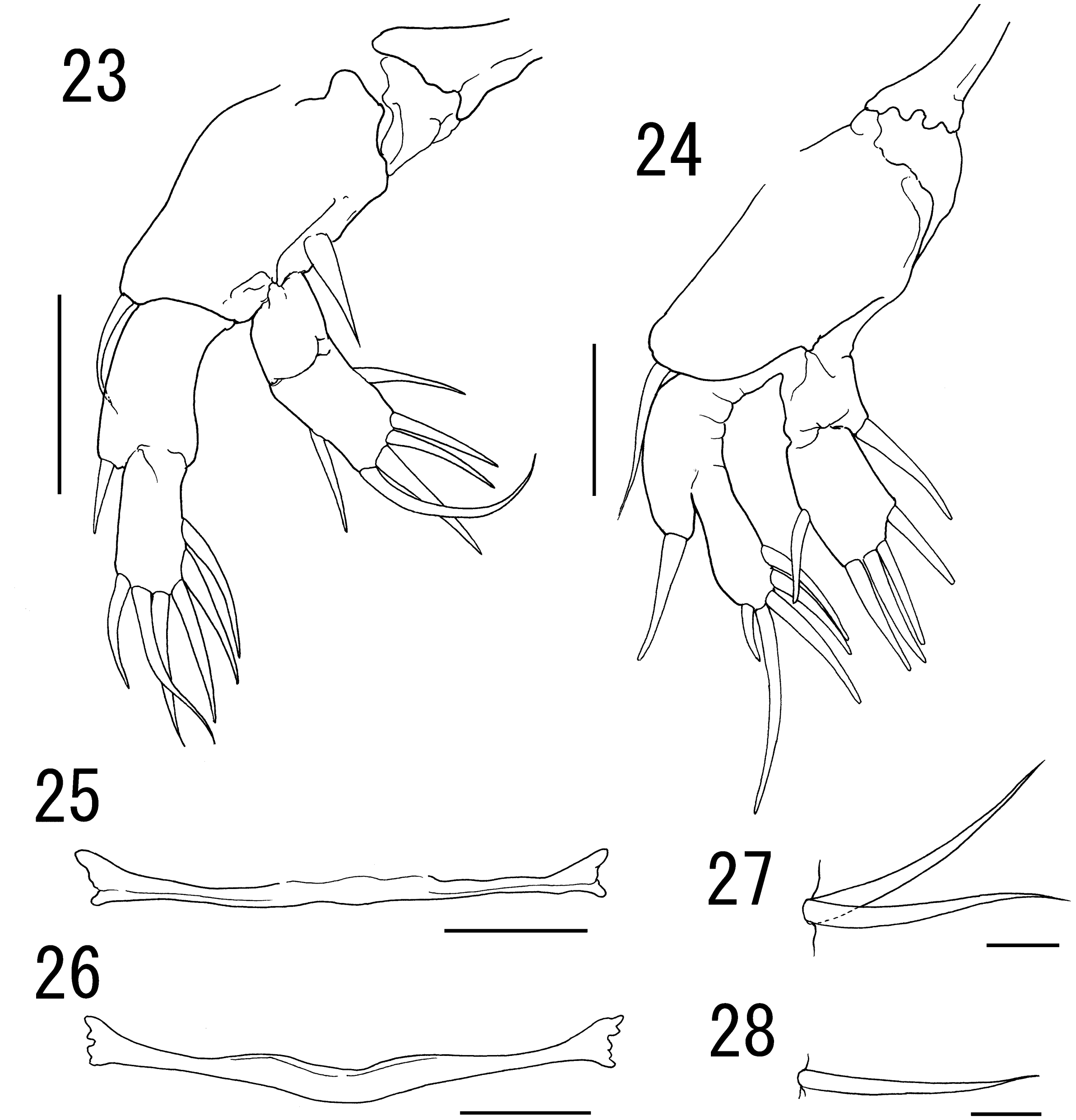


FIGURES 15–22. *Hatschekia sumireyakko* **n. sp.**, holotype female NSMT–Cr 21662. 15, habitus dorsal; 16, posterior part of trunk, dorsal; 17, right caudal ramus, dorsal; 18, right antennule, anterior; 19, right antenna, anterior; 20, mandible; 21, right maxillule, anterior; 22, left maxilla, posterior. Abbreviations: pb, parabasal papilla; rp, rostrum process. Scales: 15 = 200 µm; 16 = 40 µm; 17, 20–21 = 10 µm; 18, 19 = 50 µm; 22, 30 µm.

Rostrum with 1 round process on posterolateral corners (Fig. 18). Antennule (Fig. 18) indistinctly 5-segmented, 124 long; armature formula: 9, 5, 4, 1, 13 + 1 aesthetasc. Antenna (Fig. 19) 3-segmented; proximal segment (coxa) unarmed; middle segment (basis) ornamented with surface pits; terminal claw unarmed; proximal segment length 53; middle segment length 163; terminal claw length 22; total length 238. Parabasal papilla (Fig. 19) well developed. Oral cone robust. Mandible (Fig. 20) slender, with sharp apex. Maxillule (Fig. 21) bilobate; both lobes armed with 2 tapering elements; 2 small elements on inner lobe. Maxilla (Fig. 22) 4-segmented; proximal segment unarmed; second segment rod-like, with 1 basal seta; third segment elongate, with 1 distal seta; terminal segment small, with 1 small seta and bifid claw. Maxilliped absent.

Legs 1 and 2 (Figs 23–24) biramous, bearing 2-segmented rami; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 6
Leg 2	1–0	1–0; 5	0–1; 5



FIGURES 23–28. *Hatschekia sumireyakko* **n. sp.**, holotype female NSMT–Cr 21662. 23, right leg 1, anterior; 24, right leg 2, anterior; 25, intercoxal sclerite of leg 1, anterior; 26, intercoxal sclerite of leg 2, anterior; 27, left leg 3, ventral; 28, left leg 4, ventral. Scales: 23–24 = 20 µm; 25, 26 = 30 µm; 27, 28 = 10 µm.

Leg 1 (Fig. 23) 83 long; protopod length 32; exopod length 30 exceeding endopod length 21. Leg 2 (Fig. 24) length 80; protopod length 47; exopod length 32; endopod length 28.

Intercoxal sclerite of legs 1 and 2 (Figs 25–26) rod-like, unarmed.

Leg 3 (Fig. 27) represented by 2 simple setae on anterior 1/3 surface of trunk. Leg 4 (Fig. 28) represented by 1 simple lateral seta on posterior 2/3 of trunk.

Variability of measurement. Paratype females share all important morphological characters with the holotype. Measurement range of their body parts and appendages of type series (n = 5) was as follows: body length (excluding caudal rami) 541–657 (589 ± 49), cephalothorax length 175–197 (187 ± 8), cephalothorax width 187–210 (196 ± 9), trunk length 382–489 (425 ± 49), trunk width 184–233 (205 ± 21), urosome (excluding caudal rami) length 22–26 (23 ± 2), urosome width (excluding caudal rami) 40–55 (50 ± 6), caudal ramus length 17–22 (18 ± 2) ×, caudal ramus width 6–9 (8 ± 1), antennule length 108–124 (112 ±7), antenna proximal segment length 28–53 (40 ± 10), antenna middle segment length 117–165 (148 ± 20), antenna terminal segment length 20–34 (26 ± 5), antenna total length 174–245 (214 ± 29), leg 1 length 73–83 (78 ± 4), leg 1 protopod length 32–36 (34 ± 1), leg 1 exopod length 24–30 (26 ± 2), leg 1 endopod length 15–21 (18 ± 2), leg 2 length 63–80 (67 ± 8), leg 2 protopod length 33–47 (38 ± 6), leg 2 exopod length 26–32 (29 ± 2), leg 2 endopod length 21–28 (25 ± 3).

Description of male allotype. Body (Fig. 29) 240 long, excluding caudal rami, on allotype. Sexual dimorphism present in cephalothorax, proportion of trunk and caudal ramus, rostrum, antennule, antenna, absence of parabasal papilla, maxillule, legs 1 to 3, and presence of leg 5. Cephalothorax round with frontal part prominent 81 × 78; dorsal chitinous frame with 3 vertical bars connecting each other by posterior, horizontal bar. Trunk fusiform, longer than wide 160 × 52, widest anteriorly, gradually narrowed posteriorly. Urosome excluding caudal rami shorter than wide 16 × 26. Caudal ramus distinctly longer than wide 21 × 9.

Rostrum without distinct process. Antennule (Fig. 30) indistinctly 5-segmented, 187 long; armature formula: 10, 5, 5, 1, 13 + 1 aesthetasc. Antenna (Fig. 31) 3-segmented; proximal and middle segments (coxa and basis) unarmed; terminal claw with 2 setae near basis; proximal segment length 27; middle segment length 66; terminal claw length 26; total length 120. Maxillule (Fig. 32) bilobate; both lobes armed with 2 tapering elements; inner lobe with row of blunt spinules.

Legs 1 and 2 (Figs 33–34) biramous, bearing 2-segmented rami; terminal segment of endopods bearing plumose setae; leg armature formula as follows:

	Protopod	Exopod	Endopod
Leg 1	1–1	1–0; 6	0–0; 6
Leg 2	1–0	1–0; 5	0–1; 5

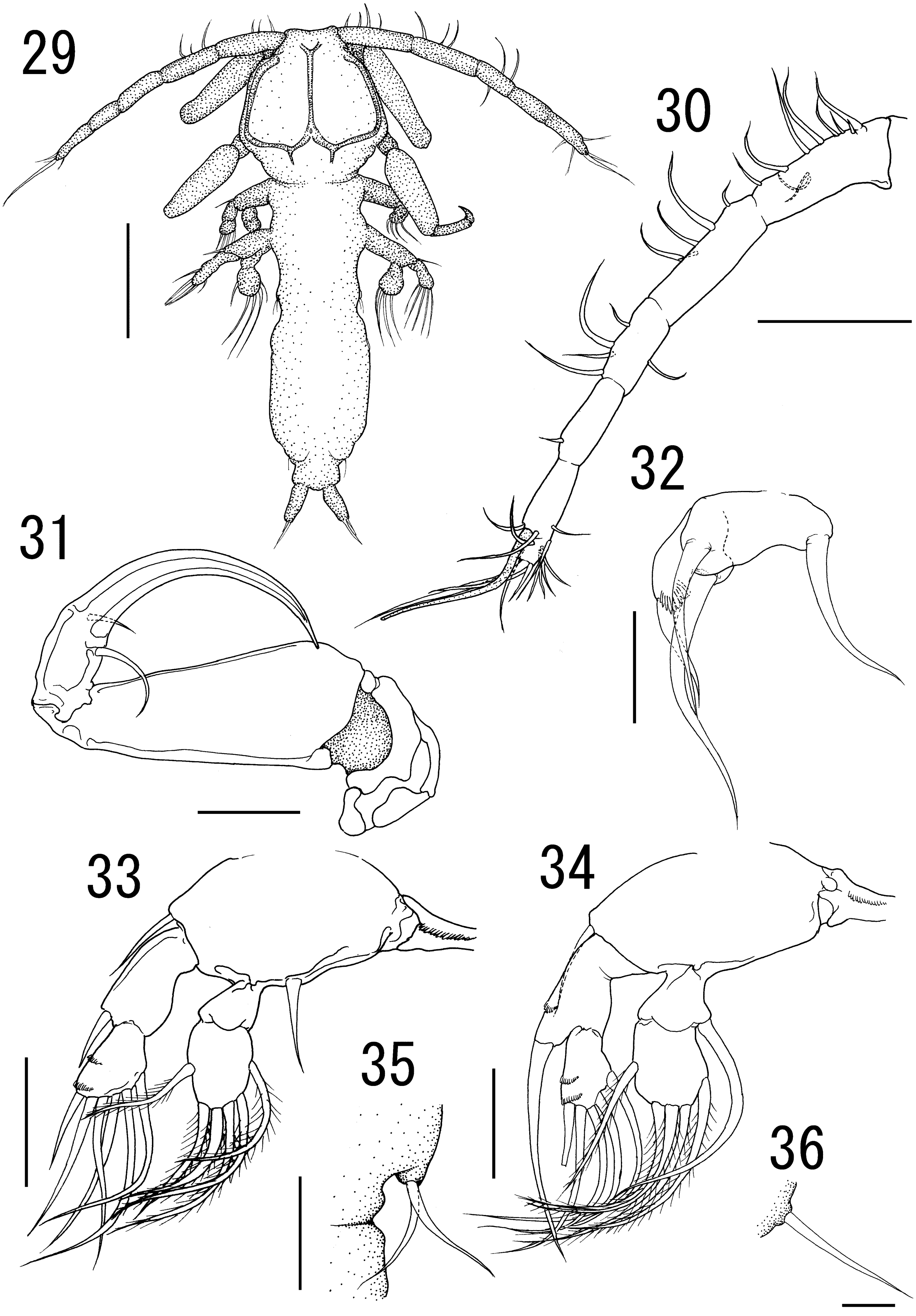
Leg 1 (Fig. 33) 90 long; protopod length 38; exopod length 32 exceeding endopod length 20. Leg 2 (Fig. 24) length 77; protopod length 45; exopod length 32; endopod length 26.

Intercoxal sclerite of legs 1 and 2 (Figs 33–34) with 1 row of blunt spinules.

Leg 3 (Fig. 35) represented by 2 simple setae on conical process located at slightly anterior to midlength of lateral margin of trunk. Leg 5 (Fig. 36) represented by 1 simple lateral seta at posterolateral corner of trunk.

Variability of measurement. Paratype males share all important morphological characters with the allotype. Measurement range of their body parts and appendages of type series (n = 6) was as follows: body (excluding caudal rami) length 240–320 (293 ± 31), cephalothorax length 81–93 (88 ± 4), cephalothorax width 78–96 (91 ± 7), trunk length 160–230 (205 ± 27), trunk width 52–68 (61 ± 6), urosome (excluding caudal rami) length 16–28 (23 ± 5), urosome (excluding caudal rami) width 26–34 (31 ± 3), caudal ramus length 21–29 (26 ± 3), caudal ramus width 9–11 (10 ± 1), antennule length 161–187 (177 ±11), antenna proximal segment length 23–38 (30 ± 5), antenna middle segment length 63–73 (79 ± 3), antenna terminal segment length 17–26 (22 ± 4), antenna total length 114–128 (122 ± 4), leg 1 length 75–90 (81 ± 6), leg 1 protopod length 34–38 (36 ± 2), leg 1 exopod length 22–32 (27 ± 3), leg 1 endopod length 17–21 (19 ± 2), leg 2 length 71–79 (76 ± 4), leg 2 protopod length 43–48 (46 ± 2), leg 2 exopod length 28–32 (30 ± 2), leg 2 endopod length 24–28 (25 ± 1).

Attachment site. Gill filaments.



FIGURES 29–36. *Hatschekia sumireyakko* **n. sp.**, alotype male NSMT–Cr 21663. 29, habitus dorsal; 30, right antennule, anterior; 31, right antenna, posterior; 32, right maxillule, anteior; 33, right leg 1, anterior; 34, right leg 2, anterior; 35, right leg 3, dorsal; 36, right leg 5, dorsal. Scales: 29 = 60 µm; 30 = 50 µm; 31, 33–34 = 20 µm; 32, 35 = 10 µm; 36 = 5 µm.

Remarks. Based on the female specimens, *Hatschekia sumireyakko* **n. sp.** shares the dorsal frame of the cephalothorax, which forms into the posterior annulus, with *H. khahajya*, *H. monacanthi* and *H. triannuli* **n. sp.** *Hatschekia triannuli* **n. sp.** differs from *H. sumireyakko* **n. sp.** by the presence of 3 protrusions along the anterior margin of the rostrum; the posterolateral lobe being extending near the posterior end of the abdomen; a 1-segmented endopod of leg 2; a considerably lesser cephalothorax length/body length ratio [0.15 ± 0.01 vs. 0.32 ± 0.02 (U-test; $p<0.001$), Table 1]; and a greater width/length ratio of the horizontal cephalothorax [1.64 ± 0.07 vs. 1.05 ± 0.05 (U-test; $p<0.001$), Table 1]. *Hatschekia sumireyakko* **n. sp.** is separable from former 2 species by the absence of process on the posterior margin of the intercoxal sclerites of legs 1 and 2 (vs. 4 processes present in *H. khahajya* and *H. monacanthi*). *Hatschekia sumireyakko* **n. sp.** can be distinguished from 4 species, *H. crenata*, *H. nohu*, *H. pacifica*, and *H. pagellibogneravi* that have been insufficiently described for the dorsal frame on the cephalothorax by the characters that distinguish these four species from *H. triannuli* **n. sp.** (see Remarks of *H. triannuli* **n. sp.)**.

Male morphology of *Hatschekia* species have only been described in nine out of 111 species, *H. conifera* Yamaguti, 1939, *H. hippoglossi* (Guérin-Méneville, 1837), *H. harkema* Pearse, 1948, *H. iridescens*, *H. monacanthi* Yamaguti, 1939, *H. petiti* Nuñes-Ruivo, 1954, *H. pinguis* Wilson, 1908, and *H. prionoti* Pearse, 1947, and *H. siganicola* El-Rashidy & Boxshall, 2011 (see El-Rashidy & Boxshall 2011; Schram & Aspholm 1997; Uyeno & Nagasawa 2009a). In *H. sumireyakko* **n. sp.**, sexual dimorphism is saliently shown on the characters of the cephalothorax, trunk, rostrum, antennule, antenna, parabasal papilla, maxillule, and leg 5. *Hatschekia monacanthi* also show sexual dimorphism in the above characters (see Uyeno & Nagasawa 2009a).

Etymology. The specific name of the new species, *sumireyakko*, refers to the Japanese common name of the host. The name is used as a noun in apposition.

Discussion

A total of 111 species, including the two new species described here, are known for the genus *Hatschekia*. Sixty nine (62%) of these 111 species have been reported from the perciform fishes (see Castro & Baeza 1986; El-Rashidy & Boxshall 2011; Ho & Kim 2001; Jones 1985; Jones & Cabral 1990; Kabata 1991; Pillai 1985; Villalba 1986). Pomacanthid fishes are widely distributed in tropical shallow waters all around the world (Nelson 2006), the family comprises about 82 species and is one of the largest families in the order Perciformes (Nelson 2006). Despite of its wide distribution as well as common occurrences, the finding of these two new *Hatschekia* species represents the first record of the genus from the pomacanthid fishes. As their commercial importance is very low, it is quite difficult to obtain sufficient fish specimens for parasitological study, which strongly suggests that more studies are required on the *Hatschekia* parasitic on the family Pomacanthidae.

The two new species described in this paper share two unusual morphological features. One of them is the cephalothorax bearing the dorsal frame with 2 semicircular and 1 posterior rings. *Hatschekia monacanthi* and *H. khahajya* also have the cephalothorax carrying the dorsal frame with a posterior ring, the shape of which is comparatively similar to that of the two new species but they lack double rings from their anterior part (see Uyeno & Nagasawa 2009a: fig. 38; 2010b: fig. 1). The species of *Hatschekia* described from monacanthid fishes share some unusual morphological characters (i.e., the cephalothorax bearing a chitinous ring on the dorsal surface; the non-segmented rami of legs 1 to 2; the four processes and the two spinular rows on the intercoxal sclerite of legs 1 to 2), suggesting that they are closely related to each other (Uyeno & Nagasawa 2010a). Furthermore, 20 species of the genus parasitic on tetraodontiform fishes share the intercoxal sclerites of legs 1 and 2 bearing 4 processes on the posterior margin (Jones 1985; Nuñes-Ruivo 1954; Uyeno & Nagasawa 2010c; Yamaguti 1939, 1953;). Uyeno & Nagasawa (2010c) suggested that the closely related host species are infected with the closely related *Hatschekia* species. Our observation based on these two new species may support this suggestion. The two new species described in this study from the pomacanthid genus *Centropyge* also share a unique condition of the dorsal frame on the cephalothorax and the mandible, which suggests that the two new species are closely related to each other.

Acknowledgements

We are grateful to all the organizers and colleagues who were involved in the KUMEJIMA 2009 Expedition. It was organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The Expedition was carried out under a permit granted to Tohru Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. We thank Euichi Hirose and Takeshi Sasaki, University of the Ryukyus, for assistance and permission to use their laboratory facilities. Part of this work received financial support from the Ocean Exposition Commemorative Park Management Foundation, Okinawa.

References

Boxshall, G.A. & Halsey, S.H. (2004) *An Introduction to Copepod Diversity.* The Ray Society, London, 966 pp.

Castro, R. & Baeza, H. (1986) Two new species of *Hatschekia* Poche, 1902 (Copepoda, Hatschekiidae) parasitic on two inshore fishes from Antofagasta, Chile. *Journal of Natural History*, 20, 439–444.

El-Rashidy, H.H. & Boxshall, G.A. (2011) Two new species of parasitic copepods (Crustacea) on two immigrant rabbitfishes (Family Siganidae) from the Red Sea. *Systematic Parasitology*, 79, 175–193.

Ho, J.-S. & Kim, I.-H. (2001) New species of *Hatschekia* Poche, 1902 (Copepoda: Hatschekiidae) parasitic on marine fishes of Kuwait. *Systematic Parasitology*, 49, 73–79.

Humes, A.G. & Gooding, R.U. (1964) A method for studying the external anatomy of copepods. *Crustaceana*, 6, 238–240.

Huys, R. & Boxshall, G.A. (1991) *Copepod Evolution*. The Ray Society, London, 468 pp.

Jones, J.B. (1985) A revision of *Hatschekia* Poche, 1902 (Copepoda: Hatschekiidae), parasitic on marine fishes. *New Zealand Journal of Zoology*, 12, 213–271.

Jones, J.B. & Cabral, P. (1990) New species of *Hatschekia* (Copepoda: Siphonostomatoida) from the gills of South Pacific fishes. *Journal of the Royal Society of New Zealand*, 20, 221–232.

Kabata, Z. (1991) Copepoda parasitic on Australian fishes, XIII: family Hatschekiidae. *Journal of Natural History*, 25, 91–121.

Nelson, J.S. (2006) *Fishes of the World*. *Fourth Edition*. John Wiley & Sons Inc., New York, 601 pp.

Nuñes-Ruivo, L.P. (1954) Parasites de poissons de mer ouest—Africains récoltés par M.J. Cadenat. III. Copépodes (2°note). Genres *Prohatschekia* n. gen. et *Hatschekia* Poche. *Bulletin de l' Institute francais d'Afrique Noire*, 16A, 479–505.

Pillai, N.K. (1985) *The Fauna of India*. *Copepod Parasites of Marine Fishes*. Zoological Survey of India, Calcutta, 900 pp.

Schram, T.A. & Aspholm, P.E. (1997) Redescription of male *Hatschekia hippoglossi* (Guérin–Méneville, [1837]) (Copepoda: Siphonostomatoida) and additional information on the female. *Sarsia*, 82, 1–18.

Uyeno, D. & Nagasawa, K. (2009a) Redescription of four species of *Hatschekia* (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on tetraodontiform fishes from Japan. *Zootaxa*, 2110, 1–21.

Uyeno, D. & Nagasawa, K. (2009b) Three new species of *Hatschekia* (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on *Abalistes filamentosus* (Pisces: Tetraodontiformes: Balistidae) from Okinawa, Japan. *Systematic Parasitology*, 74, 225–237.

Uyeno, D. & Nagasawa, K. (2010a) Three new species of *Hatschekia* (Copepoda: Siphonostomatoida: Hatschekiidae) parasitic on boxfishes (Pisces: Tetraodontiformes: Aracanidae and Ostraciidae) from Japan. *Systematic Parasitology*, 75, 147–158.

Uyeno, D. & Nagasawa, K. (2010b) A new species of parasitic copepod of the genus *Hatschekia* Poche, 1902 (Siphonostomatoida: Hatschekiidae) from filefishes (Pisces: Tetraodontiformes: Monacanthidae) from off Okinawa, Japan. *Systematic Parasitology*, 76, 53–58.

Uyeno, D. & Nagasawa, K. (2010c) The copepod genus *Hatschekia* Poche, 1902 (Siphonostomatoida: Hatschekiidae) from triggerfishes (Pisces: Tetraodontiformes: Balistidae) from off the Ryukyu Islands, Japan, with descriptions of eleven new species. *Zootaxa*, 2478, 1–40.

Villalba, C. (1986) Contribution al conocimiento del genero *Hatschekia* Poche, 1902 en Chile (Copepoda: Hatschekiidae). *Boletin de la Sociedad de Biologia de Concepcion*, Chile, 56, 155–170.

Yamaguti, S. (1939) Parasitic copepods from fishes of Japan. Part 5. Caligoida, III. *Volume Jubilare pro Professore Sadao Yoshida*, 2, 443–487, pls. 14–33.

Yamaguti, S. (1953) Parasitic copepods from fishes of Japan. Part 7. Cyclopoida, III and Caligoida, IV. *Publications of the Seto Marine Biological Laboratory*, 3, 221–231, pls. 13–17.

Zootaxa 3367: 60–68 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

New species of the copepod genus *Anthessius* Della Valle, 1880 (Poecilostomatoida: Anthessiidae) from *Turbo marmoratus* Linnaeus (Gastropoda: Turbinidae) collected during the KUMEJIMA 2009 Expedition*

DAISUKE UYENO[1, 2,3] & KAZUYA NAGASAWA[1]

[1]*Graduate School of Biosphere Science, Hiroshima University, 1-4-4 Kagamiyama, Higashi–Hiroshima, Hiroshima 739–8528, Japan.*
[2]*Marine Learning Center, 2–95–101 Miyagi, Chatan, Nakagami, Okinawa 901-0113, Japan.*
[3]*Corresponding author*
E–mails: DU, daisuke.uyeno@gmail.com; KN, ornatus@hiroshima–u.ac.jp.

* *In*: Naruse, T., Chan, T.-Y., Tan H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Anthessius isamusi **n. sp.** is described based on female and male specimens from a turbinid gastropod, *Turbo marmoratus* Linnaeus, collected in the East China Sea off Kumejima Island, the Ryukyu Islands, southern Japan, during the KUMEJIMA 2009 Expedition. The female of the new species is differentiated from its congeners by the following combination of characters: 1) the absence of denticles on the ventral surface of the anal somite; 2) the length to width ratio of the caudal ramus; 3) the antenna bearing 4 claws; 4) the maxilla with 3 distal teeth; 5) the exopod of leg 4 with 3 spines on the terminal segment, and; 6) leg 5 with a rod-like terminal segment.

Key words: Copepoda, new species, the Ryukyu Islands, gastropod

Introduction

Anthessius is the largest genus in the poecilostomatoid copepod family Anthessiidae Humes, 1986. Stock *et al.* (1963) recognised 23 species in the genus. Since then, 20 more species have been described, bringing the total to 43 known species (Avdeev & Kazatchenko 1986; Devi 1984; Do & Kajihara 1984; Ho 1983; Ho & Kim 1992; Humes 1973, 1976; Humes & Ho 1965; Humes & Stock 1965; Kim 1993, 2009; López-González *et al.* 1992; Reddiah 1966; Stock 1964; Suh & Choi 1991; Suh 1993). Almost all species are parasitic or commensal on marine bivalves and gastropods (Boxshall & Halsey 2004; Ho 1997), and some have been reported from molluscs of commercial important (e.g. Humes 1973; Humes & Stock 1965; Tanaka 1961). During the KUMEJIMA 2009 Expedition conducted in the East China Sea around Kumejima Island, the Ryukyu Islands, southern Japan in November 2009, a new species of *Anthessius* was collected from *Turbo marmoratus* Linnaeus, which is commercially important in the Indo-West Pacific.

Materials and Methods

A specimen of *Turbo marmoratus* Linnaeus, was collected by SCUBA off Kumejima Island, the Ryukyu Islands, Okinawa, southern Japan, during the KUMEJIMA 2009 Expedition. After dissecting the snails, copepods were removed by rinsing in freshwater and preserved in 80% ethanol. Copepod specimens were soaked in lactophenol for 24 hours before dissection. The appendages were dissected and observed using the method of Humes & Gooding (1964). The drawings were made with the aid of a drawing tube. The terminology followed Huys &

Accepted by T. Naruse: 14 Aug. 2011; published: 4 Jul. 2012

Boxshall (1991). Measurements in micrometres are shown as ranges with means and standard deviations in parentheses. Length and width of each body parts is in square brackets together. Type specimens are deposited in the crustacean collection of the National Museum of Nature and Science, Tokyo (NSMT) and the University of the Ryukyus Museum, Fujukan (RUMF), Okinawa.

Taxonomic account

Order Poecilostomatoida Thorell, 1859

Family Anthessiidae Humes, 1986

Genus *Anthessius* Della Valle, 1880

Anthessius isamusi n. sp.

(Figs. 1–3)

Material examined. Holotype, female (NSMT–Cr 21665), ex *Turbo marmoratus* Linnaeus (Gastropoda: Turbinidae), off Ebi-ana (26°17′N, 126°47′E), Kumejima Island, the Ryukyu Islands, East China Sea, Japan, 13 November 2009. Allotype: a male (NSMT–Cr 21666) and Paratypes: 4 females and 1 male (NSMT–Cr 21667); 2 female and 1 male (RUMF–ZC–1503), Collection data of allotype and paratypes same as that of holotype.

Description of female holotype. Body (Fig. 1A) 2240 long, excluding caudal rami (n = 7). Cephalothorax ovoid, shorter than wide 969 × 1202, widest at posterior 3/4. Three free thoracic somites in prosome distinctly separated and narrowing posteriorly. Urosome 5-segmented, 768 long. Genital complex barrel-shaped, shorter than wide 227 × 292. Anal somite (Fig. 1C) shorter than wide 124 × 152, unarmed. Caudal ramus (Fig. 1C) longer than wide 140 × 67, length/width ratio 2.08, slightly longer than anal somite, with 6 setae; outer lateral seta naked and located on subterminal, most outer and inner seta plumose, 2 middle setae with small spinules on margin.

Rostrum (Fig. 1B) broad. Antennule (Fig. 1D) 7-segmented, with armature formula 4, 17, 4, 3, 4 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae naked. Antenna (Fig. 1E) 3-segmented; proximal segment with 1 distal seta on anterior surface; middle segment with 1 subterminal seta on anterior surface; terminal segment bearing 1 short and 3 long setae proximally, 1 subterminal seta, and distal tip carrying 1seta and 2 strong hook-like claws, one of them slender and long, and the other small.

Labrum (Fig. 1F) bilobed bearing median incision. Mandible (Fig. 2A) bearing 1 lash-like serrated inner seta and apical serrated lash with 2 proximally, bifurcated teeth at outer lash basis. Maxillule (Fig. 2B) bearing 2 long and 2 small setae, 3 blunt and 1 comb-like processes. Maxilla (Fig. 2C) 2-segmented; proximal segment rod-like, unarmed; distal segment tapering into pointed process, with 2 large and 1 small teeth on convex side and 2 spines near basis. Maxilliped (Fig. 2D) digitiform, with obscure suture line and distally tapering process with 1 setule.

Legs 1 to 4 (Fig. 2E–H) with coxa, basis, and 3-segmented rami; leg armature formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–0	I–0; I–1; III, I, 4	0–1; 0–1; I, 2, 3
Leg 2	0–1	1–0	I–0; I–1; III, I, 5	0–1; 0–2; II, I, 3
Leg 3	0–1	1–0	I–0; I–1; III, I, 5	0–1; 0–2; III, I, 2
Leg 4	0–1	1–0	I–0; I–1; II, I, 5	0–1; 0–2; III, I, 1

Coxa of legs 1 to 4 with single row of small denticles on distal tip. Basis of legs 1 to 4 with single row of hairs along inner margin. Legs 1 to 3 bearing single row of fine spinules on margin of basis between endopod attachment area and outer protrusion. Proximal segment of exopod of legs 1 to 4 bearing single row of denticles along outer margin and rows of setules along inner margin; spines foliaceous, serrated along both lateral sides, excluding distal plumose spines along inner margin; terminal segment serrated along outer margin. Endopods of legs 1 to 4 fringed

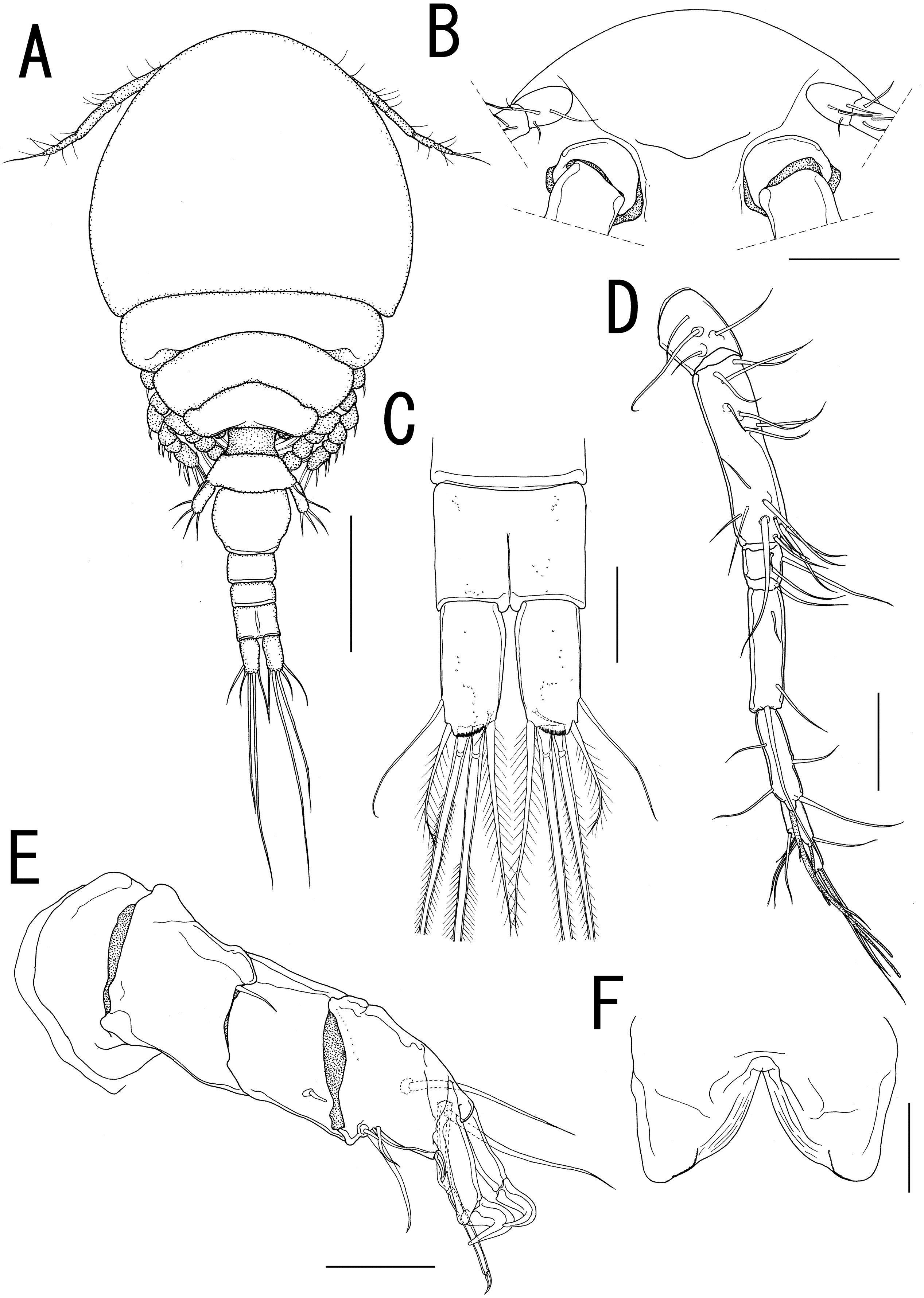


FIGURE 1. *Anthessius isamusi* **n. sp.**, female, holotype NSMT–Cr 21665: A, habitus dorsal; B, rostrum area, ventral; C, anal somite and caudal rami, ventral; D, left antennule, posterior; E, left antenna, anterior; G, labrum. Scales: A = 500 µm; B = 200 µm; C, D, E = 100 µm; F = 50 µm.

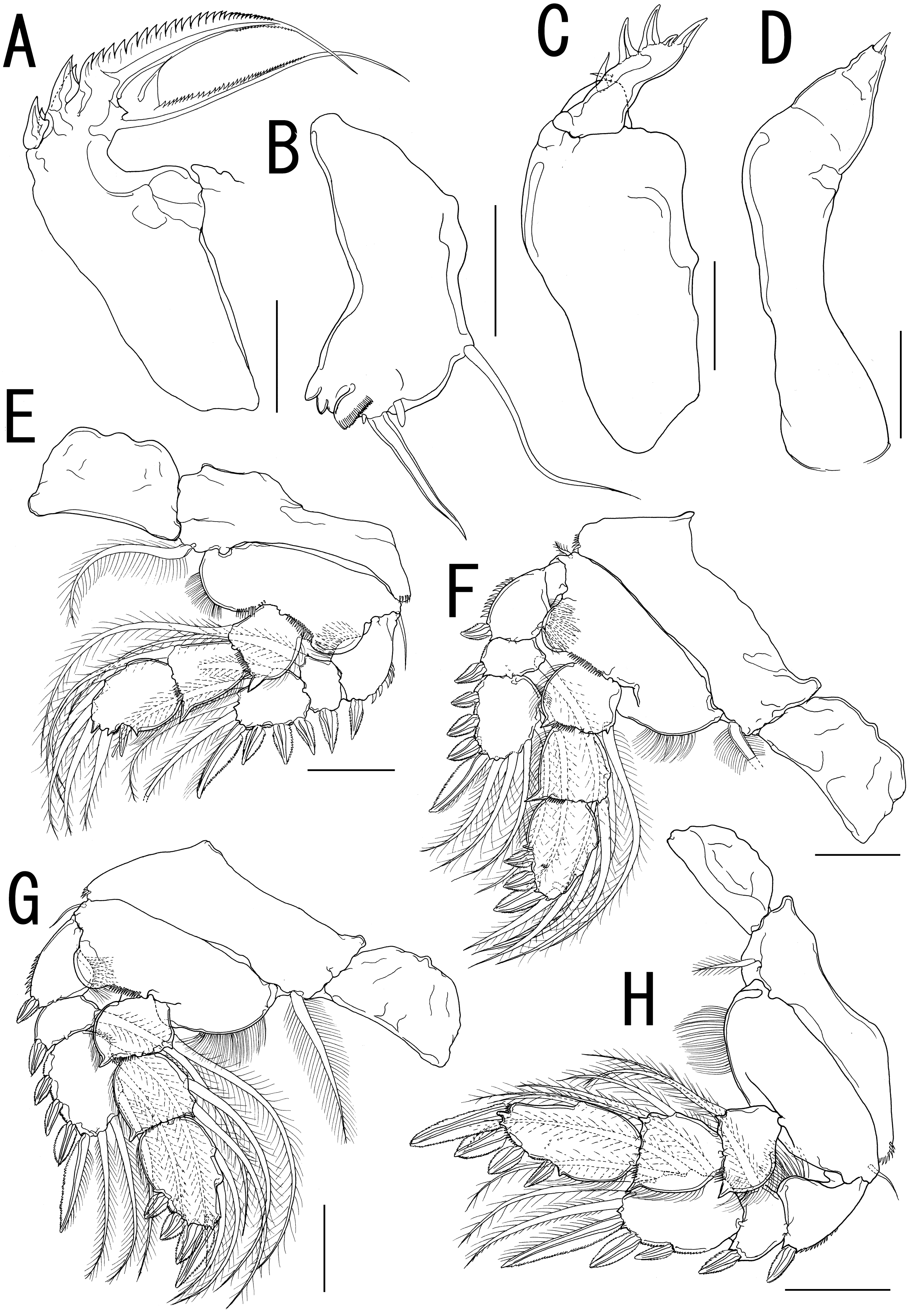


FIGURE 2. *Anthessius isamusi* **n. sp.**, female, holotype NSMT–Cr 21665: A, left mandible, posterior; B, left maxilulle, anterior; C, left maxilla, posterior; D, left maxilliped, posterior; E, left leg 1, ventral; F, right leg 2, ventral; G, right leg 3, ventral; H, left leg 4, ventral. Scales: A, C, D = 50 µm; B = 40 µm; E, F, G, H = 100 µm.

with setules along outer margin; proximal and middle segment bearing pointed process on distal tip and single row of spinules along distal margin; spines foliaceous with serrated margin, except for leg 1, legs 3 and 4 ornamented with single row of setules along inner margin. Leg 5 (Fig. 3A) 2-segmented; proximal segment incompletely fused to 5th pedigerous somite with 1 naked seta on dorsal surface; terminal segment longer than wide 144 × 55, with length/width ratio of 2.60, bearing 3 blunt spines and 1 naked seta, spinules along posterior quarter of inner margin and near base of each outer 3 elements. Leg 6 (Fig. 3A) rod-like with 2 elements.

Variability of measurement. Paratype females share all important morphological characters with the holotype. Measurement range of their body parts and appendages of female type series (n = 7) was as follows: body (excluding caudal rami) length 2063–2240 (2150 ± 65), cephalothorax length 857–989 (928 ± 46), cephalothorax width1040–1202 (1095 ± 58), urosome length 714–865 (791 ± 53), genital complex length 206–254 (225 ± 18), genital complex width 270–297 (286 ± 10), anal somite length119–126 (124 ± 2), anal somite width 142–162 (152 ± 7), caudal ramus length 133–145 (140 ± 4), caudal ramus width 63–70 (66 ± 2), caudal ramus length/width ratio 1.99–2.28 (2.16 ± 0.08), terminal segment length of leg 5 124–144 (134 ± 8), terminal segment width of leg 5 38–55 (44 ± 6), length/width ratio of terminal segment of leg 5 2.60–3.42 (3.09 ± 0.39).

Description of male allotype. Body (Fig. 3B) as in female, 1735 long, excluding caudal rami. Cephalothorax ovoid, shorter than wide 766 × 792, widest at posterior 3/4. Urosome (Fig. 3B) 6-segmented, 629 long. Genital somite (Fig. 3C) shorter than wide 203 × 221. Anal somite shorter than wide 75 × 122. Caudal ramus longer than wide 93 ± 55, with length/width ratio of 1.69. Sexual dimorphism distinctly present in antennule (Fig. 3D), antenna (Fig. 3E), and maxilliped (Fig. 3F). Antennule 7-segmented bearing 4 additional aesthetascs (Fig. 3D), with armature formula 4, 17+ 3 aesthetasc, 4, 3+ 1 aesthetasc, 4 + 1 aesthetasc, 2 + 1 aesthetasc, 7 + 1 aesthetasc; all setae naked. Antenna (Fig. 3E) as in female except proximal segment with long comb-like seta on distal margin. Maxilliped (Fig. 3F) 4-segmented; proximal segment rod-like bearing conical, subterminal process on inner margin and single row of spinules on outer distal corner; middle segment fusiform bearing 2 setae and 3 patches of spinules; third segment shortest, bearing 1 seta and 1 pointed process; terminal claw curved, with spinulated inner margin covered with spinules and bearing 1 seta. Legs 1 to 4 as in female. Leg 5 (Fig. 3C) with rod-like terminal segment, longer than wide 122 × 35, with length/width ratio of 3.46, slender than that of female. Leg 6 (Fig. 3C) represented by 2 naked setae on posterolateral tip of genital flap.

Variability of measurement. Paratype males share all important morphological characters with the aollotype. Measurement range of their body parts and appendages of male type series (n = 3) was as follows: body (excluding caudal rami) length 1600–1735 (1679 ± 70), cephalothorax length 727–766 (751 ± 21), cephalothorax width 773–840 (801 ± 34), urosome length 498–629 (567 ± 66), genital somite length 168–203 (183 ± 18), genital somite width 211–227 (220 ± 8), anal somite length 75–83 (80 ± 5), anal somite width 122–137 (129 ± 7), caudal ramus length 93–95 (94 ± 1), caudal ramus width 50–55 (53 ± 2), caudal ramus length/width ratio 1.69–1.85 (1.77 ± 0.08), terminal segment length of leg 5 109–127 (119 ± 9), terminal segment width of leg 5 28–35 (32 ± 4), length/width ratio terminal segment of leg 5 3.46–3.94 (3.78 ± 0.28).

Attachment site. In mantle cavity.

Remarks. The species of *Anthessius* can be separated into 2 groups according to the number of spines on the third exopodal segment of leg 4 of the female.The female of the new species has 3 spines on the terminal exopodal segment of leg 4. This condition is shared with the following 17 species, *A. atrinae* Suh & Choi, 1991, *A. dilatatus* (Sars, 1918), *A. graciliunguis* Do & Kajihara, 1984, *A. investigatoris* Sewell, 1949, *A. kimjensis* Suh, 1993, *A. leptostylis* (Sars, 1916), *A. longipedis* Ho & Kim, 1992, *A. lophiomi* Avdeev & Kazachenko, 1986, *A. navanacis* (Wilson, 1935), *A. nortoni* Illg, 1960, *A. pinnae* Humes, 1959, *A. placunae* Devi, 1984, *A. projectus* Kim, 1993, *A. proximus* Stock, Humes & Gooding, 1963, *A. saecularis* Stock, 1964, *A. sensitivus* Stock, Humes & Gooding, 1963, and *A. varidens* Stock, Humes & Gooding, 1963. Nine species, namely, *A. atrinae*, *A.dilatatus*, *A. graciliunguis*, *A. leptostylis*, *A. lophiomi*, *A. nortoni*, *A. pinnae*, *A. placunae*, and *A. saecularis*, are distinctly separated from the new species by the caudal ramus longer than 3 times of the width (vs. 2 times longer than wide in the new species). Three species, *A. kijimensis*, *A. navanacis*, and *A. projectus*, are differentiated from the new species by the terminal segment of leg 5 oval and shorter than twice the width, and by the maxilla bearing more than 5 teeth (vs. terminal segment of the leg 5 about 2.5 times longer than wide, and the maxilla with 3 teeth in the *A. isamusi* **n. sp.**). *Anthessius investigatoris*, *A. longipedis*, *Anthessius sensitivus* differ from the new species by the elongate terminal segment of leg 5 longer than 3 times of the width. *Anthessius varidense* differs from the new species by the following characters: the antenna bearing a very small inner most apical claw and 3 subequal claws

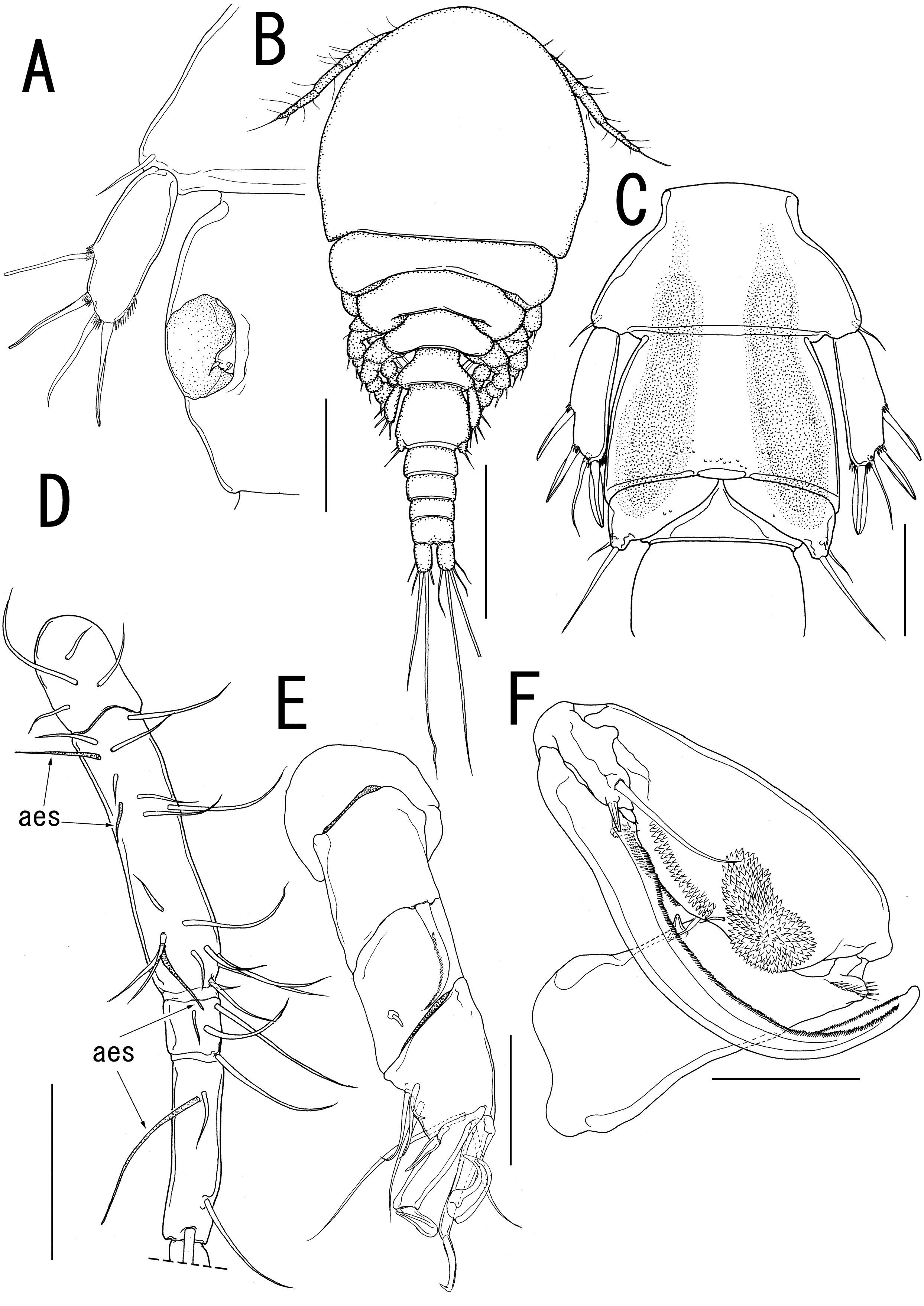


FIGURE 3. *Anthessius isamusi* **n. sp.**, female, holotype NSMT–Cr 21665: A, leg 5 and genital complex, dorsal. *A. isamusi* n. sp., male, allotype NSMT–Cr 21666. B, habitus, dorsal; C, fifth pediger and genital somite, ventral; D, first to fourth segment of left antennule, posterior, aes = aesthetasc; E, left antenna, anterior; F, left maxilliped, posterior. Scale s: A, C, D, E, F = 100 µm; B = 50 µm.

distally, and the maxilla carrying 5 teeth without protuberance (vs. the antenna bearing 2 strong, 1 long, and 1 small claws distally, and the maxilla bearing only 3 teeth). *Anthessius proximus* differs from the new species by the following characters: the antenna with 4 strong claws distally, and leg 5 with the rows of inconspicuous spinnules at the basis on each 2 distal spines (vs. the rows of spinnules existing distinctly at the basis of distal 2 spines on leg 5 in the *A. isamusi* **n. sp.**).

Etymology. The specific name of the new species, *isamusi*, is derived from an arbitrary combination of "Isamu Nakayoshi" and "musi". Isamu-san is a crackerjack fisherman in Kumejima Island and also a collector of the specimens of *T. marmoratus* for this study. He also supported the KUMEJIMA 2009 in various ways. "Musi" is a generic term for small animals in Japanese. The name "*isamusi*" alludes to the new species as "Isamu's animal", and it is also his nickname. The name is used as noun in apposition.

Discussion

The genus *Anthessius* now comprises 44 species, including 1 new species described in this study. Only two species, *A. pectinis* and *A. graciliunguis*, have been reported so far from Japanese waters (Do & Kajihara 1984; Tanaka 1961; Ueda *et al*. 2006). Among these 44 species, 21 of them (48%) are known from bivalves, but only 5 species (11%) have been found from prosobranchs (Devi 1984; Ho 1997; Kim 2009; present study, Table 1).

TABLE 1. Occurrence of the 44 species of *Anthessius* constructed after Ho (1997).

Occurrence	Number of species	Name of species
In weed washings	1	*A. brevifurca*
In plankton	5	*A. concinnus*, *A. dilatatus*, *A. graciliunguis*, *A. groenlandicus*, *A. investigatoris*
In bivalves	21	*A. alatus*, *A. amicalis*, *A. arenicola*, *A. atrinae*, *A. brevicauda*, *A. discipedatus*, *A. distensus*, *A. fitch* *A. graciliunguis*, *A. kimjensis*, *A. minor*, *A. mytilicolus*, *A. nosybensis*, *A. pectinis*, *A. pinctadae* *A. pinnae*, *A. placunae*, *A. projectus*, *A. saecularis*, *A. solecurti*, *A. solidus*
In prosobranchs	5	*A. isamusi* n. sp., *A. leptostylis*, *A. longipedis*, *A. sensitivus*, *A. teissieri*
In opisthobranchs	12	*A. arcuatus*, *A. dolabellae*, *A. hawaiiensis*, *A. lighti*, *A. navanacis*, *A. nortoni*, *A. obtusispina* *A. ovalipes*, *A. pleurobrancheae*, *A. proximus*, *A. stylocheili*, *A. varidens*
On fish	1	*A. lophiomi*

In this study, *A. isamusi* **n. sp.** is distinguished from its congeners by the following characters of the female: the unarmed anal somite on the ventral surface; the non-elongate caudal ramus; the antenna bearing 4 claws; the maxilla with 3 teeth; the fourth exopod with 3 spines on the terminal segment; and leg 5 with a rod-like, not extremely elongate terminal segment. These characters were utilized in the keys to species of *Anthessius* by Illg (1960) and Stock *et al*. (1963) and in a cladistic analysis by Ho (1997). Because the length to width ratio of the caudal ramus and the terminal segment of leg 5 cannot be used reliably all the time to distinguish between congeric species, it is better, in addition to the ratio, to use the shape of the terminal segment of leg 5 and the relative length of the caudal ramus and the anal somite.

The gastropod host, *T. marmoratus,* is widely distributed in the tropical to subtropical waters of the Indo-West Pacific and is extensively consumed as food and adornment (Poutires 1998). The distribution of *Anthessius isamusi* **n. sp.** may be as widespread as the host. We also collected and examined a number of specimens of *T. marmoratus* at Moorea Island, the South Pacific Ocean, French Polynesia during Moorea Biocode Project, in November 2010 but did not find *A. isamusi* **n. sp.** Although *T. marmoratus* has been introduced into French Polynesia since the 1960s (Poutires 1998), the copepod may not have been introduced there.

Studies have reported damage caused due to the infection of *A. pinctadae* Humes, 1973 in the pearl oyster, *Pinctada maxima* (Jameson) in northern Australia (Humphrey *et al*. 1998; Jones 2007). *Anthessius isamusi* **n. sp.** may cause similar adverse impact on the gastropod host, however, no damage in *T. marmoratus* individuals carrying *A. isamusi* **n. sp.** in this study were found.

Acknowledgements

We are grateful to all the organizers and colleagues who were engaged in the KUMEJIMA 2009 Expedition. It was organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The Expedition was conducted under a permit granted to Tohru Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. We acknowledge Il-Hoi Kim, Kangnung National University for providing valuable publications and comments. We thank Isamu Nakayoshi and Arisa Izeki, Kumejima for collecting the samples. Part of this work received financial support from the Ocean Exposition Commemorative Park Management Foundation, Okinawa.

References

Avdeev, G.V. & Kazatchenko, V.N. (1986) Parasitic copepods from fishes of the genus *Lophiomus* Gill in the Pacific. *Crustaceana*, 50, 53–67.

Boxshall, G.A. & Halsey, S.H. (2004) *An Introduction to Copepod Diversity*. The Ray Society, London, 966 pp.

Devi, S.I. (1984) A new species of copepod *Anthessius placunae* from the gills of window-pane oyster *Placenta placenta* (Linnaeus) off Kakibada Bay. *Journal of the Marine Biological Association of India*, 21, 143–146.

Do, T.T. & Kajihara, T. (1984) Two poecilostomatoid copepods, *Anthessius gracilliunguis* n. sp. and *Modiolicola bifidus* Tanaka, 1961 from the blue mussel, *Mytilus edulis galloprovincialis* Lamarck, in Japan. *Fish Pathology*, 19, 5–15.

Ho, J.-S. (1983) A new species of copepod associated with *Pleurobranchaea californica* (Gastropoda: Opisthobranchia) with discussion on *Anthessius* associated with notaspidean sea slugs. *Veliger*, 25, 393–398.

Ho, J.-S. (1997) Cladistics of the *Anthessius* Della Valle, 1880: a major genus of poecilostome copepods parasitic in Mollusca. *Phuket Marine Biological Center Special Publication*, 17, 483–493.

Ho, J.-S. & Kim, I.-H. (1992) Copepod parasites of Gastropoda from Korea. *Korean Journal of Zoology*, 35, 240–255.

Humes, A.G. (1973) Cyclopoid copepods associated with marine bivalve mollusks in New Caledonia. *Cahiers de l'Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM)*, Série Océanographie, 11, 3–25.

Humes, A.G. (1976) Cyclopoid copepods associated with Tridacnidae (Mollusca, Bivalvia) in the Moluccas. *Proceedings of the Biological Society of Washington*, 89, 491–508.

Humes, A.G. & Gooding, R.U. (1964) A method for studying the external anatomy of copepods. *Crustaceana*, 6, 238–240.

Humes, A.G. & Ho, J.-S. (1965) New species of the genus *Anthessius* (Copepoda, Cyclopoida) associated with mollusks in Madagascar. *Cahiers de l'Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM)*, Série Océanographie, 3, 79–113.

Humes, A.G. & Stock, J.H. (1965) Three new species of *Anthessius* (Copepoda, Cyclopoida, Myicolidae) associated with *Tridacna* from the Red Sea and Madagascar. *Bulletin of the Sea Fisheries Research Station Israel*, 40, 49–74.

Humphrey, J.D., Norton, J.H., Jones, J.B., Barton, M.A., Connell, M.T., Shelley, C.C. & Creeper, J.H. (1998) *Pearl oyster (*Pinctada maxima*) aquaculture: Health survey of Northern Territory, Western Australia and Queensland pearl oyster beds and farms*. *Fisheries Research Development Corporation Final Report 94/079*. Fisheries Research Development Corporation, Canberra, 108 pp.

Huys, R. & Boxshall, G.A. (1991) *Copepod Evolution*. The Ray Society, London, 468 pp.

Illg, P.L. (1960) Marine copepods of the genus *Anthessius* from the northeastern Pacific Ocean. *Pacific Science*, 14, 337–372.

Jones, J.B. (2007) Review of pearl oyster mortalities and diseases problems. *In*: Bondad-Reantaso, M.G., McGladdery, S.E. & Berthe F.C.J. (Eds.), *Pearl oyster health management: a manual*. *FAO Fisheries Technical Paper No. 503*. FAO, Rome, pp. 61–70.

Kim, I.-H. (1993) Two new species of poecilostomatoid Copepoda associated with razor clams (Bivalvia, Solenidae) in the Yellow Sea. *Korean Journal of Systematic Zoology*, 9, 191–202.

Kim, I.-H. (2009) Poecilostome cpepods (Crustacea: Cyclopoida) associated with marine invertebrates from tropical waters. *Korean Journal of Systematic Zoology*, Special Issue, 7, 1–90.

López-González, P.J., Conradi, M., Naranjo, S. & García-Gómez, J.C. (1992) A new species of *Anthessius* (Copepoda:

Poecilostomatoida) associated with *Berthella stellata* (Risso, 1826) (Gastropoda: Opisthobranchia). *Proceedings of the Biological Society of Washington*, 105, 240–248.

Poutires, J.M. (1998) Gastropods. *In*: Carpenter, K.E. & Niem, V.H. (eds.), *FAO Species Identification Guide for Fishery Purposes. The Living Marine Resources of the Western Central Pacific. Vol. 1. Seaweeds, corals, bivalves and gastropods*. FAO, Rome, pp. 363–648.

Reddiah, K. (1966) Copepods associated with Indian molluscs (E). *Anthessius mytilicolus* new species from *Mytilus viridis* at Ennore. *Advance Abstract Contribution Fisheries and Aquatic Sciences India*, 1, 36.

Stock, J.H. (1964) Sur deux espèces d'*Anthessius* (Copepoda) des Indes orientales. *Zoologische Mededelingen*, Leiden, 39, 111–124.

Stock, J.H., Humes, A.G. & Gooding, R.U. (1963) Copepoda associated with West Indian invertebrates - III. The genus *Anthessius* (Cyclopoida, Myicolidae). *Studies on the Fauna of Curaçao*, 17, 1–37.

Suh, H.L. (1993) *Anthessius kimjensis*, a new species of Anthessiidae (Copepoda; Poecilostomatoida) associated with the pelecypod *Solen grandis* Dunker in Korea. *Hydrobiologia*, 259, 187–193.

Suh, H.L. & Choi, S.D. (1991) A new species of *Anthessius* (Copepoda, Poecilostomatoida, Anthessiidae) from the pen shell, *Atrina pectinata* (Linne) in Korea. *Korean Journal of Systematic Zoology*, 7, 45–54.

Tanaka, O. (1961) On copepods associated with marine pelecypods in Kyushu. *Journal of the Faculty of Agriculture*, *Kyushu University*, 11, 249–273.

Ueda, H., Nagai, H., Hibino, M. & Tanaka, M. (2006) Redescription of a symbiotic poecilostomatoid copepod *Anthessius graciliunguis* Do & Kajihara from plankton: the second record of the species and first record of the male. *Plankton & Benthos Research*, 1, 102–108.

Zootaxa 3367: 69–78 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

First record of the genus *Thetispelecaris* Gutu & Iliffe, 1998 (Crustacea: Peracarida: Bochusacea) from a submarine cave in the Pacific Ocean*

MICHITAKA SHIMOMURA[1], YOSHIHISA FUJITA[2,3] & TOHRU NARUSE[4, 5]

[1]*Kitakyushu Museum of Natural History and Human History, 2-4-1 Higashida, Yahatahigashi-ku, Kitakyushu 805-0071, Japan. E-mail: shimomura@kmnh.jp*

[2]*University Education Center, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0231, Japan.*

[3]*Marine Learning Center, 2-95-101 Miyagi, Chatan-cho, Okinawa 904-0113, Japan.*

[4]*Transdisciplinary Research Organization for Subtropical and Island Studies, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan.*

[5]*Current affiliation: Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan. E-mail: naruse@lab.u-ryukyu.ac.jp*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new species of *Thetispelecaris* is described from a submarine cave in Japan as the first record of the genus from the Pacific Ocean. *Thetispelecaris kumejimensis* **n. sp.** differs from its congeners in the following combination of characters: carapace 1.1 times as long as wide; antennal scale with 3–4 setae; maxilliped dactylus with 4 slender setae; basis of pereopod 1 with 2 long setae ventrodistally; exopod of pereopods 4 and 5 4-segmented; basis and ischium of pereopod 3 separated; basis and ischium of pereopods 4–6 partly fused; and pleopods 4 and 5 with 2 setae apically. This study represents the sixth species of the order Bochusacea.

Key words: new species, *Thetispelecaris*, submarine cave, Kumejima Is., Bochusacea

Introduction

Bochusacea Gutu, 1998, is a small order that includes five species in three genera. The first bochusacean, *Hirsutia bathyalis* Sanders, Hessler & Garner, 1985, was discovered from bathyal depths in the western Atlantic Ocean off Suriname (Sanders *et al*. 1985). Between 1988 and 2002, three additional species were described from anchialine, submarine caves and deep-sea habitats: *Hirsutia sandersetalia* Just & Poore, 1988, from bathyal depths off southeastern Australia, *Thetispelecaris remex* Gutu & Iliffe, 1998, from anchialine and submarine caves of Bahamas, and *T. yurikago* Ohtsuka, Hanamura & Kase, 2002, from a submarine cave on Grand Cayman Island, the Caribbean Sea. The most recently described species, *Montucaris distincta,* is from the continental slope off Brazil (Jaume *et al*. 2006). Bochusacea was distinguished from the other peracaridan orders mainly by the combination of the following features (Jaume *et al*. 2006): body comprising cephalothorax incorporating only first thoracomere, pereon composed of seven somites, pleon of five somites, and pleotelson comprising sixth pleonite plus telson; eyes and eyestalks lacking; antennule with three-segmented peduncle and two flagella; antenna located on well-defined pedestal, biramous, with two-segmented protopod, four-segmented endopod with terminal segment annulated forming flagellum, and marginally setose exopodal scale on basis; pereopods 1–6 biramous, with plumose, locomotory exopods originating anterolaterally on proximal part of basis; oostegites on female pereopods 2–6, located posteromedially on coxa, fringed with long plumose setae; pleopods vestigial in female; uropods biramous, with undivided protopod and stenopodial, non-foliaceous rami; exopod two-segmented, endopod annulated, apparently five-segmented.

Accepted by J.D. Reimer: 16 Nov. 2011; published: 4 Jul. 2012

An international marine biodiversity workshop, Kumejima Marine Biodiversity Expedition — KUMEJIMA 2009 was conducted in November 2009 in the Kumejima Island, Ryukyu Islands, Japan. One of the characteristic landscapes of Kumejima is the submarine cave system; they have received attention as several interesting crustaceans have been discovered (Ng 2002; Takeda 2003). During KUMEJIMA 2009, an undescribed bochusacean species was also collected from one of submarine caves. This paper describes the species in detail. This study also represents the first record of the order Bochusacea from marine cave environments of the Pacific Ocean.

Materials and methods

Bochusaceans were collected in a submarine cave named by local SCUBA divers as “Shoggako-oki” (= off elementary school). The cave is located in a coral reef approximately 1 km offshore on the west side of Kumejima Island (26°20.012´N 126°43.961´E). The cave opens at a depth of about 39 m with an entrance ca. 6 m high and ca. 6 m wide, and extends towards the island. The cave consists at least of two parts: the first part is an almost horizontal, straight tube, ca. 35 m long and the second part is a down-sloping tube of unknown length. The cave was filled with normal seawater. Bochusaceans inhabited the end of the first part, where the floors were covered with a substantial amount of fine sand and the environment was totally dark. Specimens were collected with sealable plastic bags (27 cm x 27 cm) by scooping sand on the bottom.

The new bochusaceans were fixed and preserved in 80% ethanol. Each individual was dissected on a hollow glass slide filled with glycerin using forceps and fine needles under a binocular microscope. The body was mounted in glycerin on a hollow glass slide. Appendages were mounted in gum-chloral on a glass slide. Observations were made with a light microscope with a differential interference/phase contrast device. Total length as indicated in “Material examined” was measured from the anterior tip of rostrum to posterior tip of telson excluding setae. Terminology follows Sanders *et al*. (1985), Ohtsuka *et al*. (2002) and Jaume *et al*. (2006). The type specimens are deposited in the Kitakyushu Museum of Natural History & Human History (KMNH IvR), Fukuoka, Japan; and the Ryukyu University Museum, Fujukan (RUMF), Okinawa, Japan.

Systematics

Order Bochusacea Gutu, 1998

Family Hirsutiidae Sanders, Hessler & Garner, 1985

Genus *Thetispelecaris* Gutu & Iliffe, 1998

Type Species. ***Thetispelecaris remex*** **Gutu & Iliffe, 1998.**

Other species. ***Thetispelecaris yurikago*** **Ohtsuka, Hanamura & Kase, 2002.**

Thetispelecaris kumejimensis n. sp.

(Figs. 1–5)

Material examined. Holotype: 1 non-ovig. ♀, 1.1 mm (KMNH IvR 500,497), paratypes: ovig ♀, 1.4 mm (KMNH IvR 500.498); 2 non-ovig. ♀♀, 0.9 mm (RUMF-ZC-1134, 1135). KUMEJIMA 2009 stn. Diving 10, submarine cave “Shoggako-oki”, off western part of Kumejima Island, Ryukyu Islands, Japan, 12 November 2009.

Diagnosis. Carapace 1.1 times as long as wide; antennal scale with 3–4 setae; maxilliped dactylus with 4 slender setae; basis of pereopod 1 with 2 long setae ventrodistally; basis and ischium of pereopods 3–6 partly fused; exopod of pereopods 4 and 5 with 4-segmented; and pleopods 4 and 5 with 2 setae apically.

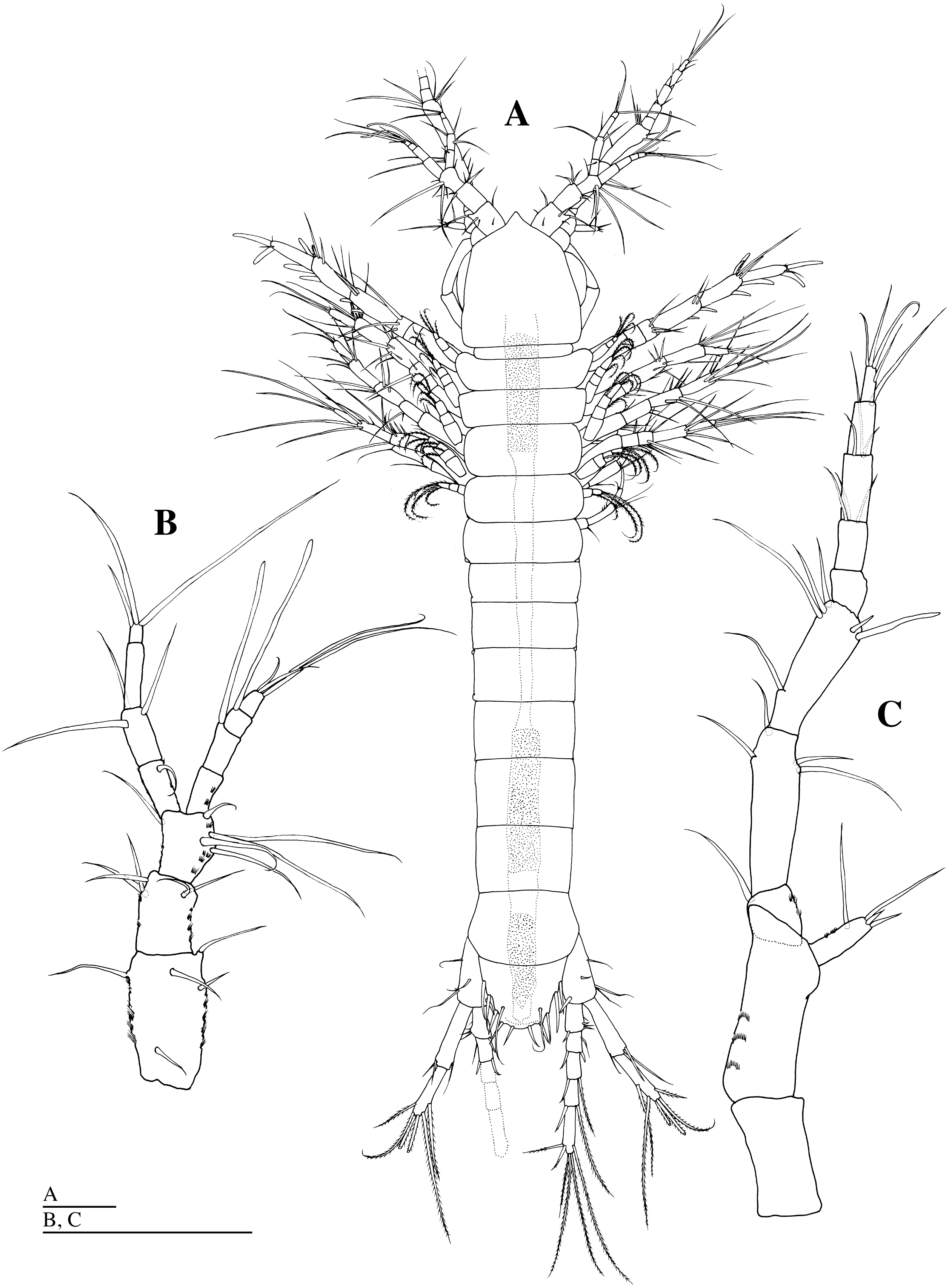


FIGURE 1. *Thetispelecaris kumejimensis* **n. sp.**, holotype. A, habitus, dorsal; B, right antennule, dorsal; C, right antenna, dorsal. Scales, 100 µm.

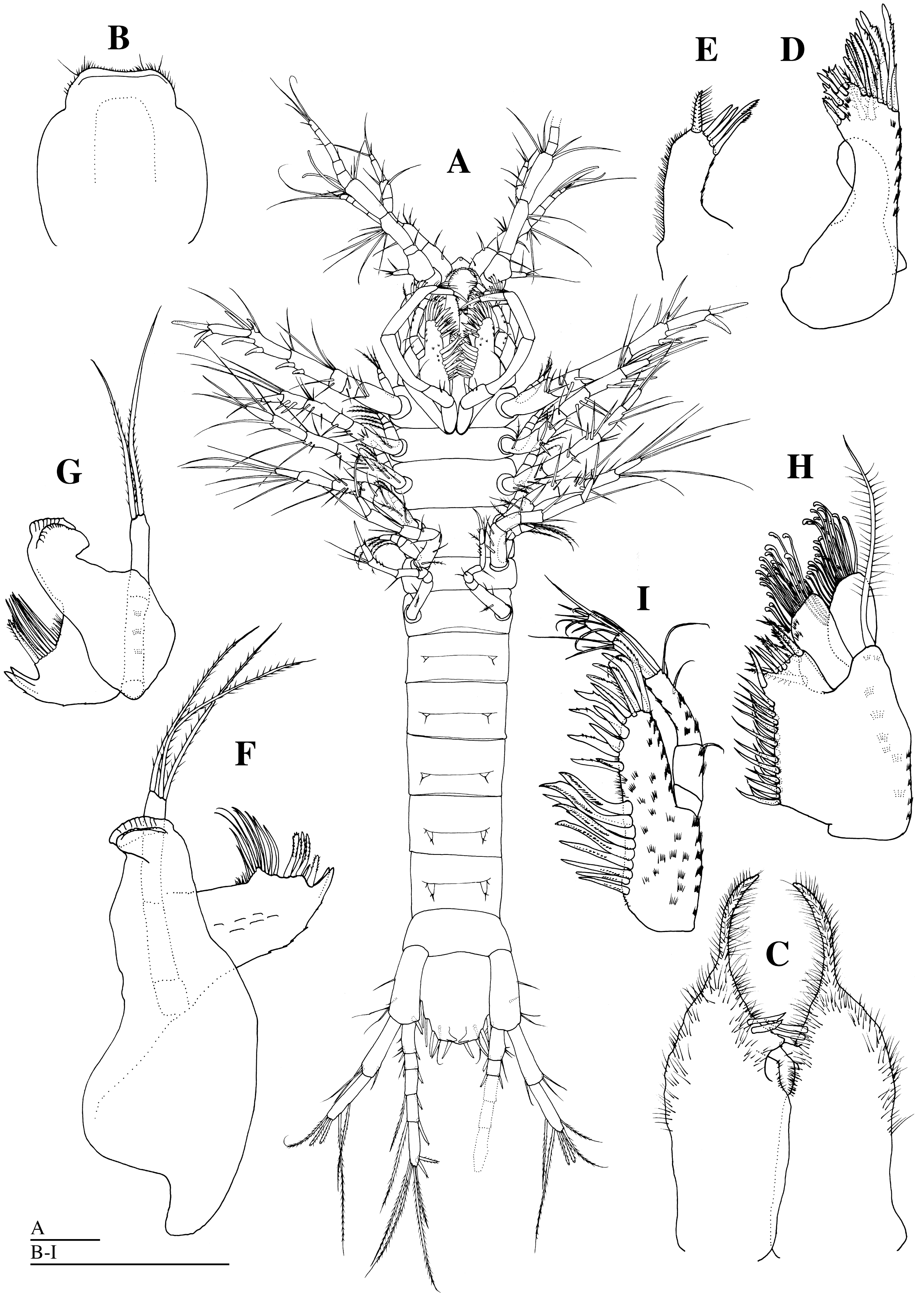


FIGURE 2. *Thetispelecaris kumejimensis* **n. sp.**, holotype, A, D–F, H, I, paratype (KMNH IvR 500,498), B, C, G. A, habitus, ventral; B, labrum, ventral; C, paragnath, ventral; D, right maxillule, dorsal; E, inner lobe of right maxillule, ventral; F, left mandible, ventral; G, right mandible, ventral; H, right maxilla, dorsal; I, right maxilliped, dorsal. Scales, 100 µm.

Description of holotype and paratype (KMNH IvR 500,498). Body (Figs. 1A, 2A) nearly cylindrical, somewhat depressed. Cephalothorax (Fig. 1A) subpentagonal in dorsal view, slightly longer than wide, without setae; rostrum produced anteroventrally, acutely pointed at tip. Pereon (Figs. 1A) shorter than pleon; first pereonite narrower than cephalothorax, shortest and narrowest; second pereonite produced anterolaterally, 2.4 times as long as first pereonite; third to sixth pereonites subequal in width; third pereonite 3.5 times as long as first pereonite; fourth to seventh pereonites gradually decreasing in length posteriorly; fourth pereonite longest, 5 times as long as first pereonite; fifth pereonite 4.8 times as long as first pereonite; sixth pereonite 4 times as long as first pereonite; seventh pereonite as long as sixth pereonite. First to fifth pleonites (Fig. 1A) gradually decreasing in width posteriorly; first to fourth pleonites gradually increasing in length posteriorly; sixth pleonite expanded posterolaterally; telson (Figs. 1A, 5A) shorter than sixth pleonite, 0.8 times as long as wide, bearing 4 pairs of simple setae laterally, pair of simple setae terminally and pair of slender setae dorsally; anus (Fig. 2A) located ventrodistally, with lateral valves.

Antennule (Fig. 1A, B) anteriorly directed, with 3-segmetned peduncle and 4-segmented inner and outer flagella; first peduncular segment longest and widest, with 2 lateral, medial and 2 dorsal simple setae, and with setules; second peduncular segment 0.6 times as long as first segment, with 2 distolateral, 3 distomedial simple setae and setules; third peduncular segment pentagonal, 0.9 times as long as second segment, with short distolateral, 4 long lateral and simple distomedial setae, and with setules. Inner flagellum (Fig. 1B) 1.4 times as long as outer flagellum; setal formula 1, 2, 1, 3. Outer flagellum (Fig. 1B); setal formula 0, 0, 0, 4; aesthetasc present on second and third segments.

Antenna (Fig. 1A, C) with 2-segmented protopod (peduncle), unisegmented scaphocerite (exopodal scale), and 8-segmented endopodal flagellum. First protopodal segment (coxa) unarmed; second segment (basis) 1.7 times as long as coxa, 3 times as long as exopodal scale, with some setules. First endopodal segment shortest; second endopodal segment 3 times as long as first segment; third endopodal segment 0.8 times as long as second segment; forth to eighth endopodal segments combined 0.7 times as long as first to third endopodal segments combined; setal formula of endopodal segments 1, 4, 6, 0, 3, 3, 1, 4.

Labrum (Fig. 2B) as long as wide, with numerous spinular rows on anterior surface; terminal portion truncate, slightly concave midway.

Mandibles (Fig. 2F, G) comprising coxa with well-developed gnathobase and 3-segmented palp. Coxal gnathobases complex in structure: incisor and molar processes widely separate; incisors with 2 cusps apically; molar processes protruded from gnathobase, heavily chitinized terminally, with several lamellar plates and grinding surface. Left mandibular incisor (Fig. 2F) with lacinia mobilis bearing spinules subterminally, with short simple and 3 spinulose setae near lacinia mobilis, and with 9 curved setae and some short setae originating from round protuberance; mandibular palp 3-segmented, slender; segment 1 small, without setae; segment 3 longest, with 3 spinulose setae at tip. Right mandibular incisor (Fig. 2G) with 2 spinulose, 7 curved and some short setae originating from round protuberance; segment 3 of mandibular palp with 2 spinulose setae apically.

Paragnath (Fig. 2C) bilobed; each lobe tapering distally, terminating in elongate hirsute projection; each lobe with inner round projection and 2 stout spines of unequal length midway.

Maxillule (Fig. 2D, E) lacking palp, comprising two segments, coxa and basis, each forming distinct endite, with numerous rows of minute spinules; coxal endite curved inward near its base, with 2 comb-like, 2 simple and 1 spinulose setae distally; basal endite curved inward at midlength, with 2 dorsal spinulose, some lateral setules and 2 groups of marginal elements, proximal group of which consisting of 6 chitinized spines and few setules, distal group of 5 short comb-like, 3 long comb-like and simple setae.

Maxilla (Fig. 2H) with quadrate coxa bearing 20 spiniform setae medially and spinulose seta ventrally, and with setules laterally and ventrally; distal inner corner with 6 spinulose and 3 simple setae; distal outer corner with long plumose seta near base outer lobe. Inner lobe with approximately 15 rake-like, blunt setae and setules; outer lobe 2 with approximately 21 rake-like, blunt setae.

Maxilliped (Fig. 2I) with elongate basis with many setules on ventral surface and 2 groups of marginal elements; proximal group consisting of 4 straight spinulose and 5 curved spinulose setae; distal group of 10 stout setae of various ornamentations and 2 simple and comb-like setae. Palp 5-segmented, longer than basis, ischium small, unarmed; merus about twice as long as ischium, with simple seta distally and setules laterally; carpus as long as proximal 2 segments combined, with 3 simple setae laterally and 2 long simple setae distally, and with setules; propodus 0.7 times as long as carpus, with 6 simple setae distally, without setules; dactylus 0.6 times as long as propodus, with 4 simple setae terminally.

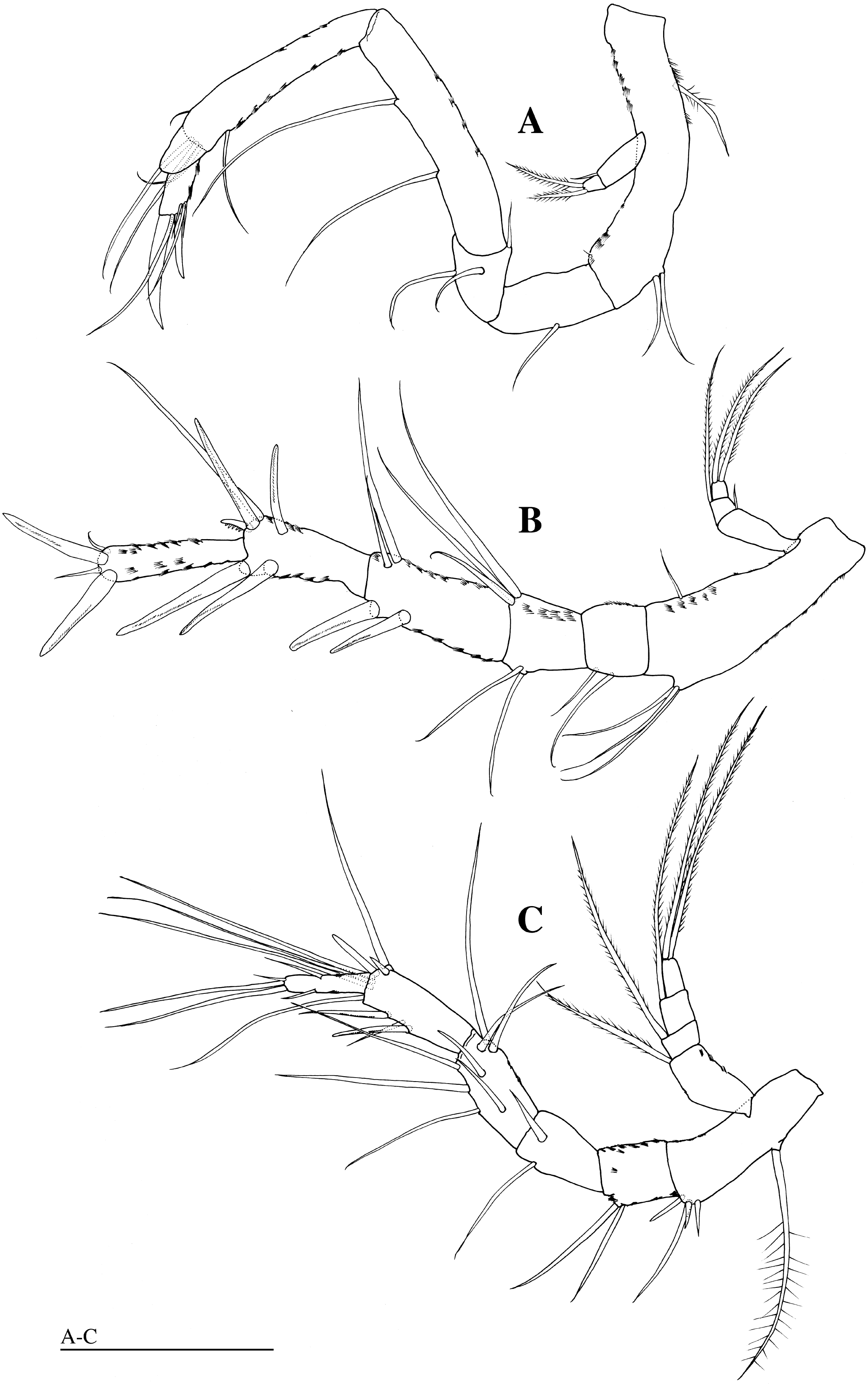


FIGURE 3. *Thetispelecaris kumejimensis* **n. sp.**, holotype. A, left pereopod 1, lateral; B, left pereopod 2, lateral; C, left pereopod 3, lateral. Scale, 100 µm.

Pereopod 1 (Figs. 2A, 3A) longest of pereopods, directed anterolaterally, modified into mouthpart appendage; basis curved dorsally, with 2 simple and plumose setae ventrally and setules; ischium 0.4 times as long as basis, with simple seta ventrally; merus triangular, with simple seta dorsodistally and 2 simple setae ventrally; carpus shorter than basis, with 2 long simple setae ventrally and setules; propodus as long as carpus, with short seta dorsally, 2 long setae distally and simple seta ventrally, and with setules; dactylus stout spine and long seta terminally, short spine and 3 setae subterminally, and with setules; exopod short, 2-segmented, setal formula 1, 2.

Pereopod 2 (Figs. 2A, 3B) thickest of pereopods, covered entirely with setules; basis protruding ventrodistally, bearing 3 long simple setae on its tip, and with short simple seta dorsally and setules; ischium quadrate, 0.3 times as long as basis, with 2 simple setae ventrally and setules; merus trapezoidal, slightly longer than ischium, with 3 simple setae dorsodistally and 2 simple setae ventrodistally; carpus twice as long as merus, with 2 simple setae dorsodistally and 2 stout setae ventrally; propodus 0.8 times as long as carpus, with short serrate, 2 stout, simple setae dorsally and 2 stout setae ventrally; dactylus slender, slightly longer than propodus, with 2 stout and simple setae apically and short seta subapically; exopod 3-segmented, setal formula 1, 1, 2.

Pereopod 3 (Figs. 2A, 3C) shorter than pereopod 2; basis with long and 3 short simple setae ventrodistally and long plumose setae ventrally; ischium 0.4 times as long as basis, with 2 simple setae ventrally; merus slightly longer than ischium, with simple seta laterally and ventrally; carpus 1.2 times as long as merus, with 2 simple setae laterally, 3 simple setae dorsally and 3 simple setae ventrally; propodus as long as carpus, with 2 short and 4 long simple setae dorsodistally and 2 stout and 2 simple setae ventrally; dactylus slender, 0.8 times as long as propodus, with short simple seta dorsally and ventrally, and with 2 long and short simple setae apically; exopod 4-segmetned, setal formula 1, 1, 1, 2. Epipod (Fig. 5C) with 6 marginal plumose setae.

Pereopod 4 (Figs. 2A, 4A); basis 3 long plumose and 3 simple setae ventrally; ischium with short simple seta ventrally; merus with 2 simple setae ventrally; carpus as long as merus, with 2 simple setae dorsally and 3 simple setae ventrally; propodus as long as carpus, with 3 simple setae dorsally and 2 simple setae ventrally; dactylus 0.4 times as long as propodus, with 2 long and short simple setae apically; exopod 4-segmeted, setal formula 1, 1, 1, 1, 2. Epipod (Fig. 5D) with 10 marginal plumose setae.

Pereopod 5 (Figs. 2A, 4B); similar to preceding leg; basis with 3 long plumose setae ventrally; ischium with simple seta ventrodistally; merus with 2 simple setae ventrally; carpus slightly longer than merus, with simple seta dorsodistally and 4 simple setae ventrally; propodus as long as carpus, with 5 long simple setae dorsodistally and simple seta ventrally; dactylus 0.7 times as long as propodus, with 2 simple setae apically; exopod 4-segmetned, setal formula 1, 1+1, 1, 2. Epipod (Fig. 5E) with 11 marginal plumose setae.

Pereopod 6 (Figs. 2A, 4C); basis with simple seta dorsally and long plumose, 2 simple setae ventrally; ischium with simple seta distally; merus with simple seta dorsodistally and ventrodistally; carpus slightly longer than merus, with simple seta dorsodistally and 2 simple setae ventrally; propodus 1.8 times as long as carpus, with simple seta and row of setules ventrally; dactylus 1.1 times as long as propodus, with long simple seta dorsally and long and short simple setae apically; exopod 4-segmented, setal formula 1, 0, 1+1, 2. Epipod (Fig. 5F) with 12 marginal plumose setae.

Pereopod 7 (Figs. 2A, 4C) shortest of pereopods; basis with 2 simple setae dorsally and simple seta ventrally; ischium unarmed; merus trapezoidal, as long as ischium, with 2 simple setae ventrodistally; carpus 1.4 times as long as merus, with simple seta dorsodistally; propodus 1.5 times as long as carpus, with 2 long simple setae dorsodistally and 3 short simple setae ventrally; dactylus half as long as propodus, with long stout seta apically and 2 short setae subapically, and with setules dorsally and ventrally.

Pleopods 1–3 (Fig. 2A) rudimentary, represented by triangular lobe with terminal seta; pleopods 4 and 5 (Figs. 2A, 5B) distinctly articulated at base, unisegmented, bearing lateral and 2 apical short setae.

Uropod (Figs. 1A, 2A, 5A) biramous; protopod 2.3 times as long as wide, with 3 lateral, dorsal simple setae and mediodistal spinulose seta. Exopod 2-segmented; segment 1 0.8 times as long as protopod, with 2 distolateral and distomedial setae; segment 2 slender than segment 1, slightly shorter than segment 1, with 1 lateral, 2 medial and 3 apical plumose setae. Endopod 5-segmented; segment 1 with 4 lateral simple and distomedial spinulose setae; segment 2 0.7 times as long as segment 1, with 2 lateral simple and distomedial spinulose setae; segment 3 1.4 times as long as segment 2, with distolateral plumose and distomedial spinulose setae; segment 4 as long as segment 3, with distolateral plumose and distomedial spinulose setae; terminal segment longest, 1.7 times as long as segment 4, with distolateral, distomedial and 3 apical plumose setae and distomedial spinulose seta.

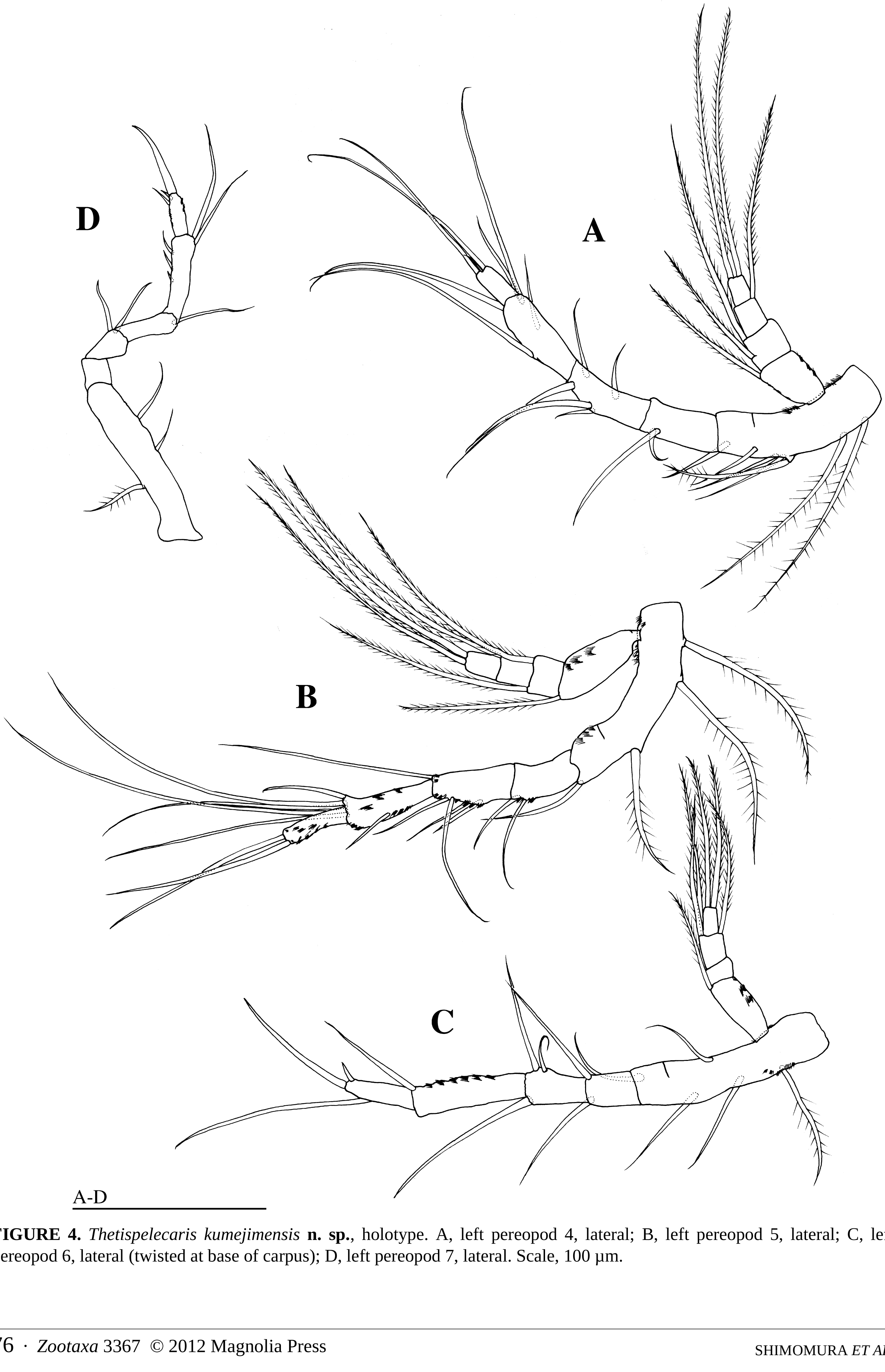


FIGURE 4. *Thetispelecaris kumejimensis* **n. sp.**, holotype. A, left pereopod 4, lateral; B, left pereopod 5, lateral; C, left pereopod 6, lateral (twisted at base of carpus); D, left pereopod 7, lateral. Scale, 100 µm.

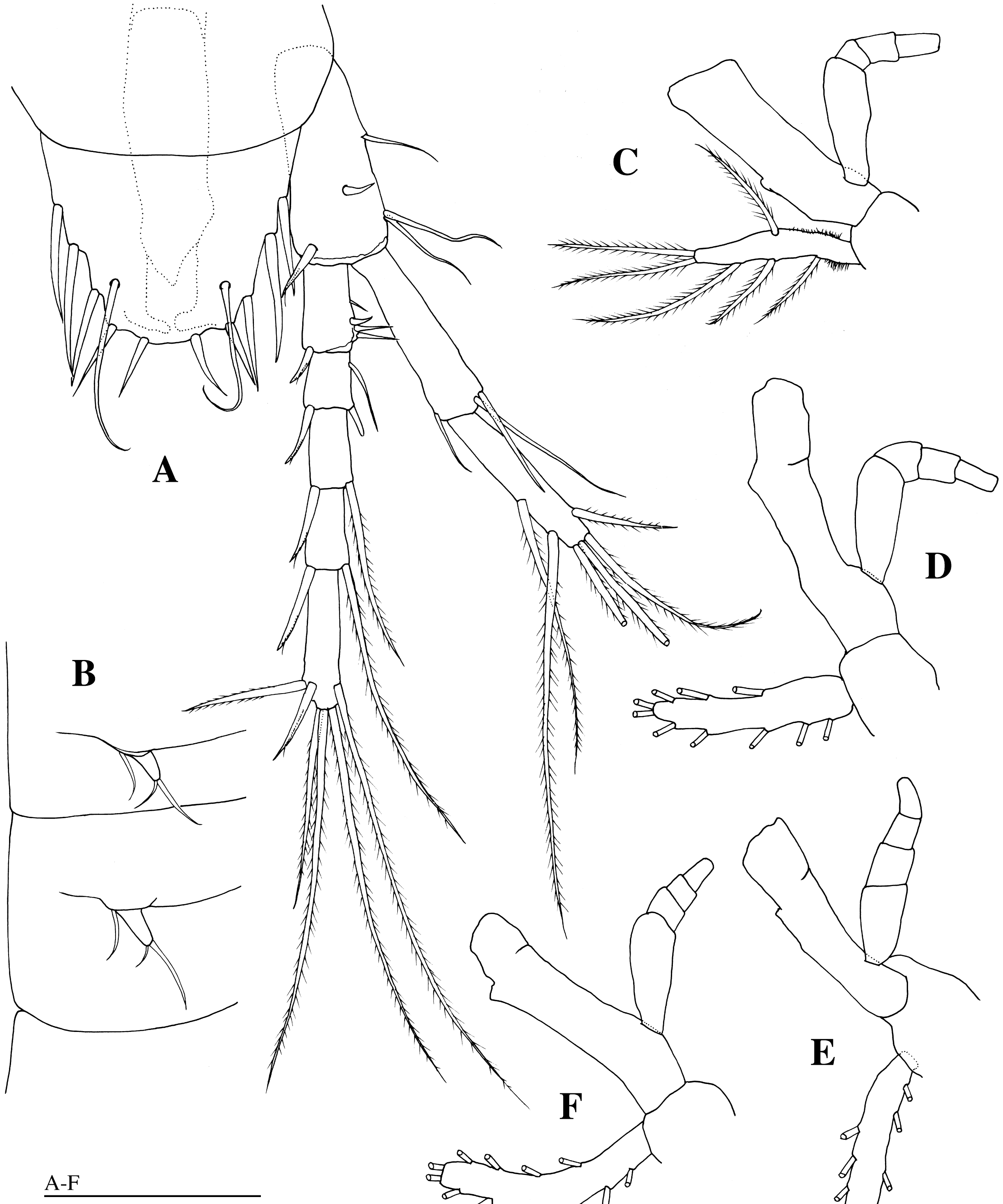


FIGURE 5. *Thetispelecaris kumejimensis* **n. sp.**, holotype. A, B, paratype (KMNH IvR 500,498), C–F. A, telson and right uropod, dorsal; B, right pleopods 4 and 5, ventral; C, left pereopod 3, lateral (setae on exopod and ischium–dactylus omitted); D, left pereopod 4, lateral (setae on epipod and exopod and merus–dactylus omitted); E, left pereopod 5, lateral (setae on epipod and exopod and merus–dactylus omitted); F, left pereopod 6, lateral (setae on epipod and exopod and merus–dactylus omitted). Scale, 100 µm.

Variation. The paratype females agree with the holotype in most characters (excluding oostegites). However, variation was observed in the number of setae of the antennal scales: 4 setae in holotype and paratypes (KMNH IvR 500,498, RUMF-ZC-1135) and 3 setae in paratype (RUMF-ZC-1134).

Etymology. The new species is named after the type locality.

Remarks. *Thetispelecaris kumejimensis* **n. sp.** resembles *T. remex* Gutu & Iliffe, 1998, from anchihaline and submarine caves in Bahamas, in having 4-segmented exopod of pereopods 4 and 5; and separated basis and ischium of pereopod 3. The two species, however, differ from one another in the following combination of features (those of *T. remex* in parentheses): carapace 1.1 times as long as wide (1.2 times as long as wide); maxilliped dactylus with 4 slender setae (3 slender setae); basis of pereopod 1 with 2 long setae ventrodistally (1 long and 2 short setae); basis and ischium of pereopods 4–6 partly fused (separated); and pleopods 4 and 5 with 2 setae apically (3 setae).

The present species differs from *Thetispelecaris yurikago* Ohtsuka, Hanamura & Kase, 2002, from a submarine cave on Grand Cayman Island, Caribbean Sea, in the following features (those of *T. yurikago* in parentheses): carapace 1.1 times as long as wide (1.3 times as long as wide); antennal scale with 3–4 setae (6 setae); maxilliped dactylus with 4 slender setae (3 spiniform and 2 fine setae); basis of pereopod 1 with 2 long setae (without setae); exopod of pereopods 4 and 5 with 4-segmented (5-segmented); and basis and ischium of pereopod 3 separated (partly fused).

Acknowledgements

We are grateful to the skilled local diver Ms. Hiromi Morino for collecting mictacean specimens. We thank Dr. Gary C. B. Poore of the Museum of Victoria and an anonymous reviewer for their critical reading of the manuscript. The collecting survey was conducted during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies (TRO-SIS) of the University of the Ryukyus, the Center for Marine Bioscience & Biotechnology (CMBB) of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research (RMBR) of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition was operated under a permit granted to T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. This study was partly supported by grant from the Narishige Zoological Award to M. Shimomura.

References

Gutu, M. (1998) Spelaeogriphacea and Mictacea (partim) suborders of a new order, Cosinzeneacea (Crustacea, Peracarida). *Travaux du Muséum National d'Histoire Naturelle Grigore Antipa*, 40, 121–129.

Gutu, M. & Iliffe, T.M. (1998) Description of a new hirsutiid (n. g., n. sp.) and reassignment of this family from order Mictacea to the new order, Bochusacea (Crustacea, Peracarida). *Travaux du Muséum National d'Histoire Naturelle Grigore Antipa*, 40, 93–120.

Jaume, D., Boxshall, G.A. & Bamber, R.N. (2006) A new genus from the continental slope off Brazil and the discovery of the first males in the Hirsutiidae (Crustacea: Peracarida: Bochusacea). *Zoological Journal of the Linnean Society*, 148, 169–208.

Ng, P.K.L. (2002) On a new species of cavernicolous *Neoliomera* (Crustacea: Decapoda: Brachyura: Xanthidae) from Christmas Island and Ryukyus, Japan. *Raffles Bulletin of Zoology*, 50(1), 95–99.

Ohtsuka, S., Hanamura, Y. & Kase, T. (2002) A new species of *Thetispelecaris* (Crustacea: Peracarida) from submarine cave on Grand Cayman Island. *Zoological Science*, 19, 611–624.

Sanders, H.L., Hessler, R.R. & Garner, S.P. (1985) *Hirsutia bathyalis*, a new unusual deep-sea benthic peracaridan crustacean from the tropical Atlantic. *Journal of Crustacean Biology*, 5(1), 30–57.

Takeda, M. (2003) *Atoportunus dolichopus*, a new cavernicolous crab of the family Portunidae (Crustacea: Decapoda) from the Ryukyu Islands. *Bulletin of the National Science Museum, Tokyo, Series A* (Zoology), 29(3), 141–146.

Zootaxa 3367: 79–94 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Gnathiidae from Kumejima Island in the Ryukyu Archipelago, southwestern Japan, with description of three new species (Crustacea: Isopoda)*

YUZO OTA

Graduate School of Biosphere Science, Hiroshima University, 1-3-2 Kagamiyama Higashi-hiroshima City, Hiroshima, 739-8511, Japan. E-mail: yota231@hiroshima-u.ac.jp

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A marine biodiversity expedition was carried out from 7 November to 22 November 2009 in Kumejima Island, the Ryukyu Archipelago, southwestern Japan. The dredge and trawl samplings from 10 to 147 m depths yielded five gnathiid species including three new *Gnathia* species. In this paper, these three new species are described based on male morphologies and three morphotypes of larvae are also described.

Key words: Gnathiid isopod, new species, biodiversity expedition, the Ryukyu Archipelago, Kumejima Island

Introduction

The family Gnathiidae Leach, 1814, is a marine isopod family containing approximately 190 species in 12 genera. They have a worldwide distribution from tropical to polar zones and occur from intertidal zones to abyssal waters up to 4,000 m deep (Camp 1988; Cohen & Poore 1994). The adults of Gnathiidae have a strong sexual dimorphism; the male has elongated mandibles but the female lacks them. On the other hand, the larvae have needle-like mouthparts which differ morphologically from adults; distinguishing their sex during the larval stage is not possible with the current stage of our knowledge. In general, the larvae (called "praniza" after feeding on their host's body fluid), are ectoparasites of teleost or elasmobranch fishes. Reproductive adults do not feed and live in benthic substrata such as sponges, dead coral or mud burrows.

In their natural environment, the adult gnathiids have been overlooked because of their cryptic lifestyle and because they have small body lengths, below 10 mm in most species. Thus, the gnathiid fauna is undersampled in most areas.

In Japanese and adjacent waters, 35 species from 6 genera have been recorded. Currently, 11 species from 4 genera have been described or recorded from the Ryukyu Archipelago locating southwestern Japan: *Elaphognathia nunomurai* Ota, Tanaka, Hirose & Hirose, 2010; *E. rangifer* (Monod, 1926) (Ota *et al*. 2010); *Gnathia camuripenis* Tanaka, 2004; *G. limicola* Ota & Tanaka, 2007; *G. grandilaris* Coetzee, Smit, Grutter & Davies, 2008 (Ota & Hirose 2009b); *G. maculosa* Ota & Hirose, 2009a; *G. nubila* Ota & Hirose, 2009b; *G. trimaculata* Coetzee, Smit, Grutter & Davies, 2009 (Ota & Hirose 2009a); *G. teruyukiae* Ota, 2011; *Tenerognathia visus* Tanaka, 2005; *Thaumastognathia tanseimaruae* Shimomura & Tanaka, 2008.

I participated in the Kumejima Marine Biodiversity Expedition (KUMEJIMA 2009) in the Ryukyu Archipelago and collected five species including three undescribed species from off Kumejima Island. In this paper, I describe male adults of the three new species as the results of this expedition.

Accepted by T. Naruse: 18 Jul. 2012; published: 4 Jul. 2012

Materials and Methods

The Kumejima Marine Biodiversity Expedition was carried out from 7 November to 22 November 2009 in Kumejima Island (Fig. 1), the Ryukyu Archipelago, southwestern Japan. Samples of dead corals and rocks from 3–225 m depth off Kumejima I. were collected by triangular dredge, rectanglar silver dredge, or beam trawl by the fishing boat "Daisan-Emimaru". The infaunal animals from the samples were washed out in sea or fresh water, and were filtered with a hand net (0.5 mm mesh) on the ship or laboratory. Gnathiids were removed from the unsorted samples under a dissection microscope.

Specimens were cleaned using a fine hair brush and dissected with sharpened tungsten needles. The removed appendages were mounted in CMCP-10 high viscosity mountant (Polyscience, Inc. Warrington, PA, USA). Observations were made with a phase-contrast light microscope; drawings were made using a camera lucida. The examined materials are deposited in Fujyukan, University Museum, Unversity of the Ryukyus, Okinawa, Japan (RUMF).

Descriptive terminology follows Cohen & Poore (1994). The total length of male adults was measured from tip of the mandible to the apex of pleotelson. Praniza larvae were measured using their head width instead of the body size because their thoraxes are often expanded by their diet.

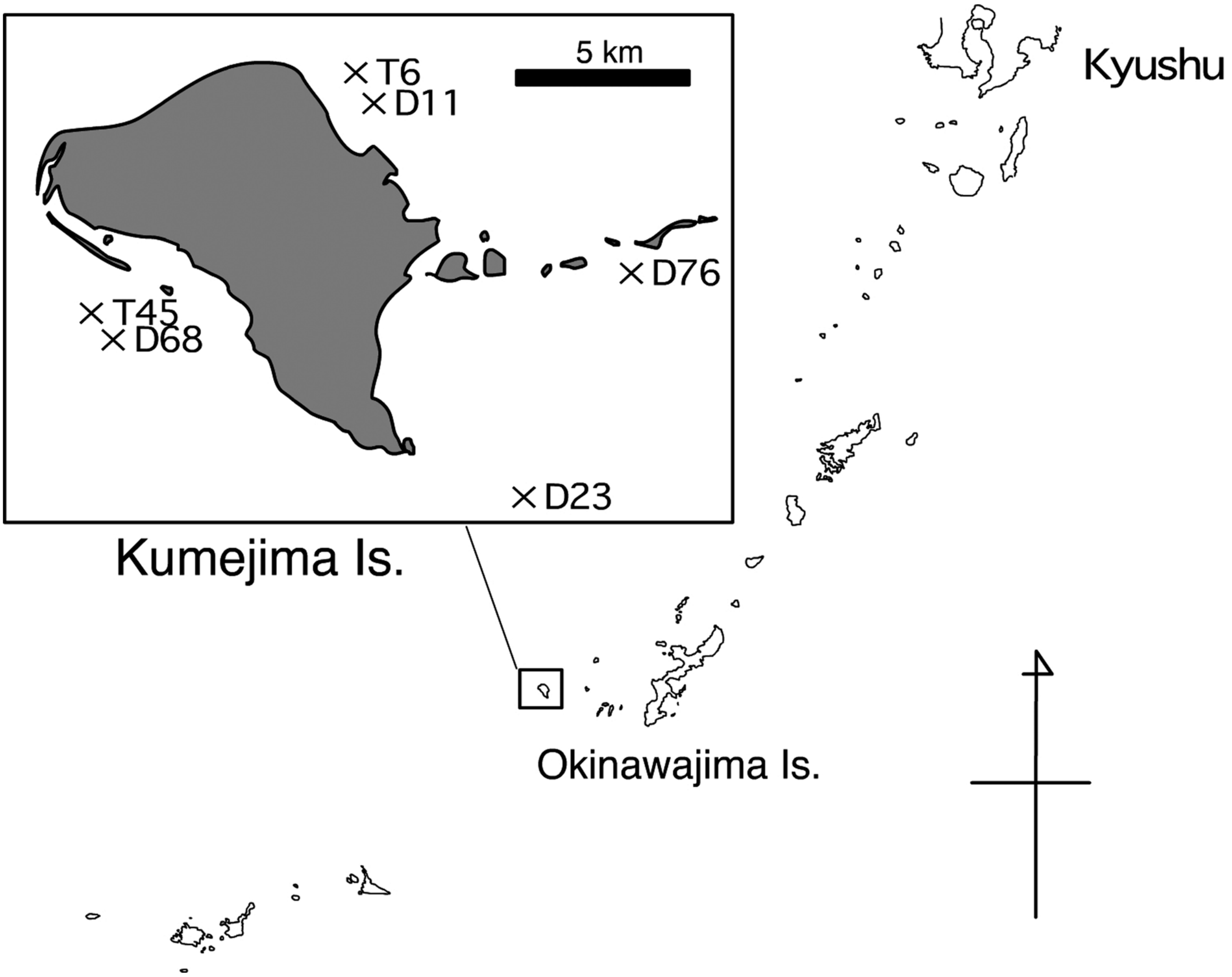


FIGURE 1. Sampling sites for triangular or silver dredge (D) and beam trawl (T) by Daisan-Emimaru.

Systematics

Family Gnathiidae Leach, 1814

Genus *Gnathia* Leach, 1814

Gnathia excavata n. sp.

New Japanese name: Eguri-umikuwagata
(Figs. 2, 3)

Material examined. Holotype. Male, 2.45 mm in total length (RUMF-ZC-1428), from Stn. Dredge 23 (triangular dredge), 26°16.380′N, 126°51.502′E – 26°15.982′N, 126°51.304′E, 147–125 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 12 November 2009.

Description. Male (Figs. 2, 3). Body 2.45 mm (n = 1).

Cephalothorax (Fig. 2A–C). Cephalothorax almost square, dorsal surface sparsely covered with setae. Dorsal sulcus deep; superior frontolateral processes acute, with 1, 2 setae on left, right process, respectively. Posterior margin slightly but widely concave. Mediofrontal process broad, rounded with slightly bifid apex, dorso-ventrally thinner than region surrounded by dorsal sulcus. Anterior parts of marginal carina visible below mediofrontal process in dorsal view. Eyes with 49 ocelli in 8 horizontal rows. Paraocular ornamentation composed of 3 indistinct tubercles. Supraocular lobe not acute.

Pereon (Fig. 2A). Pereonite 1 slightly shorter than pereonite II, not fused, separated into 2 lateral and 1 central parts by posterior margin of cephalothorax and distal margin of pereonite II (Fig 2C). Pereonite II slightly shorter than pereonite III; few setae on lateral margins. Pereonite IV with anterior constriction; anterolateral lobe absent. Pereonite V with areae laterales but not distinct. Pereonite VI slightly longer than combined length of pereonite IV and V. Pereonite VII not extending posterolateral margin of pereonite VI, overlapping pleonite I.

Pleon (Fig. 2A). Pleonites II–V subequal in length and width; epimera prominent.

Pleotelson (Fig. 2D). Width 0.90 length. Two pairs of setae on lateral margin and apex; lateral margins slightly convex.

Mandible (Fig. 2B, C). Mandible approximately half length of cephalothorax; apex curved inward and dorsally. Mandibular seta present on mid-dorsal surface near incisor. Dentate blade occupying approximately one-third of mandible length. Erisma prominent.

Antennula (Fig. 2E). 3 basal podomeres and 5 flagellar articles. Distal margins of basal podomeres I, II, III, and flagellar article V bearing 2, 2, 1, and 1 penicillate setae, respectively. Flagellar articles III–V each with 1 aesthetasc; article V bearing 3 terminal setae.

Antenna (Fig. 2F). 4 basal podomeres and 7 flagellar articles. Distal margins of basal podomeres III and IV bearing 2 and 6 penicillate setae, respectively. Flagellar articles I–VII with few setae on distal margins; article VII bearing 5 terminal setae.

Maxilliped (Fig. 3A). Endite extending to distal margin of palp article I. Palp articles I–IV external margins bearing 3, 6, 4, and 7 plumose setae, respectively; article IV bearing 5 simple terminal setae.

Pylopod (Fig. 3B). 3 articles expressed; distal margins of article I and II with 3 and 2 setae, respectively. Article I elliptical with 3 areolae bearing 27 plumose setae on internal margin and 3 setae near external margin. Article II elliptical, fringed with fine setae. Article III reduced and semicircular.

Pereopod II (Fig. 3C). Inner margins of merus, carpus, and propodus with pectinate scales. Basis oblong, outer margin with 3 penicillate setae and 2 processes. Ischium approximately two-thirds length of basis, becoming wider distally; distal margin bearing 1 long seta and 3 shorter setae. Merus approximately half of ischium length, bearing 3 setae on distal margin. Carpus subequal in length to merus, bearing 1 spine on inner-middle margin. Propodus rectangular and 1.3 times as long as carpus; inner-middle and inner-distal margins with 2 spines.

Pleopod II (Fig. 3D, E). Protopod distomedial corner with 1 coupling hook and 1 seta. Both rami lengths subequal, shape elliptical; endopod and exopod with 7 and 9 plumose setae, respectively. Top of appendix masculina bearing 1 plumose seta; another appendix masculina of left pleopod 2 lacking plumose seta. Pleopods IV and V rami shorter than pleopods I–III; exopods shorter than endopods. Exopods each with 6–11 plumose setae, endopods each with 7–9 simple setae.

Uropod (Fig. 2D). Both rami subequal in length, slightly extending to pleotelson apex. Exopod bearing 6 setae and 3 plumose setae laterally. Endopod bearing 8 setae laterally. Dorsal surface of endopod bearing 5 penicillate setae.

Penes (Fig. 3F). Fused but not prominent; tip of penes composed with 3 papillae.

Etymology. The scientific name *excavata* is derived from the Latin meaning “hollow”, referring to be deeply concaved on dorsal sulcus.

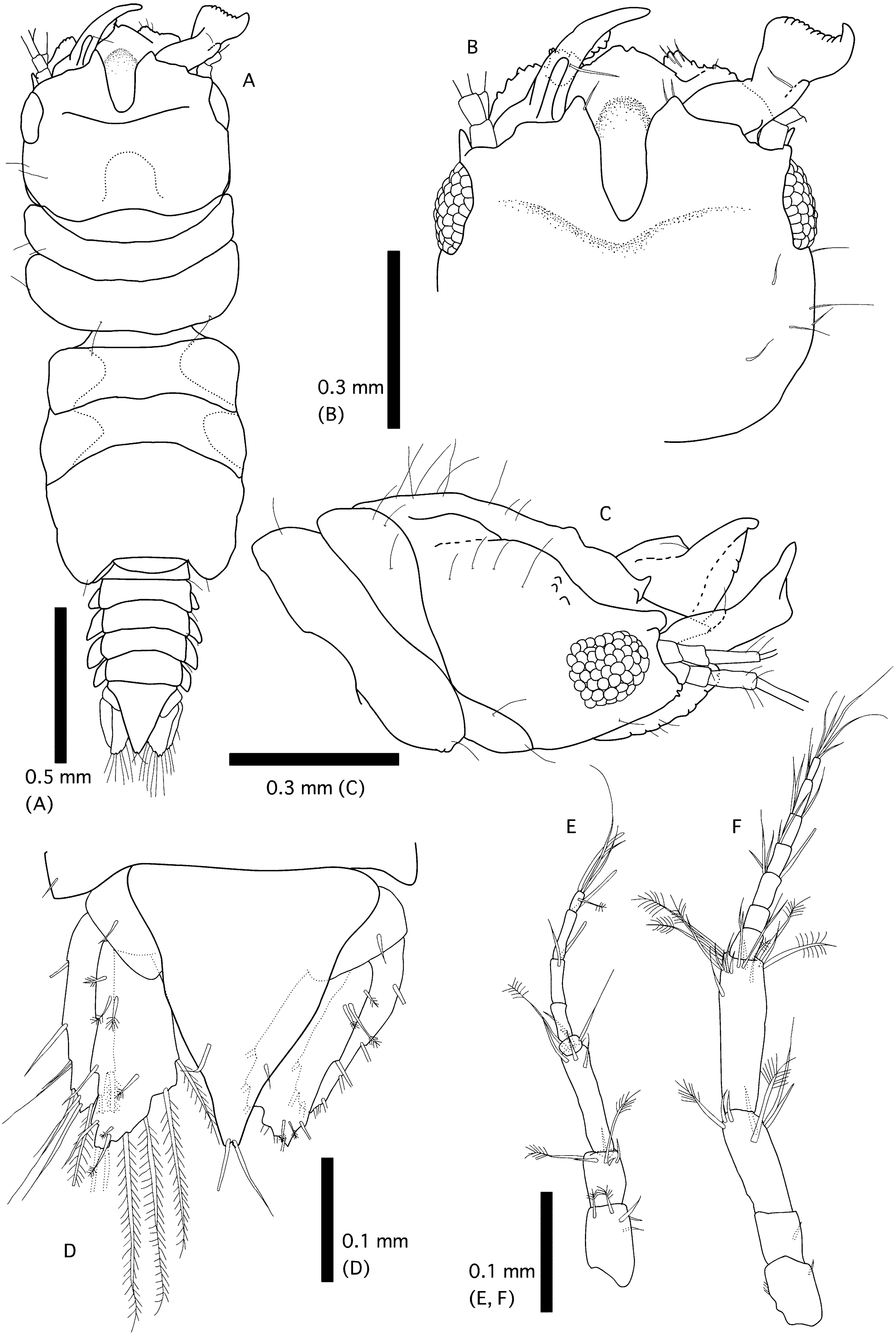


FIGURE 2. *Gnathia excavata* **n. sp.**, holotype, adult male (RUMF-ZC-1428, total length, 2.45 mm): A, body, dorsal view; B, eye and frontal border, dorsal view; C, cephalothorax and pereonite I, lateral view; D, pleotelson and uropods, dorsal view; E, left antennula, medial view; F, left antenna, medial view.

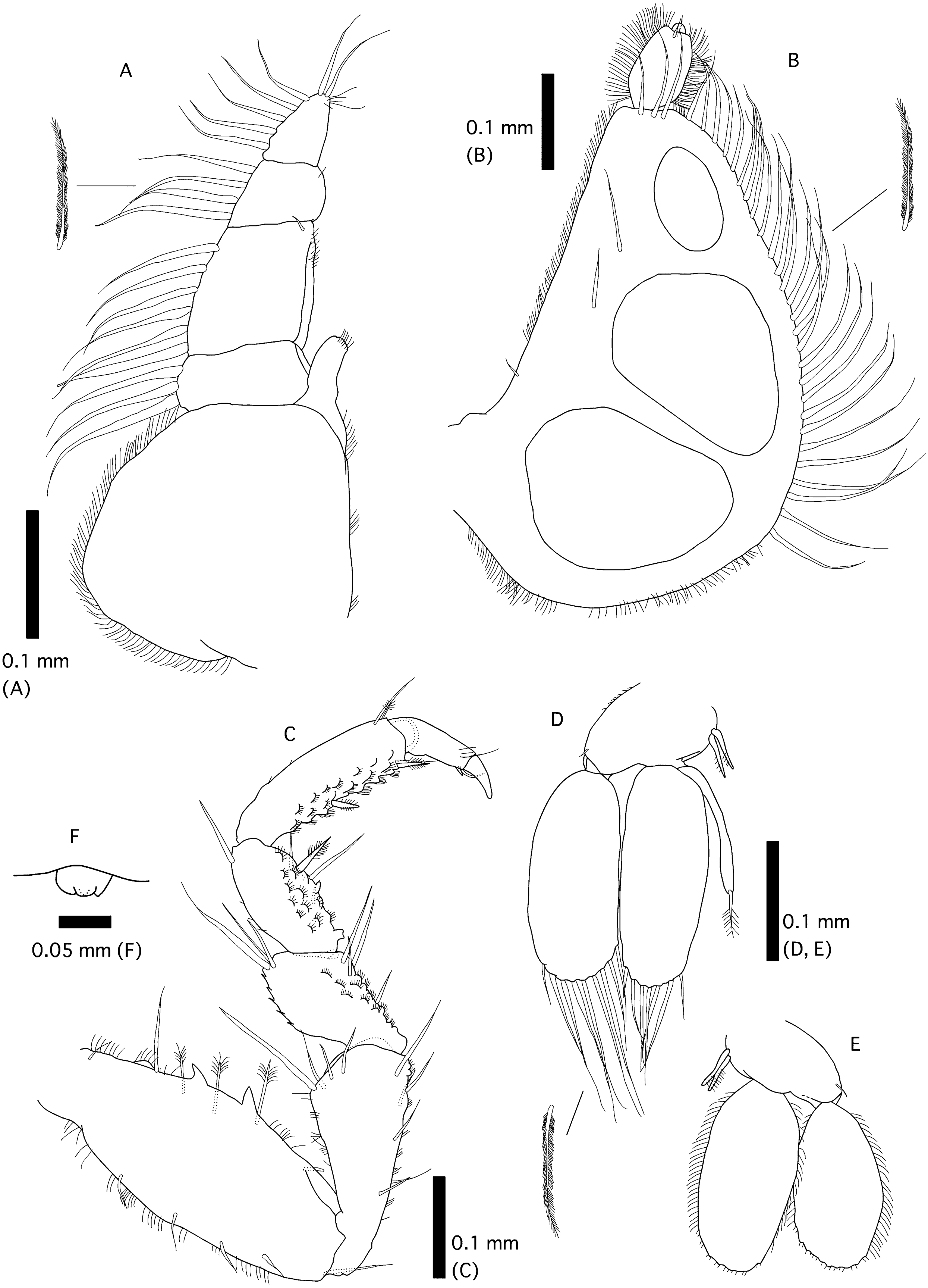


FIGURE 3. *Gnathia excavata* **n. sp.**, holotype, adult male (RUMF-ZC-1428, total length, 2.45 mm): A, left maxilliped, ventral view; B, left pylopod, ventral view; C, left pereopod II, medial view; D, left pleopod II, ventral view; E, left pleopod IV, ventral view, plumose setae were omitted; F, penes, ventral view.

Remarks. Although gnathiid morphology quite differs between male adult, female adult, and larva, the taxonomy has traditionally been based on the male morphology only. Congeners of the adult males are distinguished by the frontal border, pleotelson, pylopod, maxilliped, and their combinations. In addition to these, number of setae on the mouthparts, the presence of tubercles and setae on cephalothorax and appendix masculina on pleopod II are also frequently used.

Among the 190 species of the family Gnathiidae, *Gnathia* and *Caecognathia* species comprise the most number of species of this family (containing approximately 110 and 50 species, respectively). These two genera are closely related and have been even synonymised with each other until Cohen & Poore (1994) reviewed the classification of the Gnathiidae. Cohen & Poore (1994) recognised 10 genera, including *Gnathia* and *Caecognathia*, in the family. According to their key, *Gnathia* species can be distinguished from the congeners by the presence of a frontal process on the frontal border of the cephalothorax (not deeply excavated frontal border), the presence of paraocular ornamentation, and depth and/or width of dorsal sulcus. On the other hand, *Caecognathia* species can be distinguished from the congeners by the absence of a frontal process on the frontal border (frontal border often rounded) (Cohen & Poore 1994). However, the characters of the frontal “border” and the frontal “process” seem to be ambiguously interpreted by the authors. Some *Gnathia* species have large, rounded frontal “process” (or anteriorly pronounced frontal borders); e.g. *G. triobata* Schultz, 1966; *G. prolasius* Cohen & Poore, 1994; *G. ubatuba* Pires, 1996; *G. ricardoi* Pires, 1996. However, these characters has been termed differently by different workers, e.g. “large frontal process” (Cohen & Poore 1994), “frontal projection” (Schultz 1966) or not even noted (Pires 1996). Furthermore, the frontal borders of *Caecognathia* species are indeed pronounced anteriorly; e.g. *C. hirusta* (Schultz, 1966); *C. bicolor* (Hansen, 1916) (redescribed by Svavarsson 1999); *C. dolichoderus* Cohen & Poore, 1994. Future study may provide a better understanding on the systematic position of the genera.

Gnathia excavata **n. sp.** is most similar to *G. notostigma* Cohen & Poore, 1994, because of the following characters; the mediofrontal process is broad with bifid apex and the whole body is not covered with tubercles (Cohen & Poore 1994). However, *G. notostigma* has very pronounced paraocular ornamentation forming slight mesolateral ridge (Cohen & Poore 1994) rather than three small indistinct tubercles of the present new species.

Gnathia scabra n. sp.

New Japanese name: Ibo-eguri-umikuwagata
(Figs. 4, 5)

Material examined. Holotype. Male, 2.40 mm in total length (RUMF-ZC-1429), dead coral rubble or rock rubble, Stn. Trawl 45 (beam trawl), 26°19.907′N, 126°43.191′E – 26°20.056′N, 126°42.622′E, 67.5–76 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 16 November 2009.

Description. Male (Figs. 4, 5). Body 2.40 mm (n = 1).

Cephalothorax (Fig. 4A–C). Cephaolothorax, covered with setae and tubercles, almost square. Dorsal sulcus deeply concave. Posterior margin slightly concave. Mediofrontal process broad with remarkably concave apex. Superior frontolateral process with 3 setae. Marginal carina slightly visible below antennae in dorsal view. Eyes with 42 ocelli in 7 horizontal rows. Paraocular ornamentation indistinct, composed of several tiny tubercles. Supraocular lobe not acute.

Pereon (Fig. 4A). Pereonite I approximately half length of pereonite II, not fused; lateral parts not visible dorsally. Pereonite II and III subequal in length and width; few setae and tubercles on lateral margins. Pereonite IV with anterior constriction; anterolateral lobe absent. Pereonite V with areae laterales. Pereonite VI as long as combined length of pereonite IV and V. Pereonite VII not extending posterolateral margin of pereonite VI, overlapping pleonite I.

Pleon (Fig. 4A). All pleonites sparsely covered with setae. Pleonites II–V subequal in length and width; epimera prominent.

Pleotelson (Fig. 4D). Width approximately 1.09 of length. 4 pairs of setae on lateral margin, central part, and apex. Lateral margins slightly concave over proximal third and slightly convex at middle.

Mandible (Fig. 4B, C). Mandible approximately 0.6 times as long as cephalothorax; apex curved dorso-mesially. Mandibular seta present on mid-dorsal surface near incisor. Dentate blade occupying approximately one-third of mandible length. Erisma prominent.

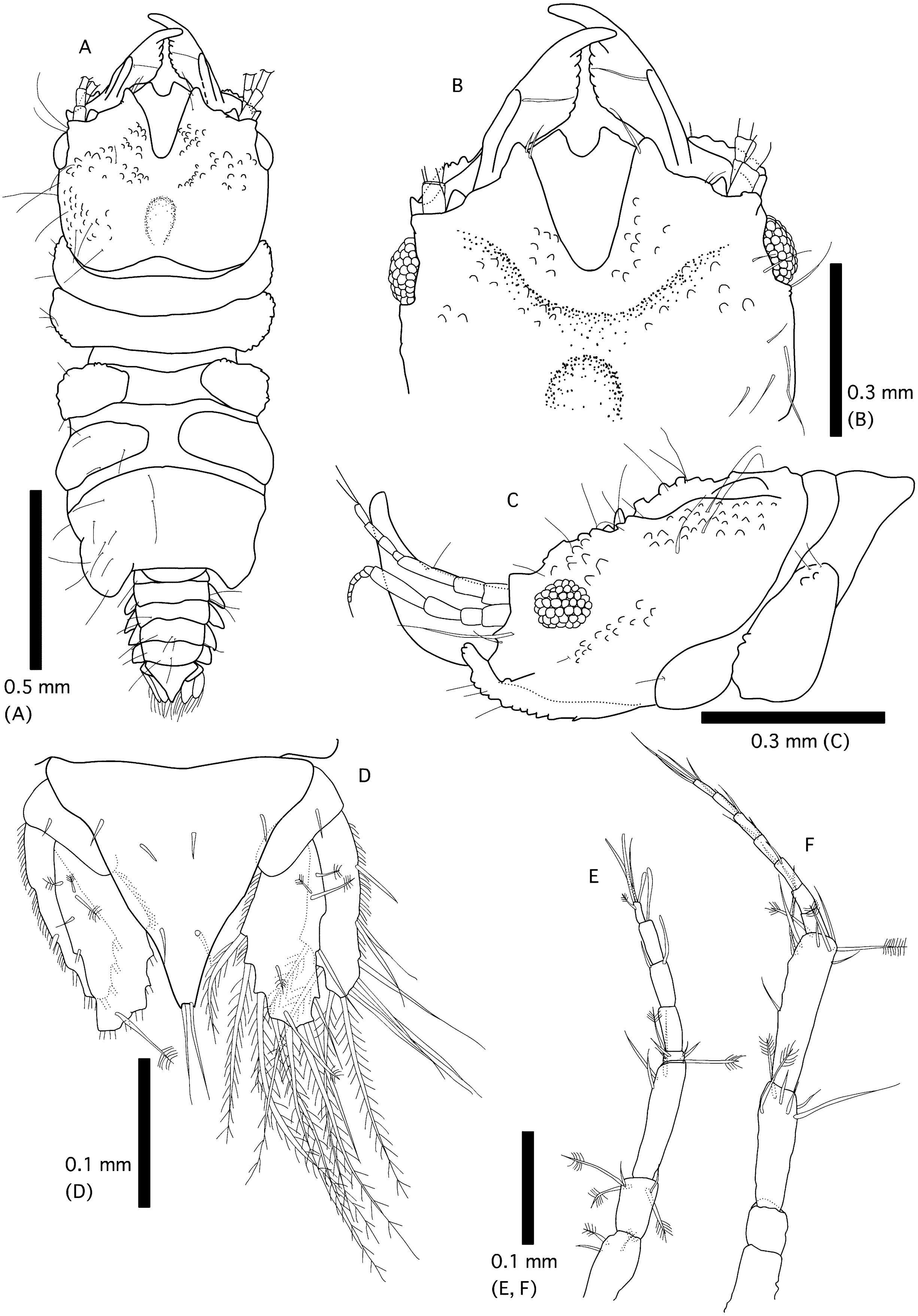


FIGURE 4. *Gnathia scabra* **n. sp.**, holotype, adult male (RUMF-ZC-1429, total length, 2.40 mm): A, body, dorsal view; B, eye and frontal border, dorsal view; C, cephalothorax and pereonite I, lateral view; D, pleotelson and uropods, dorsal view; E, left antennula, medial view; F, left antenna, medial view.

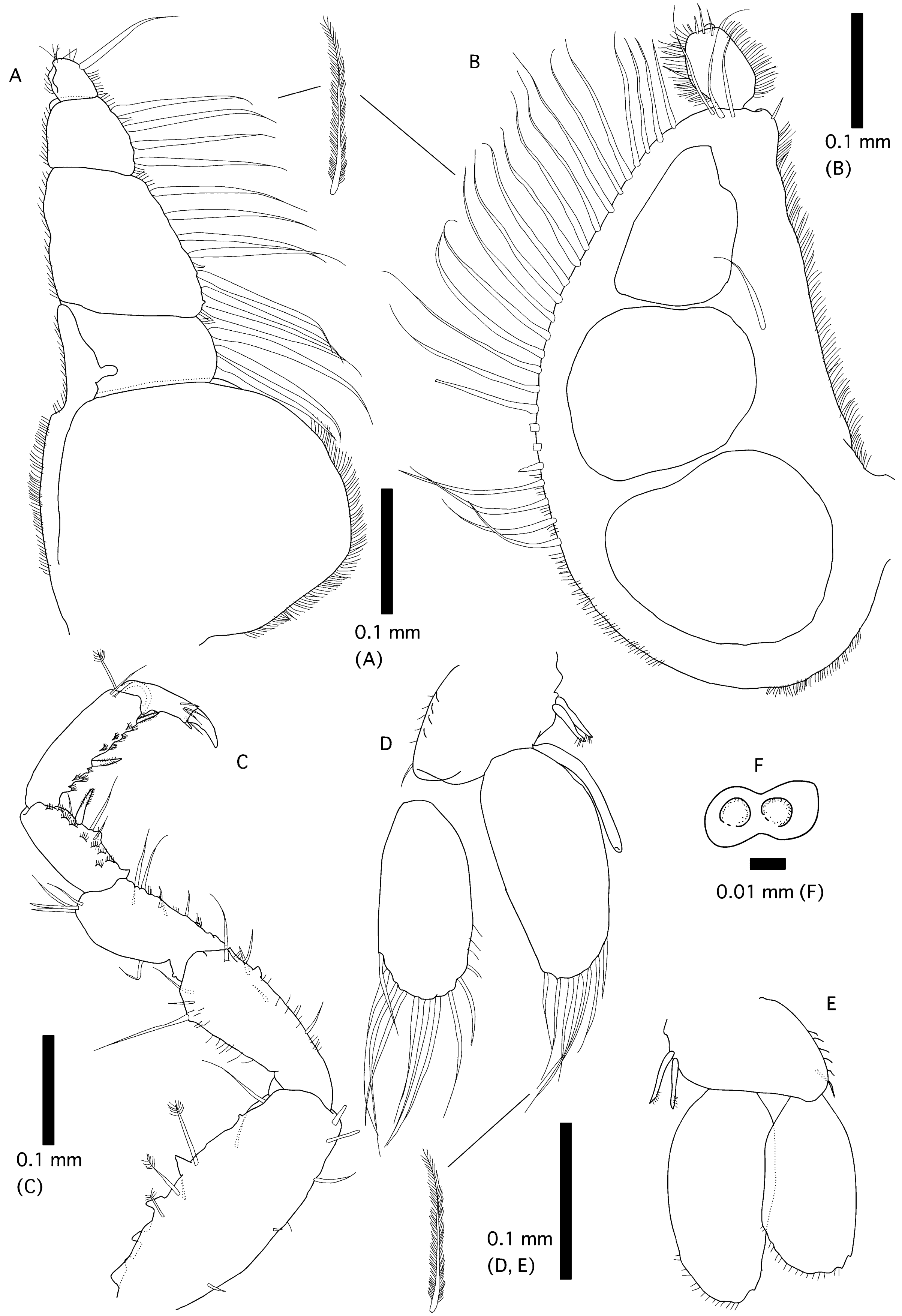


FIGURE 5. *Gnathia scabra* **n. sp.**, holotype, adult male (RUMF-ZC-1429, total length, 2.40 mm): A, left maxilliped, ventral view; B, left pylopod, ventral view; C, left pereopod II, medial view; D, right pleopod II, ventral view; E, right pleopod III, ventral view, plumose setae were omitted; F, penes, ventral view.

Antennula (Fig. 4E). 3 basal podomeres and 5 flagellar articles. Basal podomeres I, II, and III bearing 2, 3, and 1 flagellar articles on distal margins, respectively. Flagellar articles I and V bearing 2, 3, 1, 1, and 1 penicillate setae on distal margins, respectively. Articles VI–VIII each with 1 aesthetasc; article VIII bearing 2 terminal setae. Antenna (Fig. 4F). 4 basal podomeres and 7 flagellar articles. Basal podomeres III and IV bearing 2 and 3 penicillate setae on distal margins, respectively. Flagellar articles I–VII with few setae on distal margins; article VII bearing 3 terminal setae.

Maxilliped (Fig. 5A). Endite reaching distal margin of palp article 1. Palp articles I–IV bearing 3, 7, 4, and 1 plumose setae on external margins, respectively; article IV bearing 7 simple terminal setae.

Pylopod (Fig. 5B). 3-articulate; 3 setae near distal margin of article I and II, respectively. Article I elliptical with 3 areolae bearing 25 plumose setae on internal margin; 1 seta near external margin and distal margin, respectively. Article II elliptical, fringed with fine setae. Article III semicircular.

Pereopod II (Fig. 5C). Basis oblong, outer margin with 3 penicillate setae and 4 processes. Ischium approximately two-third length of basis, becoming wider distally; fine setae bearing inner and outer margins and 2 long setae near distal margin. Merus approximately two-third length of ischium, bearing 4 setae on distal corner. Inner margins of carpus and propodus covered with pectinate scales. Carpus slightly shorter than merus, bearing 1 spine and 2 processes on inner margin. Propodus rectangular and 1.3 times as long as carpus; inner-middle and inner-distal margins with 2 spines and distal corner with 1 penicillate seta.

Pleopod II (Fig. 5D, E). Protopod distomedial corner with coupling hook and 1 seta. Both rami elliptic but exopod slightly shorter than endopod; 9 and 7 plumose setae on endopod and exopod, respectively. Appendix masculina reaching half-length of endopod. Both rami of pleopods IV and V shorter than those of pleopods I–III. Endopods each with 7 or 8 simple setae. Exopods each with 8–9 plumose setae.

Uropod (Fig. 4D). Both rami subequal in length; endopod extending beyond apex of pleotelson. Exopod bearing 7 setae and 3 plumose setae laterally. Endopod bearing 6 setae and 3 plumose setae laterally. Dorsal surface of endopod bearing 5 penicillate setae.

Penes (Fig. 5F). Penes composed of 2 contiguous papillae and not prominent.

Etymology. The scientific name *scabra* is derived from the Latin meaning “rugged”, referring to its many tubercles on the head.

Remarks. *Gnathia scabra* **n. sp.** is most similar to *G. lignophila* Müller, 1993, in following characters: many tubercles present on chephalothorax and pereonite I–III, and the apex of mediofrontal process is remarkably concave (Müller 1993). This new species, however, has appendix masculina on pleopod II (it lacks in *G. lignophila*), longer mediofrontal process than frontolateral process (mediofrontal border of *G. lignophila* is always shorter than frontolateral process).

Gnathia kumejimensis n. sp.

New Japanese name: Kumejima-nokogiri-umikuwagata
(Figs. 6, 7)

Material examined. Holotype. Male 4.85 mm in total length (RUMF-ZC-1430), from Stn. Dredge 11 (triangular dredge), 26°22.806′N, 126°48.035′E – 26°22.670′N, 126°48.327′E, 68 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 10 November 2009.

Paratypes. One male from the same site as the holotype (RUMF-ZC-1431). One male (RUMF-ZC-1432), from dead coral rubble or rock rubble, Stn. Trawl 45, 26°19.907′N, 126°43.191′E –26°20.056′N, 126°42.622′E, 67.5–76 m depth, off Kumejima Island, 16 November 2009, beam trawl, towed by “Daisan-Emimaru”. One male (RUMF-ZC-1433), from rock rubble, Stn. Dredge 76, 26°19.672′N, 126°43.328′E – 26°19.698′N, 126°42.957′E, 93.2–101 m depth, off Kumejima Island, 19 Nov. 2009, triangular dredge, towed by “Daisan-Emimaru”.

Description. Male (Figs. 6, 7). Body 4.5–5.5 mm (4.78 ± 0.23 mm, n = 4). Cephalothorax (Fig. 6A–C). Cephalothorax almost rectangular, sparsely covered with setae. Dorsal sulcus narrow and shallow. Posterior margin concave. Frontal border concave with 3 setae on 2 superior frontolateral processes; frontal margin with 19 small tubercles. Mediofrontal process rounded with small round process on distal margin. Eyes with 55 ocelli in 8 horizontal rows. Paraocular ornamentation prominent, composed of several tubercles and long setae. Supraocular lobe not acute.

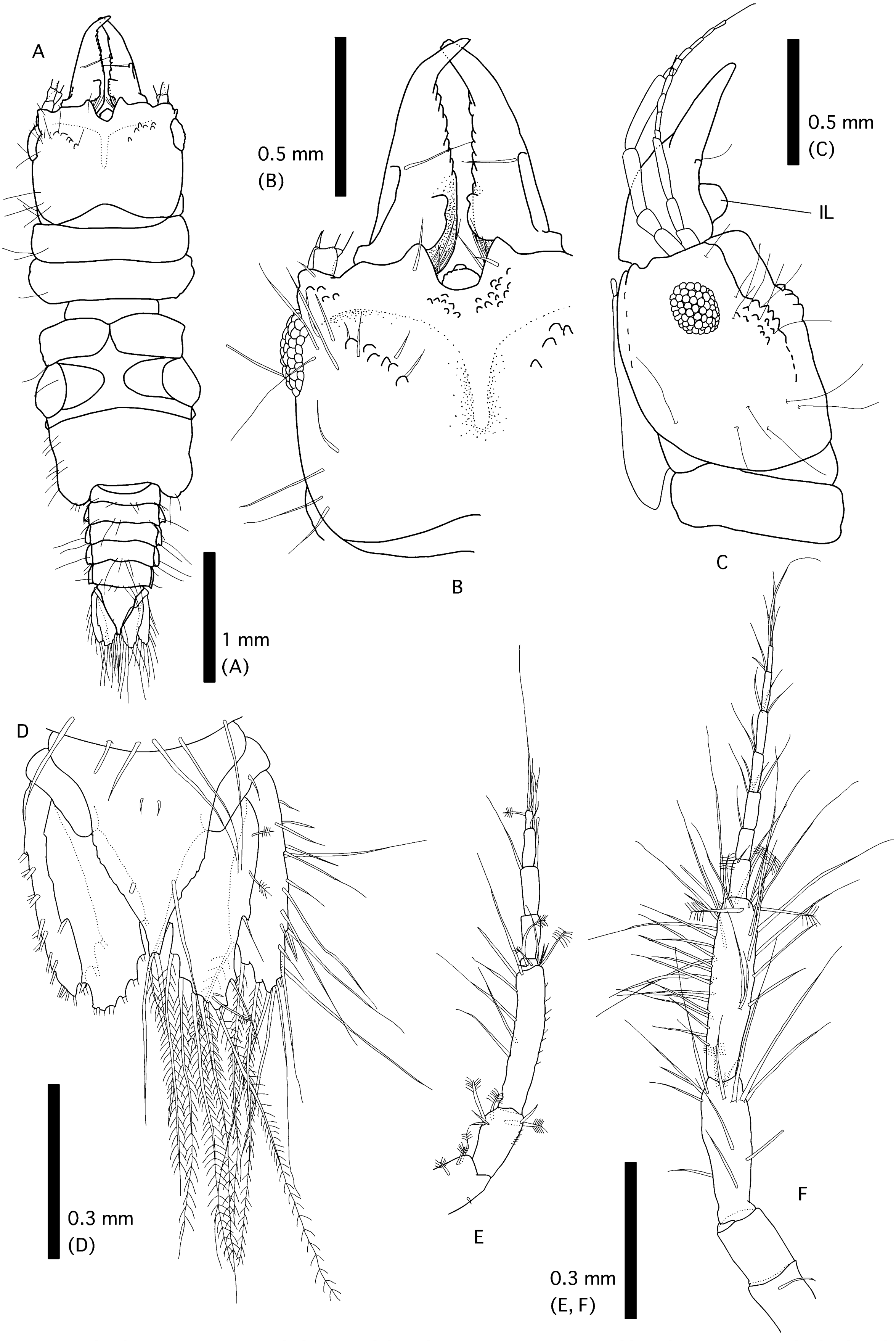


FIGURE 6. *Gnathia kumejimensis* **n. sp.**, holotype, adult male (RUMF-ZC-1430, total length, 4.85 mm): A, body, dorsal view; B, eye and frontal border, dorsal view; C, cephalothorax and pereonite I, lateral view (IL, internal lobe); D, pleotelson and uropods, dorsal view; E, left antennula, medial view; F, left antenna, medial view.

Pereon (Fig. 6A). Pereonite I slightly shorter than pereonite II, not fused, separated into 3 parts by posterior margin of cephalothorax. Pereonite II and III subequal in length and width, posterior margins almost straight. Pereonite IV with anterior constriction; median groove closed. Pereonite IV with areae laterales; semicircular parts visible. Pereonite VI as long as combined kength of pereonite IV and V. Pereonite VII not extending postero-lateral of pereonite VI, overlapping pleonite I.

Pleon (Fig. 6A). All pleonites sparsely covered with setae. Pleonites II–V subequal in length and width; epimera prominent.

Pleotelson (Fig. 6D). Width approximately 0.88 length. 3 pairs of setae bearing near lateral margin, central part, and apex. Lateral margins dentate, slightly concave at proximal third and convex at middle.

Mandible (Fig. 6B, C). Mandible approximately 0.8 times as long as cephalothorax; apex curved dorso-mesially. Mandibular seta present on mid-dorsal surface near incisor. Dentate blade occupying approximately 0.4 times as long as mandible. Erisma prominent. Internal lobe visible in lateral view, remarkably elongated dorsally, extending incisor.

Antennula (Fig. 6E). 3 basal podomeres and 5 flagellar articles. Distal margins of basal podomeres I, II, III, and flagellar articles I and V bearing 3, 3, 1, 2, and 1 penicillate setae, respectively. Basal podomere III bearing 6 long setae on external margin. Flagellar articles III and IV each with 1 aesthetasc. Flagellar article V bearing 3 terminal setae.

Antenna (Fig. 6F). 4 basal podomeres and 7 flagellar articles. Basal podomeres III and IV bearing 1 and 5 penicillate setae on distal margins, respectively. Basal podomeres III and IV densely covered with long setae on distal margin and lateral margin, respectively. Flagellar articles I–VII with few setae on distal margins; article VII bearing 4 terminal setae.

Maxilliped (Fig. 7A). Endite reaching distal margin of palp article I. Palp articles I–IV bearing 4, 7, 5, and 7 plumose setae, respectively, on external margins; article IV bearing 4 simple terminal setae.

Pylopod (Fig. 7B). 3-articulate; 13 and 14 setae bearing near distal margin of article I and II, respectively. Article I elliptical with 3 areolae bearing 30 plumose setae on internal margin; 1 penicillate seta bearing near basis. Article II elliptical, fringed with fine setae; 12 setae near distal margin. Article III elliptical.

Pereopod II (Fig. 7C). Merus, carpus, and propodus inner margins covered with pectinate scales. Basis oblong, with 3 penicillate setae and 5 processes on outer margin. Ischium approximately 0.8 times as long as basis, becoming wider distally; setae bearing sparsely and 3 long setae near outer distal margin. Merus approximately 0.6 times as long as ischium; 4 setae on distal corner and 5 process on inner margin. Carpus three-fourth length of merus, bearing 1 spine, 3 setae, and 6 processes on inner margin. Propodus rectangular and 1.5 times as long as carpus; 2 spines on inner-middle and inner-distal margins and 1 penicillate seta on distal corner. Dactylus terminating in unguis.

Pleopod II (Fig. 7D). Protopod bearing coupling hook and 1 seta on distal corner; pectinate scales on inner margin. Both rami elliptic and same length; 8 and 9 plumose setae on endopod and exopod, respectively. Appendix masculina absent. Both rami of all pleopods same shapes, length, and same number of plumose setae.

Uropod (Fig. 6D). Both rami subequal in length, extending beyond apex of pleotelson. Longest seta on uropodal rami much longer than pleotelson. Exopod bearing 16 or 19 setae and 3 plumose setae laterally. Endopod bearing 3 or 4 setae and 5 or 6 plumose setae laterally. Dorsal surface of endopod bearing 3 penicillate setae.

Penes (Fig. 7F). Penes composed of 2 contiguous papillae and not prominent.

Etymology. The scientific name *kumejimensis* is derived from the island, Kumejima where the present new species was discovered.

Remarks. The present new species is most similar to *Gnathia serrula* Kensley, Schotte & Poore, 2009, because of the following characters; frontal border is concave with mediofrontal process, pleotelson bears two pairs of long setae near the lateral margin and on the apex (Kensley *et al*. 2009). This species, however, is distinguished from *G. serrula* by dorsally elongated internal lobe on the mandibles and a much larger number of setae on the ventral surface of pylopod (27 setae versus 8; Kensley *et al*. 2009).

Gnathia camuripenis Tanaka, 2004, was also collected at the same locality of this expedition and similar in the whole shape to the present new species. *Gnathia camuripenis*, however, has prominent penes bent posteriorly on distal one-fourth length (Tanaka 2004), rather than two contiguous papillae.

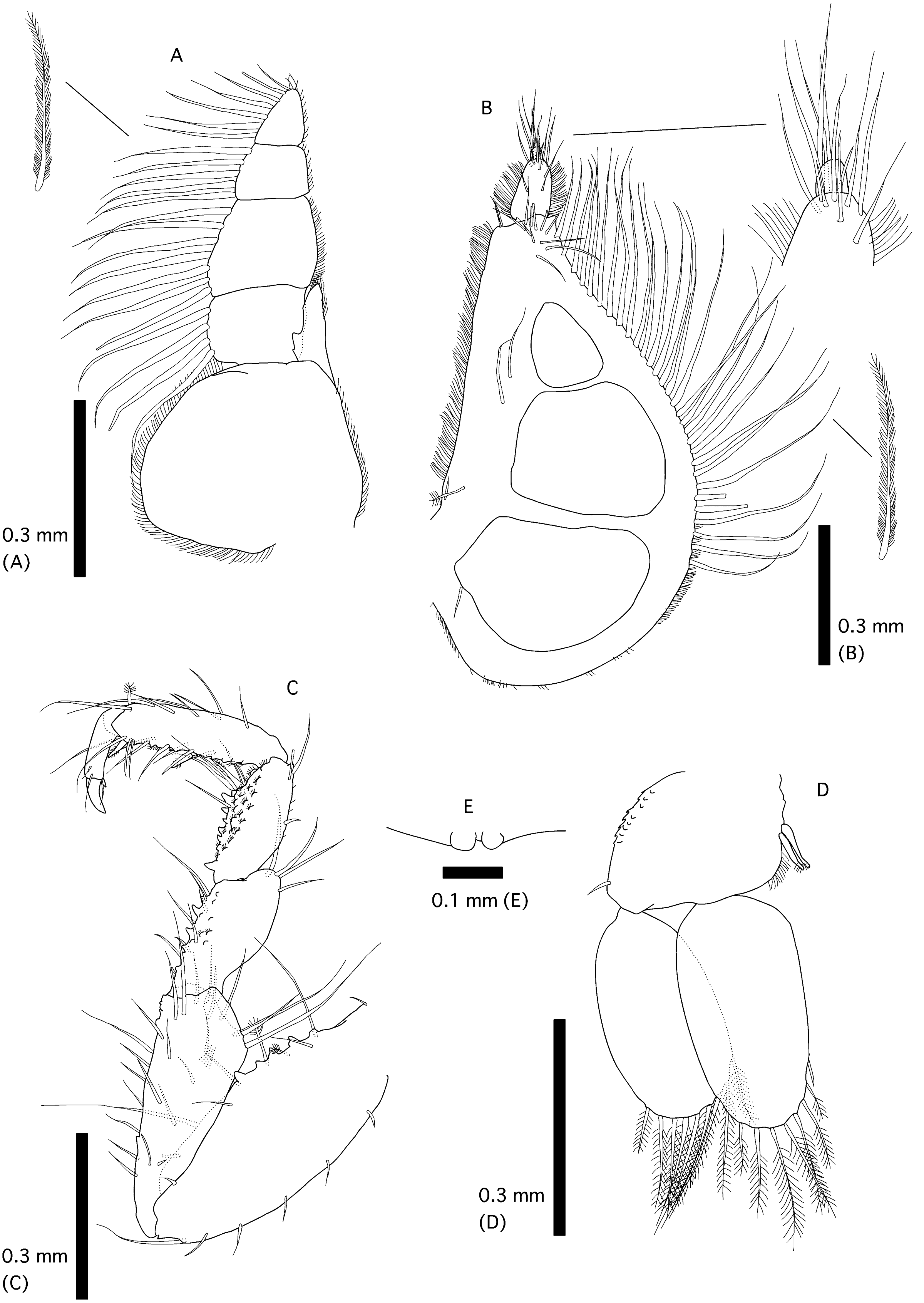


FIGURE 7. *Gnathia kumejimensis* **n. sp.**, holotype, adult male (RUMF-ZC-1430, total length, 4.85 mm): A, right maxilliped, ventral view; B, right pylopod, ventral view; C, right pereopod II, medial view; D, left pleopod II, ventral view; E, penes, ventral view.

Gnathia camuripenis Tanaka, 2004

Ganathia camuripenis Tanaka, 2004: 51 [type locality: Urasoko Bay, Ishigakijima Island, Japan, 24°27′N, 124°13′E]. — Ota *et al*. 2007: 1266. — Ota & Hirose 2009a: 57; 2009b: 49.— Ota 2010: 3; 2011: 49.

Material examined. One male 3.15 mm in total length (RUMF-ZC-1434), from sand and mud sediment, Stn. Dredge 68 (silver dredge), 26°19.095′N, 126°49.008′E – 26°18.898′N, 126°48.969′E, 10.7–17.1 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 18 November 2009.

Remarks. *Gnathia camuripenis* was originally recorded from a coral rubble trap that was placed in 0.5–1.0 m depth at Ishigakijima Island, south Ryukyus. Both adults and larvae were described in detail. The adult male of this species is easily distinguished from the other *Gnathia* species by remarkably large penes fused into a single crooked blade and mandible with 2 inner lobes (Tanaka 2004).

Tenerognathia visus Tanaka, 2005

Tenerognathia visus Tanaka, 2005: 565 [type locality: Cape Maeda, Okinawajima Island, Japan, 26°26′N, 127°46′E]. — Ota *et al*. 2007: 1266. — Kensley *et al*. 2009: 32.

Material examined. One male 1.7 mm in total length (RUMF-ZC-1435), from dead coral rubble or rock rubble, Stn. Trawl 45 (triangular dredge), 26°19.907′N, 126°43.191′E – 26°20.056′N, 126°42.622′E, 67.5–76.0 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 16 November 2009, triangular dredge.

Remarks. This species, belonging to a monospecific genus, was originally recorded from coral rubble in 2 m depth at Okinawajima Island, and from reef edge in 11–22 m depth at Ishigakijima Island. *Tenerognathia visus* is easily identified from the other genera and species by some remarkable characters; very large eyes occupying whole of the side of head, elliptical cephalosome without dorsal sulcus and paraocular ornamentation, short simple mandible, and narrow and weakly chitinized pereonites (Tanaka 2005), which resembles whole shapes of other gnathiid larvae. The specimens collected in this study were identified as *T. visus* based on the shapes of cephalothorax and pleotelson.

Praniza larvae of Gnathiidae spp. I–III

(Fig. 8)

Material examined. Gnathiidae sp. I, 0.51 mm in head width, from rock rubble, Stn. Trawl 6, 26°23.044′N, 126°47.724′E – 26°22.993′N, 126°47.901′E, 64.0–81.3 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 10 November 2009, beam trawl, towed by the fishing boat “Daisan-Emimaru”. Gnathiidae sp. II, 0.45 mm in head width, and Gnathiidae sp. III, 0.29 mm in head width, from Stn. Dredge 23, 26°16.380′N, 126°51.502′E – 26°15.982′N, 126°51.304′E, 147–125 m depth, off Kumejima, 10 November 2009, triangular dredge. Two praniza larvae of Gnathiidae sp. III, 0.26 and 0.24 mm in head width, from dead coral blocks and rock rubble, Stn. Trawl 45, 26°19.907′N, 126°43.191′E – 26°20.056′N, 126°42.622′E, 67.5–76.0 m depth, off Kumejima Island, the Ryukyu Archipelago, southwestern Japan, 16 November 2009, triangular dredge.

Remarks. Although the larval specimens were found from the same dredge samples of adults, I could not confirm that the larvae are the same species of adults described here due to mixture of sediment samples. However, I divide them into three types by the shapes and setations of head, antennae, and pleotelson (Fig. 8). From the Ryukyus, praniza larvae have been described in the following eight species; *Elaphognathia nunomurai*, *Gnathia camuripenis, G. limicola*, *G. maculosa*, *G. trimaculata*, *G. nubila*, *G. grandilaris*, *G. teruyukiae* (see Coetzee *et al*. 2008, 2009; Ota 2011; Ota & Hirose 2009a, b; Ota *et al*. 2007, 2010; Tanaka 2004). However, the three types of larvae are not identifiable with these species.

Gnathiidae sp. I (Fig. 8A–D) is distinguished from other two types by V-shaped frontal margin of clypeus, a pair of seta behind the eyes, dentate margin of pleotelson, and fine setae fringing articles of antennae. Smit & Davies (2004) indicated the morphological links within species between adults and larvae. Especially the shape of pleotelson varies considerably between species, but it appears to be a feature that remains relatively constant between life stages of the same species. Gnathiidae sp. I is relatively similar in the shape of pleotelson and dentate margin to *G. kumejimensis* **n. sp.**

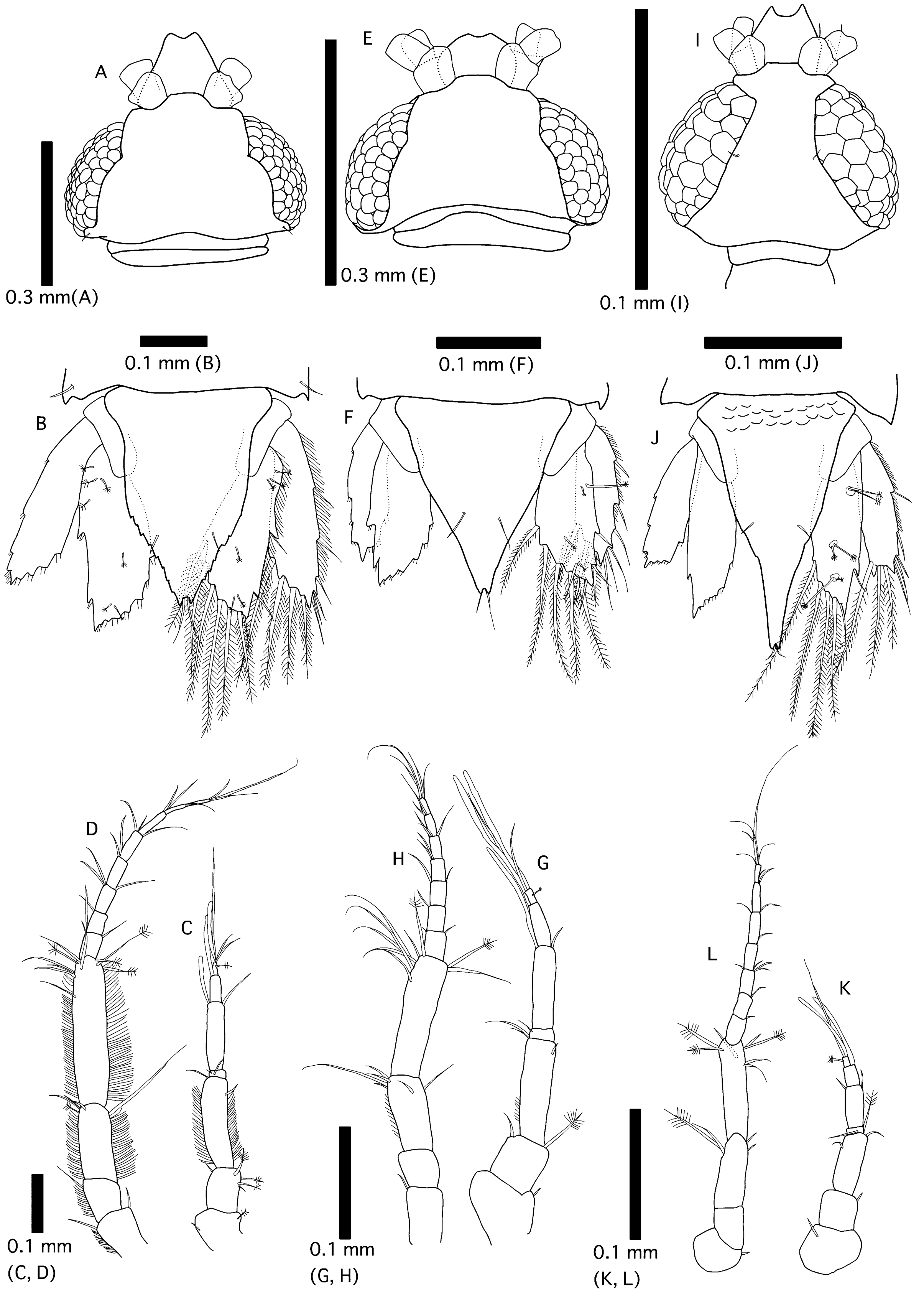


FIGURE 8. Morphotypes of Gnathiidae sp. I (A–D; 0.51 mm in head width), sp. II (E–H; 0.45 mm), and sp. III (I; 0.26 mm, J–L; 0.29 mm, another specimen). A, E, I, head, ventral view; B, F, J, pleotelson and uropods, ventral view; C, G, left antenula, medial view; D, H, left antenula, medial view; K, L, right antenula, medial view.

Gnathiidae sp. II (Fig. 8E–H) is distinguished from other two types by a circular clypeus and convex posterior margin of head. Pleotelson of this type is almost equilateral triangle with slightly convex on lateral margin and two pairs of setae; it is similar to that of *Gnathia excavata* **n. sp.**

Gnathiidae sp III (Fig. 8I–L) is easily distinguished by U-shaped frontal margin of clypeus, circular head with a pair of seta on central part, large eyes occupying whole of the side of head, elongated pleotelson extending uropod, pectinate scales on basis of pleotelson, short antenula (approximately half the length of antenna). Some of these characters (head shape, large eyes, and short antenula) are similar to those of *Tenerognathia visus* (see above; Tanaka, 2005).

Although these gnathiid larvae were not identified into species, some morphological similarity between these larvae and described adults were observed. As the indication of Smit & Davies (2004), the stable characters within the gnathiid species may be found in future studies. For the purpose it is necessary to confirm of the morphological links between larvae and adults on the basis of sufficient observation and description of larval morphologies of many gnathiid species and genera.

Acknowledgments

The specimens were collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition was conducted under a permit granted to T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. I sincerely thank to Ms. Mathilde Richer de Forges (KIWA Consulting) for assistance of field sampling. I am also indebted to the participants in this expedition and fishermen of Daisan-Emimaru for providing the materials. I am deeply indebted to Dr. George D.F. Wilson (The Australian Museum) for improving the content and language of the manuscript. Thanks are also extended to two anonymous reviewers for improving manuscript and for offering valuable comments. This study was partly supported by Mikimoto Fund for Marine Ecology and Research Fellowships of the Japan Society for Promotion of Science for Young Scientists.

References

Camp, D.K. (1988) *Bythognathia yucatanensis*, new genus, new species, from abyssal depths in the Caribbean Sea, with a list of gnathiid species described since 1926 (Isopoda: Gnathiidea). *Journal of Crustacean Biology*, 8(4), 668–678.

Coetzee, M.L., Smit, N.J., Grutter, A.S. & Davies, A.J. (2008) A new gnathiid (Crustacea, Isopoda) parasitizing two species of requiem sharks from Lizard Island, Great Barrier Reef, Australia. *Journal of Parasitology*, 94(3), 608–615.

Coetzee, M.L., Smit, N.J., Grutter, A.S. & Davies, A.J. (2009) *Gnathia trimaculata* n. sp. (Crustacea: Isopoda: Gnathiidae), an ectoparasite found parasitising requiem sharks from off Lizard Island, Great Barrier Reef, Australia. *Systematic Parasitology*, 72, 97–112.

Cohen, B.F. & Poore, G.C.B. (1994) Phylogeny and biogeography of the Gnathiidae (Crustacea: Isopoda) with descriptions of new genera and species, most from south-eastern Australia. *Memoirs of Museum of Victoria*, 54(2), 271–397.

Hansen, H.J. (1916) Crustacea Malacostraca III. Isopoda. *The Danish Ingolf Expedition*, 3(5), 1–262.

Kensley, B., Schotte, M. & Poore, G.C.B. (2009) Gnathiid isopods (Crustacea: Isopoda: Gnathiidae), mostly new, from the Indian Ocean. *Proceedings of the Biological Society of Washington*, 122(1), 32–51.

Monod, T. (1926) Les Gnathiidae. *Mémories de la Société des Sciences Naturelles du Maroc*, 13, 1–668.

Müller, H.-G. (1993) Gnathiidae from coral reefs in the Tioman Archipelago, Malaysia, with description of two new species (Crustacea: Isopoda: Cymothoidea). *Mitteilungen aus dem Zoologishen Museum in Berlin*, 69, 3–17.

Ota, Y. (2010) Seasonal fluctuations of the sponge dwelling gnathiid *Elaphognathia nunomurai* (Isopoda; Gnathiidae). Cancer, 19, 1–9. (in Japanese)

Ota, Y. (2011) A New Species of the Gnathiid Isopod, *Gnathia teruyukiae* (Crustacea: Malacostraca), from Japan, Parasitizing Elasmobranch Fish. *Bulletin of the National Museum of Nature and Science, Series A, Supplement*, 5, 41–51.

Ota, Y. & Hirose, E. (2009a) Description of *Gnathia maculosa* and a new record of *Gnathia trimaculata* (Crustacea, Isopoda, Gnathiidae), ectoparasites of elasmobranchs from Okinawan coastal waters. *Zootaxa*, 2114, 50–60.

Ota, Y. & Hirose, E. (2009b) *Gnathia nubila* n. sp. and a new record of *Gnathia grandilaris* (Crustacea, Isopoda, Gnathiidae) that parasitizes elasmobranchs from Okinawan coastal waters, Japan. *Zootaxa*, 2238, 43–55.

Ota, Y., Tanaka, K. & Hirose, E. (2007) A new species of *Gnathia* (Isopoda: Cymothoida: Gnathiidae) from Okinawajima Island, Ryukyu Archipelago, Southwestern Japan. *Zoological Science*, 24, 1266–1277.

Ota, Y., Tanaka, K., Hirose, M. & Hirose, E. (2010) Description of a new species of *Elaphognathia* (Isopoda: Gnatheidae) from Japan based on morphological and molecular traits. *Journal of Crustacean Biology*, 30(4), 710–720.

Pires, A.M.S. (1996) The gnathiids from the Brazilian southeastern continental shelf and slope: distribution, ecological notes and description of three new species. *Spixiana*, 19(1), 1–16.

Shimomura, M. & Tanaka, K. (2008) A new species of *Thaumastognathia* Monod, 1926 from Japan (Isopoda, Gnathiidae). *Crustaceana*, 81(9), 1091–1097.

Schultz, G.A. (1966) Submarine canyons of southern Calfornia. Part IV. Systematics: Isopoda. Marine isopods of the submarine canyons of the southern Californian continental shelf. *Allan Hancock Pacific Expeditions*, 27(4), 1–56.

Smit, N.J. & Davies A.J. (2004) The curious life-style of the parasitic stages of gnathiid isopods. *Advances in Parasitology*, 58, 289–391.

Svavarsson, J. (1999) The deep water gnathiid *Caecognathia bicolor* (Hansen, 1916) (Crustacea, Isopoda, Gnathiidae) – redescription and new data on its distribution–. *Rit Fiskideildar*, 16, 171–185.

Tanaka, K. (2004) A new species of *Gnathia* (Isopoda: Cymothoida: Gnathiidae) from Ishigaki Island, the Ryukyus, southwestern Japan. *Crustacean Research*, 33, 51–60.

Tanaka, K. (2005) A new genus and species of gnathiid isopod (Isopoda, Gnathiidae) from the Ryukyus, southwestern Japan. *Journal of Crustacean Biology*, 25(4), 565–569.

Zootaxa 3367: 95–102 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Hippolytidae and Barbouriidae (Decapoda: Caridea) collected during the Ryukyu “KUMEJIMA 2009” expedition*

SAMMY. DE GRAVE[1], TIN-YAM CHAN[2], Y. FUJITA[3,4] & JUNJI OKUNO[5]

[1]*Oxford University Museum of Natural History, Parks Road, Oxford OX1 3PW, U.K; sammy.degrave@oum.ox.ac.uk.*

[2]*Institute of Marine Biology and Center of Excellence for Marine Bioenviroment and Biotechnology, National Taiwan Ocean University, Keelung 20224, Taiwan, R.O.C.*

[3]*University Education Center, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan.*

[4]*Marine Learning Center, 2-95-101 Miyagi, Chatan-cho, Okinawa 904-0113, Japan.*

[5]*Coastal Branch of Natural History Museum and Institute, Chiba, 123 Yoshio, Katsuura, Chiba 299–5242, Japan.*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

The present report deals with caridean shrimps from the families Hippolytidae (7 species) and Barbouriidae (1 species) collected during the KUMEJIMA 2009 expedition in the Ryukyu Islands. The deep-water hippolytid *Gelastreutes crosnieri* Bruce, 1990 is recorded from Kumejima based on a single female specimen, representing a considerable range extension of this species from New Caledonia to Japan. The opportunity is also taken to record and illustrate the first known male specimen of *G. crosnieri*, collected during the SANTO 2006 expedition off West Mavéa Island, Vanuatu. The colour pattern of *G. crosnieri* is shown for the first time. The Kumejima and Vanuatu specimens present noticeable differences in both morphology and colouration, but appear to be conspecific based on comparison of the barcoding gene COI sequences. The recently described *Lysmata lipkei* Okuno & Fielder, 2010 is recorded for the second time, however, not representing a significant range extension of this species. The other species reported are *Saron marmoratus* (Olivier, 1811), *Saron neglectus* De Man, 1902, *Thinora maldivensis* (Borradaile, 1915), *Thor amboinensis* (De Man, 1888), *Tozeuma armatum* Paul’son, 1875 (Hippolytidae), and *Parhippolyte misticia* (Clark, 1989) (Barbouriidae).

Key words: Caridea, Hippolytidae, Barbouriidae, new records, *Gelastreutes*, Kumejima, Japan

Introduction

Between the 9th and the 20th of November 2009, an international team of crustacean workers extensively sampled the marine environment of Kumejima (Kume Island) in the Ryukyu Archipelago. In total, 42 dives and 17 intertidal collections were made, supplemented with 87 samples obtained by dredging and trawling, to a depth of 192 m.

The present report deals with the Barbouriidae and Hippolytidae (s. lat.) collected during the expedition, which although not numerically dominant nor species rich, do contain some interesting records, including *Gelastreutes crosnieri* Bruce, 1990, so far only known from one specimen from New Caledonia. Kawamoto & Okuno (2001) had previously documented the decapod fauna of Kume Island, listing and illustrating eight species of Hippolytidae, viz. *Lysmata amboinensis* (De Man, 1888), *Lysmata ternatensis* De Man, 1902; *Hippolyte commensalis* Kemp, 1925; *Hippolyte* sp.; *Phycocaris simulans* Kemp, 1916; *Saron marmoratus* (Olivier, 1811); *Saron neglectus* De Man, 1902 and *Thor amboinensis* (De Man, 1888). In addition, they recorded one species of Barbouriidae, *Parhippolyte misticia* (Clark, 1989). Recently, Marin *et al*. (2011) when erecting the genus *Alcyonohippolyte* Marin, Okuno & Chan, 2011, transferred *H. commensalis* to their new genus, with reference to the specimen illustrated in Kawamoto & Okuno (2001). Further, these authors also described *Alcyonohippolyte maculata* Marin, Okuno & Chan, 2011 and considered the photo of *Hippolyte* sp. (as well as associated specimens) in Kawamoto & Okuno (2001) as belonging to that species.

Accepted by T. Naruse: 14 Aug. 2011; published: 4 Jul. 2012

Although only four of the previously known species in the two families from Kume Island were recollected during the “KUMEJIMA 2009” expedition, we are able to herein report on three further species, viz. *Thinora maldivensis* (Borradaile, 1900), *Tozeuma armatum* Paul’son, 1875, and *Gelastreutes crosnieri*, raising the number of Hippolytidae known from the island to 11 species. In addition, we take the opportunity to report on a further specimen of the latter, rare species from the SANTO 2006 expedition in Vanuatu.

Specimens examined in this study are deposited in the Ryukyu University Museum, Fujukan, Okinawa, Japan (RUMF); National Taiwan Ocean University, Keelung, Taiwan (NTOU); Oxford University Museum of Natural History, Oxford, United Kingdom (OUMNH) and Museum national d’Histoire naturelle, Paris, France (MNHN). Post-orbital carapace length (pocl, in mm) is used as the standard measurement of size.

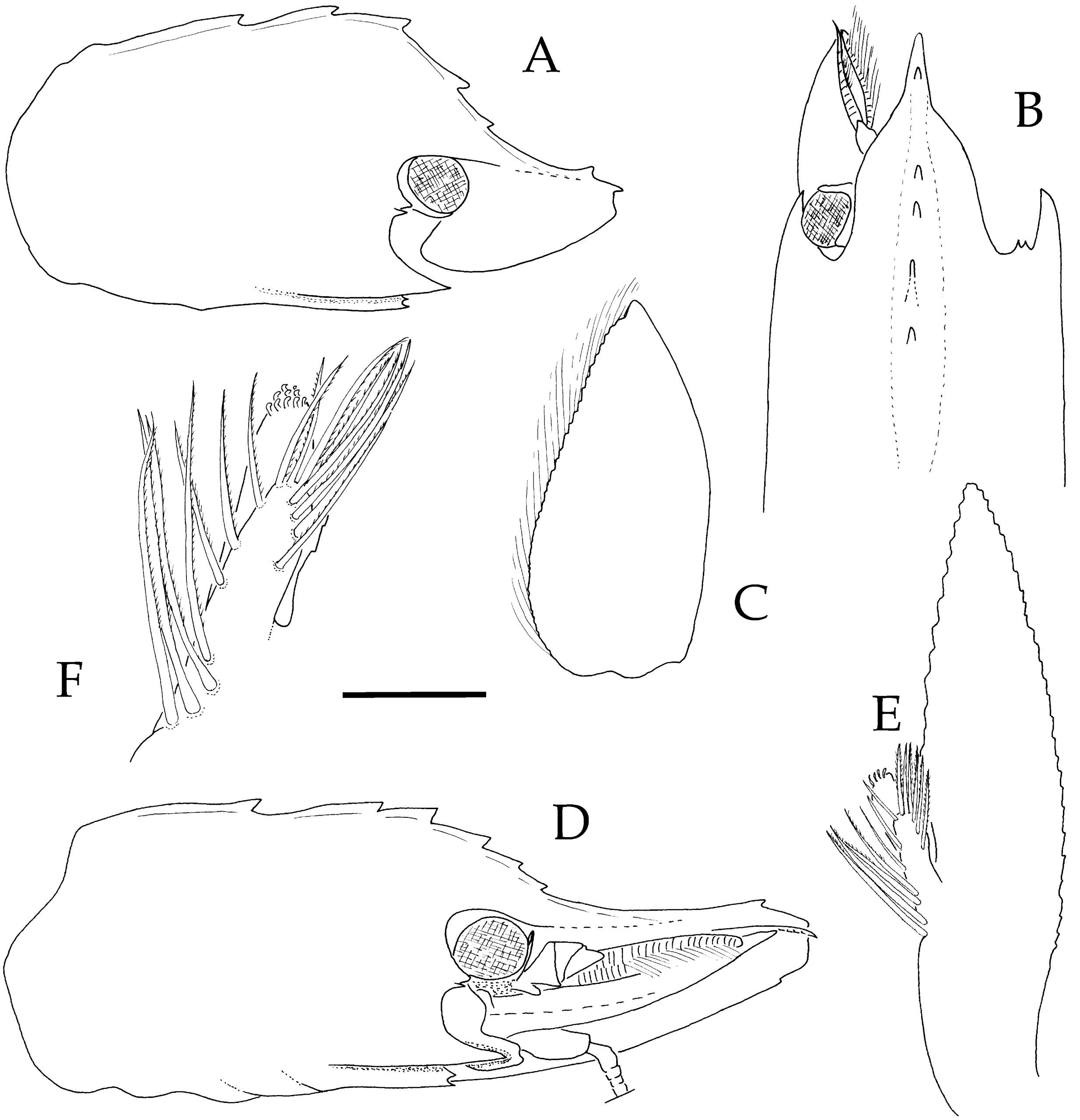


FIGURE 1. *Gelastreutes crosnieri* Bruce, 1990. Kumejima, female (pocl 4.6 mm), NTOU M01139. A, Carapace, lateral view; B, same, dorsal view; C, antennal scale. Vanuatu, male (pocl 6.5 mm), MNHN-Na 17539. D, carapace, lateral view; E, endopod of second pleopod (partly denuded); F, appendices interna and masculina. Scale bar indicates 2 mm (A, B, D), 1 mm (C), 0.5 mm (E) or 0.1 mm (F).

Systematics

Hippolytidae Spence Bate, 1888

Gelastreutes Bruce, 1990

Gelastreutes crosnieri Bruce, 1990

(Figs. 1, 2A–B)

Material examined. 1 female (pocl 4.6), Stn. Trawl 6, 26°23.044´N 126°47.724´E – 26°22.993´N 126°47.901´E, depth 64.0–81.3 m, 10 Nov. 2009, NTOU M01139.

Additional material examined. 1 male (pocl 6.5), Palikulo Bay, West Mavéa Island, Vanuatu, “SANTO 2006” Stn. AT14, 15°23.7/24’S 167°12.9/13.5’E, depth 102–120 m, 19 Sep 2006, MNHN-Na 17539.

Remarks. The single female collected during the “KUMEJIMA 2009” expedition differs somewhat from the New Caledonian female holotype (Bruce 1990), most notably in the dorsal carapace crest and the shape of the antennal scale. The dorsal carapace crest (Fig. 1A–B) is much more pronounced than in the holotype and has only 5 teeth. The distal part of the rostrum (Fig. 1A) is much shorter and has a terminal, dorsal tooth; the antennal scale is shorter and wider than in the holotype. In all other respects the Kumejima specimen closely resembles the holotype.

The specimen from Vanuatu shows a much greater resemblance to the holotype (Fig. 1D), with both the dorsal and ventral lamina of the rostrum exhibiting the typical form for the species. A further pronounced difference between both specimens is the colour pattern (see below). However, a comparison of the mitochondrial barcoding gene COI (627 bp) between the Kumejima and Vanuatu specimens shows an identical sequence (GenBank accession nos. JN251749 and JN251750, respectively); suggesting that both forms are conspecific. The presently observed differences in morphology and colour patterns are clearly not related to sexual dimorphism, as the male specimen from Vanuatu resembles the female holotype more than the female collected in Kumejima. It is also not likely to be size-related, as both specimens are not overly dissimilar in carapace length.

The appendix masculina of the Vanuatu specimen (Fig. 1E–F) is shorter than the appendix interna, and furnished with a series of serrulate setae along both its mesial and lateral margin.

Colour pattern. The specimen from Kumejima (Fig. 2A) has an overall purple to reddish background colour, with numerous darker maroon-red to deeper purple spots all over the carapace, abdomen and tail-fan. In contrast, the specimen from Vanuatu (Fig. 2B) has an overall salmon-pink colouration.

Distribution. Previously only known from a single specimen from New Caledonia, now also recorded from Vanuatu and the Ryukyu Islands.

Lysmata Risso, 1816

Lysmata lipkei Okuno & Fiedler, 2010

(Fig. 2C)

Material examined. 1 female (pocl 5.5), Stn. Dive 14, Ebi-ana, 26°17.547´N 126°47.771´E, depth 10 m, 1 Nov. 2009, NTOU M01140; 1 ov. female (pocl 4.5), Stn. Trawl 70, 26°23.831´N 126°45.685´E – 26°23.590´N 126°45.212´E, depth 95.5–123 m, 19 Nov. 2009, OUMNH.ZC.2011-02-043; 1 male (pocl 3.2), same collection data as for previous specimen, NTOU M01141.

Remarks. The present specimens of this recently described species correspond closely to the original description (Okuno & Fiedler 2010), being especially diagnostic amongst the Japanese species of *Lysmata* in having a short accessory branch on the dorsolateral antennular flagellum.

Distribution. The original description of *L. lipkei* was based on material from the Boso Peninsula (Pacific coast of Honshu), Okinawa and smaller adjacent islands, and Tokashiki-jima in the Kerama group. Thus, the Kumejima record does not materially extend its distribution range.

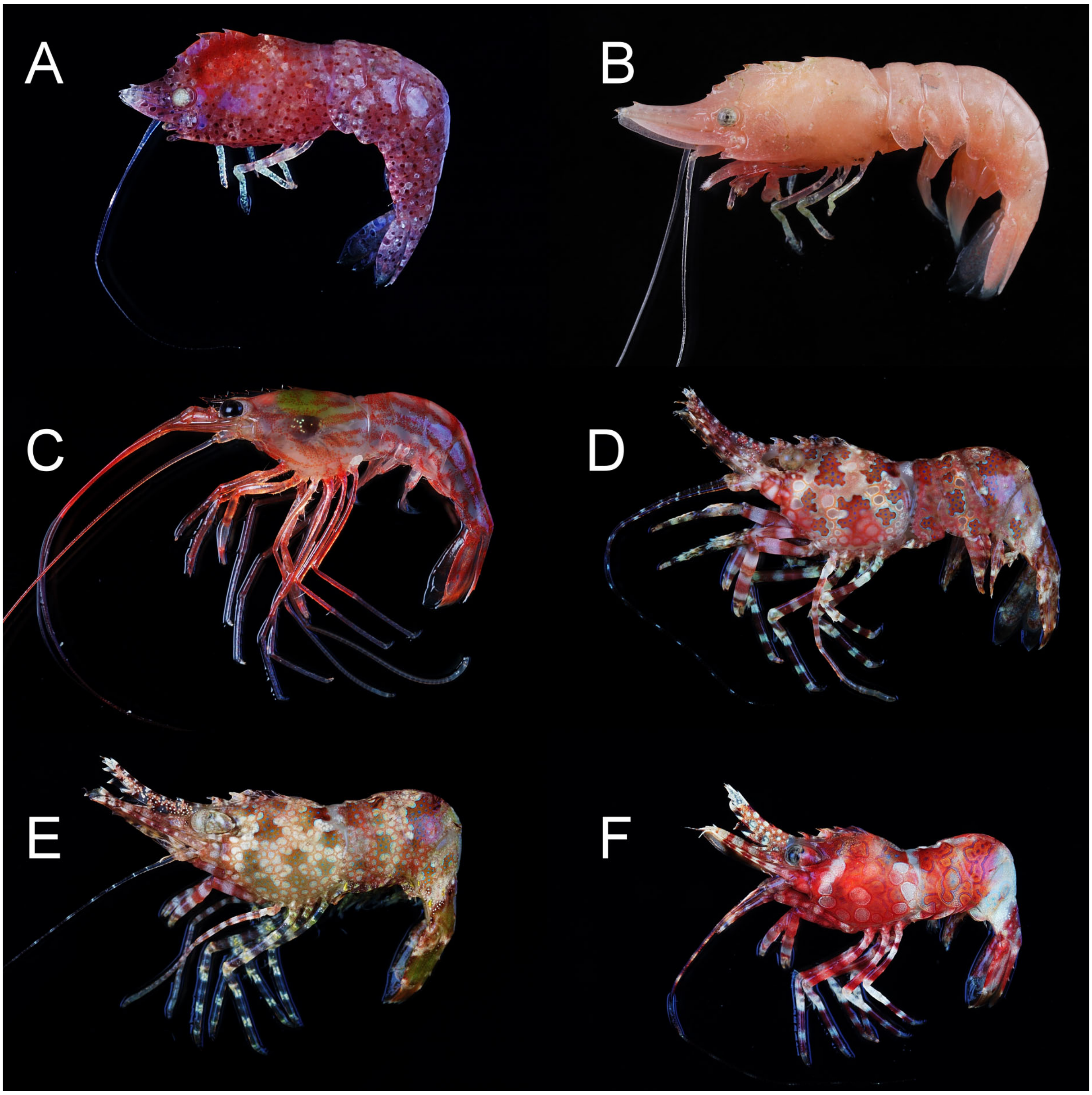


FIGURE 2. A–B, *Gelastreutes crosnieri* Bruce, 1990, Kumejima, female (pocl 4.6 mm), NTOU M01139; B, Vanuatu, male (pocl 6.5 mm), MNHN-NA17539; C, *Lysmata lipkei* Okuno & Fiedler, 2010, female (pocl 5.5 mm), NTOU M01140; D–F, *Saron marmoratus* (Olivier, 1811), D, female (pocl 6.8 mm), RUMF-ZC-1527; E, female (pocl 4.8 mm), NTOU M1159; F, female (pocl 5.8 mm), NTOU M00145.

Saron Thallwitz, 1891

Saron marmoratus (Olivier, 1811)
(Fig. 2D–F)

Material examined. 2 females (pocl 4.8, 5.0), Stn. Dive 11, entrance of Gima Port, 26°19.421´N 126°49.028´E, depth 20 m, 12 Nov. 2009, NTOU M01142; 1 female (pocl 5.8), Stn. Dive 13, off Torishama Islet, 26°19.217´N 126°44.627´E, depth < 40 m, 13 Nov. 2009, OUMNH.ZC.2011-02-044; 1 female (pocl 6.8), Stn. Dive 14, Ebi-ana, 26°17.547´N 126°47.771´E, depth 10 m, 13 Nov. 2009, RUMF-ZC-1527; 1 female (pocl 12.7), Stn. Dive 35, Ebi-ana, 26°17.547´N 126°47.771´E, depth 10 m, 13 Nov. 2009, NTOU M01143; 2 females (pocl 4.9, 5.2), Stn. Dive 26, Crasher-shita, 26°18.787´N 126°48.656´E, depth < 20 m, 17 Nov. 2009 RUMF-ZC-1528; 1 ov. female (pocl 15.4), Stn. Dive 28, 26°17.454´N 126°47.890´E, depth < 20 m, Oyako-iwa, 17 Nov. 2009, NTOU M01144; 1

female (pocl 4.8), Stn. Dive 37, Hidenchigama, depth 35–40 m, 19 Nov. 2009, NTOU M1159; 1 female (pocl 5.8), Stn. Dive 42, Ara, 26°19.00´N 126°46.50´E, depth 18 m, 20 Nov. 2009. NTOU M01145; 9 females (pocl 3.9–6.8), Stn. Intertidal 1, Ara Beach, 26°18'58.9" N 126°46'26.0" E, 16–17 Nov. 2009, night collecting, RUMF-ZC-1529; 2 ov. females (pocl 8.7, 10.0), Stn Intertidal 5, Ishidatami, Oh-jima Islet, 26°20'09.6" N 126°49'29.2" N, 19 Nov. 2009, NTOU M01146; 2 ov. females (pocl 8.3, 9.0), Stn. Intertidal 8, Madomari, 26°21'23.8" N 126°48'50.5" E, 20 Nov. 2009, NTOU M01147.

Remarks. The material corresponds closely to previous descriptions and presents no special features, although there are large variations in colour pattern present in the current material (Fig. 2D–F), along the lines of previously recorded variation for this species.

Distribution. Widely distributed in the Indo-West Pacific, from East Africa to French Polynesia and Hawaii. Previously reported from Kumejima by Kawamoto & Okuno (2001).

Saron neglectus De Man, 1902

Material examined. 1 female (pocl 4.8), Stn. Dredge 56, 26°19.360´N 126°49.204´E – 26°19.294´N 126°49.192´E, depth 4.7–7.5 m, 17 Nov. 2009, NTOU M01148.

Remarks. The single specimen presents no special features.

Distribution. Indo-West Pacific from East Africa to French Polynesia and Hawaii. Previously reported from Kumejima by Kawamoto & Okuno (2001).

Thinora Bruce, 1998

Thinora maldivensis (Borradaile, 1915)

Material examined. 1 female (pocl 1.2), Stn. Dive 21, in front of Torishima Islet, west side, 26°19.720´N 126°44.593´E, depth 50 m, 16 Nov. 2009, NTOU M01149.

Remarks. The single specimen fits perfectly the re-description of the species by Bruce (1997).

Distribution. Widely recorded throughout the Indo-West Pacific. Within Japan known from Kikai Island, Amai Islands, the Yaeyama Islands, and now Kumejima.

Thor Kingsley, 1878

Thor amboinensis (De Man, 1888)

(Fig. 3A)

Material examined. 1 ov. female (pocl 1.4), Stn. Dive 6, near Aka-todai, 26°21.225´N 126°49.628´E, depth 15–30 m, 10 Nov. 2009, NTOU M1160; 2 females (pocl 1.2, 1.7), Stn. Dive 16, Koukou-mae (in front of high school), 26°19.885´N 126°45.616´E, depth < 4 m, 14 Nov. 2009, NTOU M01150; 1 female (pocl 1.4), Stn. Dive 35, Aka-todai, 26°19.251´N 126°45.354´E, depth 15 m, 18 Nov. 2009, NTOU M01151; 1 female (pocl 1.1), Stn. Dive 42, Ara, 26°19.00´N 126°46.50´E, depth 18 m, 20 Nov. 2009, RUMF-ZC-1530; 1 female (pocl 1.3), Stn. Intertidal 2, Ifu Beach, 26°20'08.0" N 126°48'57.5" E, 17–18 Nov. 2009, night collecting, RUMF-ZC-1531; 1 ov. female (pocl 1.3), 1 female (pocl 1.1), 1 damaged specimen (pocl 0.9), Stn. Dredge 52, 26°20.409´N 126°49.675´E – 26°20.018´N 126°49.224´E, depth 4.5–5.1 m, 17 Nov. 2009, NTOU M01152.

Distribution. Widely distributed in the Indo-West Pacific and parts of the West Atlantic. Previously reported from Kumejima by Kawamoto & Okuno (2001).

Tozeuma Stimpson, 1860

Tozeuma armatum Paul'son, 1875

(Fig. 3B,C)

Material examined. 2 males (pocl 6.8, 7.0), Stn. Trawl 70, 26°23.831´N 126°45.685´E – 26°23.590´N 126°45.212´E, depth 95.5–123 m, 19. Nov. 2009, NTOU M01153; 1 female (pocl 7.2), Stn. Dredge 30, 26°17.670´N 126°53.444´E – 26°17.848´N 126°53.888´E, depth 90.7–93.3 m, 13 Nov. 2009, NTOU M01154.

Remarks. The material corresponds to the descriptions in Holthuis (1947) and Hayashi (2007), although it appears quite likely that a species complex is involved, as previous records either mention free-living specimens or specimens associated with gorgonians (Hayashi, 2007). Furthermore, the present specimens exhibit differences in colour pattern; the males were pale pink (Fig. 3B), while the female was brownish-yellow (Fig. 3C).

Distribution. Indo-West Pacific: Red Sea, South Africa, the Indian Ocean, Indonesia, Australia, New Caledonia and Japan.

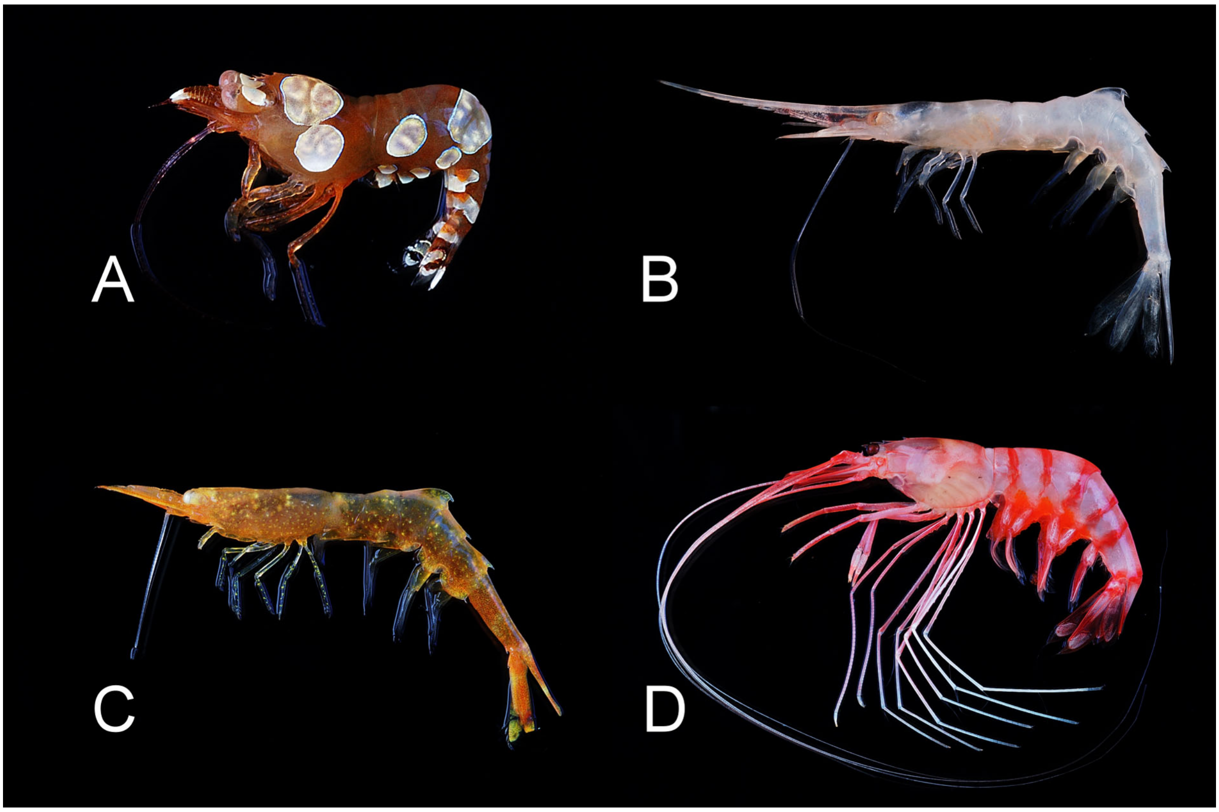


FIGURE 3. A, *Thor amboinensis* (De Man, 1888), ov. female (pocl 1.4 mm), NTOU M1160; B–C; *Tozeuma armatum* Paul'son, 1875, B, male (pocl 7.0 mm), NTOU M01153; C, female (pocl 7.2 mm), NTOU M00154; D, *Parhippolyte misticia* (Clark, 1989), ov. female (pocl 11.4 mm), NTOU M01155.

Barbouriidae Christoffersen, 1987

Parhippolyte Borradaile, 1900

Parhippolyte misticia (Clark, 1989)

(Fig. 3D)

Material examined. 2 ov. females (pocl 11.4, 11.4), 3 females (pocl 8.8–12.8), 1 male (pocl 9.3), Stn. Dive 15, Ebi-ana, 26°17.547´N 126°47.771´E, depth 10 m, 13 Nov. 2009, NTOU M01155; 1 ov. female (pocl 14.4), Stn. Dive 18, Shogakko-mae (in front of elementary school), 26°20.012´N 126°43.961´E, depth 18–39 m, under drop-off, overhang, 14 Nov. 2009, NTOU M01156; 3 ov. females (pocl 13.5–12.0), 5 females (pocl 6.5–10.4), 4 males (pocl 6.0–9.7), 24 juveniles (pocl 5.2–3.1), Stn. Dive 20, Shogakko-mae (in front of elementary school), 26°19.964´N 126°43.906´E, depth 38 m, 50 m inside from entrance of submarine limestone cave, 14 Nov. 2009, OUMNH.ZC.2011-02-045; 1 ov. female (pocl 14.3), 14 males (pocl 6.6–10.3), 4 damaged specimens (pocl 7.0–10.0), 58 juveniles (pocl 2.1–5.0), Stn. Dive 22, Shogakko-mae (in front of elementary school), 26°19.964´N 126°43.906´E, depth < 40 m, submarine limestone cave, 16 Nov. 2009, NTOU M01157; 1 ov. female (pocl 12.1), 7 females (pocl 5.6–11.2), 16 males (pocl 6.5–11.1), 9 damaged specimens (pocl 6.7–9.6), 42 juveniles (pocl 3.4–4.8), Stn. Dive 40, Hidenchigama, depth 40 m, submarine limestone cave, 20 Nov. 2009, RUMZ-ZC-1835.

Remarks. The material agrees well with the description of Clark (1989), as well as the description of material from the Ryukyu Islands by Brand & Takeda (1994). Although some, minor, variability was noted in the shape of the suborbital lobe, a key character highlighted by Chace (1997), it generally can be regarded as broadly triangular, rather than fully rounded. In all examined males the appendix masculina is distinctly longer than the appendix interna, which is the most convenient character to distinguish this species from its close congener, *Parhippolyte uveae* Borradaile, 1900. The status of the other species known from the Ryukyu Islands, *P. rukuensis* Burukovsky, 2007, requires clarification. This species was described on the basis of a single, female specimen obtained from an underwater cave on Ie-Jima Island (Burukovsky, 2007) and has not been recorded since. It differs from *P. misticia* only by its shorter rostrum, armed with a single dorsal and ventral tooth, in all other respects these taxa are highly similar and may ultimately prove to be synonyms.

Distribution. Known with certainty only from Palau (Clark 1989) and the Ryukyu Islands (Brand & Takeda 1994; Nomura *et al*. 1996; Kawamoto & Okuno 2001); previously recorded from Kumejima by Kawamoto & Okuno (2001). The record of two specimens without habitat data from the Seychelles in Brand & Takeda (1994) needs verification, as the Indo-Pacific species in the genus are hard to distinguish from each other without the presence of males and/or accurate habitat information. However, we agree with Brand & Takeda (1994) that photographs in several underwater guides (e.g. Fielding & Robinson 1987; Kuiter & Debelius 2009) are highly suggestive of a much wider distribution for *P. misticia*.

Acknowledgements

The KUMEJIMA 2009 expedition was organised by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, the Center of Excellence for Marine Bioenviroment and Biotechnology of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica, Taiwan, R.O.C. The expedition operated under a permit granted to Dr. Tohru Naruse (University of the Ryukyus) by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. We sincerely thank L. Corbari of the Museum national d'Histoire naturelle, Paris for loaning us the *Gelastreutes crosnieri* specimen from Vanuatu, K.H. Chu and C.P. Li of the Chinese University of Hong Kong for sequencing the COI of *G. crosnieri* specimens. This work was supported, in part, by the National Science Council and the Academia Sinica, Taiwan, R.O.C. to TYC. Comments by Arthur Anker greatly improved an earlier version.

References

Borradaile, L.A. (1900) On the Stomatopoda and Macrura brought by Dr. Willey from the South Seas. In: Willey, A. (Ed), *Zoological results based on material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896, and 1897, by Arthur Willey, D.Sc. Lond., Hon. M.A. Cantab*., 395–428, Plates 36–39. University Press, Cambridge.

Borradaile, L.A. (1915) Notes on Carides. *The Annals and Magazine of Natural History*, (8) 15, 205–213.

Brand, T.M. & Takeda, M. (1994) New records of the hipolytid shrimp, *Koror mysticius* Clark, 1989, from submarine caves of the Ryukyu Islands. *Bulletin of the National Science Museum, Series A (Zoology)*, 20, 77–81.

Bruce, A.J. (1990) Crustacea Decapoda: *Gelastreutes crosnieri* gen. nov., sp. nov. (Hippolytidae) from New Caledonia. In: Crosnier, A. (Ed) *Résultats des Campagnes MUSORSTOM, vol. 6. Mémoires du Muséum national d'Histoire naturelle, série A, Zoologie*, 145, 137–147.

Bruce, A.J. (1997) A new genus of hippolytid shrimp (Crustacea: Decapoda: Hippolytidae) for *Thor maldivensis* Borradaile. *Memoirs of the Queensland Museum*, 42, 13–23.

Bruce, A.J. (1998) A new name, *Thinora*, proposed for the preoccupied name *Thorina* Bruce (Crustacea: Decapoda: Hippolytidae). *Memoirs of the Queensland Museum*, 42, 398.

Burukovsky, R.N. (2007) On some new and rare shrimps from the Indo-Western Pacific [in Russian]. *Zoologicheskii Zhurnal*, 86, 1–8.

Chace, F.A. Jr. (1997) The caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine expedition, 1907–1910, Part 7: Families Atyidae, Eugonatonotidae, Rhynchocinetidae, Bathypalaemonellidae, Processidae, and Hippolytidae. *Smithsonian Contributions to Zoology*, 587, 1–106.

Christoffersen, M.L. (1987) Phylogenetic relationships of hippolytid genera, with an assignment of new families for the Crangonoidea and Alpheoidea (Crustacea, Decapoda, Caridea). *Cladistics*, 3, 348–362.

Clark, J. (1989) *Koror misticius*, new genus, new species (Decapoda: Hippolytidae), a cave shrimp from Palau. *Journal of Crustacean Biology*, 9, 445–452.

Fielding, A. & Robinson, E. (1987). *An underwater guide to Hawaii*. University of Hawaii Press, Honolulu, 156 pp.

Hayashi, K.-I. (2007) *Lysmata dispar* sp. nov., a new shrimp from the Dampier Archipelago, Western Australia, with notes on other species of the family Hippolytidae (Crustacea: Decapoda: Caridea). *Records of the Western Australian Museum*, Suppl. 73, 85–95.

Holthuis, L.B. (1947) The Decapoda of the Siboga Expedition. Part IX. The Hippolytidae and Rhynchocinetidae collected by the Siboga and Snellius expeditions with remarks on other species. *Siboga Expeditie*, 39a8, 1–100.

Kawamoto, T. & Okuno, J. (2001) *Shrimps and crabs of Kume Island, Okinawa.* [in Japanese] Hankyu Communications, Tokyo, 173 pp.

Kemp, S. (1916) Notes on Crustacea Decapoda in the Indian Museum. VII. Further notes on Hippolytidae. *Records of the Indian Museum*, 12, 386–405, Plate 36.

Kemp, S. (1925) Notes on Crustacea Decapoda in the Indian Museum. XVII On various Caridea. *Records of the Indian Museum*, 27, 249–342.

Kingsley, J.S. (1878) Notes on the North American Caridea in the Museum of the Peabody Academy of Science at Salem, Mass. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1878, 89–98.

Kuiter, R. & Debelius, H. (2009) World atlas of marine fauna. IKAN Unterwasserarchiv, Frankfurt, 725 pp.

Man, J.G., de (1888) Bericht über die von Herrn Dr. J. Brock im Indischen Archipel gesammelten Decapoden und Stomatopoden. *Archiv für Naturgeschichte*, 53, 289–600, Plates 11–22a.

Man, J.G., de (1902) Die von Herrn Professor Kükenthal im Indischen Archipel gesammelten Dekapoden und Stomatopoden. *Abhandlungen herausgegeben von der Senckenbergischen Naturforschenden Gesellschaft*, 25, 466–929, Plates 19–27.

Marin, I., Okuno, J. & Chan, T.Y. (2011) On the "*Hippolyte commensalis* Kemp, 1925" species complex (Decapoda, Caridea, Hippolytidae), with the designation of a new genus and description of two new species from the Indo-West Pacific. *Zootaxa*, 2768, 32–54.

Nomura, K., Nagai, S., Asakura, A. & Komai, T. (1996) A preliminary list of shallow water decapod Crustacea in the Kerama Group, the Ryukyu Islands. *Bulletin of the Biogeographical Society of Japan*, 51, 7–21.

Okuno, J. & Fiedler, G.C. (2010) *Lysmata lipkei*, a new species of peppermint shrimp (Decapoda, Hippolytidae) from warm temperate and subtropical waters of Japan. In: Fransen, C.H.J.M., S. De Grave & P.K.L. Ng (Eds.), *Studies on Malacostraca: Lipke Bijdeley Holthuis Memorial Volume. Crustaceana Monographs*, 14, 597–610.

Olivier, A.G. (1811) Suite de l'introduction à l'histoire naturelle des insectes. *Palémon*. In: Olivier, A.G. (Ed), *Encyclopédie Méthodique. Histoire Naturelle. Insectes*, 8, 656–670. H. Agasse, Paris.

Paul'son, O. (1875) *Studies on Crustacea of the Red Sea with notes regarding other seas. Part 1 Podophthalmata and Edriophthalmata (Cumacea)* [in Russian]. Kiev, xiv, 144 pp., 22 plates.

Risso, A. (1816) *Histoire naturelle des crustacés des environs de Nice*. Librairie Grecque-Latine-Allemande, Paris, 175 pp., 3 plates.

Spence Bate, C. (1888) Report on the Crustacea Macrura collected by the Challenger during the years 1873–76. *Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the years 1873–76*, 24, i–xc, 1–942, Plates 1–157.

Stimpson, W. (1860) Prodromus descriptionis animalium evertebratorum, quae in Expeditione as Oceanum Pacificum Septentrionalem, a Republic Federata missa, Cadwaladore Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars VIII, Crustacea Macrura. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1860, 22–47.

Thallwitz, J. (1891) Über einige neue indo-pacifische Crustaceen. *Zoologischer Anzeiger*, 14, 96–103.

Zootaxa 3367: 103–114 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Crinoid-associated pontoniine shrimps of the genus *Laomenes* Clark, 1919 (Decapoda, Caridea, Palaemonidae) from PANGLAO 2004 and KUMEJIMA 2009 Expeditions, with description of two new species

IVAN MARIN[1], TIN-YAM CHAN[2] & JUNJI OKUNO[3]

[1]*A. N. Severtzov Institute of Ecology and Evolution of RAS, Moscow, Russia.*
E-mail: coralliodecapoda@mail.ru; vanomarin@yahoo.com
[2]*Institute of Marine Biology and Center of Excellence for Marine Bioenviroment and Biotechnology, National Taiwan Ocean University, Keelung 20224, Taiwan R.O.C. E-mail: tychan@mail.ntou.edu.tw*
[3]*Coastal Branch of Natural History Museum and Institute, Chiba, 123 Yoshio, Katsuura, Chiba 299-5242, Japan. E-mail: okuno@chiba-muse.or.jp*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Four species of the crinoid-associated pontoniine shrimps of the "*Laomenes amboinensis* (De Man, 1888)" species group were collected in the Philippines PANGLAO 2004 and Ryukyu KUMEJIMA 2009 Expeditions. Two of them, *L. pestrushka* **n. sp.** from the Ryukyus and *L. gyrophthalmus* **n. sp.** from the Philippines, are new to science. The two others, *L. cornutus* (Borradaile, 1915) and *L. holthuisi* Marin & Okuno, 2010, are rarely collected species.

Key words: Crustacea, Decapoda, Pontoniinae, *Laomenes*, new species, Crinoidea, Ryukyu Islands, Philippines

Introduction

Pontoniine shrimps of the genus *Laomenes* Clark, 1919 are obligatory associated with tropical shallow water feather stars (Crinoidea, Comatulida) in the Indo-West Pacific. To date, nine valid species are known in this genus and they show a wide diversity of morphological features such as shape of cornea and eyestalk, chelipeds and dactyli of ambulatory pereiopods, colouration and host specificity (see review in Marin 2009; Marin & Okuno 2010). Although many underwater photographs of these colourful shrimps are available in guide books (e.g. Debelius 1999; Humann & Deloach 2010), magazines and internet, there are rather few taxonomic reports on the species of this genus and most species only have limited confirmed geographical records. Moreover, it is highly likely that more species are present in *Laomenes* (Marin 2009).

Examination on the material collected from the recent Philippines PANGLAO 2004 and Ryukyu KUMEJIMA 2009 Expeditions reveals two undescribed species belonging to the "*Laomenes amboinensis* (De Man, 1888)" species group (for definition see Marin 2009, and Remarks under *L. pestrushka* **n. sp.**). Moreover, two other species belonging to this species group; namely *L. cornutus* (Borradaile, 1915) and *L. holthuisi* Marin & Okuno, 2010, were also collected in these two expeditions and both were previously known only from few records (Borradaile 1915; Marin 2009; Marin & Okuno 2010; Tchesunov *et al*. 1989).

The measurement provided is postorbital carapace length (pcl., in mm), measured from the posterior margin of the orbit to the posterodorsal margin of the carapace. Only primary synonyms are given in each species account. The material examined is deposited in the Ryukyu University Museum, Fujukan, Okinawa (RUMF), the Philippines National Museum, Manila (NMCR) and the National Taiwan Ocean University (NTOU), Keelung.

Accepted by T. Naruse: 10 Mar. 2011; published: 4 Jul. 2012

Systematics

Subfamily Pontoniinae Kingsley, 1879

Genus *Laomenes* Clark, 1919

"Laomenes amboinensis (De Man, 1888)" species group

Laomenes pestrushka n. sp.

(Figs. 1–3, 8a)

Material examined. Holotype, ovigerous female (pcl. 3.1 mm) (RUMF-ZC-1399), paratype male (pcl. 2.2 mm) (NTOU M00996), Pacific Ocean, Japan, Ryukyu Islands, Kume Island, KUMEJIMA 2009, stn. Dive 12, Torishima Islet, 26°19.683′N, 126°44.625′E, scuba diving, <20 m, 12 November 2009.

Description. Holotype, ovigerous female (Fig. 1a). Carapace swollen, smooth, with antennal and hepatic teeth (Fig. 2b); antennal tooth sharp and slender, situated close to orbital angle, smaller than hepatic tooth. Rostrum long, deep, compressed laterally, and slightly directed downwards, with 5 large dorsal teeth and 1 small subapical tooth; ventral margin slightly convex, with 1 tooth situated at distal third of rostrum; rostral lamina well developed proximolaterally, with conspicuous sharp supraocular teeth (Fig. 2a). Orbit well developed, inferior orbital angle slightly produced forward, rounded. Pterygostomial angle rounded, not projected.

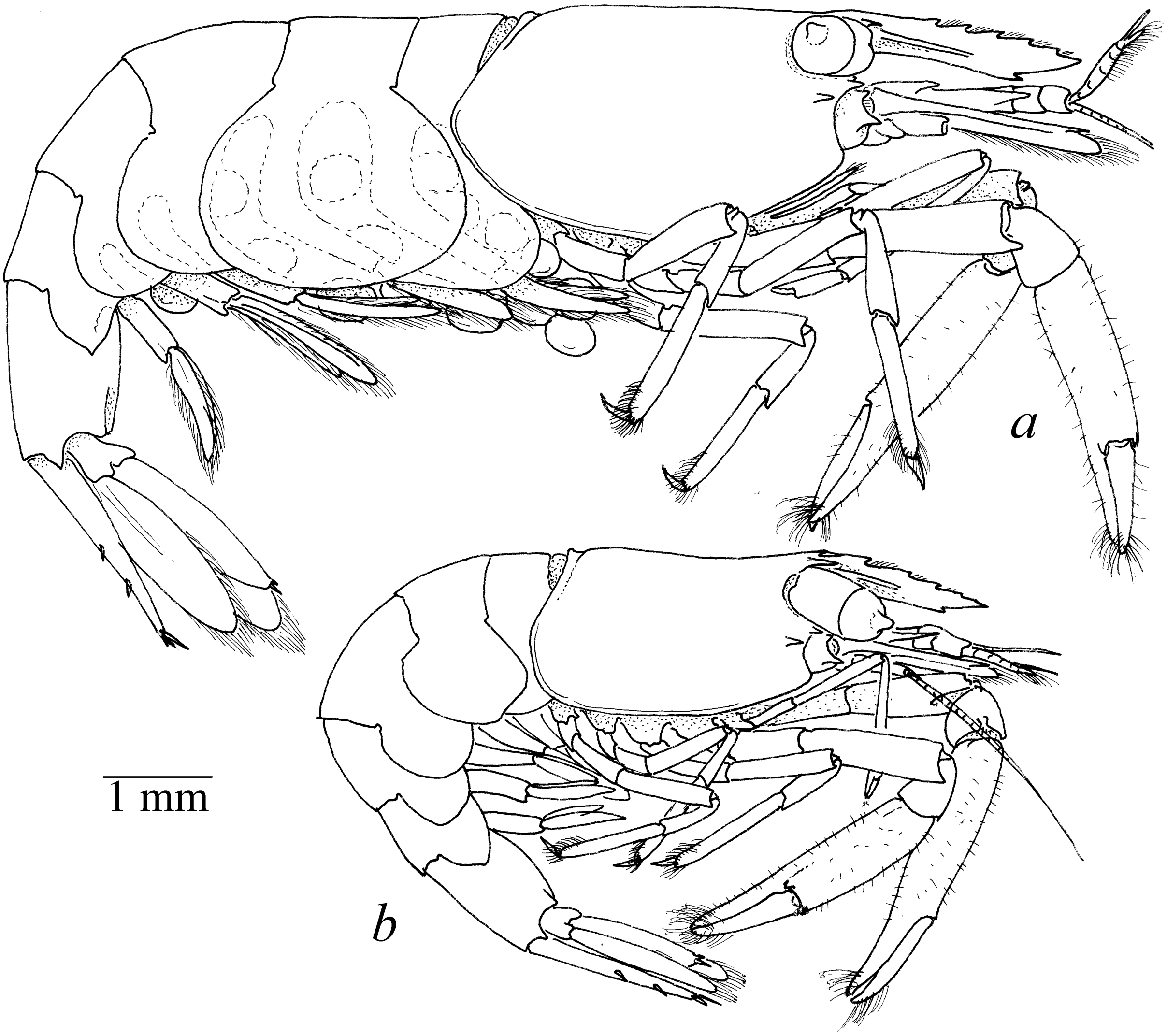


FIGURE 1. *Laomenes pestrushka* **n. sp.**: a, holotype, ovigerous female (RUMF-ZC-1399); b, paratype, male (NTOU M00996).

Abdominal somites smooth; pleurae of abdominal somites I–IV rounded, that of somite V pointed (Fig. 1a). Telson (Fig. 3a) about 3 times as long as proximal width, narrowing distally, with 2 pairs of small dorsal submarginal spines at 0.4 and 0.7 of telson length. Distal margin of telson armed with 3 pairs of spines, consisting of 1 pair of short stout lateral spines, 1 pair of long slender intermediate spines and 1 pair of plumose medial slender spines that about twice shorter than intermediate spines.

Eyes (Fig. 2a) well developed, large and stout, with subovate cornea. Eyestalk about 1.5 times as long as wide. Cornea with distinct but blunt apical papilla, bearing well marked accessory pigmented spot posterodorsally.

Antennule (Fig. 2d) well developed; basal segment of peduncle about twice longer than wide, with distolateral angle bearing stout but acute distolateral tooth and medial convex projection (lobe) (Fig. 2e); ventromedial tooth distinct, situated near medial border of basal segment; stylocerite well developed, acute; intermediate segment stout, about as long as wide, distolateral margin produced distally and laterally; distal segment stout, as long as wide.

Antenna (Fig. 2f) well developed, basicerite with sharp distoventral tooth, slightly overreaching distal margin of segment; carpocerite stout, about as long as wide; flagellum well developed; scaphocerite wide, about 3 times as long as maximal width, overreaching antennular peduncle and rostrum, with well developed acute distolateral tooth not overreaching blade.

Epistomial horns well developed, sharp. Mouthparts characteristic for genus, without any specific feature.

Pereiopod I (Fig. 2g) relatively slender; coxa with well developed and curved lobe distoventrally; basis as long as wide; ischium about 2.5 times longer than wide; merus about 7 times as long as wide; carpus equal in length to merus, about 7 times as long as wide, slightly flaring distally, with some long simple setae at carpo-propodal articulation; palm about 3 times as long as wide, subcylindrical; dactylus and fixed finger (Fig. 2h) slender, tapering distally, slightly shorter than palm, about 4 times as long as wide, cutting edges entire, tips simple with numerous simple setae.

Pereiopods II similar in shape and equal size, relatively robust (Fig. 1a); coxa with well developed and curved lobe distoventrally; basis as long as wide; ischium about 2.5 times as long as wide; merus about 3.5 times as long as wide, with straight margins and distoventral triangular projection; carpus subtriangular, stout, widening distally, with distinct distolateral notch; palm (Fig. 2i, j, k) cylindrical, about 5 times as long as wide, with straight margins; fingers slender, equal to palm length, about 5.5 times as long as wide, tips acute and curved, cutting edges straight and each armed with distinct triangular teeth (Fig. 2k).

Pereiopods III–V similar. Pereiopod III (Fig. 3c) relatively robust; ischium about 2.5 times as long as wide; merus about 4 times as long as wide; carpus about 2.5 times as long as maximal width, tapering distally, distodorsal margin overhanging proximal part of propodus; propodus about 6 times as long as wide, margins straight, armed with 3 ventral spines and 1 pair of slender distoventral spines; distal third of propodus with transverse rows of long dense plumose setae on flexor surface and fringe of setae on distolateral margin (Fig. 3d, e); dactylus (Fig. 3e) with small accessory tooth at base of unguis and stout corpus, corpus about 1.5 times as long as maximal width, unguis elongate, acute and curved; accessory tooth small, acute, produced downward and perpendicular to basal part; tuft of long setae present at proximolateral surface of unguis.

Pleopods normal, without specific feature. Uropods slender, slightly exceeding telson (Fig. 3a); distolateral margin of exopod with small fixed tooth and large mobile spine (Fig. 3b).

Male paratype (Fig. 1b). Generally similar to female. Rostral formula 6/1 (Fig. 2c). Pereiopods II similar in shape and size (Fig. 1b).

Colouration Body blackish and covered with numerous small irregular dots (Fig. 8a). Dots mostly yellowish-green and some of them arranged as thin transverse bands on dorsal body and wide longitudinal band along lateral body; dots orange in rostrum, eyes, distal parts of antennular peduncle, scaphocerite, pereiopods and tailfan. Eggs dark-brown-green.

Etymology. The species is named after its multicoloured pattern. **“***Pestrushka***”** is a Latin transcription of a common Russian nick-name for multicoloured pets or agricultural animals.

Host. Unknown, but probably associated with black-yellow or black-green coloured species of the family Comasteridae (Echinodermata, Crinoidea) such as *Capillaster multiradiatus* (Linnaeus, 1758) or green-black coloured species of the genus *Comanthus* A.H. Clark, 1908.

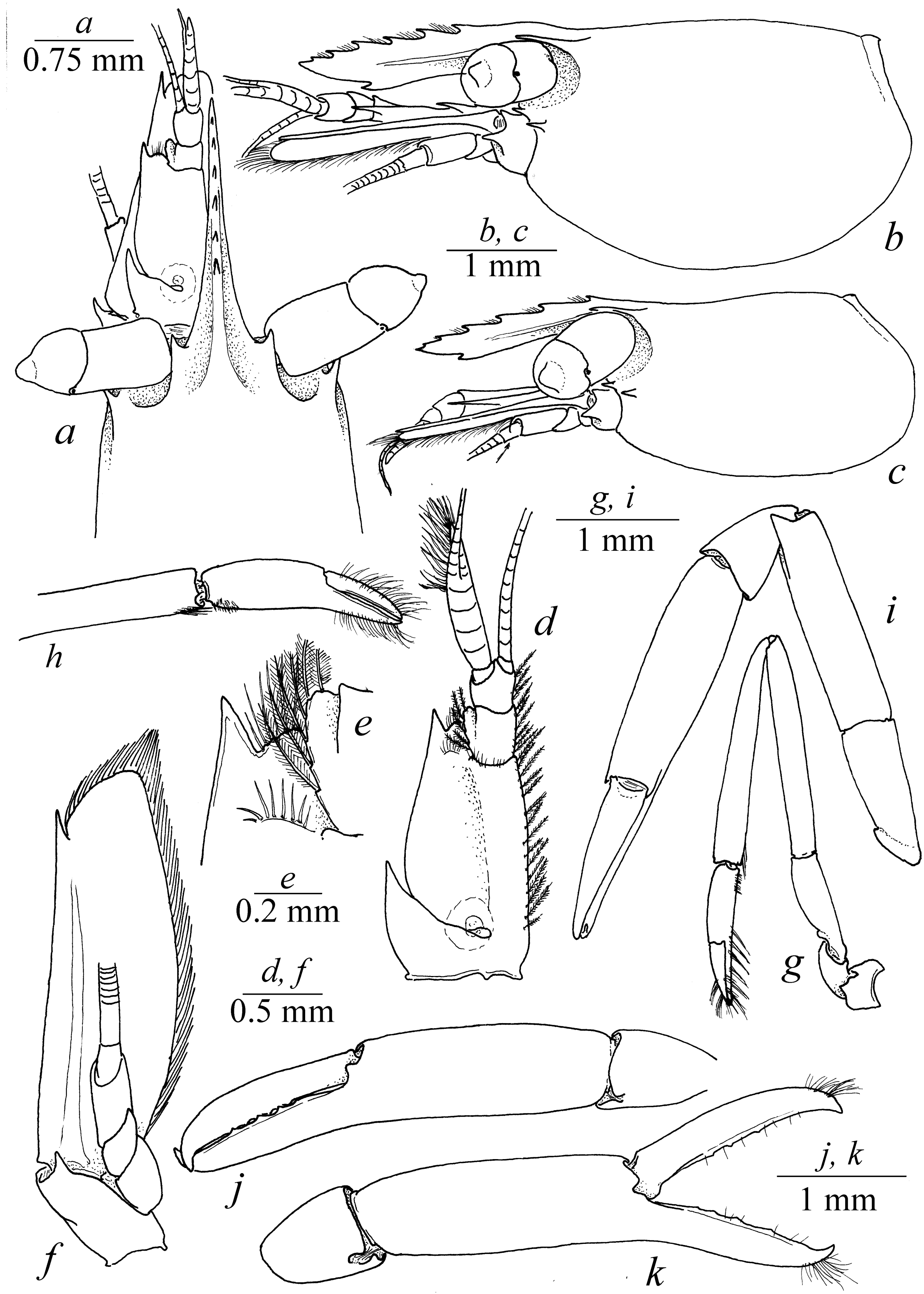


FIGURE 2. *Laomenes pestrushka* **n. sp.**, holotype, ovigerous female (RUMF-ZC-1399)(a, b, d–k) and paratype, male (NTOU M00996)(c); a, carapace and anterior appendages, dorsal view; b, c, carapace and anterior appendages, lateral view; d, antennula; e, same, distolateral margin of basal segment and lateral margin of intermediate segment; f, antenna, ventral view; g, pereiopod I; h, distal segments of pereiopod I; i, pereiopod II; j, k, chela and carpus of pereiopod II.

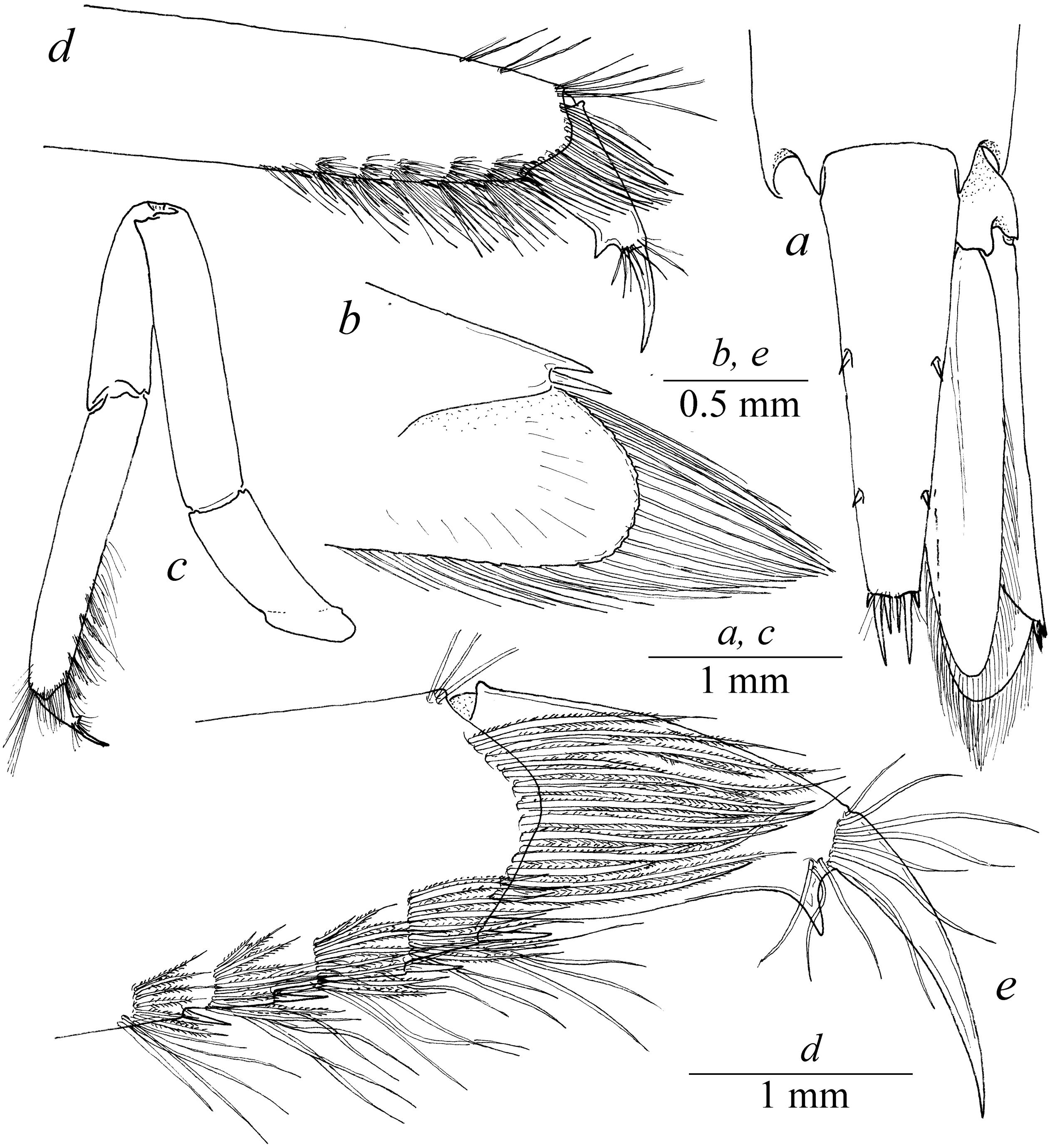


FIGURE 3. *Laomenes pestrushka* **n. sp.**, holotype, ovigerous female (RUMF-ZC-1399): a, distal part of the sixth abdominal somite, telson and right uropod; b, distal part of uropodal exopod; c, pereiopod III; d, e, distal propodus and dactylus of pereiopod III.

Distribution. All the examined specimens of this species are collected from the type locality, Kume Island, Ryukyu Islands, Japan. However, colour photographs from Sulawesi, Indonesia (see Marin 2009: fig. 35E, F, as *Laomenes* sp. "*salad*") probably also refer to the present new species.

Remarks. The "*Laomenes amboinensis* (De Man, 1888)" species group is characteristic in bearing ventral rostral tooth, distoventral spines on propodi of ambulatory pereiopods and uropodal exopod armed with a distolateral tooth. Five species are known in this group, namely *L. amboinensis*, *L. cornutus*, *L. clarki* Marin, 2009, *L. pardus* Marin, 2009, and *L. holthuisi*. The present new species differs from *L. amboinensis* in having a shorter eyestalk, single ventral rostral tooth (vs. usually 2 ventral rostral teeth in *L. amboinensis*), and a medial lobe on the distolateral margin of the basal segment of antennular peduncle (vs. such lobe absent in *L. amboinensis*). The new species can be readily separated from *L. cornutus* by its relatively more slender eyestalk and chelipeds, different ornamentations in the distolateral margins of the propodi and dactyli of the ambulatory pereiopods (see Marin, 2009). From *L. clarki,* the new species differs mainly in the forwardly-directed rostrum (vs. more slender and downwardly-directed in *L. clarki*), equal chelipeds (subequal in *L. clarki*), and shape of the dactyli of ambulatory pereiopods. *Laomenes pardus* differs from the new species in having longer fingers of the chelipeds and different shape of the dactyli of ambulatory pereiopods. *Laomenes holthuisi* differs from the new species mainly in having swollen and dissimilar chelipeds (see Marin & Okuno 2010). Moreover, the colouration is very diagnostic in the "*L. amboinensis*" species group (see Marin 2009; Marin & Okuno 2010) and the colour pattern of *L. pestrushka* **n. sp.** distinctly differs from all other known species within the group.

***Laomenes gyrophthalmus* n. sp.**

(Figs. 4, 5, 8b)

Material examined. Holotype, ovigerous female (pcl. 3.8 mm) (NMCR), Philippines, Bohol Island, PANGLAO 2004 expedition, stn. R42, Baclayon Takot, 9°37.1′N, 123°52.6′E, scuba diving, 8–22 m, 12 June 2004.

Description. Holotype, ovigerous female (Fig. 4). Carapace swollen, smooth, with well developed antennal and hepatic teeth (Fig. 5a, b); antennal tooth acute, smaller than hepatic tooth. Rostrum long, deep, compressed laterally, slightly directed downwards, dorsal border with 4 large teeth and 1 small subapical tooth; ventral boarder slightly convex, with 1 tooth situated at distal third; rostral lamina well developed proximolaterally, with distinct sharp supraocular teeth (Fig. 5b). Orbit well developed, inferior orbital angle slightly produced and rounded. Pterygostomial angle rounded, not projecting.

Abdominal somites smooth; pleura of abdominal somites I–V rounded (Fig. 4). Telson (Fig. 5e) about 3.5 times as long as proximal width, narrowing distally, with two pairs of small dorsal submarginal spines at 0.5 and 0.75 of telson length. Distal margin of telson armed with 3 pairs of spines, consisting of 1 pair of short stout lateral spines, 1 pair of long slender intermediate spines, and 1 pair of slender plumose medial spines about 0.6 times as long as intermediate spines.

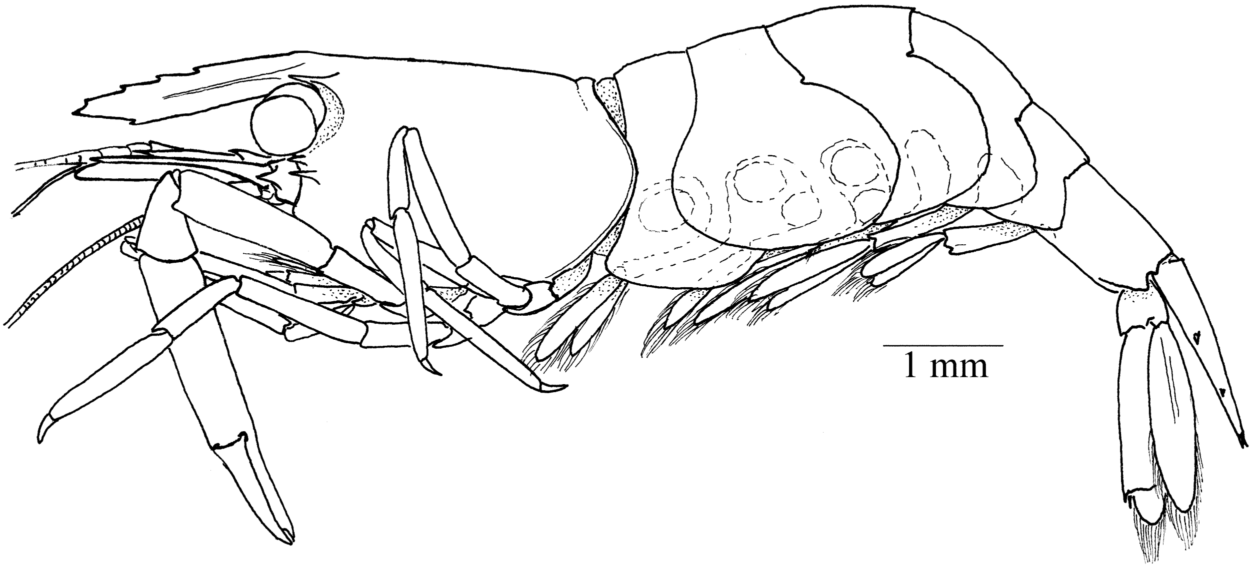


FIGURE 4. *Laomenes gyrophthalmus* **n. sp.**, holotype, ovigerous female (NMCR).

Eyes (Fig. 5a–c) well developed, large and stout, with rounded cornea. Eyestalk about 1.7 times as long as wide. Cornea rounded, without apical papilla. Distinct accessory pigmented spot present posterodorsally.

Antennule (Fig. 5b) well developed; basal segment of peduncle about 1.5 times as long as wide, with distolateral angle bearing slender acute distolateral tooth, without medial projection (lobe) (Fig. 5d); submarginal ventral tooth distinct, situated near medial border of basal segment; stylocerite well developed, acute; intermediate segment relatively slender, about 1.5 times as long as wide, distolateral margin produced distally and laterally; distal segment stout, wider than long.

Antenna well developed, basicerite with well developed lobe and sharp triangular distoventral tooth; carpocerite stout, about as long as wide; flagellum well developed; scaphocerite wide, about 3 times as long as maximal width, slightly overreaching antennular peduncle and rostrum, with well developed acute distolateral tooth which not overreaching blade.

Epistomial horns well developed, sharp. Mouthparts characteristic for genus and without specific features.
Pereiopod I (Fig. 5f) slender; coxa with well developed and curved lobe distoventrally; basis stout, as long as wide; ischium about 3.5 times as long as wide, flaring distally; merus about 7 times as long as wide; carpus slender, longer than merus, about 8 times as long as wide, flaring distally, with some long simple setae at carpo-propodal articulation; palm about 2.5 times as long as wide, subcylindrical; dactylus and fixed finger slender, tapering distally, about 4 times as long as wide, slightly shorter than palm, cutting edges entire, tips densely setose.

Pereiopod II similar in shape and size, relatively slender (Fig. 5g); coxa with well developed and curved lobe distoventrally; basis as long as wide; ischium about 3 times as long as wide; merus about 3.5 times as long as wide, with straight margins and distally projected distoventral margin; carpus subtriangular, about 1.5 times as long as wide, flaring distally, with distinct notch ventrolaterally; palm (Fig. 5h) cylindrical, about 3.5 times as long as wide, with straight margins; fingers slender, about 3 times as long as wide, about 0.7 times of the palmar length, with acute, curved tips, cutting edges bearing distinct triangular teeth.

Pereiopods III–V similar. Pereiopod III (Fig. 5i) relatively slender; coxa and basis as long as wide; ischium about 3.5 times as long as wide; merus about 4 times as long as wide; carpus about 4 times as long as maximal width, flaring distally, distodorsal margin overhanging proximal part of propodus; propodus about 6.5 times as long as wide, slightly tapering distally, margins straight and armed with 2 small ventral spines at its distal third and pair of slender distoventral spines, with long plumose setae fringing distoventral margin (Fig. 5j); dactylus (Fig. 5j) with basal part about 1.5 times as long as maximal width, unguis long, sharp and curved; accessory tooth small, triangular, directed forward, situated at proximal two-thirds of ventral dactylar margin and accompanied proximodorsally with tufts of long slender setae.

Pleopods usual for genus. Uropods slender, slightly exceeding telson; distolateral margin of exopod with small fixed tooth and movable spine.

Colouration. Body generally brown. Dorsal surfaces of carapace and abdomen covered with yellowish brown and violet thin transverse bands. Lateral carapace with row of short, thin oblique violet bands; ventrolateral border of carapace with thin longitudinal violet band and a large yellowish spot posteroventrally. Abdominal pleura covered with yellow transverse bands. Distal part of rostrum, upper orbits, dorsal eyestalk, uropods and distal part of telson yellowish. Pereiopods III to V with large yellowish spots at articulations (Fig. 8b).

Etymology. The species is named after its rounded cornea of eye, which is unique within the genus; "*gyro*" (Greek) - circle, rounded; "*ophthalmos*" (Greek) - eye.

Host. Unknown.

Distribution. The species is only known from the type locality in the Philippines.

Remarks. The present new species is unique within the genus in having a rounded cornea of eyes; all other known species (including *L. pestrushka* **n. sp.** described above) have a distinct apical papilla on the cornea (see Marin 2009; Marin & Okuno 2010). On the other hand, this new species clearly belongs to the "*L. amboinensis*" species group in having ventral rostral tooth, distoventral spines on propodi of ambulatory pereiopods and uropodal exopod armed with distolateral tooth (see Marin 2009). *Laomenes gyrophthalmus* **n. sp.** is mostly similar to *L. pardus* but can be readily separated from the latter by the basal antennular segment lacking a distally projected medial lobe at the distolateral angle, shorter fingers of the chelipeds, and shorter ventral and distoventral spines on propodi of ambulatory pereiopods, as well as the character of the cornea.

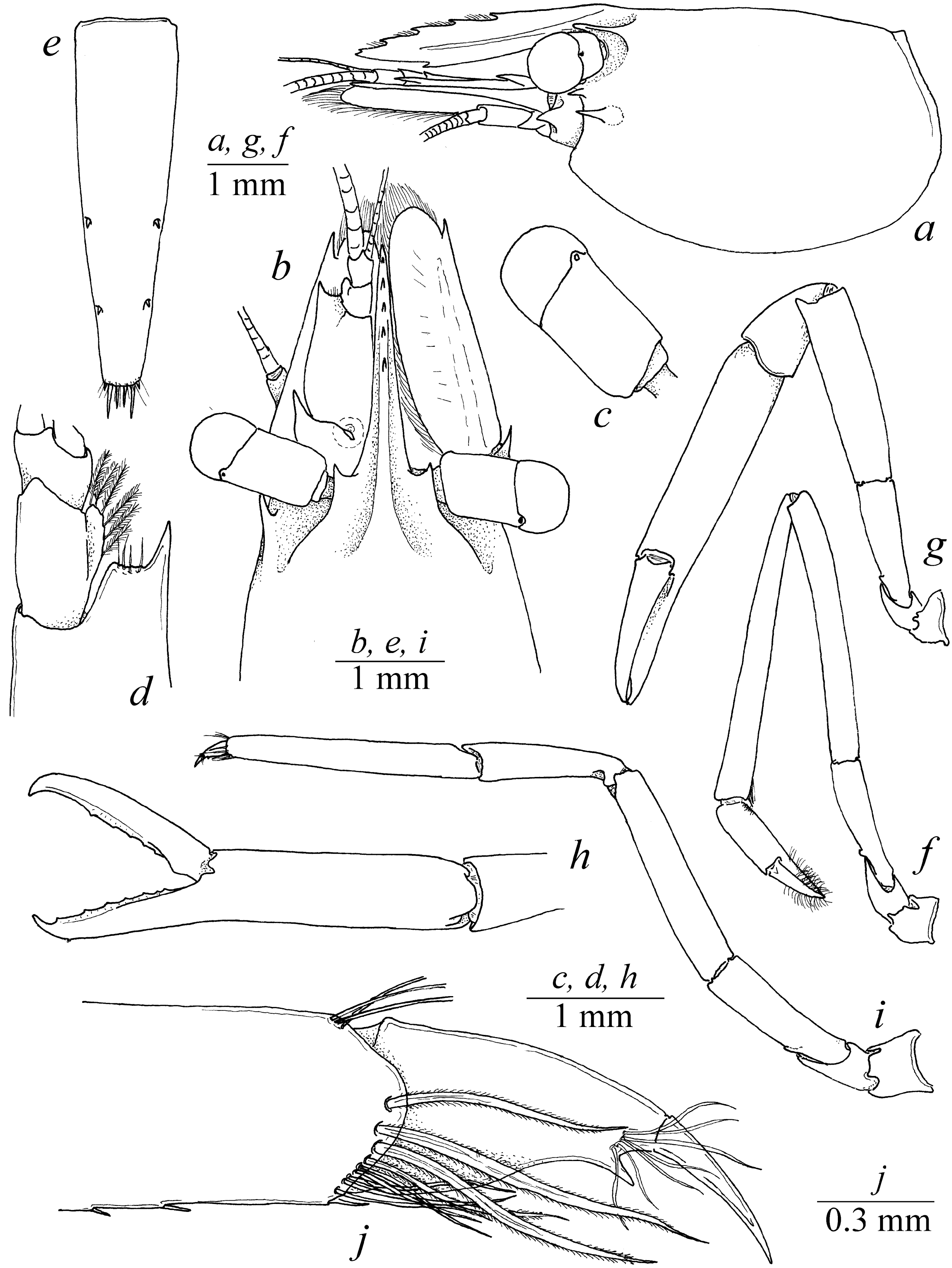


FIGURE 5. *Laomenes gyrophthalmus* **n. sp.**, holotype, ovigerous female (NMCR): a, carapace and anterior appendages, lateral view; b, front of carapace, dorsal view; c, left eye, lateral view; d, distal half of antennular peduncle; e, telson; f, pereiopod I; g, pereiopod II; h, chela of pereiopod II; i, pereiopod III; j, distal propodus and dactylus of pereiopod III.

Laomenes cornutus (Borradaile, 1915)

(Figs. 6, 8d)

Periclimenes cornutus Borradaile, 1915: 211 [type locality: Malé Atoll, Maldive Islands].

Material examined. 1 male (pcl. 1.8 mm) (NTOU M00954), Philippines, PANGLAO 2004, stn. R38, Pamilacan Island, 9°29.4′N, 123°56.0′E, scuba diving, 6–37 m, 11 June 2004; 2 juveniles (NTOU M00997), Philippines, PANGLAO 2004, stn. R75, Panglao Island, west of Pontod, 9°32.8′N, 123°42.1′E, scuba diving, 3–35 m, 3 July 2004.

Colouration. Body generally blackish-brown and bearing row of small yellowish-white dots along lateral margin of carapace and abdomen (Fig. 8d). Pereiopods and eyes also with yellowish-white dots.

Host. Unknown. Probably associated with dark coloured species feather star of the genus *Comanthus* (Echinodermata, Crinoidea, Comasteridae).

Distribution. The species is known from the Maldive Islands (type locality; Borradaile 1915, 1917; Tchesunov *et al.* 1989 as "*Periclimenes amboinensis*"; Marin 2009) and now the Philippines (present study).

Remarks. The present specimens agree well with the previous descriptions of this rarely collected species (Bruce 1978; Tchesunov *et al.* 1989, as "*Periclimenes amboinensis*"; Marin, 2009). The distinguishing characters of *L. cornutus* are relatively smaller body size, short and stout eyestalk, chela of pereiopod II with stout cylindrical palm and characteristic structure of the dactylus of pereiopod III (see Marin 2009).

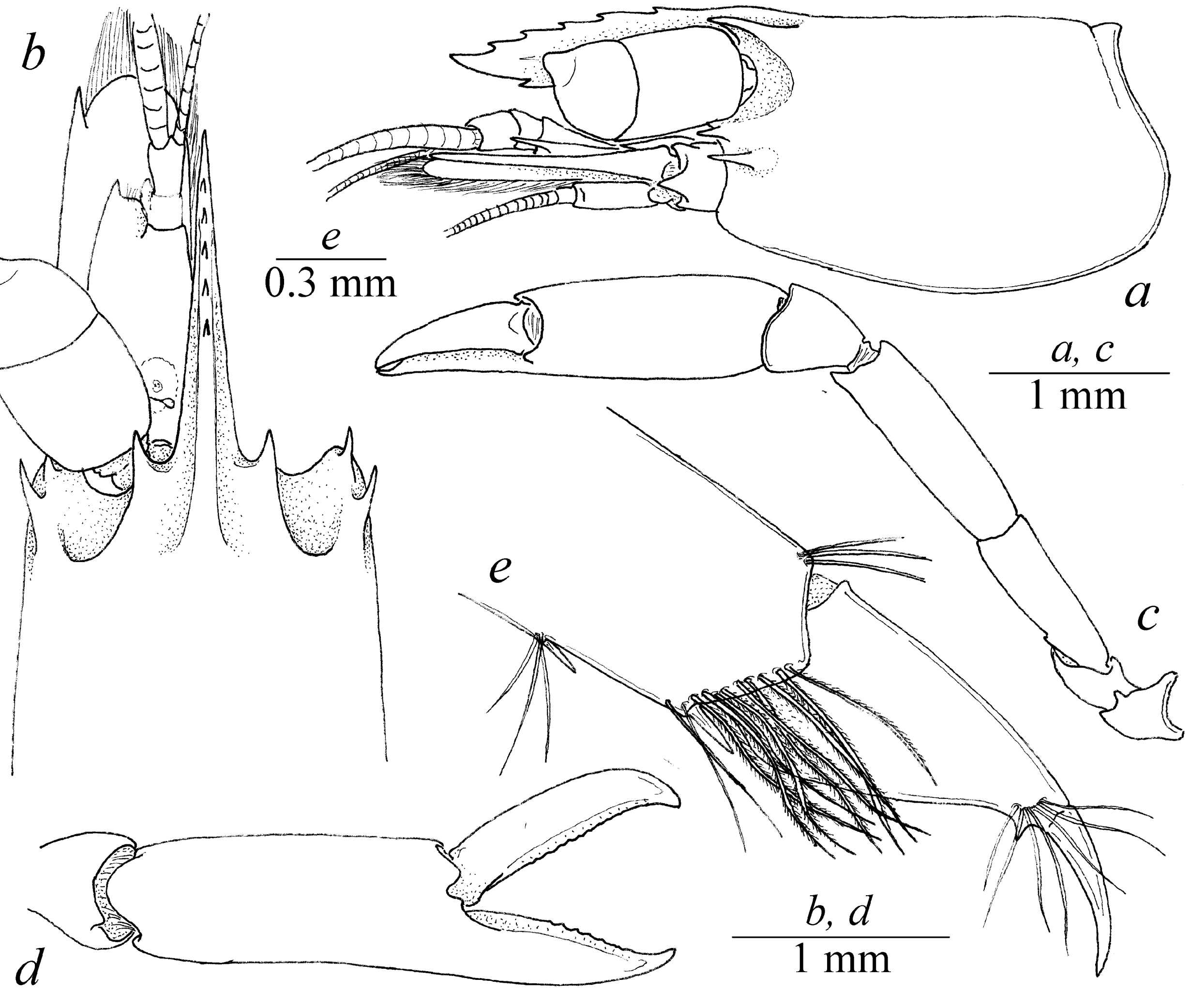


FIGURE 6. *Laomenes cornutus* (Borradaile, 1915), male (NTOU M00954): a, carapace and anterior appendages, lateral view; b, front of carapace, dorsal view; c, major pereiopod II; d, chela of minor pereiopod II; e, dactylus of pereiopod III.

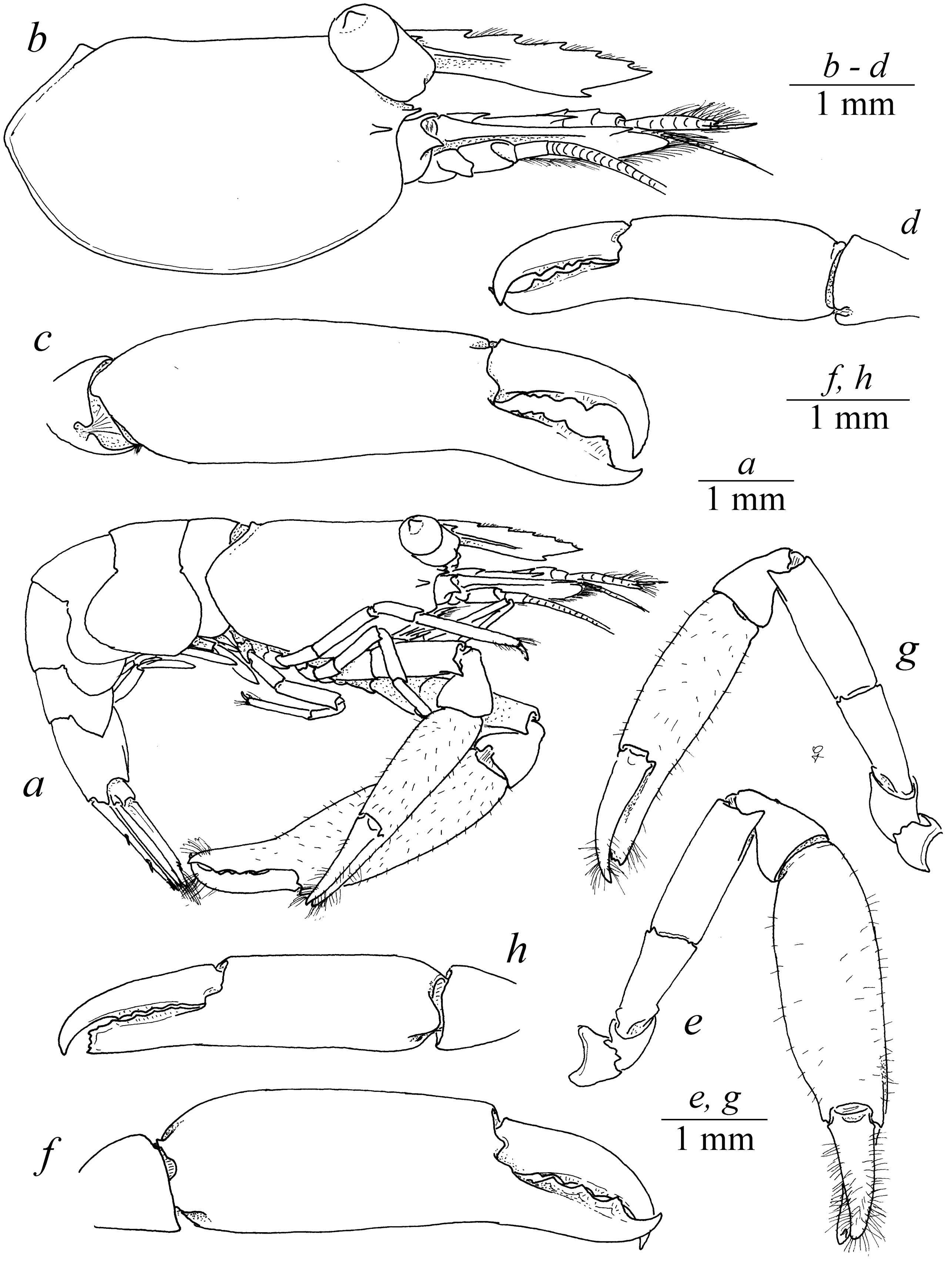


FIGURE 7. *Laomenes holthuisi* Marin & Okuno, 2010, male (a–d), ovigerous female (e–h) (NTOU M00998): a, general lateral view; b, carapace and anterior appendages, lateral view; c, f, chela of major pereiopod II; d, h, minor pereiopod II; e, major pereiopod II; g, minor pereiopod II.

FIGURE 8. Fresh colouration: a, *Laomenes pestrushka* **n. sp.**, holotype, ovigerous female (RUMF-ZC-1399); b, *L. gyrophthalmus* **n. sp.**, holotype, ovigerous female (NMCR); c, *L. holthuisi* Marin & Okuno, 2010, male (NTOU M00998); d, *L. cornutus* (Borradaile, 1915), male (NTOU M00954).

Laomenes holthuisi Marin & Okuno, 2010
(Figs. 7, 8c)

Laomenes holthuisi Marin & Okuno, 2010: 462, figs. 1–6 [type locality: Izu Islands, southern Japan].

Material examined. 1 ovigerous female (pcl 2.7 mm), 1 male (pcl 2.2 mm) (NTOU M00998), Pacific Ocean, Japan, Ryukyu Islands, Kume Island, KUMEJIMA 2009 Expedition, stn. Dive 12, Torishima Islet, 26°19.683′N, 126°44.625′E, scuba diving, <20 m, 12 November 2009.

Colouration. Body blackish and distributed with large irregular yellowish white patches (Fig. 8c).

Host. The present specimens were collected from an unidentified comatulid feather star. *Laomenes holthuisi* is known as a symbiont of yellow-black-green comasterid feather stars of the genus *Comanthina* A.H. Clark, 1909 (Echinodermata, Crinoidea, Comasteridae) such as *C. nobilis* (Carpenter, 1884) and C. *schlegelii* (Carpenter, 1881) (see Marin & Okuno 2010).

Distribution. This species is known only from Japan in the Izu Islands (type locality; Marin & Okuno 2010) and the Ryukyu Islands, Japan (present study).

Remarks. The present specimens agree well with the original description of the species provided by Marin & Okuno (2010).

Acknowledgements

The PANGLAO 2004 Marine Biodiversity Project was a collaboration between the Muséum national d'Histoire naturelle, Paris (Principal Investigator: Dr. Philippe Bouchet) and University of San Carlos, Cebu City (Principal Investigator: Dr. Danilo Largo). The PANGLAO 2004 Expedition was supported by the Total Foundation for Biodiversity and the Sea, the French Ministry of Foreign Affairs, and the ASEAN Regional Center for Biodiversity Conservation. The Philippines Bureau of Fisheries and Aquatic Resources is gratefully acknowledged for issuing a research permit on the material collected by the PANGLAO 2004. The KUMEJIMA 2009 Expedition was organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, the Center of Excellence for Marine Bioenviroment and Biotechnology of the National Taiwan Ocean University (NTOU), the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica. The KUMEJIMA 2009 was operated under a permit granted to Tohru Naruse (University of the Ryukyus) by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. This work was in part supported by the National Science Council and the Academia Sinica, Taiwan, R.O.C., to TYC, and Grant of the President of the Russian Federation MK-1235.2012.4 and PADI Foundation to IM.

References

Borradaile, L.A. (1915) Notes on Carides. *Annals and Magazine of Natural History*, ser. 8, 15, 205–213.

Borradaile, L.A. (1917) On the Pontoniinae. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner. *Transactions of the Linnean Society of London, Zoology*, 17(2), 323–396.

Clark, A.H. (1919) Some necessary changes in crustacean nomenclature. *Proceedings of Biological Society of Washington,* 32, 199.

Debelius, H. (1999) *Crustacea Guide of the World. Shrimps, Crabs, Lobsters, Mantis Shrimps, Amphipods.* IKAN, Frankfurt, 321 pp.

Humann, P. & Deloach, N. (2010) *Reef Creature Identification. Tropical Pacific*. New World Publications, Inc., Jacksonville, Florida, USA, 497 pp.

Man, J.G. de, 1888. Bericht über die von Herrn Dr. J. Brock im indischen Archipel gesammelten Decapoden und Stomatopoden. *Archiv fur Naturgeschichte*, 53(1), 215–600.

Marin, I. (2009) Crinoid-associated shrimps of the genus *Laomenes* A.H. Clark, 1919 (Caridea: Palaemonidae: Pontoniinae): new species and probable diversity. *Zootaxa*, 1971, 1–49.

Marin, I. & Okuno, J. (2010) *Laomenes holthuisi*, sp. nov., a new crinoid-associated pontoniine shrimp from Izu Islands, Japan, with some remarks on Japanese species of the genus *Laomenes* Clark, 1915. *In*: Fransen, C., De Grave, S. & Ng, P.K.L. (eds.), Studies on Malacostraca: Lipke Bijdeley Holthuis Memorial Volume. *Crustaceana Monographs*, 14, 461–472.

Tchesunov, A.V., Britayev, T.A., Larionov, V.V., Khodkina, I.V. & Tzetlin, A.B. (1989) Notes on commensals of some crinoids from Maldives coral reefs. *In*: Sveshnikov, V.A. (ed.), *Symbiosis in Marine Animals*. Moscow, pp. 166–191.

Zootaxa 3367: 115–125 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new antipatharian-associated species of the genus *Cuapetes* Clark, 1919 (Crustacea: Decapoda: Palaemonidae) and a new record of *C. nilandensis* (Borradaile, 1915) from Japan*

JUNJI OKUNO[1] & TIN-YAM CHAN[2, 3]

[1] *Coastal Branch of Natural History Museum and Institute, Chiba, 123 Yoshio, Katsuura, Chiba, 299-5242 Japan*

[2] *Institute of Marine Biology and Center of Excellence for Marine Bioenvironment and Biotechnology, National Taiwan Ocean University, Keelung 20224, Taiwan, R.O.C.*

[3] *Corresponding author. E-mail: tychan@mail.ntou.edu.tw*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Two antipatharian-associated species of the pontoniine shrimp genus *Cuapetes* Clark, *C. lanceolatus* sp. nov. and *C. nilandensis* (Borradaile), are reported from the Ryukyu Islands, Japan. The new species appears closest to *C. akiensis* (Kubo) and *C. calmani* (Tattersall), but differs considerably from the latter two species in the shape of the rostrum and the length of upper antennular flagellum. *Cuapetes nilandensis*, the type species of the genus, is recorded from Japanese waters for the first time.

Key words: Decapoda, Palaemonidae, *Cuapetes*, new species, range extension, antipatharian associate

Introduction

Bruce (2004) established a new genus *Kemponia* for several species previously recognized as members of the "*Periclimenes grandis* (Stimpson, 1860) species group". Following current nomenclatorial rules, Okuno (2009) resurrected *Cuapetes* Clark, 1919 as the senior synonym of *Kemponia*. At present, 25 species of *Cuapetes* are known worldwide (Okuno 2009).

An unfamiliar species of *Cuapetes* was reported in a field guide of decapod crustaceans from Kume Island, Ryukyu Islands (Kawamoto & Okuno 2003, 2006, 2009). This *Cuapetes* species is associated with an unidentified antipatharian living on the upper wall of large crevices. We herein describe it as new to science under the name of *C. lanceolatus* sp. nov.

During a marine biological survey under the KUMEJIMA 2009 Expedition, several specimens referred to *C. nilandensis* (Borradaile, 1915), the type species of *Cuapetes*, were also captured from Kume Island by trawling. Furthermore, the same species was collected from some diving sites at Okinawa Island by local divers. *Cuapetes nilandensis* is widely distributed in the Indo-West Pacific (Bruce 2004), but the present specimens represent the first occurrence of this species in Japanese waters.

Materials and methods

Illustrations were made with the aid of a drawing tube mounted on a Leica MZ12 stereomicroscope. Postorbital carapace length is abbreviated as CL in the text. The specimens examined in this study are deposited in the Coastal Branch of Natural History Museum and Institute, Chiba (CMNH), National Taiwan Ocean University, Keelung (NTOU), and the Ryukyu University Museum, Fujukan (RUMF).

Accepted by T. Naruse: 17 Dec. 2011; published: 4 Jul. 2012

Taxonomy

Family Palaemonidae Rafinesque, 1815

Subfamily Pontoniinae Kingsley, 1878

Genus *Cuapetes* Clark, 1919

Cuapetes lanceolatus n. sp.
(Figs. 1–4, 6A)

Periclimenes sp. B. — Kawamoto & Okuno 2003: 43, unnumbered colour fig.
Kemponia sp. — Kawamoto & Okuno 2006: 43, unnumbered colour fig.
Cuapetes sp. — Kawamoto & Okuno 2009: 43, unnumbered colour fig.

Material examined. Holotype. RUMF-ZC-1579, female, CL 3.0 mm, Umagai, Kume Island, Ryukyu Islands, Japan, 26°21′46″N 126°51′56″E, 25 m, 29 October 2002, coll. T. Kawamoto. Paratypes. RUMF-ZC-1580, ovigerous female, CL 2.6 mm, "Mystery Hole", Kume Island, Ryukyu Islands, 25 m, 9 August 2002, coll. T. Kawamoto; CMNH-ZC 02411, female, CL 3.1 mm, NTOU M01213, ovigerous female, CL 2.5 mm, 2 females CL 1.8 mm, 2.5 mm, same locality as holotype, 12 November 2002, coll. J. Okuno.

Description. Carapace (Fig. 1) glabrous, supraorbital spine absent; orbit feebly developed, inferior orbital angle slightly produced, bluntly angular; antennal spine well developed, slender, submarginal, arising slightly ventral to inferior orbital angle; hepatic spine narrow, arising distinctly ventral to level of antennal spine; epigastric spine present, feebly demarcated; pterygostomial margin rounded.

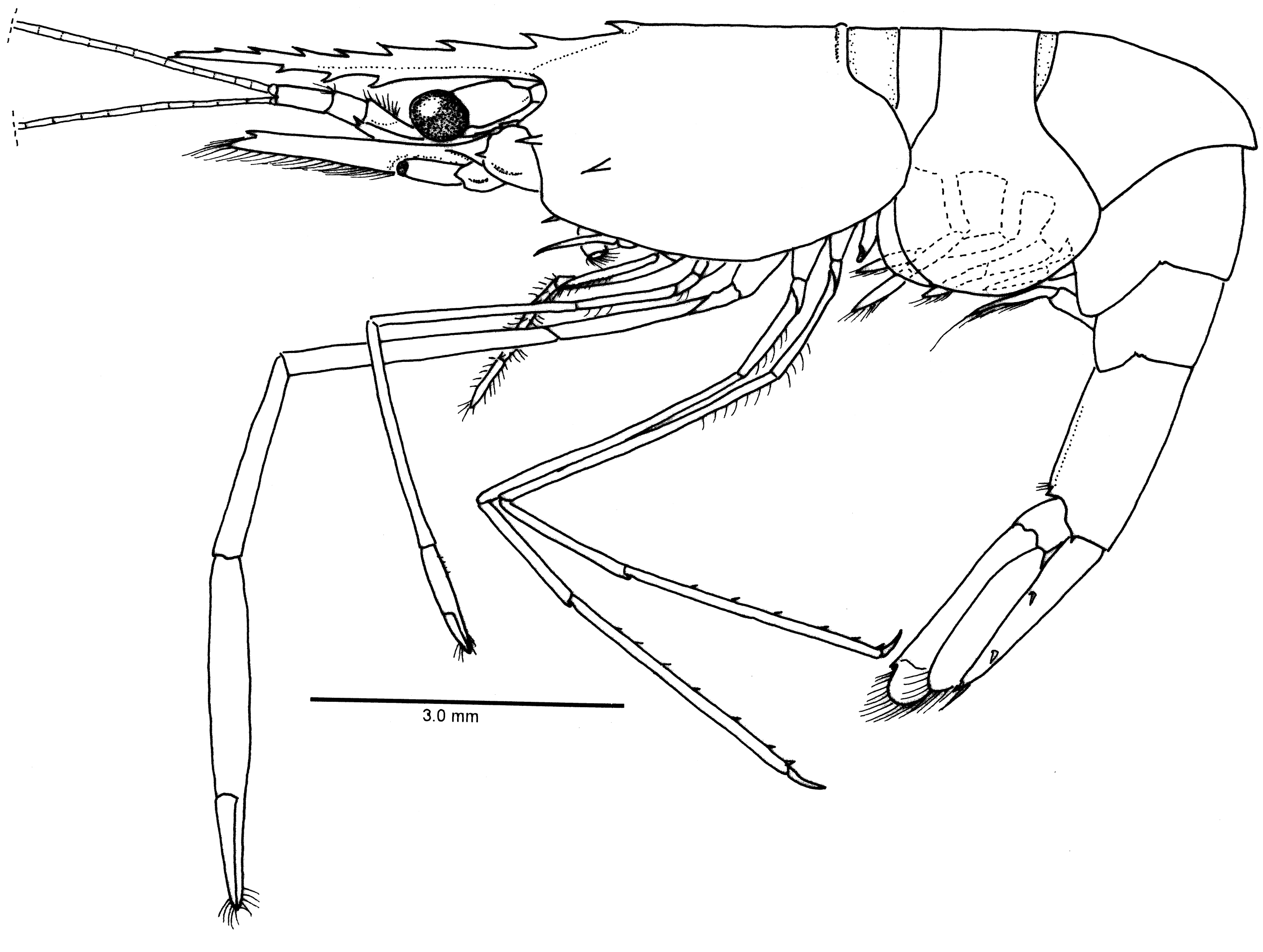


FIGURE 1. *Cuapetes lanceolatus* **n. sp.** Holotype, female, CL 3.0 mm, RUMF-ZC-1579. Entire animal, lateral view.

Rostrum (Fig. 2A, B) long, narrow, straight, horizontal, 1.1–1.6 times as long as carapace, distinctly overreaching distal blade of scaphocerite; dorsal margin armed with 8–10 (usually 9) equidistant, small, acute teeth, most proximal tooth situated just above posterior orbital margin; ventral margin armed with 2–3 (usually 3) acute teeth at about midlength.

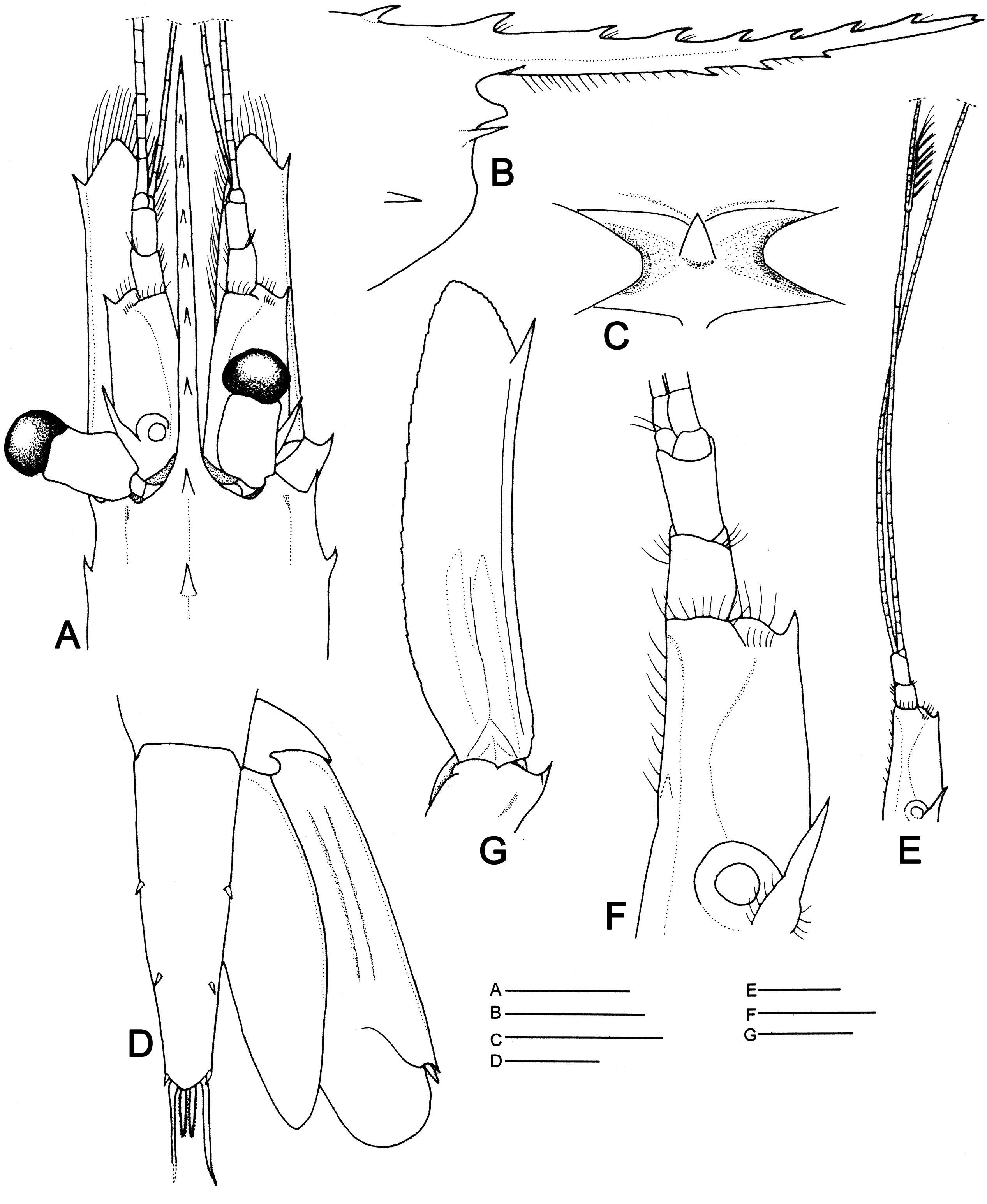


FIGURE 2. *Cuapetes lanceolatus* **n. sp.** Holotype, female, CL 3.0 mm, RUMF-ZC-1579. A, anterior part of carapace, rostrum and cephalic appendages, dorsal view; B, anterior part of carapace and rostrum, lateral view; C, fourth thoracic sternite, ventral view D, telson and right uropod, dorsal view; E, right antennule, dorsal view; F, right antennular peduncle, dorsal view; G, right scaphocerite, dorsal view. D, G, marginal setae omitted. Scale bars: A, B, E, 1.0 mm; C, D, F, G, 0.5 mm.

Fourth thoracic sternite (Fig. 2C) with acute median process, stouter than those of congeners.

Abdomen (Fig. 1) smooth, glabrous; pleura of first to third somites broad, rounded, those of fourth and fifth posteriorly produced, but blunt; posterodorsal margin of third somite not posterodorsally produced; sixth somite moderately compressed, 0.5–0.7 times as long as carapace, subequal to telson in length, posterolateral process acute, posteroventral margin slightly produced, with small tooth. Telson (Fig. 2D) slightly tapering posteriorly, posterior margin convex, with 3 pairs of spines, lateral and intermediate spines simple, intermediate spines longest, submedian spines setulose; 2 pairs of small, subequal dorsolateral spines at proximal two fifths and posterior third of telson length.

Ophthalmic somite without interocular process. Eye (Fig. 2A) with large, globular cornea, accessory pigment spot absent; stalk without dorsal tubercle, distinctly longer than corneal diameter, becoming slightly narrower distally, maximum width subequal to maximum corneal diameter.

Antennular peduncle (Fig. 2F) with proximal segment distinctly longer than distal two segments combined; distolateral margin slightly produced, rounded, with row of sparse setae, lateral margin straight, terminating distally in acute tooth, reaching level of proximal third of intermediate segment; ventromesial margin armed with small acute tooth; stylocerite slender, acute, reaching level of proximal two fifths of proximal segment; statocyst well developed, rounded. Intermediate segment robust, about third of proximal segment length, slightly obliquely articulated with distal segment. Distal segment slightly longer than intermediate segment, slender, non-setose. Upper flagellum (Fig. 2E) biramous, proximal 15–19 segments fused, shorter free ramus 7–9 segmented; lower flagellum similar to upper flagellum in width.

Antenna with stout basicerite armed ventrolaterally with acute tooth; scaphocerite (Fig. 2G) overreaching antennular peduncle, 3.7–4.5 times as long as maximum width, lateral margin feebly concave, terminating in strong tooth falling distinctly short of distal blade of bluntly angular lamella; carpocerite stout, reaching proximal fourth of scaphocerite.

Epistome unarmed.

Mandible (Fig. 3A) robust, without palp; molar process truncated distally, with large, blunt teeth; incisor process tapering distally, with 3 acute distal teeth. Maxillule (Fig. 3B) with feebly bilobed palp, internal lobe with small distal protuberance; upper lacinia broad, curved, distal margin truncated, with about 7 spines and sparse submarginal setae; lower lacinia tapering distally, with some spiniform setae distally. Maxilla (Fig. 3C) with palp slender, tapering distally; distal endite developed, narrow, deeply bilobed, densely covered with long setae distally; proximal endite obsolete, mesial margin feebly sinuous; scaphognathite well developed, posterior lobe short, tapering distally, distal half of anterior lobe narrow, distal margin subquadrate. First maxilliped (Fig. 3D) with long, slender, simple palp; distal endite with mesial margin bearing 2 rows of dense setae, rounded distally; proximal endite small, rounded, separated from distal endite by shallow notch; caridean lobe broad; exopod with well-developed flagellum; epipod large, subquadrate. Second maxilliped (Fig. 3E) with normal endopod; dactylus broad, mesial margin slightly concave; propodus with anteromesial margin broadly rounded; carpus with distinct ventromesial process; merus about twice as long as carpus; ischium and basis fused; exopod with well developed flagellum; coxa inflated mesially; epipod oval, without podobranch. Third maxilliped (Fig. 3F) with endopod slender, reaching distal third of scaphocerite, ultimate segment tapering distally, mesially with about 8 transverse rows of short setae, laterally with dense setae; penultimate segment 1.8–2.3 times as long as ultimate segment, furnished uniformly with sparse setae; antepenultimate segment clearly demarcated from basis, ventral margin sparsely setose; basis and coxa feebly demarcated, exopod with well developed flagellum, distally with long setae; coxal plate oval; small unilamellar arthrobranch present.

Branchial formula as in Table 1.

First pereiopod (Fig. 4A) long, slender, overreaching distal margin of scaphocerite by length of chela and distal third of carpus. Chela (Fig. 4B) 0.3–0.4 times as long as carapace; palm subcylindrical, slightly compressed, 2.3–2.7 times as long as dactylus, with 5 transverse rows of short serrulate grooming setae proximoventrally; fingers each terminating in small unguis, with numerous groups of short setae, cutting edges entire, situated slightly laterad. Carpus 0.7–0.8 times as long as carapace, 2.0–2.3 times as long as chela, slightly widened distally, with longitudinal row of serrulate grooming setae distoventrally (Fig. 4B). Merus 0.6–0.7 times as long as carapace, unarmed. Ischium and coxa ventrally setose.

TABLE 1. *Cuapetes lanceolatus* n. sp. Branchial formula.

	Maxillipeds			Pereiopods				
	I	II	III	I	II	III	IV	V
Pleurobranchs	—	—	—	1	1	1	1	1
Arthrobranchs	—	—	1	—	—	—	—	—
Podobranchs	—	—	—	—	—	—	—	—
Epipods	1	1	1	—	—	—	—	—
Exopods	1	1	1	—	—	—	—	—

Second pereiopods well developed, elongate, similar in form, unequal in length. Major second pereiopod (Fig. 4C) overreaching scaphocerite by combined lengths of distal fifth of merus, carpus and chela; chela 1.3–2.0 times as long as carapace, 1.9–2.7 times as long as carpus, palm 1.9–2.2 times as long as dactylus, slightly compressed, fixed finger (Fig. 4D) terminating in hooked, acutely pointed unguis, cutting edge situated laterally, armed with 3 small teeth at proximal fourth and a single large tooth at midlength, remaining part entire, sharply edged; dactylus (Fig. 4D) with cutting edge almost entire, armed proximally with a single large, triangular tooth; carpus slender, unarmed, feebly widened distally; merus slender, unarmed, 1.2–1.4 times as long as carpus; ischium slender, unarmed. Minor second pereiopod (Fig. 4E) slightly shorter than major second pereiopod, overraching scaphocerite by lengths of carpus and chela; chela 1.1–1.3 times as long as carapace, 1.7–2.0 times as long as carpus, palm 1.7–1.9 times as long as dactylus, dactylus slightly longer than that of major second pereiopod, cutting edge almost entire, armed with a single small tooth at proximal fourth; fixed finger armed proximally with 2 small teeth, with their interspace opposing dactylar tooth; merus 1.2–1.5 times as long as carpus.

Ambulatory pereiopods rather slender, similar to each other. Third pereiopod (Fig. 4G) overreaching distal margin of scaphocerite by lengths of dactylus and distal two thirds of propodus. Merus 0.8–1.0 times as long as carpus, unarmed, feebly setose. Carpus unarmed. Propodus (Fig. 4H) 2.1–2.3 times as long as carpus, 6.3–10.3 times as long as dactylus, armed ventrally with 6–8 spines, dorsal surface with few short setae. Dactylus (Fig. 4I) slender, curved, compressed laterally, unguis not demarcated, dorsal margin with a long seta at midlength. Fourth pereiopod overreaching distal margin of scaphocerite by lengths of dactylus, propodus and distal part of carpus, proportion similar to that of third pereiopod. Fifth pereiopod longest in all ambulatory pereiopods, overreaching distal margin of scaphocerite by lengths of dactylus and distal two thirds of propodus.

Uropod (Fig. 2D) with protopodite posterolaterally produced; exopod broad, overreaching telson, subquadrate distally, lateral margin nearly straight, terminating in small acute tooth, larger, mobile spine present just mesial to distolateral tooth; endopod oval, falling slightly short of posterior margin of exopod.

Colour in life (Fig. 6A). Body and appendages generally transparent, with dense red pigmentation on ventral edge of carapace, ventral midline of abdominal somites, distal part of telson, external margin of stylocerite, lateral surface of antennal basicerite, and dorsal surface of uropod. Fingers of second pereiopod pale brown, proximally ringed with pale yellow band.

Etymology. From the Latin ,”*lancea*”, meaning spear-like, in alluding to the general body form as well as the shape of the rostrum of the new species.

Common name. Jihuwa-tenaga-kakure-ebi (new standard Japanese name).

Distribution. So far only known from Kume Island, the Ryukyu Islands, southern Japan.

Ecological notes. The present new species was associated with an unidentified species of the genus *Antipathes* Pallas, 1766 (Cnidaria: Anthozoa: Hexacorallia: Antipatharia: Antipathidae) living on the upper wall of large crevices at a depth of 25 m in Kume Island. The host black coral has a dense and intricate branching growth form (see Kawamoto & Okuno 2003, 2006, 2009).

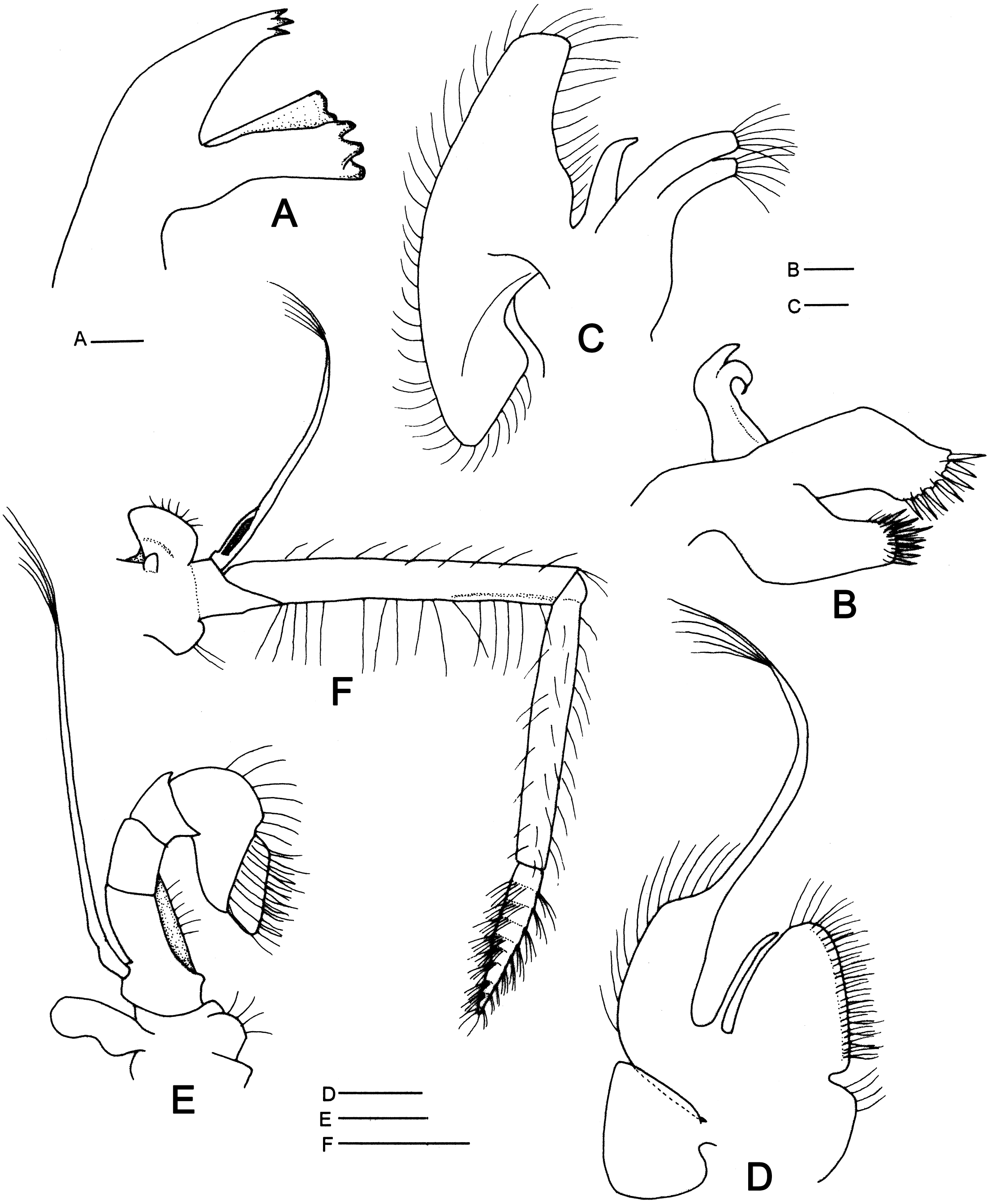


FIGURE 3. *Cuapetes lanceolatus* **n. sp.** Paratype, female, CL 3.1 mm, CMNH-ZC 02411. Right mouthparts, external view. A, mandible; B, maxillula; C, maxilla; D, first maxilliped; E, second maxilliped; F, third maxilliped. Scale bars: A–C, 0.1 mm; D, E, 0.25 mm; F, 0.5 mm.

Remarks. The present new species can be assigned to the genus *Cuapetes* on account of the following features: fixed hepatic spine present on the carapace; fourth thoracic sternite armed with an acute median process; mandibular palp lacking; first to third maxillipeds with developed exopodal flagella; second pereiopod elongate, exceeding scaphocerite; ambulatory pereiopods with simple dactyli and propodi bearing distoventral spines but lacking distoventral dense setae.

The lack of a supraorbital spine, eyestalk without dorsal tubercle and the absence of distoventral spines on the ischium and merus of the second pereiopod link the new species to *C. akiensis* (Kubo, 1936) and *C. calmani* (Tattersall, 1921). Nevertheless, the form of the rostrum and the long upper antennular flagellum readily distinguishes the new species from these two species. In *C. lanceolatus*, the rostrum is straight and narrow throughout its length, and the proximal fused part of the upper flagellum of the antennule consists of 15–19 segments. In the other two species, the rostrum is proximally straight but distinctly sinuous distally, and the midlength of the rostrum is deeper than distal part. The proximal fused part of the upper flagellum of the antennule only has 5–11 segments in *C. akiensis* and *C. calmani* (see Kubo 1936; Bruce 1987). *Cuapetes lanceolatus* further differs from *C. calmani* by the terminal tooth of the external margin of the scaphocerite falling short of the distal margin of the lamella versus exceeding the lamella in *C. calmani* (Bruce 1987). The ecology of *C. lanceolatus* also differ from *C. akiensis* and *C. calmani* with the latter two species being free living (Bruce 2004).

In pontoniine shrimps, several genera and species are known to be associated with antipatharians (e.g., Spotte *et al*. 1994; d'Udekem d'Acoz 1996; Okuno 1998; Vargas 2000; Bruce 2010), although the only other *Cuapetes* species which does so is *C. nilandensis* (see below). Morphologically, *C. lanceolatus* can be readily separated from *C. nilandensis* by the lack of a supraorbital spine.

The "*Periclimenes* sp. B", "*Kemponia* sp." and " *Cuapetes* sp." in Kawamoto & Okuno (2003, 2006, 2009) refer to the same colour photograph and the photographed individual is the holotype of *Cuapetes lanceolatus*.

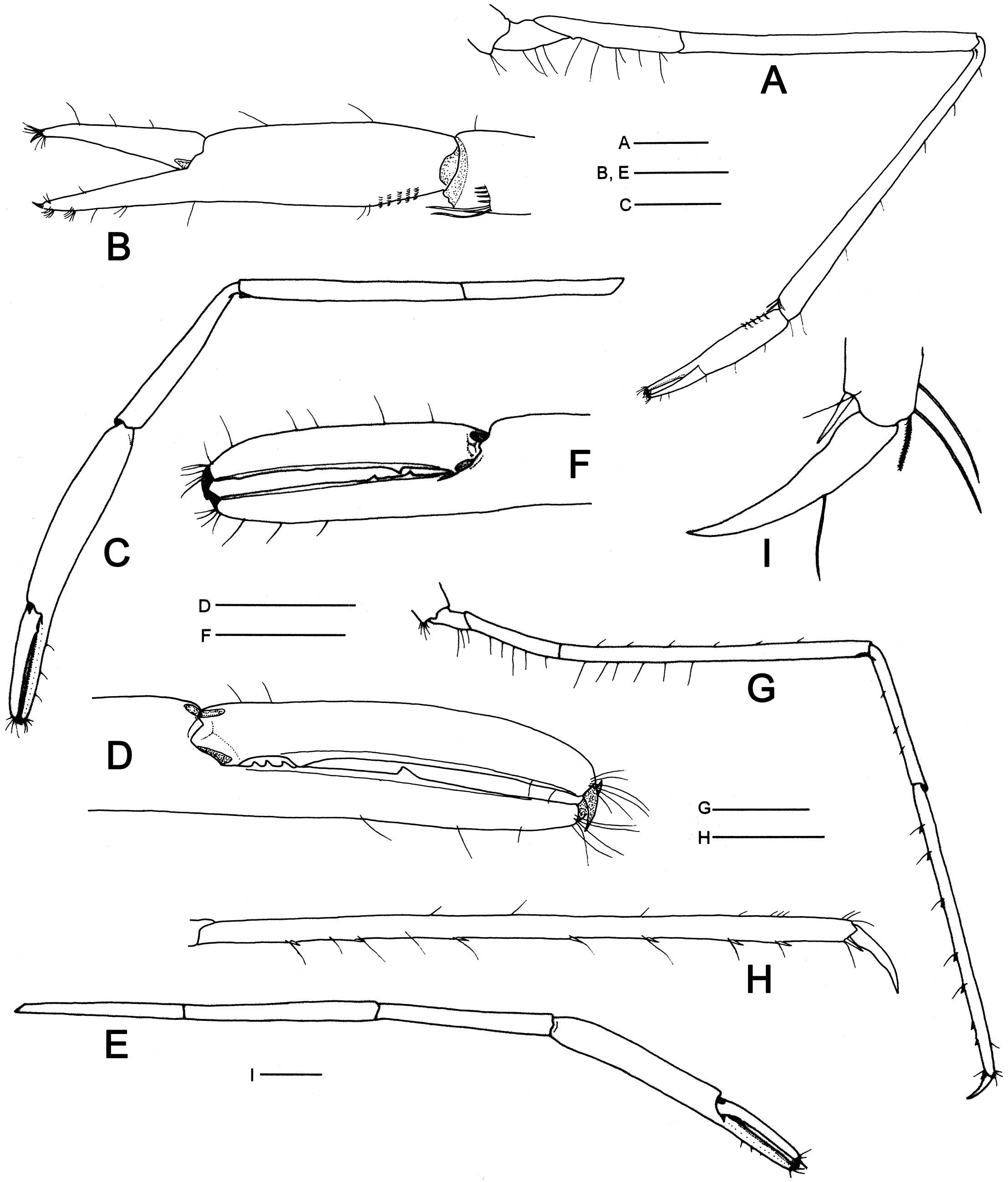


FIGURE 4. *Cuapetes lanceolatus* **n. sp.** Holotype, female, CL 3.0 mm, RUMF-ZC-1579. A, right first pereiopod, lateral view; B, same, chela and distal part of carpus, mesial view; C, left major second pereiopod, lateral view; D, same, fingers, mesial view; E, right minor second pereiopod, lateral view; F, same, fingers, mesial view; G, right third pereiopod, lateral view; H, same, propodus and dactylus, lateral view; H, same, dactylus, lateral view. Scale bars: A, D, F, H, 0.5 mm; B, 0.25 mm; C, E, G, 1.0 mm; I, 0.1 mm.

Cuapetes nilandensis (Borradaile, 1915)

(Figs. 5, 6B, C)

Periclimenes (*Falciger*) *nilandensis* Borradaile, 1915: 211; Borradaile 1917: 324, pl. 54, fig. 3.

Periclimenes (*Ancylocaris*) *nilandensis*—Kemp 1922: 172.

Periclimenes (*Harpilius*) *nilandensis*—Holthuis 1952: 58–60, fig. 22.

Periclimenes nilandensis—Bruce 1978: 222–227, figs. 8, 9; Bruce 1981: 18; Chace & Bruce 1993: 118–119; Bruce & Coombes 1995: 132; Li 2000: 214, fig. 278.

Kemponia nilandensis—Bruce 2004: 18; Li *et al*. 2004: 531–532; Li & Bruce 2006: 647–648; Marin & Savinkin 2007: 181–182, fig. 85D in colour.

Cuapetes nilandensis—Okuno 2009: 67.

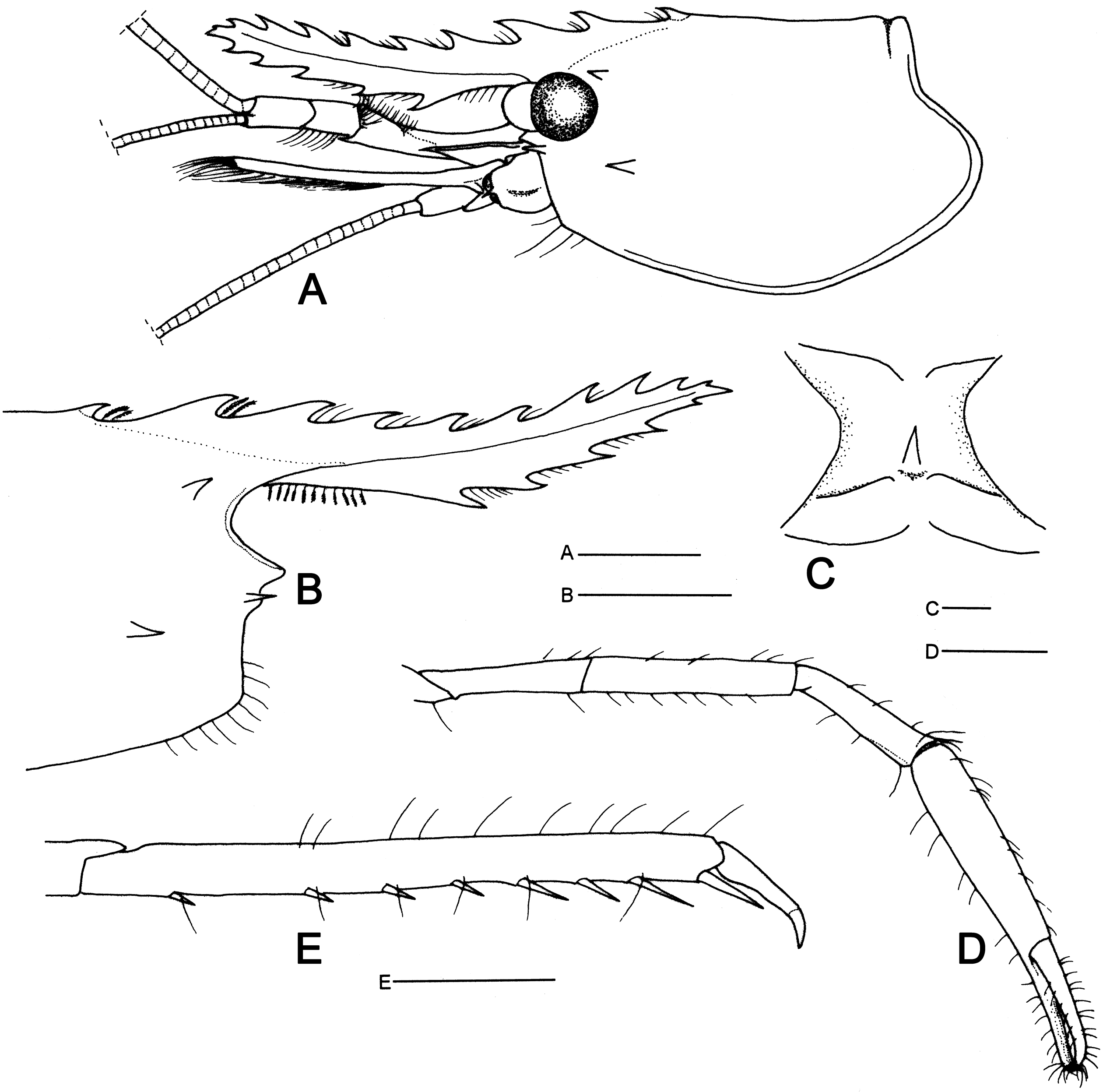


FIGURE 5. *Cuapetes nilandensis* (Borradaile, 1915). Ovigerous female, CL 2.9 mm, NTOU M01384 (A, B, D, E), female, CL 2.0 mm, CMNH-ZC 01899 (C). A, anterior part of carapace, rostrum and cephalic appendages, lateral view; B, anterior part of carapace and rostrum, lateral view; C, fourth thoracic sternite, ventral view; D, right second pereiopod, lateral view; E, propodus and dactylus of right third pereiopod, lateral view. Scale bars: A, B, D, 1.0 mm; C, 0.1 mm; E, 0.5 mm.

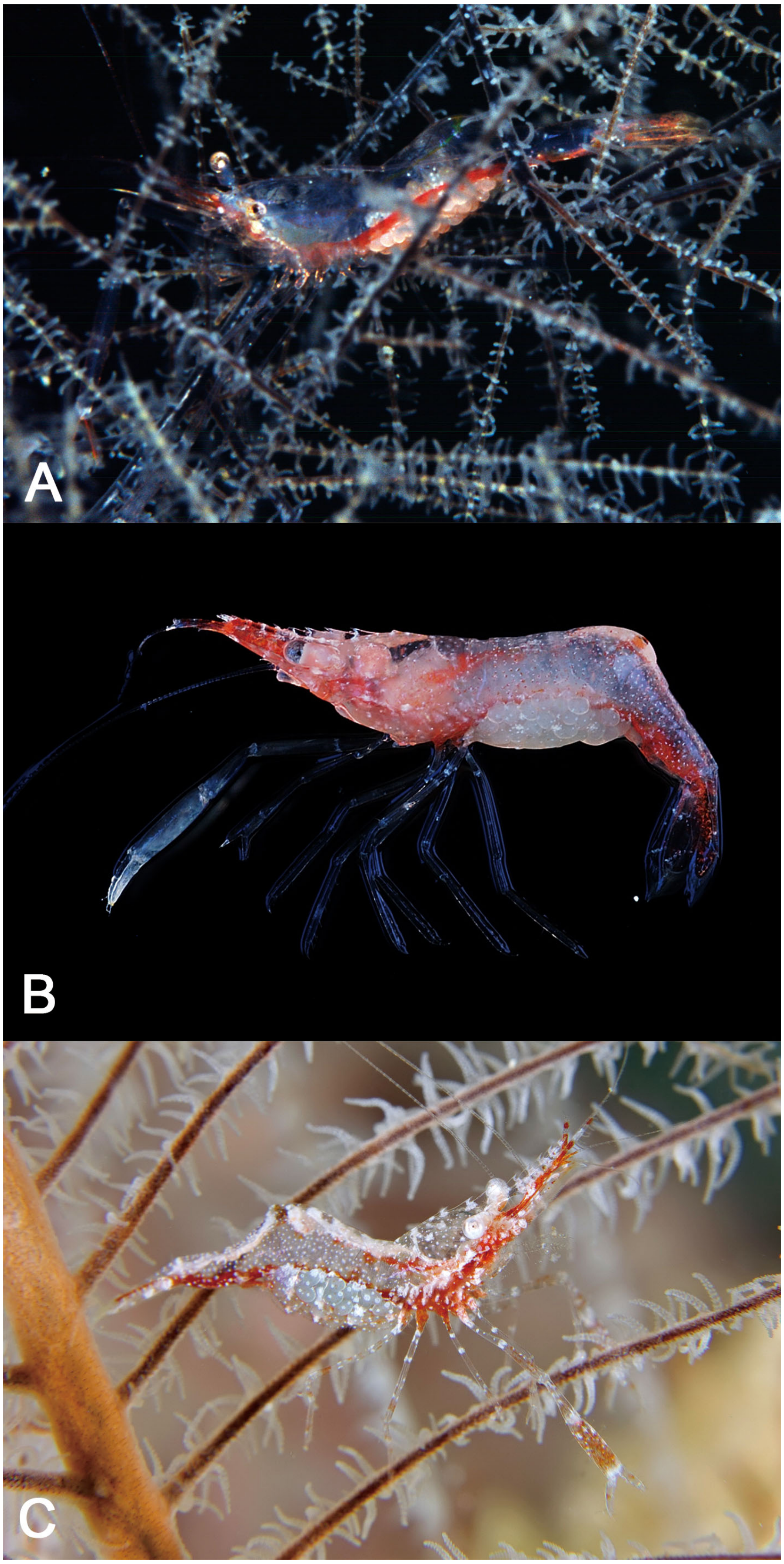


FIGURE 6. A, *Cuapetes lanceolatus* **n. sp.** Holotype, female (ova detached by collecting shock), CL 3.0 mm, RUMF-ZC-01579. *In situ*, associated with an unidentified antipatharian at Umagai, Kume Island, 25 m, 29 October 2002 (photo T. Kawamoto). B, C, *Cuapetes nilandensis* (Borradaile, 1915). B, ovigerous female, CL 3.0 mm, NTOU M01237, fresh specimen, lateral view (photo T.-Y. Chan); C, *in situ*, associated with an unidentified antipatharian at Kyoda, Nago, Okinawa Island, 30 m, November 2010 (photo Y. Yamada).

Material examined. Kume Island. NTOU M01237, 1 ovigerous female, CL 3.0 mm, NTOU M01384, 1 male, 1 female, 6 ovigerous females, CL 2.5–3.0 mm, trawl 31, 75.3–70.4 m, 26°18.785′N 126°53.249′E–26°18.904′N 126°53.563′E, 13 November 2009. Okinawa Island. CMNH-ZC 01969, 1 male, 3 females, 2 juveniles, CL 0.9–2.0 mm, Seragaki, Onna Village, 48.5 m, in association with *Parantipathes tenuispina* Silberfeld, 1909 (CMNH-ZG 4287), 13 August 2004, coll. T. Yanagisawa; CMNH-ZC 01898, 1 male, CL 1.4 mm, 1 female, CL 1.7 mm, CMNH-ZC 01899, 1 female, CL 2.0 mm, Seragaki, Onna Village, 48–50 m, in association with an unidentified antipatharia, 4 May 2005, coll. T. Yanagisawa. CMNH-ZC 02412, 1 ovigerous female, CL 2.4 mm, RUMF-ZC-1581, 2 females, CL 2.0, 2.4 mm, Kyoda, Nago, 30 m, in association with an unidentified antipatharian, 19 November 2010, coll. M. Tsuchiya and Y. Yamada.

Colouration (Fig. 6B, C). Body generally transparent. Carapace and rostrum covered with white dots; thoracic sternites vermilion; abdominal somites also with white dots, dorsal midline salmon pink, ventral midline red. Eyestalk salmon pink, cornea white. External margin of antennal scaphocerite red. All prereiopods with bases reddish, palm of second pereiopod reddish-brown.

Common name. Sabachi-tenaga-kakure-ebi (new standard Japanese name).

Distribution. Type locality: South Nilandu Atoll, Maldive Islands, Indian Ocean (Borradaile 1915). Also known from Madagascar (Bruce 1978; Li & Bruce 2006), Réunion (Li & Bruce 2006), Indonesia (Holthuis 1952), Vietnam (Marin & Savinkin 2007), Beibu Bay, South China Sea (Li *et al*. 2004), Japan (present study), Australia (Bruce 1981; Bruce & Coombes 1995), and New Caledonia (Li & Bruce 2006).

Remarks. The specimens examined here are identified with *Cuapetes nilandensis* on account of the following features: Carapace (Fig. 5A, B) armed with a supraorbital spine, pterygostomial margin furnished sparsely with long setae; rostrum (Fig. 5B) nearly horizontal but dorsally sinuous distally, slightly overreaching scaphocerite, 1.0–1.5 times as long as carapace, armed dorsally with 7–10 equidistant teeth, posterior-most tooth situated slightly posterior to orbital margin, ventrally with 3–5 teeth; fourth thoracic sternite (Fig. 5C) with an acute median process; second pereiopod (Fig. 5D) without distoventral tooth on merus, with carpus shorter than merus; ambulatory pereiopods with propodi (Fig. 5E) armed distoventrally with long spines, about half as long as dactylus. The long spines on the propodi are especially diagnostic, as all other congeners have markedly shorter spines.

Most species of *Cuapetes* are free-living, but some of them are known as to be associated with Hexacorallia: *C. amymone* (De Man, 1902) and *C. kororensis* Bruce, 1977, are obligatory associates of scleractinian corals, whilst *C. lanceolatus* (see above) and *C. nilandensis* are associated with antipatharian corals (Bruce 1998, 2004). The host specificity of *C. nilandensis* appears to be low, as it has also been recorded from Hydrozoa (Bruce 1981) and Octocorallia, such as gorgonians (Bruce 1978, 2004) and alcyonarians (Marin & Savinkin 2007). Part of the present specimens catalogued as CMNH-ZC 01969 were found on *Parantipathes tenuispina* collected together with the pandalid shrimp, *Chlorotocella gracilis* Balss, 1914 (CMNH-ZC 01970, 1 female) and the trapeziid crab, *Quadrella maculosa* Alcock, 1898 (CMNH-ZC 01971, 1 male and 1 female).

The present specimens represent the first record of *C. nilandensis* from Japan, also being the northern-most limit of its known geographical range.

Acknowledgements

The material examined was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center of Excellence for Marine Bioenvironment and Biotechnology of National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of National University of Singapore (RMBR), and the Biodiversity Research Center of Academia Sinica (BRCAS). The expedition operated under a permit granted to Dr. T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. Our cordial thanks are extended to the skilful divers, T. Kawamoto, M. Tsuchiya, Y. Yamada and T. Yanagisawa for donating the specimens examined in this study to us. Kawamoto and Yamada also kindly provided us with their excellent underwater photographs. We wish to express our sincere gratitude to H. Takaoka of the Okinawa Churaumi Aquarium for information of taxonomy on the host antipatharians.

References

Borradaile, L.A. (1915) Notes on Carides. *Annals and Magazine of Natural History*, ser. 8, 15, 205–213.

Borradaile, L.A. (1917) The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the Leadership of Mr. J. Stanley Gardiner, M.A. Volume 6, Number 8. On the Pontoniinae. *Transactions of the Linnean Society of London (Zoology)*, ser. 2, 17, 323–396, pls. 52–57.

Bruce, A.J. (1978) A report on a collection of pontoniine shrimps from Madagascar and adjacent seas. *Zoological Journal of the Linnean Society*, 62, 205–290.

Bruce, A.J. (1981) Pontoniine shrimps of Heron Island. *Atoll Research Bulletin*, 245, 1–33.

Bruce, A.J. (1998) New keys for the identification of Indo-West Pacific coral associated pontoniine shrimps, with observations on their ecology (Crustacea: Decapoda: Palaemonidae). *Ophelia*, 49, 29–46.

Bruce, A.J. (2004) A partial revision of the genus *Periclimenes* Costa, 1884 [sic] (Crustacea: Decapoda: Palaemonidae). *Zootaxa*, 582, 1–26.

Bruce, A.J. (2010) *Periclimenes nevillei* sp. nov. (Crustacea: Decapoda: Pontoniinae) from Vanuatu. *Zootaxa*, 2510, 45–54.

Bruce, A.J. & Coombes, K.E. (1995) The palaemonid shrimp fauna (Crustacea: Decapoda: Caridea) of the Cobourg Peninsula, Northern Territory. *The Beagle, Records of the Museum and Art Galleries of the Northern Territory*, 12, 101–144.

Chace, F.A. Jr. & Bruce, A.J. (1993) The caridean shrimps (Crustacea: Decapoda) of the Albatross Philippine Expedition 1907–1910. Part 6: Superfamily Palaemonoidea. *Smithsonian Contributions to Zoology*, 543, i–vii, 1–152.

Holthuis, L.B. (1952) The Decapoda of the Siboga Expedition, part XI. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species, part II: Subfamily Pontoniinae. *Siboga-Expeditie*, 39a(10), 1–254.

Kawamoto, T. & Okuno, J. (2003) *Shrimps and crabs of Kume Island, Okinawa*. First printing. Hankyu Communications, Tokyo. 173 pp. [in Japanese]

Kawamoto, T. & Okuno, J. (2006) *Shrimps and crabs of Kume Island, Okinawa*. Second printing. Hankyu Communications, Tokyo. 174 pp. [in Japanese]

Kawamoto, T. & Okuno, J. (2009) *Shrimps and crabs of Kume Island, Okinawa*. Third printing. Hankyu Communications, Tokyo. 173 pp. [in Japanese]

Kemp, S. (1922) Notes on Crustacea Decapoda in the Indian Museum. XV. Pontoniinae. *Records of the Indian Museum*, 24, 113–288, pls. 3–9.

Kubo, I. (1936) Two new littoral macrurous crustaceans from Japan. *Journal of the Imperial Fisheries Institute*, 31, 47–54, pls. 14–15.

Li, X.-Z. (2000) *Catalog of the genera and species of Pontoniinae Kingsley, 1878 (Decapoda, Palaemonidae)*. Xueyuan Press, Beijing, 319 pp.

Li, X.-Z. & Bruce, A.J. (2006) Further Indo-West Pacific palaemonid shrimps (Crustacea: Decapoda: Palaemonidae), principally from the New Caledonian region. *Journal of Natural History*, 40, 611–738.

Li, X.-Z, Manning, R.B. & Bruce, A.J. (2004) Some palaemonid shrimps (Crustacea: Decapoda) from northern South China Sea, with descriptions of two new species. *Raffles Bulletin of Zoology*, 52, 513–553.

Marin, I.N. & Savinkin, O.V. (2007) Further records and preliminary list of pontoniine (Caridea: Palaemonidae: Pontoniinae) and hymenocerid (Caridea: Hymenoceridae) shrimps from Nhatrang Bay. *In*: Britayev, T.A. & Pavlov, D.S. (eds.), *Benthic fauna of the bay of Nhatrang, southern Vietnam*. KMK Scientific Press, Moscow, pp. 175–208, figs. 83–96.

Okuno, J. (1998) *Miopontonia yongei* Bruce, 1985 (Decapoda, Caridea, Palaemonidae): New host record and colour pattern. *Crustaceana*, 71, 349–353.

Okuno, J. (2009) *Cuapetes* Clark, 1919, a senior synonym of *Kemponia* Bruce, 2004 (Crustacea: Decapoda: Palaemonidae). *Zootaxa*, 2028, 67–68.

Spotte, S., Heard, R.W. & Bubucis, P.A. (1994) Pontoniine shrimps (Decapoda: Caridea: Palaemonidae) of the northwest Atlantic. IV. *Periclimenes antipathophilus* new species, a black coral associate from the Truks and Caicos Islands and eastern Honduras. *Bulletin of Marine Science*, 55, 212–227.

Tattersall, W.M. (1921) Report on the Stomatopoda and macrurous Decapoda collected by Mr. Cyril Crossland in the Sudanese Red Sea. *Journal of the Linnean Society of London, Zoology*, 34, 345–398, pls. 27–28.

Udekem d'Acoz, C. d' (1996) Description of *Periclimenes wirtzi* sp. nov., a new pontoniine shrimp from Madeira and the Azores, with a checklist of Eastern Atlantic and Mediterranean Pontoniinae (Crustacea, Decapoda, Caridea). *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie*, 66, 133–149.

Vargas, R. (2000) *Periclimenes murcielagensis*, a new species of shrimp (Crustacea: Decapoda: Palaemonidae) living on black coral from the Pacific coast of Costa Rica. *Proceedings of the Biological Society of Washington*, 113, 17–23.

Zootaxa 3367: 126–133 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Reef lobsters of the genus *Enoplometopus* A. Milne-Edwards, 1862 (Crustacea: Decapoda: Nephropidea) from the KUMEJIMA 2009 Expedition in Okinawa, with the second record of the rare species *E. chacei* Kensley & Child, 1986*

TIN-YAM CHAN[1] & YOSHIHISA FUJITA[2,3]

[1]*Institute of Marine Biology and Center of Excellence for Marine Bioenviroment and Biotechnology, National Taiwan Ocean University, Keelung 20224, Taiwan, R.O.C. E-mail: tychan@mail.ntou.edu.tw*
[2]*University Education Center, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan.*
E-mail: galatheids@yahoo.co.jp
[3]*Marine Learning Center, 2-95-101 Miyagi, Chatan-cho, Okinawa 904-0113, Japan.*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Two reef lobsters of the genus *Enoplometopus* A. Milne-Edwards, 1862, were collected during the KUMEJIMA 2009 Expedition. The first is the very rare species *Enoplometopus chacei* Kensley & Child, 1986, which was previously known only from the male holotype collected in the Philippines. It is found that *E. chacei* has two colour forms: one form with the body covered with red dots while the other form completely lacking red dots on the body. The second species collected is *E. voigtmanni* Türkay, 1989, and represents the first recorded male of this species. Colour photographs are provided for the two species. The characters distinguishing *E. chacei* and *E. voigtmanni* from their closest congeners are discussed.

Key words: Crustacea, Decapoda, reef lobsters, *Enoplometopus chacei*, *Enoplometopus voigtmanni*, Kume Islands, Okinawa

Introduction

Although the reef lobsters genus *Enoplometopus* A. Milne-Edwards, 1862, occurs mainly in warm waters and many of them have a wide distribution in the western Pacific (see Chan & Ng 2008), only two species have been reported from the Ryukyu Islands. They are *E. occidentalis* (Randall, 1840) and *E. voigtmanni* Türkay, 1989 (e.g. Hirayama 1997; Minemizu 2000; Kawamoto & Okuno 2003). Some years ago, two specimens of *Enoplometopus* collected from the Kume Island in Okinawa were sent to the first author for identification. These two specimens are morphologically similar to *E. occidentalis* and also with an orange-red colouration. However, their colours are much "duller" than that of *E. occidentalis* in lacking distinct white ocelli on the body and with pereiopods not banded. A close examination of the specimens shows that they are likely represent the very rare species *E. chacei* Kensley & Child, 1986, which has so far been known by only the holotype male from the Philippines. However, the two specimens from Kume Island, though morphologically very similar and of the same size and sex (i.e. males), differ considerably in the presence or absence of many red dots on the carapace and abdomen. During the "KUMEJIMA 2009" expedition and in subsequent collection in the Kume Island, three more "dotted" specimens (2 males and 1 female) and two more "non-dotted" specimens (2 females) were collected. The availability of these additional specimens proved that the "dotted" and "non-dotted" forms belong to the same species and can be identified with *E. chacei*. The more specimens obtained for *E. chacei* allows a better understanding of the characteristics and colour pattern of this rare species as compared to its two closely related species *E. debelius* Holthuis, 1983, and *E. daumi* Holthuis, 1983. A comparison of partial COI sequence (or the barcoding gene, Stoeckle & Hebert 2008) also confirms that the "dotted" and "non-dotted" forms of *E. chacei* belong to the same

Accepted by T. Naruse: 17 Feb. 2011; published: 4 Jul. 2012

species, which is genetically highly divergent from *E. debelius* and *E. daumi*. Other than *E. chacei*, two full-grown males of *E. voigtmanni* were also collected during the “KUMEJIMA 2009” expedition and in subsequent collection in the Kume Island. No male of *E. voigtmanni* has been formally recorded before. The present work reports these findings.

Material and Methods

Specimens examined in this study are deposited at the Ryukyu University Museum, Fujukan, Okinawa (RUMF), National Taiwan Ocean University, Keelung (NTOU), Natural History Museum and Institute, Chiba (CBM), and the Crustacean Collection of the National Museum, Manila (NMCR). The measurements given are carapace length (cl), which is measured dorsally from the posterior point of the orbital margin to the posterior margin of the carapace. The material of *E. debelius* (3 specimens, cl 11.2–13.8 mm, NTOU M00173) and *E. daumi* (8 specimens, cl 11.2–18.5 mm, NTOU M00171, M00988, M 00989, M00990, M00991) used for comparison are the same as those cited in Chan & Ng (2008).

Taxonomic account

Enoplometopus chacei **Kensley & Child, 1980**

(Figs. 1, 2A, B, 3, 4A)

Enoplometopus chacei Kensley & Child, 1980: 520, figs. 1–2 [type locality: Philippines]. — Chan & Ng, 2008: 354, fig. 5B.
[?] *Enoplometopus occientalis*. — Kubo, 1952: 97, fig. 3, pl. 6. (not Randall, 1840)

Material examined. Kume Island, Okinawa: Hiyajo, scuba diving, 10 m, 1 Mar. 1992, 1 male (dotted) cl 33.0 mm (CBM-ZC 6696); Maenohama, gill net, 10 m, 9 Mar. 1997, 1 male (non-dotted) cl 40.9 mm (CBM-ZC 6697); KUMEJIMA 2009stn Dive 15, Ebi-ana, scuba diving, 10 m, 13 Nov. 2009, 1 female (dotted) cl 35.5 mm (NTOU M00995), 1 female (non-dotted) cl 35.3 mm (NTOU M00994); KUMEJIMA 2009 stn Dive 28, Oyako-iwa, scuba diving, >20 m, 17 Nov. 2009, 1 male (dotted) cl 31.3 mm (NTOU M00993); Tokujimu, scuba diving, 6 Dec. 2010, 1 male (dotted) cl 32.4 mm (RUMF-ZC-01323), 1 female (non-dotted) cl 25.1 mm (RUMF-ZC-01324).

Philippines, Batan Island, hand net, 2 m, 8 Jun. 1985, holotype male cl 36.7 mm (NMCR).

Diagnosis. Size moderately large (up to 40.9 mm cl). Carapace with 3 lateral, 2 intermediate, 4 median (sometimes also bearing 1 minute anterior tubercle) and 1 postcervial teeth. Postcervical tooth small but distinct, with tip well separated from carapace. Rostrum distinctly or just overreaching antennal peduncle, with 2–3 lateral teeth. Ischium of maxilliped III lacking distoventral spine. Large chelae with surface sharply granular; outer margin of fixed finger more or less spinose while that of movable finger only bearing distal spines; dorsal hinge of fingers with 1 distinct spine; ventral surface with posterior margin bearing 1 distinct spine (more often) or large tubercle at medial part near hinge between chela and carpus; merus with entire or distal 3/4 dorsal margin spinose. Abdominal pleura terminated in sharp angles but posterior margin not notched. Posterior margin of abdominal tergite VI lacking distinct spines. Telson with 1 pair of lateral spines.

Colouration. Body generally orange-red, with tips of spines and teeth whitish. Carapace with lateral surface either uniformly orange-red or covered with numerous red dots at ventral 1/3–2/3; but margins of carapace always alternated with red and white marks, with branchiostegal angle purplish red and followed by a large white spot along carapace margin; posterodorsal surface behind postcervical tooth also always covered with red dots. Antennular and antennal flagella uniformly orange-red. Lateral part of basicerite whitish. Eyes dark brown. Large chelipeds generally orange-red except dorsodistal parts of carpus and merus reddish; fingers of chela covered with 2 somewhat redder bands in males. Pereiopods II to V uniformly orange. Abdomen uniformly orange-red to more or less covered with red dots, but posterior margins of somites always alternated with red and white marks; lateral part of tergite I and pleuron I reddish and with a large white spot; ventral parts of pleura II to V also reddish with large white spots. Abdominal somite VI and tailfan uniformly orange-red, only with movable lobe at exopod of uropod bearing a large lateral dark purplish spot.

Distribution. The Philippines and Okinawa, perhaps also in Japan mainland (see Remarks), at depths of 2 to about 20 m.

Remarks. The present material from Okinawa agrees very well with the holotype from the Philippines in every diagnostic character. The postcervical tooth is damaged in the holotype and with the tip eroded. Nevertheless, the size and shape of the base of the postercervical tooth is identical between the holotype and the Okinawa material. The only obvious difference is that three specimens (1 male and 2 females; CBM ZC6696, NTOU M00994, NTOU M00995) have three lateral teeth on the right side of the rostrum (Fig. 1B). Thus, the number of lateral rostral teeth proposed by Chan & Ng (2008) to distinguish *E. chacei* from the closely related *E. debelius* and *E. daumi* becomes rather unreliable. Nonetheless, the length of the rostrum is always greater in *E. chacei*. Of the eight specimens known for this species, six have the rostrum distinctly overreaching the antennal peduncle (Fig. 1G). Only two specimens (NTOU M00994 and RUMF-ZC-01324) have the rostrum just exceeded the antennal peduncle (Fig. 1A). The rostrum of *E. debelius* is always distinctly shorter than the antennal peduncle. In *E. daumi*, the rostrum is often shorter than the antennal peduncle and rarely almost extending to the tip of the antennal peduncle. With more specimens of *E. chacei* available, one more character is found to be useful to separate the present species from *E. debelius* and *E. daumi*. At the posterior margin of the ventral surface of the large chela, there is a distinct spine, or infrequently a large tubercle, located at the medial part of the margin near the hinge between the chela and carpus in *E. chacei* (Fig. 2A, B). In *E. debelius* and *E. daumi*, there is no distinct spine at the posterior margin of the ventral chela and at most only some small tubercles may be present at this part (Fig. 2C, D). Furthermore, the size seems to be useful to separate *E. chacei* from *E. debelius* and *E. daumi*. Available specimens and information shows that *E. debelius* and *E. daumi* are smaller than cl 26 mm (including ovigerous females, see Chan & Ng 2008; Holthuis 1983) but *E. chacei* can reach to cl 40.9 mm.

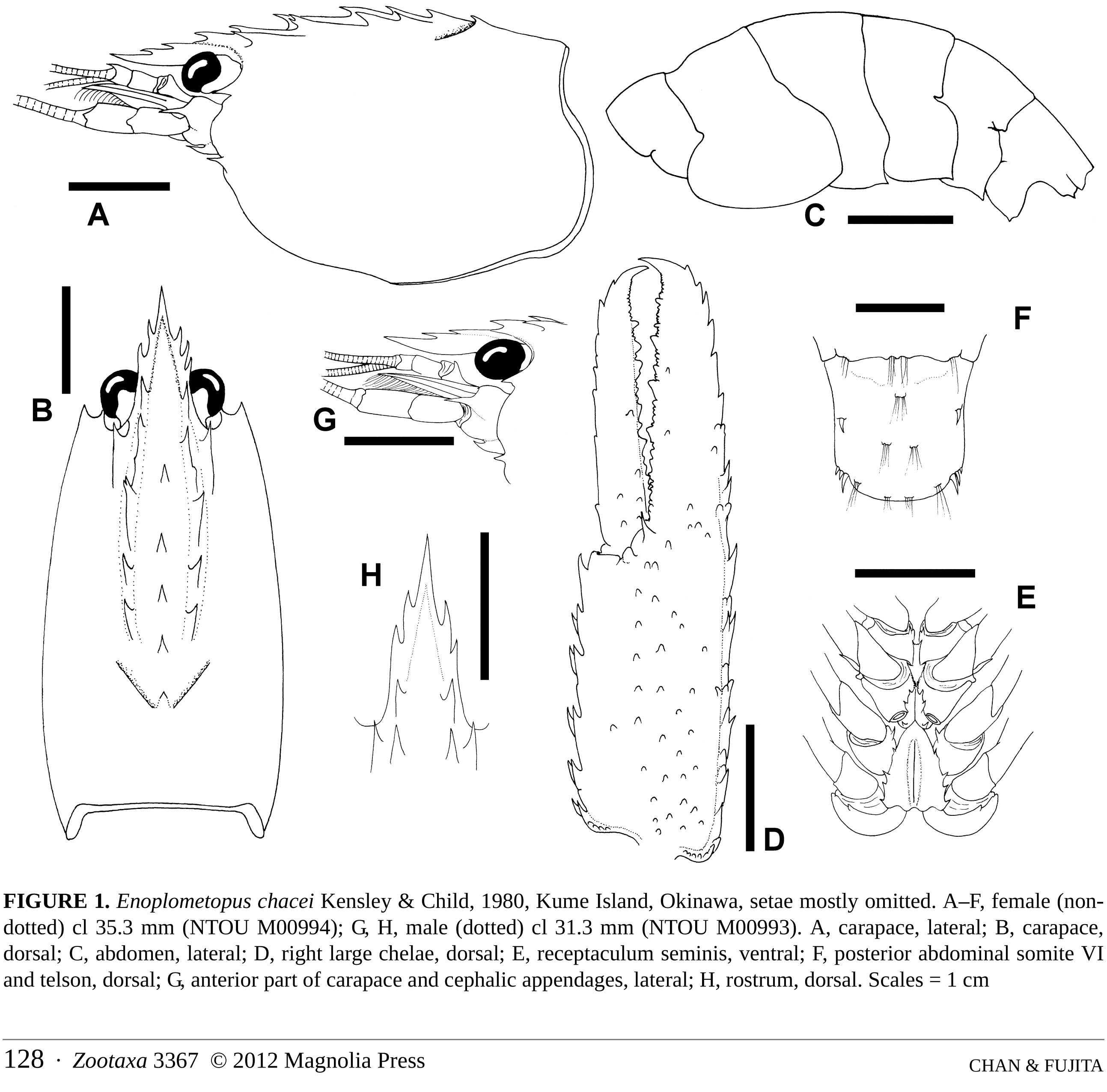


FIGURE 1. *Enoplometopus chacei* Kensley & Child, 1980, Kume Island, Okinawa, setae mostly omitted. A–F, female (non-dotted) cl 35.3 mm (NTOU M00994); G, H, male (dotted) cl 31.3 mm (NTOU M00993). A, carapace, lateral; B, carapace, dorsal; C, abdomen, lateral; D, right large chelae, dorsal; E, receptaculum seminis, ventral; F, posterior abdominal somite VI and telson, dorsal; G, anterior part of carapace and cephalic appendages, lateral; H, rostrum, dorsal. Scales = 1 cm

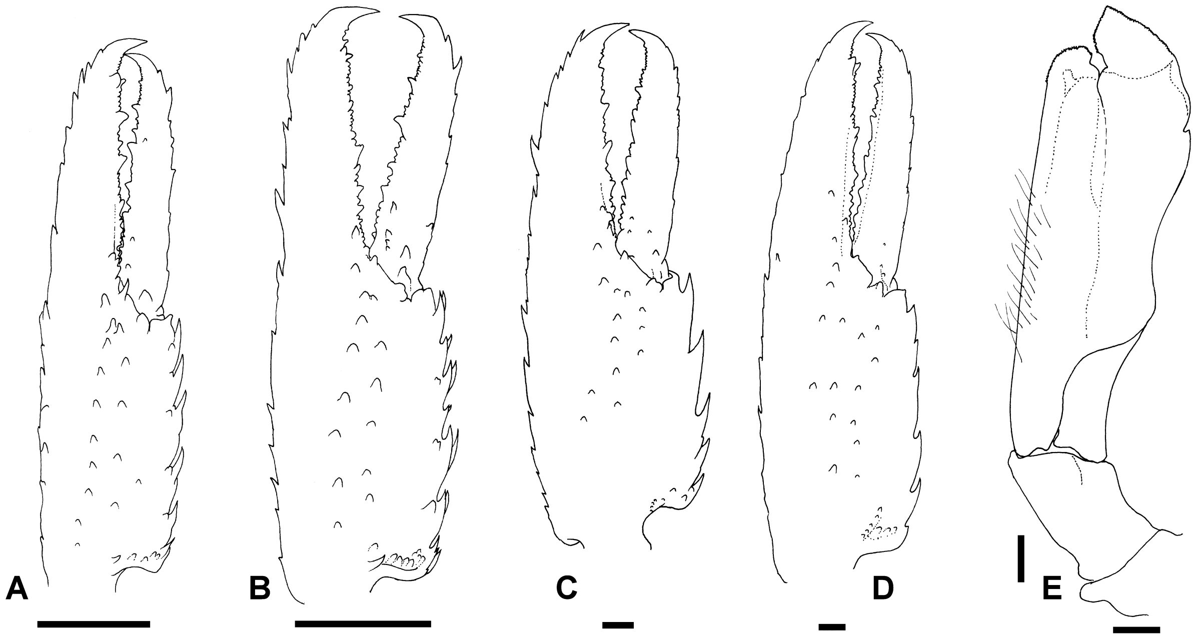


FIGURE 2. A, *Enoplometopus chacei* Kensley & Child, 1980, Kume Island, Okinawa, female (non-dotted) cl 35.3 mm (NTOU M00994); B, *E. chacei*, Kume Island, Okinawa, male (dotted) cl 31.3 mm (NTOU M00993); C, *E. debelius* Holthuis, 1983, Aquarium shop in Singapore, provenance unknown, male cl 3.8 mm (NTOU M00173); D, *E. daumi* Holthuis, 1983, Iloilo, Philippines, ovigerous female cl. 18.5 mm (NTOU M00988); E, *E. voigtmanni* Türkay, 1989, Kume Island, Okinawa, male cl 40.1 mm (NTOU M00992). A–D, right large chela, ventral; E, right pleopod I, outer. Scales: A, B = 1 cm; C–E = 1 mm.

All the present Okinawa specimens are accompanied with colour photographs and make known the actual colour pattern of *E. chacei*. Nevertheless, the Okinawa material showed two rather different colour patterns; one form with the carapace and abdomen more or less distributed with red dots (Fig. 3 A–D), while the other form completely lacking red dots on the lateral carapace and abdomen (Figs. 3E, F, 4A). The "dotted" (3 males and 1 females cl 32.4–35.5 mm) and "non-dotted" (1 male and 2 females 25.1–40.9 mm) colour patterns are not related to size and sex, nor the number of lateral teeth on the rostrum (both sides 2 lateral teeth—2 "dotted" and 2 "non-dotted" specimens, Fig. 1H; one side 2 and other side 3 lateral teeth—2 "dotted" and 1 "non-dotted" specimens, Fig. 1B). Furthermore, in the dotted form the red dots can be rather few or restricted to the lower carapace and dorsal abdomen (RUMF-ZC-01323 and NTOU M00993; Fig. 3A), distributed over the entire carapace and abdomen (CBM ZC 6696, Fig. 3D) or in-between these two extremes (NTOU M00995, Fig. 3B, C). From the original description and drawing provided by Kensley & Child (1986: 524, fig. 1), the holotype of *E. chacei* should belong to the fewer "dotted" form like the NTOU M00993 specimen (Fig. 3A). A comparison of partial COI sequence (658 bp) between the dotted (GenBank accession no. JF331659) and non-dotted (GenBank accession no. JF331660) forms shows that they have only 0.2% genetic divergence; confirming that they belong to the same species. The COI sequence divergence between *E. chacei* and *E. debelius* (GenBank accession no. JF331661)/*E. daumi* (GenBank accession no. JF331662) is 8.8–10.1%, while that between *E. debelius* and *E. daumi* is 4.1%. Although it is now confirmed that *E. chacei* has a colouration very different from *E. debelius* and *E. daumi*, the "dotted" form has a colour pattern somewhat similar to *E. debelius*. *Enoplometopus debelius* is characteristic in having the carapace and abdomen densely covered with dots (see Allen & Steene 1994; Debelius 1986, 1999; Debelius & Baensch 1994; Gosliner *et al*. 1996; Holthuis 1983; Hoover 1998; Poupin & Juncker 2010). However, the body of *E. debelius* is whitish and the dots are purplish. In the "dotted" form of *E. chacei* the body is orange-red and the dots are reddish, and therefore, the dots are rather indistinct and not that striking as in *E. debelius*. Thus, *E. chacei* can be easily distinguished from *E. debelius* by colouration. Nevertheless, the "*E. occidentalis*" specimen (male cl 23 mm) reported by Kubo (1952) from Wakayama in Japanese mainland seems to have a colour pattern in-between *E. debelius* and *E. chacei*. The black and white photograph provided by Kubo (1952: pl. 6) showed a dotted pattern more similar to that of *E. debelius*. However, Kubo (1952: 99) described the colouration of the Wakayama specimen as "All body and appendages are stained with light whitish chrome orange colour. Body marked with many spots of rather deep chrome orange colour. The spots measure about 2 mm in diameter, those of both sides of body are defined more clearly than those found on the other parts of the body...". Thus, Kubo's (1952) colour description fits better the "dotted" form of *E. chacei*. Unfortunately, the whereabouts of Kubo's (1952) specimen is now not known (Usami & Watanabe 2010). From the rather unclear photographs provided by Kubo (1952: pl. VI), the rostrum of the Wakayama specimen seems to be rather slender and longer than the antennal peduncle, and thus likely represents *E. chacei* instead of *E. debelius*.

Enoplometopus chacei has been previously thought to be very rare but seven specimens are now reported from the Kume Island. From local divers and fishermen in Kume Island, this species is not very rare there though it is mostly found in caves. The species *E. crosnieri* Chan & Yu, 1998 was also thought to be rather rare but recently many specimens were found from a wide range of localities (Chan & Ng 2008; Poupin 2003) including Japan (Nomura 2003). It is likely that *E. chacei* is not that rare when its habitat is better known (see also Mendoza *et al*. 2010). *Enoplometopus chacei* is a new record from Japan and the standard Japanese name for this species is given as Kumi-shogun-ebi.

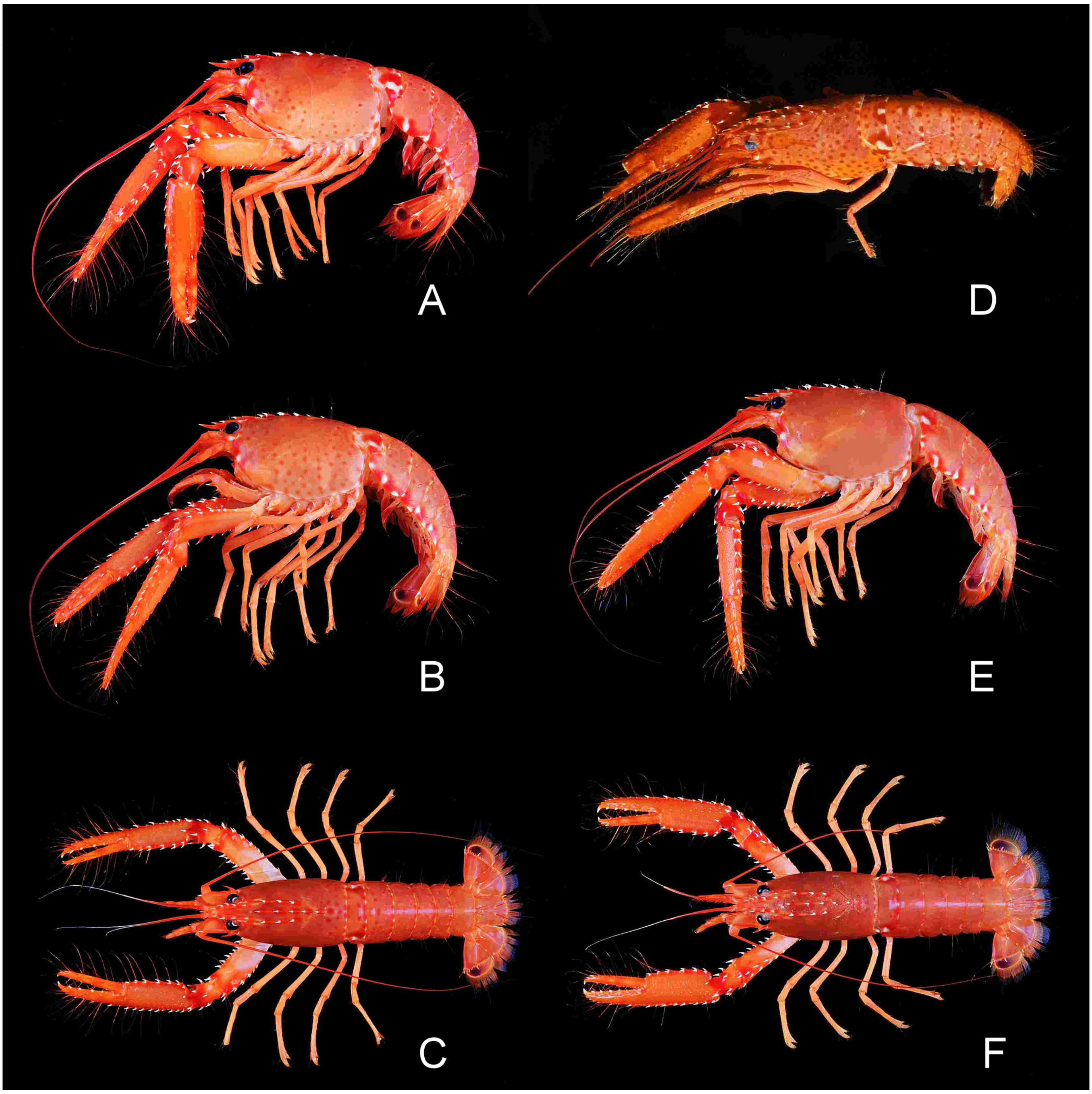


FIGURE 3. *Enoplometopus chacei* Kensley & Child, 1980, Kume Island, Okinawa. A, male (dotted) cl 31.3 mm (NTOU M00993); B, C, female (dotted) cl 35.5 mm (NTOU M00995); D, male (dotted) cl 33.0 mm (CBM ZC6696); E, F, female (non-dotted) cl 35.3 mm (NTOU M00994).

Enoplometopus voigtmanni Türkay, 1989
(Figs. 2E, 4B–D)

Enoplometopus holthuisi. — Daum, 1982: 266, unnumbered photo. — Allen & Steene, 1994: 145, unnumbered photo. (not Gordon, 1968)

Enoplometopus (*Hoplometopus*) *voigtmanni* Türkay, 1989: 226, figs. 2–3, pls 1–2 [type locality: Maldive Islands]. — Hirayama, 1997: 4, fig.7.

Enoplometopus voigtmanni. — Debelius & Baensch, 1994: 592, unnumbered photo. — Jeng, 1998: 19, unnumbered photo. — Debelius, 1999: 204, unnumbered photos. — Minemizu, 2000: 178, unnumbered photo. — Kawamoto & Okuno, 2003: 66, unnumbered photo.

[?] *Enoplometopus holthuisi*. — Bonvallot et al., 1994: 144, unnumbered photo. (not Gordon, 1968)

Material Examined. Kume Island, Okinawa: KUMEJIMA 2009 stn Dive 40, Hidenchigama, scuba diving, 40 m, 20 Nov. 2009, 1 male cl 40.1 mm (NTOU M00992); Ichunjya-shita, scuba diving, 16 m, 25 Aug. 2010, 1 male cl 39.1 mm (RUMF-ZC-01325).

Diagnosis. Size moderately large (up to about 40 mm cl). Carapace with 3 lateral, 1 intermediate, 5 median and 2 postcervial teeth. Postcervical teeth well-developed. Rostrum more or less extending to middle of distal segment of antennal peduncle, with 3–4 lateral teeth. Ischium of maxilliped III armed with distoventral spine. Large chelae with surface smooth, outer margins of fingers also smooth except sometimes with basal spines at fixed finger; dorsal hinge of fingers with 0–1 small spine; merus with entire dorsal margin spinose. Abdominal pleura terminated in elongate spines, posterior margin deeply notched; ventral spines of pleura IV and V not reaching posterior margin. Posterior margin of abdominal tergites VI armed with 2 distinct spines. Telson with 2 pairs of lateral spines. Pleopod I of males subrectangular and with deep indention at distal margin.

Colouration. Body orange-red and covered with networks of white or red streaks. Carapace with networks of white streaks. Eyes dark brown. Antennular and antennal flagella uniformly orange-red except tips of antennular flagella whitish. Large cheliped with red streaks, those on palm rather transversely straight; fingers alternated with red and white or pale orange bands. Maxilliped III and pereiopods II to V distinctly banded with white and orange-red. Abdomen including tailfan covered with irregular red lines and white spots; tips of pleura whitish; distal margins of tailfan with irregular yellowish orange patches. Pleopods orange-red with white spots.

Distribution. Indo-West Pacific and known with certainty from the Maldives, Sri Lanka, Papua New Guinea, Taiwan, Okinawa, perhaps also from Tuamotu, French Polynesia. At depths of 6–40 m.

Remarks. Although *E. voigtmanni* has been reported by many photographs in underwater guide books (Allen & Steene 1994; Debelius 1999; Debelius & Baensch 1994; Jeng 1998; Kawamoto & Okuno 2003; Minemizu 2000), there is no detailed taxonomic report on this species since its original description in 1989. The present work is also the first record on the males of this species. The male pleopod I of *E. voigtmanni* is similar to that of *E. holthuisi* and with deep indention at the distal margin (Fig. 2E). The additional specimens obtained in the present study shows that most of the distinguishing characters listed in Chan & Ng (2008) for this species are valid, only that the ventral spine of the abdominal pleuron V in the present material is nearly reaching the posterior margin of the pleuron. A comparison of more specimens from both *E. voigtmanni* and *E. holthuisi* may able to better assess distinguishing characters between these two closely related species.

An underwater photograph from Kume Island shows that *E. voigtmanni* (Fig. 4B, specimens not collected) may have the white streaks on the lateral carapace arranged somewhat as a large circle, and therefore, very similar to the colour pattern of *E. holthuisi*. Nevertheless, *E. holthuisi* differs from *E. voigtmanni* in the antennular flagellae distinctly alternated with red and white bands, and the red bands on the palms of the large chelae being indistinct or absent (see Daum 1982; Debelius 1986, 1999; Debelius & Baensch 1994; Hoover 1998; Poupin 1996, 2003; Poupin & Juncker 2010). Moreover, the large white circle on the lateral carapace is very rounded and closed, but that of *E. voigtmanni*, if present, is irregularly rounded and connected anterodorsally with a white streak which extends to the orbit. If the species in Fig. 4B is truly *E. voigtmanni*, then the photograph of “*E. holthuisi*” from Tuamotu provided by Bonvallot *et al*. (1994) likely represents *E. voigtmanni* instead of *E. holthuisi*. However, the most distinctive colour difference between these two species is at the antennular flagellae (i.e. banded or not) but they are concealed in Bonvallot *et al*.’s (1994) photograph. Thus, it can not be sure if the distribution of *E. voigtmanni* really extends to French Polynesia. In Japan, *E. voigtmanni* has so far only been found in Okinawa and still not known from the mainland.

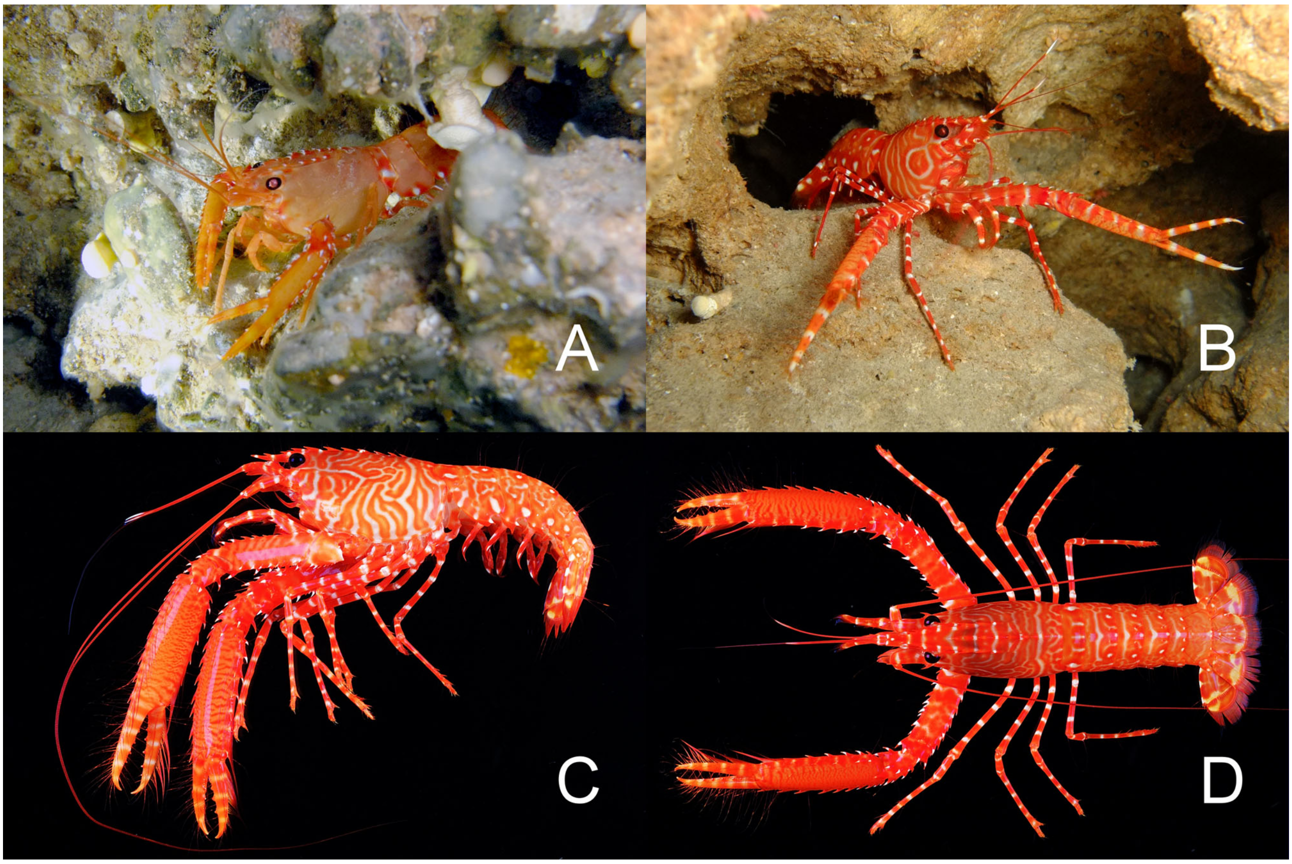


FIGURE 4. A, *Enoplometopus chacei* Kensley & Child, 1980 (non-dotted), Kume Island, Okinawa, specimen not collected; B–D, *Enoplometopus voigtmanni* Türkay, 1989, Kume Island, Okinawa: B, specimen not collected; C, D, male cl 40.1 mm (NTOU M00992).

Acknowledgements

We sincerely thank A. Izeki, I. Nakayoshi, Y. Sakamoto, S. Hirayama, K. Nomura and T. Komai for providing some of the specimens examined in the present study; A. Izeki also kindly allowing us to use her underwater photographs. The KUMEJIMA 2009 Expedition was organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, the Center of Excellence for Marine Bioenviroment and Biotechnology of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica, Taiwan, R.O.C. The expedition was operated under a permit granted to T. Naruse (University of the Ryukyus) by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. This work was in part supported by the National Science Council and the Academia Sinica, Taiwan, R.O.C., to TYC.

References

Allen, G.R. & Steene, R. (1994) *Indo-Pacific Coral Reef Field Guide*. Tropical Reef Research, Singapore, 378 pp.

Bonvallot, J., Laboute, P., Rougerie, F. & Vigneron, E. (1994) *Les atolls des Tuamotu*. Editions de l'ORSTOM, Paris, 296 pp.

Chan, T.Y. & Ng, P.K.L. (2008) *Enoplometopus* A. Milne-Edwards, 1862 (Crustacea: Decapoda: Nephropoidea) from the Philippines, with description of one new species and a revised key to the genus. *Bulletin of Marine Science*, 83(2), 347–365.

Chan, T.Y. & Yu, H.P. (1998) A new reef lobster of the genus *Enoplometopus* A. Milne-Edwards, 1862 (Decapoda, Nephropidae) from the western and southern Pacific. *Zoosystema*, 20(2), 183–192.

Daum, W. (1982) Über die Gattung *Enoplometopus*. Großkrebse im Aquarium. 3. *Die Aquarien-und Terrarien-Zeitschrift*, 35(7), 265–268.

Debelius, H. (1986) Reef lobsters: Genus *Enoplometopus*. *Freshwater and Marine Aquarium*, 9(3), 12–17.

Debelius, H. (1999) *Crustacea Guide of the World. Shrimps, Crabs, Lobsters, Mantis Shrimps, Amphipods.* IKAN, Frankfurt, 321 pp.

Debelius, H. & Baensch, H.A. (1994) *Marine Atlas.* MERGUS, Melle, 1215 pp.

Gordon, I. (1968) Description of the holotype of *Enoplometopus dentatus* Miers, with notes on other species of the genus (Decapoda). *Crustaceana*, 15(6), 79–97.

Gosliner, T.M., Behrens, D.W. & Williams, G.C. (1996) *Coral reef animals of the Indo-Pacific.* Sea Challengers, Monterey, 14 pp.

Hirayama, S., 1997. Some interesting crustacean species found on Kume-jima Island, the Ryukyu Islands. *I.O.P. Diving News*, 8(10), 2–7. [in Japanese]

Holthuis, L.B. (1983) Notes on the genus *Enoplometopus* with description of a new subgenus and two new species (Crustacea Decapoda Axiidae). *Zoologische Mededelingen*, 56(22), 281–298.

Hoover, J.P. (1998) *Hawaii's Sea Creatures. A Guide to Hawaii's Marine Invertebrates.* Mutual Publishing, Honolulu, 366 pp.

Jeng, M.S. (1998) *Shrimps and crabs of Kenting National Park.* Kenting National Part Board, Pingtung, 133 pp. [in Chinese]

Kawamoto, T. & Okuno, J. (2003) *Shrimps and crabs of Kume Islands, Okinawa.* Hankyu Communications, Tokyo, 173 pp. [in Japanese]

Kensley, B. & Child, C.A. (1986) A new species of *Enoplometopus* (Thalassinidea: Axiidae) from the northern Philippines. *Journal of Crustacean Biology*, 6(3), 520–524.

Kubo, I. (1952) On two rare species of Psalidopodidae and Nephropsidae. *Journal of the Tokyo University of Fisheries*, 39, 91–100.

Mendoza, J.C.E., Naruse, T., Tan, S.H., Chan, T.Y., Richer de Forges, B. & Ng, P.K.L. (2010) Case studies on decapod crustaceans from the Philippines reveal deep, steep underwater slopes as prime habitats for "rare" species. *Biodiversity and Conservation*, 19(2), 575–586.

Milne-Edwards, A. (1862) Faune carcinologique de l'île de la Réunion : annexe F. *In:* Maillard, L. (Ed.), *Notes sur l'île de la Réunion*, 1–16. Dentu, Paris.

Minemizu, R. (2000) Marine decapod and stomatopod crustaceans mainly from Japan. Bun-ichi Sogo Shuppan, Tokyo, 344 pp. [in Japanese]

Nomura, K. (2003) Record of two rare lobsters collected from the Kii Peninsula, middle part of Japan. *Nankiseibutsu*, 45(1), 51–55. [in Japanese]

Poupin, J. (1996) *Atlas des crustacés marins profonds de Polynésie française. Récoltes du navire Marara, 1986/1996.* Service mixte de Surveillance radiologique et biologique, Louis-Jean editions, Gap. 59 pp.

Poupin, J. (2003) Reef lobsters *Enoplometopus* A. Milne Edwards, 1862 from French Polynesia, with a brief revision of the genus (Crustacea, Decapoda, Enoplometopidae). *Zoosystema*, 25(4), 643–664.

Poupin, J. & Juncker, M. (2010) *A guide to the decapod crustaceans of the South Pacific*. Secretariat of the Pacific Community, Noumea, New Caledonia. 317 pp.

Randall, J.W. (1840) Catalogue of the crustacea brought by Thomas Nuttall and J.K. Townsend, from the west coast of North America and the Sandwich Islands, with description of such species as are apparently new, among which are included several species of different localities, previously existing in the collection of the Academy. *Journal of the Academy of Natural Sciences Philadelphia*, 8(1), 106–147.

Stoeckle, M.Y. & Hebert, P.D.N. (2008) Barcode of life. *Scientific American*, 299, 82–88.

Türkay, M. (1989) *Enoplometopus* (*Hoplometopus*) *voigtmanni* n. sp., ein neuter Riffhummer von den Malediven. *Senckenbergiana maritima* 20(5/6): 225–235.

Usami, Y. & Watanabe, S. (2010) List of Kubo collections stored in the Tokyo University of Marine Science and Technology. *Cancer*, 19, 61–69. [in Japanese]

Zootaxa 3367: 134–144 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Raymunida Macpherson & Machordom, 2000 (Crustacea: Decapoda: Anomura: Munididae) from the KUMEJIMA 2009 Expedition in the Ryukyu Islands, Japan*

MASAYUKI OSAWA
Research Center for Coastal Lagoon Environments, Shimane University, 1060 Nishikawatsu-cho, Matsue, Shimane 690-8504, Japan. E-mail: osawam@soc.shimane-u.ac.jp

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Two species of the munidid genus *Raymunida* Macpherson & Machordom, 2000, are reported from Kume Island, Ryukyu Islands, southwestern Japan. *Raymunida striata* **n. sp.** appears closest to *R. confundens* Macpherson & Machordom, 2001, and *R. dextralis* Macpherson & Machordom, 2001, but is distinguished by the second and third abdominal somites each with an uninterrupted stria between two distinct transverse ridges on the dorsal surface, the merus of the third maxilliped with a prominent distal spine on the extensor margin, and the mero-carpal articulation of the fourth pereopod reaching only to the lateral end of the anterior cervical groove of the carapace. The occurrence of *R. vittata* Macpherson, 2009, in Kume Island greatly extends its distribution range to the north hemisphere. Morphological variations of *R. vittata* are also discussed on the basis of the present specimens. An updated key to the species of *Raymunida* is provided.

Key words: Crustacea, Munididae, *Raymunida*, new species, Okinawa

Introduction

The genus *Raymunida* Macpherson & Machordom, 2000, was established for *R. cagnetei* Macpherson & Machordom, 2000 (type species), *Munida bellior* Miyake & Baba, 1967, and *M. elegantissima* De Man, 1902. Subsequently, eight new species were described: *R. confundens* Macpherson & Machordom, 2001, *R. dextralis* Macpherson & Machordom, 2001, *R. erythrina* Macpherson & Machordom, 2001, *R. formosanus* Lin, Chan & Chu, 2004, *R. insulata* Macpherson & Machordom, 2001, *R. limbata* Macpherson, 2006, *R. lineata* Osawa, 2005, and *R. vittata* Macpherson, 2009. All the 11 species have been recorded only from the Indo-West Pacific region at depths ranging from 5 to 549 m (Baba *et al*. 2008; Macpherson 2009).

In November 2009, the marine biodiversity expedition KUMEJIMA 2009 was conducted in Kume Island, Ryukyu Islands, southwestern Japan. The material of the Galatheoidea collected during the expedition includes several undescribed and poorly-known species. The present paper describes a new species of *Raymunida*. In addition, *R. vittata* Macpherson, 2009, is recorded for the second time since its original description from Vanuatu, and notes on its intraspecific variation are provided.

The type specimens of the new species are deposited in the Ryukyu University Museum, Fujukan (RUMF), Okinawa. The general terminology used in the text follows that of Baba *et al*. (2009). Postorbital carapace length (cl), the indication of specimen size, is measured from the level of the sinus formed by the rostrum and supraocular spines to the posterior margin along the midline. Article lengths of chelipeds and ambulatory legs are measured along the dorsomesial and dorsal margins, respectively. The abbreviations used in the text include: Mxp3 (third maxilliped), P1 (first pereopod, cheliped), P2–4 (second to fourth pereopods, first to third ambulatory legs), and P5 (fifth pereopod).

Accepted by T. Naruse: 2 Mar. 2011; published: 4 Jul. 2012

Taxonomy

Family Munididae Ahyong, Baba, Macpherson & Poore, 2010

Genus *Raymunida* Macpherson & Machordom, 2000

Raymunida striata n. sp.

(Figs. 1, 2, 4A)

Type material. Holotype: female (cl 8.2 mm), St. Trawl 45, 26°19.907–20.056′N, 126°43.191-42.622′E, 67.5–76.0 m, dead coral blocks and rubble, trawl, 16 November 2009 (RUMF-ZC-1415). Paratype: 1 male (cl 5.9 mm), same data as holotype (RUMF-ZC-1416).

Description. Carapace (Fig. 1A) longer than broad, cl 1.1–1.2 times carapace width; dorsal surface nearly horizontal from anterior to posterior, somewhat convex from side to side, with long transverse ridges bearing dense, short plumose setae anteriorly (some relatively long, stiff simple setae also present on posterior half of carapace in paratype, but no such setae in holotype); gastric region with row of 4 pairs of subequal-sized epigastric spines; cervical grooves distinct; one parahepatic spine, 2 branchial anterior spines, and 1 postcervical spine present on each side. Frontal margin slightly oblique, with small spine mesial to anterolateral spine; lateral orbital angle slightly produced but unarmed; infra-orbital margin produced anteriorly, with small denticles on lateral margin. Lateral margins slightly convex, each with 6 spines: 2 spines in front of and 4 spines behind anterior cervical groove; first anterolateral, situated slightly posterior to level of orbit, clearly not reaching level of sinus between rostrum and supraocular spines; second at midlength between anterolateral spine and anterior cervical groove, distinctly smaller than anterolateral spine, accompanying another small spine ventrally; 2 spines each on anterior and posterior branchial regions, decreasing in size posteriorly and bearing relatively long, stiff simple seta at each base, last spine small. Rostrum spiniform, 0.4 cl, slightly arched in lateral view; lateral margins with some short simple setae, minutely crenulate distally. Supraocular spines exceeding half length of rostrum and distal margins of corneas, subparallel, slightly directed upward or nearly horizontal in lateral view.

Pterygostomian flaps unarmed on anterior dorsal margin; lateral surface with short and long, oblique and longitudinal ridges.

Thoracic sternum (Fig. 1B) approximately 1.2 times as long as broad, broadest on sternite 7, depressed along midline. Sternite 3 (Fig. 1C) 3.2–3.6 times as broad as long (measured along midline); anterior margin with median notch and narrow projection at each lateral angle; lateral margins convergent posteriorly; posterior margin touching anterior margin of fourth sternite. Sternite 4, 2.8–2.9 times longer (measured along midline) and 2.1 times broader than preceding sternite, with 2 transverse long, feebly granulate striae, anterior stria interrupted medially; anterior margin concave, slightly narrower than sternite 3. Sternites 5 and 6 with pair of short or very short, oblique striae on lateral parts, respectively. Sternite 7 smooth. Transverse ridges of sternites 5–7 obtuse, feebly granulate, each with row of short plumose setae.

Abdominal somites (Fig. 1D, E) with dense, short plumose setae on anterior margins of transverse ridges and striae; 2 long transverse ridges present on each somite, bearing some short and long, stiff simple setae, anterior and posterior ridges on somites 2–4 and anterior ridge on somite 5 uninterrupted and somewhat elevated, but posterior ridge on somite 5 and both ridges on somite 6 interrupted in median part. Somites 2 and 3 each with uninterrupted transverse stria between 2 long ridges. Somite 4 with uninterrupted or medially interrupted transverse stria between 2 long ridges. Somite 5 with short transverse stria in posterior median part. Somite 6 with flattish posteromedian margin. Telson weakly calcified on posteromedian part, indistinctly subdivided, with short scaly ridges; distal margin with broad median notch.

Eyes (Fig. 1A, F) moderately large; corneas slightly dilated, maximum diameter approximately 0.3 length of distance between mesial bases of anterolateral spines; eyelash consisting of simple setae; relatively long, stout seta present near distal margin of rounded dorsal anterior extension of peduncle.

Basal article of antennular peduncle (Fig. 1A, F), excluding distal spines, approximately 0.2 length of carapace excluding rostrum, only reaching proximal margin of cornea, with 2 distal spines, mesial spine distinctly shorter than lateral spine; lateral margin with 2 spines, proximal spine short, located nearly level of distal margin of article, distal spine long, overreaching tip of distolateral spine.

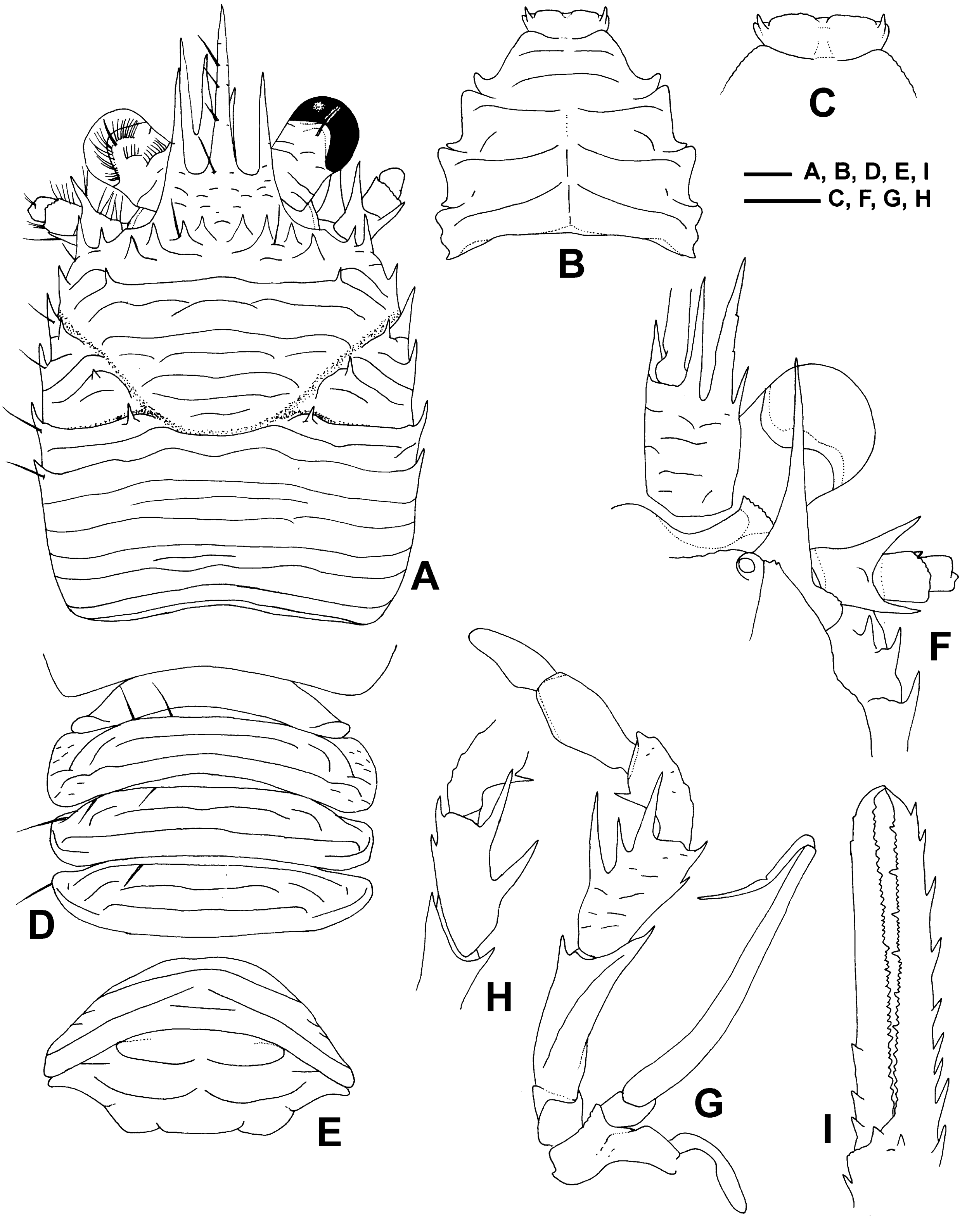


FIGURE 1. *Raymunida striata* **n. sp.**, holotype, female (cl 8.2 mm), RUMF-ZC-1415. A, carapace and cephalic appendages, dorsal view (stiff simple setae on right side and short plumose setae on transverse ridges omitted); B, thoracic sternum, ventral view (short plumose setae on transverse ridges omitted); C, sternite 3 and anterior part of sternite 4, ventral view; D, abdominal somites 1–4, dorsal view (stiff simple setae on right side and short plumose setae on transverse ridges omitted); E, abdominal somites 5 and 6, extensor view (stiff simple setae on right side and short plumose setae on transverse ridges omitted); F, anterior part of cephalothorax, showing left ocular and antennal peduncles and basal article of antennular peduncle, ventral view (setae omitted); G, left Mxp3, lateral view (setae omitted); H, right Mxp3, merus, lateral view; I, right P1, fingers, dorsal view (setae omitted). Scales = 1.0 mm.

Antennal peduncle (Fig. 1A, F) moderately short. Article 1 with long distomesial spine clearly overreaching distal margin of article 4 and slightly overreaching distal margin of basal article of antennular peduncle; distolateral angle rounded. Article 2 with 2 distinct distal spines, mesial spine longer than lateral spine, slightly overreaching distal margin of article 3; mesial margin unarmed. Article 3 unarmed or with very small tuberculate spine at dorsal distomesial angle; distal margin minutely denticulate. Article 4 unarmed.

Mxp3 (Fig. 1G, H) with basis bearing 6 or 7 denticles on mesial ventral margin. Ischium armed with strong spine at distomesial angle; dorsodistal angle acutely produced, terminating in small spine; crista dentata with 28–30 denticles. Merus as long as ischium measured on ventral margin, not narrowed distally; ventral margin with 2 or 3 slender spines, proximal and distal spines subequal in size; dorsal margin with distinct spine at distal end, subdistal part unarmed (paratype) or with small spine (holotype). Carpus with slender spine on ventrodistal margin, dorsodistal angle slightly produced. Propodus and dactylus unarmed, relatively slender. Exopod overreaching distal margin of merus.

Epipods present on Mxp3 and P1–3.

P1 (Figs. 1I, 2A) relatively slender, combined length from proximal margin of basi-ischium to tip of chela 2.8–3.0 times cl, with numerous short, scaly ridges except on fingers; ridges anteriorly bearing short plumose setae; sparse long, stiff simple setae also present, numerous on mesial margins of merus and carpus and mesial and lateral margins of chela. Merus 0.9–1.0 length of cl, 1.7–1.8 times longer than carpus, with irregular row of spines along mesial and lateral margins on dorsal surface, mesial spines much larger; mesial face also with rows of proximally diminishing spine on midline and ventral margin; lateral face with few distal spines; lateral and ventral surfaces unarmed; ventrolateral margin terminating in strong spine. Carpus 2.5–2.8 times as longer than broad; dorsal surface with mesial and lateral rows of irregular small spines; mesial surface with irregular row of some spines dorsally along midline, distal spine strongest; ventromesial margin also with row of some spines; lateral surface with some spine dorsally; ventral surface with small spines on proximal mesial part. Chela slender, 6.3–6.6 times length of breadth measured on base of fingers. Palm slightly inflated, 0.9–1.0 length of carpus, 2.3–2.6 times longer than broad, with spine at base of dactylus and mesial and lateral rows of small spines on dorsal surface; dorsolateral margin with row of spines continuing along entire length of fixed finger; ventrolateral margin with row of small spines; mesial surface with irregular row of spines on midline; ventral surface with 2 small spines on proximal mesial part and single spine at base of dactylus. Fingers 1.5–1.7 times as long as palm, slightly arched ventrally, distally curving and crossing when closed, each ending in small corneous claw; dorsal and ventral surfaces rounded; opposable margins slightly gaping, each with row of numerous irregular-sized, small, blunt and subacute teeth. Dactylus with 3 spines on proximal 0.3 of slightly crenulate dorsomesial margin.

P2–4 (Fig. 2B–H) somewhat compressed, with sparse long, stiff simple setae on margins; P2 and P3 subequal; combined length from proximal margin of basi-ischium to tip of dactylus 1.9–2.2 times cl, 1.1–1.2 times longer than that of P4. Ischia each with small spine near ventral angle of distolateral margin on P2 and 3, but unarmed in P4; mesial surface with small spine near dorsal angle of distal margin on P3 and 4, but unarmed on P2. Meri elongate subrectangular, successively shorter posteriorly (P3 merus 0.9 length of P2 merus, P4 merus 0.7 length of P3 merus); P2 relatively slender; P3 broadest at midlength; length-breadth ratio, 5.3–5.8 on P2, 4.2 on P3, 3.3–3.4 on P4; merus-propodus length ratio, 1.4 on P2, 1.2 on P3, 1.0 on P4; P2 merus 0.8–0.9 as long as cl; dorsal margin bearing rows of moderately long, plumose setae, 13 or 14 irregularly arranged spines present on entire margin of P2, 5 spines on distal 0.7 margin of P3, only single subdistal spine on P4; lateral surface with transverse scaly ridges bearing numerous, short plumose setae (sparse long, stiff simple setae also present on P3 and P4), row of spines present near dorsal margin on P3 (9 or 10 spines) and P4 (5 or 6 spines) but absent on P2; ventrolateral margin somewhat crenulated, distally with 3 spines on P2, 2 or 3 spines on P3 (if present, including submarginal spines), and 1 spine on P4; ventromesial margin with 1 subdistal spine on P2 but unarmed on P3 and 4. Mero-carpal articulation of P4 reaching lateral end of anterior cervical groove of carapace. Carpi subequal on P2 and P4, longer on P3, 0.5–0.6 length of propodi on P2–4; dorsal margin with 4 or 5, 4, 2–4 spines on P2–4, respectively; dorsodistal angle rounded; ventrodistal margin produced, with small spine; lateral surface unarmed but with somewhat elevated longitudinal crest dorsally along midline and few oblique, ridges on ventral half. Propodi not tapering distally, longest on P3, shortest on P4; length-breadth ratio, 6.9–8.3 on P2, 7.0–7.5 on P3, 6.0–6.4 on P4; dorsal margin unarmed; lateral surface with irregular row of short ridges and some long, stiff simple setae along midline; ventral margin with 8 or 9, 6 or 7, and 5–7 slender, corneous spines including distal pair on P2–4, distolateral spine larger than distomesial spine (Fig. 2D). Dactyli nearly straight, 0.5–0.6 length of propodi on P2–4, with slightly curved distal claw; ventral margin with 6 or 7 (P2), 6 (P3), and 5–7 (P4) slender, proximally diminishing, corneous spines, each spine arising from low process.

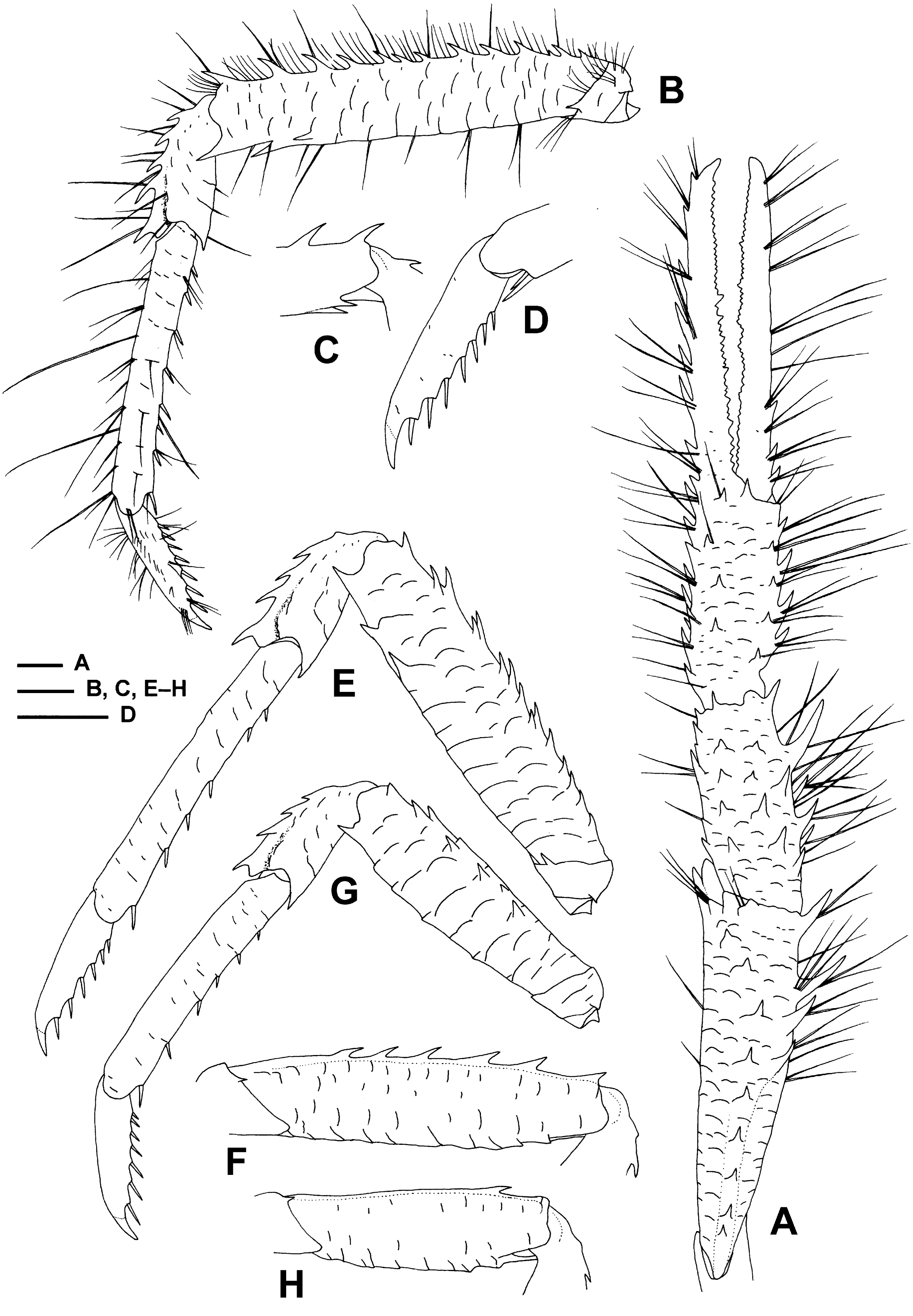


FIGURE 2. *Raymunida striata* **n. sp.**, holotype, female (cl 8.2 mm), RUMF-ZC-1415. A, left P1, dorsal view (marginal long, stiff simple setae only illustrated); B, left P2, lateral view (short plumose setae on transverse ridges omitted; short plumose setae on dorsal margins of merus and carpus simplified); C, same, distal part of merus, mesial view; D, same, dactylus, lateral view; E, left P2, lateral view (setae omitted); F, same, ischium and merus, mesial view; G, left P3, lateral view (setae omitted); H, same, ischium and merus, mesial view. Scales = 1.0 mm.

P5 chela elongate, with numerous moderately long, simple setae on dorsal and ventral faces and with numerous curved, serrate setae on ventrolateral face of palm; setation similar in male and female.

Male with 2 pairs of pleopods modified as gonopods on abdominal somites 1 and 2, second pair more developed than first; pleopods on somites 3–5 flattened, spatulate, each with row of short plumose setae on lateral margin. Female with 4 pairs of elongate pleopods on abdominal somites 2–5, those on somites 3–5 well developed.

Colouration in life (Fig. 4A). Carapace, abdomen, and P1–4 generally reddish. Carapace with small scattered, dark red marks and numerous small white marks; gastric region with narrow white bands on anterior margins of transverse ridges. Pterygostomian flap dark red, with narrow white area along dorsal margin. Abdomen with some small, dark red marks; somites 2–4 each with row of small white spots on anterior transverse ridge. P1 pale coloured on median dorsal parts of meri and carpi; palm with 1–3 white spots on proximal and distal parts of dorsal surface; fingers each with subdistal dark red ring, tips white, dorsal and ventral surfaces with some irregular, narrow white stripes. P2–4 with small white spots on dorsodistal part on merus and carpus of each P2 and P3; propodi with irregular narrow, longitudinal white marks.

Etymology. The specific name is derived from the Latin, *striatus* (striped), referring the characteristic narrow stripes on the P1 fingers in the new species.

Distribution. Only known from the type locality, Kume Island, Ryukyu Islands.

Habitat. The type specimens were collected from the depth of 67.5–76.0 m, with substratum of dead coral blocks and rubble.

Remarks. Macpherson & Machordom (2001) divided seven *Raymunida* species into two groups based on the length of the mesial spine of the antennal article 1, and mentioned that the importance of the character was supported by mitochondrial cytochrome *c* oxidase subunit I (COI) sequence data. The validity of the two groups of species is also generally supported by phylogenetic analyses on the species of *Munida* Leach, 1820, and its related genera inferred from COI and 16S rRNA sequence data (Machordom & Macpherson 2004). The first group of species (*R. bellior*, *R. confundens*, *R. dextralis*, and *R. insulata*) is characterized by the mesial spine of the antennal article 1 reaching or overreaching the distal margin of the antennular basal article; whereas the spine in the second group of species (*R. cagnetei*, *R. elegantissima*, and *R. erythrina*) never reaches the distal margin of the antennular basal article. Four additional species have been described since Macpherson & Machordom's (2001) publication. Following their grouping of species, *R. formosanus* can be assigned to the first group, and *R. limbata* and *R. vittata* to the second group. Lin *et al*. (2004) also showed that *R. formosanus* is closely related to the *R. confundens–R. dextralis* clade in their phylogenetic tree based on the COI data. However, re-examination of the holotype of *R. formosanus* (male, cl 15.4 mm, deposited in the National Taiwan Ocean University) revealed that, unlike the original description of the species, the mesial spine of the antennal article 1 slightly falls short of the distal margin of the antennular basal article. In addition, since the length of the spine varies intraspecifically in *R. lineata*, this species cannot be definitely referred to the two groups of species by Macpherson & Machordom (2001) (see Osawa 2005). Baba (2005) also reported similar variation of the spine in *R. bellior.*

Considering these intraspecific variations, the armature of the antennal article 2 is presumed as another morphological character that distinguishes the two phylogenetic groups of species by Macpherson & Machordom (2001) and Lin *et al*. (2004). The antennal article 2 is unarmed on the mesial margin in the first group, but it usually has a distinct subdistal spine on the margin in the second group (the spine is reduced to a small low protuberance in small specimens of *R. vittata*, see Remarks on the species below). All three recently described three species, *R. limbata*, *R. lineata*, and *R. vittata*, are included in the second group, whereas *R. striata* **n. sp.** is referred to the first group based on the character of the antennal article 2.

Among the first group of species presently defined, *R. striata* **n. sp.** may be closest to *R. confundens* and *R. dextralis*. The morphological characters shared by the three species are: the presence of a small spine on the frontal margin mesial to the anterolateral spine of the carapace, the possession of numerous long simple setae on the P1, the slender chela being more than six times longer than broad, the absence of a distinct longitudinal crest on the dorsal midline of each P1 finger, and the presence of a row of relatively sparse spines on the dorsolateral margin of the P1 fixed finger. However, *R. striata* **n. sp.** is distinguished from other species of the same first group including *R. confundens* and *R. dextralis* by the abdominal somites 2 and 3 each with an uninterrupted stria between two distinct transverse ridges on the dorsal surface, the Mxp3 merus with a prominent distal spine on the extensor margin, and the mero-carpal articulation of the P4 reaching only to the lateral end of the anterior cervical groove of the carapace. In the other five species of the first group, the abdominal somites 2 and 3 have no striae on the dorsal surface, the Mxp3 merus is unarmed or possesses only a small distal tooth on the extensor margin, and the mero-carpal articulation of the P4 overreaches the frontal margin of the carapace. *Raymunida striata* **n. sp.** further differs from *R. confundens* and *R. dextralis* in the presence of distinct scaly transverse ridges on the lateral surfaces of the P2–4 meri. Such distinct scaly ridges apparently absent in *R. confundens* and *R. dextralis* (see Macpherson & Machordom 2001; Lin *et al*. 2004). *Raymunida bellior* and *R. insulata* are separated from *R. striata* **n. sp.** by the absence of a small spine on the frontal margin mesial to the anterolateral spine of the carapace. *Raymunida bellior* is also distinctive in having long plumose instead of simple setae on the Pl. The stoutness of the chela and structure of the fingers of the P1 are clearly different between *R. formosanus* and *R. striata* **n. sp.** The chela is much more robust in *R. formosanus* (less than five times longer than broad) than in *R. striata* **n. sp.** (more than six times longer). The P1 fingers have a distinct longitudinal crest on each dorsal midline in *R. formosanus,* but such a crest is absent in *R. striata* **n. sp.**

The colour patterns in life are also different among *R. confundens*, *R. dextralis*, *R. formosanus,* and *R. striata* **n. sp.** The colour photograph of *R. dextralis* was given by Macpherson (1994: fig. 66) as that of *Munida bellior* before the original description of the former species. In *R. confundens* and *R. dextralis*, there is a transverse white part on the base of the rostrum and supraocular spines of the carapace, but such a distinct mark is absent in *R. striata* **n. sp.** The Pl fingers have a distinct submedian white band in *R. dextralis* and *R. formosanus*, but they bear some irregular, narrow white stripes in the new species. The P2–4 of *R. confundens*, *R. dextralis*, and *R. formosanus* have white transverse bands, whereas those of *R. striata* **n. sp.** lack such band pattern and possess irregular narrow, longitudinal white marks on the propodi (Macpherson & Machordom 2001; Lin *et al*. 2004; present study). Miyake & Baba (1967) described the colouration of *R. bellior* based on the material preserved in formalin. The species has a broad V-shaped, reddish brown band on the posterior half of the carapace and reddish brown bands on the P2–4. The colour pattern is very different from that of *R. striata* **n. sp.** The colouration of *R. insulata* is unknown (Macpherson & Machordom 2001).

Raymunida vittata Macpherson, 2009

(Figs. 3, 4B)

Raymunida vittata Macpherson, 2009: 446, fig. 7.

Material examined. 3 males (cl 7.2–10.5 mm), 3 females (cl 4.4–7.6 mm), St. Trawl 70, 26°23.831–23.590´N, 126°45.685–45.212´E, 95.5–123.0 m, dead coral blocks and rubble, trawl, 19 November 2009 (RUMF-ZC-1417).

Diagnosis. Carapace (Fig. 3A) longer than broad; 5 pairs of epigastric spines; 1 parahepatic, 1 or 2 branchial anterior, and 1 postcervical spines on each side; frontal margin with small spine lateral to lateral limit of orbit. Rostrum 0.4 cl; supraocular spines 0.6 length of rostrum. Thoracic sternites 5 and 6 (Fig. 3B) with short oblique ridges on lateral parts. Abdominal somite 2 (Fig. 3C–F) with uninterrupted long stria or row of short striae between two distinct transverse ridges on dorsal surface; somite 3 with or without some short or very short striae between two distinct transverse ridges on dorsal surface; somite 4 without striae. Antennal article 1 (Fig. 3G–J) with mesial spine usually reaching or slightly overreaching distal margin of article 4 but never reaching distal margin of basal article of antennular peduncle; article 2 usually with subdistal spine on mesial margin; article 3 bearing small but distinct spine on distomesial margin. Mxp3 merus with distinct spine on dorsodistal margin. P1 (Fig. 3K) chela relatively slender, 4.9–7.7 times length of breadth measured on base of fingers, with dorsolateral row of spines interrupted in proximal half to three fourths; fingers 1.3–1.8 times longer than palm, each with rounded longitudinal crest along dorsal midline; dactylus with 3 spines on proximomesial margin. P2–4 subequal on P2 and 3, shorter on P4; merus with irregular row of 10–12 (P2), 5 (P3), and 3 or 4 (P4) spines on dorsal margin, lateral surface with another irregular row near dorsal margin on P3 (8–10 spines) and P4 (7 or 8 spines) but unarmed on P2, lateral ventrodistal margin with 4 or 5 (P2), 2 or 3 (P3), and 1 or 2 (P4) spines (if present, including submarginal spines); mero-carpal articulation of P4 overreaching lateral end of anterior cervical groove but not reaching frontal margin of carapace; carpi with 5 (P2), 4 or 5 (P3), and 1 or 2 (P4) spines on dorsal margin; propodi with 5 or 6 ventral corneous spines including distal paired spines; dactyli with 4–6 corneous spines on ventral margin.

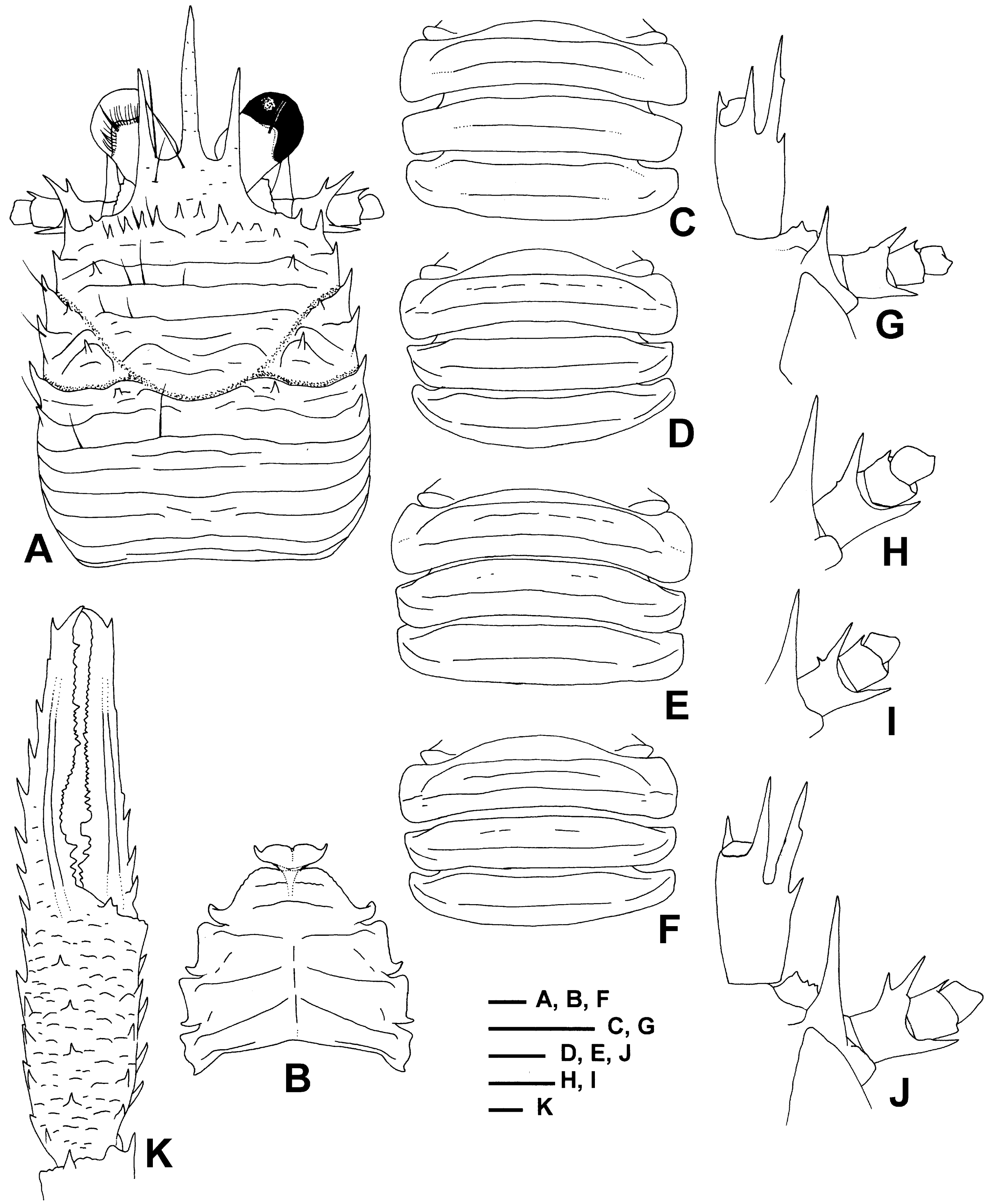


FIGURE 3. *Raymunida vittata* Macpherson, 2009. Male (cl 10.5 mm; A, B, F, J, K); female (cl 4.4 mm; C, G); male (cl 7.2 mm; D, H); female (cl 7.6 mm; E, I), RUM-ZC-1417. A, carapace and cephalic appendages, dorsal view (stiff simple setae on right side and short plumose setae on transverse ridges omitted); B, thoracic sternum, ventral view (short plumose setae on transverse ridges omitted); C–F, abdominal somites 1–4, dorsal view (setae on transverse ridges omitted); G, J, left antennal peduncle and basal article of antennular peduncle, dorsal view; H, I, left antennal peduncle, dorsal view; K, left Pl, chela, dorsal view (setae omitted). Scales = 1.0 mm.

Colouration in life (Fig. 4B). Carapace, abdomen, and P1 generally bright red. Carapace with white bands on anterior margins of transverse ridges; lateral portions white. Pterygostomian flap dark red, with relatively broad white area along dorsal margin. Abdomen with some small, dark red marks; somites 2–4 each with narrow white band on anterior margin of posterior transverse ridge. P1 pale coloured on dorsal subdistal part of each merus and dorsal median part of each carpus; palm with broad white ring on subdistal part (ring replaced by cluster of white spots in large specimens); fingers each with white ring on distal one third to half. P2–4 generally reddish on meri and carpi and orange on propodi and dactyli; meri with irregular white marks on lateral surface; carpi with narrow orange stripes on lateral surface.

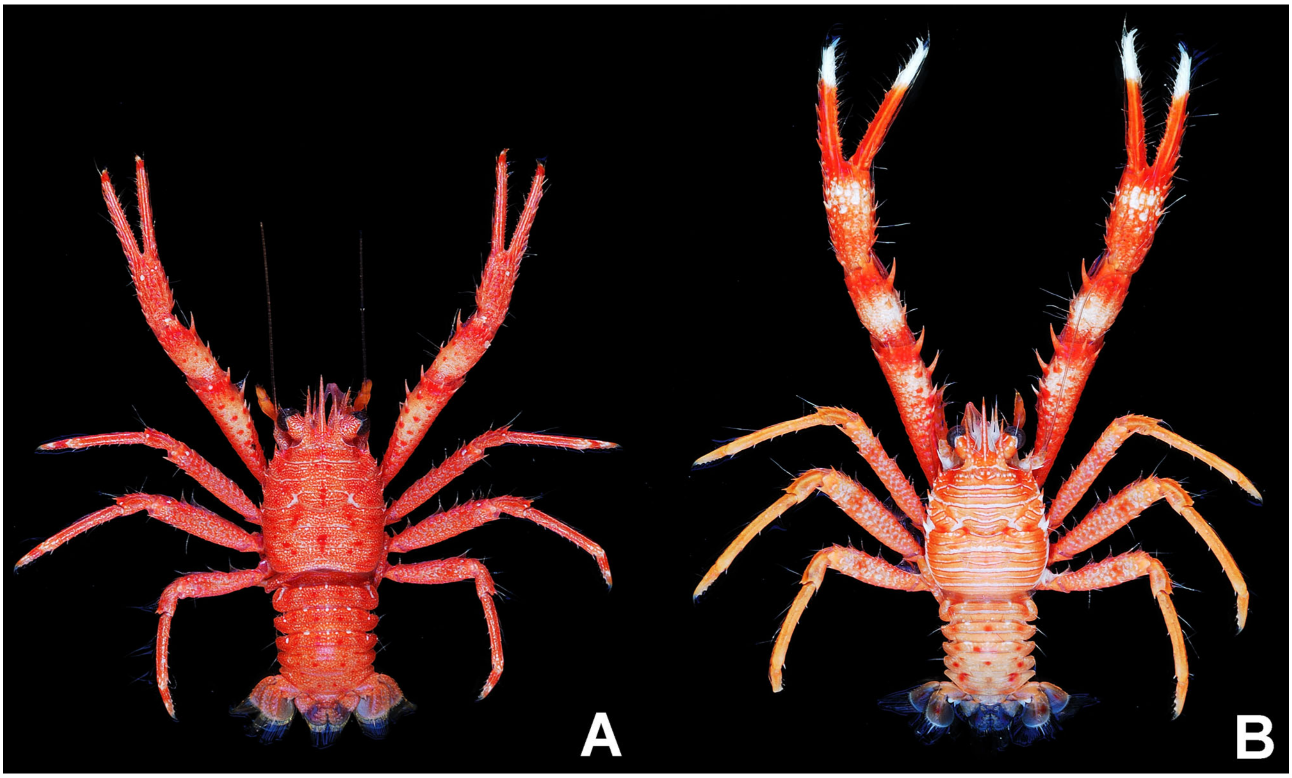


FIGURE 4. Entire animal, dorsal view. A, *Raymunida striata* **n. sp.**, holotype, female (cl 8.2 mm), RUM-ZC-1415; B, *Raymunida vittata* Macpherson, 2009, male (cl 10.2 mm), RUM-ZC-1417.

Distribution. Previously known only from Vanuatu. The present specimens greatly extend the distribution range of *R. vittata* to the northern hemisphere.

Habitat. The present specimens were collected from substratum of dead coral blocks and rubble. The type specimens from Vanuatu were collected at the depths ranging from 32 m to 118 m. The present specimens were obtained from 95.5–123.0 m.

Remarks. Macpherson (2009) described that the antennal article 3 of *R. vittata* is unarmed, but his figure (fig. 7C) shows a small spine on the distomesial margin of the article. The present specimens also have such a spine. The fixed finger of the P1 was described and illustrated by Macpherson (2009) to have a row of spines on the entire dorsolateral margin. However, the dorsolateral row of spines interrupts in the proximal half to three fourths in the present specimens. The both fingers of the P1 also have a rounded longitudinal crest along the dorsal midline in the present material. This agrees with the figure by Macpherson (2009, fig. 7E).

There are some intraspecific morphological variations in the present specimens. The mesial spine of the antennal article 1 reaches the distal margin of the peduncular article 4 in the present specimens except for the smallest female (cl 4.4 mm), in which the mesial spine only overreaches the distal margin of the peduncular article 3. Macpherson (2009) described that the spine in the small paratypes of *R. vittata* only reaches the distal margin of the antennal peduncle, unlike exceeding that margin in other larger types. The smallest female paratype and the present smallest female agree to each other in the specimen size (cl 4.4 mm), but the mesial spine of the antennal article 1 is shorter in the present specimen than the paratype. The subdistal spine on the mesial margin of the antennal article 2 is distinct in large specimens examined (two males, 10.2, 10.5 mm; female, 7.6 mm), but it is reduced to a small low protuberance in other small specimens (male, cl 7. 2 mm; two females, cl 4.4, 6.3 mm). The P1 fingers are 1.3–1.8 (mean 1.6) times longer than the palm, and comparatively shorter in two large males than in other smaller specimens. The striae of the dorsal surface of the abdominal somites 2 and 3 are also variable. The somite 2 lacks any striae between two distinct transverse ridges in the smallest female (cl 4.4 mm), but it has an uninterrupted long stria or a row of some short striae in other larger specimens. The somite 3 lacks any striae between two distinct transverse ridges in three small specimens (one male, cl 7.2 mm; two females, cl 4.4, 6.3 mm), but it possesses some short or very short striae in other large specimens.

Raymunida vittata was discriminated from *R. lineata* by the striation on the abdominal somites 2–4, relative length of the P1 fingers, and fresh colouration (Macpherson, 2009). Although the less developed striae on the abdominal somites 2–4 and comparatively shorter fingers of the P1 generally distinguish *R. vittata* from *R. lineata*, examination of the present specimens revealed that the two morphological distinctions somewhat vary as mentioned above. *Raymunida vittata* is more clearly different from *R. lineata* by the striation on dorsal surface of the abdominal somites 3 and 4. The abdominal somite 3 has no striae or a row of some, short or very short striae in *R. vittata*, whereas it usually possesses a long continuous stria (rarely interrupted in the median part) in *R. lineata*. The abdominal somite 4 lacks striae in *R. vittata*, but it bears two moderately long striae or a row of several short striae in *R. lineata*. Fresh colouration is also very different between the two species (see Osawa 2005; Macpherson 2009; present study).

Key to the species of the genus *Raymunida*

1. Antennal article 2 unarmed on mesial margin 2
– Antennal article 2 usually with subdistal spine on mesial margin (in small specimens, spine reduced to low protuberance) . 7
2. Carapace lacking long setae on dorsal surface. P1 with numerous long plumose setae . . . . . . *R. bellior* (Miyake & Baba, 1967)
– Carapace usually with some long setae on dorsal surface. P1 with numerous long simple setae 3
3. Frontal margin of carapace without spine mesial to anterolateral spine. P1 fixed finger with row of closely spaced spines on entire dorsolateral margin . . . . *R. insulata* Macpherson & Machordom, 2001
– Frontal margin of carapace with small spine mesial to anterolateral spine. P1 fixed finger with row of relatively sparse spines at least on proximal half of dorsolateral margin 4
4. Pl chela robust, less than 5 times longer than broad; dactylus with distinct longitudinal crest on dorsal midline . . . . *R. formosanus* Lin, Chan & Chu, 2004
– P1 chela slender, more than 6 times longer than broad; dactylus without longitudinal crest on dorsal midline 5
5. Abdominal somites 2 and 3 each with uninterrupted stria between 2 distinct transverse ridges on dorsal surface. Mxp3 merus with prominent distal spine on extensor margin . . . . *R. striata* **n. sp.**
– Abdominal somites 2 and 3 without striae between 2 distinct transverse ridges on dorsal surface. Mxp3 merus unarmed or with small distal tooth on extensor margin 6
6. Mero-carpal articulation of P4 not reaching sinus between rostrum and supraocular spines of carapace . . . . *R. confundens* Macpherson & Machordom, 2001
– Mero-carpal articulation of P4 overreaching sinus between rostrum and supraocular spines of carapace . . . . *R. dextralis* Macpherson & Machordom, 2001
7. Mxp3 merus unarmed on extensor margin . . . . *R. erythrina* Macpherson & Machordom, 2001
– Mxp3 merus with distal spine on extensor margin 8
8. Merocarpal articulation of P4 overreaching frontal margin of carapace . . . . *R. limbata* Macpherson, 2006
– Merocarpal articulation of P4 not reaching frontal margin of carapace 9
9. Mero-carpal articulation of P4 only reaching level of first branchial spine of carapace (lateral end of anterior cervical groove). Abdominal somite 2 with 2 short median striae between 2 distinct transverse ridges on dorsal surface. P1 fingers without longitudinal crest on dorsal midline . . . . *R. cagnetei* Macpherson & Machordom, 2000
– Mero-carpal articulation of P4 overreaching level of first branchial spine of carapace. Abdominal somite 2 with row of interrupted short or long striae or continuous stria between 2 distinct transverse ridges on dorsal surface. P1 fingers each with rounded longitudinal crest on dorsal midline 10
10. Abdominal somite 4 without striae between 2 distinct transverse ridges on dorsal surface . . . . . . *R. vittata* Macpherson, 2009
– Abdominal somite 4 with faint or distinct striae between 2 distinct transverse ridges on dorsal surface 11
11. Thoracic sternites 5 and 6 with faint, short oblique ridges on lateral part. Abdominal somites 2 and 3 with faint, very short striae between 2 distinct transverse ridges on dorsal surface . . . . *R. elegantissima* (De Man, 1902) [holotype]
– Thoracic sternites 5 and 6 with distinct, comparatively long, oblique ridges on lateral part. Abdominal somites 2 and 3 with distinct, usually continuous long stria between 2 distinct transverse ridges on dorsal surface. . . . . *R. lineata* Osawa, 2005

Acknowledgements

The material examined was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica. The Expedition was operated under a permit granted to T. Naruse of the University of the Ryukyus by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. I thank Tin-Yam Chan of the National Taiwan Ocean University for kindly taking photographs of the specimens used in this study. The manuscript benefited from the reviews of E. Macpherson of the Centro de Estudios Avanzados de Blanes (CSIC), Girona, and T. Naruse.

References

Ahyong, S.T., Baba, K., Macpherson, E. & Poore, G.C.B. (2010) A new classification of the Galatheoidea (Crustacea: Decapoda: Anomura). *Zootaxa*, 2676, 57–68

Baba, K. (2005) Deep-sea chirostylid and galatheid crustaceans (Decapoda: Anomura) from the Indo-West Pacific, with a list of species. *Galathea Reports*, 20, 1–317.

Baba, K., Macpherson, M., Poore, G.C.B., Ahyong, S.T., Bermudez, A., Cabezas, A., Lin, C.-W., Nizinski, M., Rodrigues, C. & Schnabel, K.E. (2008) Catalogue of squat lobsters of the world (Crustacea: Decapoda: Anomura-families Chirostylidae, Galatheidae and Kiwaidae). *Zootaxa*, 1905, 1–220.

Baba, K., Macpherson, M., Lin, C.-W. & Chan, T.-Y. (2009) *Crustacean Fauna of Taiwan: Squat lobsters (Chirostylidae and Galatheidae)*. National Taiwan Ocean University, Keelung, ix + 311 pp.

Leach, W.E. (1820) Galatéadées. *In*: Dictionnaire des Sciences Naturelles. F.G. Levreault, Paris, pp. 49–56.

Lin, C.-W., Chan, T.-Y. & Chu, K.-H. (2004) A new squat lobster of the genus *Raymunida* (Decapoda : Galatheidae) from Taiwan. *Journal of Crustacean Biology*, 24, 149–156.

Machordom, A. & Macpherson, E. (2004) Rapid radiation and cryptic speciation in squat lobsters of the genus *Munida* (Crustacea, Decapoda) and related genera in the South West Pacific: molecular and morphological evidence. *Molecular Phylogenetics and Evolution*, 33, 259–279.

Macpherson, E. (1994) Crustacea Decapoda: Studies on the genus *Munida* Leach, 1820 (Galatheidae) in New Caledonia and adjacent waters with descriptions of 56 new species. *In*: Crosnier, A. (ed.), Résultats des Campagnes MUSORSTOM. Volume 12. *Mémoires du Muséum National d'Histoire Naturelle*, Paris, 161, 421–569.

Macpherson, E. (2006) Galatheidae (Crustacea, Decapoda) from the Austral Islands, Central Pacific. *In*: Richer de Forges, B. & Justine, J.L. (eds.), Tropical Deep-Sea Benthos. Volume 24. *Mémoires du Muséum National d'Histoire Naturelle, Paris*, 193, 285–333.

Macpherson, E. (2009) New species of squat lobsters of the genera *Munida* and *Raymunida* (Crustacea, Decapoda, Galatheidae) from Vanuatu and New Caledonia. *Zoosystema*, 31, 431–451.

Macpherson, E. & Machordom, A. (2000) *Raymunida*, new genus (Decapoda: Anomura: Galatheidae) from the Indian and Pacific Oceans. *Journal of Crustacean Biology*, 20, 253–258.

Macpherson, E. & Machordom, A. (2001) Phylogenetic relationships of species of *Raymunida* (Decapoda: Galatheidae) based on morphology and mitochondrial cytochrome oxidase sequences, with the recognition of four new species. *Journal of Crustacean Biology*, 21, 696–714.

Man, J.G. de (1902) Die von Herrn Professor Kükenthal im Indischen Archipel gesammelten Dekapoden und Stomatopoden. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 25, 467–929, pls. 19–27.

Miyake, S. & Baba, K. (1967) New and rare species of the family Galatheidae (Crustacea, Anomura) from the Sagami Bay in the collection of the Biological Laboratory, Imperial Household, Japan. *Journal of the Faculty of Agriculture, Kyushu University*, 14, 213–224.

Osawa, M. (2005) The identity of *Raymunida elegantissima* (Crustacea: Decapoda: Anomura: Galatheidae) and description of a closely related new species from Japan. *Species Diversity*, 10, 85–104.

Zootaxa 3367: 145–154 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new genus and new species of pagurid hermit crab (Crustacea: Decapoda: Anomura: Paguroidea) from a submarine cave in Kume Island, Ryukyu Islands*

TOMOYUKI KOMAI[1,3] & MASAYUKI OSAWA[2]

[1]*Natural History Museum and Institute, Chiba, 955-2 Aoba-cho, Chuo-ku, Chiba, 260-8682 Japan. E-mail: komai@chiba-muse.or.jp*
[2]*Research Center for Coastal Lagoon Environments, Shimane University, 1060 Nishikawatsu-cho, Matsue, Shimane, 690-8504, Japan. E-mail: osawam@soc.shimane-u.ac.jp*
[3]*Corresponding author*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new genus and new species of pagurid hermit crab, *Kumepagurus cavernicolus*, is described on the basis of a single male specimen collected from a submarine cave in Kume Island, Ryukyu Islands, at a depth of 38 m. The new genus superficially resembles *Pylopaguropsis* Alcock, 1905, in having13 pairs of biserial phyllobranchiae, the operculate right chela and the possession of two terminal spines on the fixed finger of the left cheliped, but it is unique in the combination of 13 pairs of biserial gills and the presence of male sexual tubes.

Key words: Crustacea, Decapoda, Anomura, Paguridae, new genus, new species, Ryukyu Islands, submarine cave

Introduction

The shallow coral reefs and nearby environments around Kume Island, Ryukyu Islands, were extensively surveyed in November 2009 during the KUMEJIMA 2009 Expedition. Among the collections of decapod crustaceans, there was an unusual species of pagurid hermit crab obtained by SCUBA diving collections from a submarine cave. This species reported herein represents a new genus and species noteworthy not only for its unique combination of characters but also for its possible endemism to cave environments where sampling is difficult.

The holotype and single specimen was collected by a bait trap set inside of the submarine cave at a depth of 38 m, about 50 m from the entrance. The holotype is deposited in the collection of the Ryukyu University Museum, Fujukan (RUMF), Nishihara, Okinawa. General terminology follows McLaughlin (2003) (for carapace sulci) and McLaughlin *et al*. (2007), except for numbering of thoracic sternites. Shield length (sl), measured from the tip of the rostrum to the midpoint of the posterior margin of the shield, indicates specimen size.

Taxonomic account

Family Paguridae Latreille, 1802

Kumepagurus n. gen.

[new Japanese name: Kumejima-doukutsu-yadokari-zoku]

Type species. *Kumepagurus cavernicolus* **n. sp.**, by present designation.

Diagnosis. Gills biserial, 13 pairs (2 arthrobranchs above bases of third maxilliped to fourth pereopods and 1 pleurobranch on each body wall of fifth to seventh thoracic somites). Rostrum roundly triangular. Ocular acicles

Accepted by T. Naruse: 1 Jun. 2011; published: 4 Jul. 2012

simple. Third maxilliped with crista dentata consisting of moderately spaced, unequal teeth; no accessory tooth. Right cheliped massive, chela operculate; dactylus articulating obliquely with palm. Fourth pereopod simple, with propodal rasp consisting of single row of corneous scales; no preungual process. Male with medium, coiled, laterally oriented sexual tube on coxa of right fifth pereopod; left coxa with short sexual tube, directed posteriorly, tapering distally to slender, acute tip. Male with left third to fifth pleopods. Female characters unknown. Pleon dextrally twisted. Sixth pleonal tergite not strongly calcified. Telson with terminal margins strongly oblique.

Remarks. Only a single male specimen was available for study, and thus the female diagnostic characters remain unknown. This new genus resembles *Pylopaguropsis* Alcock, 1905, in the possession of 13 pairs of biserial gills and the operculate right chela. In addition, the tip of the fixed finger of the left chela bears two terminal corneous spines in this new species, a character shared only with *Pylopaguropsis* species among pagurid genera (Asakura 2000). However, *Kumepagurus* **n. gen.** is readily distinguished from *Pylopaguropsis* by the possession of prominent sexual tubes in males. Furthermore, the absence of an accessory tooth on the third maxilliped and the simple fourth pereopod, also immediately differentiate the new genus from *Pylopaguropsis*. There are no other pagurid genera characterized by the combination of the 13 pairs of biserial gills and the possession of well-developed sexual tubes.

Etymology. Named after the type locality, Kume Island. Gender: masculine.

Kumepagurus cavernicolus n. sp.

[new Japanese name: Kumejima-doukutsu-yadokari]
(Figs. 1–6)

Material examined. Holotype: male (sl 2.4 mm), 50 m from entrance inside a submarine limestone cave, Kume Island, 26°19.964′N, 126°43.906′E, 38 m, 15 November 2009, bait trap, coll. Y. Fujita & S. Ogawa, RUMF-ZC-1518.

Description. Shield (Fig. 1A, B) as long as broad; anterior margins between rostrum and lateral projections concave; anterolateral margins slightly terraced, posterior margin roundly truncate; dorsal surface with few tufts of short setae laterally. Rostrum roundly triangular, terminating in tiny sharp spine. Lateral projections obtusely triangular, not reaching level of rostral tip; each with small submarginal spine. Posterior carapace (Fig. 1B) membranous; with pair of tufts of short setae at level of midlength; posteromedian plate moderately wide, with slightly convex lateral margins; sulci cardiobranchiales parallel, extending to midlength between cervical groove and posteromedian margin of carapace.

Ocular peduncles (Fig. 1A) about 0.6 times as long as shield, moderately stout, not tapering distally or inflated basally, each with prominent tuft of stiff setae at base of cornea and few short setae dorsomesially; corneas not dilated, corneal width about 0.3 times peduncular length. Ocular acicles narrowly subtriangular, directed slightly mesially, terminating in subacute marginal spine. Interocular lobe small, visible in dorsal view.

Antennular peduncles (Fig. 1A, C), when fully extended, overreaching ocular peduncles by full lengths of ultimate segments. Basal segment with small spine on lateral margin located slightly distal to midlength; distolateral angle produced in small lobe. Ultimate segment elongate, 0.9 times as long as shield, slightly broadened distally in lateral view, with few short setae dorsally. Dorsal flagellum with distal portion much longer than proximal, aesthetasc-bearing portion.

Antennal peduncles (Fig. 1A) relatively long, overreaching distal corneal margins by full lengths of fifth segments. First segment unarmed on lateral face, ventromesial distal margin produced, with bifid spinule just lateral to antennal gland opening. Second segment with dorsolateral distal angle produced, reaching midlength of third segment, terminating in bifid spine; dorsomesial distal angle with small spine. Third segment with 1 small spine at ventrodistal margin. Fourth and fifth segments with few short setae mesially, fourth segment slightly shorter than fifth segment. Antennal acicle slender, elongate, overreaching distal corneal margin by about half own length, not reaching distal end of fifth peduncular segment, terminating in small spine, bearing prominent tuft of long setae distally and row of sparse short setae dorsomesially. Antennal flagellum (Fig. 1D) very long, each article with few short to long setae distally.

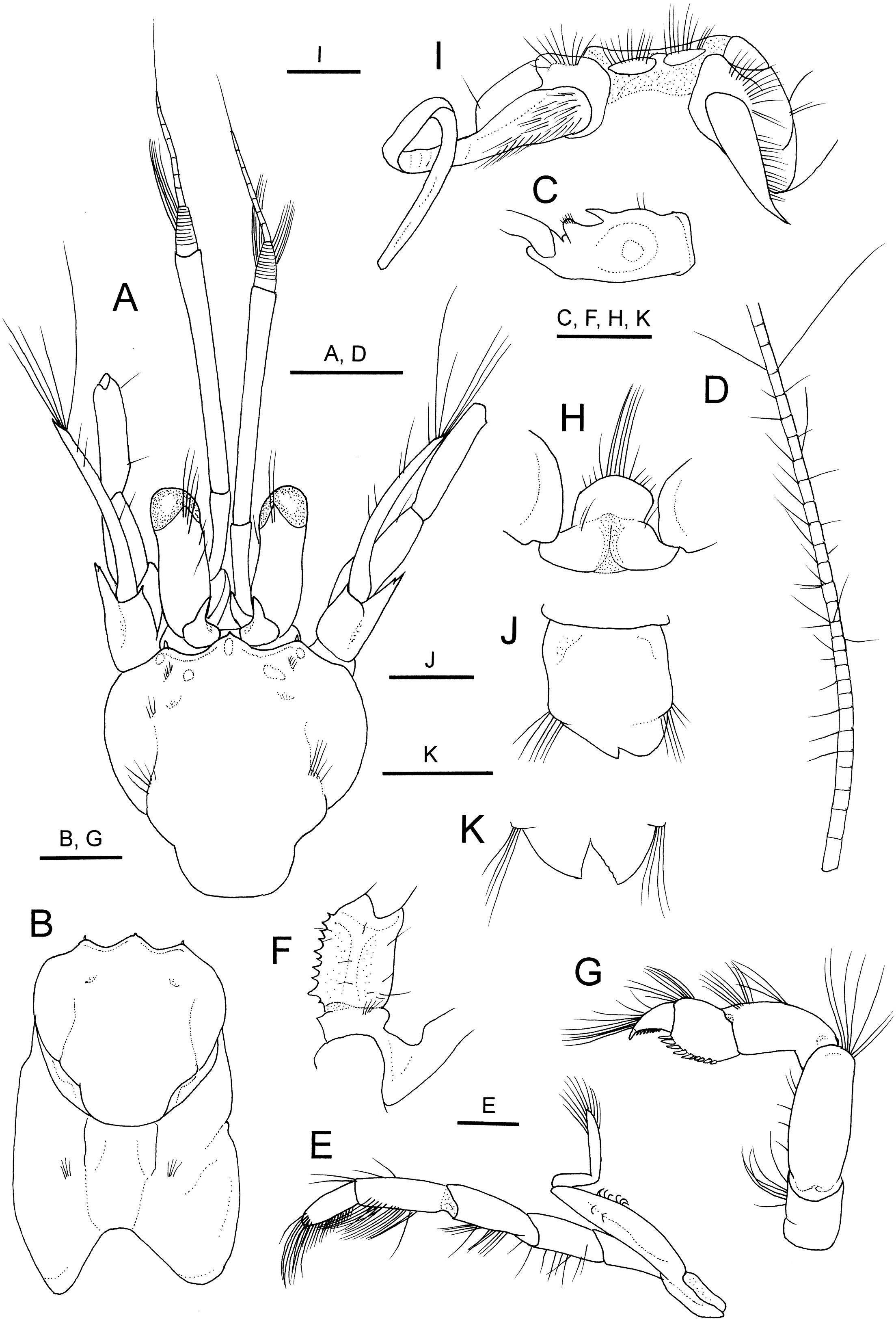


FIGURE 1. *Kumepagurus cavernicolus* **n. gen.**, **n. sp.**, holotype, male (sl 2.4 mm), RUMF-ZC-1518. A, shield and cephalic appendages, dorsal view; B, carapace, dorsal view; C, basal segment of left antennular peduncle, ventral view; D, proximal part of left antennal flagellum, dorsal view; E, left third maxilliped, lateral view; F, same, basis and ischium, ventral view; G, left fourth pereopod, lateral view; H, sixth thoracic sternite, ventral view; I, eighth thoracic sternite and coxae of fifth pereopods with sexual tubes, ventral view; J, telson, dorsal view; K, posterior lobe of telson, posterior view. Scales: A, B, D = 1 mm; C, E–K = 0.5 mm.

Mandible (Fig. 2A) without distinctive features. Maxillule (Fig. 2B) with endopod slender, weakly developed inner lobe with 1 apical spiniform seta, outer lobe elongate, with 1 terminal and 1 basal seta. Maxilla (Fig. 2C) with relatively short scaphognathite; endopod slender, gradually tapering distally (Fig. 2D). First maxilliped (Fig. 2E) with distal endite subovate; endopod reaching beyond distal margin of distal endite; exopod consisting of 2 segments and flagellum, distal segment strongly flexed laterally, proximal segment with slightly expanded lateral margin, flagellum shorter than distal segment. Second maxilliped (Fig. 2F) relatively large, with elongate exopod; flagellum well developed, flexed at proximal 0.3. Third maxilliped (Fig. 1E) with endopod relatively long and slender; carpus and merus unarmed; ischium and basis incompletely fused; crista dentata on ischium consisting of row of about 10 rather widely separated, acute teeth, accessory tooth absent; basis with 1 tiny denticle on mesial margin (Fig. 1F).

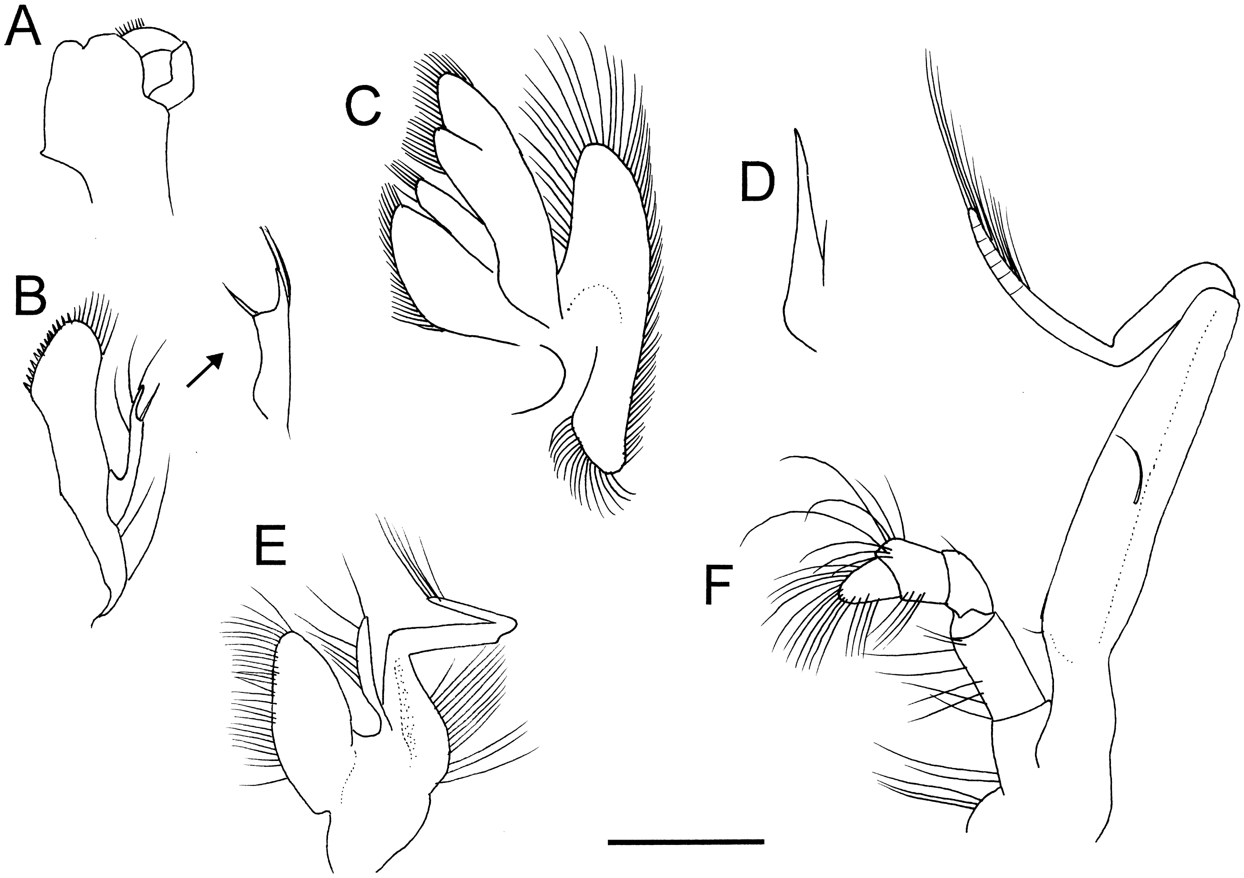


FIGURE 2. *Kumepagurus cavernicolus* **n. gen**., **n. sp.**, holotype, male (sl 2.4 mm), RUMF-ZC-1518. Left mouthparts. A, mandible, outer view; B, maxillule, outer view (proximal endite broken off); inset, endopod, lateral view; C, maxilla, outer view; D, endopod of maxilla, inner view; E, first maxilliped, outer view (proximal endite broken); F, second maxilliped, outer view. Scale = 0.5 mm.

Right cheliped (Fig. 3A–G) massive. Chela operculate, subrectangular, about 1.2 times longer than wide; propodal-carpal articulation rotated clockwise about 20° from perpendicular. Dactylus subequal in length to palm, articulating obliquely; dorsal surface with scattered blunt granules, dorsomesial margin produced, forming sharp crest with granulated margin; ventral face convex along midline, shallowly concave proximolaterally, with scattered small, blister-like tubercles; cutting edge with 3 bluntly triangular calcareous teeth, terminating in tiny, sharp corneous claw. Palm longer than carpus, widened distally, about 1.2 times wider than long; dorsal surface slightly convex in general, with scattered, occasionally corneous-tipped, granules; dorsolateral margin delimited by row of minute granules not extending onto fixed finger, distal end of dorsolateral margin forming low, but rather prominent short ridge; dorsomesial margin delimited proximally by distinct crest with slightly upturned edge, distal part of dorsomesial portion rounded; lateral, mesial, ventral surfaces (including fixed finger) densely covered with low, rounded granules (granules largest and rather blister-like on ventral surface of fixed finger and distal part of

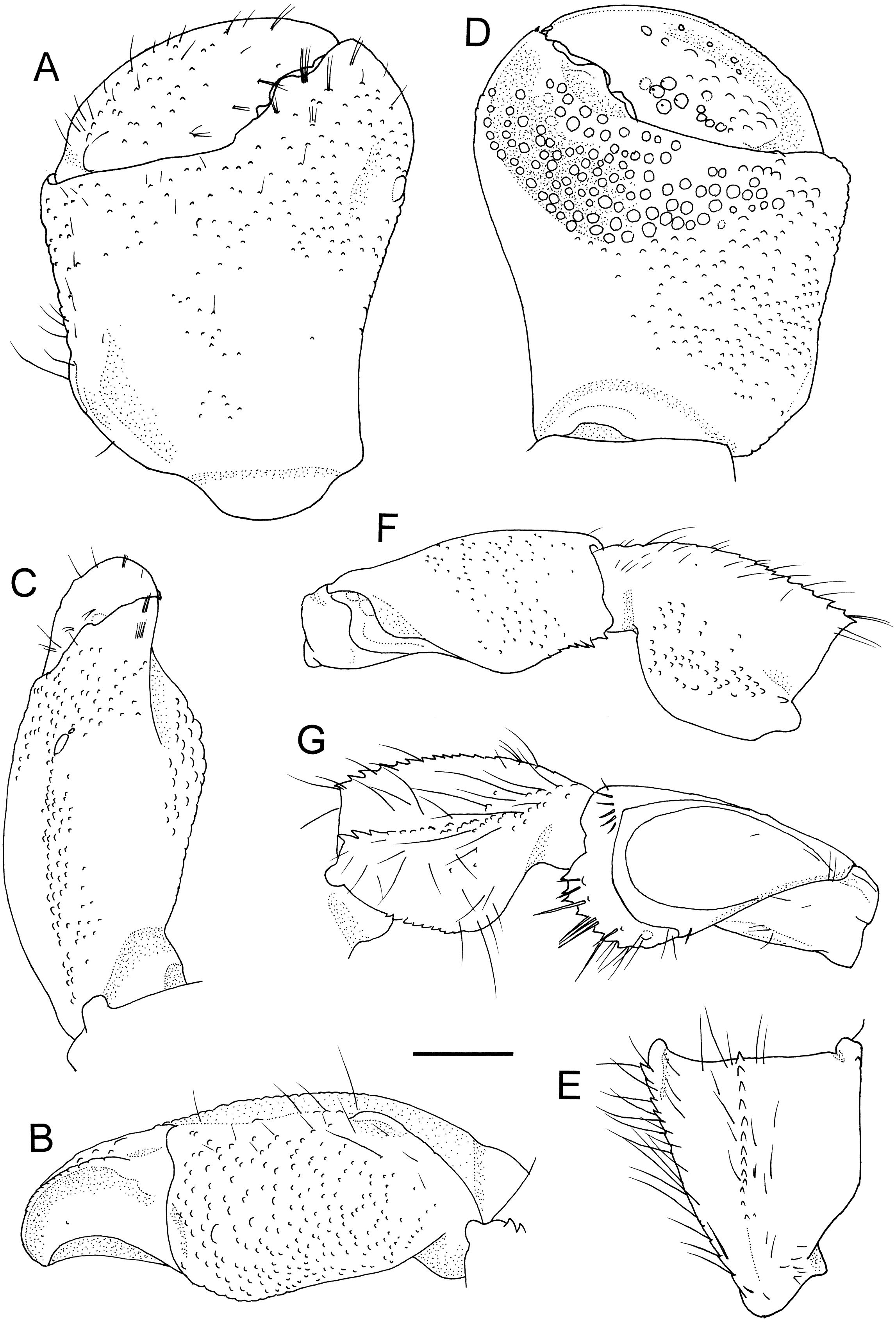


FIGURE 3. *Kumepagurus cavernicolus* **n. gen.**, **n. sp.**, holotype, male (sl 2.4 mm), RUMF-ZC-1518. Right cheliped. A, chela, dorsal view; B, same, mesial view; C, same, lateral (perpendicular) view; D, same, ventral view; E, carpus, dorsal view; F, carpus and merus, lateral view; G, same, mesial view. Scale = 1 mm.

palm), lateral surface with scattered short to long setae dorsally, ventral surface having blunt transverse ridge extending from base of dactylus to ventrolateral distal margin of fixed finger, thus ventral face of fixed finger shallowly concave. Fixed finger with markedly convex lateral face; cutting edge with 3 triangular calcareous teeth (middle tooth strongest), terminating in minute corneous claw; scattered short to moderately long setae present on dorsal surface and dorsal part of mesial face. Carpus subequal in length to merus, widened distally; dorsal surface elevated in midline, with row of small spines, sloping lateral and mesial sides with scattered granules, latter with long stiff setae adjacent to mesial margin; lateral margin faintly delimited, with 1 small distal spine, mesial margin sharply delimited by spinulose carina (spinules strongest distally) bearing long stiff setae; ventrolateral surface with scattered granules; ventromesial face nearly smooth but with scattered stiff setae; ventral surface strongly convex, with scattered granules and stiff setae, proximal part only weakly calcified. Merus with few low, transverse ridges in dorsodistal part, distalmost ridge longest, with row of short stiff setae; lateral face covered with minute granules and with iridescent sheen; ventrolateral margin elevated, strongly convex in lateral view, with row of spinules in distal half; mesial face nearly flat, smooth; ventromesial margin crested, strongly convex in lateral view, with row of spinules and stiff setae; only weakly calcified distal part of ventral surface forming deep concavity to accommodate flexed carpus, proximal part well calcified and almost flat. Ischium unarmed, with iridescent sheen on lateral face. Coxa unarmed.

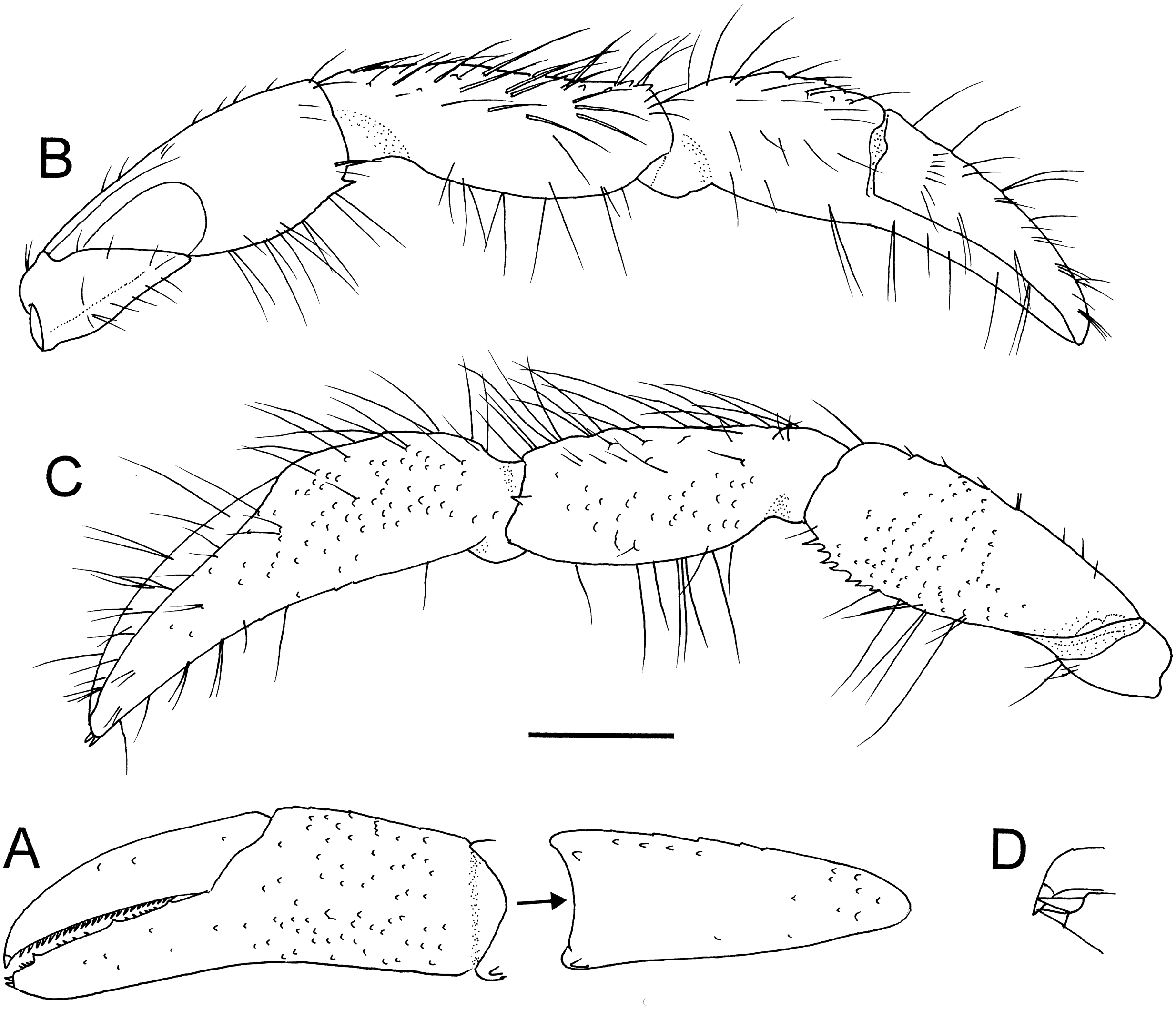


FIGURE 4. *Kumepagurus cavernicolus* **n. gen.**, **n. sp.**, holotype, male (sl 2.4 mm), RUMF-ZC-1518. Left cheliped. A, chela and carpus, dorsal view; B, entire left cheliped, mesial view; C, same,, lateral view; D, tips of fingers, dorsal view. Scales: A–C = 1 mm; D = 0.5 mm.

Left cheliped (Fig. 4A–C) moderately slender, reaching nearly to distal end of right cheliped, with slight degree of counterclockwise rotation from perpendicular. Chela about 3.1 times longer than wide and 1.4 times longer than carpus; dactylus and fixed finger only slightly curved ventrally, without hiatus. Dactylus about 1.2 times longer than palm, unarmed but with sparse tufts of short to moderately long setae, terminating in small corneous claw (Fig. 4D); dorsomesial margin not delimited; cutting edge with row of closely set corneous teeth over entire length. Palm 0.6 length of carpus; dorsal surface slightly convex, with scattered granules and sparse setae and few low protuberances mesially, without delineation of dorsolateral and dorsomesial margins; mesial and ventral faces generally smooth, with scattered setae. Fixed finger bearing 2 acute corneous spines at tip (Fig. 2D); cutting edge with few tiny acute calcareous teeth and row of sparse minute, corneous teeth. Carpus widened distally, length about 3.0 of distal width; dorsal surface sloping to lateral face, having tufts of short to long stiff setae and row of tiny spines mesially; lateral face with scattered granules, distal margin with small spine; mesial face with long stiff setae dorsally; ventral surface slightly convex, with sparse setae. Merus with sparse row of short setae on dorsal surface, dorsodistal margin unarmed; lateral face with scattered granules, ventrolateral margin with row of small spines in distal half; mesial face smooth, with few short setae, ventromesial margin with 1 distal spine, otherwise unarmed; ventral surface with sparse tufts of long setae. Ischium unarmed, with scattered short setae. Coxa unarmed.

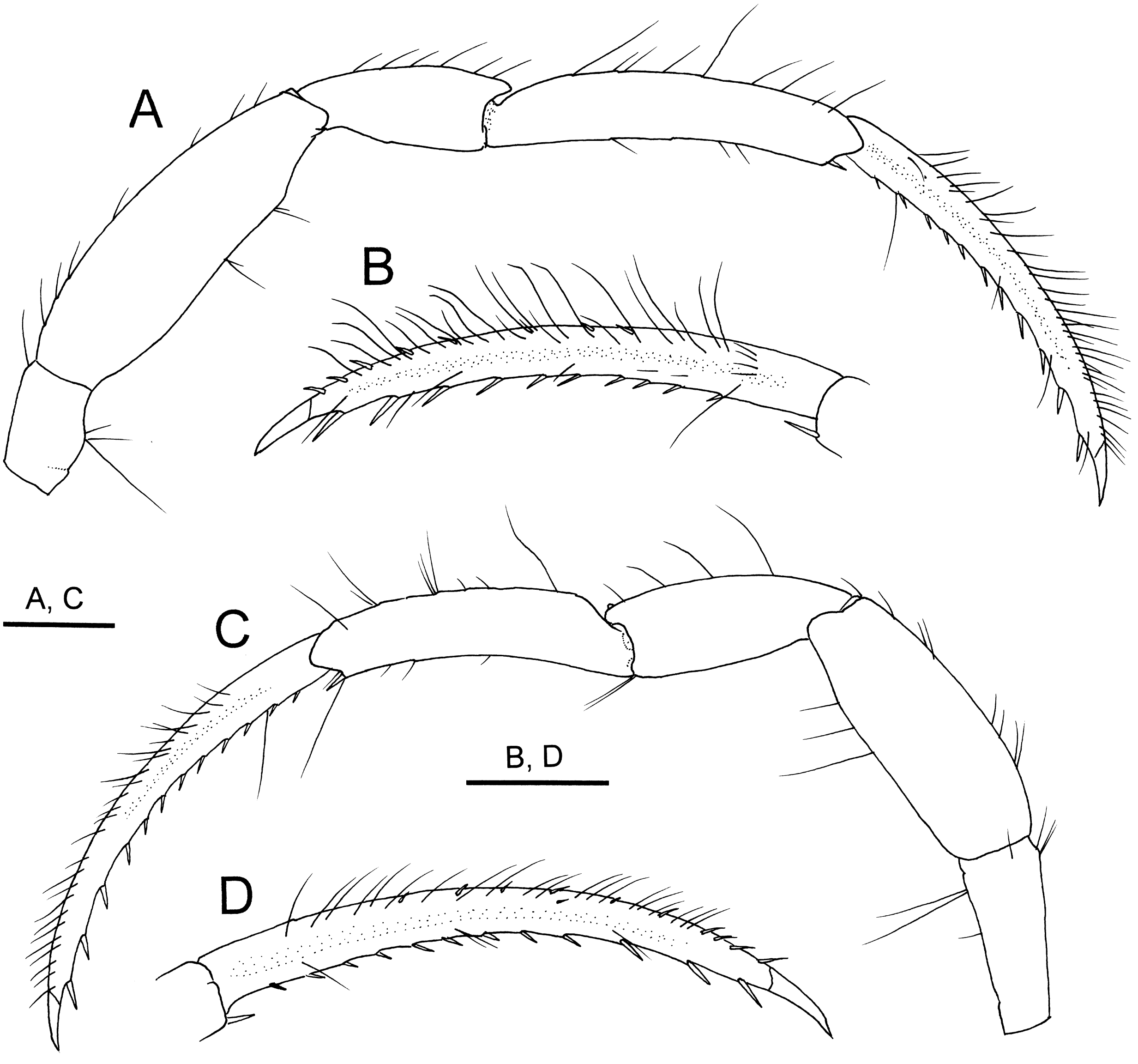


FIGURE 5. *Kumepagurus cavernicolus* **n. gen.**, **n. sp.**, holotype, male (sl 2.4 mm), RUMF-ZC-1518. Ambulatory legs. A, right second pereopod, lateral view; B, same, dactylus, mesial view; C, left third pereopod, lateral view; D, same, dactylus, mesial view. Scales = 1mm.

Ambulatory legs (Fig. 5A, C) relatively slender, slightly overreaching tip of right cheliped. Dactyli about 1.3 (second) or 1.7 (third) length of propodi, about 11.0 times longer than wide, slightly curved ventrally in lateral view, nearly straight in dorsal view, terminating in long, slender corneous claws; dorsal margins each with row of moderately long setae; lateral faces each with very shallow longitudinal sulcus; mesial faces each with very shallow longitudinal sulcus and row of 8 (second) or 9–11 (third) corneous spinules adjacent to dorsal margin; ventral margins each with 10–12 slender corneous spines increasing in size distally (Fig. 5B, D). Propodi slightly curved ventrally, those of second longer than those of third; dorsal surfaces each with sparse short and long setae; lateral and mesial faces smooth; ventral surfaces with sparse short setae, ventrodistal margins each armed with 1 or 2 slender corneous spines. Carpi with or without spinule at dorsodistal angle and with few setae on dorsal surface; lateral and mesial faces smooth. Meri unarmed, with sparse setae on dorsal and ventral surfaces; ventrolateral margins shallowly concave in distal 0.2. Ischia unarmed. Distinct concavity on ventral margin around articulation between merus and ischium in second pereopods.

Fourth pereopods (Fig. 1G) simple. Dactyli each with row of corneous teeth on ventral margin; dorsal margin with prominent tuft of stiff setae. Propodi each with tuft of setae distally on dorsal margin; rasp consisting of single row of corneous scales increasing in size distally; carpus with tufts of setae in distal half of dorsal margin.

Fifth pereopods semichelate.

Anterior lobe of sixth thoracic sternite (Fig. 1H) subsemicircular, with row of setae on anterior margin, setae longest in medial portion.

Right sexual tube (Fig. 1I) medium in length, coiled, oriented laterally, tapering distally; tip roundly truncate; basal portion with covering of numerous short setae. Left sexual tube (Fig. 1I) short, but distinctly extending beyond posterior margin of coxa, somewhat flattened, directed posterolaterally, tapering distally to acute tip; numerous short setae present on dorsal side. Coxae of fifth pereopods (Fig. 1I) unequal (left larger than right), each with transverse row of setae on anterior margin. Eighth thoracic sternite (Fig. 1I) with 2 compressed lobes, each lobe bearing marginal setae.

Pleon dextrally twisted (Fig. 6), with relatively long, unequally biramous third to fifth pleopods; fourth pleopod longest, with elongate exopod.

Telson (Fig. 1J, K) with slightly asymmetrical posterior lobes separated by very small median cleft; terminal margins strongly oblique, microscopically denticulate; transverse indentations weakly delimited, each with prominent tuft of setae.

FIGURE 6. *Kumepagurus cavernicolus* **n. gen.**, **n. sp.**, holotype, male (sl 2.4 mm), RUMF-ZC-1518. Entire animal in dorsal view, showing colouration in life. Photo: Tin-Yam Chan.

Colouration in life (Fig. 6). Shield generally white, reddish gut inside visible; posterior carapace translucent. Ocular peduncle generally white, with reddish-brown longitudinal stripe mesially and laterally on dorsal surface; cornea gray. Antennular peduncle translucent, with tinge of reddish-brown. Antennal peduncle with white first to third segments and reddish-brown fourth and fifth segments; antennal acicle white. Right chela generally pale brown, darker mesially and laterally, mesial crest white; carpus light brown, with white patches laterally and mesially on dorsal surface; merus generally light brown, lateral face with large white patch. Left chela generally light brown, whitish on lateral side of dorsal surface of palm. Dactyli of ambulatory legs white in distal 0.6–0.7, red in proximal 0.3–0.4; propodi and carpi white (on the photo, the area appears blue, but this is due to the lighting), lateral faces with red longitudinal stripes dorsally and ventrally; meri with distal and middle red bands and small proximal red spot, remainder white; ischia generally white. Pleon reddish.

Distribution. Known only from the type locality, submarine cave in Kume Island, at a depth of 38 m.

Remarks. To date, the following 11 hermit crab species have been recorded from marine caves in the Ryukyu Islands: *Paguristes jalur* Morgan, 1992; *Catapaguroides foresti* McLaughlin, 2002 (= *C. kasei* Osawa & Takeda, 2004); *C. iejimensis* Osawa & Takeda, 2004; *C. longior* Komai, Yamada & Shirakawa, 2010; *Catapagurus tuberculosus* (Asakura, 1999); *Pagurixus longipes* Osawa, Fujita & Okuno, 2006; *P. nomurai* Komai & Asakura, 1995; *P. pulcher* Osawa, Fujita & Okuno, 2006; *Pylopaguropsis bellula* Osawa & Okuno, 2007; *P. fimbriata* McLaughlin & Haig, 1989; *P. speciosa* McLaughlin & Haig, 1989 (Osawa & Takeda 2004; Osawa *et al*. 2006; Osawa & Okuno 2007; Komai *et al*. 2010). However, all but *Catapaguroides longior* occur in cryptic but normal non-cave habitats (McLaughlin & Haig 1989; Morgan 1992; Komai & Asakura 1995; Asakura 1999; McLaughlin 2002; Osawa & Okuno 2007; unpublished data), and therefore it is considered that the occurrence of these species in cave environments is rather opportunistic. *Catapaguroides longior* and the present new species have been found only in deep chambers of submarine caves, despite extensive collecting efforts in recent years. It is possible that these two species are restricted to cave environments.

Etymology. The species name is a combination of the Latin, *caverna* (= cave) and *cola* (= living), in reference to the habitat of this new species.

Acknowledgements

The material examined was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The unique specimen was obtained by skillful divers, Y. Fujita and S. Ogawa, in a submarine cave. The Expedition was operated under a permit granted to T. Naruse, the organizer of the KUMEJIMA 2009 Expedition, by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative.

References

Asakura, A. (1999) *Icelopagurus tuberculosus*, a distinct new hermit crab species (Crustacea: Decapoda: Paguridae) form Japan. *Proceedings of the Biological Society of Washington*, 112, 381–395.

Asakura, A. (2000) A review of Japanese species of *Pylopaguropsis* Alcock, 1905 (Decapoda: Anomura: Paguridae). *Crustacean Research*, 29, 70–108.

Komai, T. & Asakura, A. (1995) *Pagurixus nomurai*, new species, and additional record of *Pagurixus maorus* (Nobili, 1906), hermit crabs from Kume-jima Island, the Ryukyus, Japan (Decapoda: Anomura: Paguridae). *Journal of Crustacean Biology*, 15, 341–354.

Komai, T., Yamada, Y. & Shirakawa, N. (2010) A new hermit crab species of the genus *Catapaguroides* A. Milne-Edwards & Bouvier (Decapoda: Anomura: Paguridae) from the Ryukyu Islands, Japan, and additional record of *C. foresti* McLaughlin. *Zootaxa*, 2690, 32–42.

McLaughlin, P.A. (2002) A new species of the genus *Catapaguroides* (Decapoda, Anomura, Paguroidea, Paguridae) from Guam, Micronesia. *Crustaceana*, 75, 495–504.

McLaughlin, P.A. (2003) Illustrated keys to families and genera of the superfamily Paguroidea (Crustacea: Decapoda: Anomura), with diagnoses of genera of Paguridae. *Memoirs of Museum Victoria*, 60, 111–144.

McLaughlin, P.A. & Haig, J. (1989) On the status of *Pylopaguropsis zebra* (Henderson), *P. magnimanus* (Henderson), and *Galapagurus teevanus* Boone, with descriptions of seven new species of *Pylopaguropsis* (Crustacea: Anomura: Paguridae). *Micronesica*, 22, 123–171.

McLaughlin, P.A., Rahayu, D.L., Komai, T. & Chan, T.-Y. (2007) *A catalog of the hermit crabs (Paguroidea) of Taiwan*. National Taiwan Ocean University, Keelung, 367 pp.

Morgan, G.J. (1992) The hermit crabs (Crustacea: Decapoda: Coenobitidae, Diogenidae, Paguridae) of Christmas and Cocos (Keeling) Islands, Indian Ocean, with description of a new species of *Paguristes*. *Raffles Bulletin of Zoology*, 40, 163–174.

Osawa, M., Fujita, Y. & Okuno, J. (2006) Two new species of *Pagurixus* (Crustacea: Decapoda: Anomura: Paguridae) from submarine caves of the Ryukyu Islands, southwestern Japan. *Zootaxa*, 1148, 27–45.

Osawa, M. & Okuno, J. (2007) New species of the genus *Pylopaguropsis* (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, southwestern Japan, with notes on two poorly known pagurids. *Species Diversity*, 12, 29–46.

Osawa, M. & Takeda, M. (2004) Hermit crabs (Crustacea: Decapoda: Anomura: Paguroidea) from submarine caves in the Ryukyu Islands, south-western Japan. *Journal of Natural History*, 38, 1097–1132.

Zootaxa 3367: 155–164 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new species of the genus *Pagurus* Fabricius, 1775 (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, southwestern Japan*

MASAYUKI OSAWA
Research Center for Coastal Lagoon Environments, Shimane University, 1060 Nishikawatsu-cho, Matsue, Shimane, 690-8504 Japan.
E-mail: osawam@soc.shimane-u.ac.jp

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new species of pagurid hermit crab, *Pagurus tabataorum* **n. sp.**, is described from Kume Island, Ryukyu Islands, southwestern Japan. It appears closest to *P. capsularis* McLaughlin, 1997, known from the Tanimbar Islands in Indonesia, but is readily distinguished by the possession of numerous arcuate or sinuous, transverse scutes on the dorsal surface of the chelae. Distributional patterns of species of the genus *Pagurus* Fabricius, 1775, hitherto recorded from the Ryukyu Islands are briefly reviewed.

Key words: Crustacea, Decapoda, Anomura, *Pagurus*, new species, Ryukyus

Introduction

The KUMEJIMA 2009 Expedition was an extensive survey on the coastal marine fauna around Kume Island, Ryukyu Islands, southwestern Japan. Dredgings and trawlings during the expedition were resulted in the findings of many species of decapod crustaceans including an unusual hermit crab species of the genus *Pagurus* Fabricius, 1775. The species is herein described as new to science and illustrated in detail.

The holotype of the new species is deposited in the Ryukyu University Museum, Fujukan (RUMF), Okinawa. The measurement provided is shield length (sl), measured from the tip of the rostral lobe to the midpoint of the posterior margin of the shield. The terminology follows McLaughlin (2003) and McLaughlin *et al*. (2007) for the most part, with exception of numbered thoracic sternites and dactylus (dactyli) for dactyl (dactyls).

Taxonomic account

Family Paguridae Latreille, 1802

Genus *Pagurus* Fabricius, 1775

Pagurus tabataorum n. sp.

[New Japanese name: Chura-honyadokari]
(Figs. 1–5)

Type material. Holotype: KUMEJIMA 2009, St. Dredge 11, 26°22.670–22.806′N, 126°48.035–48.327′E, 68 m, 10 November 2009, male (sl 4.0 mm), RUMF-ZC-1508.

Description. Eleven pairs of biserial, phyllobranchiate gills.

Shield (Fig. 1A) 1.1 times as long as broad; anterior margins between rostrum and lateral projections concave; anterolateral margins sloping, posterior margin roundly truncate; dorsal surface with few tufts of short setae anterolaterally. Rostrum roundly triangular, terminating bluntly. Lateral projections obtusely triangular, not

Accepted by T. Naruse: 14 Aug. 2011; published: 4 Jul. 2012

reaching level of rostral tip, each with marginal spinule. Posterior carapace membranous, with pair of tufts of short setae on anteromedian part; posteromedian plate narrow, with subparallel lateral margins; sulci cardiobranchiales slightly sinuous, extending to midlength between cervical groove and posteromedian margin of carapace.

Ocular peduncles (Fig. 1A) about 0.7 times as long as shield, moderately stout, not inflated basally, each with row of tufts of short setae on dorsal midline and few short setae on mesial surface; corneas slightly dilated, corneal width 0.4 times peduncular length. Ocular acicles narrowly subtrianbular, terminating bluntly and with submarginal spine, separated by basal width of more than one acicle; dorsal surface slightly grooved. Interocular lobe small, visible in dorsal view.

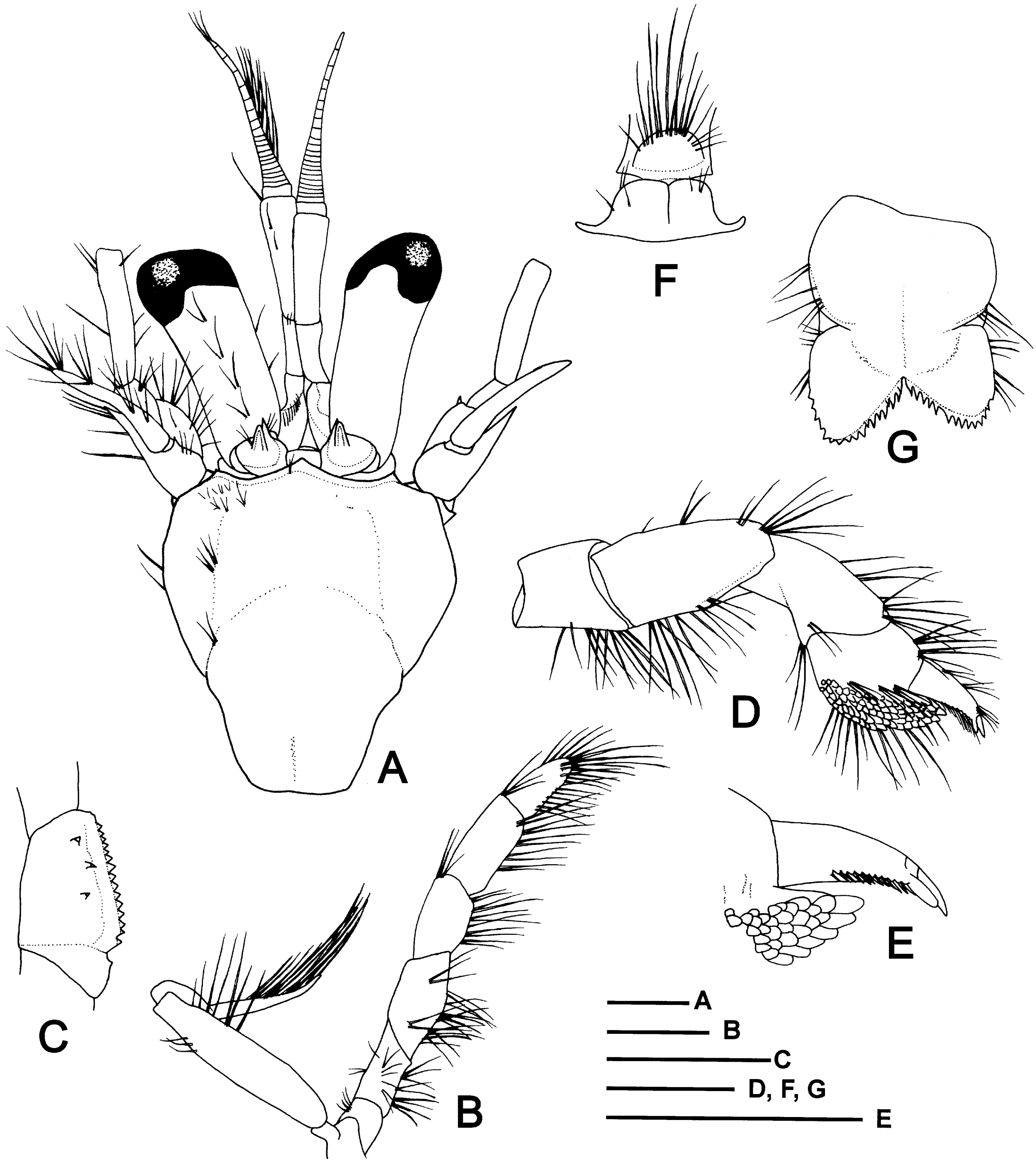


FIGURE 1. *Pagurus tabataorum* **n. sp.**, holotype, male (cl 8.2 mm), RUMF-ZC-1508: A, shield and cephalic appendages, dorsal view (setae omitted from right side); B, right third maxilliped, lateral view; C, same, basis and ischium, ventral view; D, right fourth pereopod, lateral view; E, same, dactylus and distal part of propodus, lateral view (setae omitted); F, sixth thoracic sternite, ventral view; G, telson, dorsal view. Scales = 1.0 mm.

Antennular peduncles (Fig. 1A), when fully extended, overreaching ocular peduncles by half-lengths of ultimate segments. Basal segment with small spine on lateral margin located slightly distal to midlength; distolateral angle produced in small rounded lobe. Penultimate segment with few short setae on dorsodistal margin. Ultimate segment relatively short, 0.4 times as long as shield, broadened distally in lateral view, with row of 3 setae dorsolaterally, distal seta longest. Dorsal flagellum with distal portion 1.3 times longer than proximal, aesthetasc-bearing portion.

Antennal peduncles (Fig. 1A) moderately long, slightly overreaching distal corneal margins. First segment with spinule on lateral face, ventromesial distal margin produced, with small spine just lateral to antennal gland opening. Second segment with dorsolateral distal angle produced, reaching nearly to midlength of third segment, terminating in bifid spine; dorsomesial distal angle with small spine; tufts of sparse setae present. Third segment with small spine on ventrodistal margin and tufts of sparse setae. Fourth and fifth segments with few marginal setae, fifth segment about 2.2 times as long as fourth segment. Antennal acicle slender, weakly arcuate, reaching distal corneal margin and to half-length of fifth peduncular segment, terminating bluntly, with 2 irregular rows of tufts of sparse setae mesially. Antennal flagellum moderately long, each article with few short setae distally.

Third maxilliped (Fig. 1B, C) with endopod moderately long and slender; carpus and merus unarmed; ischium and basis incompletely fused; ischium with row of 15 closely spaced teeth on crista dentata, 3 accessory teeth present; basis with 1 tiny tooth on mesial margin.

Chelipeds (Figs. 2, 3) grossly unequal. Right cheliped (Figs. 2A–C, 3A, B) massive. Chela suboval, 1.5 times longer than wide and 1.9 times longer than carpus; transverse scutes each with row of short plumose setae. Dactylus 0.7 length of palm; dorsal surface strongly convex, with interrupted arcuate scutes; dorsomesial margin with shallow sulcus between 2 rows of arcuate scutes; mesial surface with short scutes; ventral surface with short transverse ridges laterally on proximal part and some tufts of short setae; cutting ridge with 4 blunt calcareous teeth, terminating in blunt calcareous claw. Palm 1.2 times longer than carpus; dorsal surface strongly convex, slightly elevated on midline, covered with sinuous, transverse scutes, distal scutes arcuate and with single oblique row of short soft, somewhat flask-shaped capsules, distolateral part also with 2 irregularly arranged longitudinal rows of short capsules extending onto half length of fixed finger; dorsal surface of fixed finger also convex, with short and long, arcuate scutes; dorsolateral margin slightly arched on palm and strongly convex on fixed finger, delimited by blunt crest of short arcuate scutes extending onto tip of fixed finger; dorsomesial margin nearly straight, delimited by 2 irregular rows of short arcuate ridges; ventral surface convex, with short arcuate ridges bearing tufts of setae on lateral and mesial part; ventral surface of fixed finger with scattered tufts of setae; cutting edge with 8 blunt, proximally diminishing calcareous teeth, terminating in blunt calcareous claw. Carpus subequal in length to merus, widened distally in dorsal view; dorsal surface weakly convex, with row of 3 small spines on distal half of midline, 2 median spinules laterally on midline, 2 somewhat remote spines distally adjacent to dorsomesial margin, and scattered short ridges, ridges on distal half bearing short plumose setae and those on proximal half with sparse, long simple setae; dorsolateral margin not delimited; dorsomesial margin delimited by blunt carina, with row of 4 spines and sparse long setae on distal half; lateral surface dorsally with short transverse ridges; mesial surface with sparse long setae dorsally and distally; ventral surface strongly convex, with row of short setae on distal margin. Merus strongly convex and smooth on dorsal surface, dorsodistal margin with row of setae; lateral surface smooth, with some short setae ventrally; ventrolateral margin strongly convex in lateral view, with 3 small spines and moderately long setae on distal half; ventromesial margin strongly convex in mesial view, with 2 small rounded tubercles and moderately long setae on distal half; ventral surface flattish, with low, blister-like protuberances adjacent to ventrolateral margin. Ischium unarmed, with few tufts of short setae.

Left cheliped (Figs. 2D, E, 3C, D) moderately slender, nearly reaching to half-length of right dactylus, moderately compressed laterally. Chela elongate suboval, 2.8 times longer than wide and 1.2 times longer than carpus; dactylus and fixed finger not curved ventrally, without hiatus; transverse scutes each with row of short plumose setae. Dactylus approximately as long as palm; surfaces with sparse tufts of short to moderately long setae; dorsal surface weakly convex, with small blunt tubercle proximally; dorsomesial margin not delimited; cutting edge with row of closely set corneous teeth on entire length, terminating in small corneous claw. Palm 0.6 length of carpus; dorsal surface convex, bluntly but distinctly elevated on midline, with short arcuate scutes on lateral half, row of short soft, somewhat flask-shaped capsules adjacent to distal dorsolateral margin extending onto proximal 0.3 of fixed finger, 3 capsules also present on distolateral part; dorsal surface of fixed finger with sparse, short arcuate ridges and tufts of setae; dorsolateral margin delimited by row of short arcuate scutes extending onto distal 0.3 of fixed finger; lateral surface also with short arcuate scutes; dorsomesial margin not distinctly delimited; mesial surface almost smooth, but with some tufts of setae; ventral surface convex, with longitudinal row of short arcuate ridges laterally and sparse tufts of moderately long setae on mesial half; cutting edge with row of closely set corneous teeth on entire length, terminating in relatively large corneous claw. Carpus widened distally in dorsal view, slightly shorter than merus; dorsolateral and dorsomesial margins each with row of small spines, dorsomesial spines stronger than dorsolateral, spines of each row bearing short plumose setae on distal half and moderately long simple setae on proximal half; dorsal surface narrow, flat; lateral surface with slightly arcuate ridges bearing short plumose setae; mesial surface with sparse tufts of moderately long setae; ventral surface slightly convex, with sparse setae. Merus with sparse short setae on dorsal surface, dorsodistal margin with row of moderately long setae; lateral surface with short ridges; ventrolateral margin with row of small distal spines, proximal protuberances, and sparse setae; mesial surface nearly smooth, with few short setae; ventromesial margin with small subproximal spine and moderately long setae; ventral surface flattish, with some blister-like protuberances adjacent to ventrolateral and ventromesial margins. Ischium with scattered setae.

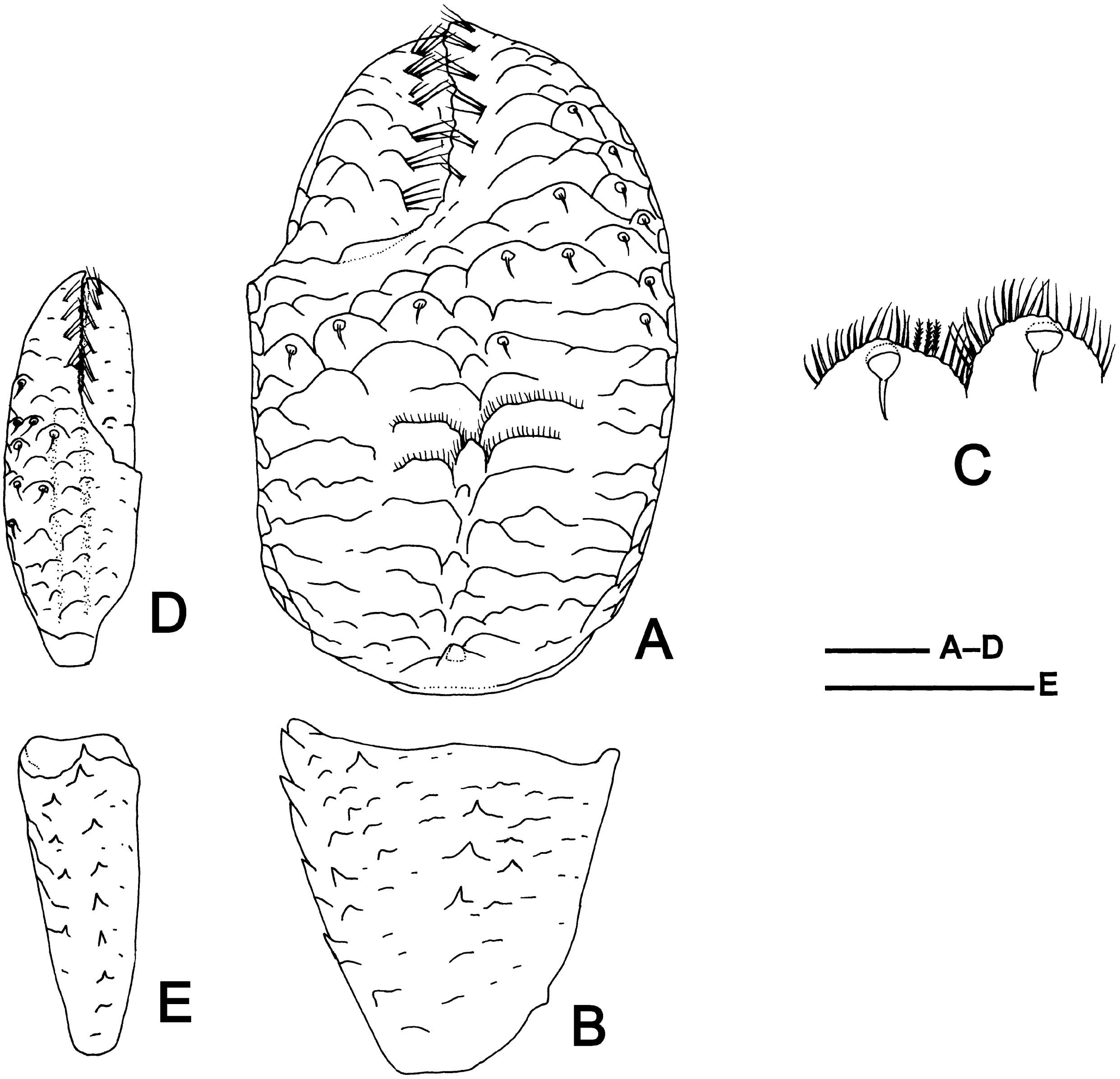


FIGURE 2. *Pagurus tabataorum* **n. sp.**, holotype, male (cl 8.2 mm), RUMF-ZC-1508: A, right cheliped, chela, dorsal view (setae mostly omitted); B, same, carpus, dorsal view (setae omitted); C, same, palm, scutes near base of dactylus, dorsal view; D, left cheliped, chela, dorsal view (setae mostly omitted); E, same, carpus, dorsal view (setae omitted). Scales = 1.0 mm.

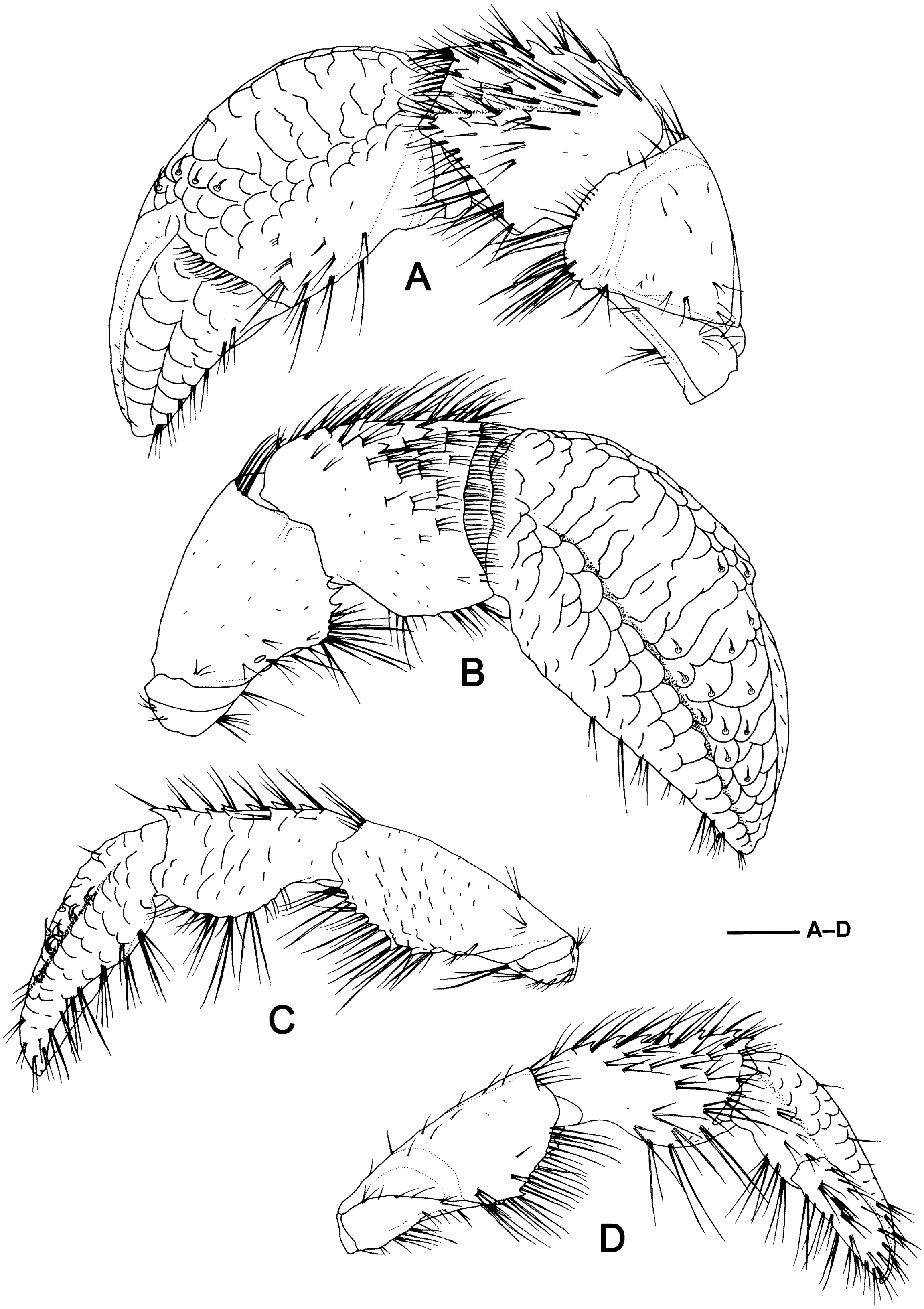


FIGURE 3. *Pagurus tabataorum* **n. sp.**, holotype, male (cl 8.2 mm), RUMF-ZC-1508: A, right cheliped, mesial view (short plumose setae on scutes and ridges omitted); B, same, lateral view (short plumose setae on scutes and ridges omitted); C, left cheliped, lateral view (short plumose setae on scutes and ridges omitted); D, same, mesial view (short plumose setae on scutes omitted). Scales = 1.0 mm.

Ambulatory legs (Fig. 4) similar from right to left, moderately slender, right second pereopod overreaching tip of right cheliped by half length of dactylus. Dactyli 1.1–1.3 length of propodi, 6.3–6.7 (second) or 7.3–8.1 (third) longer than proximal wide, slightly curved ventrally in lateral view, weakly curved mesially in dorsal view, terminating in moderately long corneous claws; dorsal margins each with row of 7–9 corneous spines and sparse setae; lateral faces each with shallow longitudinal sulcus dorsoproximally and rows of sparse setae along dorsal and ventral margins; mesial faces each with very shallow longitudinal sulcus dorsoproximally and row of 4 (second) or 6–7 (third) corneous spinules and few short setae adjacent to dorsal margin, additional short row of 2–4 spinules present on proximal midline in third pereopod; ventral margins each with 8 or 9 slender corneous spines increasing in size distally. Propodi slightly tapering distally in lateral view, 4.1–4.3 (second) or 3.7–4.1 (third) times longer than distal wide, right third pereopod stouter than left third pereopod; dorsal and ventral surfaces each with row of sparse setae; lateral and mesial faces smooth; ventral surfaces slightly convex, each with row of 5 or 6 small corneous spines including 2 spines on distal margin. Carpi with tufts of sparse setae on dorsal, lateral, and mesial surfaces; dorsal surfaces each with small spine at dorsodistal angle, additional median small spine present mesially on second pereopod but absent on third pereopod. Meri compressed laterally, unarmed, with sparse setae on dorsal and ventral surfaces; lateral and mesial surfaces with few short setae; ventrolateral distal margins nearly straight.

Fourth pereopods (Fig. 1D, E) semichelate, subequal in size, right slightly larger than left. Dactyli each with row of small corneous teeth on ventral margin; dorsal margin with row of tufts of short setae; preungual process slightly shorter than distal corneous claw, tube-like. Propodi each with prominent tuft of setae distally on dorsal margin; rasp consisting of 5 irregularly arranged rows of subovate corneous scales. Carpi and meri unarmed but bearing tufts of sparse setae on dorsal and ventral margins.

Fifth pereopods chelate; coxae equal in size, male gonopores partially obscured by tuft of short setae.

Anterior lobe of sixth thoracic sternite (Fig. 1F) subsemicircular, with row of setae on anterior margin, setae longest in medial portion. Eighth thoracic sternite developed anteriorly as 2 compressed, rounded lobes separated by shallow median depression, anterior margin with row of setae.

Pleon dextrally twisted. Male with unequally biramous second to fifth left pleopods, endopods much smaller than exopods. Female unknown.

Telson (Fig. 1G) with transverse indentations weakly delimited, each with tuft of sparse setae; posterior lobes slightly asymmetrical, separated by very small median cleft; terminal margins strongly oblique, each with row of 14 (right) or 19 (left) small spines extending onto lateral margins.

Colouration in life (Fig. 5). Shield with various sized light red markings on white ground colour. Posterior carapace pale red, with scattered small red spots. Ocular peduncles white, each with broad red ring at midlength. Antennular peduncles light red, ultimate segment with distal white ring. Antennal peduncles also light red, with irregular white marks. Chelipeds reddish brown; palms with some small red spots, ventromesial surface of right palm with moderately large red blotch; carpi and meri with white reticular pattern. Ambulatory legs light red; dactyli with white marks on median part and adjacent to distal brown corneous claw; propodi with irregular white marks on proximal and distal parts; meri with white reticular pattern.

Etymology. The new species is named in honor of Captain Eizo Tabata and his two sons, Atsushi and Yuji Tabata, of the fishing boat that operated dredging and trawling in the period of the KUMEJIMA 2009 Expedition. Their skillful efforts resulted in many new findings of coastal invertebrates around Kume Island, including the present new hermit crab.

Distribution. Only known from the type locality, Kume Island, Ryukyu Islands, at the depth of 68 m.

Remarks. *Pagurus tabataorum* **n. sp.** is unique for the genus in having many arcuate or sinuous, transverse scutes on the dorsal surface of the chelae. Such scutes are not known in other *Pagurus* species.

The new species appears close to the following seven Indo-West Pacific species: *P. capsularis* McLaughlin, 1997; *P. hirtimanus* (Miers, 1880); *P. japonicus* (Stimpson, 1858); *P. pergranulatus* (Henderson, 1896); *P. rubrior* Komai, 2003; *P. similis* (Ortmann, 1892); and *P. sinuatus* (Stimpson, 1858) in having small slender capsules on the dorsal surface of the chelae, although the number of the capsules seems to be much fewer in *P. tabataorum* **n. sp.** (cf. Komai 2003a; McLaughlin 1997; de Saint Laurent & McLaughlin 2000). This character represents a possible synapomorphy, and thus the eight species can be assumed to be phylogenetically related.

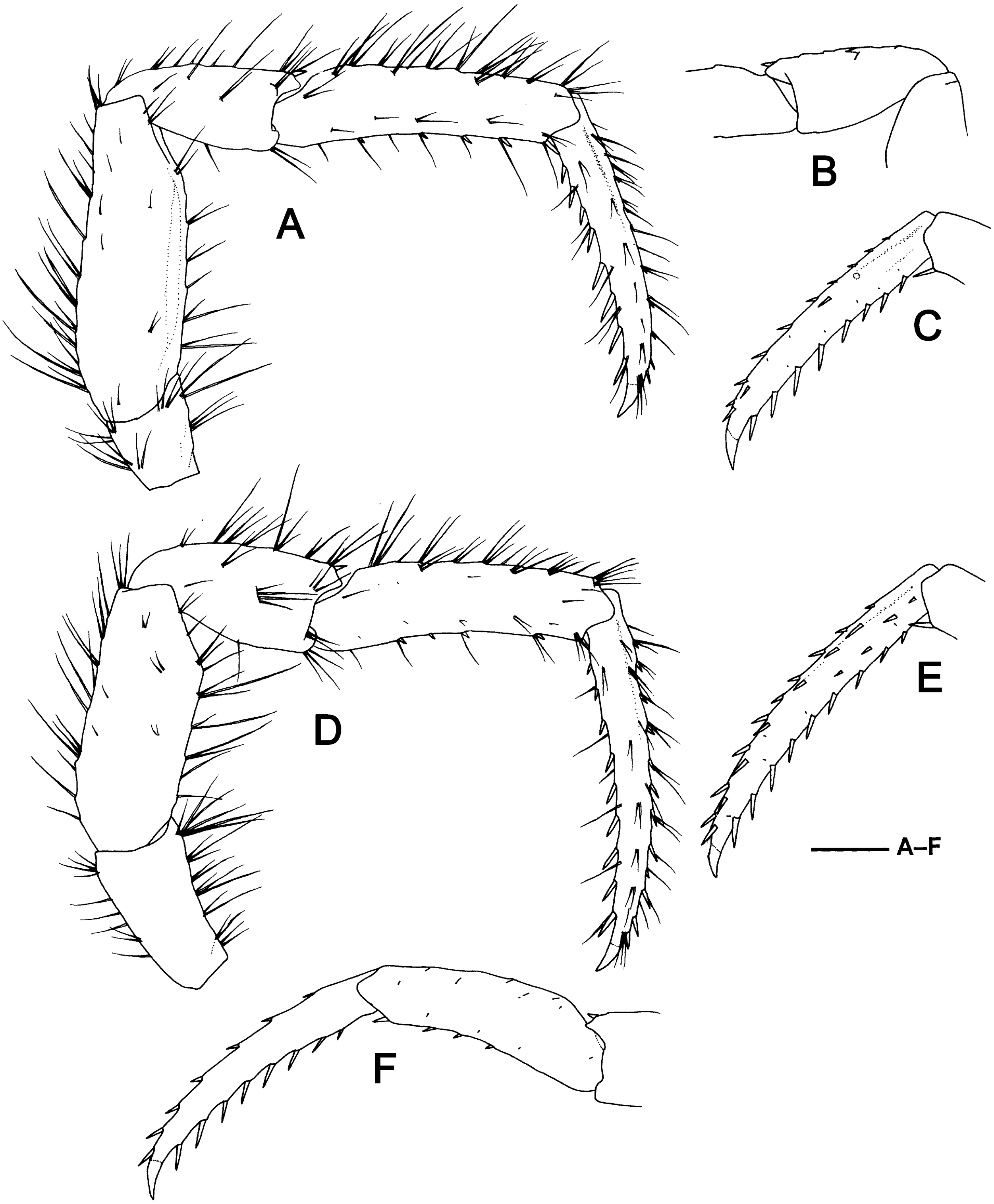


FIGURE 4. *Pagurus tabataorum* **n. sp.**, holotype, male (cl 8.2 mm), RUMF-ZC-1508: A, right second pereopod, lateral view; B, same, proximal part of propodus, carpus, and distal part of merus, mesial view (setae omitted); C, same, distal part of propodus and dactylus, mesial view (setae omitted); D, right third pereopod, lateral view; E, same, distal part of propodus and dactylus, mesial view (setae omitted); F, left third pereopod, dactylus, propodus, and distal part of carpus, lateral view (setae omitted). Scales = 1.0 mm.

Pagurus tabataorum **n. sp.** may be closest to *P. capsularis* known from Tanimbar Islands, Indonesia, in having the following characters: shield slightly longer than broad, with an obtusely triangular rostrum; ocular peduncles relatively robust, each with slightly dilated cornea; carpi of the chelipeds comparatively less spinose or tuberculate, without small slender capsules on the dorsal surface; slender dactyli and propodi of the ambulatory legs; and telson with strongly oblique, terminal margins. However, aside from the possession of transverse scutes on the dorsal surface of the chelae, *P. tabataorum* **n. sp.** is distinguished from *P. capsularis* by the absence of rows of distinct spines on the dorsolateral margin and dorsomidline of each chela and on the dorsomesial margin of the right chela. *Pagurus pergranulatus* somewhat resembles *P. tabataorum* **n. sp.** in general appearance, but differs in the right chela with a distinctly produced, subacute lobe at the dorsomesial distal angle (cf. Alcock & Anderson 1897: pl. 31, fig. 1) and the merus of the right cheliped with a distinct, somewhat wing-like ventrally produced lobe on the ventromesial margin (cf. McLaughlin 1997). The strongly oblique terminal margins of the telson discriminates *P. tabataorum* **n. sp.** from *P. hirtimanus*, *P. japonicus*, *P. rubrior*, *P. similis*, and *P. sinuatus*. In the latter five species, the mentioned margins are weakly oblique or nearly transverse. *Pagurus tabataorum* **n. sp.** is further distinguished from *P. japonicus*, *P. rubrior*, *P. similis*, and *P. sinuatus* in the absence of tubercles each with a small slender capsule on the dorsal surface of the carpi of the chelipeds. *Pagurus similis* is similar to *P. tabataorum* **n. sp.** in having relatively slender propodi and dactyli of the ambulatory legs, but different in that the ocular peduncles are much more slender, the right chela is armed with rows of distinct spines on the dorsolateral and dorsomesial margins, and the left chela has rows of distinct spines on the dorsolateral margin and dorsomidline. *Pagurus hirtimanus* is distinguishable from *P. tabataorum* **n. sp.** in that the rostrum terminates in an acute spine, the ocular peduncles are strongly concave on the lateral and mesial margins, the right chela has rows of spines on the dorsolateral and dorsomesial margins and dorsomidline, and the left chela is provided with rows of spines on the dorsolateral margin and dorsomidline.

Alcock (1905) noted that “A variety (of *P. pergranulatus*) from the south coast of Ceylon is characterized by the sculpture of the outer surface of the palm and fingers of both chelipeds, where depressed squamiform granules form an unbroken mosaic”. This suggests that the Alcock’s specimen might represent the present new species, although reexamination of his specimen is necessary to finally determine the specific identity.

FIGURE 5. *Pagurus tabataorum* **n. sp.**, holotype, male (cl 8.2 mm), RUMF-ZC-1508. Entire animal, dorsal view.

Notes on *Pagurus* species in the Ryukyu Islands

Nine nominal *Pagurus* species including the present new species are currently known from the Ryukyu Islands ranging from the Osumi Group to the Yaeyama Group: *P. angustus* (Stimpson, 1858); *P. decimbranchiae* Komai & Osawa, 2001; *P. filholi* (De Man, 1887); *P. hirtimanus*; *P. japonicus*; *P. lophochela* Komai, 1999; *P. minutus* Hess, 1865; *P. nigrivittatus* Komai, 2003; and *P. tabataorum* **n. sp.** (Komai & Mishima 2003; Komai & Osawa 2001;

McLaughlin *et al*. 2007; Minei 1973; Takeda 1976; present study; unpublished data). All the species except for *P. lophochela* and *P. tabataorum* **n. sp.** are recorded from the intertidal area to shallow subtidal depths. The known depth records of *P. lophochela* and *P. tabataorum* **n. sp.** are down to 171–181 m and 68 m, respectively (Komai & Takeda 2006; present study). Komai (2003b) redescribed *Pagurus pilosipes* (Stimpson, 1858) on the basis of the topotypic material from Okinawa Island. Subsequently, McLaughlin *et al*. (2010) noted that the species will be transferred to the genus *Boninpagurus* Asakura & Tachikawa, 2004, as the senior synonym of *B. acanthocheles* Asakura & Tachikawa, 2004, and Komai *et al.* (2011) officially made this taxonomic action.

The distributions of the species from the intertidal area to shallow subtidal depths are variable. The occurrences of *P. decimbranchiae*, *P. filholi*, and *P. japonicus* in the Osumi Group of the northern Ryukyus show the southern limit of their distribution in Japan, although *P. japonicus* has been also recorded from northern China, Korea, and northeastern Taiwan (Komai & Osawa 2001; McLaughlin *et al*. 2007; Takeda 1976; unpublished data). *Pagurus nigrivittatus* was known from Honshu to Kyushu in Japan, Korea, and Taiwan (Komai 2003b; McLaughlin *et al*. 2007), and is recently found in Okinawa Island (unpublished data). *Pagurus angustus* is known only from the Ryukyu Islands and Taiwan (McLaughlin *et al*. 2007). *Pagurus minutus* is restricted to East Asian waters, while *P. hirtimanus* is widespread in the Indo-West Pacific (Haig & Ball 1988; McLaughlin *et al*. 2007).

Acknowledgements

The marine biodiversity expedition KUMEJIMA 2009 was organized by the Transdisciplinary Research Organization for Subtropics and Island Studies of the University of the Ryukyus, the Center for Marine Bioscience and Biotechnology of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica. The expedition was conducted under a permit to T. Naruse of the University of the Ryukyus, the organizer of the expedition, by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. I thank T.-Y. Chan of the National Taiwan Ocean University for kindly taking a photograph of the specimen used in this study. The manuscript benefited from suggestions by two anonymous reviewers.

References

Alcock, A. (1905) Anomura. Fasc. I. Pagurides. *Catalogue of the Indian decapod Crustacea in the collections of the Indian Museum, volume 2.* Indian Museum, Calcutta, xi +197 pp.

Alcock, A. & Anderson, A.R.S. (1897) Crustacea, Part V. pls. 28–32. *In*: *Illustrations of the Zoology of the Royal Indian marine Surveying Steamer Investigator under the command of Commander C. F. Oldham, R. N.* Trustees of the Indian Museum, Calcutta.

Asakura, A. & Tachikawa, H. (2004) *Boninpagurus acanthocheles*, a new genus and species of hermit crab (Decapoda: Anomura: Paguridae) from shallow waters of the Ogasawara (Bonin) Islands, Japan. *Journal of Crustacean Biology*, 24, 157–167.

Fabricius, J.C. (1775) *Systema Entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus , observationibus.* Officina Libraria Kortii, Flensburgi et Lipsiae, xxxii+832 pp.

Haig, J. & Ball, E.E. (1988) Hermit crabs from north Australian and eastern Indonesian waters (Crustacea Decapoda: Anomura: Paguroidea) collected during the 1975 Alpha Helix Expedition. *Records of the Australian Museum*, 40, 151–196.

Henderson, J.R. (1896) Natural history notes from H. M. 'Investigator' Commander C.F. Oldham, R.N., commanding. Series II, No. 24. Report on the Paguridae collected during the season 1893–94. *Journal of the Asiatic Society of Bengal*, 65, 516–536.

Hess, W. (1865) *Beiträge zur Kenntnisse der Decapoden-Krebse Ost-Australiens.* Druck von Carl Georgi, Bonn, 47 pp.

Komai, T. (1999) Hermit crabs of the families Diogenidae and Paguridae (Crustacea: Decapoda: Anomura) collected during the Shin'yo-maru cruise to the Ogasawara Islands and Torishima Island, oceanic islands in Japan. *Natural History Research, Special Issue*, 6, 1–66.

Komai, T. (2003a) Identities of *Pagurus japonicus* (Stimpson, 1858), *P. similis* (Ortmann, 1892) and *P. barbatus* (Ortmann, 1892), with description of a new species (Crustacea, Decapoda, Anomura, Paguridae). *Zoosystema*, 25, 377–411.

Komai, T. (2003b) Reassessment of *Pagurus pilosipes* (Stimpson), supplemental description of *P. insulae* Asakura, and descriptions of three new species of *Pagurus* from East Asian waters (Crustacea: Decapoda: Anomura: Paguridae). *Natural History Research*, 7, 115–166.

Komai, T. & Mishima, S. (2003) A redescription of *Pagurus minutus* Hess, 1865, a senior synonym of *Pagurus dubius* (Ortmann, 1892) (Crustacea: Decapoda: Anomura: Paguridae). *Benthos Research*, 58, 15–30.

Komai, T. & Osawa, M. (2001) A new distinctive species of pagurid hermit crab (Crustacea: Decapoda: Anomura) from Japan. *Zoological Science*, 18, 1291–1301.

Komai, T. & Takeda, M. (2006) A review of pagurid hermit crab (Decapoda: Anomura: Paguroidea) fauna of the Sagami Sea, central Japan. *Memoirs of the National Science Museum*, Tokyo, 41, 71–144.

Komai, T., Yang, C.-H., Okuno, J. & Chan, T.-Y. (2011) Revisiting *Pagurus pilosipes* (Stimpson, 1858) (Crustacea: Decapoda: Anomura: Paguridae). *Zootaxa*, 3096, 41–52.

Latreille, P.A. (1802) *Histoire naturelle, générale at particulière, des Crustacés et des Insects, Volume 3*. F. Dufart, Paris, 467 pp.

Man, J.G., De (1887) Uebersicht der Indo-pacifischen Arten der Gattung *Sesarma* Say, nebst einer Kritik der von W. Hess und E. Nauck in den Jahren 1865 und 1880 beschriebenen Decapoden. *Zoologische Jahrbücher Systemischer*, 2, 639–722.

McLaughlin, P.A. (1997) Crustacea Decapoda: Hermit crabs of the family Paguridae from the KARUBAR cruise in Indonesia. *In*: Crosnier, A. & Bouchet, P. (eds.), Resultats des Champagnes MUSORSTOM, vol. 16. *Memoires du Muséum national d'Histoire naturelle*, Paris, 172, 433–572.

McLaughlin, P.A. (2003) Illustrated keys to families and genera of the superfamily Paguroidea (Crustacea: Decapoda: Anomura), with diagnoses of genera of Paguridae. *Memoirs of Museum Victoria*, 60, 111–144.

McLaughlin, P.A., Komai, T., Lemaitre, R., & Rahayu, D.L. (2010) Annotated checklist of anomuran decapod crustaceans of the world (exclusive of the Kiwaioidea and families Chirostylidae and Galatheidae of the Galatheoidea) Part I – Lithodoidea, Lomisoidea, and Paguroidea. *The Raffles Bulletin of Zoology*, Supplement 23: 5–107.

McLaughlin, P.A., Rahayu, D.L., Komai, T. & Chan, T.-Y. (2007) *A catalog of the hermit crabs (Paguroidea) of Taiwan*. National Taiwan Ocean University, Keelung, viii+365 pp.

Miers, E.J. (1880) On a collection of Crustacea from the Malaysian region. Part III. Crustacea Anomura and Macrura (except Penaeidea). *Annals and Magazine of Natural History*, ser. 5, 5, 370–384, pls. 14, 15.

Minei, H. (1973) Studies on the hermit crabs (Anomura, Paguridea) of the Ryukyu Islands. *Biological Magazine*, Okinawa, 10, 43–56.

Ortmann, A. (1892) Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen, IV. Die Abtheilungen Galatheidea und Paguridea. *Zoologischen Jahrbücher*, Abtheilung für Systematik, Geographie und Biologie der Thiere, 6, 241–326, pls. 11, 12.

Saint Laurent, M. de & McLaughlin, P.A. (2000) Superfamily Paguroidea. Family Paguridae. *In*: Forest, J., Saint Laurent, M. de, McLaughlin, P.A. & Lemaitre, R. (eds.), The Marine Fauna of New Zealand: Paguridea (Decapoda: Anomura) exclusive of the Lithodidae. *NIWA Biodiversity Memoir*, 114, 104–209.

Stimpson, W. (1858) Prodromus descriptionis animalium evertebratorum, quae in expeditione ad oceanum Pacifi cum septentrionalem, a Republica Federate missa, Cadwaldaro Ringgold et Johanne Rodgers ducibus, obseravit et descripsit. VII. [Preprint (December 1858) from] *Proceedings of the Academy of Natural Sciencs of Philadelphia*, 1858, 225–252.

Takeda, M. (1976) Littoral and inshore decapod crustaceans of Tanega-shima Island, southwestern Japan. *Memoirs of the National Science Museum*, Tokyo, 9, 151–161. [in Japanese, with English abstract]

Zootaxa 3367: 165–175 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new cryptic species in the "*Calcinus anani* Poupin & McLaughlin, 1998" species complex (Decapoda: Anomura: Diogenidae): evidence from colouration and molecular genetics*

MARIA CELIA (MACHEL) D. MALAY[1], TOMOYUKI KOMAI[2] & TIN-YAM CHAN[3,4]

[1] *Institute of Marine Biology, National Taiwan Ocean University, 2 Pei-Ning Rd., Keelung 20224, Taiwan. E-mail: machel.malay@gmail.com*

[2] *Natural History Museum and Institute, Chiba, 955-2 Aoba-cho, Chuo-ku, Chiba, 260-8682 Japan. E-mail: komai@chiba-muse.or.jp*

[3] *Institute of Marine Biology and Center of Excellence for Marine Bioenviroment and Biotechnology, National Taiwan Ocean University, 2 Pei-Ning Rd., Keelung 20224, Taiwan.*

[4] *Corresponding author, E-mail: tychan@mail.ntou.edu.tw*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new species of *Calcinus* is described from western Pacific material, including specimens previously identified as *Calcinus anani* Poupin & McLaughlin, 1998. The new species *C. fuscus* **n. sp.** differs from *C. anani* in the colouration in life, and their specific distinction is genetically supported by the barcoding gene cytochrome oxidase I (COI). The two species also have different geographic distributions, with *C. fuscus* **n. sp.** ranging from Japan to the Philippines, Papua New Guinea, and New Caledonia, while *C. anani* is restricted to French Polynesia. Moreover *C. fuscus* **n. sp.** is found at shallower depths than its sister species *C. anani*.

Key words: Hermit crab, cryptic species, colour pattern

Introduction

The small diogenid hermit crab *Calcinus anani* Poupin & McLaughlin, 1998, was originally described from French Polynesia, and subsequently reported from Japan with slight morphological differences (Asakura 2002; Okuno & Arima 2004). Later collections from Papua New Guinea hinted at genetic differences between New Guinean and Polynesian *C. anani* (Malay & Paulay 2010). Recent marine biodiversity expeditions in the Philippines (PANGLAO 2004) and the Ryukyus (KUMEJIMA 2009) collected many more specimens of *C. anani* in the Western Pacific, and allowed a detailed comparison of the morphology, colour pattern, and molecular genetics of the material from various localities. Although no morphological differences were found between the different populations, material from the western part of the Pacific always have the chelipeds with a distinctive tri-colour pattern of brown, purplish-grey and white, which is very different from the uniformly orange chelipeds in the specimens from the South Pacific. Moreover, the Western Pacific material inhabits sublittoral waters less than 82 m deep but specimens from the South Pacific were mostly collected at depths of more than 100 m. Molecular analysis of the barcoding gene cytochrome oxidase I (COI) (Bucklin *et al*. 2011; Hebert *et al*. 2003) reveals that these two morphs are specifically distinct. Therefore, we herein describe the Western Pacific form as a new species.

Material and Methods

The specimens examined are deposited in the National Taiwan Ocean University, Keelung (NTOU); Ryukyu University Museum, Fujukan, Okinawa (RUMF); Natural History Museum and Institute, Chiba (CBM); Coastal

Accepted by T. Naruse: 14 Aug. 2011; published: 4 Jul. 2012

Branch of the Natural History Museum and Institute, Chiba (CMNH); Muséum national d'Histoire naturelle, Paris (MNHN), Raffles Museum of Biodiversity Research, Singapore (ZRC), and the Florida Museum of Natural History, University of Florida (UF). Shield length (SL), measured from the rostrum tip to the posterior margin of the carapace, is the standard metric reported for all specimens examined.

Samples used in the molecular analysis are listed in Table 1, some of the samples have been previously reported in Malay & Paulay (2010). For the sequences newly generated in this study, DNA was extracted from ethanol-preserved specimens using the Geneaid genomic DNA mini kit. The mitochondrial gene fragment COI was amplified using standard Folmer primers (LCO1490 and HCO2198; Folmer *et al*. 1994). PCR conditions were as follows: 5 mins of initial denaturation at 95ºC; then 40 cycles of denaturation (95ºC, 30 s), annealing (47.8ºC, 40 s), and extension (72ºC, 40 s); followed by a final extension at 72ºC for 10 mins. PCR products were cleaned using a High Pure PCR Product Purification Kit (Roche Applied Science), and cycle-sequencing was performed on an ABI 310 Genetic Analyzer.

TABLE 1. *Calcinus* material used in the molecular analysis.

Species	No. of specimens	Locality	Voucher no.	Genbank no.
C. fuscus **n. sp.**	5	Ryukyus, Japan	RUMF-ZC-1520, NTOU A00985, NTOU A00986, NTOU A01023, NTOU A01073	JN180312–JN180316
	2	Papua New Guinea	UF 1170, 4808	FJ620250, FJ620248
	3	Philippines	ZRC	JN180317–JN180319
	1	New Caledonia	MNHN-IU-2011-701	JN243313
C. anani	1	Tuamotus	MNHN-IU-2008-15483	JN243312
	4	Marquesas	MNHN-IU-2008-15485, MNHN-IU-2011-5104, MNHN-IU-2008-16594, UF 15210	JN243311, JN243314, JN243310, FJ620249
C. argus	1	Hawaii	UF 8038	FJ620253
C. aff. *sirius*	1	Australs, Polynesia	MNHN-IU-2011-5105	FJ620251

Chromatograms were checked and edited using Geneious Pro 4.9.2 (Drummond *et al*. 2010). PAUP* ver 4.0b10 (Swofford 2002) was used to compute Kimura 2-parameter (K2P) genetic distance values for each pair of samples. The best fitting model of evolution fitting the data was computed using the Akaike Information Criterion (AIC) as employed by MrModeltest 2.3 (Nylander 2004). The likelihood-based program RAxML 7.0.4 (Stamatakis 2006) was used to perform a maximum likelihood search. A general time-reversible model plus gamma-distributed rate heterogeneity (GTRGAMMA model) and a parsimony-based starting tree were used in the likelihood analysis. Branch support was evaluated using 1,000 bootstrap replicates. A Bayesian approach was also used to estimate the phylogeny, using the program MrBayes ver 3.1.2 (Huelsenbeck & Ronquist 2001; Ronquist & Huelsenbeck 2003). Flat priors and a general time-reversible model plus invariant sites (GTR+I model; the best evolutionary model selected by MrModeltest,) were specified in the analyses. Two independent chains were each run for 1 million generations, and each chain was sampled for trees every 100 generations. To assess whether the Markov chains reached stationarity and whether the Bayesian analyses provide a reliable measure of posterior probabilities, we checked for convergence of parameter values from the 2 independent runs (Huelsenbeck *et al*. 2002, Leaché & Reeder 2002, Ronquist *et al*. 2009) using the program Tracer v1.5.0 (Rambaut & Drummond 2009). The chains converged before 100,000 generations, thus we discarded the initial 10% of the trees as the burn-in period and used the remaining 90% to calculate posterior probabilities. *Calcinus argus* Wooster, 1984 and *C.* aff. *sirius* (*sensu* Poupin & Lemaitre 2003), species closely related to *C. anani* (see Malay & Paulay 2010), were used as outgroups in the phylogenetic analysis.

Systematic Account

Calcinus fuscus n. sp.

(Figs. 1, 2)

Calcinus purcher. — Miyake & Imafuku 1980: 5. [misspelling, not *Calcinus pulcher* Forest, 1958]
Calcinus pulcher. — Miyake 1982, 1991, 1998: 114, pl. 38-5. — Asakura 1992: 39. [not *Calcinus pulcher* Forest, 1958]
Calcinus anani. — Asakura & Tachikawa 2000: 267. — Kato & Okuno 2001: 69, unnumbered photograph. — Asakura 2002: 29, figs. 2–3, 21A. — Kawamoto & Okuno 2003: 74, 1 unnumbered photograph. — Poupin & Lemaitre 2003: 8 (in part). — Okuno & Arima 2004: 54, fig. 2A. [not *Calcinus anani* Poupin & McLaughlin, 1998]

Material examined. Holotype: Kume Island, Ryukyu Islands, Japan, KUMEJIMA 2009, stn Trawl 71, 26°22.456′N, 126°42.232′E, 66–81 m, 19 November 2009, male SL 3.2 mm [RUMF-ZC-1520].

Paratypes: Ryugu, Ryukyu Islands, Japan, SCUBA, 30 m, 21 October 2001, 1 male SL 3.5 mm, [CMNH-ZC 737]. Kume Island, Ryukyu Islands, KUMEJIMA 2009, stn Diving 6, near Aka-Todai, 26°21.225′N, 126°49.628′E, 15–30 m, 10 November 2009, 1 male SL 2.5 mm [NTOU A00985] ; stn Diving 18, Shogakko-mae, 26°20.012′N, 126°43.961′E, 18–39 m, 14 November 2009, 1 male SL 2.1 mm [NTOU A00986]; stn Trawl 6, 26°23.044′N, 126°47.724′E, 64–81.3 m, 10 November 2009, 1 female SL 2.0 mm [NTOU A01023]; stn Trawl 32, 26°16.775′N, 126°48.050′E, 67.3–73.3 m, 13 November 2009, 1 male SL 3.2 mm [NTOU A01073]. Shionomisaki, Kii Peninsula, 30–40 m, lobster net, 11 March 1994, 1 female SL 3.4 mm [CBM-ZC 4911]. Nazumado, Hachijo Island, Izu Islands, SCUBA, 40 m, 30 November 2000, 1 male SL 3.7 mm [CMNH-ZC 516] ; 45 m, 4 December 2000, 1 male SL 5.1 mm [CMNH-ZC 517]; Akino-hama, Izu-oshima Island, 5 m, 12 February 2004, 1 male SL 5.7 mm [CMNH-ZC 1704].

Other material: Southeast Nang Island, Bismarck Archipelago, Papua New Guinea, SCUBA, 3–34 m, 3 July 2003, 1 male SL 4.2 mm [UF 4808]; “joeles Reef” dive site, Kimbe Bay, SCUBA, 27 m, 17.vi.2003, 1 ovig. female SL 3.5 mm [UF 11740]. Panglao Island, Bohol Province, Philippines, PANGLAO 2004, stn R47, Sungcolan, 9°38.8′N, 123°49.2′E, 4–25 m, 16 June 2004, 1 female SL 3.0 mm [ZRC]; stn R63, Napaling, 9°37.2′N, 123°46.4′E, 3–40 m, 24 June 2004, 1 male SL 3.2 mm [ZRC]; stn B9, Napaling, 9°33.1′N, 123°44.0′E, 8.5–10 m, 8 June 2004, 1 ovig. female 5.6 mm [ZRC]; stn B15, Sungcolan, 9°38.8′N, 123°49.2′E, 2–4 m, 16 June 2004, 2 males SL 3.0–4.6 mm [ZRC]; stn B32, Looc, 9°35.8′N, 123°44.6′E, 20 m, 26 June 2004, 2 males SL 4.0–4.1 mm [ZRC]; stn B36, north of Doljo, 9°35.9′N, 123°44.5′E, 24 m, 1 July 2004, 1 female SL 2.5 mm [ZRC]; stn B39, Pontod Lagoon 1 outside, 9°32.8′N, 123°42.1′E, 17–25 m, 3 July 2004, 2 females SL 3.4–4.6 mm [ZRC]; stn B42, between Momo and Napaling, 9°37.0′N, 123°46.0′E, 30–33 m, 6 July 2004, 1 male SL 4.1 mm [ZRC]. Lifou, Loyalty Islands, New Caledonia, LIFOU 2000, stn 1463, Santal Bay, 20°55.05′S, 167°03.35′E, 20–30 m, 10 November 2000, 1 female SL 2.0 mm [MNHN-IU-2011-70].

Comparative material examined. *Calcinus anani*: Moruroa Atoll, Tuamotus, RV *Marara*, stn D51, 21°53.1′S, 139°02.6′W, 140 m, 15 October 1990, 1 male SL 5.9 mm, holotype [MNHN-IU-2008-15483]. Nuku Hiva Island, Marquesas, RV *Marara*, stn D79, 8°57.6′S, 140°05.8′W, 59 m, 22 January 1991, 1 male SL 2.1 mm [MNHN-IU-2008-15592]; MUSORSTOM 9, stn DW1170, 08°45.1′S, 140°13.1′W, 104–109 m, 25 August 1997, 6 males SL 1.6–3.6 mm, 1 ovig. female SL 2.1 mm, 1 female SL 1.8 mm, paratypes [MNHN Pg5561]; MUSORSTOM 9, stn DW1170, 08°45.1′S, 140°13.1′W, 104–109 m, 25 August 1997, 1 male SL 3.5 mm [MNHN-IU-2008-15485]; MUSORSTOM 9, stn DW1170, 08°45.1′S, 140°13.1′W, 104–109 m, 25 August 1997, 1 male SL 3.1 mm [MNHN-IU-2011-5104]; stn DR1181, 08°45.5′S, 140°03.2′W, 102–130 m, 26 August 1997, 1 ovig. female SL 2.0 mm [MNHN-IU-2008-16591]; stn CP1228, 09°44.6′S, 138°51.5′W, 107–108 m, 30.viii.1997, 1 male SL 2.8 mm [MNHN-IU-2008-16594]. Ua Pou Island, MUSORSTOM 9, stn CP1265, 9°20.4′S, 140°07.3′W, 3 September 1997, 90–92 m, 1 ovig. female SL 1.7 mm, 1 male SL 1.7 mm [MNHN-IU-2008-16589]; stn. DW1143, 09°20.9′S, 140°02.7′W, 18–55 m, 22 August 1997, 1 ovig. female SL 1.8 mm [MNHN-IU-2008-16593]. Eiao Island, MUSORSTOM 9, stn DW1154, 07°58.50′S, 140°43.70′W, 102 m, 23 August 1997, 1 male SL 3.7 mm [UF 15210 (MNHN Pg6357 exchange)].

Etymology. The Latin name *fuscus* (dark, dusky) refers to the brown colouration of the chelipeds.

Description. Shield about 1.1 times longer than wide; anterior margin between rostrum and lateral projections slightly concave. Rostrum broadly triangular with subacute tip, reaching or slightly overreaching small lateral projections.

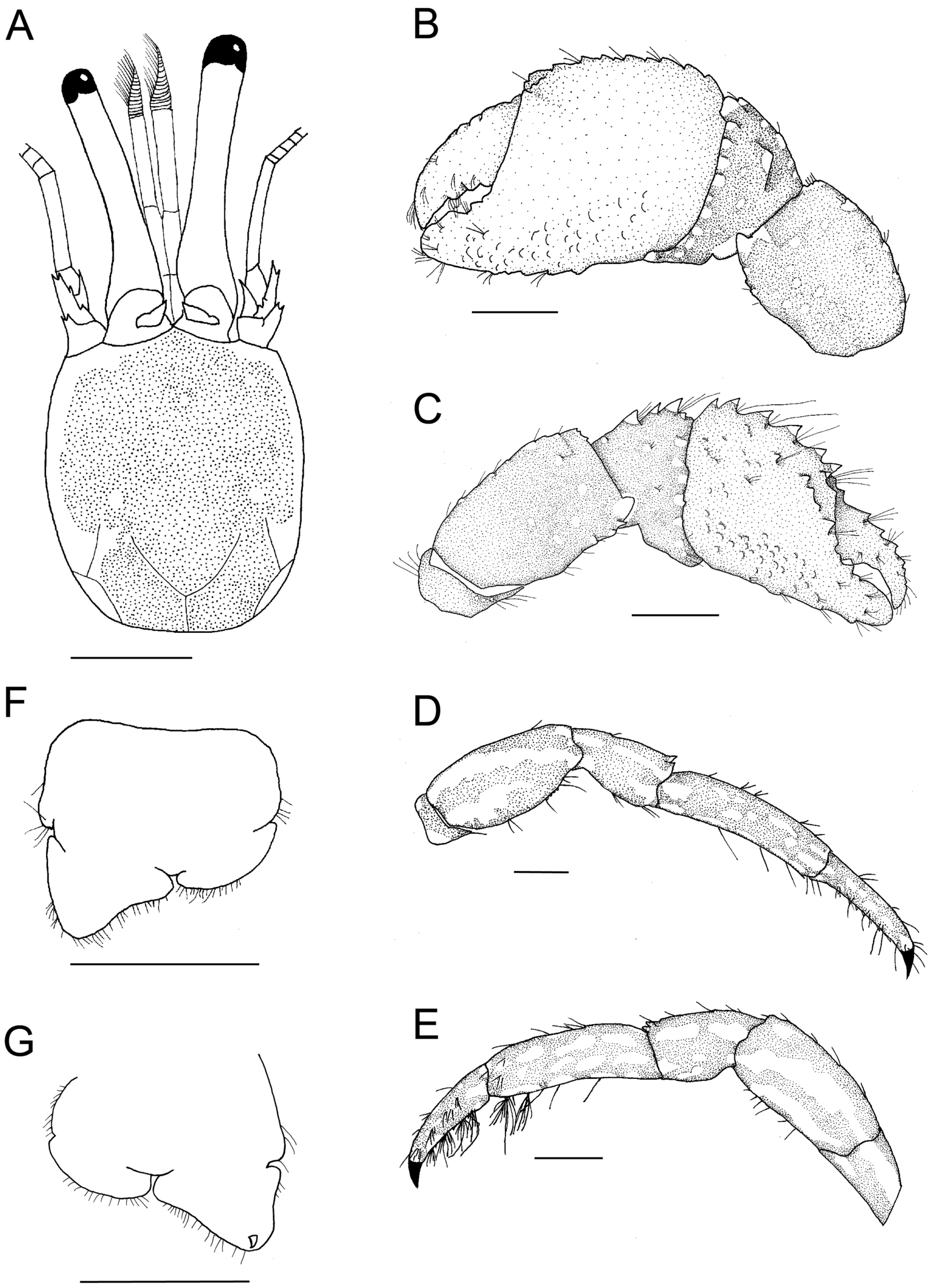


FIGURE 1. *Calcinus fuscus* **n. sp.**, holotype male SL 3.2 mm (RUMF-ZC-1520): A, shield and cephalic appendages, dorsal view; B, left cheliped, outer face; C, right cheliped, outer face; D, right second pereopod, outer face; E, left third pereopod, outer face; F, telson, dorsal view; G, telson, ventral view. Stippling on A, D, and E indicate colour patterns. Scales = 1 mm.

Ocular peduncles 0.8–1.0 length of shield, slightly wider at base, subequal. Ocular acicles subtriangular, usually with a single terminal spine, rarely bifid.

Antennular peduncles not reaching distal corneal margins.

Antennal peduncles reaching distal 0.2–0.3 of ocular peduncles. Basal segment with ventrolateral distal angle bearing 1–5 small spines or finely crenulate. Second segment with short dorsomesial distal spine, dorsolateral distal angle produced, reaching midlength of acicle, terminating in simple or bifid spine. Third segment with 1 spine on ventromesial distal angle. Fourth segment with 1 small spine on dorsodistal margin. Fifth segment unarmed. Antennal acicle terminating in strong spine, dorsomesial margin with 3–4 strong spines distally, dorsolateral margin with 1 or 2 spines distally.

Left cheliped larger than right. Left chela (including fixed finger) 1.3–1.6 times longer than wide. Dactyl 0.4–0.6 times length of palm, with 2 rows of tubercles on upper face, cutting edge with 2 or 3 triangular calcareous teeth. Fixed finger with 2 or 3 triangular calcareous teeth on cutting edge. Palm with outer face regularly convex, finely granular, with single to several small spines at dorsodistal corner; upper margin with 6–8 (rarely 10) spines, spines sometimes eroded, or sometimes even with 2 or 3 additional smaller spines interspersed; lower face with large rounded or squamous tubercles, particularly at distal part and on fixed finger, tubercles rarely forming ridge; inner surface smooth, flattened, with a few small spines occasionally bearing setae adjacent to upper margin. Carpus with strong spine at about middle portion of outer surface, several low tubercles also scattered on outer and inner surfaces; upper margin with 3–6 spines forming ridge; distal margin bearing row of large tubercles. Merus with rows of small spines on ventrolateral and ventromesial margins, dorsodistal margin occasionally with 2 small denticles on outer side; lateral and mesial surfaces scattered with small tubercles.

Right chela (including fixed finger) 1.3–1.8 times longer than wide. Dactyl 0.6–0.9 times length of palm, with 2 irregular rows of tubercles on upper face, cutting edge with 2 or 3 triangular calcareous teeth. Fixed finger with 2 or 3 calcareous teeth on cutting edge. Palm with outer face weakly convex, finely granular, with 4 or 5 spines near base of dactyl; upper margin with 5 or 6 strong spines; lower face with few low tubercles; inner surface smooth, flattened, with small spines adjacent to upper margin. Carpus with 2–4 spines on upper margin, these spines increasing in size distally; inner and outer surfaces with scattered small tubercles; distal margin with row of low tubercles. Merus unarmed on ventrolateral and ventromesial margins, or with 2–4 small spines subdistally; dorsodistal margin unarmed or armed with 2 or 3 small spines on lateral side.

Ambulatory legs similar on left and right sides. Second pereopod exceeding left cheliped by length of dactyl and distal tenth of propodus. Dactyl of left pereopod 0.6–0.9 times as long as propodus; ventral margin with widely-spaced tufts of long setae and 8–13 corneus spines. Propodus with scattered tufts of setae, usually with 1 or 2 small subdistal corneus spines on ventral margin. Carpus 0.6–0.9 times length of propodus, with 1–3 spines on dorsodistal angle. Merus usually with small denticles on distal third of ventral margin (more common on right pereopods) and 0–1 (mostly 1) small spine on ventrodistal lateral angle.

Dactyl of left third pereopod 0.7–0.8 times as long as propodus; ventral margin bearing 6–7 corneus spines, and tufts of long setae that usually form dense brush, but occasionally rather sparse. Propodus with 2 or 3 small corneus spines on ventral margin subdistally, ventral face with widely spaced tufts of long setae on distal half. Carpus 0.6–0.7 times length of propodus, with 1 or 2 spines on dorsodistal angle. Merus sometimes with small spine on ventrodistal lateral angle.

Telson with posterior lobes slightly to strongly asymmetrical, left lobe 1.1–1.6 times longer than right lobe. Terminal margins each with fringe of long setae, left lobe with 1 inwardly curved spine, right lobe usually with 1 spine (sometimes unarmed).

Colouration. Shield reddish-brown, occasionally white with reddish-brown markings, outer border light orange. Proximal two segments of antennular peduncles brown, third segment and flagellum yellow. Ocular peduncles orange proximally, progressively fading to yellowish-white distally; corneas black; ocular acicles orange. Antennal acicles white, second to fourth segments of antennal peduncle brown, fifth segment yellow, flagella transparent. Palms of chelipeds purplish-gray to gray, progressively fading to white in fingers; meri and carpi dark reddish-brown with scattered white spots; distal margin of carpi with a ring of white spots. Second to fifth pereopods generally orange, covered with white to light purple reticulated stripes and spots; reticulated pattern on second and third pereopods comprised of long stripes proximally and short stripes or spots distally. Telson mostly white.

Distribution. Western Pacific, known with certainty from Japan (Izu Islands, Kii Peninsula, and Ryukyu Islands), the Philippines (Panglao Island in the Central Visayas), Papua New Guinea (Bismarck Archipelago) and New Caledonia (Lifou), at depths of 2–81 meters.

FIGURE 2. Fresh colouration: A, *Calcinus fuscus* **n. sp.**, paratype female SL 2.0 mm, Kume Island, stn Trawl 6 (NTOUA01023); B, *C. fuscus* **n. sp.**, male SL 4.1 mm, Panglao Island, stn B42 (ZRC); C, *C. anani* Poupin & McLaughlin, 1998, holotype male SL 5.9 mm, Tuamotus, stn D51 (MNHN-IU-2008-15483); and D, *C. anani*, paratype male SL 3.5 mm, Marquesas, stn DW1170 (MNHN-IU-2008-15485). Photographs by T.Y. Chan (A, B) and J. Poupin (C, D).

Remarks. *Calcinus fuscus* **n. sp.** and *C. anani* belong to the Clade X of *Calcinus* in Malay & Paulay (2010: fig. 1A), which is comprised mainly of deep-water and high-latitude species. Based on limited collections in Japan, previous authors suggested some possible morphological differences between the Japanese and the typical forms of *C. anani*; namely the degree of setation of the third pereopods (Asakura 2002), length of the rostrum (Okuno & Arima 2004), and the structure of the telson (Okuno & Arima 2004). However, the present examination of more specimens from Japan and other western Pacific localities, as well as re-examination of the topotypic material from French Polynesia, revealed that these characters are actually quite variable. For example, the left lobe of the telson was reported as strongly protruded in the Japanese specimens (Asakura 2002: fig. 3J) and as nearly equal in size in the type material (Poupin & McLaughlin 1998: fig. 1e). However the present series of specimens showed that the left posterior lobe of the telson is 1.1–1.6 times longer than the right lobe in both the western Pacific and French Polynesian materials. The only noticeable character differing between the western Pacific and French Polynesian populations is the colouration of the chelipeds. In *C. fuscus* **n. sp.** (Fig. 2), the meri and carpi of the chelae are dark brown and scattered with some white spots, the palms are purplish gray or gray and fading distally to white fingers. There is a sharp break in colouration at the distal margins of the carpi, and this border is also marked by a ring of distinct whitish tubercles. In contrast, in *C. anani* the chelae are more or less orange overall, progressively fading to a slightly paler colour distally. *Calcinus anani* was in fact named after its generally orangeish body colour (Poupin & McLaughlin 1998).

The genus *Calcinus* is known to evolve interspecific colour differences remarkably rapidly (Malay & Paulay 2010). Even in the absence of diagnostic morphological characters, colouration is a reliable indicator of species boundaries in *Calcinus* [e.g., *C. elegans* (H. Milne Edwards, 1836) versus *C. orchidae* Poupin, 1997 (cf. Poupin 1997); *C. gouti* Poupin, 1997 versus *C. hakahau* Poupin & McLaughlin, 1998 (cf. Poupin & McLaughlin 1998); *C. gaimardii* (H. Milne Edwards, 1848) versus *C. morgani* Rahayu & Forest, 1999 (cf. Rahayu & Forest 1999); *C. californiensis* Bouvier, 1898 versus *C. mclaughlinae* Poupin & Bouchard, 2006 (cf. Poupin & Bouchard 2006)]. Moreover, cryptic species that barely differ morphologically yet are distinct in colour patterns are rather common throughout decapod crustaceans such as in the other hermit crab genera *Clibanarius bimaculatus* De Haan, 1849 versus *C. rubroviria* Rahayu, 1999 and *C. arethusa* De Man, 1888 versus *C. rutilus* Rahayu, 1999 (Rahayu 1999); *Ciliopagurus strigatus* (Herbst, 1804) complex (Poupin & Malay, 2009); porcelain crabs *Petrolisthes galathinus* (Bosc, 1802) complex (Hiller *et al*. 2006); squat lobsters *Raymunida* spp. Macpherson and Machordom, 2000 (Macpherson & Machordom 2001); peppermint shrimp *Lysmata wurdemanni* (Gibbes, 1850) complex (Rhyne & Lin 2006); alpheid shrimp *Alpheus tricolour* Anker, 2001 versus *A. fasqueli* Anker, 2001 (Anker 2001).

Figure 3 plots the mean pairwise K2P distance for sister species in the genus *Calcinus* (data based on Malay & Paulay 2010). Although there is no "barcoding gap" demarcating intraspecific vs. interspecific genetic distances in this genus, this agrees with previous observations in some other marine invertebrate groups (Meyer & Paulay 2005). The average K2P genetic distance separating the Western Pacific *C. fuscus* **n. sp.** from the South Pacific *C. anani* specimens is 6.31% (±0.37%). This clearly falls within the range of interspecific genetic distances for *Calcinus* (Fig. 3, see also Malay & Paulay 2010). On the other hand, average genetic distance within clades is only 1.38% (±0.39%), falling within the range for intraspecific distances for *Calcinus* as shown in Fig. 3. Thus, the Western Pacific populations should have a distinct specific status and warrant a new name.

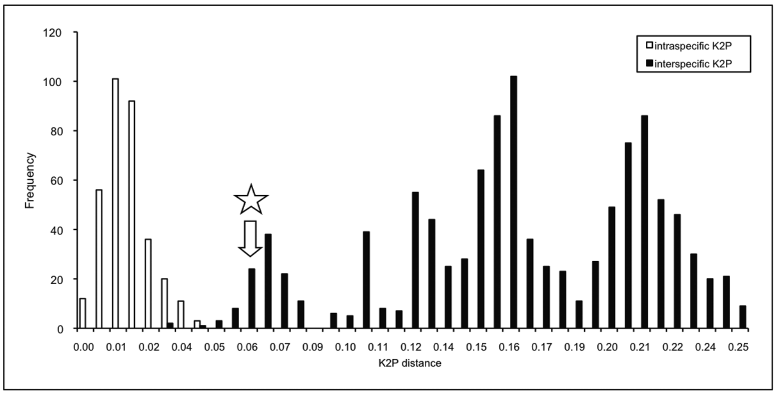


FIGURE 3. Frequency distribution of K2P genetic distances in *Calcinus*, showing both intra- and interspecific values (data from Malay & Paulay 2010). The star marks the average genetic distance between *C. fuscus* **n. sp.** and *C. anani* Poupin & McLaughlin, 1998.

The COI phylogram for *C. fuscus* **n. sp.** and *C. anani* is presented in Fig. 4. *Calcinus fuscus* **n. sp.** is again distinct from *C. anani*, with the latter species forming a monophyletic clade. On the other hand, *C. fuscus* **n. sp.** is not reciprocally monophyletic with *C. anani*, but rather forms a paraphyletic grade from which *C. anani* arises. This topology (i.e., a polytomy with a strongly supported Polynesian clade arising from within the polytomy) is concordant with a scenario where the Western Pacific *C. fuscus* **n. sp.** gave rise to the Polynesian *C. anani* through peripheral speciation. In fact, peripatric speciation at the range peripheries of older and more widespread taxa is the dominant mode of speciation in *Calcinus* (Malay & Paulay 2010). Recently separated sister species pairs are expected to show a lower degree of differentiation in biological traits (morphological, genetic, reproductive, etc.) than older sister species pairs. As two lineages diverge, they pass through polyphyletic and paraphyletic stages before finally reaching reciprocal monophyly (de Queiroz 1998; 2007). Monophyly can only be applied to terminal taxa but not ancestral lineages, because ancestors by definition are non-monophyletic (de Queiroz 1998). In the present case, the non-monophyly of the ancestor *C. fuscus* **n. sp.** can be deemed a logical consequence of the recent peripatric speciation of *C. anani*. Such a paraphyletic ancestor having wide geographical distribution with recently separated monophyletic peripheral sister species is also applied to the polar bear *Ursus maritimus* Phipps, 1774 and the widely distributed brown bear *U. arctos* Linnaeus, 1758 (see Rieppel 2009).

Other than the colouration and genetics, *Calcinus fuscus* **n. sp.** appears to differ from *C. anani* in vertical and geographical distributions. Available information shows that *Calcinus anani* occurs in deeper waters and is mainly collected from trawls and dredges at depths of more than 100 m (deepest records are at depths of 230–262 m and shallowest at 18–55 m). In contrast, *Calcinus fuscus* **n. sp.** is mainly collected by diving. Some specimens were also collected by shallow water trawling from less than 82 m. Most *Calcinus* species have well defined ecological niches with narrow depth ranges (Malay & Paulay 2010).

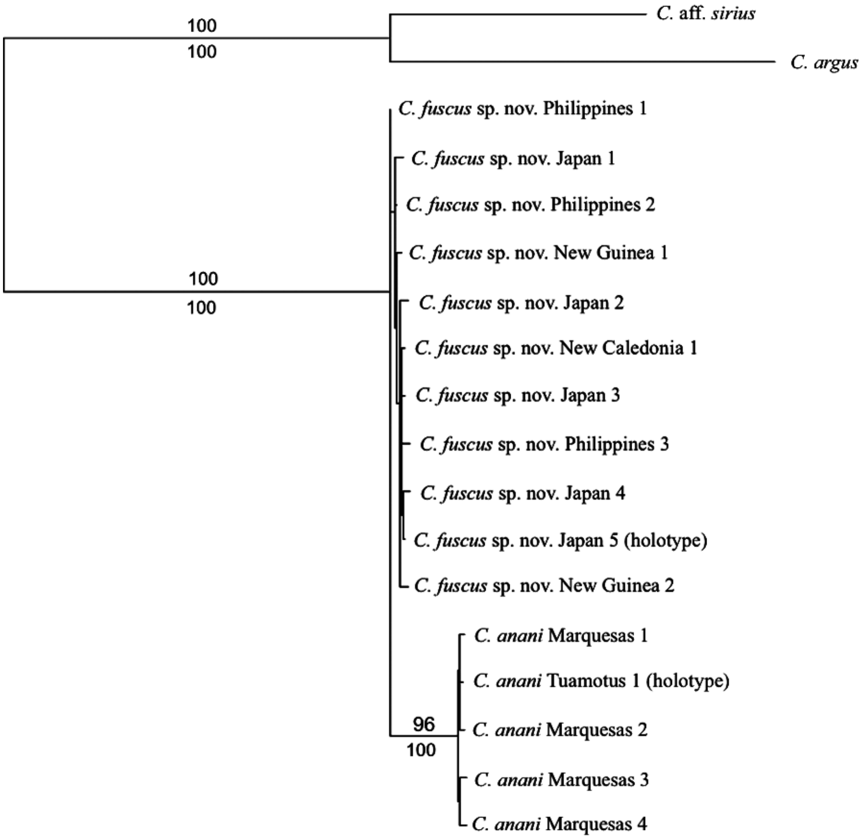


FIGURE 4. Maximum likelihood-based COI mitochondrial gene tree for *C. fuscus* **n. sp.** and *C. anani* Poupin & McLaughlin, 1998, constructed using RAxML. Values above the branches are maximum likelihood bootstraps, while values below the branches represent Bayesian posterior probabilities.

Calcinus fuscus **n. sp.** is known from Japan, the Philippines, Papua New Guinea, and New Caledonia, while the true *C. anani* seems to be restricted to Polynesia (Tuamotus, Marquesas, and the Austral Islands). Asakura & Nomura (2001) considered that a record of *C. pulcher* Forest, 1958, from Palau (Baba 1982) should be referred to as "*C. anani*". However, Baba (1982) described the colouration of the Palau material as "Spots on walking legs, orange in alcohol, remain as figured by Forest (1958: fig. 16)." This is the typical spots and stripes colouration of *C. pulcher*, and cannot be mistaken for the colour patterns of either *C. anani* or *C. fuscus* **n. sp.** Thus, it is highly likely that Baba's (1982) record of *C. pulcher* from Palau was correct.

Asakura (2002) suggested that *C. anani* and *C. sirius* Morgan, 1991 (the latter known only from Norfolk and Lord Howe Islands) might be conspecific, because he did not find significant morphological differences between the Japanese specimen he referred to as "*C. anani*" and the three paratypes of *C. sirius*. Nevertheless, as Poupin & McLaughlin (1998) noted, the different colour pattern of the ambulatory legs seems to provide evidence to distinguish *C. anani* and the present new species from *C. sirius*. Furthermore, comparison between the present material of *C. fuscus* **n. sp.** and *C. anani* with the original description of *C. sirius* shows that the upper margin of the right palm is more strongly spinose in *C. sirius* than in the new species and *C. anani*. While the colouration in life is not known for *C. sirius*, Morgan (1991) nonetheless noted that the shield of *C. sirius* has darker anterior and lateral margins; in contrast the shield margins are distinctly paler than the shield center in *C. fuscus* **n. sp.** The ocular peduncles in *C. sirius* were mentioned as deep brown in the proximal half, whereas they are paler-coloured in *C. fuscus* **n. sp.** and *C. anani*. In *C. sirius*, there is marked sexual dimorphism in the left chela, which has more developed spines and tubercles but less distinct gap between the dactyl and fixed finger in females. Such sexual dimorphism is not found in *C. anani* and *C. fuscus* **n. sp.** Finally, the body size of *C. sirius* appears to be larger than *C. anani* and *C. fuscus* **n. sp.** Of the 16 specimens known for *C. sirius*, the largest is SL 6.9 mm (Morgan 1991). The largest specimens of *C. anani* and C. *fuscus* **n. sp.** are SL 5.9 mm and 5.7 mm, respectively.

Acknowledgements

Grateful acknowledgements are extended to J. Okuno (Coastal Branch of Natural History Museum and Institute, Chiba), M. Osawa (Shimane University), L. Corbari (MNHN), J. Slapcinsky (UF), and S.K. Tan (ZRC) for loaning specimens used in this study; and J. Poupin (Ecole Navale et GEP, Brest) for allowing us to use his colour photographs. The KUMEJIMA 2009 Expedition was organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, the Center of Excellence for Marine Bioenviroment and Biotechnology of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica. The KUMEJIMA 2009 Expedition was conducted under a permit granted to Tohru Naruse (University of the Ryukyus) by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. The PANGLAO 2004 Marine Biodiversity Project was a collaboration between the Muséum national d'Histoire naturelle, Paris (Principal Investigator – Dr. Philippe Bouchet) and University of San Carlos, Cebu City (Principal Investigator – Dr. Danilo Largo). The PANGLAO 2004 Expedition was supported by the Total Foundation for Biodiversity and the Sea, the French Ministry of Foreign Affairs, and the ASEAN Regional Center for Biodiversity Conservation. The Philippines Bureau of Fisheries and Aquatic Resources is gratefully acknowledged for issuing a research permit on the material collected by the PANGLAO 2004. The University of Florida Phyloinformatics Cluster for High Performance Computing in the Life Sciences is acknowledged for computational support. We thank the editor, Tohru Naruse, and two anonymous reviewers for comments that helped improve the manuscript. This work was supported by the National Science Council and the Academia Sinica, Taiwan, R.O.C.

References

Anker, A. (2001) Two new species of snapping shrimps from the Indo-Pacific, with remarks on colour patterns and sibling species in Alpheidae (Crustacea: Caridea). *Raffles Bulletin of Zoology*, 49, 57–72.

Asakura, A. (1992) New record of the intertidal hermit crab, *Calcinus guamensis* Wooster, 1982 from Japan, with comments on Japanese *Calcinus. Journal of Natural History Museum and Institute, Chiba*, 2, 37–40.

Asakura, A. (2002) Hermit crabs of the genus *Calcinus* Dana 1851 (Crustacea Decapoda Anomura Diogenidae) with a brush of setae on the third pereopods, from Japanese and adjacent waters. *Tropical Zoology*, 15, 27–70.

Asakura, A. & Nomura, K. (2001) Hermit crabs of the genus *Calcinus* Dana, 1851 from Japan and adjacent waters (Crustacea Decapoda: Anomura: Diogenidae): *C. pulcher* Forest, 1958 and *C. lineapropodus* Morgan & Forest, 1991. *Crustacean Research*, 30, 94–110.

Asakura, A. & Tachikawa, H. (2000) A new hermit crab of the genus *Calcinus* from Micronesia, including new information on *C. revi* Poupin and McLaughlin (Decapoda: Anomura: Diogenidae). *Journal of Crustacean Biology*, 20(Special No. 2), 266–280.

Baba, K. (1982) Galatheids and pagurids of the Palau Islands (Crustacea, Anomura). *Proceedings of the Japanese Society of Systematic Zoology*, 23, 56–70.

Bosc, L.A.G. (1802) *Histoire Naturelle des Crustacés, contenant leur description et leurs meours; avec figures dessinés d'après nature* 2, 1–296.

Bouvier, E.L. (1898) Sur quelques crustacés anomoures et brachyoures recueillis par M. Diguet en Basse-Californie. *Bulletin du Muséum d'Histoire naturelle*, Paris, 4, 371–384.

Bucklin, A., Steinke, D. & Blanco-Bercial, L. (2011) DNA barcoding of marine metazoa. *Annual Review of Marine Science*, 3,

471–508.

de Queiroz, K. (1998) The general lineage concept of species, species criteria, and the process of speciation: A conceptual unification and terminological recommendations. *In*: Howard, D.J. & Berlocher, S.H. (eds.), *Endless Forms: Species and Speciation.* Oxford University Press, pp. 57–75.

de Queiroz, K. (2007) Species concepts and species delimitation. *Systematic Biology*, 56, 879–886.

Drummond, A.J., Ashton, B., Cheung, M., Heled, J., Kearse, M., Moir, R., Stones-Havas, S., Thierer, T. & Wilson, A. (2010) Geneious v4.9.2. Available from http://www.geneious.com/ (accessed 14 April 2011).

Folmer, O., Black, M., Hoeh, W., Lutz, R. & Vrijenhoek, R. (1994) DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. *Molecular Marine Biology and Biotechnology*, 3, 294–297.

Forest, J. (1958) Les Pagures du Viêt-Nam. II – Sur quelques espèces du genre *Calcinus* Dana. *Bulletin du Muséum national d'Histoire naturelle*, Paris, ser. 2, 30, 184–190, 285–290.

Gibbes, L.R. (1850) On the carcinological collections of the cabinets of natural history in the United States. With an enumeration of the species contained therein, and descriptions of new species. *Proceedings of the American Association for the advancement of Science*, 3, 165–201.

Haan, W., de (1849) Crustacea. *In*: von Siebold, P.F. (ed.), *Fauna Japonia sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava Imperium tenent, suscepto, annis 1825–1830 collegit, notis, observationibus et adumbrationibus illustravit Ph. Fr. De Siebold. Conjunctis studiis C.J. Temminck et H. Schlegel pro vertebratis atque W. De Haan pro invertebratis elaborata.* Amstelodami apud J. Muller et Co., Lugduni Batavorum, Leiden, fasc. 7, 197–243, pls. 49, 50.

Hebert, P.D.N., Ratnasingham, S. & de Waard, J.R. (2003) Barcoding animal life: cytochrome *c* oxidase subunit 1 divergences among closely related species. *Proceedings of the Royal Society*, sec. B, 270, S96–S99.

Herbst, J.F.W. (1804) *Versuch einer Naturgeschichte der Krabben und Krebse nebst einer systematischen Beschreibung ihrer verschiedenen Arten*. Gottlieb August Lange, Berlin und Stralsund, 50 pp., pls. 59–62.

Hiller, A., Kraus, H., Almon, M. & Werding, B. (2006). The *Petrolisthes galathinus* complex: Species boundaries based on colour pattern, morphology and molecules, and evolutionary interrelationships between this complex and other Porcellanidae (Crustacea: Decapoda: Anomura). *Molecular Phylogenetics and Evolution*, 40, 547–569.

Huelsenbeck, J.P., Larget, B., Miller, R.E. & Ronquist, F. (2002) Potential applications and pitfalls of Bayesian inference of phylogeny. *Systematic Biology*, 51, 673–688.

Huelsenbeck, J.P. & Ronquist, F. (2001) MrBAYES: Bayesian inference of phylogenetic trees. *Bioinformatics*, 17, 754–755.

Kato, S. & Okuno, J. (2001) *Shrimps and crabs of Hachijo Island*. TBS-Britannica, Tokyo, 157 pp.

Kawamoto, T. & Okuno, J. (2003) *Shrimps and crabs of Kume Island, Okinawa.* Hankyu Communications, Tokyo, 174 pp.

Leaché, A.D. & Reeder, T.W. (2002) Molecular systematics of the eastern fence lizard (*Sceloporus undulatus*): A comparison of parsimony, likelihood, and Bayesian approaches. *Systematic Biology*, 51, 44–68.

Linnaeus, C. (1758) *Systema Naturae per regna tria naturae, secundum classis, ordines, genera, species cum characteribus, differentiis, synonymis, locis*. Edition 10. Laurentii Salvii, Stockholm, 1, 824 pp.

Macpherson, E. & Machordom, A. (2000) *Raymunida*, new genus (Decapoda: Anomura: Galatheidae) from the Indian and Pacific Oceans. *Journal of Crustacean Biology*, 20, 253–258.

Macpherson, E. & Machordom, A. (2001) Phylogenetic relationships of species of *Raymunida* (Decapoda: Galatheidae) based on morphology and mitochondrial cytochrome oxidase sequences, with the recognition of four new species. *Journal of Crustacean Biology*, 21, 696–714.

Malay, M.C.M.D. & Paulay, G. (2010) Peripatric speciation drives diversification and distributional pattern of reef hermit crabs (Decapoda: Diogenidae: *Calcinus*). *Evolution*, 64, 634–662.

Man, J.G., de (1888) Report on the Podophthalmous Crustacea of the Mergui Archipelago, collected for the Trustees of the Indian Museum, Calcutta, by Dr. John Anderson, F.R.S., Superintendent of the Museum. *Journal of the Linnaean Society of London (Zoology)*, 22, 1–312.

Meyer, C.P. & Paulay, G. (2005) DNA Barcoding: Error Rates Based on Comprehensive Sampling. *PLoS Biology* 3, e422. [doi:10.1371/journal.pbio.0030422]

Milne Edwards, H. (1836) Observations zoologiques sur les Pagures et description d'un nouveau genre de la tribu des Paguriens. *Annales des Sciences Naturelles*, ser. 2, 6, 257–288.

Milne Edwards, H. (1848) Note sur quelques nouvelles especes du genre Pagure. *Annales des Sciences Naturelles*, ser. 3, 19, 59–64.

Miyake, S. (1982) *Japanese crustacean decapods and stomatopods in colour. I. Macrura, Anomura, and Stomatopoda. First Edition.* Hoikusha Publishing Company, Osaka, 261 pp.

Miyake, S. (1991) *Japanese crustacean decapods and stomatopods in colour. I. Macrura, Anomura, and Stomatopoda. Second Printing (Partially revised)*. Hoikusha Publishing Company, Osaka, 261 pp.

Miyake, S. (1998) *Japanese crustacean decapods and stomatopods in colour. I. Macrura, Anomura, and Stomatopoda. Third Printing (Partially revised).* Hoikusha Publishing Company, Osaka, 261 pp.

Miyake, S. & Imafuku, M. (1980) Hermit crabs from the Kii Peninsula I. *Nanki-Seibutsu, Nanki Biological Society*, 22, 1–7.

Morgan, G.J (1991) A review of the hermit crab genus *Calcinus* Dana (Crustacea: Decapoda: Diogenidae) from Australia, with descriptions of two new species. *Invertebrate Taxonomy*, 5, 869–913.

Nylander, J.A.A. (2004) MrModeltest v2. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.

Okuno, J. & Arima, H. (2004) An annotated checklist of inshore hermit crabs (Crustacea, Decapoda, Anomura) of Izu-Ohshima Island, the northern Izu Islands, Japan. *Bulletin of the Biogeographical Society of Japan*, 59, 49–69.

Phipps, C.J. (1774) *A voyage towards the North Pole*. J. Nourse, London, 253 pp.

Poupin, J. (1997) Les pagures du genre *Calcinus* en Polynésie française, avec le description de trois nouvelles espèces (Crustacea, Decapoda, Diogenidae). *Zoosystema*, 19, 683–719.

Poupin, J. & Bouchard, J.M. (2006) The eastern Pacific species of the genus *Calcinus* Dana, 1851, with description of a new species from Clipperton Island (Decapoda, Anomura, Diogenidae). *Zoosystema*, 28, 465–486.

Poupin, J. & Lemaitre, R. (2003) Hermit crabs of the genus *Calcinus* Dana, 1851 (Decapoda: Anomura: Diogenidae) from the Austral Islands, French Polynesia, with description of a new species. *Zootaxa*, 391, 1–20.

Poupin, J. & Malay, M.C. (2009) Identification of a *Ciliopagurus strigatus* (Herbst, 1804) species-complex, with description of a new species from French Polynesia (Crustacea, Decapoda, Anomura, Diogenidae). *Zoosystema*, 31, 209–232.

Poupin, J. & McLaughlin, P. (1998) Additional records of *Calcinus* (Decapoda, Anomura, Diogenidae) from French Polynesia with description of three new species and a key to Indo-West Pacific species. *Crustacean Research*, 27, 9–27.

Rayahu, D.L (1999) Descriptions of two new species of hermit crabs, *Clibanarius rubroviria* and *C. rutilus* (Crustacea: Decapoda: Anomura: Diogenidae) from Indonesia. *Raffles Bulletin of Zoology*, 47, 299–307.

Rahayu D. L. & Forest, J. (1999) Sur le statut de *Calcinus gaimardii* (H. Milne Edwards, 1848) (Decapoda, Anomura, Diogenidae) et description de deux espèces nouvelles apparentées. *Zoosystema*, 21, 461–472.

Rambaut, A. & Drummond, A.J. (2009) Tracer v1.5. Available from http://tree.bio.ed.ac.uk/software/tracer/ (accessed 14 April 2011).

Rhyne, A.L. & Lin, J. (2006) A western Atlantic peppermint shrimp complex: redescription of *Lysmata wurdemanni*, description of four new species, and remarks on *Lysmata rathbunae* (Crustacea: Decapoda: Hippolytidae). *Bulletin of Marine Science*, 79, 165–204.

Rieppel, O. (2009) Species monophyly. *Journal of Zoological Systematics and Evolutionary Research*, 48, 1–8.

Ronquist, F. & Huelsenbeck, J.P. (2003) MRBAYES 3: Bayesian phylogenetic inference under mixed models. *Bioinformatics*, 19, 1572–1574.

Ronquist, F., Huelsenbeck, J., van der Mark, P. & Lemey, P. (2009) Bayesian Phylogenetic Analysis Using MrBayes. *In*: Lemey, P., Salemi, M. and Vandamme, A.-M. (eds.), *The Phylogenetic Handbook. Second Edition.*. Cambridge University Press, Cambridge, pp. 210–266.

Stamatakis, A. (2006) RAxML-VI-HPC: Maximum Likelihood-based Phylogenetic Analyses with Thousands of Taxa and Mixed Models. *Bioinformatics*, 22, 2688–2690.

Swofford, D.L. (2002) *Phylogenetic Analysis Using Parsimony (*and Other Methods), version 4*. Sinauer Associates, Inc., Sunderland, MA.

Wooster, D.S. (1984) The genus *Calcinus* (Paguridae, Diogenidae) from the Mariana Islands including three new species. *Micronesica*, 18, 121–162.

Zootaxa 3367: 176–190 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Hermit crabs (Crustacea: Decapoda: Diogenidae) from the KUMEJIMA 2009 Expedition, Japan*

DWI LISTYO RAHAYU[1] & MASAYUKI OSAWA[2]

[1] *Marine Bio-industry Implementation Unit, Research Center for Oceanography, Indonesian Institute of Sciences (LIPI), Teluk Kodek, Kec. Pemenang, Lombok Utara 83352, NTB, Indonesia. E-mail: dwilistyo@yahoo.com*

[2] *Research Center for Coastal Lagoon Environments, Shimane University, 1060 Nishikawatsu-cho, Matsue, Shimane, 690-8504 Japan. E-mail: osawam@soc.shimane-u.ac.jp*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Hermit crabs fauna of the family Diogenidae in the Kume Island, south Japan, were found to consist of 49 species, of which 47 species were collected during the KUMEJIMA 2009 Expedition. Of the 49 species collected, 20 species, *Calcinus seurati* Forest, 1951; *Ciliopagurus krempfi* (Forest, 1952), *Clibanarius corallinus* H. Milne Edwards, 1848; *Clibanarius englaucus* Ball & Haig, 1972; *Clibanarius rhabdodactylus* Forest, 1953; *Clibanarius striolatus* Dana, 1852; *Dardanus brachyops* Forest, 1962; *Dardanus robustus* Asakura, 2006; *Dardanus scutellatus* (H. Milne Edwards, 1848); *Dardanus woodmasoni* Alcock, 1905; *Diogenes holthuisi* Asakura & Tachikawa, 2010; *Diogenes leptocerus* Forest, 1956; *Diogenes pallescens* Whitelegge, 1897; *Paguristes macrops* Rahayu & Forest, 2009; *Paguristes ocellus* Komai, 2010; *Pseudopaguristes bicolour* Asakura & Kosuge, 2004; *Pseudopaguristes bollandi* Asakura & McLaughlin, 2003; *Pseudopaguristes janetkae* McLaughlin, 2002; *Pseudopaguristes laurentae* (Morgan & Forest, 1991); and *Pseudopaguristes monoporus* (Morgan, 1987), are recorded for the first time from Kume Island. Six species, *Dardanus brachyops*, *Diogenes holthuisi*, *Diogenes leptocerus*, *Diogenes pallescens*, *Paguristes macrops*, and *Pseudopaguristes laurentae*, are discussed in detail.

Key words: Crustacea, Decapoda, Anomura, Diogenidae, Kume Island, Japan

Introduction.

In the last 20 years, hermit crabs of the southern Japanese waters are well studied, about 100 species of the families Diogenidae and Paguridae have been reported (e.g. Asakura 1991, 1992, 1999, 2000, 2001, 2002a, b, 2004, 2005; Asakura & Hirayama 2002; Asakura & Kosuge 2004; Asakura & McLaughlin 2003; Asakura & Nomura 2001; Asakura & Paulay 2003; Asakura & Tachikawa 2003, 2004, 2010; Asakura *et al*. 2002, 2003; Kawamoto & Okuno 2003, 2006; Komai 1999, 2004, 2006, 2009a, b, 2010a, b; Komai & Asakura 1995; Komai & McLaughlin 2005; Komai & Myorin 2005; Komai & Okuno 2001; Komai & Osawa 2001, 2004, 2005, 2006, 2007, 2009; Komai & Takada 2006; Komai & Nishi 1996; Komai *et al*. 2010; Kosuge & Miyake, 1992; Minemizu 2000, 2002; Osawa & Komai 2007; Osawa & Fujita 2006, 2008; Osawa & Okuno 2003; 2007; Osawa & Takeda 2004; Osawa *et al*. 2006). This paper deals with the family Diogenidae from Kume Island in the central Ryukyu Islands.

During the KUMEJIMA 2009 Expedition in November 2009 in Kume Island, 47 hermit crab species of Diogenidae were collected (Table 1). While most of the species have been recorded previously from Kume and other islands in the southern Japanese water, 20 species were collected for the first time from Kume Island. One species, hitherto identified as *Calcinus anani* by Japanese authors (Asakura & Tachikawa 2000; Kawamoto & Okuno 2003; Asakura 2002a; Okuno & Arima 2004), is considered as new to science and is being described by Malay *et al*. (2012). Five species of *Pseudopaguristes* McLaughlin, 2002a, *Pseudopaguristes bicolor*, *Pseudopaguristes bollandi*, *Pseudopaguristes janetkae*, *Pseudopaguristes shidarai*, and one undescribed species, are now being revised by the second author. In this paper, only the taxonomy of species with specific interest are treated in detail. Measurement provided in the text is shield length (in millimeter), measured from the tip of the

Accepted by T. Naruse: 6 Aug. 2011; published: 4 Jul. 2012

rostrum to the posteromedian margin of the shield. The abbreviations, Stn. and ovig., refer to Station and ovigerous, respectively. Materials studied are deposited in the collection of the National Taiwan Ocean University (NTOU), Keelung, Taiwan; the Ryukyu University Museum, Fujukan (RUMF), Okinawa, Japan; and the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore, Singapore.

TABLE 1. Checklist of hermit crabs (Family Diogenidae) from Kume Island.

Species	**Present Study**	**References**
Aniculus maximus Edmondson, 1952	Dive 41, 26°19.983´N, 126°43.934´E, 1 male, 19.3 mm (NTOU A01126)	Kawamoto & Okuno 2003: 72
Aniculus retipes Lewinsohn, 1982	Dive 02, 26°21.231´N, 126°53.113´E, 1 male, 10.6 mm (RUMF-ZC-1582); Dive 13, 26°19.217´N, 126°44.627´E, 1 male, 4.0 mm (ZRC 2011.0702); Dive 25, 26°19.866´N, 126°44.216´E, 1 female, 6.4 mm (ZRC 2011.0703); Dive 27, 26°17.454´N, 126°47.890´E, 1 female, 14.0 mm (RUMF-ZC-1583); Dive 31, 26°19.983´N, 126°43.934´E, 1 female, 11.2 mm (NTOU A01130); Dive 33. 1 ovig. female , 7 mm, (RUMF-ZC-1584); Dive 35, 26°19.251´N, 126°45.354´E, 2 males, 3.8 mm, 4.8 mm (NTOU A01134)	Kawamoto & Okuno 2003: 72
Aniculus sibogae Forest, 1984		Minemizu 2000: 129; Kawamoto & Okuno 2003: 73
Aniculus ursus (Olivier, 1812)	Dive 04, 26°21.231´N, 126°53.113´E, male, 18.6 mm (ZRC 2011.0704); Dive 15, 26°17.547´N, 126°47.771´E, male, 21.8 mm (NTOU A01137)	Minemizu, 2000: 129; Kawamoto & Okuno, 2003: 73
Calcinus elegans (H. Milne Edwards, 1836)		Minemizu 2000: 135
Calcinus fuscus Malay Komai and Chan, 2011	Dive 06, 26°21.225´N, 126°49.628´E1 male 2.5 mm (NTOU A00985); Dive 18, 26°20.012´N, 126°43.961´E, 1 male, 2.1 mm (NTOU A00986); Trawl 06, 26°23.044´N, 126°47.724´E, 1 female, 2.0 mm (NTOU A01023); Trawl 23, 26°16.380´N, 126°51.502´E, 1 male, 3.2 mm (NTOU A01073); Trawl 71, 26°22.456´N, 126°42.232´E, 1 male, 3.2 mm (RUMF-ZC-1520)	Kawamoto & Okuno 2003: 74 (as *Calcinus anani* Poupin & McLaughlin, 1998)
Calcinus gaimardii (H. Milne Edwards, 1848)	Dive 01, 26°20.769´N, 126°51.506´E, 1 female, 6.0 mm (RUMF-ZC-1585); Dive 2, 26°21.231´N, 126°53.113´E, 1 female, 5.9 mm (NTOUA01190); Dive 05, 26°20.749´N, 126°51.008´E, 3 male, 5.3–7.9 mm, 1 female, 5.5 mm (RUMF-ZC-1586); Dive 07, 26°18.793´N, 126°48.683´E, 3 females, 4.3–6.0 mm (RUMF-ZC-1587); Dive 08, 26°18.536´N 126°50.402´E, 1 female, 5.0 mm (NTOU A01191); Dive 10, 26°20.012´N, 126°43.961´E, 1 female, 2.1 mm (ZRC 2011.0781); Dive 12, 26°19.683´N, 126°44.625´E, 1 male, 6.2 mm (NTOU A01192); Dive 17, 26°19.509´N, 126°45.104´E, 1 male, 6.5 mm, 1 female, 5.4 mm (RUMF-ZC-1588); Dive 21, 26°19.720´N 126°44.593´E, 1 male 6 mm (NTOU A01193); Dive 32, 26°19.666´N, 126°49.028´E, 1 male, 5.4 mm (ZRC 2011.0811); Dive 36, 26°19.666´N, 126°49.028´E, 1 male, 5.8 mm (ZRC 2011.0782).	Minemizu 2000: 136; Kawamoto & Okuno 2003: 74
Calcinus guamensis Wooster, 1984	Dive 02, 26°21.231´N, 126°53.113´E, 1 male, 2.4 mm (RUMF-ZC-1589); Dive 27, 26°17.454´N, 126°47.890´E, 1 male, 1.4 (NTOU A01138)	Kawamoto & Okuno 2003: 75
Calcinus laevimanus (Randall, 1840)	Intertidal, 1 male, 1.9 mm (NTOU A01194) 10 males, 3.6–5.9 mm (RUMF-ZC-1590); Intertidal 01, 26°18'58.9" N, 126°46'26.0" N, 5 males, 2.1–5.1 mm, 1 female, 4.5 mm (NTOU A01195); Intertidal 02, 26°20'08.0"N, 126°48'57.5"E, 1 male, 6.0 mm (NTOU A01196); 1 male, 2.7 mm, 1 females, 4.1 mm (RUMF-ZC-1591); Intertidal 08, 26°21'23.8"N, 126°48'50.5"N, 1 male, 6.5 mm (RUMF-ZC-1592); Eef Reef, 2 males, 2.7 mm, 3.1 mm (ZRC 2011.0783); Zenida, 2 males, 1.8 mm, 3.2 mm (ZRC 2011.0784).	Minemizu 2000: 135; Kawamoto & Okuno 2003: 75
Calcinus latens (Randall, 1840)	Dive 07, 26°18.793´N 126°48.683´E, 2 males, 2.7 mm, 4.7 mm (NTOU A01197); Dive 09, 26°18.***´N, 126°50.244´E, 7 males, 3.0–5.1 mm, 7 females, 3.5–4.9 mm (RUMF-ZC-1593); Dive 11, 26°19.421´N, 126°49.028´E, 2 males, 1.2 mm, 1.3 mm, 1 female, 2.6 mm (ZRC 2011.0785); Dredge 21, 26°19.682´N, 126°50.215´E,1 female, 2.7 mm (ZRC 2011.0786); Dredge 59, 26°20.307´N, 126°49.360´E, 1 male, 3.8 mm (NTOU A01198); Dredge 82, 26°15.380´N 126°46.923´E, 1 female, 4.2 mm (NTOU A01199); Intertidal 01, 26°18'58.9"N, 126°46'26.0"E, 18 males, 1.7–4.2 mm, 6 females, 1.6-4.3 mm (RUMF-ZC-1594); Intertidal 02, 26°20'08.0" N 126°48'57.5" E, 1 female, 4.4 mm (RUMF-ZC-1595); Intertidal 03, 26°21'13.4" N, 126°42'59.6" E, 1 male, 2.2 mm (ZRC 2011.0787); Intertidal 08, 26°21'23.8"N, 126°48'50.5"E, 1 male, 2.2 mm, 1 female, 2.6 mm (NTOU A01200); Eef reef, 1 male 1.9 mm (ZRC 2011.0788)	Minemizu 2000: 134; Kawamoto & Okuno 2003: 76

Calcinus lineapropodus Morgan & Forest, 1991	Dive 01, 26°20.769´N, 126°51.506´E, 1 male, 2.7 mm, 1 female, 3.7 mm (NTOU A01201); Dive 02, 26°21.231´N, 126°53.113´E, 1 female, 3.7 mm (RUMF-ZC-1596); Dive 04, 26°21.231´N, 126°53.113´E, 1 male, 4.1 mm (NTOU A01202); Dive 06, 26°21.225´N, 126°49.628´E, 1 male, 1.4 mm (ZRC 2011.0789); Dive 08, 26°18.536´N, 126°50.402´E, 1 female, 5.1 mm (RUMF-ZC-1597); Dive 10, 26°20.012´N, 126°43.961´E, 4 males 2.9–3.9 mm (NTOU A01203); Dive 12, 26°19.683´N, 126°44.625´E, 1 male, 12.6 mm (RUMF-ZC-1598); Dive 14, 26°17.547´N 126°47.771´E, 1 male, 2.3 mm (ZRC 2011.0790); Dive 15, 2 males, 7.1, 10.2 mm (RUMF-ZC-1599); Dive 17, 26°19.509´N, 126°45.104´E, 1 male, 1.5mm, 1 female, 1.7 mm (ZRC 2011.0791); Dive 21, 26°19.720´N, 126°44.593´E, 1 male, 2.2 mm (NTOU A01204); Dive 23, 26°18.747´N, 126°45.960´E, 1 female, 3.6 mm (NTOU A01205); Dive 32, 26°19.666´N, 126°49.028´E, 1 male, 3.6 mm (ZRC 2011.0792); Dive 34, 1 male, 2.1 mm (ZRC 2011.0793)	Kawamoto & Okuno 2003: 76
Calcinus minutus Buitendijk, 1937	Dive 01, 26°20.769´N, 126°51.506´E, 1 female, 2.7 mm (ZRC 2011.0794); Dive 02, 26°21.231´N, 126°53.113´E, 1 male, 4.4 mm (NTOU A01206); Dive 04, 26°21.231´N, 126°53.113´E, 3 male, 2.9–4.3 mm, 2 females, 3.2 mm, 3.8 mm (RUMF-ZC-1600); Dive 05, 26°20.749´N, 126°51.008´E, 2 males, 2.1mm, 5.0 mm, 1 female, 3.5 mm (RUMF-ZC-1601); Dive 08, 26°18.536´N, 126°50.402´E, 5 males, 1.8–4.7 mm, 1 female, 2.4 mm (NTOU A01207); Dive 11, 26°19.421´N, 126°49.028´E, 1 male, 1.9 mm (ZRC 2011.0795); Dive 13, 26°19.217´N, 126°44.627´E, 2 males, 3.2mm, 3.4 mm (ZRC 2011.0796); Dive 17, 26°19.509´N 126°45.104´E, 1 ovig. female, 3.4 mm (NTOU A01208); Dive 21, 26°19.720´N, 126°44.593´E, 3 males, 2.9–3.4 mm, 1 female, 3.5 mm, 1 ovig. female, 4.4 mm (RUMF-ZC-1602); Dive 36, 26°19.666´N, 126°49.028´E, 1 male, 2.7 mm, 1 female, 2.3 mm (ZRC 2011.0797)	Minemizu 2000: 135; Kawamoto & Okuno 2003: 77
Calcinus morgani Rahayu & Forest, 1999	Dive 04, 26°21.231´N, 126°53.113´E, 2 males, 2.0–6.6 mm, 1 female , 5.8 mm (RUMF-ZC-1603); Dive 14, 26°17.547´N, 126°47.771´E, 1 male, 1.8 mm, 1 female, 2.8 mm (ZRC 2011.0705); Dive 15, 26°17.547´N, 126°47.771´E, 1 male, 2.3 mm, 1 female, 2.1 mm (NTOU A01145); Intertidal 05, 26°20'09.6" N, 126°49'29.2"E, 1 female, 4.2 mm (RUMF-ZC-1604)	Minemizu 2000: 136; Kawamoto & Okuno 2003: 77
Calcinus pulcher Forest, 1958	Dive 03, 26°20.777´N, 126°49.620´E, 1 male, 2.8 mm (ZRC 2011.0798); Dive 08, 26°18.536´N, 126°50.402´E, 2 males, 4.5–5.0 mm (RUMF-ZC-1605); Dive 09, 26°18.***´N, 126°50.244´E, 1 male, 3.3 mm (ZRC 2011.0799); Dive 17, 26°19.509´N, 126°45.104´E, 3 males, 3.1–3.2 mm (NTOU A01209); Dive 23, 26°18.747´N, 126°45.960´E, 1 male, 2.4 mm, 1 female, 3.1 mm (NTOU A01210); Dive 41, 26°19.983´N, 126°43.934´E, 1 male, 2.8 mm, 1 female, 3.2 mm (RUMF-ZC-1606)	Kawamoto & Okuno 2003: 78
Calcinus seurati Forest, 1951	Intertidal 10, 26°22'57.3" N, 126°44'53.8"E, 1 male, 5 mm (RUMF-ZC-1607)	
Calcinus vachoni Forest, 1958	Dive 10, 26°20.012´N, 126°43.961´E, 1 female, 2.6 mm (RUMF-ZC-1608); Dive 14, 26°17.547´N, 126°47.771´E, 1 male, 1.7 mm (RUMF-ZC-1609); Dive 23, 26°18.747´N, 126°45.960´E, 1 male, 1.2 mm (ZRC 2011.0706); Dive 28, 26°17.454´N, 126°47.890´E, 1 male, 1.6 mm (NTOU A01146)	Minemizu 2000: 138; Kawamoto & Okuno 2003: 78
Ciliopagurus krempfi (Forest, 1952)	Banta, 1 male, 6.0 mm, 80 m (RUMF-ZC-1610); Dredge 23, 26°16.380´N, 126°51.502´E, 1 female, 3.3 mm (NTOU A01147); Trawl 07, 26°23.090´N, 126°47.832´E, 1 female, 2.8 mm (RUMF-ZC-1611); Trawl 26, 26°16.600´N, 126°53.336´E, 1 male, 3.8 mm (ZRC 2011.0707)	
Ciliopagurus strigatus (Herbst, 1804)	Dive 02, 26°21.231´N, 126°53.113´E, 2 males, 4.8–5.2 mm (RUMF-ZC-1612); Dive 14, 26°17.547´N, 126°47.771´E, 1 female 1.8 mm (ZRC 2011.0708); Dive 15, 26°17.547´N, 126°47.771´E, 1 female 4.1 mm (RUMF-ZC-1613); Dive 17, 26°19.509´N, 126°45.104´E, 1 female, 3.5 mm (NTOU A01148); Dive 28, 26°17.454´N, 126°47.890´E, 1 male, 1.5 mm (ZRC 2011.0709)	Minemizu 2000: 136; Kawamoto & Okuno 2003: 74
Clibanarius corallinus (H. Milne Edwards, 1848)	Intertidal, 6 males, 5.3–6.6 mm, 1 female, 4.2 mm (RUMF-ZC-1614); 1 male, 5.4 mm (ZRC 2011.0710); Intertidal 07, 26°20'29.7" N, 126°45'33.0"E, 1 male, 6.7 mm (ZRC 2011.0711); Eef Reef, 2 males, 3.7–4.1 mm, 1 female, 3.7 mm (NTOU A01148)	
Clibanarius englaucus Ball & Haig, 1972	Intertidal 01, 26°18'58.9" N, 126°46'26.0" E, 9 males, 1.7–2.2 mm, 7 females, 1.6–2.3 mm (NTOU A01178); Intertidal 02, 26°20'08.0" N, 126°48'57.5" E, 3 males, 1.9–2.5 mm, 1 female, 2.3 mm (ZRC 2011.0712); Intertidal, Eef, 11 males, 1.7–3.5 mm, 3 females, 1.8–2.7 mm (RUMF-ZC-1615); 2 males, 1.7-2.3 mm (ZRC 2011.0713); 1 male, 3.2 mm (ZRC 2011.0714)	
Clibanarius eurysternus (Hilgendorf, 1879)	Intertidal 01, 26°18'58.9" N, 126°46'26.0" N, 6 males, 1.9–6.2 mm, 2 females, 2.8 mm, 4.1 mm (RUMF-ZC-1616); Intertidal Eef, 1 female, 3.3 mm (ZRC 2011.0715); 1 male, 4.1 mm (ZRC 2011.0716)	Kawamoto & Okuno 2003: 79

Clibanarius humilis (Dana, 1851)	Intertidal 01, 26°18'58.9" N, 126°46'26.0" N, 8 males, 1.3–2.0 mm, 3 ovig. females 1.3–1.7 mm (NTOU A01179); Intertidal 02, 26°20'08.0" N, 126°48'57.5" N, 3 males, 1.9–2.9 mm, 1 female, 2.2 mm (RUMF-ZC-1617); Intertidal 03, 26°21'13.4"N, 126°42'59.6 E, 2 males, 2.7 mm, 2.7 mm, 2 ovig. females, 2.3–2.4 mm (ZRC 2011.0717); Intertidal, Eef, 1 male, 1.9 mm, 1 female, 2.2 mm (ZRC 2011.0718); Intertidal, Eef, 1 male, 2.4 mm (RUMF-ZC-1618); Intertidal, Zenida, 5 males, 0.5–1.5 mm, 1 female, 1.0 mm, 1 ovig. female, 1.7 mm (NTOU A01180)	Kawamoto & Okuno 2003: 80
Clibanarius rhabdodactylus Forest, 1953	Intertidal, Eef, 1 male, 2.1 mm (NTOU A01181), 1 male, 2.4 mm (RUMF-ZC-1619)	
Clibanarius striolatus Dana, 1852	Intertidal, Eef, 2 females, 3.6 mm, 3.8 mm (NTOU A01182), 1 female, 4.9 mm (ZRC 2011.0719); Intertidal, Zenida, 1 male, 4.6 mm (RUMF-ZC-1620)	
Clibanarius virescens (Krauss, 1843)	Intertidal 01, 26°18'58.9" N, 126°46'26.0" E, 2 ovig. female, 2.9 mm, 3.1 mm (NTOU A01183); Intertidal, Eef, 1 male, 2.2 mm (RUMF-ZC-1621)	Kawamoto & Okuno 2003: 80
Dardanus brachyops Forest, 1962	Dredge 23, 26°16.380´N, 126°51.502´E, 1 female 4.1 mm (RUMF-ZC-1622)	
Dardanus deformis (H. Milne Edwards, 1836)	Intertidal, 1 female 7.0 mm (RUMF-ZC-1623); Intertidal 01, 26°18'58.9" N, 126°46'26.0" E, 2 males, 2.4 mm, 4.9 mm, 4 females, 4.3–5.5 mm (NTOU A01184); Intertidal 02, 26°20'08.0" N, 126°48'57.5" E, 3 females, 4.8–7.4 mm (ZRC 2011.0720); Intertidal 05, 26°20'09.6" N, 126°49'29.2" E, 2 males, 5.2 mm, 6.4 mm, 1 female, 5.3 mm (RMUF-ZC-1624)	Minemizu 2000: 143; Kawamoto & Okuno 2003: 81
Dardanus gemmatus (H. Milne Edwards, 1848)	Dive 02, 26°21.231´N, 126°53.113´E, 1 female, 11.6 mm (NTOU A01185); Dive 35, 26°19.251´N 126°45.354´E, 1 male, 5.4 mm (RMUF-ZC-1625)	Minemizu 2000: 138; Kawamoto & Okuno 2003: 81
Dardanus guttatus (Olivier, 1812)	Dive 05, 26°20.749´N 126°51.008´E, 1 male 9.5 mm (NTOU A01186); Dive 07, 26°18.793´N 126°48.683´E, 1 female 10.7 mm (RMUF-ZC-1626), 1 male 12.1 mm (RMUF-ZC-1627); Dive 10, 26°20.012´N 126°43.961´E, 1 female, 10.7 mm (NTOU A01187); Intertidal 05, 26°20'09.6" N, 126°49'29.2" E, 1 female, 5.7 mm (NTOU A01188)	Minemizu 2000: 141; Kawamoto & Okuno 2003: 82
Dardanus jacquesi Asakura & Hirayama, 2002	Dive 24, 1 male, 4.7 mm (NTOU A01189); no data, 1 male, 8.4 mm, 1 ovig. female, 5.8 mm (RMUF-ZC-1628); Trawl 07, 26°23.090´N, 126°47.832´E, 1 female, 3.9 mm (ZRC 2011.0721)	Asakura & Hirayama 2002: 214
Dardanus lagopodes (Forskål, 1775)	Dive 02, 26°21.231´N, 126°53.113´E, 2 males, 3.3 mm, 6.7 mm (NTOU A01211); Dive 3, 26°20.777´N, 126°49.620´E, 1 male, 1.8 mm (ZRC 2011.0800); Dive 04, 26°21.231´N, 126°53.113´E, 5 males, 4.9–8.9 mm (NTOU A01212); Dive 05, 26°20.749´N, 126°51.008´E, 2 males, 6.0 mm, 6.4 mm, 1 ovig. female, 11.1 mm (RUMF-ZC-1629); Dive 07, 26°18.793´N, 126°48.683´E, 1 male, 6.0 mm, 1 female, 5.3 mm (RMUF-ZC-1630); Dive 08, 26°18.536´N, 126°50.402´E, 1 male, 4.5 mm, 1 female, 6.7 mm, 1 ovig. female, 7.4 mm (RMUF-ZC-1631); Dive 09, 26°18.***´N, 126°50.244´E, 1 male, 4.5 mm, 2 females, 4.8 mm, 5.2 mm, 1 ovig. female, 4.8 mm (NTOUA01213); Dive 10, 26°20.012´N, 126°43.961´E, 2 males 5.2 mm, 6.4 mm (RUMF-ZC-1632); Dive 11, 26°19.421´N, 126°49.028´E, 3 males, 2.9 - 5.3 mm (RUMF-ZC-1633); Dive 12, 26°19.683´N 126°44.625´E, 1 male, 4.4 mm (ZRC 2011.0801); Dive 13, 26°19.217´N, 126°44.627´E, 2 males, 4.6 mm, 5.0 mm, 1 ovig. female, 5.9 mm (NTOU A01214); Dive 15, 26°17.547´N, 126°47.771´E, 2 males, 2.3 mm, 6.7 mm (RUMF-ZC-1634); Dive 16, 26°19.885´N, 126°45.616´E, 1 female, 3.9 mm (ZRC 2011.0802); Dive 17, 26°19.509´N, 126°45.104´E, 1 male, 4.6 mm (ZRC 2011.0803); Dive 21, 26°19.720´N, 126°44.593´E, 1 ovig. female, 11.4 mm (RUMF-ZC-1635); Dive 22, 26°19.964´N, 126°43.906´E, 1 male, 5.2 mm, 1 female, 5.4 mm (ZRC 2011.0804); Dive 24, 1 female, 4.0 mm (ZRC 2011.0805); Dive 28, 26°17.454´N, 126°47.890´E, 1 male, 5.7 mm (NTOU A01215); Dive 29, 26°19.983´N, 126°43.934´E, 1 male, 5.9 mm, 1 female, 5.2 mm (ZRC 2011.0806); Dive 31, 26°19.983´N, 126°43.934´E, 1 male, 5.9 mm (NTOU A01216); Dive 33, 1 male, 5.9 mm, 1 female, 5.2 mm (NTOU A01217); Dive 34, 1 female, 5.0 mm (NTOU A01218); Dive 35, 26°19.251´N, 126°45.354´E, 2 males, 6.1 mm, 6.8 mm (RUMF-ZC-1636); Dive 37, 26°19.421´N, 126°45.733´E, 2 males, 2.6 mm, 4.0 mm (NTOU A01219); Dredge 43, 26°19.605´N, 126°45.633´E, 1 male, 3.6 mm (ZRC 2011.0807); Dredge 44, 26°19.714´N, 126°45.649´E, 1 male, 5.0 mm (ZRC 2011.0808); Dredge 50, 26°19.517´N, 126°45.797´E, 1 male, 5.2 mm (NTOU A01220); Dredge 52, 26°20.409´N, 126°49.675´E, 1 male, 6.8 mm, 1 ovig. female, 5.8 mm (RUMF-ZC-1637); Dredge 59, 26°20.307´N, 126°49.360´E, 1 male, 3.3mm, 1 female, 5.2 mm, 1 ovig. female, 5.7 mm (ZRC 2011.0809); Dredge 60, 26°19.402´N, 126°50.280´E, 1 female, 5.8 mm (ZRC 2011.0810)	Minemizu 2000: 141; Kawamoto & Okuno 2003: 82

Dardanus megistos (Herbst, 1804)	Dive 10, 26°20.012´N, 126°43.961´E, 1 female, 19.0 mm (RUMF-ZC-1638), 1 male, 10.3 mm (ZRC 2011.0722); Dredge 21, 26°19.682´N, 126°50.215´E, 1 male, 4.0 mm (NTOU A01190); Gillnet, 1 male, 32.9 mm (RUMF-ZC-1639), 1 male, 26.9 mm (NTOU A01191); Intertidal 01, 26°18'58.9" N, 126°46'26.0" E, 1 male, 4.1 mm, 4 females, 5.4–5.6 mm (ZRC 2011. 0723); Intertidal 02, 26°20'08.0" N, 126°48'57.5" E, 1 male, 6.6 mm (ZRC 2011. 0724)	Minemizu 2000: 143; Kawamoto & Okuno 2003: 83
Dardanus pedunculatus (Herbst, 1804)	Gillnet, 2 males, 18.2 mm, 22.4 mm (RUMF-ZC-1640), 1 male, 20 mm (NTOU A01192); Trawl 07, 1 male, 9.5 mm (ZRC 2011. 0725)	Kawamoto & Okuno 2003: 84
Dardanus robustus Asakura, 2006	Dive 04, 26°21.231´N, 126°53.113´E, 1 male, 6.2 mm (RUMF-ZC-1641)	
Dardanus scutellatus (H. Milne Edwards, 1848)	Dive 09, 26°18.***´N, 126°50.244´E, 1 male, 6.2 mm (NTOU A01193), 1 male, 4.6 mm (RUMF-ZC-1642), 1 male, 5.8 mm (ZRC 2011.0726)	
Dardanus woodmasoni (Alcock, 1905)	Dive 09, 26°18.***´N, 126°50.244´E, 1 ovig. female, 1.3 mm (RUMF-ZC-1643)	
Diogenes holthuisi Asakura & Tachikawa, 2010	Dredge 2, 26°23.147´N, 126°44.931´E, 1 ovig. female, 1.27 mm (RUMF-ZC-1644)	
Diogenes leptocerus Forest, 1956	Intertidal 4, 26°20'57.8"N, 126°43'33.9" E, 6 males, 0.8–2.4 mm (RUMF-ZC-1645); Intertidal 03, 26°21'13.4"N, 126°42'59.6"E, 1 ovig. female 1.3 mm (ZRC 2011.0727); Dredge 55, 26°19.442´N, 126°49.211´E, 2 males, 1.1 mm, 1.1 mm, 1 ovig. female, 1.5 mm (NTOU A01221)	
Diogenes pallescens Whitelegge, 1897	Dredge 2, 26°23.147´N, 126°44.931´E, 2 males 1.4 mm, 1.4 mm (RUMF-ZC-1646); Dredge 44, 26°19.714´N, 126°45.649´E, 1 female, 1.8 mm, 1 ovig. female, 2.4 mm (NTOU A01222); Dredge 67, 26°19.940´N, 126°51.960´E, 1 male, 1.5 mm (ZRC 2011.0728)	
Paguristes jalur Morgan, 1992	Dive 08, 26°18.536´N, 126°50.402´E, 1 male, 4.6 mm (NTOU A01194); Dive 14, 26°17.547´N, 126°47.771´E, 1 male, 4.3 mm (ZRC 2011.0729); Dive 35, 26°19.251´N, 126°45.354´E, 2 males, 4.1 mm, 6.6 mm (RUMF-ZC-1647)	Kawamoto & Okuno 2003: 84
Paguristes macrops Rahayu & Forest, 2009	Dredge 23, 26°16.380´N, 126°51.502´E, 1 male, 3.5mm (RUMF-ZC-1648); Dredge 79, 26°14.686´N, 126°49.623´E, 2 females, 1.0 mm , 2.5 mm (NTOU A01223)	
Paguristes ocellus Komai, 2010	Trawl 06, 26°23.044´N, 126°47.724´E, 1 male, 3.0 mm (RUMF-ZC-1649)	
Pseudopaguristes bicolor Asakura & Kosuge, 2004	Dredge 73, 26°21.415´N, 126°41.322´E, 1 male, 2.4 mm(RUMF-ZC-1729); Trawl 29, 26°17.625´N, 126°52.940´E, 1 ovig. female, 2.8 mm (RUMF-ZC-01730); Trawl 32, 26°16.775´N, 126°48.050´E, 1 male, 2.2 mm (RUMF-ZC-1709)	
Pseudopaguristes bollandi Asakura & McLaughlin, 2003	Dredge 11, 26°22.806´N, 126°48.035´E, 1 male, 1.8 mm (RUMF-ZC-1710); Trawl 06, 26°22.575´N 126°43.761´E, 1 male, 1.7 mm (RUMF-ZC-1711)	
Pseudopaguristes janetkae McLaughlin, 2002	Dredge 10, 26°22.782´N, 126°48.201´E, 1 male, 1.7 mm (RUMF-ZC-1712)	
Pseudopaguristes laurentae (Morgan & Forest, 1991)	Dredge 78, 26°14.834´N, 126°51.951´E, 1 ovig. female, 1.6 mm (RUMF-ZC-1651), 1 male, 2.5 mm (ZRC 2011.0731)	
Pseudopaguristes monoporus (Morgan, 1987)	Dive 08, 26°18.536´N, 126°50.402´E, 1 ovig. female, 1.6 mm (RUMF-ZC-1652)	
Pseudopaguristes shidarai Asakura, 2004	Dive 25, 26°19.866´N, 126°44.216´E, 1 male, 1.6 mm, 1 female, 2.7 mm (RUMF-ZC-1713); Dive Katada 17, 26°19.509´N, 126°45.104´E, 1 male, 1.4 mm (RUMF-ZC-1714)	Kawamoto & Okuno 2003: 85 (as *Pseudopaguristes* sp.); 2006: 85.
Pseudopaguristes sp.	Dive 08, 26°18.536´N, 126°50.402´E, 1 male, 2.8 mm (RUMF-ZC-1715)	

Taxonomic account

Family Diogenidae Ortmann 1892

Dardanus brachyops **Forest, 1962**

(Fig. 1A)

Dardanus brachyops Forest, 1962: 363. — Poupin 1996: 18, pl. 8d. —Asakura *et al*. 2003: 190, figs. 1–10.

Material examined. 1 female 4.1 mm, Stn. Dredge 23, 26°16.380′N, 126°51.502′E, 12 November 2009, 125–147 m (RUMF-ZC-1611).

Remarks. *Dardanus brachyops* is the largest species in the genus *Dardanus*. Forest (1962) described this species based on three specimens with carapace length 62, 82 and 88 mm. Asakura *et al*. (2003) reported two specimens of 15.8 and 25.1 mm in shield length, from the Ryukyu and Ogasawara Islands. The same authors redescribed this species and discussed its affinity with *D. megistos* (Herbst, 1804), and *D. lagopodes* (Forskål, 1775).

The colouration of the ocular peduncles, chelipeds and pereopods and the spination of the chelipeds in the specimen examined are the same as described by Forest (1962) and Asakura *et al.* (2003). However, some differences are observed. The chelipeds are subequal in the present specimen, but the left cheliped is much larger than the right in the materials of Forest (1962) and Asakura *et al.* (2003). The lateral face of the dactyl of the left third pereopod is not flattened but has a narrow median longitudinal sulcus in the specimen examined, whereas it is flattened with a median longitudinal sulcus in the material of Asakura *et al.* (2003). This discrepancy is probably due to much smaller size of the present specimen (shield length 4.09 mm).

Colour. Shield white with few red spots. Ocular peduncles with alternately red and white bands, corneas black. Chelipeds red-orange with white spots, dactyls and fixed finger bright red. Ambulatory legs red with white spots; spots larger on meri.

Distribution. Madagascar, Chichi-jima Island in Ogasawara Islands, Ishigaki Island in Ryukyu Islands, Hawaii and French Polynesia, now recorded from Kume Island in central Ryukyus; 33–300 m.

Diogenes holthuisi **Asakura & Tachikawa, 2010**

(Fig. 1B)

Diogenes holthuisi Asakura & Tachikawa, 2010: 135, figs. 1–5.

Material examined. 1 ovig. female 1.3 mm, Stn. Dredge 2, 26°23.147′N, 126°44.931′E, 9 November 2009, 70 m (RUMF-ZC-1644).

Remarks. This species is characterized by the short, distally bifid antennal acicle without dorsal and dorsomesial rows of spines (Asakura & Tachikawa 2010: fig. 1A, a). The specimen in this study agrees well with the original description except the shield is longer than broad and the ocular peduncles are prominently inflated basally. Asakura & Tachikawa (2010) stated that the shield is as long as broad and the ocular peduncles are only slightly inflated basally in the type material. Furthermore, the lateral and mesial surfaces of the dactyls of the second and third pereopods lack longitudinal sulci in the present specimen are unlike the type material. These differences are likely to be intraspecific variation because the intraspecific variations of particular characters are known to be high in the genus *Diogenes* as indicated by McLaughlin (2002c).

Colour. Shield white, ocular peduncles reddish-pink, corneas black with a greenish tinge. Left cheliped white with brown spot near articulation of dactyl and palm; right cheliped white with pinkish-red band on articulation of palm and carpus; ischium of both chelipeds red pinkish. Ambulatory legs alternately transparent and brown; meri reddish-brown.

Distribution. Ogasawara Island and now recorded from Kume Island; 3–70 m.

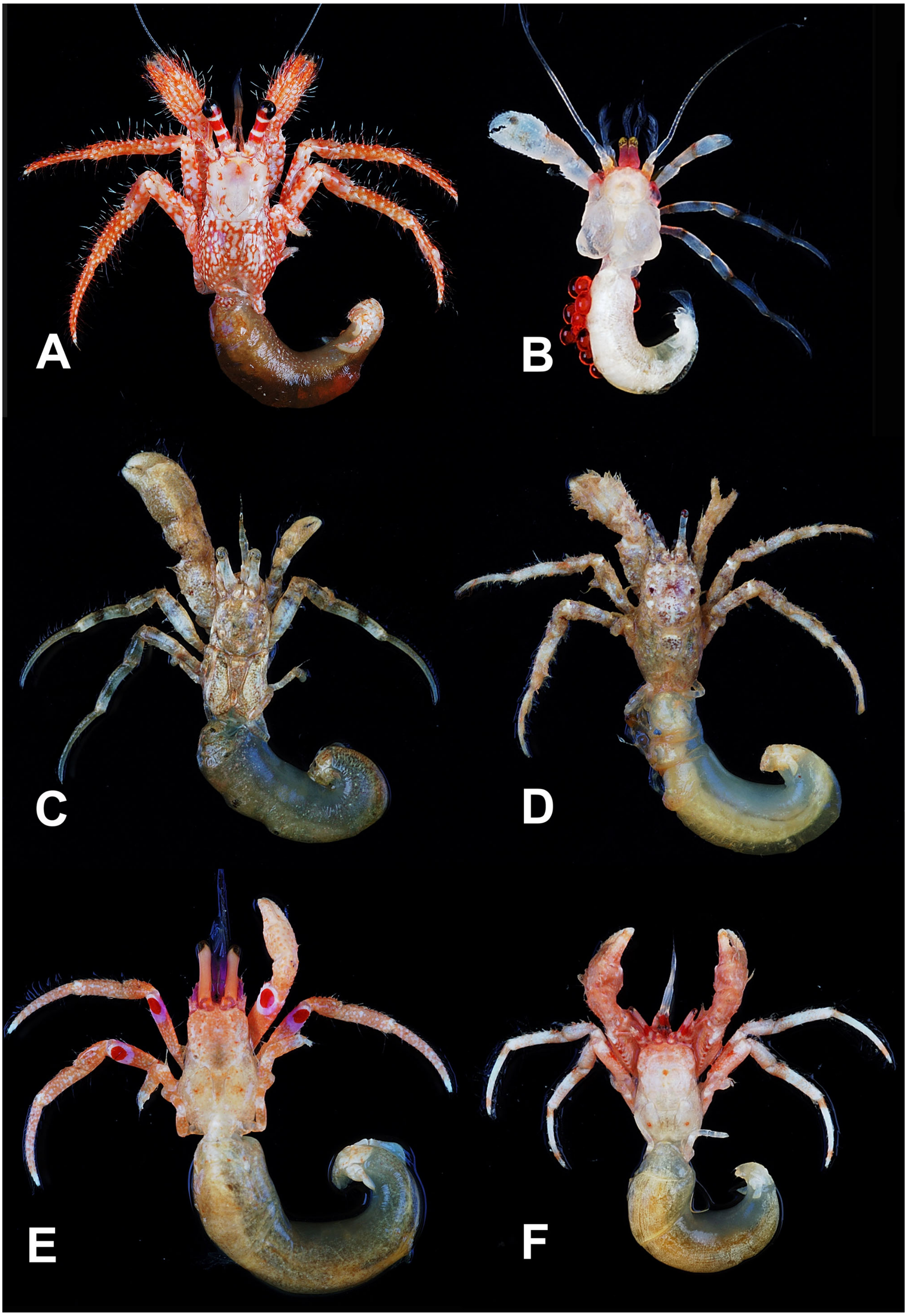


FIGURE 1. A, *Dardanus brachyops* Forest, 1962, female, 4.09 mm, Stn. Dredge 23; B, *Diogenes holthuisi* Asakura & Tachikawa, 2010, ovig. female 1.27 mm, Stn. Dredge 2; C, *Diogenes leptocerus* Forest, 1956, male, 2.4 mm, Stn. Intertidal 4 (right third pereopod missing); D, *Diogenes pallescens*, female ovig. 2.35 mm, Stn Dredge 44; E, *Paguristes macrops* Rahayu & Forest, 2009, male, 3.45 mm, Stn. Dredge 23 (left cheliped and right third pereopod missing); F, *Pseudopaguristes laurentae* Morgan & Forest, 1991, male, 2.54 mm, Stn. Dredge 78.

Diogenes leptocerus Forest, 1956

(Fig. 1C)

Diogenes leptocerus Forest, 1956: 528, figs. 8–11. — Lewinsohn, 1982a: 47. — Rahayu & Forest, 1995: 405. — Rahayu & Hortle, 2002: 616.

Material examined. 1 ovig. female 1.3 mm, Stn. Intertidal 3, Shinri Beach, 26°20′57.8″N, 126°43′33.9″E, 18 November 2009, intertidal (ZRC 2011.0728); 6 males 0.8–2.4 mm, Stn. Intertidal 4, Ohara, 26°20′57.8″N, 126°43′33.9″E, 18 November 2009 (RUMF-ZC-1645, intertidal; 1 ovig. female 1.5 mm, 2 males 1.1 mm, Stn. Dredge 55, 26°19.442′N, 126°49.211′E, 17 November 2009, 4.7–9.5 m (NTOU A01221).

Remarks. The present specimens from Kume Island are referable to *Diogenes leptocerus*, and agree very well with the original description and figure of the species (Forest 1956: 528, figs. 8–11). Rahayu & Forest (1995) and Rahayu & Hortle (2002) pointed out the difference of this species from *Diogenes spinicarpus* Rahayu & Forest, 1995: the telson is truncate and has no incision on the posterior margin. In *Diogenes spinicarpus*, the telson has a distinct median cleft on the posterior margin, and is armed with prominent spines on the left lobe, smaller spines on the right lobe. Additional differences examined in the material studied are: the ocular peduncles of *Diogenes leptocerus* are subcylindrical and prominently dilated basally but less so distally, and straight on the lateral and mesial margins; while in *Diogenes spinicarpus*, they are dilated basally and distally, and sinuous on the lateral and mesial margins.

Distribution. Somalia, Indonesia, Vietnam and now recorded from southern Japan; intertidal to 9.5 m.

Diogenes pallescens Whitelegge, 1897

(Figs. 1D, 2)

Diogenes pallescens Whitelegge, 1897: 141, pl. 6, figs. 2, 2 a–c. — Forest, 1956: 531. — Lewinsohn, 1969: 46. — Ball & Haig, 1972: 89, fig. 2. — Morgan, 1987: 176. — Rahayu, 1994: 83; 1996: 435; 2000: 391. — Rahayu & Forest, 1995: 413. — McLaughlin, 2002c: 91, figs. 1–3.

Diogenes gardineri Alcock, 1905a: 830, pl. 68, fig. 1; 1905b: 73, pl. 7, fig. 3. — Forest, 1956: 530, fig. 16. — Lewinsohn, 1969: 45. — Ball & Haig, 1972: 91. — Nakasone, 1975: 3. — Gherardi & McLaughlin, 1994: 643. — McLaughlin & Haig, 1996: 123. — Rahayu & Forest, 1995: 410. — McLaughlin & Clark, 1997: 33. — Rahayu, 2000: 390.

Diogenes senex Bouvier, 1892: 55. — Nobili, 1906a: 78; 1906b: 118. — Balss, 1927: 224. [not *Diogenes senex* Heller, 1865]

Diogenes serenei Forest, 1956: 530, figs. 12–15. — Lewinsohn, 1969: 45. — Ball & Haig, 1972: 91. — Nakasone, 1975: 3. — Morgan, 1987: 178; 1989: 402; 1990: 19. — Haig & Ball, 1988: 168. — Gherardi & McLaughlin, 1994: 643. — Rahayu, 1994: 83; 2000: 391. — McLaughlin & Haig, 1996: 123. — Rahayu & Forest, 1995: 412. — Rahayu & Komai, 2000: 29. — McLaughlin, 2002b: 420, fig. 4A–C; 2002c: 88, figs. 2C, 3C, 4C, 5C.

Material examined. 2 males, 1.4 mm, Stn. Dredge 2, 26°23.147′N, 126°44.931′E, 9 November 2009, 70 m (RUMF-ZC-1646); 1 female 1.8 mm, 1 ovig. female 2.4 mm, Stn Dredge 44, 26°19.714′N, 126°45.649′E, 14 November 2009, 17.9–42.5 m (NTOUA01222); 1 male 1.5 mm, Stn. Dredge 67, 26°19.940′N, 126°51.960′E, 18 November 2009, 6 m (ZRC 2011.0728).

Remarks. The material in this study agrees well with the redescription of the species by McLaughlin (2002c). McLaughlin (2002c) synonymized *Diogenes gardineri* Alcock, 1905, and *Diogenes serenei* Forest, 1956, to *Diogenes pallescens* and discussed at length the morphological variations of this species. The specimens examined have same intraspecific variations mentioned by McLaughlin (2002c) as follows: the length of the ocular peduncles is 0.70 to equaling of the shield length and shorter to slightly longer than the antennular peduncles; the intercalary rostral process is well developed, with or without prominent ventral spine; the meri of second pereopods are armed with one to five spines on the ventral margin; the carpi of the second pereopods are unarmed or have proximal spines on the dorsal margin.

The characters that McLaughlin (2002c) used to unify the three species mentioned above include the shape and armature of the telson: the possession of distinct median cleft and a row of small to large, posterior marginal spines which extend onto the lateral margins. In the five specimens from Kume Island, the telson lacks the median cleft, but has large marginal spines (Fig. 1G). Other differences detected are the presence of a row of spines on the ventromesial margin of the ischium of each cheliped and the presence of a prominent spine on the dorsal margin of each merus of the second pereopods (Fig. 1C, F). The ischia of the chelipeds and the dorsal margin of the meri of the second pereopods are unarmed in the material examined by McLaughlin (2002c). However, with regards to the character variability of this species, the five specimens examined from Kume Island are included in *Diogenes pallescens*. Another reason to include these specimens in *Diogenes pallescens* is the shape of the ocular peduncles which is prominently dilated proximally (Fig. 1A). It is very much like the figure of the specimen of *Diogenes pallescens* from Sek Island in New Guinea by Ball & Haig (1972, fig. 2a), although McLaughlin (2002c) mentioned and figured only the dilatation of corneas.

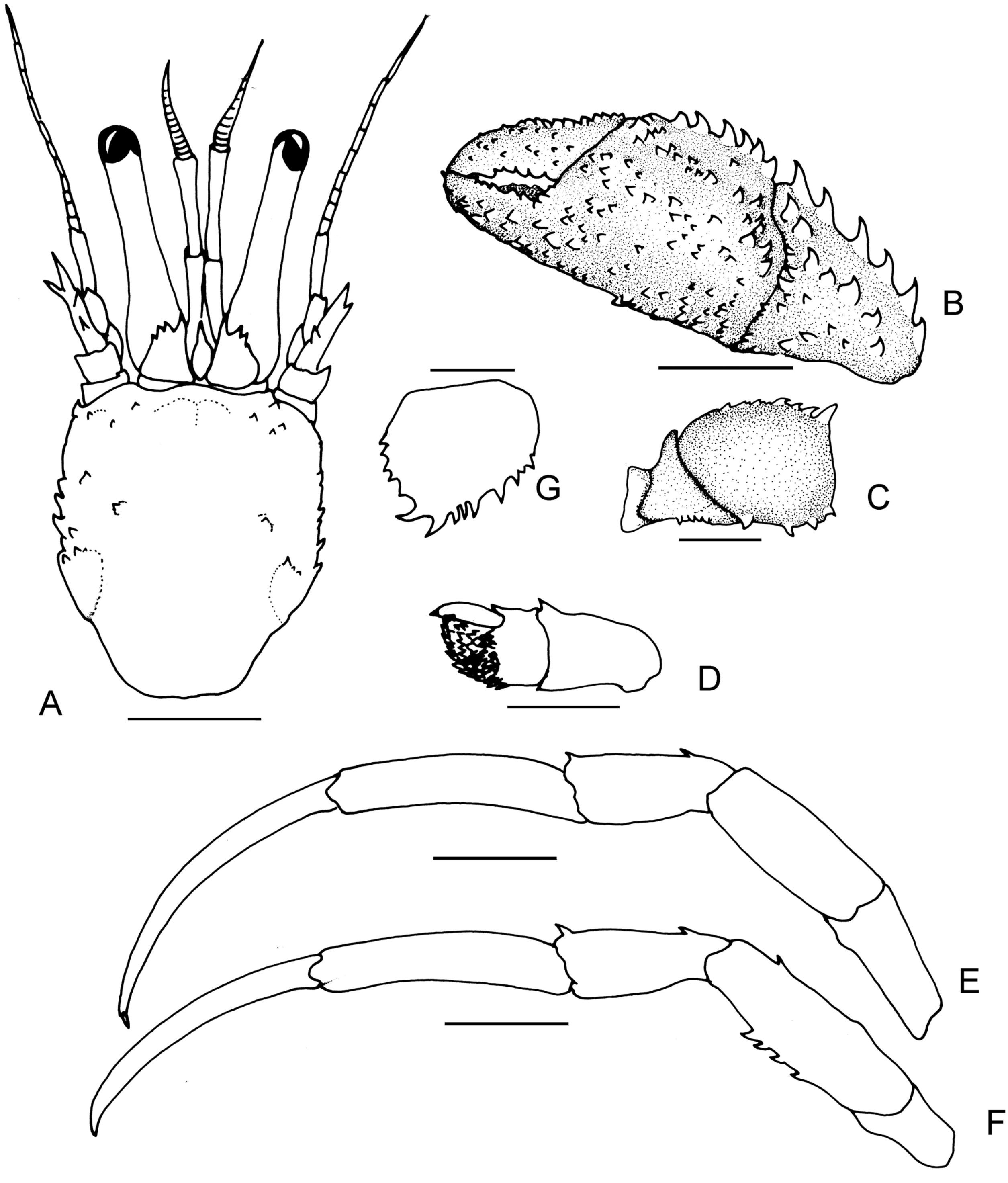


FIGURE 2. *Diogenes pallescens* Whitelegge, 1897, ovig. female 2.35 mm, Stn Dredge 44: A, shield, and ocular, antennular and antennal peduncles, dorsal view; B, left cheliped, outer view; C, merus of left cheliped, mesial view; D, distal segments of left fourth pereopod, lateral view; E, left third pereopod, lateral view; F, left second pereopod, lateral view; G, telson, dorsal view. Scales: A–C, E, F, = 1.0 mm; D, G = 0.5 mm.

Colour. Carapace mottled brown and white; shield also with reddish-pink spot medially, and dark brown spot near each lateral margin. Ocular peduncles light brown proximally, dark brown ring present in transparent white distal area. Cheliped and ambulatory legs mottled white and brown.

Distribution. Indian Ocean from East Africa to Andaman Sea and northern Australia across Malay Archipelago (Indonesia, Singapore and New Guinea) to Vietnam, Guam and Tuamotu Archipelago. And herein recorded from Kume Island in the Ryukyu Islands, 0–42 m.

***Paguristes macrops* Rahayu & Forest, 2009**

(Fig. 1E)

Paguristes macrops Rahayu & Forest, 2009: 1317, figs. 3, 4.

Material examined. 1 male 3.5 mm, Stn. Dredge 23, 26°16.380′N, 126°51.50′E, 12 November 2009, 125 m (RUMF-ZC-1648); 2 females, 1.0 mm, 2.5 mm, Stn. Dredge 79, 26°14.686′N, 126°49.623′E, 20 November 2009, 141–165m (NTOUA01223).

Remarks. *Paguristes macrops* is characterized by having rounded red spot on each of the mesial and lateral faces of the meri of the chelipeds and second and third pereopods. This character is also seen in *P. gonagrus* (H. Milne Edwards, 1836), *Paguristes balanophylus* Alcock, 1905, *Paguristes alcocki* McLaughlin & Rahayu, 2005, *Paguristes lewinsohni* McLaughlin & Rahayu, 2005, *Paguristes aulacis* Rahayu & Forest, 2009, and *Paguristes ocellus* Komai, 2010, but there are morphological and other colour differences among these species. The specimens in the present study agree well with the original description and the colouration of *Paguristes macrops*, but minor differences are noted: the ocular peduncles that are shorter than the shield, and the mesial face of the dactyl of each cheliped has only one longitudinal row of tubercles. The specimens collected (2.54, 3.45 mm in shield length) are smaller than the specimens examined by Rahayu & Forest (2009, 3.0–9.1 mm in shield length), and too limited to evaluate whether these differences are only intraspecific variations or they warrant the separation of species.

Distribution. The Philippines and now recorded from Kume Island, Japan; 83–165 m.

***Pseudopaguristes laurentae* (Morgan & Forest, 1991)**

(Fig. 1F)

Paguristes laurentae Morgan & Forest, 1991: 678, figs. 12, 13. — Davie, 2002: 55. — Komai, 1999: 11.
Paguristes brachytes Komai, 1999: 3, figs. 1–4.
Paguristes gracilis Rahayu, 2005: 28, figs. 10–11.
Pseudopaguristes laurentae. — Rahayu, 2005: 25. — McLaughlin, 2008: 261, fig. 26.

Material examined. 1 male, 2.5 mm, Stn. Dredge 78, 26°14.834′N, 126°51.951′E, 20 November 2009, 179–192 m (RUMF-ZC-1651).

Remarks. The most distinctive character of this species is the prominent ventrodistal spine of each third and fourth segment of the antennal peduncle. Additionally, one row of spines on the mesial face of the dactyl of each cheliped and the broadened appendix masculine of the second male pleopod readily set *Pseudopaguristes laurentae* apart from other members of the genus.

Distribution. From Madagascar to eastern and southern Australia, and Indonesia to Sagami-nada, Torishima, Kii Peninsula in Japan, and now recorded from Kume Island; 69–675 m.

Discussion

Most of the species of the family Diogenidae found in Kume Island are widely distributed in the Indo-West Pacific from East coast of Africa across Indian Ocean and Malaysia Archipelago to Hawaii and French Polynesia. However, several species have a restricted distribution in the Malay Archipelago and western Pacific only: *Aniculus sibogae*, *Clibanarius englaucus*, *Clibanarius rhabdodactylus*, *Paguristes macrops*, *Pseudopaguristes* *janetkae* (McLaughlin 2002a; McLaughlin *et al*. 2007; Rahayu 2000; Rahayu & Forest 2009). Five species, *Diogenes holthuisi*, *Paguristes ocellus*, *Pseudopaguristes bicolor*, *P. bollandi*, and *P. shidarai*, for this moment found only in southern Japanese waters, Ogasawara and Ryukyu Islands (Asakura 2004; Asakura & Kosuge 2004; Asakura & McLaughlin 2003; Asakura & Tachikawa 2010; Kawamoto & Okuno, 2006; Komai 2010).

Acknowledgements

The material examined was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition was conducted under a permit granted to T. Naruse, the organizer of the KUMEJIMA 2009 Expedition, by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. The senior author indebted to Tohru Naruse, University of the Ryukyus for the invitation to joint the Expedition, to Peter K.L. Ng, Raffles Museum of Biodiversity Research, National University of Singapore, and Tin-Yam Chan, National Taiwan Ocean University for the financial support for the trip to Kume Island. The comments of two anonymous reviewers improved the manuscript.

References

Alcock, A. (1905a) Marine Crustaceans. XIV. Paguridae *In:* Gardiner, J.S. (Ed.), *The fauna and geography of the Maldive and Laccadive Archipelagoes. Being an account of the work carried on and the collections made by an expedition during the years 1899 and 1900*, 2, 827–835.

Alcock, A. (1905b). Anomura. Fasc. I. Pagurides. *Catalogue of the Indian decapod Crustacea in the collections of the Indian Museum*, 2, i–xi, 1–197, pls. I-XVI. Indian Museum, Calcutta.

Asakura, A. (1991) A new hermit crab (Decapoda: Paguridae) from Rocky shores of the Ogasawara (Bonin) Islands. *Proceedings of Biological Society of Washington*, 104(4), 793–799.

Asakura, A. (1992) New record of the intertidal hermit crab, *Calcinus guamensis* Wooster, 1982 from Japan, with comments on Japanese *Calcinus*. *Journal of Natural History Museum and Institute, Chiba*, 2, 37–40.

Asakura, A. (1999) *Icelopagurus tuberculosus* a distinct new hermit crab species (Crustacea: Decapoda: Paguridae) from Japan. *Proceedings of Biological Society of Washington* 112(2), 381–395.

Asakura, A. (2000) A review of Japanese species of *Pylopaguropsis* Alcock, 1905 (Decapoda: Anomura: Paguridae). *Crustacean Research*, 29, 70–108.

Asakura, A. (2001) A revision of the hermit crabs of the genera *Catapagurus* A. Milne Edwards and *Hemigrapsus* Smith from the Indo-West pacific (Crustacea: Decapoda: Anomura: Paguridae). *Invertebrate Taxonomy*, 15, 823–891.

Asakura, A. (2002a) Hermit crabs of the genus *Calcinus* Dana, 1851 (Crustacea Decapoda Anomura Diogenidae): *C. areolatus* Rahayu & Forest, 1999. *Benthos Research*, 57(10), 11–20.

Asakura, A. (2002b) Hermit crabs of the genus *Calcinus* Dana, 1851 (Crustacea Decapoda Anomura Diogenidae) with a brush of setae on the third pereopods from Japanese and adjacent waters. *Tropical Zoology*, 15, 27–70.

Asakura, A. (2004) *Pseudopaguristes shidarai*, a new species of hermit crab (Crustacea: Decapoda: Diogenidae) from Japan, the fourth species of the genus. *Proceedings of Biological Society of Washington*, 117(2), 153–168.

Asakura, A. (2005) A review of the genus *Micropagurus* (Crustacea Decapoda Anomura Paguridae). *Zootaxa*, 1090, 1–34.

Asakura, A. (2006) *Dardanus sanguinocarpus* Degener, 1925 (Crustacea: Decapoda: Anomura: Diogenidae) species complex: a redescription of *D. sanguinocarpus* and descriptions of three new species. *Zootaxa*, 1230, 1–54.

Asakura, A., Furumi H., Nomura, K. & Tachikawa, H. (2002) A brief review of records of *Calcinus gaimardii* (H. Milne Edwards, 1848) and *C. morgani* Rahayu & Forest, 1999 from Japanese waters, with note on colour variant of *C. gaimardii* (Crustacea: Decapoda: Anomura: Diogenidae). *Biology Magazine, Okinawa*, 40, 33–40.

Asakura, A. & Hirayama, S. (2002) *Dardanus jacquesi*, a new species of hermit crab from the Indo-West pacific, with the redescription of a little known species, *Dardanus dearmatus* (Henderson, 1888) (Decapoda, Anomura, Diogenidae). *Crustaceana*, 75(3–4), 213–230.

Asakura, A & Kosuge, T. (2004) *Pseudopaguristes bicolor*, a new species of hermit crab (Crustacea: Decapoda: Diogenidae) from Japan, the third species of the genus. *Proceedings of Biological Society of Washington*, 117(1), 57–67.

Asakura, A. & McLaughlin, P. A. (2003) A new species of *Pseudopaguristes* McLaughlin, 2002 (Crustacea: Decapoda: Diogenidae) from Japan. *Proceedings of Biological Society of Washington*, 116(2), 453–463.

Asakura, A. & Nomura, K. (2001) Hermit crabs of the genus *Calcinus* Dana, 1851 from Japan and Adjacent waters (Decapoda, Anomura, Diogenidae): *C. pulcher* Forest 1985 and *C. lineapropodus* Morgan & Forest, 1991. *Crustacean Research*, 30,

94–110.

Asakura, A. & Paulay, G. (2003) *Pylopaguropsis lemaitrei*, a new species of hermit crab (Decapoda: Anomura: Paguridae) from French Polynesia. *Crustacean Research*, 32, 13–25.

Asakura, A. & Tachikawa, H. (2000) A new hermit crab of the genus *Calcinus* from Micronesia, including new information on *C. revi* Poupin & McLaughlin (Decapoda: Anomura: Diogenidae). *Journal of Crustacean Biology*, 20(Special No. 2), 266–280.

Asakura, A. & Tachikawa, H. (2003) Hermit crabs of the genus *Calcinus* Dana, 1851 from Japan and Adjacent waters (Decapoda, Anomura, Diogenidae): *C. hazletti* Haig & McLaughlin, 1984 and *C. haigae* Wooster, 1984. *Crustaceana*, 76(6), 717–739.

Asakura, A. & Tachikawa, H. (2004) *Boninpagurus acanthocheles*, a new genus and species of hermit crab (Decapoda Anomura Paguridae) from shallow water of Ogasawara (Bonin) Island, Japan. *Journal of Crustacean Biology*, 24(1), 157–167.

Asakura, A. & Tachikawa, H. (2010) *Diogenes holthuisi* a new species of hermit crab (Decapoda Anomura Paguridae) from shallow water of Ogasawara (Bonin) Island, Japan. In: Fransen, C.H.J.M., Ng, P.K.L. & De Grave, S., Studies on Malacostraca: a Homage to Lipke B. Holthuis. *Crustaceana Monographs*, 14, 133–144.

Asakura, A., Tachikawa, H. & Kosuge ,T. (2003). The first record of *Dardanus brachyops* Forest 1962 (Decapoda Anomura Diogenidae) from tropical Japan: a redescription of the male and supplemental information on female morphology. *Tropical Zoology*, 16, 189–207

Ball, E.E. & Haig, J. (1972) Hermit crabs from eastern New Guinea. *Pacific Science*, 26, 87–107.

Balss, H. (1927) Bericht über die Crustacea Decapoda (Natantia und Anomura). Zoological results of the Cambridge expedition to the Suez Canal, 1924. *Transactions of the Zoological Society of London*, 22(2), 221–227.

Bouvier, E.L. (1892) Etude sur les Paguriens recuillis par M. le Dr. Jousseaume sur les cotes de la mer Rouge. *Bulletin de la Société Philomatique de Paris*, (8)4(2), 50–55.

Buitendijk, A.M. (1937) Biological results of the Snellius expedition. IV. The Paguridea of the Snellius Expedition. *Temminckia*, 2, 251–280.

Dana, J.D. (1851) Conspectus crustaceorum quae in orbis terrarum circumnavi gatione, Carolo Wilkes e classe reipublicae foederatae duce, lexit et descripsit. (Preprint from) *Proceedings of the Academy of Natural Sciences of Philadelphia*, 5, 267–272.

Dana, J. D. (1854) Conspectus crustaceorum, etc., Conspectus of the Crustacea of the Exploring Expedition under Capt. Wilkes, U.S.N., including the Paguridea, continued, the Megalopidea, and the Macroura. Paguridea, continued, and subtribe Megalopidea. (Preprint from) *Proceedings of the Academy of Natural Sciences of Philadelphia*, 6, 6–28.

Davie, P.J.F. (2002) Crustacea: Malacostraca: Eucarida (Part 2) Decapoda – Anomura, Brachyura. In: Wellos, A. & Houston, W.W.K. (eds), *Zoological Catalogue of Australia*, 19.3B. CSIRO Publishing, Melbourne, Australia, xiv+641 pp.

Edmondson, C.H. (1952) Additional central Pacific crustaceans. *Occasional Papers of Bernice P. Bishop Museum*, 21, 67–86

Forest, J. (1951) Remarques sur quelques Paguridae du genre *Calcinus* à propos de la description de deux espèces nouvelles de Polynésie orientale: *Calcinus seurati* et *Calcinus spicatus*. *Bulletin de la Société Zoologique de France*, 76, 83–99.

Forest, J. (1952) Contributions a la revision des Crustacés Paguridae. Paguridae. I. Le genre *Trizopagurus*. *Mémoires du Muséum national d'Histoire naturelle*, ser. A, 5: 1–40.

Forest, J. (1953) Crustacés Décapodes marcheurs des îles de Tahiti et des Tuamotu. I. Paguridea. *Bulletin du Muséum national d'Histoire naturelle*, ser. 2, 25(5), 441–450.

Forest, J. (1956) Les Pagures du Viet-Nam. I. Le genre *Diogenes* Dana. *Bulletin du Muséum national d'Histoire naturelle*, ser. 2, 28, 524–532.

Forest, J. (1958) Les Pagures du Viet-Nam. II. Sur quelques espèces du genre *Calcinus* Dana. *Bulletin du Muséum national d'Histoire naturelle*, ser. 2, 30, 184–190, 285–290.

Forest, J. (1962) Sur un *Dardanus* des Hawai et de Madagascar, *D. brachyops* sp. nov. (Crustacea Paguridea Diogenidae). *Bulletin du Muséum national d'Histoire naturelle*, ser. 2, 34, 365–370.

Forest, J. (1984) Révision du genre *Aniculus*. *Crustaceana*, Supplement 8, 1–91.

Forskål, P. (1775) *Descriptiones Animalium, Avium, Amphibiorum, Piscium, Insectorum*, Vermium. Hafniae, 19 + xxxii +164 pp.

Gherardi, F. & McLaughlin, P.A. (1994) Shallow-water hermit crabs (Crustacea: Decapoda; Anomura: Paguridae) from Mauritius and Rodrigues Islands, with description of a new species of *Calcinus*. *Raffles Bulletin of Zoology*, 42(3), 613–656.

Haig, J. & Ball, E.E. (1988) Hermit crabs from northern Australian and eastern Indonesian waters (Crustacea Decapoda: Anomura: Paguroidea) collected during the 1975 Alpha Helix Expedition. *Records of the Australian Museum*, 40, 151–196.

Heller, C. (1865) Crustaceen. *In*: Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Befehlen des Commodors B. von Wüllerstorf-Urbair. *Zoologischer Theil*, 2(3), 1–280, pls. 1–25.

Herbst, J.F.W. (1804) *Versuch einer Naturgeschichte der Krabben und Krebse*. Gottlieb August Lange, Berlin und Stralsund, 3, 1–49.

Hilgendorf, F. (1879) Die von Hrn. W. Peters in Moçambique gesammelten Crustaceen. *Monatsbericht der Königlich Preussichen Akademie der Wis senschaften zu Berlin*, 1878, 782–851.

Kawamoto, T. & Okuno, J. (2003) *Shrimps and Crabs of Kume Island, Okinawa. First Edition*. Hankyu Communications, Tokyo, 173 pp. [in Japanese]

Kawamoto, T. & Okuno, J. (2006) *Shrimps and Crabs of Kume Island, Okinawa. Second Edition*. Hankyu Communications, Tokyo, 174 pp. [in Japanese]

Komai, T. (1999) Hermit crabs of the families Diogenidae and Paguridae (Crustacea; Decapoda: Anomura) collected during the Shin'yo-maru cruise to the Ogasawara Islands and Torishima Island, Oceanic Island in Japan. *Journal of Natural History Museum and Institute, Chiba*, Special Issue 6, 1–66.

Komai, T. (2004) *Calcinus areolatus* Rahayu & Forest, an invalid taxon founded on juvenile or young stages of *Calcinus morgani* Rahayu & Forest (Crustacea; Decapoda: Anomura: Diogenidae). *Biological Magazine*, *Okinawa*, 42, 25–38.

Komai, T. (2006) A new species of *Pagurixus* Melin, 1939 (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, Japan. *Zoosystema*, 28(2), 507–516.

Komai, T (2009a) A new species of the hermit crab genus *Catapaguroides* (Crustacea: Decapoda: Anomura: Paguridae) from shallow water in the Ryukyu Islands, Japan. *Species Diversity*, 14, 197–205.

Komai, T., (2009b). A review of the northwestern Pacific species of the genus *Paguristes* (Decapoda: Anomura: Diogenidae). II. Species transferred to the genus *Stratiotes*, with descriptions of two new species. *Natural History Research*, 10(2), 59–92.

Komai, T. (2010a) New species and new records of the hermit crab genus *Pagurixus* Melin, 1939 (Crustacea: Decapoda: Anomura: Paguridae) from the Indo-West Pacific. *Journal of Natural History*, 44(21–22), 1269–1342.

Komai, T. (2010b) A review of the Northwestern Pacific Species of the genus *Paguristes* (Decapoda: Anomura: Diogenidae). III. Clarification of the identity of a species heretofore referred to *Paguristes balanophilus* Alcock and description of two new species from Japan. *Natural History Research,* 11(1), 9–33.

Komai, T. & Asakura, A. (1995) *Pagurixus nomurai*, new species, and additional record of *Pagurixus maorus* (Nobili, 1906), hermit crabs from Kume-jima Island, the Ryukyus, Japan (Decapoda: Anomura: Paguridae). *Journal of Crustacean Biology*, 15(2), 341–354.

Komai, T & McLaughlin, P.A. (2005) New record and supplemental description of *Alainopaguroides andamanensis* McLaughlin (Decapoda: Anomura: Paguridae) from Japan and Indonesia. *Crustacean Research*, 34, 53–64.

Komai T & Myorin, E. (2005) A new species of *Pagurixus* (Crustacea: Decapoda: Anomura: Paguridae) from Southern Japan. *Zootaxa*, 876, 1–12

Komai, T & Nishi, E. (1996) A new species of *Paguritta* (Crustacea: Decapoda: Anomura: Paguridae) from the Western Pacific, previously confused with *P. harmsi* or *P. gracilipes*. *Raffles Bulletin of Zoology*, 44(2), 461–473.

Komai, T. & Okuno, J. (2001) Revisiting *Paguritta gracilipes* (Crustacea: Decapoda: Anomura: Paguridae), with description of its coloration in life. *Species Diversity*, 6, 295–307.

Komai, T. & Osawa, M. (2001) A new distinctive species of pagurid hermit crab (Crustacea: Decapoda: Anomura) from Japan. *Zoological Science*, 18, 1291–1301.

Komai, T. & Osawa, M. (2004) A new hermit crab species of *Pylopaguropsis* (Crustacea: Decapoda: Anomura: Paguridae) from the Western Pacific, and supplemental note on *P. laevispinosa* McLaughlin & Haig. *Zoological Science*, 21, 93–104.

Komai, T. & Osawa, M. (2005) A new species of *Trichopagurus* de Saint Laurent (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu and Yap islands, and redescription of *T. trichophthalmus* (Forest). *Zootaxa*, 801, 1–20.

Komai, T. & Osawa, M. (2006) A review of *Pagurixus boniensis* species group, with description of six new species (Crustacea: Decapoda: Anomura: Paguridae). *Zootaxa*, 1214, 1–107.

Komai, T. & Osawa, M. (2007) A new species of the hermit crab genus *Pagurixus* (Crustacea: Decapoda: Anomura: Paguridae) from the Indo-West Pacific. *Raffles Bulletin of Zoology*, 55(1), 97–105.

Komai, T. & Osawa, M. (2009) A new hermit crab species of the genus *Catapagurus* (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, southern Japan. *Zootaxa*, 2211, 57–68.

Komai, T & Takada, Y. (2006) A new species of the hermit crab genus *Pagurixus* (Crustacea: Decapoda: Anomura: Paguridae) from shallow coral reefs of Ishigaki Island, Ryukyu Islands. *Species Diversity*, 11, 327–337.

Komai, T., Yamada, Y. & Shirakawa, N. (2010) A new hermit crab species of the genus *Catapaguroides* A. Milne-Edwards & Bouvier (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, Japan, and additional record of *C. foresti* McLaughlin. *Zootaxa*, 2690, 32–42.

Kosuge, T. & Miyake, S. (1992) Record of *Dardanus imbricatus* (H. Milne Edwards, 1848) from Okinawa Island, Southern Japan. *Research on Crustacea*, 21, 121–123.

Krauss, F. (1843) *Die Südafrikanischen Crustaceen*. *Eine Zusammenstellung aller bekannten Malacostraca. Bemerkungen über deren Lebensweise und geo graphische Verbreitung*, *nebst Beschreibung und Abbildung mehrerer neuen Arten.* E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 68 pp.

Lewinsohn, Ch. (1969) Die Anomuren des Roten Meeres (Crustacea Decapoda: Paguridea, Galathidea, Hippidea). *Zoologische Verhandelingen*, 104, 1–213.

Lewinsohn, Ch. (1982a) Researches on the coast of Somalia. The shore and the dune of Sar Uanle. 33. Diogenidae, Paguridae and Coenobitidae (Crustacea Decapoda Paguridea). *Monitore Zoologico Italiano*, new series, Supplement. 16, 33–68.

Lewinsohn, Ch. (1982b). *Aniculus retipes* n. sp. ein neuer Einsiedlerkrebs aus dem Roten Meer (Decapoda, Anomura). *Crustaceana*, 42, 76–82.

Malay, M.C.D., Komai, T. & Chan, T.-Y. (2012) A new cryptic species in the "*Calcinus anani* Poupin & McLaughlin, 1998" species complex (Decapoda: Anomura: Diogenidae): evidence from coloration and molecular genetics. *In*: Naruse, T., Chan, T.-Y., Tan H. H., Ahyong, S. T. & Reimer, J. D. (2012) Scientific Results of the Kumejima Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, xxxx, xxx –xxx.

McLaughlin, P.A. (2002a) *Pseudopaguristes*, a new and aberrant genus of hermit crabs (Anomura: Paguridea: Diogenidae). *Micronesica*, 34, 185–199.

McLaughlin, P.A. (2002b) A review of the hermit crab (Decapoda: Anomura: Paguridae) fauna of southern Thailand, with particular emphasis on the Andaman Sea, and description of three new species. In N. Bruce & Berggman, M. (eds.), Biodiversity of Crustacea in the Andaman Sea – Proceeding of the workshop held at the Phuket Marine Biological Center (PMBC), Phuket, Thailand, 29 November–20 December, 1998. *Phuket Marine Biological Center Research Special Publication*, 23(2), 385–460.

McLaughlin, P.A. (2002c) *Diogenes pallescens* Whitelegge, *D. gardineri* Alcock and *D. serenei* Forest (Decapoda: Anomura: Paguroidea: Diogenidae): Distinct species or morphological variants? *Raffles Bulletin of Zoology*, 50(1), 81–94.

McLaughlin, P.A. (2008) Australian hermit crabs of the genera *Paguristes* Dana, *Stratiotes* Thomson, and *Pseudopaguristes*McLaughlin (Crustacea: Anomura: Paguroidea: Diogenidae). *Records of the Western Australian Museum*, Supplement 73, 185–271.

McLaughlin, P.A. & Clark, P. (1997) A review of the *Diogenes* (Crustacea, Paguridea) hermit crabs collected by Bedford and Lanchester from Singapore, and from the ‘Skeat’ Expedition to the Malay Peninsula, with a description of a new species and notes on *Diogenes intermedius* De Man, 1892. *Bulletin of the Natural History Museum, London (Zoology)*, 63(1), 33–49.

McLaughlin, P.A. & Haig, J. (1996) A redescription of *Diogenes senex* Heller, 1865, sensu stricto (Decapoda: Anomura: Paguridae: Diogenidae). *Pakistan Journal of Marine Science*, 4(2), 115–126.

McLaughlin, P.A. & Rahayu, D.L. (2005) Two new species of *Paguristes* (Decapoda: Anomura: Paguroidea: Diogenidae) and a review of *Paguristes pusillus* Henderson. *Zootaxa*, 1083: 37–62.

McLaughlin, P.A., Rahayu, D.L., Komai, T. & Chan, T.-Y. (2007) *A catalogue of the hermit crabs (Paguroidea) of Taiwan*. National Taiwan Ocean University, Keelung, 365p.

Milne Edwards, H. (1836) Observations zoologiques sur les Pagures et description d’un nouveau genre de la tribu des Paguriens. *Annales des Sciences Naturelle Zoologie*, Paris, ser. 2, 6, 257–288.

Milne Edwards, H. (1848) Note sur quelques nouvelles espèces du genre Pagure. *Annales des Sciences Naturelles Zoologie*, Paris, ser. 3, 10, 59–64.

Minemizu, R. (2000) *Marine Decapod and Stomatopod Crustaceans Mainly from Japan. First Edition*. Bun’ichi Sogo Shuppan, Tokyo, 344 pp. [in Japanese]

Minemizu, R. (2002) *Marine Decapod and Stomatopod Crustaceans Mainly from Japan. Second Edition*. Bun’ichi Sogo Shuppan, Tokyo, 344 pp. [in Japanese]

Morgan, G.J. (1987) Hermit crabs (Decapoda, Anomura: Coenobitidae, Diogenidae, Paguridae) of Darwin and Port Essington, northern Australia. *The Beagle, Records of the Northern Territory Museum of Arts and Sciences*, 4, 165–186.

Morgan, G.J. (1989) The hermit crabs (Decapoda: Anomura: Diogenidae, Paguridae) of southwestern Australia, with descriptions of two new species. *Records of the Western Australian Museum*, 14, 391–417.

Morgan, G.J. (1990) A collection of Thalassinidea, Anomura and Brachyura (Crustacea: Decapoda) from the Kimberley region of northwestern Australia. *Zoologische Verhandelingen*, 265, 1–90.

Morgan, G.J. (1992) The hermit crabs (Crustacea: Decapoda: Coenobitidae, Diogenidae, Paguridae) of Christmas and Cocos (Keeling) Islands, Indian Ocean, with description of a new species of *Paguristes*. *Raffles Bulletin of Zoology*, 49, 163–174.

Morgan, G.J. & J. Forest, 1991. Seven new species of hermit crabs from northern and western Australia (Decapoda, Anomura, Diogenidae). *Bulletin du Muséum national d’Histoire naturelle*, ser. 4, sec. A, 12, 649–689.

Nakasone, Y. (1975) Two rare hermit crabs from Okinawa. *Biological Magazine, Okinawa*, 13, 1–6.

Nobili, G. (1906a) Crustacés Décapodes et Stomatopodes. *In*: Mission J. Bonnier et Ch. Pérez (Golfe Persique, 1901). *Bulletin Scientifique de la France et de la Belgique*, 40, 13–159

Nobili, G (1906b) faune Carcinologique de la Mer Rouge. Décapodes et Stomatopodes. *Annales des Sciences naturelles, Zoologie*, Paris, ser. 9, 4, 1–347.

Olivier, A.G. (1811–1812) Histoire Naturelle. Insectes. *In*: *Encyclopédie Méthodique (Dictionnaire Encyclopédique Méthodique)*. Liège, Paris, vol. 8, 722 pp.

Okuno, J. & Arima, H. (2004) An annotated checklist of inshore hermit crabs (Crustacea, Decapoda, Anomura) of Izu-Ohshima Island, the nortern Izu Islands, Japan. *Bulletin of the Biogeographical Society of Japan*, 59, 49–69.

Ortmann, A.E. (1892) Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen. IV. Die Abtheilungen Galatheidea und Paguridea. *Zoologische Jahrbücher*, Abteilung für Systematik, Geographie und Biologie der Thiere, 6, 241–326.

Osawa, M. & Fujita, Y. (2006) *Clibanarius ambonensis* (Crustacea: Decapoda: Anomura: Diogenidae) from the Ryukyu Island, southwestern Japan. *Marine Biodiversity Records*, 1, e16 [8 pp.].

Osawa, M. & Fujita, Y. (2008) Two new species of *Turleania* McLaughlin, 1997 (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, southwestern Japan, and a redescription of *T. balli* (McLaughlin & Haig, 1996). *Zootaxa*, 1753, 49–68.

Osawa, M., Fujita, Y. & Okuno, J. (2006) Two new species of *Pagurixus* (Crustacea: Decapoda: Anomura: Paguridae) from submarine caves of the Ryukyu Islands, southwestern Japan. *Zootaxa*, 1148, 27–45.

Osawa, M. & Komai, T. (2007) A new hermit crab species of the *Pagurixus anceps* group (Crustacea: Decapoda:Anomura: Paguridae) from southern Japan, and supplemental notes on *P. patiae* Komai, 2006. *Zootaxa*, 1627, 41–51.

Osawa, M. & Okuno, J. (2003) A new genus and new species of the family Paguridae (Crustacea: Decapoda: Anomura), from Hachijo-jima Island, Japan, with a list of hermit crabs species found in the same collection sites. *Proceedings of Biological Society of Washington*, 116(4), 943–955.

Osawa, M. & Okuno, J. (2007) A new species of the genus *Pylopaguropsis* (Crustacea: Decapoda: Anomura: Paguridae) from the Ryukyu Islands, Southwestern Japan, with notes on two poorly known pagurids. *Species Diversity*, 12, 29–46.

Osawa, M. & Takeda, M. (2004) Hermit crabs (Crustacea: Decapoda: Anomura: paguroidea) from submarine caves in the Ryukyu Islands, south-western Japan. *Journal of Natural History*, 38, 1097–1132.

Poupin, J. (1996) *Atlas des Crustacés Marins Profonds de Polynésie Française Récoltes du Navire MARARA (1986/1996)*. Service Mixtes de Surveillance Radiologique et Biologique de l'Homme et de l'environnement, SMSRB, Montlhéry, 59pp.

Poupin, J. & McLaughlin, P. (1998) Additional records of *Calcinus* (Decapoda, Anomura, Diogenidae) from French Polynesia with description of three new species and a key to Indo-West Pacific species. *Crustacean Research*, 27, 9–27.

Rahayu, D. L. (1994) Hermit crabs (Crustacea: Decapoda: Diogenidae, Paguridae) of Kotania Bay, Seram Island, Maluku, Indonesia. *Perairan Maluku dan Sekitarnya*, 7, 73–90.

Rahayu, D.L. (1996) Notes on littoral hermit crabs (excluding Coenobitidae) (Crustacea: Decapoda: Anomura) mainly from Singapore and peninsular Malaysia. *Raffles Bulletin of Zoology*, 44, 335–355.

Rahayu, D.L. (2000) Hermit crabs from the South China Sea (Crustacea: Decapoda: Anomura: Diogenidae, Paguridae, Parapaguridae). *Raffles Bulletin of Zoology*, Supplement 8, 377–404.

Rahayu, D.L. (2005) Additions to the Indonesian fauna of the hermit crab genus *Pseudopaguristes* McLaughlin and a further division of the genus *Paguristes* Dana (Crustacea: Decapoda: Paguroidea: Diogenidae). *Zootaxa*, 831, 1–42.

Rahayu, D.L. & Forest, J. (1995) Le genre *Diogenes* (Decapoda, Anomura, Diogenidae) en Indonésie, avec la description de six espèces nouvelles. *Bulletin du Muséum national d'Histoire naturelle*, Paris, ser. 4, sec. A, 16, 383–415.

Rahayu, D.L. & Forest, J. (1999) Sur le statut de *Calcinus gaimardii* (H. Milne Edwards, 1848) (Decapoda, Anomura, Diogenidae) et description de deux espèces nouvelles apparentées. *Zoosystema*, 21, 461–472.

Rahayu, D.L. & Forest, J (2009) Le genre *Paguristes* Dana aux Philippines avec la description de deux nouvelles especes (Decapoda, Anomura, Diogenidae). *Crustaceana*, 82(10), 1307–1338.

Rahayu, D.L. & Hortle, K.G. (2002) The genus *Diogenes* (Decapoda, Anomura, Diogenidae) from Irian Jaya, Indonesia with description of a new species. *Crustaceana*, 75 (3–4), 609–619.

Rahayu, D.L. & Komai, T. (2000) Shallow-water hermit crabs (Crustacea: Decapoda: Anomura: Diogenidae and Paguridae) of Phuket, Thailand. *Phuket Marine Biological Center Research Bulletin*, 63, 21–40.

Randall, J.W. (1840) Catalogue of the Crustacea brought by Thomas Nuttall and J.K. Townsend, from the west coast of North America and the Sandwich Islands, with descriptions of such species as are apparently new, among which are included several species of different localities, previously existing in the collection of the Academy. *Journal of the Academy of Natural Sciences of Philadelphia*, 8, 106–147.

Whitelegge, T. (1897) The fauna of Funafuti [6] The Crustacea. *Australian Museum Memoirs*, 3, 7–151.

Wooster, D.S. (1984) The genus *Calcinus* (Paguridea, Diogenidae) from the Mariana Islands including three new species. *Micronesica*, 18, 121–162.

Zootaxa 3367: 191–203 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

The first zoeal stage morphology of *Crossotonotus spinipes* (De Man, 1888) and *Pseudopalicus serripes* (Alcock & Anderson, 1895), with implications for palicoid systematics (Crustacea: Brachyura: Palicoidea)*

PAUL F. CLARK[1], YOSHIHISA FUJITA[2], ALEXANDER D. BALL[3] & PETER K. L. NG[4]

[1]*Department of Zoology, The Natural History Museum, Cromwell Road, London SW7 5BD, England*
[2]*University Education Center, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan*
[2]*Marine Learning Center, 2-95-101 Miyagi, Chatan-cho, Okinawa 904-0113, Japan*
[3]*Department of Mineralogy, The Natural History Museum, Cromwell Road, London SW7 5BD, England*
[4]*Tropical Marine Science Institute and Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260, Republic of Singapore*
[1]*Corressponding author. E-mail p.clark@nhm.ac.uk*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Traditionally, *Crossotonotus spinipes* (De Man, 1888) and *Pseudopalicus serripes* (Alcock & Anderson, 1895) were assigned to the Crossotonotinae Moosa & Serène, 1981, and Palicinae Bouvier, 1898, respectively. However, Ng *et al.* (2008: 127) listed a number of major adult characters that suggested both subfamilies should be recognised as distinct families within the Palicoidea Bouvier, 1898 (see also Castro 2010, 2011; Guinot *et al.* in prep.). Recently, ovigerous specimens of *C. spinipes* and *P. serripes* were collected from Okinawajima and Kumejima, central Ryukyu Islands, Japan. The first zoeal stages of both species were hatched in the laboratory, dissected, examined, and the appendages illustrated and described. *Crossotonotus spinipes* first stage zoeas were distinguished by three characters: the absence of lateral carapace spines (present in *P. serripes*), abdominal somite 4 with a pair of dorsolateral processes directed ventrally (absent in *P. serripes*) and the presence of a small lateral spine on the telson (absent in *P. serripes*). These distinguishing features appear to support the recent division of the Palicoidea into two families.

Introduction

In the detailed taxonomic revision of the family Palicidae Bouvier, 1898, by Castro (2000), the morphological differences between the two subfamilies he recognised, Palicinae Bouvier, 1898, and Crossotonotinae Moosa & Serène, 1981, are significant. Most notably, while the last ambulatory leg (pereiopod 5) of palicines are strongly reduced and look almost vesitigial, while those of crossotonotines are normal in structure except they are relatively smaller than the other legs. In fact, crossotonotines had been classified with or near majoids, corystids, ocypodids and plagusiids by various authors (see Castro 2000: 569, for review). In their synthesis of global Brachyura, Ng *et al.* (2008: 127) commented that in addition to the characters discussed by Castro (2000) (see Table 1), a detailed unpublished study of the two subfamilies by Guinot *et al.* (in prep.) also revealed major differences, among others, in the morphologies of the thoracic sternum, abdomen, penis and gonopods. To this effect, they proposed that both subfamilies should be recognised as distinct families in the superfamily Palicoidea Bouvier, 1898 (see also Castro 2010, 2011). Unpublished molecular evidence (J. Lai *et al.*) confirms that both families are sister taxa, which split off early in their evolution, not unlike the two families now in the related Dorippoidea MacLeay, 1838 (see Sin *et al.* 2009).

First stage zoeas of species assigned to the Palicidae and Crossotonotidae have been hatched in the laboratory. The purpose of the present is to describe palicoid zoeas for the first time and compare their zoeal morphology to review if larvae characters support the establishment of two families within the Palicoidea.

Accepted by T. Naruse: 28 Sep. 2011; published: 4 Jul. 2012

TABLE 1. Major morphological differences between Palicidae and Crossotonotidae

Character	Palicidae	Crossotonotidae
Lateral margins of carapace	only anterolateral margin armed with teeth, low spines or prominent tubercles	both antero- and posterolateral margins armed with teeth, low spines and tubercles
Dorsal surface of carapace	distinctly convex	gently convex to almost flat (except for some raised parts of regions)
Epistome	dorso-ventrally broadened	narrow, not dorso-ventrally broadened
Fifth pereiopod	prominently reduced, articles very slender; structurally different from other pereiopods 2–4, attached to coxa subdorsally, above level of other ambulatory legs	smaller than but structurally similar to pereiopods 2–4, not slender; attached to coxa on same level as other ambulatory legs
Thoracic episternite 7	usually overhanging posterolateral carapace margin posterior to base of fifth pereiopod	never overhangs posterolateral carapace margin posterior to base of fifth pereiopod
Male and female abdomens	somites 1 and 2 dorso-ventrally compressed, very narrow compared to remaining somites; some somites may be fused to varying degrees	somites 1 and 2 relatively wide, not dorso-ventrally compressed, only slightly more narrow than other somites; all somites always free

The material examined was deposited in the Ryukyu University Museum, Fujukan, Okinawa, Japan (RUMF). Abbreviations used: coll. = collected; reg. no. = registration number; RUMF = Ryukyu University Museum, Fujukan, Okinawa, Japan.

Material and Methods

Adult and zoeal material. *Crossotonotus spinipes*, Maeda-Misaki, Okinawajima, Ryukyu Islands, Japan, SCUBA, night, 8 m, coll. by Y. Fujita, 31 July 2004, hatched 22 August 2004, 7 first stage zoeas dissected and examined, spent female and remaining zoeas reg. no. RUMF-ZC-1516.

Pseudopalicus serripes Dredge 43, off Kumejima, Ryukyu Islands, Japan, 26°19.605´N 126°45.633´E – 26°19.445´N 126°45.493´E, 24.6–35.4 m, 14 November 2009, hatched 17 November 2009, 9 first stage zoeas dissected and examined, spent female and remaining zoeas reg. no. RUMF-ZC-1517.

Preparation of zoea appendages. Tungsten wire (0.2 mm or 0.36 mm gauge) sharpened by electrolysis in potassium hydroxide and inserted into an aluminium alloy needle holder with a brass chuck to grip the pointed needle were use to separate zoeal appendages. The first stage zoeas were dissected on glass slides in polyvinyl lactophenol (Gray & Weiss 1950) under a Leica MZ 16 binocular microscope and the appendages allowed to clear for 24 hours before examination. Coverslips were sealed with clear nail varnish. Appendages were drawn using a Leica DMR HC microscope with with differential interference contrast (DIC) and a *camera lucida*. The sequence of zoeal descriptions was based on the malacostracan somite plan and described from anterior to posterior. Setal armature of appendages was described from proximal to distal segments and in order of endopod to exopod (see Clark *et al.* 1998). The first stage zoeas were described and fully illustrated, except for the mandible, because the only significant character of this appendage is the appearance of the palp in the zoeal phase and it is not present in the stage examined in the present study. The long antennular aesthetascs and the long plumose natatory setae of the first and second maxillipeds were drawn truncated.

Zoeal description. The first stage zoea of *C. spinipes* was described and illustrated in full, while only the characters that differed for *P. serripes* were portrayed. However, the reticulated and setosed carapace for both species was difficult to illustrate as a line drawing, consequently, in order to present details of these characters, the first stage zoea was examined with a confocal (Fig. 7) and scanning microscope (Figs. 8, 9).

Confocal microscopy. The zoeal carapace was mounted in polyvinyl lactophenol as set in a cavity slide and was naturally fluorescent under appropriate illumination conditions. In this case, samples were placed in a cavity slide and examined with a Leica TCS SP1 confocal microscope using an argon laser at a wavelength of 488nm to excite fluorescence which was detected at 510–580nm using a Reflection Short Pass beam splitter to separate the emission spectrum from the laser's excitation wavelength. A 10× objective lens was used to collect images that were composed of a series 289 of slices, each collected at a different focal plane. The images were then processed to produce a single maximum intensity profile image where the brightest pixel along the z axis at any x, y co-ordinate was used to form the final image (Fig. 7).

Scanning electron microscopy. Samples for scanning electron microscopy were dehydrated through a graded ethanol series and the critical point dried using a Balzers CPD30 critical point dryer. The samples were then mounted on 12mm pin stubs using Araldite and coated with 20nm gold palladium using a Cressington 208HR sputter coater. The specimens were examined using a Zeiss Ultra Plus field-emission SEM at 3kV (Figs. 8, 9).

Image manipulation declaration. The SEM images were converted to greyscale and their brightness and contrast levels were adjusted. The SEMs data bar has been cropped from the lower portion of the image. No other image manipulations were performed.

The confocal microscope image is a composite of 289 focal slices. This single image is derived from the brightest pixel along the z plane at any x, y coordinate (Maximum Intensity Projection). Brightness and contrast level correction was performed and the image is slightly cropped to remove an outer dashed outline characteristic of the Leica image capture software. No other image manipulations were performed.

Original images are available for comparison.

Description of first stage zoeas

Crossotonotus spinipes (De Man, 1888)

(Figs. 1, 3a–c, 4, 5, 7)

Carapace (Fig. 1a–c): reticular pattern, densely setosed; dorsal spine relatively short; rostral spine minute; lateral spines absent; 1 pair of posterodorsal setae; ventral margin with 1 pulmose anterior seta; eyes sessile.

Antennule (Fig. 1d): uniramous, endopod absent; exopod unsegmented with 3 (2 broad, 1 slender) terminal aesthetascs plus 2 terminal setae.

Antenna (Fig. 1e): protopodal process distally bilaterally spinulate, approximately equal to rostral; endopod spine present; exopod absent.

Mandible: palp absent.

Maxillule (Fig. 3a): epipod seta absent; coxal endite with 7 setae; basial endite with 5 setal processes and 2 small setal buds; endopod 2-segmented, proximal segment with 1 seta; distal segment with 6 (2 subterminal, 4 terminal) setae; exopod seta absent.

Maxilla (Fig. 3b): coxal endite bilobed with 5+3 setae; basial endite bilobed with 5+4 setae; endopod not bilobed, with 8 (3 subterminal, 5 terminal) setae; exopod (scaphognathite) margin with 4 setae and 1 long stout distal process.

First maxilliped (Fig. 4a): coxa without setae; basis with 9 setae arranged 2,2,2,3; endopod 5-segmented with 3,2,1,2,5 (1 subterminal, 4 terminal) setae respectively; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Second maxilliped (Fig. 4b): coxa without setae; basis with 4 setae arranged 1,1,1,1; endopod 3-segmented, with 1,1,5 (3 subterminal, 2 terminal) setae respectively; exopod 2-segmented, distal segment with 4 long terminal plumose natatory setae.

Third maxilliped (Fig. 4c): biramous.

Pereiopods (Fig. 4d): present, chela bilobed.

Abdomen (Fig. 5a, b): 5 somites; somite 2 with 1 pair of dorsolateral processes directed anteriorly; somites 3 and 4 with 1 pair of dorsolateral processes directed ventrally; somites 1 and 2 each with rounded posterolateral processes; somites 3–5 each with progressively longer posterolateral spinous processes towards posterior; somite 1 without setae; somites 2–5 each with 1 pair of posterodorsal setae; pleopod buds absent.

Telson (Figs. 3c, 5a, b): each fork relatively reduced in length, with 1 small lateral spine with a small spine; posterior margin with 3 pairs of stout spinulate setae and ventral medial protuberance.

Pseudopalicus serripes **(Alcock & Anderson, 1895)**

(Figs. 2, 3d, 6, 8, 9)

Carapace (Fig. 2a, b, 8, 9): lateral spines present.

Abdomen (Fig. 6a, b): somites 4 without 1 pair of dorsolateral processes directed ventrally.

Telson (Figs. 3d, 6a, b): 1 small lateral spine without small spine.

Discussion

The reticulated and setose zoeal carapaces for both species were difficult to illustrate as a line drawing. Consequently, in order to present details of these characters, the first stage zoea of *Crossotonotus spinipes* was examined with a confocal microscope (Fig. 7). However, this was not a success and the setose nature of the first stage zoea was only visible as a haze around the carapace. Internal structures such as the ommatidia of the compound eye and the presence of the internal musculature for the mandibles tended to mask out the external structure of the carapace. Furthermore, the series of 289 slices, each collected at a different focal plane, may not have sufficient to detail the small carapace setae. Therefore a scanning electron microscope was used to present the dense setation and reticulations of the zoeal carapace (Figs. 8, 9).

The first stage palicoid zoeas described hatched in an advanced stage of development for two characters with the following being described as present, a biramous third maxilliped and pereiopods with a bilobed chela (see Clark 2001, 2005, 2009; Clark & Ng 2004a, b).

Three characters appear to distinguish the first zoeae of *Crossotonotus spinipes* (De Man, 1888) (Crossotonotidae) from *Pseudopalicus serripes* (Alcock & Anderson, 1895) (Palicidae): the absence of lateral carapace spines (Fig. 1a, b) (present in *P. serripes*; Fig. 2a, b), the abdominal somite 4 possessing a pair of dorsolateral processes (Fig. 5a, b) which are directed ventrally (absent in *P. serripes*; Fig. 6a, b), and the presence of a small spine (Fig. 3c) on the lateral spine of the telson (vs. absent in *P. serripes*; Fig. 3d). Although more zoeas from other palicoid species will need to be examined to test these characters, the larval morphology does appear to support the recognition of two families, Palicidae Bouvier, 1898, and Crossotonotidae Moosa & Serène, 1981, within the Palicoidea.

Acknowledgements

We would like to thank Pedro Castro and second reviewer for commenting upon our manuscript. The material of *Pseudopalicus serripes* was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition was operated under a permit granted to Tohru Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. The first author acknowledges supporting funds from the Center of Excellence for Marine Bioenviroment and Biotechnology, National Taiwan Ocean University, Keelung; the Faculty of Science, National University of Singapore and the Departmental Investment Fund, Department of Zoology, Natural History Museum, and logistical help from British Airways.

References

Alcock, A. & Anderson, A.R.S. (1895) Natural history notes from H.M. Indian marine survey steamer 'Investigator'. Commander C.F. Oldham, R.N., commanding. Ser. II. No. 17. List of the shore and shallow water Brachyura collected during the season 1873–1894. *Journal of the Asiatic Society of Bengal*, Calcutta, 63(2, No. 4[1894]), 197–209.

Bouvier, E.-L. (1898) Observations on the crabs of the family Dorippidae. *Annals and Magazine of Natural History*, (7)1, 103–105.

Castro, P. (2000) Crustacea Decapoda: A revision of the Indo-west Pacific species of palicid crabs (Brachyura Palicidae). *In*:

Crosnier, A. (Ed.), Résultats des Campagnes MUSORSTOM, Volume 21, *Mémoires du Muséum national d'Histoire naturelle*, Paris, 184, 437–610.

Castro, P. (2010) A new species and new records of palicoid crabs (Crustacea, Decapoda, Brachyura, Palicoidea, Palicidae, Crossotonotidae) from the Indo-West Pacific region. *Zoosystema*, 32(1), 73–86.

Castro, P. (2011) Catalog of the anomuran and brachyuran crabs (Crustacea: Decapoda: Anomura, Brachyura) of the Hawaiian Islands. *Zootaxa*, 2947, 1–154.

Clark, P.F. (2001) Interpreting patterns in chaetotaxy and segmentation associated with abbreviated brachyuran zoeal development. *Invertebrate Reproduction and Development*, [2000], 38(3), 171–181, figs. 1–13.

Clark, P.F. (2005) The evolutionary significance of heterochrony in the abbreviated zoeal development of pilumnine crabs (Crustacea: Brachyura: Xanthoidea). *Zoological Journal of the Linnean Society*, 143, 417–446, figs. 1–18, tabs. 1–24.

Clark, P.F. (2009) The bearing of larval morphology on brachyuran phylogeny. *In*: Martin, J.W., Crandall, K.A., Darryl, F.L., (Eds.), *Decapod Crustacean Phylogenetics*, Crustaceans Issues CRC/Taylor & Francis ISBN: 9781420092588.

Clark, P.F., Calazans, D.K. & Pohle, G.W. (1998). Accuracy and standardization of brachyuran larval descriptions. *Invertebrate Reproduction and Development*, 33,127–144.

Clark, P.F., Harrison, K. & Goodman, S.L. (1990) Brock's Indian Archipelago Decapoda and Stomatopoda by De Man: 1887 or 1888? *Archives of Natural History*, London, 17(1), 79–80.

Clark P.F. & Ng, P.K L. (2004aa) Two zoeal stages and the megalop of *Pilumnus sluiteri* De Man, 1892 [Crustacea: Brachyura: Xanthoidea: Pilumnidae] described from laboratory reared material. *Invertebrate Reproduction and Development*, 4 (3), 205–219, figs. 1–17, tabs. 1–5.

Clark, P.F. & Ng, P.K.L. (2004b) The larval development of *Actumnus setifer* (de Haan, 1835) (Brachyura: Xanthoidea: Pilumnidae) described from laboratory reared material. *Crustacean Research*, 33, 27–50, figs. 1–17, tabs. 1–3.

Gray, P. & Weiss, G. (1950) The use of polyvinyl alcohol and its derivatives as microscopical mounting media. Part I. Water miscible mounting media. *Microscopical Society*, Series III, 20, 3, 287–291.

Guinot, D., Tavares, M. & Castro, P. (in preparation) Sexual openings of brachyuran crabs and complementary characters: implications and new insights (Crustacea Decapoda Brachyura).

MacLeay, W.S. (1838) *On the Brachyurous Decapod Crustacea. Brought from the Cape by Dr. Smith. In Smith, A., Illustrations of the Zoology of South Africa; consisting chiefly of figures and descriptions of the objects of natural history collected during an expedition into the interior of South Africa, in the years 1834, 1835, and 1836; fitted out by 'The Cape of Good Hope Association for Exploring Central Africa': together with a summary of African Zoology, and an inquiry into the geographical ranges of species in that quarter of the globe, published under the Authority of the Lords Commissioners of Her Majesty's Treasury, Invertebratae*. IV [1849]. pp. 53–71, pls. 2, 3. Smith, Elder & Co., London.

Man, J.G. de (1888) Bericht über die im indischen Archipel von Dr. J. Brock gesammelten Decapoden und Stomatopoden. *Archiv für Naturgeschichte, Berlin*, 53(I. Band 3 Heft.), 289–600, Taf. XI–XXIIa [1888]. [For dates of publication see Clark *et al.* 1990].

Moosa, M.K. & Serène, R. (1981) Observations on the Indo-West-Pacific Palicidae (Crustacea: Decapoda) with descriptions of two new subfamilies, four new genera and six new species. *Marine Research in Indonesia*, (22), 21–66, pls. 1–3.

Ng, P.K.L., Guinot, D. & Davie, P.J.F. (2008) Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology*, Supplement 17, 1–286.

Sin, Y.W., Lai, J.C.Y., Ng, P.K.L. & Chu, K.H. (2009) Phylogeny of Dorippoidea (Crustacea: Decapoda: Brachyura) inferred from three mitochondrial genes. *Invertebrate Systematics*, 23, 223–230.

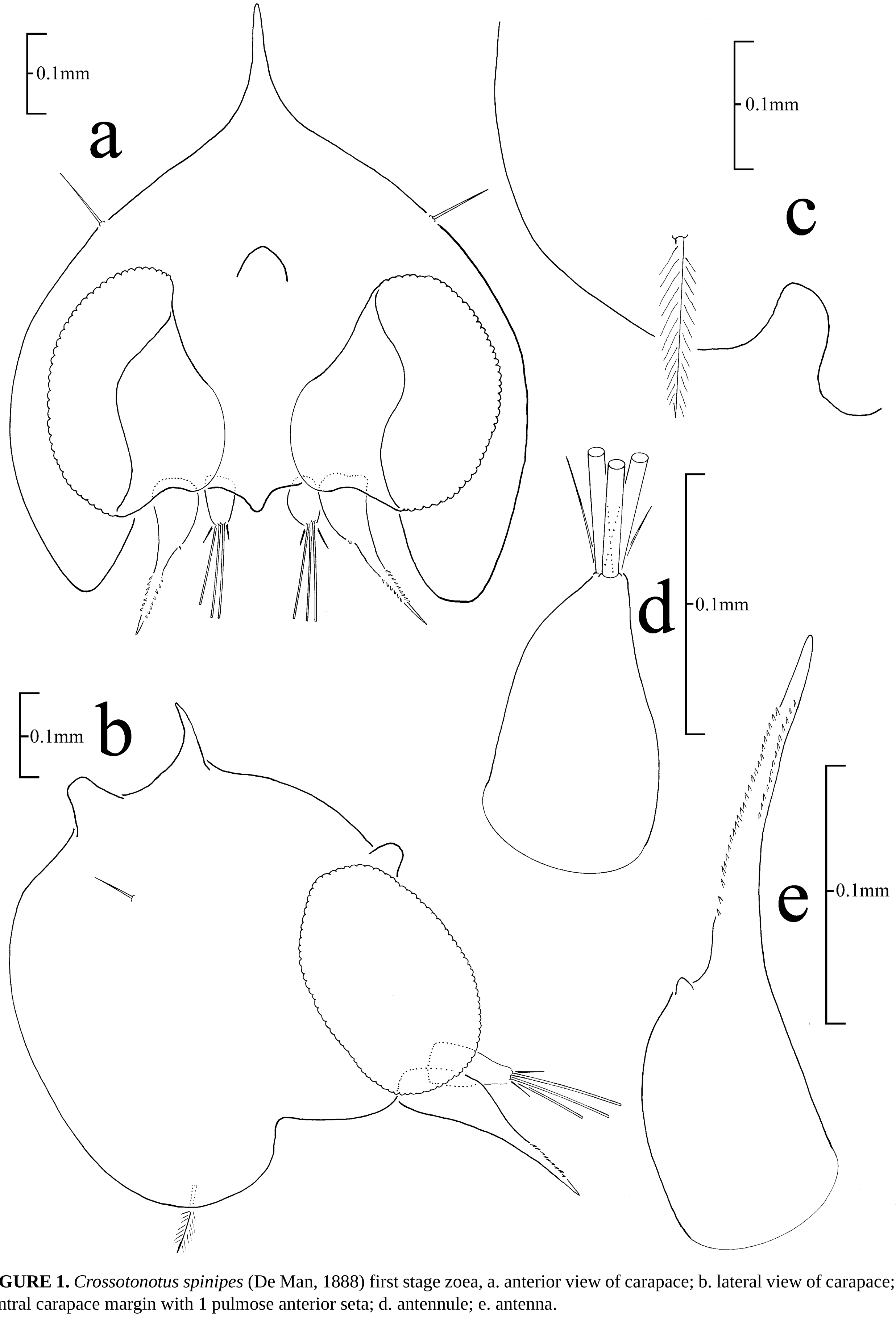


FIGURE 1. *Crossotonotus spinipes* (De Man, 1888) first stage zoea, a. anterior view of carapace; b. lateral view of carapace; c. ventral carapace margin with 1 pulmose anterior seta; d. antennule; e. antenna.

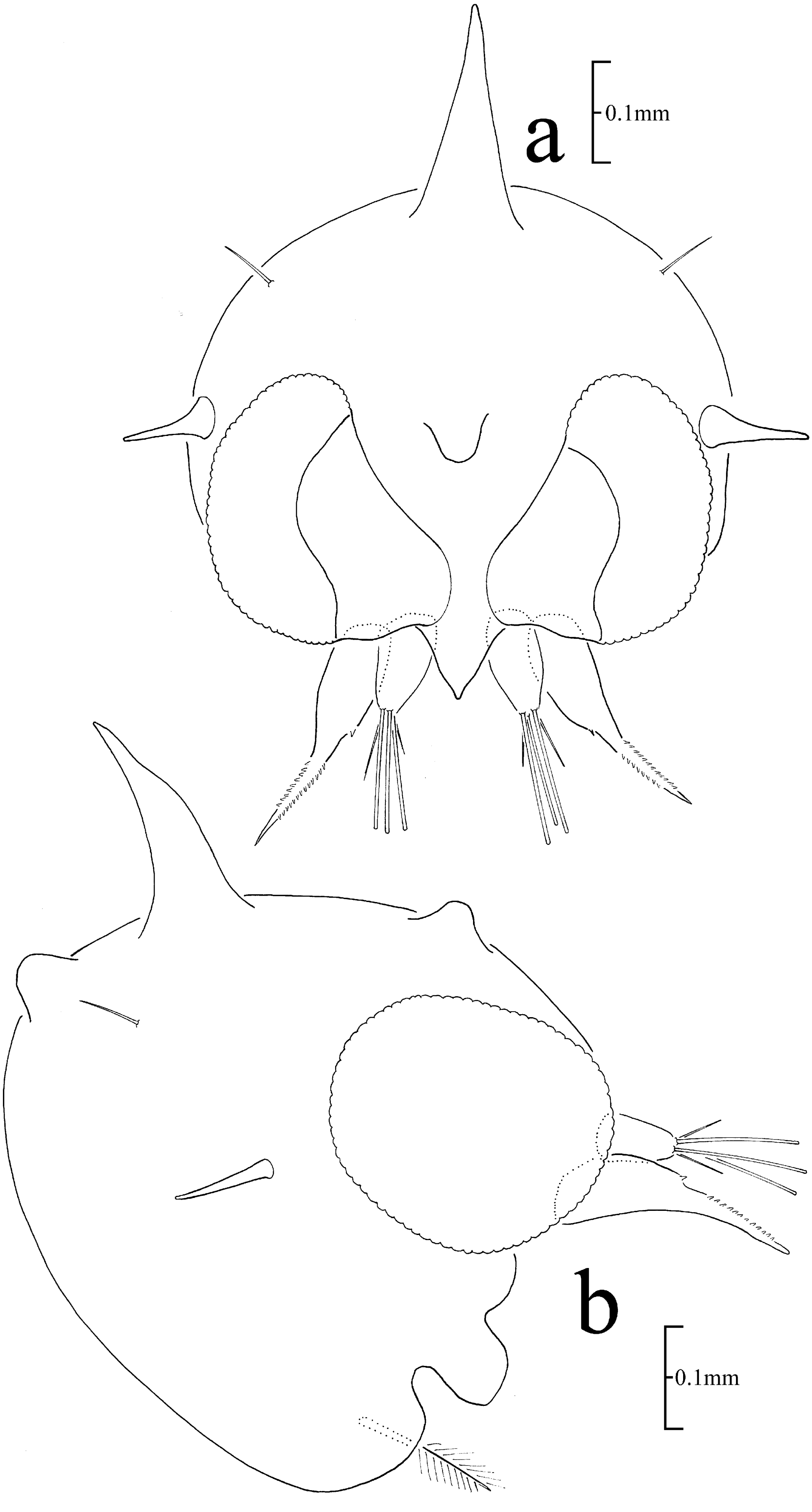


FIGURE 2. *Pseudopalicus serripes* (Alcock & Anderson, 1895) first stage zoea, a. anterior view of carapace; b. lateral view of carapace.

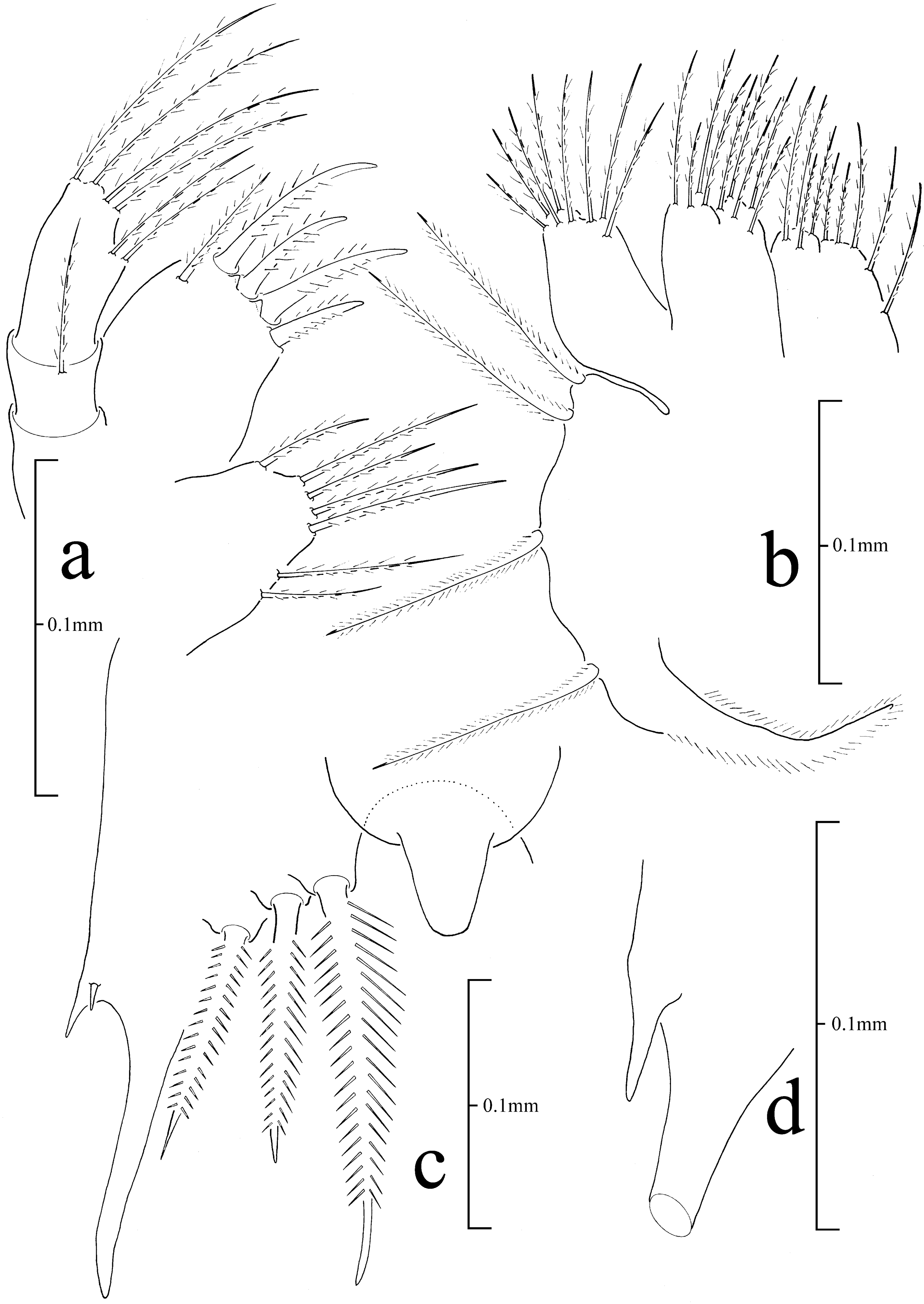


FIGURE 3. *Crossotonotus spinipes* (De Man, 1888) first stage zoea, a. maxillule; b. maxilla; c. telson; *Pseudopalicus serripes* (Alcock and Anderson, 1895) first stage zoea, d. telson.

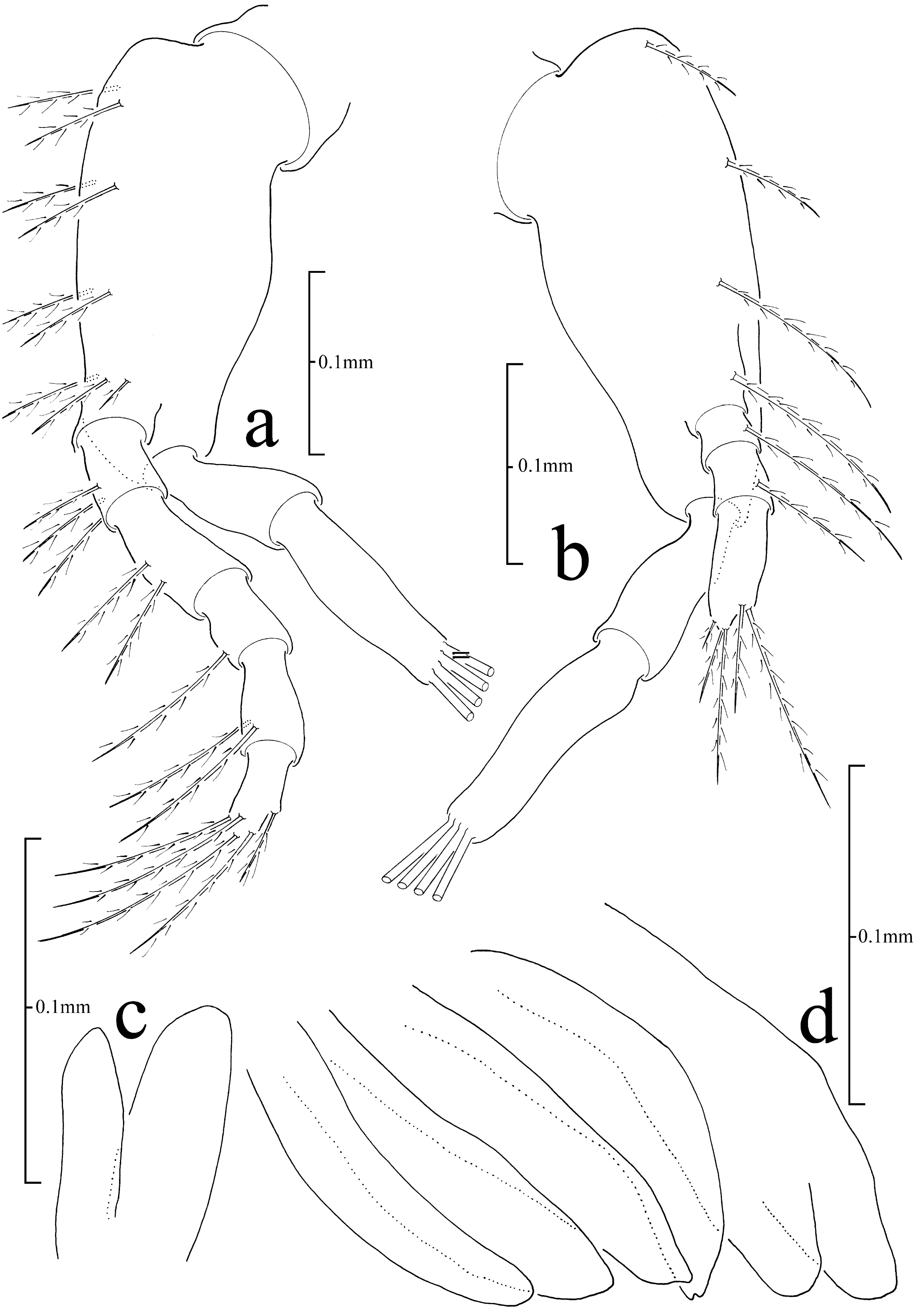


FIGURE 4. *Crossotonotus spinipes* (De Man, 1888) first stage zoea, a. first maxilliped; b. second maxilliped; c. third maxilliped; d. pereiopods.

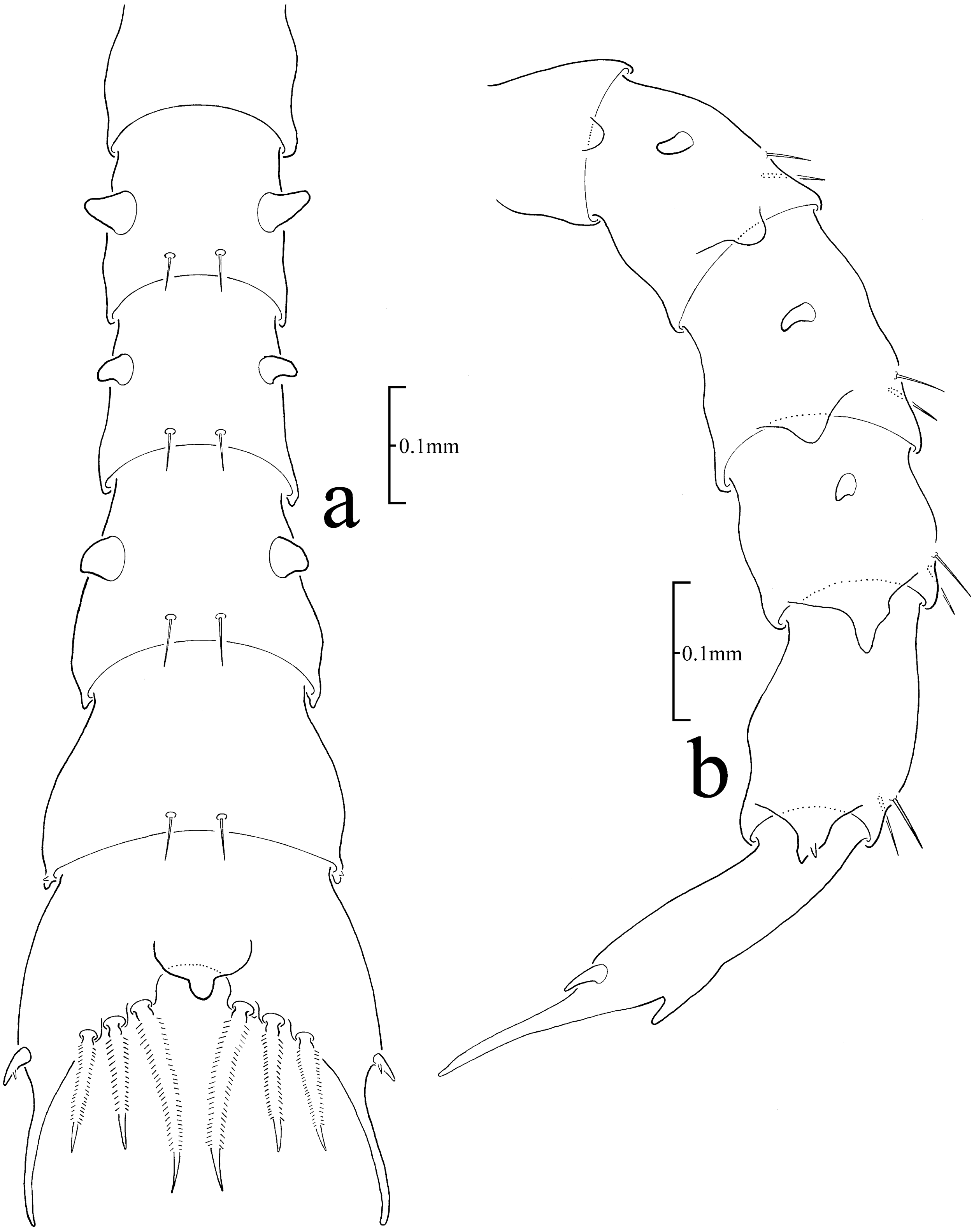


FIGURE 5. *Crossotonotus spinipes* (De Man, 1888) first stage zoea, a. dorsal view of abdomen; b. lateral view of abdomen.

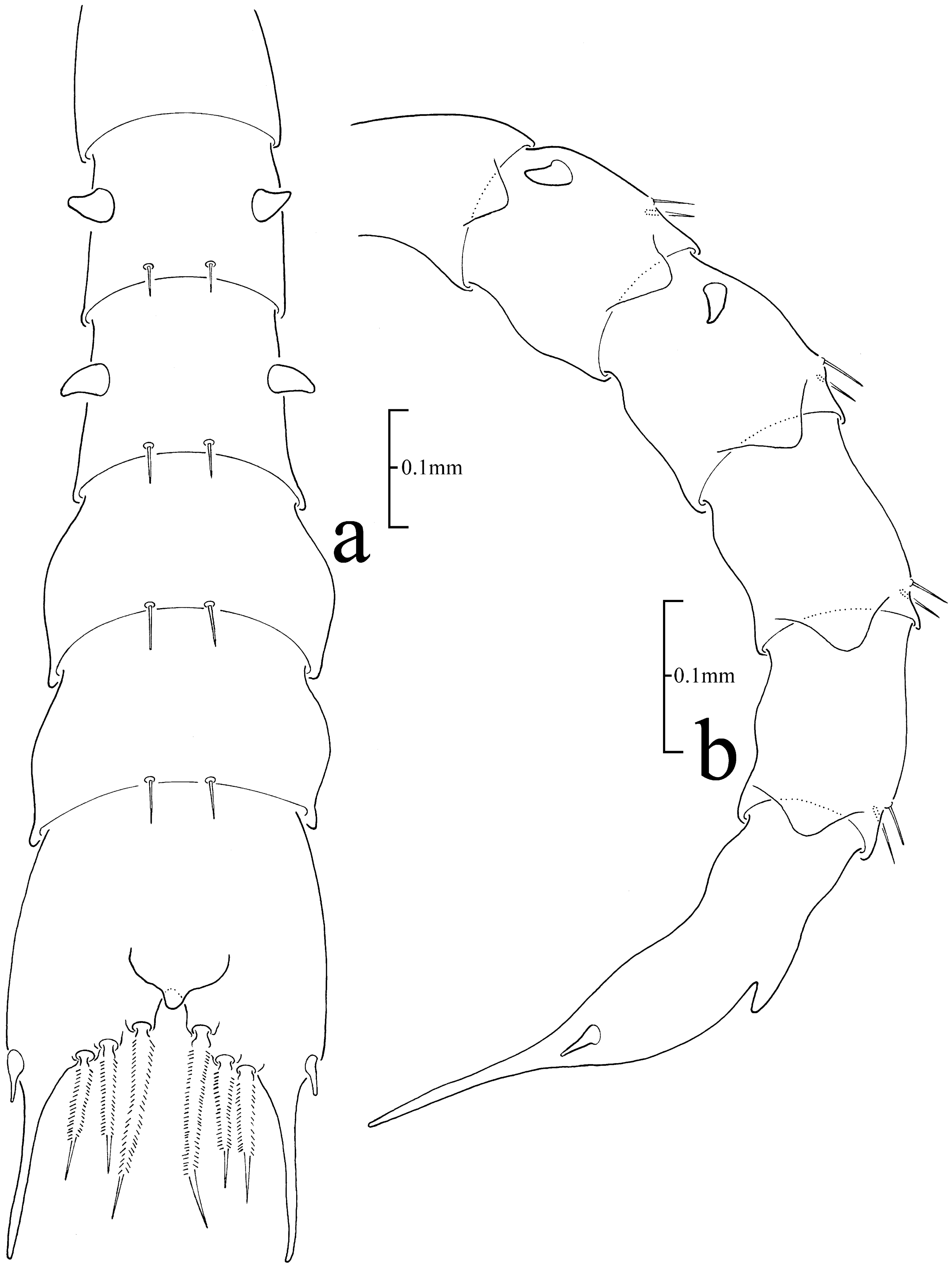


FIGURE 6. *Pseudopalicus serripes* (Alcock & Anderson, 1895) first stage zoea, a. dorsal view of abdomen; b. lateral view of abdomen.

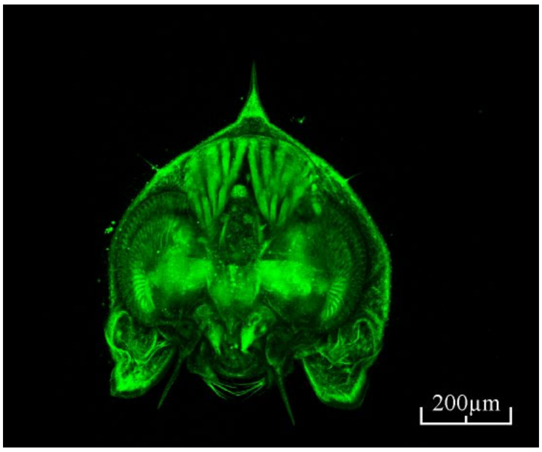


FIGURE 7. Confocal image of *Crossotonotus spinipes* (De Man, 1888), first stage zoea: note the ommatidia of the compound eye, the presence of the internal musculature for the mandibles, the paired posterodorsal carapace setae and the haze around the carapace representing its dense setation and absence of the lateral carapace spines.

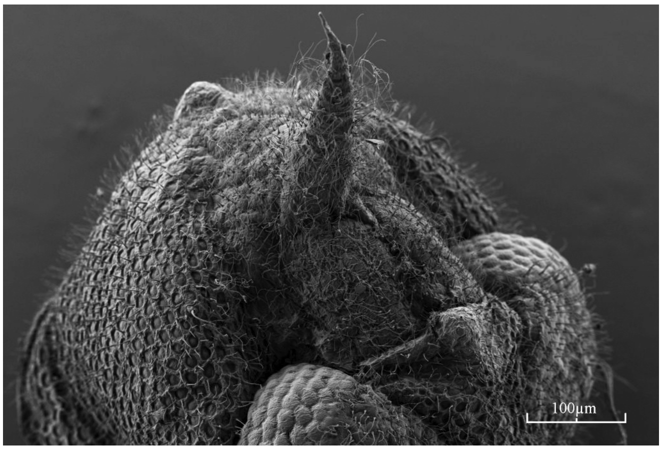


FIGURE 8. *Pseudopalicus serripes* (Alcock & Anderson, 1895) first stage zoea: scanning electron micrograph showing the dense setose carapace with reticulations.

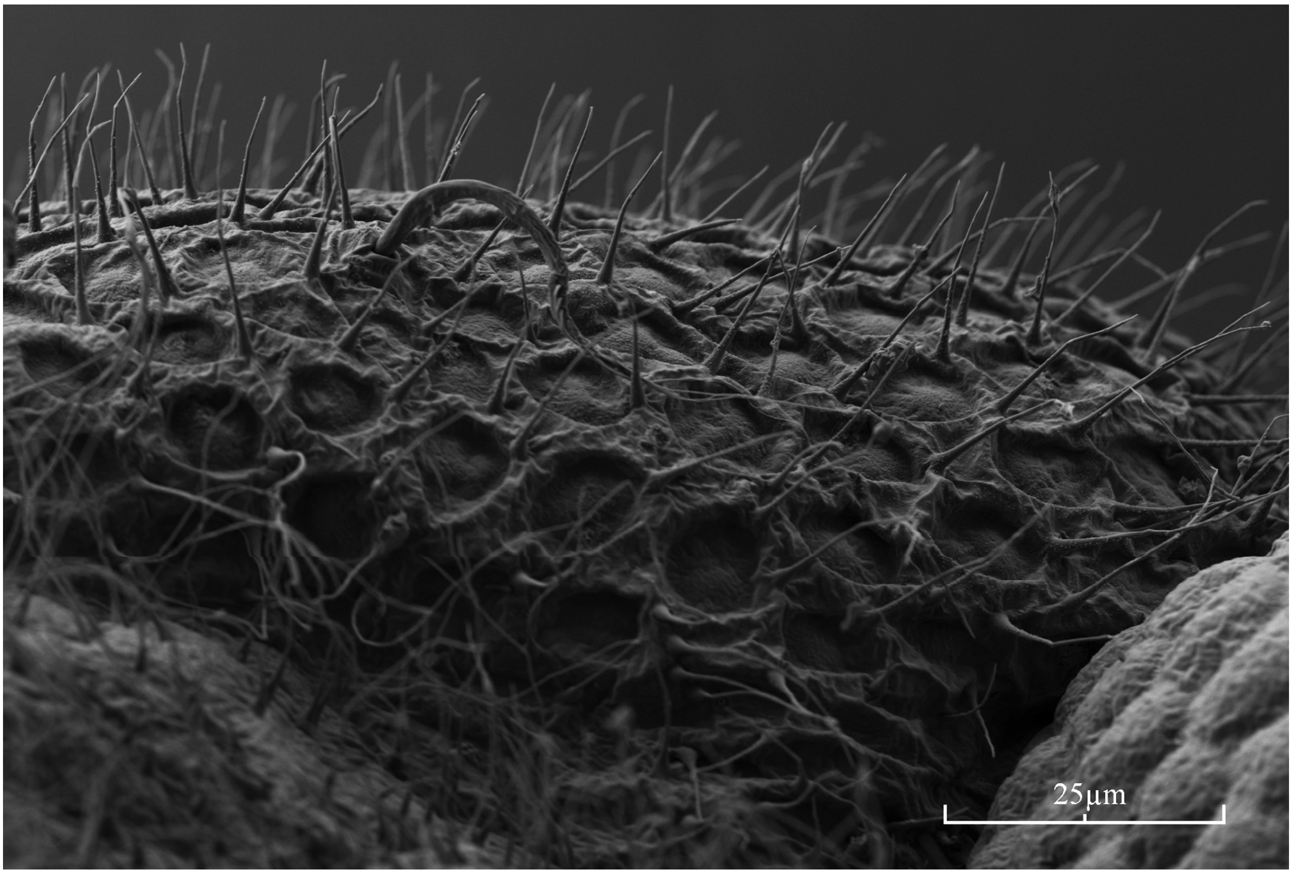


FIGURE 9. *Pseudopalicus serripes* (Alcock & Anderson, 1895) first stage zoea: Scanning electron micrograph at higher magnification showing the dense setose carapace with reticulation and the relatively larger posterodorsal carapace seta.

Zootaxa 3367: 204–210 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Kume tigra, a new genus and new species of carupine swimming crab (Crustacea: Brachyura: Portunidae) from Kume Island, Ryukyu Islands, Japan*

TOHRU NARUSE[1, 2] & PETER K. L. NG[3]

[1] *Transdisciplinary Research Organization for Subtropical and Island Studies, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan*

[2] *Current affiliation: Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan. E-mail: naruse@lab.u-ryukyu.ac.jp*

[3] *Tropical Marine Science Institute and Department of Biological Sciences, National University of Singapore, Kent Ridge, Singapore 119260, Republic of Singapore. E-mail: peterng@nus.edu.sg*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new genus and species of swimming crab of the family Portunidae Rafinesque, 1815, is described from Kume Island, Ryukyus, Japan. The new genus of the subfamily Carupinae Paul'son, 1875 is allied to the genera *Pele* Ng, 2011, and *Libystes* A. Milne-Edwards, 1867, but differs in the shapes of the carapace, thoracic sternum, third maxilliped, merus of the cheliped, fifth pereiopod, male abdomen and gonopods.

Key words: *Kume tigra*, new genus, new species, taxonomy, Kumejima, Ryukyu Islands, Japan

Introduction

During the Kumejima Marine Biodiversity Expedition "KUMEJIMA 2009", an interesting species of portunid crab was collected from a depth of 55 m by a SCUBA diver. This species is similar to *Pele* Ng, 2011, and *Libystes* A. Milne-Edwards, 1867, but differs from them in several generic characters. The present study describes it as a new species in a new genus.

The present study follows the classification used in Ng *et al.* (2008) and De Grave *et al.* (2009) in which the Carupinae is recognised as a subfamily within the Portunidae. On the basis of a detailed cladistic analysis of adult characters, Karasawa *et al.* (2008) argued that the Catoptrinae Borradaile, 1903, (including *Libystes* and *Catoptrus* A. Milne-Edwards, 1870) should be recognised as a distinct family. However, Schubart & Reuschel (2009), using molecular datasets, demonstrated that *Libystes* and *Catoptrus* are clearly nested in a clade that includes most of the other portunids, indicating that the group is probably just a subfamily of the Portunidae.

The measurements provided, in millimeters, are carapace length and width, respectively. The abbreviations G1, G2 and P2–P5 are used for the male first and second gonopods and second to fifth pereiopods, respectively. Specimens examined are deposited in Muséum national d'Histoire naturelle (MNHN), Paris; the Ryukyu University Museum, Fujukan (RUMF), Okinawa, Japan; and the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore. Comparative material of *Libystes* and *Pele* used for this study have been listed in Ng (2011).

Taxonomic account

Family PORTUNIDAE Rafinesque, 1815

Accepted by S.T. Ahyong: 18 Jan. 2012; published: 4 Jul. 2012

Subfamily CARUPINAE Paul'son, 1875

Kume n. gen.

Type species. *Kume tigra* **n. gen., n. sp.**, by present designation.

Diagnosis. Carapace tranversely broad, with oblique granulated crest on metabranchial region. Supra- to infraorbital magins continuous, supraorbital margin without fissure. Anterolateral margin with 5 teeth. Posterior margin of epistome with wide median projection. Endostomial ridges distinct. Eyes mobile, relatively short, with thick eyestalk, well developed cornea, filling orbit. Third maxilliped rectangular, ischium slightly longer than merus, merus with distolateral angle produced, not prominently auriculiform. Male thoracic sternum relatively wide; sternites 1–3 fused, sternites 3 and 4 separated by shallow groove; sternoabdominal cavity relatively wide, sutures between thoracic sternites 4 to 8 medially interrupted, ending at inner part of lateral slope of sternal cavity; no longitudinal groove discernible; distinct press button abdominal locking mechanism rod-like, positioned near inner end of suture 4/5 on sternite 5. Vulva transversely elliptical, on middle part of sternite 6, without sternal cover or ridge. Chelipeds subequal in both sexes; anterior margin of merus without distinct tooth or spine; chela long, fingers straight in outer view, weakly curved inwards in upper view, occlusal margins lined with numerous sharp teeth. P2–P4 similar in shape; P5 shortest, with laterally compressed propodus, dactylus slightly longer than propodus, lanceolate, laterally flattened. Male abdomen relatively wide; somite 2 fused to somite 3 with median part of suture not visible; somites 3–5 completely fused, forming right-angled triangular structure with telson; telson triangular, slightly broader than long. G1 simple, cylindrical, tapering gently to subtruncate tip; G2 about half length of G1, tip bifurcated.

Etymology. This genus is named after the name of the island "*Kume*", where the expedition "KUMEJIMA 2009" took place. Gender is masculine.

Remarks. *Kume* **n. gen.** superficially most closely resembles *Pele* in its very broad carapace (Figs. 1, 2a; Ng, 2011: figs. 3A, 4A, 5, 7A). *Kume* **n. gen.** can be separated from *Pele* by the presence of an oblique granulated crest on the metabranchial region of the carapace (vs. absent in *Pele*; Ng 2011: figs. 5A, B, 7A); proportionately shorter ischium and slightly auriculiform distolateral angle of the merus of the third maxilliped (Fig. 2c) (vs. proportionately longer ischium and non-auriculiform angle; Ng 2011: fig. 7D); unarmed anterior margin of the cheliped merus (Fig. 2d) (vs. armed with subdistal tooth in *Pele*; Ng 2011: figs. 2C, 4A, 8A), lanceolate dactylus of P5 (Fig. 2f) (vs. almost straight, slightly upcurved in *Pele*; Ng 2011: figs. 3A, 4A, 8B); the male has symmetrical chelae and the occlusal margins of the fingers have normal teeth (Fig. 2d, e) (vs. with unequal chelae and spine-like teeth along occlusal margin of pollex of minor chela in *Pele*; Ng 2011: fig. 6C); rod-like press-button male abdominal locking mechanism (Fig. 3a, b) (vs. peg-like in *Pele*; Ng 2011: fig. 7E, G); the complete absence of a longitudinal median line on the sternoabdominal cavity (Fig. 3b) (vs. shallow line present in *Pele*; Ng 2011: fig. 7E); the relatively smaller and elliptically shaped vulva (vs. large, rounded in *Pele*; Ng 2011: fig. 9); short and broad telson with a relatively broader anterior part of the sternoabdominal cavity (Fig. 3c) (vs. elongated, linguiform telson and relatively narrower sternoabdominal cavity; Ng 2011: fig. 8C); almost straight, simple G1 (Fig. 3d) (vs. G1 with a stout base and long, straight and slender distal part, sharply bent medially in *Pele*; Ng 2011: figs. 6A, 8D, E); and bifurcated distal end of G2 (Fig. 3e) (vs. unilobed in *Pele*; Ng 2011: fig. 8F).

Kume **n. gen.** is also similar to *Libystes* A. Milne-Edwards, 1867, *sensu lato*, in its unarmed anterior margin of the cheliped merus (Fig. 2d) and the slender dactylus of P5 (Fig. 2f). The differences between *Kume* **n. gen.** and *Libystes* are: broad and elliptical shape of the carapace (Figs. 1, 2a) (vs. subquadrate to subovate in *Libystes*); slightly produced distolateral angle of the third maxilliped (Fig. 2c) (vs. prominently auriculiform in *Libystes*); the absence of the longitudinal median line on the sternal cavity (Fig. 3b) (vs. longitudinally line present, but posterior end fused in *Libystes*); and the G1 is gently curved, subcylindrical with a tapering distal part (Fig. 3d) (vs. very slender and sinuous or short and subtruncate in *Libystes*) (see Ng 2011 for details of *Libystes*).

Ng (2011) has discussed the systematic problems with *Libystes* and the allied genus *Catoptrus* A. Milne-Edwards, 1870, at length (see also Fujita & Naruse 2011), noting that *Libystes* will need to be separated into at least two groups in an ongoing revision of the genus by the present authors. As such, this matter will not be elaborated on here.

Kume tigra n. sp.

(Figs. 1–3)

Material examined. Holotype: male, 2.4 × 4.7 mm, RUMF-ZC-1400, KUMEJIMA 2009 Stn. Diving 1, Umagai, Kume Island, Ryukyu Islands, Japan, 26°20.769′ N, 126°51.506′ E, -55 m, coll. KUMEJIMA 2009, 9 Nov. 2009. Paratypes, 1 female, 2.9 × 6.1 mm, ZRC 2010.0182, 1 ovig. female, 3.3 × 6.4 mm, RUMF-ZC-1401, same data as holotype.

Diagnosis. See for genus.

Description. Carapace broadly transverse, carapace width 1.94–2.12 times length, dorsal surface almost smooth except for granulated epi- and mesobranchial regions and prominent oblique granulated crest on metabranchial region. Frontal margin almost straight, slightly produced, deflexed medially, medially notched in dorsal view. Supra- to infraorbital magins continuous, rimmed, supraorbital margin without fissure; infraorbital margin concave on mesial half. Orbit rounded; eyes mobile, relatively short, with thick eyestalk, upper surface rather flattened, almost completely filling orbit; cornea well developed. External orbital angle low, indistinct, anterolateral margin with 5 small teeth, weakly cristate between first to fifth teeth, teeth slightly larger than granules on branchial regions, first to fourth teeth placed equidistantly, maximum width of carapace between fifth teeth. Subhepatic and pterygostomial regions granulated. Epistome relatively narrow longitudinally; posterior margin with distinct median notch. Endostomial ridges distinct. Third maxilliped rectangular, ischium slightly longer than merus without trace of median sulcus; merus with distolateral angle produced; distal end of exopod not reaching distolateral angle of merus, with long flagellum.

Male thoracic sternum relatively broad; sternites 1–3 completely fused; sternites 3 and 4 delimited by groove, deep medially, shallow laterally; sternoabdominal cavity relatively wide; sutures between thoracic sternites 4–8 medially interrupted, ending just at inner part of lateral slope of cavity; distinct press button present near inner end of suture 4/5 on sternite 5; no longitudinal line discernible; slight depression visible on each side below level of inner ends of suture 7/8. Female thoracic sternum wide, condition of sternites same as male; vulva on middle part of sternite 6; transversely elliptical.

Chelipeds subequal in male and female, relatively long, robust; chela as long as carapace width; merus slightly longer than palm, triangular in cross-section, anterior margin lined with granules, without distinct tooth or spine; carpus short, smooth, inner angle rounded. Chela relatively long, palm shorter than fingers; fingers straight in outer view, weakly curved inwards in upper view, distal ends strongly hooked; occlusal margins lined with numerous sharp teeth.

P2–P4 similar in shape, P2 longest. Male P2 granulated on anterior and posterior margins of merus, outer, inner margins of propodus, outer margin of dactylus; granulation relatively weaker in P3; P4 similar but no granulation on posterior margin of merus and inner margin of propodus. Female legs similar to that of male, but P2 propodus granulated only on inner margin, P3 and P4 meri and dactyli granulated only on anterior margins and outer margins, respectively. P5 in both sexes shortest, propodus slightly longer and wider than carpus, laterally flattened; dactylus slightly longer than propodus, lanceolate, laterally flattened, outer margin nearly straight, outer margin and distal quarter of inner margin lined with fine spines.

Male abdomen relatively wide; somite 1 longitudinally narrow; somite 2 laterally separated but functionally fused to somite 3 medially, without indication of a suture; somites 3–5 completely fused; telson triangular, tip rounded, slightly broader than long; somite 3 to telson forming almost right-angled triangle.

G1 simple, gently curving outwards, distal half almost straight, cylindrical in shape, tapering gently to subtruncate tip. G2 slender, about half G1 length, tip distinctly bifurcated.

Colour. In life, the carapace is pinkish to yellowish white, while the ambulatory legs are white with pink patterns. The cheliped is also pinkish white, but the fingers are striped with white and maroon (Fig. 1). The striped pattern is somewhat variable, being prominent in the two female specimens (Fig. 1b) but less obvious in the holotype male (Fig. 1a).

Etymology. The new species is named after the Latin "*tigra*" for tiger, alluding to its striped cheliped fingers. The name is used as noun in apposition.

FIGURE 1. Colours in life. *Kume tigra* **n. gen. et sp.** a, holotype male, 2.4 × 4.7 mm, RUMF-ZC-1400; b, paratype female (2.9 × 6.1 mm), ZRC 2010.0182.

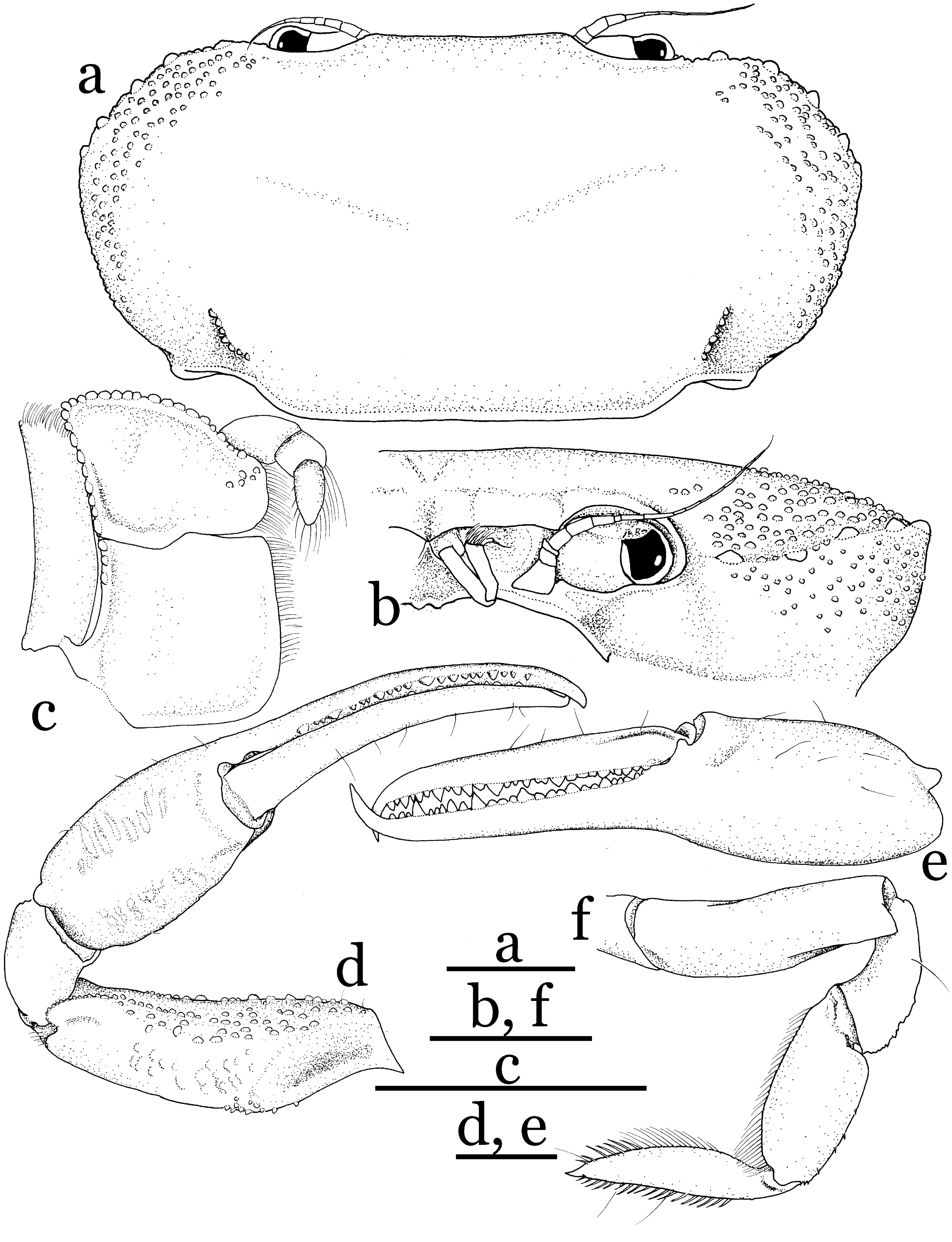


FIGURE 2. *Kume tigra* **n. gen. et sp.** Paratype female (2.9 × 6.1 mm), ZRC 2010.0182.
a, carapace, dorsal view; b, cephalothorax, anterior view; c, right third maxilliped; d, left cheliped, upper view; e, left chela; f, right fifth pereopod. Scales = 1.0 mm.

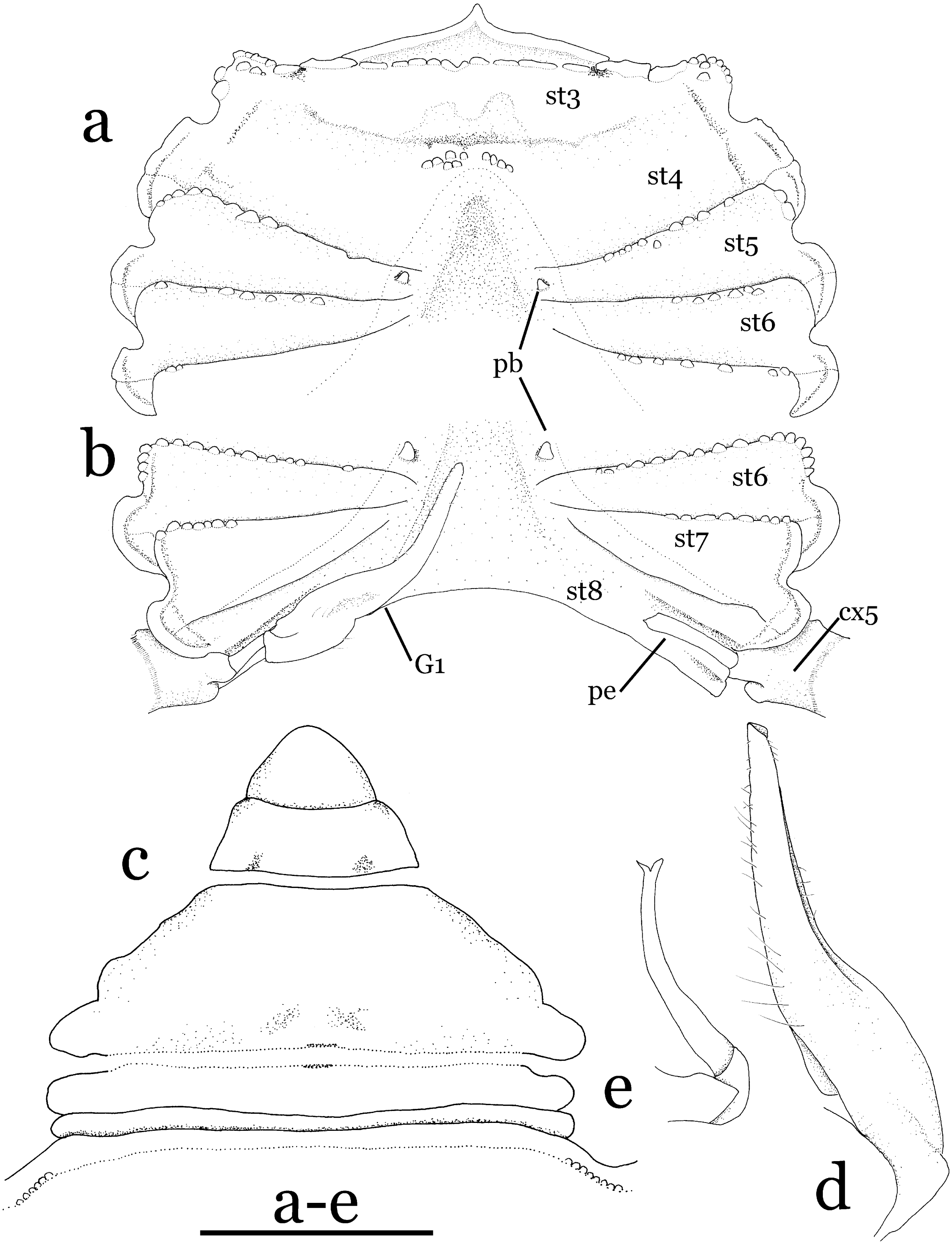


FIGURE 3. *Kume tigra* **n. gen. et sp.** Holotype male (2.4 × 4.7 mm), RUMF-ZC-1400.
a, anterior thoracic sternum; b, posterior thoracic sternum; c, abdomen and telson; d, left G1; e, left G2. cx5 = coxa of fifth pereopod; G1 = male first gonopod; pb = press-button; pe = penis; st3–8 = thoracic sternites 3–8. Scales: a–c = 1 mm; d, e = 0.5 mm.

Acknowledgements

Material examined was collected during the KUMEJIMA 2009 Expedition organized and funded by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), Biodiversity Research Center of the Academia Sinica (BRCAS), and Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR). The expedition operated under a permit granted to T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative.

References

Alcock, A. (1900) Materials for a carcinological fauna of India. No. 6. The Brachyura Catometopa or Grapsoidea. *Journal of the Asiatic Society of Bengal*, Calcutta, 69(3), 279–486.

Borradaile, L.A. (1903) Marine Crustaceans. IV. Some remarks on the classification of the crabs. *In*: Gardiner, J.S. (Ed.) *The Fauna and Geography of the Maldive and Laccadive Archipelagoes*, Cambridge University Press, 1, 424–429.

De Grave, S., Pentcheff, N.D. Ahyong, S.T., Chan, T.-Y., Crandall, K.A., Dworschak, P.C., Felder, D.L., Feldmann, R.M., Fransen, C.H.J.M., Goulding, L.Y.D., Lemaitre, R., Low, M.E.Y., Martin, J.W., Ng, P.K.L., Schweitzer, C.E., Tan, S.H., Tshudy, D. & Wetzer, R. (2009). A classification of living and fossil genera of decapod crustaceans. *Raffles Bulletin of Zoology*, Supplement 21, 1–109.

Fujita, Y. & Naruse, T. (2011) *Catoptrus iejima*, a new species of cavernicolous swimming crab (Crustacea: Brachyura: Portunidae) from a submarine cave at Iejima, Ryukyu Islands, Japan. *Zootaxa*, 2918, 29–38.

Karasawa, H., Schweitzer, C.E. & Feldmann, R.M. (2008) Revision of Portunoidea Rafinesque, 1815 (Decapoda: Brachyura) with emphasis on the fossil genera and families. *Journal of Crustacean Biology*, 28(1), 82–127.

Milne-Edwards, A. (1867) Descriptions de que1ques espèces nouvelles de Crustacés Brachyures. *Annales de la Société entomologique de France*, (4)7, 263–288.

Milne-Edwards, A. (1870) Note sur *Catoptrus*, n. g., appartenant à la division des Crustacés Brachyures Catométopes. *Annales du Science naturelles, Zoologie*, (5)18, 82.

Ng, P.K.L. (2011) *Pele ramseyi*, a new genus and new species of anchialine swimming crab (Crustacea: Brachyura: Portunidae) from the Hawaiian Islands. *Zootaxa*, 2737, 34–48.

Ng, P.K.L., Guinot, D. & Davie, P.J.F. (2008) Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology*, Supplement 17, 1–286.

Paul'son, O. (1875) *Investigations on the Crustaceans of the Red Sea with Notes on Crustacea of the Adjacent Sea, Part 1, Podophthalmata and Edriophthalmata (Cumacea) with 21 Plates of Figures*, xiv +144 pp., pls. 1–21, Kulzhenko, Kiev [in Russian].

Rafinesque, C.S. (1815) *Analyse de la Nature ou Tableau de l'Univers et des Corps organisés*. Palermo, pp. 12–24.

Rathbun, M.J. (1924) New species of crabs from Samoa. *Proceedings of the Biological Society of Washington*, 37, 127–128.

Schubart C.D. & Reuschel, S. (2009) A proposal for a new classification of Portunoidea and Cancroidea (Brachyura: Heterotremata) based on two independent molecular phylogenies. *In*: Martin, J.W., Crandall, K.A. & Felder, D.L. (Eds.), *Crustacean Issues 18: Decapod Crustacean Phylogenetics*. Taylor & Francis/CRC Press, Boca Raton, Florida, pp. 533–549.

Zootaxa 3367: 211–221 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

The identity of *Pilumnoplax acanthomerus* Rathbun, 1911 (Crustacea: Decapoda: Brachyura: Xanthidae), with new records from the central and western Pacific*

JOSE CHRISTOPHER E. MENDOZA[1,4], PAUL F. CLARK[2] & PETER K. L. NG[1, 3]

[1] *Department of Biological Sciences, National University of Singapore, 14 Science Drive 4, 117543 Singapore*
[2] *Zoology Department, Natural History Museum, Cromwell Road, London SW7 5BD, England*
[3] *Tropical Marine Science Institute, National University of Singapore, 18 Kent Ridge Road, 119227 Singapore*
[4] *Corresponding author. E-mail dbsjose@nus.edu.sg*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa,* 3367, 1–280.

Abstract

The identity of the rare xanthid crab, *Pilumnoplax acanthomerus* Rathbun, 1911, originally described from the Amirante Islands in the western Indian Ocean, is elucidated. Števčić (2005) transferred the species from *Pilumnoplax* Stimpson, 1858, to a new genus, *Linnaeoxantho.* This monotypic genus is re-diagnosed and new morphological characters are highlighted. New records from Ryukyu and Line Islands, in the western and central Pacific, respectively, are reported. *Linnaeoxantho* is compared with the morphologically similar *Melybia* Stimpson, 1871, from the western Atlantic, and their affinities are discussed. Linnaeoxanthinae Števčić, 2005, is here recognised as a valid xanthid subfamily for *Linnaeoxantho* and *Melybia,* and is considered to have priority over Melybiidae Števčić, 2005.

Keywords: Xanthoidea, *Pilumnoplax, Linnaeoxantho acanthomerus*, *Melybia*, range extension, Amirante Islands, Ryukyu Islands, Line Islands, western Atlantic

Introduction

Rathbun (1911) described an unusual species, *Pilumnoplax acanthomerus* from a male and an ovigerous female collected off the Amirante Islands, western Indian Ocean, by the Percy Sladen Trust Expedition to the Indian Ocean in 1905. Later, in his list of Indo-West Pacific Brachyura, Serène (1968) introduced the manuscript name "*Neopilumnoplax*" and assigned to this genus a number of species including *P. acanthomerus*; but the species epithet was preceded by a question mark (Table 1). In his introduction, Serène (1968: 33) wrote "The classification of BALSS (1957) with the changes proposed by SERÈNE (1965) is amended by taking into consideration amendments since suggested mainly by GUINOT (1967–68). It is still provisional…". Probably as a direct consequence of this, *Neopilumnoplax* was only listed by Serène (1968: 90) as a "manuscript name", without diagnosis or designation of a type species and the name is therefore a nomen nudum. However, as part of her preliminary research into natural brachyuran groupings, Guinot (1969) commented on a number of problematic goneplacid taxa. *Neopilumnoplax* was discussed in detail by Guinot (1969: 689), together with a footnote in English communicated by Serène. In this footnote, Serène stated that as indicated by Tesch (1918), *Pilumnoplax* Stimpson, 1858, was partly a synonym of *Eucrate* De Haan, 1835, *Heteropilumnus* De Man, 1895, and *Lophoplax* Tesch, 1918. Serène then established *Neopilumnoplax* as a new genus to include the species described after Stimpson (1858) by providing a diagnosis for his new taxon mainly adapted from a definition used by Miers (1886) for *Pilumnoplax heterochir* (Studer, 1883). The footnote continued in French, with Guinot (1969) saying that Serène had chosen *P. heterochir* as the type species and that for the moment *Neopilumnoplax* was limited to this species and *P. americana* Rathbun, 1898. Through these comments, Guinot made the name *Neopilumnoplax* available, and she attributed the new taxon to Serène. Considering the manner in which *Neopilumnoplax* was

Accepted by T. Naruse: 15 Aug. 2011; published: 4 Jul. 2012

established, the authorship of the genus should therefore be Serène, in Guinot, 1969. In her final paper on the preliminary research into the natural groupings of Brachyura, Guinot (1971) listed the taxa that she assigned to the goneplacid subfamily Carcinoplacinae. Under “C. other Carcinoplacinae — Goneplacinae” she inserted question marks as prefixes to *Neopilumnoplax* and *Bathyplax* thereby indicating her uncertainty over the systematic position of these taxa.

TABLE 1. The list of *Neopilumnoplax* species as presented exactly by Serène (1968).

Neopilumnoplax SERÈNE, Ms name

Neopilumnoplax heterochir (STUDER, 1883)
" sinclairi ALCOCK, 1899
" abyssicola MIERS, 1886
" cooki RATHBUN, 1911
" ?acanthomerus RATHBUN, 1911

Currently, *Eucrate* De Haan, 1835, is classified in the Euryplacidae Stimpson, 1871, and *Neopilumnoplax* Serène in Guinot, 1969, in the Mathildellidae Karasawa & Kato, 2003, both of which are assigned to the Goneplacoidea MacLeay, 1838 (Ng *et al.* 2008; Castro & Ng 2010; Castro *et al.* 2010).

Guinot (1969) did not assign *Pilumnoplax sinclairi* Alcock & Anderson, 1899, to *Neopilumnoplax*, saying that it was a distinct Indo-Pacific form, and later (Guinot, 1971) only included it with doubt in her list of *Neopilumnoplax* species by inserting a question mark as a prefix to this taxon (see Ng *et al*. 2008). Furthermore, she did not place *P. acanthomerus* in any specific genus and only stated that this species was not a real *Pilumnoplax*. Guinot (1969: 689) expressed uncertainty about its classification within Goneplacidae, commenting: “La *Pilumnoplax acanthomerus* Rathbun, 1911, des îles Amirantes, ne ressemble en rien aux espèces jusqu’ici mentionées. C’est un Crabe énigmatique dont nous nous demandons s’il agit d’une Goneplacidae.” [The *Pilumnoplax acanthomerus* Rathbun, 1911, from Amirante Islands, does not resemble any of the species previously mentioned. It is an enigmatic crab, and we doubt that it is a true goneplacid]. Indeed, *P. acanthomerus* is not treated in her later synthesis of goneplacoid taxa (Guinot 1971). Furthermore, after Serène & Lohavanijaya (1973) examined the species of *Pilumnoplax*, they stated that *P. acanthomerus* belonged to a new genus which was being described by the senior author; but this description was never published. The matter was eventually resolved by Števčić (2005: 45), who named a new subfamily, Linnaeoxanthinae, in the Xanthidae MacLeay, 1838. He provided a brief description of the subfamily but did not state what the diagnostic characters of the taxon were nor explain how it differed from other subfamilies. In the same paragraph, Števčić (2005: 45) then assigned *Linnaeoxantho*, a new genus, as the type genus of the subfamily, and indicated that its type species was *Pilumnoplax acanthomerus* Rathbun, 1911. He did not provide additional diagnoses for either *Linnaeoxantho* or *P. acanthomerus*. Nevertheless, this action made both Linnaeoxanthinae Števčić, 2005, and *Linnaeoxantho* Števčić, 2005, available names since Article 13.5 of the Code (ICZN 1999) states that “The combined description or definition of a new nominal family-group taxon and a single new nominal genus of which the name provides the basis for the new family-group name [Art. 11.5] is deemed to confer availability on each name under Article 13.1.1, but for such names published after 1930 availability is not conferred on either name unless a type species is fixed for the new nominal genus [Arts. 13.2 and 13.3].” The short description provided by Števčić (2005) did include details of the gonopods, suggesting that he had examined the types, as Rathbun (1911) did not mention gonopod morphology in her original description. Ng *et al*. (2008: 203) recognised *Linnaeoxantho* Števčić, 2005, as a valid xanthid genus with the following comment: “The carapace of *P. acanthomerus* looks very much like species of *Xanthias*, but it has spinous legs and chelipeds, as well as a relatively flattened and spinous chela with sharp fingers. It is clearly a xanthid, and likely to be in the subfamily Xanthinae as defined at present. In view of the unsettled taxonomy of the many of the xanthid subfamilies, particularly Xanthinae, it is premature to recognise the Linnaeoxanthinae Števčić, 2005. We have tried to re-examine the specimen, supposedly in the Cambridge University zoology collections, but the specimen could not be found (Ray Symonds & Paul Clark, pers. comm.).” (Ng *et al*. 2008: 209).

Recently, additional specimens of *L. acanthomerus* were collected from the western and central Pacific (Ryukyu and Line Islands, respectively), considerably extending the range of this species. Furthermore, the type specimens were found in the U.S. National Museum of Natural History, and were made available to the authors for study. Due to the relative obscurity of *L. acanthomerus*, the purpose of this present report is to re-describe this rare species in detail, together with accompanying figures, and to discuss its affinities within the Xanthidae.

Material and methods

The system of classification in this paper essentially follows that of Ng *et al*. (2008). Measurements for the material examined pertain to carapace length × carapace width. The terminology of Dana (1851) is used for the designation of the carapace regions, e.g., 2M, 3M, etc. The following abbreviations are used in the text: ab1–ab6, abdominal somites 1–6; G1, first male gonopod; G2, second male gonopod; mxp1–mxp3, first to third maxillipeds; and P1–P5, first to fifth pereiopods (P1 as chelipeds). Other abbreviations used: coll. = collected by; ovig. = ovigerous; stn = station. The thoracic somites and sternites are numbered from 1 to 8. The thoracic sternal sutures are referred to by the number of the two sternites that they involve, and thus are numbered from 1/2 to 7/8.

The material examined is deposited in the following reference collections: Florida Museum of Natural History, University of Florida, Gainesville, FL (UF); Smithsonian Institution, National Museum of Natural History, Washington, D.C. (USNM); and the Zoological Reference Collection, Raffles Museum of Biodiversity Research, National University of Singapore (ZRC).

Systematic account

XANTHIDAE MacLeay, 1838

Linnaeoxanthinae Števčić, 2005

Linnaeoxanthinae Števčić, 2005: 45.
Melybiidae Števčić, in Martin & Davis, 2001: 112 (nomen nudum).
Melybiidae Števčić, 2005: 88.

Diagnosis. Carapace subhexagonal, wider than long; dorsal surface slightly convex, regions poorly indicated. Eyes relatively large. Supraorbital margin with distinct notch. Basal antennal article subrectangular, flagellum long. Posterior margin of epistome with median part straight. Male thoracic sternum wide; median line present only at level of sternites 7, 8. Chelipeds long, unequal; merus, carpus spinose; chelae flattened. Merus, carpus and propodus of ambulatory legs spinose on anterior margin; merus of P2, P3 with subdistal spine on posterior margin. G1 relatively stout; G2 about one-third length of G1, terminal segment short. Male gonopore on coxa of P5.

Remarks. See genus.

Linnaeoxantho Števčić, 2005

Pilumnoplax. — Rathbun 1911: 237 (partim).
Neopilumnoplax Serène, 1968: 90 (partim) (nomen nudum) (not *Neopilumnoplax* Serène, in Guinot, 1969: 689).
Linnaeoxantho Števčić, 2005: 45.
Linnaeoxanthus [sic]. — Ng *et al*. 2008: 203. — De Grave *et al.* 2009: 43.

Type species. *Pilumnoplax acanthomerus* Rathbun, 1911, by monotypy; gender feminine.

Diagnosis. Carapace subhexagonal, wider than long; dorsal surface regularly finely granulate, slightly convex, regions poorly indicated. Front wide, bilobate, ventrally deflexed, with distinct row of granules posterior to frontal margin. Eyes relatively large, corneas well developed. Supraorbital margin with distinct notch. Basal antennal article subrectangular, flagellum long. Anterolateral margin much shorter than posterolateral margin; with 4 acute projecting teeth, including exorbital angle, fourth tooth small, spiniform. Buccal cavity widened anteriorly, not completely covered by third maxillipeds. Posterior margin of epistome with median part straight. Male thoracic sternum wide; median line present only at level of sternites 7, 8. Chelipeds long, unequal; merus, carpus spinose; chelae flattened; palm longer than fingers, fingers stout, grooved, with small tufts of setae; fixed finger with large tooth near tip, dactylus keeled on superior margin. Ambulatory legs moderately long, merus, carpus and propodus spinose on anterior margin; merus of P2, P3 with subdistal spine on posterior margin. G1 relatively stout, distal half somewhat flattened, spinose, gently curved outward. G2 about one third length of G1, terminal segment short. Male gonopore on coxa of P5, just anterior to coxo-sternal condyle.

Remarks. Rathbun (1911) originally assigned her species to *Pilumnoplax* (junior synonym of *Eucrate*), and by Serène (1968), with doubt, to *Neopilumnoplax* (Table 1). This species has been attributed to a number of families including Goneplacidae MacLeay, 1838, by Serène (1968), Euryplacidae, by Manning & Holthuis (1981) and Mathildellidae, by Karasawa & Kato (2003). But according to Guinot (1969), Ng & Manuel-Santos (2007) and Castro & Ng (2010), it does not belong to any of these families. Serène & Lohavanijaya (1973) also briefly mentioned that, due to its short G2, the species does not belong to Goneplacidae-Carcinoplacidae. Goneplacids, euryplacids and mathildellids all have freely articulating abdominal somites 3–5 (Castro & Ng 2010: fig. 1; Ng & Manuel-Santos 2007: fig. 10D–F) (vs. fused, Fig. 4C). Furthermore, euryplacids have a G1 tapering almost to a point (Castro & Ng 2010: figs. 11E, 14) (vs. relatively stout and blunt, Fig. 4F–H), and a long penis protected by a penial groove or tube (Castro & Ng 2010: figs. 16E, 17G) (vs. short, unprotected penis, Fig. 4B). Mathildellids also have a slender, tapering G1 (Ng & Manuel-Santos 2007: 45) (vs. stout, blunt G1, Fig. 4F–H), and a G2 as long as the G1 (Ng & Manuel-Santos 2007: 45) (vs. G2 about half as long as G1, Fig. 4I).

Despite the superficial carapace resemblance to some goneplacoids, *Linnaeoxantho* has more xanthoid characters, but its general morphology is so unusual that Števčić (2005) established Linnaeoxanthinae for it within Xanthidae. However, he did not provide any reason for this action other than a brief, generalized description. This present study suggests that *Linnaeoxantho* can be classified in the Xanthidae on account of the third to fifth somites of the male abdomen being immovably fused and the stout, curved G1 which is twice as long as the G2. Ng *et al.* (2008) did not follow the monotypic establishment of Linnaeoxanthinae as proposed by Števčić (2005) to accommodate *Linnaeoxantho*. Instead they retained this genus within the Xanthinae, prior to a re-examination of the types and an elucidation of the relationships within this apparently polyphyletic and artificial grouping. Recently, Lai *et al.* (2011) presented a molecular phylogeny of the Xanthidae, supported by morphological characters, the most comprehensive analysis on the family thus far. They showed that the subfamily Xanthinae is indeed polyphyletic, and suggested that more subfamily-level taxa should be recognised. Now that the type material has been found and more specimens have been examined, *Linnaeoxantho* is here considered most similar to the monotypic *Melybia* Stimpson, 1871, from the Caribbean (type species: *Melybia thalamita* Stimpson, 1871; see Stimpson, 1871: 144; A. Milne-Edwards, 1880: 275; Rathbun 1930: 562, pl. 230 figs. 1, 2; Williams 1984: 430, fig. 342) in the general shape of the carapace and pereiopods. In particular, both taxa have (1) a transversely subhexagonal carapace (Figs. 1, 2); (2) prominently quadridentate carapace anterolateral margins (Figs. 1, 2); (3) a relatively broad, bilobate and deflexed front (Figs. 2, 3B); (4) a broad, oblique superior orbital margin, with large eyes and well-developed corneas (Fig. 2); (5) narrow mxp3 which are widely separated from each other (Figs. 3A, 3B); (6) long, unequal chelipeds, with spinose meri and carpi, flattened chelae, with a double row of spiniform tubercles on the superior border of the palm, and fingers much shorter than the palm (Figs. 1, 2, 3E, F); and (7) moderately long and slender ambulatory legs, with anteriorly spinose meri, with a differential occurrence of the subdistal spine on the posterior margin of the ambulatory meri, present only on P2 and P3 in *Linnaeoxantho* (Figs. 2, 4D, E) (present in P2–P4 in *Melybia*) (see also *Melybia forceps* A. Milne-Edwards, 1880: 274, pl. 49, figs. 1–1e, a junior synonym of *M. thalamita*). A good series of specimens of *M. thalamita* were examined in the USNM for the present study and the resemblance between these two taxa is remarkable. Indeed, perhaps the only reason why this connection has not been made until now is due to the disparate distributions of these two taxa, and the relative rarity of *L. acanthomerus*. Interestingly, Števčić (2005: 88) was of the opinion that *Melybia* merited its own family, Melybiidae Števčić, 2005, but he inexplicably classified it in the Portunoidea Rafinesque, 1815. However, his treatment of Melybiidae and its characters was cursory and unhelpful for comparative purposes. He also does not explain why he placed Melybiidae in the Portunoidea and not within Linnaeoxanthinae. Melybiidae was first used in a letter by Števčić to Martin & Davis (2001: 112), but as the name was not acompanied by any diagnosis or description. Melybiidae Števčić in Martin & Davis, 2001, must be regarded as a nomen nudum, and the first valid use of the name was in Števčić (2005).

This present study agrees with Ng *et al.* (2008) in assigning *Melybia* to the Xanthidae, prior to a systematic revision of this group. However, both *Linnaeoxantho* and *Melybia* are here considered related, and fall within or are allied to what is now understood as the Xanthidae (viz. Lai *et al.* 2011). *Linnaeoxantho* and *Melybia* share a suite of diagnostic characters (see diagnoses for subfamily and genus) that distinguish them from the Xanthinae s. str. (viz. Lai *et al.*, 2011) and suggest that they can be placed in their own subfamily, for which the names Linnaeoxanthinae Števčić, 2005, and Melybiinae Števčić, 2005, are available. However, as the names appeared in the same paper (Števčić 2005), the Code regards both as simultaneously published and neither has priority. In such a case, the First Reviser principle comes into effect. Therefore, Linnaeoxanthinae Števčić, 2005, is chosen here as having priority over Melybiinae Števčić, 2005, whenever these two taxa are regarded as synonyms.

Linnaeoxantho acanthomerus (Rathbun, 1911)
(Figs. 1–4)

Pilumnoplax acanthomerus Rathbun, 1911: 237, pl. 18 fig. 13. — Guinot 1969: 689. — Serène & Lohavanijaya 1973: 69. — Manning & Holthuis 1981: 161.
Neopilumnoplax ? *acanthomerus*. — Serène 1968: 90.
Linnaeoxantho acanthomerus. — Števčić 2005: 45.
Linnaeoxanthus [sic] *acanthomerus* — Ng *et al.* 2008: 203 (list). — Ng & Castro 2010: 25.

Material examined. Types: holotype ♂, 12.9 × 8.5 mm, paratype 1 ♀ ovig., 15.0 × 10.1 mm (USNM 41353), stn E21, 54 m (30 fms), Amirante Islands, coll. J. Stanley Gardiner, H.M.S. *Sealark*, 17 Oct. 1905. Additional material: 1 ♂, 7.1 × 5.5 mm (ZRC 2012.0160), "Dive Ola", scuba, 24 m, Kumejima Is., Ryukyu Islands, Japan, coll. P.F. Clark *et al.*, 9 Nov. 2009; 1 ♀, 11.0 × 7.5 mm (UF 10556), outer reef slope, from dead *Pocillopora* head, 10–15 m, Tabuaeran Atoll, Kiribati, Line Islands, coll. G. Paulay & N. Knowlton, 12 Aug. 2005.

FIGURE 1. *Linnaeoxantho acanthomerus* (Rathbun, 1911), young ♂, 7.1 × 5.5 mm (ZRC 2012.0160), Kumejima Is., Ryukyu Islands, Japan; live coloration.

Description of holotype. Carapace (Fig. 2A) subhexagonal, width about 1.5 × length; dorsally slightly convex, dorsal surface covered with several, discrete, round granules, larger on anterior third; regions mostly not well defined, anterior part of 2M, 3M well delineated by narrow, shallow grooves, 2M undivided. Front relatively wide, about 0.4 × maximum carapace width; slightly deflexed ventrally; separated from orbits by deep notch; separated into 2 lobes by shallow median notch; anterior margin sinuous, lateral lobes moderately prominent, with distinct, neat row of granules immediately posterior. Anterolateral margin about half length of posterolateral margin; armed with 4 acute, projecting teeth, including exorbital tooth; first (exorbital) tooth broadest at base, fourth smallest, spiniform; carapace widest at level of third tooth; posterolateral margin straight; central portion of posterior margin slightly concave. Suborbital, subhepatic, pterygostomian regions granulate.

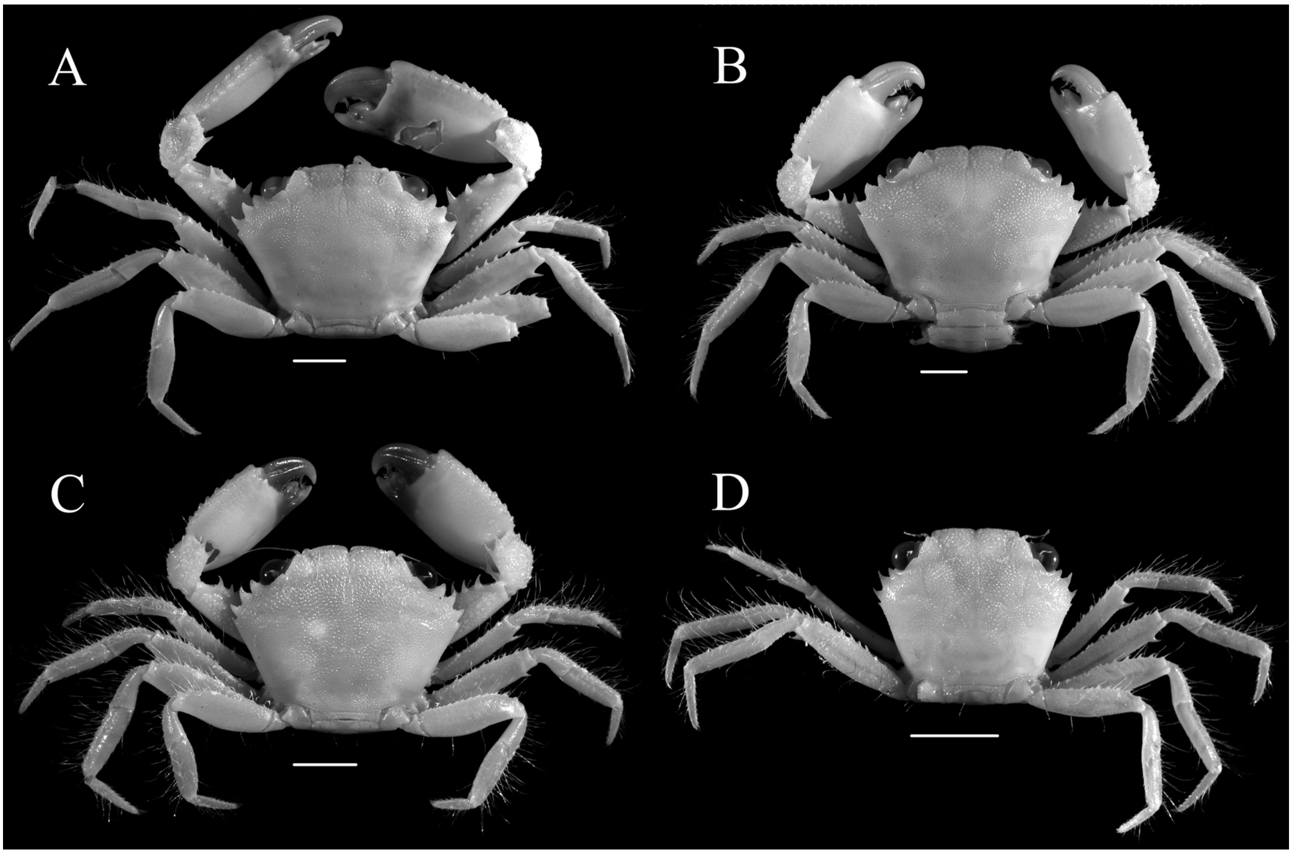


FIGURE 2. *Linnaeoxantho acanthomerus* (Rathbun, 1911). A, holotype ♂, 12.9 × 8.5 mm (USNM 41353), B, paratype ♀, 15.0 × 10.1 mm (USNM 41353), Amirante Islands; C, ♀, 11.0 × 7.5 mm (UF 10556), Kiribati; D, 7.1 × 5.5 mm (ZRC 2012.0160), Kumejima. Scales: A–D = 3.0 mm.

Orbits (Fig. 2A) large, margins finely granulate, subcristate; superior, inferior orbital margins each with distinct notch, continuing posteriorly as short fissure; eyes large, ocular peduncles short, stout, corneas well developed. Antennular fossae (Fig. 3B) large, antennules folding transversely. Basal article of antennae (Fig. 3B) subrectangular, with small distolateral extension entering orbital hiatus; antennal flagellum long, exceeding exorbital angle by one-third of its length. Epistome (Fig. 3B) broad; central region of posterior margin nearly straight, lateral regions of posterior border convex. Endostome without oblique ridges. Mxp3 (Fig. 3A, B) smooth, slender, not completely closing buccal cavity; merus subquadrate, median length about 0.4 × median length of ischium; ischium subrectangular, with shallow submedian sulcus; exopod long, subrectangular, with prominent mesial projection subdistally.

Thoracic sternum (Figs. 3A, 4B) broad, finely granulate; sternites 1, 2 fused, large, separated from sternite 3 by distinct suture 2/3; sternites 3, 4 almost completely fused except at lateral edges; sternite 4 broad, without visible median line; sternites 5, 6 similar in shape, sternite 7 with anterior portion much larger than episternite, sternite 8 completely covered by abdominal somite 3; sternal press-button on posterior half of sternite 5, closer to suture 5/6; sutures 4/5, 5/6 interrupted medially, sutures 6/7, 7/8 complete; median, membranous, uncalcified region at level of suture 6/7; median line only visible at level of sternites 7, 8.

Chelipeds (P1) (Fig. 1, 2, 3E, F) unequal. Meri finely granulate, long, distal portions well exceeding margins of carapace; anterior margin armed with four conspicuous spines distributed along entire length. Carpus coarsely granulate on external surface; with 2 prominent spines on inner angle, 1 on top of the other; large conical granules interspersed on dorso-distal and dorso-internal margins. Major chela broad, flattened; superior margin of palm with double row of conical granules; internal and external surfaces of palm finely granulate; fingers about half length of palm, tips strongly recurved, with discrete, small tufts of stiff setae; pigment localized throughout length of fingers, except tips, also on distal fourth of palm; dactylus with dorsal keel and longitudinal groove on both external and internal surfaces; cutting margin of dactylus with several low teeth, cutting margin of fixed finger with one broad, molariform tooth, set apart from distal tip by deep notch. Minor chela nearly identical in form but smaller.

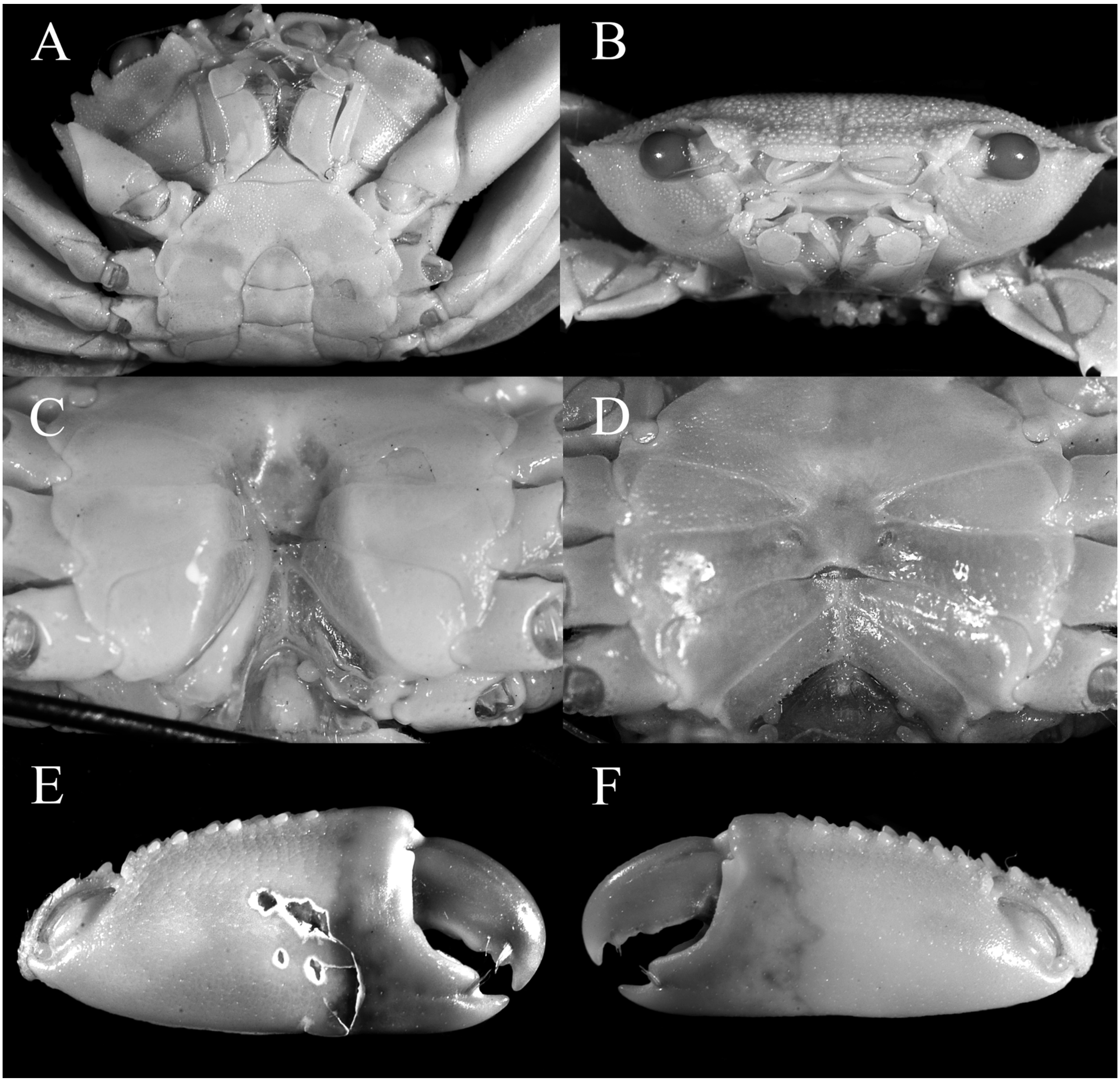


FIGURE 3. *Linnaeoxantho acanthomerus* (Rathbun, 1911). A, C, E, F, holotype ♂, 12.9 × 8.5 mm (USNM 41353); B, D, paratype ♀, 15.0 × 10.1 mm (USNM 41353). A, ventral view; B, frontal view; C, male thoracic sternum; D, ♀ thoracic sternum; E, major chela; F, minor chela.

Ambulatory legs (P2–P5) (Figs. 1, 2, 4D, E) relatively long, with long setae; P2, P5 shortest, P3, P4 longest; total length of P4 about 1.5 × maximum carapace width. Meri flattened, length about 2.7 × width; anterior margin armed with several spines throughout entire length; posterior margin with strong spine subdistally on P2, P3, absent in P4, P5. Carpi, propodi similarly spinose on anterior margins. Dactyli straight, ending in chitinous claw. Short, stiff spiniform setae on posterior margins of propodi and on anterior and posterior margins of dactyli.

Abdomen (Fig. 3A, 4C) short, tip of telson reaching just posterior to level of coxo-sternal condyles of P1 coxae. Abdominal somites 1, 2 (ab 1, 2) trapezoidal, width 6.0–8.0 times length; somites 3–5 (ab 3–5) fused, lateral margins greatly concave, vestiges of sutures visible externally as small lateral notches; posterolateral regions of ab 3 with cupuliform depression, locking with episternite 7 in closed abdomen; somite 6 (ab 6) subrectangular, width about 1.8 times length, lateral margins slightly concave. Telson subtriangular, tip rounded, lateral margins slightly convex; subequal in length to ab 6.

G1 (Figs. 4F–H) short, stout, curved; distal tip reaching just beyond level of sternal suture 5/6, into small, shallow, transverse depression; distal half covered with conical granules, short spiniform setae towards distal tip; distal tip bilobate, without long, plumose subterminal setae. G2 (Fig. 4I) nearly straight; slightly more than one-third length of G1; terminal process about 0.3 times total length. Penis relatively short (Fig. 4B) emerging from large gonopore, located just anterior to coxo-sternal condyle of P5.

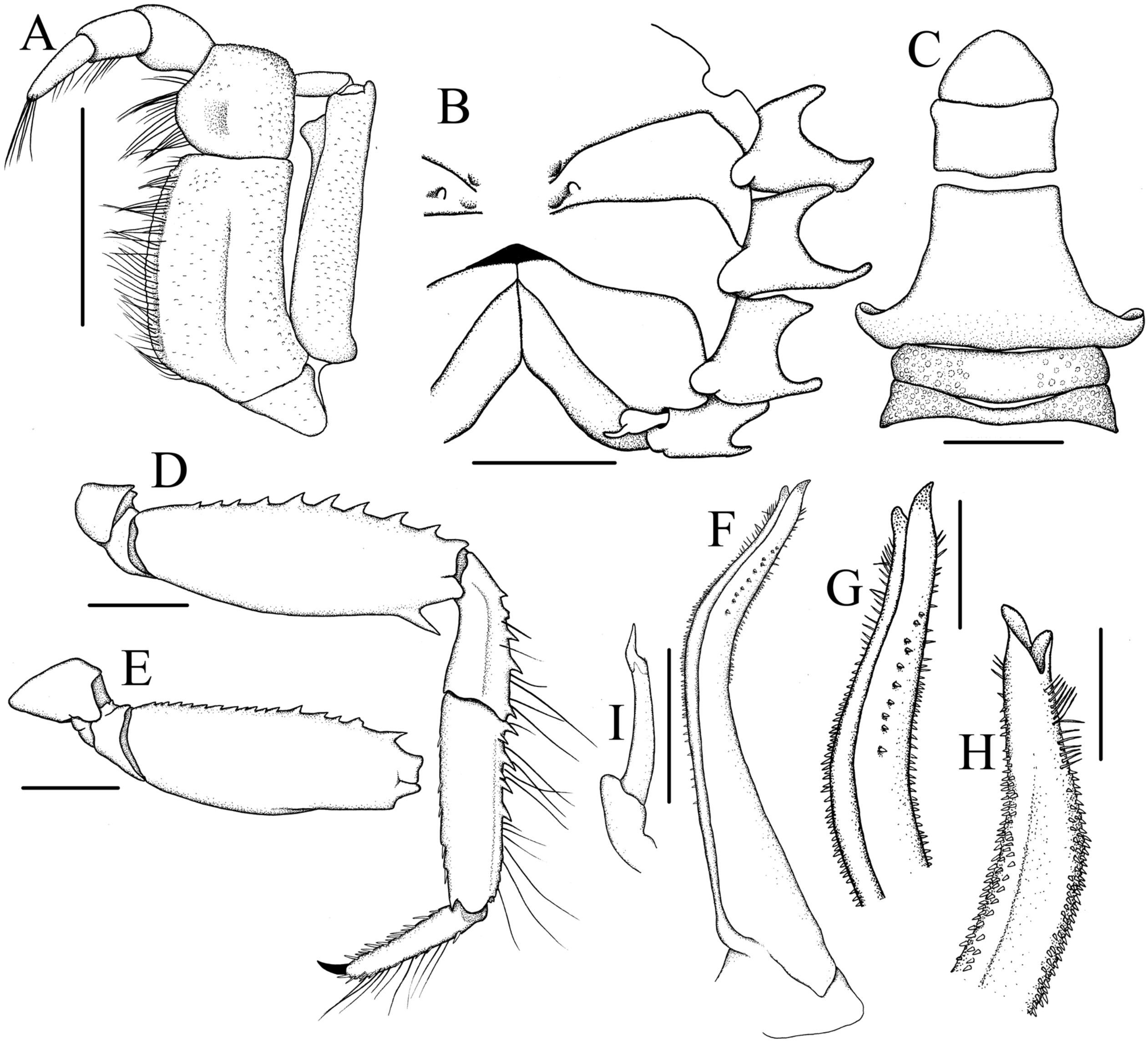


FIGURE 4. *Linnaeoxantho acanthomerus* (Rathbun, 1911), holotype ♂, 12.9 × 8.5 mm (USNM 41353). A, left mxp3; B, thoracic sternum and penis; C, abdomen and telson; D, right P3; E, right P5, coxa, basis-ischium, merus; F–H, left G1, F, entire external view, G, distal tip, external view, H, distal tip, internal view; I, left G2, external view. Scales: A–E = 2.0 mm; F, I = 1.0 mm; G, H = 0.5 mm.

Female morphology. Similar in most respects to male (see Figs. 2B, C, 3B), except for sexual characters; abdomen broader, all somites and telson freely articulated; vulvae (Fig. 3D) moderate in size, oval, positioned on thoracic sternite 6, mid-way between sutures 5/6, 6/7, membrane nearly completely covering gonopores. Chelipeds, in particular meri, relatively shorter than in the male; dark pigmentation limited to fingers of chela.

Coloration (Fig. 1)**.** Carapace reddish-brown, symmetrically specked with yellow on anterior regions and anterolateral margins. Cornea of eyes also reddish-brown. Chelipeds same color as carapace, meri banded alternately with reddish-brown and dirty white; fingers dark brown except, at tips which are white, dark brown pigment extending onto palm in males. Ambulatory meri banded reddish-brown and dirty white, with dirty white bands at joints of carpi, propodi and dactyli. Long, stiff setae on ambulatory legs yellow. See also a colour photo of an uncollected specimen from Indonesia (Humann & DeLoach 2010: 185).

Remarks. The occurrence of *Linnaeoxantho acanthomerus* in the Ryukyu and Line Islands (Figs. 1, 2C, D), including one photographic record from Indonesia (no specimens collected; Humann & DeLoach, 2010), significantly widens the range of this species. The type specimens were dredged from a depth of about 54 m, but the new material reveals that this species also occurs at shallower depths (depth range: 10–54 m). From the notes of the collectors of the new material it is also apparent that this species can be found amongst living or dead corals on reef slopes.

Acknowledgements

We would like to thank Rafael Lemaitre and Karen Reed (USNM) and Gustav Paulay, Arthur Anker, John Slapcinsky and Sandy Beemis (UF) for their assistance with specimen loans and museum visits. We also thank the organizers and members of the Kumejima 2009 Expedition, notably Tohru Naruse, as well as Tan Heok Hui and Nguyen Thanh Son for assistance with photography, and Tan Siong Kiat for assistance with specimen cataloguing. The second author acknowledges supporting funds from the Center of Excellence for Marine Bioenviroment and Biotechnology, National Taiwan Ocean University, Keelung; the Faculty of Science, National University of Singapore and the Departmental Investment Fund, Department of Zoology, Natural History Museum, and logistical help from British Airways. Part of this study was funded by the European Distributed Institutes of Taxonomy's (EDIT) third series of Integrating Research Grants which supported an exchange of researchers between the Muséum national d'Histoire naturelle, Paris, National University of Singapore, National Museum of Natural History (Smithsonian Institution), Washington, D.C., The Natural History Museum, London and University of Louisiana at Lafayette. We are grateful for being allowed to undertake part of our research project at the Museum Support Center, Smithsonian Institution (EDIT partner). It was a privilege to have access to this magnificent facility and we are grateful to all the staff for making us most welcome. We also thank Daniéle Guinot and an anonymous reviewer for their helpful comments and suggestions for the improvement of this paper.

References

Alcock, A. (1899) *An account of the deep-sea Brachyura collected by the Indian Marine Survey Ship Investigator.* Trustees of the Indian Museum, Calcutta. i–iv + pp. 1–85, pls. 1–4.

Alcock, A. & Anderson, A.R.S. (1899) Natural history notes from H.M. Royal Indian Marine Survey Ship 'Investigator', Commander T.H. Heming, R.N., commanding. Series III., No. 2. An account of the deep-sea Crustacea dredged during the surveying-season of 1897–98. *Annals and Magazine of Natural History* (7) 3, 1–27.

Balss, H. (1957) Decapoda. VIII. Systematik. *In*: Bronns, H.G. (Ed.), *Klassen und Ordnungen des Tierreichs*, Geest & Portig K.-G., Leipzig, Band 5, Abteilung 1, Buch 7, Lieferung 12, pp. 1505–1672.

Castro, P. & Ng, P.K.L. (2010) Revision of the family Euryplacidae Stimpson, 1871 (Crustacea: Decapoda: Brachyura: Goneplacoidea). *Zootaxa*, 2375, 1–130.

Castro, P., Guinot, D. & Ng, P.K.L. (2010) A new family for *Sotoplax robertsi* Guinot, 1984, with a key to the Goneplacoidea (Crustacea: Decapoda: Brachyura). *Zootaxa*, 2356, 35–56.

Dana, J.D. (1851) Conspectus Crustaceorum quæ in Orbis Terrarum circumnavigatione, Carolo Wilkes e classe Reipublicæ Fœderatæ Duce, lexit et descripsit. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 5, 267–272.

De Grave, S., N.D. Pentcheff, S.T. Ahyong, T.-Y. Chan, K.A. Crandall, P.C. Dworschak, D.L. Felder, R.M. Feldmann, C.H.J.M. Fransen, L.Y.D. Goulding, R. Lemaitre, M.E.Y. Low, J.W. Martin, P.K.L. Ng, C.E. Schweitzer, S.H. Tan, D. Tshudy & R. Wetzer (2009) A classification of living and fossil genera of decapod crustaceans. Raffles Bulletin of Zoology, Supplement

No. 21, 1–109.

Guinot, D. (1967a) Les anciens genres *Micropanope* Stimpson et *Medaeus* Dana. Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. II. *Bulletin du Museum national d'Histoire naturelle,* Paris, sér. 2, 39(2), 345–374.

Guinot, D. (1967b) Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. III. A propos des affinités des genres *Dairoides* Stebbing et *Daira* de Haan. *Bulletin du Museum National d'Histoire Naturelle*, Paris, sér. 2, 39(3), 540–563.

Guinot, D. (1968) Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. IV. Observations sur quelques genres de Xanthidae. *Bulletin du Muséum National d'Histoire Naturelle*, Paris, sér. 2, 39(4), 695–727.

Guinot, D. (1969) Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. VII. Les Goneplacidae (suite et fin). *Bulletin du Muséum national d'Histoire naturelle*, sér. 2, 41(3), 688–724.

Guinot, D. (1971) Recherches préliminaires sur les groupements naturels chez les Crustacés Décapodes Brachyoures. VIII. Synthèse et bibliographie *Bulletin du Muséum national d'Histoire naturelle*, [1970] sér. 2, 42(5) [1970], 1063–1090.

Haan, W. de (1835) Crustacea. *In*: von Siebold, P.F. (Ed.), *Fauna Japonica, sive Descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batava imperium tenent, suscepto, annis 1823–1830 collegit, notis, observationibus et adumbrationibus illustravit P.F. de Siebold. Conjunctis studiis C.J. Temminck et H. Schlegel pro Vertebratis atque W. de Haan pro Invertebratis elaborata Regis auspicus edita*. P.F. v. Siebold. Leiden, Lugundi-Batavorum. Decas II, 25–64, pls. 9–15, 17, C, D.

Humann, P. & DeLoach, N. (2010) *Reef Creature Identification - Tropical Pacific*. Florida, USA: New World Publications, Inc. 497 p.

ICZN, International Commission on Zoological Nomenclature (1999) *International Code of Zoological Nomenclature 4th Edition*. The International Trust for Zoological Nomenclature and The Natural History Museum, London, I–XXIX + 1–306 pp.

Karasawa, H. & Kato, H. (2003) The family Goneplacidae MacLeay, 1838 (Crustacea: Decapoda: Brachyura): systematics, phylogeny, and fossil records. *Paleontological Research*, 7(2), 129–151.

Lai, J.C.Y., Mendoza, J.C.E., Guinot, D., Clark, P.F., Ng, P.K.L. (2011). Xanthidae MacLeay, 1838 (Crustacea: Decapoda: Brachyura) systematics: A multi-gene approach with support from adult and larval morphology. *Zoologischer Anzeiger*, 250(4), 407–448.

MacLeay, W.S. (1838) On the brachyurous decapod Crustacea brought from the Cape by Dr. Smith. In: Smith, A. (Ed.) *Illustrations of the Annulosa of South Africa; being a portion of the objects of natural history chiefly collected during an expedition into the interior of South Africa, under the direction of Dr. Andrew Smith, in the years 1834, 1835. and 1836; fitted out by "The Cape of Good Hope Association for Exploring Central Africa"*. London: Smith, Elder, and Co., 53–71 pp, 2 plates.

Man, J.G. de (1895) Bericht über die von Herrn Schiffscapitän Storm zu Atjeh, an den westlichen Küsten von Malakka, Borneo und Celebes sowie in der Java-See gesammelten Decapoden und Stomatopoden. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Thiere,* 8(4), 485–609.

Manning, R.B. & Holthuis, L.B. (1981) West African brachyuran crabs (Crustacea: Decapoda). *Smithsonian Contributions to Zoology* 306, i–xii, 1–379.

Martin, J.W. & Davis, G.E. (2001). An updated classification of the recent Crustacea. Los Angeles, Natural History Museum of Los Angeles County, Los Angeles. Number 39, x+1–124.

Miers, E.J. (1886) Report on the Brachyura collected by H.M.S. Challenger during the years 1873–1876. *In*: Thomson, C. & J. Murray (Eds.), *Report of the Scientific Results of the Voyage of H.M.S. Challenger during the years 1873–76, Zoology.* Published by Order of Her Majesty's Government, Edinburgh. 17(49), i–l [= 1–50] + 1–362 pp., pls. 1–29.

Milne-Edwards, A., 1880. Études préliminaires sur les crustacés. *In*: Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico, and in the Caribbean Sea, 1877, '78, '79, by the United States Coast Survey Steamer "Blake," Lieut.-Commander C.D. Sigsbee, U.S.N., and Commander J.R. Bartlett, U.S.N., commanding. VIII. *Bulletin of the Museum of Comparative Zoology*, Harvard College, 8(1), 1–68, pls. 1, 2.

Ng, P.K.L., Guinot, D. & Davie, P.J.F. (2008) Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology,* Supplement No. 17, 1–286.

Ng, P.K.L. & Manuel-Santos, M.R. (2007) Establishment of the Vultocinidae, a new family for an unusual new genus and new species of Indo–West Pacific crab (Crustacea: Decapoda: Brachyura: Goneplacoidea), with comments on the taxonomy of the Goneplacidae. *Zootaxa*, 1558, 39–68.

Rafinesque, C.S. (1815) *Analyse de la nature ou Tableau de l'Univers et des Corps Organisés*. Imprimerie de Jean Barravecchia, Palerme, 224 pp.

Rathbun, M.J. (1898) The Brachyura of the biological expedition to the Florida Keys and the Bahamas in 1893. *Bulletin from the Laboratories of Natural History, State University of Iowa*, 4(3), 250–294, pls. 1–9.

Rathbun, M.J. (1911) Marine Brachyura. *In*: The Percy Sladen Trust Expedition to the Indian Ocean in 1905 under the leadership of Mr. J. Stanley Gardiner. Vol. III. No. IX. *Transactions of the Linnaean Society of London*, *Zoology* 14(2), 191–261, pls. 15–20.

Rathbun, M.J. (1930) The cancroid crabs of America of the families Euryalidae, Portunidae, Atelecyclidae, Cancridae, and

Xanthidae. *Bulletin of the United States National Museum*, 152, 1–609.

Serène, R. (1965) *Guide for Curators of Brachyuran Collections in Southeast Asia*. Applied Scientific Research Corporation of Thailand, Bangkok, 65 pp.

Serène, R. (1968) The Brachyura of the Indo–West Pacific region. *In*: *Prodromus for a Check-list of the (Non-planctonic) Marine Fauna of South East Asia*. Singapore: Singapore National Academy of Science and UNESCO Regional Center for Science and Technology for Southeast Asia. 120 p.

Serène, R. & Lohavanijaya, P. (1973) The Brachyura (Crustacea: Decapoda) collected by the Naga Expedition, including a review of the Homolidae. *Naga Report. Scientific Results of Marine Investigations of the South China Sea and the Gulf of Thailand*, 4(4), 1–186, pls. 1–21.

Števčić, Z. (2005) The reclassification of brachyuran crabs (Crustacea: Decapoda: Brachyura). *Fauna Croatica*, 14 (Supplement 1), 1–159.

Stimpson, W. (1858) Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Septentrionalem, a Republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit. Pars IV. Crustacea Cancroidea et Corystoidea. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 10, 31–40.

Stimpson, W. (1871) Preliminary report on the Crustacea dredged in the Gulf Stream in the Straits of Florida by L.F. de Pourtales, Assist. U. S. Coast Survey. Part I. Brachyura. *Bulletin of the Museum of Comparative Zoölogy at Harvard College*, 2, 109–160.

Studer, T. (1883) Verzeichniss der wahrend der Reise S.M.S. *Gazelle* an der weskuste von Afrika, Ascension und dem Cap der Guten Hoffnung Gesammelten Crustaceen. *Abhandlungen der Klasse Preussischen Akademie der Wissenschaften, Berlin*, 1882, 1–32.

Tesch, J.J. (1918) The Decapoda Brachyura of the Siboga Expedition. II, Goneplacidae and Pinnotheridae. *Siboga Expéditie*, 39(C1), 149–296, pls. 7–18.

Williams, A.B. (1984) *Shrimps, Lobsters, and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida*. Washington, D.C.: Smithsonian Institution Press. 550 pp.

Zootaxa 3367: 222–231 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Two new species of *Indopinnixa* Manning & Morton, 1987 (Decapoda: Brachyura: Pinnotheridae) from the Ryukyu Islands, Japan*

TOHRU NARUSE[1] & TADAFUMI MAENOSONO[2]

[1] *Transdisciplinary Research Organization for Subtropical and Island Studies, University of the Ryukyus, 870 Uehara, Taketomi, Okinawa 907-1541, Japan. E-mail:naruse@lab.u-ryukyu.ac.jp*

[2] *Kankyosha, 1-4-5-102 Kyozuka, Urasoe, Okinawa 901-2111, Japan. E-mail: maenosono@kankyo-sha.co.jp*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Two new species of pinnotherid crabs of the genus *Indopinnixa* Manning & Morton, 1987, are described from Kume and Okinawa islands, Ryukyu Islands, Japan. The new species are distinguished from congeners as well as allied *Pinnixa* species by a combination of characters of the carapace, male abdominal somites, ambulatory legs, and/or male first gonopod.

Key words: *Indopinnixa*, new species, Pinnotheridae, Kumejima, Okinawa, Ryukyu Islands, taxonomy

Introduction

The pinnotherid genus *Pinnixa* White, 1846, is a very speciose group found mainly on the western Atlantic and eastern Pacific coasts of South to North America; with only 6 out of 56 species found in Indo-Pacific waters (Coelho 2005; Komatsu & Takeda 2009; Manning & Morton 1987; Ng *et al*. 2008; Sakai 1934; Stimpson 1858;). *Indopinnixa* Manning & Morton, 1987, a genus closely allied to *Pinnixa*, currently contains only four species: *I. sipunculana* Manning & Morton, 1987, *I. mortoni* Davie, 1992, both from Hong Kong, *I. kasijani* Rahayu & Ng, 2010, and *I. moosai* Rahayu & Ng, 2010, both from Lombok, Indonesia. Manning & Morton (1987) separated *Indopinnixa* from *Pinnixa* mainly by the presence of fusion of the male fifth and sixth abdominal somites. However, of the 56 recognised species of *Pinnixa* (Komatsu & Takeda 2009; Ng *et al*. 2008), several *Pinnixa* from the New World are known to possess various degrees of fusion of the male abdominal somites (Table 1). This suggests that *Indopinnixa* may need to be redefined at a later date. For example, within *Pinnixa*, Manning & Felder (1989) recognised a *P. cristata*-complex with distinct morphological features. It appears likely that when a global revision of the genus will necessitate the splitting of the group. Recently we obtained two undescribed species of pinnothereliine crabs from the Ryukyu Islands, which are referable to *Indopinnixa* as presently defined.

The measurements provided, in millimeters, are carapace length (CL) and carapace width (CW) respectively. The abbreviations G1, G2 and P2–P5 are used for the male first and second gonopods and second to fifth pereiopods, respectively. Specimens examined are deposited in the Ryukyu University Museum, Fujukan (URMF), Okinawa, Japan; and the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research, National University of Singapore.

Accepted by Tin-Yam Chan: 30 Aug. 2011; published: 4 Jul. 2012

TABLE 1. Degree of fusion of the male abdominal somites in *Indopinnixa* Manning & Morton, 1987, and *Pinnixa* White, 1846.

Species	Male abdomen	Type locality	Reference
Indopinnixa kumejima **n. sp.**	3–6 functionally fused, all borders visible	Kumejima, Ryukyu Islands	Present study
I. oryza **n. sp.**	4–6 functionally fused, all borders visible	Okinawa, Ryukyu Islands	Present study
I. sipunculana Manning & Morton, 1987	5 & 6 fused	Hong Kong	Manning & Morton (1987: 544, fig. 1E)
I. mortoni Davie, 1992	5 & 6 fused, suture visible	Hong Kong	Davie (1992: 355, fig. 1F)
I. kasijani Rahayu & Ng, 2010	5 & 6 fused, suture visible	Lombok, Indonesia	Rahayu & Ng (2010: fig. 3C)
I. moosai Rahayu & Ng, 2010	5 & 6 fused, suture visible	Lombok, Indonesia	Rahayu & Ng (2010: fig. 6E)
Pinnixa rapax Bouvier, 1917	2–5 immobile	Brazil	Bouvier (1917: 393)
P. transversalis (H. Milne Edwards & Lucas, 1842)	Some of 3–6 usually partially fused	Chile	Rathbun (1918: 132, fig. 75)
P. plectrophoros Glassell, 1935	3–6 fused	Sonora, Mexico	Glassel (1935: 102)
P. faxoni Rathbun, 1918	4–6 fused	Trinidad	Rathbun (1918: 133, fig. 77)
P. darwini Garth, 1960	4–6 fused	Galapagos	Garth (1960: 41, fig. 1E)
P. leptosynaptae Wass, 1968	4–6 fused	Florida	Wass (1968: 139, fig. 2)
P. pembertoni Glassell, 1935	4–6 fused	Baja California	Glassel (1935: 103)
P. floridana Rathbun, 1918	5/6 and 3/4 fused to each other	Florida	Rathbun (1918: fig. 82)
P. bahamondei Garth, 1957	4–6 showing some degree of fusion	Chile	Garth (1957: 75, fig. 5)
P. arenicola Rathbun, 1922	4–6 incompletely fused	Curaçao	Rathbun (1924: 17, fig. 4); Thoma *et al.* (2009: 78, fig. 1a, 2b, d)
P. vanderhorsti Rathbun, 1922	4–6 fused	Curaçao	Rathbun (1924 17, fig. 2)

Taxonomic account

Family Pinnotheridae De Haan, 1833

Subfamily Pinnothereliinae Alcock, 1900

Indopinnixa Manning & Morton, 1987

Indopinnixa kumejima n. sp.

(Figs. 1–3)

Material examined. Holotype: male, 2.7 × 6.5 mm, RUMF-ZC-1397, off Shimajiri, Kume Island, Ryukyu Islands, Japan, KUMEJIMA 2009 stn. Dredge 69, 26°19.054´N 126°48.702´E – 26°18.958´N 126°48.724´E, 5.6–13.1 m, mud, coll. KUMEJIMA 2009, 18 Nov. 2009. Paratypes: 1 male, 2.4 × 5.6 mm, ZRC 2010.0181, 1 male, 1.8 × 4.0 mm, RUMF-ZC-1398, same data as holotype.

Description. Carapace (Figs. 1a, 2a) elliptical, CW 2.30–2.39 times CL, dorsal surface concave at gastric region and along posterolateral margin of mesobranchial region, with one transverse ridge on cardiac region, leaving some distance from posterolateral margin, anterolateral margin inserted onto carapace toward postorbital region, junction between antero- and posterolateral margins produced laterally, placed just anterior to base of P4.

Front narrow, slightly wider than orbit, frontal margin straight. Supraorbital and infraorbital margins continuous, entire; inner orbital tooth indistinct.

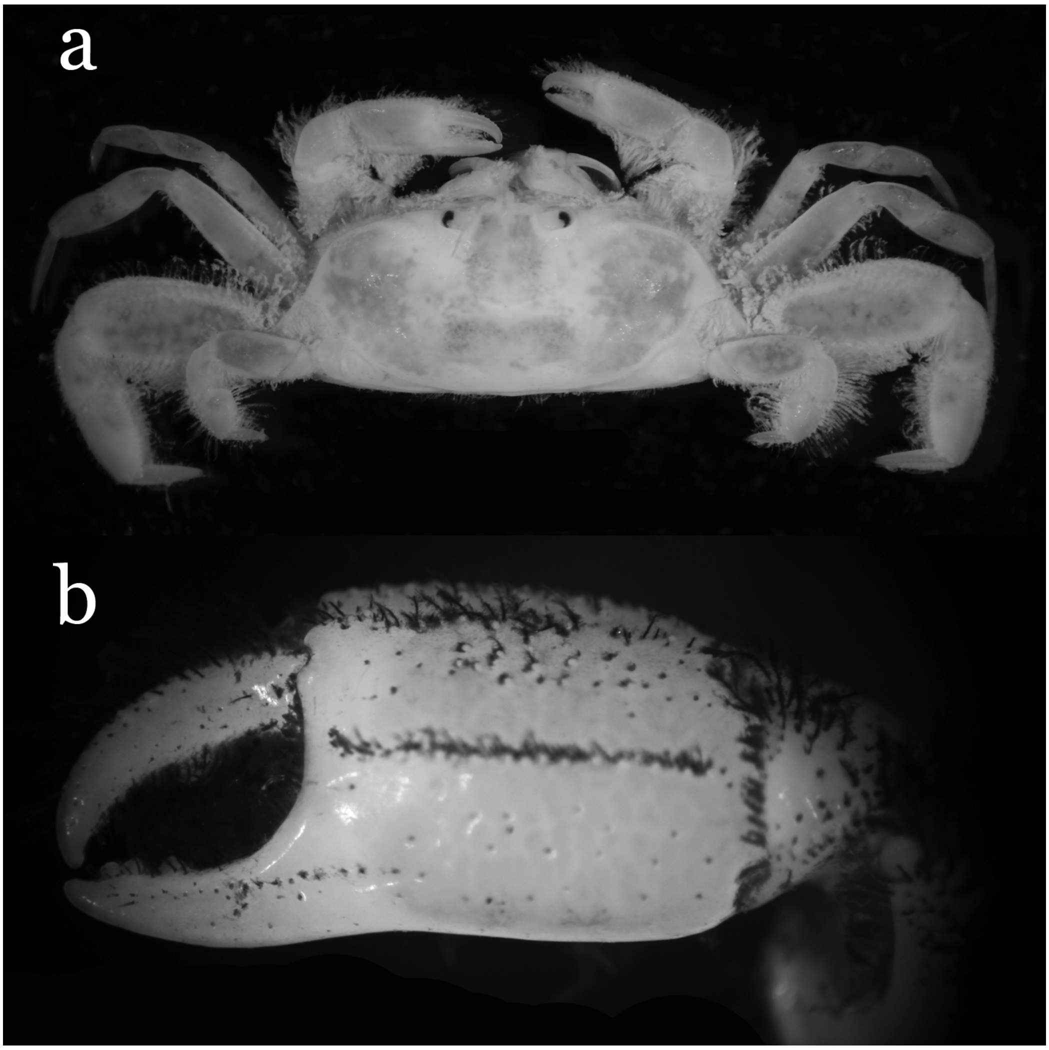


FIGURE 1. Holotype of *Indopinnixa kumejima* **n. sp.**: a, habitus; b, left chela.

Epistome with median triangular projection on posterior margin. Antennule set transversely. Antenna distally intruded into orbit. Eye subcircular, short, with distinct cornea. Third maxilliped (Fig. 2b) with ischium and merus fused; palp large, propodus and dactylus tongue-shaped, dactylus attached to subproximal part of lateral margin of propodus; mesial margin of dactylus and distal margins of propodus and carpus with long setae; exopod simple, reaching distal end of ischium-merus, with long flagellum.

Chelipeds (Fig. 1a) relatively large, subequal. Merus with lower and upper margins setose, lower inner margin dilated, lamellar, lower surface concave, chela partially fit in concave part when folded. Carpus with distal margin setose. Chela (Figs. 1b, 2c) relatively large, rather compressed laterally, proximal part of inner surface setose, palm with outer lower surface smooth, glabrous, with 2 longitudinal rows of setae on middle and near upper margin of outer surface; upper surface sparsely granulated. Fingers about half-length of palm, extensor and occlusal margins setose; immovable finger with 3 basally-fused teeth subdistally, movable finger with 1 triangular tooth medially and few smaller teeth. Ambulatory legs fringed with short setae, P2, P3 similar in shape, P4 (Figs. 1a, 2d) longest, stoutest, P5 (Figs. 1a, 2e) shortest; merus of P4, P5 with dense mat of setae on posterior margin, P4 with both upper and lower margins of posterior surfaces of meri and both upper and lower margins of inner surface of propodi lined with granules, hollowed between margins.

Sternoabdominal cavity deep, continuous to buccal cavern. Margin of sternoabdominal cavity with buttons on posterior angle of thoracic sternites 4 and angle between sternites 6 and 7, buttons corresponding to lateral concavities of sixth and fourth abdominal somites when abdomen closed, forming locking mechanism. Penis sternal.

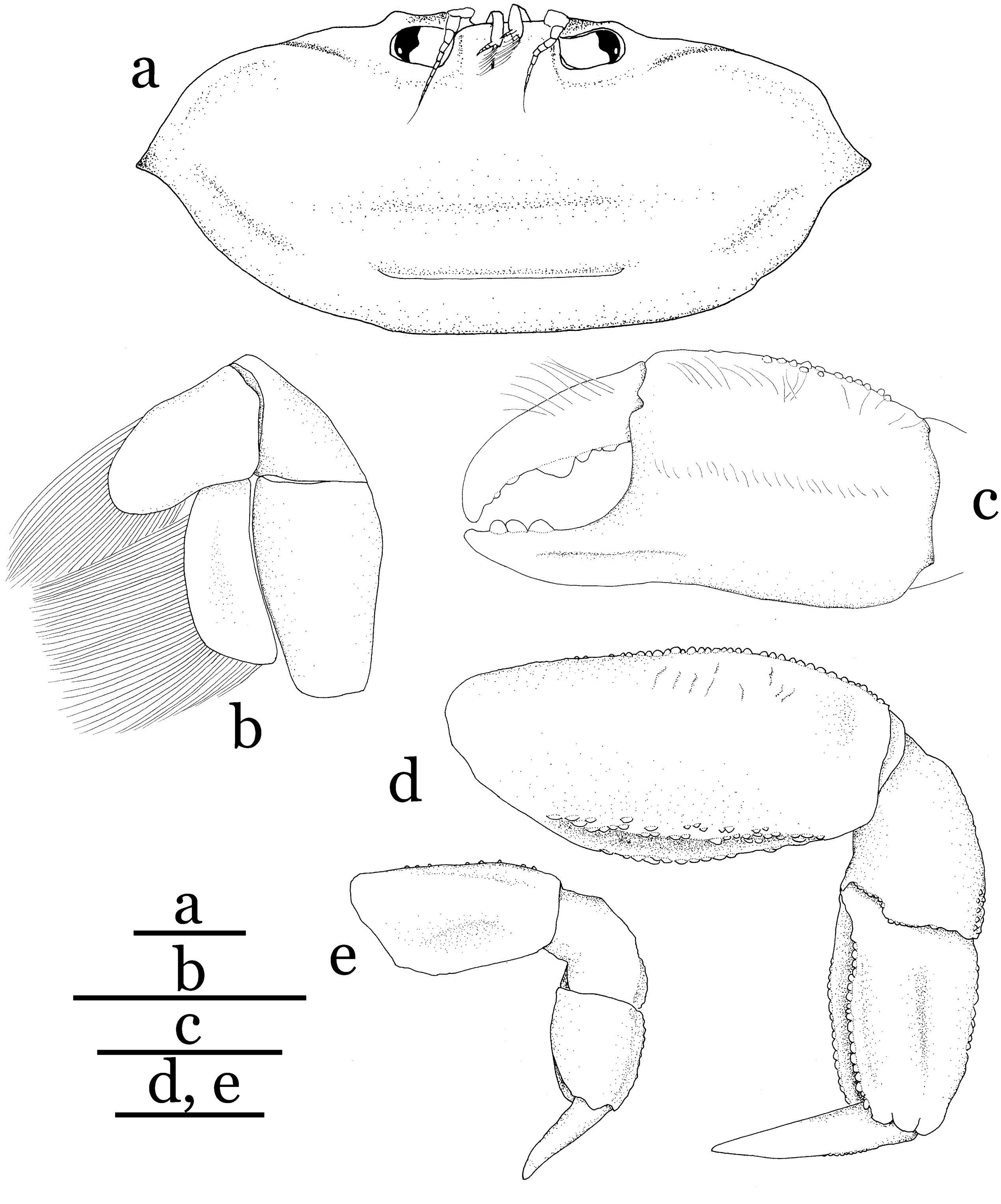


FIGURE 2. Holotype of *Indopinnixa kumejima* **n. sp.**: a, carapace, dorsal view; b, left third maxilliped; c, left chela; d, right fourth pereiopod (denuded); e, right fifth pereiopod (denuded). Scales: a–e = 1 mm.

Male abdomen (Fig. 3a) with first somite partially concealed under posterior margin of carapace; third somite convergent distally; third to sixth somites externally demarcated by shallow grooves but functionally fused, lateral margins of fourth and sixth somites concave; telson as wide as third somite, distally rounded, longer than sixth somite, distal margin weakly concave medially. G1 (Fig. 3b, c) gradually curved outwards, distal tip scoop-like, with concave surface on mesial side. G2 (fig. 3d) small.

Etymology. The new species is named after Kumejima (= Kume Island), the type locality of the species. The name is used as noun in apposition.

Ecological note. Speicmens of *Indopinnixa kumejima* **n. sp.** were collected by dredging at a depth of 5.6 – 13.1 m with a muddy substratum.

Remarks. *Indopinnixa kumejima* **n. sp.** can be distinguished from *I. sipunculana* Manning & Morton, 1987, and *I. mortoni* Davie, 1992, by the presence of a transverse ridge on intestinal region of the carapace (Fig. 2a). Moreover, *I. kumejima* **n. sp.** has a proportionately much wider carapace (CW 2.30–2.39 times CL) (vs. 1.83 (male) to 2.15 (female) times in *I. sipunculana*; 1.75 times in *I. mortoni*) (Davie 1992; Manning & Morton 1987). Rahayu & Ng (2010) described two *Indopinnixa* species from Lombok, Indonesia, both of which have a transverse ridge on the intestinal region of the carapace. *Indopinnixa kumejima* **n. sp.**, however, can be differentiated by its relatively wider carapace (CW 2.30–2.39 times CL) (vs. 1.92 (male) and 2.0 (female) times in *I. kasijani*; 1.83–2.00 times in *I. moosai*) (Rahayu & Ng 2010). The shape of the G1 is also diagnostic. The G1 of *I. kumejima* **n. sp.** is gently curving outwards, with spoon-shaped apical process, concave surface on mesial side (Fig. 3d, c). The apical process of *I. kasijani* is sinuous, while that of *I. moosai* is almost straight with rounded distal tip (Rahayu & Ng 2010: figs. 3A, B, 6A–D).

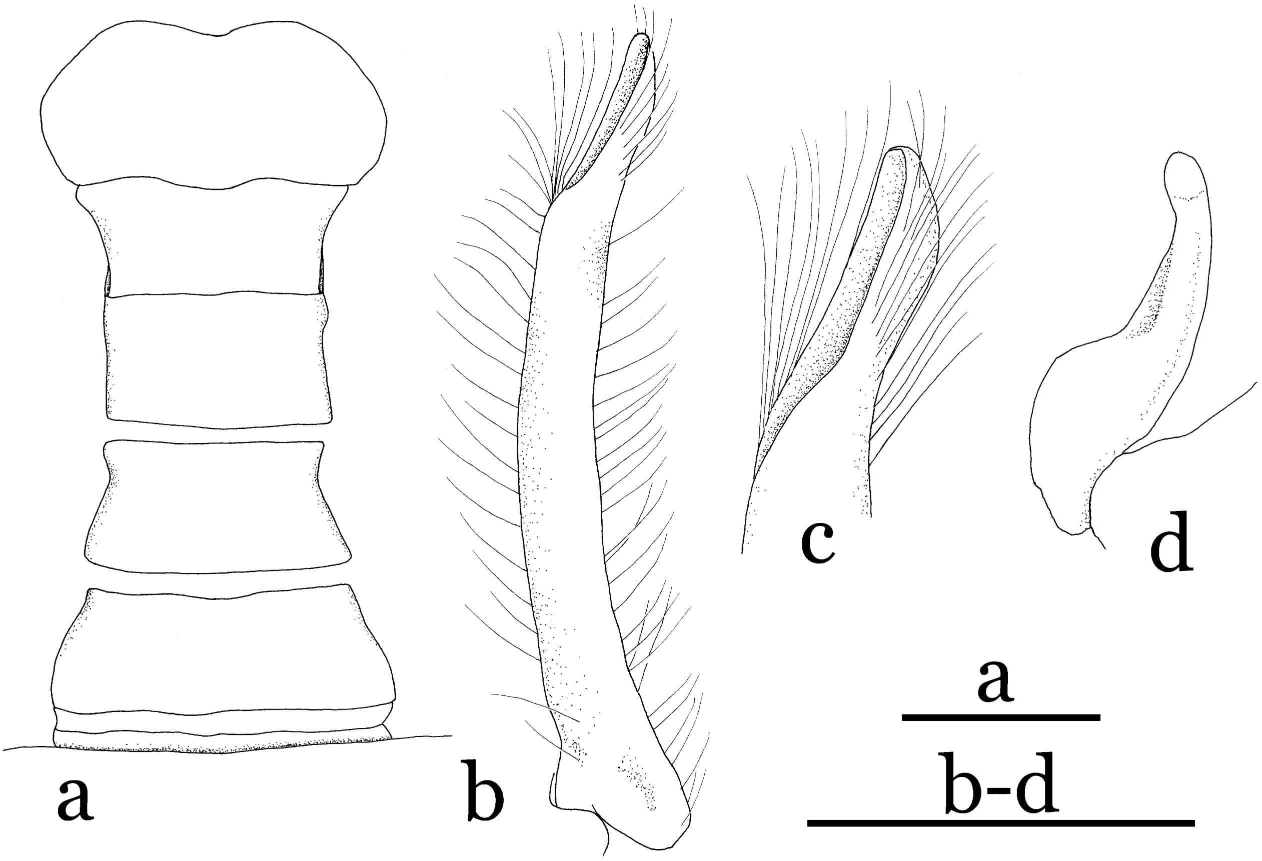


FIGURE 3. Holotype of *Indopinnixa kumejima* **n. sp.**: a, male abdomen and telson; b, left G1, ventral view; c, distal tip of left G1, ventral view; d, left G2, dorsal view. Scales: a, b = 1 mm; c, d = 0.5 mm.

Pinnixa pembertoni Glassell, 1935, and *P. penultipedalis* Stimpson, 1858, are perhaps close to *I. kumejima* **n. sp.** *Pinnixa pembertoni* was described based on a single male specimen from Baja California. The fusion of male fourth to sixth abdominal somites links this species to *Indopinnixa*. However, the disjunct distribution of *P. pembertoni* from western Pacific *Indopinnixa* spp., and the lack of a figure or photograph makes it difficult to determine its generic position. *Indopinnixa kumejima* **n. sp.** can be still separated from *P. pembertoni* by the relatively broader carapace (CW 2.30–2.39 times CL in the new species vs. about two times in *P. pembertoni*) and the condition of the fusion of the male abdominal somites (third to sixth somites are functionally fused in the new species vs. fourth to sixth somites are fused in *P. pembertoni*) (Figs. 1a, 2a, 3a; Glassell 1935: 102). *Pinnixa penultipedalis* was described by a single female specimen from Hong Kong. Since the key character of *Indopinnixa* is the fusion of male abdominal somite, it is again impossible to clarify its generic position. The new species differs from *P. penultipedalis* in the proportionally wider carapace (CW 2.30–2.39 of CL vs. 2.11 in *P. penultipedalis*), cardiac ridge not reaching lateral margin of the carapace rather than spanning the whole breadth in *P. penultipedalis*), and the proportionally narrower P4, with merus about half as broad as long (vs. four-fifths as broad as long in *P. penultipedalis*) (Figs. 1a, 2a, d; Stimpson 1858: 54; 1907: 143).

An opportunity is taken here to comment on the taxonomy of *P. penultipedalis*. Manning & Morton (1987) pointed out that *P. penultipedalis* sensu Shen (1937) is not *P. penultipedalis* s. s., because "Shen's species, which probably is undescribed, differs from *P. penultipedalis* … in lacking a distinct ridge across the posterior part of the carapace" (Manning & Morton 1987: 545). Other than the transverse ridge of the carapace, the most characteristic feature of *P. penultipedalis* is the very wide merus of P4, which is about four-fifth as wide as long (Stimpson 1858; 1907). Although several authors have recorded "*P. penultipedalis*" from Japan (Nagasaki: Ortmann 1904; Harimanada, eastern Seto Inland Sea: Watanabe & Tanida 2001; Oki Island, Sea of Japan: Yamauchi & Konishi 2005), China (Tsangkou, Shan Dong Province: Shen 1937), and even from Mozambique (Inhambane: Barnard 1955), it is probable that none of these records are *P. penultipedalis* s. s. The specimens recorded by Shen (1937), Watanabe & Tanida (2001) and Yamauchi & Konishi (2005) possess a transverse ridge only on the cardiac region, instead of a distinct ridge that spans the whole width of the posterior part of the carapace. The specimens recorded by Ortmann (1904) and Barnard (1955) may have such a complete ridge on the carapace, but the carapace is too narrow (CW 1.95 times CL in Ortmann 1904; 1.86 times in Barnard, 1955) when compared with *P. penultipedalis*. Sakai (1976) had already doubted the identity of Ortmann's (1904) specimen of *P. penultipedalis* without further comment. Even among these non-*P. penultipedalis* specimens, there are species-level differences. For example, although Shen's (1937) specimen possesses tubercles on the upper surfaces of the cheliped palm and movable fingers, such tubercles are not described for the specimens of Yamauchi & Konishi (2005). This suggests that the specimens previously identified as *P. penultipedalis* may actually belong to several undescribed species. Their taxonomy will need to be revised in the future. In any case, all these taxa differ from *I. kumejima* **n. sp.**

***Indopinnixa oryza* n. sp.**

(Figs. 4–6)

Material examined. Holotype: male, 2.6 × 4.3 mm, RUMF-ZC-1394, Inanse, Urasoe, Okinawa Island, Ryukyu Islands, Japan, coll. T. Maenosono, 5 Jul. 2009. Paratypes: 1 male, 2.1 × 3.5 mm, RUMF-ZC-1395, 1 male, 2.0 × 3.3 mm, ZRC 2010.0179, Sesoko Island, Ryukyu Islands, Japan, coll. T. Maenosono, 16 May 2009; 1 ovig. female, 2.2 × 3.8 mm, RUMF-ZC-1396, Sesoko Island, Ryukyu Islands, Japan, coll. T. Maenosono, 8 June 2009; 1 ovig. female, 1.8 × 3.1 mm, ZRC 2010.0180, Sesoko Island, Ryukyu Islands, Japan, coll. T. Maenosono, 7 May 2009.

Description. Carapace (Fig. 4a) suboval, CW 1.62–1.77 times CL, dorsal surface slightly convex longitudinally and transversely, scattered with setae, antero- and posterolateral margins continuous, lateral margin cristate except for anterior and posterior portions. Front sloping anteroventrally, frontal margin straight. Supraorbital and infraorbital margins continuous, entire, inner orbital tooth indistinct, orbit short, fully occupied by eye (Fig. 5a).

Epistome with median tooth on posterior margin. Antennule set transversely. Antenna with basal article posteriorly protruding beyond posterior margin of epistome, distally intruded into orbit. Eye subcircular, short, with distinct cornea. Third maxilliped (Fig. 5b) with ischium and merus fused; palp large, palp segments in similar length, propodus and dactylus tongue-shaped, dactylus attached to subproximal part of lateral margin of propodus; mesial margin of dactylus and distal margins of propodus and carpus with long setae; exopod simple, reaching distal quarter of ischium-merus, with long flagellum.

Chelipeds subequal, scattered with setae; chela (Fig. 5c) moderately large, palm with outer lower surface smooth, glabrous, outer upper surface setose, fingers slightly longer than half the length of palm; immovable finger nearly straight, occlusal margin blade-like, except for pointed tip; movable finger deflexed subdistally, extensor surface granulated. Ambulatory legs fringed with short setae, P2, P3 and P5 similar in shape, P5 (Fig. 5e) shortest, P4 (Fig. 5d) longest and stoutest; merus of P4 relatively stout, anterodistal angle roundly expanded.

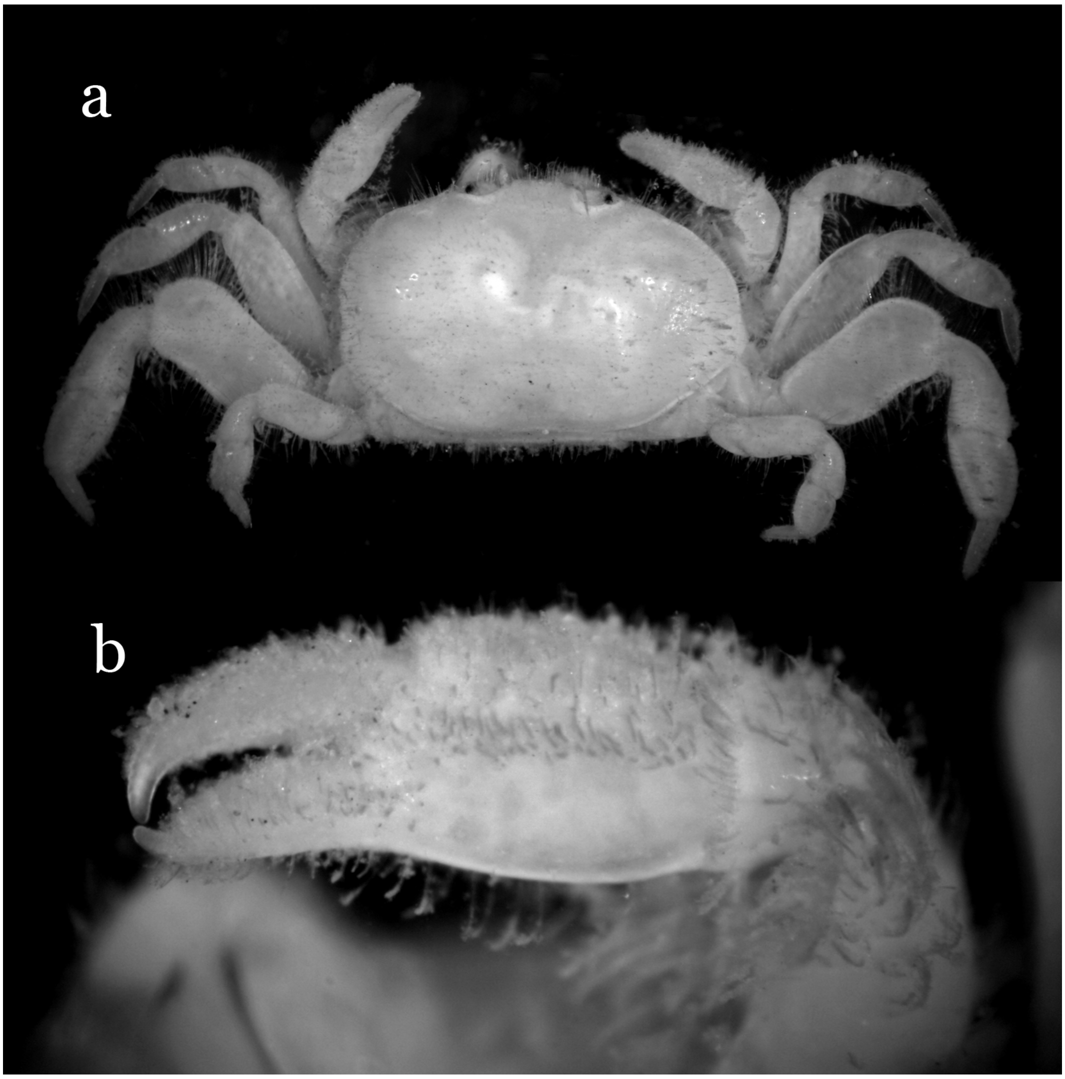


FIGURE 4. Holotype of *Indopinnixa oryza* **n. sp.**: a, habitus; b, left chela.

Sternoabdominal cavity deep, continuous to buccal cavern. Margin of sternoabdominal cavity with one button on thoracic sternites 4 and 5 each, with longitudinal ridge along sternites 6 to 7, buttons and distal end of ridges corresponding to lateral end of sutures of abdominal somites or telson, forming locking mechanism. Penis sternal. Male abdomen (Fig. 6a) with first somite concealed under posterior margin of carapace; third somite convex laterally; fourth to sixth somites externally demarcated by shallow grooves but functionally fused, lateral margins of each somite concave, fourth and fifth somites with bud-like pleopods; telson distally rounded, longer than sixth somite, slightly wider than sixth somite. G1 (Fig. 6b, c) gently arching, apical process beak-like, process directed outwards. G2 (Fig. 6d) small.

Etymology. The species name “oryza” (= rice) alludes to the shape of the carapace of the new species. The name is used as noun in apposition.

Ecological note. Specimens of *Indopinnixa oryza* **n. sp.** were collected from a subtidal (1 m) silty reduced layer under buried rock. Although sipunculan worms and peanut worms were collected from the same habitat, it remains unknown whether *I. oryza* **n. sp.** is commensal with these worms.

Remarks. *Indopinnixa oryza* **n. sp.** can be differentiated from *I. sipunculana* and *I. mortoni* by its beak-like and outwardly directed apical process of the G1 (Fig. 6b, c) and functionally fused fourth to sixth abdominal somites of male (Fig. 6a) (Rahayu & Ng 2010: figs. 3A–C, 6A–E). In addition, the anterolateral margin of *I. oryza* **n. sp.** is nearly entire, with very slight notch (Fig. 4a), whereas *I. sipunculana* and *I. mortoni* possess a distinct notch (Manning & Morton 1987: fig. 1A; Davie 1992: fig. 1C).

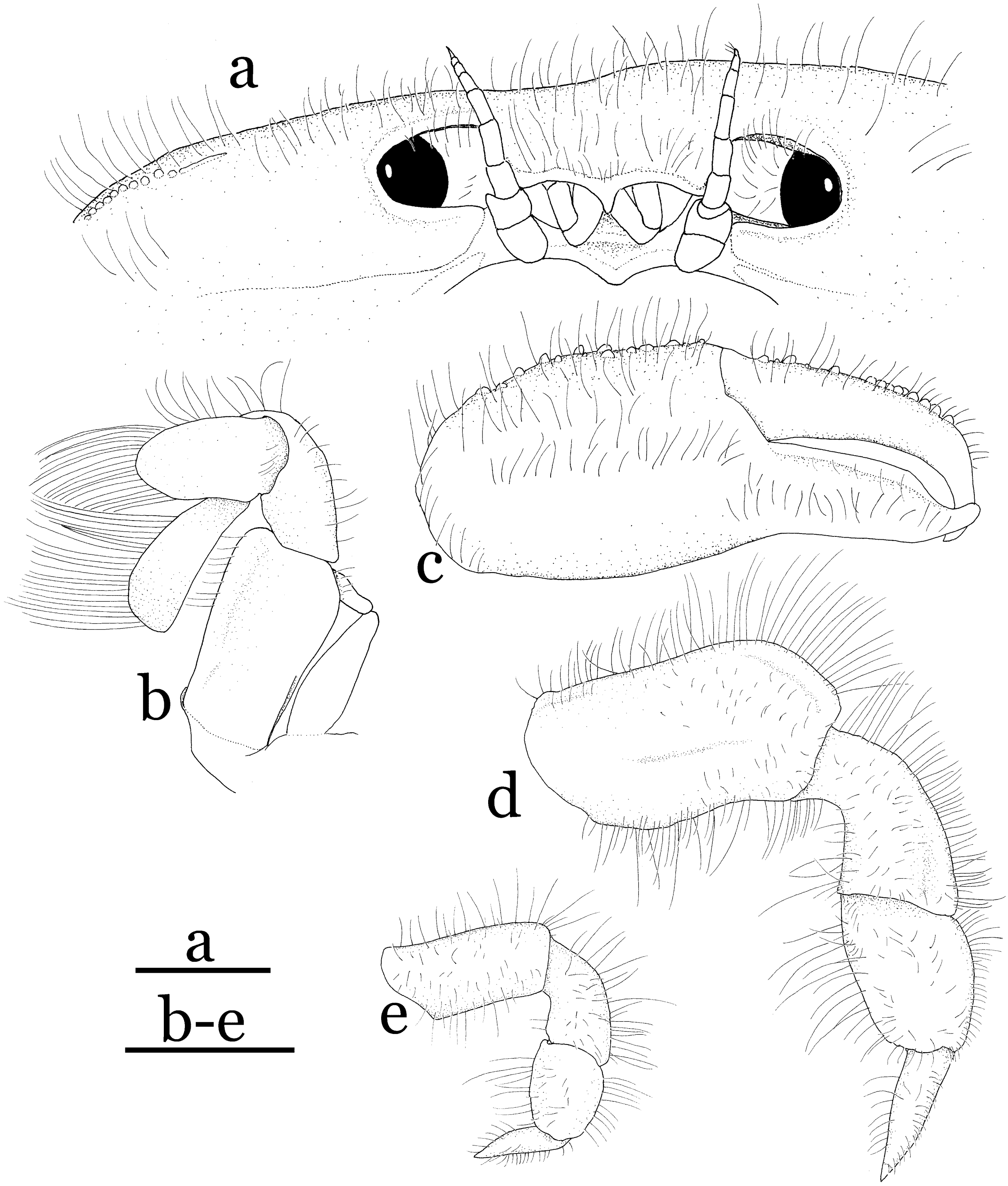


FIGURE 5. Holotype of *Indopinnixa oryza* **n. sp.**: a, cephalothorax, anterior view; b, left third maxilliped; c, right chela; d, right fourth pereiopod; e, right fifth pereiopod. Scales: a–e = 0.5 mm.

Indopinnixa oryza **n. sp.** is morphologically similar to some *Pinnixa* species, such as *P. leptosynaptae* Wass, 1968, from Florida, and *P. darwini* Garth, 1960, from Galapagos Islands, in their relatively narrow carapace, fused fourth to sixth abdominal somites of male, and proportionally similar lengths of pereiopods (Wass 1968: figs. 1, 2; Garth 1960: fig. 1A, E). *Indopinnixa oryza* **n. sp.**, however, can be differentiated from *P. leptosynaptae* by the smooth dorsal surface of the carapace (Fig. 4a) (vs. having four transverse ridges in *P. leptosynaptae*; Wass 1968: fig. 1), the beak-like apical process of the G1 (Fig. 6b, c) (vs. without differentiated tip in *P. leptosynaptae*; Wass

1968: fig. 6), the presence of sutures on the outer sides of fused abdominal somites (Fig. 6a) (vs. without sutures on the outer sides of fused abdominal somites in *P. leptosynaptae*; Wass 1968: fig. 2), and prominently projected lobe of the subdistal portion of the anterior margin of P4 merus (Fig. 5d) (vs. not prominently projected in *P. leptosynaptae*; Wass 1968: fig. 1). In addition, *I. oryza* **n. sp.** can be differentiated from *P. darwini* by the rounded telson (Fig. 6a) (vs. triangular in *P. darwini*; Garth 1960: fig. 1E) and prominently projected lobe of the subdistal portion of the anterior margin of P4 merus (Fig. 5d) (vs. not prominently projected in *P. darwin*; Garth 1960: fig. 1A).

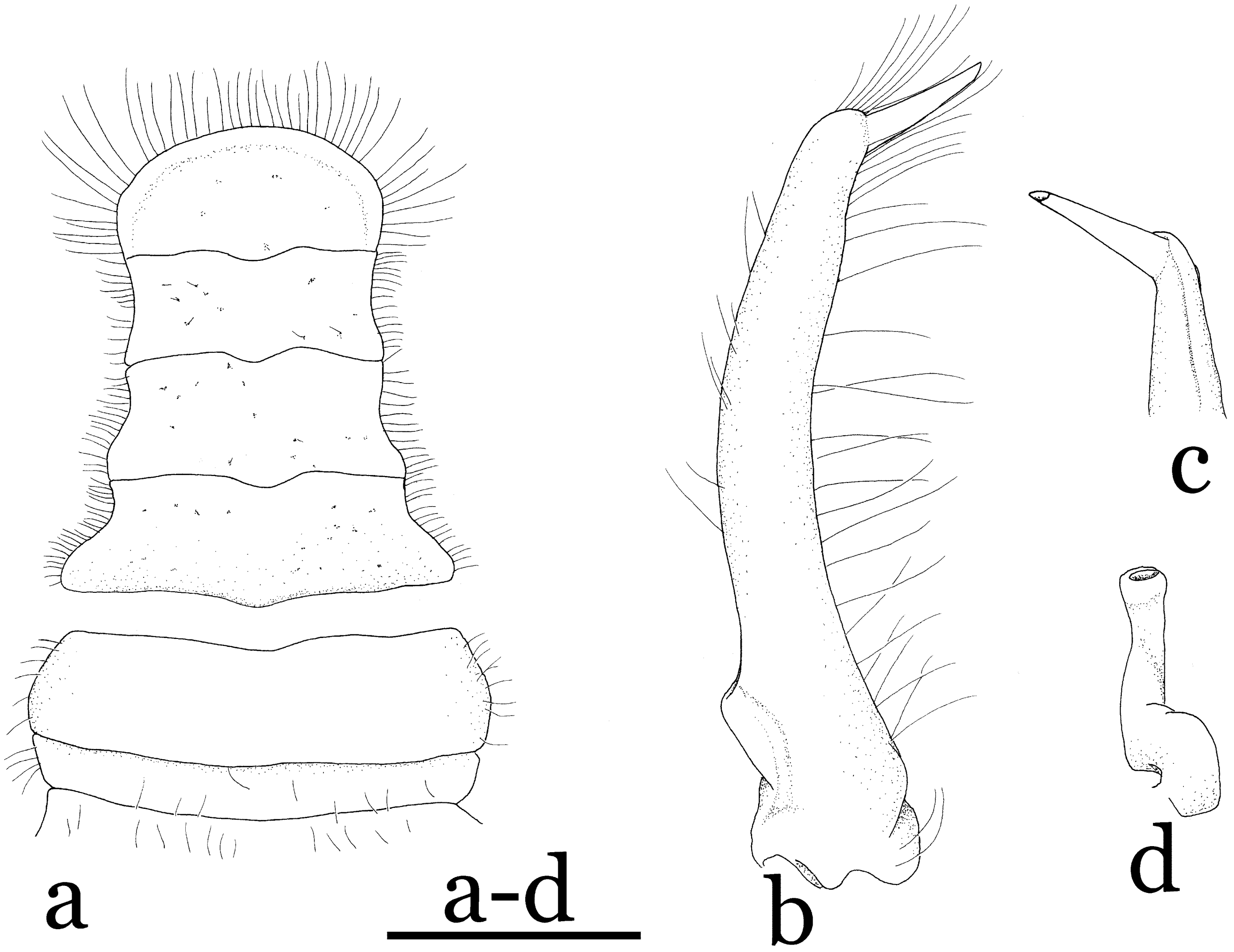


FIGURE 6. Holotype of *Indopinnixa oryza* **n. sp.**: a, abdomen and telson; b, left G1, ventral view; c, distal tip of left G1, dorsal view; d, left G2, ventral view. Scales: a = 1 mm; b–d = 0.5 mm.

Acknowledgements

We thank Peter K. L. Ng (National University of Singapore) and Tomoyuki Komai (Natural History Museum and Institute, Chiba) for their suggestions which improved this paper.

A part of the material examined was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition was operated under a permit granted to T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative.

References

Alcock, A. (1900) Materials for a carcinological fauna of India No. 6. The Brachyura Catometopa or Grapsoidea. *Journal of the Asiatic Society of Bengal*, 69(3), 279–456.

Barnard, K.H. (1955) Additions to the fauna-list of South African Crustacea and Pycnogonida. *Annals of the South African Museum*, 43(1), 1–107.

Bouvier, E.-L. (1917) Gonoplacidés et Pinnothéridés nouveaux recueillis au cours des campagnes Américaines du “Hassler” et du “Blake”. *Bulletin du Muséum national d’Histoire naturelle*, Paris, 23(1–7), 391–398.

Coelho, P.A. (2005) Descrição de *Austinixa bragantina* sp. nov. (Crustacea, Decapoda, Pinnotheridae) do litoral do Pará, Brasil. *Revista Brasileira de Zoologia*, 22(3), 552–555.

Davie, P.J.F. (1992) A new species and new records of intertidal crabs (Crustacea: Brachyura) from Hong Kong. *In*: Morton, B. (ed.), *The marine flora and fauna of Hong Kong and southern China III. Proceedings of the Fourth International Marine Biological Workshop: The Marine Flora and Fauna of Hong Kong and Southern China, Hong Kong*. Hong Kong University Press, Hong Kong, pp. 345–359.

Garth, J.S. (1957) Reports of the Lund University Chile Expedition 1948–49. 29. The Crustacea. Decapoda Brachyura of Chile. *Lunds Universitets Årsskrift*, new series, Section 2, 53(7), 1–130, pls. 1–4.

Garth, J.S. (1960) *Pinnixa darwini*, a new species of pinnotherid crustacean from the Galapagos Islands. *Pacific Science*, 14(1), 39–42.

Glassell, S.A. (1935) New or little known crabs from the Pacific Coast of Northern Mexico. *Transactions of the San Diego Society of Natural History*, 8(14), 91–106, pls. 9–16.

Komatsu, H. & Takeda, M. (2009) A new species of the genus *Pinnixa* (Decapoda: Brachyura: Pinnotheridae) from Otsuchi Bay, northeastern Japan. *Bulletin of the National Museum of Natural Science*, Series A, Supplement 3, 199–204.

Mannning, R.B. & Felder, D.L. (1989) The *Pinnixa cristata* complex in the Western Atlantic, with descriptions of two new species (Crustacea: Decapoda: Pinnotheridae). *Smithsonian Contributions to Zoology*, 473, i–iii, 1–26, frontispiece.

Manning, R.B. & Morton, B. (1987) Pinnotherids (Crustacea: Decapoda) and leptonaceans (Mollusca: Bivalvia) associated with sipunculan worms in Hong Kong. *Proceedings of the Biological Society of Washington*, 100(3), 543–551.

Milne Edwards, H. & Lucas, H. (1842–1844) Crustacés. *In*: d’Orbigny, A. (ed.), *Voyage dans l’Amerique méridionale (le Brésil, la république orientale de l’Uruguay, la république Argentine, la Patagonie, la république du Chili, la république de Bolivia, la république du Pérou), exécutée pendant les années 1826, 1827, 1828, 1829, 1830, 1831, 1832 et 1833*. P. Bertrand, Vve Levrault, Paris, Strasbourg, vol. 6(1), 1–37, pls. 1–17.

Ng, P.K.L., Guinot, D. & Davie, P.J.F. (2008) Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology*, Supplement 17, 1–286.

Ortmann, A. (1904) Die Decapoden-Krebse des Strassburger Museums, mit besonderer Berükishtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu-Inseln gesammelten und zur Zeit im Strassburger Museum aufbewahrten Formen. VIII Theil. Abtheilung: Brachyura (Brachyura genuina Boas) III. Unterabtheilung: Cancroidea, 2. Section: Cancrinea, 2. Gruppe: Catametopa. *Zoologischen Jahrbücher*, Abtheilung für Systematik, Geographie und Biologie der Tiere, 7, 683–772, pl. 23.

Rahayu, D.L. & Ng, P.K.L. (2010) Two new species of *Indopinnixa* Manning & Morton, 1987 (Crustacea: Brachyura: Pinnotheridae) from Lombok, Indonesia. *Zootaxa*, 2478, 59–68.

Rathbun, M.J. (1918) The Grapsoid crabs of America. *Bulletin of the United States National Museum*, 98, i–xxii, 1–461, 161 plates.

Rathbun, M. J. (1922) New species of crabs from Curaçao. *Proceedings of the Biological Society of Washington*, 35, 103–104.

Rathbun, M. J. (1924) Brachyuran crabs collected at Curaçao. Bijdragen tot de Kennis der Fauna van Curaçao. *In*: Resultaten eener reis van Dr. C.J. van der Horst in 1920. *Bijdragen tot de Dierkunde*, 23, 13–22, pl. 3.

Sakai, T. (1934) Species of the genus *Pinnixa* (Pinnotherid crab) found in the Far East. *Science Reports of the Tokyo Bunrika Daigaku*, Section B, 2, 37–43.

Sakai, T. (1976) *Crabs of Japan and the Adjacent Seas*. Kodansha, Tokyo, xxix+773 pp. [English text] + 461 pp. [Japanese text] + 251 pp. [plate volume].

Shen, C.J. (1937) Second addition to the fauna of brachyuran Crustacea of North China, with a check list of the species recorded in this particular region. *Contributions from the Institute of Zoology, National Academy of Peiping*, 3(6), 277–313.

Stimpson, W., (1859) Prodromus descriptionis animalium evertebratorum quae in Expeditione ad Oceanum Pacificum Septentrionalem a Republica Federata Missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit—Part V, Crustacea Ocypodoidea. *Proceedings of the Academy of Natural Science of Philadelphia*, 10, 93–110.

Stimpson W. (1907) Report on the Crustacea (Brachyura and Anomura) collected by the North Pacific Exploring Expedition 1853–1856. *Smithsonian Miscellaneous Collections*, 49, 1–240.

Thoma, B.P., Heard, R.W. & Felder, D.L. (2009) Redescription of *Pinnixa arenicola* Rathbun, 1922 (Decapoda: Brachyura: Pinnotheridae), with new observations on its range and host. *Proceedings of the Biological Society of Washington*, 122(1), 72–80.

Wass, M.L. (1968) A new pinnixid commensal with a holothurian (Crustacea: Decapoda). *Tulane Studies in Zoology*, 14(4), 137–139.

Watanabe, T. & Tanida, K. (2001) Record of pinnotherid crab, *Pinnixa penultipedalis* Stimpson, 1858 (Crustacea, Brachyura) from Harima-nada, Seto Inland Sea. *Nankiseibutsu*, 43(2), 163–164. [in Japanese]

White, A. (1846) Notes on four new genera of Crustacea. *Annals and Magazine of Natural History*, 18(118), 176–178, pl. 2, figs. 1–6.

Yamauchi, T. & Konishi, K. (2005) Notes on rare *Pinnixa* crabs (Decapoda, Brachyura, Pinnotheridae) of Japan. *Crustaceana*, 77(10), 1237–1243.

Zootaxa 3367: 232–251 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Stomatopod Crustacea of the KUMEJIMA 2009 Expedition, Japan*

SHANE T. AHYONG
Australian Museum, 6 College St., Sydney, NSW 2010, Australia. Email: shane.ahyong@austmus.gov.au

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

The stomatopod Crustacea collected during the KUMEJIMA 2009 expedition to Kume Island, Ryukyu Islands, southern Japan, are reported. The collection comprises 20 species from three superfamilies, six families and 15 genera. Of these 20 species, 10 are new records for Japan, of which one species, *Gonodactylellus kume,* is new to science. The new species ranges from Japan to northern Australia and is most similar to *G. micronesicus* (Manning, 1971), differing in the colour of the meral spot of raptorial claw and shape of the pleopod 1 endopod of adult males. The identities of *Alima angusta* Dana, 1852, and *A. gracilis* H. Milne Edwards, 1837, as junior synonyms of *A. neptuni* Linneaus, 1758, are fixed by neotype selection. A checklist of the 68 species of Stomatopoda recorded from Japan is provided.

Keywords: Stomatopoda, *Gonodactylellus*, *Alima*, Kume, Ryukyus, Japan, Australia, mantis shrimp

Introduction

In November 2009, the KUMEJIMA 2009 expedition explored coral reefs and adjacent environments around Kume Island, Ryukyu Islands, southern Japan. Sampling was conducted using a variety methods including dredge, trawl and on SCUBA. Prior to the present study, 58 species of Stomatopoda were known from Japanese waters, with only 13 species reported from the Ryukyus (Komai 1927, 1940; Moosa 1989; Ahyong *et al.* 2000; Ahyong 2001; Osawa *et al.* 2004; Ahyong *et al.* 2008). The present report details the Stomatopoda collected from Kume Island, comprising 20 species of which one is new to science, 10 are first records for Japanese waters and 15 are first records for the Ryukyus; all are first records for Kume Island.

Materials and methods

Morphological terminology follows Ahyong (2001) and Ahyong *et al.* (2008). All specimen measurements are given in mm. Total length (TL) is measured along the dorsal midline from the tip of the rostral plate to the apices of the submedian teeth of the telson. Carapace length (CL) is measured along the dorsal midline of the carapace and excludes the rostral plate. The abdominal-width carapace-length index (AWCLI) is given as 100 × (width of abdominal somite 5)/CL. Specimens are deposited in the Ryukyu University Museum, Fujukan, Okinawa (RUMF), the Australian Museum, Sydney (AM), the Western Australian Museum, Perth (WAM), the Raffles Museum of Biodiversity Research, National University of Singapore (ZRC) and the National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM). New records for Japan are indicated (*). New records for the Ryukyu Islands are indicated (#)

SYSTEMATICS

GONODACTYLOIDEA Giesbrecht, 1910

GONODACTYLIDAE Giesbrecht, 1910

Accepted by T. Naruse: 18 Jan. 2012; published: 4 Jul. 2012

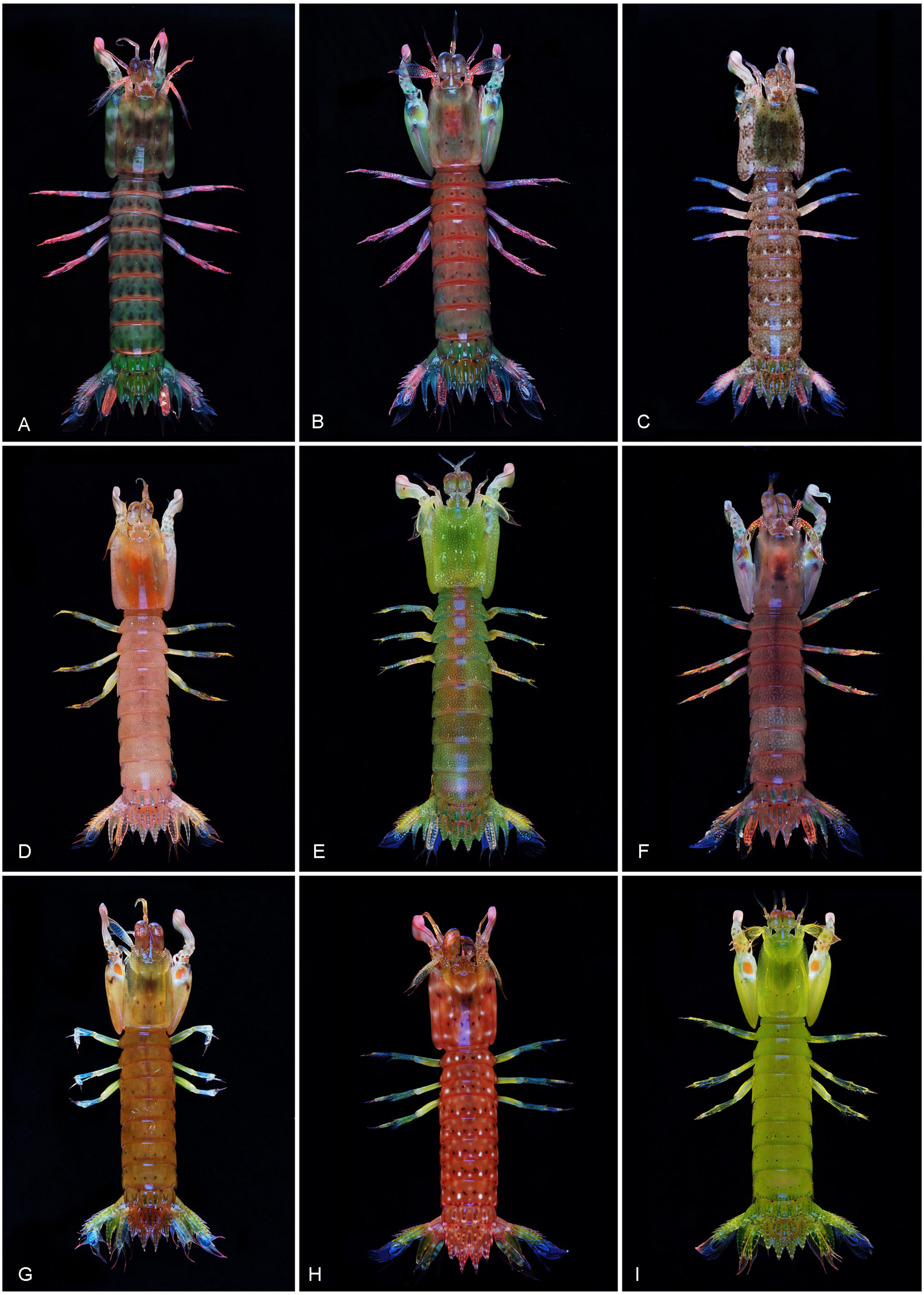


FIGURE 1. Colour variation in *Gonodactylaceus*. *Gonodactylaceus falcatus* (Forskål, 1775): A, male TL 41 mm (RUMF-ZC-01246); B, male TL 33 mm (RUMF-ZC-01241); C, male TL 33 mm (AM P87561); D, female TL 37 mm (RUMF-ZC-01246); E, female TL 42 mm (RUMF-ZC-01246); F, female 26 mm (RUMF-ZC-01246). *Gonodactylaceus glabrous* (Brooks, 1886): G, male TL 25 mm (RUMF-ZC-01249); H, female TL 28 mm (RUMF-ZC-01250); I, female TL 40 mm (RUMF-ZC-01253).

Gonodactylaceus falcatus (Forskål, 1775)

(Fig. 1A–F)

Cancer falcatus Forskål, 1775: 96 [type locality: Djeddah, Red Sea, by neotype selection (Manning & Lewinsohn 1981)].

Gonodactylus glabrous. — Fukuda 1908: 511, pl. 2, fig. 2; 1910: 141; 1913: 72. — Komai 1927: 340 [not *G. glabrous* (Brooks, 1886)].

Gonodactylus falcatus. — Utinomi 1956: 92, pl. 46, fig. 5 (colour plate). — Manning 1965: 260. — Moosa 1989: 224.

Gonodactylus chiragra var. *mutatus* Lanchester, 1903: 450 [type locality: Furnadu Velu, Miladumadulu Atoll, Maldive Islands, 6°00'N, 73°10'E].

Gonodactylus glaber var. *rotundus* Borradaile, 1907: 211–212, pl. 22: fig. 2 [type locality: Coetivy, Seychelles, 7°08'S, 56°16'E, and Zanzibar, 6°10'S, 39°12'E].

Gonodactylus insularis Manning & Reaka, 1982: 347–351, figs. 1, 2 [type locality: Kidrenen Island, Enewetak, 11°22'50"N, 162°10'30"E]. — Moosa 1989: 224.

Gonodactylus aloha Manning & Reaka, 1981a: 190–200, figs. 1–3 [type locality: Oahu, Hawaiian Islands].

Gonodactylus siamensis Manning & Reaka, 1981b: 479–482, fig. 1 [type locality: Sattahip, Gulf of Thailand, 12°40'N 100°52'E].

Gonodactylus takedai Moosa, 1989: 225–226, fig. 1 [type locality: Miyanohama, Chichi-jima, Ogasawara Islands].

Gonodactylaceus gravieri Manning, 1995: 42, 43, 46–48, fig. 13 [type locality: Poulo Condore, Vietnam].

Gonodactylaceus falcatus. — Ahyong 2001: 35–38, fig. 17. — Osawa *et al.* 2004: 7. — Hamano, 2005: 12, 21–22, fig. 2-5a–d. — Ahyong 2007: 334; 2012: 19–22, figs 7, 8.

Material. RUMF-ZC-01241, 1 male (TL 33 mm), 26°19.351–19.305´N, 126°49.673–49.768´E, 14 m, dredge 18, 11 Nov 2009; RUMF-ZC-01242, 2 males (TL 12, 19 mm), 1 female (TL 19 mm), 26°19.907–20.056´N, 126°43.191–42.622´E, 67.5–76.0 m, dead coral rubble, dredge 45, 16 Nov 2009; RUMF-ZC-01243, 1 male (TL 32 mm), 26°20.409–20.018´N 126°49.675–49.224´E, 5.1–4.5 m, dead coral branches, rubble, dredge 52, 17 Nov 2009; RUMF-ZC-01244, 1 male (TL 20 mm), 1 female (TL 27 mm), 26°19.456–19.400´N, 126°49.450–49.182´E, 4.5–9.0 m, dead coral blocks, trawl 54, 17 Nov 2009; RUMF-ZC-01245, 1 female (TL 18 mm), 26°19.442–19.378´N, 126°49.211–49.198´E, 4.7–9.5 m, dredge 55, 17 Nov 2009; RUMF-ZC-01246, 2 males (TL 21–41 mm), 4 females (TL 26–42 mm), 26°19.360´N 26°19.294´N, 126°49.204´E 126°49.192´E, 7.5–4.7 m, dead coral blocks, rubble, dredge 56, 17 Nov 2009; RUMF-ZC-01247, 1 male (TL 14 mm), 26°19.622–19.424´N, 126°49.511–49.450´E, 9.4–12.5 m, rubble, seaweed, dredge 57, 17 Nov 2009; RUMF-ZC-01248, 1 female (TL 18 mm), 26°19.553–19.463´N, 126°49.510–49.491´E, 9.1–13.3 m, sand, dredge 58, 17 Nov 2011; AM P87561, 1 male (TL 33 mm), 1 female (TL 26 mm), 26°20.307–20.158´N, 126°49.360–49.334´E, 5.1–6.4 m, trawl 59, 18 Nov 2009; ZRC 2011.0823, 2 females (TL 10, 27 mm), 26°19.095–18.898´N, 126°49.008–48.969´E, 10.1–17.1 m, sand, mud, dredge 68, 19 Nov 2009.

Remarks. *Gonodactylaceus falcatus* is widely distributed in the Indo-West Pacific and has already been reported from Japanese waters, including the Ryukyus. All males exceeding TL 12 mm exhibit sexually modified endopods on pleopod 1. The overall body colouration of *G. falcatus* is highly variable but also sexually dimorphic. In males, each somite usually has a transverse row of 4–6 dark spots or patches that become proportionally larger with increasing size; females lack these dark patches; the meral spot of raptorial claw in both sexes is yellow (Fig. 1A–F).

Distribution. Western Indian Ocean to Hawaii (introduced) including Australia, New Zealand and Japan; intertidal to at least 23 m (Ahyong 2001).

Gonodactylaceus glabrous (Brooks, 1886)*#

(Fig. 1G–I)

Gonodactylus glabrous Brooks, 1886: 22, 64, pl. 14: fig. 5, pl. 15: figs. 7, 9 [type locality: Samboangan reefs, Philippines].

Gonodactylus bossorotundus Roxas & Estampador, 1930: 94, 122, pl. 6: figs. 1, 2 [type locality: Samboangan reefs, Philippines, by neotype designation (Ahyong 2001)].

Gonodactylus chiragra var. *crescentus* Roxas & Estampador, 1930: 94, 120, pl. 5: fig. 3 [type locality: Samboangan reefs, Philippines, by neotype designation (Ahyong 2001)].

Gonodactylaceus glabrous. — Ahyong 2001: 38–40, fig. 18.

Material. RUMF-ZC-01249, 1 male (TL 25 mm), 26°19.714–19.579´N, 126°45.649–45.707´E, 17.9–42.5 m, rubble, dredge 44, 14 Nov 2009; RUMF-ZC-01250, 1 female (TL 28 mm), 26°19.449–19.478´N, 126°45.748–45.800´E, 8.9–9.3 m, dead coral branches, rubble, dredge 51, 16 Nov 2009; RUMF-ZC-01251, 1 female (TL 39 mm), 26°20.409–20.018´N 126°49.675–49.224´E, 5.1–4.5 m, dead coral branches, rubble, dredge 52, 17 Nov 2009; RUMF-ZC-01252, 1 female (TL 29 mm), 26°19.456–19.400´N, 126°49.450–49.182´E, 4.5–9.0 m, dead coral blocks, trawl 54, 17 Nov 2009; RUMF-ZC-01253, 1 female (TL 40 mm), 26°20.307–20.158´N, 126°49.360–49.334´E, 5.1–6.4 m, trawl 59, 18 Nov 2009; AM P87562, 1 female (TL 39 mm), 26°20.307–20.158´N, 126°49.360–49.334´E, 5.1–6.4 m, trawl 59, 18 Nov 2009; ZRC 2011.0820, 2 females (TL 18–19 mm), Koukou-mae (in front of high school), 26°19.885´N, 126°45.616´E, <4 m, mud, dead coral rubble, yabby pump, dive 16, 14 Nov 2009.

Remarks. The specimens represent the first record of *G. glabrous* sensu stricto from Japanese waters. Previous records of *G. glabrous* from Japan (e.g., Fukuda 1908, 1910, 1913) are based on *G. falcatus*. *Gonodactylaceus glabrous* exhibits highly variable body patterning similar to that of *G. falcatus* reported above, but the meral spot of raptorial claw is orange rather than yellow (Fig. 1G–I).

Distribution. Western Australia, Indonesia, the Philippines and now from Japanese waters; intertidal to 42.5 m.

Gonodactylellus annularis Erdmann & Manning, 1998*#

(Fig. 2A)

Gonodactylellus annularis Erdmann & Manning, 1998: 617–618, fig. 1b [type locality: Kapoposang, Spermonde, Indonesia]. — Ahyong 2001: 48–49, fig. 22. — Ahyong & Naiyanetr 2002: 283.

Material. RUMF-ZC-01255, 1 male (TL 14 mm), 1 female (TL 16 mm), 26°19.789–19.733´N, 126°52.103–52.070´E, 18.7–20.5 m, rubble, dredge 61, 18 Nov 2009; RUMF-ZC-01256, 1 female (TL 9 mm), 26°19.517–19.513´N, 126°45.797–45.782´E, 9.6–13.2 m, dead coral branches, rubble, dredge 50, 16 Nov 2009; RUMF-ZC-01257, 1 male (TL 9 mm), 26°19.456–19.400´N, 126°49.450–49.182´E, 4.5–9.0 m, dead coral blocks, trawl 54, 17 Nov 2009.

Remarks. The specimens agree well with published accounts and represent the first record from Japanese waters. The ocular scales are partially fused, having a small median emargination. The 9 mm male (RUMF-ZC-01257) is a juvenile, having short penes and an unmodified pleopod 1 endopod.

Distribution. Andaman Sea, Thailand to Indonesia, northern Australia and now from Kume, southern Japan; 4.5–20.5 m.

Gonodactylellus kume sp. nov.*#

(Fig. 2B–F, 3)

Gonodactylus incipiens. — Moosa, 1991: 158 [part, not *G. incipiens* (Lanchester, 1903)].
Gonodactylellus micronesicus. — Ahyong 2001: 57, fig. 27A–I [part, Indian Ocean and Lizard Island specimens only]; 2007: 334. [Not *G. micronesicus* (Manning, 1971)]

Type material. HOLOTYPE: RUMF-ZC-01262, male (TL 22 mm), 26°19.449–19.478´N, 126°45.748–45.800´E, 8.9–9.3 m, dead coral branches, rubble, dredge 51, 16 Nov 2009. PARATYPES: RUMF-ZC-01272, 1 male (TL 17 mm), 26°19.449–19.478´N, 126°45.748–45.800´E, 8.9–9.3 m, dead coral branches, rubble, dredge 51, 16 Nov 2009; RUMF-ZC-01258, 1 female (TL 19 mm), Umagai, 26°20.769´N, 126°51.506´E, 5–50 m, Dive 1, 9 Nov 2009; RUMF-ZC-01259, 1 male (TL 17 mm), Nanguchi, 26°18.536´N, 126°50.402´E, < 25 m, dead coral rubble, reef-end, dive 8, 11 Nov 2009; RUMF-ZC-01260, 1 male (TL 19 mm), 1 female (TL 20 mm), 26°18.330–18.351´N, 126°49.730–49.734´E, 27–28 m, 27–28 m, trawl 15, 11 Nov 2009; RUMF-ZC-01261, 1 female (TL 19 mm), Umagai, 26°20.769’N, 126°51.506’E, 55 m, dive 1b, 9 Nov 2009; RUMF-ZC-01267, 1 male (TL 16 mm), Tengoku-to-Zigoku, 26°19.421´N, 126°45.733´E, 6–8 m, dive 37, 19 Nov 2009; AM P87563, 2 males (TL 15–21 mm), 26°19.714–19.579´N, 126°45.649–45.707´E, 17.9–42.5 m, rubble, dredge 44, 14 Nov 2009; RUMF-ZC-01263, 1 female (TL 16 mm), 26°19.502–19.494´N, 126°45.570–45.796´E, 50–11.4 m, dead coral branches, rubble, dredge 49, 16 Nov 2009; ZRC 2011.0824, 1 male (TL 17 mm), 1 female (TL 14 mm), 26°19.517–19.513´N, 126°45.797–45.782´E, 9.6–13.2 m, dead coral branches, rubble, dredge 50, 16 Nov 2009; AM P87564, 1 female (TL 21 mm; with gastropod *Caledoniella* and rhizocephalan parasites), Imazuni, 53 m, SCUBA, 10 Nov 2009.

Other material. AUSTRALIA: AM P84085, 1 male (TL 16 mm), Wall of Fish, Yonge Reef, outer Great Barrier Reef, Queensland, 14°34.8’S, 145°37.2’E, 27 m, coral rubble, coll. M. Porter *et al.*, 2 Jun 2010; WAM C45805, 1 female (TL 22 mm), Cassini, 13°57.094’S, 125°37.447’E, 2 m, st. 37/K10-T4, coll. Skipton, 18 Oct 2010. PAPUA NEW GUINEA: AM P64464, 1 female (TL 18 mm, with gastropod *Caledoniella*), Horseshoe Reef, Bootless Inlet, 9°30.5’S 147°15.5’E, base of reef slope, outer face, coral rubble with some *Padina*, 30 m, PNG-21, coll. S. Arnam & J. Lowry, 28 Oct 1980; AM P64468, 1 female (TL 15 mm), north end of Kiriwinna Island, Papua New Guinea, poison station, coll. Collette, Goldman & Palmer, 7 Jun 1970. SOLOMON ISLANDS: AM P64465, 1 male (TL 10 mm), between Tandai & Koilo Points, Guadalcanal, Solomon Islands, 09°22.5'S 159°52.2'E, airlift over small encrusted coral heads on grey sand, 15 m, SI-2, coll. R. Springthorpe 24 Sep 1991.

Diagnosis. Ocular scales separate, subtriangular, apices rounded. Rostral plate basal portion anterolateral angles rounded; lateral margins divergent anteriorly. Raptorial claw dactylus without proximal notch in adults. Thoracic somite 6 lateral processes truncate ventrally, wider than that of thoracic somite 7. Pleopod 1 endopod with indistinct lateral lobe on posterior endite; lateral lobe narrow, small, margin continuous with or hardly breaking from general outline of distal ‘endite’. Telson surface without dorsal spinules; intermediate teeth apices extending posteriorly well beyond apices of intermediate denticles; intermediate carina extending anteriorly beyond midlength of accessory median carina; emargination between submedian and intermediate teeth acute; lateral teeth indicated by a shallow notch; median carina with small posterior tubercle or spinule, otherwise unarmed dorsally; accessory median carinae unarmed, extending anteriorly to about midlength of median carina or to posterior one-third in males with inflated median carina; anterior submedian carinae extending anteriorly as far as base of median carina; knob present.

Description. Eyes elongate; cornea subconical. Ocular scales separate, subtriangular, apices rounded. Antennular peduncle length 0.63–0.73 CL. Antennal scale length 0.38–0.42 CL.

Rostral plate as long as wide or longer than wide; basal portion with transverse or slightly sloping posteriorly; anterolateral angles rounded; lateral margins divergent anteriorly; median spine longer than base, without ventral keel.

Raptorial claw dactylus without proximal notch on outer margin in adults; propodus with proximal movable spine, opposable margin sparsely pectinate proximally.

Mandibular palp 3-segmented.

Thoracic somite 6 lateral processes truncate ventrally, wider than that of thoracic somite 7. Thoracic somite 8 anterolateral margin rounded; sternal keel obsolete.

Pleopod 1 endopod with indistinct lateral lobe on posterior ‘endite’; lateral lobe narrow, small, usually evenly rounded (obtusely angular in holotype), margin continuous with or hardly breaking from general outline of distal ‘endite’, demarcated at most by small notch.

Abdominal somite 1–5 posterolateral angles unarmed. AWCLI 688–752. Abdominal somite 6 with posteriorly armed submedian, intermediate and lateral bosses.

Telson as wide as or wider than long, surface without dorsal spinules; with 10–14 spiniform submedian denticles. Submedian teeth unarmed dorsally, dorsal carina relatively slender. Intermediate teeth distinct, apices sharp, extending posteriorly well beyond apices of intermediate denticles; intermediate carina slender, extending anteriorly beyond midlength of accessory median carina; emargination between submedian and intermediate teeth acute. Lateral teeth indicated by a shallow notch, apex angular to blunt, not projecting well off margin of telson. Median carina more strongly inflated in males than in females; with small posterior tubercle or spinule, otherwise unarmed dorsally. Accessory median carinae unarmed, extending anteriorly to about midlength of median carina or to posterior one-third in males with inflated median carina. Anterior submedian carinae smooth, unarmed, straight or slightly arcuate, extending anteriorly as far as base of median carina. Knob present. Telson ventral surface without carinae on submedian or intermediate teeth.

Uropodal protopod terminal spines with outer spine longer. Uropodal exopod proximal segment outer margin with 9–11 movable spines, distalmost spine exceeding apex of distal segment; inner margin setose; distal margin with ventral spine; exopod distal segment rounded, entire margin setose. Uropodal endopod narrow, length 3.29–3.71 breadth; with low dorsolateral carina; entire margin setose.

Colour in life. (Fig. 2B–F) Overall body colour variable, ranging from mottled pale green to red. Raptorial claw dactylus pink-orange; meral spot red.

Measurements. Males (n = 10) TL 10–22 mm, females (n = 9) TL 14–22 mm. Other measurements of holotype: CL 4.6 mm, antennular peduncle 3.1 mm, antennal scale 1.8 mm, abdominal somite 5 width 3.2 mm.

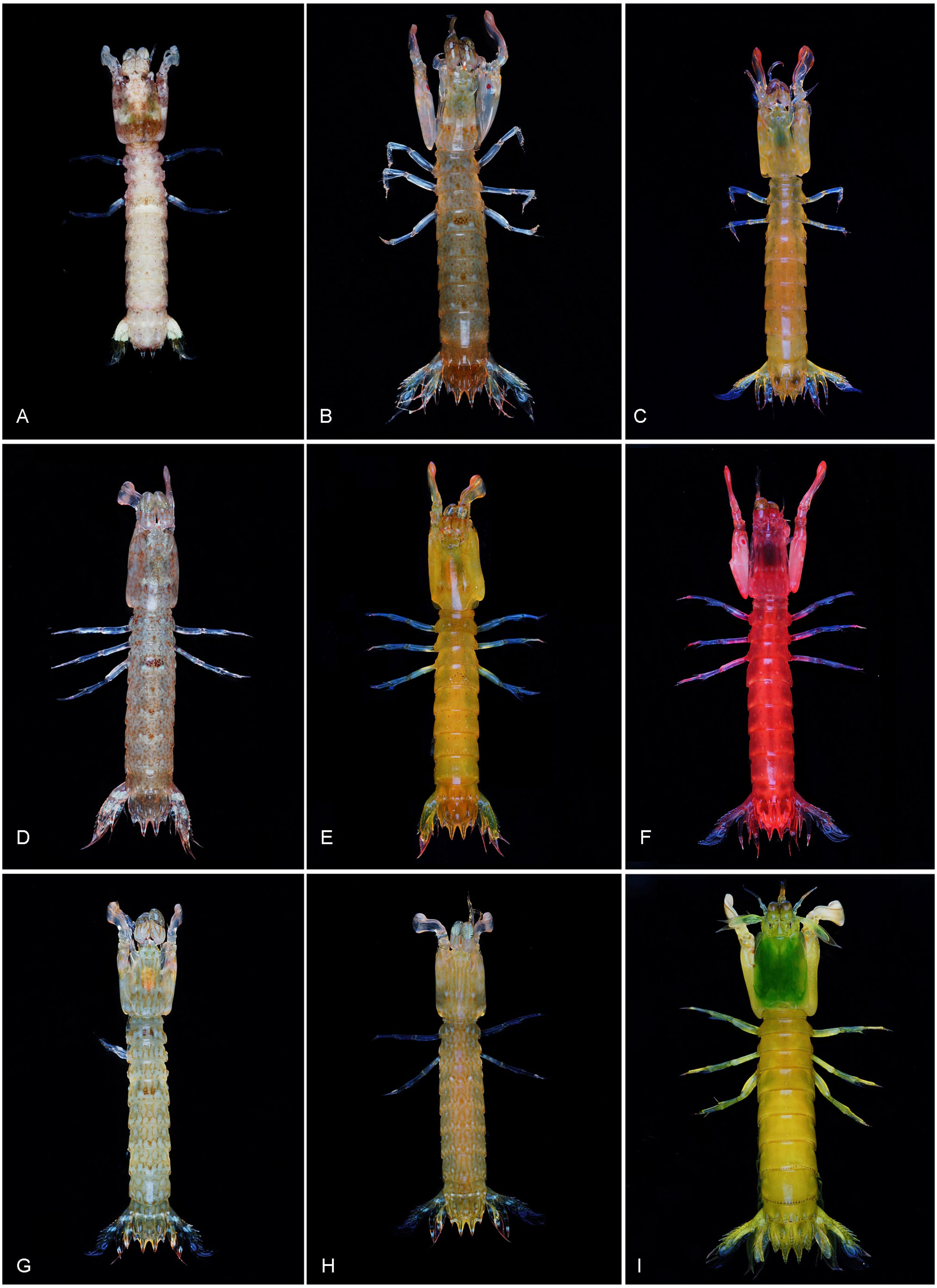


FIGURE 2. A, *Gonodactylellus annularis* Erdmann & Manning, 1998, female TL 16 mm (RUMF-ZC-01255); B–F, *Gonodactylellus kume* sp. nov., (B) female paratype TL 19 mm (RUMF-ZC-01258), (C) female paratype TL 19 mm, (RUMF-ZC-01261), (D) male paratype TL 17 mm (RUMF-ZC-01259), (E) male holotype TL 22 mm (RUMF-ZC-01262), (F) male paratype TL 19 mm (RUMF-ZC-01260); G–H, *Gonodactylellus rubriguttatus* Erdmann & Manning, 1998, female TL 16 mm (ZRC 2011. 0822), female TL 27 mm (RUMF-ZC-01266); I, *Gonodactylellus viridis* (Serène, 1954), female TL 37 mm (RUMF-ZC-01270).

FIGURE 3. *Gonodactylellus kume* sp. nov. A–J, male holotype, TL 22 mm (RUMF-ZC-01262). K, male paratype, TL 14 mm (ZRC 2011.0824). L, female paratype, TL 21 mm (AM P87564). M, male paratype, TL 21 mm (AM P87564). A, anterior cephalothorax. B, ocular scales. C, right antennal protopod. D, right raptorial claw. E, thoracic somites 6–8, right lateral view. F, posterior abdominal somites, telson and right uropod. G, abdominal somites 4–5, right posterolateral angles. H, telson, right lateral view. I, right uropod, ventral view. J, right pleopod 1 endopod, anterior view. K, outline of rostral plate and ocular scales. L, telson. M, distolateral margin of right pleopod 1 endopod, anterior view. Scale A–I, L = 1.0 mm; J–K, M = 0.5 mm.

Etymology. Named after the expedition and type locality, Kume; used as a noun in apposition.

Remarks. Prior to this study, *Gonodactylellus* Manning, 1995, contained 21 species from the Indo-West Pacific (Ahyong 2001, 2008, 2012; Ahyong & Erdmann 2007). *Gonodactylellus kume* sp. nov. most closely resembles *G. micronesicus* (Manning, 1971) and *G. rubriguttatus* Erdmann & Manning, 1998, sharing unarmed accessory median carinae on the telson, which extend anteriorly to near the midlength of the median carina. The separate instead of fused ocular scales distinguish *G. kume* and *G. micronesicus* from *G. rubriguttatus*. The red instead of white meral spot of the raptorial claw distinguishes *G. kume* and *G. rubriguttatus* from *G. micronesicus*. Male *G. kume* differ from both *G. micronesicus* and *G. rubriguttatus* in having an indistinct lobe on the outer margin of the distal 'endite' of the pleopod 1 endopod. The lateral lobe in *G. kume* is narrow, with its margin continuous with or hardly breaking from the general outline of the distal 'endite' (demarcated at most by small notch; Fig. 3J, M)), rather than projecting laterally as a prominent flap (strongly demarcated by a deep notch) as in *G. rubriguttatus* and *G. micronesicus* (see Ahyong 2001: 29J; 2002a: fig. 3F). Whilst both sexes of *G. kume* differ from *G. rubriguttatus* by the separate instead of fused ocular scales, specimens of female *G. kume* in which the colour is faded will be difficult to distinguish from *G. micronesicus*.

As in other species of *Gonodactylellus*, the telson carinae of adults are sexually dimorphic. Telson carinae in females and early adult males are relatively slender, whereas those of large males are more inflated, with the median carina tumid, largely obscuring the accessory median carinae. In these large males, the anterior ends of the accessory median carinae are subsumed by the median carina and thus reach anteriorly only as far as the posterior one-third instead of the midlength of the median carina. Males in the present series range from TL 10–21 mm; all have fully developed penes and modified pleopod 1 endopods. The proximal notch on the outer margin of the dactylus of the raptorial claw is distinct in juveniles, faint or indistinct by TL 15 mm, and absent above TL 15 mm. Two females (TL 18 mm, AM P64464; TL 21 mm, AM P87564) are parasitized by the gastropod mollusc, *Caledoniella montrouzieri* Souverbie, 1869.

Records of *G. micronesicus* from Western Australia, the Cocos-Keeling Islands and New Caledonia (Ahyong 2001, 2007) are referrable to *G. kume* sp. nov. Queensland specimens reported by Ahyong (2001) as *G. micronesicus* are referrable to two species: *G. kume* (Lizard Island specimens) and an undescribed species of *Gonodactylellus* currently under study (non-Lizard Island specimens). This revised distribution of *G. micronesicus* suggests that the species favours oceanic island habitats in the central-western to central Pacific, from Micronesia, Guam and French Polynesia. In contrast, *G. kume* occurs along the western margins of the western Pacific (between Japan and Australia) to the eastern Indian Ocean (between northwestern Australia and the Cocos-Keeling Islands).

Habitat. Coral reef amongst rubble; 8.9–55 m.

Distribution. Western Pacific to eastern Indian Ocean, from southern Japan to Papua New Guinea, the Solomon Islands, New Caledonia and northern Australia.

Gonodactylellus rubriguttatus Erdmann & Manning, 1998*#

(Fig. 2G–H)

Gonodactylus incipiens. — Moosa, 1991: 158 [part].

Gonodactylellus rubriguttatus Erdmann and Manning, 1998: 619–620, fig. 1d [type locality: Tanjung Torosie, Komodo/Rinca, Indonesia]. — Ahyong 2001: 60–61, fig. 29; 2007: 334.

Material. RUMF-ZC-01264, 1 male (TL 18 mm), 26°23.090–22.966´N, 126°47.832–47.937´E, 82.0–81.3 m, rubble, trawl 7, 10 Nov 2009; RUMF-ZC-01265, 1 female (TL 13 mm), 26°22.806–22.670´N, 126°48.035–48.327´E, 68 m, dredge 11, 10 Nov 2009; RUMF-ZC-01266, 1 female (TL 24 mm), 26°16.961–17.028´N, 126°52.508–51.952´E, 136–126 m, trawl 27, 12 Nov 2009; RUMF-ZC-01268, 1 female (TL 19 mm), 26°16.775–16.759´N, 126°48.050–47.810´E, 67.3–73.3 m, iron anchor, dead coral blocks, rubble, trawl 32, 13 Nov 2009; AM P87565, 2 males (TL 17–23 mm), 1 female (TL 23 mm), 26°19.907–20.056´N, 126°43.191–42.622´E, 67.5–76 m, dead coral blocks, rubble, trawl 45, 16 Nov 2009; ZRC 2011.0821, 1 male (TL 24 mm), 26°19.553–19.463´N, 126°49.510–49.491´E, 9.1–13.3 m, sand, dredge 58, 17 Nov 2011; ZRC 2011. 0822, 1 female (TL 16 mm), 26°19.672–19.698´N, 126°43.328–42.957´E, 101–93.2 m, rubble, dredge 76, 19 Nov 2009; RUMF-ZC-01269, 1 female (TL 14 mm), 26°15.271–15.475´N, 126°47.659–47.224´E, 116–125 m, shells, rubble, dredge 81, 20 Nov 2009.

Remarks. The present specimens are the first record of *G. rubriguttatus* from Japanese waters. The lateral lobe of the distal endite of pleopod 1 is well-developed in all males examined.

Distribution. Northern Australia, Indonesia, New Caledonia and now from Japanese waters; 6–136 m.

Gonodactylellus viridis (Serène, 1954)

(Fig. 2I)

Gonodactylus chiragra var. *viridis* Serène, 1954: 6, 7, 10, 74, 75, 76, 87, fig. 13–3 (type locality: Cauda Bay, Vietnam).
Gonodactylus viridis. — Manning 1978: 4, fig. 2a–c. — Moosa 1989: 226.
Gonodactylellus incipiens. — Manning 1995: 63: fig. 24 [TL 30 mm female only, not *G. incipiens* (Lanchester, 1903)].
Gonodactylinus viridis. — Ahyong & Norrington 1997: 100. — Manning 1995: 66–68, figs. 8c, d, 9c, 10e, 11c, 25a.
Gonodactylellus viridis. — Ahyong 2001: 63–64, fig. 31. — Hamano 2005: 12, 23, fig. 2-5h–j.

Material. RUMF-ZC-01273, 1 male (TL 18 mm), Ara Beach, 26°18'58.9" N, 126°46'26.0"E, intertidal stn 01, 16 Nov 2009; RUMF-ZC-01270, 1 female (TL 37 mm), Shinri Beach, 26°21'13.4" N, 126°42'59.6" E, intertidal stn 3, 18 Nov 2009; RUMF-ZC-01271, 2 males (TL 21–24 mm), 4 females (TL 17–27 mm), Ishidatami, Oh-jima Islet, 26°20'09.6" N, 126°49'29.2" E, intertidal stn 5, 18–19 Nov 2009; AM P87566, 1 female (TL 25 mm), Ishidatami, Oh-jima Islet, 26°20'09.6" N, 126°49'29.2" E, intertidal stn 5, 18–19 Nov 2009.

Remarks. *Gonodactylellus viridis* as currently understood represents a species complex, but the present specimens represent *G. viridis* sensu stricto. Moosa (1989) first recorded *G. viridis* from the Ryukyus.

Distribution. Andaman Sea and northwestern Australia eastwards to Taiwan and Japan; intertidal to shallow subtidal.

Gonodactyloideus cracens Manning, 1984*#

(Fig. 4A)

Gonodactyloideus cracens Manning, 1984: 83–86, fig. 1 [type locality: Northwest Shelf, Western Australia, 19°50'S, 115°34'E]. — Moosa 1986: 379, fig. 3. — Ahyong 2001: 65, fig. 32; 2004: 3.

Material. RUMF-ZC-01276, 1 juvenile female (TL 13 mm), 26°16.600–16.399´N, 126°53.336–53.083´E, 157–166 m, trawl 26, 12 Nov 2009; RUMF-ZC-01254, 1 female (TL 38 mm), 26°23.831–23.590´N, 126°45.685–45.212´E, 95.5–123 m, blocks, rubble, fish, decapods, cnidarians, trawl 70, 19 Nov 2009.

Remarks. The juvenile female differs from the adult in having shorter, less pronounced accessory median carinae on the telson and a posterior spine only on the median carina. The small posterior spines on the accessory median and anterior submedian carinae of the telson characteristic of adult *G. cracens* are incipient in the juvenile. The eyes of the juvenile are slightly compressed dorsoventrally, approaching the adult condition.

Distribution. Northwestern Australia, the Philippines and now from Japan; 80–166 m.

Gonodactylus childi Manning, 1971#

Gonodactylus childi Manning, 1971: 75–77 [type locality: Runit (Yvonne) Island, Eniwetak Atoll, 11°32'47"S 162°21'56"E]. — Ahyong 2001: 67, fig. 33. — Osawa *et al.* 2004: 5–6, fig. 3A–D. — Hamano 2005: 12, 23, fig. 2-5k–m.
Gonodactylus chiragra. — Fukuda 1908: 510 (part); 1910: 141 (part); 1913: 72 (part). — Komai 1927: 338 [part] [Not *G. chiragra* (Fabricius, 1781)].
Not *Gonodactylus childi* Manning, 1971: fig. 1 [paratypes = *Gonodactylellus incipiens* (Lanchester, 1903)].

Material. RUMF-ZC-01275, 1 female (TL 26 mm), Ishidatami, Oh-jima Islet, 26°20'09.6" N, 126°49'29.2" E, intertidal stn 5, 18–19 Nov 2009.

Remarks. *Gonodactylus childi* was reported from the Ogasawara Islands (Chichi-jima) and Izu Islands (Miyake-jima or Nii-jima) by Osawa *et al.* (2004), so the present record is the first for the Ryukyus.

Distribution. Australia to Indonesia, Taiwan, Japan, Enewetak Atoll and French Polynesia; intertidal to shallow subtidal (Ahyong *et al.* 2008).

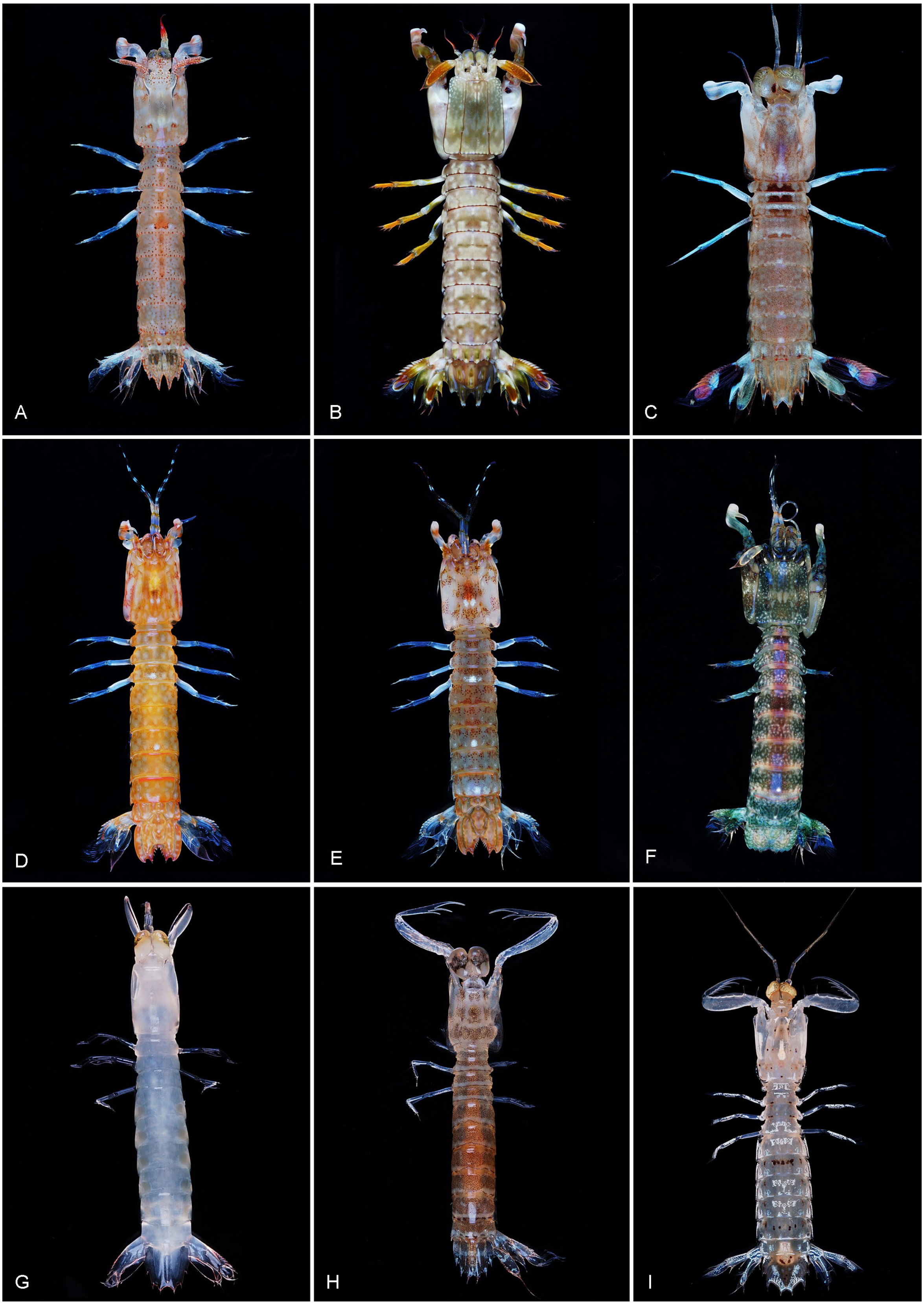


FIGURE 4. A, *Gonodactyloideus cracens* Manning, 1984, female TL 38 mm (RUMF-ZC-01254); B, *Gonodactylus chiragra*, male TL 64 mm (RUMF-ZC-01274); C, *Odontodactylus hansenii* Pocock, 1893, female TL 22 mm (RUMF-ZC-01279); D–E, *Chorisquilla pococki* Pocock, 1975, female TL 29 mm (RUMF-ZC-01277), male TL 21 mm (AM P87568); F, *Haptosquilla glyptocercus* (Wood-Mason, 1875), female TL 27 mm (RUMF-ZC-01278); G, *Pseudosquilla ciliata* (Fabricius, 1787), female postlarva TL 20 mm (AM P87570); H, *Pseudosquillana richeri* (Moosa, 1991), female TL 15 mm (RUMF-ZC-01280); I, *Alima neptuni* (Linnaeus, 1768), female TL 26 mm (RUMF-ZC-01285).

Gonodactylus chiragra (Fabricius, 1781)

(Fig. 4B)

Squilla chiragra Fabricius, 1781: 515 [type locality: restricted to Ambon, Indonesia, 3°43'S 128°12'E, by neotype selection (Manning 1981: 217)].
Gonodactylus chiragra. — Fukuda 1908: 510 (part), pl. 3, fig. 1; 1910: 141 (part); 1913: 72 (part). — Komai 1927: 338–339 (part). — Ahyong 2001: 67–70, fig. 34. Osawa *et al.* 2004: 5. — Hamano 2005: 12, 24, fig. 2-5n–p. — Ahyong 2007: 334.

Material. RUMF-ZC-01274, 1 male (TL 64 mm), Ohara, 26°20'57.8" N, 126°43'33.9" E, intertidal stn 4, 18 Nov 2009; AM P87567, 1 male (TL 27 mm), Ishidatami, Oh-jima Islet, 26°20'09.6" N, 126°49'29.2" E, intertidal stn 5, 18–19 Nov 2009.

Remarks. *Gonodactylus chiragra* was first reported from the Ryukyus by Fukuda (1908).

Distribution. Western Indian Ocean to Australia, Indonesia, Vietnam, the Philippines, New Caledonia, Taiwan, Japan and French Polynesia; intertidal to shallow subtidal.

ODONTODACTYLIDAE Manning, 1980

Odontodactylus hansenii (Pocock, 1893)*#

(Fig. 4C)

Gonodactylus Hansenii Pocock, 1893: 477, pl. 20b [type locality: Macclesfield Bank, South China Sea].
Odontodactylus hansenii. — Ahyong 2001: 78–79; 2002b: 829; 2004: 6–7; 2007: 334.

Material. RUMF-ZC-01279, 1 female (TL 22 mm), 26°23.090–22.966´N, 126°47.832–47.937´E, 82.0–81.3 m, rubble, trawl 7, 10 Nov 2009.

Remarks. The specimen agrees well with Ahyong (2001). The proximal segment of the uropodal exopod is mostly black, and is longer than distal segment; abdominal somites 3–5 each have a posterolateral spine.

Distribution. Macclesfield Bank (South China Sea), the Philippines, New Caledonia, Hawaii, and now from Japanese waters; 81–439 m.

PROTOSQUILLIDAE Manning, 1980

Chorisquilla pococki Manning, 1975#

(Fig. 4D–E)

Gonodactylus excavatus. — Odhner 1923: 15 [not *G. excavatus* Miers, 1880].
Chorisquilla pococki Manning, 1975: 256–258, fig. 1b, 2 [type locality: Macclesfield Bank, South China Sea]. — Ahyong 2001: 91. — Hamano 2005: 13, 29–30, fig. 2-7a–b. — Ahyong 2007: 334.
Chorisquilla excavata. — Moosa 1986: 383–384, fig. 4; 1991: 163 [not *C. excavata* (Miers, 1880)].

Material. RUMF-ZC-01277, 2 females (TL 10, 45 mm), 26°19.907–20.056´N, 126°43.191–42.622´E, 67.5–76 m, dead coral blocks, rubble, trawl 45, 16 Nov 2009; AM P87568, 1 male (TL 21 mm), 26°19.449–19.478´N, 126°45.748–45.800´E, 8.9–9.3 m, dead coral branches, rubble, dredge 51, 16 Nov 2009.

Remarks. The specimens agree well with published accounts (Manning 1975; Moosa 1986). Odhner (1923) first reported *C. pococki* from Japanese waters (Ogasawara Islands), and the present specimens are the first records for the Ryukyus.

Distribution. South China Sea including the Philippines to Japan; 8.9–76 m.

Haptosquilla glyptocercus (Wood-Mason, 1875)
(Fig. 4F)

Gonodactylus glyptocercus Wood-Mason, 1875: 232 [type locality: Nicobar Is, Andaman Sea, 8°00'N 93°30'E]. — Kemp, 1913: 11, 186–187. — Komai 1927: 341–342.
Protosquilla cerebralis Brooks, 1886: 22, 72, pl. 14: figs. 2, 3, pl. 16: figs. 2, 3 [type locality: Levuka, Fiji, 17°42'S 178°50'E]. — Fukuda 1908: 507, pl. 1, fig. 1; 1910: 139; 1913: 72.
Haptosquilla glyptocercus.—Manning, 1995: 21, 102–104, pl. 18, figs. 9 m, 43b, 52, 53. — Ahyong 2001: 104–105, fig. 50. — Osawa *et al.* 2004: 7–8, fig. 3E. — Hamano 2005: 13, 33, fig. 2-7j–l. — Ahyong 2007: 334.

Material. RUMF-ZC-01278, 1 female (TL 27 mm), Ishidatami, Oh-jima Islet, 26°20'09.6" N, 126°49'29.2" E, intertidal stn 5, 18–19 Nov 2009; AM P87569, 1 female (TL 26 mm), same locality.

Remarks. *Haptosquilla glyptocercus* was first recorded from the Ryukyus by Fukuda (1908).

Distribution. Andaman Sea to Australia, New Caledonia, the Philippines, Japan, Vietnam, Fiji, Enewetak Atoll and Guam; intertidal to shallow subtidal (Ahyong 2001).

PSEUDOSQUILLIDAE Manning, 1977

Pseudosquilla ciliata (Fabricius, 1787)#
(Fig. 4G)

Squilla ciliata Fabricius, 1787: 333 [type locality: Exmouth Gulf, Western Australia, by neotype selection (Ahyong 2001)].
Squilla stylifera Lamarck, 1818: 189 [type locality: unknown].
Squilla quadrispinosa Eydoux & Souleyet, 1842: 362, pl. 5, fig. 1 [type locality Sandwich Islands (= Hawaiian Islands)].
Pseudosquilla ciliata var. *occidentalis* Borradaile, 1900: 398, 402 [type locality: West Indies].
Pseudosquilla ciliata. — Fukuda 1909: 57, pl. 2, fig. 4; 1910: 145; 1913: 72. — Kemp, 1913: 10, 96–100. — Komai 1927: 323. — Ahyong 2001: 112–115, fig. 55. — Osawa *et al.* 2004: 8. — Hamano 2005: 13, 36, fig. 2-8a–d.

Material. AM P87570, 1 female postlarva (TL 20 mm), 26°19.714–19.579´N, 126°45.649–45.707´E, 17.9–42.5 m, rubble, dredge 44, 14 Nov 2009.

Remarks. The specimen represents the first record of *P. ciliata* from the Ryukyus and agrees well with the description of the postlarva by Manning (1977).

Distribution. Widely distributed throughout the tropical Indo-West Pacific, eastern and western Atlantic.

Pseudosquillana richeri (Moosa, 1991)
(Fig. 4H)

Pseudosquilla richeri Moosa, 1991: 175–176, fig. 5 [type locality: New Caledonia, 18°27.2'S 163°02.3'E].
Pseudosquillana richeri. — Ahyong *et al.* 2000: 306–310, figs. 2, 3. — Ahyong 2001: 115, fig. 56; 2007: 334.

Material. RUMF-ZC-01280, 1 female (TL 15 mm), 26°18.330–18.351´N, 126°49.730–49.734´E, 27–28 m, 27–28 m, trawl 15, 11 Nov 2009; RUMF-ZC-01281, 1 juvenile male (TL 16 mm), Nanguchi, 26°18.536´N, 126°50.402´E, < 25 m, dead coral rubble, reef-end, dive 8, 11 Nov 2009.

Remarks. The specimens have the banded colour pattern characteristic of juvenile *P. richeri*. Ahyong *et al.* (2000) first recorded *P. richeri* from the Ryukyus (Amami-oshima Island).

Distribution. Red Sea to Australia, New Caledonia, the Philippines, Oceania, French Polynesia and from Japan; intertidal to at least 15 m (Ahyong 2001).

LYSIOSQUILLOIDEA Giesbrecht, 1910

NANNOSQUILLIDAE Manning, 1980

Acanthosquilla multifasciata (Wood-Mason, 1895)#

Lysiosquilla multifasciata Wood-Mason, 1895: 1–2, figs. 22–24 [type locality: Bombay, India]. — Komai 1927: 332–333.
Lysiosquilla Valdiviensis Jurich, 1904: 372, pl. 26: fig. 2 [type locality unknown].
Lysiosquilla biminiensis var. *pacificus* Borradaile, 1900: 395, 398, 403 [type locality: Blanche Bay, New Britain, 4°16'S 152°13'E].
Acanthosquilla multifasciata.— Manning 1995: 143–147, pls. 25, 26, figs. 78b, 80b, 81a,b,e,f, 82a,b, 83–86. — Ahyong 2001: 144–146, fig. 71. — Hamano 2005: 13, 43, fig. 2-11e–j. — Ahyong 2007: 334.

Material. RUMF-ZC-01282, 1 female (broken; CL 8.7 mm), 26°19.838–19.725´N, 126°52.013–51.670´E, 10.4–13.6 m, dredge 65, 18 Nov 2009.

Remarks. The specimen, the first record of *A. multifasciata* from the Ryukyus, lacks the body posterior to abdominal somite 1. The dactyli of both raptorial claws are armed with 6 teeth.

Distribution. Red Sea to Vietnam, Australia, Japan and Hawaii; intertidal to 73 m (Ahyong 2001).

Pullosquilla thomassini Manning, 1978#

Lysiosquilla n. sp.— Odhner 1923: 7.
Pullosquilla thomassini Manning, 1978: 20–21, fig. 9 [type locality: Grand Recif, Tuléar, Madagascar]. — Ahyong 2001: 168, fig. 84.

Material. RUMF-ZC-01283, 1 female (TL 11 mm), 26°19.054–18.958´N, 126°48.702–48.724´E, 5.6–13.1 m, mud, dredge 69, 18 Nov 2009; AM P87571, 1 male (TL 12 mm), 1 female (TL 12 mm), Koukou-mae (in front of high school), 26°19.885´N, 126°45.616´E, <4 m, mud, dead coral rubble, yabby pump, dive 16, 14 Nov 2009; RUMF-ZC-01284, 1 male (TL 10 mm), 1 female (TL 10 mm), 26°19.442–19.378´N, 126°49.211–49.198´E, 4.7–9.5 m, dredge 55, 17 Nov 2009.

Remarks. *Pullosquilla thomassini* ranges widely in the Indo-West Pacific, including southern Japan (Ogasawara Islands) (Ahyong 2001). The present specimens are the first records for the Ryukyu Islands. The armature of the false eave (16–20 spines) and dactyli of the raptorial claws (12–16 teeth) are within the documented range (Manning 1978; Ahyong 2001).

Distribution. Widespread throughout the Indo-West Pacific, from Madagascar and the Red Sea to Australia, southern Japan (Ogasawara and Ryukyu Islands) and French Polynesia; intertidal to 40 m (Ahyong 2001).

SQUILLOIDEA Latreille, 1802

SQUILLIDAE Latreille, 1802

Alima neptuni (Linnaeus, 1768)*#
(Fig. 4I)

Cancer neptuni Linnaeus, 1768: 226 [type locality: Bimini Harbor, Bimini Islands, Straits of Florida, by neotype selection (Holthuis 2000)]. — Holthuis 2000: 17–18.
Alima hyalina Leach in Tuckey, 1817: unnumbered plate in appendix IV to Tuckey [Porto Praya, Cape Verde Islands].
Alima gracilis H. Milne Edwards, 1837: 509 [type locality: Bimini Harbor, Bimini Islands, Straits of Florida, by present neotype selection].
Alima angusta Dana, 1852: 631 [type locality: Bimini Harbor, Bimini Islands, Straits of Florida, by present neotype selection].
Squilla alba Bigelow, 1893: 103 [type locality: Bimini Harbor, Bimini Islands, Straits of Florida].
Alima gracillima Borradaile, 1907: 216, pl. 22, fig. 5 [type locality: Western Indian Ocean].
Alima neptuni. — Ahyong 2001: 188–189; 2002a: 362.

Material. RUMF-ZC-01285, 1 female (TL 26 mm), Suna Point, 26°18´N, 126°50.244´E, < 9 m, sand, rubble, dive 9, 11 Nov 2009.

Remarks. The single specimen of *A. neptuni* collected here represents the first record of the species from Japanese waters and agrees well with published accounts (Manning 1977; Ahyong 2001, 2002a). The abdominal carinae are spined as follows: submedian 6, intermediate 5–6, lateral 5–6, marginal 3–5.

Confusion has long surrounded the identities of *A. neptuni* and its suggested synonyms, *A. alba* (Bigelow, 1893) [type locality: Bimini Islands], *A. angusta* Dana, 1852 [original type locality: eastern Atlantic Ocean, 02°30'N, 17°15'W], *A. gracillima* Borradaile, 1907 [type locality: western Indian Ocean]; *A. gracilis* H. Milne Edwards, 1837 [original type locality: Indian Ocean]; *A. hyalina* Leach, 1817 [type locality: Cape Verde Islands] (Manning 1962; Schotte & Manning 1993; Holthuis 2000). Apart from *A. alba*, all of these names were erected based on larval forms. Holthuis (2000) took the first formal step towards stabilizing these names by fixing a neotype for *A. neptuni* using the lectotype of *A. alba* (USNM 18495, female, TL 41 mm) making the two nomina objective synonyms. The identities of *Alima angusta* and *A. gracilis*, however, remained ambiguous, both too being originally based on larvae, for which the type material is now lost. To stabilize the identities of Dana's and Milne Edwards' species, the neotype of *A. neptuni* (= lectotype of *A. alba*) is selected as the simultaneous neotype of both *A. angusta* and *A. gracilis*. Thus, *A. angusta*, *A. alba* and *A. gracilis* are each objective synonyms of *A. neptuni*, each having its name anchored to the same specimen and same type locality, the Bimini Islands.

As suggested by Manning (1969), *A. gracillima*, described from larvae collected in the western Indian Ocean, probably represents an early larva of *A. neptuni* (as *A. hyalina*).

Distribution. All tropical oceans except the eastern Pacific. In the Indo-West Pacific, ranging from the western Indian Ocean to Hawaii and French Polynesia.

Cloridina chlorida (Brooks, 1886)*#

Squilla chlorida Brooks, 1886: 21, 40, pl. 2, figs. 1–5 [type locality: Amboina, Indonesia, 3°43'S 128°12'E, 27 m].
Cloridina chlorida. — Manning 1995: 24, 192. — Ahyong 2001: 232–233, fig. 113; 2007: 335.

Material. RUMF-ZC-01286, 1 juvenile male (TL 17 mm), 26°19.581–19.409´N, 126°44.271–44.607´E, 60–94 m, sand, dredge 39, 14 Nov 2009.

Remarks. The specimen is a juvenile, having a partially modified pleopod 1 endopod and no armed carinae on abdominal somites 1–5. The dorsal processes of the antennular somite are acutely angular rather than spinular as in adults, and the postanal carina is absent as is usually the case in adults. As in adults, the raptorial claws have five teeth on the dactylus and thoracic somite 5 has a spiniform lateral spine and a small ventral spine. The dorsally mottled colour pattern is similar to that of adults.

Distribution. Madagascar to Australia, Indonesia, Vietnam, New Caledonia and now from Japan; 10–108 m (Ahyong 2001).

Leptosquilla schmeltzii (H. Milne Edwards, 1837)*#

Squilla schmeltzii H. Milne Edwards, 1837: 11, pl. 2, fig. 7 [type locality: Upolu, Samoa].
Leptosquilla schmeltzii. — Moosa 1991: 207–208. — Ahyong 2007: 335.

Material. RUMF-ZC-01287, 2 females (TL 14 mm; 1 broken, CL 2.9 mm), 26°19.553–19.463´N, 126°49.510–49.491´E, 9.1–13.3 m, sand, dredge 58, 17 Nov 2011.

Remarks. The specimens are in poor condition and both lack the raptorial claws.

Distribution. East Africa and the Red Sea to Indonesia, New Caledonia, Samoa and now from Japan; 11–45 m (Moosa 1991).

Parvisquilla multituberculata (Borradaille, 1898)*#

(Fig. 5)

Squilla multituberculata Borradaille, 1898: 38, pl. 6, figs 7, 7a–c [type locality: Sandal Bay, Lifou].
Parvisquilla xishaensis Liu, 1975: 183–184, 196, pl. 1, figs 1–6 [type locality: Xisha Islands, China].
Parvisquilla multituberculata. — Manning 1978: 16–18, fig. 8. — Ahyong & Erdmann 2003: 346–347.

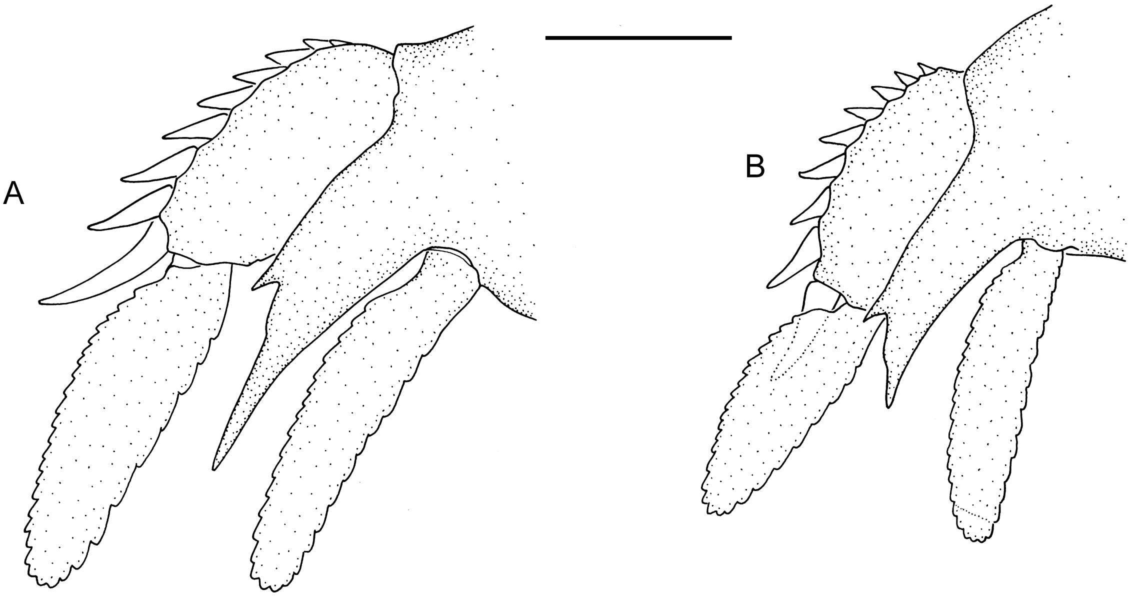


FIGURE 5. *Parvisquilla multituberculata* (Borradaile, 1898), right uropod, ventral view (RUMF-ZC-1288). A, male, TL 11 mm. B, female, TL 9 mm. Scale = 0.5 mm.

Material. RUMF-ZC-01288, 1 male (TL 11 mm), 1 female (TL 9 mm), 26°19.907–20.056´N, 126°43.191–42.622´E, 67.5–76 m, dead coral blocks, rubble, trawl 45, 16 Nov 2009.

Remarks. As reported by Ahyong & Erdmann (2003) for *P. multituberculata*, sexual dimorphism in the present specimens is evident in the length of the primary spine of the uropodal protopod, being proportionally longer in males than in females (Fig. 2).

Distribution. Widely distributed in the Indo-West Pacific, from the western Indian Ocean to French Polynesia; a new record for Japanese waters.

CHECKLIST OF STOMATOPODA FROM JAPAN

Hamano (2004) listed 56 species of Stomatopoda from Japan, but inadvertently omitted *Pseudosquillana richeri,* recorded from the the Ryukyus by Ahyong *et al.* (2000). Subsequently, Ahyong *et al.* (2008) removed *Harpiosquilla japonica* from the synonymy of *H. harpax,* bringing the total to 58 species. The results of the present study raise the number of stomatopod species recorded from Japan to 68. Species studied herein are in bold. New records for Japan are indicated (*). New records for the Ryukyu Islands are indicated (#)

- BATHYSQUILLOIDEA Manning, 1967
  - Bathysquillidae Manning, 1963
    - *Bathysquilla crassispinosa* (Fukuda, 1909)
- ERYTHROSQUILLOIDEA Manning & Bruce, 1984
  - Erythrosquillidae Manning & Bruce, 1984
    - *Erythrosquilla hamano* Ahyong, 2001
- GONODACTYLOIDEA Giesbrecht, 1910
  - Gonodactylidae Giesbrecht, 1910
    - *Gonodactylaceus glabrous* (Brooks, 1886)*#
    - *Gonodactylaceus falcatus* (Forskål, 1775)
    - *Gonodactylellus annularis* Erdmann & Manning, 1998*#

- *Gonodactylellus kume* sp. nov. *#
- *Gonodactylellus rubriguttatus* Erdmann & Manning, 1998*#
- *Gonodactylellus snidvongsi* (Naiyanetr, 1987)
- *Gonodactylellus viridis* (Serène, 1954)
- *Gonodactyloideus cracens* Manning, 1984*#
- *Gonodactylus childi* Manning, 1971#
- *Gonodactylus chiragra* (Fabricius, 1781)
- *Gonodactylus platysoma* Wood-Mason, 1895
- *Gonodactylus smithii* Pocock, 1893

Odontodactylidae Manning, 1980

- *Odontodactylus brevirostris* (Miers, 1884)
- *Odontodactylus hansenii* (Pocock, 1893) *#
- *Odontodactylus japonicus* (De Haan, 1844)
- *Odontodactylus scyllarus* (Linnaeus, 1758)

Protosquillidae Manning, 1980

- *Chorisquilla pococki* Manning, 1975#
- *Chorisquilla tuberculata* (Borradaile, 1907)
- *Chorisquilla* sp.
- *Echinosquilla guerini* (White, 1861)
- *Haptosquilla glyptocercus* (Wood-Mason, 1875)
- *Haptosquilla pulchella* (Miers, 1880)
- *Haptosquilla tanensis* (Fukuda, 1911)

Pseudosquillidae Manning, 1977

- *Pseudosquilla ciliata* (Fabricius, 1787)#
- *Pseudosquillana richeri* (Moosa, 1991)
- *Raoulserenea hieroglyphica* (Manning, 1972)
- *Raoulserenea oxyrhyncha* (Borradaile, 1898)

Takuidae Manning, 1995

- *Mesacturus furcicaudatus* (Miers, 1880)
- *Taku spinosocarinatus* (Fukuda, 1909)

LYSIOSQUILLOIDEA Giesbrecht, 1910

Lysiosquillidae Giesbrecht, 1910

- *Lysiosquilla sulcirostris* Kemp, 1911
- *Lysiosquillina maculata* (Fabricius, 1793)

Nannosquillidae Manning, 1980

- *Acanthosquilla derijardi* Manning, 1970
- *Acanthosquilla multifasciata* (Wood-Mason, 1895)#
- *Bigelowina phalangium* (Fabricius, 1798)
- *Pullosquilla thomassini* Manning, 1978#

Tetrasquillidae Manning & Camp, 1993

- *Acaenosquilla latifrons* (De Haan, 1844)
- *Allosquilla varicosa* (Komai & Tung, 1930)
- *Tetrasquilla mccullochae* (Schmitt, 1940)

PARASQUILLOIDEA Manning, 1995

Parasquillidae Manning, 1995

- *Faughnia formosae* Manning & Chan, 1997
- *Faughnia haani* (Holthuis, 1959)
- *Faughnia serenei* Moosa, 1982
- *Pseudosquillopsis dofleini* (Balss, 1910)

SQUILLOIDEA Latreille, 1802

Squillidae Latreille, 1802

- *Alima hieroglyphica* (Kemp, 1911)

Alima neptuni (Linnaeus, 1768) *#
Anchisquilla fasciata (De Haan, 1844)
Busquilla quadraticauda (Fukuda, 1911)
Carinosquilla multicarinata (White, 1849)
Clorida japonica Manning, 1978
Cloridina chlorida (Brooks, 1886) *#
Cloridopsis scorpio (Latreille, 1828)
Erugosquilla woodmasoni (Kemp, 1911)
Harpiosquilla annandalei (Kemp, 1911)
Harpiosquilla harpax (De Haan, 1844)
Harpiosquilla japonica Manning, 1969
Harpiosquilla melanoura Manning, 1968
Kempella mikado (Kemp & Chopra, 1921)
Lenisquilla lata (Brooks, 1886)
Leptosquilla schmeltzii (H. Milne Edwards, 1837)*#
Levisquilla inermis (Manning, 1965)
Lophosquilla costata (De Haan, 1844)
Oratosquilla kempi (Schmitt, 1931)
Oratosquilla oratoria (De Haan, 1844)
Oratosquillina perpensa (Kemp, 1911)
Parvisquilla multituberculata (Borradaile, 1898)*#
Quollastria gonypetes (Kemp, 1911)
Quollastria imperialis (Manning, 1965)
Squilloides leptosquilla (Brooks, 1886)

Acknowledgements

The KUMEJIMA 2009 Expedition was a jointly organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition operated under a permit from the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative granted to the expedition leader, T. Naruse of the University of the Ryukyus. Colour photographs of specimens examined were taken by T.-Y. Chan of the National Taiwan Ocean University. Thanks go to Karen Reed (USNM) and Andrew Hosie (WAM) for loan of additional specimens.

References

Ahyong, S.T. (2001) Revision of the Australian Stomatopod Crustacea. *Records of the Australian Museum*, Supplement 26, 1–326.

Ahyong, S.T. (2002a) Stomatopod Crustacea from the Marquesas Islands: results of MUSORSTOM 9. *Zoosystema*, 24, 347–372.

Ahyong, S.T. (2002b) A new species and new records of Stomatopoda from Hawaii. *Crustaceana*, 75, 827–840.

Ahyong, S.T. (2004) New species and new records of stomatopod Crustacea from the Philippines. *Zootaxa*, 793, 1–28.

Ahyong, S.T. (2007) Shallow water Stomatopoda of New Caledonia (0–100 m). *In*: Payri, C.E. & Richer de Forges, B. (Eds), *Compendium of Marine Species from New Caledonia. Documents Scientifiques et Techniques*, Vol. II7, 333–335. IRD Noumea, Noumea.

Ahyong, S.T. (2008) Stomatopod Crustacea from the Dampier Archipelago, Western Australia. *Records of the Western Australian Museum*, Supplement 73, 41–55.

Ahyong, S.T. (2012) The Marine Fauna of New Zealand: Mantis Shrimps (Crustacea: Stomatopoda). *NIWA Biodiversity Memoir*, 125, 1–112.

Ahyong, S.T. & Erdmann, M.V. (2003) The stomatopod Crustacea of Guam. *Micronesica*, 35–36, 315–352.

Ahyong, S.T. & Erdmann, M.V. (2007) Two new species of *Gonodactylellus* from Indonesia. *Raffles Bulletin of Zoology*, 55,

89–95.

Ahyong, S.T., Manning, R.B. & Reed, K. (2000) Revision of *Pseudosquillana* Cappola & Manning, 1995 (Crustacea: Stomatopoda: Pseudosquillidae). *Raffles Bulletin of Zoology*, 48, 301–311.

Ahyong, S.T. & Naiyanetr, P. (2002) Stomatopod Crustaceans from Phuket and the Andaman Sea. *Phuket Marine Biological Centre Special Publication*, 23, 281–312.

Ahyong, S.T. & Norrington, S.F. (1997) Stomatopod Crustacea in the Macleay Museum, University of Sydney. *Proceedings of the Linnean Society of New South Wales*, 118, 97–110.

Ahyong, S.T., Chan, T.-Y. & Liao, Y.-C. (2008) *A Catalog of the Mantis Shrimps (Stomatopoda) of Taiwan*. National Science Council, Taiwan, R.O.C., Taipei, vii + 191 pp.

Balss, H. (1910) Ostasiatische Stomatopoden. Beiträge zur Naturgeschichte Ostasiens. Herausgegeben von Dr. F. Doflein. *Abhandlungen der Wissenschaften, Mathematisch-Naturwissenschaftliche Klasse, Munich*, supplement 2, 2, 1–11.

Bigelow, R.P. (1893) The Stomatopoda of Bimini. *Johns Hopkins University Circulars*, 12(106), 102–103.

Borradaile, L.A. (1898) On some Crustaceans from the South Pacific—Part I: Stomatopoda. *Proceedings of the Zoological Society of London*, 1898, 32–38.

Borradaile, L.A. (1900) On the Stomatopoda and Macrura brought by Dr Willey from the South Seas. *In*: Willey, A. (Ed.), *Zoological Results based on the material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896, and 1897*, 4, 395–428. Cambridge University Press, Cambridge.

Borradaile, L.A. (1907) Stomatopoda from the western Indian Ocean. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of J. Stanley Gardiner. *Transactions of the Linnean Society of London (2, Zoology)*, 12, 209–216, pl. 22.

Brooks, W.K. (1886) Report on the Stomatopoda collected by H.M.S. Challenger during the years 1873–76. *The Voyage of the H.M.S. Challenger, Zoology*, 16, 1–116, pl. 1–16.

Dana, J.D. (1852–1855) Crustacea, Part 1. *United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N.*, 13, 1–685 (1852). Atlas, 1–27, pls. 1–96 (1855). C. Sherman, Philadelphia.

Erdmann, M.V. & Manning, R.B. (1998) Preliminary descriptions of nine new stomatopod crustaceans from coral reef habitats in Indonesia and Australia. *Raffles Bulletin of Zoology*, 46, 615–626.

Eydoux, F. & Souleyet, L.F.A. (1842). *Crustacés*. Voyage autour du Monde exécuté pendent les années 1836 et 1837 sur la Corvette La Bonite Commandée par M. Vaillant, Capitaine de Vaiseau, Zoologie, 1, 219–272. Arthus Bertrand, Paris.

Fabricius, J.C. (1781) *Species Insectorum Exhibentes Eorum Differentias Specificas, Synonyma Auctorum, Loca Natalia, Metamorphosin Adiectis, Observationibus, Descriptionibus* 1, vii + 552. Hamburgii et Kilonii.

Fabricius, J.C. (1787) *Mantissa insectorum sistens eorum species nuper detectas: adjectis characteribus genericis, differentiis specificis, emendationibus, observationibus*, 1, 1–348. Proft Hafniae.

Fabricius, J.C. (1793) *Entomologia Systematica Emendata et Aucta. Secundum Classes, Ordines, Genera, Species. Adjectis Synonimis, Locis, Observationibus, Descriptionibus*, 2, pp. vii + 519. Hafniae.

Fabricius, J.C. (1798) *Supplementum Entomologiae Systematicae*, pp. ii + 572. Hafniae.

Forskål, P. (1775) *Descriptiones Animalium, Avium, Amphibiorum, Piscium, Insectorum, Vermium*, pp. 19 + xxxii + 164. Hauniae (Copenhagen).

Fukuda, T. (1908) Japanese Stomatopoda. *Doubutsugaku Zasshi*, 20, 505–512, pl. 1. (In Japanese).

Fukuda, T. (1909) Japanese Stomatopoda. *Dobutsugaku Zasshi*, 21, 54–62, 167–174, pl. 5 (In Japanese; published in English, 1910).

Fukuda, T. (1910) Report on Japanese Stomatopoda with descriptions of two new species. *Annotationes Zoologicae Japonenses*, 7, 139–152, pl. 4.

Fukuda, T. (1911) Supplement to Japanese Stomatopoda. *Dobutsugaku Zasshi*, 23, 173–175.

Fukuda, T. (1913) Two Japanese stomatopods, with list of stomatopods in the Japanese waters. *Doubutsugaku Zasshi (Zoological Magazine)*, 25, 69–72. (In Japanese)

Giesbrecht, W. (1910) Stomatopoden, Erster Thezil. *Fauna und Flora des Golfes von Neapel*, 33, i–vii, 1–239, pl. 1–11.

Haan, W. de, (1833–1850) Crustacea. In: *Fauna Japonica sive descriptio animalium, quae in itinere per Japoniam, jussu et auspiciis superiorum, qui summum in India Batavia Imperium tenent, suscepto, annis 1823–1830 collegit, notis observationibus et adumbrationibus, ed. Ph.F. von Siebold*, pp. 243, illustravit. A. Arnz, Lugdunum Batavorum.

Hamano, T. (2005) Biology of stomatopod crustaceans and stock management of the Japanese mantis shrimp *Oratosquilla oratoria*. Japan Fisheries Resource Conservation Association, Tokyo, 208 pp. (In Japanese).Holthuis, L.B. (1959) Stomatopod Crustacea of Suriname. *Studies on the Fauna of Suriname and other Guyanas*, 10, 173–191.

Holthuis, L.B. (2000) Nomenclatural notes on eighteenth century Stomatopoda (Hoplocarida). *Journal of Crustacean Biology*, 20, 12–19.

Jurich, B. (1904) Die Stomatopoden der Deutsche Tiefsee-Expedition. *Wissenschaftliche Ergebnisse der deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898–1899*, 7, 361–408, pls. 25–30.

Kemp, S. (1911) Preliminary descriptions of new species and varieties of Crustacea Stomatopoda in the Indian Museum. *Records of the Indian Museum*, 6, 93–100.

Kemp, S. (1913) An account of the Crustacea Stomatopoda of the Indo-Pacific region, based on the collection in the Indian Museum. *Memoirs of the Indian Museum*, 4, 1–217.

Kemp, S. & Chopra, B. (1921) Notes on Stomatopoda. *Records of the Indian Museum*, 22, 297–311.

Komai, T. (1927) Stomatopoda of Japan and adjacent localities. *Memoirs of the College of Science, Kyoto Imperial University, series B*, 3, 307–354.

Komai, T. (1940) *Gonodactylus furcicaudatus* Miers, a remarkable stomatopod. *Annotationes Zoologicae Japonenses*,19(1), 47–50.

Komai, T. & Tung, Y.M. (1930) Report on the Stomatopoda Collected by the surveying ships of the Imperial Fisheries Experimental Station on the continental shelf bordering Japan. *Annotationes Zoologicae Japonenses*, 13(1), 13–19.

Lamarck, J.B.P.A. (1818). *Histoire naturelle des animaux sans vertèbres présentant les caractères généraux et particulier de ces animaux, leur distribution, leur classes, leurs familles, leurs genres, et la citation des principales espèces qui s'y rapportent; précédée d'une introduction offrant la détermination des caractères essentiels, de l'animal, sa distinction du végétal et des autres corps naturels, enfin, l'exposition des principes fondamentaux de la zoologie*, 5, 1–612. Déterville, Paris.

Lanchester, W.F. (1903) Stomatopoda, with an account of the varieties of Gonodactylus chiragra. Marine Crustaceans VIII. *In*: Gardiner, J.S. (Ed.), *The fauna and geography of the Maldive and Laccadive Archipelagoes: being the account of the work carried on and of the collections made by an expedition during the years 1899 and 1900*, 1, 444–459.

Latreille, P.A. (1802) *Histoire naturelle, générale et particulière, des Crustacés et des Insectes*, 3, 1–467. F. Dufart, Paris.

Latreille, P.A. (1828) Squille, Squilla. *Encyclopédie Méthodique.Entomologie ou Histoire naturelle des Crustacés, des Arachnides et des Insectes*, 10, 467–475. Agasse, Paris.

Liu, J.Y. (1975) On a collection of stomatopod Crustacea from the Xisha Islands, Guangdong Province, China. *Studia Marina Sinica*, 10, 183–197, pl. 1.

Linnaeus, C. (1758) *Systema Naturae per Regna Tria Naturae, Secundum Classes, Ordines, Genera, Species, cum Characteribus,Differentiis, Synonymis Locis*. Edition 10, vol. 1, pp. iii + 824. Holmiae.

Linnaeus, C. (1768) *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis locis*, 3, 1–236. Stockholm, 12th ed.

Leach, W. E. (1817–1818) A general notice of the animals taken by Mr John Cranch, during the expedition to explore the source of the River Zaire. *In:* Tuckey, J. K. (Ed.), *Narrative of an expedition to explore the River Zaire, usually called the Congo, in South Africa, in 1816, under the Direction of Captain J. K. Tuckey, R. N., to which is added the journal of Professor Smith, some general observations on the country and its Inhabitants, and an appendix, containing the natural history of that part of the Kingdom of Congo through which the Zaire flows*. Appendix 4, 407–419 (1818), 1 unnumbered plate (1817). John Murray, London.

Manning, R.B. (1962) *Alima hyalina* Leach, the pelagic larva of the stomatopod crustacean *Squilla alba* Bigelow. *Bulletin of Marine Science of the Gulf and Caribbean*, 12(3), 496–507.

Manning, R.B. (1963) Preliminary revision of the genera *Pseudosquilla* and *Lysiosquilla* with descriptions of six new genera. *Bulletin of Marine Science of the Gulf and Caribbean*, 13, 308–328.

Manning, R.B. (1965) Stomatopoda from the collection of His Majesty The Emperor of Japan. *Crustaceana*, 9, 249–262, pls. 11–12.

Manning, R.B. (1967) Preliminary account of a new genus and a new family of Stomatopoda. *Crustaceana*, 13(2), 238–239.

Manning, R.B. (1968) Stomatopod Crustacea from Madagascar. *Proceedings of the United States National Museum*, 124, 1–61.

Manning, R.B. (1969) Stomatopod Crustacea of the Western Atlantic. *Studies in Tropical Oceanography*, 8, 1–380.

Manning, R.B. (1970). Some stomatopod crustaceans from Tuléar, Madagascar. *Bulletin du Muséum national d'Histoire naturelle,Paris*, series 2, 41(6), 1429–1441. (Dated 1969, published 1970).

Manning, R.B. (1971) Two new species of *Gonodactylus* (Crustacea, Stomatopoda), from Eniwetok Atoll, Pacific Ocean. *Proceedings of the Biological Society of Washington*, 84, 73–80.

Manning, R.B. (1972) Two new species of *Pseudosquilla* (Crustacea, Stomatopoda) from the Pacific Ocean. *American Museum Novitates*, 2484, 1–11.

Manning, R.B. (1975) Two new species of the Indo-West Pacific genus *Chorisquilla* (Crustacea, Stomatopoda), with notes on *C. excavata* (Miers). *Proceedings of the Biological Society of Washington*, 88, 253–262.

Manning, R.B. (1977) A monograph of the West African stomatopod Crustacea. *Atlantide Report*, 12, 25–181.

Manning, R.B. (1978) New and rare stomatopod Crustacea from the Indo-West Pacific region. *Smithsonian Contributions to Zoology*, 264, 1–36.

Manning, R.B. (1980) The superfamilies, families, and genera of Recent Stomatopod Crustacea, with diagnoses of six new families. *Proceedings of the Biological Society of Washington*, 93, 362–372.

Manning, R.B. (1981) Neotype selection for the stomatopod *Squilla chiragra* Fabricius, 1781. *Crustaceana* 40(2), 217–219.

Manning, R.B. (1984) *Gonodactyloideus cracens* n.gen., n.sp., a new stomatopod crustacean from Western Australia. *The Beagle, Occasional Papers of the Northern Territory Museum of Arts and Sciences*, 1, 83–86.

Manning, R.B. (1995) Stomatopod Crustacea of Vietnam: the legacy of Raoul Serène. *Crustacean Research*, Special number 4, 1–339.

Manning, R.B. & Bruce, A.J. (1984) *Erythrosquilla megalops*, a remarkable new stomatopod from the western Indian Ocean. *Journal of Crustacean Biology*, 4(2), 329–332.

Manning, R.B., & Camp, D.K. (1993) Erythrosquilloidea, a new superfamily, and Tetrasquillidae, a new family of stomatopod Crustaceans. *Proceedings of the Biological Society of Washington*, 106, 85–91.

Manning, R.B., & Chan, T.-Y. (1997) The genus *Faughnia* from Taiwan, with the description of a new species (Stomatopoda:

Parasquillidae). *Journal of Crustacean Biology*, 17, 546–554.

Manning, R.B. & Lewinsohn, Ch. (1981) Selection of a Neotype for *Cancer falcatus* Forskål, 1775 (Stomatopoda). *Crustaceana*, 41(3), 314–316.

Manning, R.B. & Reaka, M.L. (1981a) *Gonodactylus aloha*, a new stomatopod crustacean from the Hawaiian Islands. *Journal of Crustacean Biology*, 1(2), 190–200.

Manning, R.B. & Reaka, M.L. (1981b) *Gonodactylus siamensis*, a new stomatopod crustacean from Thailand. *Proceedings of the Biological Society of Washington*, 94(2), 479–482.

Manning, R.B. & Reaka, M.L. (1982) *Gonodactylus insularis*, a new stomatopod crustacean from Enewetak Atoll, Pacific Ocean. *Proceedings of the Biological Society of Washington*, 95, 347–351.

Miers, E.J. (1880) On the Squillidae. *Annals and Magazine of Natural History*, 5, 1–30, 108–127.

Miers, E.J. (1884) Crustacea. *In*: *Report on the zoological collections made in the Indo-Pacific Ocean during the voyage of H.M.S. "Alert," 1881–2*, pp. 178–322, 513–575, pls. 18–35, 46–52.

Milne Edwards, H. (1837) *Histoire naturelle des Crustacés,comprenant l'anatomie, la physiologie et la classification de ces animaux*, 2, 1–532. Atlas, 32 pp, pls. 1–14, 14 bis, 15–25 bis, 26–42. Roret, Paris.

Moosa, M.K. (1982) *Faughnia serenei*, new species, a stomatopod from the South China Sea. *Journal of Crustacean Biology*, 2, 600–604.

Moosa, M.K. (1986) Stomatopod Crustacea. Résultats du Campagnes MUSORSTOM I & II Philippines, 2. *Mémoires du Muséum national d'Histoire naturelle, Paris, series A, Zoologie*, 133, 367–414, pl. 1.

Moosa, M.K. (1989) Some stomatopods (Crustacea: Stomatopoda) from Japanese waters, with description of a new species. *Bulletin of the National Science Museum, Tokyo, series A*, 15, 223–229.

Moosa, M.K. (1991). The Stomatopoda of New Caledonia and Chesterfield Islands. *In*: Richer de Forges, B. (Ed.), *Le benthos de fonds meubles des lagons de Nouvelle-Calédonie*, 1, 149–219. Editions de l'ORSTOM, Paris.

Naiyanetr, P. (1987) Two new stomatopod crustaceans from Thailand with a key to the genus *Manningia* Serène, 1962. *Crustaceana*, 53(3), 237–242.

Odhner, T. (1923) Indopazifiche Stomatopoden. *Göteborgs Kungliga Vetenskaps-och Vitterhets-Sämhalles Handlingar*, 27(4), 1–16, pl. 1.

Osawa, M., Mitsuhashi, M. & Takeda, M. (2004) Discovery of the type specimen of *Lysiosquilla crassispinosa* Fukuda, 1909 (Crustacea: Stomatopoda) and Fukuda's stomatopod specimens. *Benthos Research*, 59, 1–10.

Pocock, R.I. (1893) Report upon the stomatopod crustaceans obtained by P. W. Bassett-Smith, Esq., Surgeon R. N., during the cruise, in the Australian and China seas, of H.M.S. "Penguin," Commander W. U. Moore. *Annals and Magazine of Natural History*, series 6, 11, 473–479, pl. 20B.

Roxas, H.A. & Estampador, E. (1930) Stomatopoda of the Philippines. *Natural and Applied Science Bulletin, University of the Philippines*, 1, 93–131.

Schmitt, W.L. (1931) Chinese Stomatopoda collected by S.F. Light. *Lingnan Science Journal*, 8, 127–155. (Dated 1929, printed 1931).

Schmitt, W.L. (1940) The stomatopods of the west coast of America, based on collections made by the Allan Hancock Expedition, 1933-38. *Allan Hancock Pacific Expeditions*, 5, 129–225.

Schotte, M. & Manning, R.B. (1993) Stomatopod Crustacea from Tobago, West Indies. *Proceedings of the Biological Society of Washington*, 106, 566–581.

Serène, R. (1954) Observations biologiques sur les stomatopodes. *Mémoires de l'Institut Océanographique de Nhatrang*, 8, 1–93, pls. 91–10.

Souverbie, S.M. (1869) Diagnoses de mollusques inédits provenant de la Nouvelle-Calédonie. Journal de Conchyliologie, 17, 416–421.

Utinomi, H. (1956) *Coloured illustrations of sea shore animals of Japan*. Hoikusha, Osaka, i–xviii, 1–167, pls 1–64, figs. 1–44.

White, A. (1849) Description of two new species of Crustacea. *Proceedings of the Zoological Society of London* 15, 144, pl. 6 (also published in *The Annals and Magazine of Natural History*, series 2, 4, 381–382, 1849) (Dated 1848, printed 1849).

White, A. (1861) Descriptions of two species of Crustacea belonging to the families Callianassidae and Squillidae. *Proceedings of the Zoological Society of London* 1861, 42–44, pls. 6, 7.

Wood-Mason, J. (1875) (On some new species of stomatopod Crustacea). *Proceedings of the Asiatic Society of Bengal* 1875, 231–232 (untitled).

Wood-Mason, J. (1895) *Figures and descriptions of nine species of Squillidae from the collection of the Indian Museum*. Indian Museum, Calcutta, pp. 1–11, pls 1–4.

Zootaxa 3367: 252–260 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new species of *Neoferdina* and three new records of sea stars (Echinodermata: Asteroidea) collected from Kumejima Island, southwestern Japan*

YOICHI KOGURE[1] & YOSHIHISA FUJITA[2]

[1] *Japan Sea National Fisheries Research Institute, 1-5939-22 Suido-cho, Chuo-ku, Niigata 951-8121, Japan.*
E-mail: seastar@affrc.go.jp
[2] *University Education Center, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

Sea stars were collected at depths ranging from 91 to 160 m around Kumejima Island situated in the middle of the Ryukyu Islands chain in the Western Pacific. Sampling was carried out using a dredge or beam trawl in November 2009, as part of the KUMEJIMA 2009 Expedition. The specimens included an undescribed species of the genus *Neoferdina*, and three species that have never been reported in Japanese waters. Features that characterise this new species, *Neoferdina longibrachia*, include: extremely long and narrow arms, no alternating arrangement of large and small superomarginal plates, body surface (except for the marginal plates) completely covered with granules, and an adambulacral armature with 3 furrow spines.

Key words: starfish, *Neoferdina longibrachia*, Ryukyu Islands, taxonomy

Introduction

The Ryukyu Islands chain, an arc of islands extending 1,200 km between Kyushu and Taiwan, stretches from the northern edge of the tropical region to the southern edge of the temperate region. The islands form a coastal ecosystem with an extraordinary diversity of marine organisms. An analysis of species richness based on fish, corals, snails, and lobsters has shown that the South Japan region is an important marine biodiversity hotspot (Roberts *et al*. 2002).

In terms of the species richness of asteroids in the waters around the Ryukyu Islands, there is little or only fragmentary information, with the exception of the shallow-water common species (Djakonov 1930; Goto 1914; Hayashi 1930). The latest guidebook dealing with asteroid and ophiuroid fauna in the Japanese coastal region (Saba & Irimura 2002) refers to tropical/subtropical species in southern Japan; however, the asteroids dealt with in the book are mainly members of shallow-water species. Furthermore, recent scientific evidence provided by trawls or remotely operated vehicles has indicated the possible presence of numerous asteroids that are new to Japan in the relatively deep waters around the Ryukyu Islands (Kogure 2008; Kogure *et al*. 2009; Kogure & Kaneko 2010). Therefore, most of the remaining unknown species probably inhabit the bottoms beyond the depth limit of scuba diving technology; a faunal survey that includes the deep-water bottom has become imperative.

An international project was started in 2009 to examine the marine fauna between the intertidal and sublittoral zone in the Ryukyu Islands, where the maximum depth exceeds 150 m. In November, an intensive marine faunal survey of Kumejima Islands, the KUMEJIMA 2009 Expedition was undertaken. The survey collected three species of asteroids, which are new records for Japan as well as a new species of *Neoferdina*. These four newly-discovered species from relatively deep waters contribute to the ongoing discovery of marine biodiversity in the Ryukyu Islands.

Accepted by T. Naruse: 16 Sep. 2011; published: 4 Jul. 2012

Material and Methods

Asteroid specimens were obtained between November 10th and 20th, 2009, from waters at depths ranging from 91 to 160 m around Kumejima Island. Kumejima belongs to the Ryukyu Island chain and is located approximately 100 km west of Okinawa Island in southwestern Japan. Sampling was conducted using a dredge or beam trawl. The collected specimens were anesthetized with seawater containing magnesium sulfate, photographed, and preserved in 70% ethanol for identification. The body size of each specimen was measured to the nearest 0.1 mm with a digital caliper. The number of marginal plates was counted between the interradial midline and the arm tip. For illustrative purposes, the marginal plates were numbered serially from the arm base to the tip. For example, the 1st superomarginal and inferomarginal plates are situated in the most proximal part of the interradial area, which form interradial midlines on the abactinal and actinal surfaces, respectively. The following 2nd marginal plates are bordered on the distal part of these 1st marginal plates. In the same way, the carinal plates were numbered serially from the center of the disk to the arm tip, as necessary.

The specimen examined in this study has been deposited in the Ryukyu University Museum, Fujukan (RUMF) in Okinawa, Japan. The following abbreviations have been used to refer to the body size: R, the arm length measured from the center of the disk to the tip of the arm; r, the disk radius measured from the center of the disk to the edge where 2 arms meet; and R/r, the ratio of the arm length to the disk radius.

Taxonomic account

Order Paxillosida Perrier, 1884

Family Astropectinidae Gray, 1840

Genus *Patagiaster* Fisher, 1906

Patagiaster sphaerioplax Fisher, 1913

[New Japanese name: Nanyo-momiji]
(Fig. 1)

Patagiaster sphaerioplax Fisher, 1913: 623; 1919: 154. — Jangoux *et al*. 1989: 168. — A.M. Clark 1989: 284.

Material examined. One specimen, RUMF-ZE-00032, KUMEJIMA 2009 Stn. Dredge-23, 26°16.380–15.982′N, 126°51.304–51.502′E, 125–147 m, 12 November 2009.

Description. Single specimen with R = 23.8 mm and r = 9.6 mm (R/r = 2.5). Abactinal surface covered with closely packed paxillae. Larger paxillae reaching more than 1 mm in diameter, with approximately 40 peripheral and 35 central spinelets.

Number of superomarginal plates, 16; inferomarginal plates, 16. Superomarginal plates separated from inferomarginal plates by well-developed longitudinal fasciolar groove. Superomarginal plates covered with beadlike granules and a peripheral series of slender spinelets.

All inferomarginal plates aligned opposite to superomarginal plates. Surface of inferomarginal plates completely covered with slender spinelets.

Actinal plate elliptical in shape, with slender spinelets. Single series of plates extending to 4th inferomarginal plate. Paired actinal plates located just behind mouth plates, followed by longitudinal series of 5 odd plates (Fig. 1B); distal margin of outermost odd plate adjoining interradial suture between 1st inferomarginal plates.

Each adambulacral plate with 7 relatively long, furrow spines, followed by 10–16 subambulacral spines arranged in more or less 3–4 longitudinal series.

Madreporite completely concealed by spinelets.

Distribution. This species was known from the vicinity of Romblon Island of the Philippine Islands at depth of 143 m (type locality), and the Flores Sea, Indonesia at depths of 350–500 m (Jangoux *et al*. 1989). The present study represents the first record of the species from Japan. The distribution range of the species is extended to north.

Remarks. The material collected mostly agrees with the original description of the species. We could not confirm whether the shape of 1–3 small spines on the inferomarginal plates of the examined specimen was lanceolate or not, probably because they were abraded and damaged during the dredging operations.

The present study shows the colour in life of the abactinal surface as bright orange with the radial abactinal plates tinged with olive green (Fig. 1A). Prior accounts have not reported the colour in life of this rarely encountered species.

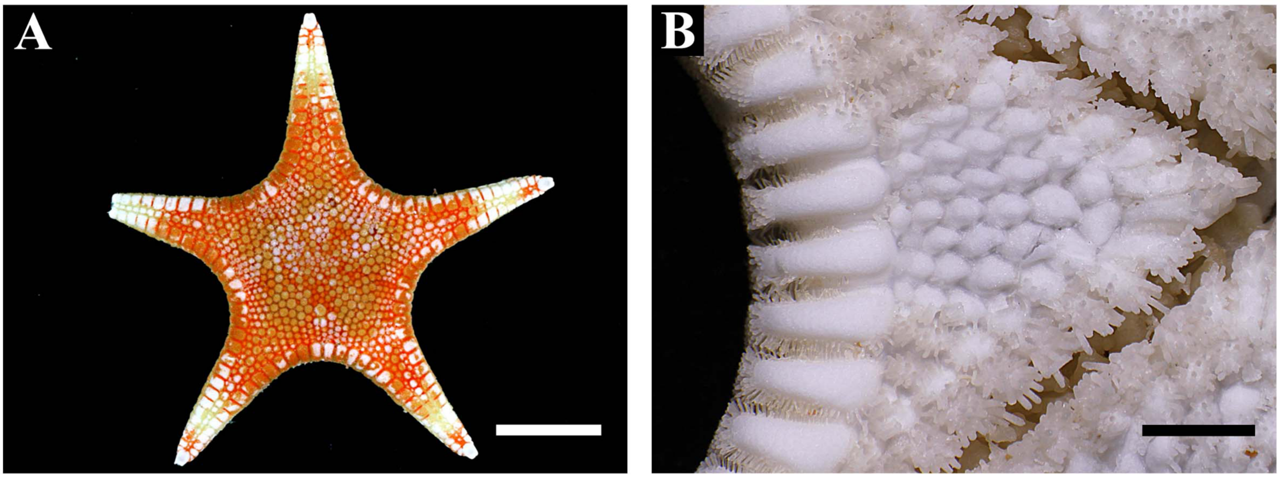


FIGURE 1. *Patagiaster sphaerioplax* Fisher, 1913 (RUMF-ZE-00032): A, abactinal view of entire animal in living condition; B**,** denuded actinal surface showing the 5 odd plates on the interradial midline. Scales: A = 10 mm; B = 2 mm.

Order Valvatida Perrier, 1884

Family Goniasteridae Forbes, 1841

Genus *Calliaster* Gray, 1840

Calliaster elegans Döderlein, 1922

[New Japanese name: Hanayaka-togesugata-hitode]
(Fig. 2)

Calliaster elegans Döderlein, 1922: 49; 1924: 62. — A.H. Clark 1952: 284. — Jangoux *et al*. 1989: 168. — A.M. Clark 1993: 246.

Material examined. One specimen, RUMF-ZE-00033, KUMEJIMA 2009 Stn. Trawl-27, 26°16.961–17.028′N, 126°51.952–52.508′E; 126–136 m, 12 November 2009.

Description. A small specimen (Fig. 2A) with R = 15.8 mm and r = 5.4 mm (R/r = 2.9). One regenerating arm. Abactinal, actinal and marginal plates with smooth surface, more or less inflated. All plates fringed with coarse granules (Fig. 2B, C). Most of plates topped by one conical spine. Considerable loss of spines observed; but shallow hollows formed by broken spines on plates showing pattern of spine arrangement.

Abactinal plates round or elliptical in shape. Conical spines on 3rd to 5th carinal plates, as well as on central 9 abactinal plates.

Number of superomarginal plates, 6; inferomarginal plates, 6. Superomarginal plates tumid; 5 distal plates abutting each other over radial midline. First and 2nd superomarginals each bearing 2 spines; 3rd to 5th plates with single spine; 6th plate lacking spines; terminal plate with 2–4 spines. Inferomarginal plate also tumid with 2–3 spines near upper edge.

Each interradial actinal surface composed of 10–11 rounded square or rounded triangular actinal plates surrounded by 1st inferomarginal, adambulacral, and mouth plates. Two largest actinal plates situated in center of each interradial area, bearing conspicuous paddle-like pedicellariae (Fig. 2D).

Each mouth plate having 7 marginal spines (furrow series). Three suboral spines pointing upward; middle suboral spine longest, reaching up to 2 mm.

Number of adambulacral plates, 26; each plate bearing 6 furrow spines. Proximal 2–3 adambulacral plates having one robust, conical subambulacral spine. No pedicellariae on adambulacral plate.

Distribution. This species was known from the Flores Sea, Indonesia (type locality), and Marshall Islands at depths of 113–137 m (A.H. Clark 1952). The present study represents the first record of the species from Japan. The distribution range of the species is extended to north.

Remarks. *Calliaster erucaradiatus* Livingstone, 1936, known from Australia, closely resembles this species. The presence of the pedicellariae is used to distinguish *C. elegans* from C. *erucaradiatus* (Livingstone, 1936). However, recent examination of *C. erucaradiatus* specimens from Taupo Seamount, Australia, revealed the existence of small pedicellariae. This fact suggests that *C. erucaradiatus* may be synonymous to *C. elegans* (H.E.S. Clark & McKnight 2001). Examination of further specimens of this seldom encountered species would be required to determine the exact relationship between *C. erucaradiatus* and *C. elegans*. In the present study, we identified our material as *C. elegans*, based on the presence of remarkable pedicellariae.

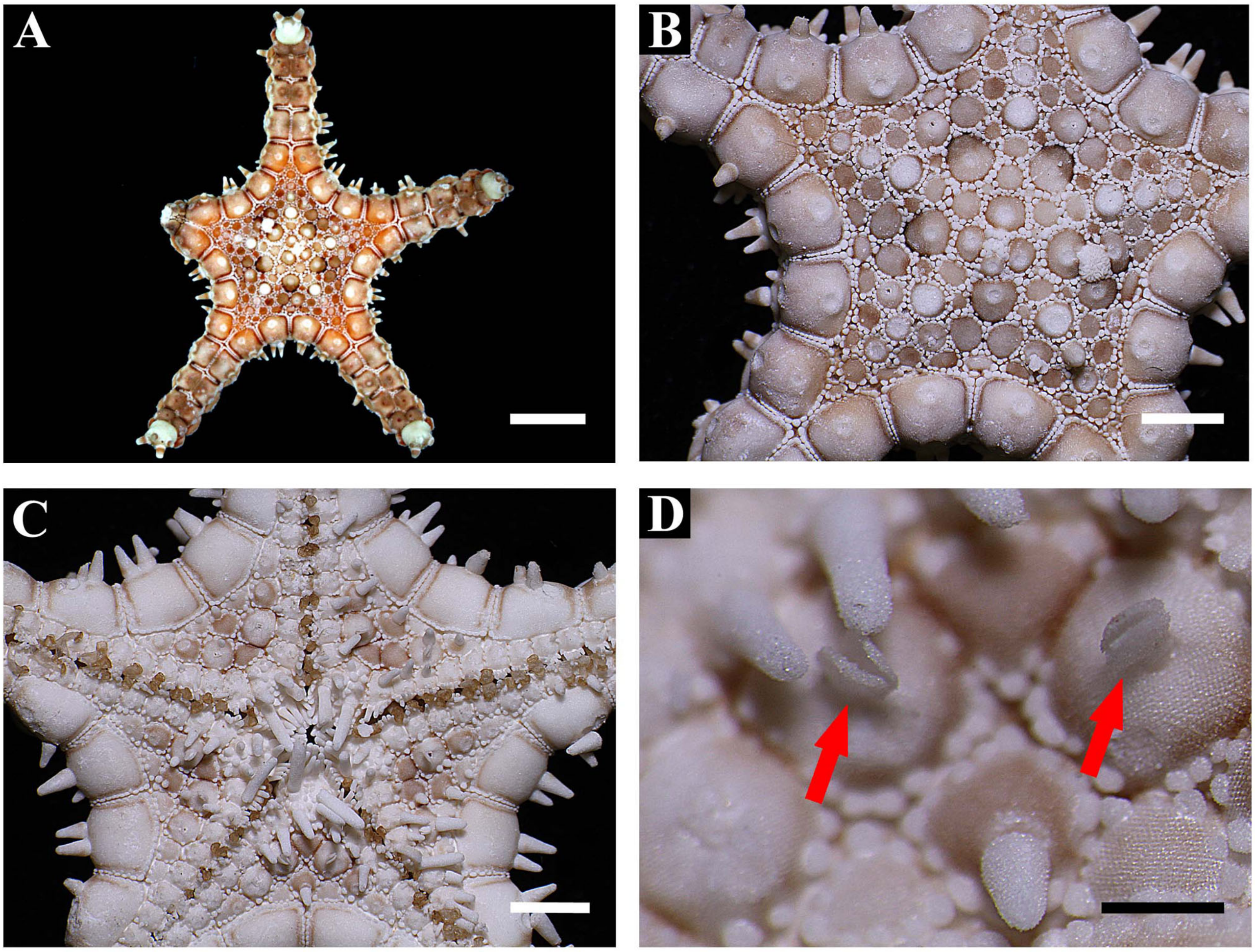


FIGURE 2. *Calliaster elegans* Döderlein, 1922 (RUMF-ZE-00033): A, abactinal view of entire animal in living condition; B, close-up of the abactinal surface; C, close-up of the actinal surface; D, paddle-like pedicellariae on the actinal plates indicated by arrows. Scales: A = 5 mm; B, C = 2 mm; D = 0.5 mm.

Genus *Neoferdina* Livingstone, 1931

Neoferdina longibrachia n. sp.

[New Japanese name: Udenaga-akamon-hitode]
(Fig. 3)

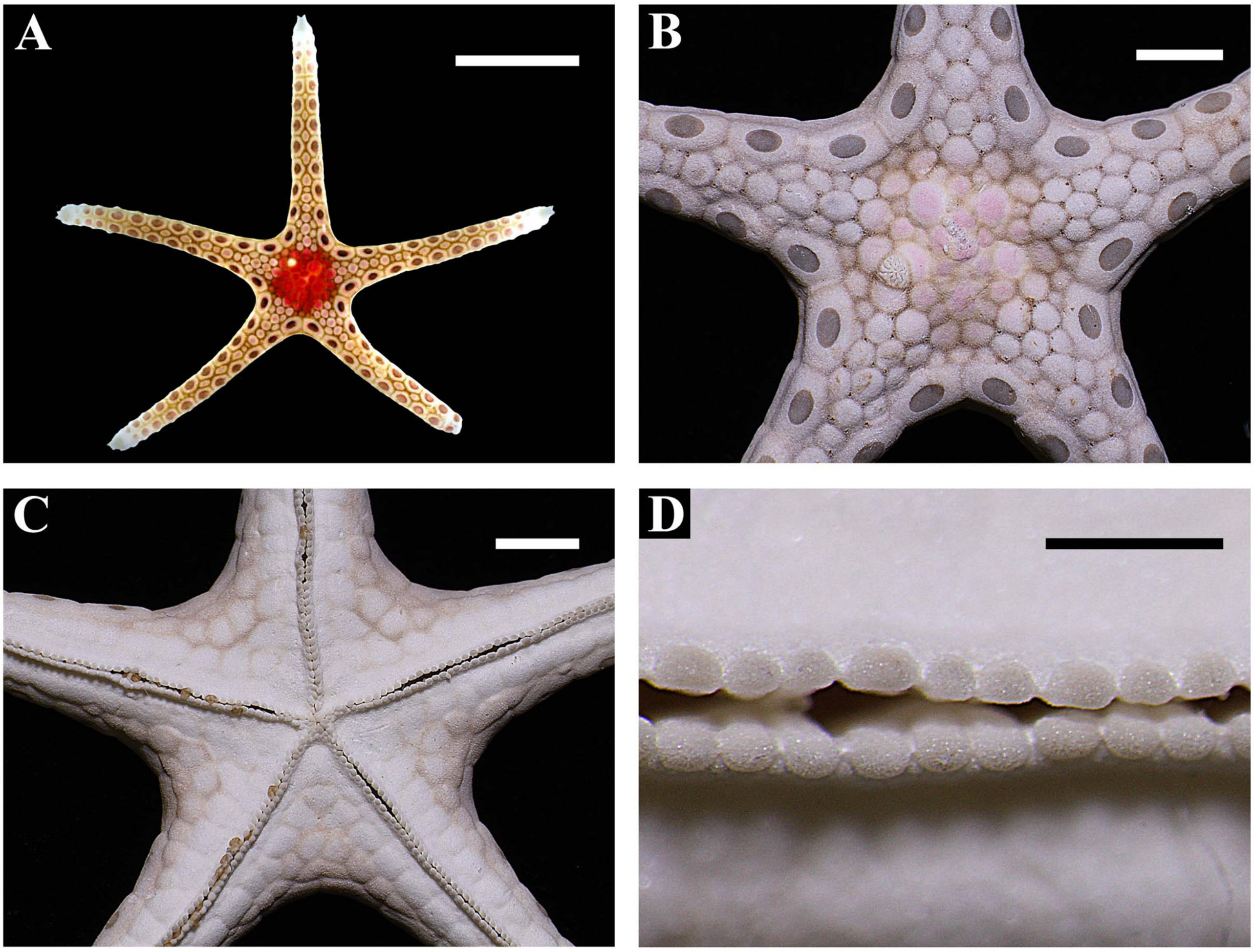


FIGURE 3. *Neoferdina longibrachia* **n. sp.** (RUMF-ZE-00034): A, abactinal view of entire animal in living condition; B, close-up of the abactinal surface; C, close-up of the actinal surface; D, furrow spines on the 14th–12th adambulacral plates (proximal region is on the right). Scales: A = 10 mm; B, C = 2 mm; D = 0.5 mm.

Material examined. Holotype, one specimen, RUMF-ZE-00034, KUMEJIMA 2009 Stn. Trawl-25, 26°16.554–16.655′N, 126°52.714–53.487′E, 151–160 m, 12 November 2009.

Diagnosis. A species of *Neoferdina* with long, narrow arms; R/r exceeding 5.0. Size of superomarginal plates decreasing gradually from arm base to tip. At arm base, 3 regular longitudinal series of abactinal plates between superomarginals. Marginal plates, except for 1st inferomarginal plate, having central bare smooth surface surrounded by fine granules. Abactinal, actinal, adambulacral plates completely covered with granules. Adambulacral armature consisting of 3 short, thick, blunt furrow spines. Single papula, counting 2–4 around abactinal plate at arm base.

Description. Flattened body with 5 long, narrow arms (Fig. 3A). Body proportions as follows: R = 21.6 mm, r = 3.8 mm (R/r = 5.7), width of arm base between 1st and 2nd superomarginal plates 2.9 mm.

Abactinal surface composed of round or elliptical plates. All abactinal plates covered with fine granules. Abactinal plates arranged in 3 regular longitudinal series at arm base (Fig. 3B); carinal plates extending to 8th superomarginal plates, other outer 2 series ending at 2nd superomarginal plates.

Madreporite triangular in shape, with rounded corners, 0.8 mm wide, located interradially about half way between center of disk and disk margin.

Number of superomarginal plates, 12; inferomarginal plates, 12; all of them in contact with each other. Superomarginal plates elongated ellipse; 1st plate with following dimensions: length = 2.0 mm, width = 1.2 mm. Superomarginal plates gradually reduced in size from arm base to tip. Fine granules confined to peripheral areas of superomarginal plate; center of plate completely naked.

Inferomarginal plates elongated ellipse, approximately 2 times longer than width. All plates aligned opposite to superomarginals. First inferomarginal plate entirely covered with granules; other plates with fine granules at their bases; center of each plate lacking granules, with a smooth appearance.

Actinal plate square or rectangular in shape, with rounded corners, entirely covered with dense granules. Arrangements of actinal plates, excluding adambulacral pates, as follows: single odd plate adjacent to mouth plate; innermost series composed of 18–20 plates adjacent to adambulacrals, extending to 9th inferomarginal plate; outer 2nd series composed of 4 plates, reaching only 2nd inferomarginals; single outermost plate situated just below 1st inferomarginal plate (Fig. 3C).

Adambulacral plate narrow, longer than width, completely covered with granules. Adambulacral armature consisted of 3 short, thick, blunt furrow spines, arranged in one longitudinal series along ambulacral furrow (Fig. 3D). Adambulacral plate lacking subambulacral spines.

Mouth plate, having 5–6 marginal spines, covered with granules. Single marginal spine at proximal end conspicuous, forming paired apical spines together with adjoining proximal spine.

Terminal plate conspicuous, 1.2 mm long, 1.2 mm wide; two tiny conical projections at tip of plate.

Single papula, counting 2–4 around each abactinal plate at arm base. No papulae on actinal surface.

Etymology. The specific epithet is named for its long arms, which are the remarkable body shape characteristics that separate this species from most other *Neoferdina* species.

Remarks. The genus *Neoferdina* is known from the tropical and subtropical waters of the Indo-Pacific regions. At present, 5 species are recognized as valid member of this genus: *N. cumingi* (Gray, 1840), *N. glyptodisca* (Fisher, 1913), *N. japonica* Oguro & Misaki, 1986, *N. kuhli* (Müller & Troschel, 1842), and *N. offreti* (Koehler, 1910). Among them, *N. cumingi*, *N. japonica*, and *N. offreti* are distributed in southern Japanese waters (Saba & Irimura 2002).

The present species differs from the previously known Japanese species by virtue of the extremely long, narrow arms; the ratio of R to r of *N. longibrachia* is more than 5, whereas that of the other Japanese species is less than 4. In addition to the body shape, the arrangements of the marginal and abactinal plates are the main distinguishing characteristics. The present species is distinct from *N. cumingi*, based on the arrangement of the superomarginal plates, which are gradually reduced in size from the base of arm to the tip; those of *N. cumingi* are arranged in an alternating pattern of large, bare plates and small, granule-covered plates (A.M. Clark & Rowe 1971). *Neoferdina japonica* and *N. offreti* have no such alternating pattern of large and small superomarginals; however, in addition to the remarkable difference of the R/r value between these species and *N. longibrachia*, they can be distinguished from *N. longibrachia* by having more abactinal plates at the base of arms: *N. japonica* and *N. offreti* has 7 and 5 longitudinal series, respectively, whereas *N. longibrachia* has 3 series.

It is expected that the R/r value and the number of marginal plates may change in accordance with the body size. However, the original description of *N. japonica*, and the examination of small individuals of *N. cumingi* and *N. offreti* collected in the KUMEJIMA 2009 Expedition firmly establish the peculiarity of *N. longibrachia*. The body shape and the number of marginal plates of each species compared are as follows: *N. japonica* (R = 40–42 mm, R/r = 2.5–2.8, number of marginal plates = 11–12), *N. cumingi* (R = 14 mm, R/r = 2.5, number of marginal plates = 7–8), and *N. offreti* (R = 19 mm, R/r = 2.9, number of marginal plates = 8–9).

Two *Neoferdina* species, *N. glyptodisca* and *N. kuhli* have never been recorded in Japanese waters. One of them, *N. glyptodisca*, differs from *N. longibrachia* by virtue of a small R/r, which of the type specimen with R = 35 mm is 3.2 (Fisher, 1919), as well as large, prominent, and centrally bare abactinal plates.

The other species, *N. kuhli*, was insufficiently described by Müller & Troschel (1842) in Germany, with little morphological information and no figures. Unfortunately the only specimen as the holotype of *N. kuhli* obtained from Java has been lost (Jangoux 1973). The original description of *N. kuhli* indicated the body proportion of R/r = 5.0, which resembles that of *N. longibrachia*. However, *N. kuhli* clearly differs from *N. longibrachia* by having an irregular arrangement of abactinal plates, and large, bare abactinal plates that lack central granules (Müller & Troschel 1842).

Family Oreasteridae Fisher, 1911

Genus *Halityle* Fisher, 1913

***Halityle regularis* Fisher, 1913**

[New Japanese name: Ruriiro-mozaiku-hitode]
(Fig. 4)

Halityle regularis Fisher, 1913: 211; 1919: 362. — Döderlein 1935: 108. — A.M. Clark & Rowe 1971: 53. — Baker & Marsh 1976: 107. — Jangoux 1986: 124. — A.M. Clark 1993: 304. — Rowe & Gates, 1995: 102.
Culcitaster anamesus H.L. Clark, 1914: 144.
Halityle anamesus. — H.L. Clark, 1946: 109.

Material examined. Two specimens, RUMF-ZE-00035 (larger specimen), RUMF-ZE-00036, KUMEJIMA 2009 Stn. Trawl-77, 26°15.606–15.929′N, 126°49.404–49.985′E, 91–105 m, 20 November 2009.

Description. Two large specimens with R = 124.9 mm, r = 90.3 mm (R/r = 1.4), and R = 98.3 mm, r = 72.3 mm (R/r = 1.4). External features of larger specimen described below.

Abactinal side inflated (Fig. 4A). Abactinal plates covered with fine granule. Conspicuous, triangular papular areas among abactinal plates. Elliptical madreporite with radiating striae situated at approximately one-third r from center of disk. Longest diameter of madreporite 6 mm.

Vertical lateral side of body formed by marginal plates. Total numbers of superomarginal and inferomarginal plates 20–22 and 40–44, respectively.

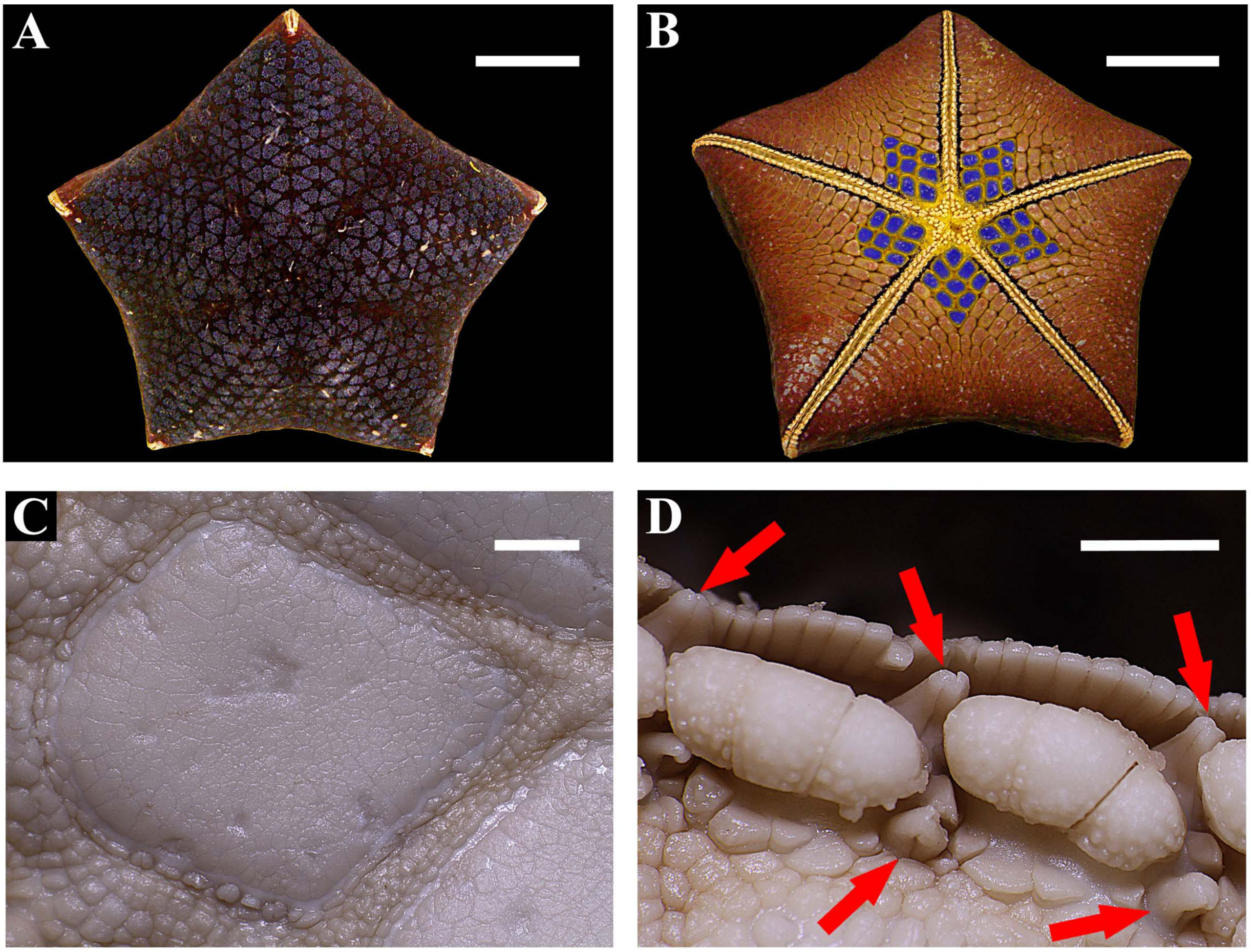


FIGURE 4. *Halityle regularis* Fisher, 1913 (RUMF-ZE-00035): A, abactinal view of entire animal in living condition; B, actinal view of entire animal in living condition; C, close-up of the proximal odd plate on the actinal surface showing the smooth surface, and coarse granules surrounding the plate; D**,** adambulacral armature on the 14th–13th adambulacral plates with arrows indicating the lanceolate pedicellariae (proximal region is on the right). Scales: A, B = 50 mm; C, D = 2 mm.

Actinal surface composed of regularly arranged actinal plates. Inner plates forming 3 longitudinal series along ambulacral furrow. Rhombic or triangular odd plate placed at proximal part of each series; other plates rectangular in shape. Series of plates adjacent to adambulacral plates extending to near arm tip. Outside these 3 longitudinal series, regularly arranged smaller plates forming 5 longitudinal series; these outer series composed of elliptical or roundish square plates without odd plates. Surface of actinal plate flat, relatively smooth. Eight to 9 actinal plates of each interradial area around mouth, surrounded by relatively large, coarse granules (Fig. 4C).

Adambulacral plate armed with 9–11 long, flat furrow spines. Just behind furrow spines, 3–4 large, domed subambulacral spines covered with coarse granules. These subambulacral spines in very close contact with each other, forming massive bumped shape. Between adambulacral plates, 1–2 large, lanceolate pedicellariae (Fig. 4D).

Distribution. The type locality is the Sulu Archipelago in the southwestern Philippines at depth of 16 m. This species has also been collected from throughout the Indo-West and South Pacific region, including New Caledonia (Jangoux 1986), the Philippines, Western Australia, Somalia, Madagascar, and Kenya (Baker & Marsh 1976). The present study represents the first record of the species from Japan. The distribution range of the species is extended to north.

Remarks. *Halityle* Fisher, 1913, is a monotypic genus. Hubert Lyman Clark (1946) transferred *Culcitaster anamesus* H. L. Clark, 1914, to *Halityle*, but it is regarded as a junior synonym of *H. regularis* (Baker & Marsh 1976; A.M. Clark 1993; Döderlein 1935).

The general appearance of the abactinal surface of this species bears some resemblance to that of *Culcita novaeguineae* Müller & Troschel, 1842, which is abundant in the coral reefs of the Ryukyu Islands. *Halityle regularis* can be distinguished from *C. novaeguineae* by the regularly arranged actinal plates, and the unique colouration. The actinal plates of *H. regularis* are smooth and conspicuously tessellated, whereas those of *C. novaeguineae* are obscure and covered by numerous granules. The base colour of the abactinal and actinal surfaces of *H. regularis* is dark or light brown. In contrast to this inconspicuous base colour, the ambulacral furrows, and plates around the mouth are vividly coloured. The colouration of the adambulacral plates, mouth plates, and tube feet are bright yellow. The most striking colour is observed around the mouth: 8–9 actinal plates around the mouth plates of each interradial area are coloured cobalt blue with a bright yellow fringe (Fig. 4B).

Acknowledgements

We are grateful to Dr T. O'Hara (Museum Victoria, Australia) and Dr C. Mah (National Museum of Natural History, Smithsonian Institution, USA) for providing assistance with hard-to-find literature. We also thank two reviewers who made valuable comments which helped to improve the manuscript.

The KUMEJIMA 2009 Expedition was organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus (TRO-SIS), the Center for Marine Bioscience & Biotechnology of the National Taiwan Ocean University (CMBB), the Raffles Museum of Biodiversity Research of the National University of Singapore (RMBR), and the Biodiversity Research Center of the Academia Sinica (BRCAS). The expedition was operated under a permit granted to T. Naruse by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative.

References

Baker, A.N. & Marsh, L.M. (1976) The rediscovery of *Halityle regularis* Fisher (Echinodermata: Asteroidea). *Records of the Western Australian Museum*, 4(2), 107–116.

Clark, A.H. (1952) Echinoderms from the Marshall Islands. *Proceedings of the United States National Museum*, 102, 265–303.

Clark, A.M. (1989) An index of names of recent Asteroidea Part 1: Paxillosida and Notomyotida. pp. 225–347. *In*: Jangoux, M. & Lawrence, J.M. (eds.), *Echinoderm Studies, 3*. A.A. Balkema, Rotterdam, 383 pp.

Clark, A.M. (1993) An index of names of recent Asteroidea Part 2: Valvatida. pp. 187–366. *In*: Jangoux, M. & Lawrence, J.M. (eds.), *Echinoderm Studies, 4*. A.A. Balkema, Rotterdam. 368 pp.

Clark, A.M. & Rowe, F.W.E. (1971) *Monograph of Shallow-water Indo-West Pacific Echinoderms*. Trustees of the British Museum (Natural History), London, 238 pp.

Clark, H.E.S. & McKnight, D.G. (2001) The Marine Fauna of New Zealand: Echinodermata: Asteroidea (sea-stars) Order Valvatida. *NIWA Biodiversity Memoir*, 117, 1–270.

Clark, H.L. (1914) The echinoderms of the Western Australian Museum. *Records of the Western Australian Museum and Art Gallery*, 1(3), 132–173.

Clark, H.L. (1946) The echinoderm fauna of Australia. Its composition and its origin. *Carnegie Institution of Washington Publication*, 566, 1–567.

Döderlein, L. (1922) Uber die Gattung *Calliaster* Gray. *Bijdragen tot de Dierkunde*, 22, 47–52.

Döderlein, L. (1924) Die Asteriden der Siboga-Expedition. II. Pentagonasteridae. *Siboga-Expedition*, 46(2), 49–69.

Döderlein, L. (1935) Die Asteriden der Siboga-Expedition. III. Oreasteridae. *Siboga-Expedition*, 46(3), 71–110.

Djakonov, A.M. (1930) Echiniden, Ophiuriden und Asteriden gesammelt von Prof. P.J. Schmidt bei den Riu-Kiu Inseln im Jahre 1926–1927. *Zoologische Jahrbücher*, 59, 233–252.

Fisher, W.K. (1906) The starfishes of the Hawaiian Islands. *Bulletin of the United States Fish Commission*, 23, 987–1130.

Fisher, W.K. (1911) Asteroidea of the North Pacific and adjacent waters. 1. Phanerozonia and Spinulosida. *Bulletin of the United States National Museum*, 76, 1–419.

Fisher, W.K. (1913) Four new genera and fifty-eight new species of starfishes from the Philippine Islands, Celebes, and the Moluccas. *Proceedings of the United States National Museum*, 43, 599–648.

Fisher, W.K. (1919) Starfishes of the Philippine seas and adjacent waters. *Bulletin of the United States National Museum*, 3, 1–712.

Forbes, E. (1841) *A History of British Starfish and Other Animals of the Class Echinodermata*. John van Voorst, London, 267 pp.

Goto, S. (1914) A descriptive monograph of Japanese Asteroidea. *The Journal of the College of Science, Imperial University of Tokyo*, 29, 1–808.

Gray, J.E. (1840) A synopsis of the genera and species of the class Hypostoma (Asterias Linnaeus). *Annals of the Magazine of Natural History*, 6, 175–184; 275–290.

Hayashi, R. (1930) Sea-stars of the Ryukyu Islands. *Bulletin of the Biogeographical Society of Japan*, 8, 197–221.

Jangoux, M. (1973) Le genre *Neoferdina* Livingstone. (Echinodermata: Asteroidea, Ophidiasteridae). *Revue de Zoologie et de Botanique Africaines*, 87, 775–794.

Jangoux, M. (1986) Les astérides, pp. 109–153. *In*: Guille, A. *et al.* (Eds.) *Guide des étoiles de mer, oursins et autres échinodermes du lagon de Nouvelle-Calédonie*. ORSTOM, Paris, 238 pp.

Jangoux, M., Ridder, C.D., Massin, C. & Darsono, P. (1989) The holothuroids, echinoids and asteroids (echinodermata) collected by the Snellius-II expedition. *Netherlands Journal of Sea Research*, 23(2), 161–170.

Koehler, R. (1910) An account of the shallow-water Asteroidea. *Echinoderma of the Indian Museum*, Part 6, 1–192.

Kogure, Y. (2008) Rediscovery of the astropectinid sea star *Ctenophoraster diploctenius* (Echinodermata, Asteroidea) for the first time in a century from southwestern Japanese waters. *Bulletin of the Biogeographical Society of Japan*, 63, 199–204. [in Japanese with English abstract]

Kogure, Y. & Kaneko, A. (2010) A solasterid asteroid *Seriaster regularis* (Echinodermata, Asteroidea, Velatida) found in the Okinawa Islands: The first record from Japanese waters. *Bulletin of the Biogeographical Society of Japan*, 65, 97–102. [in Japanese with English abstract]

Kogure, Y., Kaneko, A. & Mah, C.L. (2009) A rarely encountered oreasterid sea star, *Astrosarkus idipi* (Echinodermata, Asteroidea), newly recorded from Japanese waters. *Biogeography*, 11, 73–76.

Livingstone, A.A. (1931) On the restriction of the genus *Ferdina* Gray (Asteroidea). *Australian Zoology*, 6(4), 305–309.

Livingstone, A.A. (1936) Descriptions of new Asteroidea from the Pacific. *Records of the Australian Museum*, 19, 383–390.

Müller, J. & Troschel, F.H. (1842) *System der Asteriden*. Braunschweig, 134 pp.

Oguro, C. & Misaki, H. (1986) A new sea-star, *Neoferdina japonica*, from Japan. *Proceedings of the Japanese Society of Systematic Zoology*, 34, 60–64.

Perrier, E. (1884) Mémoire sur les étoiles de mer recueillis dans la Mer des Antilles et la Golfe de Mexique. *Nouvelle Archives Museum d'Histoire naturelle de Paris*, 6(2), 127–276.

Roberts, C.M., McClean, C.J., Veron, J.E.N., Hawkins, J.P., Allen, G.R., McAllister, D.E., Mittermeier, C.G., Schueler, F.W., Spalding, M., Wells, F., Vynne, C. & Werner, T.B. (2002) Marine biodiversity hotspots and conservation priorities for tropical reefs. *Science*, 295, 1280–1284.

Rowe, F.W.E. & Gates, J. (1995) *Zoological catalogue of Australia. 33. Echinodermata.* CSIRO, Melbourne, 510 pp.

Saba, M. & Irimura, S. (2002) *Sea Stars and Brittle Stars in Japanese Waters.* TBS-BRITANNICA, Tokyo. 135 pp. [in Japanese]

Zootaxa 3367: 252–268 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Comanthus kumi, a new shallow-water comatulid (Echinodermata: Crinoidea: Comatulida: Comasteridae) from the Ryukyu Islands, Japan*

YOSHIHISA FUJITA[1,2,4] & MASAMI OBUCHI[3]
[1] *University Education Center, University of the Ryukyus, 1 Senbaru, Nishihara-cho, Okinawa 903-0213, Japan.*
E-mail: galatheids@yahoo.co.jp
[2] *Marine Learning Center, 2-95-101 Miyagi, Chatan-cho, Okinawa 904-0113, Japan.*
[3] *Biological Institute on Kuroshio 560 Nishidomari, Otuski-cho, Kochi, 788-0333 Japan.*
E-mail: obuchitarou@yahoo.co.jp
[4] *Corresponding author*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new species of the genus *Comanthus* A.H. Clark, 1908, is described on the basis of specimens collected from Kume Island and Okinawa Island, the Ryukyu Islands, Japan. *Comanthus kumi* **n. sp.** is distinguished from all ten congeners by having extremely elongate arms exceeding 300 mm in length and the colouration in life. The new species concealed its whole body in a crevice or small hole on coral reefs during the day and protruded only several elongate arms on the reef surface at night. This habit suggests that the new species is nocturnal.

Key words: Crinoidea, Comatulida, Comasteridae, new species, Okinawa

Introduction

The species of the comatulid genus *Comanthus* A.H. Clark, 1908 are well known in shallow-water coral reefs (Kogo 1998; Rowe *et al*. 1986). The genus was established by A.H. Clark (1908), and revised by Hoggett & Rowe (1986) and Rowe *et al*. (1986), the latter two revisions chiefly based on the shapes and distributions of combed pinnules as follows: 1) proximal comb segment transversely-oriented and saucer-like; 2) remaining comb teeth usually confluent with lateral margin of each segment, and; 3) combed pinnules occur beyond the second pinnule (P_2) and sometimes to near arm tip (Hoggett & Rowe 1986; Rowe *et al*. 1986).

Hoggett & Rowe (1986) recognised 11 species. Consequently, Kogo (1998) referred *Comanthus imbricata* (A.H. Clark, 1908), to the genus *Oxycomanthus* Rowe, Hoggett, Birtles & Vail, 1986. The genus *Comanthus* therefore now contains ten species: *C. alternans* (Carpenter, 1881); *C. briareus* (Bell, 1882); *C. delicata* (A.H. Clark, 1909); *C. gisleni* Rowe, Hoggett, Birtles & Vail, 1986; *C. mirabilis* Rowe, Hoggett, Birtles & Vail, 1986; *C. parvicirrus* (Müller, 1841); *C. suavia* Rowe, Hoggett, Birtles & Vail, 1986; *C. taviana* (A.H. Clark, 1911); *C. wahlbergii* (Müller, 1841); and *C. weberi* (A.H. Clark, 1912).

During the course of our studies on the shallow-water comatulid species diversity in the Ryukyu Islands (see Kogo & Fujita 2000; Obuchi *et al*. 2009), an unusual species of *Comanthus* was found by SCUBA dives at night off Kume Island and Okinawa Island. The present paper herein describes the species as new to science.

Materials and Methods

The method for measurements of specimens generally follows that of Messing *et al*. (2000). In addition, the maximum width and length of the brachial and pinnular ossicles were also measured. Terminology for

Accepted by T. Naruse: 10 Jun. 2011; published: 4 Jul. 2012

morphological description generally follows those of Rowe *et al.* (1986) and Messing *et al.* (2000). The abbreviations used in the text are almost same as in our previous paper (Obuchi *et al.* 2009) and are shown below.

Br: division series or brachitaxis, a series of ossicles following a radial ossicle or axillary and including the next axillary. A preceding Roman numeral indicates the location from most proximal. The following Arabic subscript numeral indicates the number of ossicles in the series.

br: brachial, each ossicle of division series or undivided arm. Brachial of division series is preceded by a Roman numeral. The following Arabic subscript numeral indicates the location in each division series or undivided arm.

P: pinnule, side branch of arm composed of small segments or pinnulars. Sequential Arabic subscript numeral or lower case alphabet indicates position of pinnule on outer or inner side of arm bifurcation, respectively (e.g., P_1, P_2, or P_a, P_b). Pinnule arising from II Br series is represented as P_D.

+: articulation joined by syzygy.

The type specimens are deposited in the Ryukyu University Museum, Fujukan (RUMF), Okinawa, Japan.

Taxonomic account

Family Comasteridae A.H. Clark, 1908

Genus *Comanthus* A.H. Clark, 1908

Comanthus kumi n. sp.

(Figs. 1–4)

Material examined. Holotype: Aka-todai, Kume Island, Ryukyu Islands (KUMEJIMA 2009, Diving St. 43), 26°19.251′N, 126°45.354′E, 11.6 m depth, 20 November 2009, night, SCUBA diving, coll. Y. Fujita, RUMF-ZE-00025.

Paratypes: Aka-todai, Kume Island, Ryukyu Islands, 26°19.251′N, 126°45.354′E, 8.6 m, 17 October 2010, night, SCUBA diving, coll. Y. Fujita, RUMF-ZE-00026. Same locality and data as RUMF-ZE-00026, 9.4 m, RUMF-ZE-00027. Maeda-misaki, Onna, Okinawa Island, Ryukyu Islands, 20.4 m, 28 May 2009, night, SCUBA diving, coll. Y. Fujita, RUMF-ZE-00028. Mizugama, Yomitan, Okinawa Island, Ryukyu Islands, 15.7 m, 4 January 2000, night, SCUBA diving, coll. Y. Fujita, RUMF-ZE-00029.

Comparative material. *Comanthus gisleni* Rowe, Hoggett, Birtles, & Vail, 1986. Mizugama, Yomitan, Okinawa Island, Ryukyu Islands, 7.1 m, 1 December 1997, SCUBA diving, coll. Y. Fujita, RUMF-ZE-00030 (Fig.5A).

Comanthus parvicirrus (Müller, 1841). Maeda-misaki, Onna, Okinawa Island, Ryukyu Islands, 6.7 m, 12 August 2000, night, SCUBA diving, coll. Y. Fujita, RUMF-ZE-00031 (Fig.5B).

Diagnosis. A large species with elongated arms exceeding 300 mm in length. Centrodorsal small, 3.0–3.3 times radial length, discoidal. Radials visible, narrow. Disk small, smooth, hemispherical; mouth marginal; anal papilla central. Cirri weak, sometimes absent; mature cirri up to IV, 6–8 mm long, with 13–15 segments; aboral sides of distal segments each with transverse ridge. Arms 20–27 in number; anterior arms reaching 3 times longer than posterior arms. In IBr 2, IIBr, and IIIBr 4(3+4) or 2, each ossicle rounded laterally. First brachial syzygy at br_{3+4}, second at $br_{10+11\sim13+14}$, and following at 3–6 (usually 4) intervals of muscular articulations. Discretely combed pinnules present at intervals of varying length on the proximal 1/5 to 1/3 of each anterior, long arm (arising closest to mouth) and distal half of each posterior, short arm. P_D and P_1 almost similar in shape and length, each with 7–14 comb teeth; P_2 shortest, with 7–14 teeth; proximal comb teeth saucer-shaped; primary comb teeth triangular, confluent, each accompanied by a small secondary tooth. Middle segments of distal pinnules with spinose distal aboral edges. Colouration in life almost uniform: white ground colour with yellow-orange broad blotches on the ossicles united by syzygy.

Description of holotype. Centrodorsal (Figs. 1C, D, 2A). Small, 2.9 mm in diameter, 3.2 times wider than radial length, low discoidal, pentagonal; marginal row of cirrus sockets producing rugged edge; polar area slightly concave, smooth.

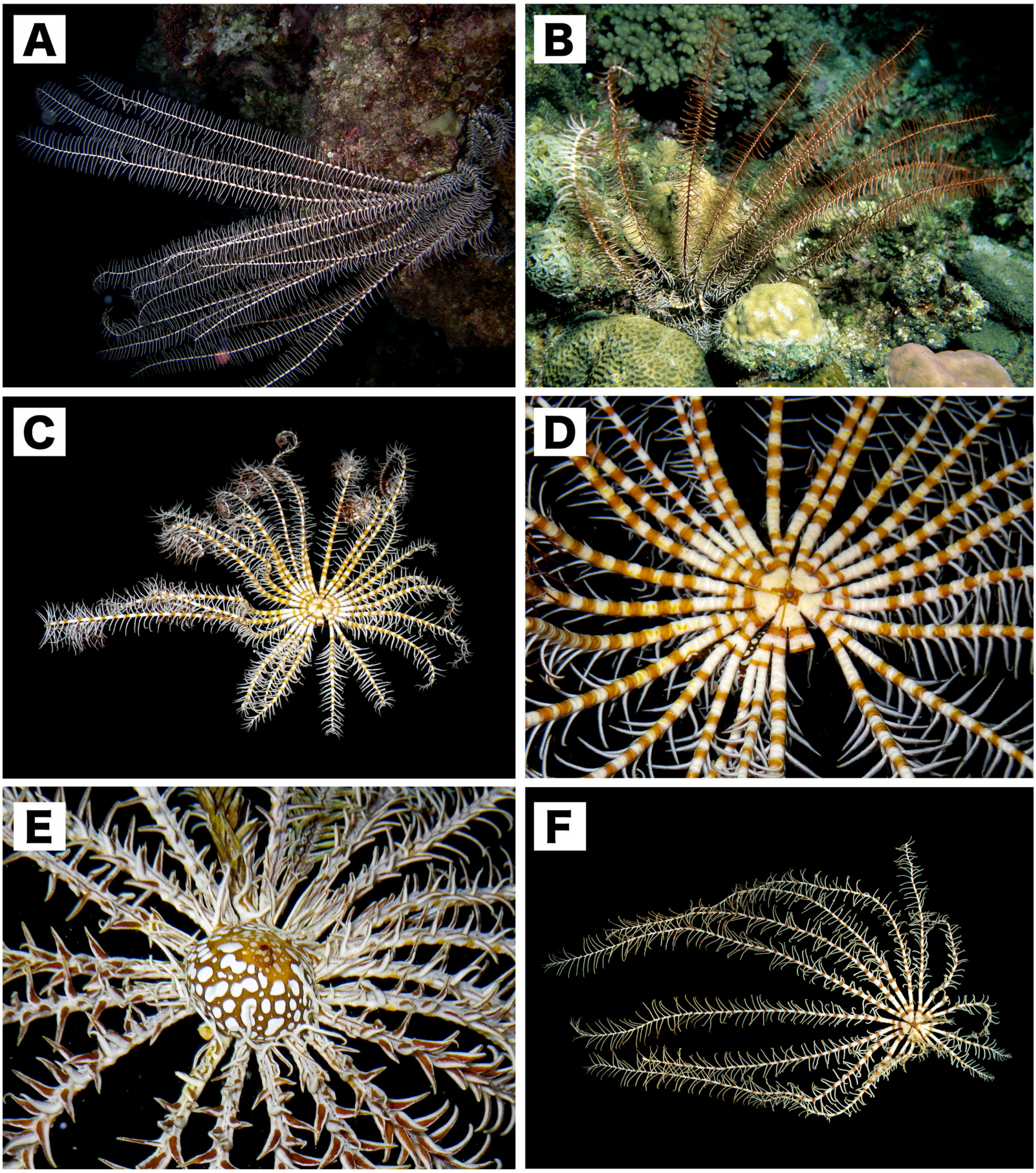


FIGURE 1. *Comanthus kumi* **n. sp.** in life: A, B, posture at night, specimens not collected; C, whole animal, aboral view, holotype, RUMF-ZE-00025; D, centrodorsal, radials and proximal part of rays, aboral view, holotype, RUMF-ZE-00025; E, disk, oral view, paratype, RUMF-ZE-00027; F, whole animal, aboral view, paratype, RUMF-ZE-00029.

Cirri (Fig. 2F). Three mature (one broken through examination), 5 rudimentary, and 1 scar; 2 mature cirri each 6.8 and 7.7 mm long, composed of 14 or 15 segments. Cirrus segments each compressed laterally; first segment very short; second 1.5 times broader than long; third 1.3 times longer than broad; fourth to sixth segments 1.3–1.4 times longer than broad. Following segments squarish (approximately as long as broad) or gradually decreasing in length (mostly broader than long). Eighth to penultimate segments each with transverse ridge, bearing irregular minute spines on aboral margin. Terminal claw approximately twice as long as penultimate segment, curved, with sharply pointed apex.

Rays (Figs. 1C, D, 2A, B). Radials visible, 3.6 times broader than long, narrow, forming rounded pentagon. Division series, except for first ossicle, each well separated from adjacent ray branches. IBr series composed of 2 ossicles, connected tightly by synarthry; Ibr_1 short, 3.7–4.1 times broader than long, oblong, united laterally to neighboring ossicles; Ibr_2 2.1–2.2 times broader than long, axillary, triangular, laterally separated from neighboring ossicles. IIBr series all composed of 4 ossicles; IIbr_3 and IIbr_4 connected by syzygy; IIbr_1 short, 2.1–2.2 times broader than long, almost oblong, united interiorly; IIbr_2 short, 3.0–3.5 times broader than long, trapezoidal, laterally separated from neighboring ossicle, bearing P_D; IIbr_4 pentagonal. Six IIIBr series (4 exterior and 2 interior) present; not twisted; all composed of 4 ossicles, IIIbr_3 and IIIbr_4 connected by syzygy.

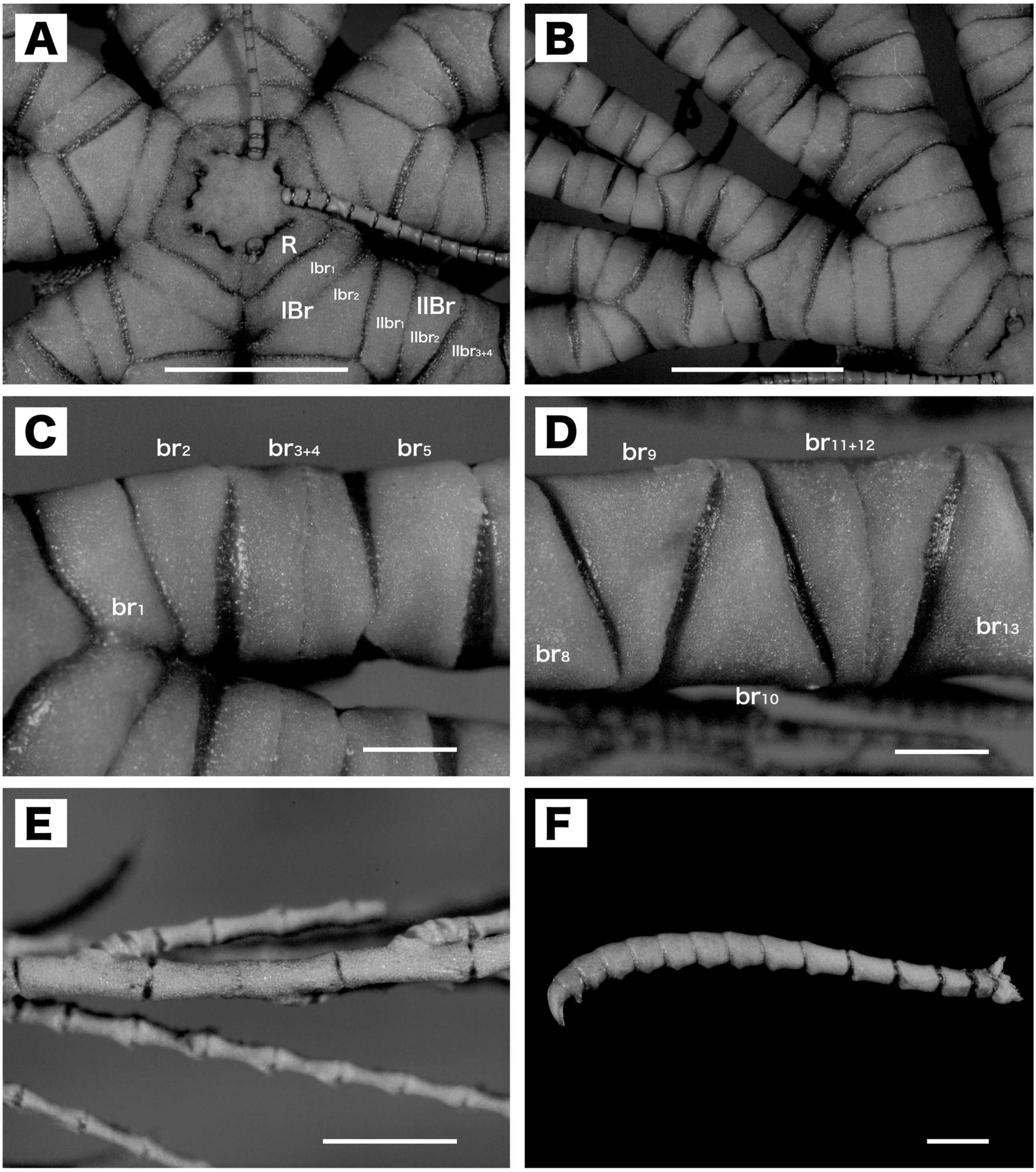


FIGURE 2. *Comanthus kumi*, **n. sp.**, holotype, RUMF-ZE-00025. A, centrodorsal, radials, and proximal part of rays, aboral view; B, proximal part of one ray, aboral view; C, first to fifth arm brachials, aboral view; D, eighth to thirteenth arm brachials, aboral view; E, distal brachials of arm and proximal part of pinnules, aboral view; F, detached cirrus, lateral view. Abbreviations: R, radial; IBr, first division series; IIBr, second division series; br, brachial. Scales: A, B = 5.0 mm; C–F = 1.0 mm.

Arms (Figs. 1C, D, 2B–E). Twenty-seven in number (2 arms broken and lost through examination); anterior and posterior rays 250–290 mm and 79–81 mm, respectively. Proximal brachials short, rounded laterally, broader than long; br$_1$ 2.1–2.6 times broader than long, oblong, united interiorly to neighboring br$_1$; br$_2$ 1.9–2.2 times broader than long, trapezoidal, with exterior margin much longer than interior margin, separated from neighboring ossicles; br$_3$ and br$_4$ 1.4–1.9 times broader than long, articulated by syzygy; br$_{3+4}$ oblong; br$_5$ and br$_6$ nearly oblong, 1.6–2.0 and 1.5–1.8 times broader than long, respectively. Brachials succeeding middle ones 1.3–1.7 times broader than long, gradually diminishing in width distally, cuneate alternately. Brachials near arm tip 2.0–3.2 times longer than wide, slender, circular cylindrical. All brachials uniformly smooth. First arm syzygy at br$_{3+4}$; second at br$_{10+11}\sim_{12+13}$; following intervals of 3 or 4 muscular articulations.

Pinnules (Figs. 3, 4). Unbroken arm (234 mm long) of anterior rays with at least 94 pinnules, short arm (74.3 mm long) of posterior rays with at least 33 pinnules. Genital pinnules on P$_3$– P$_{15}$. Combed pinnules present discretely on P$_{20}$– P$_{26}$ of anterior (long) arms (proximal 1/4 or 1/3 of arm) and on P$_{20}$–P$_{27}$ of posterior (short) arms (at least half of arm). P$_D$ 10.5–13.1 mm long; proximal pinnulars broader than long, composed of 36–38 segments, with 7–10 comb teeth; middle to distal pinnulars with length and width subequal or longer than broad; proximal comb teeth saucer-shaped; primary teeth triangular, confluent with lateral margin of pinnular, with small secondary tooth. P$_1$ 8.8–11.7 mm long, with 31–38 segments bearing 8–10 comb teeth; combed pinnulars as in P$_D$. P$_2$ shortest, 4.0–4.9 mm long, with 22–27 segments bearing 7–10 comb teeth. Following pinnules sometimes lacking combs: P$_3$ 5.7 mm long, with 22–28 segments bearing 6–10 comb teeth; P$_4$ 5.2 mm long, with 22 segments bearing 7 comb teeth. Pinnules on inner side of arm (P$_a$, P$_b$ …) similar to in those on outer side of arm. Middle segments of terminal pinnules with fringe of spines on distal aboral edge (Fig. 3D).

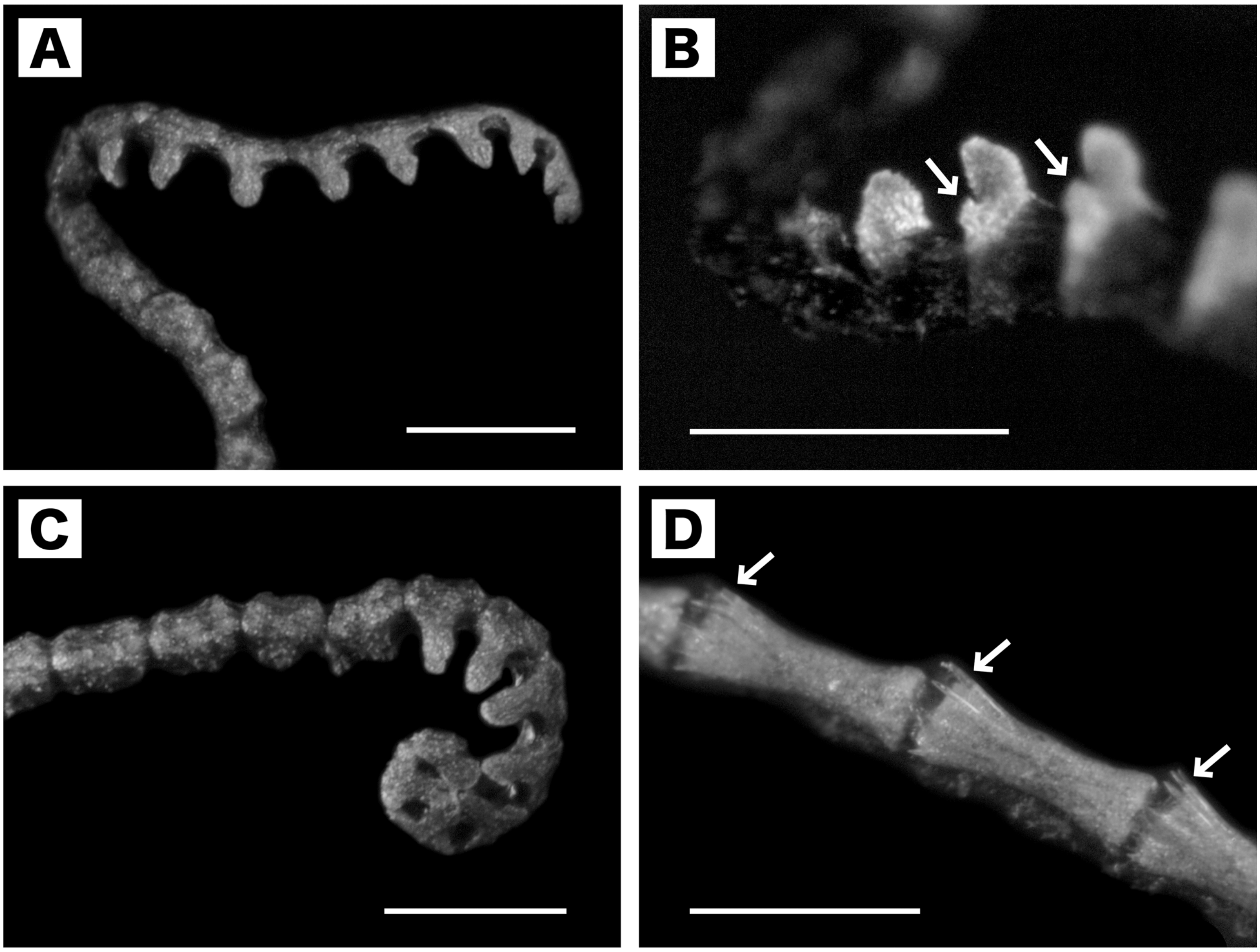


FIGURE 3. *Comanthus kumi* **n. sp.,** holotype, RUMF-ZE-00025, lateral views of pinnules: A, terminal comb of P$_D$; B, proximal combed segments of P$_D$, arrows indicate small secondary teeth; C, terminal combs of P$_1$; D, small spines (arrows) on middle segments of distal pinnule, dorsal view. Scales = 0.5 mm.

Disk. Small, ca. 13.6 mm in diameter, smooth, hemispherical; mouth marginal and anal papilla central.

Notes on Paratypes. Largest specimen (RUMF-ZE-00028). Centrodorsal 2.9 mm in diameter, 3.3 times wider than radial length; arms 26 in number, anterior arms 295–320 mm long, posterior arm 110–115 mm long; cirri X (4 mature, 4 rudimentary, and 2 sockets), mature cirri 7–8 mm long, composed of 15 or 16 segments; division series IBr 2, IIBr 4(3+4) , IIIBr 4(3+4), IVBr 4(3+4); first arm syzygy at br_{3+4}, second at br_{10+11}~$_{13+14}$; following intervals 3–6 (mainly 4) muscular articulations; proximal pinnules with 9–14 comb teeth, combed pinnules present on proximal 1/3 (at least P_{30} of whole pinnules) in each anterior arm and extending nearly to tip of each posterior arm [P_{36} of whole 46 pinnules].

Smallest specimen (RUMF-ZE-00029) (Fig.1F). Centrodorsal 2.4 mm in diameter, 3.0 times wider than radial length; arms 20 in number, anterior rays 160 mm long, posterior 36–40 mm long; cirri VI (1 mature and 5 rudimentary), mature cirrus 6 mm long, composed of 13 segments; division series IBr 2, IIBr 4(3+4) or 2; proximal pinnules with 9–11 combs, combed pinnules present on proximal 1/5 to 1/4 [at least P_{13} of whole 66 pinnules] of each anterior arm and on proximal 1/2 of each posterior arm (P_7 of whole 15 pinnules).

Colouration in life. Ground body white; centrodorsal stellate yellow-orange; aboral side of arms and brachial ossicles of rays and arms white; ossicles united by syzygy with yellow-orange broad blotches. Cirri yellow-orange. Pinnules white in aboral view, with yellow-orange blotches. Disk dark orange, with white blotches.

Etymology. The new species is named after the old name of Kume Island, *Kumi*, where the holotype of the species was collected. Used as noun in apposition. The standard Japanese name for this species is given here as "Nichirin-umishida"

Distribution. Known only from the Ryukyu Islands (Kume Island and Okinawa Island), Japan in 8.6–20.4 m.

Habitat. The whole body of the species is concealed in a crevice or small hole on the coral reefs during the day. However, several longer anterior arms of the species were protruded from the inhabited crevice at night. This suggests that *Comanthus kumi* **n. sp.** is a nocturnal species.

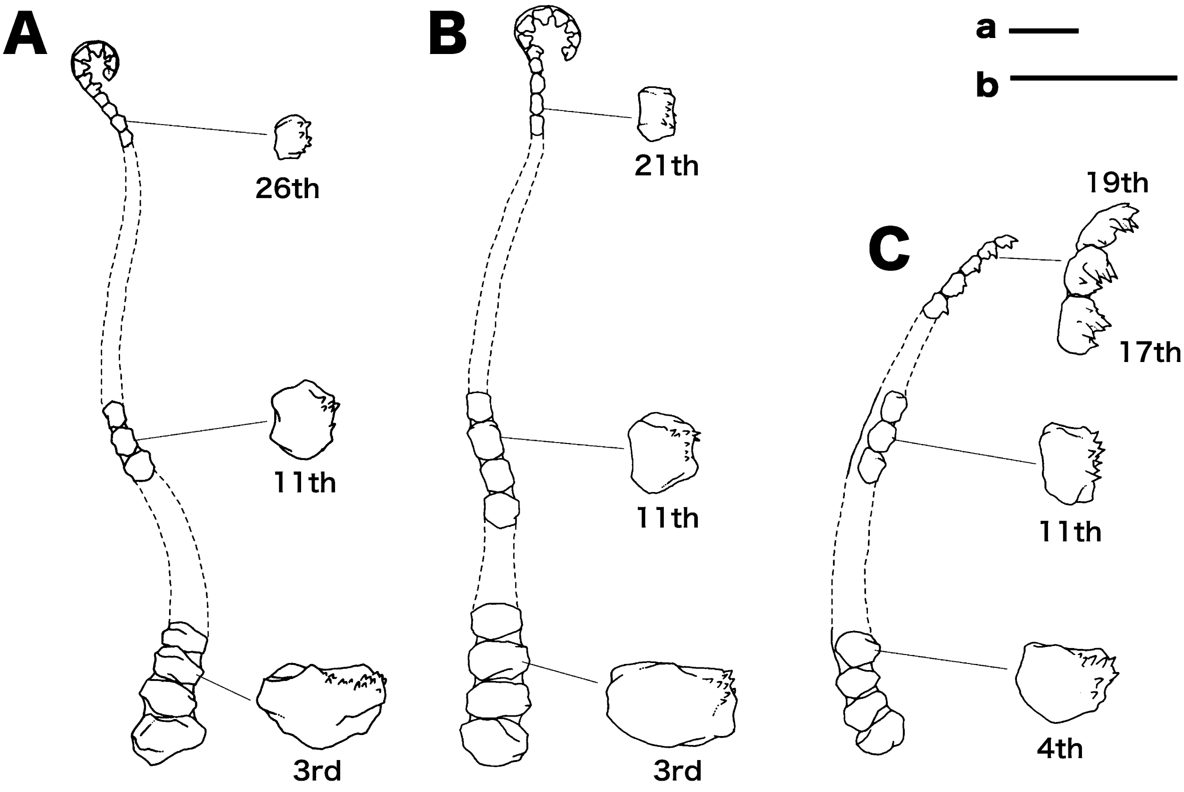


FIGURE 4. *Comanthus kumi* **n. sp.,** holotype, RUMF-ZE-00025, pinnules: A, P_D, lateral view; B, P_1, lateral view; C, P_5, lateral view. Scales = 1.0 mm; upper for whole pinnules, lower for enlarged pinnulars.

Remarks. *Comanthus kumi* **n. sp.** may be closest to *C. gisleni* in that the middle segments of the distal pinnules have a fringe of spines on each distal aboral edge (Fig. 3D). However, the new species is distinguished from *C. gisleni* by the length of the anterior arm and the structure of the brachial ossicles. The anterior arm of *C. kumi* **n. sp.** is elongated and exceeds 300 mm in length, whereas that of *C. gisleni* is only at most 150–160 mm. The brachial ossicles are smooth and slightly rounded on the aboral and lateral surfaces in *C. kumi*, while they are flattened and everted laterally in *C. gisleni* (see Kogo, 1998; Rowe *et al*. 1986). The body colouration in life is also clearly different between the two species (Figs. 1 and 5). In *C. kumi* **n. sp.**, the colouration is almost uniform, the brachial ossicles are white in ground colour and the ossicles united by syzygy have yellow-orange broad blotches (Fig. 1C, D, F); whereas in *C. gisleni*, the brachial ossicles vary in the ground colour (e.g. dark brown, black, brown, see Rowe *et al*. 1986; Fig.5) and each possesses a darker longitudinal line on the dorsal midline.

Comanthus kumi **n. sp.** also resembles *C. parvicirrus* and *C. suavia* in having distinctly visible radials which are not obscured by the centrodorsal, and the relatively large centrodorsal of 2 times wider than the length of the radial. However, the new species differs from the latter two species in the presence of a fringe of spines on the distal aboral edge of the middle segments of each distal pinnule. Such a fringe of spines is absent in *C. parvicirrus* and *C. suavia.*

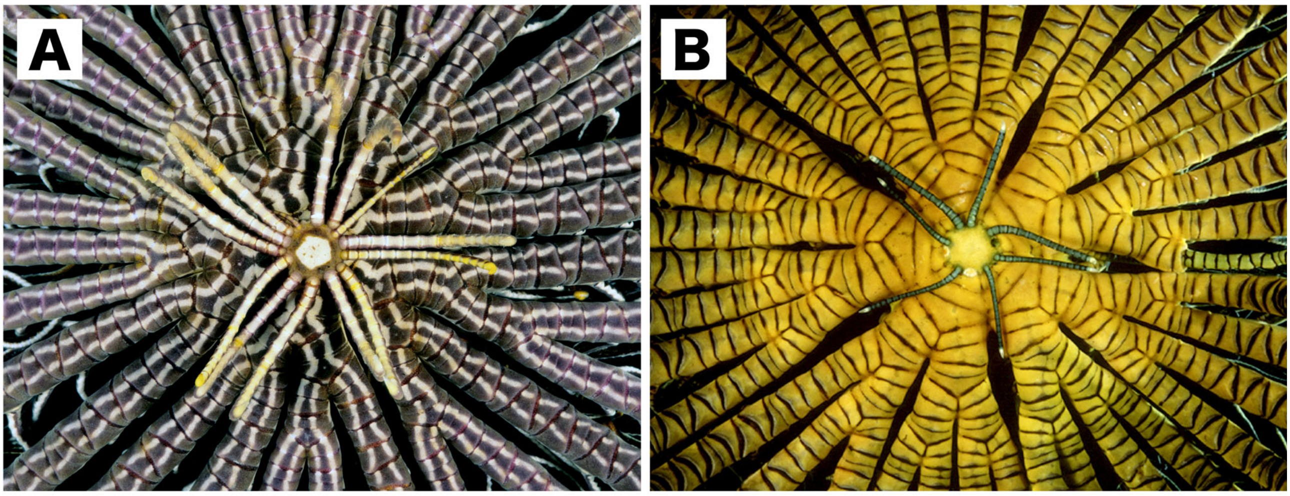


FIGURE 5. Colouration in life of aboral side of centrodorsal, division series, and proximal part of arms: A, *Comanthus gisleni* Rowe, Hoggett, Birtles, & Vail, 1986, RUMF-ZE-00030; B, *Comanthus parvicirrus* (Müller, 1841), RUMF-ZE-00031.

Acknowledgements

We sincerely thank I. Nakayoshi and A. Izeki for their kind help in the animal collection. Thanks are also due to Charles G. Messing (Oceanographic Center, Nova Southeastern University) and an anonymous reviewer for reviewing our manuscript: to M. Osawa (Shimane University) for his valuable comments and suggestions on the early draft of the manuscript. The holotype specimen was collected during the KUMEJIMA 2009 Expedition organized by the Transdisciplinary Research Organization for Subtropical and Island Studies of the University of the Ryukyus, the Center for Marine Bioenvironment and Biotechnology of the National Taiwan Ocean University, the Raffles Museum of Biodiversity Research of the National University of Singapore, and the Biodiversity Research Center of the Academia Sinica. The expedition was conducted under a permit granted to T. Naruse of the University of the Ryukyus by the Okinawa Prefectural Governor and the Kumejima Fisheries Cooperative. This study is also received financial support from the “Kume Island Project” funded by the Mitsui & Co. Ltd. Environment Fund.

References

Clark, A.H. (1908) Preliminary notice of a collection of recent crinoids from the Philippine Islands. *Smithsonian Miscellaneous Collections*, 52, 199–234.

Hoggett, A.K. & Rowe, F.W.E. (1986) A reappraisal of the family Comasteridae A.H. Clark, 1908 (Echinodermata: Crinoidea), with the description of a new subfamily and a new genus. *Zoological Journal of the Linnean Society*, 88, 103–142.

Kogo, I. (1998) Crinoids from Japan and its adjacent waters. *Osaka Museum of Natural History*, Special Publication, 30, 1–148.

Kogo, I. & Fujita, Y. (2000) Three species of the shallow-water comatulids from Okinawa Island, new records in Japan (Crinoidea: Comatulida). *Bulletin of the Osaka Museum of Natural History*, 54, 1–12.

Messing, C.G., Ameziane, N. & Eleaume, M. (2000) Echinodermata Crinoidea: Comatulid crinoids of the KARUBAR Expedition to Indonesia. The families Comasteridae, Asterometridae, Calometridae and Thalassometridae. *In:* Crosnier, A. (ed.), Résultats des Campagnes MUSORSTOM, vol. 21. *Mémoires du Museum national d'Histoire naturelle*, 184, 627–702.

Obuchi, M., Kogo, I. & Fujita, Y. (2009) A new brooding feather star of the genus *Dorometra* (Echinodermata: Crinoidea: Comatulida: Antedonidae) from the Ryukyu Islands, southwestern Japan. *Zootaxa*, 2008, 61–68.

Rowe, F.W.E., Hoggett, A.K., Birtles, R.A. & Vail, L.L. (1986) Revision of some comasterid genera from Australia (Echinodermata: Crinoidea), with descriptions of two new genera and nine new species. *Zoological Journal of Linnean Society*, 86, 197–277.

Zootaxa 3367: 269–273 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new *Obliquogobius* Koumans, 1941 (Teleostei: Gobiidae) from Kumejima, Ryukyu Islands, Japan

I-SHIUNG CHEN[1,4], ZEEHAN JAAFAR[2,4] & KWANG-TSAO SHAO[3,5]

[1]*Institute of Marine Biology & CMBB, National Taiwan Ocean University, Keelung 202, Taiwan, R.O.C.*
[2]*Department of Biological Sciences, National University of Singapore, Singapore 117543*
[3]*Biodiversity Research Center, Academia Sinica, Taipei, Taiwan, R.O.C.*
[4]*Both authors contributed equally to this paper*
[5]*Corresponding author (zoskt@gate.sinica.edu.tw)*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new species of *Obliquogobius* was collected from the deep waters off Kumejima, Ryukyu Islands, Japan. The new species may be distinguished from its congeners by the following combination of characters: second dorsal fin rays I/9; anal fin rays I/10; pectoral fin rays 21; longitudinal scale rows 22; transverse scale rows 7; gill opening wide, extending to vertical of rear margin of pupil; colouration in preservative: ground colour beige; no markings on body except for inverted-triangular grayish-black mark on head, the broad end originating below eye and the apex terminating at the posterior extent of the lower jaw, and dorsal third of caudal fin dusky with random small black spots on fin membrane and life colouration: vertical yellow band under eye; one wide longitudinal yellow band originating on the posterior end of the operculum coursing along mid-flank, terminating at posterior end of caudal fin, band increasingly wider, such that posterior half of body completely yellow and band tapering in width to cover only lower two-thirds of caudal fin region.

Key words: *Obliquogobius*, Gobiidae, new species, Kumejima, Japan

Introduction

The marine gobiid genus *Obliquogobius* Koumans, 1941, was established for *Gobius cometes* Alcock, 1890. The genus is characterized by: body elongate, compressed; head compressed; eyes large; interorbital width narrow; mouth oblique with prominent lower jaw; gill opening wide; body, breast and belly scaled; midline of nape naked; scales ctenoid posteriorly and cycloid anteriorly; caudal fin obliquely pointed (Koumans 1941). This genus was also observed to have several rows of short barbels on the head, most notably two rows on the lower half of the head. Koumans (1941) reported that *Obliquogobius* resembles *Parachaeturichthys* Bleeker, 1874, but noted that it differs in head squamation, extent of gill opening and the presence of the aforementioned barbels.

The genus remained monotypic from its description in 1941 until Goren (1992) described *Obliquogobius turkayi* from the Red Sea. Shibukawa & Aonuma (2007) subsequently described three species from Japanese waters and other localities; *Obliquogobius cirrifer*, *O. megalops* and *O. yamadai*. As *Gobius cometes* (Alcock, 1890), was obtained from the coast of Madras, India, these species described from Japan, East China Sea and Philippines were the first verifiable records of the occurrence of this genus in the Western Pacific.

Dredging efforts during an expedition to Kumejima, Ryukyu Islands, Japan, in 2009, obtained the single specimen of an undescribed species of this genus. We here describe this species and provide a key, adapted from Shibukawa & Aonuma (2007), to the nominal members of *Obliquogobius* occurring in the Western Pacific.

Accepted by Tan Heok Hui: 18 Oct. 2011; published: 4 Jul. 2012

Materials and Methods

Dredging was conducted at depths of 141–165 m off Kumejima, Ryukyu Islands, Japan. The single specimen obtained was photographed before the right fin was clipped for preservation in analytical grade ethanol for future molecular analyses. The fish was initially fixed in 10% buffered formalin and subsequently stored in 70% ethanol. Measurements were made using metric dial calipers. Morphometry follows Miller (1988) and Chen & Fang (2006). Meristic counts follow Akihito *et al*. (1984), Chen & Fang (2006), and Chen & Miller (2008).

Terminology of cephalic sensory canals and papillae follow Wongrat & Miller (1991) which they adapted from Sanzo (1911). The holotype is deposited at the National Museum of Nature and Science, Tokyo, Japan (NSMT). Abbreviations of meristic features are as follows: anal fin (A); caudal fin (C); first and second dorsal fins (D1 and D2 respectively); pectoral fin (P); pelvic fin (V); longitudinal scale series (LS); predorsal scales (PreD); transverse scale rows (TR); and vertebral count (VC). All lengths are presented in proportion of standard length in mm (SL).

Systematics

Obliquogobius fluvostriatus **n. sp.**

(Figs. 1, 2)

Material examined. Holotype, NSMT-P102090, 24.3 mm SL, male, Dredge Station No. 79; Kumejima, Ryukyu Islands, Japan, 26°14.686′N, 126°49.623′E, 141–165 m depth, Tabata (triangular dredge); 11 Nov. 2009; coll. Y.C. Liao *et al*.

Diagnosis. *Obliquogobius fluvostriatus* **n. sp.** is distinguished from other congeners by the following combination of features: D2 rays I/9; A rays I/10; P rays 21; VC 26; LR 22; TR 7; belly scaled; isthmus, P base, cheek, predorsal region and operculum naked; gill opening very wide, extending forward of the vertical through rear margin of pupil; and specific life colouration as head with vertically infraorbital yellow band; one wide longitudinal yellow band from operculum terminating at posterior end of caudal fin, band increasingly wider, such that posterior half of body completely yellow.

Description. Body proportions listed in Table 1. Body elongate, compressed. Head large (30.1% SL), compressed; snout profile slightly pointed and blunt, snout rather short. Eyes large, dorsal margin prominent; bony interorbital width narrow. Mouth oblique, forms a 45–50° angle to the horizontal, lower jaw terminates at a vertical of through anterior margin of the pupil. Lower jaw prominent; upper and lower jaws with 3–4 rows of conical teeth; outermost row of teeth irregularly arranged; 11–12 teeth on each side of upper jaw approximately four times larger than the rest; vomerine teeth absent; tongue truncate, weakly notched mid-tongue. Anterior naris a short tube, posterior naris as large hole. Gill opening very wide, extends anteroventrally through the rear margin of eye. VC 10 + 16 = 26. Dorsal pterygiophore formula 3/221101/9.

Fins. D1 rays VI; D2 rays I/9; A rays I/10; P rays 21(left); V rays I/5+I/5; C segmented rays 17; C branched rays 13. D1 rays reaching D2 origin when adpressed; D2 rays shorter, not reaching segmented C rays when adpressed. P elliptical and long, rear tip extending posterior to vertical of A origin; A origin inserted into vertical of second element of D2; V rounded and moderately long, reaching genital papillae when adpressed, frenum absent, two sides of V joined together by concave, low connecting membrane, all soft rays of V splits into three branches twice. C asymmetrical with upper half of rays more protruded than those of lower half.

Scales. LS 22; TR 7; PreD 0. Scales on body ctenoid posteriorly and cycloid anteriorly. Belly scaled; isthmus, pectoral fin base, cheek and operculum naked. Middle extension of predorsal region entirely naked. Anterolateral extension of scales on head to above terminal pore ρ of anterior oculoscapular canal, anterodorsal portion of nape partially abraded.

Head lateral-line system. Canals: Oculoscapular canal present: anterior terminal paired pores σ, single interorbital pore λ, single pore κ, paired pores ω, paired postorbital pore α and lateral terminal pore ρ; preopercular canal with three pores as γ, δ and ε.

Sensory papillae: Infraorbital papillae pattern longitudinal: row *a* short and not reaching vertical midline of eye; row *b* very short, along the lower margin of orbit, row *c* extending beyond vertical midline of orbit, row *d* with densely set papillae, row *cp* as single papilla, row *f* as paired papillae.

TABLE 1. Holotype morphometry of *Obliquogobius fulvostriatus* **n. sp.**, from Kumejima, Japan

Character	Value
Body length (mm)	23.4
% in Standard length	
Head length	30.1
Predorsal length	39.6
Snout to 2nd dorsal length	51.8
Snout to anus	50.5
Snout to anal fin origin	52.8
Prepelvic length	25.9
Caudal peduncle length	25.0
Caudal peduncle depth	10.9
1st dorsal fin base	14.3
2nd dorsal fin base	19.3
Anal fin base	19.8
Caudal fin length	28.9
Pectoral fin length	28.3
Pelvic fin length	24.0
Body depth at pelvic fin origin	19.0
Body depth at anal fin origin	17.1
Body width at anal fin origin	10.3
Pelvic fin origin to anus	23.5
% in Head length	
Snout length	23.0
Eye diameter	45.2
Cheek depth	26.4
Postorbital length	44.7
Head width in maximum	61.3
Head width in upper gill opening	34.9
Bony interorbital width	4.4
Fleshy interorbital width	16.9
Low jaw length	40.7
% in caudal peduncle length	
Caudal peduncle depth	43.3

Colouration in fresh preservative and markings. The following description is based on a photograph taken of a fresh specimen prior to preservation (Fig. 1). Ground colour beige to light gray; infraorbital yellow band about a half of pupil diameter in width, band originating below eye and coursing ventrally and terminates at rear margin of lower jaw, band does not persist in preservative; inverted-triangular grayish black mark obscured under yellow band when live; when preserved, only an inverted-triangular gray mark remains, the broad end originates below eye and the apex terminates at the posterior end of the lower jaw; mark made up of closely-set melanophores; region of snout anterior to aforementioned black mark beige and devoid of melanophores; anterior tips of upper and lower lips light pink; one wide longitudinal yellow band originating at the posterior end of the operculum and courses along mid-flank, terminating at posterior end of caudal fin, band about one pupil width, band increasingly widens such that posterior half of body is uniformly yellow; band immediately decreases in width at the origin of caudal fin, covering only lower two-thirds of C region; upper third of C dusky, due to random small black spots on fin membrane; yellow longitudinal band does not persist in preservative; lower two-third of C hyaline in preservative; D1 slightly damaged but some melanophores observed distally; D2 hyaline with thin longitudinal yellow stripe at base, stripe does not persist in long preservative; P, V and A hyaline.

FIGURE 1. *Obliquogobius fulvostriatus* **n. sp.**, holotype, NSMT-P102090, 24.3 mm SL, 141–165 m depth, Kumejima, Ryukyu Islands, Japan. Photograph by S.H. Su.

Distribution. This species is only known from Kumejima, Ryukyu Islands, Japan.

Etymology. The specific name, *fulvostriatus,* is derived from the longitudinal yellow band (in Latin: "*fulvo* + *striata*") on the trunk, a conspicuous character in the fresh specimen.

Remarks. *Obliquogobius fulvostriatus* **n. sp.** and *O. megalops* Shibukawa & Aonuma, 2007, have wide gill openings and a low connecting membrane between the pelvic fins versus narrower gill openings and the pelvic fins completely united in congeners. However, *O. fulvostriatus* **n. sp.** can be differentiated from *O. megalops* by these characters: D2 rays I/9, A rays I/10, P rays 21 (vs. D2 rays I/8, A rays I/9, P rays 23); black T-shaped mark absent from C base (vs. present); and dark markings absent from the body in the preserved specimen (vs. 5 narrow vertical black bars in preserved specimens).

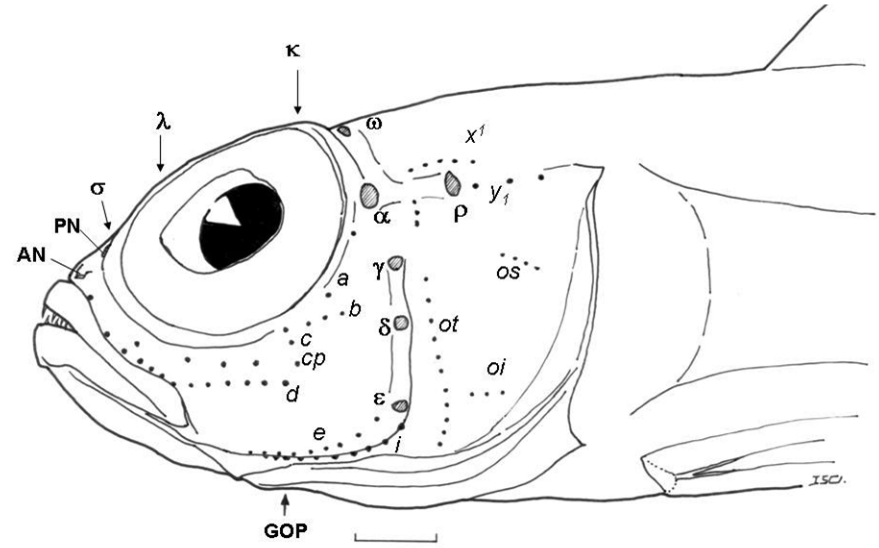


FIGURE 2. Head lateral-line system of *Obliquogobius fulvostriatus* **n. sp.**, holotype, NSMT-P102090, 24.3 mm SL. Scale = 1 mm. The arrow indicates the ventral extent of gill opening. Abbreviations: AN and PN = anterior and posterior nares, respectively; GOP = anteroventral extension of gill opening. Illustration by I-Shiung Chen.

An artificial key to *Obliquogobius* species in Western Pacific.

1. Gill opening terminates before or at vertical through the posterior margin of preopercle 2
- Gill opening terminates at vertical through rear margin of pupil 3
2. Second dorsal fin rays I/8; lateral body with median gray spot; and caudal fin base with two gray transverse bars . . . . *Obliquogobius cirrifer*
- Second dorsal fin rays I/9-10; lateral body with 6 transverse yellow stripes; and caudal fin base with a black spot . . . . *Obliquogobius yamadai*
3. Second dorsal fin rays I/8; anal fin rays I/9; black T-shaped mark present on caudal fin base; and 5 lateral narrow, vertical black bars on body *Obliquogobius megalops*
- Second dorsal fin rays I/9; anal fin rays I/10; no marks on caudal fin base; and no dark markings on body . . . . *Obliquogobius fulvostriatus* **n. sp.**

Acknowledgments

We are very grateful for the great assistance of Dr. H. H. Tan, Dr. Y. C. Liao, Mr. S. P. Huang and Mr. S. H. Su during the field trip of Kumejima Expedition 2009. KTS wishes to thank Academia Sinica for a three year Thematic Research Project grant from 2009–2011. ISC wishes to acknowledge the research grant support from NSC and also support for the marine biodiversity project from CMBB, NTOU from 2009-2010.

References

Alcock, A.W. (1890) Natural history notes from H.M. Indian marine survey steamer ‘Investigator’, Commander R.R. Hoskyn, R.N., commanding.—No. 16. On the bathybial fishes collected in the Bay of Bengal during the season 1889–1890. *Annals and Magazine of Natural History*, ser. 6, 6(33), 197–222.

Akihito, Prince, Hayashi, M., Yoshino, T., Shimada, K., Senou, H. & Yamamoto, T. (1984) Suborder Gobioidei. *In*: Masuda, H., Amaoko, K., Araga, C., Uyeno, T. & Yoshino, T. (eds.), *The Fishes of the Japanese Archipelago.* Tokai University Press, Tokyo, pp. 236–289.

Bleeker, P. (1874) Esquisse d’un système naturel des Gobioïdes. *Archives Néerlandaises des Sciences exactes et naturelles*, 9, 289–331.

Chen, I.-S. & Fang, L.-S. (2006) A new species of *Rhinogobius* (Teleostei: Gobiidae) from the Hanjiang Basin in Guangdong Province, China. *Ichthyological Research*, 53(3), 247–253.

Chen, I.-S. & Miller, P.J. (2008) Two new freshwater gobies of genus *Rhinogobius* (Teleostei: Gobiidae) in southern China, around the northern region of the South China Sea. *Raffles Bulletin of Zoology*, Supplement 19, 225–232.

Goren, M. (1992) *Obliquogobius turkayi*, a new species of gobiid fish from the deep water of the central Red Sea. *Senckenbergiana maritima*, 22(3–6), 265–270.

Koumans, F.P. (1941) Gobioid fishes of India. *Memoirs of the Indian Museum*, 13(3), 205–329.

Miller, P.J. (1988) New species of *Corcyrogobius*, *Thorogobius* and *Wheelerigobius* from west Africa (Teleostei: Gobiidae). *Journal of Natural History*, 22(5), 1245–1262.

Sanzo, L. (1911) Distribuzione delle papille cutanee (organi ciatiforme) e suo valore sistematico nei gobi. *Mitteilungen der Zoologischen Station Neapel*, 20, 249–328.

Shibukawa, K. & Aonuma, Y. (2007) Three new species of the deep-dwelling goby genus *Obliqougobius* (Teleostei: Gobiidae: Gobiinae) from Japan, with comments on the limits of the genus. *Bulletin National Museum Natural Sciences*, ser. A, Supplement 1, 137–142.

Wongrat, P. & Miller, P.J. (1991) The innervation of head neuromast rows in eleotridine gobies (Teleostei: Gobiidae). *Journal of Zoology*, *London*, 225, 27–42.

Zootaxa 3367: 274–280 (2012)
www.mapress.com/zootaxa/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

A new deepwater goby of the genus *Discordipinna* Hoese & Fourmanoir, 1978 (Teleostei: Gobiidae) from Kumejima of the Ryukyus, Japan*

I-SHIUNG CHEN[1, 4], TOSHIYUKI SUZUKI[2, 4] & KWANG-TSAO SHAO[3, 5]

[1] *Institute of Marine Biology & CMBB, National Taiwan Ocean University, Keelung 202, Taiwan, ROC. (email: isc@mail.ntou.edu.tw)*
[2] *Kawanishi-midoridai Senior High School, 1-8 Kouyoudai, Kawanishi, Hyogo 666-0115, Japan*
(email: trimma-toshiyuki@hop.ocn.ne.jp)
[3] *Biodiversity Research Center, Academia Sinica, Taipei, Taiwan, ROC. (email: zoskt@gate.sinica.edu.tw)*
[4] *Both authors contributed equally to this paper.*
[5] *Corresponding author*

* *In*: Naruse, T., Chan, T.-Y., Tan, H.H., Ahyong, S.T. & Reimer, J.D. (2012) Scientific Results of the Marine Biodiversity Expedition — KUMEJIMA 2009. *Zootaxa*, 3367, 1–280.

Abstract

A new goby species of *Discordipinna* was collected by trawling from the deep waters off Kumejima, the Ryukyu Islands, Japan. The new species, *Discordipinna filamentosa*, can be well distinguished from the only other described species, *D. griessingeri* Hoese & Fourmanoir, 1978, by the following unique combination of features: (1) fins: first dorsal fin rays VI; pectoral fin rays 16; and first dorsal fin with the longest, filamentous first ray in male extending far beyond caudal fin base when adpressed; (2) squamation: longitudinal scale rows 26; transverse scale rows 8 and predorsal naked; (3) dorsal pterygiophore formulae 3/122101/9; (4) head lateral-line system: a longitudinal pattern of infraorbital papillae and both anterior oculoscapular canal and preopercular canal present, lacking posterior oculoscapular canal; and (5) its distinctive coloration. An artificial key to species of *Discordipinna* is also provided.

Key words: *Discordipinna*, Gobiidae, new species, Kumejima, Japan

Introduction

Fishes in the family Gobiidae belong to one of largest group of marine teleost fishes in the World (Miller 1988; Wu 2008). The coral reef-associated gobiid genus, *Discordipinna* Hoese & Fourmanoir, 1978, is a very small-sized goby with a longitudinal infraorbital papilla pattern (Hagiwara *et al*. 1996; Akihito *et al*. 2002; Motomura & Matsuura 2010). The type species of the genus is *Discordipinna griessingeri* Hoese & Fourmanoir, 1978, with the holotype collected in the Gulf of Aqaba, Red Sea and other type series and recent records from the West Pacific including Indonesia, the Philippines as well as Japan (Hagiwara *et al*. 1996; Akihito *et al*. 2002).

In the 2009, Kumejima Expedition of Japan, a single gobiid specimen was collected by trawling net during deepwater marine biodiversity collections of the coral-reef region. This species was considered new by Suzuki & Shibukawa (2004), based on a series of underwater photographic records of by Japanese scuba divers. The aims of this paper are to present a formal description of this very rare new species as well as provide a diagnostic key for of *Discordipinna* species in the Indo-Pacific region.

Materials and methods

The type specimen of the new goby was collected by using a 1 m beam trawl from deepwater habitat with coral rubbles off Kumejima, Ryukyu Islands of southern Japan. Other comparative congeneric specimens were collected by scuba diving.

Accepted by Tan Heok Hui: 15 Nov. 2011; published: 4 Jul. 2012

All the counts and measurements were made from specimens preserved in 70% ethanol after fixation of 10% formalin. Morphometric methods followed Miller (1988) except the length of first dorsal-fin rays; meristic methods followed Akihito *et al*. (1984), Chen & Fang (2006) and Chen & Miller (2008). Terminology of head sensory canals and free neuromast organs (sensory papillae) were from Wongrat & Miller (1991) based on Sanzo (1911).

Meristic abbreviations are as follows: A = anal fin; C = caudal fin; D1 = first dorsal fin; D2 = second dorsal fin; LR = longitudinal scale rows; TR = transverse scale series from second dorsal fin origin to anal fin; V = pelvic fin; and VC = vertebral count. All fish lengths are expressed as standard length (SL).

The type specimen of this new species is deposited at the National Museum of Nature and Science, Tokyo, Japan (NSMT). Other congeneric material and photographs are deposited at Kanagawa Prefectural Museum of Natural History, Kanagawa, Japan (KPM) and the Pisces collections of National Taiwan Ocean University, Keelung, Taiwan (NTOUP).

Systematics

Discordipinna griessingeri **Hoese & Fourmanoir, 1978**

(Japanese name: Homura-haze)
(Fig. 1)

Discordipinna griessingeri Hoese & Fourmanoir, 1978: 21 (El Himeira, Sinai, Egypt, Gulf of Aqaba, Red Sea). — Hagiwara *et al*. 1996: 2. — Akihito *et al*. 2002: 1250. — Suzuki & Shibukawa 2004: 443. — Motomura *et al*. in Motomura & Matsuura 2010: 208.

Materials examined. NTOUP-2011-01-001, 3 specimens, 13.3–13.7 mm SL, Cebu Island, the Philippines, coll. A. Chen *et al*., 8 Nov., 2009.

FIGURE 1. *Discordipinna griessingeri,* NTOUP-2011-01-001, 13.7 mm SL, Mactan Island, Cebu, Philippines. Photograph by Shih-Pin Huang.

Diagnosis. This species can be well distinguished from congeners by the unique combination of the following features: (1) fins: first dorsal fin rays V; pectoral fin rays 17–20 (modally 18); and first dorsal fin with the longest anterior two rays in male and the fin membrane deeply indented between the first two dorsal spines; (2) squamation: longitudinal scale rows 22–25; transverse scale rows usually 6–7 and predorsal naked; (3) dorsal pterygiophore formulae 3/41001/8; 10 + 16 = 26 vertebrae; (4) head lateral-line system: reduced, longitudinal pattern of infraorbital papilla and anterior oculoscapular canal present (with pore λ singular on middle of interorbital region, pore κ singular on posterior interorbital region and lateral section as pores α, β, and ρ) but lacking both preopercular and posterior oculoscapular canals; and (5) coloration pattern: body creamy yellow with wide longitudinal brown band on ventral half; head with many round brownish black spots; first dorsal fin orange red; pectoral fin orange with an oblique translucent band; second dorsal and caudal fins with several deep brown blotches each having a central black spot.

Distribution. This species is distributed from the Red Sea, the Indian Ocean to the tropical West Pacific region in countries including the Philippines, Malaysia, Indonesia, Taiwan, Japan (Ryukyu Islands to Wakayama Prefecture, middle of the main island, Japan) (Hagiwara *et al*. 1996; Akihito *et al*. 2002; Suzuki & Shibukawa 2004; Chen unpublished data).

Discordipinna filamentosa **n. sp.**

(New Japanese name: Naginata-haze)
(Figs. 2–4)

Discordipinna sp. 1. — Suzuki & Shibukawa 2004: 444.

Material examined. Holotype. NSMT-P104037, 15.7 mm SL, Trawl 7, 80–82 m depth, GPS 26°23.090´ N, 126°47.832´ E, 1 m Beam Trawl, Kumejima, Okinawa Island, the Ryukyu Islands, Japan, coll. Liao Y.C. *et al*., 11 Nov. 2009.

Photographic records from Image Database of Fishes in the Kanagawa Prefectural Museum of Natural History, Japan (KPM-NR). (A) Kumejima, the Ryukyu Islands, Japan: KPM-NR 36520, 64 m depth, H. Kobayashi, 26 Jun. 2000. (B) Okinawajima, the Ryukyu Islands, Japan: KPM-NR 38565, 37 m depth, U. Adachi, 3 Aug. 2000. (C) Tsutomezaki, Kashiwajima Island, Shikoku, Japan: KPM-NR 33814, 55 m depth, S. Kubo, 11 Oct. 1999. (D) Borneo Island, Malaysia: KPM-NR 22220, 30 m depth, F. Konno, 2 Jan. 1997.

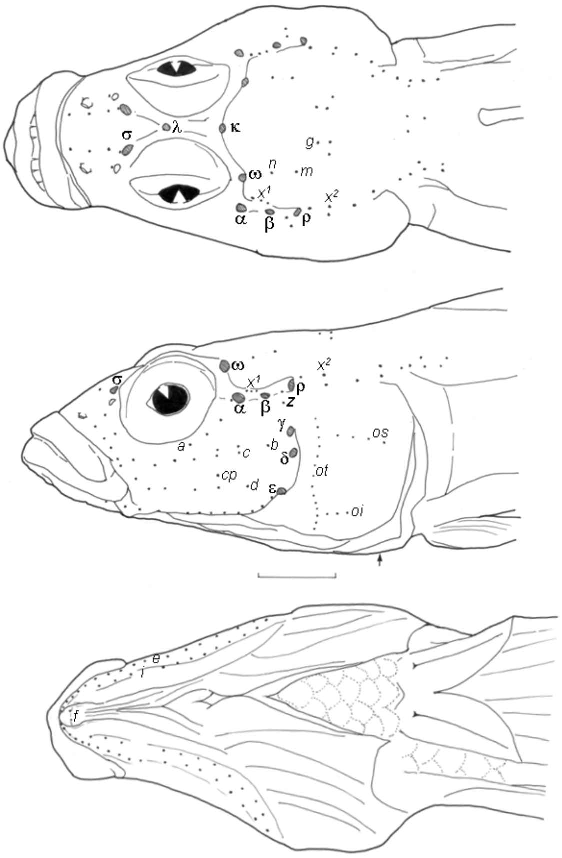


FIGURE 2. Head lateral-line system of *Discordipinna filamentosa*, NSMT-P10437, male, holotype, 15.7 mm SL, Kumejima, the Ryukyu Islands, Japan. The arrow indicates the ventral limit of gill-opening. Illustration by I-Shiung Chen. (Bar = 1 mm)

Diagnosis. *Discordipinna filamentosa* **n. sp.** can be well distinguished from the only other described species, *D. griessingeri* Hoese & Fourmanoir, 1978, by the following unique combination of features: (1) fins: first dorsal fin rays VI; pectoral fin rays 16; and first dorsal fin with the longest, filamentous first ray in male extending far beyond caudal fin base when depressed; (2) squamation: longitudinal scale rows 26; transverse scale rows 8 and predorsal naked; (3) dorsal pterygiophore formulae 3/122101/9; 10 + 16 = 26 vertebrae; (4) head lateral-line system: a loosely arranged, longitudinal pattern of infraorbital papilla and anterior oculoscapular canal present (with median pore λ singular on middle of interorbital region, lateral section as pores α, β, and ρ) and preopercular canal (with three pores γ, δ and ε), lacking posterior oculoscapular canal; and (5) distinctive coloration: body generally creamy white; head with a snow-white oblique band from upper lip to upper part of opercle; dorsal side of snout scattered with tiny, densely-set tiny orange to brown spots; trunk with three lateral, oblique orange to brown bands which generally fused ventrally, and lateral body with 4–5 thin longitudinal yellow stripes; first dorsal fin yellow with 12 major transverse deep brown bands mainly on filamentous portion of the fin and an oval translucent mark on basal protion of that; second dorsal fin yellow with about four rounded gray blotches each having a central deep black spot against yellow background; caudal fin yellow with a shallow "C" shaped snow-white mark basally and several round deep black spots on upper half; anal and pelvic fins entirely deep black; and pectoral fin with a snow-white wedge.

Description. Body proportions are described in Table 1. Body subcylindrical anteriorly, compressed posteriorly. Head modrate large, snout somewhat pointed in lateral view. Eye large, dorsolateral. Mouth somewhat oblique about 40 degrees to horizontal line, the rear margin extending slightly beyond vertical of anterior margin of eye. Lower lip anteriormost. Both jaws with 2–4 rows of tapered sharp teeth, and outer rows enlarged. Anterior nasal pore a short tube and posterior nasal pore a round opening. Gill-opening restricted, extending forward ventrally somewhat beyond a vertical at upper edge of the opening. Dorsal pterygiophore formula 3/122101/9. 10 + 16 = 26 vertebrae.

Fins. First dorsal fin rays VI; second dorsal fin rays I/8; anal fin rays I/8; pectoral fin rays 16. First dorsal fin elongate with the longest, filamentous first ray in male extending far beyond caudal fin base when adpressed. Origin of anal fin inserted just below origin of first branched ray of second dorsal fin. Rear tips of second dorsal and anal fins when adpressed do not reach procurrent rays of caudal fin. Pectoral fin rather large (32.1% in SL) and oblong, the rear margin extending beyond the vertical of origin of anal fin. Pelvic fin long (35.1% in SL) with large frenum and membrane arounf its spinous rays bilobed. Rear tip of pelvic fin extending beyond the vertical through anus. Caudal fin large (40.4%), elliptical with fin length longer than the head length.

Scales. Body with rather large ctenoid scales; belly scales cycloid; longitudinal scale rows 26; transverse scale rows 8; predorsal scale 0. Prepelvic and belly with cycloid scales. Head and predorsal region entirely naked.

Head lateral-line system. Canals: Anterior oculoscapular canal extension with anteriorly paired terminal pores σ slightly behind posterior nasal pore. Pore λ singular on middle of interorbital region; pore κ singular on rear dorsal vertical of orbit beyond pore λ. Paired pores ω behind eyes on nape. Lateral extension of anterior oculoscapular canal behind orbit as pore α, followed by middle pore β and terminal pore ρ. Preopercular canal present, with three pores: dorsally terminal pore γ; middle pore δ and ventrally terminal pore ε.

Papillae: Cheek with loosely arranged, longitudinal infraorbital papillae. Row *a* very short with four papillae, not extending to vertical through middle of eye. Row *b* short, merely with three papillae. Rows *c* and *d* longer with more papillae in row *c*, and row *c* extending posteriorly to vertical through poreα. Opercle with three main rows as rows *os*, *ot* and *oi* with both rows *ot* and *oi* slightly separated. Row *f* as paired papillae. Other papillae rows shown in detail as in Fig. 1.

Colouration in freshly preserved specimen. Body with generally creamy white background. Head creamy yellow to orange pinkish and an oblique, snow-white band from upper jaw to lower part of eye, then horizontally to posterior region of head to upper region of opercle. Dorsal side of snout and upper part of orbit scattered with tiny, densely-set orange to brown spots. Trunk with three rather oblique orange to brown bands which generally fuse ventrally, and lateral body with 4–5 very thin, longitudinal yellow stripes.

First dorsal fin light yellow with 12 major transverse deep brown bands mainly on filamentous portion of the fin and an oval translucent mark on basal protion of that. Second dorsal fin yellow with a translucent, longitudinal band on lower half region and also with four main gray marks each having a central deep black spot against yellow background. Caudal fin yellow with a shallow "C" shape snow-white mark, distal region with thin deep black margin surrounded by a thin snow white margin. Several round deep black spots on upper half of caudal fin membrane with the largest on upper region. Anal fin entirely deep black. Pelvic fin entirely deep black except anterior basal region in orange gray. Pectoral fin with a snow-white oblique, wide triangular wedge; upper 1/2 region of fin membrane with several tiny deep black spots.

TABLE 1. Morphometry of holotype of *Discordipinna filamentosa*.

Cat. No.	**NSMT-P10437**
Standard length (mm)	15.7
% Standard length	
Head length	32.5%
Predorsal length	36.8%
Snout to 2nd dorsal length	57.8%
Snout to anus	61.4%
Snout to anal fin origin	64.6%
Prepelvic length	28.8%
Caudal peduncle length	17.8%
Caudal peduncle depth	8.2%
1st dorsal fin length	80.3%
1st dorsal fin base	13.2%
2nd dorsal fin base	22.7%
Anal fin base	19.5%
Caudal fin length	40.4%
Pectoral fin length	32.1%
Pelvic fin length	35.1%
Body depth at pelvic fin origin	15.1%
Body depth at anal fin origin	12.3%
Body width at anal fin origin	6.3%
Pelvic fin origin to anus	32.8%
% Head length	
Snout length	29.2%
Eye diameter	24.9%
Cheek depth	19.8%
Postorbital length	53.6%
Head width in maximum	54.8%
Head width in upper gill	27.8%
Bony interorbital width	2.3%
Fleshy interorbital width	10.0%
Low jaw length	25.6%
% Caudal peduncle length	
Caudal peduncle depth	61.9%

Distribution. So far, the single specimen was collected from the deepwater trawling of up to 82 m depth off Kumejima, Ryukyu, Japan. However, some underwater photographic records taken by Japanese scuba divers have provided live images of this species around Kashiwajima, Shikoku, Japan; Okinawajima, the Ryukyu Islands, Japan; and Malaysia. Based on scuba diving witness and current trawl specimen record, it seems to live in 30 to 82 m depth water with substratum of coral-reef hard debris.

Etymology. The specific name referred to Latin-“*filamentum*” meaning the thread-like elongation of fin, a diagnostic feature, as very thin and long extension of the anterior two spinous rays of first dorsal fin.

FIGURE 3. *Discordipinna filamentosa*, NSMT-P10437, male, holotype, 15.7 mm SL, Kumejima, the Ryukyu Islands, Japan. Photograph by Shih-Pin Huang.

Morphological comparison with the congeners. *Discordipinna filamentosa* **n. sp**. can be well distinguished from the type species, *D. griessingeri* Hoese & Fourmanior, 1978, in this genus by the following features: (1) fin ray counts: first dorsal fin rays VI vs. V; pectoral fin rays 16 vs. 17–20; (2) dorsal pterygoiphore formula 3/122101/9 vs. 3/41001/8; (3) dorsal fin shape: first ray of first dorsal-fin longest in male vs. second ray of dorsal-fin base longest in male; and its fin membrane simply pointed vs. biforked; (4) head canals: preopercular canal present vs. preopercular canal absent; and (5) specific coloration pattern: head with a horizontal white band vs. many round, deep black spots; pelvic fin with a snow-white oblique, wide band vs. unmarked pale white background; first dorsal fin with about 12 transverse brown bands vs. entirely orange red; and anal fin entirely black vs. with lower 2/3 region orange red and upper 1/3 region translucent.

FIGURE 4. Live underwater photograph of *Discordipinna filamentosa*, KPM-NR 38565, Okinawa Island, the Ryukyu Islands, Japan. Photograph by Yukinobu Adachi. 37 m depth, 3 Aug. 2000.

Although the difference of dorsal pterygoiphore formula between the two species can be observed, another shallow water species that resembles a *Discordipinna* (Gobiidae, indet. Gen and sp. 14 sensu Suzuki & Shibukawa 2004) also shares the same dorsal pterygiophore formula (3/122101/9) with *Discordipinna filamentosa*. These three species share a similar longitudinal pattern of infraorbital papillae which can be considered as an essential feature for defining this gobioid genera (sensu Miller). The differentiation of the preopercular canal and dorsal pterygiophore formula may be considered as the potential features to separate them up to the generic level if there is further more morphological evidence likely from osteological sruvey. In addition, they share a reduced, longitudinal pattern of infraorbital sensory papillae and the feature of a restricted gill-opening, thus further anatomical and osteological evidences need to be gathered.

An artificial key to the species of *Discordipinna* in the Indo-Pacific region.

1. Preopercular canal absent; first dorsal fin rays V; distal membrane extension of first dorsal fin of male biforked (Indo-Pacific) . . . . *D. griessingeri*

\- Preopercular canal present; first dorsal fin rays VI; distal membrane extension of first dorsal fin of male pointed 2

2. First dorsal fin of male extending far beyond vertical through caudal fin base when depressed; papillae of dorsal side behind orbit and lower corner of cheek below pore without long dermal projections; pelvic fin entirely black (Japan, Malaysia). . . . . *D. filamentosa* **n. sp.**

\- First dorsal fin of male not extending to vertical through caudal fin base when depressed; papillae of dorsal side behind orbit and lower corner of cheek below pore ε with a pair of long dermal projections; pelvic fin 2–3 widely transverse snow white bands against black background (Ryukyus, Japan). . . . . *D.* sp. 1

Acknowledgments

We are very grateful for the great effort of the trawling team, especially Dr. P. K. L. Ng, Dr. N. Toru, Dr. T. Y. Chan, Dr. H. H. Tan, Dr. Z. Jaafar, Dr. Y. C. Liao, Mr. M. Y. Lee and Mr. S. P. Huang, for helping with the collections of several lots of deepwater gobies and taking specimen photographs in the 2009 Kumejima expedition. The author (ISC) wishes to thank the grant support from NSC, Taiwan and also the team project of marine biodiversity research from CMBB, NTOU and Academia Sinica. The author (TS) wishes to thank Mr. Y. Adachi and Dr. H. Senou (KPM) for providing the underwater gobiid images.

References

Akihito, Prince, Hayashi, M. & Yoshino, T. (1984) Suborder Gobioidei. *In*: Masuada, H., Amaoka, K, Araga, C., Uyeno, T, & Yoshino, T. (eds) *The Fishes of Japanese Archepelargo*. Tokai University Press, Tokyo, pp. 236–289.

Akihito, Sakamoto, K., Ikeda, Y. & Sugiyama, K. (2002) Gobioidei. in Nakabo, T. [ed.] *Fishes of Japan with pictorial keys to the species*. English edition. Tokai University Press, Tokyo, pp. 1139–1310, 1596–1619.

Chen, I.-S. & Fang, L.S. (2006) A new species of *Rhinogobius* (Teleostei: Gobiidae) from the Hanjiang basin in Guangdong Province, China. *Ichthyological Research*, 53, 247–253

Chen, I.-S. & Miller, P.J. (2008) Two new freshwater gobies of genus *Rhinogobius* (Teleostei: Gobiidae) in southern China, around the northern region of the South China Sea. *The Raffles Bulletin of Zoology,* Supplement 19, 225–232.

Hagiwara, K., Ikeda, Y. & Hayashi, M. (1996) First record of the gobiid fish, *Discordipinna griessingeri* (Peciformes; Gobiidae) from Japanese waters. *I. O. P. Diving News* 7(8), 2–6. (In Japanese)

Hoese, D.F. & Fourmanoir, P. (1978) *Discordipinna griessingeri*, a new genus and species of gobiid fish from the tropical Indo-West Pacific. *Japanese Journal of Ichthyology*, 25, 19–24.

Miller, P.J. (1988) New species of *Corcyrogobius*, *Thorogobius* and *Wheelerigobius* from west Africa (Teleostei: Gobiidae). *Journal of Natural History*, 22, 1245–1262.

Motomura, H. & Matsuura, K. [eds.] (2010) *Fishes of Yaku-shima Island.* National Museum of Nature and Science, Tokyo.

Sanzo, L. (1911) Distribuzione delle papille cutanee (organi ciatiformi) e suo valore sistematico nei. Gobi. *Mitteilungen aus der zoologischen Sation zu Neapel*, 20, 249–328. (in Italian)

Suzuki, T. & Shibukawa, K. (2004) Genus *Discordipinna* and Gobiidae indet. Gen. and sp. 14. in Senou, H. [ed.] *A Photographic Guide to the Gobioid Fishes of Japan.* Heibonsha, Tokyo, pp 443–444, 480–481. (in Japanese)