

# A new slipper lobster of the genus *Galearctus* Holthuis, 2002 (Crustacea, Decapoda, Scyllaridae) from New Caledonia

**Chien-Hui YANG**

Institute of Marine Biology, National Taiwan Ocean University,  
2 Pei-Ning Road, Keelung 20224, Taiwan (R.O.C.)

**I-Shiung CHEN  
Tin-Yam CHAN**

Institute of Marine Biology, National Taiwan Ocean University,  
2 Pei-Ning Road, Keelung 20224, Taiwan (R.O.C.)  
and Center of Excellence for Marine Bioenvironment and Biotechnology,  
National Taiwan Ocean University,  
2 Pei-Ning Road, Keelung 20224, Taiwan (R.O.C.)  
tychan@mail.ntou.edu.tw

Yang C.-H., Chen I.-S. & Chan T.-Y. 2011. — A new slipper lobster of the genus *Galearctus* Holthuis, 2002 (Crustacea, Decapoda, Scyllaridae) from New Caledonia. *Zoosystema* 33 (2): 207-217. DOI: 10.5252/z2011n2a4.

## ABSTRACT

Material previously identified as *Galearctus kitanoviriosus* (Harada, 1962) from New Caledonia has been found to consist of two distinct species. These species differ in the shape of the gastric tooth, third pereopod propodus, antennal segment IV and thoracic sternum. The shallow water form is the true *G. kitanoviriosus*, while the deep-water form is new to science. Genetic comparison of the sequence of the barcoding gene, mitochondrial cytochrome c oxidase subunit (COI), also supports the separation.

## KEY WORDS

Crustacea,  
Decapoda,  
Scyllaridae,  
*Galearctus*,  
New Caledonia,  
new species.

## RÉSUMÉ

*Une nouvelle cigale de mer du genre Galearctus Holthuis, 2002 (Crustacea, Decapoda, Scyllaridae) de Nouvelle-Calédonie.*

Du matériel de Nouvelle-Calédonie, initialement rapporté à *Galearctus kitanoviriosus* (Harada, 1962), consiste en fait en deux espèces. Ces espèces diffèrent par la forme de la dent gastrique, le propode du troisième péréopode, le segment antennaire IV et le sternum thoracique. L'espèce vivant en eaux peu profondes correspond à *G. kitanoviriosus*, alors que l'espèce d'eaux profondes est nouvelle. La comparaison des séquences du gène mitochondrial COI, utilisé pour le barcode, confirme cette séparation.

## MOTS CLÉS

Crustacea,  
Decapoda,  
Scyllaridae,  
*Galearctus*,  
Nouvelle-Calédonie,  
espèce nouvelle.

## INTRODUCTION

Slipper lobsters of the genus *Scyllarus* Fabricius, 1775 *sensu lato* have been recently divided into 14 genera by Holthuis (2002). *Galearctus* Holthuis, 2002 is characterized in having arborescent sculpture on the abdomen, fourth segment of antenna bearing only one carina, anterior protrusion of the thoracic sternum tongue-like and with a minute median incision ended in groove, the propodus of the third pereiopod usually wider than that of the second pereiopod and lacking distinct anteroventral tooth. Five species are included in *Galearctus* by Holthuis (2002), namely *G. timidus* (Holthuis, 1960), *G. kitanoviriosus* (Harada, 1962), *G. umbilicatus* (Holthuis, 1977), *G. aurora* (Holthuis, 1982) and *G. rapanus* (Holthuis, 1993). Recently, one more species, *G. lipkei* Yang & Chan, 2010, was added, that had been previously confused with *G. aurora* (including those specimens examined by Holthuis 2002). When preparing the description of *G. lipkei*, the present authors had re-examined all the *Galearctus* material used in Holthuis (2002) and deposited in the Muséum national d'Histoire naturelle, Paris. As part of this study we also found some misidentified specimens assigned to *G. kitanoviriosus* by Holthuis (2002). *Galearctus kitanoviriosus* was previously only known from north-east Asia (e.g., Japan, Korea and Taiwan) in shallow waters less than 100 m deep (see Harada 1962; Kim & Park 1972; Miyake 1982; Chan & Yu 1993; Wang *et al.* 1998; Debelius 1999; Minemizu 2000), but Holthuis (2002) identified many specimens from the South Pacific (e.g., New Caledonia, Chesterfield Islands and Fiji) as this species, and most of them were collected from 230-680 m deep. *Galearctus kitanoviriosus* is rather common in Taiwan (Chan & Yu 1986, 1993). Detailed comparisons of the Taiwanese material with those South Pacific specimens assigned to *G. kitanoviriosus* by Holthuis (2002) showed that there are marked differences between the specimens collected from shallow and deep waters, particularly in the sculpture on the thoracic sternum, presence or absence of the two hairy grooves on the propodus of the third pereiopod, the height of gastric tooth and the number of teeth on the anterior margin of the antennal segment IV. Molecular analysis of the barcoding gene mitochondrial cytochrome c

oxidase I (COI, see Hebert *et al.* 2003; Bucklin *et al.* 2011) between the shallow and deep water forms confirms that they represent different species. The deep water form is herein described as new.

## MATERIAL AND METHODS

The specimens examined are deposited in the Muséum national d'Histoire naturelle, Paris (MNHN), National Taiwan Ocean University, Keelung (NTOU), Coastal Branch of the Natural History Museum and Institute, Chiba (CMNH), Queensland Museum (QM) and University of Florida, Gainesville (UF). The carapace length (cl) is measured along the dorsal midline from the tip of the rostrum to the posterior margin of the carapace. The terminology used mainly follows Holthuis (2002) and Yang & Chan (2010).

Comparative material of *Galearctus kitanoviriosus*: **Japan.** Ose-saki, Numazu, NW coast of Izu Peninsula, Suruga Bay, Honshu, 5 m, 12.V.1996, 1 ♂ 26.0 mm cl (CMNH-ZC 01431). Submarine cave at Occho-ga-hama, Hachijojima, Izu Island, 15 m, 30.VIII.1996, 1 ♂, 21.0 mm cl (CMNH-ZC 01945).

**Taiwan.** Dasi fishing port, Yilan County, 16.IV.1988, 1 ovig. ♀, 31.5 mm cl (NTOU M01016). — Same data, V.2004, 1 ♂, 22.08 mm cl (NTOU M01017). — Kueihou fishing port, Taipei County, 3.VI.2006, 1 ♂, 18.2 mm cl (NTOU M01018). — Longdong fishing port, Taipei County, 60-120 m, V.1999, 5 ♂♂, 19.7-26.9 mm cl, 1 ovig. ♀, 21.9 mm cl (NTOU M00981). — Same data, V.2008, 1 ♂, 21.5 mm cl (NTOU M01019). — Hepingdao fishing port, Keelung, 5.X.1982, 1 ♂, 24.2 mm cl (NTOU M01020). — Same data, V.1993, 1 ovig. ♀, 23.6 mm cl (NTOU M01021). — Same data, 7.VI.2000, 1 ovig. ♀, 31.4 mm cl (NTOU M01022). — Same data, 13.VI.2006, 1 ♀, 26.8 mm cl, 2 ovig. ♀♀, 28.0-28.9 mm cl (NTOU M01023). — VI.2006, 1 ♀, 25.9 mm cl (NTOU M01024). — IV.2009, 1 ♂, 22.3 mm cl (NTOU M01025). — No specific locality, 1 ♀, 24.9 mm cl (NTOU M01026).

**New Caledonia.** S. îlot Ua, RV *Vauban*, stn 248, 22°30'S, 166°46'E, 8-15 m, 29.XI.1978, 1 ovig. ♀, 23.0 mm cl (MNHN-Pa 775). — Île Ouen, east end of Baie Iré, 0.5-1.5 m, 19.I.1999, 1 ♀, 16.0 mm cl (UF 1022).

All except one species (i.e., *G. umbilicatus*) of *Galearctus* are included in the molecular analysis. *Chelarctus aureus* (Holthuis, 1963) and *Scammarctus batei* (Holthuis, 1946) are used as the outgroups

TABLE 1. — Six *Galearctus* species and outgroups used for partial COI gene sequences analysis.

Species	Locality	Voucher no.	Genbank accession no.
<i>G. aurora</i>	Marquesas Island	NTOU M00864	GU289682
<i>G. avulsus</i> n. sp.	New Caledonia, holotype	MNHN-IU-2010-1910	JF331656
<i>G. kitanoviriosus</i>	Taiwan	NTOU M00981	JF331658
<i>G. lipkei</i>	Taiwan	NTOU M00860	GU289679
<i>G. rapanus</i>	Australes Islands	MNHN-IU-2008-16596	JF331657
<i>G. timidus</i>	New Caledonia	MNHN-Pa 1192	JF320942
<i>Chelarctus aureus</i>	Taiwan	NTOU M00979	JF411065
<i>Scammarctus batei</i>	Philippines	NTOU M00984	JF411066

(Table 1). Total DNA was extracted from muscle tissue (10–20 mg) using the Genomic DNA Mini kit (Geneaid). The universal primer, LCO1490/HCO2198, was used to amplify the 657 bp sequence of COI gene (Folmer *et al.* 1994). PCR reaction was performed in 50 µl reactions with 50 to 200 ng of the DNA extraction, 5 µl of 10X polymerase buffer (SUPER-THERM), 10 mM magnesium chloride (MgCl<sub>2</sub>), 2.5 mM of deoxyribonucleotide triphosphate mix (dNTP) (PROTECH Inc.), 5 µM each primer (MDBio Inc.), 1 unit of *Taq* polymerase (5 units/µl, SUPER-THERM), and additional 0.3 µl of 1% bovine serum albumin (BSA; stock concentration–0.5 mg/µl). The PCR cycling condition was as followed: 5 min at 95°C for initial denaturation, then 40 cycles of 30 sec at 94°C, 30 sec at 47.8°C, 30 sec at 72°C, and final extension for 10 min at 72°C. After checking the size and quality of PCR products by 1% agarose gel for electrophoresis, the High Pure PCR Product Purification kit (Roche Applied Science) was used to purify the PCR products. The same PCR primer set was employed for cycle sequencing on an ABI 310 Genetic Analyzer (Applied Biosystems). The sequences data set was converted into a NEXUS format for Bayesian inference (MrBayes, ver. 3.1.2, Ronquist *et al.* 2005). MrModeltest 2.2 (Nylander 2004) was used to evaluate a best-fit model of DNA substitution and calculated the pairwise nucleotide divergence by PAUP\* (Swofford 2000). Two independent Markov Chain Monte Carlo (MCMC) search were run with four chains each for 1 000 000 generations with trees sampled every 1000 generations. A 50% majority-rule consensus tree was obtained from all post-burn-in sampled trees.

## SYSTEMATICS

Family SCYLLARIDAE Latreille, 1802  
Genus *Galearctus* Holthuis, 2002

*Galearctus avulsus* n. sp.  
(Figs 1; 2)

*Galearctus kitanoviriosus* – Holthuis 2002: 565 (in part), fig. 25 (not Harada 1962).

TYPE MATERIAL. — Holotype: **New Caledonia**. BERYX 11, stn CP 22, 24°44'S, 168°07'E, 490–510 m, 17.X.1992, 1 ovig. ♀, 31.0 mm cl (MNHN-IU-2010-1910).

Paratypes: **New Caledonia**. Norfolk Ridge, SMIB 3, stn DW 14, 23°40'S, 168°00'E, 246 m, 22.V.1987, 1 ♀, 26.0 mm cl (MNHN-Pa 1274). — Matthew Island, VOLSMAR, stn DW 39, 22°20.5'S, 168°43.5'E, 305 m, 8.VI.1989, 1 ♀, 26.0 mm cl (MNHN-Pa 1384). — BERYX 11, stn CH 26, 24°42'S, 168°08'E, 230–260 m, 17.X.1992, 1 ovig. ♀, 26.0 mm cl (MNHN-IU-2010-1911). — BATHUS 1, stn CP 711, 21°43.16'S, 166°36.35'E, 315–327 m, 13.V.1993, 1 juv., 9.0 mm cl (MNHN-Pa 1859). — HALIPRO 1, stn CP 851, 21°43'S, 166°37'E, 314–364 m, 19.V.1994, 1 ♂, 11.0 mm cl (MNHN-Pa 1861). — HALICAL 1, stn 2, 20°47.5'S, 164°52'E, 658–680 m, 23.XI.1994, 1 ♂, 13.0 mm cl (MNHN-Pa 1860).

**Chesterfield Islands**. Dredge, 250 m, 22.V.1979, 1 ♀, 26.8 mm cl (MNHN-IU-2009-46).

TYPE LOCALITY. — New Caledonia, 24°44'S, 168°07'E, at depths of 490–510 m.

ETYMOLOGY. — The Latin *avulsus*, alluding to the meaning which is tear away or avulsion, refers to the longitudinal median groove at the posterior part of the thoracic sternite I being distinctly widen posteriorly and somewhat like torn away in the new species. All other known species of *Galearctus* have very narrow median longitudinal groove at the posterior part of the thoracic sternite I.

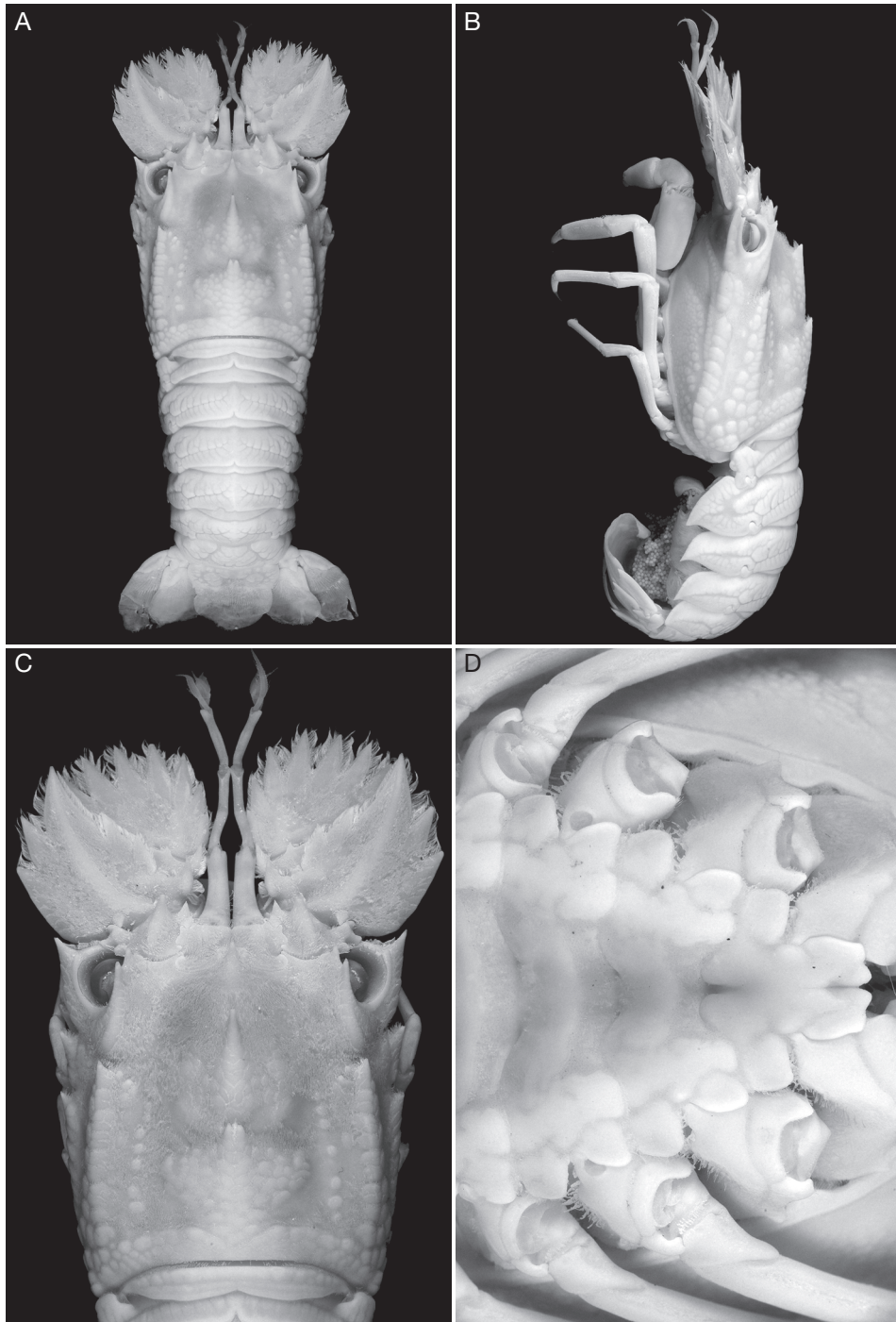


FIG. 1. — *Galearctus avulsus* n. sp., holotype ♀ cl 31.0 mm, New Caledonia, MNHN-IU-2010-1910: **A**, dorsal view; **B**, lateral view; **C**, carapace, dorsal view; **D**, anterior part of thoracic sternum, ventral view.

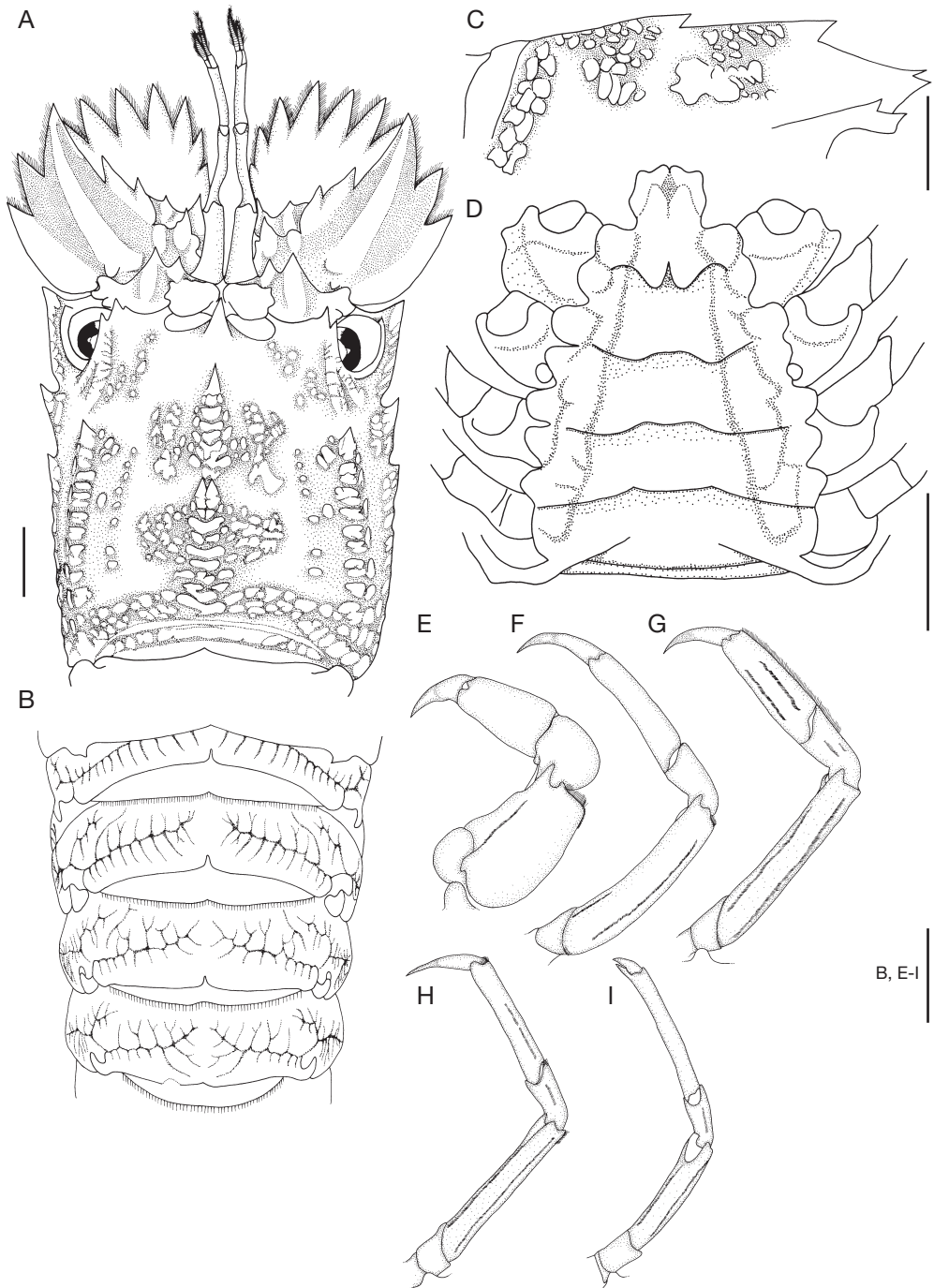


FIG. 2. — *Galearctus avulsus* n. sp., holotype ♀ cl 31.0 mm, New Caledonia, MNHN-IU-2010-1910: **A**, carapace, dorsal view; **B**, abdominal somites I-IV, dorsal view; **C**, carapace, lateral view; **D**, thoracic sternum; **E**, pereopod I; **F**, pereopod II; **G**, pereopod III; **H**, pereopod IV; **I**, pereopod V. Scale bars: 5 mm.

DISTRIBUTION. — South Pacific from New Caledonia, Chesterfield Islands, and probably Fiji, at depths of 230–680 m.

COLORATION. — Not known.

#### DESCRIPTION

Carapace (Figs 1A–C; 2A, C) with squamiform tubercles and short pubescence. Rostral tooth well developed, sharply pointed and hanging over base of antennular somite. Pregastric tooth completely absent. Gastric tooth moderately elevated and about 1.5 times as high as rostral tooth, followed posteriorly by 6 transverse rows of squamae, each row with 3 or 4 fused squamae. Anterior submedian ridge divided into two lines; inner line composed of 6 or 7 larger but irregular squamae; outer line with smaller and fewer squamae. 2 or 3 tubercles present between postrostral and anterior submedian ridges. Cardiac tooth deeply bifurcate and distinctly elevated, followed posteriorly by 6 or 7 transverse rows of 1–3 large flattened squamae. Posterior postrostral ridge flanked with patch of 17 or 18 squamae, making posterior submedian ridges indistinct. 7 or 8 distinct intermediate tubercles present. 1 large squama present between intermediate tubercles and posterior branchial ridge. Cervical groove shallow and relatively narrow, thus anterior and posterior branchial carinae relatively close. Anterior branchial ridge bearing 2 large, sharp teeth anteriorly. Posterior branchial ridge with anterior end forming an acute tooth, followed posteriorly by double row of 8 or 9 squamiform tubercles. Postorbital ridge not sharp. Intercervical ridge composed of 4 or 5 squamae. Anterolateral, mediolateral and posterolateral teeth as flattened squamiform tubercles except anteriormost tubercle of each part which forms a strong tooth, posterolateral part with 10 or 11 squamae. Posterior marginal groove deep, narrow. Posterior margin of carapace medially incised.

Abdomen (Figs 1A, B; 2B) with arborescent sculpture, median areas only slightly elevated and without dorsal carina. Articulate surfaces of each tergite more or less smooth, only tergite II always with shallow interrupted transverse grooves. Posterior margins of tergites I to III deeply incised medially, that of IV weakly incised medially. Pleura II to IV sharply pointed posteroventrally, posterior margins

smooth (Fig. 1B). Posterior margin of telson bearing 2 pairs of teeth (outer pair larger) and without spines in-between.

Anterior margin of antennal segment VI with 7 teeth, outer six large and slender while inner one obtuse and short. Antennal segment IV bearing 2 distinct teeth on anterior margin; outer margin armed with 2 large teeth; dorsal surface with only 1 oblique median carina. Fused antennal segments II and III with 2 teeth on anterior margin, outer tooth distinctly larger than inner tooth (Figs 1C; 2A).

Pereiopod I stout and shorter than other pereiopods (Fig. 2E). Propodus of pereiopod II slender; about 1.5 times as long as dactylus (Fig. 2F). Propodus of pereiopod III not subchelate, distinctly wider and flatter than that of pereiopod II, bearing 2 long and parallel hairy longitudinal grooves on outer surface (Fig. 2G). Pereiopod IV sometimes with 1 interrupted hairy groove on outer surface of propodus (Fig. 2H). Carpi of pereiopod III to V each with 0 or 1 hairy groove on outer surface of carpus and 1 or 2 hairy grooves on outer surface of merus (Fig. 2G–I).

Anterior margin of thoracic sternum produced forwards, tongue-like and with anterolateral angles distinctly produced; median part of anterior margin of tongue-like process triangularly protruded but medially incised, incision continuous posteriorly as a groove that is sometimes triangularly expanded medially (Figs 1D; 2D). Entire median part of thoracic sternum deeply sunken, only lateral borders bluntly elevated. Well-developed and rounded transverse carinae separating each thoracic sternite. Only short and posteriorly divergent median longitudinal groove present at posterior part of sternite I (base of pereiopod I). Last thoracic sternite sometimes bearing median tubercle, posterolateral angle unarmed in females but developed into small tooth in males.

Eggs small and numerous, about 0.5 mm in diameter.

#### REMARKS

The present new species is separated from *G. kitano-viriosus* by the following characters: 1) anterior margin of antennal segment IV with 2 distinct teeth in *G. avulsus* n. sp. (Figs 1A, C; 2A), but

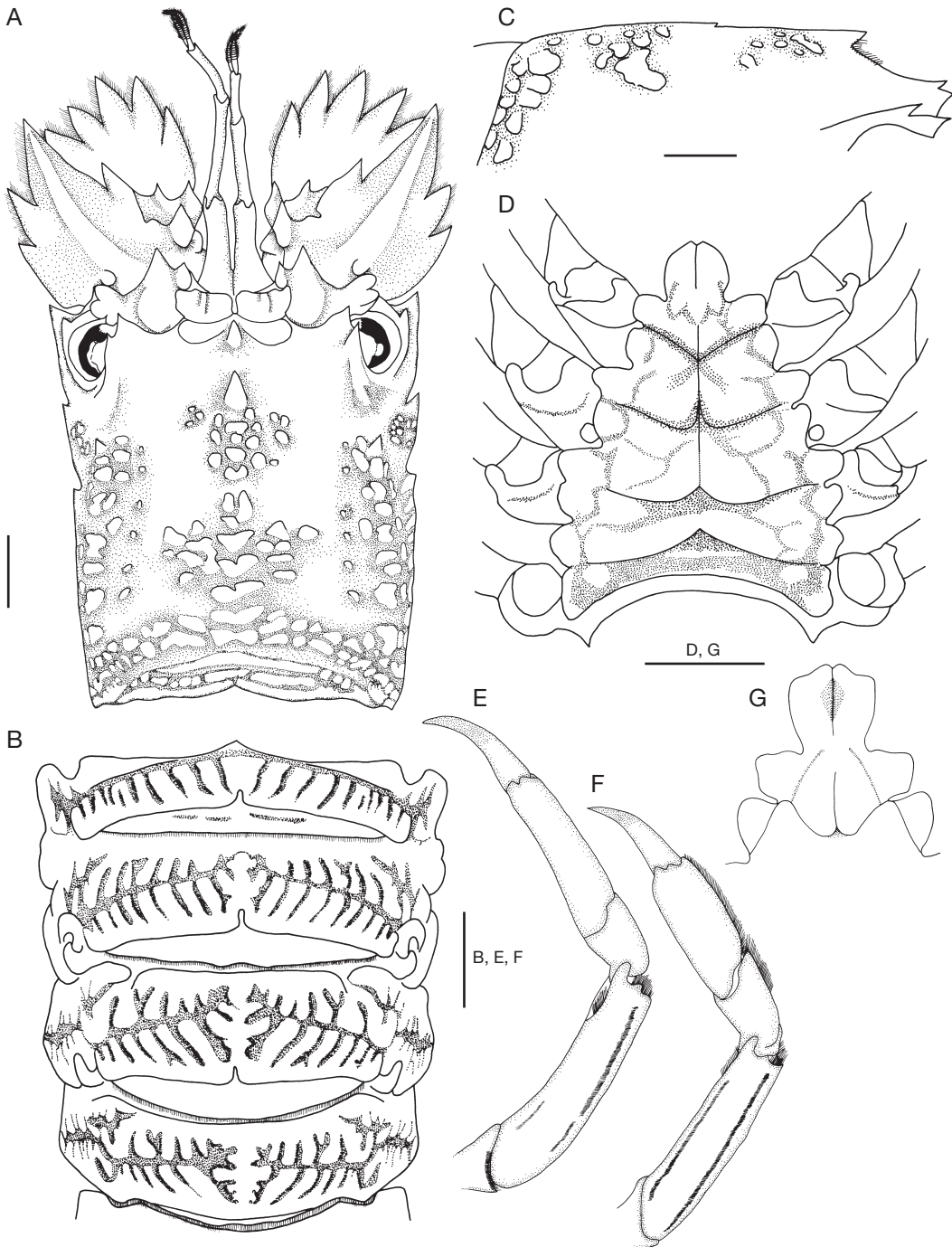


FIG. 3. — **A-F**, *Galearctus kitanoviriosus* (Harada, 1962), ♀ cl 21.9 mm, Taiwan, NTOU M00981; **A**, carapace, dorsal view; **B**, abdominal somites I-IV, dorsal view; **C**, carapace, lateral view; **D**, thoracic sternum; **E**, pereiopod II; **F**, pereiopod III; **G**, *G. rapanus* (Holthuis, 1993), ♀ cl 30.7 mm, Australes Islands, NTOU M00865, anterior part of thoracic sternum. Scale bars: 5 mm.

TABLE 2. — Uncorrected (“P”) distance of 657 bp of mitochondrial cytochrome c oxidase I gene amongst the species of the genus *Galearctus*, except *G. umbilicatus*. \*, outgroups.

	<i>G. avulsus</i>						<i>*Chelarctus aureus</i>
	<i>G. aurora</i>	n. sp.	<i>G. kitanoviriosus</i>	<i>G. lipkei</i>	<i>G. rapanus</i>	<i>G. timidus</i>	
<i>G. aurora</i>	–						
<i>G. avulsus</i> n. sp.	0.152	–					
<i>G. kitanoviriosus</i>	0.160	0.152	–				
<i>G. lipkei</i>	0.138	0.175	0.157	–			
<i>G. rapanus</i>	0.164	0.145	0.164	0.173	–		
<i>G. timidus</i>	0.145	0.169	0.152	0.143	0.164	–	
<i>*Chelarctus aureus</i>	0.170	0.190	0.184	0.199	0.202	0.167	–
<i>*Scammarctus batei</i>	0.184	0.193	0.193	0.196	0.204	0.175	0.169

only with one tooth in *G. kitanoviriosus* (Fig. 3A); 2) cardiac tooth distinctly elevated (Figs 1B; 2C) in *G. avulsus* n. sp., but very low and almost level with dorsal carapace in *G. kitanoviriosus* (Fig. 3C); 3) both anterior and posterior submedian ridges composed of many more squamae in *G. avulsus* n. sp. (Figs 1A, C; 2A) than in *G. kitanoviriosus* (Fig. 3A); 4) outer surface of propodus of pereopod III always with two long setal grooves in *G. avulsus* n. sp. (Fig. 2G), but usually without grooves (70%) or rarely (30%) with 2 short setal grooves in *G. kitanoviriosus* (Fig. 3F); 5) anterior extension of the thoracic sternum tongue-like, and with its anterolateral angles distinctly protruded in *G. avulsus* n. sp. (Figs 1D; 2D), but rather triangular and with its anterolateral margins oblique in *G. kitanoviriosus* (Fig. 3D); and 6) *G. avulsus* n. sp. has the thoracic sternum, including the posterior half of sternite I, distinctly sunken medially, a medial longitudinal groove is only present on the posterior half of sternite I, and each sternite is separated by distinct transverse ridges (Figs 1D; 2D). In *G. kitanoviriosus*, the thoracic sternum is only weakly depressed medially, but bears a distinct median longitudinal groove along the anterior half of the sternum, and each sternite is separated by transverse grooves and not by ridges (Fig. 3D).

Besides the differences listed above, the posterolateral angles of the last thoracic sternite are sometimes developed into teeth in *G. kitanoviriosus* females (Fig. 3D), but always unarmed in *G. avulsus* n. sp. females (Fig. 2D). Moreover, the articulate surfaces of the abdominal tergites II to IV sometimes also bear shallow interrupted

transverse grooves in *G. kitanoviriosus* (Fig. 3B), but these areas are always smooth in *G. avulsus* n. sp. (Fig. 2B). *Galearctus avulsus* n. sp. appears to be restricted to waters deeper than 200 m, while *G. kitanoviriosus* is distributed in less than 100 m deep. For the New Caledonia and Chesterfield Islands material assigned by Holthuis (2002) to “*G. kitanoviriosus*” and deposited at MNHN, all but one specimen are actually *G. avulsus* n. sp. and they were all collected from 230–680 m deep. Only the specimen registered as MNHN-Pa 775 is truly *G. kitanoviriosus*, and it is the only one collected from shallow water (8–15 m). Another New Caledonian specimen from the University of Florida (UF 1022) was also available for the present study. This specimen was collected from 0.5–1.5 m deep, and has both the morphological characters and typical coloration of *G. kitanoviriosus*. The live coloration of *G. avulsus* n. sp. is so far unknown. Holthuis (2002) mentioned that there are three specimens from Fiji deposited in the MNHN that belong to “*G. kitanoviriosus*”, however they can not be located at present. As these three Fiji specimens were collected from 316–357 m deep, they most likely belong to *G. avulsus* n. sp. Moreover, there are two more specimens mentioned by Holthuis (2002) from New Caledonia and deposited in the National Museum of Natural History, Washington, D.C. (USNM 1000666), and Rijksmuseum van Natuurlijke Historie, Leiden (RMNH D 48767). As they were also collected from deeper water (247–290 m), they are also likely to belong to *G. avulsus* n. sp.



A comparison amongst the 657 bps of the bar-coding mitochondrial COI gene (Table 2) shows that there is a 15.2% sequence divergence between *G. avulsus* n. sp. and *G. kitanoviriosus*, which is higher than that between *G. aurora* and *G. lipkei* (13.8%). A difference of 15.2% divergence in the partial sequence of COI is generally considered to be more than sufficient to separate species in decapod crustaceans (Daniels *et al.* 2002; Rava-gio & Juinio-Meñez 2002; Cabezas *et al.* 2009). The available partial COI gene sequences for the Scyllaridae show the interspecific divergence of species in this family ranging from 2 to 25% (Burton & Davie 2007; Yang *et al.* 2008; Palero *et al.* 2009; Yang & Chan 2010). On the other hand, the intraspecific sequence divergence of *G. kitanoviriosus* is only 0.4% between the Taiwanese and New Caledonian material (unfortunately attempts to obtain the sequence for the Japanese material failed). The genetic data (Fig. 4) suggest that the present new species is actually most similar to *G. rapanus* (14.5%). Indeed, *G. avulsus* n. sp. and *G. rapanus* (4 specimens examined: Australes Islands, 2 ♀♀ 27.7-30.7 mm cl, NTOU M00865; Lord Howe Island, 2 ♀♀ 19.5-24.3 mm cl, QM W29060) are morphologically quite similar and with small specimens almost identical with others. Although large specimens of *G. rapanus* can be readily separated from *G. avulsus* n. sp. by having the outer tooth of the antennal segments III extraordinarily large and the thoracic sternum distinctly narrower, these differences are not so obvious between smaller individuals. This is partly due to the outer surface of the propodus of the pereopod III in *G. rapanus* that may bear 1 or 2 setal grooves (1 setal groove in the Australes Islands, 27.7 mm cl female and Lord Howe Island

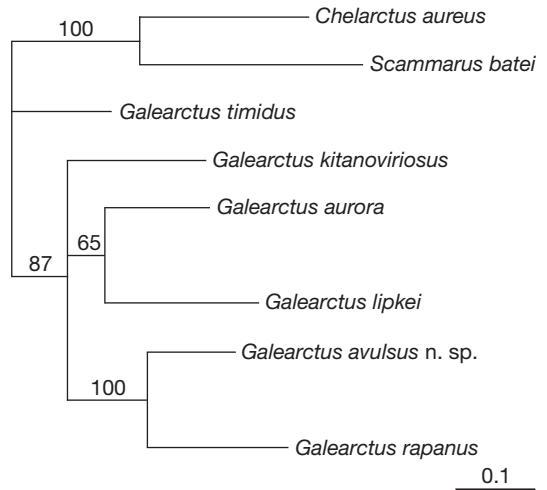


FIG. 4. — Bayesian tree from 657 bp COI gene among *Galearctus* species and outgroups based on the best-fitting model (HKY+I+G). Posterior probability from Bayesian inference shown on branches.

19.5 mm cl female, 2 setal grooves in the Lord Howe Island 24.3 mm cl female) instead of always naked (Australes Islands 30.7 mm cl female), as described by Holthuis (1993, 2002). Nevertheless, the longitudinal median groove at the posterior part of the thoracic sternite I is distinctly wider posteriorly in *G. avulsus* n. sp. (Figs 1D; 2D) but always very narrow and not posteriorly divergent in *G. rapanus* (Fig. 3G). Moreover, the posteriorly divergent median longitudinal groove at the posterior part of the thoracic sternite I in *G. avulsus* n. sp. is unique in the genus. All other known species of *Galearctus* have very narrow median longitudinal groove on the thoracic sternite I. The following revised key is given for the separation of the species in *Galearctus*.

KEY TO THE SPECIES OF *GALEARCTUS*

1. Cardiac tooth very low and almost level with dorsal carapace surface ..... *G. kitanoviriosus*  
 — Cardiac tooth distinctly elevated from dorsal carapace surface ..... 2
2. Gastric tooth extraordinarily high, its anterior height distinctly more than half the distance between anterior base of gastric tooth and tip of rostral tooth ..... 3  
 — Gastric tooth not extraordinarily high, its anterior height much less than half the distance between anterior base of gastric tooth and tip of rostral tooth ..... 4

3. Articulate surfaces of abdominal tergites II to V at most bearing 1 incomplete transverse groove; outer surface of propodus of pereopod II naked and smooth ..... *G. timidus*  
 — Articulate surfaces of abdominal tergites II to V with 2 distinct crenulated transverse grooves, outer surface of propodus of pereopod II bearing 2 setal parallel grooves .....  
 ..... *G. umbilicatus*
4. Antennal segment IV with 2 well-developed teeth on anterior margin ..... 5  
 — Antennal segment IV with only 1 well-developed tooth on anterior margin ..... 6
5. Median longitudinal groove at posterior part of thoracic sternite I very narrow, not widen posteriorly; antennal segment III with outer tooth much more than 2 times larger than inner tooth at least in adults ..... *G. rapanus*  
 — Median longitudinal groove at posterior part of thoracic sternite I distinctly widen posteriorly; antennal segment III with outer tooth about 2 times larger than inner tooth .....  
 ..... *G. avulsus* n. sp.
6. Anterior margin of antennal segment IV with only 1 large tooth; teeth on antennal segment VI sharp and slender; last thoracic sternite generally lacking a posterolateral tooth in females ..... *G. lipkei*  
 — Anterior margin of antennal segment IV generally with 1 large tooth and an additional small tooth or tubercle; teeth on antennal segment VI wide and chubby; last thoracic sternite with posterolateral teeth in females ..... *G. aurora*

### Acknowledgements

Sincere thanks are extended to A. Crosnier, R. Cléva, L. Corbari and P. Martin-Lefevre from MNHN, for allowing the third author to examine the crustacean collection of their museum and loaning us specimens; G. Paulay (UF), J. Okuno (CMNH) and P. Davie (QM) for sending us on loan their specimens. The New Caledonia deep-water material originates from various cruises of the IRD/MNHN Tropical Deep-Sea Benthos programme, many of which owe to the indefatigable experience and skills of Bertrand Richer de Forges (see Richer de Forges 1990, 1993). This work was supported by grants from the National Science Council, Taiwan, R.O.C. and the Academia Sinica, Taiwan, R.O.C.

### REFERENCES

BUCKLIN A., STEINKE D. & BLANCO-BERCIAL L. 2011. — DNA barcoding of marine metazoan. *Annual Review of Marine Science* 3: 471-508.  
 BURTON T. E. & DAVIE P. J. F. 2007. — A revision of the shovel-nosed lobsters of the genus *Thenus* (Crustacea: Decapoda: Scyllaridae), with descriptions of three new species. *Zootaxa* 1429: 1-38.  
 CHAN T.-Y. & YU H. P. 1986. — A report on the *Scyllarus* lobsters (Crustacea: Decapoda: Scyllaridae)

from Taiwan. *Journal of Taiwan Museum* 39 (2): 147-174.  
 CHAN T.-Y. & YU H. P. 1993. — *The Illustrated Lobsters of Taiwan*. SMC Publishing Inc., Taipei, x + 247 p.  
 CABEZAS P., MACPHERSON E. & MACHORDOM A. 2009. — Morphological and molecular description of a new species of squat lobster (Crustacea: Decapoda: Galatheidae) from the Solomon and Fiji Islands (South-West Pacific). *Zoological Journal of the Linnean Society* 156 (3): 465-493.  
 DANIELS S. R., STEWART B. A., GOUWS G., CUNNINGHAM M. & MATTHEE C. A. 2002. — Phylogenetic relationships of the southern African freshwater crab fauna (Decapoda: Potamonautidae: *Potamonautes*) derived from multiple data sets reveal biogeographic patterning. *Molecular Phylogenetics and Evolution* 25: 511-523.  
 DEBELIUS H. 1999. — *Crustacea Guide of the World. Atlantic Ocean. Indian Ocean. Pacific Ocean*. IKAN, Frankfurt am Main, 321 p.  
 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 (5): 294-299.  
 HARADA E. 1962. — On the genus *Scyllarus* (Crustacea Decapoda: Reptantia) from Japan. *Publications of the Seto Marine Biological Laboratory* 10: 109-132.  
 HEBERT P. D. N., CYWINSKA A., BALL S. L. & DEWAARD J. R. 2003. — Biological identifications through DNA barcodes. *Proceedings of the Royal Society of London B*

- Biological Sciences 270: 313-321.
- HOLTHUIS L. B. 1993. — *Scyllarus rapanus*, a new species of locust lobster from the South Pacific (Crustacea, Decapoda, Scyllaridae). *Bulletin du Muséum national d'Histoire naturelle, Paris* 4<sup>e</sup> sér., section A, 15 (1-4): 179-186.
- HOLTHUIS L. B. 2002. — The Indo-Pacific scyllarine lobsters (Crustacea, Decapoda, Scyllaridae). *Zoosystema* 24 (3): 499-683.
- KIM H. S. & PARK K. B. 1972. — Faunal studies on the Macrurans in Korea, in *Floral Studies on some Taxa of Plants and Faunal Studies on some Taxa of Animals in Korea*. Ministry of Science and Technology, Seoul: 185-222.
- MINEMIZU R. 2000. — *Marine Decapod and Stomatopod Crustaceans Mainly from Japan*. Bun-ichi Sogo Shuppan Publishing Co., Tokyo, 344 p.
- MIYAKE S. 1982. — *Macrura, Anomura and Stomatopoda. Japanese Crustacean Decapods and Stomatopods in Color*. Hoikusha Publishing Co., Osaka, vii + 261 p.
- NYLANDER J. A. A. 2004. — *MrModeltest v2*. Program distributed by the author. Evolutionary Biology Centre, Uppsala University.
- PALERO F., CRANDALL K. A., ABELLÓ P., MACPHERSON E. & PASCUAL M. 2009. — Phylogenetic relationships between spiny, slipper and coral lobsters (Crustacea, Decapoda, Achelata). *Molecular Phylogenetics and Evolution* 50: 152-162.
- RAVAGO R. G. & JUINIO-MENEZ M. A. 2002. — Phylogenetic position of the striped-legged forms of *Panulirus longipes* (A. Milne-Edwards, 1868) (Decapoda, Palinuridae) inferred from mitochondrial DNA sequences. *Crustaceana* 75 (9): 1047-1059.
- RICHER DE FORGES B. 1990. — Explorations for bathyal fauna in the New Caledonian economic zone, in CROSNIER A. (ed.), Résultats des campagnes MUSORTSOM, volume 6. *Mémoires du Muséum national d'Histoire naturelle*, sér. A, 145: 9-54.
- RICHER DE FORGES B. 1993. — Campagnes d'exploration de la faune bathyale faites depuis mai 1989 dans la zone économique de la Nouvelle-Calédonie. Liste des stations, in CROSNIER A. (ed.), Résultats des campagnes MUSORTSOM, volume 10. *Mémoires du Muséum national d'Histoire naturelle* 156: 27-32.
- RONQUIST F., HUELSENBECK J. P. J. & VAN DER MARK P. 2005. — *MrBayes 3.1.2: User manual*. MrBayes 3.1, Florida, U.S.A.
- SWOFFORD D. L. 2000. — *PAUP\*: Phylogenetic Analysis Using Parsimony (\* and Other Methods)*. Version 4.0b10. Sinauer Associates, Sunderland, Massachusetts.
- WANG B., QIAN Z. & DONG Y. 1998. — Studies on the family Scyllaridae (Crustacea Decapoda) from Chinese coast. *Journal of Xiamen University (Natural Science)* 37 (3): 443-453.
- YANG C.-H., CHEN I.-S. & CHAN T.-Y. 2008. — A new slipper lobster of the Genus *Petrarctus* (Crustacea: Decapoda: Scyllaridae) from the west Pacific. *The Raffles Bulletin of Zoology* 2008 supplement 19: 71-81.
- YANG C.-H. & CHAN T.-Y. 2010. — A new slipper lobster of the Genus *Galearctus* Holthuis, 2002 (Decapoda: Scyllaridae) from Taiwan and Japan, in FRANSEN *et al.* (eds), Studies on Malacostraca. *Crustaceana Monographs* 14: *Lipke Bijdeley Holthuis Memorial Volume*: 735-745.

Submitted on 30 June 2010;  
accepted on 16 March 2011.