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A new clawed lobster of the genus *Nephropsis* Wood-Mason, 1872 (Crustacea: Decapoda: Nephropidae) from the Indonesian deep-sea cruise, SJADES 2018

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Abstract. A new species of the clawed lobster genus *Nephropsis* Wood-Mason, 1872, collected recently by the South Java Deep-Sea Biodiversity Expedition (SJADES 2018) off the southern coast of Java in Indonesia, is described. The new species is closely related to *Nephropsis carpenteri* Wood-Mason, 1885, but differs in the shapes of the carinae and groove on the carapace, as well as in the spination and relative length of the pereopods. The large sequence divergence in the barcoding gene COI also supports the recognition of the new species.

Key words. new species, *Nephropsis carpenteri*, COI barcode, biodiversity expedition, Java

INTRODUCTION

Members of the genus *Nephropsis* Wood-Mason, 1872, are deep-sea clawed lobsters, with 15 species known to date (Chan, 2010). Although these lobsters are found in oceans around the world (Macpherson, 1990, 1993; Holthuis, 1991; Chang & Chan, 2019), only two species (*N. carpenteri* Wood-Mason, 1885, and *N. malhaensis* Borradaile, 1910) are found in the Indian Ocean. In Indonesian waters, seven species of *Nephropsis* have been reported, namely *N. acanthura* Macpherson, 1990; *N. ensirostris* Alcock, 1901; *N. holthuisi* Macpherson, 1993; *N. serrata* Macpherson, 1993; *N. stewarti* Wood-Mason, 1872; *N. suhmi* Bate, 1888; and *N. sulcata* Macpherson, 1990 (Bate, 1888; Chan, 1997). All of them were recorded from the northern and eastern parts of Indonesia (Flores Sea, Makassar Strait, Banda Sea, and Arafura Sea). The recent South Java Deep-Sea Biodiversity Expedition 2018 (SJADES 2018), organised by Indonesia and Singapore off the Indian Ocean side of Indonesia, collected several specimens of *Nephropsis*. Amongst them are two males showing the characteristics of the Indian Ocean endemic, *N. carpenteri*. Nevertheless, close comparison with the topotypic material of *N. carpenteri* from the Bay of Bengal revealed several subtle differences between them. Molecular analysis of the COI gene barcodes showed that there are also large genetic differences between the Javanese material and *N. carpenteri*, as well as with *N. aculeata* Smith, 1881, which is closely related to *N. carpenteri* and from the western Atlantic. Therefore, it was determined that the Indonesian form is new to science and warrants a new name and formal description, provided herein.

MATERIAL AND METHODS

The material examined is deposited in the Museum Zoologicum Bogoriense, Cibinong, Bogor, Indonesia (MZB); Lee Kong Chian Natural History Museum, Singapore (ZRC); Department of Aquatic Biology and Fisheries, University of Kerala (DABFUK); National Taiwan Ocean University, Keelung, Taiwan (NTOU); and Muséum national d'Histoire naturelle, Paris (MNHN). Carapace length (cl) is measured dorsally from the orbital margin to posterior margin of carapace. The terminology used follows Macpherson (1990) and Holthuis (1991).

The following comparative material are listed here: *Nephropsis carpenteri* – Myanmar, RV DR. FRIDTJOF NANSEN, stn 18, 18.2375°N, 93.631°E, 466 m, 3 May 2015, 1 ovigerous female, cl 32.9 mm, NTOU M02248; India, Sakthikulangara fishing harbour, Kollam district, Kerala, commercial trawler, 20 March 2017, 1 male, cl 22.1 mm, DABFUK/AR-ACH-6.

For molecular genetic analysis, taxa closely related to *N. carpenteri* (see "Remarks" below) are included. They are: the topotypic specimen of *N. carpenteri* from the Bay of Bengal (NTOU M02248) recently collected by the FAO "Nansen" survey; the specimen of *N. carpenteri* recently collected from southern India (DABFUK/AR-ACH-6), the present SJADES specimens, and a specimen of *N. aculeata*

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Table 1. Specimens used for the barcoding COI gene sequence comparisons.

Species	Locality	Voucher no.	GenBank no.
Nephropsis rahayuae, new species	South Java	MZB Cru 5053	MN725106
	South Java	ZRC 2020.0126	MN725108
Nephropsis carpenteri	Myanmar	NTOU M02248	MN725107
	India	DABFUK/AR-ACH-6	MN725105
Nephropsis aculeata	French Guiana	MNHN IU-2013-2552	MN725109

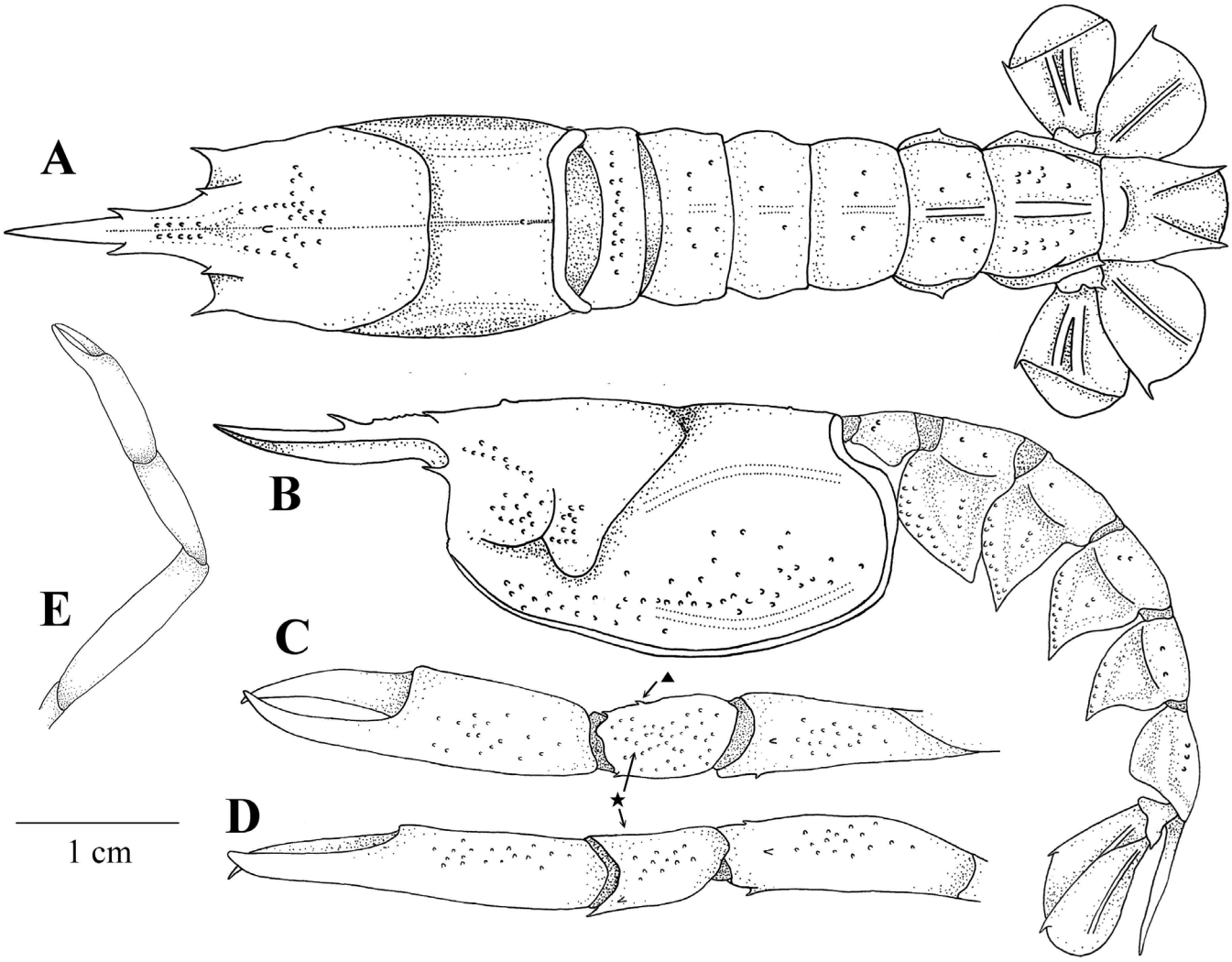

Fig. 1. *Nephropsis rahayuae*, new species, holotype, male (cl 23.8 mm), MZB Cru 5053. A, carapace and pleon, dorsal view; B, same, lateral view; C, left cheliped I, dorsal view; D, same, lateral view; E, left pereopod II, lateral view. ★: position of dorsal spines; ▲: position of spines at lower margin of inner surface.

(GUYANE 2014, stn. CP4369, MNHN IU-2013-2552) from French Guiana (Table 1).

Genomic DNA was extracted from pleopod muscle tissue using the DNeasy Blood & Tissue Kit (QIAGEN). The barcoding region of the cytochrome oxidase I (COI) gene was amplified using universal primers (Folmer et al., 1994). The PCR amplification was performed in 25 µl mixture containing 50–250 ng of the DNA extract, 2.5 µl of 10X polymerase buffer, 3 mM of $MgCl_2$, 200 nM of each primer, 200 µM of dNTPs (PROTECH, Taipei, Taiwan), and 1U of ProTaq™ DNA polymerase (5U μl^{-1}, PROTECH). The PCR cycling profile was 5 min at 94°C for initial denaturation, followed by 35 cycles of 30 s at 95°C, 40 s at 48°C, and 40 s at 72°C, and a final extension at 72°C for 10 min. The PCR products were sent to a commercial company for further purifying (Geneaid) and sequencing (ABI 3730 XL automated sequencer). The complementary consensus sequences were aligned by Clustal W implemented in Bioedit (Hall, 1999) to check the accuracy of each sequence. The COI sequences were then assembled and aligned by MUSCLE implemented in MEGA v.7 (Kumar et al., 2016). Uncorrected pairwise

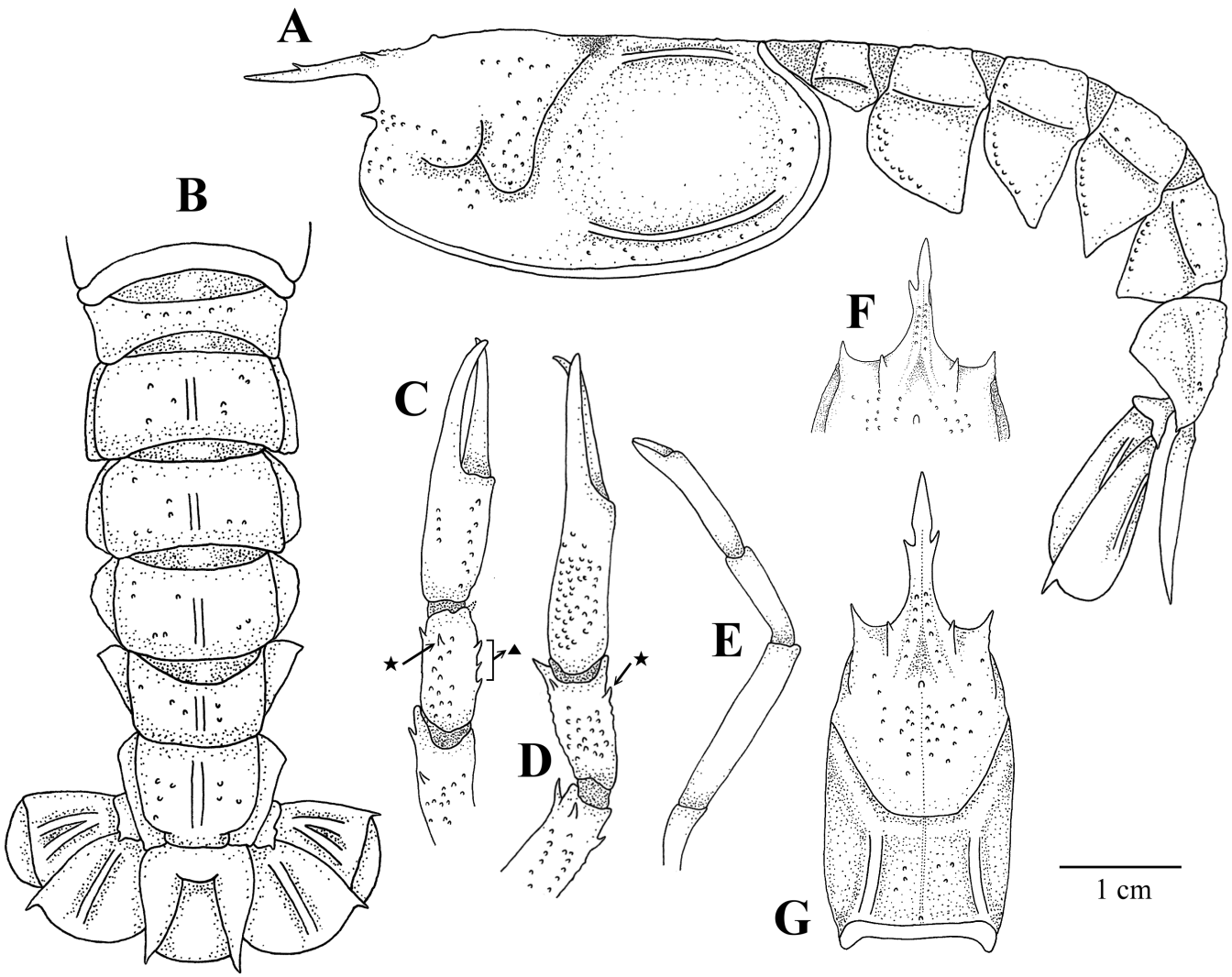

Fig. 2. *Nephropsis carpenteri* Wood-Mason, 1885. A–F, Myanmar, ovigerous female (cl 32.9 mm), NTOU M02248; G, Sakthikulangara fishing harbour, India, male (cl 22.1 mm), DABFUK/AR-ACH-6. A, carapace and pleon, lateral view; B, pleon, dorsal view; C, left cheliped I, dorsal view; D, same, lateral view; E, left pereopod II, lateral view; F, anterior part of carapace, dorsal view; G, carapace, dorsal view. ★: position of dorsal spines; ▲: position of spines at lower margin of inner surface.

divergences (*p*-distance) among the species were performed by the same software package.

TAXONOMY

Family Nephropidae Dana, 1852

Nephropsis Wood-Mason, 1872

Nephropsis rahayuae, new species
(Figs. 1, 3A, B)

Material examined. Holotype: male (cl 23.8 mm), south of Java, SJADES 2018, stn CP 33, 7°42.912′S, 107°36.559′E, 525–312 m, 29 March 2018 (MZB Cru 5053). Paratype: 1 male (cl 15.8 mm), south of Java, SJADES 2018, stn CP 20, 6°42.320′S, 105°08.682′E, 325–362 m, 27 March 2018 (ZRC 2020.0126).

Description. Carapace finely granulated (Fig. 1A, B). Rostrum 0.6–0.7 times as long as carapace length, tip slightly curved upwards, bearing a pair of lateral spines just behind mid-length; median groove extending anteriorly beyond lateral rostral spines. Subdorsal carinae finely denticulate, without distinct spines. Supraorbital and antennal spines well-developed, post-supraorbital spine absent. Cervical, postcervical and hepatic groove distinct. Postcervical groove U-shaped in dorsal view, with median straight part 0.7 times as wide as carapace width at same position. Intermediate and lateral carinae present but indistinct. Gastric tubercle near supraorbital spines, their distance about 0.3 times the distance between gastric tubercle and postcervical groove. Distance between orbital margin and postcervical groove 1.5–1.6 times the distance between postcervical groove and posterior margin of carapace.

Pereopod I finely granulate (Fig. 1C, D), densely pubescent on dorsal surface; fingers 0.8–0.9 times as long as palm; carpus with an anteroventral spine, a small subdistal spine on outer-lower margin, inner surface with a distal spine on upper margin and a subdistal spine at lower margin of carpus; merus bears a small subdistal spine dorsally, a strong anteroventral spine on inner margin, and a small subdistal

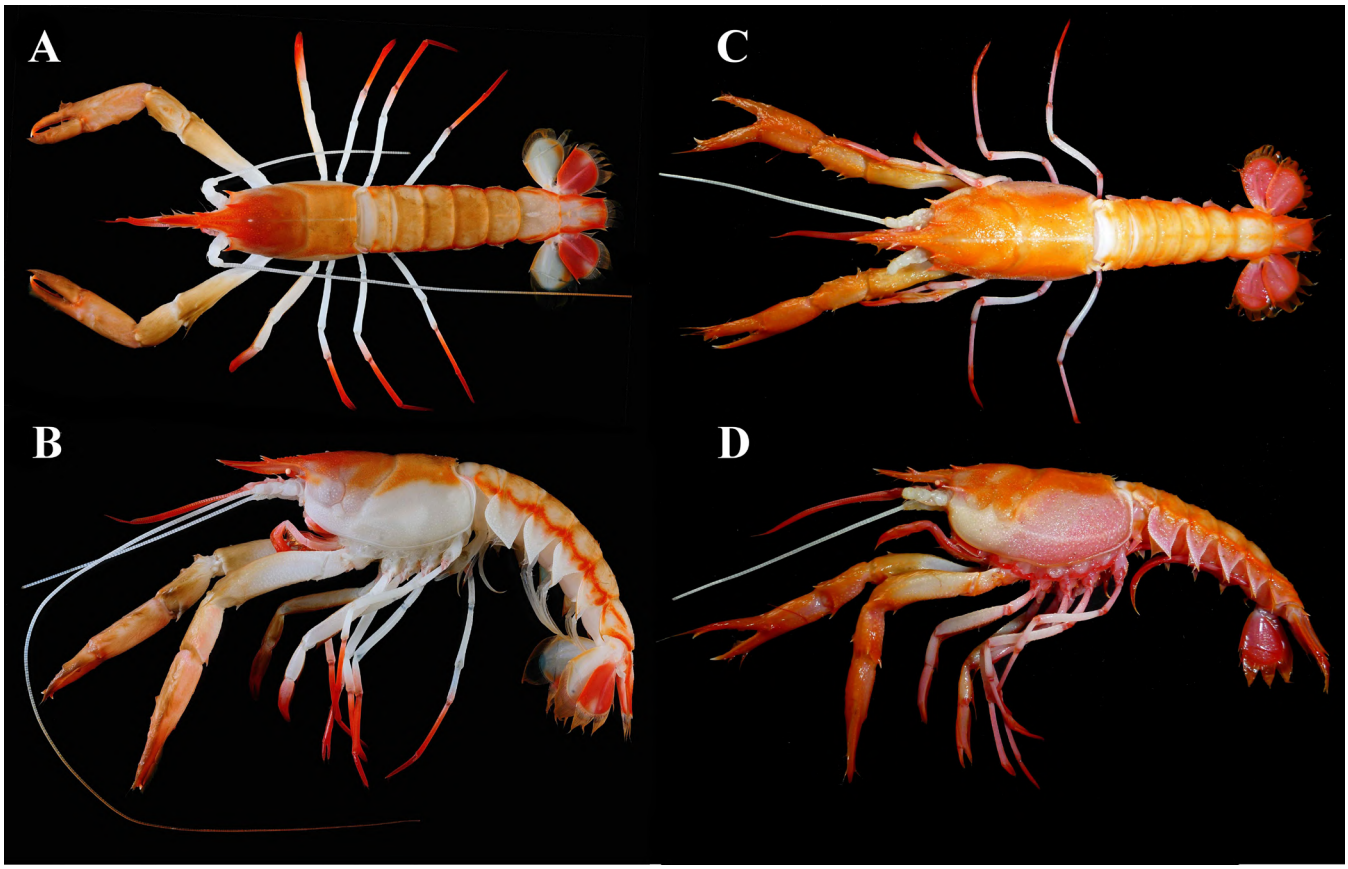

Fig. 3. A, B, *Nephropsis rahayuae*, new species, holotype, male (cl 23.8 mm), MZB Cru 5053; C, D, *Nephropsis carpenteri* Wood-Mason, 1885, Sakthikulangara fishing harbour, India, male (cl 22.1 mm), DABFUK/AR-ACH-6.

spine on outer surface. Pereopod II unarmed (Fig. 1E), dorsal and ventral margins covered with long setae; carpus 0.9–1.0 times palm length. Pereopod III overreaching distal end of rostrum, less stout than pereopod II; carpus 0.6–0.7 times as long as palm; merus about two times as long as carpus. Pereopod IV and V smooth, non-chelate; dactylus 0.6–0.7 times as long as propodus.

Pleon generally smooth (Fig. 1A, B), with some granules, covered with short soft hairs. Pleonal somites II–VI bearing dorsal median carina but with those on somites II–IV rather indistinct. Posterior margin of somite V unarmed. Anterior margin of pleuron II strongly convex and lacking spine, terminating ventrally in a blunt or sharp angle. Anterior margins of pleura III–V moderately convex, each ending ventrally as a long spine. Telson without erected dorsal spine near base. Uropod generally smooth (Fig. 1A, B), sparsely covered with short soft hairs. Posterior angle of uropodal protopod armed with a spine. Uropodal exopods with conspicuous, fully formed diaeresis.

Etymology. The new species is named after Dwi Listyo Rahayu, the Indonesian chief scientist of the SJADES 2018 deep-sea cruise.

Colouration in life. Body generally whitish (Fig. 3A, B) and covered with light brown pubescence. Rostrum, dorsal carapace, distal parts of pereopods II to V, uropodal endopods, lateral margin of pleonal tergites, and margins of telson pale orange to reddish. Antennular flagella reddish. Antennal flagella whitish but with distal portion becoming orange-red. Eyes whitish. Chela of pereopod I slightly pinkish.

Distribution. Only known from southwestern Java, Indonesia, at depths of 312–525 m.

Remarks. The SJADES material is very similar to *N. carpenteri* by having one pair of lateral rostral spines, lacking post-supraorbital spine and pleon with a median carina. *Nephropsis carpenteri* has so far been known with certainty only from India and Myanmar (Wood-Mason, 1885; Alcock, 1901; Macpherson, 1990; Holthuis, 1991; Watabe & Iizuka, 1999; Radhakrishnan et al., 2019). The access of recently collected material of *N. carpenteri* from Myanmar (NTOU M02248) and India (DABFUK/AR-ACH-6) allows detailed comparisons with the present two specimens taken from southern Java. Their colourations are very similar (Fig. 3). Although the Java form is whiter than the India material and the exopod of uropod almost entirely whitish instead of reddish, two specimens from Myanmar show either a red (only photograph without specimen examined) or white (NTOU M02248) exopod. Nevertheless, the two Java specimens differ from the India and Myanmar materials of *N. carpenteri* by the intermediate and lateral carinae on the carapace being rather indistinct (Fig. 1B), and the post-cervical groove being U-shaped in dorsal view (with the median straight part 0.7 times as long as the carapace width at the same position; Fig. 1A). The two specimens of

N. carpenteri from India and Myanmar have well-marked intermediate and lateral carinae on the carapace (Fig. 2A), and the post-cervical groove is somewhat V-shaped in dorsal view (with the median straight part 0.3–0.4 times as long as the carapace width at the same position; Fig. 2G). The carpus of the large cheliped (pereopod I) is less spiny in the Java form (no dorsal spine, 1 spine at lower margin of inner surface; Fig. 1C, D) than in the India and Myanmar material (1 dorsal spine, 2–3 spines at lower margin of inner surface; Fig. 2C, D). On the other hand, the rostrum (Fig. 1A, B) and carpus of pereopod II (Fig. 1E) appear to be longer in the Java form (rostrum longer than half carapace length, carpus of pereopod II 0.9–1.0 times as long as palm) than in *N. carpenteri* material from India and Myanmar (rostrum less than half carapace length, carpus of pereopod II 0.7–0.8 times as long as palm; Fig. 2A, E) (also see Alcock & Anderson, 1894; Alcock, 1901; Macpherson, 1990). Moreover, the dorsal carinae on the pleonal somites II to IV are less distinct in the Java form (Fig. 1A) as compared to the India and Myanmar material (Fig. 2B).

Comparisons on the barcoding COI gene sequence (638–657 bp) showed that the two SJADES specimens have 99.8% similarity with each other, while the two India and Myanmar specimens have 99.7% similarity with each other. However, the Java form has 8.3–8.5% sequence divergence from the topotypic *N. carpenteri* material (i.e., from the Bay of Bengal). Such a high COI sequence divergence (i.e., >5%) is generally considered to be the interspecific difference in decapod crustaceans (Jones & Macpherson, 2007; Chan et al., 2009; Malay et al., 2012; da Silva et al., 2013; Komai et al., 2019). As both morphological and genetic differences can be found between the Java material and *N. carpenteri*, the Java form is determined to be a distinct species with the new name *N. rahayuae*, new species.

Other than *N. carpenteri*, *N. rahayuae*, new species, is also close to *N. aculeata* from the western Atlantic (Macpherson, 1990; Holthuis, 1991). These three species differ from the congeners by a combination of characters: having one pair of lateral rostral spines, lacking a post-supraorbital spine, pleon bearing a median carina, no erect dorsal spine on the telson, and uropodal exopod with diaeresis. *Nephropsis rahayuae*, new species, can be readily distinguished from *N. aculeata* (see Holthuis, 1974, 1991) by the distance between the supraorbital spine and gastric tubercle being about 0.3 times the distance between gastric tubercle and postcervical groove (Fig. 1A, B) (versus about 0.5 times in *N. aculeata*), and the dorsal median carina on the pleonal somites II–IV being rather indistinct (Fig. 1A) (versus these being distinct in *N. aculeata*). Moreover, the carpus of pereopod II is shorter than the palm in *N. rahayuae*, new species (Fig. 1E) but distinctly longer than the palm in *N. aculeata.* The COI sequence divergence between *N. rahayuae*, new species, and *N. aculeata* is as high as 17.1–17.2%.

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