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Crustacea Decapoda: Palinuridae, Scyllaridae and Nephropidae collected in Indonesia by the KARUBAR Cruise, with an identification key for the species of *Metanephrops*

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ABSTRACT

The lobsters collected by the KARUBAR cruise from Indonesia are examined. Twenty-one species are identified, ten of which being newly recorded in Indonesia. Moreover, the KARUBAR cruise obtained an intact specimen of *Metanephrops arafurensis* (de Man, 1905) and a re-description is given for this poorly known species. The four species groups in *Metanephrops* are redefined and a revised key to the species of *Metanephrops* is provided.

RÉSUMÉ

Crustacea Decapoda : Palinuridae, Scyllaridae et Nephropsidae récoltés en Indonésie lors de la campagne KARUBAR. Clé d'identification des espèces du genre *Metanephrops*.

Les espèces appartenant aux familles des Palinuridae, Scyllaridae et Nephropidae, récoltées lors de la campagne KARUBAR en Indonésie, ont été étudiées: 21 espèces ont été trouvées, dont 10 n'avaient pas encore été signalées en Indonésie. Un spécimen de *Metanephrops arafurensis* (de Man, 1905) ayant été récolté, cette espèce, mal connue, est redécrite. Les quatre groupes d'espèces du genre *Metanephrops* sont redéfinis et une clé d'identification de toutes les espèces de ce genre est proposée.

INTRODUCTION

The KARUBAR cruise in 1991 collected a number of deep-sea lobster specimens from Indonesia. The material is found to contain five species of palinurids, five species of scyllarids and 11 species of nephropids. Although no new species were found, the KARUBAR material extends the known distributions for many species, such as *Linuparus trigonus* (von Siebold, 1824), *Palinustus unicornutus* Berry, 1979, *Ibacus pubescens* Holthuis, 1960, *I. novemdentatus* Gibbes, 1850, *Nephropsis acanthura* Macpherson, 1990, *N. holthuisi* Macpherson, 1993,

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N. serrata Macpherson, 1993, *N. stewarti* Wood-Mason, 1872, *N. sulcata* Macpherson, 1990, and *Metanephrops australiensis* (Bruce, 1966). The most interesting finding is a complete specimen of *Metanephrops arafurensis* (de Man, 1905), which was previously known only from a mutilated type. Together with the additional knowledge gained of the characteristics of the other *Metanephrops* species, their relationships are discussed and a revised key to the species of this genus is provided.

MATERIAL AND METHODS

The specimens used in the present study are deposited at the Muséum national d'Histoire naturelle, Paris (MNHN), Puslitbang Oseanologi-LIPI, Indonesia (POLIPI), National Taiwan Ocean University (NTOU), National Museum of Natural History, Washington, D.C. (USNM), Nationaal Natuurhistorisch Museum, Leiden (RMNH) and Zoologisch Museum, University of Amsterdam, Amsterdam (ZMA). Furthermore, the collections of the MNHN and NTOU contain 15 of the 18 known species of *Metanephrops*. Only three species, namely *M. binghami* from the Caribbean, *M. motunauensis* and *M. challengeri* from New Zealand have not been examined. Their characteristics are mainly by referring to YALDWYN (1954), HOLTHUIS (1964, 1991), JENKINS (1972) and TAKEDA (1990).

The terminology used for the body parts of *Nephropsis* mainly follows MACPHERSON (1990), while that for *Metanephrops* follows CHAN & YU (1991). The measurements are of carapace length (cl) which is measured along the dorsal midline from the postorbital margin to the posterior margin of the carapace. Only restricted synonymies of Indonesian records and important works on the species are given.

In the lists of material, CP = beam trawl, CC = shrimp otter trawl, DW = Warren dredge.

SYSTEMATIC ACCOUNT

Family PALINURIDAE

Genus *LINUPARUS* White, 1847

Linuparus trigonus (von Siebold, 1824)

Palinurus Trigonus von Siebold, 1824: 15 (type-locality: Japan).
Linuparus trigonus - HOLTHUIS, 1991: 114, figs 215-216.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Tanimbar Islands*: stn CP 66, 09°01'S, 132°09'E, 1.11.1991, 211-217 m: 1 ♀ 91.2 mm (MNHN). — Stn CP 79, 09°16'S, 131°22'E, 250-239 m, 3.11.1991: 1 ♀ 72.3 mm (POLIPI). — Stn CP 83, 09°23'S, 131°00'E, 285-297 m, 4.11.1991: 1 ♂ 69.1 mm (POLIPI).

REMARKS. — Although this species is often reported in the western Pacific (Japan, Korea, China, Taiwan, the Philippines and Australia, at depths of 30-318 m), it is recorded here for the first time in Indonesia.

Genus *PALINUSTUS* A. Milne Edwards, 1880

Palinustus unicornutus Berry, 1979

Palinustus unicornutus Berry, 1979: 93, figs 1, 2, 3G (type-locality: Natal, South Africa). — HOLTHUIS, 1991: 126, figs 235-236. — CHAN & YU, 1995: 381, fig. 4, 8B, 9B, 10B.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn DW 18, 05°18'S, 133°01'E, 205-212 m, 24.10.1991: 1 ♂ 17.1 mm (MNHN).

REMARKS. — *P. unicornutus* was previously thought to be restricted to the eastern coast of South Africa. Recently, however, it was found that this species actually has a wide distribution in the Indo-West-Pacific (CHAN & YU, 1995).

Palinustus waguensis Kubo, 1963

Palinustus waguensis Kubo, 1963: 63, figs 1-3 (type-locality: Japan). — HOLTHUIS, 1991: 126, figs 237-238. — CHAN & YU, 1995: 389, fig. 7, 8D, 9E, 10E.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn DW 30, 05°39'S, 132°56'E, 118-111 m, 26.10.1991: 1 ♂ 31.4 mm (MNHN).

REMARKS. — Similar to *P. unicornutus*, recent finds show that this species is also widely distributed in the Indo-West-Pacific (CHAN & YU, 1995). Nevertheless, its occurrence in Indonesia had already been suggested by HOLTHUIS (1991).

Genus *PUERULUS* Ortmann, 1897

Puerulus angulatus (Bate, 1888)

Panulirus angulatus Bate, 1888: 81, pl. 11-figs 1-4 (type-locality: New Guinea).
Puerulus angulatus - HOLTHUIS, 1991: 162, figs 301-302.
Not *Puerulus angulatus* - DE MAN, 1916: 36, pl. 2-fig. 5 (= *Puerulus velutinus* Holthuis, 1963).

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn DW 2, 05°47'S, 132°13'E, 209-240 m, 22.10.1991: 1 juv. 14.3 mm (POLIPI). — Stn DW 18, 05°18'S, 133°01'E, 205-212 m, 24.10.1991: 1 ♂ 50.3 mm (POLIPI). — Stn CP 36, 06°05'S, 132°44'E, 268-210 m, 27.10.1991: 4 juv. 14.8-17.9 mm (MNHN).
Tanimbar Islands: stn CP 85, 09°22'S, 131°14'E, 245-240 m, 4.11.1991: 1 juv. 13.4 mm (MNHN). — Stn CP 88, 08°45'S, 130°47'E, 1188-1178 m, 5.11.1991: 1 juv. 13.0 mm (MNHN).

REMARKS. — This species is widely distributed in the Indo-West-Pacific (from 274 to 536 m deep) and has been reported from Indonesia by HOLTHUIS (1991). The specimen from Stn CP 88 has the body spines and pleopods exceptionally long and was collected from great depth (1188-1178 m). Since the arrangement of the spines on body in this specimen is very similar to those of the other juveniles of this species, it is probably still in the very early puerulus stage.

Puerulus velutinus Holthuis, 1963

Puerulus angulatus - DE MAN, 1916: 36, pl. 2-fig. 5 (*non* Bate, 1888).
Puerulus velutinus Holthuis, 1963: 55 (type-locality: Indonesia); 1966: 273; 1991: 165, figs 307-308.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CP 35, 06°08'S, 132°45'E, 390-502 m, 27.10.1991 : 1 ovig. ♀ 58.0 mm (MNHN).

REMARKS. — *P. velutinus* is unique in the genus, in bearing a large postorbital spine. It is known from the southern Philippines down to NW Australia (WADLEY & EVANS, 1991), at depths of 485-683 m.

Family SCYLLARIDAE

Genus *IBACUS* Leach, 1815

Ibacus brevipes Bate, 1888

Ibacus brevipes Bate, 1888: 62, pl. 9-fig. 1 (type-locality: Indonesia). — HOLTHUIS, 1985: 47, figs 13-14; 1991: 201, figs 384-385.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CP 36, 06°05'S, 132°44'E, 268-210 m, 27.10.1991: 6 ♂ 20.6-38.5 mm, 2 ♀ 21.7-40.3 mm (POLIPI).

REMARKS. — The KARUBAR specimens were taken from almost the same locality and depth as the type collected by the *"Challenger"* (i.e. 05°49.15'E, 132°14.14'E, 256 m) near the Kai Islands. In the KARUBAR material the number of posterolateral teeth on the carapace may be as high as 18 (12-17 in HOLTHUIS, 1985). As mentioned by HOLTHUIS (1985), the teeth on the anterior margin of the distal antennal segment are sometimes strongly reduced in the males. This species has been reported from the South China Sea, the Philippines, Indonesia and New Caledonia (at depths of 186-457 m).

Ibacus pubescens Holthuis, 1960, comb. nov.

Ibacus ciliatus pubescens Holthuis, 1960: 147 (type-locality: the Philippines); 1985: 33, fig. 8; 1991: 203, fig. 338-right.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CP 36, 06°5'S, 132°44'E, 268-210 m, 27.10.1991: 1 ♀ 24.4 mm (POLIPI).

Tanimbar Islands: stn CP 82, 09°32'S, 131°02'E 219-215 m, 4.11.1991: 1 ♀ 35.3 mm (MNHN). — Stn CP 85, 09°22'S, 131°14'E, 245-240 m, 4.11.1991: 1 ♀ 21.8 mm (POLIPI).

REMARKS. — This present form differs from the typical *I. ciliatus* (von Siebold, 1824) by having the entire body distinctly pubescent and slightly more posterolateral teeth on the carapace (one KARUBAR specimen even has 15 posterolateral teeth on one side). The typical form has a northern distribution, from Japan to the South China Sea and northern Philippines. The pubescent form has been found in the southern range of the distribution of the species (i.e. southern Philippines and NW Australia), but is only reported for the first time from Indonesia here. Similar to the figure provided by HOLTHUIS (1985, 1991), the posterior margin of abdominal tergite V is evenly serrated in the KARUBAR material. However, all the specimens from Taiwan have the posterior margin of abdominal tergite V provided with only three or four distinct tubercles near the lateral ends (CHAN & YU, 1993: 187-upper photo). The figures of *I. ciliatus ciliatus* given by HOLTHUIS (1985, 1991) also show a similar arrangement of tubercles on abdominal tergite V. Thus, it seems justifiable to treat the pubescent, southern form as a distinct species, rather than subspecies, as in the comparable situation of *Metanephrops velutinus* and *M. andamanicus*. It is interesting that material from the Philippines to Australia often has the body more pubescent.

The depth range of this species is from 151-391 m (HOLTHUIS, 1985).

Ibacus novemdentatus Gibbes, 1850

Ibacus novemdentatus Gibbes, 1850: 19 (type-locality: unknown). — HOLTHUIS, 1985: 52, figs 15-17; 1991: 204, figs 390-391.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn 35, 06°08'S, 132°45'E, 390-502 m, 27.10.1991 : 1 ♀ 7.0 mm (POLIPI).

Tanimbar Islands: stn CP 81, 09°35'S, 131°02'E, 200-207 m, 4.11.1991: 1 ♂ 52.0 mm (POLIPI).

REMARKS. — Although *I. novemdentatus* is widely distributed in the Indo-West-Pacific (at depths of 37-400 m), it has nevertheless not been reported from Indonesia before. This species generally bears 8 posterolateral teeth on the carapace, but the male from the KARUBAR cruise has 7, while the female has 9 posterolateral teeth.

Genus *SCYLLARUS* Fabricius, 1775

Scyllarus sp.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CP 5, 05°49'S, 132°18'E, 269-299 m, 22.10.1991: 1 juv. 7.4 mm (MNHN). — Stn DW 32, 05°47'S, 132°51'E, 170-106 m, 26.10.1991: 1 juv. 6.6 mm (MNHN).

REMARKS. — These two specimens are very young juveniles (probably at the very early postlarval stages). No trace of gonopores is found and their pleopods are extremely long. The thoracic sternum has the anterior process undeveloped (i.e. anterior end of the thoracic sternum truncate and not anteriorly protruded at all) and bears a pair of elongate posterolateral spines. The juvenile of *S. cultrifer* collected by the KARUBAR cruise (see below) has a similar size but the pleopods are rudimentary and the anterior extremity of the thoracic sternum already shows the characteristic shape of the species. Thus, it is highly likely that these two small specimens are the juveniles of a large *Scyllarus* species. They show some similarities to *S. crenatus* (WHITELEGGE, 1900), described from East Australia, in possessing a distinct rostrum, the arborescent markings on the abdomen being indistinct (almost absent in one specimen) and only the posterior margins of abdominal somites I to III medially incised. *S. crenatus* is still known only from the types and it is also likely that WHITELEGGE's (1900) specimens (about cl 5.2 mm) are juveniles of other species. This situation is further complicated because the taxonomic status of many species of *Scyllarus* is still unclear.

Scyllarus cultrifer (Ortmann, 1897)

Arctus cultrifer Ortmann, 1897: 272 (type-locality: Japan).
Arctus sordidus - BATE, 1888: 66, pl. 9-fig. 3 (*non* Stimpson, 1860).
Scyllarus cultrifer meridionalis Holthuis, 1960: 150 (type-locality: the Philippines).

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn DW 24, 05°32'S, 132°51'E, 243-230 m, 26.10.1991: 1 ♀ 8.0 mm (MNHN).

REMARKS. — *S. cultrifer* is unique in the genus by having both the pereiopods III and IV subchelate. This species is widely distributed in the Indo-West-Pacific (from littoral to about 290 m deep). HOLTHUIS (1960) assigned the southern material (i.e. from the Philippines, Indonesia and east of South Africa) to a distinct subspecies, *S. cultrifer meridionalis* Holthuis, 1960. However, the KARUBAR specimen shows intermediate characters between the typical and southern forms. Its posterior margin of abdominal tergite IV lacks a median incision but the other characteristics all conform to the typical form. As suggested by HARADA (1962) and CHAN and YU (1993), it may not be necessary to divide this species into two subspecies. *S. cultrifer* has already been reported by BATE (1888, under the name "*Aractus sordidus*") from the Kai Islands.

Family NEPHROPIDAE

Genus *NEPHROPSIS* Wood-Mason, 1873

Nephropsis acanthura Macpherson, 1990

Nephropsis acanthura Macpherson, 1990: 311, figs 5d, 9d-f, 11a-b, 16d (type-locality: the Philippines). — HOLTHUIS, 1991: 35, fig. 61-62. — GRIFFIN & STODDART, 1995: 234.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Tanimbar Islands*: stn CP 87, 08°47'S, 130°49'E, 1017-1024 m, 5.11.1991: 1 ♂ 11.1 mm (POLIPI). — Stn CP 89, 08°39'S, 131°08'E, 1084-1058 m, 5.11.1991: 1 ovig. ♀ 18.9 mm (MNHN).

REMARKS. — Although this species is widely distributed in the Indo-West-Pacific (at depths of 720-1305 m), it is here recorded for the first time from Indonesia. *N. acanthura* is distinct in having an erect basal spine on the telson and can be distinguished from the closely related species *N. occidentalis* Faxon, 1893, from the eastern Pacific by the rostrum being distinctly longer than one-half the carapace length. The size of *N. acanthura* is also smaller than its eastern Pacific counterpart. However, the carapace is not granulate in the KARUBAR specimens and that of the female is rather heavily pubescent. Furthermore, the carapace of the male has some post-supraorbital spinules which are lacking in the female (see also GRIFFIN & STODDART, 1995).

Nephropsis ensirostris Alcock, 1901

Nephropsis ensirostris Alcock, 1901: 162, pl. 1-fig. 2 (type-locality: Arabian Sea). — DE MAN, 1916: 113. — MACPHERSON, 1990: 303, figs 5a, 6, 8a-b, 16a. — HOLTHUIS, 1991: 41, figs 71-72.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Tanimbar Islands*: stn CP 70, 08°41'S, 131°47'E, 413-410 m, 2.11.1991: 1 ♂ 19.5 mm (MNHN). — Stn CP 72, 08°36'S, 131°33'E, 699-676 m, 2.11.1991: 1 ♀ 16.8 mm (POLIPI).

REMARKS. — The present species is unique in the genus in lacking teeth on the rostrum. *N. ensirostris* is widely distributed in the Indo-West-Pacific (at depths of 315-1300 m) and its occurrence in Indonesia has been recorded by DE MAN (1916) and MACPHERSON (1990). The two KARUBAR males agree well with the description of MACPHERSON (1990), except that the outer spine on the terminal half of the carpus of large cheliped is absent in one specimen and poorly developed on one side in the other. The smaller male also has the left anterior spine of the subdorsal carina missing.

Nephropsis holthuisi Macpherson, 1993

Nephropsis holthuisi Macpherson, 1993: 55, figs 1-3 (type-locality: NW Australia). — GRIFFIN & STODDART, 1995: 234.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CP 38, 07°40'S, 132°27'E, 620-666 m, 28.10.1991: 1 ♀ 9,0 mm (MNHN).

Tanimbar Islands: stn CC 57, 08°19'S, 131°53'E, 603-620 m, 31.10.1991: 1 ♂ 32.1 mm, 1 ovig. ♀ 28.1 mm (MNHN).

REMARKS. — This species is extremely similar to *N. rosea* Bate, 1888, from the western Atlantic. MACPHERSON (1993) only used the relative position of the gastric tubercle on the carapace to separate them. Other than being smaller in size, the Indo-West-Pacific material appears to have the anterior margin of the abdominal pleuron II slightly more convex and the large chelae less granulate [three specimens of *N. rosea* from French Guyana (MNHN-AS 574) were compared]. Since, at present, only six specimens are known from north-western and eastern Australia and Indonesia (at depths of 603-1105 m), more material is necessary to determine the taxonomic status of this Indo-West-Pacific form.

Nephropsis serrata Macpherson, 1993

Nephropsis Stewarti - DE MAN, 1916: 112, pl. 3-fig. 17. (*non* Wood-Mason, 1872).
Nephropsis serrata Macpherson, 1993: 59, figs 4-6 (type-locality: NW Australia).
? *Nephropsis hamadai* Watabe & Ikeda, 1994: 102 (type-locality: Japan).

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CC 21, 05°14'S, 133°00'E, 688-694 m, 25.10.1991: 3 ♂ 19.4-26.4 mm, 2 ♀ 22.5-32.3 mm (MNHN). — Stn CP 38, 07°40'S, 132°27'E, 620-666 m, 28.10.1991: 1 ♂ 26.3 mm, 12 ♀ 13.0-30.1 mm, 1 juv. 9.4 mm (POLIPI).

Tanimbar Islands: stn CP 59, 08°20'S, 132°11'E, 405-399 m, 31.10.1991: 1 ♀ 23.1 mm (MNHN).

REMARKS. — The present species is very similar to *N. stewarti* and they often occur together. Nevertheless, *N. serrata* differs constantly from the latter species in having some additional spines on the subdorsal carina. Thus, the *"Siboga"* specimen reported by DE MAN (1916) from the Kai Islands has the subdorsal carina denticulate and should belong to the present species instead of *N. stewarti*. The size of *N. serrata* is also much smaller than that of *N. stewarti*. However, the differences in the rostral length and large chela between these two species, mentioned by MACPHERSON, (1993), appear to be rather variable in *N. stewarti*.

N. hamadai Watabe & Ikeda, 1994, recently described from Japan, is very similar to *N. serrata*. The characters, such as the shape of the coxae of the pereiopods and the relative distances of the orbital margin, cervical groove and posterior margin of the carapace, used by WATABE and IKEDA to distinguish *N. hamadai* from *N. serrata*, are found to be very variable in the KARUBAR and North Western Australian specimens (10 specimens in NTOU, CSIRO in exchange). It is highly likely that *N. hamadai* belongs to the same species as *N. serrata*.

N. serrata was previously known from western Australia only. The present report extends its range northward to Indonesia, at depths of 300-694 m.

Nephropsis stewarti Wood-Mason, 1873

Nephropsis stewarti Wood-Mason, 1873: 60 (type-locality: Andaman Sea).
Nephropsis stewarti - MACPHERSON, 1990: 312, figs 5e, 10, 11c-d, 16. — HOLTHUIS, 1991: 45, figs 80-81.
Not *Nephropsis Stewarti* - DE MAN, 1916: 112, pl. 3-fig. 17 (= *N. serrata* Macpherson, 1993).

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CP 12, 05°23'S, 132°37'E, 436-413 m, 23.10.1991: 2 ♂ 13.8-24.6 mm, 1 ♀ 25.3 mm (MNHN). — Stn CP 35, 06°08'S, 132°45'E, 390-502 m, 27.10.1991: 1 ♂ 53.9 mm (MNHN). — Stn CP 39, 07°47'S, 132°26'E, 477-466 m, 28.10.1991: 1 ♀ 51.8 mm (MNHN).
Tanimbar Islands: stn CC 56, 08°16'S, 131°59'E, 552-549 m, 31.10.1991: 1 spec. 58.0 mm (POLIPI). — Stn CP 59, 08°20'S, 132°11'E, 405-399 m, 31.10.1991: 1 ♂ 64.1 mm (MNHN). — Stn CP 69, 08°42'S, 131°53'E, 356-368 m, 2.11.1991: 1 ♂ 32.5 mm (MNHN).

REMARKS. — This species is widely distributed in the Indo-West-Pacific (at depths of 170 to over 1060 m). However, the previous record in Indonesia by DE MAN (1916) actually represented *N. serrata*. Thus, it can be considered that *N. stewarti* is correctly reported from Indonesia only now. *N. stewarti* is probably the largest species of the genus, the body length (excluding the rostrum) of a male collected by the KARUBAR cruise reaching 18.2 cm.

Nephropsis sulcata Macpherson, 1990

Nephropsis sulcata Macpherson, 1990: 319, figs 13e-g, 14a-b, 15a-b, 16g (type-locality: the Philippines). — HOLTHUIS, 1991: 47, figs 84-85.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Tanimbar Islands*: stn CP 81, 09°35'S, 131°02'E, 200-207 m, 4.11.1991: 2 ovig. ♀ both 21.0 mm, 4 ♀ 15.7-21.5 mm (MNHN). — Stn CP 87, 08°47'S, 130°49'E, 1017-1024 m, 5.11.1991: 1 ♂ 22.1 mm, 2 ♀ 12.2-22.5 mm (POLIPI). — Stn CP 89, 08°39'S, 131°08'E, 1084-1058 m, 5.11.1991: 1 ♂ 15.6 mm (rostrum missing, tentatively identified as the present species) (MNHN).

REMARKS. — *N. sulcata* is widely distributed in the Indo-West-Pacific but has not been recorded in Indonesia before. Moreover, one lot of the KARUBAR specimens (Stn CP 81) was collected at a depth of only 200-207 m which is much shallower than previously thought for *N. sulcata* (415-1115 m deep in MACPHERSON, 1990; 1993).

It is found that some characteristics used by MACPHERSON (1990) to separate *N. sulcata* from the closely related Atlantic species *N. atlantica* Norman, 1882, are not very satisfactory [specimens of *N. sulcata* and *N. atlantica* in MNHN, mentioned by MACPHERSON (1990), have been compared]. The dorsal carina on the abdomen is also very distinct and the median groove of the rostrum may sometimes overreach the distal rostral teeth in the material from the Atlantic. On the other hand, the distance between the post-supraorbital spine and the gastric tubercle is often more than 0.5 (to about 0.6) times the distance between the gastric tubercle and the post-cervical groove in the Indo-West-Pacific material. Nevertheless, the size of Indo-West-Pacific specimens appears to be much smaller than that of the Atlantic material and the carpus of pereiopod II is always shorter than the palm. Furthermore, the posterior border of the abdominal somite V often bears a distinct spine in the Indo-West-Pacific specimens, but this spine is usually absent in the material from the Atlantic.

Genus *METANEPHROPS* Jenkins, 1972

Metanephrops arafurensis (de Man, 1905)

Figs 1, 2 a-c, 3, 4 b, 5 b

Nephrops arafurensis de Man, 1905: 587; 1916: 107, pl. 3-fig. 16 (type-locality: Indonesia). — YALDWYN, 1954: 730.
Metanephrops arafurensis - JENKINS, 1972: 171. — CHAN & YU, 1987: 184. — HOLTHUIS, 1991: 67, figs 130-131.

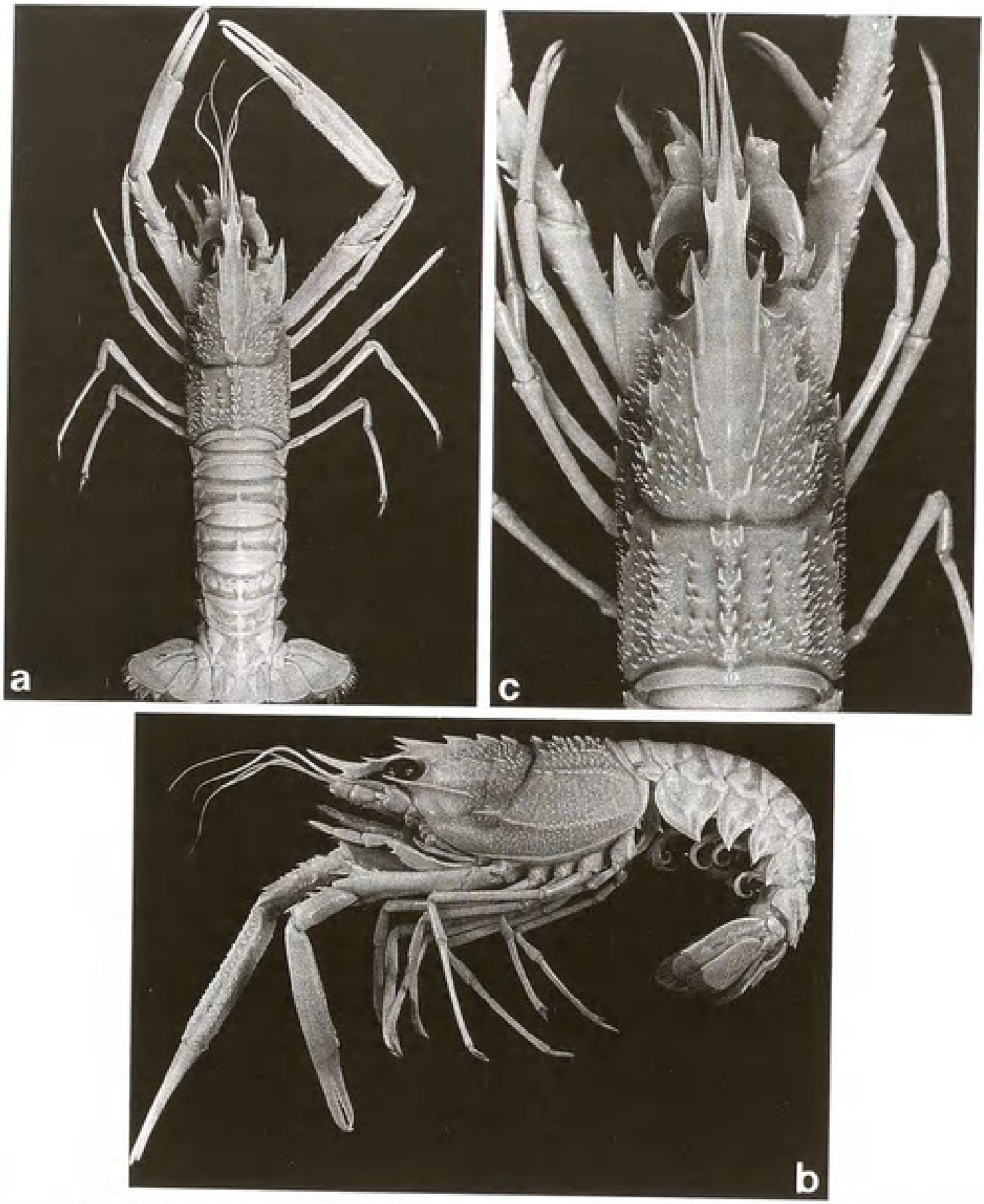

FIG. 1. — *Metanephrops arafurensis* (de Man, 1905). Indonesia, Tanimbar Islands, 7°46'S, 132°31'E, 443-468 m, ♂ 50.7 mm (MNHN): **a**, dorsal view; **b**, lateral view; **c**, dorsal view of carapace.

MATERIAL EXAMINED. — **Indonesia**. *"Siboga"*: stn 262, 05°53.8'S, 132°48.8'E, 560 m, 12.18.1899: 1 ♂ 34.0 mm, type (ZMA).

KARUBAR. *Tanimbar Islands*: stn CC 40, 07°46'S, 132°31'E, 443-468 m, 28.10.1991: 1 ♂ 50.7 mm (MNHN).

DESCRIPTION. — Carapace spinulose. 4-5 post-rostral teeth present. Region between post-rostral carinae only having some spinules on posterior part. Posterior margin of hepatic groove spinulose, but that of cervical groove lacking spines except those at anterior ends of post-cervical ridges. Three lateral, post-cervical ridges present. Antennal spine wing-like and with outer margin somewhat crenulated. Distal segment of maxilliped III rather long and slender. Large cheliped weakly ridged but covered with sharp tubercles, with inner margins bearing some large spines, and outer margin of chela angular.

Abdomen with distinct dorsal carina (that of somite I with only anterior end present); raised parts naked but depressed parts heavily pubescent; tergite I with deep, but short, lateral transverse furrows; tergites II and III with broad but medially interrupted transverse furrows (as wide as or wider than main facade and having intermediate, narrow, eroded, transverse carina between) and dorsally arched, lateral, longitudinal furrows, submedian notches rudimentary but some pits may be present on raised parts near dorsal carina; sculpture on tergite IV similar, but with main facade broader and having more (and larger) pits, while ventral end of lateral furrow recurved anterodorsally; non-articular surface of tergite V with raised parts less than depressed parts and mainly composed of an eroded cross at middle; tergite VI with median ridge bearing a pair of submedian spines, as well as strong spines at both anterior and posterior ends, posterolateral spine well-developed, lateral lobe terminated posteriorly by a strong spine and outer margin having 2-3 spines. Abdominal pleura ventrally pointed and with margins crenulated. Telson bearing 3 spinules at middle, with pair of elongate, submedian, basal spines and 2-3 large spines on dorsolateral ridges. Endopod of uropods covered with spinules and having a strong basal spine, exopod only with outer part spinulose. Posterolateral spines of telson and uropods all very well-developed.

COLORATION. — Body generally orange pink. Eyes dark brown. Anterior carapace somewhat pink. Large cheliped slightly banded with pale and deep orange bands. Distal 2/3 of fingers of large chelae and hinges of abdominal somites whitish.

SIZE. — The two males known are cl 34 mm and 50 mm.

DISTRIBUTION. — Only known near the Kai Islands in Indonesia, at depths of 443-560 m.

REMARKS. — *M. arafurensis* was originally described from a multilated specimen and no other material had been obtained since the original description. The finding of a complete specimen (although with left large cheliped smaller and probably regenerated) of this species by the KARUBAR cruise is therefore of particular importance.

The KARUBAR male is almost identical with the type (condition good except for original damage), except that the right post-rostral carina bears only four teeth (actually the fifth post-rostral tooth is rather small and situated more medially than the anterior teeth). Aside from lacking pits on the raised parts near the dorsal carina, the sculpture of the anterior three abdominal somites of the KARUBAR male is very similar to that of the type. Although no illustration was given by DE MAN (1916) of the posterior abdomen, a broken abdominal somite IV and the left third of somite V are present in the type. They are also very similar to those of the KARUBAR male and only differ in the arrangement of pits on the raised parts.

Many authors (eg. BRUCE, 1966; JENKINS, 1972; CHAN & YU, 1987; HOLTHUIS, 1991) suspected that *M. arafurensis* is most similar to *M. australiensis*. Indeed the spinulation of the carapace is almost identical between these two species, with only the spines being relatively more well-developed and the post-rostral carina sometimes bearing one more, small tooth in *M. arafurensis*. However, the large cheliped and abdominal sculpture of *M. arafurensis* are very different to those of *M. australiensis*. The presence of spinules on the exopods of the uropods and the middle of the telson also separate the former species from the latter.

The spinulose large cheliped and complicated abdominal sculpture of *M. arafurensis* show close resemblance with the fossil species *M. motunauensis* Jenkins, 1972, from the late Pliocene of New Zealand. The large chelipeds appear to be almost identical in these two species. The spinulation of the carapace and of the tail fan are also very similar, except that the entire posterior margin of the cervical groove is spinulose in *M. motunauensis*.

Although *M. motunauensis* seems to have fewer spinules on the posterodorsal carapace and tail fan, these spinules may well be eroded and become indistinct in fossils. The clearest difference between *M. arafurensis* and *M. motunauensis* is of the abdominal sculpture. Although the basic patterns of sculpture are similar [although JENKINS (1972) mentioned a difference in the shape of the lateral longitudinal furrows actually similarly arched dorsally in both species], the transverse furrows of *M. motunauensis* are narrow, as in most of the other species of the genus. However, the transverse furrows are very broad in *M. arafurensis* with the abdominal tergites IV and V having many pits and that of the latter even largely depressed. Furthermore, the median ridge of abdominal tergite VI bears three pairs of submedian spines in *M. motunauensis*, but the two anterior pairs of spines are represented by a single, large spine in *M. arafurensis*.

M. arafurensis seems to be very rare as only one specimen was obtained by the intensive samplings of the KARUBAR cruise and the specimen was collected from almost the same location and depth as the type.

Metanephrops australiensis (Bruce, 1966)

Fig. 2 d-e, 3, 4 b

Nephrops australiensis Bruce, 1966b: 245; pls 25-27 (type-locality: NW Australia).
Metanephrops australiensis - JENKINS, 1972: 171. — CHAN & YU, 1987: 184. — HOLTHUIS, 1991: 68, figs 134-135.

MATERIAL EXAMINED. — **Australia**. *"Umitaka Maru"*: N.E. of Port Hedland, 17°05'S, 119°48'E, 434 m, 26.11.1964: 1 ovig. ♀ 51.8 mm paratype (RMNH-D21151).

N.W. Shelf. 18°19'S, 117°49'E, 414 m, 25.2.1985: 1 ♂ 50.6 mm (NTOU, CSIRO in exchange). — 16°31'S, 120°16'E, 440 m, 28.8.1986: 4 juv. 19.4-21.5 mm (NTOU, CSIRO in exchange). — 16°32'S, 120°25'E, 440 m, 30.8.1986: 1 ♂ 57.2 mm (NTOU, CSIRO in exchange).

Indonesia. KARUBAR. *Kai Islands:* stn CP 35, 06°08'S, 132°45'E, 390-502 m, 27.10.1991: 1 juv. 11.1 mm (MNHN).

Philippines. *"Albatross"*: stn D5290, 13°40'09"N, 120°55'30"E, 391 m, 22.2.1908: 2 ♀ 31.8-35.3 mm (USNM 170461).

REMARKS. — It is interesting that the present species was supposed to be endemic to NW Australia (at depths of 418-500 m), but is now found in Indonesia. Although the specimen collected by the KARUBAR cruise is a small juvenile, it has the typical abdominal sculpture of the species, except for lacking distinct pits. However, its posteriormost post-rostral teeth are situated more medially and the posterior region between the post-rostral carinae bears more spinules. Moreover, the exopods of the uropods, as well as the middle and lateral parts of the telson, bear some spinules. These spinules are always absent in larger specimens (i.e. from cl 19.1 mm onwards). The fingers are also slightly longer than the palm (1.1 times) in the juvenile. Nevertheless, all these different characters in juveniles may merely represent the ancestral relationships between *M. australiensis* and *M. neptunus*.

The northward distribution of *M. australiensis* actually reaches as far as the Philippines. The *Metanephrops* collection in the USNM has a lot of two females obtained by the *"Albatross"* from the Philippines (USNM 170461) very similar to the present species. The only difference between the two Philippine specimens and the material of Australia (NTOU and RMNH) is that the lateral abdomen possess rudimentary longitudinal furrows. These longitudinal furrows on abdominal tergites II and III are quite distinct (though very shallow) in the smaller female (fig. 4e). Furthermore, the intermediate, eroded carinae within the transverse furrows of abdominal tergite II are very distinct in this female and the large chelae are slightly more granulate in the Philippine specimens. Nevertheless, since specimens from Australia sometimes also have rudimentary longitudinal furrows laterally on the abdomen (fig. 4d) and since these furrows are intermediately developed in the other female from the Philippines, it does not seems necessary to treat the Philippine material as a different species.

M. australiensis nonetheless mainly occurs in NW Australia. The extensive sampling in the Philippine-Indonesian region by many large expeditions has so far only obtained three specimens of this species (i.e. one juvenile by the KARUBAR cruise and two females by the *"Albatross"*).

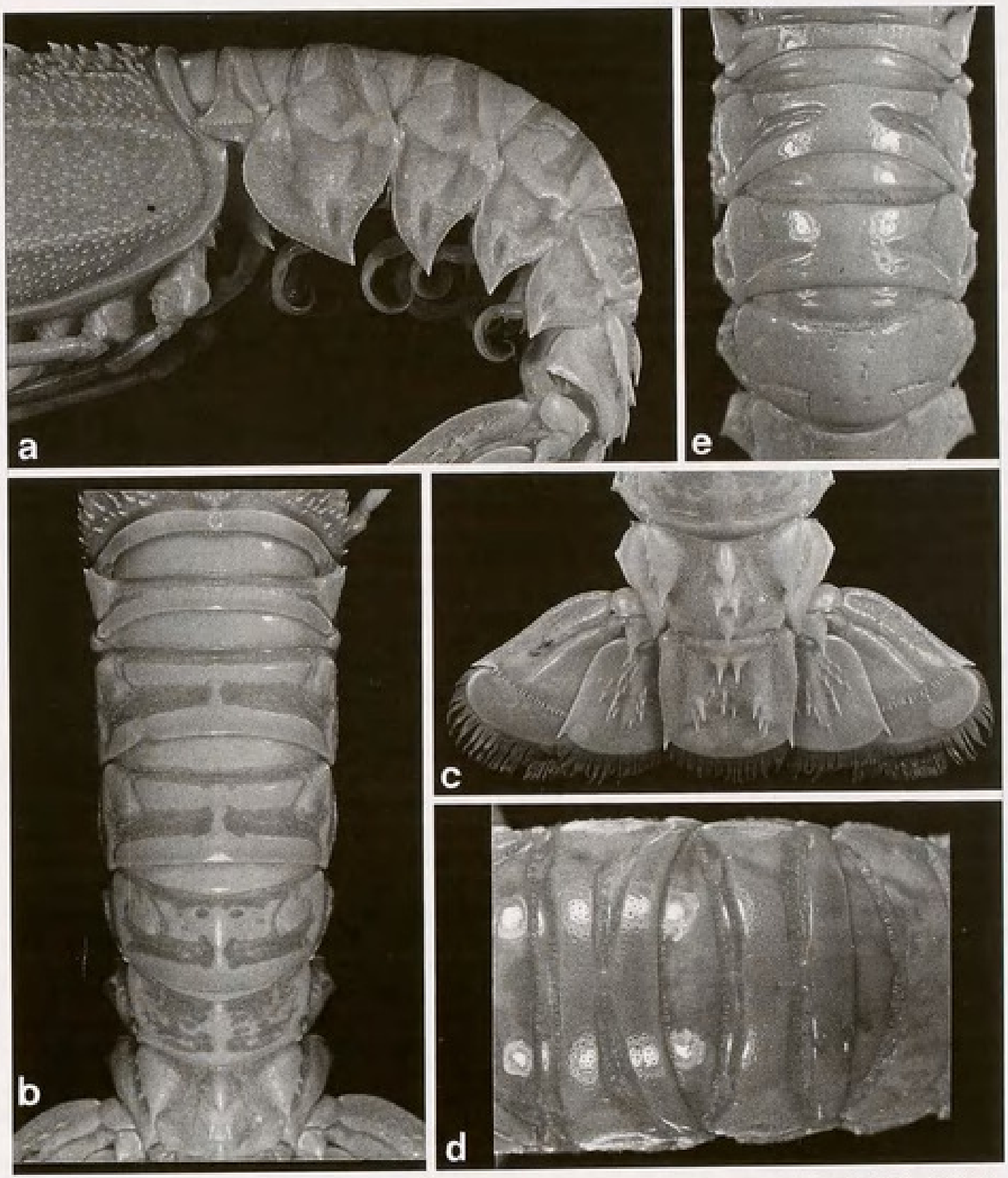

FIG. 2 a-c. — *Metanephrops arafurensis* (de Man, 1905), Indonesia, Tanimbar Islands, 7°46'S, 132°31'E, 443-468 m, ♂ 50.7 mm (MNHN): **a**, lateral view of abdomen; **b**, dorsal view of abdomen; **c**, dorsal view of posterior abdominal somites and tail fan.

FIG. 2 d-e. — *Metanephrops australiensis* (Bruce, 1966): **d**, NW Australia, 18°19'S, 117°49'E, 414 m, ♂ 50.6 mm (NTOU, CSIRO in exchange): dorsal view of abdominal tergites II and III. — **e**, The Philippines, 13°40.09'N, 120°55.3'E, 392 m, ♀ 31.8 mm (USNM 170461): dorsal view of abdominal tergites I-IV.

Metanephrops neptunus (Bruce, 1965)

Fig. 3, 4 b, 5 c-d

Nephrops neptunus Bruce, 1965: 274, pls 13-15 (type-locality: South China Sea).
Metanephrops neptunus - JENKINS, 1972: 171. — CHAN & YU, 1987: 184. — MACPHERSON, 1990: 299. — HOLTHUIS, 1991: 76, figs 148-149.

MATERIAL EXAMINED. — **South China Sea**. *"Cape St. Mary"*: stn 26, 19°25.5'-19°22'N, 114°07.5'-114°11'E, 732-795 m, 7.1.1964: 1 ♂ 59.0 mm allotype (RMNH-D21152).
Tungsha Tao (or Pratas), coll. Taiwan Fisheries Research Institute, Keelung: 1 spec.
Philippines. *"Albatross"*: stn 5423, 09°38.3'N, 121°11'E, 929 m, 31.3.1909: 1 ♀ 42.0 mm (USNM 170451).
Indonesia. KARUBAR. *Kai Islands*: stn CP 20, 05°15'S, 132°59'E, 769-809 m, 25.10.1991: 1 ♂ 87.1 mm (MNHN).
Tanimbar Islands: stn CP 38, 07°40'S, 132°27'E, 620-666 m, 28.10.1991: 1 juv. 15.3 mm (MNHN).
CORINDON 2: stn 214, Makassar Strait, 00°31.4'N, 117°50.1'E, 595 m, 1.11.1980: 1 spec. (MNHN-AS 257).
Australia. N.W. Shelf, 18°19'S, 117°49'E, 414 m: 2 ♂ 26.0-69.0 mm, 1 ovig. ♀ 71.6 mm, 1 ♀ 36.5 mm (NTOU, CSIRO in exchange).

REMARKS. — *M. neptunus* has been reported in Indonesia by MACPHERSON (1990), from Makassar. As mentioned by BRUCE (1965), the anterior transverse furrows of the abdominal tergites II and III are rather variable in this species. These furrows can be as long as the posterior transverse furrows (i.e. in the two large specimens of the KARUBAR and the Makassar specimen) or have the submedian parts variably raised and fused with the main facades [i.e. in the types, the specimen from Tungsha Tao, the specimen from the Philippines, the small specimen from KARUBAR and some specimens from Australia (WADLEY & EVENS, 1991 and specimens in NTOU)]. The red colour of the body also varies a lot in different individuals. Some have the body nearly all red (i.e. the female from KARUBAR, which has only the abdominal somites I to IV whitish, fig. 5 c) while some others are mainly white (i.e. the Australian specimen in WADLEY & EVANS, 1991). Half red and half white individuals can also be found (eg. the types, specimens from Tungsha Tao, Makassar, and the KARUBAR male, fig. 5 d). Since no correlation is found between colour patterns, shape of the anterior transverse furrows on the abdomen, localities, depth and sexes, they probably represent natural variations of the species.

Apart from its huge size and presence in deeper waters, the general appearance of *M. neptunus* rather differs from all the other species of the genus [eg. smaller eyes, only two lateral post-cervical ridges, large chelae with fingers considerably longer (1.3-1.5 times) than palm, each of abdominal tergites II to V bearing two transverse furrows, etc.]. The small juvenile obtained by the KARUBAR cruise already has all these "aberrant" characteristics. Thus, although juveniles of *M. australiensis* show some resemblances with *M. neptunus*, they can be readily distinguished from each other.

Although *M. neptunus* is widely distributed from the South China Sea to western Australia (at depths of 300-940 m and usually more than 500 m) and has a very large size (body length reaching 25 cm in HOLTHUIS, 1991), it is nowhere abundant. This may perhaps be due to this species inhabiting rather deep waters and suitable fishing grounds not having been located.

Metanephrops sibogae (de Man, 1916)

Fig. 3, 4 b

Nephrops sibogae de Man, 1916: 102, pl. 4-fig. 18 (type-locality: Indonesia). — YALDWYN, 1954: 730.
Metanephrops sibogae - JENKINS, 1972: 171. — CHAN & YU, 1987: 184. — HOLTHUIS, 1991: 79, figs 154-155. — GRIFFIN & STODDART, 1995: 232

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Tanimbar Islands*: stn CP 62, 09°01'S, 132°42'E, 246-253 m, 1.11.1991: 9 ♀ 24.0-43.6 mm (MNHN). — Stn CP 78, 09°06'S, 131°24'E, 295-284 m, 3.11.1991: 4 ♂ 34.7-54.4 mm, 1 ovig. ♀ 37.2 mm, 3 ♀ 18.6-45.8 mm, 2 juv. 13.3-13.8 mm (MNHN). — Stn CP 79, 09°16'S, 131°22'E, 250-239 m, 3.11.1991: 3 ♂ 20.5-49.9 mm, 5 ♀ 15.9-33.4 mm (MNHN). — Stn CP 83, 09°23'S, 131°E, 285-297 m, 4.11.1991: 4 ♂ 18.2-42 mm, 1 ♀ 33.8 mm (POLIPI).

REMARKS. — *M. sibogae* is very similar to *M. boschmai* (Holthuis, 1964) but is generally considered to differ in the inner margin of the merus of the large cheliped lacking large spines (HOLTHUIS, 1964, 1991; CHAN & YU, 1987). However, 1-3 large spines are found on the merus of the large cheliped in 23 of the 32 specimens collected by the KARUBAR cruise. Therefore, the use of the spinulation on the large chelipeds to separate these two species is not at all satisfactory. Nevertheless, a direct comparison of some *M. boschmai* specimens from western Australia (NTOU and 6 paratypes at RMNH) shows that several constant differences can be found between the two species (see also GRIFFIN & STODDART, 1995).

The posterior margin of the hepatic groove always bears 4-6 spinules in *M. boschmai*, while these spinules are lacking in all the *M. sibogae* specimens examined. Furthermore, there are 1-5 additional spinules present around the dorsal postorbital spines in *M. boschmai* and these spinules are usually absent in *M. sibogae* (only two specimens have an additional spinule on one side of the carapace). The paired spines on the dorsal post-cervical ridge are well-separated in *M. boschmai*, but abutting in *M. sibogae*. The median ridge of abdominal tergite VI is generally armed with a pair of submedian spines in *M. boschmai*, but only a single median spine in *M. sibogae*. Very rarely (2/32) an additional pair of posterior submedian spinules may be present in *M. sibogae* (as shown in DE MAN, 1916: pl. 6-fig. 18) though these are always smaller than the median spine. On the other hand, the median ridge of abdominal tergite VI may occasionally lack distinct spines in both species. As mentioned by HOLTHUIS (1946) the distal segment of maxilliped III is more oval in *M. boschmai* (1.8-2.04 times as long as broad in *M. boschmai* and 2.6-3.2 times as long as broad in *M. sibogae*). The shape of the scaphocerite, however, is not very different between the two species as described by HOLTHUIS (1964). The large chela is weakly ridged and granular (sometimes rather sharp) in adults of *M. sibogae*, but always rounded and very finely granular in *M. boschmai*. Other than inhabiting different regions (i.e. *M. sibogae* occurs from southern Indonesia to northern Australia at depths of 246-320 m, while *M. boschmai* is restricted to western Australia at similar depths), the two species have very different coloration (see WADLEY & EVANS, 1991). *M. sibogae* is rather uniformly orange-pink. The colour of *M. boschmai* is much attractive: Its body is also orange-pink but the posterior margins of each abdominal tergite and tailfan are whitish, while the large chela has the fixed finger red, but the movable finger whitish. Furthermore, the postorbital margin is deep red in some small specimens of *M. boschmai*.

The abdomen is generally smooth in the present species. However, sometimes rudimentary, transverse, as well as longitudinal, grooves, or rows of shallow pits, may be present on the abdomen (also present in *M. boschmai*, but usually even less distinct).

Metanephrops velutinus Chan & Yu, 1991

Fig. 3, 4 b, 5 a

Metanephrops velutinus Chan & Yu, 1991: 35, pls 2b, 4b, 6c, 8a, c-d (type-locality: the Philippines). — HOLTHUIS, 1991: 82, figs 160-161. — GRIFFIN & STODDART, 1995: 233.

MATERIAL EXAMINED. — **Indonesia**. KARUBAR. *Kai Islands*: stn CC 10, 05°21'S, 132°30'E, 329-389 m, 23.10.199: 2 ♂ 35.7-48.6 mm, 1 ovig. ♀ 51.9 mm, 1 ♀ 37.2 mm (MNHN). — Stn CP 12, 05°23'S, 132°37'E, 436-413 m, 23.10.1991, 1 ♂ 44.8 mm (MNHN). — Stn CP 34, 06°09'S, 132°41'E, 435-445 m, 27.10.199: 4 ♂ 26.7-49.1 mm, 1 ovig. ♀ 47.9 mm, 2 ♀ 32.5-56.4 mm (MNHN).

Tanimbar Islands: stn CC 40, 07°46'S, 132°31'E, 443-468 m, 28.10.1991: 2 ♂ 43.7-56.4 mm (POLIPI). — Stn CC 41, 07°45'S, 132°42'E, 401-393 m, 28.10.1991: 5 ♂ 18.1-55.3 mm, 1 ovig. ♀ 47.5 mm, 1 ♀ 55.1 mm (MNHN). — Stn CC 42, 07°53'S, 132°42'E, 354-350 m, 28.10.1991: 3 ♂ 36.0-40.8 mm, 2 ovig. ♀ 49.1-50.8 mm, 2 ♀ 39.4-55.3 mm (MNHN). — Stn 59, 08°20'S, 132°11'E, 405-399 m, 31.10.1991: 1 ♂ 41.9 mm (POLIPI). — Stn CP 69, 08°42'S, 131°53'E, 356-368 m, 2.11.1991: 3 ♂ 35.5-46.5 mm, 2 ♀ 38.6-39.9 mm (POLIPI).

REMARKS. — The present species was only recently described by CHAN and YU (1991) from the Philippines and western Australia, where it was previously mistaken for *M. andamanicus* (Wood-Mason, 1891). The 34 specimens collected by the KARUBAR cruise in southeastern Indonesia all have the raised parts of the abdomen coarse and pubescent. The record of *M. andamanicus* by DE MAN (1916) from the other side of Indonesia was suspected to represent the present species (CHAN & YU, 1991). However, a re-examination of DE MAN's (1916) specimen [*"Siboga"*: stn 12, Java Sea, 07°15'S, 115°15.6'E, 289 m, 14.3.1899: 1 ♂ 44.9 mm (ZMA)] revealed

that the raised parts of its abdomen are naked and smooth. The *Metanephrops* collection of the USNM also contains two *M. andamanicus* specimens from the Java Sea [Cruise 684, Java Sea, 08°34'S, 114°36'E, 322 m, 22.6.1981: 1 ♂ 34.0 mm, 1 ♀ 50.0 mm (USNM 456448)]. Thus, it is possible that *M. andamanicus* has a distribution from the Indian Ocean to the western part of Indonesia, while *M. velutinus* occurs from the Philippines down to the eastern part of Indonesia and western Australia (at depths of 238-702 m). Material from intermediate localities, such as the Flores and Banda Seas, will probably provide more insights to the exact distribution of these two, closely related species. This species was found recently in the Torres Strait.

NOTES ON THE RELATIONSHIPS OF THE SPECIES OF *METANEPHROPS*

The discovery that the poorly known species *M. arafurensis* is very similar to the single fossil species of the genus, *M. motunauensis*, along with improved knowledge of the species of *Metanephrops* in recent years (CHAN & YU, 1987, 1991, MACPHERSON, 1990), allow a brief revision of the relationships between the species of this genus.

The number of species (including the fossil species) of *Metanephrops* has been increased from 14 to 18 since its erection in 1972. Generally, members of this genus are divided into four groups (DE MAN, 1916; YALDWYN, 1954; JENKINS, 1972; CHAN & YU, 1987; HOLTHUIS, 1991). The *"japonicus"* group has the carapace smooth, abdomen conspicuously sculptured and the large chela bearing prominent, spinulated ridges. The *"binghami"* group has the carapace finely granulate, abdomen smooth but the large chela with prominent spinulate ridges. The *"arafurensis"* group has the carapace spinulose, abdomen with conspicuous furrows and the large chela variably ridged. The *"thomsoni"* group has the carapace smooth, abdomen weakly sculptured or smooth, and the large chela also weakly ridged to smooth.

The division of the genus into these four groups appears to be valid for the 18 species known at present:

The *"japonicus"* group. — *M. japonicus* (Tapparone-Canefri, 1873), *M. andamanicus* (Wood-Mason, 1891), *M. sagamiensis* (Parisi, 1917), *M. formosanus* Chan & Yu, 1987, *M. mozambicus* Macpherson, 1990, *M. armatus* Chan & Yu, 1991, and *M. velutinus* Chan & Yu, 1991.

The *"binghami"* group. — *M. rubellus* (Moreira, 1903) and *M. binghami* (Boone, 1927).

The *"arafurensis"* group. — *M. arafurensis* (de Man, 1905), *M. neptunus* (Bruce, 1965), *M. australiensis* (Bruce, 1966) and *M. motunauensis* Jenkins, 1972.

The *"thomsoni"* group. — *M. thomsoni* (Bate, 1888), *M. challengeri* (Balss, 1914), *M. sibogae* (de Man, 1916), *M. boschmai* (Holthuis, 1964) and *M. sinensis* (Bruce, 1966).

However, the spines and ridges on the large chela are rather small and weak in some species of the "*japonicus*" group, such as *M. velutinus* and *M. formosanus*. The abdomens of *M. mozambicus* and *M. formosanus* lack a distinct dorsal carina and have the sculpture rather simple (CHAN & YU, 1987, 1991). On the other hand, the large chela in some species of the "*thomsoni*" group is somewhat granulate-ridged (e.g. *M. sibogae*) or has large spines (e.g. *M. thomsoni*). Moreover, distinct transverse furrows are present on the abdomen of *M. sinensis* and *M. thomsoni*. Within the "*arafurensis*" group, the abdominal sculpture can be very complicated (e.g. *M. neptunus* and *M. arafurensis*) or rather simple (e.g. *M. australiensis*) while the large chela may be heavily spinulose (e.g. *M. neptunus*) or nearly smooth (e.g. *M. australiensis*).

The spinulation of the carapace, however, appears to be quite constant in separating the species groups of *Metanephrops*. The *"arafurensis"* group has the carapace uniformly spinulose. The *"binghami"* group has the carapace rather smooth but the entire posterior margins of both the hepatic and cervical grooves are spinulose. The carapaces of the *"japonicus"* and" *thomsoni*" groups are smooth, with the posterior margins of the cervical grooves not serrated. Moreover, the ridging of the large chela appears to have two, somewhat different, forms regardless of the degree of development of spines on it. In the "*japonicus*" and "*binghami*" groups, both the dorsolateral and ventrolateral margins of the large chela are strongly ridged, making the outer border of the chela a flat surface (that of the "*japonicus*" group also has a longitudinal, medial depression). On the other hand, the outer border of the large chela in the "*arafurensis*" and "*thomsoni*" groups is always angular. Although there are large differences in the complexity of the abdominal sculpture amongst the species of the *"japonicus"* and *"arafurensis"* groups, the

furrows on the abdomen are always distinctive in these two groups. Moreover, distinct longitudinal furrows are present in the *"japonicus"* group, while the *"arafurensis"* group usually has some large pits on the abdomen (not clear in the fossils of *M. motunauensis*). The abdomens of some species of the *"thomsoni"* group are sculptured, but only narrow transverse furrows are present, without large pits on tergites. It should also be noted that the uropods of the *"arafurensis"* group are unique in being spinulose. Thus, the definitions of the four species groups are modified as follows:

***"Arafurensis"* group.** — Carapace uniformly spinulose. Large chela moderately to weakly ridged and from spinulose to finely granulate, outer border always angular. Abdomen conspicuously sculptured, with or without deep longitudinal furrows but always bearing some large pits at least in adults (not clear in the fossil species *M. motunauensis*). Dorsal surface of uropods spinulose.

***"Japonicus"* group.** — Carapace generally smooth, only bearing some spines on anterior and dorsal parts, posterior margin of cervical groove not serrated. Large chela ridged and sharply tuberculate to spinulose, outer border somewhat flat, with a longitudinal medial depression. Abdomen conspicuously sculptured and with deep longitudinal furrows. Uropods unarmed dorsally.

***"Binghami"* group.** — Carapace generally smooth, but entire posterior margins of hepatic and cervical grooves spinulose. Large chela ridged and spinulose, with outer border flat. Abdomen not sculptured and uropods unarmed dorsally.

***"Thomsoni"* group.** — Carapace generally smooth except for some spines on anterior and dorsal parts. Large chela smooth to weakly ridged, bearing a few large spines; outer border always angular. Abdomen smooth or bearing only narrow, transverse furrows. Uropods unarmed dorsally.

Since the distinguishing characters previously used for some species are also found to be unsatisfactory (e.g. *M. sibogae* vs. *M. boschmai* and *M. thomsoni* vs. *M. sinensis*, etc.), a revised key to the species of *Metanephrops* is provided:

1. Carapace rather uniformly spinulose; dorsal surface of uropods covered with spinules ..... **2** (*"arafurensis"* group)
— Carapace smooth between ridges and large spines; uropods unarmed dorsally **5**

2. Region between post-rostral carinae heavily spinulose; abdominal tergites II to V each with two transverse furrows; large chelae with fingers distinctly longer than palm ..... *M. neptunus*
— Region between post-rostral carinae only bearing some spinules on posterior part; abdominal tergites II to V each with one transverse furrow; large chelae with fingers shorter than palm **3**

3. Abdomen lacking deep longitudinal furrows; large chelae finely granular or nearly smooth. ..... *M. australiensis*
— Abdomen with deep longitudinal furrows; large chelae sharply tuberculate **4**

4. Posterior margin of cervical groove not serrated; transverse furrows on abdominal tergites more or less as wide as main facades ..... *M. arafurensis*
— Posterior margin of cervical groove entirely spinulose; transverse furrows on abdominal tergites much narrower than main facades ..... *M. motunauensis* (fossil species)

5. Posterior margin of cervical groove entirely spinulose ..... **6** (*"binghami"* group)
— Posterior margin of cervical groove not serrated **7**

6. Spinules present between post-rostral carinae; abdominal tergites III to V bearing distinct lateral spines; dorsolateral post-cervical ridge nearly smooth ..... *M. rubellus*
— Spinules absent between post-rostral carinae; abdominal tergites III to V without lateral spines; dorsolateral post-cervical ridge spinulose ..... *M. binghami*

7. Abdomen bearing distinct transverse and longitudinal furrows; large chelae distinctly ridged, with outer borders flat ..... **8** (*"japonicus"* group)
— Abdomen smooth or having only narrow transverse furrows; large chelae smooth or weakly ridged, with outer border angular ..... **14** (*"thomsoni"* group)

8. Abdominal tergite V bearing distinct lateral spines; median ridge of tergite VI dorsally armed with paired spines **9**
— Abdominal tergite V without distinct lateral spines; median ridge of tergite VI unarmed dorsally **10**

9. Raised parts of abdomen subdivided; abdominal tergite I bearing well-developed dorsal carina ..... *M. japonicus*
— Raised parts of abdomen smooth; abdominal tergite I lacking distinct dorsal carina ..... *M. armatus*

10. Large spines present on large chela; abdomen without dorsal carina ..... *M. formosanus*
— Large spines absent on large chela; abdomen bearing dorsal carina **11**

11. Post-rostral carinae usually with at least one side having 4-5 teeth; spine on lateral lobe of abdominal tergite VI long and nearly reaching posterolateral groove .... *M. sagamiensis*
— Post-rostral carinae never bearing more than 3 teeth; spine on lateral lobe of abdominal tergite VI short and with tip far from posterolateral groove **12**

12. Raised parts of abdomen coarse and pubescent ..... *M. velutinus*
— Raised parts of abdomen smooth and naked **13**

13. Abdomen with dorsal carina well-developed; main facades of abdominal tergites IV and V well-separated from dorsal carina, those of tergites II and III bearing posterior submedian notches ..... *M. andamanicus*
— Abdomen with dorsal carina almost leveled; main facades of abdominal tergites IV and V more or less fused with dorsal carina, those of tergites II and III with posterior submedian notches minute or absent ..... *M. mozambicus*

14. Abdomen bearing transverse furrows **15**
— Abdomen smooth **16**

15. Three postorbital spines present; large chela without large spines along inner margin but lateral margin of movable finger bearing bush of setae; abdominal tergite I usually having short, lateral, transverse furrows ..... *M. sinensis*
— 2 postorbital spines present; large chela generally bearing some large spines along inner margin, lateral margin of movable fingers naked; abdominal tergite I generally lacking distinct transverse furrows ..... *M. thomsoni*

16. Dorsal post-cervical ridge unarmed, except at anterior end ..... *M. challengeri*
— Dorsal post-cervical ridge spinulose **17**

17. Posterior margin of hepatic groove armed with spinules; large chela rounded; median ridge of abdominal tergite VI generally bearing a pair of submedian spines ... *M. boschmai*
— Posterior margin of hepatic groove devoid of spinules; large chela weakly ridged; median ridge of abdominal tergite VI generally bearing a median spine ..... *M. sibogae*

DEPTH AND GEOGRAPHICAL DISTRIBUTIONS OF THE SPECIES OF *METANEPHROPS*

Figures 3 and 4 show the known vertical and geographical distributions for the species of *Metanephrops*. Members of the *"japonicus"* group have the widest distribution in the Indo-West-Pacific. The *"binghami"* group is

restricted to the western Atlantic. Species of the *"thomsoni"* group mainly occur along the western periphery of the Pacific, from Japan to New Zealand. The *"arafurensis"* group has a similar, but more restricted, distribution in the Philippine-Australian region (with only the fossil species found in New Zealand). Since most of the species (11 out of 18) are present in the Indo-Malay region, the genus probably originated there. JENKINS (1972) is likely right in suggesting that the *"binghami"* group originated from the Indo-Malay region and migrated to the Atlantic through the Tethys, instead of reaching the Atlantic via southern Africa.

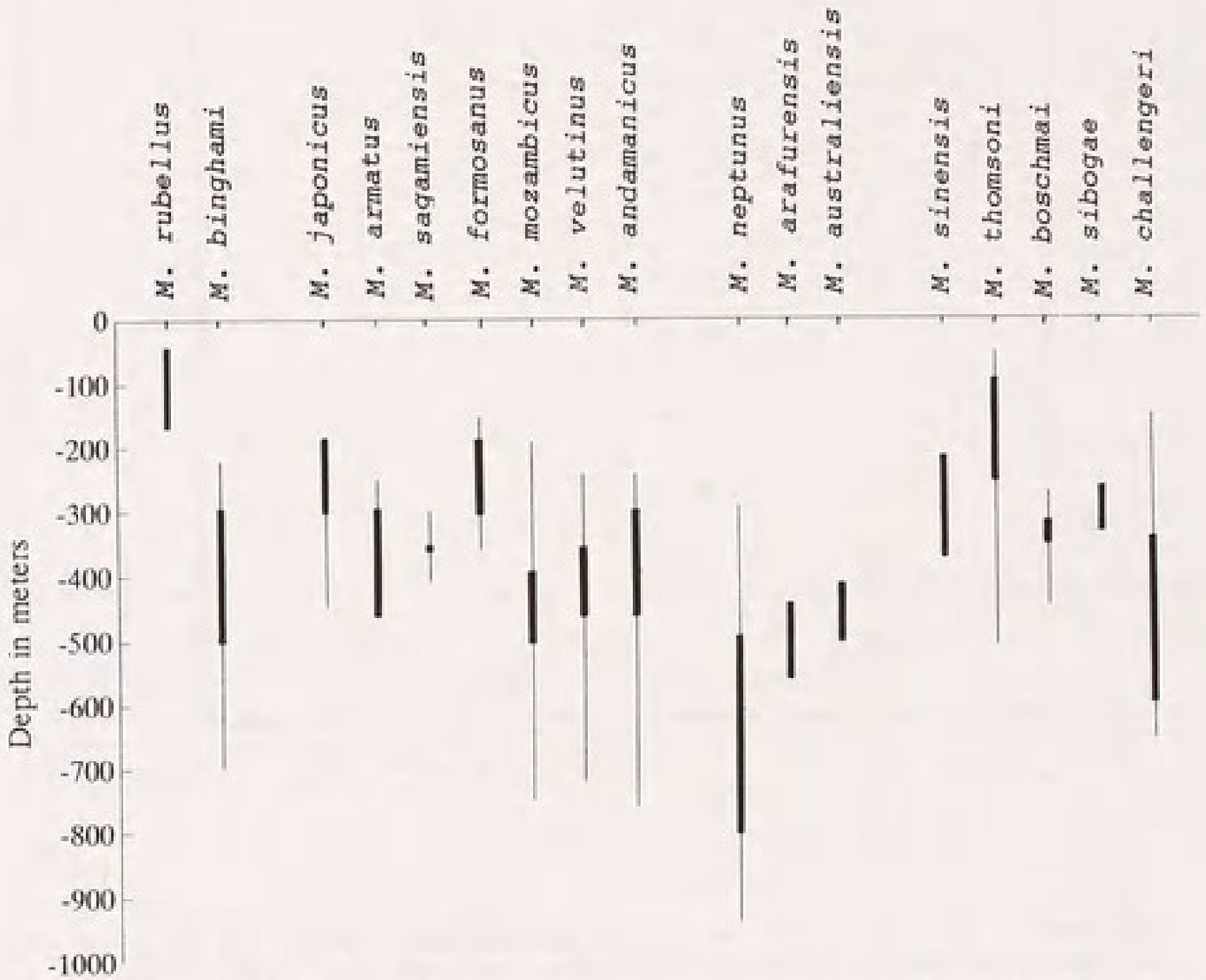

FIG. 3. — Vertical distribution of the extant species of *Metanephrops*. Thick bars represent main distribution of the species.

Amongst the four species groups, the *"japonicus"* group seems to be the most successful in terms of having the most species and spread to the other parts of the Indo-West-Pacific. As suggested by JENKINS (1972), the *"thomsoni"* group is probably the youngest, and therefore still has a limited distribution. However, I disagree with JENKINS (1972) when he suggests that members of the *"thomsoni"* group, by being rather abundant, are actively displacing species of the other groups north- and southwardly. It is now known that species of different groups are often found in the same region, and *M. australiensis*, as well as all the members of the *"japonicus"* group, also occur in large numbers, being exploited commercially (CHAN & YU, 1987, 1991; WADLEY & EVANS, 1991; HOLTHUIS, 1991). On the other hand, species of *Metanephrops* have rather clear vertical zonations. In the same

region, members of the *"thomsoni"* group are usually found in shallower waters and those of the *"arafurensis"* group in deeper waters, while species of the *"japonicus"* group occur in between the two (CARTER *et al.*, 1983; Anon., 1984; CHAN & YU, 1987, 1993; WALLNER & PHILLIPS, 1988).

FIG. 4 a. — Geographical distribution of the species of *Metanephrops* of the *"binghami"* group:▲: *M. binghami*; ●: *M. rubellus*.

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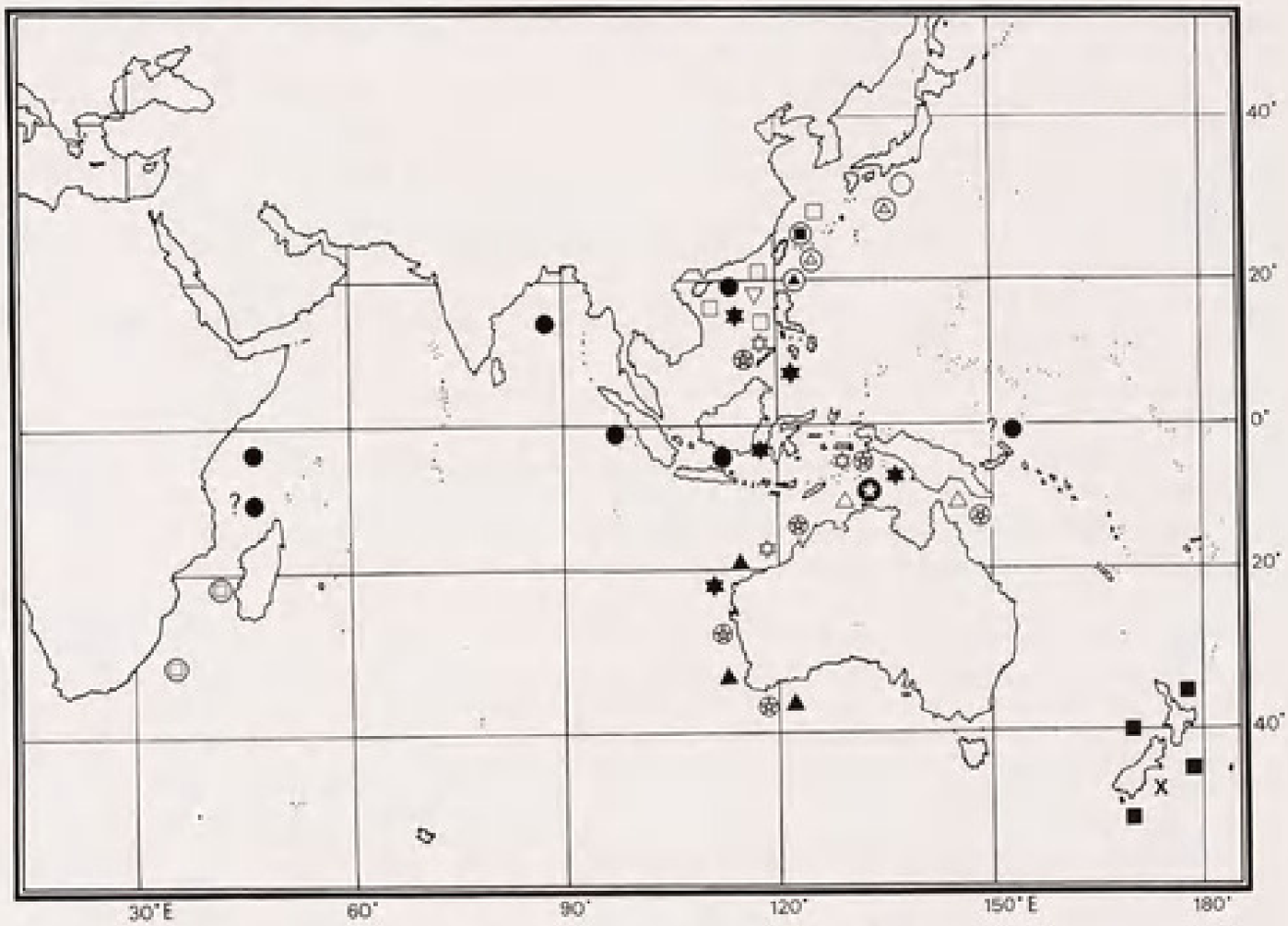

FIG. 4 b. — Geographical distribution of the species of *Metanephrops*

The *"japonicus group"* : ○: *M. japonicus*, ●: *M. andamanicus*, ◎: *M. sagamiensis*, ◉: *M. formosanus*, ◎: *M. mozambicus*, ■: *M. armatus*, ⊛: *M. velutinus*.
The *"arafurensis"* group : ✪: *M. arafurensis*, ✸: *M. neptunus*, ☼: *M. australiensis*, ✕: *M. motunauensis*.
The *"thompsoni"* group : □: *M. thomsoni*, ■: *M. challengeri*, △: *M. sibogae*, ▲: *M. boschmai*, ▽: *M. sinensis*.

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FIG. 5 a. — *Metanephrops velutinus* Chan & Yu, 1991. Indonesia, Tanimbar Islands, 7°46'S, 132°31'E, 443-468 m, ♂ (POLIPI).

FIG. 5 b. — *Metanephrops arafurensis* (de Man, 1905). Indonesia, Tanimbar Islands, 7°46'S, 132°31'E, 443-468 m, ♂ 50.7 mm (MNHN).

FIG. 5 c-d. — *Metanephrops neptunus* (Bruce, 1965): **c**, Indonesia. Kai or Tanimbar Islands, 1 ♀ 79.2 mm (POLIPI). — **d**, Indonesia. Kai Islands, 05°15'S, 132°59'E, 769-809 m, ♂ 87.1 mm (MNHN).