

Taxonomic Studies on Deep Water Lobsters from The Andaman Sea of Thailand

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ABSTRACT: The deep water lobster specimens from the Andaman Sea of Thailand collected from the Thai-Danish BIODEEP cruises “RV. Chakratong Tongyai” during 1996-2000, ‘M.V. SEAFDEC’ in 1994, ‘M.S. Dhanarajana’ in 1989 and ‘M.V. Paknam’ in 1987 were described and illustrated. They belong to the family Nephropidae: *Metanephrops andamanicus* (Wood-Mason, 1891) and *Nephropsis stewarti* Wood-Mason, 1873; family Palinuridae: *Linuparus trigonus* (Siebold, 1824); *Palinustus waguensis* Kubo, 1963 and *Puerulus sewelli* Ramadan, 1938. Future biodiversity research and study in the area need to be promoted.

KEY WORDS: Taxonomy, deep water lobster, Andaman Sea, Thailand.

INTRODUCTION

The Andaman Sea is part of the Bay of Bengal, the eastern Indian Ocean, and covers about 800,000 km². The Thai Economic Exclusive Zone (EEZ) comprises roughly 140,000 km², of which about three quarters lies within the 1,000 m depth contour, and the rest has maximum depths of 2,400 m. The slope is somewhat unusual, as it falls towards deeper water from the shelf break at about 200 m depth but has a further sharp step around 700 m depth, a phenomenon which is most strongly pronounced in the northern region (Nishida and Sivasubramaniam, 1986).

Biodiversity studies on the marine fauna along the west coast of Thailand are scattered and their coverage are in-

adequate. The fauna of the sandy and muddy bottoms was first investigated by the Fifth Thai-Danish Expedition in 1966, using the research vessel ‘M.S. Dhanarajana’ (Seidenfaden *et al.*, 1968). The expedition was successful in its scientific research programme, the training of groups of young Thai marine biologists, and in the creation of the nucleus for the comprehensive marine fauna reference collection for the latter established Phuket Marine Biological Center (PMBC). However only depth down to about 80 m were surveyed. Surveys at greater depth were conducted later, aiming at the evaluation of natural resources, e.g. the Thai-Japanese Joint Oceanographic and Fisheries Survey in 1981 at depths of 30-300 m, and topographic studies and deep sea trawling in 1987 and 1989 by the Southeast Asian

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Fisheries Development Center (SEAFDEC) at depths of 100-400 m.

After the establishment of the Phuket Marine Biological Center Reference Collection, biodiversity studies were continued, especially during 1980s (literature list in Aungtonya *et al.*, 2000; Hylleberg, 2001), including a quantitative programme (Chatananthawej and Bussarawit, 1987).

In deeper waters, a few investigations have been performed down to about 400 m. They partly aim at potential natural resources, which among the invertebrates are species of prawns and deep-sea lobsters such as appear from the Bay of Bengal Programme (Nishida and Sivasubramaniam, 1986), and at oceanographic conditions on fishing grounds in the Thai-Japanese Joint Oceanographic and Fisheries Survey in 1981 (Takahashi and Ruangsvakul, 1983) and the Southeast Asian Fisheries Development Center (SEAFDEC) studied in 1987 (Ananpongsuk, 1989).

In the last ten years, a number of surveys have been carried out, but most of these studies were confined to the biodiversity of marine national parks, coral reef ecosystem and the offshore Island (e.g. Carr, 1991; Janekarn and Kiørboe, 1991; Bussarawit, 1995). A number of new species and new records were reported and described, and type specimens have been deposited at the Reference Collection, Phuket Marine Biological Center (e.g. Nateewathana, 1990, 1995, 1997; Hylleberg and Na-

teewathana, 1991a, 1991b, Sirimontraporn and Bussarawit, 1993; Bruce and Bussarawit, 2004).

The Biodiversity of the Andaman Sea Shelf (BIOSHELF) and Biodiversity of Andaman Deep Sea project (BIO-DEEP) during 1996-2000 has been supported by the Scientific Cooperation Programme (SCP) between Denmark and Thailand in connection with the supply of the marine research vessel 'R.V. Chakratong Tongyai' from DANIDA to PMBC.

The objective of the project is to expand our general knowledge of the diversity of benthos at depth down to 1,000 m within the Thai EEZ and to provide additional specimens to be deposited in the PMBC Reference Collection. Apart from knowledge gained about the species present in the entire area, this information can be applied in the future sustainable use of yet undiscovered commercial species. In all cases, the results will be needed in studies of food chains and food availability in deep water, which also constitute major issues in fisheries biology.

This paper aims to study the deep water lobsters diversity collected from the 'BIODEEP' cruises, including specimens deposited in the PMBC Reference Collection.

MATERIALS AND METHODS

The deep water lobsters were obtained from bottom trawls of the 'R.V. Chakra-

tong Tongyai' BIOSHELF's cruises during 1996-2000 and M.V. Paknam of Southeast Asian Fisheries Development Center (SEAFDEC)'s cruises at depth range 100-400 m in 1987 and 1989. The collected materials were fixed in 10 % neutralized formalin and subsequently transferred to 75% ethyl alcohol. Taxonomic descriptions followed Holthuis (1965, 1991), Chan (1998), Chan and Yu (1991, 1995), Ramadan (1938). The studied specimens are deposited in the Reference Collection of Phuket Marine Biological Center, Phuket, Thailand.

SYSTEMATIC ACCOUNTS

Family Nephropidae Dana, 1852

Diagnosis: Body tubular, almost naked or covered with thick fur antennae very long and thread-like; first 3 pairs of legs ending in pincers, first pair greatly enlarged; tail fan entirely hardened.

Diagnostic characters: Moderate to

large size crustaceans. Body tubular, surface almost naked or covered with thick fur. Carapace (or head) with a well developed rostrum, ornamented with spines or nodules, occasionally smooth. Eyes usually well developed and black, or small and lacking pigmentation, or even absent. Antennae very long and thread-like; antennal scale, if present, with inner margin unarmed and curved. First 3 pairs of legs forming true pincers, with the first pair greatly enlarge and long. Both abdomen and tail fan well developed and powerful. Abdomen smooth or variously sculptured, pleura ending in acute ventral tooth. Tail fan entirely hardened, telson with fixed spines and posterior margin broadly convex.

Coloration: with the typical coloration of a deep sea crustacean from white to pink or red, some species with special marking (usually red and/or white) on body; setae or hairs are light brown.

Key to genera of the family Nephropidae (Chan, 1998).

- 1a. Eyes large and black; antennal scale present; body provided with some spines but never uniformly spinose *Metanephrops*
- 1b. Eye minute, cornea lacking pigmentation 2
- 2a. Antennal scale present; body more or less uniformly spinulose and not covered with soft pubescence..... *Acanthacaris*
- 2b. Antennal scale absent; body not uniformly spinulose but covered with thick pubescence *Nephropsis*

Key to species of the genus *Metanephrops* (Chan, 1998).

- 1a. Carapace rather uniformly spinulose; dorsal surface of uropods covered with spinules 2

- 1b. Carapace smooth between the ridge and large spines uropods unarmed dorsally.....4
- 2a. Abdominal segments each with 2 transverse grooves; large pincer with finger distinctly; longer than palm.....*M. neptunus*
- 2b. Abdominal segments each with 1 transverse groove only; large pincer with finger shorter than palm.....3
- 3a. Abdomen with deep longitudinal furrows; large pincer covered with sharp tubercles.....*M. arafurensis*
- 3b. Abdomen without distinct longitudinal furrows; larger pincer finely granular to nearly smooth.....*M. australiensis*
- 4a. Abdomen with distinct transverse and longitudinal grooves; large pincers distinctly ridged, with outer border flat.....5
- 4b. Abdomen smooth or with only narrow transverse grooves; large pincer smooth or weakly ridged, with outer border always angular.....6
- 5a. Elevated parts of abdomen naked and smooth*M. andamanicus*
- 5b. Elevated parts of abdomen coarse and pubescent*M. volutinus*
- 6a. Abdomen smooth, without grooves.....*M. sibogae*
- 6b. Abdomen with narrow transverse grooves7
- 7a. Two postorbital spines present; large pincers with inner margin naked but often bearing some large spines; first abdominal segment generally without distinct transverse grooves.....*M. thomsoni*
- 7b. Three postorbital spines present; large pincers without large spines, long inner margin, abdominal segment usually generally with short transverse grooves.....*M. sinensis*

Genus *Metanephrops* Jenkins, 1972
(Type species: *Nephrops japonicus*
Tapparone-Canefri, 1873)

All the tropical western Atlantic and Indo-West Pacific lobsters formerly assigned to the genus *Nephrops*, are now placed in *Metanephrops* (Holthuis, 1991). The known species of the genus now number 17, not including the fossil species.

Metanephrops andamanicus
(Wood-Mason, 1891)
 (Figures. 1a-d, 2)

Nephrops andamanicus Wood-Mason, 1891: pl. 4; Burukovski, 1983: 157
Nephrops thomsoni var. *andamanica* Alcock, 1901: 153

Metanephrops andamanicus Holthuis, 1984: 992; Chan and Yu, 1987: 535; Chan and Yu, 1991: 32-35.

Common name: Andaman lobster.

Materials examined: PMBC6814, lat. 6° 45.070'N, long. 97° 57.020'E, coll. A. Nateewathana, 20.3.1989, 4 specimens (32-52 mm carapace length); PMBC6815, lat. 6° 49.070'N, long.

97° 53.080'E, coll: A. Nateewathana, 20.3.1989, 3 specimens, (12-28 mm carapace length); PMBC6816, lat. 7° 01.790'N, long. 97° 53.890'E, coll: A. Nateewathana, 19.3.1989, 1 specimen (38 mm carapace length); PMBC6818, lat. 6° 41.070'N, long. 97° 58.020'E, coll: A. Nateewathana, 20.3.1989, 3 specimens (36-40 mm carapace length); PMBC6819, lat. 7° 34.040'N, long. 97° 44.040'E, coll: A. Nateewathana, 19.3.1989, 6 specimens (31-63 mm carapace length).

Diagnostic characters: Rostrum, with low and smooth dorsal carina, just exceeding to distinctly overreaching antennal peduncle. Always 3 pairs of post rostral teeth present. Supraorbital horns with dorsal margin slightly convex to almost straight, short but stout and reaching from 1/3 to 2/3 of eyes, generally directed upwards and outwards but sometimes parallel with rostrum and even slightly curving inwards. Carapace rather obese in large individuals. Spines and tubercles on carapace from well developed to small. Upper hepatic spine large or almost absent. Lateral postcervical ridges finely granular to almost smooth and with or without anterior spine.

Big chelae generally broad, from subequal to strongly asymmetrical, distinctly ridged and covered with sharp tubercles; inner margin of palm without large spines and outer base of movable finger sometimes with a small tubercle. Carpus of big cheliped generally bluntly tubercular in addition

to the presence of a few large spines which are mostly placed at the distal end and rarely are also present on the inner margin sharply granular to tubercular.

Articular surface of abdomen generally naked and smooth. Non-articular surface with broad to somewhat narrow but marked dorsal carina and shallow sculpture; raised parts naked and smooth while grooves broad but shallow. Tergite I somewhat with rudimentary dorsal carina at anterior 1/2 with transverse furrow broadly interrupted medially. Main facades of tergites II and III broad and with large to moderately large posteriorly submedian notches, anterior margin usually horizontal (rarely slightly oblique), anterolateral and posterolateral angles strongly projected laterally and sometime jointed with lateral facades (most often at II). Main facade of tergite IV well defined but rather longitudinally elongated and often with outer margin somewhat right angled. Posterior facades of tergites II to IV with small to large anterior submedian notches. Tergite V without lateral spine but sometimes with a minute tubercle, main facade generally broad and sometime with a minute tubercle, main facade generally broad and sometime with margin poorly defined. Median ridge at tergite VI dorsally smooth. Posteriorly directed spines at tergite VI and tail fan short (very short in large individuals), with those at lateral lobes of tergite VI far from the posterolateral grooves.

Coloration: Body generally orange-red. Eyes black-brown with golden reflections. Antennal and antennular flagella red. Orbital margin to base of supra-orbital horn and entire cervical groove covered with broad white bands (posterior half of rostrum also white in small individuals). Ventral part of carapace white and pink. Abdominal hinges white. Color at posterior borders of abdominal tergites deeper. Tail-fan also deeper colored but with posterior margin somewhat whitish. Big cheliped usually very slightly banded but sometimes distinctly banded with red and white in females. Pereiopods white or pink while pleopods are pink to pink-red.

Habitat, biology and fisheries: The habitat is hard mud at depths from 250

to 750 m, but mostly from 300 to 450 m. The lobsters live in burrows. Longhurt (1970) mentioned the species as a potential fishery resource off Hong Kong. It is possible that the same is true in other parts of its range. Its size and the fact that the species lives on trawable bottoms are in favour of this supposition (Holthuis, 1991).

Distribution: Indo-West Pacific from eastern Africa to the Andaman Sea, South China Sea, Indonesia, Papua New Guinea.

Remarks: The size of *M. andamanicus* is quite large and it has possibly a commercial potential. The coloration is distinct in the entire cervical groove being covered by a broad white band.

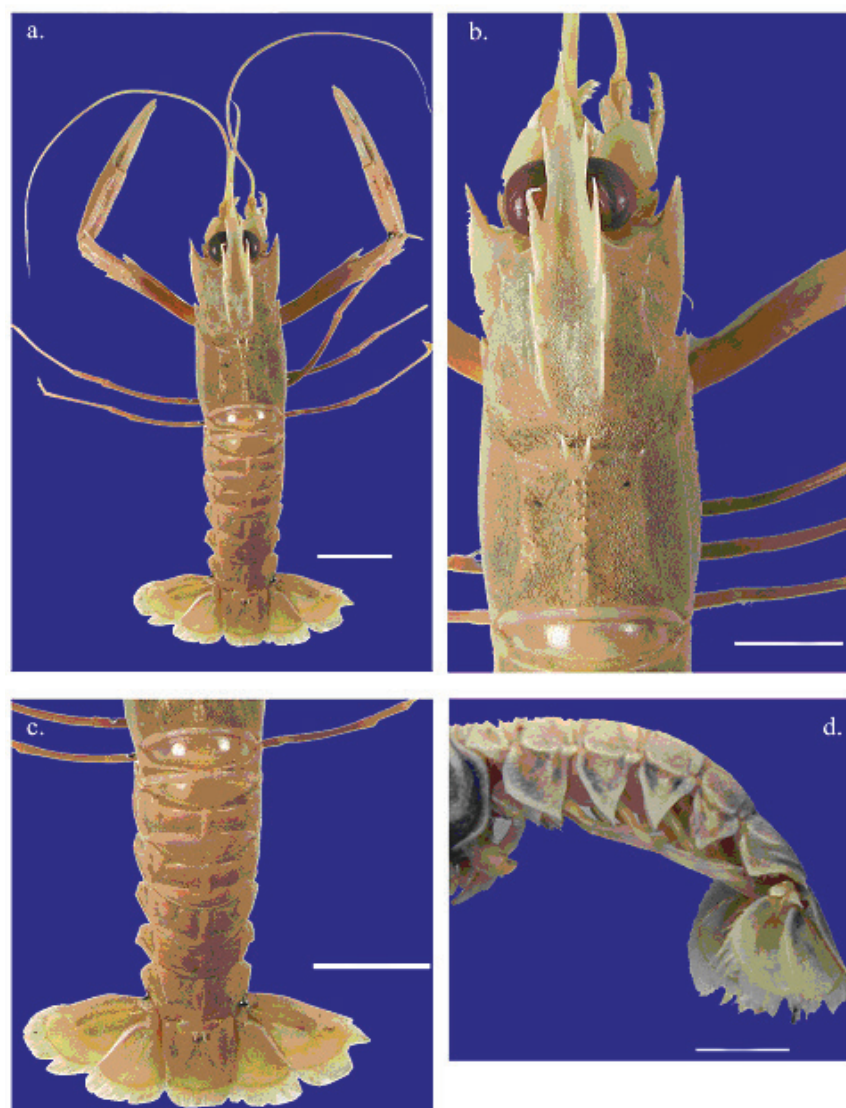


Figure 1. *Metanephrops andamanicus* (Wood-Mason, 1891)(PMBC 6818)

a. dorsal view

b. carapace (dorsal view)

c. abdomen (dorsal view)

d. abdomen (lateral view)

Scale bars: 1 cm.

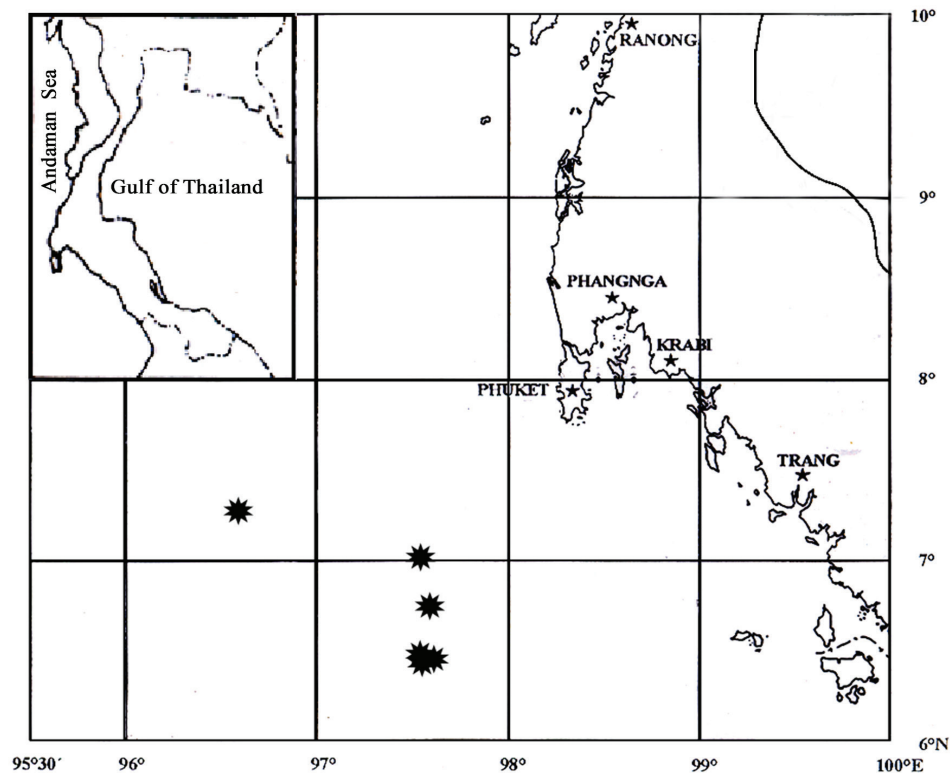


Figure 2. Distribution of *Metanephrops andamanicus* (Wood-Mason, 1891) from the Andaman Sea of Thailand.

Key to species of the genus *Nephropsis* (Chan, 1998).

- 1a. Rostrum without lateral teeth *N. ensirostris*
- 1b. Rostrum with lateral teeth 2
- 2a. Rostrum with 2 pairs of lateral teth..... 3
- 2b. Rostrum with 1 pair of lateral teth..... 4
- 3a. Abdomen with median longitudinal carina *N. sulcata*
- 3b. Abdomen without a median longitudinal carina..... *N. suhmi*
- 4a. Basal part of telson with an erect dorsal spine..... *N. acanthura*
- 4b. Basal part of telson without an erect dorsal spine..... 5
- 5a. Abdomen with a median longitudinal carina..... *N. holthuisi*
- 5b. Abdomen without a median longitudinal carina 6
- 6a. Subdorsal ridges of carapace spinose *N. serrata*
- 6b. Subdorsal ridges of carapace lacking spines..... *N. stewarti*

Genus *Nephropsis* Wood-Mason, 1873
(Type species: *Nephropsis stewarti*
Wood-Mason, 1873)

At present 13 species of the genus are known, 5 from the Atlantic, 7 from Indo-West Pacific, and one from the eastern Pacific region (Holthuis, 1991). None of this species are currently fished on a commercial scale, but some are of potential interest.

***Nephropsis stewarti* Wood-Mason,**
1873
 (Figures 3a-e, 4)

Nephropsis stewarti Wood-Mason,
 1873: 151; Holthuis, 1991: 45, fig.
 80.

Common name: Indian Ocean lobster.

Materials examined: PMBC6817, Andaman Sea, lat. 7° 34.040'N, long. 97° 44.040' E, trawl, 400 m, coll: A. Nanteewathana, 19.3.1989, 1 specimen (33 mm carapace length); PMBC17373, Andaman Sea, lat. 7° 21.125'N, long. 97° 26.322'E, trawl, 520-532 m, coll. S. Bussarawit and C. Aungtonya, 27.01.1999 (27-42 mm carapace length); PMBC16865, lat. 6° 46.000'N, long. 97° 33.000'E, trawl, 501-513 m, coll: C. Aungtonya and V. Vongpanich, 22.2.2000, 6 specimens (30-43 cm carapace length).

Diagnostic characters: a small to medium size lobster. Body cylindrical, covered with thick fur. Carapace with a well-developed rostrum armed with 1

pair of lateral spines; anterior carapace bearing only supraorbital and antennal spines; subdorsal ridges without spines. Eyes minute, cornea lacking pigmentation. Antennae long and thread-like; antennal scale absent. First 3 pairs of legs ending in pincers; First pair rather stout and very hairy. Abdomen without median longitudinal carina, all pleura sharply pointed ventrally but lacking spines on front edges. Tail fan entirely hardened; outer blade showing a transverse fissure; telson with a pair of fixed posterolateral spines but unarmed dorsally.

Coloration: body whitish and covered with thick grey fur. Anterior carapace including rostrum, ventral surface, mouth parts and tail fan pink-red. Antennal and antennular flagella orange. Legs orange-pink, with distal segments reddish; large pincers sometimes slightly orange. Eggs white.

Habitat, biology and fisheries: Mostly between 500 to 750 m depth on soft muddy substrate. A common bycatch of deep water trawling operations throughout its range. Although it is probably the largest and most common species of the genus, its quantity is too small for significant interest to fisheries at present.

Distribution: Indo-West Pacific region from the Gulf of Aden and East Africa to Japan, East India Archipelago, Andaman Sea, Bay of Bengal, Arabian Sea, African coast, off Natal, Taiwan, Philippines, Indonesia, and Western Australia.

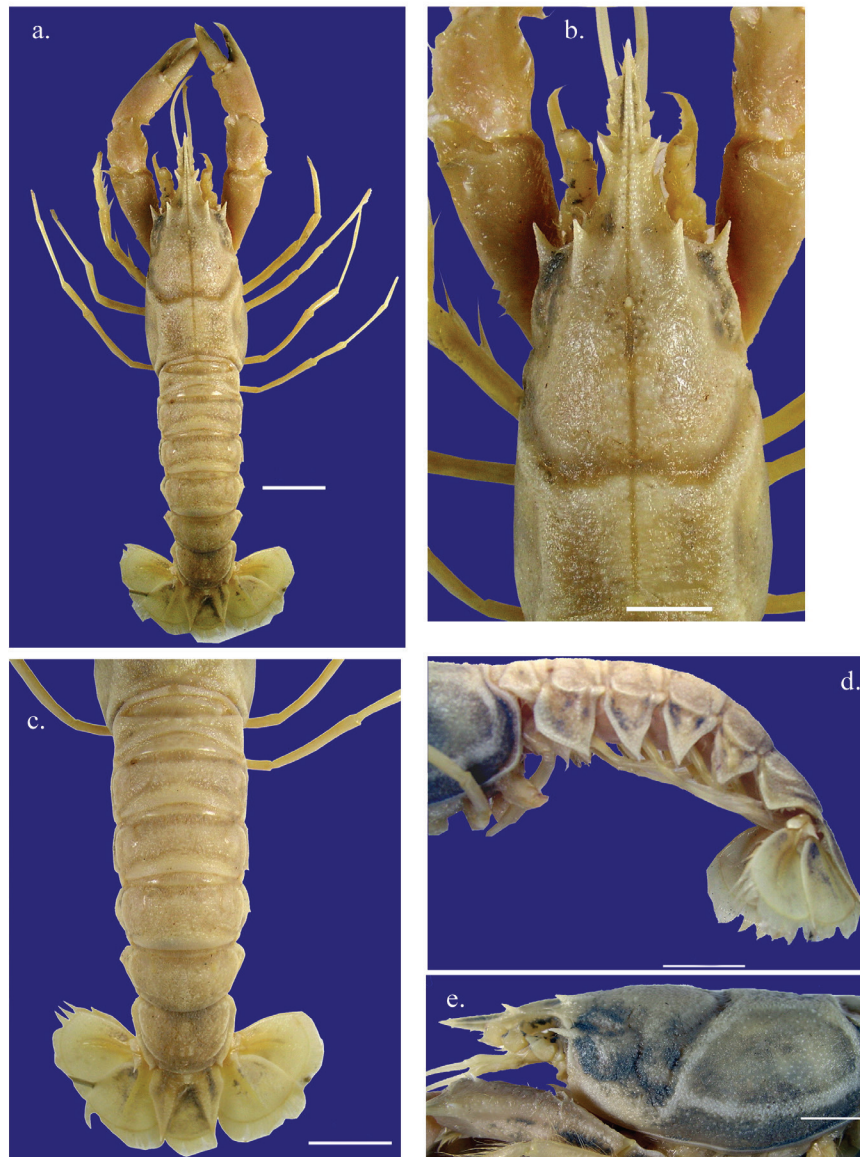


Figure 3. *Nephropsis stewarti* Wood-Mason, 1873 (PMBC 6817)

a. dorsal view

b. carapace (dorsal view)

c. abdomen (dorsal view)

d. abdomen (lateral view)

e. carapace (lateral view)

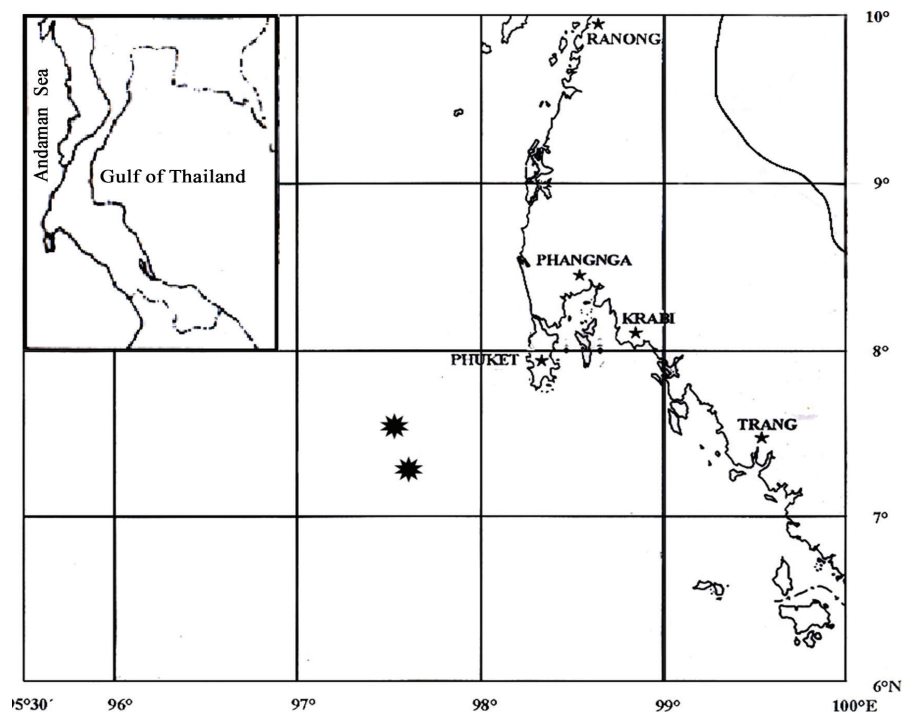


Figure 4. Distribution of *Nephropsis stewarti* Wood-Mason, 1873 from the Andaman Sea of Thailand.

Family Palinuridae Latreille, 1802

Diagnostic: Body tubular or slightly flattened dorsoventrally; hairs few and scattered; rostrum absent or reduced to a small spine; carapace subcylindrical or prismatic, laterally rounded or straight, surface spiny and with a pair of large frontal horns above eyes; antennae very long and rather thick, whip-like or spear-like; legs without true pincers and first pair (except in *Justitia*) not to only slightly longer than the following legs, but often somewhat more robust; posterior half of tail fan soft and flexible.

Diagnostic characters: Moderate to large-sized crustaceans. Body tubu-

lar or slightly flattened dorsoventrally; hairs few and scattered. Carapace (or "head") subcylindrical or box-like, laterally rounded or straight. Without a well-developed rostrum, ornamented with spines and granules of various sizes, sometime with scale-like sculpture. Eyes well developed, each protected by a strong, spiny frontal projection of the carapace (frontal horns). Antennae rather thick and very long, whip-like or spear-like antennal scale absent; antennulae slender and each with 2 long or short flagellae. Bases of antennae often separated by a broad antennular plate usually bearing some spines. In some genera a projection from the base of antenna is developed and forms with

the rim of the antennal plate a stridulating organ which can produce a grating sound by movement of the antenna. Legs generally simple, without true pincers; the first pair not only slightly longer than the following legs, but often somewhat more robust. Both abdomen and tail fan well developed and

powerful, posterior half of tail fan soft and flexible. Abdomen segments either smooth or each provided with 1 or more transverse grooves. Color: mostly brightly colors and provided with special markings, bands or soft, or uniformly colored.

Key to the genera of family Palinuridae (Chan, 1998)

- 1a.** Carapace covered with scale-like sculpture; each abdominal segments with 4 or more transverse grooves; first pair of legs sometimes enlarged and forming false pincers in males *Justitia*
- 1b.** Carapace without scale-like sculpture; abdomen smooth or each segment at most with 2 transverse grooves; first pair of legs simple and never enlarged.....**2**
- 2a.** Frontal horns truncated; proximal segment of antennular peduncle longer than antennal peduncle; leg very spinous..... *Palinustus*
- 2b.** Frontal horns pointed; proximal segment of antennular peduncle distinctly shorter than antennal peduncle; leg sparsely covered with spines.....**3**
- 3a.** Carapace subcylindrical, without median keel; antennule with flagellum longer than peduncle; abdominal pleura ending in 1 strong tooth only..... *Panurilus*
- 3b.** Carapace box-like, with a median keel; antennule with flagellum much shorter than peduncle; abdominal pleura ending in 2 or more strong teeth.....**4**
- 4a.** Frontal horns small and fused at the middle of anterior carapace; abdominal pleura ending in short teeth; antennae thick, inflexible and shorter than body length..... *Linuparus*
- 4b.** Frontal horns large and widely separated; abdominal pleura ending in 2 long teeth; antennae slender and much longer than body length..... *Puerulus*

Key to species of the genus *Linuparus* (Chan, 1998).

- 1a.** Strong median teeth present between frontal horns; epistome ridges with strong anterior teeth; second and third abdominal pleura bearing basal teeth *Linuparus trigonus*
- 1b.** No strong median teeth between frontal horns; epistome ridges without strong anterior teeth; second and third abdominal pleura without basal teeth..... *Linuparus sordidus*

Genus *Linuparus* White, 1847
(Type species: *Palinurus trigonus*
Von Siebold, 1824)

Apart from a great number of fossil species, the genus *Linuparus* has three species, *L. somniosus*, *L. sordidus* and *L. trigonus* reported in the world (Holthuis, 1991).

Linuparus trigonus
(von Siebold, 1824)
 (Figures 5a-d, 6)

Palinurus trigonus von Siebold, 1824, p. 15, 1826, p. 20.

Linuparus trigonus Holthuis, 1946, p. 121, p. 11, figs. l, j; Barnard, 1950, p. 820; Kubo, 1960, p. 101, pl. 50, fig. 1; Holthuis, 1965: 264.

Materials examined: PMBC 6826, lat. 7° 01.790'N, long. 97° 53.890'E, trawl, 340 m. coll: A. Nateewathana, 19.3.1989, 1 specimen (74 mm carapace length); PMBC 10996, lat. 6° 52.030'N, long. 98° 13.070'E, 160 m, coll: S. Bussarawit and A. Nateewathana, 27.3.1994, 1 specimen (160 mm carapace length); PMBC19616, lat. 7° 02.000'N, long. 98° 10.000'E, trawl, 277-288 m, coll: C. Aungtonya and V. Vongpanich, 1.3.2000, 1 specimen (16 cm carapace length); PMBC19620, R.V. Dhanarajana, trawl, coll: Thongdee, 2 specimens (160-180 mm carapace length).

Diagnostic characters: Carapace pris-

matic and with median keel behind cervical groove surface of coarsely granulated, with teeth somewhat eroded and lacking teeth on posterior marginal ridge. Strong median teeth present between frontal horns. Antennular peduncle nearly equal to antennal peduncle. Antennal flagellum thick, flattened, inflexible and slightly shorter than body length. Anterior margin of epistome strongly produce teeth. Pereiopods flattened laterally. Second and third abdominal pleura bearing basal teeth.

Coloration: Body orange-red on dorsal surface and white on ventral surfaces. Eyes dark brown.

Distribution: Indo-West Pacific region, Japan, Korea, China, Taiwan, Philippines, eastern and western Australia.

Habitat, biology and fisheries: The species has been reported from depths between 30 to 318 m. The substrate on which this species is caught is described as sand or mud, sometimes with shells; some older records indicated rocky environment. Occasionally this species is taken by trawls, but apparently nowhere very abundant. Rarely sold in fish markets in the Philippines. This species is caught commercially on small scale off northern Australia and Queensland during the northern prawn fishery closed seasons. The lobsters are tailed off because their rigid antennae make them difficult to pack up.

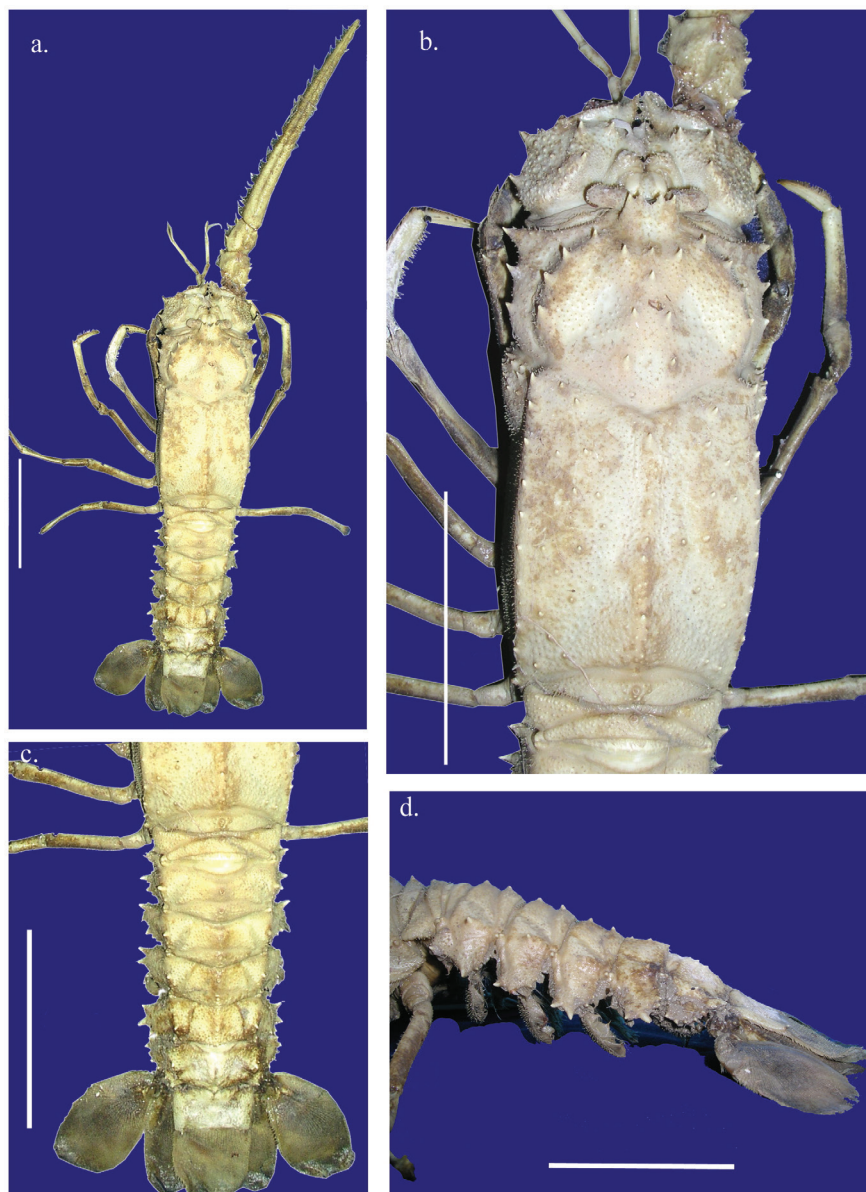


Figure 5. *Linuparus trigonus* (Von Siebold, 1824) (PMBC 6826)

a. dorsal view

b. carapace (dorsal view)

c. abdomen (dorsal view)

d. abdomen (lateral view)

Scale bars = 5 cm. (except b. = 1 cm.)

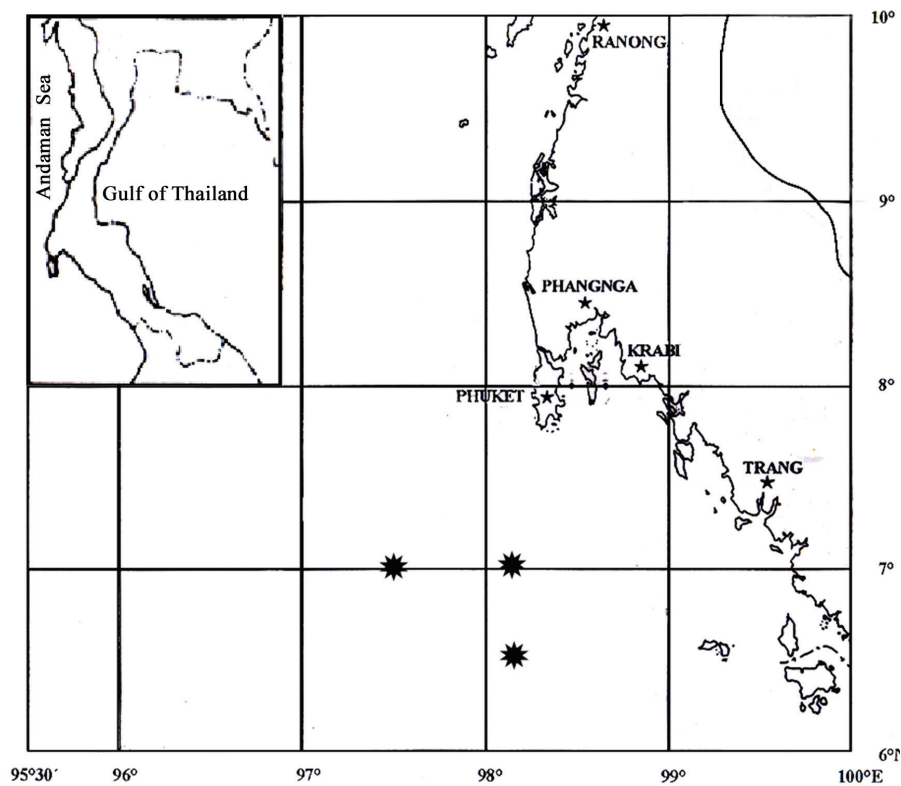


Figure 6. Distribution of *Linuparus trigonus* (Siebold, 1824) from the Andaman Sea of Thailand.

Genus *Palinustus*

A. Milne Edwards, 1880

(Type species: *Palinustus truncatus*

A. Milne Edwards, 1880)

The genus is characterized by the shape of the frontal horns, that do not end in a sharp point but in a broad, bluntly truncate top that sometimes is crenulated; a strong spine is present on the outer margin of each horn (Holthuis, 1991).

Four species have been described by Holthuis (1991) and later a new species of this genus has been described by Chan and Yu (1995). None with any commercial value as the species all

seems to be very scarce and all occur at considerable depths.

Diagnosis: Body spiny, with carapace somewhat prismatic. Rostrum absent but sometimes having median spine on anterior margin of carapace. Supraorbital horns widely separated and truncate. Eyes large and kidney-shaped. Proximal segment of antennular peduncle longer than antennal peduncle. Antennular flagellum shorter than distal segment of peduncle, while antenna long with whiplike flagellum. Well-developed stridulating organs present. Pereiopods heavily spinulose. Abdomen with distinct dorsal carina and bearing 2 trans-

verse grooves on each tergite. Ventral margins of abdominal pleural terminating in 2 acute spines. Pleopod I present in females (Chan and Yu, 1995).

Distribution: Indo-West Pacific and the western Atlantic near the West Indies. At depths of 59-670 m.

Remarks: The genus is unique in the Palinuridae in the supraorbital horns be-

ing truncate instead of sharply pointed. Five species are currently recognized in this genus. Except *P. mossambicus*, the characteristics and colorations of the other four species are now well understood. The genus has a typical Tethys distribution, with some species widely distributed. Nevertheless, the small size and rareness of this genus prevent commercial consideration.

Key to species of the genus *Palinustus* (Chan and Yu, 1995).

- 1a. Raised parts of abdominal tergites almost naked.....2
- 1b. Entire abdominal tergites distinctly pubescent3
- 2a. Anterior margin of carapace between supraorbital horns with 2-6 additional spines other than median spine; postorbital and antennal spines very short and less than half as long as branchiostegal spine; posterior margin of thoracic sternum bearing pair of submedium spines only; abdominal sternites VI generally without tooth.....*P. truncatus*
- 2b. Anterior margin of carapace, between supraorbital horns armed with single median spine only; postorbital, antennal, and branchiostegal spines moderately long and similar in size; posterior margin of thoracic sternum bearing many additional spines other than pair of submedian spines; abdominal sternite VI having median tooth*P. unicornutus*
- 3a. Posterior margin of abdominal tergite VI and anterior margin of epistome not serrated; dorsomesial surface of distal antennal segment unarmed; postorbital, antennal, and branchiostegal spines moderately long and similar in size*P. holthuisi*
- 3b. Posterior margin of abdominal tergite VI and anterior margin of epistome distinctly serrated; dorsomesial surface of distal antennal segment usually bearing spine (s).....4
- 4a. Postorbital, antennal, and branchiostegal; spines all extraordinary long and similar in size; area between antennal spine and cervical groove smooth; dorsomesial surface of distal antennal segment armed with 3-6 spines; abdominal sternite VI lacking median tooth*P. mossambicus*
- 4b. Postorbital spine distinctly shorter than antennal and branchiostegal spines; area between antennal spine and cervical groove provided with 7-10 spines and spinules; dorsomesial surface of distal antennal segment usually armed with 1 or 2 spines; abdominal sternite VI bearing median tooth*P. wuguensis*

***Palinustus waguensis* Kubo, 1963**

(Figures 7a-d, 8)

Palinustus waguensis Kubo, 1963: 63, figs. 1-3; Holthuis, 1991: 126, figs. 237-238; Chan and Yu, 1995: 1389, figs. 7, 8D, 9E, 10E.

Common name: Japanese blunthorn lobster.

Materials examined: PMBC6825, lat. 6° 51.030'N, long. 98° 31.060'E, trawl, 95 m. coll: A. Nateewathana, 16.3.1989, 1 specimen (14 mm carapace length); PMBC 10282, Phuket Fisheries Company, trawl, coll: Mr Khunchit, 10.1.1994, 2 specimens (38-40 mm carapace length); PMBC16866, lat. 7° 01.000'N, long. 98° 19.000'E, trawl, 119-116 m, coll: C. Aungtonya and V. Vongpanich, 23.2.2000, 17 specimens (20-39 mm carapace length); PMBC17926, Phuket Fishing Port, coll: S. Bussarawit, 13.2.1998, 8 specimens (23-35 mm carapace length).

Diagnostic characters: Body heavily pubescent with spines well developed. Anterior margin of carapace between supraorbital horns bearing 4-8 spines; inner margin of supraorbital horn armed with 2-5 spines. Antennal and branchiostegal spines more or less as long as widest diameter of eye (latter spines slightly smaller), but postorbital spines short and about half as long as antennal spine. Distal antennal segment with dorsomesial surface armed with 1 or 2 spines and of segment length. Epistome with central region evenly tuberculate,

anterolateral corners not developed as strong tooth and lateral regions with only median parts tuberculate. Thoracic sternum with lateral margins distinctly serrated; posterior margin with median region general bearing 1 pair of short submedian spines, lateral regions unarmed or occasionally having 1 or 2 sharp tubercles. Distal fourth segment of maxilliped III armed with 3-9 fixed spines along ventral margin, while carpus of pereopod I having 1 or 2 fixed spines along dorsal margin. Dactyli of pereopod I about 4.5 times as long as broad. Abdominal tergites distinctly pubescent, with lateral oblique furrows well defined. Posterior margin of abdominal tergite VI distinctly serrated. Abdominal sternite I having spinulose along entire margin, with submedian pair of spines largest; sternites II-V each generally bearing outer pair of larger and inner pair of smaller spines, with that of II often having some additional spinules on lateral parts; sternite VI armed with strong median tooth and 8-12 other teeth.

Coloration: Body including pleopods generally orange. Anterior margin of carapace between supraorbital horns and posterior part of stridulating ridge on antennular plate reddish. Eyes dark brown. Antennal flagella provided with broad pale bands. Maxilliped III and meri of pereopods covered with many dense narrow red rings, while distal segments of pereopods bearing broad orange red bands. Hinges between carapace and abdomen, as well as inner bases of endopods of uropods, with pair of

large white spots. Lateral oblique furrows of abdominal tergites and ventral pleura also somewhat whitish. Margins of noncalcified parts of tail fan reddish.

Distribution: Widely distributed in the Indo-West Pacific from Japan to Taiwan, the Philippines, Indonesia, Thailand, India and Madagascar. At depth of 72-118 m (about 180 m in Holthuis, 1991).

Habitat, biology and fisheries: The species is reported from rather shallow depths in Japan, where it is sometimes caught in lobster traps nets. This lobster is often sold to the public aquarium on the Japanese east coast. The species has been obtained in large number from certain areas in India. The specimens from India and the Philippines were taken at depths between 72 and 84 m. The juvenile from Ambon, Indonesia, came from a depth of 180 m, from a stony bottom. This species is of very limited interest in fisheries. In Thailand, dried lobsters are occasionally sold as souvenirs to tourists.

Remarks: *Palinustus waguensis* can be readily separated from the other species of the genus by the body heavily pubescent, the postorbital spine much smaller than the antenal and branchiostegal spines, both the epistome and the lateral

margins of the thoracic sternum distinctly serrated, the dorsomesial surface of the distal antennal segment bearing 1 or 2 spines, and abdominal sternite I armed with a row of well-developed spines.

Chan and Yu (1995) reported that the spines on the anterior margin of the carapace between the supraorbital horns are generally irregularly arranged in *P. waguensis*. The variation in the characteristics of *P. waguensis* has caused some confusion in the taxonomy of *Palinustus*. As suspected by Holthuis (1991) all materials previously identified as *P. mossambicus* must be assigned to *P. waguensis*.

Unlike the morphological characters, the coloration of *P. waguensis* appears to be much more constant. The materials from Japan, Taiwan, Indonesia and Thailand all show dense narrow red rings on maxilliped III and the meri of the pereopods. This striking color pattern can easily separate *P. waguensis* from the other species of the genus which have broad bands only on the thoracic appendages.

Although still rare, *P. waguensis* is probably the most common species of the genus and has a wide geographic distribution.

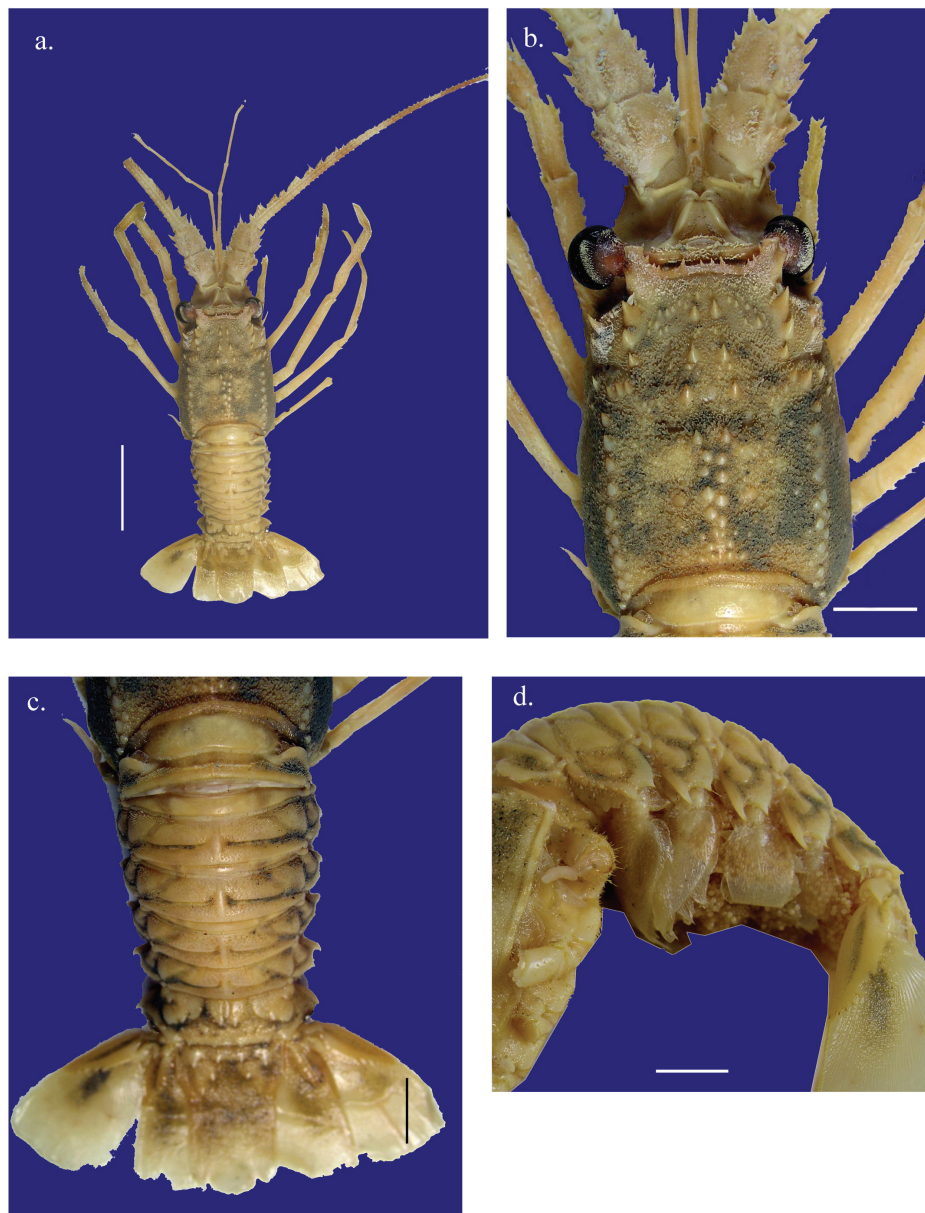


Figure 7. *Palinustus waguensis* Kubo, 1963 (PMBC 16866)

a. dorsal view

b. anterior part and carapace (dorsal view)

c. abdomen (dorsal view)

d. abdomen (lateral view)

Scale bars = 1 cm. (except a. = 5 cm., c. = 2 cm.)

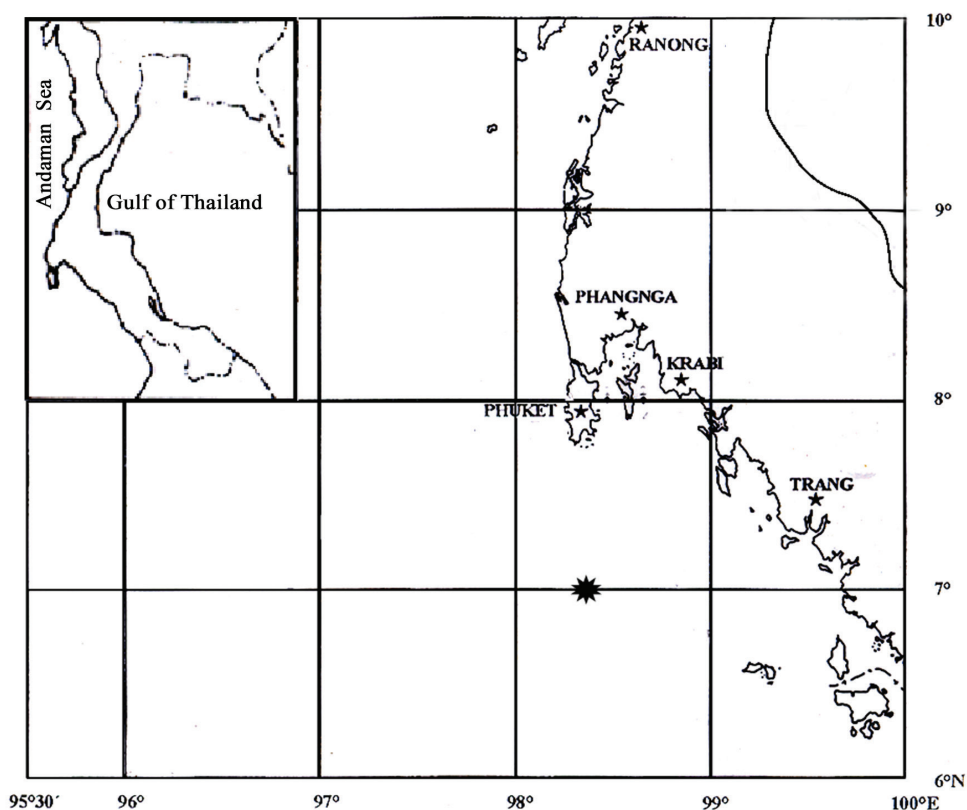


Figure 8. Distribution of *Palinustus waguensis* Kubo, 1963 from the Andaman Sea of Thailand.

Genus *Puerulus* Orthman, 1897
(Type species: *Puerulus angulatus*
Bate, 1888)

So far four species i.e. (*P. ventrinus*, *P. angulatus*, *P. carinatus*, *P. sewelli*) have

been recognized in this genus. All of them are deepwater forms. One of them (*P. sewelli*) is subject to minor fishery. The others are not fished, but are of potential interest (Holthuis, 1991).

Key to species of the genus *Puerulus* (Holthuis, 1991).

- 1a.** Postorbital spine present. No teeth, but 6 post-cervical and 6 intestinal tubercles on the median keel (carina) of the carapace. Tubercles on carapace low and largely obscured by the pubescent. Eyes large, much broader than long *P. velutinus*
- 1b.** Postorbital spine absent. Median keel (carina) of carapace with 3 to 5 post-cervical and 2 or 4 intestinal teeth. Tubercles of carapace usually distinct and not obscured by the pubescence. Eyes smaller, longer than broad..... **2**

- 2a.** Three to more teeth between the frontal horns and the cervical groove. Median keel of the carapace with 3 postcervical and two intestinal teeth. Fifth pereopod of male not chelate.....*P. angulatus*
- 2b.** Two teeth between frontal horns and the cervical groove**3**
- 3a.** Median keel of carapace with 3 postcervical and 2 (occasional 3 or 4) intestinal teeth. Fifth pereopod of male chelate.....*P. carinatus*
- 3b.** Median keel of carapace with 5 postcervical and 2 to 3 intestinal teeth. Fifth pereopod of male not chelate*P. sewelli*

***Puerulus sewelli* Ramadan, 1938**
(Figures 9a-e, 10)

Puerulus sewelli Ramadan, 1938: 128, figs. 3-5; Holthuis, 1946: 110; Sewell, 1955: 200-203.

Common name: Arabian whip lobster.

Materials examined: PMBC6823, lat. 7° 34.040'N, long. 97° 44.040'E, trawl, depth 400 m, coll: A. Nateewathana, 13.3.1989, 1 specimen (77 mm carapace length); PMBC6824, lat. 6° 49.070'N long 97° 53.080'E, trawl, 317 m, coll: A. Nateewathana, 20.3.1989. 1 specimen (55 mm carapace length); PMBC6901, Andaman Sea; PMBC 7552, Andaman Sea; 3 specimens (67-70 mm carapace length); PMBC 16862, lat. 6° 45.000'N, long. 98° 06.000'E, Agassiz trawl, depth 303-313 m, coll: C. Aungtonya and V. Vongpanich, 23.2.2000, 2 specimens (72-80 mm carapace length).

Diagnostic characters: The lateral margins of the carapace are cut into three teeth, which decrease in posterior succession, in front of the cervical groove and are serrated behind it. The posterior tooth is not far in advance of

the cervical groove. On the inner side of the large supra-orbital tooth there are two small teeth or only a single one that may processes a double head. The infra-orbital spine is large, and has below and anterior to it a prominence which is half as long as the spine and is cut into two teeth, and behind it two other teeth. On the gastric region there are two anteriorly convergent, longitudinal rows of eroded spines or elongated tubercles. Behind the cervical groove there is a longitudinal carina bearing a row of 7-10 eroded teeth or elongated tubercles, which are the unequal size, and some of which may be double. Usually the last two or three of these are smaller than those anterior of them. The whole surface of the carapace is studied with miliary tubercles, which, on the side walls, are arranged in regular series. The pre-cervical region of the carapace is much shorter than the post-cervical. The transverse part of the cervical groove is very narrow, and from its lateral ends there extend backwards two very shallow grooves, marked by the absence of miliary tubercles. The shape of the region of the carapace enclosed between the cervical groove and these two last mentioned grooves is very

characteristics of the species.

The abdominal terga are carinated; the carina of the sixth segment being double. The second to fifth terga are transversely grooved near the posterior edge. The carina of the first tergum carries a large anterior spine and a smaller posterior one. The carinae of the second to fifth terga each carry two spines anterior to the transverse groove and one posterior to it. Each tergum, from the second to fifth, has at either pleural end a batch of vesicular tubercles in addition to a few small tubercles on either side of the carina. The pleura of the second to fifth segment are transverse obliquely by a row of tubercles, and terminate in a pair of teeth which are large in the female and small in the male. The pleural of the sixth somites ends in a small tooth. The last six thoracic sterna each carry a median tubercle, and the last five one or two teeth on their raised lateral margins. The first abdominal sternum has a transverse row of four spines. The second to fifth have each a pair of median spines and the sixth has two transverse rows of spines. These spines are very distinct in the males and young females, but in adult females they almost disappear except on the first sternum.

The antennal peduncle is more than half as long as the carapace and the basal segment is longer than the second and third jointed together. The antennal peduncle is spinose on its outer margin in adult specimens. In a small specimen from the Indian Museum it is spinose on both outer and inner margins. In

adult specimens the outer margin of the penultimate segment carries four teeth and that of the terminal segment one to three teeth. There is a strong spine at the distal end of the inner margin of the penultimate segment and two very reduced ones on the inner margin. Of the terminal segment. The antennal flagellum is described by Alcock (1901) as being more than twice the length of the body; in none of the specimens from the John Murray Expedition is it complete. The external maxillipeds reach the middle of the second segment of the antennal peduncle and to just beyond the proximal end of the basal segment of the antennular peduncle; its exopodite reaches the middle of the carpus. The proximal halves of the merus and ischium are very strongly serrated on their edges.

In the male the thoracic legs increase in length from the first pair, which is about seven-eighths the length of the carapace, to the last pair, which is less than twice as long as the carapace. The first pair of legs reaches the end of the penultimate joint of the antennal peduncle; the second reaches the end of the terminal segment of the antennal peduncle; the third reaches by half the length of the dactylus beyond the second pair and to the distal end of the second segment of the antennal peduncle; the fourth pair reaches as far as the third and so does the fifth pair. In the female the thoracic legs increase in length up to the fourth pair, and the fifth, which are chelate, are as long as the fourth. The first pair of legs reaches the end of the penulti-

mate joint of the antennal peduncle; the second pair reaches the end of the terminal joint of the antennal peduncle; the third pair reaches almost as far as the second the fourth pair just fail to reaches as far as the third and the fifth reaches the middle of the dactylus of the fourth.

Distribution: Western Indian Ocean: Somalia, Gulf of Aden; off Pakistan, southwest and south India, Gulf of Mannar and Arabian Sea.

Habitat, biology and fisheries: This species is known from depth between

180 and 1,300 m, most common between 180 and 300 m; on a substrate of coarse sand, hard mud and shells. Between 1974 to 1997, the species was commercially fished off the east coast of Somalia. In the Gulf of Aden, experimental trawling was carried out with average catches of 10 to 129 kg/hour. Off southwest of India, rich grounds were found, where the fishery for this species might become commercially rewarding. The annual sustainable yield in the area was estimated at 6,700 tons. The operations were carried out by deep sea trawlers. The lobster tails were sold deep frozen.

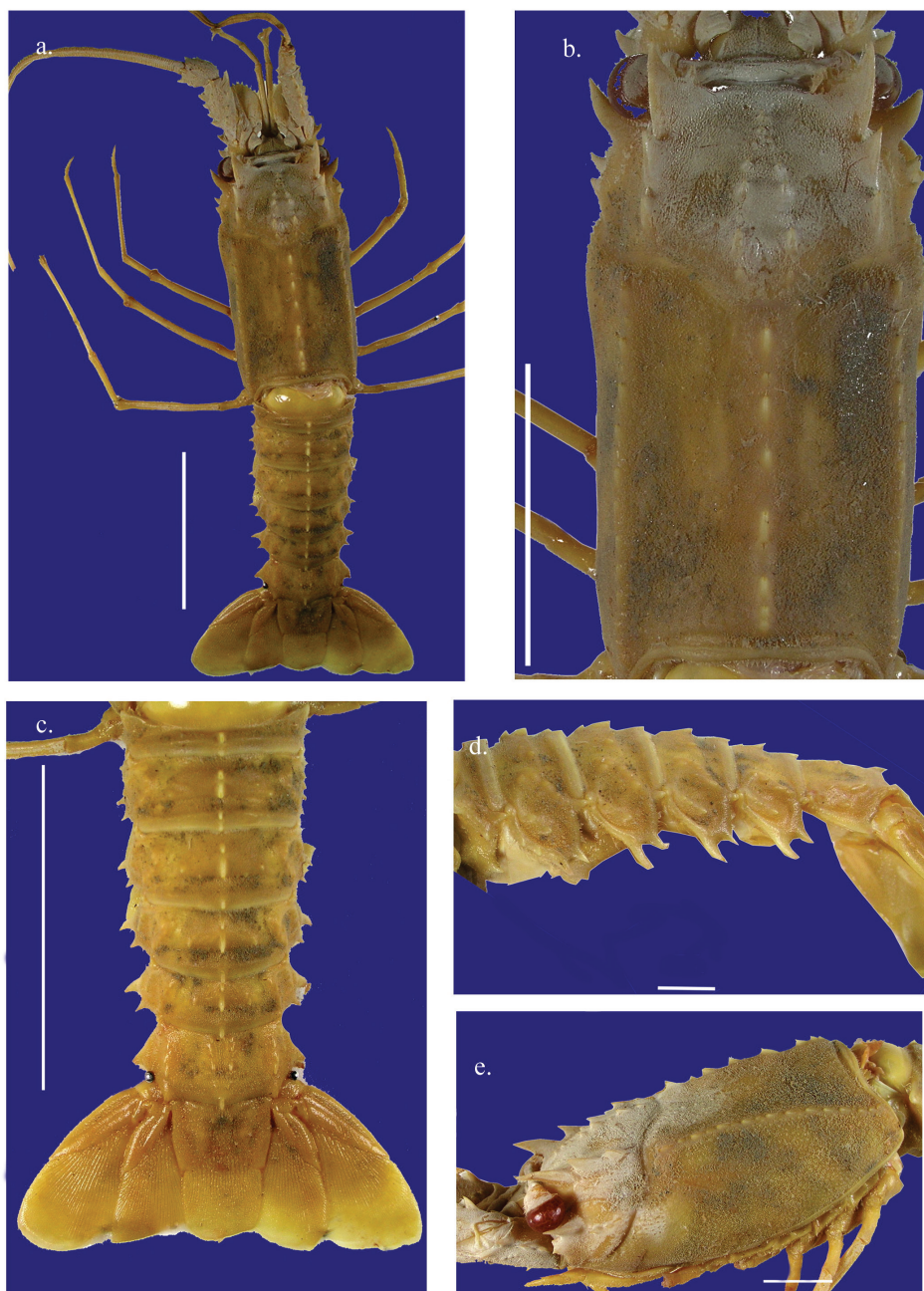


Figure 9. *Puerulus sewelli* Ramadan, 1938 (PMBC 6824)

a. dorsal view

b. carapace (dorsal view)

c. abdomen (dorsal view)

d. carapace (lateral view)

e. carapace (lateral view)

Scale bars = 5 cm. (except d, e. = 1 cm.)

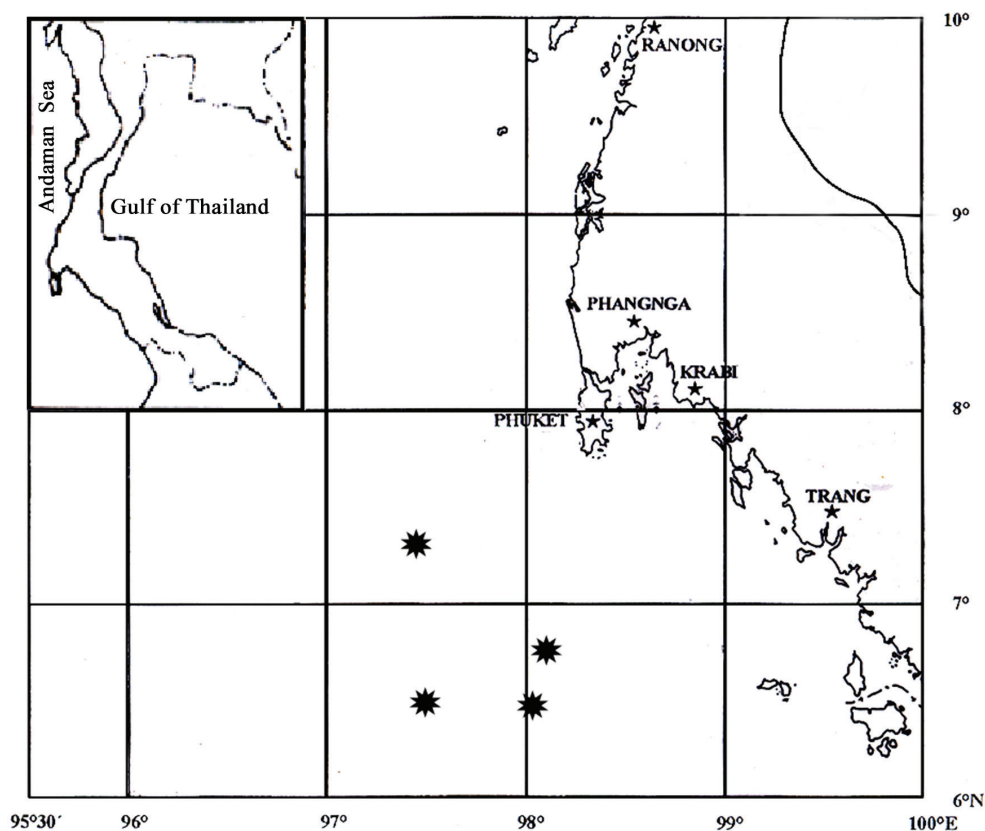


Figure 10. Distribution of *Puerulus sewelli* Ramadan, 1938 from the Andaman Sea of Thailand.

DISCUSSION

This study described 5 species of deep water lobsters found in the Andaman Sea of Thailand on the Thai-Danish Scientific Cooperation Program on R.V. Chakratong Tongyai and specimens in the PMBC Reference Collection. Five species of them were previously recorded by Ananongsuk (1989) i.e. *Metanephrops andamanicus*, *Nephropsis stewarti*, *Stereomastis andamanensis*, *Puerulus sewelli* and *Linuparus trigonus*. Chan (1998) reported that dried specimens of *Palinustus waguensis* are occasionally sold as souvenirs to tourists. Naiyanetr (1998) reported 5 spe-

cies from the Andaman Sea where *Linuparus trigonus* has been recorded from the South of the Gulf of Thailand.

The deep water crustacean fauna in the Andaman Sea BIODEEP sampling comprised of fish, shrimp, lobster and crab. These groups were interesting because they are expected to become a new fishery resources in the future. The value of catch per unit effort (CPUE) is still low. However the present data is not significant due to limited number of investigation. Therefore, there is a need for more survey with appropriated gears in the future in order to obtain additional information.

ACKNOWLEDGEMENTS

I would like to thank to PMBC Directors for their supports, the Thai-Danish Cooperation Program for BIODDEEP cruises for supporting of this study. I also thank captain and crews of R.V. Chakratong Tongyai, Dr. Charatsee Aungtonya, Ms. Vararin Vongpanich and staff of PMBC Reference Collection Unit for their field assistances. Special thanks to Dr. Anuwat Nateewathana, former chief of PMBC Reference Collection for the collected samples, Mr. Thongdee (Exploratory Fisheries Division) and Mr. Kanchit (Phuket Fisheries Company) for the donated specimens. Ms. Koraon Wongkhamhang for helping in taking and editing photos.

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