

**THE FRESHWATER CRABS AND PRAWNS
(CRUSTACEA: DECAPODA)
OF BAKO NATIONAL PARK, SARAWAK, MALAYSIA,
WITH DESCRIPTIONS OF ONE NEW GENUS AND
THREE NEW SPECIES**

Peter K. L. Ng

ABSTRACT. - Five families and 10 species of freshwater decapod crustaceans, including one new genus and three new species, are reported from Bako National Park in Sarawak, Malaysia, viz. Palaemonidae: *Macrobrachium rhodochir*, new species, *M. callirrhoe* (De Man, 1898), *M. sintangense* (De Man, 1898), *M. pilimanus* (De Man, 1879), Atyidae: *Caridina typus* H. Milne Edwards, 1837, *C. bakoensis*, new species, Gecarcinucidae: *Terrathelphusa kuchingensis* (Nobili, 1901), *Bakousa sarawakensis*, new genus and new species, Parathelphusidae: *Perithelphusa borneensis* (Von Martens, 1868), and Grapsidae: *Pseudosesarma bocourti* (A. Milne Edwards, 1869).

INTRODUCTION

Bako National Park (size 27 square kilometres) is located about 37 km northeast of Kuching, the state capital of Sarawak (Fig. 1). The park was established in 1957 and was the first national park set up in Sarawak. Although the geology and flora of the park has been relatively well studied (Wilford, 1971; Ashton, 1971), its fauna is much less well known. Other than the mammals and birds (Rothschild, 1971), and some general accounts of the invertebrates, almost nothing else is known. The freshwater fauna is almost completely unknown. Cubitt & Payne (1990: 137) figured a bright red semiterrestrial crab from Bako National Park which was identified as a species of *Perbrinckia* (Gecarcinucidae). Ng (1989b) showed that the Bornean and Javan species previously referred to *Perbrinckia* should be transferred to a new genus, *Terrathelphusa*, and suggested that the red Bako crab might be *Terrathelphusa kuchingensis* (Nobili, 1901).

Between June and July 1994, collections were made throughout the main freshwater drainages in Bako National Park as part of a joint survey between the National Parks of Sarawak (Forestry Department) and the 1994 Zoology Honours Class as well as staff of the

P. K. L. Ng - Department of Zoology, National University of Singapore, Kent Ridge, Singapore 0511, Republic of Singapore.

Department of Zoology, National University of Singapore. A total of nine species of decapod crustaceans were collected - six species of prawns from two families (Palaemonidae and Atyidae) and four species of crabs from three families (Gecarcinucidae, Parathelphusidae and Grapsidae). Of these, three are new species - *Macrobrachium rhodochir*, new species, *Caridina bakoensis*, new species (Atyidae) and *Bakousa sarawakensis*, new genus and new species (Gecarcinucidae). All the others are new records for the park. Unfortunately, the unidentified *Terrathelphusa* species from Bako was not obtained, and its identity remains unknown.

The present paper serves to document and describe the 10 species of decapod crustaceans obtained or known from Bako National Park. Specimens are deposited in the Forestry Department of Sarawak (FDS); Sarawak Museum (SM), Kuching; Rijksmuseum van Natuurlijke Historie (RMNH), Leiden; and the Zoological Reference Collection (ZRC), Department of Zoology, National University of Singapore. Abbreviations used are G1 for the male first pleopod, G2 for the male second pleopod, cl for carapace length (measured from behind orbit to posterior margin of the carapace), and tl for total length. Measurements of the crabs are of the carapace width and length respectively.

NOTES ON THE WATERS OF BAKO

Bako National Park has at least seven vegetation types (Ashton, 1971), but most of these types are present only in small patches. The fresh water throughout the park contains a high concentration of tannins and other phenolic substances which gives the water a dark, tea-colour, appearing almost black from the surface. These are however, not true blackwaters as the acidity of the waters in Bako are relatively high (ca. 5.5). The water is usually clear. The tea-coloured water are probably originates from the patches of heath and peat swamp forest on various parts of the island (Ashton, 1971).

TAXONOMY

FAMILY PALAEMONIDAE

Macrobrachium rhodochir, new species

(Fig. 1)

Material examined. - Holotype - male (10.8 mm cl) (ZRC 1995.236), small stream parallel to Tajur Waterfall, Sungai Tajur, about 200 m away, coll. P. K. L. Ng, 29 Jun.1994.

Paratypes - 11 specimens (SM/FDS), Tajur Waterfall, Sungai Tajur, coll. P. K. L. Ng et al., 29 Jun.1994. — 1 male (11.3 mm cl), 3 ovigerous females (largest 9.2 mm cl), 13 specimens (ZRC 1995.240), Tajur Waterfall, Sungai Tajur, coll. T. Tan et al., 29 Jun.1994. — 1 ovigerous female, 6 specimens (ZRC 1995.244), Tajur Waterfall, Sungai Tajur, coll. P. K. L. Ng et al., 29 Jun.1994. — 14 specimens (ZRC 1995.243), Tajur Waterfall, Sungai Tajur, coll. T. Tan et al., 29 Jun.1994. — 5 specimens (ZRC 1995.239), Tajur Waterfall, Sungai Tajur (Site 2), coll. T. Tan et al., 29 Jun.1994. — 1 ovigerous female, 13 specimens (ZRC 1995.238), Tajur Waterfall, Sungai Tajur, coll. N. Sivasothi et al., 30 Jun.1994. — 1 male (ZRC 1995.237), collected at base of Tajur Waterfall, Sungai Tajur, about 10 m from sea, coll. P. K. L. Ng, 30 Jun.1994. — 15 specimens (SM/FDS), streams in Bukit Gondol, upper reaches of Sungai Serait, coll. N. Sivasothi et al., 28 Jun.1994. — 2 ovigerous females, 19 specimens (ZRC 1995.242), upper stretches of Sungai Serait, Bukit Gondol, coll. N. Sivasothi et al., 28 Jun.1994. — 1 ovigerous female, 11 specimens (ZRC 1995.241), waterfall at Sungai Seloar, coll. T. Tan et al., 30 Jun.1994.

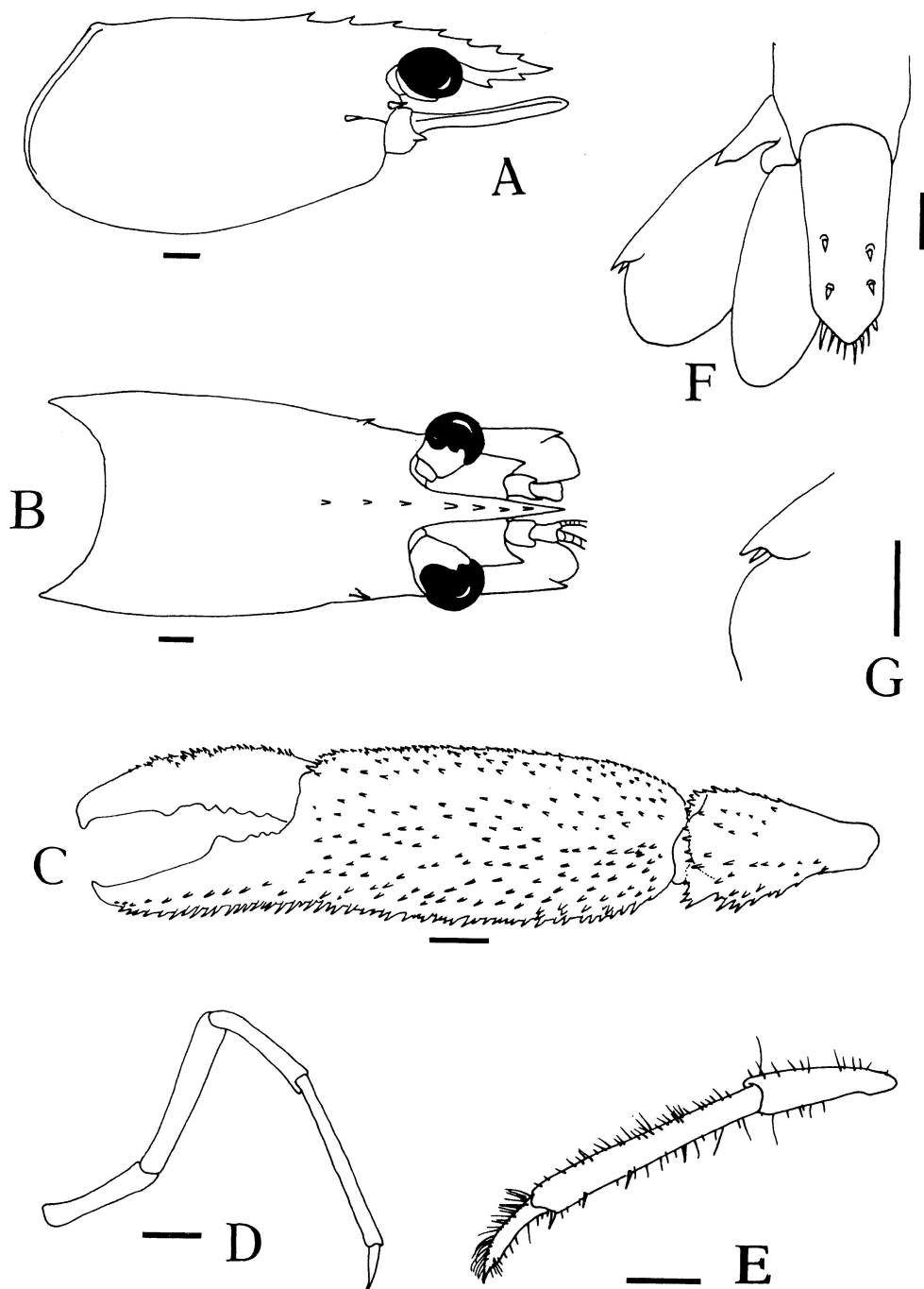


Fig. 1. *Macrobrachium rhodochir*, new species. Holotype male (10.8 mm cl) (ZRC 1995.236), Tajur Waterfall area. A, carapace (lateral view); B, carapace (dorsal view); C, right chela; D, right fifth pereiopod; E, left third pereiopod; F, telson and uropods; G, spine on exopod of uropod. Scales = 1.0 mm.

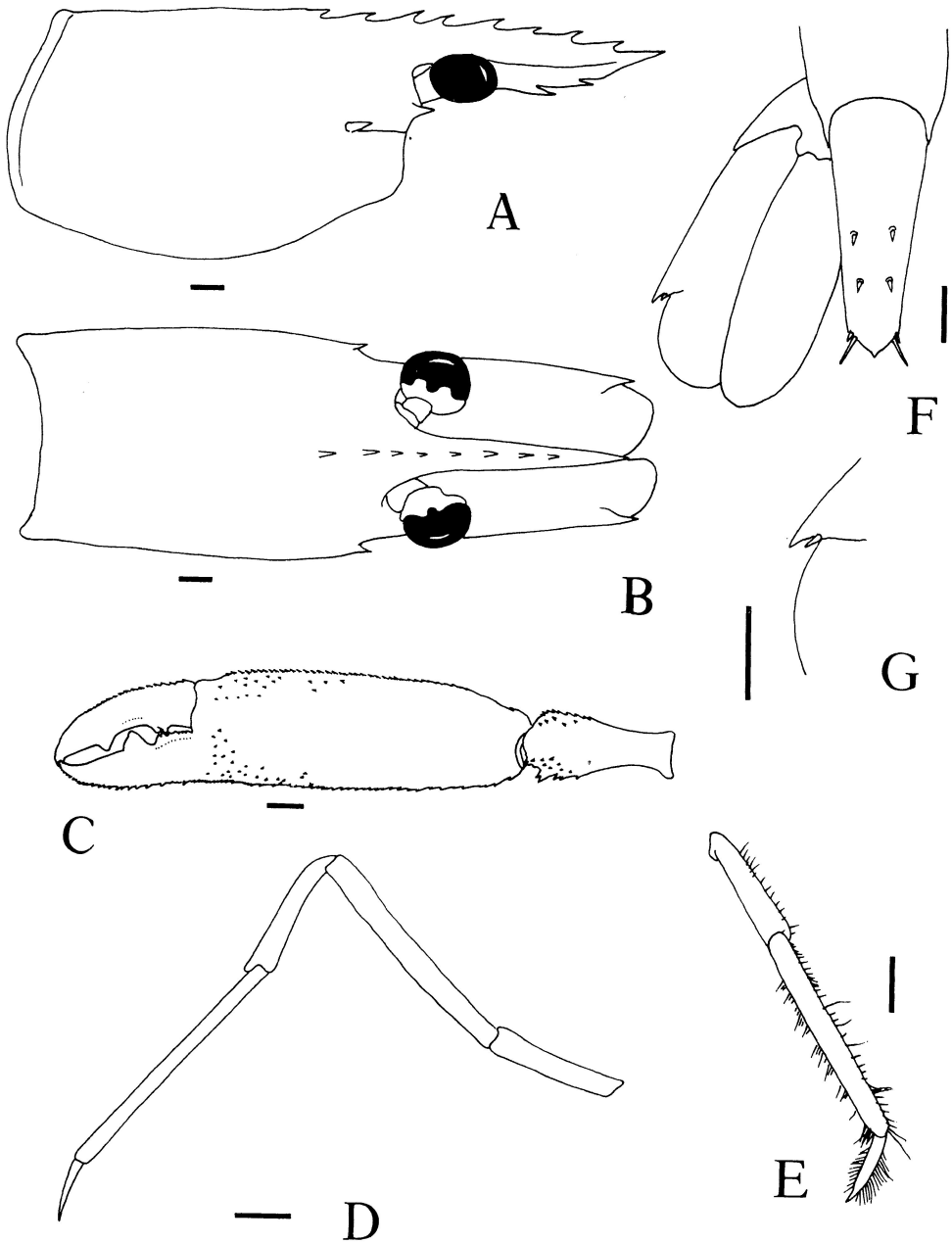


Fig. 2. *Macrobrachium clymene*. Male (12.3 mm cl) (ZRC 1995.261a), Marudi, Baram District, northern Sarawak. A, carapace (lateral view); B, carapace (dorsal view); C, right chela; D, left fifth pereiopod; E, left third pereiopod; F, telson and uropods; G, spine on exopod of uropod. Scales = 1.0 mm.

Etymology. - The name is derived from the Greek “rhodos” and “cheira” for red hand, alluding to the usual red to purplish red colour of the second pereiopod in this species.

Remarks. - *Macrobrachium rhodochir*, new species, bears a remarkably close resemblance to *M. clymene* (De Man, 1902), especially in the form of the second pereiopods. *Macrobrachium rhodochir* however, can easily be separated from *M. clymene* by several characters, viz. the shorter rostrum which is ca. 0.45 times length of the carapace (versus ca. 0.62 times length of carapace), shorter scaphocerite which is ca. 0.5 times carapace length (versus 0.7 times carapace length), fewer teeth on the dorsal margin of the rostrum (7-9, mode 7; versus 8-10, mode 8), more inflated carapace, with the lateral margins of the anterior part of the carapace (when observed from above) distinctly convex (versus carapace less inflated, the lateral margins of the anterior part being almost straight), proportionately shorter fifth pereiopod (carpus length is 6.4 times width versus 9.2; propodus length is 1.6 times carpus length versus 1.8), the tips of the fingers of the major chela are bent sharply (against gently curving), and the tip of the telson is rounded (against pointed) (see *M. clymene*, Figs. 2, 3).

Macrobrachium clymene is known from the Baram (type locality) and Mulu areas in northern Sarawak (De Man, 1902; Holthuis, 1979), but I have recently examined a good series collected from lowlands from near the type locality in Marudi (Baram), northern Sarawak [14 specimens (ZRC 1995.261) (Figs. 2, 3), coll. T. Tan & M. Kottelat, Jun.1994]. The series of specimens agree quite well with the excellent description and figures of the species by De Man (1902). The rostral dentition of most of the specimens is 8 on the dorsal margin and 2 on the ventral margin. Only in three specimens was the rostral formula different - 8/3, 7/2 and 9/4, the latter being a juvenile.

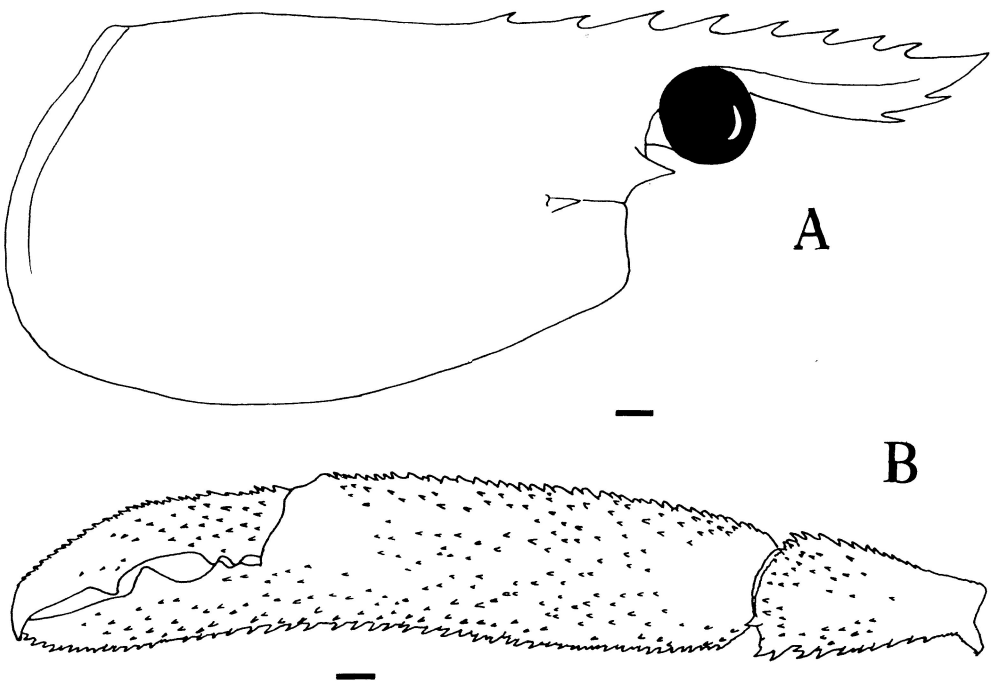


Fig. 3. *Macrobrachium clymene*. Male (16.0 mm cl) (ZRC 1995.261b), Marudi, Baram District, northern Sarawak. A, carapace (lateral view); B, right chela. Scales = 1.0 mm.

The shape of the rostrum of *M. rhodochir* varies somewhat, from blade-like (reaching the edge of the scaphocerite) to being shorter (well before the edge of the scaphocerite). The more elongate carpus and presence of longitudinal ridges on the distinctively more elongate fingers of the chela of the second pereopod easily distinguishes *M. callirrhoe* from *M. rhodochir* (and *M. clymene*), which in Bako, occur sympatrically in the Sungai Serait area. The ridges on the fingers however, are not distinct or even absent in smaller specimens and females of *M. callirrhoe*.

Ecology and biology. - *Macrobrachium rhodochir* was collected mainly from fast flowing waters with rocky and/or sandy substrates, and is the only prawn present in waterfalls and the other streams in northern Bako in the Sungai Tajur area.

The entire second pereopod in young male and females is a crimson to bright red, and in large males, the second pereopod is striking reddish-purple to deep purple.

The eggs of *M. rhodochir* are large, measuring 1.8 by 1.1 mm, and the development is certainly of the completely abbreviated type.

***Macrobrachium callirrhoe* (De Man, 1898)**
(Fig. 4)

Palaemon (*Macrobrachium*) *callirrhoe* De Man, 1898: 152, Fig. 3.

Macrobrachium callirrhoe (sic) - Holthuis, 1950: 197.

Macrobrachium callirrhoe - Chace & Bruce, 1993: 24.

Material examined. - 3 males (largest 12.8 mm cl), 2 ovigerous females (larger 10.0 mm cl) (ZRC 1995.249), 10 specimens (SM/FDS), Ulu Assam trail, coll. D. Chung et al., 29 Jun.1994. — 2 ovigerous females, 13 specimens (ZRC 1995.248), 1 male, 1 female (ovigerous) (RMNH), Ulu Assam trail, coll. D. Chung et al., 29 Jun.1994. — 1 juvenile (ZRC 1995.247), Ulu Assam trail, coll. D. Chung et al., 29 Jun.1994. — 1 male (12.9 mm cl), 10 ovigerous females (largest 7.8 mm cl), 32 specimens (ZRC 1995.245), Ulu Assam trail, first two streams, coll. P. K. L. Ng et al., 30 June 1994. — 2 specimens (ZRC 1995.250), Ulu Assam trail, coll. K. L. Yeo, 30 Jun.1994. — 30 specimens (ZRC 1995.246), middle stretches of Sungai Serait, coll. N. Sivasothi et al., 1 Jul.1994.

Remarks. - The species was described on the basis of four males from Mandai river at Nanga Raoen and Ketoengau river, both from the Kapuas basin, and has never been reported since. The present record of *Macrobrachium callirrhoe* from Bako is a notable northward extension of its known range.

Ecology and biology. - The specimens of *M. callirrhoe* were collected from two main areas. One area, the Ulu Assam area, is adjacent or runs through a small patch of peat swamp, and is lowland near the sea. The water is shallow, with sand substrates and extensive leaf litter beds. The second area is further north in higher ground, in the Sungai Serait area.

The eggs of *M. callirrhoe* are very large, measuring some 2.3 by 1.2 mm, and the development is certainly of the completely abbreviated type.

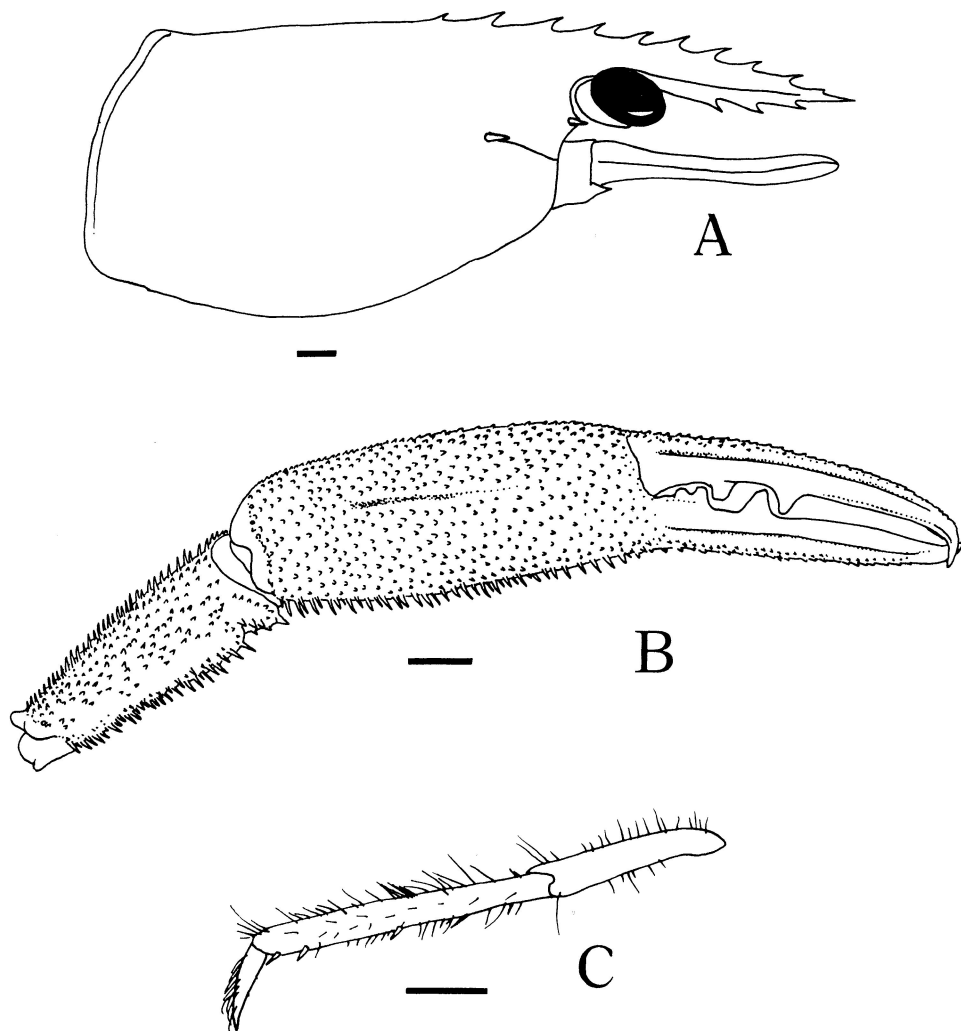


Fig. 4. *Macrobrachium callirrhoe*. Male (12.9 mm cl) (ZRC 1995.245), Ulu Assam. A, carapace; B, left chela; C, left third pereiopod. Scales = 1.0 mm.

***Macrobrachium pilimanus* (De Man, 1879)**
(Fig. 5)

Palaemon pilimanus De Man, 1879: 181.

Macrobrachium pilimanus - Holthuis, 1950: 214; Holthuis, 1979: 9, Fig. 1; Chace & Bruce, 1993: 35.

Material examined. - 1 ovigerous female (10.5 mm cl) (ZRC 1995.251), upper stretches of Sungai Serait, Bukit Gondol, coll. N. Sivasothi et al., 28 Jun.1994. — 2 males (larger 7.1 mm cl), 1 ovigerous female (9.1 mm) (ZRC 1995.252), middle stretch of Sungai Serait, coll. N. Sivasothi et al., 1 Jul.1994.

Remarks. - The taxonomy of the *M. pilimanus* species complex is still unresolved. Johnson's (1960) understanding of the species-complex is less than satisfactory (see Holthuis, 1979), and in recent years, several new species and changes have been made (Chong, 1989;

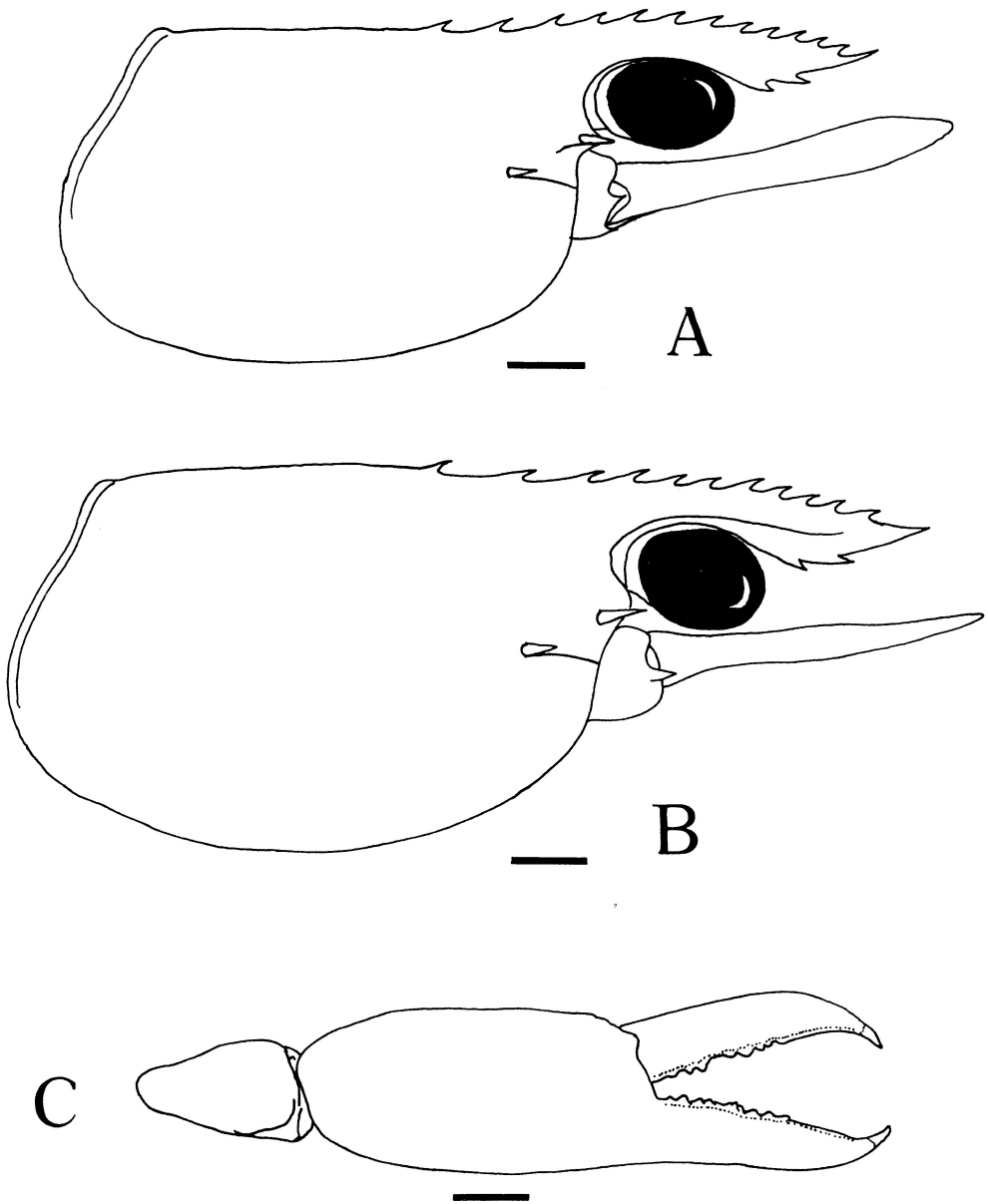


Fig. 5. *Macrobrachium pilimanus*. A, C, male (7.1 mm cl), (ZRC 1995.252), Sungai Serait; B, ovigerous female (9.1 mm) (ZRC 1995.252), Sungai Serait. A, B, carapace; C, left chela (long setae not drawn). Scales = 1.0 mm.

Chong & Khoo, 1987a, b, d). The present specimens fit into the concept of *M. pilimanus* sensu lato (Ng, 1985; Chong & Khoo, 1987c; Ng & Choy, 1990a, b). The rostra of the four Bako specimens available are rather longer than those of typical *M. pilimanus* in that they almost reach the anterior edge of the scaphocerite. In this aspect, it seems closer to *M. ahkowi* Chong & Khoo, 1987. The pubescence on the chela of the second pereopod in the Bako specimens is also rather sparser compared with more typical specimens of *M. pilimanus* I have seen from other parts of Southeast Asia (see Ng & Choy, 1990a), but the significance of this cannot be ascertained as too few Bako specimens were collected.

In Bako National Park, *M. pilimanus* can be easily separated from *M. rhodochir* and *M. callirrhoe* by the short, cup-shaped carpus of the second pereopod, smooth or slightly granulated surfaces of the carpus and chela, and the presence of long, soft setae on the chela. The teeth on the dorsal margin of the rostrum are also set distinctly closer to each other.

Ecology and biology. - This is normally a torrent species, occurring in fast waters with sand to rocky substrates. The present specimens were obtained from relatively fast flowing waters with sand substrates and dense vegetation on the banks. The larval development of *M. pilimanus* is of the completely abbreviated type (Chong & Khoo, 1987c).

***Macrobrachium sintangense* (De Man, 1898)**

(Fig. 6)

Palaemon (Eupalaemon) sintangensis De Man, 1898: 438, Fig. 1.

Macrobrachium sintangense - Holthuis, 1950: 151; Chace & Bruce, 1993: 38.

Material examined. - 1 male (SM/FDS), Ulu Assam trail, coll. D. Chung et al., 29 Jun.1994. — 1 male (cl 14.2 mm) (ZRC 1995.253), Ulu Assam trail, coll. P. K. L. Ng et al., 30 Jun.1994. — 4 specimens (ZRC 1995.254), middle stretches of Sungai Serait, coll. N. Sivasothi et al., 1 Jul.1994. 1 ovigerous female (cl 14.2 mm), 1 specimen (ZRC 1995.255), stream at Telok Delima, coll. D. Chung et al., 30 Jun.1994.

Remarks. - First described from Sintang in the Kapuas basin, *Macrobrachium sintangense* has been reported from many parts of Southeast Asia (Holthuis, 1950; Ng, 1990). The present specimens agree very well with the type descriptions, although the pubescence on the movable finger is still not well developed. The pubescence on the movable finger is apparently only obvious in large dominant males. Also, the distinct rows of granules on both sides of the cutting edge of the dactylus is absent in the present specimens, again, probably because they are still immature (see Holthuis, 1950; Chong et al., 1987).

Ecology and biology. - *Macrobrachium sintangense* is normally found in larger streams and rivers with relatively faster flowing water. The collection of a few specimens of this species in the shallow streams of the Ulu Assam area is interesting. One of the specimens from Tanjong Delima is an ovigerous female collected several hundred metres from the sea, and the eggs are about 0.8-0.9 mm in size. The larval development of *M. sintangense* is of the semi-abbreviated type (Sabar, 1979).

FAMILY ATYIDAE

***Caridina typus* H. Milne Edwards, 1837**

(Fig. 7)

Caridina typus H. Milne Edwards, 1837: 363.

Material examined. - 39 specimens (ZRC 1995.256), 15 specimens (SM/FDS), 4 specimens (RMNH), beginning of trail from beach which leads to Tajur Waterfall, next to sea, in freshwater pool at base of rocks, coll. P. K. L. Ng, 29 Jun.1994. — 2 females (ZRC 1995.257), 6 specimens (SM/FDS), Tanjung Sapi, near sea, coll. D. Chung et al., 28 Jun.1994. — 6 specimens (ZRC 1995.258), Tanjung Sapi, coll. D. Chung et al., 30 Jun.1994.

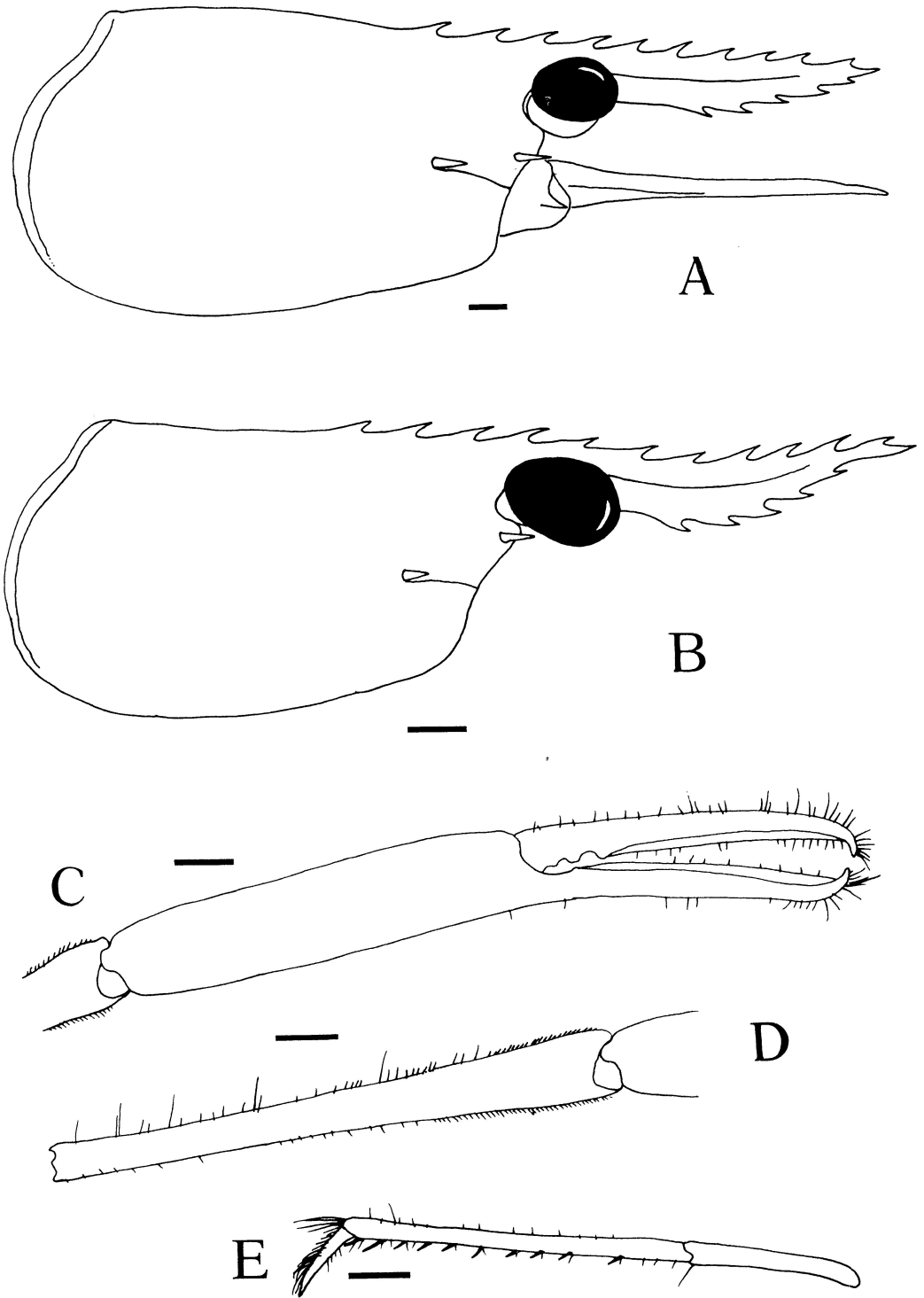


Fig. 6. *Macrobrachium sintangense*. A, C, male (cl 14.2 mm) (ZRC 1995.253), Ulu Assam; B, juvenile (9.2 mm cl) (ZRC 1995.254), Sungai Serait. A, B, carapace; C, left chela and part of carpus; D, carpus and part of chela; E, left third pereopod. Scales = 1.0 mm.

Remarks. - This species has a very variable rostral shape and structure, a fact already well demonstrated by De Man (1892) (see also Bouvier, 1925; Ng, 1985). The size range of the present specimens vary greatly, with females from Tanjung Sapi (average ca. 8.5 mm cl) larger than any from Tajur (largest ca. 6.4 mm cl).

Ecology and biology. - The species occurs in fresh water streams, usually near the sea (see Johnson, 1963, Ng, 1985). The present specimens from the Tajur area were collected in a freshwater pool at the base of large rocks in the supralittoral zone of Tajur beach. The fresh water is from seepage from the adjacent forest. They were extremely abundant in the pools here, and some of the females were ovigerous. A dragonfly nymph was also collected. The Tanjung Sapi specimens were collected from a brackish water tidal stream, in which mangrove gobies (*Mugilogobius*) were also obtained.

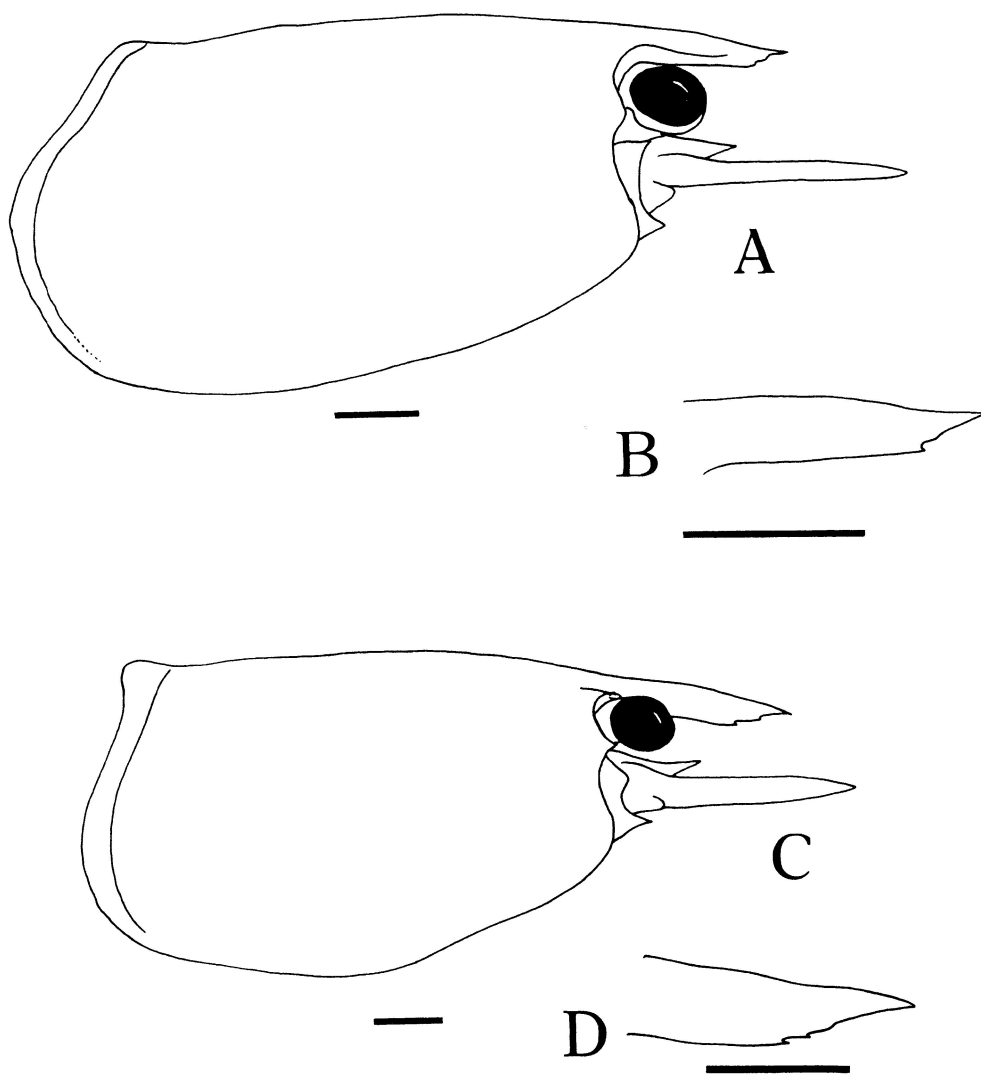


Fig. 7. *Caridina typus*. A, B, ovigerous female (8.5 mm cl) (ZRC 1995.258), Tanjung Sapi; C, D, mature female (6.4 mm cl) (ZRC 1995.256), base of Tajur. Scales = 1.0 mm.

Caridina bakoensis, new species

(Figs. 8-10)

Material examined. - Holotype - Ovigerous female (3.6 mm cl, 13.9 mm tl) (ZRC 1995.259), middle stretch of Sungai Serait, coll. N. Sivasothi et al., 1 Jul.1994.

Paratypes - 1 ovigerous female (3.3 mm cl, 13.3 mm tl) (ZRC 1995.260), 1 female (3.4 mm cl, 13.8 mm tl) (SM), same data as holotype.

Diagnosis. - Rostrum short, straight, reaches to mid-point of second segment of the antennular peduncle and mid-point of scaphocerite; upper margin with 12-14 movable spines, 4-5 of which are behind the orbit, distalmost part unarmed; ventral margin almost straight, with 2 denticles on distal part; distal part of midrib of rostrum reaches almost to tip, proximal part confluent with postorbital margin. Antennal spine pronounced, sharp. Margin of fifth

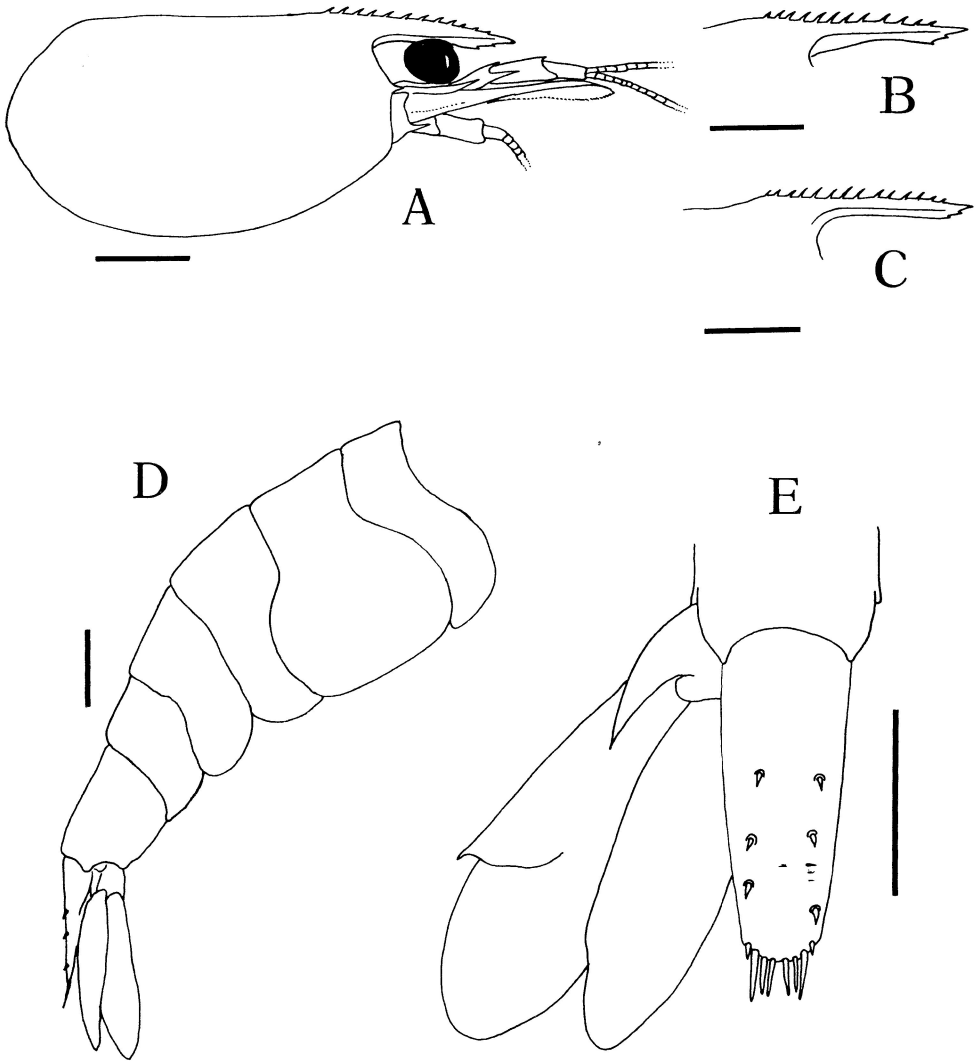


Fig. 8. *Caridina bakoensis* new species. Sungai Serait. A, Holotype ovigerous female (3.6 mm cl), (ZRC 1995.259); B, paratype ovigerous female (3.3 mm cl) (ZRC 1995.260); C-E, paratype female (3.4 mm cl) (SM). A, carapace; B, C, rostra; D, abdomen; E, telson and uropods. Scales = 1.0 mm.

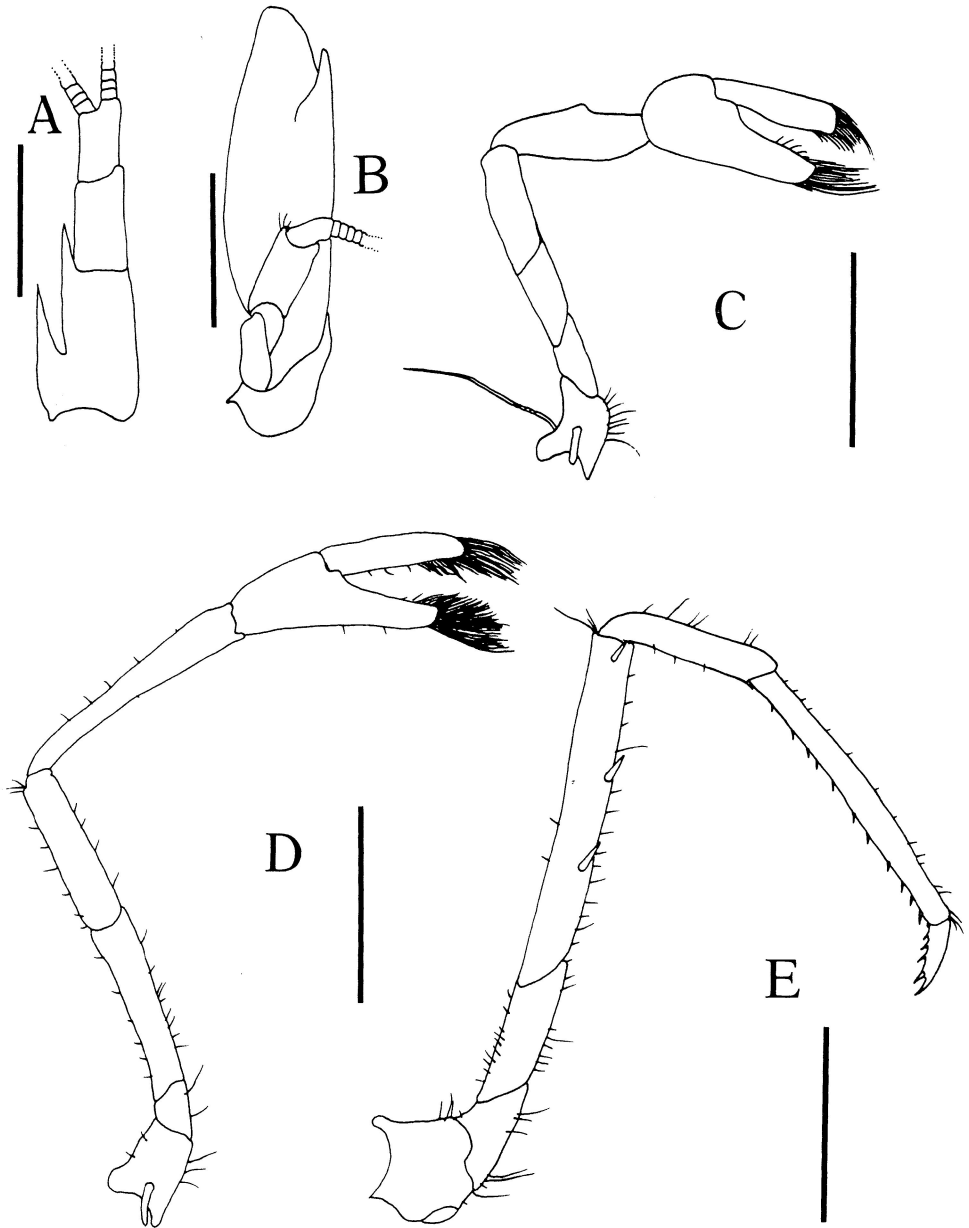


Fig. 9. *Caridina bakoensis*, new species. Sungai Serait. Paratype female (3.4 mm cl) (SM). A, right antennule; B, right antenna; C, first right pereiopod; D, second right pereiopod; E, third right pereiopod. Scales = 1.0 mm.

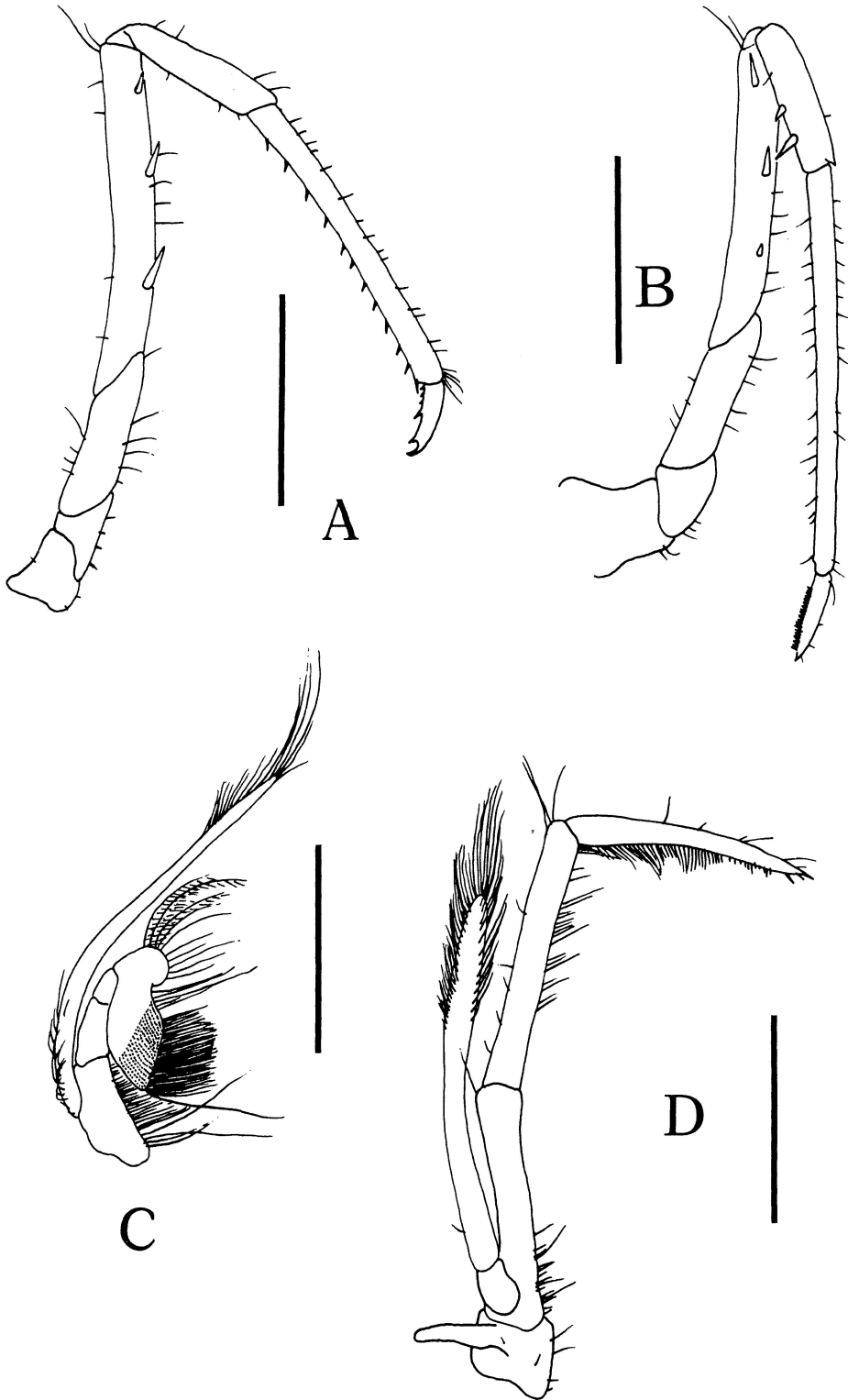


Fig. 10. *Caridina bakoensis* new species. Sungai Serait. Paratype female (3.4 mm cl) (SM). A, fourth right pereiopod; B, fifth right pereiopod; C, right second maxilliped; D, right third maxilliped. Scales = 1.0 mm.

somite convex; distal edge of pleurite of fifth somite angular; sixth somite slightly longer than telson. Outer margin of telson gently convex, without distinct tooth; dorsal surface with 6 small spines on posterior two-thirds; posterior margin relatively wide, rounded; outer posterior spines short; with 6 intermediate plumose spines. Diarsis of exopod of uropod with about 15 spinules. Scaphocerite reaches beyond antennular peduncle, outer margin slightly convex; inner margin strongly convex. Stylocerite reaches to just before distal edge of antennular peduncle; anterolateral angle of basal segment strongly sharp, produced, reaches beyond mid-point of second segment. First pereopod with elongate carpus, subequal in length to chela, segments unarmed, epipod present; second pereopod with long carpus, longer than chela, segments unarmed, epipod present; third pereopod long, dactylus with 4 sharp, subdistal spines on ventral margin, ventral margin of propodus with 11 movable spinules, ventral margin of merus with 3 movable spines; fourth pereopod with 3 spinules on proximal half of ventral margin of dactylus and 2 spines on distal half, propodus with 12 movable spinules on ventral margin, merus with 3 movable spines on ventral margin; fifth pereopod with large number of comb-like spinules on ventral margin of dactylus, ventral margin of propodus with 18-21 spinules or stiff hairs, ventral margin of carpus with 2 movable spines, ventral margin of merus with 3 movable spines. Egg size (non-eyed stage) 1.0 by 0.6 mm.

Etymology. - The species is named after Bako National Park.

Remarks. - The very large eggs of *C. bakoensis* are its most diagnostic feature as no other species of Sundaic *Caridina* has eggs of this size. *Caridina excavatoides* Johnson, 1961, and *C. temasek* Choy & Ng, 1991, also have large eggs but theirs are distinctly smaller than those of *C. bakoensis* (1.0 by 0.6 mm against ca. 0.8 by 0.5 mm for both *C. excavatoides* and *C. temasek*).

Ecology and biology. - The most outstanding feature of *C. bakoensis* are its very large eggs which measure 1.0 by 0.6 mm, and the larval development is likely to be completely abbreviated (see Choy & Ng, 1991). The number of eggs is very small. The ovigerous paratype female (cl 3.3 mm) has only 16 eggs whereas the ovigerous holotype female (cl 3.6 mm) appears to have a similar number (eggs not removed from abdomen for exact count for holotype).

FAMILY GECARCINUCIDAE

Terrathelphusa Ng, 1989

Terrathelphusa kuchingensis (Nobili, 1901)

Potamon (Geothelphusa) kuchingensis Nobili, 1901: 5.

Potamon (Geothelphusa) kuchingense - Rathbun, 1905: 217.

Parathelphusa (Liothelphusa) kuchingensis - Colosi, 1920: 27.

Thelphusula melanippe buergeri - Bott, 1970b: 61 (part) (not *Potamon (Geothelphusa) burgeri* De Man, 1899)

Terrathelphusa kuchingensis - Ng, 1989b: 127, Pl. 4, Fig. 3, Colour plate 2B.

Remarks. - The genus *Terrathelphusa* contains five described species (Ng, 1989b; Ng & Wowor, 1990) of terrestrial crabs, all of which are known thus far, only from Java and Borneo. The species were previously placed in the genus *Perbrinckia* Bott, 1970, but Ng (1989b) showed that this genus should be restricted for the Sri Lankan species, transferring the Indonesian ones to their own genus (see Bott, 1970a, b; Ng, 1989b).

One of the most poorly known species is *T. kuchingensis* which has not been collected since its description. The types were supposedly obtained from the Kuching area (Nobili, 1901). Ng (1989b), who redescribed the species, also suggested that a red crab photographed by Mr. Gerald Cubitt in Bako (published in Cubitt & Payne, 1990: 137 as a species of *Perbrinckia*) might be *T. kuchingensis*, but in the absence of specimens, this cannot be confirmed. The animal which was photographed was foraging on the well shaded, damp and leaf-strewn forest floor, along the trail to Tajur Falls. This area is a patch of heath forest, about 30 minutes from base camp. "The setting was light forest - not in the open areas. The crab was at the side of the track and scuttled into the undergrowth" (G. Cubitt, in litt., August 3 1994).

***Bakousa*, new genus**

Type species. - *Bakousa sarawakensis*, new species, by present designation.

Diagnosis. - Carapace squarish, posterolateral margins not distinctly separated from gently convex anterolateral margins, epibranchial tooth very low or almost confluent with external orbital angle, postorbital cristae very weak or indistinct, epigastric cristae distinct, margins may be sharp, frontal margin deflexed, with or without ridge just above margin, complete frontal median triangle absent. Ischium of third maxilliped rectangular, exopod with well developed flagellum, longer than width of merus. Ambulatory legs normal, not elongated. Male abdomen T-shaped. G1 stout, directed outwards, terminal segment short, cone-shaped. G2 with long distal segment, longer than half length of elongate basal segment.

Etymology. - The name (gender feminine) is derived from an arbitrary combination of the name Bako (type locality of the type species), and the last three letters of "Thelphusa", a common suffix for many freshwater crab genera.

Remarks. - *Bakousa*, new genus, is established for three species, all from northwestern Borneo. The species, *Bakousa sarawakensis*, new species, *Potamon (Geothelphusa) kenepai* De Man, 1899, and *Potamon (Geothelphusa) hendersonianum* De Man, 1899, all share similar characters in the shape and structure of the G1 and G2. Their G1s are relatively slender, with an elongated cone-shaped terminal segment, and the distal segment of the G2 is equal or longer than the basal segment.

Potamon (Geothelphusa) kenepai was referred to the genus *Adeleana* Bott, 1969 (type species *Adeleana forcarti* Bott, 1969) by Bott (1970), in which the G1 is stout, with the terminal segment short, and the distal segment of the G2 very short, quite unlike that of *Potamon kenepai*. Similarly, *Potamon (Geothelphusa) hendersonianum* was referred to the genus *Thelphusula* Bott, 1969 (type species *Potamon (Geothelphusa) buergeri* De Man, 1899) by Bott (1970). The G1s of *Thelphusula* species however, are very slender, with the terminal segment very long and cylindrical, and the distal segment of the G2 is short to very short (see Bott, 1970b; Ng & Goh, 1987; Ng, 1991). I have examined the types of *Potamon (Geothelphusa) kenepai* and *Potamon (Geothelphusa) hendersonianum* in the Leiden Museum (unpublished data) and neither possess gonopods which permit their retention in the genera *Adeleana* and *Thelphusula* respectively as was done by Bott (1970). On the other hand, their gonopods agree excellently with those of *Bakousa sarawakensis*, and suggest that both should be transferred to *Bakousa* instead.

Bakousa is perhaps closest to the troglobitic *Stygothelphusa* Ng, 1989 (type species by monotypy, *Potamon (Thelphusa) bidiense* Lanchester, 1900), but differs in having a more elongate and rectangular third maxilliped ischium, a much stouter G1 and a proportionately shorter G2 basal segment (see Ng, 1989a). The ambulatory legs and chelipeds of *Stygothelphusa* are also very much longer than those of any *Bakousa* species.

***Bakousa sarawakensis*, new species**

(Figs. 11, 12)

Material examined. - Holotype - male (13.8 by 11.3 mm) (ZRC 1995.233), side tributary flowing into Tajur Waterfall, Sungai Tajur, coll. P. K. L. Ng, 29 Jun.1994.

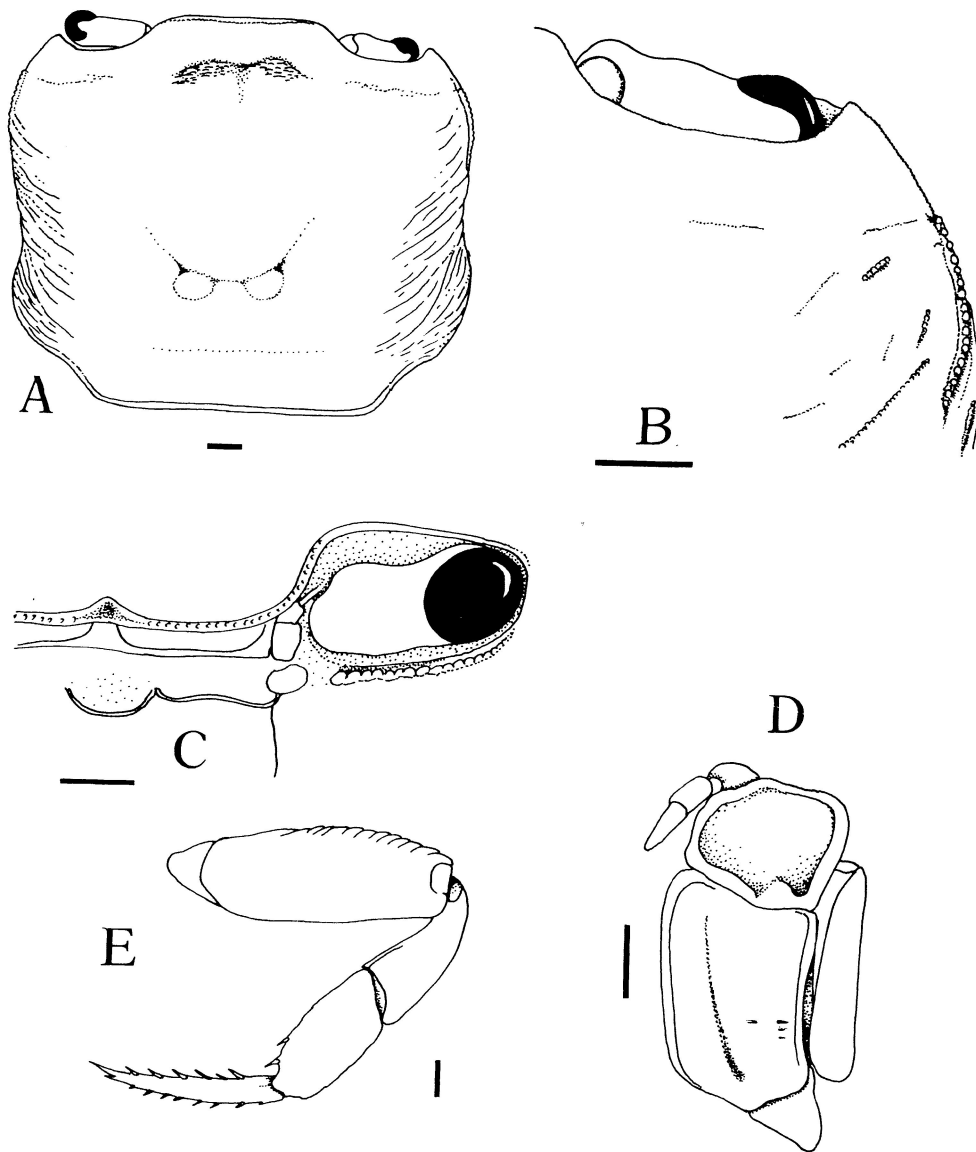


Fig. 11. *Bakousa sarawakensis*, new species. Holotype male (13.8 by 11.3 mm) (ZRC 1995.233), Tajur Waterfall. A, carapace; B, right anterolateral region of carapace; C, front margin and left orbit (frontal view); D, left third maxilliped; E, right fifth ambulatory leg. Scales = 1.0 mm.

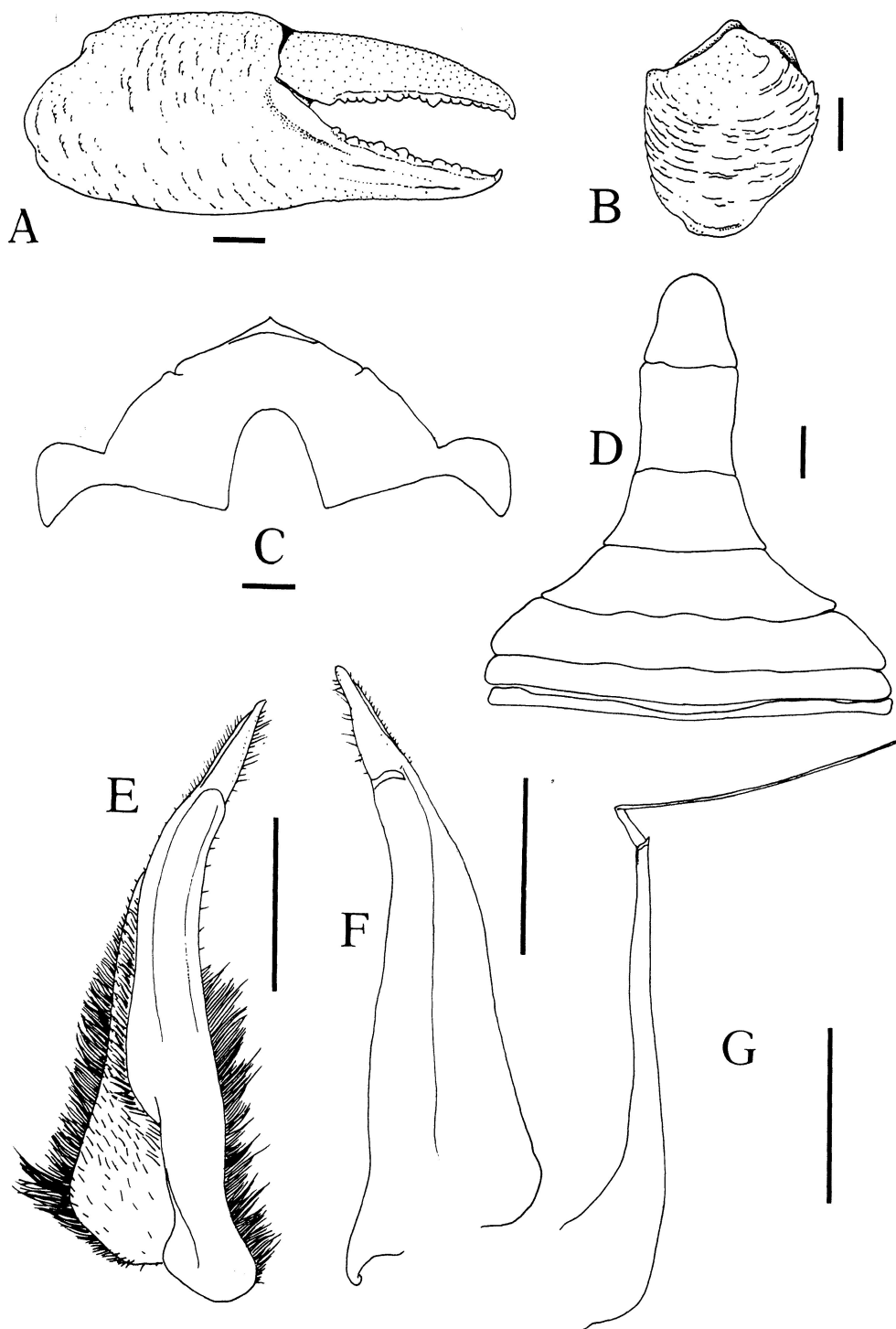


Fig. 12. *Bakousa sarawakensis*, new species. Holotype male (13.8 by 11.3 mm) (ZRC 1995.233), Tajur Waterfall. A, right chela; B, right carpus of cheliped; C, anterior sternal segments; D, abdomen; E, F, left G1; G, left G2. E, ventral view; F, dorsal view. Scales = 1.0 mm.

Paratypes - 1 male (11.3 by 9.2 mm) (ZRC 1995.235), small stream parallel to Tajur Waterfall, Sungai Tajur, about 200 m away, coll. P. K. L. Ng, 29 Jun.1994. — 1 male (7.0 by 5.9 mm) (SM), vegetation in main Tajur Waterfall, Sungai Tajur, coll. T. Tan et al., 29 Jun.1994. — 1 male (8.2 by 7.3 mm) (ZRC 1995.234), upper stretches of Sungai Serait, Bukit Gondol, in leaf litter, coll. N. Sivasothi et al., 28 Jun.1994.

Diagnosis. - Lateral regions of carapace very rugose; epibranchial tooth indistinct, almost confluent with external orbital angle; outer margin of external orbital angle lined with fine rounded granules, with those on anterolateral margin distinctly larger. Postorbital cristae indistinct, epigastric cristae rugose, not crested; frontal margin straight, no trace of dorsal ridges. G1 terminal segment short, cone-shaped, ca. 0.2 times length of subterminal segment. G2 with long distal segment, ca. 0.7 times length of basal segment.

Etymology. - The species is named after the state of Sarawak.

Remarks. - The species is easily separated from the other two *Bakousa* species. Compared to *B. kenepai*, *B. sarawakensis* has an almost undiscernible epibranchial tooth (small but visible in *B. kenepai*), the frontal margin is almost straight (sinuous in *B. kenepai*), the lateral regions of the carapace, ambulatory legs and outer surfaces of the chelipeds are much more rugose (almost smooth in *B. kenepai*), the epigastric regions are rugose, without any distinct crest (margins sharp in *B. kenepai*), and the G1 subterminal segment is proportionately shorter and stouter. Compared to *B. hendersoniana*, *B. sarawakensis* has no ridges above the frontal margin (distinct in *B. hendersoniana*), the lateral regions of the carapace, ambulatory legs and outer surfaces of the chelipeds are more rugose (almost smooth in *B. hendersoniana*), and the G1 is straighter (curved more strongly outwards, with the distal part of the subterminal segment more bent in *B. hendersoniana*).

It seems unlikely that *B. sarawakensis* is conspecific with the red Bako crab tentatively identified as *Terrathelphusa kuchingensis* in Ng (1989b). Not only was the red Bako crab fully terrestrial (Ng, 1989b: 128), its carapace was also much more strongly inflated and the frontal margin was more strongly deflexed (Ng, 1989b: colour plate 2B). The colour of *B. sarawakensis* is also dark brown, and not bright red.

Ecology and biology. - The holotype was collected from under a large rock in a shallow stream next to the main waterfall. The paratype male from Tajur was obtained inside a rotting piece of submerged wood, whereas the Gondol male was collected in leaf litter.

FAMILY PARATHELPHUSIDAE

Perithelphusa borneensis (Von Martens, 1868)

(Fig. 13)

Thelphusa borneensis Von Martens, 1868: 18.

Perithelphusa borneensis - Bott, 1969: 363; Bott, 1970b: 68, Pl. 16 fig. 86-88, Pl. 29 fig. 63.

(See Bott, 1970b for rest of synonymy)

Material examined. - 1 male (ZRC 1995.231), Ulu Assam trail, site 5, coll. D. Chung et al., 29 Jun.1994. — 3 juveniles (ZRC 1995.229), Ulu Assam trail, first two streams, coll. D. Chung et al., 30 Jun.1994. — 2 females (ZRC 1995.227), Ulu Assam trail, coll. at night, P. K. L. Ng, 28 Jun.1994. — 1 male (ZRC1995.232), Ulu Assam trail, coll. K. L. Yeo, 30 Jun.1994. — 5 males, 9 juveniles (ZRC 1995.230), middle stretches of Sungai Serait, coll. N. Sivasothi et al., 1 Jul.1994. — 3 juveniles (ZRC1995.228), upper stretches of Sungai Serait, Bukit Gondol, coll. N. Sivasothi et al., 28 Jun.1994.

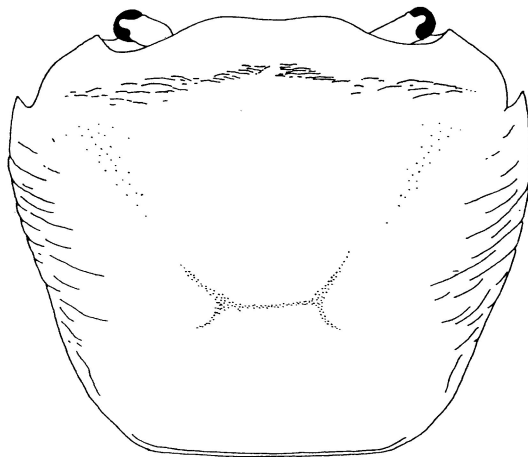


Fig. 13. *Perithelphusa borneensis*. Female (23.3 by 19.9 mm) (ZRC 1995.227). Carapace. Scale = 1.0 mm.

Remarks. - Four species are now known at present in *Perithelphusa*, viz. *P. borneensis* (Von Martens, 1868), *P. buettikoferi* (De Man, 1899), *P. rouxi* Bott, 1970, and *P. lehi* Ng, 1986 (see Ng, 1986). Bott (1970) synonymised *Potamon* (*Perithelphusa*) *borneensis* var. *hiliaris* De Man, 1899, and *Potamon* (*Perithelphusa*) *silvicola* De Man, 1899, with *Perithelphusa borneensis* (Von Martens, 1868), an action which I agree with.

Perithelphusa borneensis has been well characterised by other workers (see Bott, 1970b) and adults cannot be mistaken for any other species in western Borneo. The swollen carapace is very distinctive, although the dorsal surface is less convex when specimens are young.

Perithelphusa borneensis has a very wide distribution in northern Borneo, occurring from western and northwestern Kalimantan through Sarawak to the Mulu area (Bott, 1970b; Holthuis, 1986; unpublished data).

The live colour is dark green to reddish-brown, with smaller specimens possessing numerous small black spots on the carapace, chelipeds and ambulatory legs.

Ecology and biology. - The species occurs in all kinds of water bodies, from stagnant pools and streams in freshwater and peat swamps to clear-water streams and rivers (unpublished data). The inflated carapace seems to be an adaptation to living in poorly oxygenated water rather than for a terrestrial lifestyle. Specimens of *P. borneensis* have never been observed on dry land, and were always collected inside water.

FAMILY GRAPSIDAE

Pseudosesarma bocourti (A. Milne Edwards, 1869) (Fig. 14)

Sesarma bocourti A. Milne Edwards, 1869: 28.

Sesarma (*Sesarma*) *bocourti* - Tesch, 1917: 135.

Pseudosesarma bocourti - Seréne & Soh, 1970: 400.

(See Tesch, 1917 for rest of synonymy)

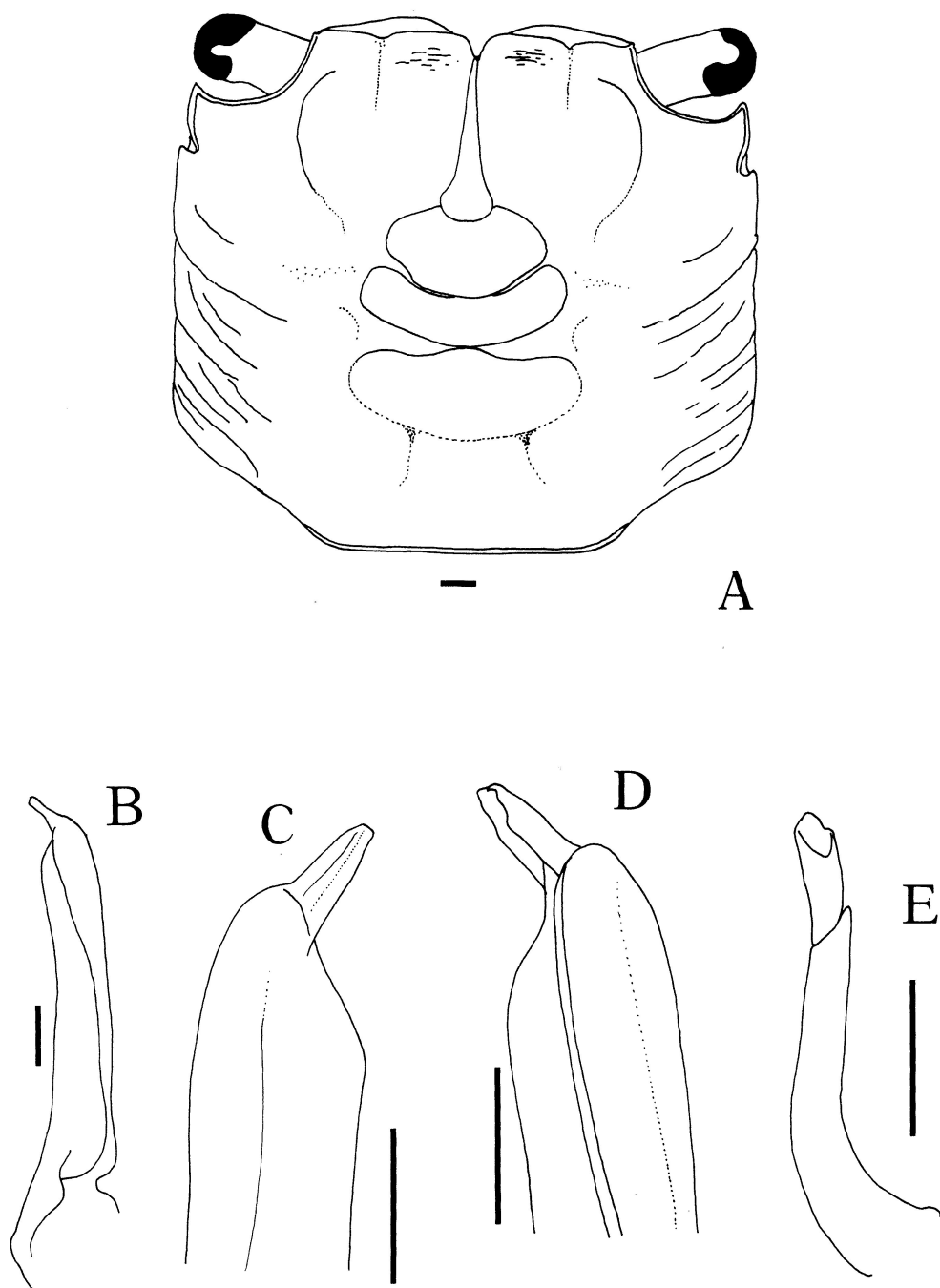


Fig. 14. *Pseudosesarma bocourti*. Male (26.3 by 23.0 mm) (ZRC 1995.226). A, carapace (hairs denuded); B, left G1 (hairs denuded); C, D, distal part of left G1 (hairs denuded); E, left G2. A, D, dorsal view; C, ventral view. Scales = 1.0 mm.

Material examined. - 1 male (26.3 by 23.0 mm) (ZRC 1995.226), 1 male, 1 female (SM/FDS), in peat swamp, beginning of Ulu Assam trail, coll. P. K. L. Ng, 28 Jun.1994. — 1 male (ZRC 1995.225), in peat swamp, beginning of Ulu Assam trail, coll. P. K. L. Ng & M. Lateef, 29 Jun.1994.

Remarks. - This is a rather poorly known sesarmine species first described from Bangkok (Thailand) and since been reported from Japan, Borneo and Malaysia (see Tesch, 1917; Tweedie, 1940). Tweedie (1940) queried the record from Japan, the species otherwise having a Southeast Asian distribution. The species was first recorded from Sarawak by Zehntner (1894). It is uncertain if all the specimens from Malaysia, Borneo and Sumatra referred to this species are actually conspecific, and there appear to be differences in the proportions of the male abdomen and structure of the chelae. A re-examination of the types is necessary before any more can be said.

Ecology and biology. - In the ZRC is a large series of this species from freshwater swamps in Kota Tinggi, Johor which had been collected by the late Michael Tweedie. I have also obtained specimens from coastal peat swamps in Pekan (Pahang) and Sarawak. The present specimens agree very well with these specimens.

They dig burrows in the peat substrate, often among roots and debris, and emerge only late at night to feed on dead leaves and other vegetable matter. The crabs are terrestrial in habits and have been obtained several hundred metres from the nearest water source. The habitat (a coastal peat swamp) where they were collected, the beginning of the Ulu Assam trail, is only about 300 metres from the sea.

ACKNOWLEDGEMENTS

I thank Abang Kassim (Deputy Director of Forestry, Sarawak) and Encik Sapuan (Head, Sarawak National Parks) for permission to collect in Bako. The kind help rendered by Charles Leh (Ministry of Environment and Tourism, and Sarawak Museum) at all levels helped to make the survey of Bako a success, for which we are most grateful. Peter Davie (Queensland Museum) kindly identified *Pseudosesarma bocourti* for me during his visit here. Lipke Holthuis kindly reviewed the manuscript. Field assistance by N. Sivasothi, Tommy Tan, Daphne Chung and Alvin Wong, as well as the Zoology Honours Class (1994) is gratefully acknowledged.

REFERENCES

- Ashton, P. S., 1971. The plants and vegetation of Bako National Park. *Malay. Nat. J.*, Kuala Lumpur, **24**: 151-162.
- Bott, R., 1969. Flussskribben aus Asien und ihre Klassifikation. (Crustacea, Decapoda). *Senckenbergiana biol.*, Frankfurt, **50**(5/6): 359-366.
- Bott, R., 1970a. Die Susswasserkrabben von Ceylon. *Ark. Zool.*, **22**: 627-640, Pls. 1-6.
- Bott, R., 1970b. Die Susswasserkrabben von Europa, Asien, Australien und ihre Stammesgeschichte. Eine Revision der Potamoidea und Parathelphusoidea (Crustacea, Decapoda). *Abh. Sencken. Naturf. Ges.*, Frankfurt, **526**: 1-338, Pls. 1-58.
- Bouvier, E. -L., 1925. Recherches sur la Morphologie, les variations et la distribution systematique des crevettes d'eau douce de la famille des Atyides. *Encyclopedie Entomologique*, **4**: 1-370.

- Chong, S. S. C., 1989. A new species of freshwater prawn, *Macrobrachium gua* sp. nov. (Decapoda, Caridea, Palaemonidae) from Sabah, East Malaysia, Borneo. *Crustaceana*, Leiden, **56**(1):31-38.
- Chong, S. S. C. & H. W. Khoo, 1987a. Abbreviated larval development of the freshwater prawn, *Macrobrachium pilimanus* (De Man, 1879) (Decapoda: Palaemonidae), reared in the laboratory. *J. Nat. Hist.*, London, **21**: 763-774.
- Chong, S. S. C. & H. W. Khoo, 1987a. A new species of freshwater prawn, *Macrobrachium johnsoni* spec. nov. (Decapoda: Caridea: Palaemonidae) from Peninsular Malaysia, and a description of its first zoea. *Zool. Med.*, Leiden, **61**(25): 359-370.
- Chong, S. S. C. & H. W. Khoo, 1987b. *Macrobrachium ahkowi* nom. nov., a replacement name for *Macrobrachium johnsoni* Chong & Khoo, 1987, preoccupied by *Macrobrachium johnsoni* Ravindranath, 1979 (Decapoda: Caridea: Palaemonidae). *Zool. Med.*, Leiden, **61**(37): 561-562.
- Chong, S. S. C. & H. W. Khoo, 1987c. Abbreviated larval development of the freshwater prawn, *Macrobrachium pilimanus* (De Man, 1879) (Decapoda: Palaemonidae), reared in the laboratory. *J. Nat. Hist.*, London, **21**: 763-774.
- Chong, S. S. C. & H. W. Khoo, 1987d. *Macrobrachium malayanum* (Roux, 1934) stat. nov. (Decapoda, Palaemonidae) as a synonym of *M. geron* Holthuis, 1950, with notes on its distribution. *J. Nat. Hist.*, London, **21**: 903-913.
- Chong, S. S. C., H. W. Khoo & P. K. L. Ng, 1987. Presence of the Japanese freshwater prawn *Macrobrachium nipponense* (De Haan, 1849) (Decapoda, Caridea, Palaemonidae) in Singapore. *Zool. Med.*, Leiden, **61**(22): 313-317.
- Choy, S. C. & P. K. L. Ng, 1991. A new species of freshwater atyid shrimp, *Caridina temasek* (Decapoda: Caridea: Atyidae) from Singapore. *Raffles Bull. Zool.*, **39**(2): 265-277.
- Colosi, G., 1920. I Potamonidi del R. Museo Zoologico di Torino. *Boll. Mus. Zool. Anat. comp.*, R. Univ. Torino, **35**(734): 1-39.
- Cubitt, G. & J. Payne, 1990. *Wild Malaysia. The wildlife and scenery of Peninsular Malaysia, Sarawak and Sabah*. New Holland Publishers, London, 208 pp.
- Holthuis, L. B., 1950. Subfamily Palaemonidae. The Palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. I. The Decapoda of the Siboga Expedition. Part X. *Siboga Exped. Monogr.*, **39**(a9): 1-268.
- Holthuis, L. B., 1979. Cavernicolous and terrestrial decapod crustacea from northern Sarawak, Borneo. *Zool. Verh.*, Leiden, **171**: 1-47, Pls. 1-8
- Holthuis, L. B., 1986. Decapoda. In: *Stygofauna Mundi. A Faunistic, Distributional, and Ecological Synthesis of the World fauna inhabiting Subterranean Waters (including the Marine Interstitial)*. Ed. L. Botosaneanu, Leiden, E. J. Brill. Pp. 589-615.
- Johnson, D. S., 1960. Sub-specific and infra-specific variation in some freshwater prawns of the Indo-Pacific region. *Proceedings of the Centenary and Bicentenary Congress of Biology*, Singapore, 1958, pp. 170-181.
- Johnson, D. S., 1961. Notes on the freshwater Crustacea of Malaya. I. The Atyidae. *Bull. Natn. Mus. Singapore*, **26**: 120-153.
- Johnson, D. S., 1963. Distributional and other notes on some freshwater prawns (Atyidae and Palaemonidae) mainly from the Indo-West Pacific Region. *Bull. Natn. Mus. Singapore*, **32**: 5-30.
- Lanchester, W. F., 1900. On some malacostracous crustaceans from Malaysia in the collection of the Sarawak Museum. *Ann. Mag. nat. Hist.*, (7)**6**(33): 249-265, Pl. 12.

- Man, J. G. De, 1879. On some new and imperfectly known Podophthalmus crustacea of the Leyden Museum. *Notes Leyden Mus.*, 1: 53-73.
- Man, J. G., De, 1892. Decapoden des Indischen Archipels. *Zool. Ergebnisse einer Reise in Niederlandisch Ost-Indien*, 2: 265- 527.
- Man, J. G. De, 1898. Zoological Results of the Dutch Scientific Expedition to Central Borneo. The Crustacea. Part I, Palaemonidae. *Notes Leyden Mus.*, 20: 137-161, Pls. 6-8.
- Man, J. G. De, 1899. Zoological Results of the Dutch Scientific Expedition to Central Borneo. The Crustacea. Part II, Brachyura. *Notes Leyden Mus.*, 21: 53-144, Pls. 5-12.
- Man, J. G. De, 1902. Die von Herrn Professor Kükenthal in Indischen Archipel gesammelten Dekapoden und Stomatopoden. In: W. Kükenthal, Ergebnisse einer zoologischen Forschungsreise in den Molukken und Borneo. *Abh. Senckenberg. Naturforsch. Ges.*, 25: 467-929, Pls. 19-27.
- Martens, E., Von, 1868. Ueber einige neue Crustaceen. *Monatsber. k.-p. Akad. Wiss. Berlin*, 1868: 608-615.
- Milne Edwards, A., 1869. Notes sur quelques nouvelles espèces du genre *Sesarma* (Say). *Nouv. Arch. Mus. Hist. Nat.*, Paris, 5: 25-31.
- Milne Edwards, H., 1837. *Histoire naturelle des Crustacés, comprenant l'anatomie, la physiologie et la classification de ces animaux*. Paris. 2: 1-532, atlas, plates 1-14, 14 bis, 15-25, 25 bis, 26-42.
- Ng, P. K. L., 1985. Freshwater Decapod Crustaceans from Pulau Tioman, West Malaysia. *Zool. Med., Leiden*, 59(14): 149-162.
- Ng, P. K. L., 1986. *Perithelphusa lehi* sp. nov., a new species of freshwater crab from Sarawak (Crustacea Decapoda, Brachyura, Parathelphusidae). *Sarawak Mus. J.*, Kuching, n.s., 36(57): 291-295, Pls. 15, 16.
- Ng, P. K. L., 1989a. The identity of the cavernicolous freshwater crab *Potamon (Thelphusa) bidiense* Lanchester, 1900 (Crustacea: Decapoda: Brachyura: Gecarcinucidae) from Sarawak, Borneo, with description of a new genus. *Raffles Bull. Zool.*, Singapore, 37: 63-72.
- Ng, P. K. L., 1989b. *Terrathelphusa*, a new genus of semiterrestrial freshwater crabs from Borneo and Java (Crustacea: Decapoda: Brachyura: Sundathelphusidae). *Raffles Bull. Zool.*, Singapore, 37: 116-131, Colour Plate 2A, B.
- Ng, P. K. L., 1990. The Freshwater Crabs and Prawns of Singapore. In: *Essays in Zoology*. Eds. L. M. Chou and P. K. L. Ng. Department of Zoology, National University of Singapore. Pp. 189-204.
- Ng, P. K. L., 1991. Bornean freshwater crabs of the genus *Arachnothelphusa* gen. nov. (Crustacea: Decapoda: Brachyura: Gecarcinucidae). *Zool. Med.*, Leiden, 65(1): 1-12.
- Ng, P. K. L. & S. C. Choy, 1990. The Caridean Prawns (Crustacea: Decapoda) of the Endau-Rompin Park, Malaysia. *Malay. Nat. J.*, Kuala Lumpur, 43(4): 302-312.
- Ng, P. K. L. & S. C. Choy, 1990. Notes on some freshwater caridean prawns (Palaemonidae and Atyidae) from the Endau-Rompin area, Johore-Pahang, Peninsular Malaysia. *Raffles Bull. Zool.*, Singapore, 38(1): 11-20.
- Ng, P. K. L. & R. Goh, 1987. Cavernicolous freshwater crabs (Crustacea Decapoda, Brachyura) from Sabah, Borneo. *Stygologia*, Leiden, 3(4): 313-330, Pls. 1-3.
- Ng, P. K. L. & D. Wowor, 1990. *Terrathelphusa adipis*, new species (Crustacea: Decapoda: Brachyura: Sundathelphusidae) from Kalimantan, Borneo. *Raffles Bull. Zool.*, Singapore, 38(2): 263-268.

- Nobili, G., 1901. Note intorno ad una collezione di Crostacei di Sarawak (Borneo). *Boll. Mus. Zool. Anat. Comp.*, R. Univ. Torino, **16**(397), 1-14.
- Rathbun, M. J., 1905. Les crabes d'eau douce. *Nouv. Arch. Mus. Hist. nat.*, Paris, (4)7: 159-323, Pls. 13-22.
- Rothschild, G., 1971. Animals in Bako National Park. *Malay. Nat. J.*, Kuala Lumpur, **24**: 163-169.
- Sabar, F., 1979. Kehidupan Udang Regang, *Macrobrachium sintangense* (De Man). *Berita Biologi*, Bogor, **2**(3): 45-49.
- Seréne, R. & C. L. Soh, 1970. New Indo-Pacific genera allied to *Sesarma* Say 1877 (Brachyura, Decapoda, Crustacea). *Treubia*, Bogor, **27**(4): 387-416.
- Tesch, J. J., 1917. Synopsis of the genera *Sesarma*, *Metasesarma*, *Sarmatium* and *Clistocoeloma*, with a key to the determination of the Indo-Pacific species. *Zool. Meded.*, **3**: 127-260, Pls. 15-17.
- Wilford, G. E., 1971. Geology of Bako National Park. *Malay. Nat. J.*, Kuala Lumpur, **24**: 170-172.
- Zehntner, L., 1894. Crustacés de l'Archipel Malais. *Rev. Suisse Zool.*, **2**: 135-214, Pls. 7-9.

Received 20 Dec 1994

Accepted 25 Feb 1995