

# CAVERNICOLOUS AND TERRESTRIAL DECAPOD CRUSTACEA FROM NORTHERN SARAWAK, BORNEO

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With 9 text-figures and 8 plates

During the 1977-1978 Royal Geographical Society Mulu (Sarawak) Expedition a number of Decapod Crustacea was obtained. Some were collected by Mr. Philip Chapman in the course of studies of the invertebrates of the limestone caves in the Gunong Mulu National Park, 4th Division of Sarawak, and the Niah National Park south of Miri. Another expedition member, Dr. N. M. Collins, collected several crabs in pitfall traps and one in a soil core in the course of studies of terrestrial invertebrates of the Mulu area.

I am most indebted to Messrs Chapman and Collins for placing this interesting collection of cavernicolous and terrestrial Decapoda at my disposal, and for the extensive information on the localities, habitats and the biology of the species, as well as for descriptions of the colour of living specimens.

The material, including holo- and allotypes, now forms part of the collection of the Rijksmuseum van Natuurlijke Historie, Leiden. Paratypes of the new species and duplicates of others are deposited in the British Museum (Natural History).

After the report on the above collections was written, three more freshwater crabs, this time collected by the botanists of the expedition, were received through the kind offices of Dr. R. W. Ingle, British Museum (Natural History). As these specimens provided important additional information (two specimens were males of a new species, which in the other material was only represented by females; the third was a species not collected by either Mr. Chapman or Dr. Collins), they are included here. The material (a female of *Palawanthelphusa pulcherrima* and the male holo- and paratypes of *Sundathelphusa tenebrosa*) forms part of the collection of the British Museum.

The abbreviations cb., cl., and tl. are used here for carapace breadth, carapace length, and total length, respectively.

Text-figures 2a, d, and 3a, and pls. 1 and 2 have been executed by Mr. A. Bos, staff artist of the Rijksmuseum van Natuurlijke Historie, who also inked the other text-figures. Mr. E. L. M. van Esch, photographer of the Museum, made the photographic illustrations of pls. 3 to 7. For the colour photograph of pl. 8, I am much indebted to Mr. P. Chapman.

#### LOCALITIES

The following information has partly been obtained from the collectors and is partly cited from the publication "Caves of Mulu" edited by D. B. Brook and A. C. Waltham, published in 1978 by the Royal Geographical Society, London.

The Gunong Mulu National Park, established in 1975, is situated in the extreme northern part of Sarawak at about 4°N 115°E and covers more than 500 square km. The altitude varies from about 65 m in the alluvial lowland rainforest to that of the summit of Gunong (= Mt.) Mulu of 2376 m. In the central part, around Gunong Api there are limestone ridges containing the caves dealt with below; this area lies in the basin of the Tutoh River (Sungei Tutoh) a tributary of the Baram River. Most of the caves have the longitudinal axis S.W.-N.E., and all are more or less parallel. In the park Decapoda were collected in the following localities:

1. The alluvial lowland rain forest. The lowest part of the park (altitude about 65 m) is covered by alluvial lowland rain forest which is frequently flooded by heavy rains that cause the rivers to overflow. The water table was very near the soil surface, and the whole area was dissected by small streams although the nearest large river was about a kilometre away. Standing water was frequent after rain storms. Crabs were collected in pitfall traps (one was obtained in a soil core). Species obtained: *Thelphusula granosa* new species, *Perbrinckia loxophthalma* (De Man), *Geosesarma gracillima* (De Man).

2. Deer Cave, Gua Payau (Brook & Waltham, 1978: 7-10, maps, figs.). This cave is situated in the extreme south of Gunong Mulu National Park. It is a single tunnel-like passage through a limestone ridge east of the valley of the Melinau River. The surveyed length of the cave is about 1750 m, the distance between the northern and southern entrance is about 900 m. It is nowhere less than 90 m high and wide and therefore day light penetrates practically the entire cave. A small stream passes through the larger part of the cave. A river in the northern part of the cave connects, through a sump area, with the river of the Deer Water Cave (see below, no. 3). Just north of the midpoint of the cave, a steep ramp by the west wall allows a high level loop of passage to be reached. A small side passage off the

loop contains a trickling stream (named "Crab Inlet") which enters two gravel-floored pools containing swiftlet guano. In one pool, the water has a temperature of 23°C, an O<sub>2</sub> saturation of 67%, and a conductivity ( $\Omega^{-1}$ ,  $\text{cm}^{-1} \times 10^{-6}$ ) of 111. In this pool two specimens of the crab *Cerberusa caeca* were observed, one was collected. Opposite the above mentioned ramp, against the eastern wall of the main passage is another pool, the "Guano Pool", which is approximately 20 m<sup>2</sup> in area and nowhere more than 5 cm deep. The bottom consists of a layer of bat guano of about 1 m. The water has a temperature of 23.7°C, an O<sub>2</sub> saturation of 48% and a conductivity of 252. The smell, because of the bat guano, is very bad. The only species found here is the shrimp *Macrobrachium clymene*. The outflow of the Guano Pool joins the small inlet stream that passes through the greater part of the cave to emerge at the southwestern entrance of the cave. The water of this stream, which passes large deposits of bat guano in the cave, smells about as bad as that of Guano Pool; apart from bat guano, the substrate consists of gravel and slimy rocks, the temperature of the water of the stream was noted to be 23.5°C, the O<sub>2</sub> saturation 104%, and the conductivity 86. In this stream, at about 100 m from the S.W. entrance the shrimps *Macrobrachium clymene* and *M. pilimanus* were collected, as well as the crab identified here as *Sundathelphusa tenebrosa* new species.

3. Deer Water Cave, Lubang Sungei Payau (Brook & Waltham, 1978; 11, fig., map on p. 8). A narrow simple conduit for a river, which lies just west of and parallel with Deer Cave, with which it is connected at the northern end through a sump area. It is about 600 m long. In this cave, about 100 m from the southern (and only) entrance a specimen of *Sundathelphusa tenebrosa* was found.

4. Snake Cave, Lubang Ular (Brook & Waltham, 1978: 7, 12, map). A small cave, 1 km of which has been explored. Like the northern entrance of Deer Cave (no. 2) it opens into the Garden of Eden Valley, its entrance being about 180 m north of that of Deer Cave. Snake Cave contains a small stream, which drains a terrace above the level of the main river. This stream and that of Deer Cave originate from a common drainage basin. The only species collected here was the shrimp *Macrobrachium clymene*.

5. Green Cave, Lubang Hijau (Brook & Waltham, 1978: 7, 10, 12-15, figs., maps). This cave lies to the north of both Deer and Snake Caves and runs parallel with them. Its southern entrance opens high on the north slope of the Garden of Eden Valley, and it passes through the full width of the range north of the valley, emerging on the north flank of it. It is a fossil conduit and appears to have been the continuation to the north of Deer Cave. Its explored length is about 3 km, the direct distance between the north and

south entrances is about 1500 m. The cave is high (about 90 m) in the south, lower (about 25 m) in the north. A small stream that flows from south to north is seen at times in it. Four specimens of the crab *Cerberusa caeca* were collected in this stream, slightly north of the middle of the cave, at about 600 m from the north entrance.

6. Clearwater Cave, Gua Air Jernih (Brook & Waltham, 1978: 7, 16-25, figs., maps). This is the largest of all the caves of Gunong Mulu National Park, and like the others it extends roughly in a S.W.-N.E. direction. The explored passages are about 25 km long. The direct distance between the northern and southern entrances is more than 5 km. The southern part of the cave forms a passage way for the Clearwater River; the river passage is about 30 m high and wide, its length is almost 2 km. In the river the shrimp *Macrobrachium pilimanus* (at about 500 and 1200 m from the entrance) was found as well as the crab *Sundathelphusa tenebrosa* (at about 1400 and 1800 m from the entrance). Beyond the passage of the Clearwater River the cave continues north as a fossil tunnel, the southern part of which is called Inflation Passage, followed later by Revival Passage (about 750 and 1600 m long, respectively), near its northern end Revival Passage has a branch of about 600 m long carrying the same name. The two passages are roughly about 25 to 50 m high and have on the average a similar width. At six places in Inflation and Revival Passages the crab *Cerberusa caeca* was found; it occurred in small pools with a bottom of clay, some with a deposit of limestone flakes or swiftlet guano. The water temperature in these pools was found to be 22.5 to 22.9°C, the O<sub>2</sub> saturation 87 to 98% and the conductivity 75 to 99. On a level below the side branch of Revival Passage and connected with it, is a narrow passage, named Snake Track, which has an entrance to the west, opening into the Melinau River Valley. At a distance of about 15 m from the entrance of Snake Track, the crab *Cerberusa tipula* was found on flow stone in an area of smooth stalagmitic deposit, interspersed with clear pools. In the northern part of Clearwater Cave, between Revival Passage and the northern exit, a distance of roughly 1400 m, no Decapoda were collected.

7. Wonder Cave, Gua Ajaib (Brook & Waltham, 1978: 7, 27-33, maps, figs.). This cave is situated to the east of the northern part of Clearwater Cave, and has its entrance on the northern slope of Hidden Valley. Three miles of passage have been explored in it. It is formed by a rather complex, often zig-zag arranged set of passages. Only a single species of Decapod was found here, viz., the crab *Cerberusa tipula*, a specimen of which was obtained at about 10 m from the entrance, where the passage is only a few metres wide and high.

8. Sink hole in Hidden Valley. Hidden Valley is a limestone valley south of Gunong Api; several caves (e.g., Wonder Cave) open into it. In a sink hole, i.e. a place where a river disappears underground, 2 specimens of the crab *Isolapotamon collinsi* were collected. This sinkhole marks the place where the Clearwater River after being epigeal in Hidden Valley, disappears underground in small fissures among boulders and sand; the river turns up again in Clearwater Cave as an underground river, about 4 km to the southeast.

The only locality outside Gunong Mulu National Park, where during the expedition Decapoda were collected is the following:

9. Niah Great Cave, one of the well known Niah Caves (about 3°49'N 113°47'E) situated to the south of Miri (4°23'N 113°59'E) and 90 km west-south-west of Gunong Mulu National Park. Crabs belonging to the species *Adeleana chapmani* were found here in shallow pools with a bottom of mud and gravel, containing swiftlet droppings. The collector remarked: "In view of the constant traffic of tourists, nest-gatherers and guano sweepers in Niah Caves (the floor is beaten hard and flat by countless feet, and it is very difficult to find even tiny patches of undisturbed guano) it is amazing that these animals persist".

#### SYSTEMATIC ACCOUNT

#### Macrura Natantia (shrimps)

#### PALAEMONIDAE

#### **Macrobrachium clymene** (De Man, 1902)

*Palaemon (Macrobrachium) clymene* De Man, 1902: 794, pl. 25 fig. 50.

Deer Cave, Gunong Mulu National Park (loc. 2): in small cave stream about 100 m from southern entrance, where the stream emerges; 7 March 1978. — "Guano Pool" in northern part of Deer Cave, connected with stream in which previous sample was collected; depth of water nowhere more than 5 cm, depth of bat guano deposit on bottom of pool 1 m; 25 April 1978, leg. P. Chapman.

Snake Cave, Gunong Mulu National Park (loc. 4); in stream near entrance; 12 March 1978; leg. P. Chapman.

Size. — In the above three localities 14 specimens were taken in all; the lots of each locality were not kept separate by the collectors. The carapace length of the specimens ranges from 8 to 20 mm, the total length from 19 to 50 mm; there are no ovigerous females in the material.

Descriptive remarks. — The species has been very extensively described and excellently figured by De Man (1902). The present material agrees well

with De Man's account. The rostrum in the above specimens has 7 or 8 dorsal teeth (in De Man's types 8 or 9), and 2 ventral (like in the types); only in a single specimen one instead of two ventral teeth were found.

As most of the legs are detached, it is impossible to say whether or not the large chelipeds are equal, but my impression is that that is so. In most of the second chelipeds the fingers are less than half as long as the palm, resembling De Man's (1902) pl. 25 fig. 50h. These chelipeds, twelve in number (of which only one is attached, viz., to a male with cl. 16 mm) have the chela 12 to 17 mm long; the merus and carpus are of a whitish or bluish colour, the chela is brown or purple with dark chocolate brown fingers. The dentition of the fingers of the largest of these chelipeds shows much resemblance to that in the chela figured by De Man (1902, pl. 25 fig. 50d), having two large teeth on the cutting edge of the dactylus and one, between these, on that of the fixed finger. Immediately behind the proximal large tooth of the dactylus there is a much smaller tooth, while the basal ridge on the cutting edge of the fixed finger, also shown by De Man, in my specimen is distinctly crenulate, consisting of five rounded denticles. The four smaller second legs (length of the chela 7 to 11 mm) are more slender than the larger and the fingers are more than half as long as the palm: in the smallest the length of the fingers is  $\frac{5}{7}$  of that of the palm.

Colour. — In the chelipeds of the preserved specimens the merus and carpus are of a whitish or bluish colour, the chela is brown or purple, with dark chocolate brown fingers. Mr. Chapman, in his field notes, remarked that the specimens from Guano Pool and Snake Cave, apart from the eyes, were colourless, while the specimens from near the entrance of Deer Cave were variable in colour: from pale muddy green-blue to olive-brown, which made them difficult to discern against the streambed, which also had these colours.

Distribution. — The species was originally described after material collected in the Baram River, N. Sarawak, in 1902, and since then was only known from the types. The present specimens are the first additional material to be reported of the species. Holthuis's (1950: 210) discussion of *M. clymene* was based on part of the type series. It is possible that the species has a restricted range, as the present material was collected rather close to the type locality. The exact position of the type locality is not known, De Man (1902: 794) cited it as "aus dem Baramflusse, Borneo". The type material was collected by professor Willy Kükenthal, who visited the Baram River from 4 August to 10 September 1894 (see Kükenthal, 1896: 250-297). During that period he stayed most of the time in or near the town of Baram (= Marudi,  $4^{\circ}11'N$   $114^{\circ}19'E$ ), about 60 miles (= 100 km) above the

mouth of the Baram River and about 50 km west of Mt. Mulu. From 21 August to about 1 September Kükenthal made an excursion up the Baram and Tutoh Rivers: the Baram River was followed up to Long Mari (= Long Miri,  $3^{\circ}35'N$   $114^{\circ}26'E?$ ), and the Tutoh River slightly beyond Batuh Blah (= Rumah Penghulu Bayak,  $4^{\circ}00'N$   $114^{\circ}29'E$ ). The last mentioned locality lies about 25 km south-west of Mt. Mulu. The exact extent of Kükenthal's travels in the Baram River area is shown on his map 7 (Kükenthal, 1896: 264). It is most likely that Kükenthal obtained his freshwater shrimps in the Marudi area as he stayed there longest, but they may even originate from higher up the Baram River basin.

Remarks. — Although the present specimens were collected in caves, they do not show any obvious adaptation to subterranean life and do not seem to be different from Kükenthal's specimens, which evidently were obtained from an epigean river. The fact that the Mt. Mulu animals were taken mostly near the entrances of the caves of course also is significant in this respect.

### **Macrobrachium pilimanus** (De Man, 1879) (fig. 1)

*Palaemon pilimanus* De Man, 1879: 181.

Deer Cave, Gunong Mulu National Park (loc. 2); 7 March-25 April 1978; leg. P. Chapman; 4 specimens.

Clearwater Cave, Gunong Mulu National Park (loc. 6); main stream at 500 and 1200 m from the entrance; 7 April 1978; leg. P. Chapman; 6 specimens (including 1 ovigerous female).

Size. — The carapace length of the specimens varies from 11 to 19 mm and the total length from 30 to 47 mm. The single ovigerous female has cl. 17 mm, tl. 46 mm.

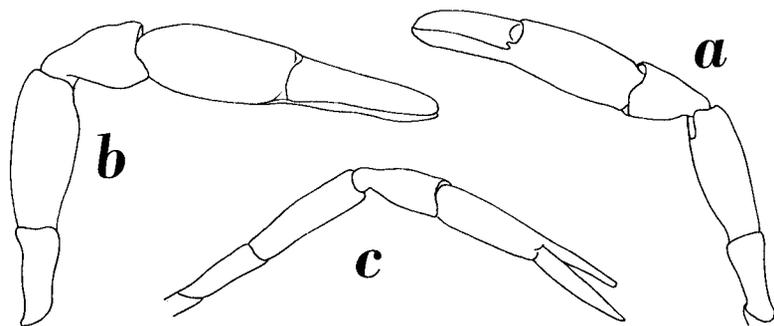


Fig. 1. *Macrobrachium pilimanus* (De Man), from Deer Cave, large second legs. a, specimen with cl. 13 mm; b, specimen with cl. 14 mm; c, specimen with cl. 15 mm. a-c,  $\times 3.5$ .

Descriptive notes. — The subspecies *Palaemon (Macrobrachium) pilimanus leptodactylus* De Man, 1892 and *Palaemon (Macrobrachium) pilimanus malayanus* J. Roux, 1935, which I had synonymized with *Macrobrachium pilimanus* (De Man) (see Holthuis, 1950: 214-220), were resurrected by Johnson (1958: 265, figs. 4, 5; 1964: 10-15, figs. 2, 3) and considered good species: *Macrobrachium leptodactylus* (De Man, 1892) and *M. malayanus* [recte *malayanum*] (J. Roux, 1935).

The above specimens from Clearwater River Cave undoubtedly all belong to the typical *M. pilimanus* as conceived by Johnson: they have the merus of the second pereopod swollen and the carpus short and cup-shaped. None of the specimens has chelipeds like the one illustrated by Johnson (1958, fig. 5B; 1964, fig. 3) for a specimen from Borneo that he considered as possibly belonging to *M. leptodactylus*.

Of the specimens of the other sample (from Deer Cave) two (cl. 13 and 14 mm) are typical *M. pilimanus* in the shape of the merus of the second cheliped, which is swollen, and the carpus, which is cup-shaped (fig. 1a, b). However, the larger of these two specimens has the fingers slightly gaping and longer than the palm, characters, which according to Johnson, are characteristic for *M. malayanum* and *M. leptodactylus*. A third specimen (cl. 15 mm) of the same Deer Cave sample has the carpus much more elongate and the merus not swollen (fig. 1c), and in this respect resembles *M. malayanum*, but it has the fingers about as long as the palm and definitely less hairy than in the typical specimens of *M. pilimanus*; the aspect of the cheliped of this specimen is more that of a juvenile. None of the specimens of this sample fully fits any of the three species as defined by Johnson and each shows characters of at least two of these.

The problem of the *M. pilimanus* complex is so complicated that only the study of an extensive material from numerous localities all over its range and the study of live specimens in their natural habitat, can make clear whether the extraordinary variability within this complex is caused by age, sex, environmental conditions, seasonal conditions, or by taxonomic differences (probably by a combination of some of these). For the time being therefore I treat the various forms as belonging to a single species, *Macrobrachium pilimanus*.

Colour. — In life all specimens were noted to be colourless apart from the black pigment of the eyes.

Distribution. — *Macrobrachium pilimanus* was originally described from Central Sumatra and has since been reported from Java, the Malay Peninsula and Borneo. *M. leptodactylus* has the same distribution, although its occurrence in Borneo needs confirmation. *M. malayanum* is only known from

Malaya and Borneo. All three "species" are found in epigeal waters, viz., fast flowing streams, usually in the mountains. There are a few records of the occurrence of *M. pilimanus* in caves, viz., from Bua Cave near Sidjungdjung, West Sumatra (in tepid water of the cave), from Panumbangan, West Java (in stalactitic caves), from Guwa Gremeng Cave, Sewu Mts., near the south coast of Central Java (in a rivulet); all these cave records are by Holthuis (1950: 215-217). As most records of the species are from outside of caves, it must be considered an incidental troglophile only.

### Brachyura (crabs)

The crabs of the collections studied here must be assigned to three superfamilies: Potamoidea, Gecarcinoidea and Grapsoidea. The first two of these are true fresh water crabs and were formerly considered a single family, viz., the Potamidae (usually incorrectly written Potamonidae). Bott (1970) in his revision of the Indo-West Pacific freshwater crabs, however, recognized no less than 6 families, which he placed in two superfamilies; the latter were named Potamoidea and Parathelphusoidea by him. Although I have the feeling that Bott's superfamilies of freshwater crabs are not of equal rank with the other superfamilies recognized in Brachyura, my experience with these groups is not extensive enough to allow me to give a well-founded opinion; therefore I follow Bott's classification here.

Of the nine species of freshwater crabs discussed in the present report three belong to the Potamoidea and six to the Gecarcinoidea. One species of Grapsoidea is represented.

### Potamoidea

#### POTAMIDAE

#### **Cerberusa** new genus

Definition. — Carapace widest in the frontal area, narrowing posteriorly, convex. Anterolateral margin short, carinate, without teeth or epibranchial incision, carina posteriorly curving onto the dorsal surface of the carapace. Posterolateral margin long, broadly rounded, with transverse curved ridges. Front flat, directed somewhat down, without frontal triangle. Epigastric lobes inconspicuous, post-orbital ridges absent or weak. Cervical groove only visible in the median area.

Abdomen of male triangular, second and third segments widest; third to

seventh segments gradually narrower. Seventh segment an equilateral triangle with a rounded apex.

Eyes smaller to much smaller than the orbit, sometimes reduced and without pigment. Orbits large, orbital margin entire.

Epistome distinct. Efferent openings very large, circular, reaching to lateral margin of oral field.

Mandibular palp three-segmented; last segment simple, not bifurcate.

Third maxilliped without flagellum on exopod. Exposed surface of ischium and merus with a longitudinal groove slightly closer to outer margin than to inner.

Pereiopods slender to very slender. Fingers of chelipeds closing over their full length.

First gonopod of male rather robust, regularly tapering towards the top, which is curved outward. Last segment of first gonopod short, triangular, curved. Second pleopod of male very slender, distal segment thin, thread-like and recurved.

Remarks. — The shape of the mandibular palp shows that the new genus belongs to Bott's (1970: 133) superfamily Potamoidea, and the shape of the gonopod of the male makes its assignment to the family Potamidae necessary. Of the Potamid genera, *Cerberusa* is closest to *Potamon* and *Geothelphusa*. From *Potamon* it differs by the absence of distinct postorbital cristae and epigastric lobes, and by the convex carapace. In these characters it shows a closer resemblance to *Geothelphusa*, from which, however, it differs in (1) the shape of the carapace, which in *Geothelphusa* has the anterolateral margin only slightly shorter than the posterolateral, (2) the absence of a flagellum from the exopod of the third maxilliped, (3) the shape of the large cheliped of the male, which does not have gaping fingers, and (4) the long and recurved second male gonopods, which in *Geothelphusa* are straight and shorter than the first pair.

Type species: *Cerberusa caeca* new species.

Gender of generic name: feminine.

The genus is represented in the present collection by two species, both of which are new. They can be distinguished with the help of the following key:

1. Eyes with distinct pigment. Body not white. Anterolateral margin of carapace carinate, carina anteriorly stopping before reaching the orbital margin. Post-orbital ridges absent. Second and third walking legs (= pereiopods three and four) 2.5 times as long as the width of the carapace . . . . . *Cerberusa tipula* new species
- Eyes strongly reduced, without pigment, filling less than half the orbit. Body colourless. Anterolateral margin of carapace carinate, carina anteriorly fused with orbital margin. Post-orbital ridges present, although weak. Second and third walking legs (= third and fourth pereiopods) about twice as long as carapace width . . . . .  
 . . . . . *Cerberusa caeca* new species

**Cerberusa tipula** new species (text-fig. 2, pl. 1, pl. 3 fig. 1)

Clearwater Cave, Gunong Mulu National Park (loc. 6); 15 m inside entrance of Snake Track (= lower north-west entrance); on flowstone, out of the water; 28 April 1978; leg. P. Chapman; 1 male holotype.

Wonder Cave, Hidden Valley, Gunong Mulu National Park (loc. 7); 10 m from cave entrance; in pool with a bottom sediment of guano; in darkness; 28 March 1978; leg. P. Chapman; 1 female paratype.

Size. — The carapace length of the male holotype is 13 mm, the carapace breadth 18 mm. In the female paratype these measurements are respectively cl. 16 mm, cb. 20 mm.

Description. — The carapace is rather convex, the anterior part is directed distinctly down. It is widest at  $1/4$  of its length measured from the anterior margin; its outline is about trapezoid. The front and the anterolateral margins form a regular faintly convex arch (fig. 2a). The front (fig. 2b), when measured at its base, is about  $1/3$  of the greatest breadth of the carapace. It is directed slightly down and its anterior margin is evenly convex; there is no frontal triangle. The anterolateral angles of the front are more than  $90^\circ$  and are rounded. The dorsal surface of the front carries minute scattered tubercles. The lateral margin of the front merges under a slight curve with the orbital margin which is crested. The epigastric lobes of the carapace are very indistinct and hardly noticeable, the median groove between the lobes is distinct. The postorbital ridges are absent. The anterolateral margin of the carapace is carinated and granular or minutely serrate. Anteriorly the carina stops abruptly before attaining the crested orbital margin; posteriorly it curves inward and continues a short distance over the dorsal surface of the carapace. Before this curved posterior part of the anterolateral carina, the anterolateral part of the carapace shows some short transverse rows of granules, which in the middle of the carapace are replaced by pits. The posterolateral margin of the carapace is very broadly rounded and shows several (more than 10) transverse rows of granules, which start in the lateral part of the posterior region of the dorsal surface of the carapace and extend all the way to the ventral part of the carapace; these rows are often interrupted and irregular. The median area of the posterior half of the carapace, like that of the anterior half, is smooth and pitted and does not show granules at all. The H-shaped depression is distinct; behind it a faint transverse elevation or inconspicuous low and wide transverse ridge is discernable.

The eyes do not quite fill the orbit and can be fully retracted in it. The cornea is distinct and rounded; it is provided with black pigment and is somewhat narrower than and less than half as long as the eyestalk. The outer margin of the orbit is widely rounded and is not in touch with the anterolateral carina. The upper part of the orbital carina is smooth, the lower

portion is evenly and minutely granular; the inner gap of the orbital margin is not quite filled by the antennal peduncle and the antennal flagellum can enter the orbit.

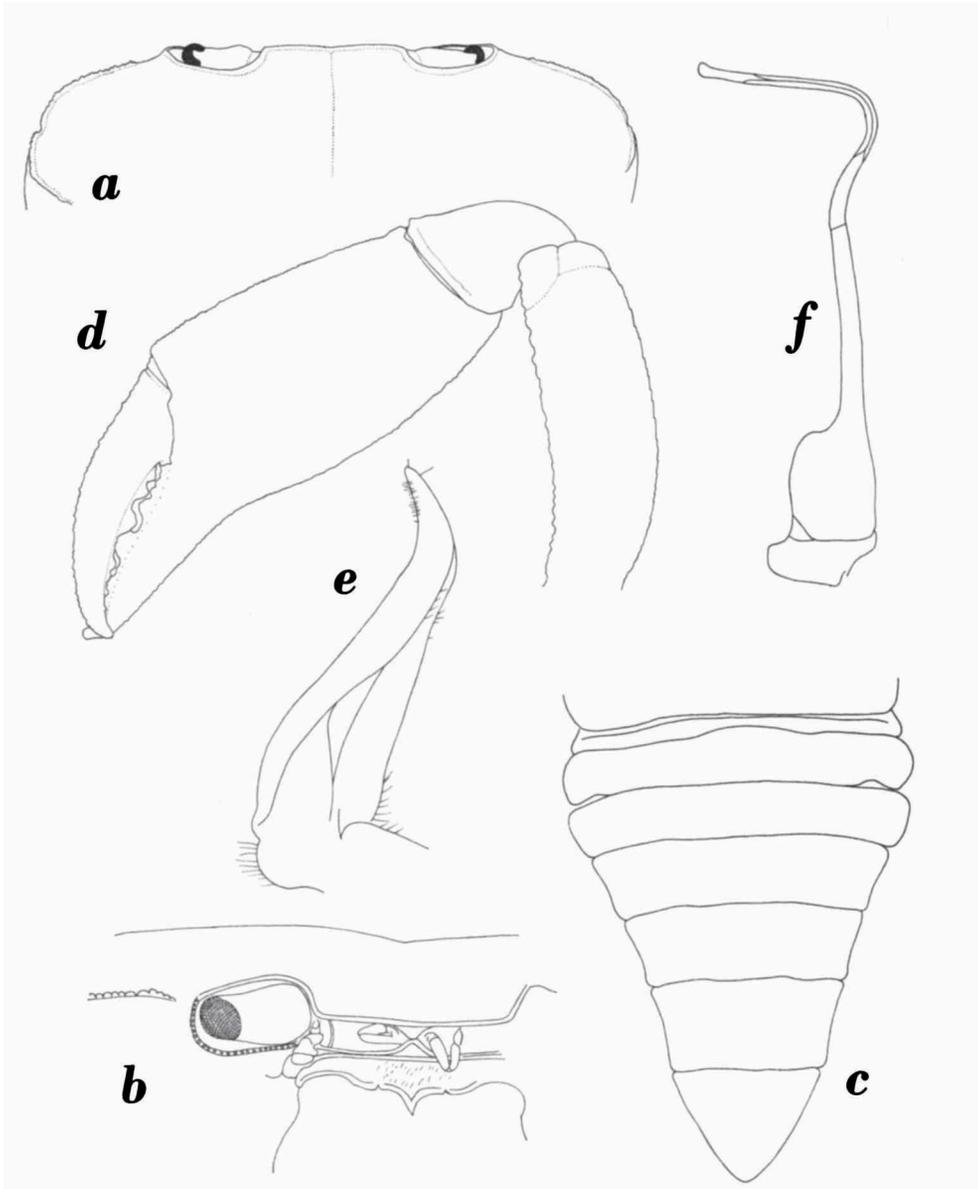


Fig. 2. *Cerberusa tipula* new species, male holotype. a, anterior part of carapace in dorsal view; b, front in anterior view; c, abdomen; d, large cheliped; e, first gonopod; f, second gonopod. a,  $\times 4.5$ ; b, c,  $\times 6$ ; d,  $\times 7$ ; e, f,  $\times 12.5$ .

The epistome has the anterior margin straight. The posterior margin ends in a small triangular median point and near the lateral ends, where it forms the anterior margin of the efferent openings, it is concave. The openings of the efferent channel are very large, occupying about half the width of the epistome, they reach laterally as far as the lateral margin of the oral field.

The last segment of the mandible is oval and simple, not bifurcate, it is slightly longer than the second segment. The third maxillipeds completely fill the oral cavity; their exopods have no flagellum.

The first legs of the male are unequal in size and shape (pl. 3 fig. 1). The larger (the right in the male holotype) (fig. 2d) has the fingers practically as long as the palm (measured along the upper margin). The fingers do not gape, but close over their full length; they end in a sharp curved point, the two points crossing. Both fingers are minutely granular and show a few longitudinal grooves, which are most distinct near the tips. The dactylus shows a large tooth in about the middle of the cutting edge, proximally of which there are two smaller teeth, and distally one still smaller tooth; the rest of the distal part of the edge is minutely serrate or crenulate. The fixed finger has a somewhat similar arrangement of teeth, but instead of two proximal smaller teeth of the same size, there is a row of four teeth, which become smaller towards the base of the finger. The palm of the chela is slightly swollen and minutely granular; it becomes lower towards the base. The carpus has a faint shallow groove on the outer surface and a short triangular tooth on the inner; small granules are present on both surfaces. The merus has stronger granules, but no teeth or spines. The smaller cheliped is more slender than the larger. The fingers are longer than the palm, have grooves and granules similar to those of the large leg, but the cutting edges show only numerous very small denticles which are evenly distributed over their length. The palm is lower and thus more slender than in the large cheliped. In the female (pl. 1) the left and right chelipeds are similar and resemble the small cheliped of the male.

The walking legs are extremely long and narrow. The second pereopod (= first walking leg) is 36 mm long, being thus twice as long as the carapace is wide. The dactylus is very slender and almost as long as the propodus. It is quadrangular in cross-section, with spinules on the four ridges. The propodus bears several small spinules in the distal part of the posterior margin, but more conspicuous are numerous stiff short erect bristles that are placed all over the segment. Similar short erect bristles, often in groups of two or three, are also found on the other segments of the walking legs. The carpus is more than half as long as the propodus, and the merus is as long as propodus and carpus together. The third pereopod is 50 mm long,

being thus more than 2.5 times as long as the carapace is wide. The fourth leg is almost as long as the third, and the fifth is of the length of the second. The ratio between the length of the various segments is about the same in all legs.

The male abdomen (fig. 2c) is regularly triangular with all segments free. The first segment is short with a transverse median carina. The second segment is distinctly longer and wider than the first, with the third it is the widest of the segments. The third to seventh segments become progressively narrower, but longer. The second segment is about 5 times as wide as long, the sixth segment is twice as wide as long. The seventh segment forms an equilateral triangle of which the top is rounded.

The first male gonopods (fig. 2e) reach about to the middle of the sternite of the second pereopod. The distal segment is short, about half as long as the preceding segment; it is curved outward and regularly narrows to an acute tip. The second gonopods of the male (fig. 2f) are very slender. The distal segment is thread-like and about as long as the preceding segment. The basal part of this second gonopod is directed obliquely forward and inward, the distal segment is strongly recurved near the middle, its distal half being directed outward.

Colour. — In the preserved male specimen the sternum and the legs are very pale yellowish, this light colour contrasts strongly with the dark purplish grey colour of the carapace. In the female this contrast is less distinct. Mr. Chapman stated that in both specimens "the carapace was bluish-grey in life, edged with lemon-yellow. The legs were pale lemon-yellow".

Biology. — According to Mr. Chapman's field notes "this is an amphibious form, and very shy of light. Both specimens were captured while scuttling away at speed. This "shyness" may account for their apparent scarcity".

### ***Cerberusa caeca* new species (text-fig. 3, pls. 2, 8)**

Deer Cave, Gunong Mulu National Park (loc. 2); Crab Inlet pool, bottom with gravel and swiftlet (= *Collocalia* spec.) guano; 26 April 1978; leg. P. Chapman; 1 male.

Green Cave, Gunong Mulu National Park (loc. 5); in small stream at 600 m from north entrance; 12 March 1978; leg. P. Chapman; 2 males (the largest is the holotype) and 2 females.

Clearwater Cave, Gunong Mulu National Park (loc. 6); Inflation Passage; gravel-floored pool in dribbly streams, absent from manganese depositing dribbles; 13 April 1978; leg. P. Chapman; 2 females.

Size. — The holotype male has a carapace length of 12.5 mm and a carapace breadth of 17 mm. In the other material cl. is 7.5-12.5 mm (♂♂) and 7-11 mm (♀♀), and cb. is 10-17 mm (♂♂), and 9.5-15 mm (♀♀). The specimens of Clearwater and Deer Caves (cl. 7-8 mm, cb. 9.5-11 mm)

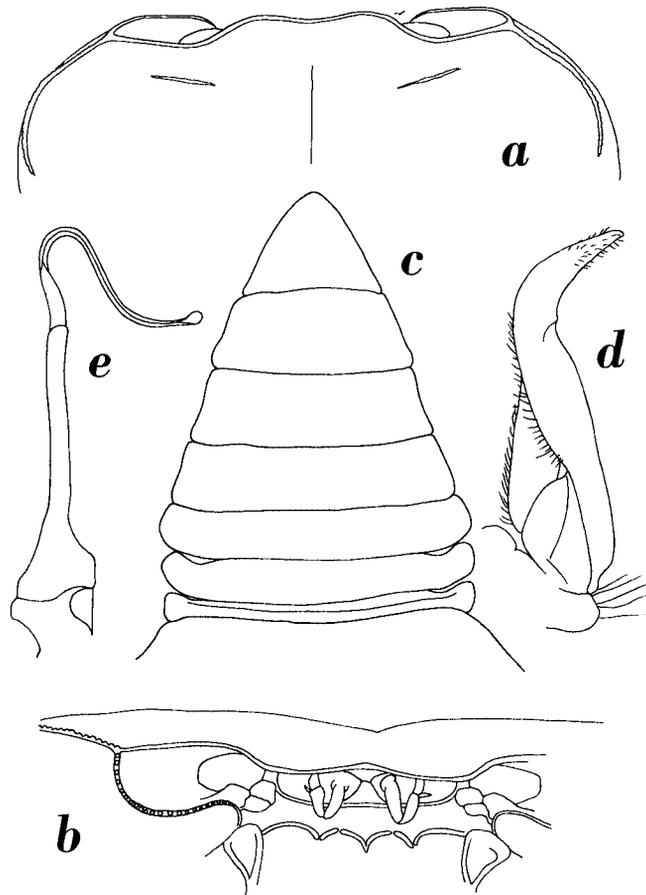


Fig. 3. *Cerberusa caeca* new species, male paratype. a, anterior part of carapace in dorsal view; b, front in anterior view; c, abdomen; d, first gonopod; e, second gonopod. a, b,  $\times 4$ ; c,  $\times 6$ ; d, e,  $\times 12.5$ .

are distinctly smaller than those of Green Cave (cl. 10-12.5 mm, cb. 14-17 mm).

Description. — The carapace is trapezoid in outline with rounded angles; it is rather distinctly convex, especially the anterior part is curved down. It is widest in the anterior fourth. The front, the orbits and the anterolateral margins do not form an evenly curved arc as in *C. tipula*, but a more angular line (fig. 3a). The front (fig. 3b), when measured at the base is more than  $1/3$  as wide as the carapace, and is more than 6 times as wide as long. It is rather flat and directed slightly down, but is fully visible in dorsal

view; its distal margin is concave in the middle and convex at the sides. The anterolateral angles of the front are broadly rounded and very wide, being much more than  $90^\circ$ . The lateral margin of the front is oblique and passes under a very gradual and wide curve into the upper margin of the orbit. The margin of the front and the upper orbital margin are both crested and smooth, without granules. The surface of the entire carapace and the front is finely and minutely shagreened; it shows a few scattered pits. The post-orbital ridges are rather low and indicated by a transverse row of granules. The epigastric lobes are hardly indicated, but the groove between them is distinct. The H-shaped groove in the middle of the carapace is distinct, but the rest of the cervical groove is lacking. The anterolateral margin is short, being about half as long as the posterolateral. It bears a distinct ridge, which anteriorly reaches to the orbital margin and fuses with it; posteriorly, slightly behind the widest part of the carapace, the anterolateral carina curves inward and up onto the dorsal surface of the carapace. The carina is granular or finely serrate, all the denticles being of similar size; no epibranchial tooth, or epibranchial incision is noticeable. A slight concavity in the margin indicates the place where otherwise the epibranchial incision would have been. Behind the postorbital carina a few more transverse rows of tubercles may be present. The posterolateral margin of the carapace is broadly rounded and shows several short transverse ridges that carry granules.

The eyes are strongly reduced, filling less than half the orbit and showing no pigment at all (fig. 3b). They are bullet-shaped, sometimes with a shallow groove in the distal end. The orbit is large; the upper margin is smooth and slightly sinuous. Laterally the orbital margin forms an angle where it touches the anterolateral carina. From this angle the orbital margin goes down and, with a broad curve, is directed inward again until it reaches the antennal peduncle. Inside the orbit a ridge is visible, which extends from the inner gap inward and passes in front of the eye, seemingly keeping the eye in place. The antennal peduncle does not fill the entire inner gap of the orbit and the antennal flagellum can enter the orbit.

There is no frontal triangle. The epistome has the upper margin straight. The lower margin ends in a median triangle with a rather sharp prolonged apex. At either side of this triangle the lower margin shows two concavities, one more triangular (for the reception of the palp of the third maxilliped), the other rounded (forming the anterior margin of the efferent opening). The efferent opening is large and occupies the outer fourth of the anterior margin of the oral field.

The mandibular palp is three-segmented with the last segment simple and

oval. The third maxilliped has the exopod well developed, but without a flagellum.

The first pereopods of the male are unequal (pl. 2). The larger chela (the right in one of the males, the left in the other) has the dactylus about as long as the palm (measured along the dorsal line). The fingers are rather high and end in a sharp curved tip; the two tips crossing. The cutting edges of the fingers bear about ten small teeth, which diminish in size distally. The fingers are shallowly grooved and pitted, but show no granules. The palm is slightly swollen, its surface is smooth, with a few pits, but without granules or at the most a few scattered ones. The palm is slightly higher distally than proximally. The carpus bears on the inner margin a blunt tooth followed by two smaller. On the upper surface there are scattered tubercles. The merus also shows many tubercles, these are slightly stronger than those of the carpus. The smaller cheliped is more slender than the larger. The fingers are longer than the palm. The grooves on the fingers are deeper than in the larger chela and some granules are present. The cutting edges of the fingers have more teeth (about 15 to 20), which are of about the same size, although smaller denticles are interspersed among the larger. The palm is narrower and more tuberculate than in the large chela; the upper margin, in side view, even looks somewhat serrate. The carpus and merus resemble those of the larger leg.

The second and fifth pereopods (= first and fourth walking legs) are about  $4/3$  as long as the carapace is wide, the second being slightly shorter than the fifth. The third and fourth pereopods are about twice as long as the carapace breadth. All the legs are very slender. The dactylus is only slightly shorter than the propodus. It is quadrangular in cross-section and on each of the four ridges there is a row of spinules. Spinules are also present on the posterior margin of the propodus. The carpus is about as long as the dactylus, while the merus is the longest of all segments. Tubercles, but no spines or spinules, are present on carpus and merus. Short, stiff, erect hairs, often in groups of 2 or 3 are present on the distal segments of the walking legs.

The male abdomen (fig. 3c) is regularly triangular and has all segments free. The first segment is the shortest and bears a distinct transverse carina. The second is somewhat longer and wider than the first, it is practically as wide as the third segment, which is the widest of the abdominal segments. From the third to the sixth segment the width of the abdomen becomes gradually less, but the segments increase in length. The sixth segment is  $2/5$  as long as its basal width, while the second segment is about 7 times as wide as long. The seventh segment is an equilateral triangle with a broadly rounded top.

The first gonopod of the male (fig. 3d) is rather robust. The distal segment is about half as long as the previous, and is L-shapedly curved outward; it narrows gradually distally. The second gonopods (fig. 3e) have the distal segment very long and thread-like; slightly before the middle the segment is bent backward, showing a similar shape as in *C. tipula*.

The female differs from the male in that the left and right chelipeds are equal in size and shape; they resemble the minor cheliped of the male. The abdomen in the female is more widely triangular than in the male.

Colour. — In the preserved material the colour is uniformly pale yellowish. No black pigment is present at all. Mr. Chapman noted that the "colour in life was pure white in all cases (darker gut contents could sometimes be seen through the dorsum of the carapace)" (pl. 8).

Biology. — The species is a true troglobite, and as shown by its white colour, long legs and blindness, is fully adapted to life in the dark. Mr. Chapman remarked that he found *Cerberusa caeca* only in completely dark parts of the caves, where he observed the specimens in pools, dribbles or small streams. He "was intrigued by the pattern of distribution of the crabs, which were regularly found in some pools but not in others apparently indistinguishable, within the same cave system". He "analysed some pools for conductivity (a crude measure of hardness), temperature and O<sub>2</sub> saturation. The results were none too clear, but suggested that acceptable conditions were present in most pools in most caves", whether or not these pools were inhabited by crabs.

As to food, Mr. Chapman observed two crabs "in Deer Cave ("Crab Inlet") picking at the near-clean carcass of a swiftlet which had fallen into a pool. This may well be an important source of food, together with nesting debris (eggshells, bits of moss, etc.). No other observations on feeding behaviour were made".

Mr. Chapman made also the following observations on the biology of the animals: "These crabs move very little, except when the water of their pools is disturbed, or when a bright light is shone on them, they then scuttle away. Despite their blindness, they are light sensitive. When placed in an unfamiliar container, the chelae are used constantly to explore the objects and other crabs that they contact — much as hermit crabs do when they first contact an unfamiliar gastropod shell. The rearing up — chelae outstretched threat display typical of most crabs when threatened was never seen, though they attempted to nip a finger placed on the carapace. No "berried" or egg-carrying females were seen".

Remarks. — A film of 8 live specimens collected in Clearwater Cave has been made on the spot by a team of the British Broadcasting Corporation

during the expedition. This film was later shown on television. All 8 specimens managed to escape after their performance.

The number of species of blind cave crabs is much smaller than that of blind cave *Macrura*. At present only 5 such blind species of cavernicolous crabs are known. The longest known is *Typhlopseudothelphusa mocinoi* Rioja, 1953 from a cave in Mexico. This long-legged white and blind cave crab for a long time was the only known freshwater crab that had lost all eyesight. Then, in 1976, Delamare Deboutteville (1976: 115-129) described two new species of the same genus, *T. mitchelli* and *T. juberthiei* from caves in Guatemala. The species belong to the family Pseudothelphusidae, which Bott (1970: 21) assigned to the superfamily Pseudothelphusoidea. Cottarelli & Argano (1977: 207) described a fourth Middle American blind cave crab, viz., *Trichodactylus mensabak* from Mexico (Chiapas). This too is a typical troglobite, being blind, without pigment and with very long legs; it belongs to the freshwater crabs of the family Trichodactylidae, which Bott (1970) did not assign to any particular superfamily. So far as I know no blind cave crabs have ever been reported from any other part of the world, and the presence of *Cerberusa caeca* in Bornean caves therefore is doubly interesting.

#### ISOLAPOTAMIDAE

This family is represented in the collection by a single species:

#### ***Isolapotamon collinsi*** new species (text-fig. 4, pl. 4)

Sinkhole of Clearwater River next to camp 6, Hidden Valley, Gunong Mulu National Park (loc. 1); 27 March 1978; leg. P. Chapman; 2 males.

Size. — The carapace length of the two males is 35 and 40 mm, the carapace breadth 50 and 56 mm respectively. The largest specimen is the holotype.

Description. — The carapace (pl. 4 fig. 1) is practically flat in both directions; its greatest width lies at  $\frac{1}{3}$  of the length from the anterior margin. The front is directed forward and not or hardly at all down, it is fully visible in dorsal view. There is no trace of a frontal triangle. The front is somewhat more than  $\frac{1}{3}$  as wide as the carapace, when measured at its base. The anterior margin of the front is about  $\frac{2}{7}$  of the carapace width, it is about straight, being very shallowly V-shapedly incised in the middle, the two halves being slightly convex. The anterolateral angles of the front are broadly rounded and hardly forwards produced. The lateral margins of the front merge very gradually with the upper orbital margin. The upper

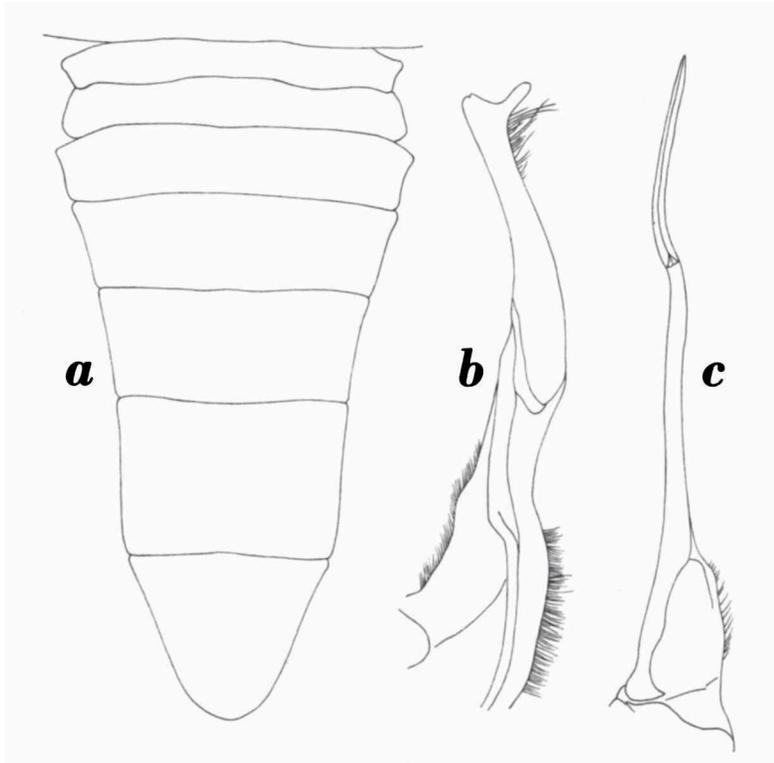


Fig. 4. *Isolapotamon collinsi* new species, male holotype. a, abdomen; b, first gonopod; c, second gonopod. a,  $\times 3$ ; b, c,  $\times 6$ .

surface of the front is flat and shows only some small granules. The outer orbital angle forms a blunt angle. The anterolateral margin is evenly carinate with a distinct epibranchial incision; on the dorsal side of the carina granules are visible. The epigastric lobes and postorbital carinae are well visible, but not particularly strong. The epigastric lobes lie before the postorbital ridges and do not form a single line with them. The epigastric lobes are placed in an oblique direction, being directed somewhat forward near the median line of the body. A short distance behind the epigastric lobes there are two similar, but less distinct submedian transverse ridges. The H-shaped groove of the carapace is sharp and deep. The cervical groove in its lateral part is very shallow, becoming even less conspicuous distally. The entire surface of the carapace is roughened by pits and granules; in the anterolateral part the granules are strongest and arranged in transverse rows.

The lower margin of the orbit, like the upper, is crested and granular. The upper margin continues into the anterolateral margin of the carapace. The

lower orbital margin, however, stops short before attaining the upper margin, and the two do not merge.

The eyes (pl. 4 fig. 2) are well developed, fill practically the entire orbit and have the cornea deeply pigmented. The cornea is wider than the eyestalk.

The antennal peduncle closes the orbital gap, but the flagellum lies within the orbit. A suborbital row of irregular tubercles or short ridges is visible.

The anterior margin of the epistome is triangularly forwards produced in the middle. It is deeply concave in the center. Also the posterior margin ends in a triangular median process, this is directed posteriorly; a rounded posteriorly directed angle is visible on the posterior margin between the excavation for the efferent opening and that for the distal segments of the third maxilliped. The efferent opening is not circular but very broadly transverse.

The mandible has the distal segment of the palp not bifurcate.

The third maxillipeds close the entire oral field (but for the efferent openings). The merus and ischium show a longitudinal groove over the middle. The exopod has a well developed multi-articulate flagellum.

The chelipeds of the male are decidedly unequal. The larger leg has the fingers somewhat longer than the palm and distinctly gaping basally. Both fingers show three or four distinct ridges on the outer surface. These ridges are separated by grooves, and are the more striking as they are coloured dark brown, while the grooves do not show that colour. Numerous pits are present on the fingers. The teeth on the cutting edges of the fingers are black. The basal tooth of the dactylus is the strongest and somewhat molariform. On the rest of the cutting edge of the dactylus there are some 6 rather large teeth, which are separated from each other by groups of 4 (in the proximal part of the edge) or 2 (in the distal part) small teeth. The tips of the fingers are curved and crossing; like the teeth, they are black. The cutting edge of the fixed finger shows a large gap basally. The teeth in and just following the gap are the largest; of the distal teeth about three are somewhat larger than the rest, the smaller teeth being arranged in groups of about three. The ridges of the fixed finger do not continue on the palm. The palm is slightly longer than high, being highest distally. Numerous small granules, arranged in vertical or oblique rows are placed on the outer surface of the palm; the inner surface of the palm is smoother. The carpus shows a similar pattern of granules on its outer surface as does the palm. The inner surface of the carpus bears a strong tooth, below and behind of which there is a much smaller 2-topped or single tooth. Between this smaller tooth and the base of the carpus there is a peculiar short elevated ridge. A faint groove is visible on the outer (upper) surface of the carpus. The outer surface of the merus is smooth or slightly granular; the distal margin of its lower

surface shows a strong conical pointed tooth. The dorsal margin of the merus does not bear a tooth, but a subdistal groove is distinct on the outer surface. The small cheliped resembles the larger in most respects, but the chela is more slender. The fingers are relatively longer, the palm relatively lower; the dentition of the cutting edge of the dactylus has a rather regular arrangement of 6 or 7 larger teeth, separated from one another by 1 to 3 small teeth. The fixed finger shows this arrangement also, only in the basal part there are several larger teeth, while there is also an indication of a gap.

The walking legs (pereiopods 2 to 5) are not unusually long. The dactylus is about as long as the propodus and longer than the carpus. It has the four edges ridge-like and provided with spinules. The posterior margin of the propodus bears 2 rows of spinules, the distal spinule of each row being the strongest. Pereiopods 2 and 5 are of about the same length, they are shorter than pereopods 3 and 4, which likewise are of about equal length. The merus of pereopods 2 and 5 is about 2.6 to 2.7 times as long as wide and somewhat more than half as long as the carapace. The merus of pereopods 3 and 4 is 3.3 to 3.5 times as long as wide and about 0.7 times as long as the carapace. The lower surface of the merus shows two unarmed carinae, one along the anterior, the other along the posterior margin.

The male abdomen (fig. 4a) is elongate triangular, and after an initial widening, narrows regularly towards the apex. The first and second segments are of about equal length and equal width. The third segment is longer and wider than the second, it narrows distally. This narrowing continues in the fourth and fifth segments: the distal width of the fifth segment is about  $\frac{2}{3}$  of the greatest (= basal) width of the third. The sixth segment is only slightly narrower distally than proximally. Segments 2 to 6 incl. become progressively longer: the sixth segment being about three times as long as the second; its length is  $\frac{2}{3}$  of its width. The seventh segment is almost equilaterally triangular with a broadly rounded top; it is slightly longer than the sixth segment.

The first male gonopod (fig. 4b) has the distal segment slender and about as long as the proximal segment. It is almost straight and directed slightly inward. The top is blunt with an inconspicuous incision. The outer margin of the segment, just below the top, bears a peculiar thumb-like process, below which several hairs are implanted. The second gonopod (fig. 4c) is straight. The distal segment is slightly curved at the base and ends in a pointed top; it is about half as long as the basal segment.

Colour. — The colour of the preserved specimens is an olive grey with the ridges, granules etc. marked in brown. The brown colour predominates dorsally and on the chelipeds, the grey colour ventrally.

Remarks. — Neither in the colour, nor in the development of the eyes or the slenderness of the appendages, does the present species show any obvious adaptation to subterranean life.

The present new species is extremely close to *Isolapotamon griswoldi* (Chace, 1938), which has been well described and figured by Chace (1938: 10-12, pl. 1), and which originates from the Mt. Kinabalu region of Borneo. The general shape and structure of the carapace of the two species is very similar, except that in *I. griswoldi* the greatest width lies farther back. The large chela in the male of *I. griswoldi* is said to have the fingers slightly gaping, practically throughout their length, while in *I. collinsi* the gape is strong and restricted to the basal third of the fingers, the rest of the edges closing. The legs in *I. griswoldi* have the segments relatively much shorter than in *I. collinsi*, while the segments of the abdomen in Chace's species are much wider than in the present species. The subdistal outer process of the first male gonopod in *I. griswoldi* is short and broad, being directed sideways or even slightly back. In *I. collinsi* it is slenderer and directed obliquely forward.

#### Gecarcinoidea

##### GECARCINUCIDAE

As stated before, I follow here Bott's (1970) classification of the fresh water crabs, even though I am not convinced of the necessity to assign them to three (or four?) superfamilies. The fact that the name Gecarcinoidea is used here instead of the name Parathelphusoidea, which was accepted by Bott, is purely due to nomenclatural considerations. Bott's superfamily Parathelphusoidea, namely, contains both the families Gecarcinidae Rathbun (1904: 233, 238, 245, 247) and Parathelphusidae Alcock (1910: 1; 1910a: 254, 255). As Rathbun's family name is older than that of Alcock, it has priority, and the superfamily name should be based on it. Thus the correct superfamily name is Gecarcinoidea Rathbun, 1904.

Of the six species of Gecarcinoidea in the present collection, three belong to the family Gecarcinidae as defined by Bott (1970), two to the Sundathelphusidae, and one to the Parathelphusidae.

#### ***Adeleana chapmani*** new species (text-fig. 5, pl. 3 fig. 2)

Niah Great Cave, northern Sarawak (loc. 9); small guano-floored pools in the dark zone; 22 May 1978; leg. P. Chapman; 1 male holotype; 3 female paratypes.

Size. — The carapace breadth of the male holotype is 13 mm, that of the females 13 to 16 mm, the carapace length of the holotype is 11 mm, of the paratypes 11 to 12.5 mm.

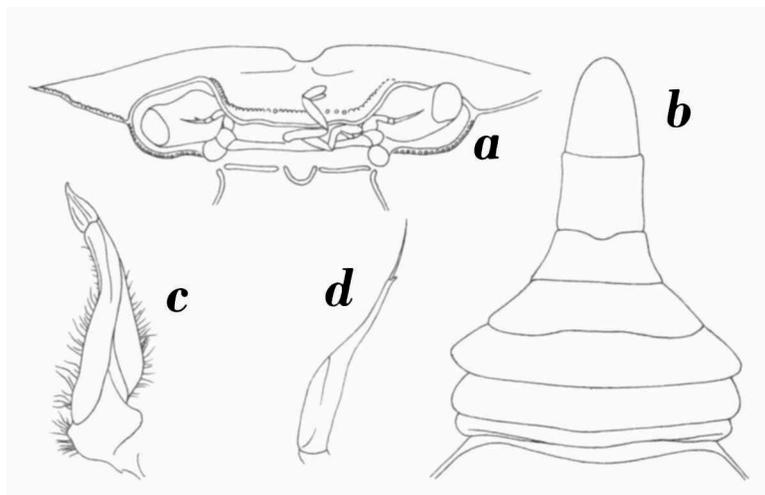


Fig. 5. *Adeleana chapmani* new species, male holotype. a, front in anterior view; b, abdomen in dorsal view; c, first gonopod in posterior view; d, second gonopod in posterior view. a, b,  $\times 6$ ; c, d,  $\times 12.5$ .

Description. — The carapace (pl. 3 fig. 2) is rather convex in a longitudinal direction. The greatest width is at the end of the anterior fourth. The front is wide, when measured at its base it is somewhat less than half as wide as the carapace. It is curved down and does not show a frontal triangle. Its anterior margin is almost straight or slightly concave. The anterolateral angles are broadly rounded; the lateral margin is straight and merges under a broad curve with the upper orbital margin. The upper surface of the front is flat and finely pitted. A granular ridge extends practically parallel to and slightly behind and above the anterior margin of the front; laterally it curves up and runs next to the lateral margin of the front, to disappear at the place where this lateral margin meets the upper orbital margin. The feature of the double margin of the front is most characteristic. The epigastric lobes are present but indistinct, they are separated by a deep but wide median longitudinal groove. Also the postorbital carinae are indicated, but they are indistinct. The upper surface of the carapace is rather coarsely pitted and a few tubercles are seen anterolaterally. There is a faint trace of the cervical groove, which, however, does not reach the anterolateral margin. The H-shaped groove is not very conspicuous and behind it is a low transverse ridge. The anterolateral margin of the carapace is carinate but does not show any teeth; anteriorly it reaches to the orbital margin and merges with it. The posterolateral margin is broadly rounded and bears short transverse ridges.

The eyes (fig. 5a) almost completely fill the orbit. The cornea is short and

narrower than the peduncle, but it possesses dark pigment. The lower margin of the orbit is granular.

The anterior margin of the epistome is almost straight, the posterior shows a narrow median trapezoid or rounded protuberance. This protuberance is separated by a deep triangular incision from the lateral part of the posterior margin, which is about straight and forms the anterior margin of the efferent opening.

The palp of the mandible has the last segment deeply bilobed. The exopod of the third maxilliped ends in a distinct flagellum.

In the single male specimen the left and right chelipeds are unequal. The fingers of the larger cheliped end in sharp curved tips, which are crossing; both fingers show grooves which are separated by granular ridges. The cutting edge of the dactylus shows 5 large teeth in the basal half, the distal of these being largest; the distal part of the cutting edge bears several small teeth with corneous tips. The cutting edge of the fixed finger is similar to that of the dactylus, but the distal two large teeth are wider apart and separated by a minute tubercle, they form a gap in which the larger tooth of the dactylus fits. The palm is  $\frac{3}{4}$  as high as long and slightly swollen, it is pitted and bears scattered granules. The carpus bears one strong tooth on the inner margin. The merus has a squamiform tuberculation. The smaller cheliped is similar to the larger, but is more slender, with the teeth on the cutting edges less different in size. It is possible that the present male specimen has not yet attained its full size and that in larger specimens the difference between the chelipeds is greater.

The walking legs are slender. The second pereopod (= first walking leg) is less than 1.5 times as long as the carapace is wide, the third leg is twice as long as the carapace width, the fourth is slightly shorter than the third, and the fifth is somewhat longer than the second. The dactylus is about as long as the propodus and bears 4 longitudinal rows of spinules. The posterior margin of the propodus also bears some spinules, and a spine is present on the postero-distal angle. The carpus is short. The merus is again slender. The merus of the last leg is 4 times as long as wide and measures  $\frac{3}{4}$  of the length of the carapace.

The male abdomen (fig. 5b) is T-shaped. The first segment is short and rather wide with a transverse dorsal carina. The second segment is distinctly longer and somewhat wider than the first. The posterior margin of the third segment projects on either side beyond the second segment, but anteriorly it becomes narrower; it is slightly longer than the second segment. The fourth segment is about as long as the third, and like the third it narrows distally. The third and fourth segments together form a trapezium of which the

upper margin (= the distal margin of the fourth segment) is half as wide as the base (= proximal margin of the third segment). The fifth segment narrows somewhat distally, but not as much as the fourth. The sixth segment remains of the same width throughout. The fourth and the fifth segments are of about the same length, the sixth is definitely longer. The seventh segment gradually and slightly narrows towards a broadly rounded apex; its lateral margins are straight. The female abdomen is a wide semi-oval with a broadly rounded top.

The first gonopod of the male (fig. 5c) is rather short and broad. It is curved outward with a very gradual curve. The distal segment is less than half as long as the penultimate; it is conical and ends in a narrow point. The second gonopod (fig. 5d) is about as long as the first. The last segment is thin and thread-like; it is distinctly shorter than the penultimate segment which in its distal part also is narrow; a small tooth is present at the line separating the two segments.

Colour. — The living animals were noted to have “a creamy white colour”. The preserved material is of a pale brown colour, the legs being lighter than the carapace.

Biology. — Mr. Chapman remarked that this species was found in a habitat almost exactly like that inhabited by *Cerberusa caeca*: shallow pools with a bottom of mud and gravel and with swiftlet (*Collocalia* spec.) droppings. Great parts of the cave are strongly disturbed as they are much frequented by people (tourists, guano- and birdnest-collectors).

The animals were found in total darkness.

The species shows some adaptations to subterranean life (white colour, rather slender legs, slightly reduced eyes), but these are not as extreme as in the case of the *Cerberusa* species.

Remarks. — The shape of the last segment of the mandibular palp and the absence of a frontal triangle show that the present species belongs to the Gecarcinucidae of Bott's classification. The short distal segment of the first male gonopod and the general shape of that gonopod place it in Bott's Liothelphusinae. Although the species shows much resemblance to some species of *Thelphusula*, the short distal segment of the first male gonopod makes that it is more logically assigned to *Adeleana*.

A comparison of the present material with the holotype of *Adeleana kenepai* (De Man), also from Borneo, showed the following differences: In *A. kenepai* the carapace is more quadrangular, narrowing less strongly in the posterior half. The anterolateral margin of the carapace has a slight, but distinct epibranchial incision near the end of the cervical groove; the anterior margin of the front is bilobed; the upper surface of the front is not

flat but concave in the middle, each half being convex; the tubercular ridge behind the anterior margin of the front does not continue along the lateral margin, but stops at the anterolateral angles of the front; the epigastric lobes are rather distinct, while the postorbital ridge is absent; the cervical groove reaches to the anterolateral margin; the posterior margin of the carapace is more than half as wide as the carapace itself, in *A. chapmani* it is much shorter. The legs in *A. kenepai* are much shorter and less slender than in *A. chapmani*. The male abdomen in *A. kenepai*, although T-shaped, differs from that of *A. chapmani* in that the lateral margins of the sixth segment and the basal half of the seventh are not straight and parallel: in the sixth segment, namely, the margins are somewhat convex, while in the seventh the margins are convex at the base and concave in the middle. In *A. kenepai* the posterior margin of the epistome has the median part widely convex and not semicircular. Furthermore the third maxilliped in *A. kenepai* has the flagellum strongly reduced.

The other Bornean species of *Adeleana*, *A. forcarti* Bott, 1969, differs from *A. chapmani* in the straight first male gonopod, the presence of a, be it indistinct, epibranchial tooth, the squarish shape of the carapace, the short and robust legs, and the bilobed front. It seems quite likely that the specimens described and figured by Chace (1938: 16, pl. 3) as *Parathelphusa* (*Liothelphusa*) *kadamiana* (Borradaile), and assigned by him to Borradaile's species with some doubt, actually belong to *A. forcarti*, even though Bott (1970: 61, under *Thelphusula melanippe kadamiana*) accepted Chace's identification as correct.

#### ***Thelphusula granosa* new species (text-fig. 6, pl. 5)**

Alluvial lowland rain forest, Gunong Mulu National Park, 4°03'N 114°56'E (loc. 1); caught in a pitfall trap in a frequently flooded alluvial forest; 13 March 1978; leg. N. M. Collins; 3 males. — Same locality; 24 March 1978; leg. N. M. Collins; 7 males and 3 females. — Same locality; 27 March 1978; leg. N. M. Collins; 5 males and 1 female.

Size. — The carapace length of the males ranges from 13 to 23 mm, the carapace width from 16 to 26 mm. In the females these measurements are 12 to 18 mm and 14 to 22 mm respectively.

Description. — The body is very thick and heavy (pl. 5). The carapace is convex, slightly wider than long; the greatest breadth is in the anterior third. The posterior width of the carapace is only slightly less than the anterior, so that the carapace gives a quadrangular impression. The dorsal surface of the carapace is quite rugose by the presence of granules or coarse pits. In the anterior half (in the gastric and frontal regions) the granules are distinct, single or arranged in short transverse rows. On the branchial

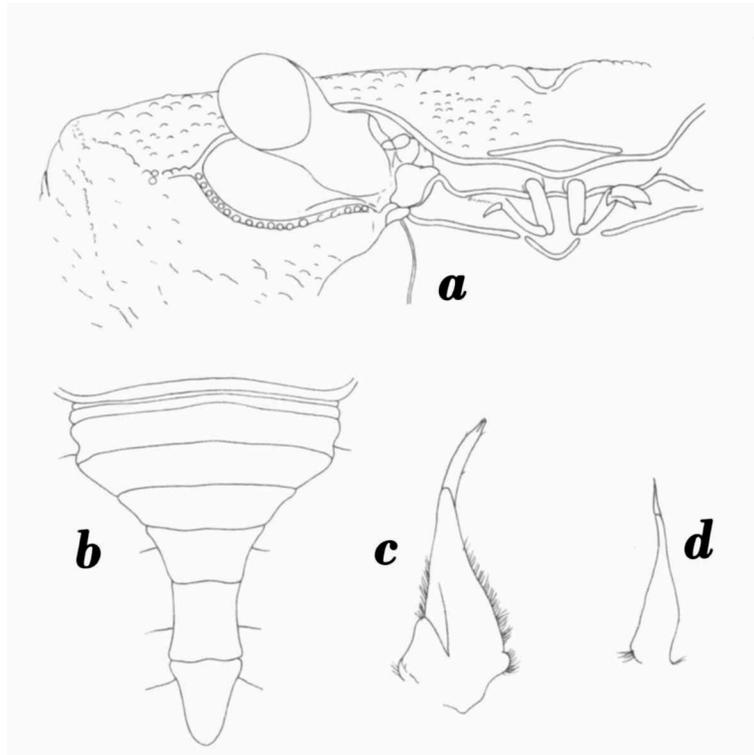


Fig. 6. *Thelphusula granosa* new species, male paratype. a, front in anterior view; b, abdomen; c, first gonopod; d, second gonopod. a, b,  $\times 3$ ; c, d,  $\times 6$ .

regions the transverse rows are longer, especially in the lateral parts. The rough pits are most distinct in the posterior and central part of the carapace. The epigastric lobes are not very pronounced, and visible as oval elevations at either side of the base of the anterior median groove, which extends from the top of the mesogastric region forward, becoming very obscure in the frontal region. No postorbital ridges are present, but compared to the rest of the carapace the region immediately behind the orbit is quite smooth. A cervical groove is visible, but does not reach the anterolateral margin of the carapace. The front (pl. 5 fig. 2; textfig. 6a) is flat and turned somewhat down. The anterior margin is bilobed in dorsal view. The true anterior margin curves down in the middle and a granular ridge, which is placed above it, obscures it in dorsal view. In most specimens this granular ridge is strong and about half as long as the frontal width, laterally it stops before reaching the frontal margin; the arrangement is very much like in specimens with a frontal triangle. In some specimens the additional granular ridge, although present and sharp, is less distinct, being broken up and the various parts not

necessarily from a single line. The anterolateral margin is sharp, but not formed of a single crest; actually there are several oblique granular crests on the margin, each curving inward at its posterior end and continuing on the dorsal surface of the carapace as an interrupted row of granules. The first of the anterolateral ridges is separated from the orbital margin by a concavity. The posterior margin of the carapace is shorter than the front-orbital border, but distinctly more than half the width of the carapace.

The eyes are well developed with a rounded, well-pigmented cornea. The orbits are short and wide and placed transversely, they are entirely filled by the eyes. The lower orbital margin is regularly granular, the upper is practically smooth.

The anterior margin of the epistome is sinuous, the posterior margin shows a broad posteriorly directed median lobe, which is triangular with a broadly rounded top. The efferent openings are large and reach laterally beyond the lateral margin of the oral field. The third maxilliped has a rather distinct longitudinal groove on the inner half of the exposed surface of the ischium.

In the intact male specimens the left and right chelipeds are unequal, in some the right leg is the larger, in others the left. In both chelipeds the fingers close over their full length. The chela of the larger cheliped is twice as long as high. The fingers are about as long as the palm, and have the cutting edge with the teeth of almost equal size; these teeth are grouped in sets of about three, the middle of which is slightly longer than the others. Both the fingers and the palm are coarsely and rather densely granular, both outside and in; the outside granulation is the more conspicuous of the two. The carpus has the outer surface also granular, but with the granules smaller than on the palm. The inner margin of the carpus shows a broad, somewhat flattened triangular tooth. The merus bears numerous short rows of tubercles, and dorsally it is provided with a subdistal transverse groove. The smaller cheliped is more slender than the larger; its fingers are longer than the palm. In the females the left and right chelipeds are equal and resemble the smaller cheliped of the male.

The walking legs are slender, but less so than in several other species of the genus. The merus of the fifth leg is about 3 times as long as wide and about  $2/3$  as long as the carapace. The dactylus of the walking legs is slender and slightly longer than the propodus; it is quadrangular in cross-section, each of the ridges bearing spinules. The slender merus shows no teeth.

The male abdomen (fig. 6b) is T-shaped: the first two segments are broadest, the third at its base is about as broad as the first and second, while it narrows distally. The third, fourth and fifth segments narrow

gradually and together form a kind of trapezium; the base of the third segment is about 3.5 times as wide as the distal margin of the fifth. The sixth segment is narrow throughout, being even slightly wider at the top than at the base. The first segment is shortest and has a sharp transverse carina; the second is longer than the first but shorter than the third, the fourth is about as long as the second, and the fifth is about as long as or slightly longer than the third; the sixth is about 1.5 times as long as the fifth. The seventh segment is elongate triangular with a rounded apex, and a lateral margin which is somewhat concave basally and convex distally. The surface of the abdomen and of the thoracic sternum is smooth and shiny, with a few scattered pits. The abdomen of the largest female (cb. 22 mm) is widely oval, and reaches sideways to the bases of the pereopods, it has a blunt top. In the smallest female (cb. 14 mm) the abdomen is more triangular, leaving a distinct part of the thoracic sternum uncovered. The third female (cl. 19 mm) has the shape of the abdomen about intermediate between those of the other two.

The first male gonopod (fig. 6c) is simple, curved outward in the distal part and narrowing gradually towards the tip, which itself is slightly constricted. The distal segment is slender, being about 5 times as long as wide and slightly less than half as long as the penultimate segment. The second gonopod (fig. 6d) is slender with a narrow, distally further narrowing distal segment, which is short, being less than  $1/4$  of the preceding segment.

Biology. — See Collins, 1979.

Remarks. — The present new species differs from *Thelphusula hendersoniana* (De Man, 1899), *T. melanippe* (De Man, 1899) and *T. luidana* (Chace, 1938) in the shape of the front, which in those species has the anterior margin about straight, while above it a long (*T. melanippe*, *T. hendersoniana*) or short (*T. luidana*) row of granules is present; this row usually is very close to and parallel with the anterior margin. In *Thelphusula buergeri* (De Man, 1899), however, the anterior margin of the front dips down in the middle, like in the present species, and a structure resembling a frontal triangle is formed, although (again like in the present species) the upper margin is incomplete. *Thelphusula granosa* differs from *T. buergeri* in the following points. (1) In *T. granosa* the carapace is far rougher than in *T. buergeri*, where it is rather smooth. (2) In *T. buergeri* the anterolateral margin of the carapace shows a single carina, not a succession of oblique carinae. (3) *T. buergeri* shows no cervical groove. (4) The chelipeds of *T. buergeri* lack the strong granulation shown by *T. granosa*. (5) *T. buergeri* is a much smaller species (cl. 10 mm, cb. 13 mm) than *T. granosa* (cl. 18-19 mm, cb. 21.5-22 mm).

It seems entirely unlikely that *Thelphusula buergeri* (De Man, 1899) and *T. melaniippe* (De Man, 1899) are only subspecifically different as was the opinion of Bott (1970: 58-62). The differences in the shape of the front, the carapace and the legs are of such a nature that there can hardly be any doubt that two species are involved. Of both species the type material could be examined. The carapace of *T. melaniippe* is wide and flat with postorbital ridges, an epibranchial incision and a distinct cervical groove, while that of *T. buergeri* is narrow, convex, without postorbital ridges, without epibranchial incisions and without indication of a cervical groove in the branchial regions.

*T. granosa* resembles *T. buergeri* in essential characters like the shape of the front, the general shape of the carapace, that of the abdomen and the male gonopods. There is little doubt in my mind that these two species belong to the same genus. As *T. buergeri* is the type species of the genus *Thelphusula*, I confidently assign the present new species also to that genus.

I am not as confident about the correctness of placing the genus *Thelphusula* in the family Gecarcinucidae. Bott (1970), who placed great emphasis on the presence or absence of the frontal triangle, distinguished the families Gecarcinucidae, Parathelphusidae and Sundathelphusidae largely on this character. In the Gecarcinucidae the frontal triangle is supposed to be absent, being present in the two other families. However, the front of the genus *Thelphusula* was described by Bott (1970: 58) as follows: "Stirn ohne Stirndreieck, zuweilen mit einer dem Stirnrand parallel verlaufenden Oberkante". As stated above, the central part of the anterior margin of the front in *Thelphusula buergeri* and in *T. granosa* curves down and a row of granules makes a "pseudofrontal margin", forming thereby a more or less distinct "frontal triangle". The "pseudofrontal" margin does not merge with the actual frontal margin. The frontal triangle of the Sundathelphusidae with an incomplete upper margin, shows an extremely great resemblance to the situation in some species of *Thelphusula*. It seems possible that either the presence or absence of the frontal triangle is not of the great importance that Bott attached to it, or the genus *Thelphusula* is better placed in the family Sundathelphusidae. In the latter case a new study is necessary in order to find out whether all species now assigned to *Thelphusula* actually belong in that genus. The present paper is not the place in which that problem can be solved.

#### ***Thelphusula baramensis* (De Man, 1902) (text-fig. 7)**

*Potamon (Potamonautes) baramense* De Man, 1902: 553, pl. 20 fig. 16.

*Thelphusula baramensis* — Bott, 1970: 60, pl. 9 figs. 94-96, pl. 27 fig. 38.

Alluvial lowland rain forest, Gunong Mulu National Park, 4°03'N 114°56'E (loc. 1); caught in a pitfall trap in alluvial, often flooded forest; 24 March 1978; leg. N. M.

Collins; 1 male, 1 female. — Same locality; 27 March 1978; leg. N. M. Collins; 2 males.  
 Kerangas Forest, Gunung Mulu National Park, 4°03'N 114°56'E; caught in a pitfall  
 trap in boggy area of tropical heath forest; 2 March 1978; leg. N. M. Collins; 1 male.

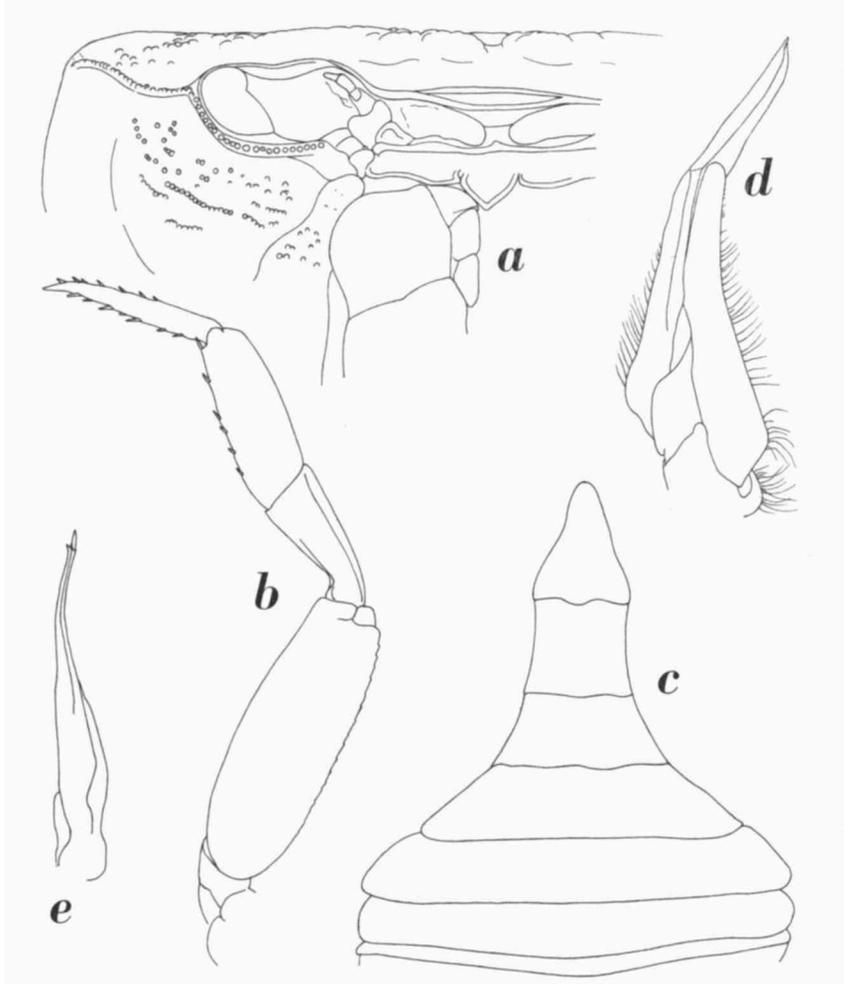


Fig. 7. *Thelphusula baramensis* (De Man), male from Kerangas Forest. a, front in anterior view; b, third pereiopod; c, abdomen; d, first gonopod; e, second gonopod. a, c,  $\times 6$ ; b,  $\times 3$ ; d, e,  $\times 12.5$ .

Size. — The male from Kerangas Forest is the largest specimen with cl. 17 mm, cb. 21 mm. In the other males the carapace length ranges from 13 to 14 mm, the carapace width from 15 to 16 mm. In the female cl. is 12 mm, cb. 15 mm.

Description. — The carapace is rather convex in a longitudinal direction.

It is 1.1 to 1.25 times as wide as long and has its greatest width in the anterior fourth. The front (fig. 7a) is wide; when measured at its base it is slightly less than half as wide as the carapace. It is directed slightly down and is flat with a slight longitudinal median groove; its surface is finely pitted. The anterolateral angles of the front are widely rounded, its anterior margin is somewhat concave in the middle. The anterior margin consists of two parallel or almost parallel ridges; the lower of these ridges is the true anterior margin; the upper, which projects somewhat over the lower, is an additional ridge, which laterally fuses with the true anterior margin. This upper ridge is about half as long as the true anterior margin. In the small specimens the two ridges lie almost flat against one another, in the larger specimen they are separated by a triangular space and form a pseudo-frontal triangle. The dorsal surface of the carapace is smooth and finely pitted over its greater part. The postorbital ridges are distinct, as are also the epigastric lobes. The ridges and the lobes together form an irregular interrupted carina. The anterolateral margin of the carapace bears a sharp ridge, which merges with the orbital margin. It is granular and shows a faint indication of an epi-branchial tooth. At about  $1/4$  of the length of the lateral margin the anterolateral carina curves inward onto the dorsal surface of the carapace and stops there. The posterolateral margin of the carapace is broadly rounded and bears several transverse curved sharp granular carinae or rows of granules. In the extreme anterolateral part of the carapace granulae, some arranged in short transverse rows, are present. The H-shaped depression in the center of the carapace is distinct. The cervical groove is distinct near the H-shaped depression, but becomes fainter distally and fades out long before reaching the anterolateral margin. Behind the H-shaped depression is a rounded blunt transverse carina, which almost reaches the posterolateral margins. The posterior margin of the carapace is about intermediate in width between the base of the front and the front-orbital border.

The eyes completely fill the orbits. The cornea is well developed and pigmented, it is as wide as the eyestalk. The upper orbital margin merges with the lateral frontal margin under a wide curve; its larger part is straight; laterally it is fused with the anterolateral carina. The lower orbital margin is curved and granular, the granulation is far more distinct than that of the upper margin. The upper and lower orbital margins and the anterolateral margin meet in one point.

The anterior margin of the epistome is sinuous. The posterior margin shows a median triangular lobe at either side of which the margin is deeply incised. The rest of the posterior margin is almost straight, either half showing a faint and wide angle in the middle. The part lateral of this

median angle forms the anterior margin of the efferent opening, which is widely triangular in shape, with the outer anterior angle open.

The palp of the mandible has the last segment deeply bilobed and of the typical Gecarcinucoid type.

The ischium of the third maxilliped shows an oblique groove on the exposed surface. This groove starts in the middle of the basal part of the ischium and ends in the inner half of the distal part of that segment. The exopod has the flagellum well developed and multiarticulate.

In the males the chelipeds are only slightly unequal in shape and size; in the smaller specimens the difference is even less distinct than in the larger. The larger cheliped has the fingers, relative to the palm, somewhat shorter than the smaller cheliped, and in it the palm is relatively higher. In both chelipeds the fingers close over their full length. The cutting edges carry teeth of slightly different size, the larger of these usually are separated by one or two smaller. The fingers of the smaller leg of the largest male are about twice as long as the upper margin of the palm and about as long as the lower margin. In the larger cheliped the fingers are slightly longer than the upper margin of the palm, but they are distinctly shorter than the lower margin. Several longitudinal rows of granules are visible on the fingers, these rows are slightly elevated; the granules on the dorsal surface of the dactylus are largest. The outer surface of the palm bears distinct scattered granules; on the inner surface these granules are less numerous. The carpus and merus show numerous short transverse rows of granules on the outer surface. The inner margin of the carpus shows a distinct flattened triangular tooth, which is blunt in the larger, more acute in the smaller cheliped. In the smaller specimens of the present material the larger cheliped shows more resemblance to the smaller.

The walking legs (fig. 7b) are slender, but not excessively so. The merus of the fifth leg is less than  $\frac{2}{3}$  as long as the carapace, and the length of the entire second leg is somewhat less than 1.3 times the carapace width. The third leg (= second walking leg) is the longest of the walking legs, being about 1.2 times as long as the second leg, and slightly longer than the fourth. The fifth and the second legs are of about equal length. The dactylus of the walking legs is about as long as the propodus and has the usual four longitudinal rows of spinules. The propodus bears some spinules on the posterior margin. The carpus is somewhat shorter than the propodus and shows a distinct longitudinal carina on the outer surface. The merus is the longest segment and is about as long as carpus and propodus together; it is about three times as long as wide.

The male abdomen (fig. 7c) is T-shaped. The first segment is very short

and wide, with a distinct transverse carina. The second segment is about twice as long as the first and a fraction wider. The third segment is somewhat longer than and as wide as or slightly wider than the second, being widest at the base. The fourth, fifth, and sixth segments become progressively longer and narrower. The fourth, which is slightly longer than the third, is trapezoid in shape, its anterior width being about  $4/7$  of its basal width. Also the fifth segment is trapezoid and narrows strongly distally. The sixth segment is more quadrangular; it is longer than wide. The seventh segment is about as long as the sixth; it is elongate triangular with a rounded top and slightly concave sides.

The first gonopod of the male (fig. 7d) is of the normal *Thelphusula*-type, it is simple, curved outward and narrows gradually towards the tip, which itself is again rather suddenly constricted to a narrow point. The distal segment is slender, about 5 times as long as wide and about half as long as the preceding segment. The second gonopod (fig. 7e) is slender with a very short, but slender distal segment, which measures less than  $1/15$  of the length of the basal segment.

Biology. — See Collins, 1979.

Distribution. — So far the species was only known from the type material, described both by De Man (1902) and Bott (1970: 60, pl. 9 fig. 94-96, pl. 27 fig. 38). The type locality is "aus dem Baram-Fluss in Nord-West-Borneo" (De Man, 1902: 553). Like the type material of *Macrobrachium clymene* (see pp. 8, 9) and *Geosesarma gracillimum* (see p. 45) the types of the present species were collected by Prof. Willy Kükenthal in 1894, and the remarks given on pp. 8 and 9 concerning the Kükenthal Baram collection also apply to the type locality of *Thelphusula baramensis*. The present material thus has been collected rather close to the type locality of the species.

Remarks. — Although the present material was not directly compared to type material of *Potamon baramense* De Man, it agrees so well with De Man's (1902) and Bott's (1970) accounts, that I do not hesitate to identify it with that species.

#### SUNDATHELPHUSIDAE

### ***Perbrinckia loxophthalma* (De Man, 1892) (pl. 6)**

*Geothelphusa loxophthalma* De Man, 1892a: 245, pl. 9 fig. 3.

*Perbrinckia loxophthalma* - Bott, 1970: 67, pl. 10 figs. 18-20, pl. 28 fig. 44.

Alluvial lowland rain forest, Gunong Mulu National Park,  $4^{\circ}03'N$   $114^{\circ}56'E$  (loc. 1); caught in a pitfall trap in alluvial, often flooded forest; 13 March 1978; leg. N. M. Collins; 1 male. — Same locality; 24 March 1978; leg. N. M. Collins; 2 males, 1 female.

Size. — The carapace length of the three males is 17, 21 and 25 mm; their carapace breadth is 24, 28, and 35 mm, respectively. The female has the carapace length 22 mm, the carapace breadth 30 mm.

Descriptive notes. — The specimens agree very well with the published descriptions of the species, and could be directly compared with the holotype. In the type the carapace is somewhat more swollen laterally and the anterolateral crista is less distinct. The male abdomen of the present specimens is less slender than in the type, but has the same general shape. In the shape of the gonopods no differences were noted.

Biology. — See Collins, 1979.

Distribution. — The single type specimen (a male cl. 23 mm, cb. 35 mm) was collected in 1846 by C. A. L. M. Schwaner "at the island of Borneo". According to Van Steenis-Kruseman (1950: 478), Schwaner's itinerary in 1846 was as follows: "1846. From Bandjermasin (Dec. 9) by proa to Martapoera (9), Sg. Raja (10), Batoe Belian (11), and back to Sg. Raja and Bandjermasin (12)", i.e. in the extreme southeastern part of Borneo. It is possible that Schwaner in 1846, but before his December trip, made other exploratory travels in Borneo, but these also were in the southeastern part. Between 1843 and 1848, namely, Schwaner explored the basins of the Mahakam, Barito and Kapuas Rivers, all in southern and south-eastern Borneo.

The only other specimens of this species that have been reported upon in the literature are a male (cl. 19 mm, cb. 25 mm) and a female (cl. 25 mm, cb. 34 mm) from "Sarawak (Doria e Beccari)" reported upon by Nobili (1900: 504). The identity of that material with the present species was later confirmed by Bott (1970: 67), who examined both Nobili's specimens. The exact locality of Nobili's specimens is not known, but it certainly is in southern Sarawak, most probably in the immediate neighbourhood of Kuching. O. Beccari and G. Doria, who arrived on 19 June 1865 in Borneo, stayed from that date until the beginning of March 1866 in Kuching; in March 1866 they went to Singapore, from where Doria returned to Europe. As shown by Beccari's (1904: 1-85, map opp. p. 137) narrative, most of the time was spent in the immediate vicinity of Kuching ( $1^{\circ}33'N$   $110^{\circ}20'E$ ); in September 1865 an excursion was made up the Batang-Lupar River as far east as Undup, just east of Simanggang ( $1^{\circ}15'N$   $111^{\circ}26'E$ ).

Material from the Aru Islands that Nobili (1899: 263) brought to the present species, was shown by Bott (1970: 67, 75) to be *Sundathelphusa aruana* (Roux).

It thus seems that *Perbrinckia loxophthalma* is restricted to the island of Borneo, but has a rather wide range there.

***Sundathelphusa tenebrosa*** new species (text-fig. 8, pl. 7)

Deer Cave, Gunong Mulu National Park (loc. 2); stream near S.W. entrance; under rock; 10 March 1978; leg. P. Chapman; 1 female.

Deer Water Cave, Gunong Mulu National Park (loc. 3); in stream at about 100 m from entrance; 25 April 1978; leg. P. Chapman; 1 female with *Temnocephala*.

Clearwater Cave, Gunong Mulu National Park (loc. 6); in main stream passage near river junction; 13 April 1978; leg. P. Chapman; 2 females.

Camp 2, west ridge of Gunong Mulu, Gunong Mulu National Park, 4°03'N 114°53'E; Dipterocarp forest, in pool of 2 by 2 m, 10 cm deep, with pebble and gravel bottom, in a clear and cold mountain stream just above its subterranean part; altitude 500 m; collected at night; 18 March 1978; 2 males (the larger is the holotype).

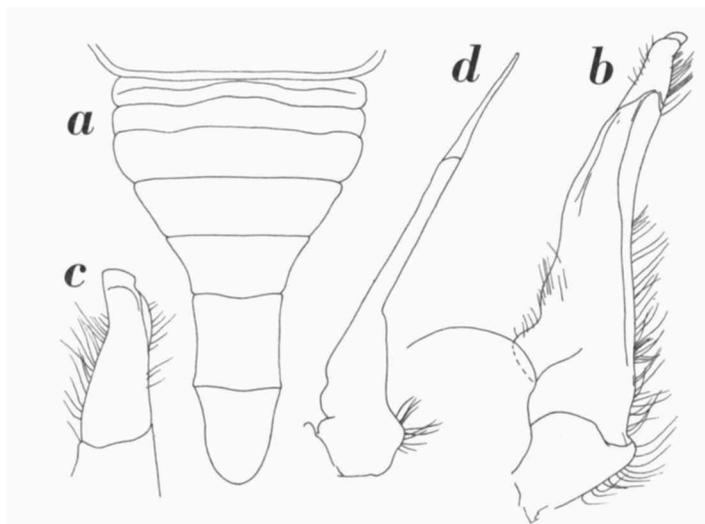


Fig. 8. *Sundathelphusa tenebrosa* new species, male holotype. a, abdomen; b, first left gonopod, posterior view; c, top of first left gonopod, anterior view; d, second gonopod. a,  $\times 3$ ; b, d,  $\times 12.5$ ; c,  $\times 25$ .

Size. — The carapace length of the two males is 19 and 21 mm, the carapace breadth 22 and 25 mm respectively. The four females are distinctly larger than the males, their carapace length lies between 24 and 29 mm, their carapace breadth between 28 and 36 mm.

Description. — Behind the postorbital ridges the carapace is only slightly convex in a longitudinal direction; before these ridges, however, it dips rather strongly down. Transversely the carapace is rather flat. It is broadest in the anterior third; its greatest width, however, is only slightly (1.1 to 1.2 times) more than its length. The posterolateral margins are rather straight, the anterolateral are strongly arched. In dorsal view the anterior margin of the front is slightly sinuous, being somewhat concave in the middle; it lies in or behind the arc formed by the anterolateral margins. The external orbital

angle is bluntly triangular and projects a fraction beyond the arc. The front is rather flat and shows a few scattered coarse tubercles. The true anterior frontal margin in the middle of each half is directed obliquely down and forms the lateral margins of the frontal triangle. The upper margin of the frontal triangle is formed by a blunt, but distinct ridge, which laterally touches the true anterior margin, but usually does not fully merge with it.

The presence of a very deep cervical groove which is clearly visible throughout its length, is one of the most conspicuous characters of the species. The groove starts at the H-shaped central depression and from there goes obliquely forward in a straight or slightly sinuous line, reaching the anterolateral margin near the epibranchial incision. Also the post-orbital ridges are distinct. They form a somewhat sinuous crest that at places is interrupted; they are flat posteriorly, very steep anteriorly. Medially they end in the post-frontal lobes, which are somewhat swollen, not so sharply defined and covered by a network of reticulating short ridges. Between the two postfrontal lobes there is a deep median groove which continues posteriorly for some distance, but is hardly noticeable on the front. Behind the H-shaped central depression the carapace is flat.

The anterolateral margin of the carapace has no teeth, only a small, but distinct epibranchial incision is present in all specimens. Before and for a short distance behind the incision, the anterolateral margin is crested. Anteriorly this crest merges completely with the crest of the orbital margin. The crest is not quite smooth but shows irregular tubercular elevations. Near and behind the widest part of the carapace the lateral margin is broadly rounded and shows parallel curved rows of tubercles, which run from the ventral surface on to the dorsal surface and often are somewhat crest-like. By the presence of these ridges and tubercles, as well as of tubercles and pits near the postorbital ridges, the lateral and anterior parts of the carapace obtain a rough appearance, to which is also contributed by the deep cervical grooves and the pronounced postorbital ridges.

The orbits are only slightly (about 7/6) wider than high. The margin is crested and minutely, but not very strongly tuberculate. The upper and lower orbital margins and the anterolateral margin of the carapace meet in a single point. The eyes have the cornea about as wide as the stalk. The cornea is well developed, with black pigment.

The anterior margin of the epistome is almost straight, being only slightly produced forward in the middle. The posterior margin shows a median bluntly triangular lobe with a minute incision at either side. The rest of the margin shows a blunt angle in the middle; the part laterally of the angle forms the anterior margin of the efferent opening, which is oval and oblique.

The mandibular palp has the typical Gecarcinucoid incision.

The ischium of the third maxilliped has the oblique longitudinal groove placed closer to the inner than to the outer margin. The exopod has the flagellum well developed and multi-articulate.

In the present material the right and left chelipeds of both sexes are equal in shape and size. Although the males are distinctly smaller than the females, they seem sexually mature; it is of course possible that they may grow larger and that then also one of the chelipeds will grow larger than the other. The fingers of the chelae are about 1.5 times as long as the palm, when measured dorsally. The tips of the fingers are sharp, curved, crossing, and horn-coloured. The cutting edges bear numerous (about 30) small denticles; in this row of denticles the slightly larger are often separated by two or more smaller. The fingers show several longitudinal rows of pits, which on the outer surface are placed in longitudinal grooves. The palm shows tubercles which are arranged in more or less distinct short transverse rows. The carpus has a strong, obliquely anteriorly directed, sharp dorsal spine; the outer surface of the carpus has a longitudinal depression and many tubercles arranged as on the palm. Similar tubercles are found on the merus. The merus has neither a dorsal nor an inner spine; a subdistal groove is present.

The walking legs are slender, but not excessively so. The merus of the fifth leg is half as long or slightly more than half as long as the carapace; in the females it is about 3 times as long as wide, in the males less than three times. The length of the second pereopod is only slightly more than the carapace width. The second pereopod is the shortest of the walking legs, being slightly shorter than the fifth; the third and fourth legs are the longest. The dactylus of the second pereopod is slightly longer than the propodus; it bears the usual four rows of spinules. The propodus shows two rows of four or five spines on the lower surface, the distal of these spines being the longest. The dorsal margin of the propodus shows a double carina with some irregular tubercles. The dorsal carina of the carpus is single; a distinct longitudinal carina is present on the outer surface of the carpus and a similar but less distinct carina on the inner surface. There are no spines on carpus or merus. The merus does not show a subdistal dorsal tooth either. The general shape and armament of the third to fifth pereopods is like that of the second, only the dactylus, and especially the propodus are distinctly longer in legs 3 and 4. In the present male specimens the legs are slightly less slender than in the females.

The male abdomen is T-shaped (fig. 8a). The first segment is very short; it is as wide as the second and shows a transverse ridge over the full width. The second segment, although short, is slightly longer than the first. The

third segment is about as long as the first and second together; at its base it is slightly wider than the second segment, but narrows distally. The fourth, fifth and sixth segments are all distinct, and successively longer and narrower. Segments 3, 4, and 5 make a trapezium of which the base is more than twice as broad as the top; the basal width is about 1.6 the total length of the trapezium. The sixth segment is longer than wide and has the sides slightly concave; otherwise it is of about the same width over its full length. The seventh segment is slightly longer than the sixth and tongue-shaped with a broadly rounded top. The female abdomen is oval, being distinctly longer than wide, and has a widely triangular distal segment.

The first male gonopod (fig. 8b, c) is short and straight or slightly curved outward; it reaches hardly beyond the anterior margin of the sternite of the fourth leg. The distal segment is short, being less than  $1/3$  of the length of the previous segment. It is elongate triangular with a broadly truncated top, which is directed somewhat outwards. The second gonopod (fig. 8d) is about as long as the first, and very slender. Its distal segment measures about  $1/3$  of the total length of the appendage.

Colour. — The preserved females are dark, somewhat mottled brown dorsally, more greyish ventrally. In life their colour was noted to be "brown with orange-brown edges to the carapace". The preserved males are paler than the females and have more of a reddish brown colour dorsally; ventrally they are very light greyish brown, being paler there than on the dorsum. The field label accompanying the males gives the following colour description of the living animal: "Dorsally dark brown with a slight purplish tinge. Venter pale brown, mouthparts dark and purple tinged".

Biology. — Although all specimens have been found in the dark, either in caves or collected at night, the species certainly is no troglobite. The dark colour of the animals, the well developed and well pigmented eyes and the relatively short legs show that there is hardly any morphological adaptation to life in the dark. Also the fact that the males were found in epigean waters and the females from Deer Cave and Deer Water Cave near the entrances of these caves, is significant in this respect.

Remarks. — The present new species resembles *Sundathelphusa halmaherensis* (De Man, 1902) from Halmahera, Moluccas, Indonesia, very closely. According to Bott (1970: 78) in *S. halmaherensis* the deep cervical grooves are not connected with the central H-shaped depression, the fifth segment of the male abdomen has the lateral margins parallel, and the first male gonopod is pointed. In those characters *S. halmaherensis* differs evidently from *S. tenebrosa*. *S. halmaherensis* so far is only known from the single type specimen, a juvenile male. This specimen was collected by Prof. Willy

Kükenthal in Halmahera during an expedition at which he also visited the Baram River area of Sarawak and collected fresh water Decapods there. The remote possibility that the type of *S. halmaherensis* was incorrectly labelled and actually came from Borneo should be kept in mind; in that case *S. tenebrosa* might prove to be a synonym of *S. halmaherensis*. But first more should be known of both species. Unfortunately Bott (1970) did not figure the male pleopods of *S. halmaherensis*.

#### PARATHELPHUSIDAE

##### **Palawanthelphusa pulcherrima** (De Man)

*Potamon* (*Parathelphusa*) *tridentatum pulcherrimum* De Man, 1902: 550, pl. 20 fig. 15.  
*Palawanthelphusa pulcherrima* - Bott, 1970: 129, pl. 24 figs. 92-94, pl. 31 fig. 96.

In stream near Camp 2, west ridge of Gunong Mulu, Gunong Mulu National Park, 4°03'N 114°53'E; 500 m alt.; sandstone/clay bank, Dipterocarp forest; about 18 March 1978; leg. A. C. Jermy; 1 female.

Size. — The carapace length of the single specimen is 20 mm, the carapace width 23 mm.

Descriptive notes. — The specimen agrees so well with De Man's above cited description and with paralectotypes in the collection of the Rijksmuseum van Natuurlijke Historie, that there can be no doubt about its identity. The spotted colour described and figured by De Man is also very noticeable in the present specimen.

Bott (1970: 117) in his key to the genera and subgenera of Parathelphusinae separated *Parathelphusa* from *Palawanthelphusa* by that in the former genus "alle Seitenzähne gross und spitz [sind]", while in the latter "mindestens der mittlere Seitenzahn reduziert [ist]". However, in the key to the species of *Palawanthelphusa*, Bott (1970: 119) used the same character ("Alle Seitenzähne sehr spitz, gross und scharf") to distinguish *Palawanthelphusa pulcherrima*, the type species of the genus *Palawanthelphusa*, from most other species of the genus. This character thus cannot be used to distinguish the two genera, which, if at all distinct, probably have to be separated best on characters derived from the male pleopods: first male gonopod short and acute in *Parathelphusa*, slender, tubeshaped and distally open in *Palawanthelphusa*.

Distribution. — The type locality of the present species is "aus dem Baramfluss auf Borneo" (De Man, 1902). This locality is the same as the type locality of *Macrobrachium clymene* (De Man), *Thelphusula baramensis* (De Man) and *Geosesarma gracillimum* (De Man), and has been extensively dealt with under the first (pp. 8, 9) and last (p. 45) of these species. This type locality is rather close to the locality of the present specimen. Bott (1970:

130) reported the species furthermore from "Zentral-Borneo" (without a more accurate locality indication) and "Bettontan, N-Borneo". The latter locality possibly is Sungei Betotan, Sabah, 5°47'N 117°52'E.

Grapsoidea

GRAPSIDAE

Sesarminae

**Geosesarma gracillimum** (De Man, 1902) (text-fig. 9)

*Sesarma* (*Sesarma*) *ocypoda gracillima* De Man, 1902: 522, pl. 19 fig. 9; Tesch, 1917: 179, pl. 17 fig. 1.

*Geosesarma gracillimum* Serène & Soh, 1970: 403.

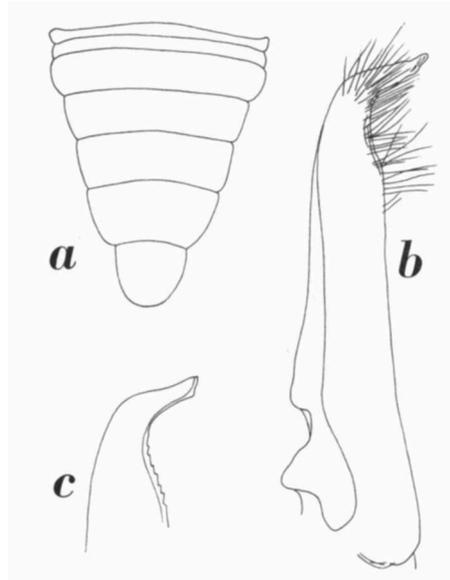


Fig. 9. *Geosesarma gracillimum* (De Man), male. a, abdomen; b, left first gonopod; c, denuded tip of left first gonopod. a,  $\times 6$ ; b, c,  $\times 25$ .

Alluvial lowland rainforest, Gunong Mulu National Park, 4°03'N 114°56'E (loc. 1); taken from soil core from frequently flooded alluvial forest; 5 June 1978; leg. N. M. Collins; 1 male. — Same locality; caught in pitfall trap in a frequently flooded forest; 13 March 1978; leg. N. M. Collins; 1 female. — Same locality; found in pitfall trap in frequently flooded forest, together with *Perbrinckia loxophthalma* (De Man); 24 March 1978; leg. N. M. Collins; 14 postlarvae.

Size. — Carapace length and carapace breadth of the male are both 10 mm, those of the female both 13 mm.

Descriptive notes. — The specimens agree well with the published descriptions and figures by De Man (1902) and Tesch (1917), who placed the species in the nominate subgenus of the genus *Sesarma*, and considered it a subspecies of *Sesarma ocyroda* Nobili, 1899. Serène & Soh (1970) resurrected the genus *Geosesarma* De Man, 1892, and treated the present form as a species distinct from *Geosesarma ocyroda* (Nobili). They used the incorrect spelling *ocyrodum* for the epithet of that name; *ocyroda*, namely, is a noun and, if used as an epithet, does not change its ending with the gender of the generic name with which it is cited.

The male abdomen (fig. 9a) and the male gonopods (fig. 9b, c) have not been figured before. Therefore they are depicted here. The abdomen is triangular and regularly tapers distally; the distal segments are longer and narrower than the proximals. The seventh segment is about as long as wide at the base, and has the top broadly rounded. The first male gonopod has the tip rather abruptly curved outward and it ends in an obliquely truncate apex.

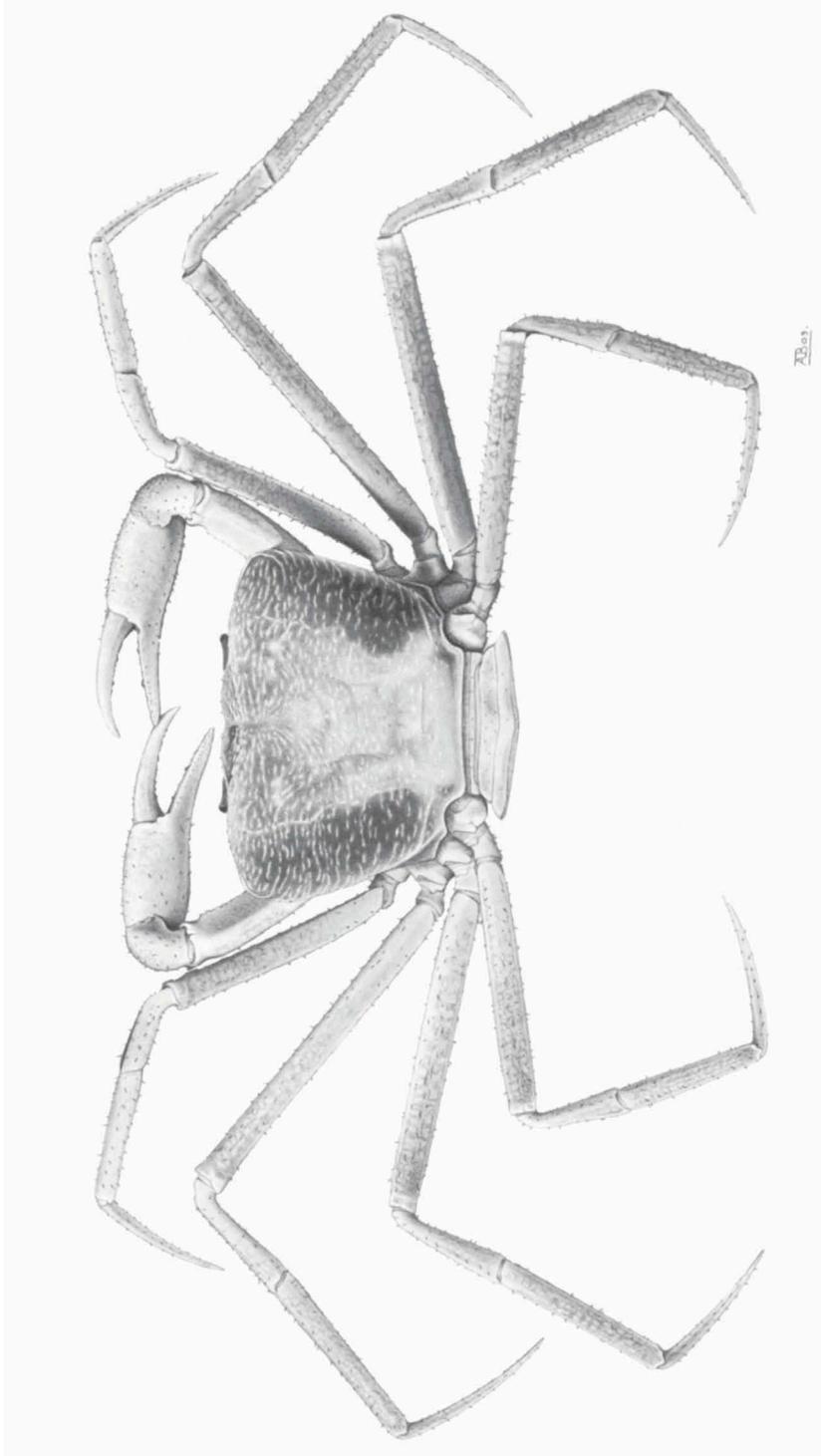
Biology. — See Collins, 1979.

Distribution. — The type locality of the species is “aus dem Baramfluss, Borneo”. Like the types of *Macrobrachium clymene*, the types of the present species were collected by W. Kükenthal during his stay on the Baram River from 4 August to 10 September 1894. The exact type locality is not known and it may be either in the neighbourhood of Marudi ( $4^{\circ}11'N$   $114^{\circ}19'E$ ) or up the Baram River as far as Long Mari and the Tutoh River as far as Rumah Penghulu Bayak (see pp. 8, 9 of the present paper). The altitude is unknown, but the locality is definitely one with fresh water. Tesch (1917) reported the species from the Natuna Islands, S. China Sea, Indonesia; and Tweedie (1936: 52) obtained a series of specimens from a stream near the River Yum, Plus Valley, eastern Perak, Malaya. The specimens that Tweedie assigned to the present species were taken at an altitude of 2500 to 3000 feet (= 800 to 1000 m). The altitude at which the types were found is not known but may be slightly less than that at which the present Gunong Mulu specimens were taken. The greatest altitude in the Natuna Islands is 3146 feet (= about 1030 m), but the altitude at which Tesch's specimens were taken is not known. A. L. van Hasselt, who collected these animals visited the islands in February 1896 and explored the island of Bunguran. Here he climbed Mt. Runai, the highest mountain of the group (vid. Van Hasselt & Schwartz, 1898: 472-476, where the height of the mountain is given as “meer dan drie duizend voeten” (more than 3000 feet); unfortunately no capture of crabs is mentioned in this narrative).

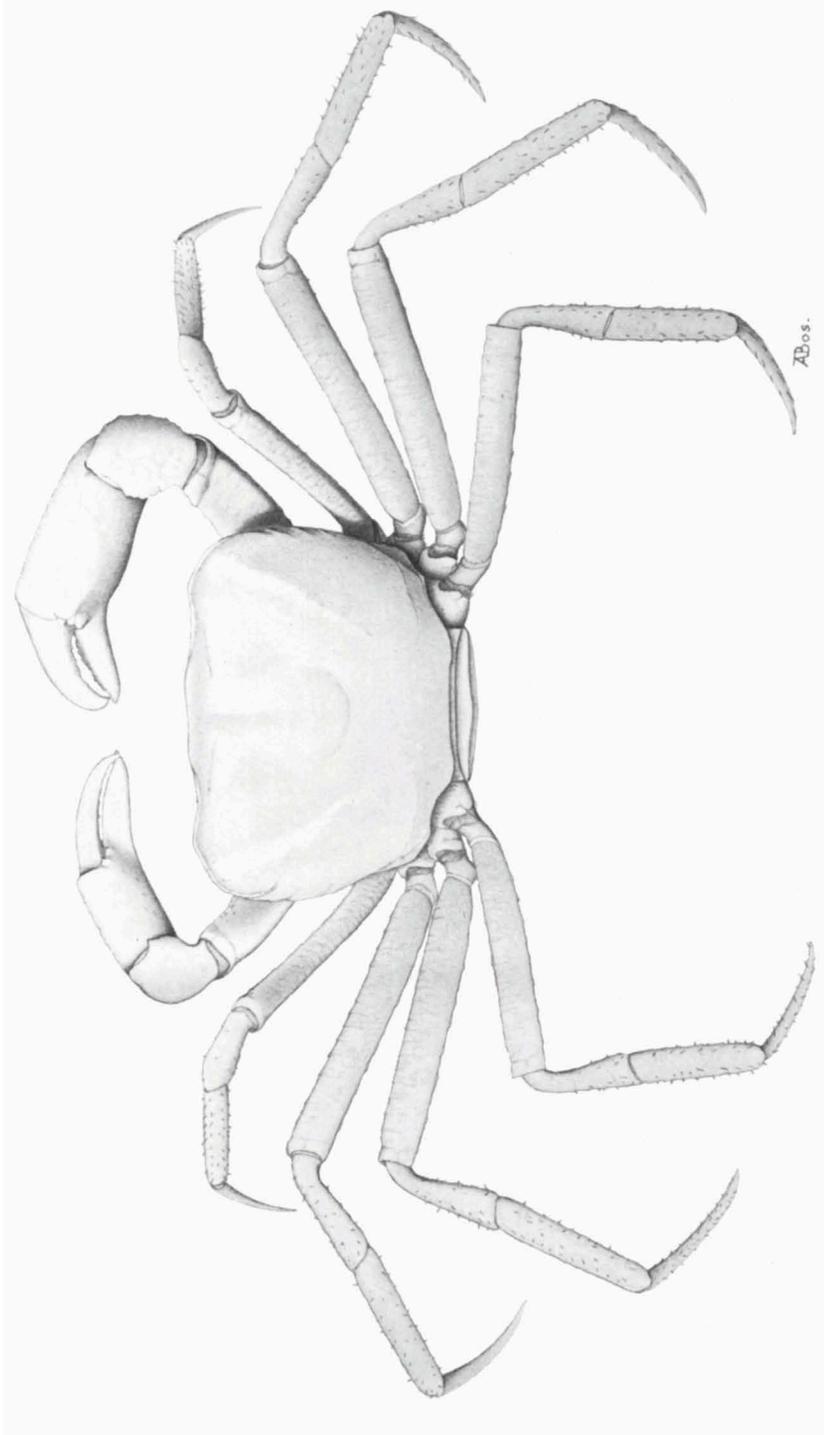
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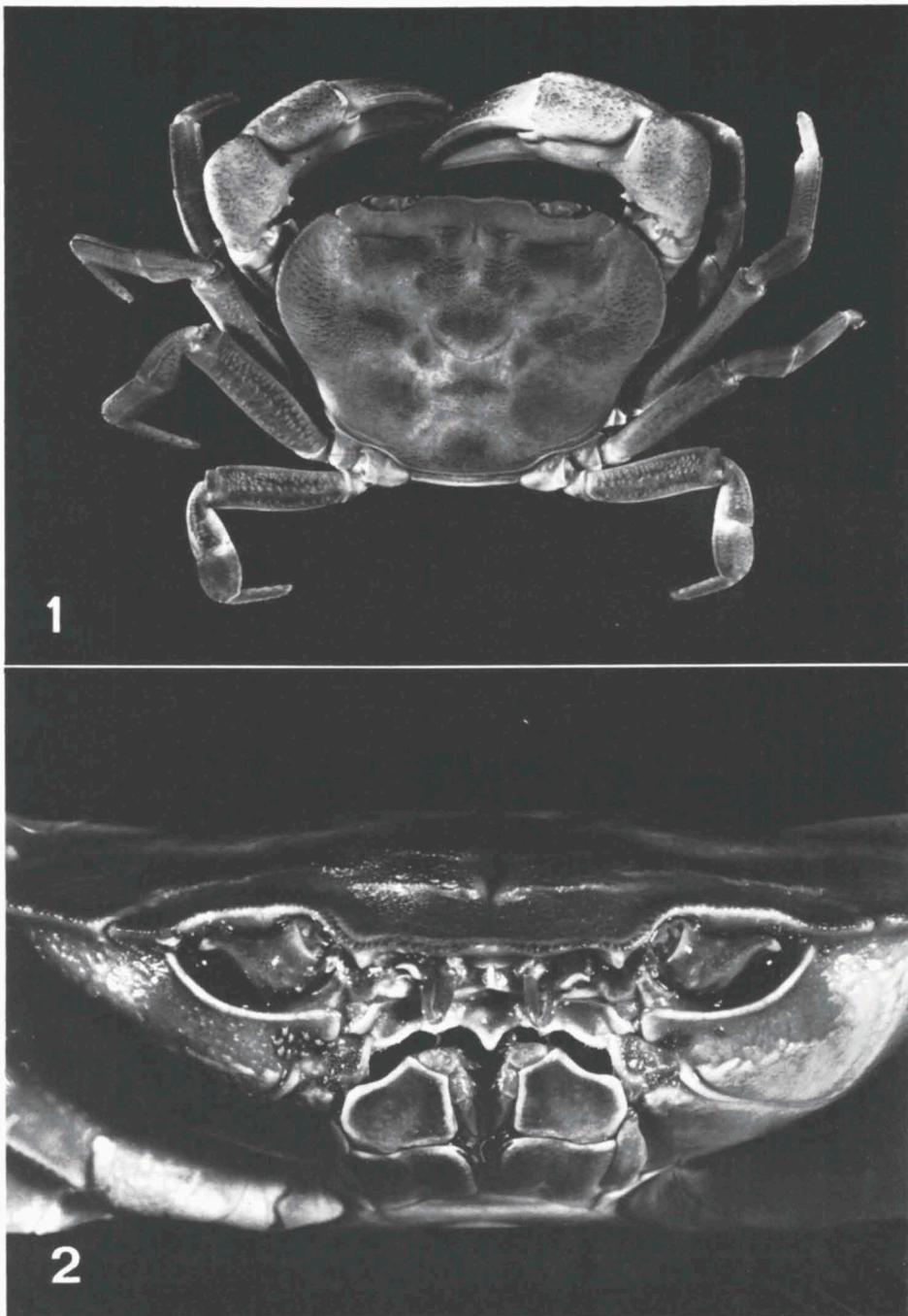
*Cerberusa tipula* new species, female paratype. × 2.4.



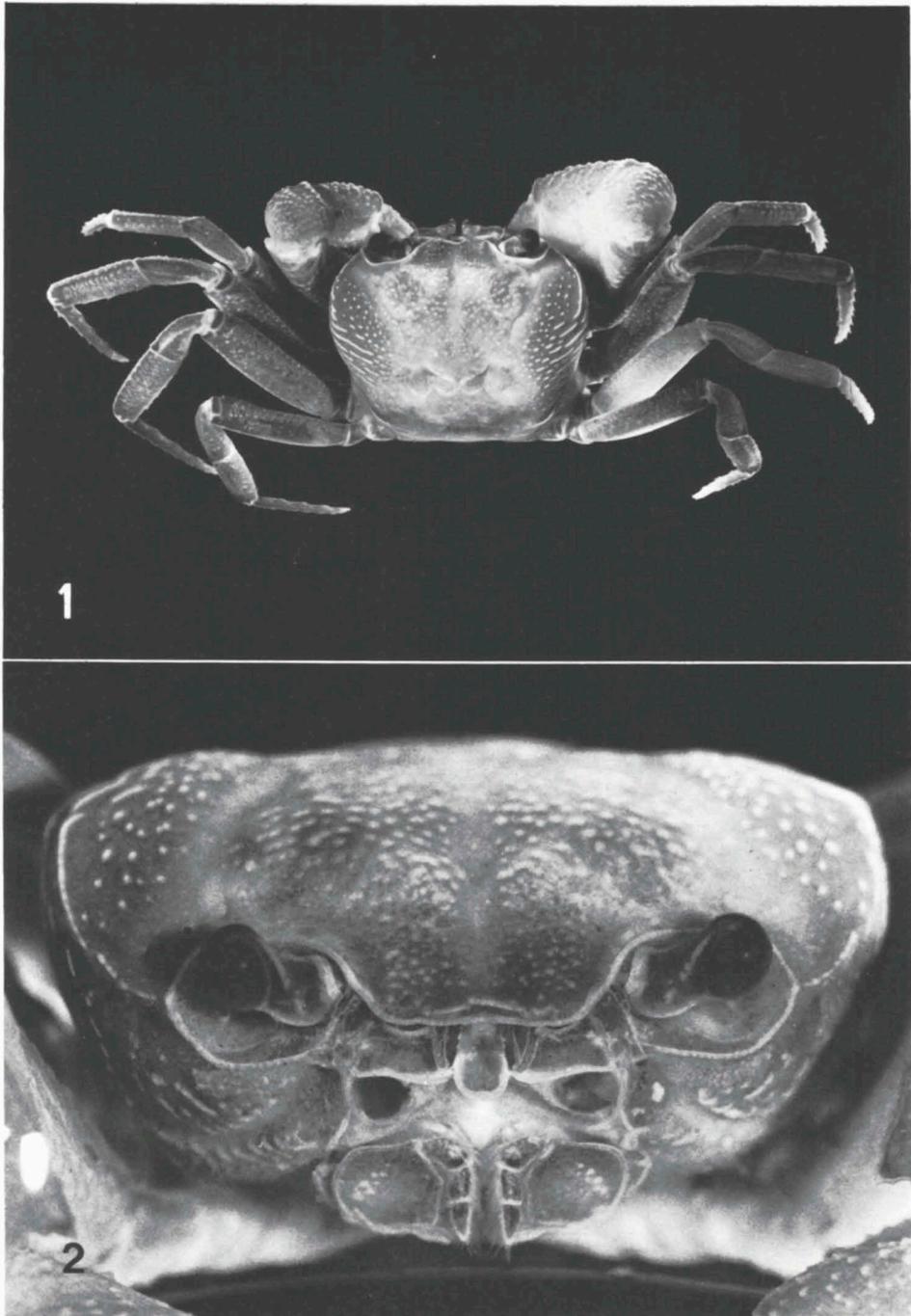
*Cerberusa caeca* new species, male holotype.  $\times 2.8$ .



1, *Cerberusa tipula* new species, male holotype.  $\times$  1.6.  
2, *Adeleana chapmani* new species, female paratype.  $\times$  1.8.



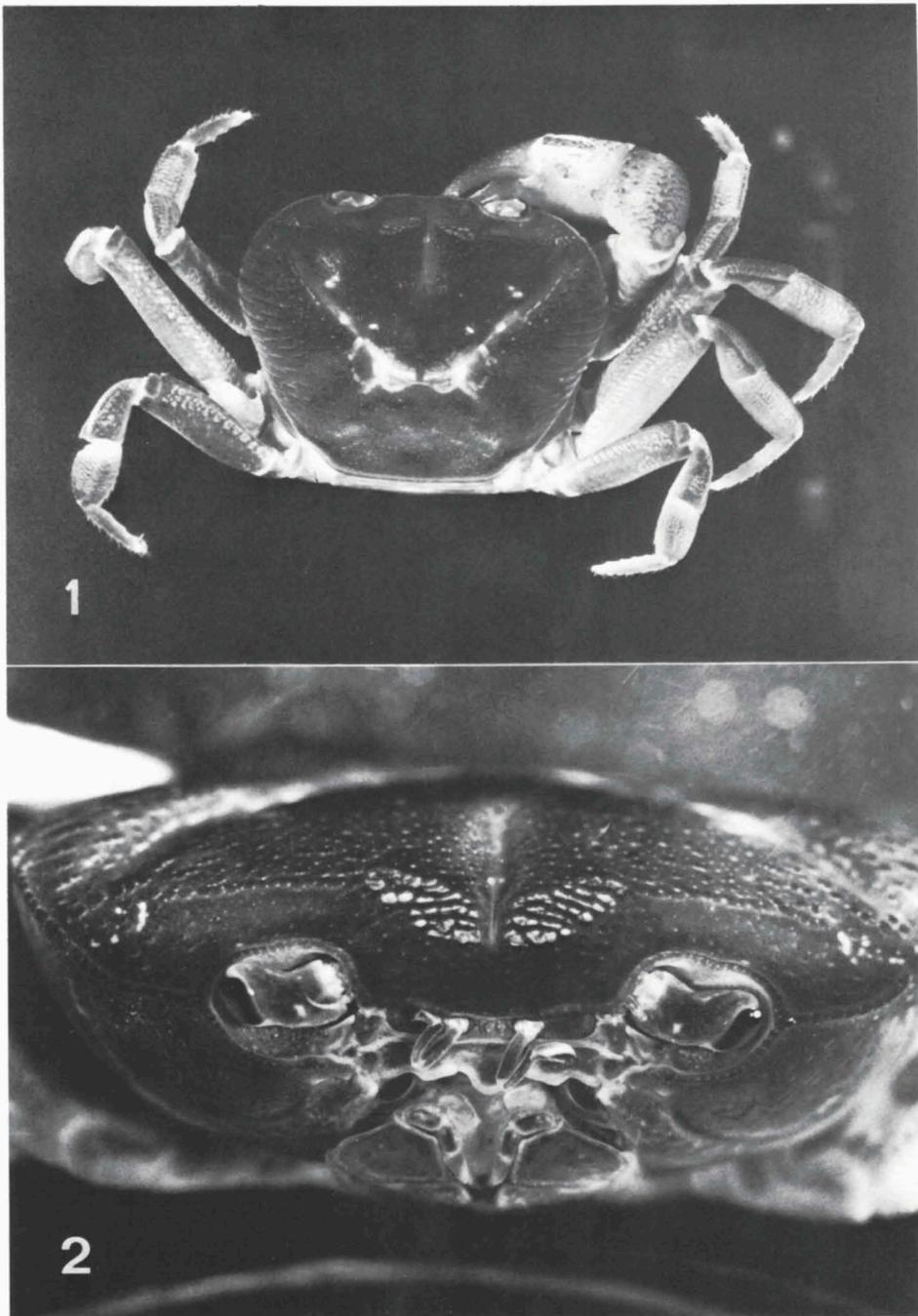
*Isolapotamon collinsi* new species, male holotype. 1, specimen in dorsal view; 2, front view of body. 1, natural size; 2,  $\times 2.6$ .



*Thelphusula granosa* new species, male holotype. 1, specimen in dorsal view; 2, front view of body. 1,  $\times 1.4$ ; 2,  $\times 4.5$ .



*Perbrinckia loxophthalma* (De Man), male. Gunong Mulu National Park. 1, specimen in dorsal view; 2, front view of the body. 1,  $\times 1.5$ ; 2,  $\times 4.5$ .



*Sundathelphusa tenebrosa* new species, female paratype. 1, animal in dorsal view;  
2, front view of body. 1,  $\times 1.4$ ; 2,  $\times 4.0$ .



*Cerberusa caeca* new species, live specimen in Green Cave.