

**REVISION OF THE ANCHIALINE VARUNINE CRABS
OF THE GENUS *ORCOVITA* NG & TOMASCIK, 1994
(CRUSTACEA: DECAPODA: BRACHYURA: GRAPSIDAE),
WITH DESCRIPTIONS OF FOUR NEW SPECIES**

Peter K. L. Ng, Danièle Guinot and Thomas M. Iliffe

ABSTRACT. - Four new species of the varunine crab genus *Orcovita* Ng & Tomascik, 1994, viz. *O. gracilipes*, *O. mollitia*, *O. fictilia* and *O. angulata* are described from the Pacific islands of Niue, Guam and the Philippines. The genus was previously considered monotypic, with only the Indonesian type species, *O. saltatrix* Ng & Tomascik, 1994. A key to the genus is provided. All known *Orcovita* species are anchialine and/or cavernicolous crabs.

INTRODUCTION

Ng & Tomascik (1994) described an unusual new genus and new species of grapsid crab, *Orcovita saltatrix*, from an anchialine lagoon in a raised atoll in Kakaban, between Borneo and Sulawesi in Indonesia. Although *Orcovita* clearly belongs to the subfamily Varuninae, it is very distinct with regards to its broad and rectangular carapace, well developed frontal median triangle, broadly triangular external orbital angle, elongate and slender pereopods, and a short and stout G1.

The third author, in his investigations of the anchialine fauna in the Pacific, obtained numerous crabs which were subsequently referred to the first and second authors for study (see Ng et al., 1994). Among the crabs collected from caves and sinkholes in the islands of Niue, Guam and the Philippines archipelago are a good series of specimens clearly referable to the genus *Orcovita*. The study of this material showed that they contained representatives of four species, all of which are undescribed. The present paper serves to describe these four new species and provides a key to the genus.

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MATERIALS AND METHODS

The abbreviations G1 and G2 are used for the male first and second pleopods respectively; M, D and P refer to the ambulatory merus, propodus and dactylus respectively, the number preceding it referring to the respective ambulatory leg. Measurements are of the carapace width and length respectively. The terms used essentially follow those used by Crosnier (1965). The term anchialine is used in the sense of Holthuis (1973).

Specimens are deposited in the Muséum national d'Histoire naturelle (MNHN), Paris, France; Zoological Reference Collection (ZRC), Department of Zoology, National University of Singapore; Museum Zoologicum Bogoriense (MZB), Bogor, Indonesia; United States National Museum of Natural History (USNM), Smithsonian Institution, Washington D.C.; National Museum (NMCR), Manila; Zoological Collection of the University of Ljubljana, Slovenia (ULS); and the Nationaal Natuurhistorisch Museum (NNM), Leiden, The Netherlands.

TAXONOMY

FAMILY GRAPSIDAE MACLEAY, 1838

SUBFAMILY VARUNINAE H. MILNE EDWARDS, 1853

Orcovita Ng & Tomascik, 1994

Orcovita Ng & Tomascik, 1994: 939.

Type species. - *Orcovita saltatrix* Ng & Tomascik, 1994, by original designation and monotypy.

Diagnosis. - Carapace rectangular to subrectangular, distinctly broader than long; dorsal surface smooth; regions poorly defined; epigastric cristae very low; postorbital cristae very low to not discernible. External orbital angle very broad, outer margin distinctly convex; frontal median triangle present, formed by 3 granuliform ridges. Antennal segments entering orbital hiatus. Antennules broad. Eyes well developed, cornea pigmented. Third maxilliped with very broad, stout exopod, as wide or slightly wider than ischium; anteroexternal angle of merus strongly auriculiform. Chelipeds relatively long, with distinct pulvinus (swollen area with thin, membranaceous cuticle) with setose surrounding areas present at base of fingers of both male chelae; pulvinus usually also present in females although relatively smaller, setae varies from dense and long to sparse to almost undiscernible. Ambulatory legs subcylindrical in cross-section, segments long, slender; dorsal and ventral margins gently serrated in first ambulatory merus, progressively less serrated from first to third ambulatory merus, appearing rough to uneven in fourth ambulatory merus. Male abdomen not retained by a "bouton-pressure" (cf. Guinot, 1979), with only a sternal ridge surrounding telson. G1 with truncate tip. G2 very short, no distal segment present (modified from Ng & Tomascik, 1994: 939).

Remarks. - Ng & Tomascik (1994: 940) have discussed the affinities of *Orcovita* with other varunine genera and there is no need to elaborate on this here. Externally, *Orcovita* most closely resembles *Ptychognathus* Stimpson, 1858, especially with regards to the pulvinus

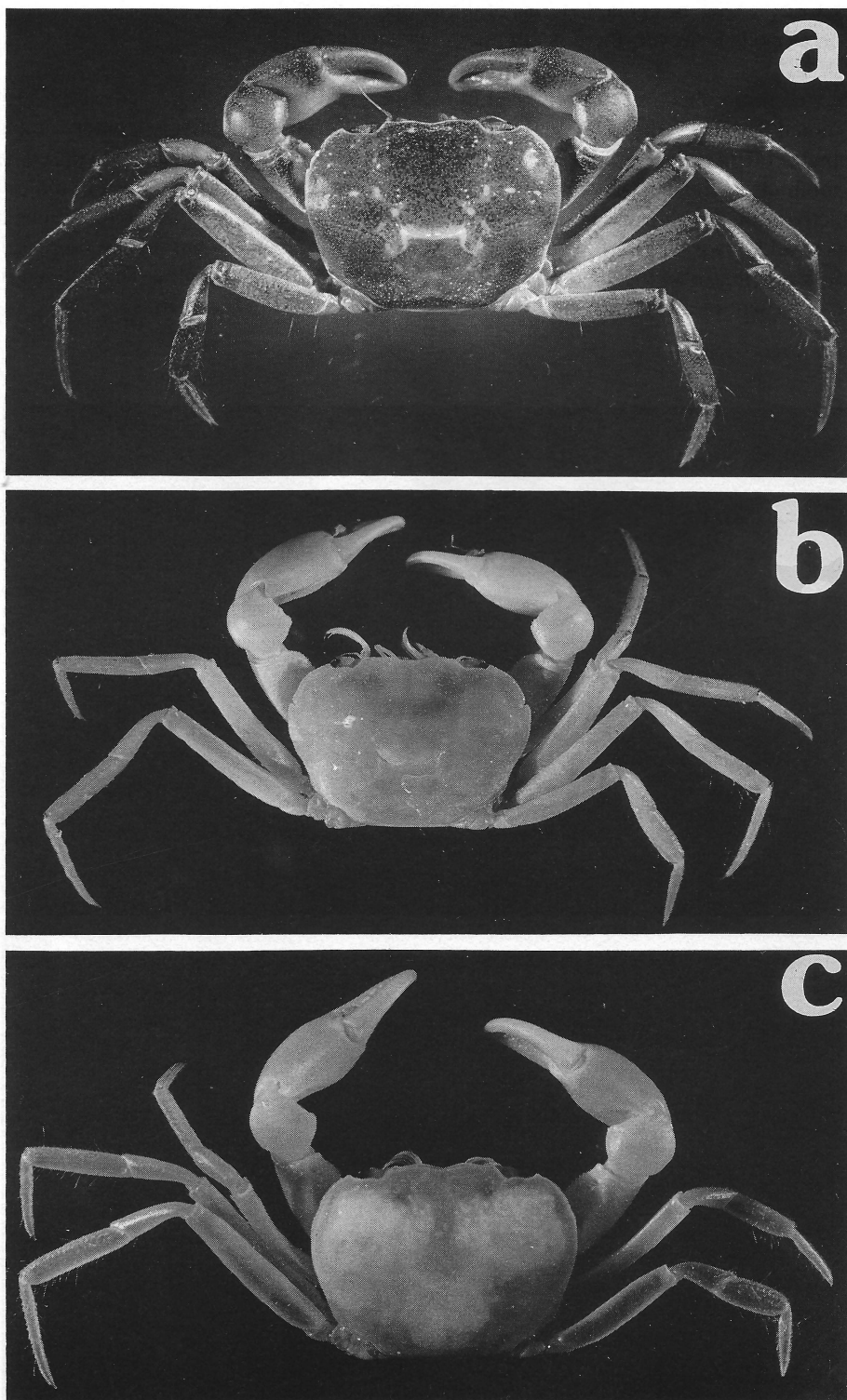


Fig. 1. a, *Orcovita saltatrix* Ng & Tomascik, 1994, paratype male (17.0 by 13.0 mm) (MNHN B-22891); b, *O. gracilipes*, new species, holotype male (18.5 by 13.1 mm) (MNHN B-22892); c, *O. mollitia*, new species, holotype male (12.6 by 9.6 mm) (MNHN B-22895).

and setose parts of the chela. In terms of the carapace, frontal margin, anterolateral margins, and pereiopods however, there is not much resemblance.

Sexual dimorphism is quite marked in members of this genus. Ng & Tomascik (1994: 943) noted that the chelipeds of males are longer and the chelae relatively stouter compared to females for *O. saltatrix*, and this is also valid for the other four species recognised here. The tooth on the inner distal angle of the chelipedal carpus is low and obtuse in males but distinctly more developed and much stronger in females. The outer surface of the chela in males in all known species is smooth, but in females, there is a low but visible submarginal longitudinal ridge near the ventral margin which extends across the pollex. This submarginal ridge is present in all five species although it is very weak in *O. gracilipes*.

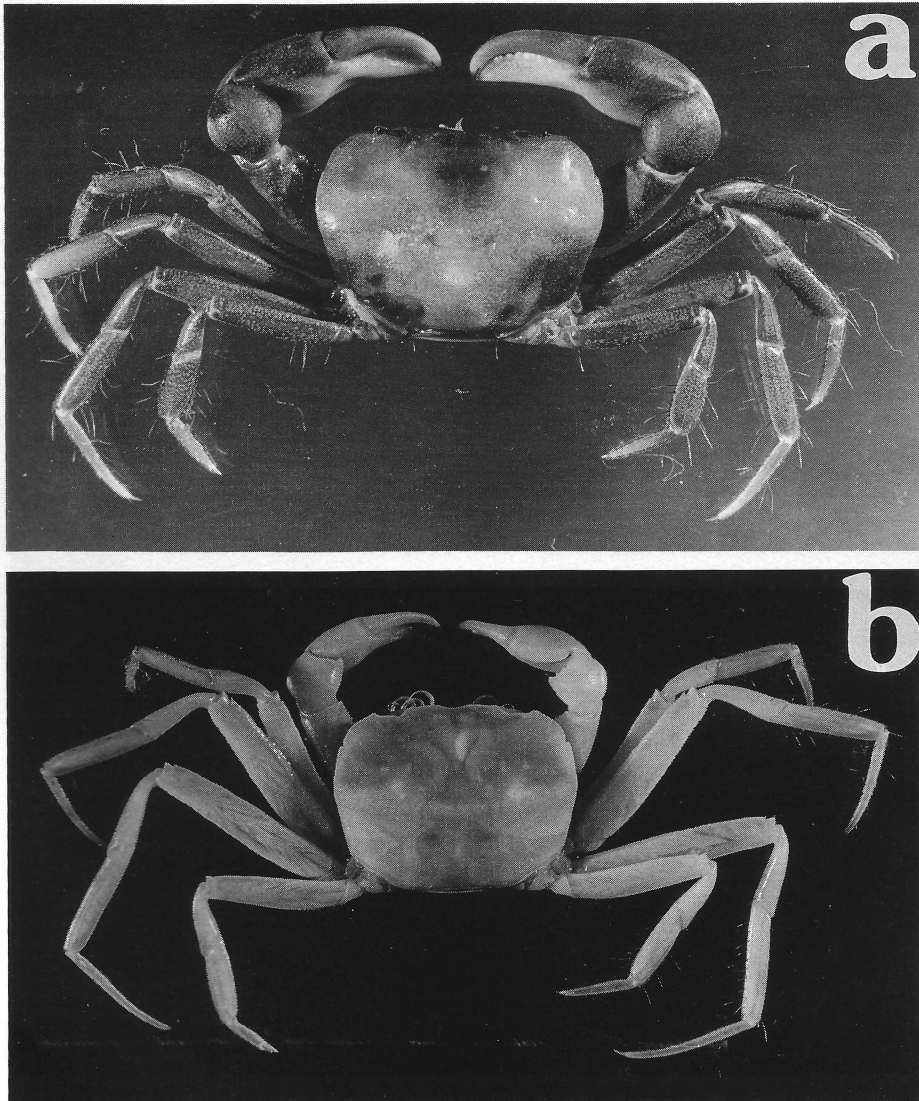


Fig. 2. a, *Orcovita fictilia*, new species, holotype male (21.5 by 15.3 mm) (NMCR); b, *O. angulata*, holotype female (16.7 by 13.0 mm) (USNM 364310b).

One ovigerous specimen of *O. gracilipes* was obtained and it has small eggs (ca. 0.3 mm diameter), suggesting that the first zoeae are small and the larval stages have a relatively long planktonic life.

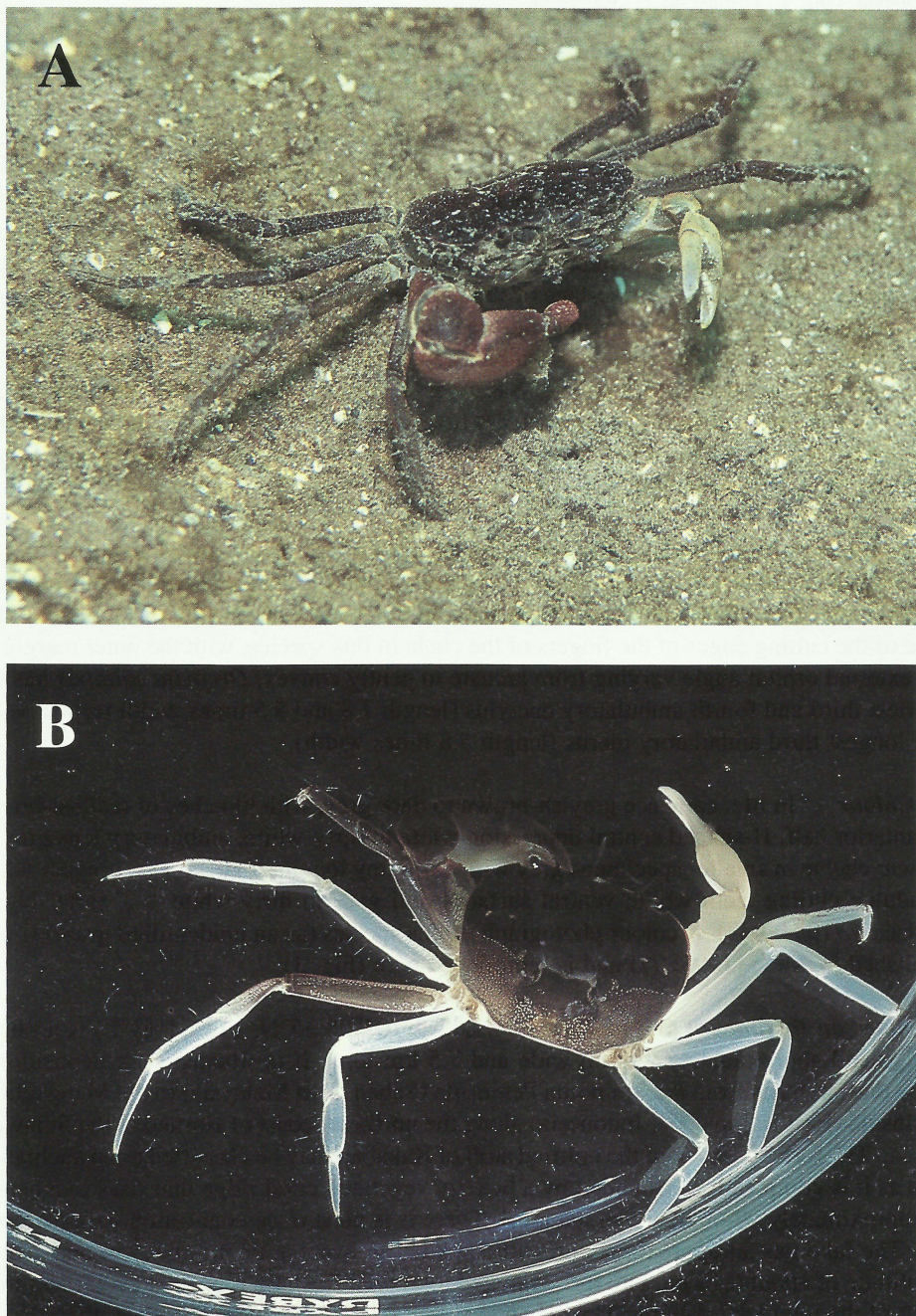


Fig. 3. Live colours. A, *Orcovita saltatrix* Ng & Tomascik, 1994, in Kakaban Lake, specimen not collected (photograph: G. R. Allen); B, *O. fictilia*, new species, female (17.0 by 13.0 mm) (USNM 364310a).

***Orcovita saltatrix* Ng & Tomascik, 1994**

(Figs. 1a, 3A, 4, 5)

Orcovita saltatrix Ng & Tomascik, 1994: 937, Figs. 3-7.

Material examined. - Holotype - male (19.0 by 14.0 mm) (MZB), ca. 11 m depth, Kakaban, Indonesia, coll. T. Tomascik, 27 Sep.1993.

Paratypes - 7 males (largest 23.0 by 16.1 mm), 2 females (19.4 by 14.9 mm, 19.4 by 14.6 mm) (ZRC 1994.4220), 2 males (MNHN B-22891), 1 male (NNM), ca. 10 m depth, same locality as holotype, coll. T. Tomascik, 29 Sep.1993.

Diagnosis. - Carapace broader than long (width ca. 1.4 times length). External orbital angle separated from anterolateral margin by distinct, V-shaped cleft; posterolateral margins minutely granular, appearing smooth, gently concave to straight, converging gradually towards posterior margin of carapace. Outer surface of male major chela smooth, without any trace of a longitudinal sulcus, outer surface of female chela with weak submarginal longitudinal ridge adjacent to ventral margin; areas adjacent to male pulvinus with well developed setae, female pulvinus very small to undiscernible, with very short or no setae; outer surfaces of tips of fingers glabrous. 3M length ca. 5.8 times width, 3P length ca. 4.3 times width, 3D length ca. 7.8 times width, 4M length ca. 4.4 times width, 4P length ca. 3.1 times width, 4D length ca. 5.5 times width. Width of segment 6 of male abdomen ca. 2.1 times length; length of telson ca. 1.3 times length of segment 6.

Remarks. - *Orcovita saltatrix* has been described and discussed in detail by Ng & Tomascik (1994), and there is no need to elaborate upon the species here. Ng & Tomascik (1994) commented that there is some variation in the density and length of the setae at the base of the cutting edges of the fingers of the chela in this species, with the outer margin of the external orbital angle varying from arcuate to gently convex. *Orcovita saltatrix* has the shortest third and fourth ambulatory dactylus (length 7.8 and 5.5 times width respectively) and longest third ambulatory merus (length 5.8 times width).

Colour. - "In life, carapace greyish-brown to dark grey, with blotches of reddish-brown on anterior half, H-shaped central depression white to dirty-white; ambulatory legs grey to brown; chelae in smaller specimens grey with dark grey longitudinal streaks; greyish-white in adults; cutting teeth white; ventral surfaces dull grey to dirty white" (after Ng & Tomascik, 1994: 943). A colour photograph of this species (as an unidentified grapsid) was published in Allen (1995: 77) and is reproduced here (Fig. 3).

Notes on the habitat and biology. - "Kakaban (02°08'35"N, 118°31'13"E) is a raised atoll island approximately 2.5 km wide and 7.5 km long. It is situated on a depositional basin that stretches from the Simporna Peninsula (Sabah, East Malaysia) to the Mangkalihat Peninsula (East Kalimantan, Indonesia) along the northeast coast of Borneo in the Sulawesi Sea" The former lagoon of the uplifted atoll of Kakaban may be classified as an anchialine lake as it is completely surrounded by a heavily vegetated coral ridge that rises to a height of approximately 50-60 m above sea level. There is no surface connection with the open sea. The lake has an approximate area of 3.9 km², an average depth of 8.5 m and a tidal amplitude of about 0.19 m, with the estimated total tidal flushing (per tidal cycle) less than 2.5% of the total lake volume. The pH and salinity of the lake water are lower than that of the surrounding sea water (pH 7.6-7.8 against average of pH 8.3, salinity 26-28 ppt against 32-35 ppt). The average water temperature is distinctly higher than the surrounding waters

(surface 32°C, 31°C at a depth of about 10 m, against 26°-28°C). The dissolved oxygen (measured at mid-afternoon) was 6.6 mg/l at the surface and 5.6 mg/l at a depth of about 10 m, against that of seawater which ranges from 6.0-6.4 mg/l. The lake at Kakaban is fringed by a narrow mangrove belt about 3-5 m wide The sediments in the lake can be roughly grouped into three types. Type 1 is a dark sediment found exclusively under the stilt roots

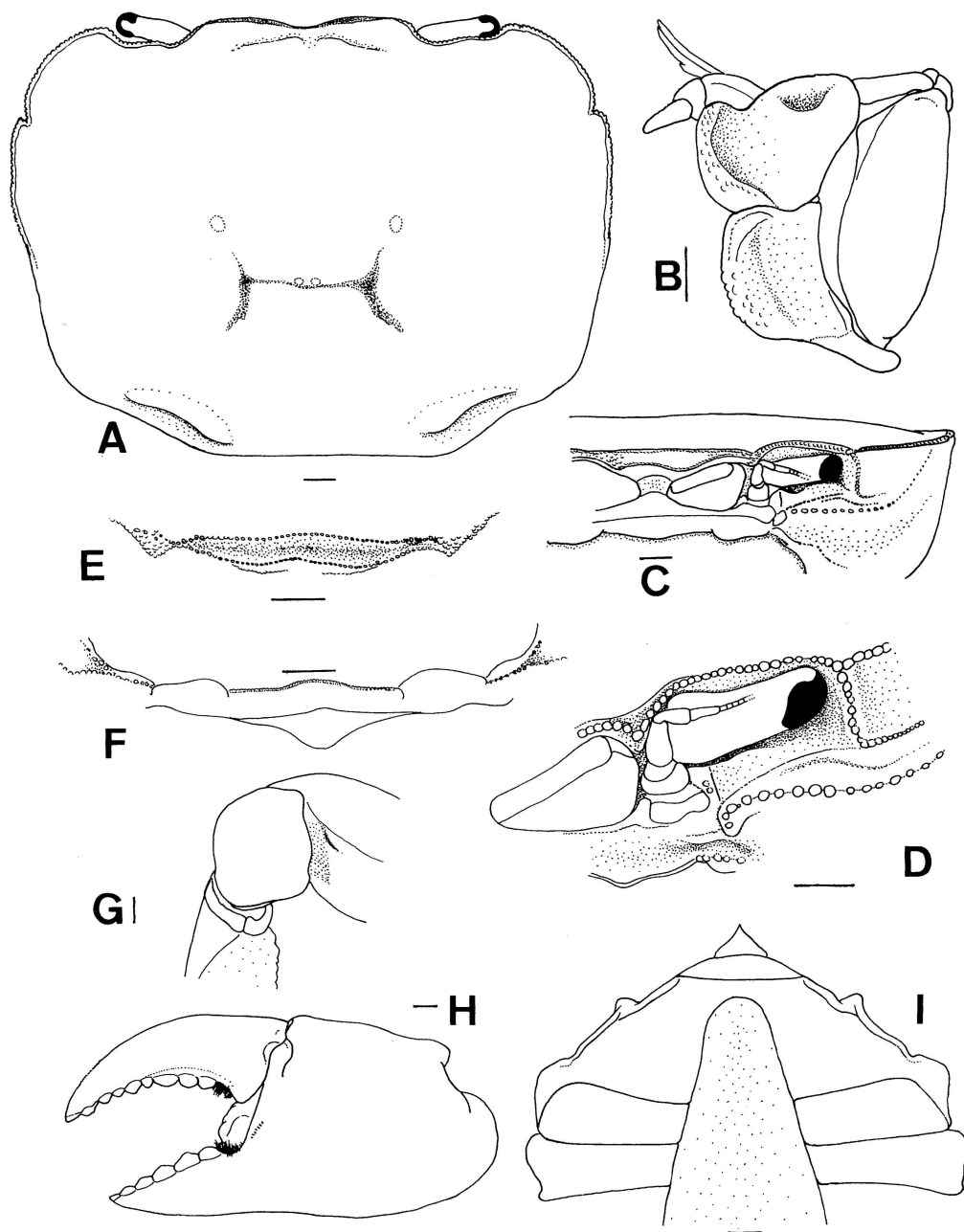


Fig. 4. *Orcovita saltatrix* Ng & Tomascik, 1994. Holotype male (19.0 by 14.0 mm) (MZB). A, carapace; B, left third maxillipeds; C, frontal view of carapace; D, antennae, antennules and orbits (frontal view); E, frontal median triangle; F, posterior margin of epistome; G, distal part of merus, carpus and proximal part of chela (dorsal view); H, left chela; I, anterior thoracic sternites. Scales = 1.0 mm.

of *Rhizophora* and consists mainly of mangrove detritus, some weathered ‘beach’ rock and fragments from *Halimeda* and the bivalve *Brachydontes variabilis* which are very abundant on the stilt roots. Type 2 sediment is a fine mud covering most of the lake bottom. Type 3 sediment consists mostly of *Halimeda* fragments and is dominant in the lake’s extensive *Halimeda* meadows. *Orcovita saltatrix* were observed only on Type 1 and Type 2 sediments. Preliminary observations indicate that the crabs are found only at depths greater than 2 m. The crabs move gently over the bottom and when disturbed, swiftly burrow into the soft mud.” (after Ng & Tomascik, 1994: 944-947). Allen (1995: 77) notes that the crab lives in “... silty burrows”.

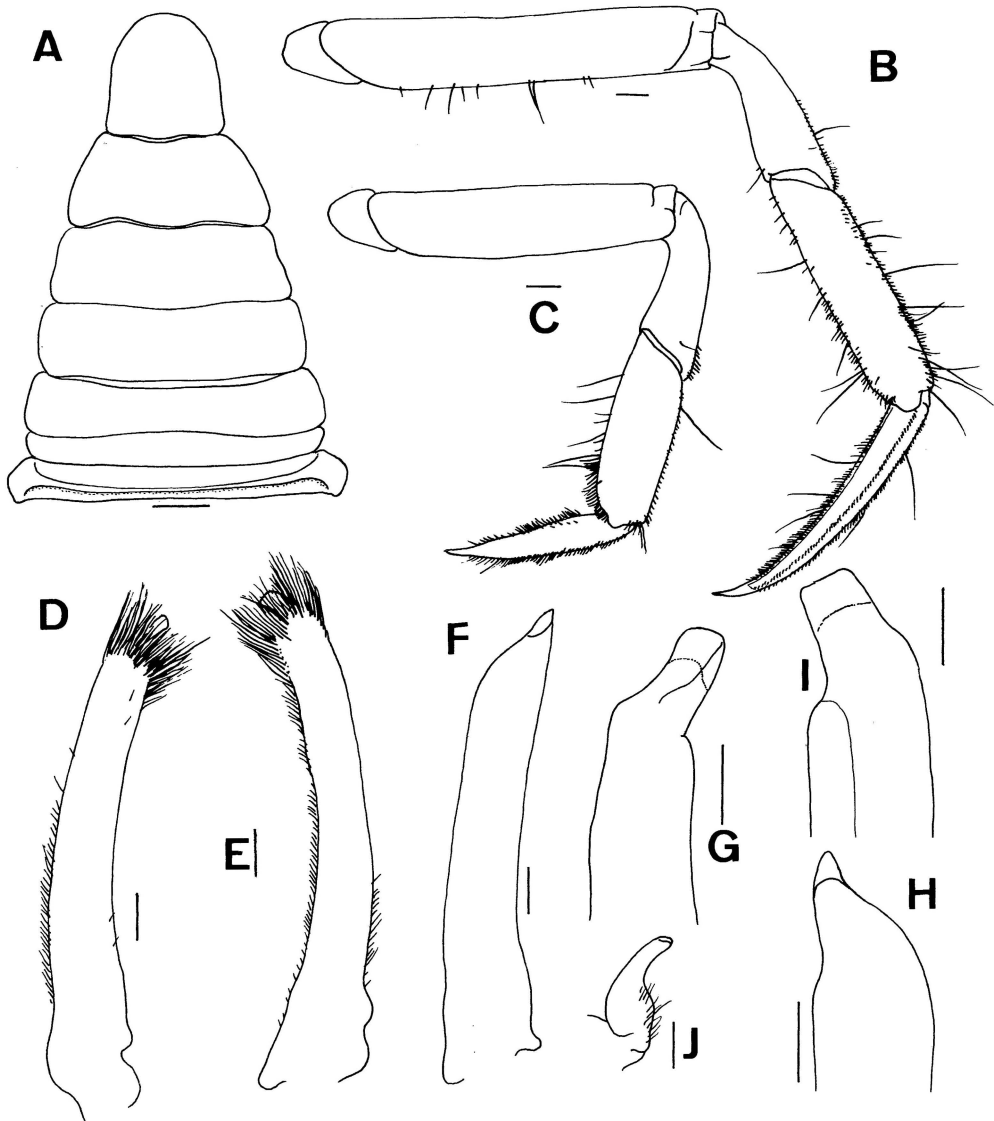


Fig. 5. *Orcovita saltatrix* Ng & Tomascik, 1994. Holotype male (19.0 by 14.0 mm) (MZB). A, abdomen; B, right third ambulatory leg; C, left fourth ambulatory leg; D-I, left G1; G-I, distal part of left G1; J, left G2. D-E, with setae; A, F-I, denuded. Scales: A-C = 1.0 mm; D-J = 0.5 mm.

***Orcovita gracilipes*, new species**

(Figs. 1b, 7, 8)

Material examined. - Holotype - male (18.5 by 13.1 mm) (MNHN B-22892), station 88-006, Vaikona Chasm, Niue, coll. T. M. Iliffe, 6 Feb.1988, with plastic bottle baited with fish and left overnight at 13 m depth.

Paratypes - 3 males, 2 females (larger, ovigerous, 17.4 by 12.5 mm) (MNHN B-22893), 1 female (NNM), 1 male, 1 female (ZRC 1996.96-97), same data as holotype.

Others - 1 female (19.6 by 13.9 mm) (MNHN B-22894), station 88-009, Anatuku Chasm, Niue, coll. T. M. Iliffe, 12 Feb.1988, with plastic bottle baited with fish and left overnight at 20 m depth.

Diagnosis. - Carapace broader than long (width ca. 1.4 times length). External orbital angle separated from anterolateral margin by distinct, V-shaped cleft; posterolateral margins distinctly granulated, concave, converging distinctly towards posterior margin of carapace. Outer surface of male major chela smooth, with a shallow but clear longitudinal sulcus on the upper half in large males, outer surface of female chela with very weak submarginal longitudinal ridge adjacent to ventral margin; areas adjacent to male and female pulvinus with long setae, often completely obscuring pulvinus; outer surfaces of tips of fingers glabrous; border strongly corneous. 3M length ca. 5.7 times width, 3P length ca. 5.1 times width, 3D length ca. 10.8 times width, 4M length ca. 4.7 times width, 4P length ca. 3.2 times width, 4D length ca. 5.9 times width. Width of segment 6 of male abdomen ca. 2.1 times length; length of telson ca. 1.1 times length of segment 6.

Etymology. - The name alludes to the long and slender ambulatory legs of the species (from the Latin "gracilis" for long, slender and "pes" for foot).

Remarks. - With regards to the elongate ambulatory legs and dense setose areas surrounding the pulvinus on the chela, *O. gracilipes* seems to be closest to *O. saltatrix*, but there are several key differences. *Orcovita gracilipes* can be separated from *O. saltatrix* in the structure and shape of the posterolateral margin of the carapace, proportions of the ambulatory merus and propodus, degree of granulation on the inner distal margin of the chelipedal carpus, proportions of the male abdominal segment 6 (Table 1). The external orbital angle of *O. gracilipes* is also usually less strongly arcuate compared to that on *O. saltatrix* (Fig. 3A vs. 5A), but, in at least one specimen of *O. gracilipes* (Fig. 5K), this is not the case. *Orcovita gracilipes* is also the only species in the genus in which the outer surface of the major chela in large males has a shallow but discernible longitudinal sulcus on the upper half.

The degree of pubescence around the pulvinus of the chela in *O. gracilipes* is very marked - more so than for any other species. In both males and females, the setae are very long and dense, often completely obscuring the pulvinus. These setae are distinctly longer than those in male *O. saltatrix* or *O. mollitia*. In other *Orcovita* species, the setae around the pulvinus of female chelae are very weak to absent. The density and length of the setae are correlated with the strength of the pulvinus, particularly in females. In females of species in which the setae are very sparse and short, the pulvinus is frequently small to indistinct (e.g. *O. saltatrix* and *O. fictilia*). In *O. gracilipes*, the pulvinus in males and females are equally well developed. Even in juvenile specimens (e.g. male 12.1 by 9.0 mm, MNHN B-22893), the pulvinus is well developed and the setae long and dense.

The proportions of the elongate ambulatory legs ally *O. gracilipes* with *O. angulata*, but

the carapace of *O. gracilipes* is very different, appearing proportionately longer, the lateral margins are distinctly more rounded, the third and fourth ambulatory propodus and dactylus is proportionately much longer, the outer surface of the chela is smooth and has no longitudinal ridge, the area surrounding the pulvinus on the chela is covered with long setae and the tips of the fingers of the chela are glabrous (Table 1).

The submarginal longitudinal ridge present near the ventral margin of the female chela is very weak in *O. gracilipes* compared to other species. In larger female specimens, the ridge almost cannot be discerned.

Colour. - Not known. The preserved specimens are a uniform yellowish white.

Notes on the habitat and biology. - Niue is a single, 259 km², raised limestone atoll located 386 km east of Vava'u, Tonga, in the south Pacific at 19°04'S 169°53'W (Fig. 6). A 20 m high sea cliff at the inner edge of a narrow reef platform surrounds the island, and inland, a second terrace rises to become a central plateau about 60 m above sea level. Faulting during uplift has produced many deep chasms that run parallel to the coastline. Well developed karst relief is present all around the margins of the island.

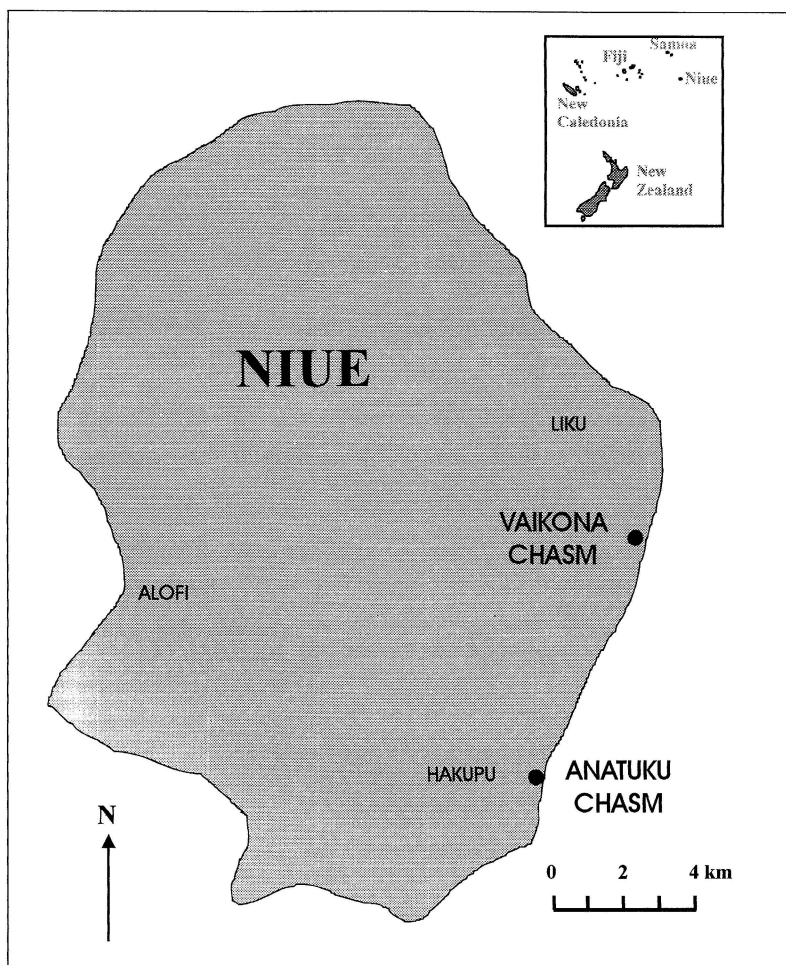


Fig. 6. Map of Niue showing the locations of Vaikona and Anatuku Chasms.

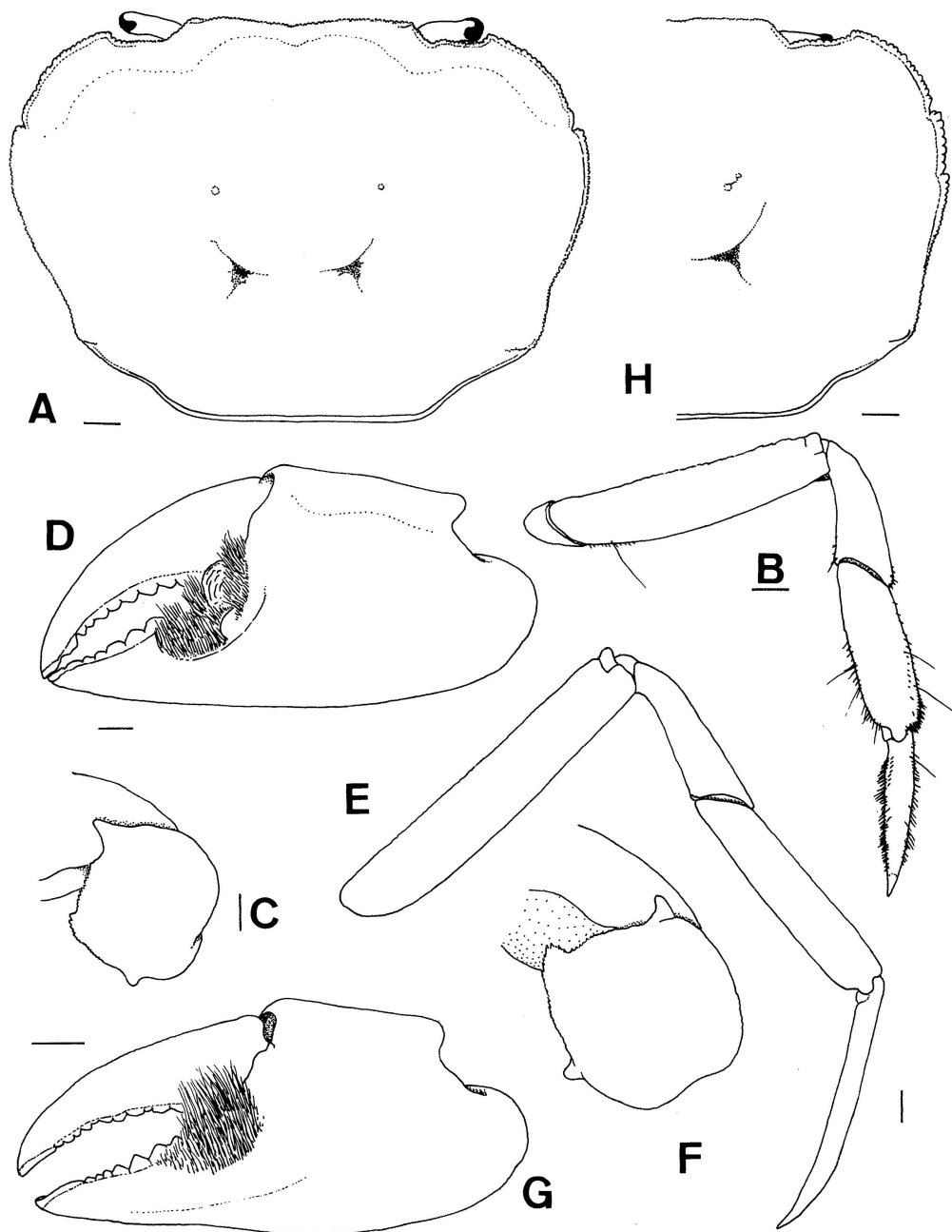


Fig. 7. *Orcovita gracilipes*, new species. A-E, holotype male (18.5 by 13.1 mm) (MNHN B-22892); F, paratype female (16.8 by 12.2 mm) (NNM); G, paratype female (15.5 by 11.1 mm) (MNHN B-22893); H, paratype female (ovigerous, 17.4 by 12.5 mm) (MNHN B-22893). A, H, carapace; B, right fourth ambulatory leg; C, F, carpus and proximal part of right chela (dorsal view); D, G, left chela; E, right third ambulatory leg. Scales = 1.0 mm.

The type locality, Vaikoma Chasm, is located 150 m inland from the east coast of the island, 1.7 km southeast of the village of Liku. The chasm is reached by a well marked, 1.5 km long path from the coastal road, and is about 20 m deep to the water level with sheer vertical walls. One enters the rift through a small hole on one side with a series of drops negotiated with the aid of a handline. In the main open section of the rift is a clear deep pool. At the far side of this pool is a chamber in total darkness with a dry section containing pyramid-like cairns 1 m high. After the cairns is another dark lake with two narrow rift passages which taper off. The length of the main part of the chasm is 200 m. Salinities were 8.5 ppt at 0 and 1 m, 10 ppt at 3 m, 15 ppt at 10 m, and 30 ppt at 16 m depth. The water temperature was constant at 23°C above 10 m, but increased to 27°C at 16 m. Fish and shrimps were also collected from the pool.

A single female specimen was also collected from Anatuku Chasm. Anatuku is 150 m inland from the east coast, 1 km southeast of the village of Hakupu. This chasm is on the south side of the road from the village to the Tuhia-atua landing place, between the upper and lower cliffs. The steep-walled entrance rift is visible from the road. This rift first descends along a breakdown floor, then ascends over a mound beneath a surface opening, before finally dropping down to a clear deep pool. The pool is over 100 m long by 0.5 to 4 m wide. At the bottom of the entrance slope, the pool is 24 m deep, while farther along the rift, depths of 32 m are reached. Around the pool, the chasm is mostly roofed over, but at mid-day, shafts of sunlight briefly illuminate the pool. The bottom of the pool consists of breakdown, organic detritus, silt and some larger logs. Underwater stalactites and draperies are present on the walls. Salinity was constant at 1.5 ppt for the first 10 m, increasing to 24 ppt at 20 m and 31 ppt at 24 m. Visible haloclines were observed at 11 and 21 m. Water temperature was uniform with depth at 22°C. Shrimps and copepods were also collected from the deeper waters of the pool.

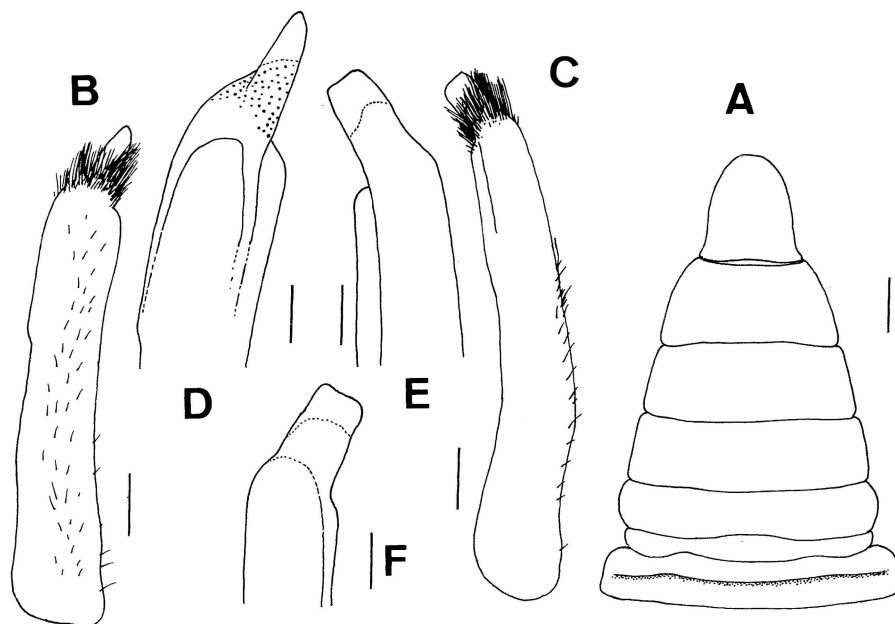


Fig. 8. *Orcovita gracilipes*, new species. A-E, holotype male (18.5 by 13.1 mm) (MNHN B-22892). A, abdomen; B-F, left G1; D-F, distal part of left G1. B, D, ventral view; C, E, dorsal view; F, dorso-marginal view. B-C, with setae; A, D-F, denuded. Scales: A = 1.0 mm; B, C = 0.5 mm; D-F = 0.25 mm.

***Orcovita mollitia*, new species**

(Figs. 1c, 10, 11)

Material examined. - Holotype - male (12.6 by 9.6 mm) (MNHN B-22895), station 85-015, Faifai Beach Cave, Guam, coll. T. M. Iliffe, 27-28 Jan. 1985, with plastic bottle trap baited with crab parts and left overnight in 3 m water depth.

Paratypes - 5 males, 4 females (MNHN B-22896), 2 males, 2 females (largest 12.8 by 9.7 mm) (ZRC 1996.98-101), same data as holotype.

Others - 1 male (14.9 by 10.9 mm) (USNM 364310c), station 85-009, Marbo Cave, in cave pool, Guam, in 0-5 m water depth, coll. T. M. Iliffe, 20 Jan. 1985, with plastic bottle trap baited with hermit crab and left overnight in 3 m water depth.

Diagnosis. - Carapace broader than long (width ca. 1.3-1.4 times length). External orbital angle separated from anterolateral margin by small notch (sometimes indistinct), epibranchial tooth very small to indistinct; posterolateral margins gently granulated, gently concave, converging towards posterior margin of carapace. Outer surface of male major chela smooth, without any trace of a longitudinal sulcus, outer surface of female chela with low but distinct submarginal longitudinal ridge adjacent to ventral margin; areas adjacent to male and female pulvinus with short setae, sometimes almost glabrous; outer surfaces of tips of fingers glabrous in small specimens, with short setae in larger specimens. 3M length ca. 5.7 times width, 3P length ca. 5.2 times width, 3D length ca. 12.9 times width, 4M length 4.2-4.7 times width, 4P length 2.8-3.2 times width, 4D length ca. times 7.6 width. Width of segment 6 of male abdomen ca. 3.0 times length; length of telson ca. 1.4 times length of segment 6.

Etymology. - The name alludes to the small size and delicate appearance of the species (from the Latin "mollitia" for weakness).

Remarks. - *Orcovita mollitia* seems to be closest to *O. fictilia*, especially with regards to the shape of the carapace and anterolateral margins. They differ clearly however, in the form of their chela and proportions of their ambulatory legs (Table 1).

Orcovita mollitia is also the smallest of the known species of *Orcovita*, with the largest mature male only 14.9 by 10.9 mm (USNM 364310c), and the largest mature female 12.9 by 9.7 mm (paratype, ZRC 1996.100).

The degree of pubescence surrounding the pulvinus of the chela varies a great deal in this species, from almost glabrous to highly setose. In general however, the setae in males tend to be longer. The tips of the fingers of the chelae are usually glabrous, although in the largest male (14.9 by 10.9 mm, USNM 364310c), it is setose. This suggests that this character might be associated with size. This is interesting, as in *O. fictilia*, setae are present on the tips of the chelae in small specimens and are lost in large individuals. This large male has an unusual coloration in that many of its ambulatory legs and one of its chelipeds is white and not grey. This suggests that these appendages are recently regenerated structures.

The holotype male has a rather short fourth ambulatory dactylus (length 5.7 times width) compared to those in other specimens (length ca. 7.6 width), and suggests that it may have previously been damaged.

Colour. - Not known. The preserved specimens vary from grey to greyish-brown.

Notes on the habitat and biology. - Guam is the largest and southernmost of the Mariana Islands, and is located in the western Pacific at 13°28'N and 144°45'E (Fig. 9). The island is 50 km long, 6-18 km wide, and 541 km² in area. The northern part of Guam consists of a rolling upland plateau of emerged limestone with no permanent rivers or streams, bounded by towering cliffs along much of the coastline. The southern part of Guam is a mountainous volcanic upland fringed with limestone along the east coast. Exposed rocks range in age from late Eocene to Recent. Most of the northern plateau and the fringing limestone along the east coast of southern Guam are Pliocene and Pleistocene age Mariana limestone, the youngest widespread formation on the island. During the recent Pleistocene, the island was uplifted and the terraces were cut by shifting glacial levels.

The type locality, Faifai Beach Cave, is on the west coast of Guam. It is located at the base of a cliff about 100 m inland from the beach south of Two Lover's Point. A clump of prehistoric latte stones lie in front of the cave. The cave is divided into two small chambers, each containing an anchialine pool. Surface water temperature and salinity were 25.2°C and 2.6 ppt respectively, with maximum water depth at 5 m. Shrimps and amphipods were also collected from the pools.

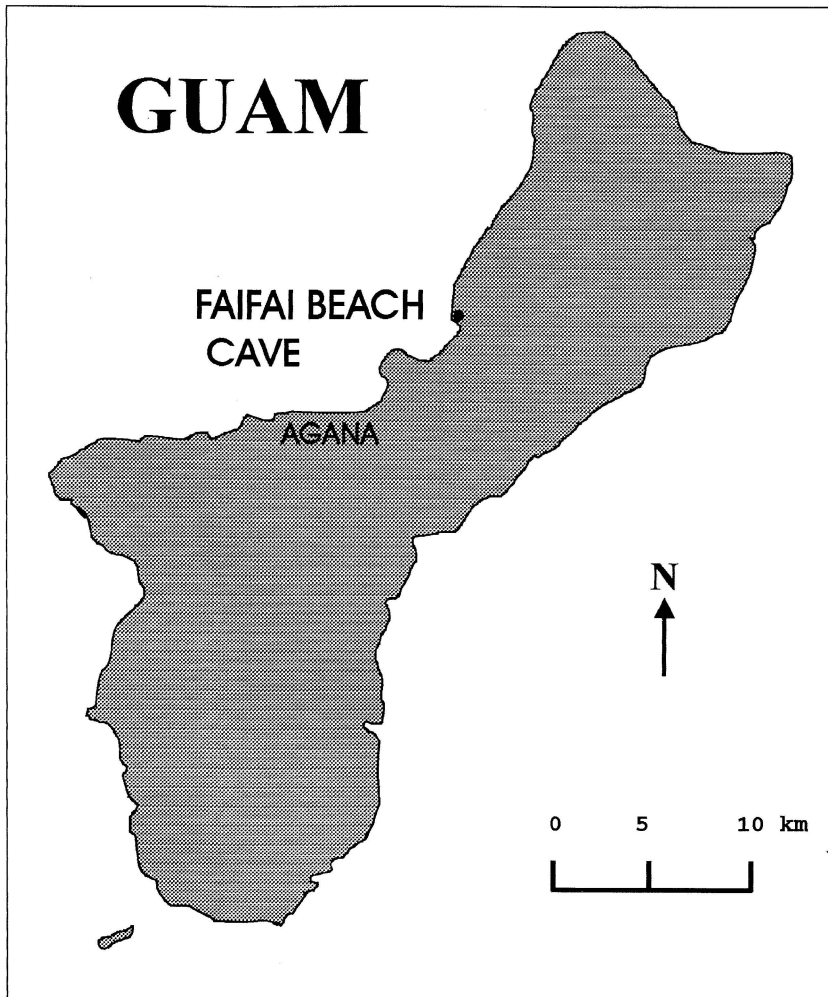


Fig. 9. Map of Guam showing the location of Faifai Beach Cave.

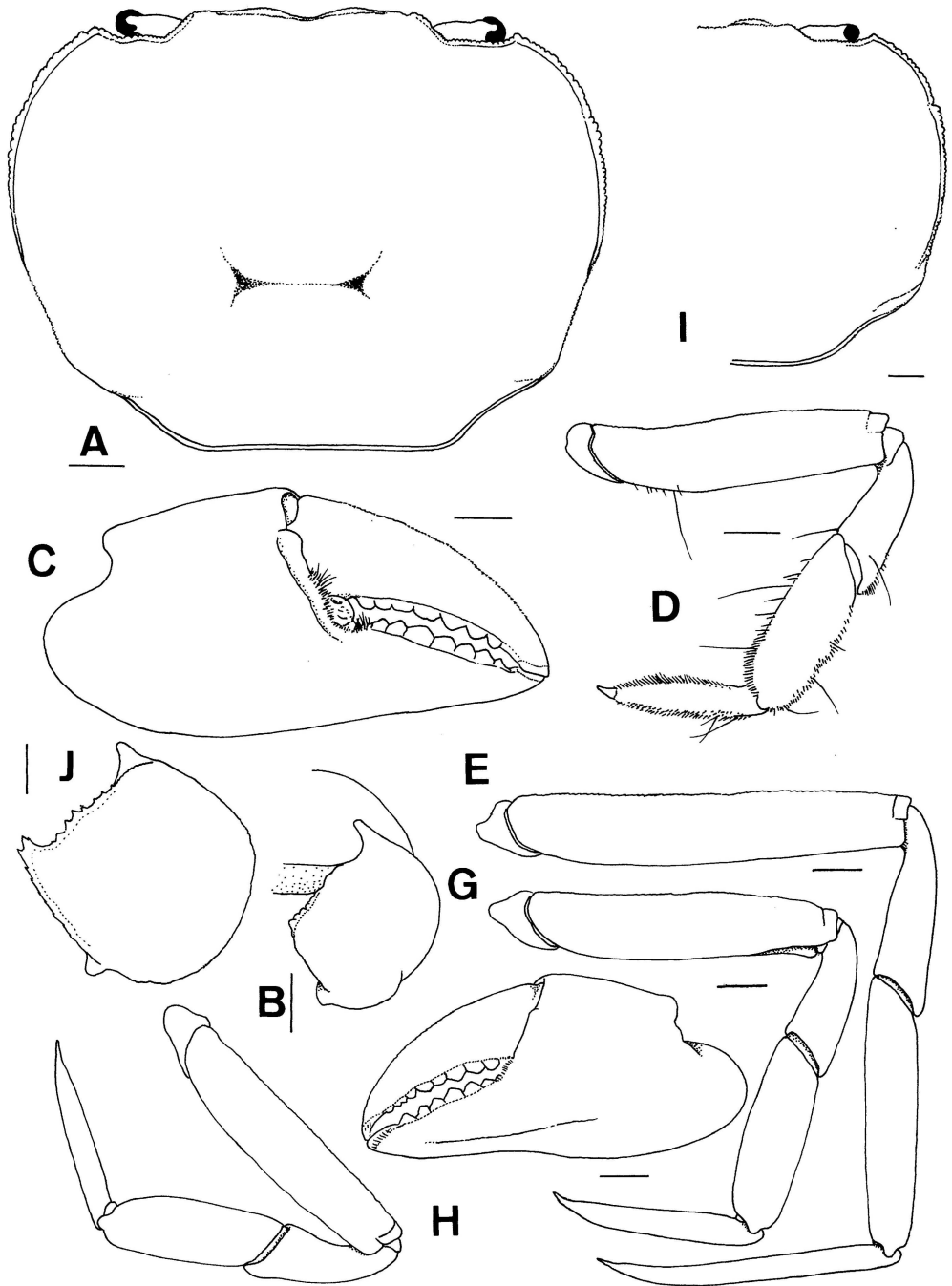


Fig. 10. *Orcovita mollitia*, new species. A-D, holotype male (12.6 by 9.6 mm) (MNHN B-22895); E, F, paratype male (12.9 by 9.6 mm) (ZRC 1996.98); G, male (14.9 by 10.9 mm); H, J, paratype female (12.9 by 9.7 mm) (ZRC 1996.100); I, paratype male (12.8 by 9.7 mm) (ZRC 1996.99). A, I, carapace; B, carpus and proximal part of right chela (dorsal view); C, right chela; D, F, G, right fourth ambulatory leg; E, right third ambulatory leg; H, left chela; J, right carpus and proximal part of right cheliped (dorsal view). Scales = 1.0 mm.

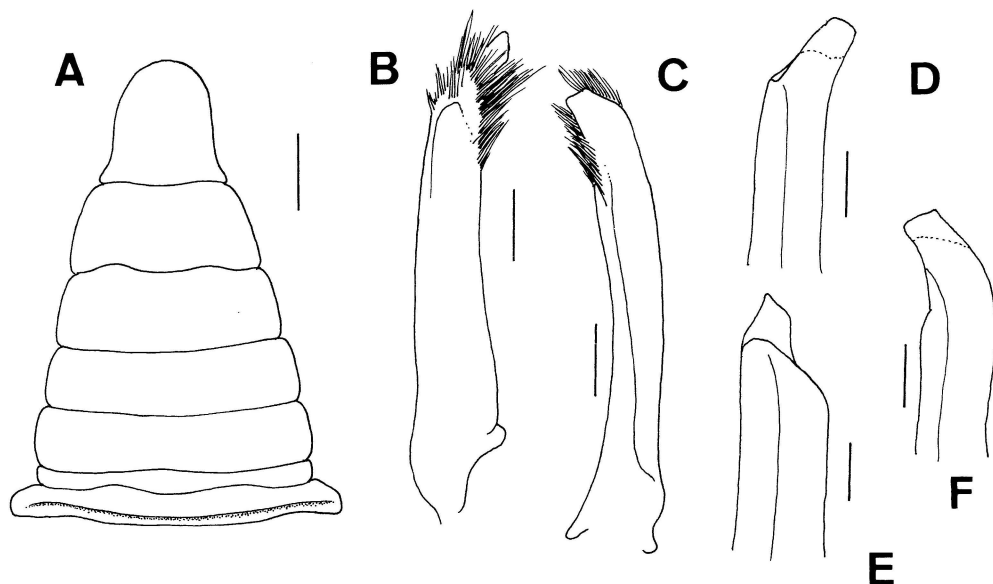


Fig. 11. *Orcovita mollitia*, new species A-D, holotype male (12.6 by 9.6 mm) (MNHN B-22895). A, abdomen; B-F, left G1; D-F, distal part of left G1. B, D, ventral view; E, dorso-marginal view; C, F, dorsal view. B-C, with setae; A, D-F, denuded. Scales: A = 1.0 mm; B, C = 0.5 mm; D-F = 0.25 mm.

The other locality where the species was collected was Marbo Cave, which is on the east coast near Andersen South Air Force Base. The cave is located at the base of a hill some 300 m inland. It consists of a collapse chamber divided by breakdown into four pools at varying light levels. Surface water temperature and salinity were 26.3°C and 4.3 ppt respectively, while maximum water depth was 6 m. Also collected from the pool were amphipods and three species of shrimps.

***Orcovita fictilia*, new species**
(Figs. 2a, 3B, 13-15)

Material examined. - Holotype - Male (21.5 by 15.3 mm) (NMCR), station PH I, Hinagdanan Cave, -3 m, Binag-Dauis, Panglao Island, Bohol, Philippines, coll. B. Sket, 2 Jan.1995.

Paratypes - 1 male (17.2 by 12.3 mm) (ZRC 1996.102), 1 female (15.0 by 11.0 mm) (NNM), same data as holotype. — 1 male (18.0 by 13.0 mm), 2 females (larger 18.7 by 14.0 mm) (ZRC), 1 male, 2 females (MNHN B-22897), 1 male, 1 female (ULS), 2 females (NMCR), Hinagdanan Cave, -0.5 m, Binag-Dauis, Panglao Island, Bohol, Philippines, coll. B. Sket, 2 Jan.1995.

Others - 2 males (larger 14.1 by 10.6 mm), 6 females (largest 14.9 by 10.3 mm) (MNHN B-22898), 2 males, 2 females (ZRC 1996.106-109), station 85-62, Taula Cave, Panglao Island, Bohol, Philippines, with dipnet from 0-1 m depth, coll. T. M. Iliffe, 3 Apr.1985. — 4 males (largest 17.7 by 12.7 mm) (MNHN), 1 male, 1 female (15.7 by 11.6 mm) (ZRC 1996.110-111), station 85-62, Taula Cave, Panglao Island, Bohol, Philippines, coll. T. M. Iliffe, 3 Apr.1985, with dipnet from 0-1 m depth. — 1 female (17.0 by 13.0 mm) (USNM 364310a), station 85-61, Cansista Cave, Panglao Island, Bohol, Philippines, coll. T. M. Iliffe, 2 Apr.1985, with plastic bottle trap left overnight in 1 m water depth.

Diagnosis. - Carapace broader than long (width 1.4-1.5 times length). External orbital angle separated from anterolateral margin by small but distinct cleft (occasionally only a

notch present), epibranchial tooth small, low; posterolateral margins gently to minutely granulated, gently concave, converging towards posterior margin of carapace. Outer surface of male major chela smooth, without any trace of a longitudinal sulcus, outer surface of female chela with low but distinct submarginal longitudinal ridge adjacent to ventral margin; areas adjacent to male and female pulvinus with short to very short setae, sometimes almost glabrous; tips of fingers corneous, outer surfaces of tips of fingers with short setae in small specimens, obscure to absent in larger specimens. 3M length ca. 5.3 times width, 3P length ca. 4.2 times width, 3D length ca. 9.1 times width, 4M length 4.2-4.4 times width, 4P length 2.6-3.0 times width, 4D length 6.2-6.9 times width. Width of segment 6 of male abdomen ca. 2.2 times length; length of telson ca. 1.3 times length of segment 6.

Etymology. - The name alludes to delicate appearance of the carapace (from the Latin noun "fictilia" for pottery). Used as a noun in apposition.

Remarks. - *Orcovita fictilia* seems to be closest to *O. angulata* with regards to the very short setae present on the areas surrounding the pulvinus and the setose tips of the fingers of the chela. In all other aspects of the carapace proportions, anterolateral margin armature, structure of the chela and proportions of the ambulatory legs, however, the two species differ significantly (Table 1).



Fig. 12. Map of the Philippines showing the locations of Koron and Panglao Islands.

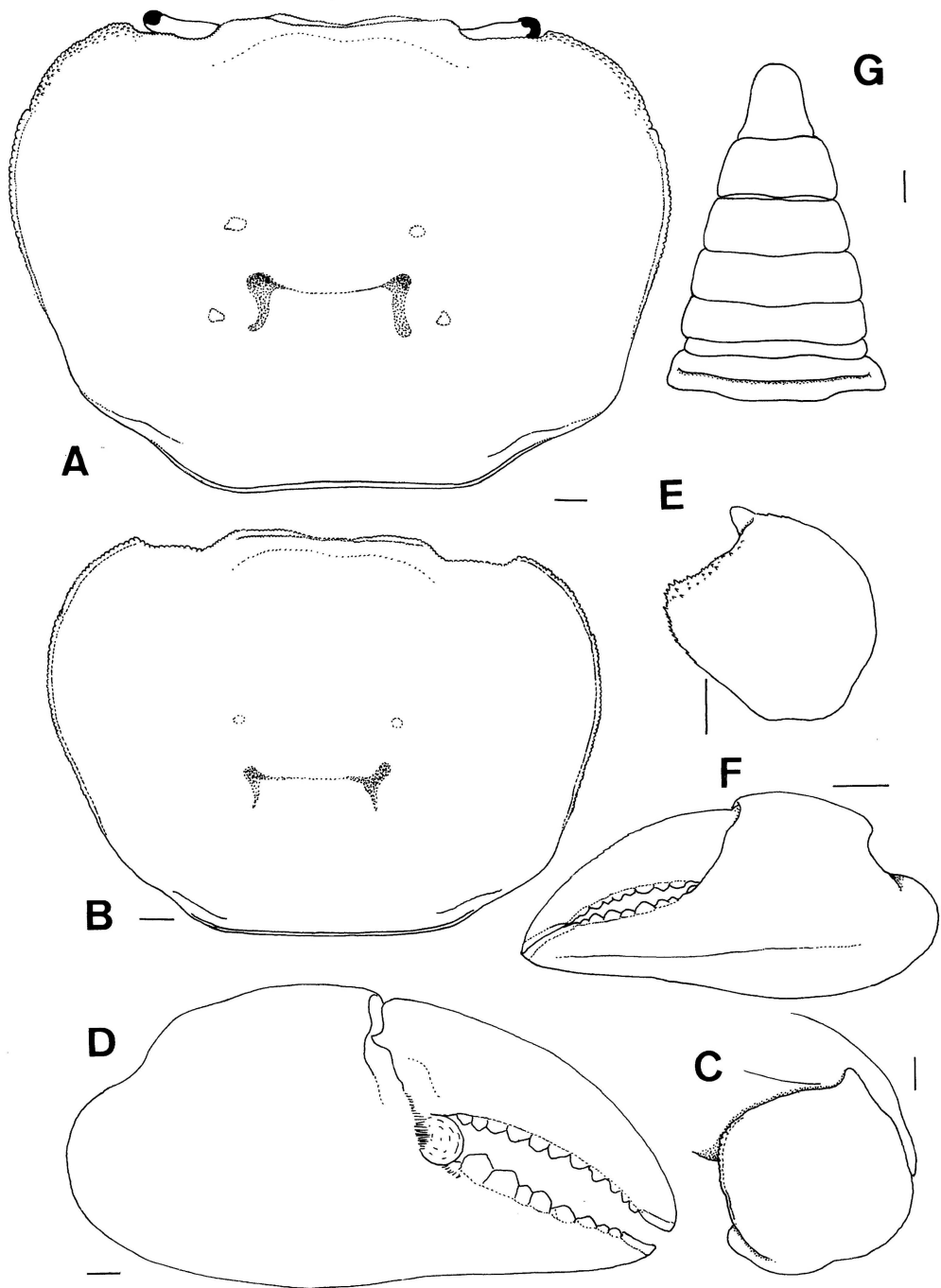


Fig. 13. *Orcovita fictilia*, new species. A, C, D, G, holotype male (21.5 by 15.3 mm) (NMCR); B, paratype male (18.0 by 13.0 mm) (ZRC 1996.103); E, paratype female (18.7 by 14.0 mm) (ZRC); F, female (14.1 by 10.6 mm) (ZRC 1996.108). A, B, carapace; C, E, right carpus of cheliped; D, right chela; E, left chela. Scales = 1.0 mm.

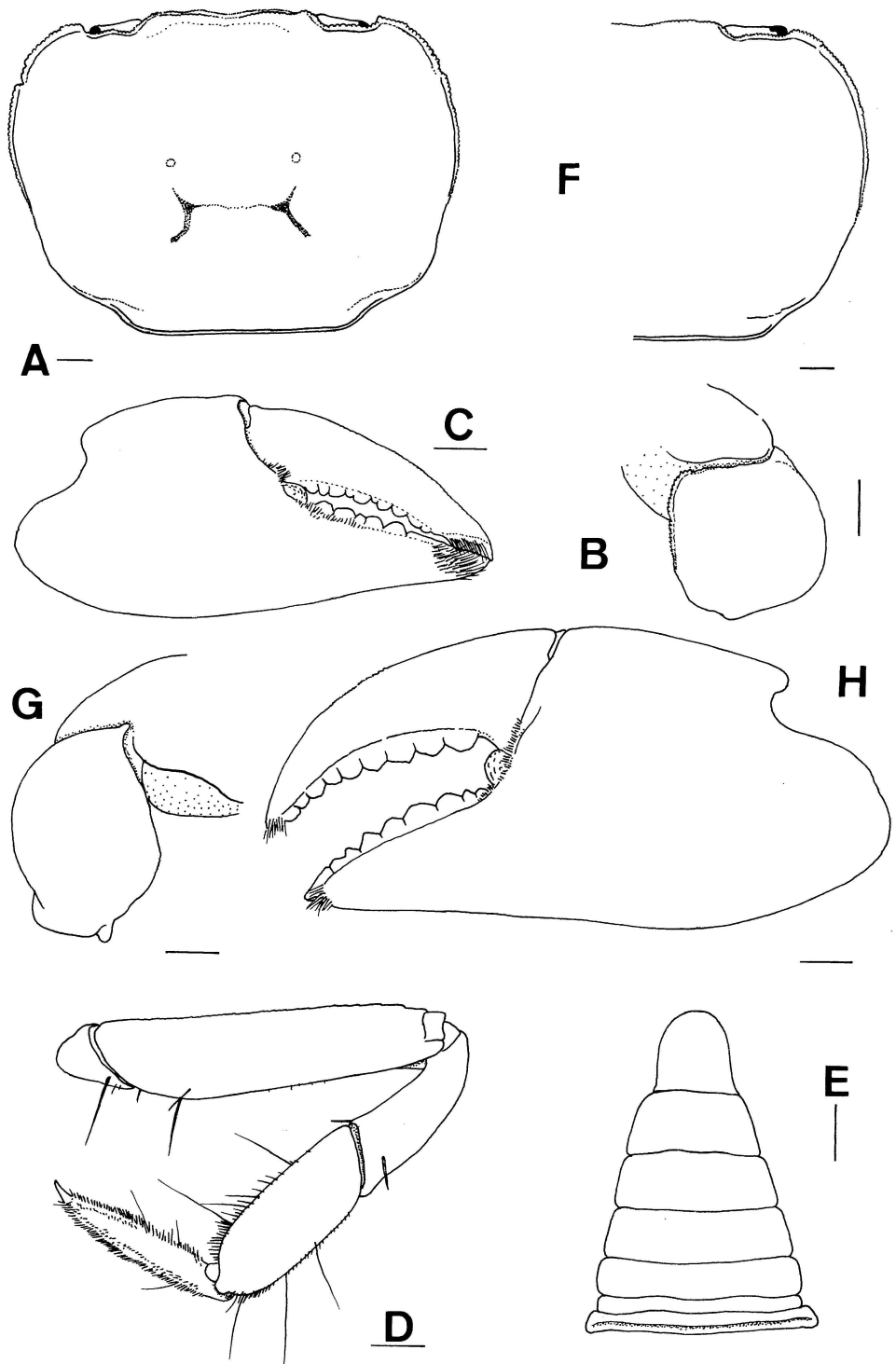


Fig. 14. *Orcovita fictilia*, new species. A-E, male (14.1 by 10.6 mm) (MNHN B-22898); F, paratype male (14.2 by 9.8 mm) (MNHN-B22897); G, H, male (15.1 by 11.2 mm) (ZRC 1996.106). A, carapace; B, carpus and proximal part of right chela (dorsal view); C, right chela; D, right fourth ambulatory leg; E, abdomen; F, carapace; G, carpus and proximal part of left cheliped (dorsal view); H, left chela. Scales = 1.0 mm.

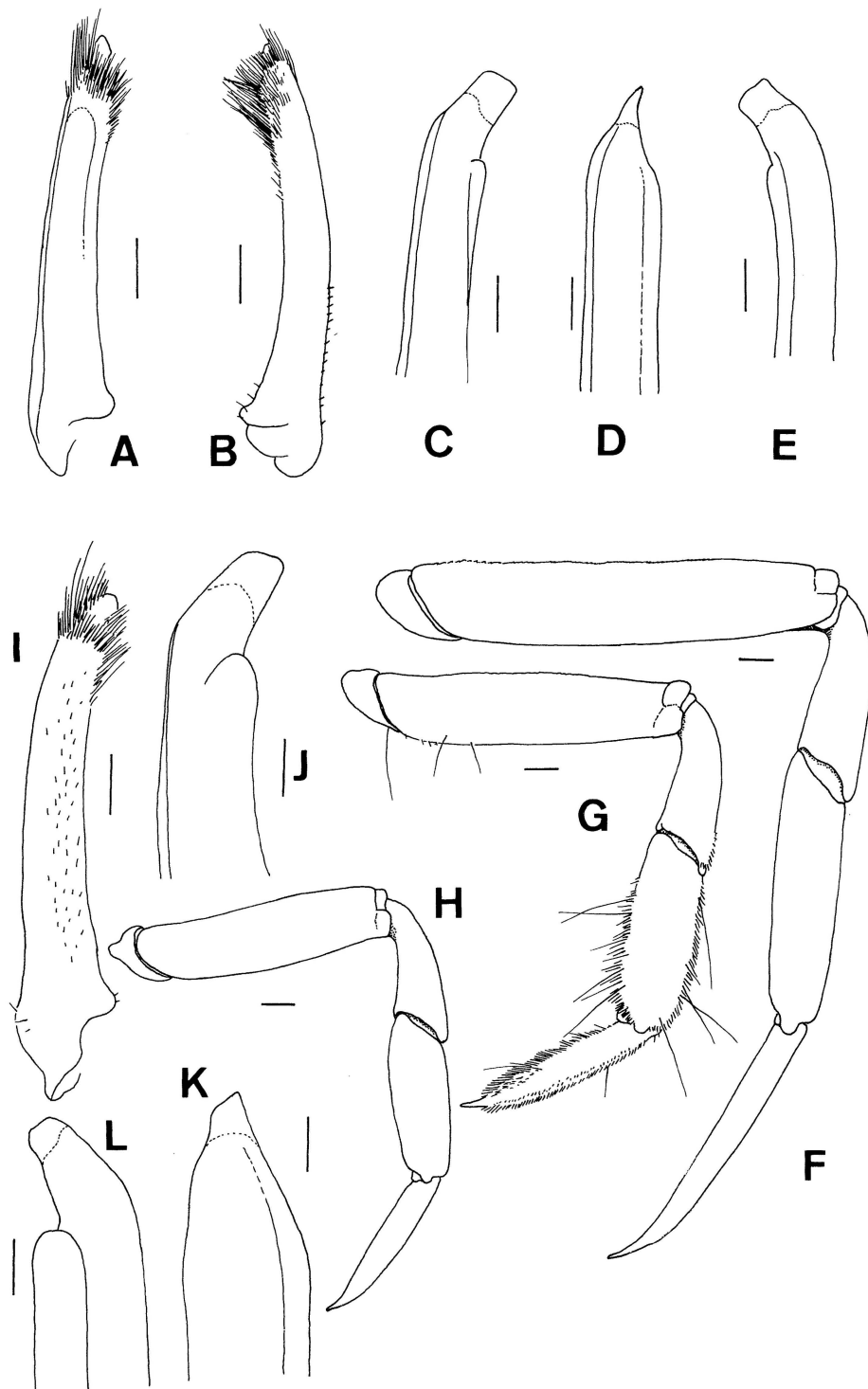


Fig. 15. *Orcovita fictilia*, new species. A-E, holotype male (21.5 by 15.3 mm) (NMCR); F, G, I-L, male (14.1 by 10.6 mm) (MNHN B-22898); H, male (17.0 by 13.0 mm) (USNM 364310a). A-E, I-L, left G1; C-E, J-L, distal part of left G1; F, right third ambulatory leg; G, H, right fourth ambulatory leg. A, C, I, J, ventral view; D, K, dorso-marginal view; B, E, L, dorsal view. A, B, I, with setae; C-E, J, denuded. Scales: A, B, I = 0.5 mm; C-E, J-L = 0.25 mm; F-H = 1.0 mm.

Orcovita fictilia also closely resembles *O. mollitia*, especially with regards to the shapes of the carapace and anterolateral margin, but differs clearly in ambulatory leg proportions and structure of the chela (Table 1).

The degree of granulation on the posterolateral margin is strongest in smaller specimens, becoming more obscure in large males and females. In the holotype and largest females, the posterolateral margin appears almost smooth, not unlike *O. saltatrix*. The degree of concavity and convergence of the posterolateral margin however, does not change significantly between size-groups.

One female (17.0 by 13.0 mm, USNM 364310a) from Cansista Cave differs from all the other specimens in having a relatively flatter dorsal carapace surface, especially on the gastric and branchial regions, but in all other aspects, it agrees with *O. fictilia*, and is tentatively referred to this species. With regards to the relatively flatter carapace, this female specimen resembles *O. angulata* from Koron Island, but this species differs markedly from *O. fictilia* in lateral armature and proportions of the ambulatory legs (Table 1).

Colour. - Not known. The preserved specimens are a uniform yellowish white.

Notes on the habitat and biology. - Panglao Island is situated in the south-central Philippines about 500 km south of Manila at 9°35'N 123°50'W (Fig. 12). This low limestone island, which is located only 1 km off the southwest corner of Bohol Island, has numerous anchialine sinkholes and small caves. *Orcovita fictilia* was obtained from two different cave systems here, Tauala and Cansista Caves.

The type locality, Tauala Cave, is a sinkhole containing a pool regularly used by the local villagers for bathing and washing laundry. Salinity and temperature were 4 ppt and 29°C respectively. Amphipods, cyclopoid copepods, isopods (species of Gnathiidea) and molluscs were also collected.

Cansista Cave, where one large female was collected, is a collapse sinkhole containing a pool in darkness about 8 to 10 m below the surface of the ground. Salinity in the pool was 6 ppt and maximum water depth about 4 m. Shrimps, amphipods, cyclopoid copepods, isopods (Gnathiidea sp.), molluscs and polychaetes were also collected in this pool.

Orcovita angulata, new species

(Figs. 2b, 16)

Material examined. - Holotype - Female (16.7 by 13.0 mm) (USNM 364310b), station 85-56, Raft Cave, Koron Island, Philippines, coll. T. M. Iliffe, 28 Mar.1985, with a dipnet from the water surface, from a floating log.

Paratype - 1 female (15.8 by 12.2 mm) (ZRC 1996.112), same data as holotype.

Diagnosis. - Carapace broader than long (width ca. 1.3 times length); posterobranchial region flat. External orbital angle separated from anterolateral margin by distinct cleft; posterolateral margins gently granulated, almost straight, converging gradually towards posterior margin of carapace. Chelipedal carpus with very well developed serrated tooth on inner distal angle. Outer surface of female chela with low but distinct submarginal longitudinal

ridge adjacent to ventral margin; areas adjacent to female pulvinus with very short setae; outer surfaces of tips of fingers with short setae. 3M length ca. 5.4 times width, 3P length ca. 5.4 times width, 3D length ca. 16.1 times width, 4M length ca. 4.6 times width, 4P length ca. 3.7 times width, 4D length ca. 6.6 times width. G1 not known.

Etymology. - The Latin name “*angulata*” alludes to the angular appearance of the junction at the antero- and posterolateral margins.

Remarks. - *Orcovita angulata* is very distinctive among the known *Orcovita* species with regards to its proportionately less broad carapace, the angular antero-posterolateral junction and the very elongate third and fourth ambulatory propodus and dactylus (proportionately the longest for any known *Orcovita* species). Although only females are

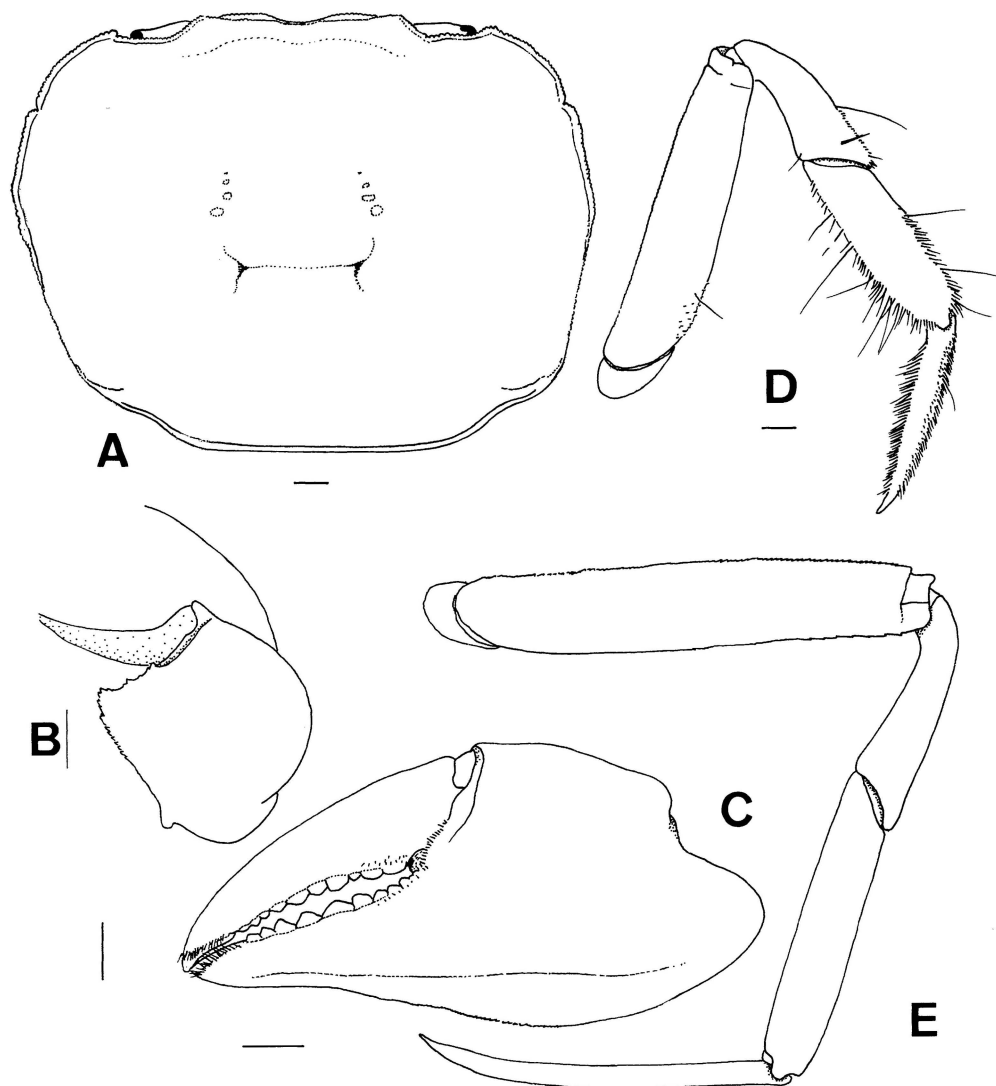


Fig. 16. *Orcovita angulata*, new species. Holotype male (16.7 by 13.0 mm) (USNM 364310b). A, carapace; B, carpus and proximal part of left chela (dorsal view); C, left chela; D, right fourth ambulatory leg; E, right third ambulatory leg. Scales = 1.0 mm.

known (both are mature specimens), the differentiating characters are taxonomically significant and independent of sex. The length of the ambulatory legs allies *O. angulata* with *O. gracilipes*, but, in its proportions and all other aspects, they differ markedly (Table 1).

The dorsal carapace surface of *O. angulata* also appears distinctly flatter, especially on the branchial and gastric regions, compared to the other *Orcovita* species, but the value of this character is difficult to assess with just two specimens. The dorsal carapace surface of one female specimen of *O. fictilia* (17.0 by 13.0 mm) (USNM 364310a) is also relatively flat, but still less so compared to *O. angulata*.

Colour. - Not known. The preserved specimens are a uniform yellowish white.

Notes on the habitat and biology. - Koron Island is about 250 km southwest of Manila in the central Philippines at 11°55'N 120°15'W (Fig. 12). It is situated at the southeastern corner of the larger island of Busuanga. The island consists of highly karstified limestone with elevations to over 600 m. Numerous caves on this island are exploited as commercially important sources of valuable birds' nests made by cave swiftlets.

In the type locality, Raft Cave, located on the north side of Koron Island, a large bamboo raft and platform have been constructed to provide access to crevices near the ceiling where the birds usually nest. The cave entrance consists of a small crevice that drops vertically for 10 m into the center of a totally dark lake chamber which is 30 m long by 18 m wide. Water depth was at least 15 m. Also collected from this lake were shrimps, copepods, ostracods and polychaetes.

GENERAL DISCUSSION

Although the G1s have not been used in the present study to separate the five species of *Orcovita*, they are nevertheless useful. They are rather difficult to use because the distalmost part is twisted at slightly but distinctly different angles. The rest of the G1 structure also differs in stoutness and slight differences in curvature. These differences, however, are difficult to appreciate and use unless one places the G1s side by side for direct comparisons. All five species, however, can easily be separated on the basis of their external morphologies.

It is important to note that all five species occur in anchialine habitats. *Orcovita saltatrix* inhabits an anchialine open lagoon, whereas the other four species have all been found in caves or sinkholes. The distribution of the species are very disjunct (Kakaban - between Borneo and Sulawesi, Niue, Guam and Philippines), but all agree so well in the main characters that we have little doubt that they are congeneric.

Table 1. Differences between known species of *Orcovita*

	<i>O. saltatrix</i>	<i>O. gracilipes</i>	<i>O. mollitia</i>	<i>O. fictilia</i>	<i>O. angulata</i>
Carapace proportions (width vs. length)	ca. 1.4	ca. 1.4	ca. 1.3	1.3-1.5	ca. 1.3
External orbital angle	separated from anterolateral margin by distinct, V-shaped cleft	separated from anterolateral margin by distinct, V-shaped cleft	separated from anterolateral margin by small notch (sometimes indistinct), epibranchial tooth very small to undiscernible	separated from anterolateral margin by small notch (sometimes indistinct), epibranchial tooth small to almost undiscernible	separated from anterolateral margin by distinct cleft
Posterolateral margins	smooth, gently concave to straight, not distinctly converging	granulated, concave, distinctly converging	gently granulated, gently concave, gently converging	gently granulated, gently concave, gently converging	gently granulated, almost straight, not distinctly converging
Area around male pulvinus	with well developed setae	with long, well developed setae	with short setae	with very short to short setae	with very short setae
3M	ca. 5.8	ca. 5.7	ca. 5.7	ca. 5.3	ca. 5.4
3P	ca. 4.3	ca. 5.1	ca. 5.2	ca. 4.2	ca. 5.4
3D	ca. 7.8	ca. 10.8	ca. 12.9	ca. 9.1	ca. 16.1
4M	ca. 4.4	ca. 4.7	4.2-4.7	4.2-4.4	ca. 4.6
4P	ca. 3.1	ca. 3.2	2.8-3.2	2.6-3.0	ca. 3.7
4D	ca. 5.5	ca. 5.9	ca. 7.6	6.2-6.9	ca. 6.6
Width of male abdominal segment 6 (vs. length)	ca. 2.1	a. 2.1	ca. 3.0	ca. 2.2	—
Length of male telson (vs. segment 6)	ca. 1.3	ca. 1.1	ca. 1.4	ca. 1.3	—
Provenance	Kakaban (Indonesia)	Niue	Guam	Panglao (Philippines)	Koron (Philippines)

NB. Proportions of ambulatory legs based on maximum length against width.

KEY TO THE GENUS *ORCOVITA*

1. Carapace appearing distinctly rectangular; posterolateral margins almost straight, subparallel, not distinctly convergent towards posterior carapace margin (Indonesia; Philippines) 2
- Carapace appearing more hexagonal; posterolateral margins concave, distinctly convergent towards posterior carapace margin (Niue; Guam; Philippines) 3
2. Junction between antero- and posterolateral margins rounded; posterolateral margin smooth; lengths of third and fourth ambulatory propodus 4.3 and 3.1 times width respectively, lengths of third and fourth ambulatory dactylus 7.8 and 5.5 times width respectively (Kakaban: Indonesia) ..
..... *O. saltatrix*
- Junction between antero- and posterolateral margins angular; posterolateral margin granulated; lengths of third and fourth ambulatory propodus 5.4 and 3.7 times width respectively, lengths of third and fourth ambulatory dactylus 16.1 and 6.6 times width respectively (Koron: Philippines)
..... *O. angulata*
3. Posterolateral margins strongly convergent; external orbital tooth always clearly separated from rest of anterolateral margin by deep, distinct cleft, margin never entire; pulvinus on chela partially to completely obscured by long setae in males and females; length of fourth ambulatory dactylus 5.9 times width (Niue) *O. gracilipes*
- Posterolateral margins gently convergent; external orbital tooth separated from rest of anterolateral margin by small cleft, sometimes absent, with margin appearing almost entire; pulvinus on chela in males and females surrounded by short setae, sometimes appearing almost glabrous; length of fourth ambulatory dactylus more than 6.5 times width 4
4. Length of third ambulatory propodus 5.2 times width, lengths of third and fourth ambulatory dactylus 12.9 and 7.6 times width respectively; G1 relatively stout (Fig. 11B, C) (Guam)
..... *O. mollitia*
- Length of third ambulatory propodus 4.2 times width, lengths of third and fourth ambulatory dactylus 9.1 and 6.2-6.9 times width respectively; G1 relatively slender (Fig. 15A, B) (Panglao: Philippines) *O. ficilia*

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