The Genus *Calcinus* (Paguridea, Diogenidae) from the Mariana Islands Including Three New Species [1]

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Abstract - Eleven species belonging in genus *Calcinus* (Decapoda, Anomura, Diogenidae) from Mariana Islands are described. This includes three previously undescribed species: *Calcinus argus, Calcinus haigae*, and *Calcinus guamensis*. Observations on life color, distribution, and natural history are given. A key to the genus is presented.

Introduction

The Mariana Islands are oceanic islands situated well within the Indo-West Pacific faunal region. They form a chain of fifteen islands which run in a roughly northern direction from Guam (13°27'N, 144°45'W) to Farallon de Pajaros or Uracas (16°01'N, 146°05'W). The nearest large landmass is the Philippine Islands over one thousand kilometers to the west. The southern Mariana Islands of Guam, Rota, Tinian, Saipan, and Farallon de Medinilla are made up of old volcanic and uplifted material. These five islands offer a wide variety of habitats including river mouths, mangrove swamps, fringing reefs, shallow lagoons and reef flats, and exposed rocky coasts. The more nothern islands are geologically younger and without extensive reef development. They are volcanic and the most northern, Uracas, is almost completely covered with lava from a 1943 eruption. Pagan erupted violently in May, 1981, while this manuscript was in preparation.

The greatest part of the material examined was collected and described between the spring of 1973 and December 1977 as part of thesis work towards a M. S. degree in biology at the University of Guam. While most of the hermit crabs described in this paper were collected on Guam, a total of thirty-three days was spent on the rarely visited islands north of Saipan in 1975 with the University of Guam Marine Laboratory on two biological collecting expeditions. Collections from Saipan were made by the author and University of Guam Marine Laboratory personnel. A new record for ***Calcinus seurati*** was collected from Pagan Island in 1981 by Roy Kropp, University of Guam.

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1 University of Guam Marine Laboratory Contribution No. 179.

Special attention has been given to the recording of complete liver color and ecological information for all species. This information is especially useful for field identification and is usually absent from the literature.

Methods

Animals were collected by hand from as many locations as possible from intertidal to as deep as 30 meters. Ecological and behavioral observations were made while collecting. Live color notes were made while animals were still living or when freshly killed after removal from shells. Measurements are of carapace length (CL) measured from the tip of the rostrum to the posterior end of the carapace, along the midline. Illustrations and measurements were done with the help of a Nikon profile projector and a Bausch and Lomb stereo microscope. Station locations are shown in Figures 1 and 2 and described on Table 1.

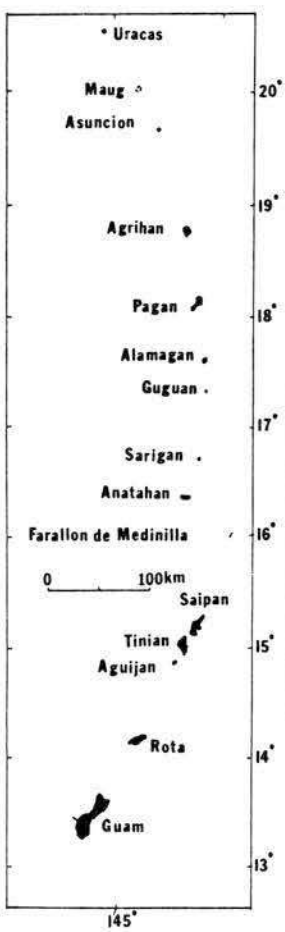

Fig. 1. Map of the Mariana Islands.

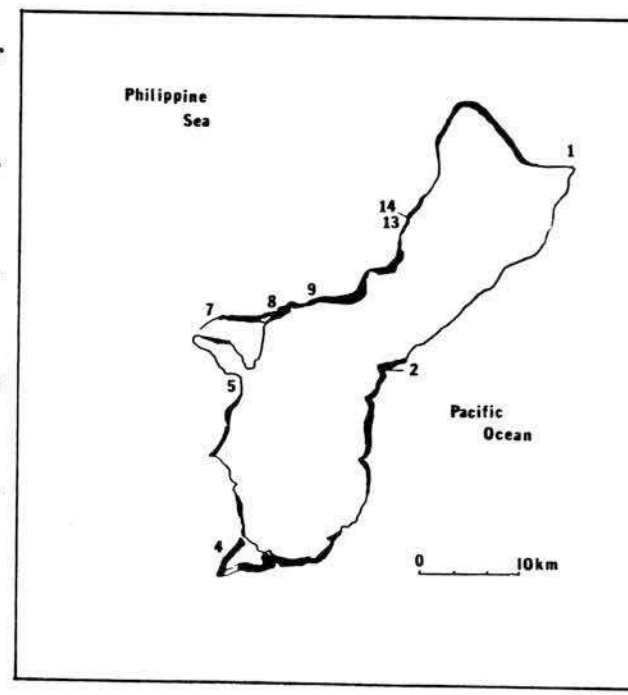

Fig. 2. Map of Guam showing station locations. Reef platforms are shown in solid black.

Table 1. Collecting Stations. (NW) Station numbers refer to stations assigned during expedition to northern islands.

ISLAND	STATION	DESCRIPTION
Maug	M1 (NW21)	Southwest of North Island, 10 to 20 m, steep broken boulder substrate with some live coral.
	M2 (NW22)	East of West Island, 3 to 5 m, submerged reef, live coral.
	M3 (NW31)	Volcanic intertidal, east side of West Island.
	M4 (NW32)	Shore and intertidal, inside of West Island.
Asuncion	AS2 (NW20)	Southwest bay, shore and intertidal, tide pools.
	AS3 (NW28)	Under boat at anchor, 10 to 20 m, volcanic boulders and live coral.
	AS4 (NW28a)	Intertidal and subtidal along bay below camp site, volcanic rock and coral.
Pagan	P3 (NW25a)	North side of Sengan Peninsula on dock and intertidal, volcanic and live coral.
	P4 (NW25b)	North side of Sengan Peninsula from intertidal to 30 m, coral and volcanic rock and sand.
	P5 (NW25c)	North side of Sengan Peninsula, under boat to peninsula, to 15 m, volcanic sand, rock and live coral.
	P6 (NW25d)	Subtidal, snorkeling along dock to end of Appaan Peninsula.
	RK1	Intertidal, exposed intertidal pools.
	RK2	Intertidal, raised limestone pools.
Alamagan	AL1 (NW12)	Southwest bay at anchorage, to 20 m, old reef limestone, live coral.
Guguan	GU1	Western shore at aa lava flow, to 15 m, large volcanic boulders.
	GU2 (NW10)	Western bay at anchorage, 10 to 15 m.
	GU3 (NW35)	South of anchorage, intertidal.
	GU4 (NW37)	Anchorage to 35 m, coral rubble and live coral on volcanic substrate.
Anatahan	AN3 (NW5)	West coast at "Obs. Spot," boulder beach, aa barricade, and landward tide pools.
Saipan	S1	Tanapag harbor. See Doty and Marsh, 1977.

Table 1. Continued.

ISLAND	STATION	DESCRIPTION
Guam	Stat. 1	Pati Point: A very exposed coast with no reef flat; erosion benches line the shore. Beyond the benches the bottom is smooth limestone substrate with large coral rocks and some live coral. The area is characterized by extreme exposure to high surf and currents.
	Stat. 2a.	Pago Bay, Intertidal. Sand and coral rock.
	Stat. 2b.	Pago Bay, Erosion benches at north end, very exposed.
	Stat. 2c.	Pago Bay, Moat. Sandy bottom, little water movement.
	Stat. 2d.	Pago Bay, Inner reef flat. Exposed during lowest tides, with deeper pools, coral rubble, and algal beds.
	Stat. 2e.	Outer reef flat. Exposed during normal low tides. Coral rocks, flat limestone and algae.
	Stat. 2f.	Pago Bay. Reef margin. Exposed algal ridge at low tide. Nearly constant exposure to surf.
	Stat. 2g.	Marine Laboratory sea water intake channel. Exposure to moving clean sea water, high surf.
	Stat. 5a.	Agat Bay. Facpi Point. Most exposed part of bay.
	Stat. 5b.	Agat Bay. Anae Island. Similar to Facpi Point.
	Stat. 5e.	Agat Bay. Sewer outfall. Calm, protected, often silty water.
	Stat. 5f.	Agat Bay. Rizal Beach. Similar to Nimitz Beach but with clearer water.
	Stat. 7.	Luminao Barrier Reef. Exposed to clear, rough water. The inner reef area is covered with water even at the lowest tides; live coral and sand.
	Stat. 8a.	Piti Reef. Cabras outfall. Calm clear water.
	Stat. 9.	Adelupe Point. An area with high exposure to strong currents and high surf. Substrate is coral rubble and live coral.
	Stat. 13.	Tanguisson Point. Moderate exposure, clear moving water, bottom is coral rubble and live coral.
	Stat. 14.	N.C.S. mounds. Submarine mounds off of N.C.S. beach come to about five meters from surface; live coral and coral rubble; clean moving water.

Genus *Calcinus*

Calcinus, with eleven species, is the largest of the Marianas hermit crab genera. Different species are found from the intertidal to a depth of at least thirty meters. Most species are limited to fairly specific reef zones. These hermit crabs all are generally small in size and generalists in their shell preference; shell size is usually the determining factor. Most species are quite sedentary and often hang upside down, or onto steep ledges or slopes; when they are disturbed they let go with the second and third periopods, retract into their shells, and fall. This behavior probably serves the crab as protection from many predators. Some seem to feed on small encrusting organisms on coral rubble. A few species commonly walk and hang among the branches of living corals. These crabs may be eating coral polyps, or, more likely, material attached to the mucus that the corals exude. When disturbed these species will retract into their shells and fall into the coral colony.

The species in this genus are very much alike morphologically. A few can be easily distinguished only by very different color patterns or by their place of collection. In all species the carapace shield is smooth and well calcified; the rostrum evident but small. The eyestalks are often long and slender, never short. The left cheliped is smooth along the dorsal margin and larger than the right. In all but one species the right cheliped is serrate, often with a raised crest along the dorsal margin. The finger tips of both chelae are porcellaneous. The entire surfaces of the first three periopods are smooth, relatively hairless, and spineless except for the claws of the second and third periopods which are corneous. The genus is usually divided into two groups according to the presence or absence of a strong brush of hairs along the ventral margins of the propodi and dactyls of the third periopods. The function of the brush is not known, and is not found on the first or second periopods.

KEY TO THE SPECIES OF *CALCINUS* FROM THE MARIANA ISLANDS

1. Brush of hairs present along inner border of propodi and dactyls of third periopods 2

   Propodi and dactyls of third periopods may have hairs but no brush; about as hairy as second periopods 5

2(1). Periopods two and three ringed by bands of color. 3

No distinct bands of color on periopods two and three. 4

3(2). Periopods two and three with alternate bands of bright dark blue and black. Eyestalks dark blue along entire length except for a small black area at bases. Outer surface of left chelae with many rounded tubercles [Intertidal]. . . . . *C. elegans*

Periopods two and three with alternate bands of dark red, orange, and white. Eyestalks white at bases with a wider orange band in the middle followed by a narrow white band before corneas. Outer surface of left chelae smooth or with a few small, shallow depressions [Just below intertidal] . . . . . *C. imperialis*

4(2). Periopods two and three fairly uniformly brown, white at distal ends of dactyls. Basal halves of eyestalks black, distal halves blue with a narrow black line separating corneas. Left chelae slightly tuberculate on outer surfaces [Outer reef flat to approximately five meters] . . . . . *C. gaimardi*

Periopods two and three reddish brown with conspicuous white spots. Eyestalks dark brown, fade slightly to white before corneas. Left chelae smooth [Subtidal] . . . . . *Calcinus argus*

5(1). Left chelae very large, almost operculate, smooth. Dorsal margin of right chelae without serrations 10

Left chelae larger than right but not enormous. Dorsal margin of right chelae with serrations 6

6(5). Inner and outer surfaces of palms of both chelae grayish with a darker spot in the center of each surface. Propodi of second and third periopods with alternate longitudinal stripes of brown and yellowish white. Eyestalks red, fade slightly near corneas. [Found at scuba depths in live coral heads]. . . . . *Calcinus* sp. 1

No dark spot on inner and outer surfaces of chelae.

Second and third periopods without longitudinal stripes 7

7(6). Eyestalks with basal halves black, distal halves white with a thin white line separating corneas. [Outer reef flat and margin] . . . . . *Calcinus guamensis*

Eyestalks may be more than one color but colors are never separated by a distinct border 8

8(7). Distal halves of propodi and all of dactyls of periopods two and three purple with darker spots, carpi and meri purple. [Found at scuba depths] . . . . . *Calcinus haigae*

Periopods two and three not purple with spots distally 9

9(8). Dactyls of second and third periopods uniformly orange, other segments white with small orange specks. Propodi and dactyls only slightly more hairy than meri and carpi. [Found at scuba depths in live coral heads] . . . . . *C. minutus*

Proximal halves of dactyls of second and third periopods black, distal halves white; other segments olive green. Propodi and dactyls of second and third periopods much more hairy than meri and carpi. [Common on inner reef flat] . . . . . *C. latens*

10(5). The dactyls of the walking legs are shorter than the propodi. There is no strong margin along the upper, outer margins of the propodi of the second walking legs [Intertidal] . . . . . *C. laevimanus*

The dactyls of the walking legs are about the same length as the propodi. There is a strong margin along the upper, outer margins of the propodi of the second walking legs [Intertidal] . . . . . *C. seurati*

The type material is to be deposited at the Allan Hancock Foundation, University of Southern California and at the B. P. Bishop Museum, Honolulu. Additional material will be retained at the University of Guam Marine Laboratory.

Calcinus elegans (H. Milne Edwards, 1836)

Pagurus elegans
H. Milne Edwards, 1836:278, pl. 13, figs. 2, 2a.

Pagurus pictus
Owen, 1839:83, pl. 25, figs. 2, 2a.

Pagurus decorus
Randall, 1839:134.

Calcinus elegans
Miyake, 1956:18, 21, figs. 12, 13.
Lee, 1969:54, 54, text fig. 10.

MATERIAL: 11 males - CL 6.4 to 17.5 mm; 12 females (6 ovigerous) - CL 4.4 to 11.2 mm. Shells - ***Turbo*** sp., ***Drupa*** sp. From - Maug (Stats. M2, M4), Asuncion (Stat. AS3), Pagan (Stats. P5, P6), Guguan (Stat. GU3), Guam (Stats. 2b, 2c, 2f, 2g).

DISTRIBUTION: This species is found from the east coast of Africa through the Indian Ocean to Indonesia and Philippines; northwards to Japan, The Ryukyu Islands and Hawaiian Islands; south and east to the Society Islands and Bismark Archipelago.

COLOR IN LIFE: Entire carapace mottled light olive green; forward margin of shield and rostrum whitish. There may be regular, symmetrical-about-midline patterns of small brown specks on shield and posterior carapace. Antennal acicles, peduncles and flagella bright orange. Antennular peduncles and flagella dark brown. Ocular acicles and bases of eyestalks dark brown to black; the rest of eyestalks brilliant dark blue with thin black band separating corneas which are black with silverish blue tint. Abdomen transparent, internal organs yellow dorsally, pink ventrally. Pleopods transparent white. Abdominal terga poorly calcified, same color as soft part of abdomen. Telson and uropods whitish olive green. Chelipeds similar in color; dorsal surfaces of meri and carpi dark brown to dark olive green, ventral surfaces lighter brown to green. White on

tips of spines and tubercles of all segments. Propodi olive green with many white tubercles distally. Ends of propodi and dactyls white; purple hairs on ends of propodi. Periopods two and three carpi and meri bright blue on proximal halves with a few black spots along dorsal margins, distal halves of carpi and meri black with many very small. blue spots. Propodi with proximal one-fourth blue, followed by black band with small, blue spots which occupies about one-half of total length of segments, distal one-fourth of segments blue with a few large black spots; thin white band separates black, corneous claws. Periopod four blue with black spots fading to white on proximal segments. Periopod five light blue with black spots fading to white distally. Hairs on chelipeds and propodi and dactyls of periopods two and three bright purple, as is brush of hairs on propodi and dactyls of periopod three.

COLOR IN ALCOHOL (after eleven months): Carapace shield whitish with brownish tint; brown spot just inside of rostrum. Posterior carapace and entire abdomen (terga, pleopods and tail segments) whitish; rasps on uropods brown. Ocular acicles light brown, eyestalks pinkish white, corneas black. Antennal acicles, peduncles and flagella, antennular peduncles and flagella, and mouthparts all yellow brown fading to yellow and white at some extremities. Both chelipeds yellow brown with white on ends of fingers and on tubercles and spines. Periopods two and three with wide alternate bands of pinkish white and reddish brown; orange brown in some depressions; hairs purple. Periopods four and five reddish brown and white with some orange spots in depressions.

DESCRIPTION: Color is by far the most distinctive characteristic. Carapace shield rectangular, longer than wide. Rostrum pointed, not sharp; extends well beyond lateral projections. A few tufts of hairs on anterior margin of posterior carapace. Ocular acicles small with single spine pointing towards midline. Eyestalks inflated basally; extend beyond antennal peduncles and are, at border between stalks and corneas, the same length as antennular peduncles. Antennal acicles with a few sharp spines which extend as far as penultimate segment of antennal peduncles. Telson with left lobe longer. Uropods larger on left side. Left cheliped larger and longer than right; dorsolateral margin of left palm smooth, right serrate. Both chelipeds have distinctive large, smooth tubercles on distal halves of palms and all of fingers. Strong spine on dorsal, distal margin of carpi of periopods one, two, and three. Distinctive brush of hairs along ventral margin of propodi and dactyls of periopod three, periopod two not nearly as hairy. Claws of periopods two and three long, corneous and curved.

HABITAT: This species is moderately common on the outer reef flat and margin, to a depth of about five meters. It also occurs on wet erosion benches and exposed rocky shores. Small individuals of this species seem to prefer the shells of *Drupa* sp. while large animals are found in a large variety of shells. These animals are associated with *Aniculus aniculus* and *Calcinus gaimardi.*

Calcinus imperialis Whitelegge, 1901

Calcinus imperialis
Whitelegge, 1901:48-51, fig. 52.

MATERIAL: 2 males - CL 4.2, 4.3 mm; 3 females (2 ovigerous) - CL 5.6 to 5.9 mm. Shells - not recorded. From Asuncion (Stat. AS 4), Pagan (Stats. P3, P5), Guam (in fish guts, see habitat).

DISTRIBUTION: This species has been reported from Sydney to Norfolk and Lord Howe Islands. This Marianas record is a considerable extension of the known range of this species.

COLOR IN LIFE: Live colors were not taken from Northern Marianas specimens. Fresh periopods two and three were taken from a fish gut on Guam and colors were recorded. Both periopods two and three are very similar in color. Meri white basally, orange red distally with a thin white band at distal end. Carpi orange on proximal third; middle third dark red; distal third white. Propodi with proximal half white which turns to light orange at middle. At middle of propodi there are dark reddish orange bands which fade to white by distal quarter of segment. Proximal and distal thirds of dactyl white; middle dark red. Claws black.

COLOR IN ALCOHOL (after 18 months): Carapace shield, posterior carapace, abdomen and tail segments uniformly transparent whitish. Eggs on females yellowish white. Ocular scales, antennal acicles and bases of peduncles light orange white. Basal three quarters of eyestalks light orange. Distal quarter white. Corneas black. Chelipeds uniformly light orange white with darker orange on basal third of movable fingers. Periopods two and three are similar in color. Meri whitish with a large orange spot on dorsal surface in middle of segment. Carpi and propodi light orange on proximal third; middle third dark orange; distal third white. Proximal and distal thirds of dactyls white. Middle dark orange. Claws black. Colors on periopods two and three appear in distinct bands.

DESCRIPTION: Carapace shield nearly hairless; with many small depressions. Shield slightly longer than wide; appears square. Rostrum pointed; extends well beyond lateral projections. Anterior margins of shield between lateral projections and rostrum straight; perpendicular to midline. Eyestalks reach well beyond antennular and antennal peduncles. Left eyestalk slightly longer than right. Lengths of both eyestalks are approximately six and a half times greater than the minimum diameters. Antennal acicles reach to the bases of the penultimate segment of the peduncles, and have sharp spines along the inner lateral margins. The bases of the antennal peduncles have a strong bifed spine at the outer distal margin. Left cheliped larger and a bit longer than right. Left palm slightly tuberculate on distal surfaces. Fingers of both chelae curve so that only the finger tips touch when the hand is closed. Right cheliped more hirsute, spinose and elongate than left which is nearly smooth and hairless. Dorsal margins of palm and movable finger of right chelae quite spinose. Left and right periopods two and three are similar. Carpi with a single strong spine at dorsal distal margin. Other segments smooth with a few hairs along dorsal and ventral margins and on dactyls. Claws curved, corneous. Dactyl of left periopod three and to a lesser extent right periopod three considerably more hirsute than either periopod two. Telson with left lobe slightly longer.

HABITAT: The animal is not well known. Only a few specimens have been found from Asuncion and Pagan Islands. Identifiable second and third periopods have been found in a fish gut from Guam. The Marianas specimens were found just below the intertidal on a volcanic substrate. The Guam record is from a wrasse. Living specimens were found associated with ***Calcinus elegans*** and ***C. gaimardi.***

REMARKS: Marianas specimens are quite a bit smaller than those reported by Whitelegge (1901) and differ in a few characters. Whitelegge's material has longer eyestalks and two or three distinct depressions on the hand of the large cheliped. Marianas material has shorter eyestalks and the large hand is smooth. According to J. Haig (personal communication), Dr. Forest in Paris says that this difference may be caused by the difference in size of the specimens.

Calcinus gaimardi (H. Milne Edwards, 1848)

Pagurus gaimardi
H. Milne Edwards, 1848:63

Calcinus gaimardii
Alcock, 1905:53, 56, pl. 5, fig. 3.
Calcinus gaimardi
Fize and Serene, 1955:40, 49, pl. 2, figs. 5-8, text figs. 7, 8.
Miyake, 1956:326, text figs. 16, 17.
Lee, 1969:53, 54, text fig. 11.
Ball and Haig, 1972:101.

MATERIAL: 13 males - CL 5.4 to 14.8 mm; 9 females (3 ovigerous) - CL 6.8 to 16.3 mm. Shells - ***Trochus niloticus, Drupa*** sp., ***Cypraea*** sp. From - Asuncion (Stat. AS3), Pagan (Stat. P6), Alamagan (Stat. AL1), Saipan (Stat. SI), Guam (Stats. 2d, 2e, 2g, 14).

DISTRIBUTION: This species is known from the east coast of Africa through the Indian Ocean, Indonesia, Philippines; northwards to Japan and Ryukyus; east to Marshall and Gilbert Islands; and south to Society Islands and Australia.

COLOR IN LIFE: Ground color of entire carapace olive green; elongate brown spot along both sides of forward one half of carapace shield; two small brown spots in middle, along midline of shield. Three spots along groove between shield and posterior carapace; there may be a brownish tint along sides of posterior carapace. Antennal acicles, peduncles and flagella bright orange. Antennular peduncles brown, fading to orange at distal ends; flagella orange. Ocular acicle dark brown, white at tip. Basal halves of eyestalks dark brown with a few blue specks; distal halves blue though proportion of blue and brown is variable. Corneas black with white specks. Abdomen transparent, orange organs visible dorsally fading ventrally. Abdominal terga olive green to orange. Pleopods transparent white. Telson and tail segments white to light olive green with a brown spot at the base, on midline, of each segment. Chelipeds dark brown fading to light brown and to white along jaws; white on tubercles of other segments. Periopods two and three; all segments dark brown except distal one half of dactyls which are white; claws corneous, black. White specks in depressions on periopods one, two, and three. Periopods four and five white and brown, poorly-defined alternating bands on all segments.

COLOR IN ALCOHOL (after one year): Anterior part of carapace shield reddish brown with small white depressions. Posterior carapace and posterior shield white. Narrow white edge on anterior margin of shield between rostrum and lateral projections which are reddish brown. Ocular acicles and eyestalks reddish brown, fading to white near corneas which

are black. Antennal acicles, peduncles and flagella, antennular peduncles and flagella, and mouthparts all faded reddish brown to orange on extremities. Entire abdomen: terga, pleopods and tail segments, whitish; on terminal margins of last two terga preceding telson there may be a brownish tint. Periopods one, two, and three reddish brown; chelipeds slightly darker; white on ends of some spines and tubercles, on tips of chelae and distal ends of dactyls of periopods two and three preceeding black claws. Periopod four mottled white and light brown. Periopod five white.

DESCRIPTION: Carapace shield rectangular, longer than wide. Rostrum pointed, extends beyond lateral projections. Ocular acicles pointed, with single spine curving inward. Eyestalks inflated basally; reach beyond antennular peduncles. Antennal acicles long with many small spines. Abdomen without distinguishing characters, telson symmetrical. Left cheliped larger than right. Inner palm and dorsolateral margin of left chelae smooth; outer palm with many small tubercles. Dactyl of left cheliped with many small tubercles. Dorsolateral margin of palm and dactyl of right cheliped serrate. Dorsal, distal margin of right carpus with spine; left, without. Dorsal, distal margin of carpi of periopods two and three with spine. Brush of hairs on propodi and dactyls of priopods three. Claws of periopods two and three corneous, sharp and curved.

HABITAT: This species is common on the outer reef flat, margin, and reef front to depths of approximately five meters. It seems to prefer areas with clean, moving water. Specimens inhabit a large variety of shells especially *Drupa* spp., and may be found with *Calcinus elegans* in shallower portions of its habitat.

Calcinus argus n. sp.

Fig. 3

MATERIAL: Holotype: Feb. 17, 1977. Adelup Point, Guam (Stat. 9). 25 m.
Female, CL 5.7 mm. In *Coralliophila violacea.*
Paratypes: Aug. 6, 1975. NCS mounds, Guam (Stat. 14). 10 m.
Female, CL 7.2 mm. In *Cerithium* sp.
Nov. 10, 1976. Adelup Point, Guam (Stat. 9). 15 m. Two females, CL 7.1, 5.0 mm. In *Cerithium* sp. and *Drupina grossularia.*
July 12, 1975. Guguan, Northern Mariana Islands (Stat. GU4).
30 m. Male, CL 5.1 mm. In *Coralliophila violacea.*

Nov. 10, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Male, CL 10.3 mm. This specimen was used for drawings.
Nov. 15, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Female, CL 8.3 mm.
Nov. 22, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Female, CL 3.6 mm.

COLOR IN LIFE: Carapace shield shiny white with two very small but distinct brown spots in middle of shield behind Y-shaped depression. Posterior carapace white with a brown spot at most forward part on midline that connects to a similar spot at most posterior part of shield. Rostrum and a narrow band at forward margin of shield dark reddish brown. Ocular scales and most of eyestalks dark reddish brown, stalks fade distally to a light brown, then a white band before corneas, which are black with a few small white spots. Antennal acicles and bases of peduncles reddish brown with white on spines, flagella transparent yellowish brown. Antennular peduncles dark reddish brown, fading distally; flagella and hairs transparent yellowish brown. Abdomen transparent yellowish brown, lighter ventrally; terga and pleopods transparent whitish, tail parts white with some brown on margins of telson and uropods, and on bases of uropods. Periopods one, two, and three all similar in color; ground color of all segments dark reddish brown with many white spots that are in no particular pattern but spaced fairly evenly. Tips of fingers of both chelae white; claws of second and third periopods black; hairs on legs white. Periopods four and five mottled white and light reddish brown.

COLOR IN ALCOHOL (after one year): The live color patterns are still visible. Carapace shield and posterior carapace white; a distinct brown spot connects forward part of posterior carapace and shield at midline. Rostrum and forward margin of shield, especially behind antennal peduncles, brownish. Ocular scales and eyestalks brown; eyestalks fade to white before black corneas. Antennal acicles, peduncles and flagella, antennular peduncles and flagella, and mouth parts light reddish brown with white on spines. Abdomen, terga, pleopods, and tail parts white. Periopods one, two, and three reddish brown with many white spots; tips of fingers of chelipeds white; claws of periopods two and three black. Periopods four and five white with very faded brown mottling.

DESCRIPTION: Carapace (Fig. 3A) shield slightly longer than broad; the ratio of length to breadth approximately 9:8. Rostrum small, pointed, exceeds lateral projections which are almost as pointed as rostrum.

Surface of shield smooth and hairless with a few scattered small depressions.

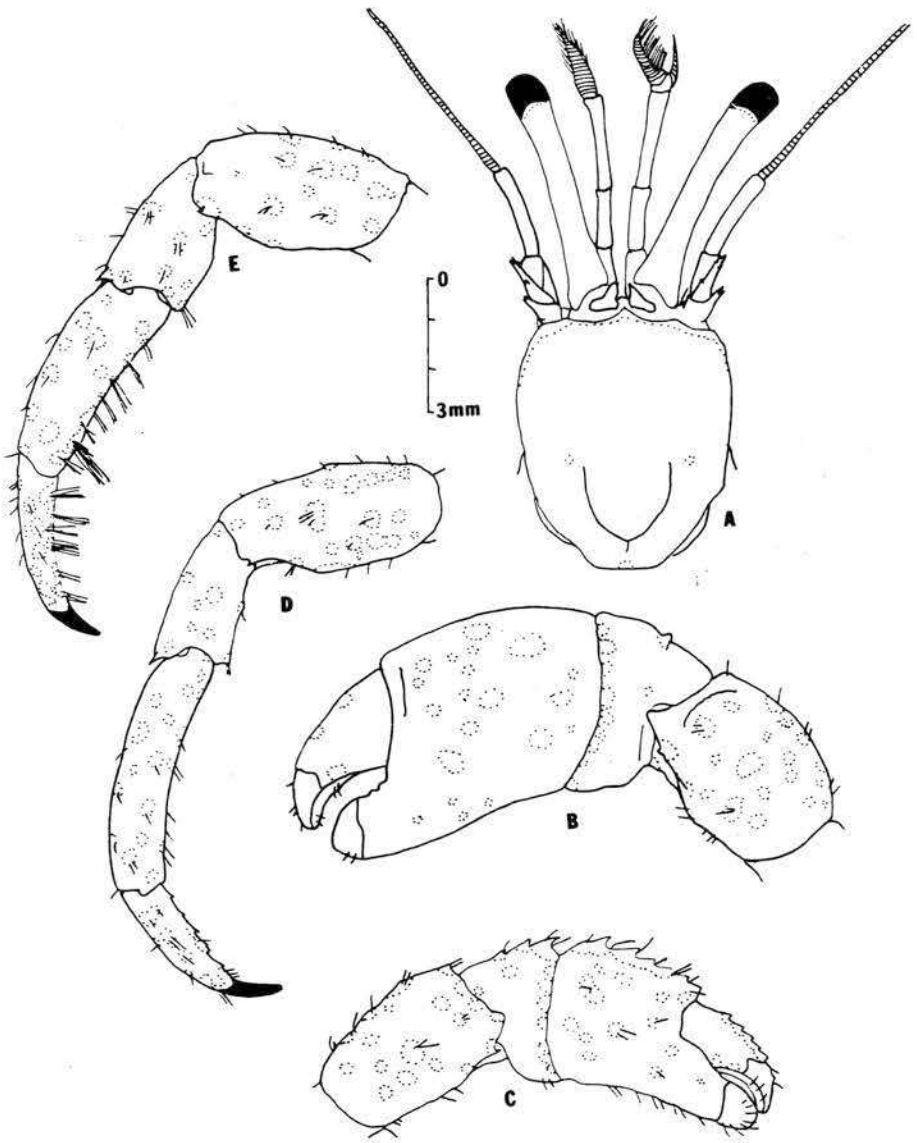

Fig. 3. ***Calcinus argus*** n. sp. A, carapace; B, left cheliped; C, right cheliped; D, left periopod 2; E, left periopod 3.

Ocular scales small, wide set, roughly triangular; point slightly inwards and terminate in a small spine or pair of spines. Eyestalks appear equal though left is very slightly the longer; the ratio of left to right eyestalk lengths is approximately 16:15. Eyestalks moderately long and slender, inflated basally and slightly at corneas; approximately eight times longer than their minimum diameters. The shorter eyestalk is longer than the width of the forward carapace shield; their ratio is approximately 9:7. Antennular peduncles, when fully extended, reach to cornea of shorter eyestalk; base of peduncles with two spines; one on inner distal margin; the other longer and bifurcate, on the outer distal margin. Antennal acicles reach just beyond base of last segment of peduncles, with a single or double small spine on middle of outer surface and four to five distinct small spines at distal ends. Some specimens bear an extremely small spine on the distal dorsal margin of the penultimate segment of antennal peduncles. There are only a few short, fine hairs on antennal acicles, the bases of peduncles and between ocular scales.

On large specimens the left cheliped (Fig. 3B) is much larger and longer than the right; on the holotype and small specimens the left cheliped is larger and only a bit longer than the right. On large specimens the left chelae extends to middle of dactyl of the first walking leg; on the holotype the left chelae extends to middle of propodus of first left walking leg. Left cheliped merus with a single, small spine at distal end of outer ventral margin; another small, low spine at dorsal distal margin which is not present on large specimens; carpus with a large protuberance on outer upper middle surface; outer distal margin with a few low bumps; inner surface and distal margin smooth. Palm smooth with some small low tubercles distally and on movable finger. Entire left cheliped appears smooth; only a very few fine hairs on all segments, especially finger tips.

Right cheliped (Fig. 3C) more spinose and hirsute than left; reaches nearly to last third of propodus of first right walking leg. Merus with a single spine just before distal end of outer ventral margin; carpus with a strong spine at distal end of dorsal margin and a pair of smaller spines behind. Dorsal margin of palm with four to six strong spines that form a slightly raised crest; a few smaller spines on the outer surface. Movable finger with a few large and small spines on outer surfaces; the spines decrease in size distally. Movable finger curved, almost spoonshaped distally, with a straight cutting edge that touches opposing finger when hand is closed. Finger tips close together to form a spoon-like depression along inner margins of fingers. Finger tips with strong tufts of hairs;

other segments more hirsute than corresponding segments of left cheliped.

Both first walking legs (Fig. 3D) are very similar. Meri compressed, with a single spine at outer, ventral distal margin. Carpi with a single spine at distal end of dorsal margin. Propodi cylindrical, smooth, without spines. Dactyls with a row of approximately six very small, transparent spines along ventral margins; claws small, curved, corneous, occupy approximately one seventh of entire length of dactyls. Both first walking legs appear smooth with only a few hairs along dorsal and ventral margins of all segments.

Both second walking legs (Fig. 3E) are very similar, distinctly different from first walking legs by the presence of dense tufts of hairs on ventral surfaces of distal halves of propodi and on all segments of dactyls. Second walking legs are shorter and stouter than first walking legs, especially propodi. Meri with a single small spine at outer, distal, ventral margins; stouter than meri of first walking legs. Carpi with a single sharp spine at distal ends of dorsal margins. Meri and carpi with a few short fine hairs along dorsal and ventral margins, slightly more hirsute than corresponding segments of first walking legs. Propodi cylindrical, stouter than those of first walking leg; without spines; dorsal surface only a bit more hirsute than carpi; ventral surfaces become very hairy distally. Dense hairs along ventral margins of dactyls hide a few small spines, dorsal surfaces only moderately hirsute. Claws curved, corneous, occupy approximately one seventh of total length of dactyls.

Telson with left lobe larger and longer than right; terminal margins of both lobes with a brush of long, transparent hairs.

REMARKS: ***Calcinus argus*** belongs to the group of ***Calcinus*** species in which the propodi and dactyls of the third periopods are considerably more hirsute than the same segments on the second periopods. In the Mariana Islands this group includes *C. gaimardi* (H. Milne Edwards, 1848) (see Ball and Haig 1972;101 and Miyake 1956:326, text figs. 16, 17), *C. elegans* (H. Milne Edwards, 1836) (see Miyake 1956:320, figs. 12, 13, and Lee 1969: 53, 54, text fig. 10) and *C. imperialis* Whitelegge, 1901 (see pp. 48-51, fig. 52). The other Indo-West Pacific member of this group is *C. vachoni* Forest, 1958 (see pp. 1-14, figs. 2, 3, 9, 10, 15) from Viet Nam. *C. argus* can immediately be differentiated from these, and all other members of the genus, by its unique coloration. There are no other ***Calcinus*** species that have all surfaces of the first

three periopods covered with fair-sized, evenly spaced, light-colored spots against a dark background. A few other species may have small dark spots on the dactyls and distal parts of the propodi of the second and third periopods but they can not be confused with *C. argus*.

C. elegans is also found only in the intertidal areas where there is exposure to moving, clean seawater, and never in deeper water over the reef, as is *C. argus*.

C. imperialis is another apparently intertidal species that, like *C. elegans*, has all segments of the second and third periopods ringed with distinct bands of color. The few Mariana Islands specimens in the University of Guam Marine Laboratory collection are quite small (CL approximately 5 mm). On these specimens the dorsal margins of the carpus and palm of the right cheliped are considerably less spinose and hirsute and the rostrum more pronounced than on *C. argus*. Whitelegge describes the hand of the left cheliped as having three very distinct depressions. These depressions are difficult to discern on our small specimens but are always absent on *C. argus*.

C. argus differs from Forest's description of *C. vachoni* by having longer and more slender eyestalks, a longer and less rounded carapace shield and less spination at the terminal margins of the ocular scales.

C. gaimardi is perhaps the species that most closely resembles *C. argus*. *C. gaimardi* is found intertidally and to a depth of approximately 10 m outside of the reef, where it is found with *C. argus* which also occurs in deeper water. *C. gaimardi* is extremely common and, though it attains a much larger size, small animals are commonly found occupying the same shells and reef areas as *C. argus*. The most obvious difference between the two species is in the coloration of the eyestalks and the first three periopods. Morphologically they look very much alike. On *C. argus* the antennular peduncles reach a bit further and the left palm is less tuberculate and compressed than that of *C. gaimardi*.

Calcinus sp. 1

MATERIAL: 25 males - CL 3.2 to 8.0 mm; 11 females (7 ovigerous) CL - 3.5 to 6.5 mm. Shells - not recorded. From - Maug (Stat. M1), Asuncion (Stat. AS3), Pagan (Stat. P4), Alamagan (Stat. AL1), Guguan

(Stats, GU1, GU2), Guam (Stats. 5b, 13, 14).

DISTRIBUTION: So far this species is only known from Indonesia (J. Haig, personal communication). This Marianas record is a considerable extension of the known range of this species.

COLOR IN LIFE: Carapace shield gray-green fades towards posterior nearly to white at posterior margin. Rostrum and forward margin of shield brownish green. Two dark spots on forward middle of shield about halfway from midline to lateral margins, one on each side. Posterior margin of shield with three dark spots. Posterior carapace almost white with two dstinct spots, one each side, between midline and lateral margins. Entire carapace with many very small, yellow gold spots. Ocular acicles yellow white with an orange area in the centers. Eyestalks bright red-orange, fading to pale gray-purple at distal quarters; corneas black with many small white specks. Antennal acicles and peduncles brown with white at tips of spines; flagella transparent yellow. Antennular peduncles brown except for distal third of last segment which is blue; flagella and hairs orange-yellow. Abdomen white, slightly transparent along sides. Abdominal terga white, with distinct pattern of one small brown spot at midline at forward margin of each plate and two spots on posterior margins, equidistant from midline. Uropods white, telson white with a brown spot in middle of posterior margin. Pleopods transparent white. Chelipeds identical: meri and carpi brown with white spines, undersides light gray. Chelae brown, fading to blue-gray and white at tips. There are two dark purple spots: one on inner and one on outer middle surface of palm. Periopods two and three have the dorsal surfaces of peri with large areas of white and brown; tubercles white. Ventral and inner surfaces of meri bright red-orange. Carpi entirely red-orange with white spines on dorsal, distal margins. Proximal four-fifths of meri with brown lateral stripes against a yellowish background, distal one-fifth yellowish white with brown spots. Dactyls red-orange, fading to white before black claws. Periopods four with all segments white; meri with roughly defined bands of purple at center, a few orange spots on distal fourths of meri; pale purple areas on dorsal surfaces of carpi. There is a purple spot on propodi, just before dactyls. Periopod five white; basal halves of meri brownish as are distal halves of carpi and proximal halves of dactyls; yellow spots on some areas.

COLOR IN ALCOHOL (after one year): Carapace shield and posterior carapace white; anterior part of shield may have light brown tint. Ocular acicles and basal parts of eyestalks pinkish white, distal parts of eyestalks

white; corneas black. Antennal acicles, peduncles, and flagella; antennular peduncles and flagella; and mouth parts pinkish white. Entire abdomen and abdominal appendages white. Ventral surfaces of chelipeds white; dorsal surfaces brownish white; ends of palms and all of fingers white; dorsal surfaces of meri darker brown. The two darker brown spots are plainly visible on the inner and outer surfaces of each palm. Periopods two and three are similar to life but faded; carpi, meri, and dactyls pinkish brown; darker brown patches on dorsal surfaces of meri; propodi whitish with longitudinal reddish brown stripes; claws black. Periopods four and five white.

DESCRIPTION: Carapace shield almost square, only slightly longer than wide. Rostrum pointed, not sharp; slightly longer than lateral projections. Ocular acicles very small with one or more very fine spines on distal margins. Eyestalks inflated at bases; curve slightly outward and reach beyond antennular peduncles, corneas small. Antennal acicles spinose and massive; are as thick as basal segments of peduncle. Left lobe of telson much larger and longer than right. Left cheliped longer and larger than right. Dorsolateral margin of left palm with a few rounded spines; right with raised serrate carina. Fingers of chelae curved so that only tips touch when jaws are closed. Periopods two, three, four and five without distinguishing characters.

HABITAT: Specimens are commonly found outside of the reef at depths between five and twenty-five meters. They occupy a large variety of shells and are found with ***Calcinus minutus*** in the branches of ***Acropora*** spp. and ***Pocillopora*** spp. corals. When the animals are disturbed they will retract into their shells and fall to the center of the coral; they are very difficult to remove. The crab is also found on live massive corals and coral rubble.

REMARKS: This species which somewhat resembles ***Calcinus pulcher*** Forest, is presently being described by Patsy A. McLaughlin (Florida International University) and Janet Haig of U.S.C. Specimens from the Mariana Islands differ from Forest's (1958) description of ***C. pulcher*** in a few important characters. The carpi and dactyls of periopods two and three which, on Marianas material are dark reddish orange, are described by Forest as: the carpi of periopod two bright red overlain by dark longitudinal streaks, the carpi of periopod three with dark longitudinal stripes and no red; the dactyls of periopods two and three with a median dark red band with darker longitudinal streaks. Otherwise the animals are the same with distinctive dark streaks on the propodi of periopods

two and three and the dark spots on the inner and outer surfaces of chelae of the chelipeds. At J. Haig's suggestion I will leave the identification of Marianas specimens at *Calcinus* sp. 1.

Calcinus guamensis n. sp.

Fig. 4

MATERIAL: Holotype: April 26, 1977. Pago Bay (Stat. 2g) Guam. Intake channel 1 m. Male, CL 4.7 mm. In *Trochus maculatus.*
Paratypes: April 26, 1977. Same location as holotype.
Male, CL 5.7 mm, *In Latirus* sp.
Female, CL 3.8 mm. In *Conus chaldeus.*
Female, CL 3.3 mm. In *Morula uva.*
Female, CL 3.2 mm. In *Morula uva.*
Male, CL 4.8 mm. In *Morula uva.*
Female, CL 2.8 mm. In *Morula uva.*
Male, CL 3.2 mm. In *Mutra paupercula.*
Male, CL 2.9 mm. In *Morula uva.*
March 1, 1977. Agat Bay (Stat. 5e) Guam. Near sewer outfall 3 m. Coll. D. Hammel.
Female (Ovigerous) CL 4.2 mm. In *Cypraea moneta.*
March 21, 1977. Pago Bay (Stat. 2g) Guam. Intake channel 1 m.
Female (Ovigerous) CL 4.3 mm. In *Morula uva.*
Female (Ovigerous) CL 5.1 mm. In *Morula uva.*
Female (Ovigerous) CL 2.9 mm. In *Morula uva.*
Male, CL 2.9 mm. In *Morula uva.*
Male, CL 3.6 mm. In *Morula uva.*
March 12, 1976. Pago Bay (Stat. 2g) Guam. Intake channel 1 m.
Male, CL 6.2 mm. In *Drupa ricinus.*
Female (Ovigerous) CL 5.4 mm. In *Drupa ricinus.*
Female (Ovigerous) CL 4.3 mm. In *Drupa ricinus.*
Female, CL 4.3 mm. In *Morula granulata.*
Female, CL 3.8 mm. In *Peristernia nassatula.*
July 8, 1975. Asuncion Northern Marianas (Stat. AS4), 4 m.
Male, CL 4.8 mm. In *Morula uva.*
Female (Ovigerous) CL 4.9 mm. In *Morula uva.*
Female (Ovigerous) CL 4.6 mm. In *Morula uva.* Guguan, Northern Marianas (Stat. GU3).
Male, CL 5.0 mm. In *Nerita (Ritena) plicata.*
July 5, 1976. Pagan, Northern Marianas (Stat. P6), 2 m.

Female, CL 4.3 mm. In *Mitra* sp.
Female, CL 3.2 mm. In *Morula uva.*
Male, CL 3.8 mm. In *Mitra paupercula.*

COLOR IN LIFE: Carapace shield light olive green with a light brown tinted area on middle of posterior surface. There are two conspicuous small black spots along cervical groove, equidistant from midline about halfway to lateral margins of shield. Posterior carapace pinkish brown with white mottling. Ocular scales light olive green followed by a black band with white specks that occupies the middle halves of stalks; distal quarters of stalks light olive green. Corneas black with a few white spots. Antennal acicles and peduncles light olive green with white hairs; most distal segment of peduncles and all of flagella orange. Antennular peduncles and flagella olive green; white hairs on flagella. Both chelipeds nearly identical, distal third of meri black with white tubercles; proximal two thirds olive green. Carpi black with relatively large white tubercles, except for undersides of distal margins which are olive green. Chelae olive green fading to whitish yellow at finger tip. Many fine tubercles on palms and fingers are lighter olive green than surrounding surfaces. Periopods two and three olive green on all segments, except dactyls which are black with a few large white tubercles on proximal thirds; distal two thirds white. Claws black. Periopods four light olive green with white hairs, conspicuous black spot at bases of dactyls. Periopods five light olive green with white hairs. Sternites and coxae of all periopods light olive green. Abdomen pinkish, transparent; internal organs on dorsal surface give appearance of brown stripe running along midline. Pleopods transparent white, eggs red on ovigerous female. Tail segments light olive green.

COLOR IN ALCOHOL (after eight months): Animal fades immediately after preservation. Carapace shield and posterior carapace white. There are two distinct black spots on cervical groove (see live color notes). Ocular scales, basal and distal quarters of eyestalks white, center halves of eyestalks and corneas black. Antennal acicles and peduncles white, except for last segment of peduncles and flagella which are very pale green. Entire abdomen and tail segments transparent white. Chelipeds and periopods two and three as in life, except olive green portions have faded to white. Periopods four and five as in life; prominent black spot at bases of dactyls of periopod four still plainly visible.

DESCRIPTION: Carapace shield (Fig 4A) longer than broad; ratio of length to breadth approximately 7:6. Rostrum acute, pointed; exceeds lateral projections which are not as pointed. Entire surface of shield smooth, with many fine depressions; a distinct Y-shaped groove on middle, posterior portion, and a few very fine hairs along forward lateral margins.

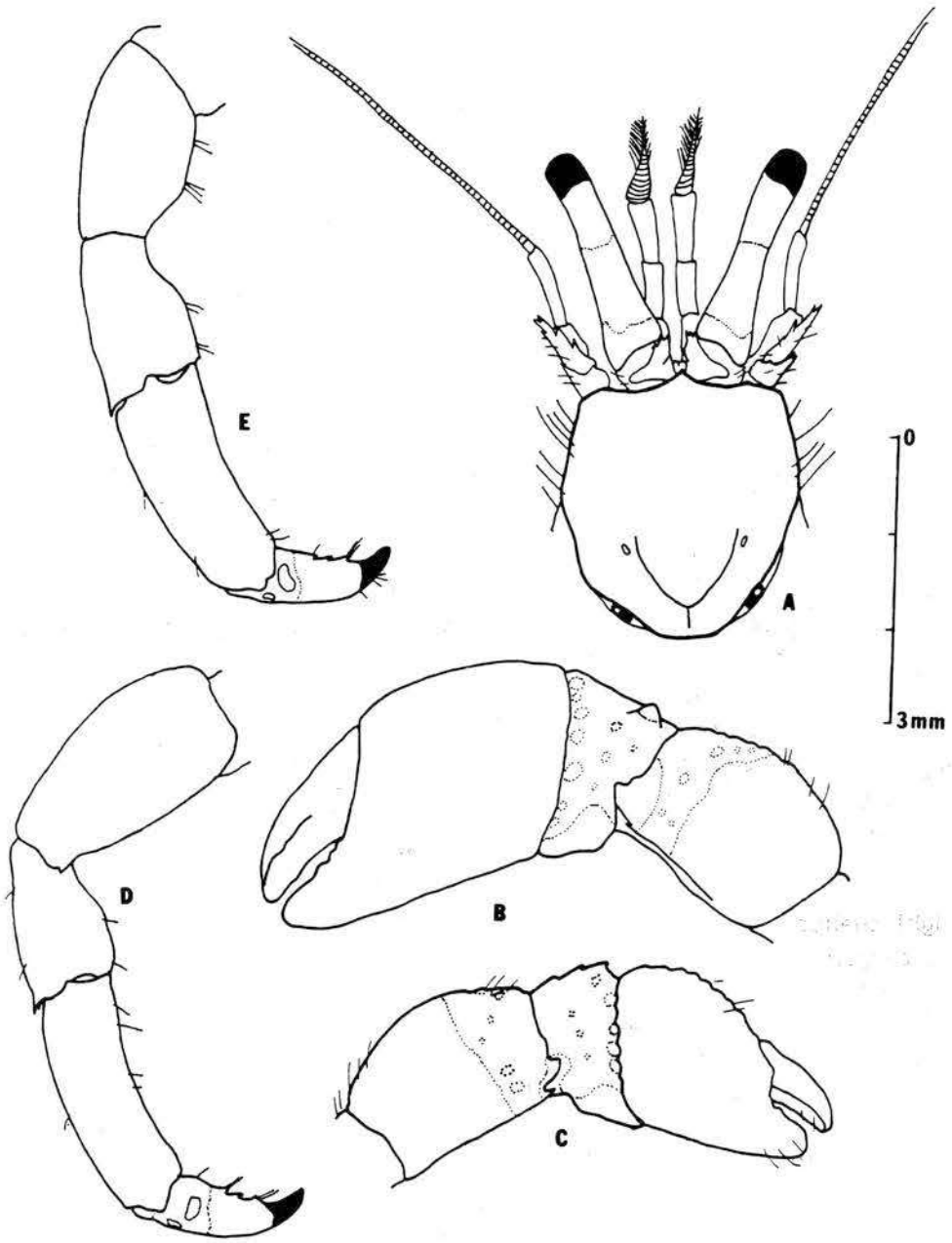

Fig. 4. ***Calcinus guamensis*** n. sp. A, carapace; B, left cheliped; C, right cheliped; D. left periopod 2; E, left periopod 3.

Ocular scales roughly triangular, wide set, and small, with approximately three small sharp spines at terminal margins. Eyestalks equal or nearly so; on the holotype the left is slightly longer; the ratio of lengths approximately 14:13. Both eyestalks approximately seven times longer than minimum diameters, inflated basally and a little before corneas. The shorter eyestalk is slightly longer than the forward margin of the shield and reaches farther than antennal peduncles and a bit farther than antennular peduncles. Antennal acicles long, thin, with 3-4 small sharp spines at terminal margins and a few more along inner lateral surfaces; reach beyond bases of last segments of peduncles. Bases of antennal peduncles with a single spine pointing outwards. On all specimens examined the antennal flagella are short and never reach as far as the second periopods. There are a few very fine hairs along antennal acicles and peduncles and at bases of eyestalks.

Chelipeds small, nearly equal on small animals and some females; the left larger on larger animals. On large males the left hand (Fig. 4B) is smooth and more elongate than on females and smaller males. On the females the left hand is somewhat granulous and shortened. On the holotype (a male)the left hand extends beyond the dactyl of the left second periopod, on small animals the left hand may not extend beyond the base of the propodus. Both chelae with only a few fine hairs. Merus of left cheliped with a single small spine on lower distal outer margin; a row of similar but smaller spines on lower distal inner margin. Proximal dorsal surface of merus smooth becoming rough towards distal half which is tuberculate, especially along outer and inner distal margins. Carpus tuberculate, more so on females; without spines; with a single large tubercle on the middle of the outer surface in both sexes. Palm and fingers minutely tuberculate, smoother than carpus. Movable finger with a few large teeth along proximal half of claw on outer lateral margin; a few tufts of fine hairs on finger tips.

Right cheliped (Fig. 4C) more spinose and a bit more hirsute than left; dorsal margin of merus smooth or with a few very small spines along distal half; a single small spine at dorsal distal margin and another sharper spine on lower outer distal margin, slightly behind joint; lower, inner merus unarmed. Distal third of merus with a few large tubercles, proximal two-thirds smooth. Carpus, tuberculate, especially dorsally, with a large spine at dorsal, distal margin; two smaller spines behind it. Hand with many small spines and a well-defined ridge of approximately five large low spines along dorsal margin. When hand is closed fingers meet only along cutting edge at finger tips; finger tips with a few tufts of short hairs.

Left and right periopods two (Fig. 4D) the same size and shape; all segments smooth with only a few fine hairs on dorsal and ventral margins and on dactyls. Meri with a single small spine at lower, outer, distal margins. Carpi with a single small prominent spine that may be immediately surrounded with smaller spinules at dorsal, distal, margins. Propodi cylindrical, smooth. Proximal halves of dactyls tubrculate, distal halves smooth; approximately three small spines along the ventral margins before curved, corneous claws.

Left and right periopods three (Fig. 4E) the same size and shape; hairs and spination very much alike though third periopods a bit shorter and stouter than the second periopods. Meri with a few very small spines along distal halves of lower, inner margins. Carpi with a single prominent spine that may be surrounded by a few much smaller ones at dorsal, distal margins; more pronounced than on periopods two. Propodi cylindrical, smooth, without spines. Proximal halves of dactyls tuberculate, distal halves smooth; with a few small, transparent spines along ventral margins before curved, corneous claws.

Telson with left lobe longer and a bit larger than right. This is a somewhat variable character but in all specimens examined the left lobe is always at least a bit larger than right. Terminal margin of telson with fine, long hairs.

HABITAT: This species seems to have the same habitat requirements as *Calcinus latens*. It is found intertidally and just over the reef where there is clear, moving water. The animal does not seem to have specific shell requirements and inhabits a large variety of shells.

REMARKS: *Calcinus guamensis* most closely resembles *C. rosaceus* Heller, 1861 (see Forest 1956: 222-227, figs. 5-8), and to a lesser extent, *C. minutus* Buitendijk, 1937 (see Forest 1958:1-14, figs. 1, 6-8, 14, 18, and Nakasone, 1975: 1-6, fig. 1) and *C. nitidus* Heller, 1865 (see Forest 1956: 218-227, figs. 1-4). In these species both periopods two and three have approximately the same amount of relatively sparse hairs, and all are small and relatively compact.

C. guamensis can be easily distinguished from all other species of *Calcinus* by its distinctive coloration: it is the only known species with black areas on the proximal surfaces of the dactyls of periopods two and three, the distal halves of the meri and most of the carpi of both chelipeds, and on the middle, dorsal surfaces of the eyetalks. When the

animal is alive and not retracted into its shell, all of the black parts of the body are in contact with one another and areas merge together to form a broad, black band. *C. guamensis* is also perhaps the smallest and most compact *Calcinus* existing.

The shape of the carapace shield and the size and proportions of head appendages and walking legs of *C. guamensis* are much like those of *C. rosaceus* as described by Forest (1956). Without the distinct color difference the two species would be hard to tell apart. Forest reports the color of *C. rosaceus* in alcohol is pinkish with a white area before the corneas and on the dactyls and propodi of the walking legs. There are also a few morphological differences that may be somewhat variable among specimens of the same species; *C. rosaceus* appears to have stronger spination along the ventral margins of the dactyls of periopods two and three, a more rounded rostrum, and more spines on the bases of the antennular peduncles than does *C. guamensis*.

Both *C. nitidus* and *C. minutus* can be differentiated from *C. guamensis* by their coloration and the relatively longer and more slender eyestalks. *C. minutus* is (in life) fairly uniformly cream white with distinctive orange coloration and small spots on the fingers of the chelipeds and on the distal half of the propodi and all of the dactyls of periopods two and three.

Forest reports that *C. nitidus* is whitish with red orange markings on the forward part of the rostrum, on the internal, external and lower parts of the meri, and on the proximal halves and internal and external faces of the propodi of the chelipeds; dactyls and distal parts of propodi of walking legs are intense red orange, the rest of the walking legs reddish orange. *C. nitidus* appears to have a more elongate major chelae, a more spinose right chelae, more spines along the dactyls of periopods two and three, and a bit more elongate carapace shield than does *C. guamensis*.

Calcinus baigae n. sp.

Fig. 5

MATERIAL: Holotype. May 6, 1977. Adelupe Pt., Guam (Stat. 9), 15 m.
Male, CL 6.4 mm. In *Drupella cornus*.
Paratypes. May 6, 1977. Adelupe Pt., Guam (Stat. 9), 15 m.
Male, CL 6.4 mm. In *Latirus* sp.
Female, CL 3.5 mm. In *Mitra* sp.
Two juveniles, CL 2.0, 2.1 mm. In *Morula uva*.

August 20, 1975. Pati Pt., Guam (Stat. 1), 12 m. Female, CL 6.4 mm. In *Morula uva.*
September 1975. Glass breakwater, Guam (Stat. 7). Ocean side, 12 m. Female, CL 8.6 mm. In *Bursa rhodostoma.*
Febrary 17, 1976. Adelupe Pt., Guam (Stat. 9), 25 m. Juvenile, CL 2.5 mm. In *Coralliophila violacea.*

COLOR IN LIFE: Carapace shield whitish with purple tint on anterior. Two elongate dark purple areas on lower sides of shield, behind antennal peduncles. There is a white spot on the inner, anterior parts of these purple areas. There are three purple spots on the anterior margin of the carapace shield; one large one on midline and a darker, more distinct, smaller spot on each side, about halfway to sides of shield. Ocular scales dark purple with white at ends of spines. Eyestalks uniformly brownish purple with a narrow white band separating corneas which are black with a few white spots. Antennal acicles and basal segments of peduncles dark purple with white on ends of spines. Last segment to peduncles and all of flagella transparent orange brown. Antennular peduncles and flagella, and mouth parts dark bluish purple. Abdomen transparent pinkish. Ventral surface with many small white spots. Dorsal surface without spots. Abdominal terga whitish pink. Pleopods transparent white. Telson and tail parts white with orange spots on the bases of the uropods and the two plates preceding telson, on the midline posteriorly. Chelipeds dark purple with some white on tubercles fading to light purple on distal halves of palm and all of movable fingers. Finger tips white. Distal halves of palm and fingers on both chelae with some orange spots. All segments of periopods two and three purple that is lighter than on chelipeds. Ends of dactyls white with black claws. Distal halves of propodi and all of dactyls white with black claws. Distal halves of propodi and all of dactyls of periopods two and three with some fairly uniformly spaced orange spots. Periopods four and five purple and white mottled, with some dark orange spots. Rasps on periopods four light greenish yellow.

On smaller specimens (down to CL 2.3 mm) there is a tendency for the posterior carapace and carapace shield to be lighter; the smallest specimens are almost white. On all animals three distinct spots are visible along the posterior margin of the carapace shield. Head appendages are also the same color on small and large specimens. The orange spots on the ends of chelae and propodi and dactyls of periopods two and three are even more distinct on small animals than on large ones. Otherwise,

the first three periopods are very much alike in color on large and small specimens. On the smallest animals there are dark orange patches on the dorsal bases of the dactyls of periopods two and three; these are not visible on large animals.

COLOR IN ALCOHOL (after 13 months): Posterior carapace white, shield white with two small reddish brown spots along posterior margin, two larger reddish brown patches behind antennal peduncles. Ocular scales and bases of antennal peduncles reddish brown with white on tips of scales and spines. Distal segment of antennal peduncles and all of flagella, and antennular peduncles and flagella, brownish yellow. The first three periopods pinkish purple, darker distally, especially on chelae. Tips of chelae and ends of dactyls white. Claws of periopods two and three black. There are many small bright orange spots on the propodi and dactyls of the first three periopods. Periopod four white with some small pale orange spots. Periopod five, abdomen, and abdominal segments white; pale orange spots on telson and uropods.

DESCRIPTION: Carapace shield (Fig. 5A) longer than wide; the ratio of length to breadth approximately 6:5. Rostrum not broad; tip acute and greatly exceeds lateral projections which are rounded. Shield covered with many minute depressions; only a few fine hairs along the lateral margins.

Ocular scales small, roughly triangular, with approximately three small, sharp spines along the terminal margins. Eyestalks equal on holotype; on some specimens the left appears to be very slightly larger. Eyestalks inflated basally and a bit at corneas, are approximately eight times longer than their minimum diameters and longer than the width of the anterior carapace shield. First segment of the antennal peduncles with a protruding pair of spines on dorsal, distal, outer margin; a smaller spine at dorsal, inner, middle margin. Antennal acicles slender and spinose; reach just beyond bases of last segment of peduncles; with approximately four small spines at terminal margins and a few more small spines along dorsal, inner margins. Antennal peduncles reach to distal third of eyestalks; antennular peduncles reach nerly to bases of corneas. There are only a few short, fine hairs along forward margin of shield, bases of eyestalks, and antennal acicles and peduncles.

Left cheliped (Fig. 5B) larger and longer than right; on small specimens the difference in size between the left and right chelae is not as evident. On the holotype, a male (CL 6.4 mm), the left cheliped extends almost to the middle of the dactyl of the second, left periopod; merus with a

single sharp spine approximately four-fifths of the way along the distal, outer, ventral margin; inner margin with two smaller spines. Outer surface smooth with a few small tubercles, inner surface smooth; may be a single very small spine at the distal, ventral, inner margin that is not evident on small specimens. Carpus more tuberculate than merus, with a row of tubercles and small, rounded spines along the distal, outer margin; a large rounded knob at the middle of the outer, dorsal surface. Proximal surface of palm smooth, becoming tuberculate distally, and especially dorsally. Upper surface of movable finger with a few parallel rows of very small spines; a few large teeth along the outer, lateral margin of the jaw; both fingertips with a few tufts of short hairs. The left cheliped of the largest female specimen (CL 3.9 mm) looks very much like that of the holotype; the dorsal outer margin of the palm and movable finger are a bit more tuberculate and the hand appears to be slightly less elongate.

Male and female right chelipeds (Fig. 5C) are very much the same; more spinose and hirsute than left; reach to middle of propodus of right second periopod. Merus with a single spine approximately at distal one third of outer, ventral margin; on inner ventral margin there is a row of three smaller spines; merus tuberculate with a few small spines and hairs only along dorsal and ventral margins. Carpus with approximately four spines along dorsal margin; at dorsal, distal margin there is a single large spine with one or two smaller spines below and behind; inner surface smooth except for a few rounded spines along distal margin; outer surface tuberculate with a few hairs along distal margin. Palm with a row of five or six strong spines along dorsal margin; inner surface smooth with a few tubercles on upper surface; outer surface spinose with hairs on middle and dorsal margins. Movable finger with dorsal margin spinose; spines decrease in size distally. Fingers, when closed, touch only at finger tips, form a hoof-shaped cutting edge.

Second periopods (Fig 5D) very smooth, with only a few fine hairs along dorsal and ventral margins; left and right the same size and shape. Meri with a single prominent spine at lower distal inner and outer margins. Carpi smooth, with a single large, prominent spine at dorsal, distal margin. Propodi smooth, cylindrical, without spines. Dactyls smooth, with a small corneous claw and a row of approximately five very small spines along ventral margins, behind claws.

Third periopods (Fig. 5E) very much like second periopods, smooth with only a few hairs. The dactyls and propodi of third periopods are a bit more compressed and stout than second periopods; the propodi are also

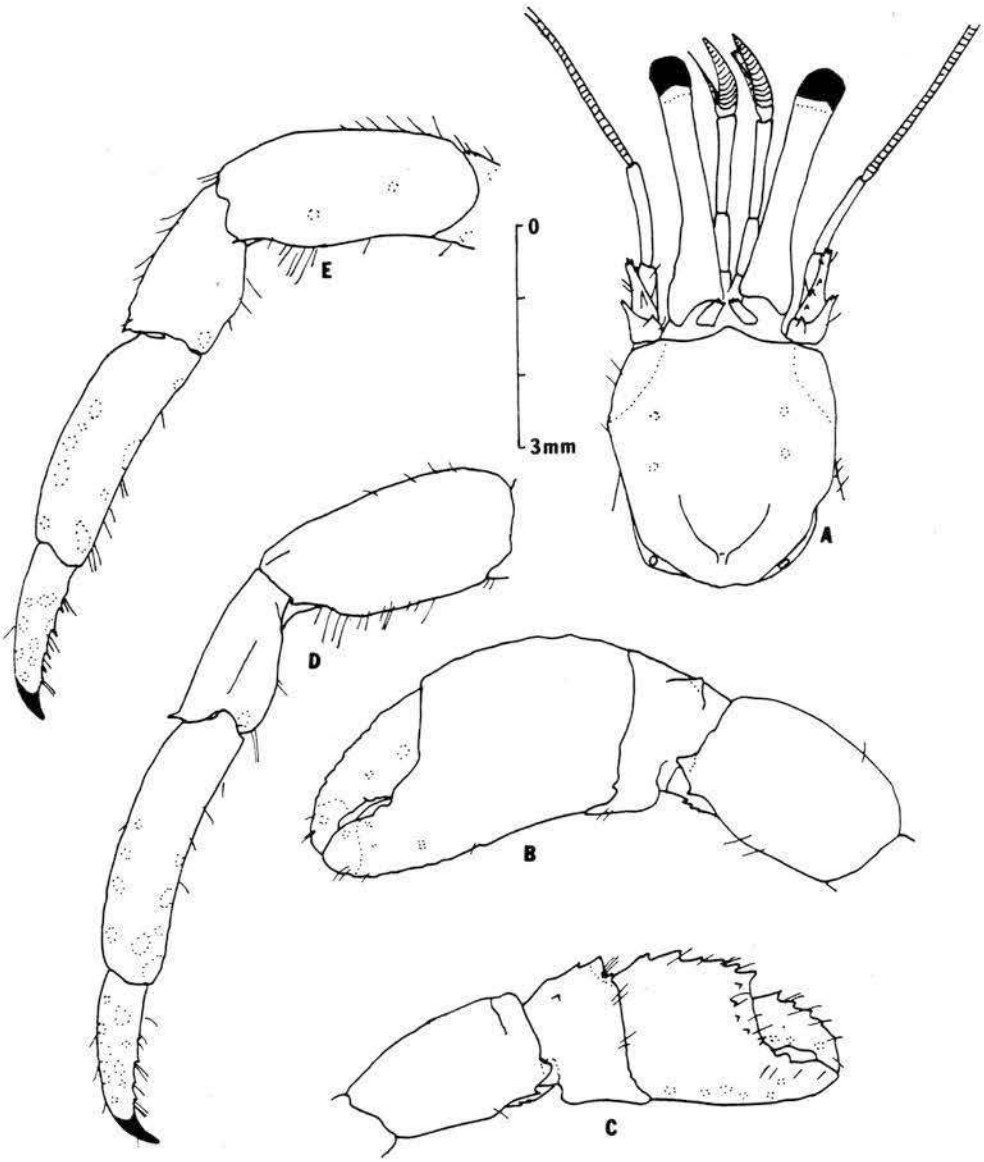

Fig. 5. *Calcinus haigae* n. sp. A, carapace; B, left cheliped; C, right cheliped; D, left periopod 2; E, left periopod 3.

slightly shorter. Meri with single spines at distal ends of outer and inner ventral margins. Carpi smooth, with single prominent spines at dorsal, distal margin. Propodi cylindrical, smooth, without spines. Dactyls smooth, with small corneous claws and single rows of approximately five very small spines along ventral margins, behind claw.

Telson with left lobe longer and larger than right; a somewhat variable character though all specimens show some degree of elongate of the left lobe. There are a few long, fine hairs along the terminal margins of both lobes; terminal margins also with many small, sharp spines.

HABITAT: This species is found outside of the reef at depths between approximately seven and twenty-five meters. These crabs occupy a large variety of shells and are found among the branches of live corals or on a coral rubble substrate. Disturbed animals will retract into their shells and fall into the coral colony or into crevices in the rubble; making collection difficult. This species is not common and is often associated with ***Calcinus argus*** and ***Calcinus minutus.***

REMARKS: ***Calcinus haigae*** can be differentiated from other, closely related species of the genus by its unique coloration. The two most closely-related species have similar small, dark spots on the distal parts of the first three periopods, and belong to the group of ***Calcinus*** where the amount of hair along the dactyls and the ends of the propodi of the second and third periopods is about equal. These three species are also distinguished by their relatively long, slender eyestalks and walking legs, sparseness of hairs on the legs and body similar size and habitats.

C. minutus Buitendijk, 1937 (see Forest 1958:185, text figs. 1, 6-8, 14, 18 and Nakasone, 1975:3-5, fig. 2) is the most common species of ***Calcinus*** at the Guam locations where ***C. haigae*** has been found. Both are associates among the branches of live corals and on coral rubble, and both seem to inhabit a large variety of shells. In life *C. minutus* is nearly completely white; the bases of the antennal peduncles are darker, brownish, and the distal parts of the second and third periopods are dark orange; there are small orange brown spots on the finger tips of chelipeds and on the distal parts of the second and third periopods. *C. haigae* has a white shield with darker, purple areas behind the antennal peduncles; the chelipeds are dark purple fading to white distally; the second and third periopods are lighter purple, fading distally; there are small dark orange spots on the fingers of the chelipeds and on the distal parts of the second and third periopods. *C. haigae* can also be differentiated

from *C. minutus* by some morphological features. The ocular scales are relatively smaller and less spinose on *C. minutus*, and the inner margins of the meri of both chelipeds are more spinose on *C. haigae*. The second and third periopods of *C. haigae* are noticeably longer and more slender than those of *C. minutus*.

C. nitidus Heller, 1865 (see Forest 1956:218-227), figs. 1-4) is an apparently rare species from Tahiti. According to Forest the species is not well known. There is little habitat information; Forest says that the species is not common in the intertidal. *C. nitidus* is quite like *C. haigae* in the proportion of the carapace, eyestalks, and periopods. According to Forest (translated from French) the colors of *C. nitidus* are: (in alcohol) "whitish with spots and areas colored red-orange; a large spot in front of the rostrum, on the inner, outer, and ventral surfaces of the meri, on the proximal halves and on the inner and outer surfaces of the propodi of both chelipeds. Dactyls and distal parts of the propodi of the walking legs bright red-orange; the rest of these legs pink-orange." Morphologically the two species appear to differ with *C. haigae* having slightly longer and more slender walking legs and eyestalks. The rostrum and spines on the inner, dorsal surface of the bases of the antennal peduncles are more developed on *C. haigae*.

C. rosaceus Heller, 1861 (see Forest 1956:222-227, figs. 5-8) and *C. guamensis* both resemble *C. haigae* but can be easily be differentiated by their relatively much shorter and thicker eyestalks and walking legs, and greatly different coloration.

Calcinus minutus Buitendijk, 1937

Calcinus minutus

Buitendijk, 1937:269, text figs. 13-15.
Forest, 1958: 185, text figs. 1, 6-8, 14, 18.
Ball and Haig, 1972:102.
Nakasone, 1975:3-5, fig. 2.

MATERIAL: 3 males - CL 5.6 to 6.3 mm; 1 female - CL 4.7 mm. Shells not recorded. From - Guam (Stats. 5a, 9).

DISTRIBUTION: This species is known from Indonesia east and north to Viet Nam, Okinawa, Japan and the Ryukyus, and south to New Guinea. The Guam record is an eastward extension of the known range of the species.

COLOR IN LIFE: Carapace shield white; a small darker light orange area on forward, center of shield, another smaller light orange area at distal end of shield. Posterior carapace purplish pink with white mottling; sides below shield dark brown. Ocular acicles brown, eyestalks light pink, corneas black with a few white spots. Antennal acicles and peduncles pink and brown mottled, distal segments of peduncles and flagella transparent green. Basal segments of antennular peduncles dark brown, most distal segment brownish green on proximal half, distal half white. Flagella greenish brown; hairs on flagella white with orange bases. Mouth parts dark brown. Both chelipeds entirely white with many tiny orange or brown spots in depressions; there may be a pale orange patch on outside distal surface of meri. Periopods two and three white with many tiny orange or brown spots in depressions; distal ends of propodi and all of dactyls orange; claws corneous, dark brown. Periopods four and five white with many small orange spots, as on other walking legs. Abdomen pinkish with gray-white mottling dorsally; ventral surface whitish pink transparent; abdominal terga same as dorsal soft area. Pleopods transparent white. Tail segments white with a few orange specks.

COLOR IN ALCOHOL (after ten months): Entire animal white. Posterior carapace and abdomen transparent whitish. Ocular and antennal peduncles and dactyls of periopods two and three with light orange tint. Tips of claws of periopods two and three corneous and dark brown.

DESCRIPTION: Carapace shield rectangular, longer than wide. Rostrum pointed, longer than lateral projections. Two distinct spot-like depressions on posterior shield, symmetrical about midline about two thirds of the way from midline to lateral margins. Ocular acicles with two or three small spines on distal margins. Telson with left lobe slightly longer than right. Dorsolateral margin of palm of large left cheliped smooth; same margin serrate on smaller right cheliped. Spine on dorsal, distal joint of carpi of periopods two and three. Entire animal is smooth with few spines or hairs.

HABITAT: This species is commonly found in a wide variety of shells at scuba depths to approximately thirty meters, always outside of reef. The animals are normally found in small groups of two to about ten individuals living among the branches of ***Acropora*** sp. or ***Pocillopora*** sp. corals. When disturbed the animals retract into their shells and fall to the center of the coral where it is almost impossible to remove them. Commonly found with *Calcinus* sp. 1.

Calcinus latens (Randall, 1839)

Pagurus latens
Randall, 1839:135.

Pagurus cristimanus
H. Milne Edwards, 1848:64.

Calcinus intermedius
De Man, 1881:102

Calcinus terrea-reginae
Haswell, 1882:760.

Calcinus latens
Alcock, 1905:53, 58, pl. 5, fig. 5.
Forest, 1951:94, text figs. 14-18.
Fize and Serene, 1955:40, 58, pl. 2, figs. 9-11, test fig. 9.
Miyake, 1956:331, text figs. 20, 21.
Lee 1969:53, 55, text fig.. 12.
Ball and Haig, 1972:101, 102.

MATERIAL: 20 males - CL 4.5 to 14.4 mm. 5 females (2 ovigerous) - CL 3.8 to 7.7 mm. Shells - ***Drupa*** sp., ***Trochus niloticus, Natica*** sp., ***Cypraea*** sp., ***Strombus*** sp. From - Saipan (Stat. S1), Guam (Stats. 2d, 2e, 2g, 5e, 5f).

DISTRIBUTION: This species is widely distributed from the east coast of Africa and Persian Gulf through the Indian Ocean to Philippines and Indonesia south to Australia, and the Society Islands, east to the Tuamotu, Gilbert, Marshall and Hawaiian Islands, and north to the Ryukyus and southern Japan.

COLOR IN LIFE: Ground color of carapace shield olive green, darker along forward margin. Tips of rostrum and lateral projections white; white spots in irregular pattern on entire shield. Dark green spot in midline on posterior margin of shield. Posterior carapace light olive green, darker along some lateral grooves; many white spots and specks on entire posterior carapace. Ocular acicles pinkish, eyestalks entirely pink, lighter distally, corneas black with fine silver white lines and specks. Antennal acicles and peduncles olive green with white at ends of spines, flagella yellow green. Antennular peduncles; most distal two segments blue on distal one half and black on basal one half of both segments; flagella orange with hairs that are orange basally fading to white distally. Abdomen transparent green, darker dorsally; sides appear orange because of internal organs. Pleopods light transparent green. Tail segments olive green with darker areas in middle of segments. Uropods yellowish white. Ground color of both chelipeds dark olive green fading gradually distally. Movable finger and distal part of palms white. Tips of spines white on all segments. Periopods two and three: meri and carpi olive green with white on spines and tubercles; ground color of propodi olive green, lighter than meri and carpi; proximal one-half to two-thirds of propodi with pinkish tint. Proximal one-third to one-half of dactyl dark brown, almost black, distal parts white; claws corneous, black. Ground color of periopod four light green white, conspicuous dark green spots on base of dactyls, dorsolateral margins of propodi and carpi. Tips of dactyls corneous, black. Periopod five olive green, darker on dorsal parts of segments; rasp yellowish.

COLOR IN ALCOHOL (after 18 months): Carapace shield whitish with brown tint towards anterior. Posterior carapace and entire abdomen (soft parts, terga, pleopods and tail segments) off-white or brownish white. Ocular acicles light brown with white on distal margins. Eyestalks cream white, corneas black. Antennal acicles, peduncles and flagella, antennular peduncles and flagella and mouth parts very light orange brown with white on spines and some extremities. Chelipeds gray olive green to light brown; finger tips and spines white. Meri, carpi and propodi of periopods two and three all light brown; on some specimens carpi are darker gray olive green; dactyls with proximal halves reddish brown, distal halves white, claws black. Periopods four and five light brown.

DESCRIPTION: Carapace shield rectangular, longer than wide. Rostrum pointed, extends well beyond lateral projections. Shield nearly without hairs. Ocular acicles small with single spine. Eyestalks thin and long, slightly inflated at bases, extend nearly to ends of antennular flagella.

Antennal acicles large with a few large spines. Left lobe of telson slightly larger and longer than right. Left cheliped larger and longer than right. Dorsolateral margin of left palm with hard ridge, not serrate; outer surface of left palm smooth without hairs. Dorsolateral margin of right palm with serrate carina; outer surface of palm with some hairs. Tips of both chelae curved so that only tips touch when jaws are closed. Sharp spine on dorsal, distal margins of carpi of periopods one, two, and three. Periopods two and three smooth with few hairs; claws corneous, sharp and curved.

HABITAT: This species is very common on inner and outer reef flats which are not exposed to high surf, and are never found outside of the reef. Individuals are found in a wide variety of shells and seem to be able to tolerate stagnant, very warm water. They commonly associate with *Clibanarius humilis* and *Calcinus laevimanus.*

Calcinus laevimanus (Randall, 1839)

Pagurus laevimanus
Randall, 1839:135.

Pagurus lividus
H. Milne Edwards, 1848:63.

Calcinus herbstii
Alcock, 1905:53, pl. 5, fig. 4.
Forest, 1951:89, text figs. 2, 5, 6, 9.

Calcinus herbsti
Fize and Serene, 1955:40, 41, pl. 2, figs. 1-4, text fig. 6.

Calcinus laevimanus
Miyake, 1956:323, text figs. 14, 15.
Ball and Haig, 1972:100,101.

MATERIAL: 17 males - CL 5.0 to 18.0 mm; 7 females (4 ovigerous) - CL 3.5 to 13.9 mm. Shells - ***Trochus niloticus, Drupa*** sp., ***Cerithium*** sp., ***Turbo*** sp., ***Nerita*** sp., ***Littorina*** sp. From - Maug (Stat. M3), Asuncion (Stat. AS2), Guguan (Stat. GU3), Anatahan (Stat. AN3), Guam (Stats. 2a, 2d, 2e, 2c, 8a).

DISTRIBUTION: This species is known from the east coast of Africa through the Indian Ocean to Indonesia, and the Philippines; northward to Japan, east to the Marshall and Hawaiian Islands, and south to Australia and Society Islands.

COLOR IN LIFE: Carapace shield olive green, darker on some specimens than on others, white in minute pits on shield, and on anterior shield. Posterior carapace olive green, paler than shield. Ocular acicles olive green fading to white at tips. Thin orange bands on bases of eyestalks, basal one third of eyestalks light blue, distal two thirds orange with a thin greenish blue band separating blue black corneas from eyestalks. Corneas appear blue but under high magnification are black with many light blue specks. Antennular peduncles blue; thin orange band at joint between distal two segments, antennular flagella orange. Antennal peduncles and flagella orange. Soft parts of abdomen transparent olive green with orange organs visible through skin. Abdominal terga olive green, may have orange tint in middle of each plate. Telson olive green, lighter near outside borders. Right cheliped; merus carpus and all except tip and edge of jaws of propodus dark gray to black; edge and tip of jaws of propodus and a thin line on dorsal, distal joint of merus white. Left cheliped same color as right except that the amount of white on large, smooth propodus (palm and movable finger), may be greater, color may vary from entirely white to entirely black except for thin white line on jaws. Periopods two and three: base color of carpi, meri, and propodi chestnut brown. On meri and carpi there are dark gray to black stripes running lengthwise along outer surfaces of segments. Propodi brown, darker towards distal joint. Base color of dactyls white with a small dark brown to black around dactyls on distal one-half; claws corneous, black.

COLOR IN ALCOHOL (after one and one half years): Carapace shield, posterior carapace and entire abdomen (terga, pleopods and tail parts) whitish with very light brown tint in some areas. Ocular acicles and basal parts of eyestalks white; distal parts of eyestalks yellow with narrow white band separating corneas which are black. Antennal acicles, peduncles and flagella, antennular peduncles and flagella and mouth parts white; last segment of antennal peduncles yellowish. Chelipeds

brownish gray; tips of fingers and some of left palm white. Periopods two and three reddish brown with darker longitudinal stripe on outer surface of carpi and meri; dactyls white with a single brown spot on inner and outer surface near distal joint; narrow brown band separates claws which are black. Periopod four white with faded brown mottling. Periopod five white.

DESCRIPTION: Carapace shield smooth, nearly as wide as long with two distinct depressions symmetrical about midline, about halfway from lateral margin to midline on posterior third of shield. Rostrum pointed, extends slightly beyond lateral projections. Ocular acicles triangular, pointed at tip; may be straight or curve slightly outwards. Eyestalks inflated basally then narrowing for last two thirds of length; they extend slightly beyond antennular peduncles. Antennal acicles triangular with many small pines. Telson asymmetrical; left lobe longer. Hairs along terminal margin of telson. Chelipeds unequal; left vastly larger and longer than right. Both chelipeds smooth with few hairs, no spines and many small tubercles on all surfaces; left hand almost circular; right elongate. Periopods two and three smooth with a few hairs along lower lateral margin of dactyls; single spine on dorsal, distal joint of carpi.

HABITAT: This species is very common at the high intertidal on rocky and rubble substrates and seems to be able to withstand exposure to air, in intense sun. It is often associated with ***Clibanarius humilis*** and *Clibanarius virescens.*

REMARKS: ***Calcinus laevimanus*** and ***C. seurati*** are very closely related species. See the remarks section for ***C. seurati*** for a discussion of the differences between the two.

Calcinus seurati Forest, 1951

Calcinus seurati
Forest, 1951:83, 90 Text figs. 1 - 9.
Forest, 1953:556
Holthuis, 1953:44

MATERIAL: 2 males - CL 5.5, 6.3. Shells ***Turbo*** sp., ***Nerita pilicata.*** From Pagan (RK 1, 2). All collected by R. Kropp.

DISTRIBUTION: Forest (1951, 1953) reports ***C. seurati*** from the Tuamotu and Society Islands. The Pagan record greatly extends the range for this species.

COLOR IN LIFE: Because specimens were not collected by the author, live color notes were not taken.

COLOR IN ALCOHOL (after one and one half years): Carapace shield, posterior carapace and abdomen uniformly whitish. Ocular acicles and basal halfs of eyestalks white. Distal halfs of eyestalks orange-brown, corneas black. Antennular peduncles white; flagella pale orange. Antennal acicles and peduncles white, flagella orange. Chelipeds white, slightly darker, brownish on proximial segments. Periopods one and two with dactyls white with brown spots distally, brown proximally; propodi brown at both proximal and distal ends, white in the middle. Carpi white with a brown stripe across outer surface. Meri white with a brown central band. Periopods three and four white, slightly brownish distally.

DESCRIPTION: Carapace shield smooth with small pits towards sides and forward margin. There is a small distinct Y shaped groove on rear half of shield. Rostrum small barely exceeding lateral projections. Ocular acicles small, pointed are inflated below tips and convex along outer margins. Eyestalks only slightly inflated basically are longer than antennular peduncles. Antennal acicles are small, pointed, with many small spines. Telson with left lobe slightly larger. Chelipeds unequal with the left much larger and longer. Both chelipeds smooth with many small tubercles. On periopods one and two dactyls are shorter than the propodi. There is a definite ridge along the upper margin of the propodi of the second walking legs.

HABITAT: Pagan specimens were collected from raised limestone pools in the splash zone bench; both locations on the windward side of the island.

REMARKS: This species was first described by Forest in 1951 after reviewing the collections made in French Polynesia between 1901 and 1905 by Gaston Seurat which were originally described by Nobili in 1907. Some specimens that were determined to be ***Calcinus herbstii*** (now ***C. laevimanus)*** were found to belong to a separate species described as ***C. seurati*** by Forest.

The two species are superfically quite alike both morphologically and ecologically. According to Forest there are six distinct differences:

1. On *C. seurati* the relative lengths of the ocular and antennular peduncles is less, the antennular peduncles rarely reach the base of the corneas.

2. On *C. laevimanus* the opthalmic scales are small, inflated below the tips and angled. The anterior margins are strongly convex. On *C. seurati* the scales are larger, the anterior borders are nearly straight and the scales are close together.

3. On *C. seurati* the fixed finger of the large cheliped is longer than on *C. laevimanus*.

4. The dactyls of the walking legs are shorter than the propodi on *C. laevimanus* while on *C. seurati* there is not much difference.

5. On *C. laevimanus* the external face of the propodi of the second walking legs are less high and strongly convex; the upper borders do not have a strong margin and there is no distinct margin separating the outer and upper sides.

6. The colors of the two species are quite different, particularly the markings on the outer surfaces of the proximal segments of the second and third walking legs. On *C. seurati* there is a single longitudinal band on the carpus and perpendicular marking on the merus. On *C. laevimanus* there are multiple bands which run lengthwise along the carpus and merus of both legs.

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