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Title: The Shallow-Water Hermit Crabs of the Mariana Islands (Decapoda, Paguridea: Coenobitidae, Diogenidae, Paguridae).

Approved: Lucius G. Eldredge
LUCIUS G. ELDREDGE, Chairman, Thesis Committee

A collection of shallow-water hermit crabs from the Mariana islands, representing thirty-three species in nine genera and three families, is described. One new species of Aniculus and three new species of Calcinus are described and illustrated.

Nearly all of the hermit crab species reported in this paper are new records for the Mariana Islands as little work has been done previously. Considerable range extensions into the tropical western Pacific are reported for the following species: Aniculus maximus, Clibanarius virescens, Calcinus imperialis, Calcinus sp. 1, Calcinus minutus, Dardanus crassimanus, Orthopagurus harmsi, and Pylopaguropsis zebra.

THE SHALLOW-WATER HERMIT CRABS OF THE MARIANA ISLANDS (DECAPODA, PAGURIDEA: COENOBITIDAE, DIOGENIDAE, PAGURIDAE)

by

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TO THE GRADUATE SCHOOL:

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The two biological expeditions to the islands north of Saipan were funded by the Marvin J. Coles Memorial Fund at Guam Oil and Refinery (GORCO), the U. S. National Park Service, Office of Sea Grant (No. 04-5-158-45), and the University of Guam Marine Laboratory. Saipan collections were made possible through a harbor survey funded by the Government of the Northern Marianas. Agat Bay, Guam, was investigated under a contract from GORCO. During the first years of my collecting, I was engaged in research on the coconut crab Birgus latro funded by Sea Grant (No. 04-4-158-4).

Finally, I would like to extend special thanks to Janet Haig of the University of Southern California Allan Hancock Foundation without whose help my work would not have been possible. She is always quick and interested and has been able to help identify and confirm difficult and new species. She has also provided me with literature and valuable advice.

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INTRODUCTION

The purpose of this paper is to describe the hermit crabs of the Mariana Islands in the tropical western Pacific (see Fig. 1). Special attention has been given to the recording of complete live color and ecological information for all species. This information is especially useful for field identification and, for some species, absent in published literature. Well-known species are not discussed in as much detail as are new and rare species. References are given to original descriptions, important synonyms, and other useful literature that, in most cases, the author has seen. This study is limited to the semi-terrestrial and shallow-water (to approximately thirty meters) hermit crabs of the families Coenobitidae, Diogenidae, and Paguridae.

Most of the hermit crabs treated in this paper were collected by the author between the spring of 1973 and December 1977. A few older museum specimens and material collected by others were also examined. All material used for new species descriptions and live color notes was collected by the author. In 1975 two trips were taken to the rarely visited islands north of Saipan (see Fig. 2) by students and faculty of the University of Guam Marine Laboratory, for the express purpose of making biological collections and observations. A total of thirty-three days was spent aboard the chartered schooner 'New World' in the northern islands. Collections from Saipan and Tinian were made by the author and University of Guam Marine Laboratory personnel. The bulk of the material examined was collected on Guam.

The Mariana Islands (Fig. 2) form a double chain of fifteen islands which extends in a roughly northward direction from Guam (13°27'N, 144°45'W) to Farallon de Pajaros, or Uracas (16°01'N, 146°05'W). The southern islands of Guam, Rota, Tinian, Saipan, and Farallon de Medinilla are made up of old volcanic and uplifted limestone 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 northern 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.

The Marianas are oceanic islands situated well within the Indo-West Pacific faunal region. The nearest large land mass is the Philippine Islands over one thousand kilometers to the west. The terrestrial flora and fauna of the Marianas are typical of oceanic islands with some unique and endemic species. The more isolated northern islands are especially unspoiled and a large flightless bird, the Marianas megapode (Megapodius laperouse laperouse), can still be observed. In contrast to the land, the marine fauna is rich and diverse. The hermit crabs of the Marianas are not well known. A few species have been reported in general works. Stafford (1905) lists three species from Guam; Birgus latro, Aniculus aniculus, and Dardanus punctulatus (D. megistos). Prowazek (1913) lists three species from the "Marianen" islands; Birgus latro, Aniculus aniculus, and Pagurus sp. Holthius (1953) identified Birgus latro, Clibanarius sp., Pagurus (Calcinus) laevimanus, Calcinus gaimardi, and, tentatively Coenobita perlatus and Coenobita rugosa from Saipan. Recent technical reports of the

University of Guam Marine Laboratory (Doty and Marsh 1977, Eldredge et al. 1977, Jones et al. 1974) list species that the author has identified.

Other more extensive work has been done on the hermit crabs of the tropical western Pacific north of Australia. Ball and Haig (1972) provide a list of nineteen species identified along with eleven other species reported from eastern New Guinea. Lee (1969) describes twenty-two species from Taiwan. Estampador (1937) lists forty-one species from the Philippines. Miyake (1956) lists ten hermit crabs from the Tokara Islands off of southern Japan. Ooishi (1964) lists twelve species from the Amami Islands which lie still further south of Japan. Ooishi (1970) also lists ten species from the Bonin Islands which are situated north of the Marianas chain. Twenty species are noted from the Marshall Islands (Holthius, 1953). Perhaps the most useful work is that of Fize and Serene (1955) on the hermit crabs of Viet Nam. They include keys and illustrations of many shallow water forms. They also discuss in detail morphological variations within species and historical problems with species identification and nomenclature.

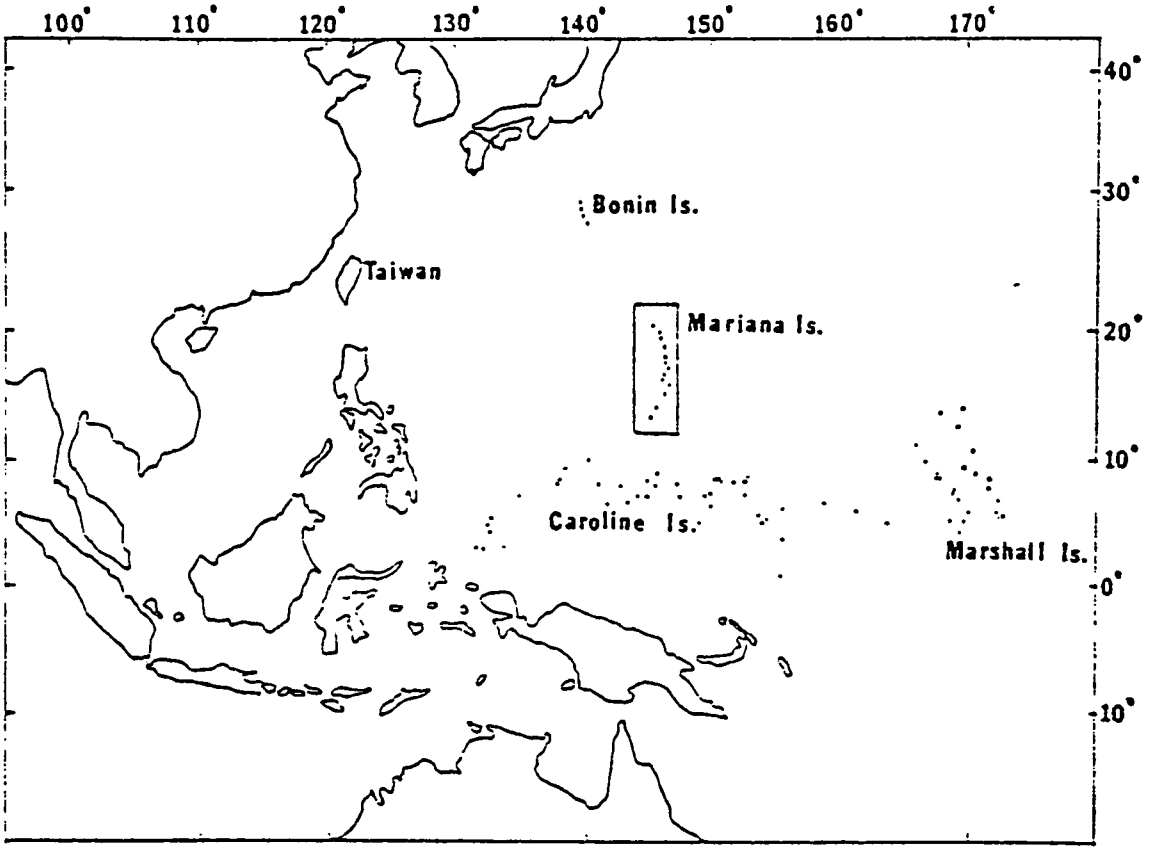

Figure 1. Map of Western Pacific Ocean showing the location of the Mariana Islands [adapted from the National Geographic Society, 1969].

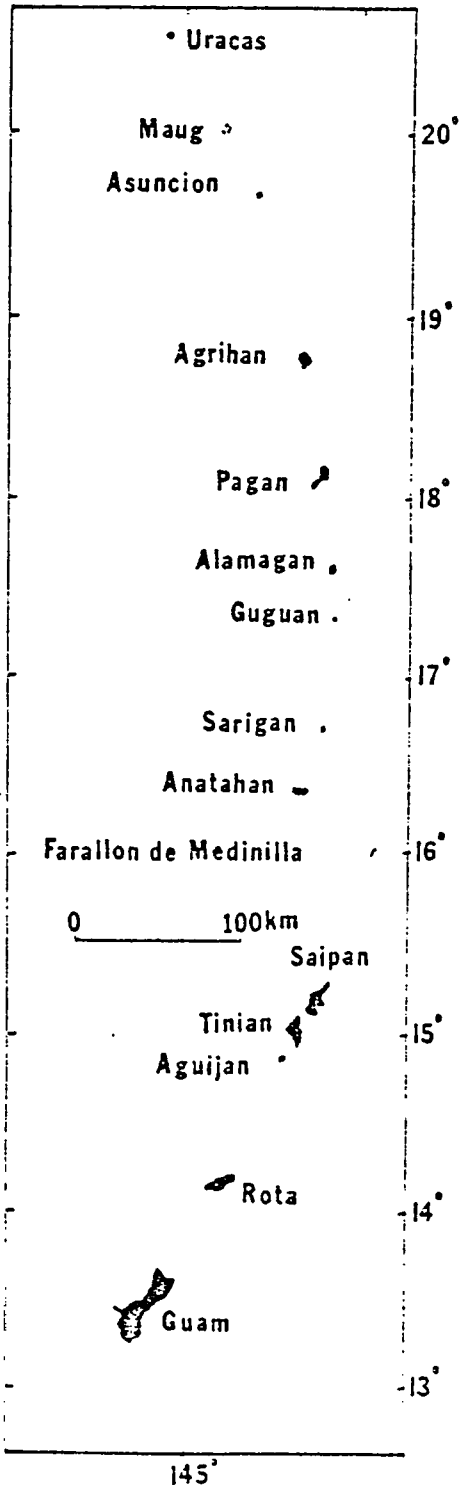

Figure 2. Map of Mariana Islands [adapted from Bryan, 1971].

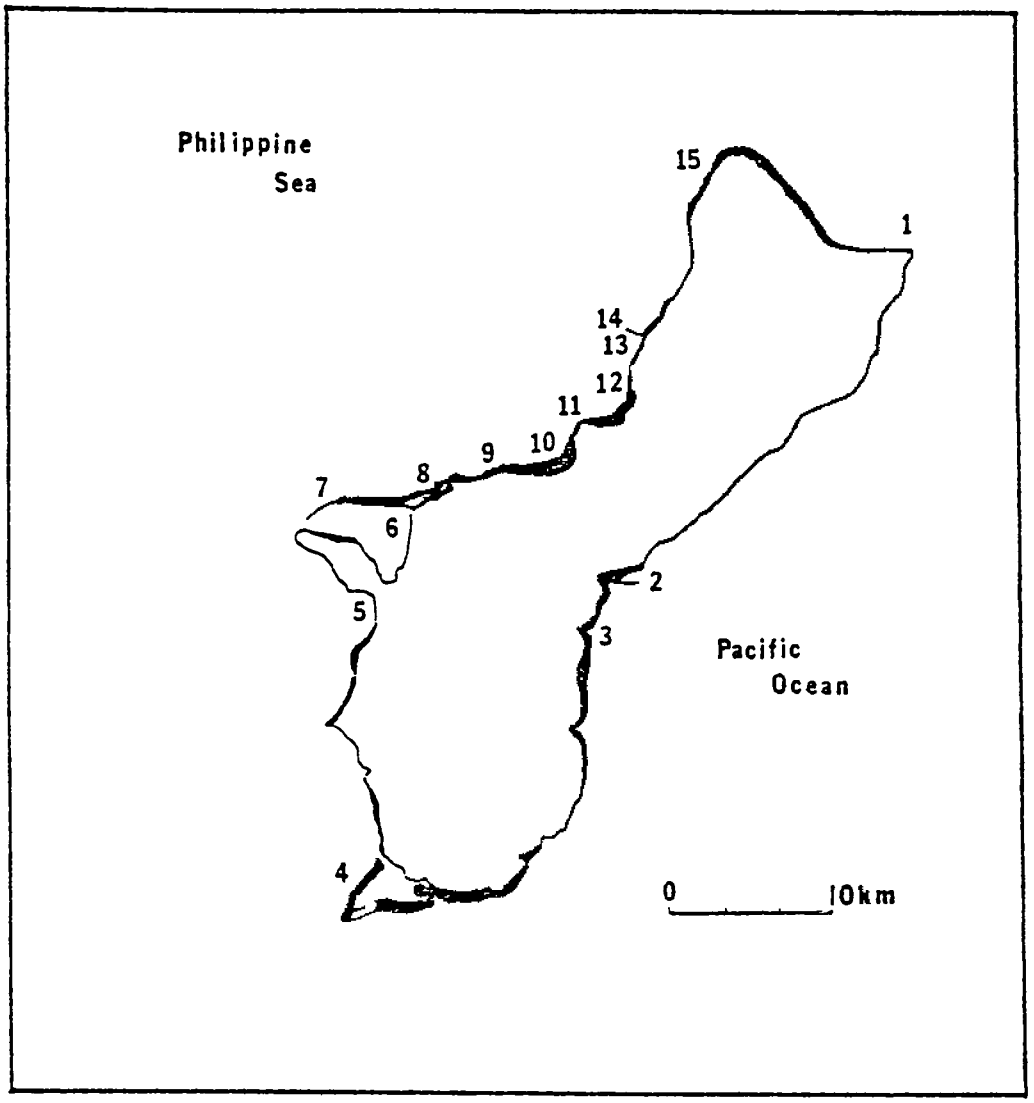

Figure 3. Map of Guam showing station locations. Reef platforms are shown in solid black.

METHODS

Animals were collected by hand, by walking along the shore or reef flat, snorkeling, or with scuba to a depth of approximately thirty meters. Collecting was done primarily in the daytime. On the islands north of Saipan collections were usually made on the leeward sides of islands at or near protected anchorages. Guam collections are from a wide variety of habitats. See Figures 2 and 3, and Tables 1 and 2 for maps and short descriptions of collecting stations.

Following collection, animals used for live color information and original descriptions were immediately removed from their shells, either by breaking the shell or relaxing the animal in seawater and magnesium chloride, or kept for a short time in aquaria. All animals were preserved in 70% ethyl alcohol. On the islands north of Saipan specimens were preserved in 10% formalin upon collection, examined, and put in alcohol on return to Guam. Unfortunately, the small size of the specimens and the busy schedule aboard ship made close examination of the fresh material impossible. Consequently, all descriptive work was carried out at the University of Guam Marine Laboratory.

Illustrations depict live or freshly dead material. Original descriptions are modeled after recent descriptions of animals belonging to the same or closely related genera: Haig (1974) for Calcinus and McLaughlin and Bailey-Brock (1975) for Aniculus. New species are described in detail, whereas better-known species are treated less thoroughly. For all species, complete live color notes are given. Keys are given to the three families dealt with in this paper. Keys to

genera are given for the families Coenobitidae and Diogenidae, and keys to species are also given for the genera with more than one species. For definitions of many descriptive terms and hermit crab anatomy see McLaughlin (1974). 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. Larger crabs were measured with vernier calipers.

Ecological and behavioral observations were made while collecting. Substrate where the animal was found and the general habitat were recorded. Observations of animals kept in aquaria were also made. Specimens are deposited at the University of Guam Marine Laboratory, type material is deposited at the B. P. Bishop Museum, Honolulu, Hawaii.

Table 1. Collecting Stations.

ISLAND	STATION	DATE	DESCRIPTION
Uracas	U1 (NW24)	20/1/75	Sand and basalt boulder substrate, 10 to 15 m, some live coral and mollusks.
Maug	M1 (NW21)	19/1/75	Southwest of North Island, 10 to 20 m, steep broken boulder substrate with some live coral.
	M2 (NW22)	19/1/75	East of West Island, 3 to 5 m, submerged reef, live coral.
	M3 (NW31)	8/6/75	Volcanic intertidal, east side of West Island.
	M4 (NW32)	9/6/75	Shore and intertidal, inside of West Island.
	M5 (NW33)	8/6/75	North end of East Island, intertidal volcanic rock and sand.
	M6	10/2/71	From Randall collection.
Asuncion	AS1 (NW19)	19/1/75	Southwest bay at anchorage, 10 to 15 m, steep broken volcanic substrate.
	AS2 (NW20)	18/1/75	Southwest bay, shore and intertidal, tide pools.
	AS3 (NW28)	6/6/75	Under boat at anchor, 10 to 20 m, volcanic boulders and live coral.
	AS4 (NW28a)	8/6/75	Intertidal and subtidal along bay below camp site, volcanic rock and coral.
Pagan	P1 (NW13)	14/1/75	East coast at Degusa shore, intertidal, raised limestone and sand.
	P2 (NW16)	16/1/75	East coast at Degusa at anchorage, 15 to 20 m, sand and boulders.
	P3 (NW25a)	5/6/75	North side of Sengan Peninsula on dock and intertidal, volcanic and live coral.
	P4 (NW25b)	6/6/75	North side of Sengan Peninsula from intertidal to 30 m, coral and volcanic rock and sand.
	P5 (NW25c)	6/6/75	North side of Sengan Peninsula, under boat to peninsula, to 15 m, volcanic sand, rock and live coral.

Table 1. Continued.

ISLAND	STATION	DATE	DESCRIPTION
Pagan	P6 (NW25d)	5/6/75	Subtidal, snorkeling along dock to end of Apaan Peninsula.
	P7 (NW26)	5/6/75	Intertidal, north side of Apaan Bay.
Alamagan	AL1 (NW12)	12/1/75	Southwest bay at anchorage, to 20 m, old reef limestone, live coral.
Guguan	GU1 (NW9)	11/1/75	Western shore at aa lava flow, to 15 m, large volcanic boulders.
	GU2 (NW10)	11/1/75	Western bay at anchorage, 10 to 15 m.
	GU3 (NW35)	11/6/75	South of anchorage, intertidal.
	GU4 (NW37)		Anchorage to 35 m, coral rubble and live coral on volcanic substrate.
Anatahan	AN1 (NW1)	7/1/75	Southwest bay at first anchorage, 10 to 15 m, coral coulder and lava substrate.
	AN2 (NW3)	17/1/75	Southwest shore at base of volcanic cliffs, 10 to 15 m, volcanic substrate.
	AN3 (NW5)	8/1/75	West coast at "Obs. Spot," boulder beach, aa barricade, and landward tide pools.
Saipan	S1	--	Tanapag harbor. See Doty and Marsh, 1977.
Tinian	T1	Jan. 74	Reef at outside of breakwater at harbor entrance, live coral on reef substrate.

NOTE: (NW) station numbers refer to stations assigned during expedition to Northern islands.

Table 2. Guam Collecting Stations.

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. 2. Pago Bay. A wide, exposed bay with extensive reef-flat development. At the northern and southern ends of the bay there are erosion benches. The University of Guam Marine Laboratory is situated at the northern end of the bay where there is a small intake channel for the Laboratory's sea water system. The entire bay faces the windward coast and is characterized by exposure to high surf.

- Stat. 2a. Intertidal. Sand and coral rock.
- Stat. 2b. Erosion benches at north end, very exposed.
- Stat. 2c. Moat. Sandy bottom, little water movement.
- Stat. 2d. 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. 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. 2h. Reef front. To twenty-five meters, limestone and coral rubble bottom, exposed to storm surf.

Stat. 3. Ylig River. Small stand of mangrove, low salinity, protected water.

Stat. 4. Cocos Lagoon. A large shallow (to 10 meters) lagoon protected by a well developed barrier reef. The lagoon is normally quite calm.

- Stat. 4a. Barrier reef, similar to Pago Bay (Stat. 2d, 2e).
- Stat. 4b. Lagoon. Calm water, live coral and sand.

Stat. 5. Agat Bay. A large shallow bay on the lee side of the island. During most of the year the bay is calm. The reef flat system is only moderately developed because of many small streams that enter the bay. The water is shallow and sedimentation is evident.

- Stat. 5a. Facpi Point. Most exposed part of bay.
- Stat. 5b. Anae Island. Similar to Facpi Pt.
- Stat. 5c. Nimitz Beach. Shallow, often silty water.
- Stat. 5d. Gaan Point. Clean, protected water.
- Stat. 5e. Sewer Outfall. Calm, protected, often silty water.
- Stat. 5f. Rizal Beach. Similar to Nimitz Beach but with clearer water.

Stat. 6. Apra Harbor. Calm, usually clean water; live coral and sand.

Table 2. Continued.

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. 8. Piti Reef, at southern end of Piti area.
Stat. 8a. Cabras outfall. Calm clear water.
Stat. 8b. Piti reef. Portected most of the year.

Stat. 9. Adelupe Point. An area with high exposure to strong currents and high surf. Substrate is coral rubble and live coral.

Stat. 10. Agana Boat Basin. Low salinity; shallow, silty water, moderate surf.

Stat. 11. Alupang Cove, north end of Agana Bay. Perhaps the most polluted shallow water area on Guam, shallow slow moving water, at times very low salinity.

Stat. 12. Tumon Bay. A large well developed reef-flat system encloses shallow bay, protected during most of the year, water is usually clear, at times low salinity. Inner reef areas are not exposed during the lowest tides.

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.

Stat. 15. Uruno Point. Moderate exposure clear water. Typical reef flat, exposed at lowest tides.

PAGURIDEA

Five families of Paguridea have been collected from the Mariana Islands. Of these, two (Lithodidae and Parapaguridae) are deep-water families that are not treated in this paper. The remaining three families are terrestrial (Coenobitidae) or occur in shallow water (Diogenidae and Paguridae). Within these three families are all hermit crabs which have a more or less asymmetrical abdomen and carry a mollusk shell for some part of their lives (one species lives in serpulid worm tubes). The carapace of these animals is elongate and, to varying degrees, feebly calcified behind the cervical groove. Only the first pair of legs are chelate; the second and third pairs are large, and the fourth and fifth pairs small. The abdomen is usually elongate and soft, the uropods are adapted for holding the body in empty mollusk shells or other hollow objects.

KEY TO THE SHALLOW WATER AND TERRESTRIAL PAGURIDS FROM THE MARIANA ISLANDS.

1. Each antennular flagellum ends in a filament. The antennular peduncles rarely approach the carapace in length. Intertidal and subtidal 2

   Each antennular flagellum ends abruptly and bluntly. The antennular peduncles are nearly as long as or even longer than the carapace. Terrestrial ..... Coenobitidae

2. The external maxillipeds are approximated at bases. The chelipeds are equal, or subequal, or the left is vastly the larger ..... Diogenidae

The external maxillipeds are widely separated at bases. The right cheliped is vastly larger than the left ..... Paguridae

Family Coenobitidae

The family Coenobitidae comprises two genera--Coenobita and the monotypic genus Birgus. Both are terrestrial genera which spend only their larval stages as part of the plankton. All species of Coenobita carry mollusk shells, while Birgus latro does so only as a very small juvenile. This family can be easily distinguished from other pagurids by the antennular flagella, which end abruptly and bluntly, and the antennular peduncles, which are extremely long; nearly as long as or even longer than the carapace. These crabs are found from the upper littoral to at least five km from shore, never under water. Birgus, also known as the coconut crab, is perhaps the largest pagurid; specimens weighing more than four kg have been found in the northern Mariana Islands.

KEY TO THE GENERA OF THE FAMILY COENOBITIDAE FROM THE MARIANA ISLANDS

Abdomen large, nearly symmetrical, folds under body; terga well developed, sometimes overlapping. Posterior carapace broad, nearly circular. Post juvenile animals do not carry a shell. ..... Birgus

Abdomen long and curved, terga only moderately well calcified, never overlapping. Posterior carapace not especially broad. Carries mollusk shell ..... Coenobita

Genus *Birgus*

Only one species, *B. latro*, belongs to this genus. It is the large, well-known coconut crab. This species is terrestrial and carries a mollusk shell for only a short period of its life, as a juvenile. The posterior carapace is broad, nearly round. The shield is narrow with a prominent rostrum. The chelipeds and periopods two and three are large, hirsute, and rugose, with many corneous-tipped spines distally. The left cheliped is considerably larger than the right. The second periopods are usually much longer than the chelae and third periopods. The coxae of the fifth periopods are not produced to any great extent. There are fourteen pairs of gills which are reduced as respiration takes place, primarily, on the membrane that lines the gill chamber.

Birgus latro (Linnaeus, 1767)

Cancer latro

Linnaeus, 1767:1049.

Birgus latro

Alcock, 1905:150, 151, pl. 16.

Reyne, 1939:283-320.

MATERIAL:

4 males - CL 69.0 to 131.0 mm; 2 females - (1 ovig.) 69.0, 63.8 mm. From - University of Guam Marine Laboratory museum specimens are from Guam and Saipan. This author has observed the animal on Guam, Rota, Tinian, Saipan, Anatahan, Sarigan, Guguan, Alamagan, Pagan, Agrihan, Asuncion, and Maug. Uracas was also visited and no Birgus were found.

DISTRIBUTION:

This species is known from the east coast of Africa through the Indian Ocean to Indonesia and the Philippines, north to the Ryukyus, and east to Line and Tuamotu Islands. According to Reyne (1939) it is absent from the Northern Indian Ocean and the western parts of the Malay Archipelago.

COLOR IN LIFE:

This specimen, perhaps more than any other hermit crab, shows a high degree of variation in its coloration. This can probably be attributed, in part, to its terrestrial existence; the physiological differences in each animal during the wet and dry seasons, and the different stages of the molt cycle. A typical post-juvenile specimen

is fairly uniformly dark purplish blue on the entire carapace, periopods, and terga of the abdomen. On the periopods there are darker gray brown ridges. The eyestalks, antennular and antennal peduncles and flagella are uniformly dark brownish. The corneas are red brown and separated from the eyestalks by a thin white line. The claws of the second and third periopods and finger tips of the chelae are corneous and black. The soft part of the abdomen is brown. Some specimens late in the molt cycle (and during especially dry periods) become lighter, reddish purple. The carapace and periopods of a freshly molted specimen are light purple blue, while the cast off molt is pinkish brown.

COLOR IN ALCOHOL:

Within a few months after preservation the entire carapace, eyestalks, antennal and antennular peduncles and flagella, periopods and terga of the abdomen of all specimens become reddish brown. There are darker reddish brown areas on the carapace and periopods. The corneas are dark red brown. The soft part of the abdomen is dark brown.

DESCRIPTION:

Carapace shield narrow; posterior carapace broad, nearly circular. Rostrum prominent, pointed. Eyestalks rounder along outer cross section; flattened along inner surfaces. Corneas do not completely encircle distal ends of the eyestalks. There are tufts of hairs at the distal, dorsal ends of the eyestalks. The left cheliped is larger and longer than the right. The second periopods are considerably longer than the chelipeds and the third periopods. The

first three pairs of periopods have raised, rugose ridges, often with corneous-tipped spines. The finger tips of the second and third periopods and the finger tips of the chelae are corneous. The abdomen is large and rounded, with well-developed terga.

HABITAT:

This large terrestrial species is often found a great distance from shore. The females, which are generally smaller than the males, must return to the shore to deposit fertilized eggs into the ocean. The eggs hatch immediately and remain for a period of time as plankton before coming ashore as small, shell-carrying juveniles. At some point, when the animal is still very small, it abandons its shell and moves inland. Small animals and juveniles are quite cryptic and are extremely difficult to find. A few small, post-juvenile specimens have been found under rocks on Cocos Island at the southern tip of Guam. Adult animals are found throughout the Mariana Islands, especially in the more northern islands where human pressure is minimal. In the southern Marianas, where predation by humans is intense, the animals are becoming quite rare and are almost always found at night. On some of the northern islands large individuals can be found in the daytime. Birgus lives singly and is probably to some degree territorial. In the southern Mariana Islands the crab is usually found in limestone forest areas where there are many hiding places. In the northern islands it can be found among volcanic boulder areas, as well as in deep burrows among stands of coconut trees.

Genus Coenobita

In the Mariana Islands there are four species of this genus; all spend their larval life as plankton before emerging from the sea to continue their life on land. Post-larval animals will die if kept submerged in sea water for more than a short time. The Marianas species show varying degrees of adaptation to terrestrial life. Two of the larger species have been able to exploit the plentiful shells of the giant African land snail, Achatina fulica, and can be found far inland. The other two species are found close to shore, one in a large variety of shells, the other almost always in Turbo spp.

The species of Marianas Coenobita can be separated on the basis of color and morphological differences. In all species the carapace is elongate and well calcified. The rostrum is small, almost obsolete. The eyestalks are usually compressed. The antennular peduncles are very long; the flagella compressed and blunt at tips. The left cheliped is much larger than the right. The second and third periopods are stout, not much longer than the chelipeds. The carapace and periopods are generally smooth, sometimes granulous, never extremely hairy or spinose. On the coxa of the fifth periopods of the males there is, to some degree, a pronounced enlargement which forms a sexual tube. The females possess three biramous pleopods which are absent or rudimentary on the males. There are fourteen pairs of gills, but the first four pairs are nonfunctioning rudiments.

Coenobita brevimanus Dana, 1852

Coenobita clypeata var. brevimanus

Dana, 1852:473.

Coenobita clypeata

Henderson, 1888:51.

Fize and Serene, 1955:5, 7, pl. 1, fig. 1, text fig. 1.

(not C. clypeata Herbst, 1791.)

Coenobita clypeatus

Ortmann, 1892:316, pl. 12, fig. 20.

Alcock, 1905:141, 142, pl. 15, figs. 1, 1a.

Coenobita hilgendorfi

Terao, 1913:388.

Coenobita brevimanus

Ball and Haig, 1972:88, 89.

MATERIAL:

3 males - CL 14.0 to 48.1 mm; 3 females (1 ovigerous) - CL 15.3 to 25.7 mm. Shells - Achatina fulica, Turbo sp. From - terrestrial on Maug and Guam.

DISTRIBUTION:

This species is known from the east coast of Africa through the Indian Ocean to Burma and Viet Nam, north to Marshall and Line Islands, south to New Guinea and the Tuamotus.

COLOR IN LIFE:

A typical specimen has the carapace, ocular scales, eyestalks, antennal acicles, peduncles, flagella and periopods one through four

fairly uniformly dark brownish purple, though color of these parts of the animal seem to be quite variable and range from a dark purple to light pinkish. The specimens described are the most common form near the University of Guam where they were collected. Ventral and outer surfaces with a more purple tint especially outer surface of hand of left cheliped. Corneas black. Abdomen transparent dark brown. Hard parts of abdomen light brown and dark brown mottled.

COLOR IN ALCOHOL (after approximately four years):

Carapace shield light pinkish with darker brown in depressions. Posterior carapace similar but darker. Ocular scales, eyestalks, antennal acicles, peduncles light pinkish. Dorsal surface of last segment of antennal peduncles with a darker purple; flagella dark purple. Periopods one through four pinkish purple. Claws and finger tips black. Abdomen white; hard parts brownish white.

DESCRIPTION:

Rostrum evident but does not extend much above anterior margin or approach lateral projections. Carapace smooth, nearly hairless, with many very small depressions. At corneas, eyestalks are rounded in cross section. Eyestalks are approximately three times longer than minimum diameter; corneas occupy approximately one fourth of the total length of the eyestalks. Eyestalks reach just beyond base of last segment of antennal peduncles. Antennal acicles are not fused to the second segment of the peduncles. Ocular scales small, obtusely triangular. Periopods one, two, and three with only a few fine hairs and granulations on outer surfaces.

There is a tuft of hairs on the upper, inner surface of the palm of the right cheliped. The coxa of the fifth periopods on the male are moderately pronounced.

HABITAT:

This is the largest species of Coenobita found in the Mariana Islands and is found furthest inland. The animal can be found in large numbers quite far from shore. The crab is especially common on islands where the giant African land snail, Achatina fulica, is found. The crabs seem to prefer this strong, light shell.

Coenobita cavipes (Stimpson, 1858)

Coenobita cavipes

Stimpson, 1858:245.

Alcock, 1905:146, pl. 14, fig. 1.

Barnard, 1950:470.

Fize and Serene, 1955:29-35, pl. 1, text fig. 5.

MATERIAL:

1 male - CL 36.0 mm; 3 females (1 ovigerous) - CL 33.0 to 37.6 mm.

Shells - all Achatina fulica. From - Guam.

DISTRIBUTION:

This species is known from the east coast of Africa through the Indian Ocean to Indonesia and the Philippines, north at least as far as Marianas, south to New Guinea.

COLOR IN LIFE:

Posterior carapace and shield, ocular scales, eyestalks, antennal acicles and bases of peduncles, and dorsal and outer surfaces of periopods one, two, three, and four are dark brown. Corneas black. Last segments of antennal peduncles light orange brown. Antennal flagella dark brown. Middle of outer surface of left cheliped with a dark gray brown patch. Abdomen dark brown. Terga and tail segments mottled dark and yellow brown. Eggs on ovigerous female dark brownish red.

COLOR IN ALCOHOL (after three years):

Carapace shield dark brown with a darker patch on center. Posterior carapace dark brown on anterior half fading to light yellow brown posteriorly. Center of posterior carapace darker brown along grooves. Ocular scales, eyestalks, and bases of antennal peduncles dark brown. There is a fine white line that separates the black corneas. The last segment of antennal peduncles whitish yellow. Flagella gray green. Periopods one, two, and three are fairly uniformly dark brown on dorsal and outer surfaces, lighter yellow brown on inner and ventral surfaces. There may be a darker patch on the outer surface of palm of left cheliped, and on outer surfaces of carpi of periopods two and three. Periopods four and five mottled orange brown and yellow brown. Abdomen yellow white. Tail segments light orange white, darker in grooves.

DESCRIPTION:

Rostrum not prominent, does not exceed lateral projections which are pointed. Carapace shield smooth, without spines, with a few fine hairs on posterior lateral margins. Ocular scales small, acutely triangular with a terminal spine. Eyestalks short, compressed, approximately three times longer than the minimal diameter. Eyestalks reach to middle of last segment of antennal peduncles. Antennal acicles compressed, fused to second segment of peduncles. Periopods one, two, and three lightly granulous on outer upper surfaces. There are distinct patches of hairs on the upper, inner surface of the palms of both chelipeds. Propodus of third left periopod flattened with a hard ventral margin on inner surface.

Propodi of right third and both second periopods not as flattened, with less pronounced ventral margins. Coxae of fifth periopods on the male are weakly pronounced.

HABITAT:

This species seems to fall somewhat between the beach forms C. perlata and C. rugosa and the more terrestrial C. brevimanus in its adaptation to life on land. It is not common and can be found in the limestone rubble and seaward margin of the limestone forest south of the University of Guam Marine Laboratory, usually no more than a few hundred meters from the sea. It is usually found in the shells of Achatina fulica.

Coenobita rugosa H. Milne Edwards, 1837

Coenobita rugosa

H. Milne Edwards, 1837:241.

Fize and Serene, 1955:5, 12, pl. 1, figs. 3, 5, 7-10, text figs. 2, 3a.

Coenobita rugosus

Alcock, 1905:141, 143, pl. 14, figs. 3, 3a.

Holthius, 1954:16, figs. 4c, 4d.

Lewinsohn, 1969:94, text fig. 17.

MATERIAL:

5 males - CL 7.2 to 14.4 mm; 5 females (1 ovigerous) - CL 7.3 to 17.4 mm. Shells - Achatina fulica, Littorina sp. From - Pagan, Guam.

DISTRIBUTION:

This species is known from the east coast of Africa through the Indian Ocean to Indonesia and the Philippines, north to the Bonin Islands, east to the Marshall and Line Islands, and south to Australia, and the Society Islands.

COLOR IN LIFE:

Colors are quite variable. Carapace light brownish beige, anterior margin of shield dark gray as are many minute spots and, on some specimens, larger patches in center of shield. Ocular scales light brownish beige in centers, darker gray along margins. Eyestalks nearly white, or very light beige; on some specimens there is dark gray along inner dorsal lateral margins, corneas dark brown.

Antennular peduncles and flagella, antennal flagella and last segment of antennal peduncles gray olive green; there may be a light bluish tint on proximal dorsal surface of last segment of antennular acicles. Basal segments of antennal peduncles grayish brown. Chelipeds and periopods two and three same color as carapace with a highly variable amount of darker mottling; outer surface of left hand and left periopods two and three may have a light purple or olive green tint, on many specimens there is a distinctive dark gray or brown patch on the middle of the outer surface of the left hand; finger tips and claws dark brown to black. Abdomen light brownish beige dorsally, transparent yellow ventrally; tail segments very light beige, almost white.

COLOR IN ALCOHOL (after five months):

As in life colors are variable. Ground color of carapace and first three periopods varies from very light beige to darker brown or olive green. Ocular scales light ground color in centers, darker gray on margins and tips. Eyestalks light ground color, some specimens with dark gray along dorsal, inner lateral margins; corneas black. First three periopods ground color with a highly variable amount of darker patches and mottling, outer surface of large left hand often with a distinctive dark gray to brown patch in middle; outer surfaces of left periopods one, two, and three often with a purplish or olive green tint; finger tips and claws black. Abdomen gray to brownish beige, tail segments light ground color.

DESCRIPTION:

Carapace shield smooth with many minute punctations and a few short fine hairs. Rostrum low and blunt, much shorter than lateral projections which are pointed. Ocular scales close-set, acutely triangular with a sharp terminal point. Eyestalks short, compressed along inner lateral sides, corneas occupy a bit less than one third of the total length of stalks, which reach to ends of antennal peduncles. Antennal acicles small, fan shaped, with serrate dorsal margins; fused to the second segment of peduncles. Left cheliped larger and a bit longer than right. Outer surface of left hand smooth lightly punctate with a distinct transverse ridge of low tubercles just below dorsal margin that acts as a stridulating apparatus. There are distinct tufts of hairs on the upper, inner margins of both chelae. Left periopods three and, to a lesser extent, periopod two, with flattened outer surfaces on distal segments and hard dorsal and ventral margins, outer surfaces of these segments flat in cross section while those of the right periopods are elliptical. Coxae of the fifth periopods in the male are a bit more pronounced in the males than in the females.

HABITAT:

This is the smallest and probably the most common species of Coenobita found in the Mariana Islands. The animal is found in a large variety of shells of both terrestrial and marine mollusks, often in large numbers, and never far from the ocean.

Coenobita perlatus H. Milne Edwards, 1837

Coenobita perlatus

H. Milne Edwards, 1837:242.

Alcock, 1905:145, pl. 14, fig. 2.

Coenobita purpurea

Stimpson, 1907:198.

Coenobita perlata

Fize and Serene, 1955:24-30, text fig. 4, pl. 1a.

MATERIAL:

4 males - CL 21.0 to 40.7 mm; 2 females - CL 28.3, 31.2 mm. Shells - Turbo sp. From - Collected on Maug, Pagan, Anatahan, Guam.

DISTRIBUTION:

This species is known from the Indian Ocean to Indonesia and the Philippines, Australia, Tuamotu, Gambier and Marshall Islands, north to at least Mariana Islands and Viet Nam.

COLOR IN LIFE:

Posterior carapace, carapace shield, ocular scales, eyestalks, antennal peduncles, and all five periopods usually dark red orange, occasionally darker brown, with lighter yellow orange on the many granules. Corneas, finger tips of chelipeds, and claws of walking legs black. Antennal flagella light yellow orange or brown. Abdomen transparent yellow brown, lighter ventrally. Hard parts of abdomen and abdominal appendages orange or mottled white and orange.

COLOR IN ALCOHOL (after two years):

Carapace shield, eyestalks, antennal acicles and periopods one, two, three, and four all dark reddish orange with light yellow orange on granules, spines and margins of some periopod segments. Posterior carapace dark red orange at anterior middle surface fading to light yellow orange at ends and sides. Corneas shiny black. Last segment antennal and antennular peduncles and flagella light yellow. Hairs on animal light yellow. Abdomen dark yellow white. Tail segments light yellow white.

DESCRIPTION:

Rostrum low. Anterior margin of carapace shield deeply concave. Carapace shield granulate with hairs on outer posterior sides. There is a row of small spines along outer sides of anterior margin of shield leading to lateral projections. Ocular scales acutely triangular with a few spines. Eyestalks short, highly compressed along inner surface, approximately four times longer than minimum diameter. Corneas occupy less than one-fourth of total length of eyestalks. Eyestalks reach to proximal one-third of last segment of antennal peduncles. Antennal acicles flattened, fused to the second segment of peduncles. Walking legs granulate on all outer surfaces. There are tufts of hairs on the upper, inner margins of both chelae. There is a row of low tubercles forming a stridulating apparatus of the outer, upper surface of the left chela. The coxa of the right fifth periopod on the male is strongly produced into a long curved tube.

HABITAT:

This species, along with C. rugosa is never found more than a few hundred meters from the sea. It seems to prefer the shells of Turbo spp. On Guam the animal is fairly common on the low, atoll-like, Cocos Island. Elsewhere on Guam, and in the northern islands, it is not common. The author has observed these crabs in very large concentrations on the dry, uninhabited, islands in the northern Marshall Islands.

Family Diogenidae

Formerly the families Diogenidae, Parapaguridae, and Paguridae belonged to two subfamilies of a family called Paguridae. These subfamilies were Pagurinae (Diogenidae) and Eupagurinae (Parapaguridae and Paguridae). They are now considered to be separate families based primarily on the position of the third maxillipeds. In the family Diogenidae animals have the third maxillipeds widely separated at their bases and the chelipeds are equal or subequal, or the left is vastly the larger. This family comprises nearly all of the common shallow-water species in the Mariana Islands.

KEY TO THE GENERA OF THE FAMILY DIOGENIDAE FROM THE MARIANA ISLANDS

1. The first three periopods ringed by grooves 2
   The first three periopods not ringed by grooves (there may be rings of color but no grooves) 3

2(1). Anterior carapace divided into complete lobes. On the female the pleopods are large and flattened forming a brood pouch ..... Aniculus
   Anterior carapace not divided. On the female the pleopods do not form a brood pouch. In the Marianas there is only one species which has a greatly flattened carapace, occupies shells with narrow apertures such as Conus spp. and is subtidal ..... Trizopagurus

3(1). Chelipeds equal or subequal, open and close horizontally. All species occur intertidally or in very shallow water, often where there is fresh water input ..... Clibanarius

The left cheliped is nearly always larger than the right (in one species, Dardanus guttatus, they are subequal); the chelipeds open and close vertically 4

4(3). Fingertips of chelae calcareous. Fixed rostrum. First three periopods porcellaneous, relatively hairless .... Calcinus

Fingertips of chelae corneous. Rostral scale present. First three periopods spiny and hairy ..... Dardanus

Genus Aniculus

Two of the three species of Aniculus from the Mariana Islands are quite large and usually found in the intertidal zone, often in areas of heavy surge and rough surf. They are most commonly found in the strong, heavy shells of Turbo spp. The third species, which is described for the first time in this paper, is found outside of the reef, at scuba depths. It is considerably smaller than the two intertidal species and can be found in a large variety of shells. All three species are usually found singly, less often in pairs.

The three Marianas species of Aniculus look quite similar, though one is considerably smaller. The animals all have a well-calcified carapace shield that is longer than wide. The rostrum is moderately developed. The eyestalks are long and slender. The first three pairs of periopods are ringed by regular transverse grooves. The chelipeds are relatively small and equal. The fingers are spooned with large hoof-shaped, corneous tips. According to Forest (1952) Aniculus differs from the closely related genus Trizopagurus, and all other Diogenidae, by the division of

the anterior region of the carapace into complete lobes, and by the unpaired female pleopods which have the external rami greatly enlarged to form a large abdominal brood pouch.

KEY TO THE SPECIES OF ANICULUS FROM THE MARIANA ISLANDS

1. Antennal peduncles reach nearly to the bases of the corneas. Both lobes of telson equal. Coxae of periopods one, two, and three with grooves similar to those on other segments of periopods. Eyestalks without longitudinal stripes .... A. aniculus

Antennal peduncles reach only to middle of eyestalks. Left lobe of telson larger. Coxae of the first three periopods smooth. Eyestalks with one or more longitudinal stripes 2

2(1). Animal is hairy; tips of chelae and distal halves of dactyls of periopods two and three bear many long, stiff bright red hairs which are much different in color from the other body hairs. No fine red stripes running lengthwise on all segments of periopods two and three. Rare, intertidal .... A. maximus

Animal is not especially hairy; all hairs on body light reddish brown basally, white distally. Fine red stripes run lengthwise on all segments of periopods two and three. Animal is subtidal ..... Aniculus n. sp. 1

Aniculus aniculus (Fabricius, 1787)

Pagurus aniculus

Fabricius, 1787:327.

Pagurus ursus

Oliver, 1811:640.

Aniculus typicus

Dana, 1852:461;1855, pl. 29, fig. 1.

Aniculus aniculus

Alcock, 1905:94-96, pl. VII, fig. 6.

MATERIAL:

3 males - CL 31.6 to 36.7 mm. 7 females (2 ovigerous) - CL 26.0 to 32.5 mm. Shells - Turbo sp., Trochus niloticus. From - Maug (Stat. M5), Asuncion (Stat. AS3), Pagan (Stat. P3, P7), Anatahan (Stat. AN3), Guam (Stats. 2c, 4a, 5c, 13).

DISTRIBUTION:

This species is known from the east coast of Africa to the Philippines, Society Islands, Marshall and Line Islands and southern Japan.

COLOR IN LIFE:

Carapace yellowish brown with darker purple brown in grooves. Hairs on body golden yellow. Eyestalks pale green, darker basally, with an almost white band separating the black corneas. Antennal flagella pale green. Periopods one, two, and three mottled greenish gold and light purple, grooves reddish yellow. Carpi of periopods one, two, and three darker greenish gold.

COLOR IN ALCOHOL (after eight months):

Carapace shield and forward part of posterior carapace cream white with reddish brown in grooves and depressions. Ocular scales reddish brown basally fade to cream white distally. Eyestalks reddish brown at bases fading quickly to light orange for most of their lengths. Corneas black. Antennular peduncles and antennal acicles and peduncles cream white. Antennal flagella pale yellow. The first three periopods are similar in color; ground color of all segments light orange to cream white, reddish brown in grooves of scutes and on outer and inner dorsal surfaces of carpi, finger tips of chelae and claws of periopods two and three black. All hairs light orange. Posterior part of posterior carapace and abdomen transparent whitish. Tail segments cream white with some reddish brown on uropods.

DESCRIPTION:

Carapace shield longer than wide. Rostrum pointed, exceeds lateral projections. Hairs present along lateral and forward margins of shield. Ocular acicles large and triangular, with a sharp double spine at tip. Eyestalks equal, shorter than forward margin of shield. Eyestalks are expanded distally and approximately six times longer than minimum diameter. Antennular peduncles, when fully extended, reach to ends of eyestalks. Antennal acicles long, thin and hairy; barely reach to bases of penultimate segment of peduncles. Chelipeds are equal and large; reach to middle of dactyl of first walking leg. A large, sharp, corneous-tipped spine is present on dorsal distal margin of the first two periopods,

spine present but smaller on periopod three. Many parallel rings of scutes ring all segments of the first three periopods. Dorsal surfaces of meri, carpi, and dactyls of the first three periopods with small corneous spines and many long, stiff hairs on margins of scutes. Scutes are smaller and hairs shorter on the outer surfaces of all segments of the first three periopods. Tips of fingers of both chelae hoof-shaped and corneous. Claws of periopods two and three long, sharp and corneous. Coxae of the first three periopods with a few grooves similar to scutes on other segments. Telson with both lobes approximately equal. Entire front part of animal gives appearance of being very furry.

HABITAT:

Specimens are not common. They are found intertidally where there is clean moving water or on reef margin; often in quite rough water. This hermit crab usually inhabits species of Turbo shells and less often Trochus niloticus shells. Specimens are usually found associated with Calcinus elegans. For a hermit crab of such large size, it does little to disturb even a crowded aquarium.

Aniculus maximus Edmondson, 1952

Aniculus maximus

Edmondson, 1952:79-81, text fig. 7, photograph p. 81.

MATERIAL:

1 female - CL 23.0 mm. Shell - *Turbo* sp. From - Pagan (Stat. P3).

DISTRIBUTION:

Species has been known only from the Hawaiian Islands.

COLOR IN LIFE:

Entire animal is nearly uniformly bright golden orange with yellow hairs. Finger tips of chelae and ends of dactyls of periopods two and three with large clumps of bright red hairs. All periopod segments with slightly darker (than yellow background) reddish orange at ends of segments and at joints. Leg segments banded whitish yellow. Eyestalks pale orange with darker orange stripes running down dorsal and ventral surfaces. Corneas black. Telson pale yellow with a purple patch on the larger left lobe.

COLOR IN ALCOHOL (after 18 months):

Entire carapace yellowish white with some light orange on middle forward margin of posterior carapace and along anterior margin and forward lateral sides of shield. Ocular acicles and antennal acicles and bases of peduncles mottled white and light orange. Eyestalks yellowish orange with a narrow, darker orange stripe running along the dorsal and ventral surfaces of each stalk. Corneas black. Periopods one, two, and three light yellowish orange on

basal segments becoming progressively darker distally, some light red along dorsal and ventral margins of propodi and dactyls. Finger tips of chelae and ends of dactyls of periopods two and three dark red. Corneous claws and finger tips of chelae black. All hairs yellowish white. Abdomen transparent whitish. Tail segments yellowish white.

DESCRIPTION:

Carapace shield longer than wide. Rostrum low and blunt; does not exceed lateral projections. Ocular scales large and triangular with a few small, sharp spines along inner lateral margin. Eyestalks exceed width of forward margin of shield. Eyestalks equal, are approximately nine times longer than the minimum diameter. Antennular peduncles, when fully extended, reach to margins of eyestalks and corneas. Antennal acicles long and thin, reach to middle of last segment of peduncles. Lateral and forward margins of shield, antennal peduncles and acicles, and bases of eyestalks with many long, fine hairs. Chelipeds equal, reach just past the bases of the dactyls of the second periopods. All segments of the first three periopods are ringed by narrow scutes. Dorsal surfaces of meri and carpi of both chelae with corneous-tipped spines. Dorsal and ventral surfaces of the first three periopods with many long, fine hairs; dactyls of periopods two and three and finger tips with many stiff hairs. Finger tips of chelae hoof shaped, corneous. Claws of periopods two and three sharp, corneous. Coxae of the first three periopods smooth, without grooves. Telson and uropods larger and more well-developed on left side.

HABITAT:

Little is known as only one specimen has been found. The animal was found in a Turbo sp. shell on a volcanic substrate in the intertidal zone. The area is characterized by moderate exposure to surf and clean, moving seawater. Aniculus aniculus and Calcinus elegans were found in the same location.

REMARKS:

Animal fits Edmondson's 1952 description. The species can easily be separated from A. aniculus, which is the same size and lives in the same habitat. The color of the first three periopods and eyestalks and the shape of the rostrum are the most obvious differences. The single specimen from Pagan is quite a bit smaller (CL 23 mm) than Edmondson's original material (CL 68 mm).

Aniculus n. sp.

MATERIAL:

Holotype: Nov. 15, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Male - CL 12.0 mm.

Paratypes: May 6, 1977. Adelupe Point, Guam (Stat. 9). 20 m. Male - CL 14.4 mm, in *Chicoreus* sp. shell.

May 6, 1977. Adelupe Point, Guam (Stat. 9). 20 m. Male - CL 6.4 mm, in *Mitra eremitarum* shell.

March 17, 1977. Adelupe Point, Guam (Stat. 9). 20 m. Female - CL 8.2 mm, in *Coralliophila violacea* shell.

Nov. 3, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Male - CL 9.3 mm.

Nov. 3, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Male - CL 9.1 mm.

Nov. 3, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Male - CL 12.2 mm.

Nov. 15, 1977. Tanguisson Point, Guam (Stat. 13). 10 m. Female - CL 5.6 mm, in *Coralliophila violacea* shell.

COLOR IN LIFE:

Entire animal covered with hairs that are reddish brown basally and white distally. Ground color of entire carapace yellowish brown. Sides and middle of posterior carapace darker brown. Shield and posterior carapace with white patches and spots on all surfaces. Middle area of shield lighter yellow turning to brown distally. Rostrum, antennal acicles and ocular scales mottled white and reddish brown. Eyestalks green, fading to yellowish

near corneas. There are four equidistantly spaced, distinct black lateral lines that run the length of each eyestalk.

Corneas silver with the lateral black lines from stalk meeting on the middle of the dorsal surface of each cornea. Antennular peduncles and flagella transparent yellowish green. Antennal flagella transparent light yellow. Mouth parts green with white spots. Both chelipeds are the same color: proximal half of meri olive green with some white on ridges. Carpi the same color as meri. Chelae dark reddish brown on outer and inner lower surfaces, upper surfaces reddish brown with green on distal margin at joint with dactyl. There are a few black tipped spines on dorsal surfaces of chelae. Movable fingers are mottled reddish brown and green with some white; finger tips black. Periopods two and three are the same color; meri, carpi and propodi all reddish brown to violet on proximal half of each segment; distal halves green. Ridges on some segments reddish brown. On all segments there are some very fine, dark red lines. Dactyls olive green with black claws. Periopods four and five mottled whitish yellow and light brown. Abdomen reddish brown on dorsal surface, lighter ventrally. Terga and tail segments reddish brown with white spots.

COLOR IN ALCOHOL (after 10 months);

Posterior half of shield, posterior carapace, abdomen and abdominal appendages, and periopods four and five all faded to a uniform light yellow brown. Forward half of shield, ocular scales, antennal acicles and bases of peduncles, and the first three periopods light brown orange with white mottling. Corneas, finger tips, claws, and

spines black. Hairs light yellow. The distinctive brown longitudinal stripes on the eyestalks are still plainly visible against a much lighter yellow background.

When a fresh specimen without its shell is placed in alcohol the liquid quickly becomes yellow brown in color. The pigments of most other hermit crabs are not nearly so solvent in alcohol.

DESCRIPTION:

Carapace shield slightly longer than broad; anteriolateral margins slope forward. Anterior margins between rostrum and lateral projections concave; posterior margin roundly truncate with well defined Y-shaped groove on posterior surface; with well defined longitudinal grooves from anterior shield to Y, and a transverse groove behind rostrum. Scattered tufts of hairs on lateral and anterior margins of shield; thicker tufts of hairs just behind rostrum and lateral projections. Rostrum short; exceeds or just barely exceeds lateral projections; terminates acutely; may or may not be pointed. Lateral projections rounded or as pointed as rostrum.

Eyestalks long and slender; exceed antennular peduncles and are slightly shorter than length of shield, though longer than width of forward shield. They are inflated basally and at corneas, and are approximately 10 times longer than minimum diameters, with a few fine hairs at bases and along inner and outer dorsolateral surfaces. Ocular scales roughly triangular, acute terminally; with or without sharp terminal spine or pair of small spinules; inner dorsolateral margin straight; outer dorsolateral margin

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

1. Eyestalks are not strongly compressed in cross section. There is a tuft of hair on the inner, upper surface of the right chela only. Antennal acicles are not fused to the second segment of the peduncles ..... *C. brevimanus*

Eyestalks are strongly compressed in cross section. There are tufts of hair on the upper, inner surface of both chelae. Antennal acicles are fused to the second segment of peduncles 2

2(1). Outer surface of left cheliped without stridulating apparatus. Coxae of both fifth periopods weakly pronounced in males .. .. *C. cavipes*

Stridulating apparatus present on upper, outer surface of left cheliped 3

3(2). Propodus and dactyl of third left periopod flattened on outer surface with a hard dorsal ridge. Outer palm of left chela smooth. Coxa of fifth right periopod moderately pronounced in males ..... *C. rugosa*

Propodus and dactyl of third left periopod convex, dorsal ridge not much harder than that on other periopods two and three. Outer surfaces of first three periopods granulate. Coxa of right fifth periopod strongly pronounced in males. Animal bright reddish orange ..... *C. perlatus*

concave. Scales nearly touch at bases, with a few fine hairs on dorsal surfaces.

Antennular peduncles moderately long, reach nearly to bases of corneas; penultimate and ultimate segments with a few hairs dorsally. Basal segment unarmed; flagella longer than last segment of peduncles, with long terminal whip.

Antennal peduncles short, reach just beyond middle of eyestalks, with supernumary segmentation (see McLaughlin 1974); fifth segment with a few fine hairs dorsally and distally; fourth segment unarmed, hairy; third segment unarmed, with a strong brush of stiff hairs along terminal and inner dorsal margins; second segment with a strong spine on outer dorsolateral distal margin that may be obscured by a brush of long stiff hairs. Acicle reaches just past base of last segment of peduncles; with many long, stiff hairs on outer and lateral surfaces, with single terminal spine.

Mandibles with penultimate segment of palp compressed and broadened basally. Maxillules (Fig. 4A) with poorly developed endopodite and stiff bristles along margins of proximal endites. Maxillae (Fig. 4B) with distinctive indentation along lower middle margin of scaphgnathites; endopodites broad, tapering basally to a fine tip that slightly exceeds scaphgnathites. First maxillipeds (Fig. 4C) with exopodites broadened basally, slender distally, greatly exceeding endopodites. Second maxillipeds (Fig. 4D) with basis ischium fusion incomplete. Third maxillipeds (Fig. 4E) with basis ischium fusion incomplete, basis unarmed; ischium with crista dentata and accessory tooth well-developed, meri and carpi unarmed.

Chelipeds (Figs. 5A,B) equal or slightly subequal; short, similar in armature and ornamentation; reach to propodi of second periopods. Dactyls short, with transverse rows of very small corneous-tipped spines along dorsal surface that are partially obscured by long stiff hairs; outer cutting edge with two large calcareous teeth, two other large teeth on middle and outer edge; finger tips corneous, hoof-shaped. Palms long, longer than meri, with regular transverse grooves on all surfaces; dorsal surfaces and outer margins of cutting edges of fixed fingers with many fine corneous-tipped spines and long hairs; other surfaces with fine hairs along distal margins of grooves; fixed fingers with approximately six calcareous teeth on inner, outer, and middle surfaces. Carpi short, approximately two-thirds length of meri, with a few transverse grooves that are a bit less pronounced than on palms; dorsal, distal margins with a single, moderately-sized, corneous tipped spine and approximately six much smaller, corneous-tipped spines along dorsal, distal outer margins; long stiff hairs along dorsal surfaces; fine short hairs along grooves as on palm. Meri with inner surface smooth; outer surface with transverse grooves, inner ventral margin with two distinct lobes, both with four to five small calcareous spines; dorsal surfaces with long, stiff hairs; outer surfaces with fine, short hairs as on palm, a few distinct tufts of long hairs along ventral outer margins.

Periopods two (Fig. 6B) and three (Fig. 6C) similar in shape, armature and ornamentation. Dactyls short, approximately two-thirds as long as propodus with many long hairs and approximately eight very small, corneous-tipped spines along ventral margins. Few

more small corneous-tipped spines may be present on distal outer, and inner surfaces. Terminal claws corneous, short, point downwards. Propodi moderately compressed with transverse, shallow grooves along dorsal and ventral surfaces, middle inner and outer surfaces smooth, long hairs along dorsal and ventral margins; short fine hairs present along grooves, as on palms of chelae. Carpi short; approximately two-thirds as long as propodi along dorsal margins; similar to propodi in hairiness and presence of shallow transverse grooves on dorsal and ventral surfaces. There is a small circular depression on middle of inner surface. Meri compressed; approximately as long as propodi; second and third periopods differ by the presence of regular, shallow, transverse grooves that are present on the dorsal and ventral surfaces of periopod three and absent on periopod two. There are also a few very small corneous-tipped spinules present on the ventrodistal margins of the meri of periopod two which are absent on periopod three.

Fourth periopods (Fig. 6D) subchelate; dactyls without preungal process; propodal rasps well developed, encompass approximately one-half of outer face of carpi; a small, well-developed, corneous-tipped spine on dorsal, distal angle that may be obscured by a tuft of long hairs. Other hairs present on dorsal and ventral margins of all segments, especially distally.

Fifth periopods chelate.

Males with four very small, unpaired, biramous appendages; exopodites well-developed, leaflike; endopodites reduced. In

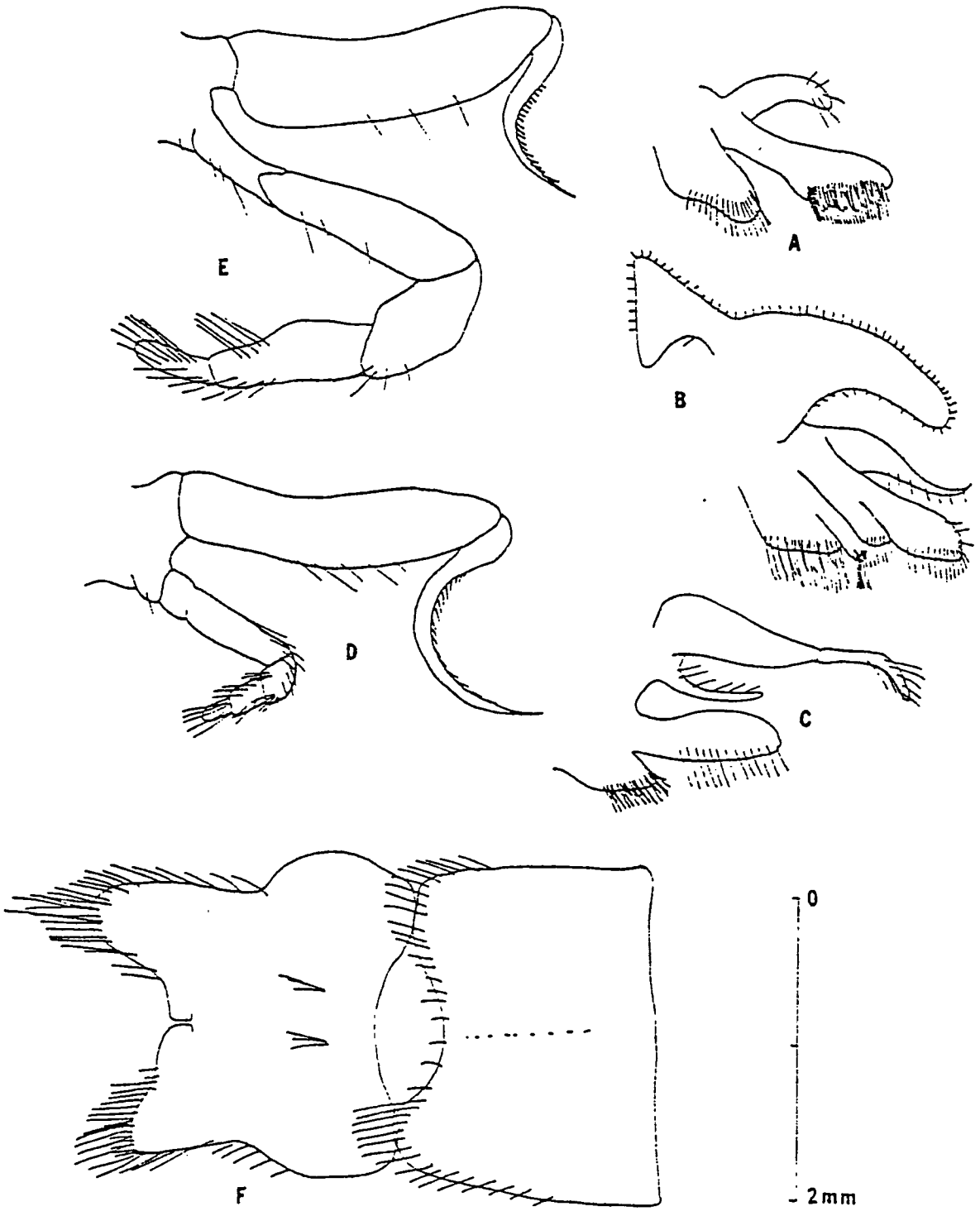

Figure 4. Aniculus n. sp. A, maxillule; B, maxilla; C, 1st maxilliped; D, 2nd maxilliped; E, 3rd maxilliped; F, telson.

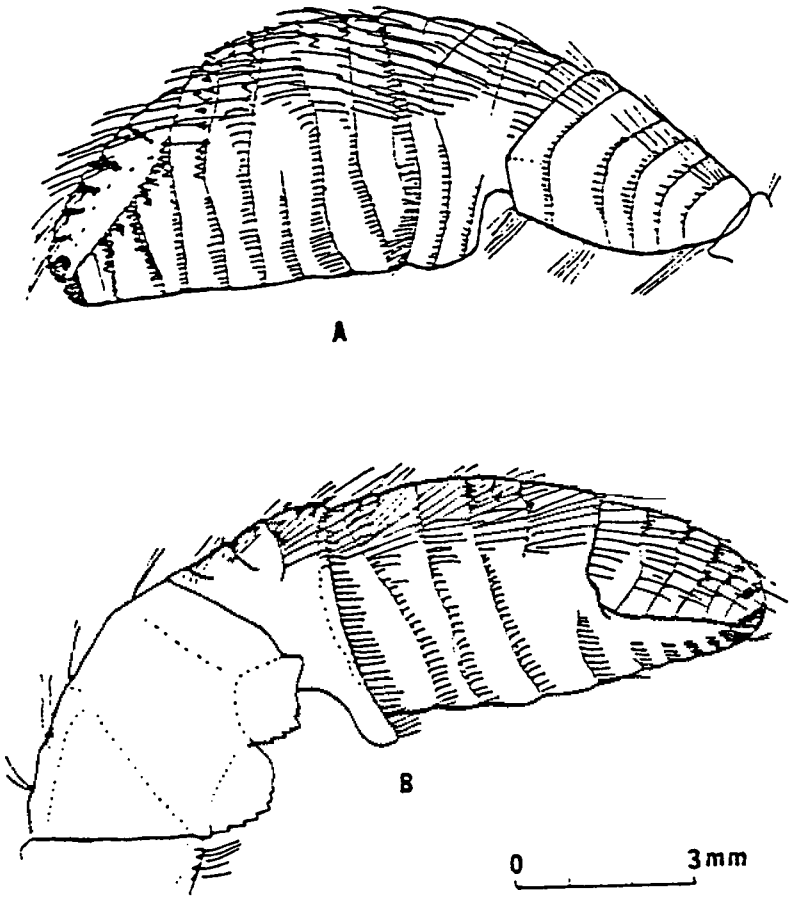

Figure 5. Aniculus n. sp. A, right cheliped; B, left cheliped.

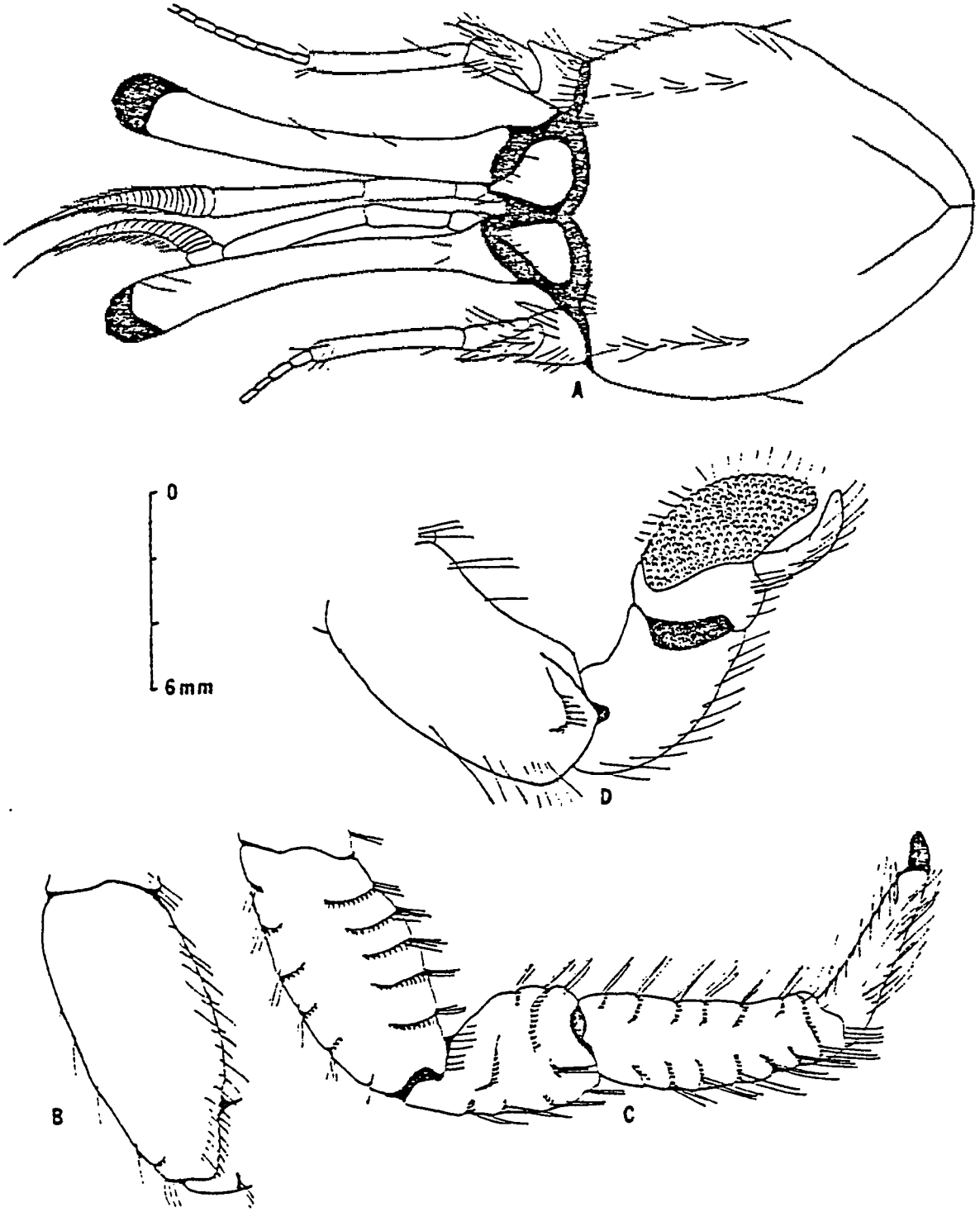

Figure 6. Aniculus n. sp. A, carapace; B, left periopod 2; C, left periopod 3; D, left periopod 4.

females the first three pleopods have large, paddle-shaped exopodities and smaller endopodites that are divided on distal margins by a V-shaped indentation. Fourth pleopods small, biramous.

Uropods larger and more elongate on left side. Telson (Fig. 4F) with left lobe larger and longer than right; both lobes triangular; terminal and lateral margins with long fine hairs especially terminal ends of both lobes; medial cleft deep.

HABITAT:

All animals were collected at two locations in Guam, Mariana Islands; at Adelupe (Stat. 9) and Tanguisson (Stat. 13) Points in 10 - 20 m of water on the first reef terrace and seaward slope. Both areas are exposed to moderate-to-strong waves and currents, and have live coral and limestone rubble bottoms. The animals are found in a variety of shells singly or in groups of two or three animals, usually on the rubble. Occasionally small animals can be found among the branches of live corals. Calcinus minutus and Calcinus sp. 1 are the most common species of hermit crabs in both locations. It is interesting to note that the other two species of Aniculus; A. maximus and A. aniculus, are intertidal species, whereas Aniculus n. sp. is always found in deeper water.

REMARKS:

Aniculus sp. 1 appears to be most closely related to Aniculus maximus Edmondson, 1952 (see pp. 79-81, figs. 7, 8), another rare species reported from Hawaii and, in this paper, Pagan, Mariana Islands. Edmondson gives no habitat information, but the Pagan specimen of A. maximus was found intertidally, as is the more common

Aniculus aniculus (Fabricius, 1878) (see Alcock 1905:94-96, pl. 7, fig. 6). Both are considerably larger than the new species; CL of a typical Aniculus n. sp. is approximately 10 mm compared with 30 mm for A. aniculus and 23.0 mm for the Pagan specimen of A. maximus, Edmondson's specimens are much larger. In spite of the ecological and size differences, Aniculus n. sp. resembles A. maximus in a number of ways. Both species possess similar longitudinal dark stripes of color on the eyestalks, asymmetrical telsons (the left lobe longer and larger than the right), relatively low rostrums and similarly shaped ocular scales. A. maximus can be easily differentiated from Aniculus n. sp. by its coloration and by the proportions of the distal segments of the second and third walking legs; A. maximus is farily uniformly bright yellow orange with dark bright red hairs on the finger tips of the first three walking legs. The dactyls of the second and third periopods are nearly as long as the propodi. In Aniculus n. sp. the dactyls are considerably shorter than the propodi and the animal is farily uniformly dark red brown with dull, red brown hairs. There is another interesting similarity between these two species that could be of taxonomic significance; in both species the outer lower margin of the scaphgnathite of the maxillae are concave and indented, whereas in A. aniculus this margin is concave.

Aniculus n. sp. can easily be differentiated from Aniculus Aniculus by the color of the eyestalks, which are not striped, larger and more spinose ocular scales and a more symmetrical telson and pronounced rostrum.

There is another Pacific species of Aniculus; A. elegans Stimpson, 1858 which was discussed by Edmondson. A. elegans has a more pointed rostrum.

Genus Trizopagurus

Most of the known species of Trizopagurus are found in quite deep water. In the Marianas only one species, T. strigatus, is found in shallow water. This small species is most often found outside the reef, at depths of between approximately five and thirty meters. This crab is one of the three species of Diogenidae in the Marianas which have a greatly flattened carapace. This enables the crabs to utilize shells with narrow apertures, e.g., Conus and Cypraea spp.

Trizopagurus very closely resembles Aniculus but can be differentiated by the carapace shield, which is not divided into a complete lobes; the pleopods of the female, which do not form a brood pouch; and the presence of a strudulating apparatus on the chelae. The rostrum is not prominent. The eyestalks are long and slender. The chelae are equal with spooned, hoof-shaped, corneous finger tips. The first three pairs of periopods are ringed by regular transverse grooves. The claws of periopods two and three are sharp and corneous. There is one pair of gills attached to the bases of the fifth periopods. Four pleopods with two well-developed rami are characteristic of both sexes. The telson is strongly indented at the midline; the left lobe is larger. On the one Marianas species the carapace is greatly flattened and the chelipeds are small.

Trizopagurus strigatus (Herbst, 1804)

Cancer strigatus

Herbst, 1804:61, pl. 1, fig. 3.

Pagurus strigatus

Hilgendorf, 1878:820, pl. 2, fig. 8.

Pagurus annulipes

H. Milne Edwards, 1848:63.

Aniculus strigatus

Henderson, 1893:422.

Alcock, 1905:97, pl. 7, fig. 4.

Trizopagurus strigatus

Forest, 1952:2, 6, 19-28, 30, 34-37, figs. 5, 14, 21.

Ball and Haig, 1972:94.

MATERIAL:

8 males - CL 5.3 to 11.9 mm; 3 females (1 ovigerous) - CL 8.2 to 10.2 mm. Shells - all *Conus* spp. From - Alamagan (Stat. AL 1), Guguan (Stats. GU1, GU2), Guam (Stats. 5b, 1, 14).

DISTRIBUTION

This species is widely distributed from the east coast of Africa and the Red Sea, to New Guinea, the Society and Hawaiian Islands and the Ryukyu Islands.

COLOR IN LIFE:

Posterior carapace and shield bright white. Small brown spots may be present on posterior end of shield and along midline of posterior carapace. Much smaller brown spots over entire carapace are visible

through microscope. Ocular scale and eyestalks bright orange. Corneas transparent orange with small greenish brown speck in centers. Antennal acicles and peduncles bright orange with lighter spots on ends of some spines, flagella transparent whitish orange. Entire antennule bright orange except for distal halves of flagella and hairs which are transparent purplish. Sides of abdomen orange with longitudinal narrow yellow stripes. Dorsal surface of soft part of abdomen white with yellow bands. Abdominal terga similar but darker than soft part. Pleopods pale transparent whitish orange. Telson yellow with darker orange along terminal margin. Large orange spots present on segments just before telson. Uropods dark orange with a few yellow spots. All segments of both chelipeds and periopods two and three with narrow alternating bands of dark orange and yellow, bands present but not as well defined on periopods four and five. Finger tips of chelipeds and claws of periopods black.

COLOR IN ALCOHOL (after approximately two years):

Live color patterns still plainly visible on legs, though faded. Entire carapace shield white. Posterior carapace white with yellowish tint. Two brown spots in middle of shield behind lateral projections. Ocular scales, eyestalks, antennular peduncles, antennal acicles and peduncles and mouth parts all light to dark orange. Corneas black. Chelipeds and periopods two and three with narrow alternating bands of dark orange and yellow, tips of chelae and legs black. Periopods four and five mottled light orange and light yellow white. Abdomen transparent white. Tail segments mottled light orange and yellow white.

DESCRIPTION:

Entire animal forward of abdomen dorsoventrally flattened. Carapace shield very slightly wider than long. Rostrum blunt; does not exceed lateral projections. Anterior margin of shield nearly straight. Two small but distinct depressions in middle of shield approximately behind lateral projections. Ocular scales with a few small pointed spines on distal margin. Eyestalks short; left slightly longer. Shorter eyestalk approximately five times longer than minimum diameter. Antennal acicles spinose. Chelipeds equal, small, ringed by narrow grooves or scutes. Chelipeds reach nearly to bases of propodi of first walking legs. Tips of fingers hoof-shaped; corneous. Periopods two and three like chelipeds; narrow scutes ring all segments. A few very short hairs present on distal margins of scutes; claws of dactyls curved, sharp and corneous. Telson with left lobe longer than right.

HABITAT:

This hermit crab is always found outside of the reef, usually at depths between five and twenty five meters. It lives in shells with narrow apertures, such as Conus spp. It is usually found singly on coral rubble, on small pockets of sand or fine rubble, but rarely on live coral.

Genus Clibanarius

Five species of Clibanarius are known from the Mariana Islands. All are limited to the intertidal and shallow reef flat zones, often occurring in areas of reduced salinity near river mouths and natural seepage areas. Two species, C. humilis and C. virescens, are very small animals that are found in large aggregations on rocks, often exposed to the air at low tide, at the intertidal zone. C. striolatus and C. eurysternus are larger species that are most often found just below the intertidal zone in areas of reduced salinity. Because of its greatly flattened carapace C. eurysternus is able to utilize shells with narrow apertures such as Conus and Strombus spp. C. corallinus is the largest and hairiest species. It is found on the reef flat, usually alone, moving about much like a Dardanus. The other species are more sedentary.

Species of the genus Clibanarius can most easily be separated by color, size, and habitat. All species have a small rostrum, slender eyestalks and a well-calcified carapace shield. The chelipeds are equal or subequal, and open and close on a horizontal plane. The chelae are tuberculate with hoof-shaped with corneous fingertips. The claws of the second and third periopods are tuberculate. One species has a greatly flattened carapace; the others have a carapace which is longer than wide.

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

1. Periopods two and three with well-defined longitudinal colored stripes 2

   Periopods two and three with no well-defined stripes 3

2(1). Carapace greatly flattened; coxae of fifth periopods widely separated. Eyestalks and carapace shield with longitudinal stripes. Inhabits shells with narrow apertures such as *Conus* and *Strombus* ..... *C. eurysternus*

   Carapace not greatly flattened; coxae of fifth periopods not widely separated. Eyestalks and carapace shield without longitudinal stripes. Inhabits shells with round apertures ..... *C. striolatus*

3(1). Eyestalks much longer than the forward margin of the carapace shield. First three periopods covered with many stiff, gold hairs. Carapace shield and first three periopods dark reddish brown. Animals with a carapace length of over one centimeter are common ..... *C. corallinus*

   Eyestalks never longer than forward margin of the carapace shield. Carapace shield and periopods not brown; the dactyls of periopods two and three are lighter than the preceding segments. Animal small; carapace length usually less than eight millimeters 4

4(3). Eyestalks shorter than the forward margin of the carapace shield and stout. Rostrum small; barely exceeds lateral projections. Periopods two and three smooth and nearly hairless. Eyestalks orange with a wide white line separating each cornea; may be a whitish patch along inner, dorsal, proximal surface of stalks ..... C. humilis

Eyestalks about the same length as forward margin of the carapace shield. Rostrum exceeds lateral projections. Periopods two and three with noticeable hairs. Eyestalks dark orange with a very thin white line separating corneas; may be a dark grayish tint along the inner, dorsal, margin of of each stalk ..... C. virescens

Clibanarius eurysternus Hilgendorf, 1878

Pagurus (*Clibanarius*) *eurysternus*

Hilgendorf, 1878:822, pl. 3, figs. 9, 10.

Clibanarius eurysternus

Fize and Serene, 1955:118-123, fig. 17.

Miyake, 1956:8-11, figs. 4, 5.

MATERIAL:

5 males - CL 4.2 to 15.0 mm; 3 females (2 ovigerous) - CL 10.3 to 13.2 mm. Shells - *Strombus* sp., *Cerithium* sp., *Drupa* sp., *Conus* sp. From - Guam (Stats. 2c, 2d).

DISTRIBUTION:

This species is known from the east coast of Africa and the Indian Ocean, east to the Philippines, Australia, and the Marshall and Gilbert Islands, north to southern Japan.

COLOR IN LIFE:

Ground color of carapace pale yellow. Dark brown to black longitudinal stripes run lengthwise on entire carapace. Two dark brown elongate spots, one on each side, on forward shield. Eyestalks, antennal peduncles, antennular peduncles pale yellow with longitudinal brown stripes; four stripes on eyestalks, two stripes on antennal and antennular peduncles. Corneas black with white specks. Antennal flagella very pale transparent yellow; dorsal distal end of each segment of flagella with a thin pale orange band; some segments completely or only partially olive green. Entire antennal flagellum gives appearance of alternate bands of pale yellow and

olive green, though bands do not correspond to individual segments of each flagellum. Distal segments of first three periopods with hairs which may hide colors. Ground color of periopods one, two and three pale yellow. All segments with the same dark brown longitudinal stripe pattern as carapace. Tips of fingers of chelae and claws of periopods two and three dark brown. Ventral surface of abdomen greenish brown, dorsal surface greenish yellow with dark green to brown spots. Uropods and telson yellow green; darker stripes present on telson.

COLOR IN ALCOHOL (after 18 months);

Live color patterns clearly visible though faded. Carapace shield, antennular peduncles, eyestalks, antennal acicles and peduncles, and all periopods with parallel longitudinal alternating stripes of dark brown on a light yellow ground color. Tips of chelae and claws of periopods two and three black. Entire abdomen and posterior carapace transparent brown orange.

DESCRIPTION:

Entire animal forward of abdomen dorsoventrally flattened. Carapace shield slightly longer than wide. Rostrum pointed; extends well beyond lateral projections which are blunt. Ocular scales with a few sharp spines along distal margins. Eyestalks equal or left slightly longer on large individuals. Both eyestalks approximately six times longer than minimum diameter. Antennal acicles and peduncles spinose. Chelipeds small, equal; reach to base of propodi of first walking legs. Finger tips of chelae corneous, hoof-shaped. Periopods one, two, and three each with a single sharp spine on the

dorsal distal margin of carpi; a few spinds along dorsal margins of carpi and palms of chelipeds. First and second walking legs generally smooth though moderately hairy. Sharp, curved, corneous claw on periopods two and three. Telson nearly square; both lobes equal.

HABITAT:

Specimens are not common and have been found only at Pago Bay (Stat. 2) in the high intertidal on a sandy rubble bottom. The animal seems to prefer shells with narrow apertures, such as Strombus and Conus spp., but is also sometimes found in shells with round apertures. It is found in calm water where there is some freshwater runoff and seepage and may be associated with Clibanarius striolatus.

Clibanarius striolatus Dana, 1852

Clibanarius stiolatus

Dana, 1852:463; 1855, pl. 29, figs. 3a-e.

Alcock, 1905:46, pl. IV, fig. 7.

Fize and Serene, 1955:97-105, fig. 13.

MATERIAL:

9 males - CL 5.0 to 10.4 mm; 4 females (1 ovigerous) - CL 10.2 to 14.1 mm. Shells - *Trochus niloticus*, *Cerithium* sp. From - Guam (Stats. 2c, 3, 8a, 10).

DISTRIBUTION:

This species is known from the southeast coast of Africa, Indian Ocean, and Indonesia to Australia; and from the Society Islands to the Ryukyu Islands.

COLOR IN LIFE:

Ground color of entire carapace brownish olive green; light brown blotch in center of carapace shield. Forward margin of shield and rostrum light brown green. Carapace shield mottled dark olive green with many small yellow brown to white spots. Light marking runs lengthwise on forward half of carapace shield on both sides, behind antennal acicles. Posterior carapace olive green with poorly-defined brownish stripes running lengthwise; many light green to white spots on posterior carapace. Carapace colors vary among specimens, but all appear greenish with fine light spots. Shades, colors and degree of stripedness of posterior carapace highly variable. Antennal acicles mottled light and dark shades of olive

green; peduncles with longitudinal stripes alternating light yellowish olive green and dark olive green; flagella light green dorsally with a darker stripe on both sides, light green ventrally. Joints between segments of flagella orange. Ocular acicles olive green, darker toward margins. Base of eyestalk dark brown, major length of eyestalks olive green dorsally fading to light green or white ventrally, color very near corneas fades to yellow; corneas black. There may be a small dark patch on dorsal surface of each eyestalk close to base, against olive green background. Antennular peduncles dark brown; flagella orange. Soft parts of abdomen greenish; ventral surface light milky green, dorsally darker olive green with some brown mottling. Abdominal terga poorly calcified; olive green with some darker mottling. Pleopods light olive green, darker along longitudinal margins. Telson and tail parts olive green, lighter along margins. Dorsal surfaces of all segments of both chelipeds dark olive green with lighter olive green spots where hairs grow; tips of some spines on carpus and hand corneous, black. Ventral surface of movable finger light brown yellow; darker brown stripe along length of inner ventral surface of movable finger. Ventral surface of palm and other segments of chelipeds light olive green with lighter spots. Tips and jaws of chelae corneous, dark brown to black. Poorly defined stripes (almost mottling) run lengthwise along all segments of both chelipeds. Periopods two and three bright olive green (almost blue), dark brownish olive green stripes run lengthwise on all segments. Tip of dactyls white; claw long, corneous, black. Colors fade somewhat at joints of all segments. Yellow hairs on legs and carapace.

COLOR IN ALCOHOL (after 13 months):

Live color patterns are still plainly visible, though faded. Carapace shield whitish yellow with reddish brown mottling, especially on forward center of shield. Rostrum and lateral projections yellow white. Antennal acicles and peduncles, ocular scales and antennular peduncles light yellow white with some brown mottling; last segment of antennal peduncles with distinct light brown stripes. Antennular and antennal flagella light yellow. Eyestalks light yellow with a light brown tint at middle of dorsal surface at base. Corneas black with white at very end. Chelipeds light yellow with a lot of brown mottling, especially on outer surfaces of carpi and palm. Finger tips black. Periopods two and three with light brown longitudinal stripes against a yellow ground color. Stripes most distinct on outer surfaces. Claws black. Posterior carapace, abdomen, and tail segments yellow white; most heavily calcified tail segments with some brown mottling.

DESCRIPTION:

Carapace shield longer than wide. Rostrum pointed; exceeds lateral projections. Forward margin of shield between lateral projections and very concave. Ocular scales small, triangular; point towards midline; two to three small spines at terminal margins. Eyestalks equal, slightly longer than forward margin of shield. Length of eyestalks is approximately seven times that of minimum diameter. Antennular peduncles, when fully extended, reach just to margin of cornea and eyestalk. Antennal peduncles not as long as eyestalks. Antennal acicles spinose, reach just beyond bases of last segment of peduncles. Chelipeds subequal, either left or right may be

slightly larger; left is generally more spinose. Chelipeds, when fully extended, reach to proximal third of propodus of first walking leg (one specimen has chelipeds much shorter). Chelipeds with a row of strong spines along dorsal margin of carpi and palms, strongest on palms. Tubercles and spines present on other surfaces of chelipeds, especially carpus and palm. Finger tips hoof-shaped, corneous. Periopods two and three with dactyls equal to or slightly longer than propodi. There is a strong single spine present on dorsal, distal margin of carpi, other segments smooth. Periopods one, two, and three with fine, long hairs on distal segments. Telson with both lobes equal or left slightly larger (on largest specimens).

HABITAT:

This species is common in intertidal areas where water is calm, and seems to be able to tolerate water of low salinity. Animals are usually found in a large variety of shells on a rocky rubble substrate and very small and large animals are often found together.

Clibanarius corallinus (H. Milne Edwards, 1848)

Pagurus corallinus

H. Milne Edwards, 1848:63.

Pagurus globoso-manus

Dana, 1851:271.

Clibanarius corallinus

Alcock, 1905:43, 48, pl. 5, fig. 1.

Forest, 1953:442, 443.

Fize and Serene, 1955:77, 132, text fig. 20.

Miyake, 1956:11-13, figs. 6, 7.

Lee, 1969:41, 43.

Ball and Haig, 1972:96.

MATERIAL:

5 males - CL 10.8 to 21.9 mm; 2 females (1 ovigerous) - CL 17.5 to 20.2 mm. Shells - Trochus niloticus. From - Guam (Stats. 2c, 2e, 2d).

DISTRIBUTION:

This species is found from the Indian Ocean east to the Philippines, Marshall and Gilbert Islands and Fanning Island, south to Australia and the Society Islands, and north to Japan.

COLOR IN LIFE:

Ground color of entire carapace dark reddish brown; posterior carapace lighter with a well-defined light yellow-brown line that begins approximately one half of the way up shield and runs the length of posterior carapace along midline; lateral sides of posterior carapace,

and to a lesser extent shield, with lighter tint. Ocular scales dark reddish brown, lighter on centers of dorsal surfaces. Eyestalks dark orange with a fine, dark reddish brown stripe running along dorsal surfaces, parallel to midline; a fine light gray line separates the dark bluish gray corneas. Antennular peduncles dark reddish brown fading distally; flagella orange. Antennal peduncles and acicles dark reddish brown; lighter on spines and distally, flagella brownish orange. Mouth parts brown. First three periopods uniformly dark reddish brown; bases of spines on chelae lighter yellow brown with black, corneous spines. Finger tips of chelae and claws of periopods two and three black; hairs brown, fade distally. Periopods four and five light reddish brown. Soft parts of abdomen light, transparent reddish brown, tergal plates and tail segments darker; a distinct lighter yellow brown line extends along midline, on dorsal surface of abdomen.

COLOR IN ALCOHOL (after 6 years):

Carapace shield uniformly reddish brown with some white in depressions. Ocular scales, antennal acicles and bases of peduncles light brown. Antennal flagella yellowish white. Eyestalks yellowish white with a light brown stripe that runs the length of the dorsal surface of each stalk, darkest basally. Corneas black. All five periopods reddish brown, yellowish white on spines and depressions. Hairs on entire animal yellowish, darker basally. Finger tips of chelae and claws of periods two and three black. Abdomen and most of posterior carapace transparent yellowish; forward part of posterior carapace reddish brown. Telson and uropods yellowish white.

DESCRIPTION:

Carapace shield much longer than wide with many small pits on entire surface; hairs only on forward and lateral margins. Rostrum small with sharp terminal spine; exceeds lateral projections which are low and blunt. Ocular acicles small, close set; with small spines along outer lateral and terminal margins. Eyestalks equal, longer than the width of the forward margin of the carapace shield, and thin. The stalks are approximately seven times longer than the minimum diameter. Antennular peduncles, when fully extended, reach to ends of corneas. Antennal acicles and bases of peduncles large, hirsute, and spinose; acicles extend just beyond the bases of the last segment of the peduncles. Chelipeds equal; fingers open and close on a horizontal planes. All palms and carpi, and the dorsal surfaces of the meri of both chelae spinose and hirsute. Meri of chelae large, compressed, with a relatively smooth outer surface. Chelae reach to bases of the dactyls of the second periopods. Finger tips hoof-shaped, corneous. Periopods two and three very similar - outer surfaces of meri and carpi smooth and relatively hairless; propodi and dactyls and all dorsal and ventral surfaces bear long, stiff hairs. The left periopods two and three are a bit more hirsute than the right. Claws of the second and third periopods long, curved, and corneous. Telson with both lobes equal; uropods a bit larger on left side.

HABITAT:

This species seems to be limited to water on the inner and outer reef flats, and almost always in the shells of Trochus niloticus. A relatively large, active, crab; it is found singly.

Clibanarius humilis (Dana, 1851)

Pagurus humilis

Dana, 1851:271.

Clibanarius humilis

Forest, 1953:443-446, figs. 1, 5.

Forest, 1956c:1055, 1057-1059.

MATERIAL:

6 males - CL 5.9 to 4.6 mm; 5 females - CL 4.5 to 3.7 mm. Shells - mostly in small, badly worn Strombus spp. From - Guam (Stat. 12).

DISTRIBUTION:

Members of this species are found from the Indian Ocean east to Indonesia, Fiji, and the Gilbert Islands, south to the Society, and Cook Islands, and north southern Japan.

COLOR IN LIFE:

Ground color of entire carapace dark olive green. Sides of posterior carapace lighter greenish gray. Forward lateral sides of shield darker than the rest of shield. Forward margin of shield white, and thickest behind lateral projections. Entire carapace with many white to light gray spots, with dark olive green in grooves. Ocular scales dark olive green fading at extreme distal margin to light gray green. Ground color of eyestalks dark orange with a brownish tint at the base, fading to white approximately four-fifths of the way to corneas which are black with small light green spots. On some specimens there is a whitish area at middle of dorsal surface of eyestalks towards the inner margin. Antennular peduncles dark

green, fading slightly at distal end of last segment; flagella light orange; hairs light yellow orange. Basal segments of antennal acicles dark olive green, distal segments light yellow orange. All but last segment of antennal peduncles dark olive green; distal segment and flagella orange. Mouth parts mottled light and dark olive green. Both chelipeds the same color; ground color of all segments brownish olive green; bases of meri lighter than distal ends; carpi and palms fairly uniformly brown olive green fading to light green brown on fingers; finger tips black. All segments of chelipeds have many light gray green spots on tubercles and spines. Periopods two and three the same color; meri with bright orange stripe along dorsal margins; sides of meri and ventral surfaces brown olive green; carpi fairly uniformly dark brown green, slightly lighter along outer side; propodi with bright orange stripe against a lighter orange background only on proximal half of segment; distal half of segment similar to carpi; dactyls uniformly light orange, but may be a bit darker on proximal, dorsal half; claw black. Periopods four and five mottled light orange, dark and light olive green. Abdomen transparent; olive green dorsally, red-orange along sides, light pink ventrally. Telson and tail segments light olive green. It is important to note that upon preservation the light olive green of carapace turns reddish brown, the corneas lose the small spots and the abdomen becomes uniformly dark reddish brown.

COLOR IN ALCOHOL (after two months):

Animals have faded little; live color patterns are still plainly visible. Carapace shield mottled light yellow brown and light

brown. There are darker patches on the forward sides of the shield, below the lateral projections. Posterior carapace nearly transparent; calcified parts are same color as shield. Ocular scales light brown fading to white at tips. Inner surfaces of bases of eyestalks pale white; outer surfaces and a wide band at middle of each stalk light red brown followed by a white band before corneas, which are black basally becoming transparent distally. Antennal acicles, peduncles and flagella and antennular peduncles and flagella very light yellow brown and white mottled, almost transparent. Chelipeds nearly uniformly light brown with lighter yellow brown on many small spines. Finger tips black. Periopods two and three are the same color; meri, carpi, and propodus light blue purple, darker dorsally; meri and propodi with an orange stripe on dorsal outer surfaces. Dactyls pale orange, darker dorsally; claws black. Periopods four and five very light gray white, almost transparent. Abdomen nearly transparent, whitish orange, calcified parts light yellow white.

DESCRIPTION:

Carapace shield only slightly longer than wide, appearing almost square. Rostrum small, pointed; barely exceeds lateral projections which are not as pointed. Anterior margin of shield between lateral projections and rostrum concave. Ocular scales small, triangular with two or three small spines at tergal margins. Eyestalks equal, not as long as forward margin of shield. Eyestalk length approximately four and half times the minimum diameter. Antennular peduncles, when fully extended, are longer than eyestalks. Antennal

acicles small, spinose; reach to distal ends of penultimate segment of peduncles. Chelipeds similar in shape; reach to distal ends of propodi of first walking legs. Spination similar on both chelipeds; there is a row of spines along the dorsal margins of the carpi and palms (this character is most evident on largest specimens); finger tips hoof-shaped and corneous. Periopods two and three with dactyls shorter than propodi. All segments generally smooth with a single small spine at dorsal distal margin of carpi and a row of very small spines along underside of forward part of dactyls; claws small, corneous. On the outer dorsal margin of the propodi of the third left periopod there is a slightly elevated ridge. This ridge is elevated slightly more than on the right periopod three and both second periopods. Periopods one, two, and three with long fine hairs, especially on distal segments. On larger specimens the left lobe of the telson is slightly larger; on small animals lobes are equal.

HABITAT:

Large and small aggregations of this species found in the intertidal zone, often exposed, out of the water. Individuals occupy a large variety of small, badly worn shells, and are associated with Clibanarius virescens and Calcinus laevimanus.

Clibanarius virescens (Krauss, 1843)

Pagurus virescens

Krauss, 1843:56, pl. 4, fig. 3.

Clibanarius virescens

Hilgendorf, 1878:821, pl. 3, fig. 11.

Barnard, 1950:435.

MATERIAL:

11 males - CL 3.2 to 8.2 mm; 7 females (3 ovigerous) - CL - 3.2 to 6.8 mm. Shells not recorded. From - Guam (Stats. 2a, 12).

DISTRIBUTION:

This species is known from the east coast of Africa through the Persian Gulf to Indonesia, south to Australia, and north to Japan and Viet Nam. This Guam record extends the known range of this species to the tropical western Pacific.

COLOR IN LIFE:

Ground color of entire carapace light olive green mottled with darker gray olive green and many dark gray to black spots. Forward margin of shield very light olive green with a small darker spot in center of rostrum. Forward lateral sides of shield dark olive green. On small animals entire carapace is much lighter in color and more uniformly light olive green to light grayish than large specimens. Ocular scales dark olive green, lighter on extreme distal margins. Eyestalks dark orange with a darker grayish tint along inner dorsal and terminal ends. A fine very light gray line separates corneas which are black with white spots. There are small blue areas on

ventral sides of eyestalks near bases, and towards midline of animal. Antennular peduncles bright blue dorsally, dark gray to brown ventrally, flagella and hairs on flagella dark orange. Antennal acicles and all but last segment of peduncles dark olive green with lighter areas on small spines, last segment of peduncle and flagella orange. Mouth parts mottled light and dark olive green. Ground color of all segments of both chelipeds dark olive green. Inner surface of meri with light blue tint. Soft tissue at joints between meri and carpi light blue. Carpi and palms olive green. Lighter olive green on ends of fingers before tips which are corneous and black. All segments of chelipeds with light olive green spots on spines. Peripods two and three have highly variable coloration but generally follow this pattern: On large individuals meri, carpi, and propodi almost entirely dark olive green with lighter olive green on spines and spots, there may be orange areas on dorsal proximal parts of each segment. Dactyls light orange proximally becoming light gray olive green before black claws. Smaller animals have a much larger percentage of orange on leg segments, especially on propodi which, in some cases, are entirely orange. Dactyls are light orange fading to very light green or gray before black claws. On some specimens periopod three, especially base of propodi, has a much larger percentage of orange than does periopod two. Periopods four and five mottled light and dark olive green, almost transparent on very small animals. Abdomen transparent light green to orange. Telson and tail segments light olive green. It is important to note that immediately upon preservation in alcohol light olive green areas on carapace turn to light orange brown.

COLOR IN ALCOHOL (after two months):

Live color patterns still plainly visible. Some animals are much more faded than others preserved at the same time. Darkest animals are colored as follows: Carapace shield light orange brown; a bit darker in center and behind lateral projections. Posterior carapace nearly transparent; most calcified parts are light yellow brown. Ocular scales orange brown at bases, darker brown distally. Eyestalks light orange brown at bases and along dorsal outer sides; dorsal inner sides and bands around corneas light purple blue; corneas black. Antennal peduncles and flagella light reddish brown, acicles brownish olive green, mottled. Antennular peduncles light blue purple. Chelipeds fairly uniformly dark olive green; lighter green on spines and fingers fades to light orange near black tips. Periopods two and three similar color: meri, carpi, and propodi all dark brown; proximal halves of propodi of left and right third periopods light orange brown. Dactyls of periopods two and three light white orange basally; distal thirds light blue, claws black. Periopod four mottled light blue and white. Periopod five white. Abdomen transparent light orange; hard parts yellow white. On more faded specimens all colors are lighter, especially carapace which is almost white with dark patches visible behind lateral projections. Periopods one, two, and three are all light orange brown; propodi of both periopods three with proximal halves almost white.

DESCRIPTION:

Carapace shield only a bit longer than wide. The ratio of length to width is approximately 9:8. The forward middle surface of shield covered with many small depressions; end and sides of shield are

smooth; a few tufts of long fine hairs along the sides of shield. Rostrum small and pointed; exceeds lateral projections which are rounded. Forward margin of shield between rostrum and lateral projections only slightly concave. Ocular scales small, triangular, close set, with three or four small spines at terminal margin. Eyestalks equal, approximately the same length as the forward margin of carapace shield. Antennular peduncles, when fully extended, reach to terminal ends of corneas. Eyestalks approximately six times longer than minimum diameter. Eyestalks cylindrical, only slightly inflated at bases and corneas. Antennal acicles reach to bases of last segment of peduncles. Acicles spinose and hairy with two small spines at terminal ends. Antennal flagella short, extend almost to ends of first walking legs. Left cheliped slightly larger and more spinose than right. Left cheliped extends just beyond middle of propodi of first walking legs, right a bit shorter. A strong spine at dorsal, distal margin of carpus of left cheliped is much less distinct on right. Carpi and palms of both chelipeds spinose and hairy. Periopods two and three with dactyls shorter than propodi, hairy on all segments. Distinct, raised ridge along dorsal margin of propodus of left periopod three; this segment is also flattened on outer surface. Other propodi of right periopods two and three and second left periopod rounded in cross-section, without strong dorsal ridge. Left lobe of telson slightly larger and longer than right.

HABITAT:

This species usually occurs in large aggregations at the high intertidal; where it commonly inhabits a large variety of shells. It is often associated with Clibanarius humilis and Calcinus laevimanus.

Genus Calcinus

Calcinus, with ten 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 porcellanous. 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 or hairs along the ventral margins of the propodi and dactyls of the third periopods. The function of the brush is not known, and does not occur 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 .... 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 .... 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 n. sp. 1

5(1). Left chelae very large, almost operculate, smooth. Dorsal margin of right chelae without serrations. Intertidal, very common ..... C. laevimanus

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 n. sp. 2

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 n. sp. 3

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

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 (Stats. 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-mid-line 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. SL), 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 preceeding 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 preceding 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 periopods 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 n. sp. 1

MATERIAL:

Holotype: Feb. 17, 1977. Adelupe 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. Adelupe 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 depressions. 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 balck. Periopods four and five white with very faded brown mottling.

DESCRIPTION:

Carapace (Fig. 7A) 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.

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. Antennal peduncles reach just beyond middle 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. 7B) 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 protuberence 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. 7C) 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 spoon-shaped 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.

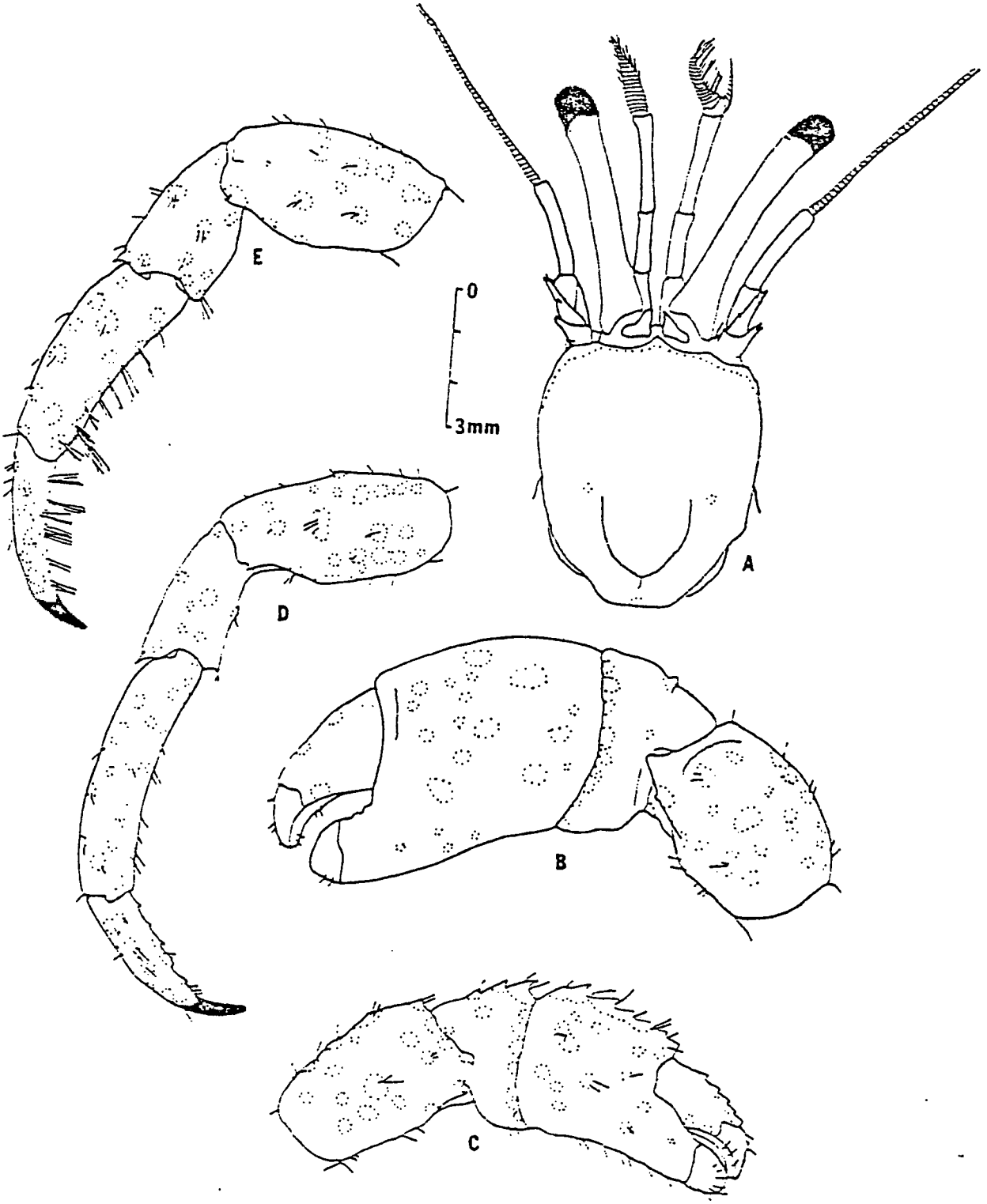

Figure 7. Calcinus n. sp. 1. A, carapace; B, left cheliped; C, right cheliped; D, left periopod 2; E, left periopod 3.

Both first walking legs (Fig. 7D) 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. 7E) 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 bruch of long, transparent hairs.

REMARKS:

Calcinus n. sp. 1 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 *Calcinus gaimardi* (H. Milne Edwards, 1848) (see Ball and Haig 1972;101 and Miyake 1956:326, text figs. 16, 17), *Calcinus elegans* (H. Milne Edwards, 1836) (see Miyake 1956:320, figs. 12, 13, and Lee 1969: 53, 54, text fig. 10), and *Calcinus imperialis* Whitelegge, 1901 (see pp. 48-51, fig. 52). The other Indo-West Pacific member of this group is *Calcinus vachoni* Forest, 1958 (see pp. 1-14, figs. 2, 3, 9, 10, 15) from Viet Nam. *Calcinus* n. sp. 1 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 *Calcinus* n. sp. 1.

There are a few important morphological and ecological differences between *Calcinus* n. sp. 1 and the four closely related species discussed above. *Calcinus elegans* has more and stronger spination on the inner lateral margins of the antennal acicles and considerably stronger tuberculation on the fingers and distal parts of the palms of both chelae than does *Calcinus* n. sp. 1. *Calcinus 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 Calcinus n. sp. 1.

Calcinus imperialis is another apparently intertidal species that, like Calcinus 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 Calcinus n. sp. 1. 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 Calcinus n. sp. 1.

Calcinus n. sp. 1 differs from Forest's description of Calcinus 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.

Calcinus gaimardi is perhaps the species that most closely resembles Calcinus n. sp. 1. Calcinus gaimardi is found intertidally and to a depth of approximately 10 m outside of the reef, where it is found with Calcinus n. sp. 1 which also occurs in deeper water. Calcinus 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 Calcinus n. sp. 1. 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 Calcinus n. sp. 1

the antennular peduncles reach a bit further and the left palm is less tuberculate and compressed than that of Calcinus gaimardi.

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 spot on inner and outer surface near proximal joint; band of 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 spines. 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.

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 distinct 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 meri 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 centers, 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 worked on by 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 n. sp. 2

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 *Mitra 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, darker in centers. Basal quarters of eyestalks 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. 8A) 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 tiny depressions; a distinct Y-shaped groove on middle, posterior portion, and a few very fine hairs along forward lateral margins.

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. 8B) is smooth and more elongate than on females and smaller males. On the females the left hand is somewhat

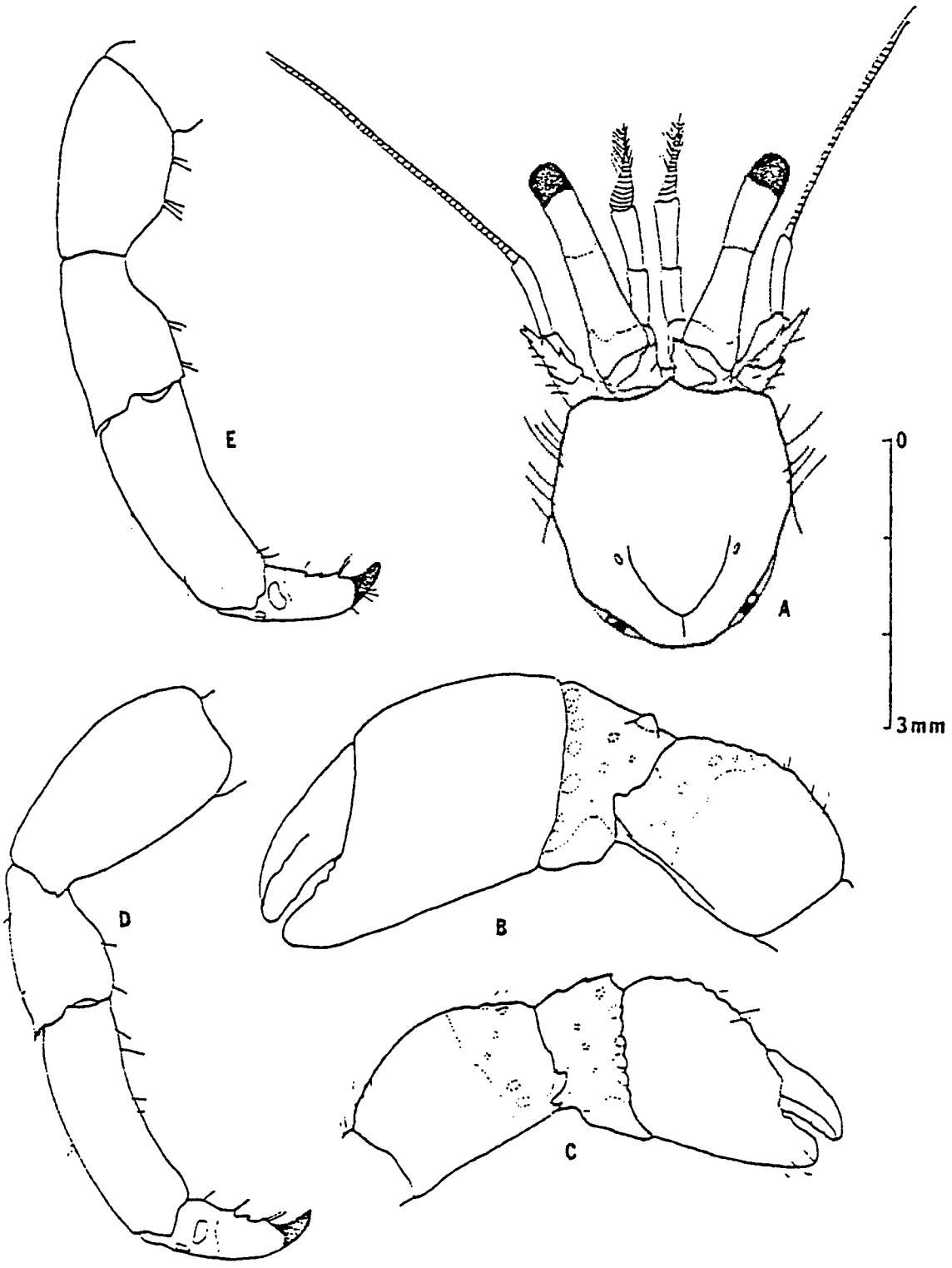

Figure 8. Calcinus n. sp. 2. A, carapace; B, left cheliped; C, right cheliped; D, left periopod 2; E, left periopod 3.

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 jaw on outer lateral margin; a few tufts of fine hairs on finger tips.

Right cheliped (Fig. 8C) 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. 8D) 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 tuberculate, distal halves smooth; approximately three small spines along the ventral margins before curved, corneous claws.

Left and right periopods three (Fig. 8E) 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 n. sp. 2 most closely resembles Calcinus rosaceus Heller, 1861 (see Forest 1956b:222-227, figs. 5-8), and to a lesser extent, Calcinus minutus Buitendijk, 1937 (see Forest 1958:1-14, figs. 1, 6-8, 14, 18, and Nakasone, 1975:1-6, fig. 1), and Calcinus nitidus Heller, 1865 (see Forest 1956b: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.

Calcinus n. sp. 2 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 eyestalks. 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. Calcinus n. sp. 2 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 Calcinus n. sp. 2 are much like those of C. rosaceus as described by Forest (1956b). 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 Calcinus n. sp. 2.

Both C. nitidus and C. minutus can be differentiated from Calcinus n. sp. 2 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 Calcinus n. sp. 2.

Calcinus n. sp. 3

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*.

February 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 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. 9A) 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

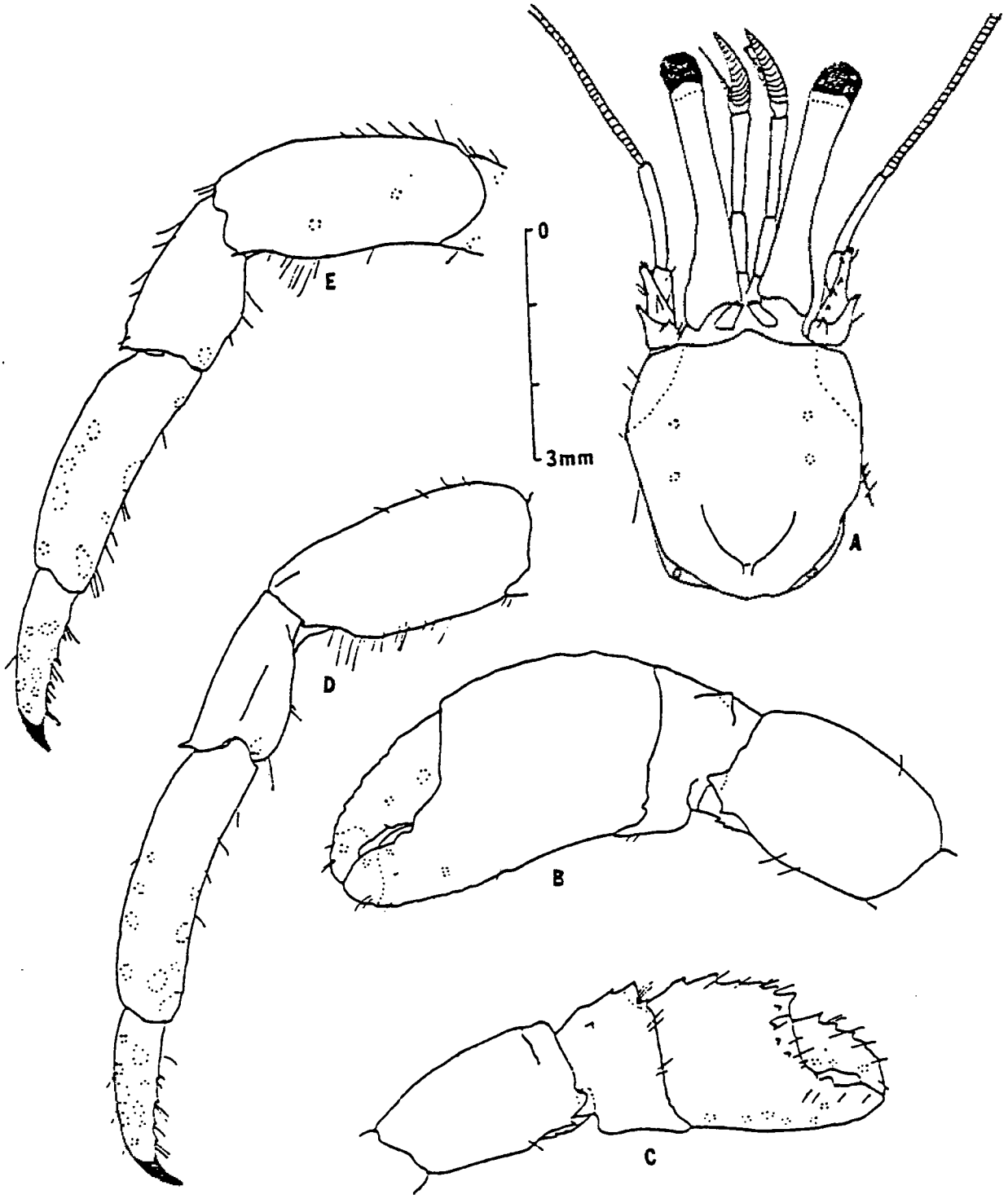

Figure 9. Calcinus n. sp. 3. A, carapace; B, left cheliped; C, right cheliped; D, left periopod 2; E, left periopod 3.

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 nearly 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. 9B) 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 tuberclate 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. 9C) 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. 9D) 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. 9E) 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 slightly shorter. Meri with single spines at distal ends of outer and inner ventral margins. Carpi smooth, with single prominent spines at dorsal, distal margine. 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 Aniculus n. sp., Calcinus n. sp. 4, and Calcinus minutus.

REMARKS:

Calcinus n. sp. 3 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.

Calcinus 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 Calcinus n. sp. 3 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. Calcinus n. sp. 3 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. Calcinus n. sp. 3 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 Calcinus n. sp. 3. The second and third periopods of Calcinus n. sp. 3 are noticeably longer and more slender than those of C. minutus.

Calcinus nitidus Heller, 1865 (see Forest 1956b: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 Calcinus n. sp. 3 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 Calcinus n. sp. 3 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 Calcinus n. sp. 3.

Calcinus rosaceus Heller, 1861 (see Forest 1956b:222-227, figs. 5-8) and Calcinus n. sp. 2 both resemble Calcinus n. sp. 3 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., *Cyprea* 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.

Genus *Dardanus*

All seven of the hermit crabs in this genus are the largest marine hermit crabs found in the Marianas. Only two species of *Aniculus* approach them in size. Occasionally, extremely large specimens of a few species of *Dardanus* are found in large, rare, mollusk shells such as *Charonis tritonis* and some of the large *Lambis* spp. Two species are usually found with stinging sea anenomes on their shells that help to protect them from predators. Both of these crabs, when disturbed, will run quickly while the anenome releases long stinging acontia. These two are able to utilize the light, brittle shells of *Tonna perdix* and the African land snail, *Achatina fulica*, probably because of the protection the anenomes provide from such animals as octopi and large wrasses. Most species are found singly and appear to be roaming about within a specific zone of the reef. Two species are common both on the reef flat and in deeper water outside of the reef, though smaller organisms reside on the reef flat.

All species of the genus are large and hairy. The genus is divided into two groups on the basis of the appearance of the eyestalks. These are long and slender on most Marianas species; otherwise they are short and broad with the corneas inflated. The two Marianas species that belong to the latter group are also a bit less hairy than the others and are the only species which are usually found carrying anenomes on their shells. All *Dardanus* have the carapace shield well calcified, and the usual rostrum is replaced by a movable rostral scale. There is a setose, fleshy or partly calcified spur present behind the third pleopod on both sexes and there are fourteen pairs of gills. On all but one Marianas species the left cheliped is larger than the right. On one species, *D. guttatus*, the chelipeds are subequal and the carapace is greatly

flattened enabling the animal to utilize shells such as Conus and Cyprea spp. On many species of Dardanus the outer surface of the propodus and dactyl of the third left periopod is flattened and hairless, much more so than on the other periopods.

KEY TO THE SPECIES OF DARDANUS FROM THE MARIANA ISLANDS

1. Eyestalks extend very nearly to or even surpass the ends of the antennular peduncles. Corneas never occupy as much as one third of the total length of the stalks. Eyestalks not ringed with bands of color except sometimes adjacent to corneas. Shell usually without anemones 2

Eyestalks short and broad, never reach to the ends of the antennular peduncles. Corneas occupy a third or more of the total length of the stalks. Eyestalks ringed by bands of color. Shell usually with anemones 6

2(1). Carapace greatly flattened. Chelipeds small and subequal. Animal inhabits shells with flattened apertures such as Conus and Cypraea spp. ..... D. guttatus

Carapace not greatly flattened. Left cheliped larger than right. Inhabits shells with round apertures 3

3(2). Outer surface of last segments of third left periopod greatly flattened, almost concave in cross section, without hairs. Left chelae elongate 4

Outer surface of last segments of third left periopod not greatly flattened; convex in cross section, with hairs. Left chelae large but not especially elongate 5

4(3). Antennal peduncles reach to the middles of the corneas. Last segment of the antennal peduncles without distinctive longitudinal brown stripe on dorsal surface. Left chelae approximately one and one half times longer than wide. Found outside of the reef in clear, clean water .... D. crassimanus

Antennal peduncles do not reach corneas. Last segment of antennal peduncles with stripe. Left chelae very elongate, approximately twice as long as wide. Found in calm or stagnant water inside the reef ..... D. scutellatus

5(3). Entire animal is bright reddish orange with many black-bordered white spots. Antennal flagella white. Eyestalks dark reddish orange with a thin white line separating black corneas. Left cheliped larger and longer than right .... D. megistos

Animal is not reddish orange with white spots. Antennal flagella light greenish yellow. Eyestalks grayish purple with a thin yellow line separating black corneas. Left cheliped larger but not especially longer than right .... D. lagopodes

6(1). Lower, outer half of the palm of the left hand is smooth. Outer surface of the propodus and dactyl of the third left periopod is greatly flattened; a hard ridge along the dorsal margins of these segments. Eyestalks banded black at bases followed by yellowish green and a darker brownish band before large yellow green corneas .... D. deformis

Lower, outer half of palm of the left hand with many large tubercles. Last segments of third left periopod are not greatly flattened; similar to right third and both second periopods. Eyestalks banded with a red base followed by white then red again before large silver gray corneas ..... *D. gemmatus*

Dardanus guttatus (Oliver, 1911)

Pagurus guttatus

Oliver, 1811:640, pl. 311, fig. 2.

Alcock, 1905:87, pl. 9, figs. 26, 27.

Fize and Serene, 1955:173-182, figs. 26, 27.

Dardanus guttatus

Lee, 1969:49, 50, fig. 8.

MATERIAL:

12 males - CL 7.0 to 47.5 mm; 6 females - CL 6.3 to 23.7 mm. Shells - Lambis sp., Conus spp., Cyprea spp. From - Maug (Stats. M1, M6), Pagan (Stat. P5), Guguan (Stat. GU1), Tinian (Stat. T1), Guam (Stats. 1, 2e, 2h, 13, 15).

DISTRIBUTION:

This species is known from the east coast of Africa and Indian Ocean to Philippines, Viet Nam, north to Taiwan, the Ryukyus, and east and south to Fanning and the Marshall Islands.

COLOR IN LIFE:

Forward and side margins of carapace shield brown with many large, white, irregular spots. The rest of shield is light sky blue with some narrow brown and white spots in grooves. Posterior end of shield greenish blue with some white spots. Sides and posterior part of posterior carapace brown with white spots and some elongate brown patches just inside of lateral borders. Two distinct brown spots with white centers in middle of posterior carapace. Ocular scales brown with white spots. Eyestalks yellowish olive green with

narrow white band separating black corneas. Antennal acicles and all but last segment of peduncles brown with white spots; last segment of peduncles and all of flagella olive green. Antennules olive green fading distally to yellowish olive green flagella. Mouth parts brown with white spots. Ventral surface of abdomen white, side and dorsal surfaces brown with white spots. Pleopods, telson, uropods, brown with white spots. Rasps on uropods greenish brown. All segments of chelipeds brown with white spots, hairs many. Finger tips black. Distinct light sky blue patch on dorsal surface of carpi of both chelipeds and periopods two and three. Periopods two, three, four, and five very hairy; brown with white spots. Claws of periopods two and three black. Entire animal with white tipped brown hairs.

COLOR IN ALCOHOL (after 13 months):

Carapace shield, posterior carapace and all of abdomen brownish white. There is a darker brownish tint on forward shield and posterior margins of abdominal terga. Ocular scales white. Eye-stalks light yellow with narrow white band separating black corneas. Antennal acicles and peduncles and flagella and mouth parts white. Periopods one, two, and three with all segments reddish brown with many irregular shaped white spots. Distinctive large white patch on dorsal surface of carpi of first three periopods. Claws of periopods two and three and tips of chelae black. Periopods four and five mottled white and light reddish brown. All hairs yellowish and white.

DESCRIPTION:

Entire animal forward of abdomen dorsoventrally flattened. Carapace shield slightly longer than wide. Eyestalks stout, extend to ends of antennular peduncles. Chelipeds subequal with left only slightly larger and longer. Both chelipeds extend approximately to middle of dactyls of first walking legs. Left and right periopods two are not the same; outer surface of propodus and dactyls of left periopod two flattened with hard ridges along dorsal and ventral margins, cresent-shaped in cross section. Right periopod two similar to both periopods three rounded in cross section. Coxae of periopods four and five fairly widely separated with elongate sternites.

HABITAT:

This crab inhabits shells with narrow apertures such as Lambis, Conus, and Cypraea spp. Small individuals are moderately common on the reef flat where small animals are found and are usually quite active. Larger animals are found outside the reef. One very large animal (CL 47.5 mm) was found in a Lambis shell; this may indicate that the size of the animals in the Marianas may be limited by the availability of suitable mollusk shells.

Dardanus crassimanus (H. Milne Edwards, 1836)

Pagurus crassimanus

H. Milne Edwards, 1836:277.

Pagurus setifer

Haan, 1849:209.

Pagurus sculptipes

Stimpson, 1858:246.

Pagurus (s. s.) pavimentatus

Hilgendorf, 1878:816, pl. 3, figs. 1-5.

Dardanus crassimanus

Buitendijk, 1937:55.

Lee, 1969:49, fig. 7.

MATERIAL:

5 males - CL 5.6 to 19.7 mm; 10 females (3 ovigerous) - CL 6.7 to 14.5 mm. Shells - Trochus spp. and others. From - Uracas (Stat. U1), Asuncion (Stats. AS1, AS4), Pagan (Stats. P2, P4, P5, P6), Guguan (Stats. GU1, GU2), Anatahan (Stat. AN2), Guam (Stats. 2h, 14).

DISTRIBUTION:

This species has been reported from East Africa to Korea, Taiwan, and Japan. This new record from the Mariana Islands extends the known range to the tropical western Pacific.

COLOR IN LIFE:

This species seems to occur in two color varieties. In Guam the common one is a light colored form whereas in the northern islands,

and rarely on Guam, a dark form exists. In alcohol the two forms are quite similar. The difference in colors may somehow be related to the difference in habitat between Guam and the northern islands; in Guam the animals are found on generally light colored limestone reefs whereas in the northern islands the animals are found on very dark volcanic substrate. Light variety: carapace shield mottled light cream white and light orange; light orange patches on middle, inner sides. Posterior carapace cream white and red mottled; transparent yellowish distally. Rostrum, antennal acicles and bases of peduncles cream white with sparse reddish mottling; last segment of antennal peduncles and flagella yellowish green; antennular peduncles mottled red and white basally; flagella and distal segments of peduncles yellowish green. Eyestalks grayish white with a thin yellow area before black corneas. Ground color of all periopods grayish cream white with darker reddish brown mottling; outer surfaces of carpi of periopods two and three with large orange red patches; finger tips black. Hairs on periopods brownish red basally, white distally. Abdomen transparent yellowish, lighter ventrally; tail parts grayish cream white. Dark variety: abdomen, posterior carapace, all periopods and most of shield mottled cream white and dark brownish purple. Dorsal, proximal surfaces of carpi of periopods two and three and a large spot on middle of carapace shield smooth, black. Middle outer surfaces of carpi and meri of chelipeds with dark red patches; two small red spots on shield, behind much larger black area. Eyestalks purplish with thin yellow area before black corneas. Antennular peduncles, flagella and distal segments of antennal peduncles, and all of antennal flagella transparent

yellow brown. Ocular scales, antennal acicles and bases of peduncles mottled cream white and brownish purple. Ventral surface of abdomen transparent whitish; tail segments mottled white and purple; telson nearly white.

COLOR IN ALCOHOL (after one year):

Carapace shield very light pinkish white with light reddish brown spots, large reddish brown patch behind ocular acicles. Posterior carapace white with some reddish brown on most anterior part. Abdomen, pleopods, and abdominal terga white; some reddish brown at bases of uropods and sides and terminal margin of telson. Ocular acicles light pinkish white with some darker reddish brown spots on distal margin. Eyestalks light pinkish, turning yellow just before black corneas. Antennal acicles and bases of peduncles pinkish white with some reddish brown, distal segments of peduncles and flagella white. Antennular peduncles and flagella white. The first three periopods pinkish white with some reddish brown; with distinct reddish brown patch on the dorsal surfaces of the carpi. Spines on the first three periopods white basally, some with dark brown, corneous tips. Hairs on periopods light brown basally, white distally. Finger tips of chelae and claws of periopods two and three dark brown or black. Periopods four and five mottled pinkish white and darker reddish brown.

DESCRIPTION:

Length and width of carapace shield nearly equal. Lateral projections exceed anterior margin between them which is slightly convex. Shield smooth with only a few minute depressions. Rostral scale

small. Ocular scales roughly fan shaped, widest at terminal margins with hairs and spines at anterior margins on inner sides. Antennal and antennular peduncles extend to middle of corneas of eyestalks. Eyestalks are approximately four-and-a-half times longer than their minimum diameters. Bases of antennal peduncles and all of acicles hirsute and spinose. Left cheliped much larger and longer than right; extends to the middle of the dactyl of the first left walking leg. Left palm elongate, approximately one-and-a-half times longer than the maximum width. Dorsal and outer surfaces of left palm with many corneous tipped spines, inner surface smooth. There is a hard ridge along ventral margin of palm. Dorsal surface of propodus with a few large spines. Right cheliped small, hirsute and spinose, extends to base of the dactyl of right first walking leg. Dorsal margin of right palm with two parallel rows of corneous tipped spines. Finger tips of both chelae corneous. Right periopods two and three and left periopod two are all quite similar; all segments rounded in cross section with hairs on dorsal and ventral margins and all of dactyls. Dorsal distal margin of carpi with a few large corneous-tipped spines. Middle outer surfaces of carpi especially smooth. Merus and carpus of left periopod three similar to other periopods two and three. Propodus and dactyl greatly flattened with a definite raised longitudinal medial ridge along middle of outer surface of propodus. Propodus and dactyl concave, cresent-shaped in cross section. Dactyl is approximately six-fifths times longer than propodus. Propodus and dactyl with very hard dorsal and ventral ridges on margins. Outer surface of both dactyls and propodi hairless. Claws on all periopods two and three corneous.

Left lobe of telson may be larger and longer than right, though this is a variable character.

HABITAT:

Individuals of this species are found on the reef front, usually at depths between five and fifteen meters. On Guam the animal is rare, perhaps because of the large numbers of the larger species, D. lagopodes, which occupy Trochus niloticus shells on Guam. On the islands north of Saipan, D. crassimanus is quite common and large specimens of D. lagopodes cannot be found, presumably because of the lack of suitable shells.

Dardanus scutellatus (H. Milne Edwards, 1848)

Pagurus scutellatus

H. Milne Edwards, 1848:62.

Fize and Serene, 1955:189-195, fig. 29.

Pagurus fabimanus

Dana, 1851:270; 1855:454, pl. 28, figs. a, c.

Dardanus fabimanus

Buitendijk, 1937:273, figs. 18, 19.

Dardanus scutellatus

Buitendijk, 1937:273, figs. 16, 17.

MATERIAL:

3 males - CL 9.9 to 18.7 mm; 4 females (2 ovigerous) - CL 11.3 to 13.7 mm. Shells - Strombus spp., Cerithium sp., Trochus spp. From - Guam (Stats. 4b, 11, 14).

DISTRIBUTION:

This species is distributed from the east coast of Africa and Indian Ocean to the Philippine Islands, Indonesia, south to Australia and Society Islands, east to the Gilbert, and Marshall Islands, and north to the Bonin and Ryukyu Islands.

COLOR IN LIFE:

Ground color of carapace shield gray olive green and brown mottled; smooth area on anterior; middle of shield is brown with small blue spots. Posterior carapace mottled olive green, white, and brown. Ocular acicles and dorsal surfaces of eyestalks olive green, ventral surfaces of eyestalks white. A thin yellow line on dorsal ends of

eyestalks separates corneas which are black proximally and silver gray distally. Antennal acicles and basal segments of peduncles mottled olive green, white and brown; last segment of peduncles dark brown on dorsal and ventral surfaces; laterally light olive green; flagella olive green. Antennular peduncles with dark brown longitudinal stripes on dorsal and ventral surfaces; sides white, yellow orange tint on joints; flagella and hairs orange. Mouth parts mottled olive green, white and brown. Ventral surface of abdomen white, lateral and dorsal surfaces whitish gray with fine orange mottling and some larger whitish spots and more defined orange lines on dorsal surface. Abdominal terga and tail segments mottled olive green, white and brown similar to posterior carapace; rasps on uropods brown orange. All periopods similar with all segments mottled brown and gray olive green with many red hairs. Tips of chelae and claws on periopods two and three corneous, black. Dorsal surfaces of carpi and meri of periopods one, two, and three with darker brown patches similar to anterior, middle of carapace shield. Outer palm of large left cheliped usually with sediment obscuring color. Coxa and sternite of periopods olive green and white mottled.

COLOR IN ALCOHOL (after 13 months):

Front half of carapace shield brownish orange with white spots. Rear portion of shield, posterior carapace, and all parts of the abdomen grayish white. There are some small brownish orange patches on the most anterior parts of the posterior carapace. Ocular scales light brownish orange. Basal four-fifths of the eyestalks grayish purple dorsally, lighter ventrally. Distal fifth of eyestalks light

yellow. Corneas black. Antennal acicles, peduncles, and flagella and antennular peduncles and flagella whitish yellow. There is a distinctive dark brown orange stripe on the dorsal surface of the last segment of the antennal peduncles. First three periopods all similarly colored. All surfaces light brownish orange, darker dorsally. Finger tips and claws black. Periopods four and five mottled light brownish orange and white. Hairs on entire animal very light brownish orange.

DESCRIPTION:

Carapace shield slightly longer than wide. Lateral projections exceed anterior margin between them which is slightly convex. Shield smooth and nearly hairless with a few small depressions on forward surfaces. Rostral scale very small with a few hairs. Ocular scales large, widest at anterior margins, with a few hairs and spines along anterior margins. Eyestalks longer than antennal peduncles, which extend only to middles of the corneas. Eyestalks approximately four-and-a-half times longer than the minimum diameter of stalks. Bases of antennal peduncles with a strong spine at outer, distal surfaces. Antennal acicles spinose, extend to bases of last segment of peduncles. Left cheliped is much larger and longer than right, extending to middle of dactyl of the left first walking leg. Left palm very elongate, approximately twice as long as greatest width. Dorsal surfaces of palm and movable finger spinose. Outer surface of palm with many smaller spines. Hard ridge along lower margin of palm. Inner surface of palm smooth. Right cheliped small, hirsute, and spinose, extends to middle of propodus of right first walking leg. Finger tips of both chelae corneous. Right periopods two and

three and left periopod two are similar: all segments rounded in cross section with a few hairs and spines along dorsal and ventral surfaces and over all of dactyls. Left periopod three propodus and dactyl with outer surfaces flattened. Outer surface of propodus not concave. Both propodus and dactyl hairless on the outer, flattened surface. Outer surface of dactyl concave, almost cresent shaped in cross section. Dactyl is approximately eight-fifths longer than propodus. Claws of periopods two and three corneous. Left lobe of telson may be larger and longer than right, though this seems to be a variable character.

HABITAT:

This species is common in areas where the water is shallow and slow moving, and often low in salinity. It often occurs in stagnant, polluted areas. It inhabits a large variety of shells, but most often occupies Trochus niloticus. Individuals are found singly or in small aggregations.

Dardanus megistos (Herbst, 1804)

Cancer megistos

Herbst, 1804:23, pl. LXI, fig. 1.

Pagurus punctulatus

Oliver, 1811:641.

Alcock, 1905:81, pl. 8, fig. 1.

Pagurus spinimanus

H. Milne Edwards, 1848:61.

Pagurus megistos

Fize and Serene, 1955:150-156, fig. 24.

Dardanus megistos

Forest, 1956a:48.

MATERIAL:

13 males - CL 7.0 to 49.1 mm; 2 ovigerous females - CL 24.7, 74.4 mm. Shells - *Trochus niloticus*, *Charonia tritonis*, *Achatina fulica*. From - Guam (Stats. 2d, 2e, 2c, 4a, 5c, 6, 8a, 12).

DISTRIBUTION:

This species is known from the east coast of Africa through the Indian Ocean to western Australia, Indonesia and Philippines, south in the Pacific Ocean to the Great Barrier Reef and the Society Islands and east to the Hawaiian Islands and Line Islands.

COLOR IN LIFE:

Carapace shield bright reddish orange covered with white spots bordered by black. Forward margin of shield with a row of white spots bordered by black. Ocular scales brownish orange with a

darker area in center and at distal margins. Eyestalks dark red with a narrow white line separating dark brown, almost black, corneas. Antennular peduncles orange. Antennal peduncles orange, flagella white. All periopods, abdomen and telson bright reddish orange with white spots bordered by black on calcified areas; without black borders on the soft parts of the abdomen. Red hairs present along distal segments of periopods and forward margin of carapace.

COLOR IN ALCOHOL (after two years):

Colors similar to in life but faded. Carapace shield, anterior part of posterior carapace, tail segments, and periopods one through five all light orange with many fairly evenly spaced white spots that are bordered by black. Posterior part of posterior carapace and soft parts of abdomen whitish. Ocular scales, antennal acicles, and peduncles orange with white on spines. Eyestalks dark reddish borwn with a narrow gray line separating black corneas. Antennal flagella white. Periopods and lateral and forward margins of carapace with orange hairs. Claws of periopods and finger tips of chelae black.

DESCRIPTION:

Carapace shield longer than wide. Rostral scale blunt, does not exceed lateral projections which are sharper than scale. Ocular scales large, usually with four small sharp spines along terminal margins. Eyestalks large, expand distally. Eyestalks equal, approximately five times longer than the minimum diameter of stalk. Antennal acicles with a few large spines. Antennal flagella long.

Antennular peduncles extend fully, slightly beyond corneas. Left cheliped much larger and longer than right. Both chelipeds very hairy and spinose, especially on outer surfaces. Tips of chelae hoof shaped, corneous. Periopods two and three with left and right sides the same except for the left third periopod propodus and dactyl which may be a bit flattened on outer surface. Periopods two and three less hairy than chelipeds. Telson with both lobes equal.

HABITAT:

This large and active species is usually found singly on shallow reef flats and lagoon areas. Smaller specimens are usually found on the inner reef areas, larger ones deeper, rarely outside reef. Individuals are found in Trochus niloticus shells. One very large animal (CL 74.4 mm) was found in a Charonia tritonis shell, which suggests that perhaps the availability of suitable shells may limit the ultimate size of the animals.

Dardanus lagopodes (Forskal, 1775)

Cancer lagopodes

Forskal, 1775:93.

Pagurus sanguinolentus

Quoy and Gaimard, 1824:532, pl. 79, fig. 2.

Fize and Serene, 1955:159, 166, pl. 4, figs. 4, 5, text fig. 25.

Pagurus affinis

H. Milne Edwards, 1836:274.

Pagurus depressus

Heller, 1861:22.

Pagurus euopsis

Dana, 1852:452;1855; pl. 28, figs. 6 a-c.

Alcock, 1905:80, 86, pl. 9, fig. 2.

Dardanus lagopodes

Lewinsohn, 1969:32, pl. 12.

Ball and Haig, 1972:92, 93.

MATERIAL:

14 males - CL 8.6 to 33.0 mm. 5 females (1 ovigerous) - CL 11.2 to 18.8 mm. Shells - Trochus niloticus, Cerithium sp., Turbo sp. From - Maug (Stat. M1), Asuncion (Stat. AS3), Alamagan (Stat. AL1), Guguan (Stats. GU1, GU2), Anatahan (Stat. AN1), Saipan (Stat. S1), Tinian (Stat. T1), Guam (Stats. 2e, 2h, 4b, 5a, 14).

DISTRIBUTION:

This species has been reported from the east coast of Africa, Indian Ocean, Persian Gulf to Indonesia, and the Philippines, and

to Australia, the Society, east to Hawaiian Islands and north to Japan.

COLOR IN LIFE:

In the Mariana Islands two color varieties of this species occur. The lighter variety is considerably more common than the dark one, especially on Guam. On the more northern Mariana Islands, where large animals are rare, specimens were collected and preserved before live color notes could be taken. It is not known if the darker variety is more common on the northern islands; in alcohol the varieties are very much alike. Light variety--ground color of carapace shield light purple with much white and reddish brown mottling; a smooth, dark bluish purple area on forward center of shield. Posterior carapace dark orange brown with white spots of various sizes, especially in longitudinal grooves. Entire animal except abdomen with numerous white and brown banded hairs. Ocular acicles mottled brown and white. Eyestalks grayish purple with bright yellow bands separating black corneas. Antennal acicles and bases of peduncles mottled white and reddish brown; distal two segments of peduncles and flagella yellow-green. Mouth parts reddish brown with white spots and mottling. Ground color of both chelipeds purplish with much reddish brown and white mottling; finger tips and some spines corneous, dark brown. Ground color of periopods two and three light purple with poorly defined darker stripes running lengthwise, some white to light purple spots. Dorsal surfaces of carpi and dorsal distal surfaces of meri with smooth dark purple patches; claws black. Periopods four and five reddish brown with white mottling and spots. Abdomen transparent

reddish with many white spots. Terga, pleopods, and tail segments reddish brown with white mottling and spots. Dark variety--entire animal blackish purple. Carapace shield purple with darker blackish purple area on middle anterior. Posterior part of shield with a few white spots and dark purple mottling. Ocular scales, antennal acicles and bases of peduncles, and mouth parts, dark purple with white spots. Last segment of antennal peduncles and all of flagella and antennular peduncles and flagella olive green. Last segment of antennular peduncles dark brown on dorsal margin. Eyestalks light purple fading to yellow before black corneas. Hairs on entire animal dark purple with white bands and spots. Periopods one, two, and three mottled light and dark purple and white. Finger tips and claws black. There may be white spots at bases of some hairs on all segments. Distal halves of meri and all of carpi with outer surfaces smooth, dark blackish purple; propodi with three poorly-defined dark purple stripes on dorsal and ventral margins and outside middle surface. Stripes not visible on left periopod three propodus. Abdomen transparent dark purple; ventral surface whitish, dorsal surface and sides with many white spots. All calcified parts of abdomen dark purple with white spots; telson grayish.

COLOR IN ALCOHOL (after 13 months):

Live color patterns still visible though it is nearly impossible to tell the two color varieties apart. Posterior carapace shield light purple. Most of forward shield with a darker purple patch. Ocular scales and antennal acicles and peduncles light yellow-white with reddish brown spots and patches. Eyestalks light yellow, corneas black. All periopods light yellowish brown with extensive

reddish brown spots and mottling. Dorsal outer surfaces of carpi and meri of periopods two and three, and to a lesser extent chelipeds, with a darker reddish patch similar to the one on the forward carapace shield. Propodi and dactyls of periopods two and three with poorly defined reddish brown stripes. Hairs on entire animal light brown basally fading to white distally. Tips of chelae and claws of periopods two and three black. Abdomen and posterior carapace transparent yellowish.

DESCRIPTION:

Carapace shield longer than wide. Lateral projections small, triangular, with a few small hairs and spines at distal margins. Rostral scale small with two small spines at terminal margin. Ocular scales large, wide-set, and roughly fan-shaped. Eyestalks equal, longer than forward margin of carapace shield. Eyestalks approximately seven times longer than the minimum diameter of stalk. Antennular peduncles, when fully extended, reach to margins of eyestalks and corneas. Antennal acicles and bases of peduncles with a few large spines and long hairs. Left cheliped larger but only a bit longer than right. Outer surfaces of both chelae with many spines and long stiff hairs, inner surfaces smooth. Tips of fingers of chelae and claws of periopods two and three corneous. Periopods two and three relatively smooth and hairless on outer surfaces of all segments except propodus and dactyl of the third left periopod, which are hirsute and somewhat flattened. Dorsal and ventral surfaces of all segments of periopods two and three hairy. There is a large, single, corneous-tipped spine on the

dorsal, distal margin of the carpi of both periopods two and three. Telson with left lobe larger.

HABITAT:

This species is moderately common and is usually found on reef front at depths between five and twenty-five meters, singly or in pairs. Nearly always found in Trochus niloticus shells. The lack of Trochus niloticus in the more northern Mariana Islands may explain the smaller size of these animals, which are usually found in Turbo sp. shells.

Dardanus deformis (H. Milne Edwards, 1836)

Pagurus deformis

H. Milne Edwards, 1836:272, pl. 13, figs. 4, 4a.

Alcock, 1905:81, 88, pl. 9, fig. 4.

Forest, 1953:556, 557.

Fize and Serene, 1955:159, 199, pl. 4, fig. 6, text figs. 31, 33, E, F.

Pagurus cavipes

White, 1847:122.

Dardanus deformis

Ball and Haig, 1972:93, 94.

MATERIAL:

2 males - CL 21.2, 26.0 mm; 12 females (1 ovigerous) - CL 12.8 to 21.3 mm. Shells - Turbo sp., Tonna perdix, Achatina fulica. From - Saipan (Stat. S1), Guam (Stats. 2d, 2e, 5d, 8b, 12).

DISTRIBUTION:

This species is known from the east coast of Africa and Indian Ocean to Indonesia, the Philippines, to Australia and the Society Islands, east to the Marshall, and Hawaiian Islands, and north to the Ryukyu Islands.

COLOR IN LIFE:

Ground color of carapace shield olive green with some yellowish white spots and a few smaller orange brown spots and yellow hairs. Posterior carapace similar to shield with gold-yellow in lateral grooves and a few white spots. Ocular scales olive green, lighter

basally. Bases of eyestalks yellow followed dark gray or brown followed by a light gray white and another more narrow dark band separating corneas which are yellow gray. Antennal acicles and basal segments of peduncles olive green with white patches; last segment of peduncles and flagella lighter olive green. Antennular peduncles and flagella olive green, hairs on flagella light orange. Abdomen transparent, light gray-green to brown ventrally, light brown dorsally. Abdominal terga light olive green. Telson and tail segments darker olive green with very small orange spots in depressions. All periopods similar in color surfaces light and darker olive green mottled, especially inner and ventral surfaces, outer and dorsal surfaces similar but with cream white tint. Outer palm of left cheliped cream white. Extremely fine reddish brown lines in tiny depressions on outer surfaces of periopods. Tips of chelae and claws of periopods two and three dark brown. Undersides of anterior body light cream white.

COLOR IN ALCOHOL (after 18 months):

Carapace shield, ocular scales, antennal acicles and peduncles with a light brownish yellow ground color and a slightly darker pinkish tint in some areas. Eyestalks banded with gray brown around base followed by a larger, light yellow brown area and then a slightly darker patch before black corneas. Periopods one, two, and three with pale yellow brown ground color, lighter on ventral surfaces, dorsal and outer surfaces with a darker purple tint on most surfaces; tips of chelae and claws of periopods two and three black. Tail segments light brownish yellow. Posterior carapace and abdomen transparent yellowish.

DESCRIPTION:

Carapace shield almost square, slightly longer than wide. Ocular scales large with a few large spines. Eyestalks stout, shorter than antennular peduncles, extend to ends of antennal peduncles. Left cheliped larger and longer than right. Dorsal margin of left palm spinose with a few parallel rows of spines on upper outer surface; lower outer surface of palm smooth without spines or hairs; inner surface with a few hairs. Right cheliped small with spines and hairs on all surfaces. Tips of both chelipeds and claws of periopods two and three corneous. Periopods two and three different on left and right sides. Right periopods two and three with all segments rounded or elliptical in cross section; dorsal and ventral margins not sharply defined. Propodi and dactyls of left periopods two and three cresent shaped in cross section, dorsal and ventral margins hard.

HABITAT:

Individuals of this species are not common. They are found in calm slow moving water on inner and outer reef flats. They are often active at night with D. gemmatus. This crab carries the sea anenomes Calliactis polypus and Sagartiomorpha paguri which stream long stinging (acontia) filaments when the crab is disturbed. These hermit crabs are found singly or in small groups of up to four animals. They inhabit the strong, light shells, most often Tonna perdix. The presence protective of the sea anenomes may enable the crab to carry the light shells.

Dardanus gemmatus (H. Milne Edwards, 1848)

Pagurus gemmatus

H. Milne Edwards, 1848:60.

Forest, 1953:557, figs. 10, 11.

Dardanus gemmatus

Dechance, 1964:33.

MATERIAL:

4 males - CL 24.0 to 40.8 mm; 1 female - CL 24.8 mm. Shells - Tonna perdix. From - Guam (Stats. 4a, 7).

DISTRIBUTION:

This species is widely distributed from Indian Ocean to Indonesia, eastward to the Society, Marquesa, and Hawaiian Islands to Laysan.

COLOR IN LIFE:

Carapace shield brownish orange with a darker patch on forward middle surface. Posterior carapace transparent, brownish. Rostral scale, antennal acicles, peduncles and flagella, and antennular peduncles pale purple-brown. Eyestalks banded with white at bases, then a wide blood-red layer, a narrow white and then wide red band, terminating in the black to silver gray corneas. Chelipeds with pale orange hands and a darker purplish tint on the dorsal surfaces of the carpi. Finger tips black. Periopods two and three with basal segments pale purplish orange, darker on distal segments; all segments with fine longitudinal orange lines. Claws black. Abdomen transparent purple brown; terga golden brown with darker bars at middle of each segment running perpendicular to midline.

COLOR IN ALCOHOL (after 18 months):

Carapace shield pinkish white, darker along forward margin and anterior center. Ocular acicles, antennal acicles and peduncles same color as shield. Eyestalks reddish borwn with a thin white band circling the middle of each stalk; another thinner white band separates black corneas. The first three periopods light whitish brown with darker purple tint on dorsal and outer surfaces. Tips of chelae and claws of the second and third periopods black. Posterior carapace, abdomen, and tail parts yellowish white. Hairs on entire animal yellow.

DESCRIPTION:

Carapace shield nearly square, slightly longer than wide. A brush of short hairs is present just inside of anterior margin of shield, at midline. Rostral scale with two small hirsute spines at terminal margin. Ocular acicles large, wide-set, with a row of small, sharp spines along terminal margins. Eyestalks short and stout; corneas inflated. Eyestalks approximately twice as long as minimum diameter. Antennal acicles with small sharp spines. Left cheliped much larger and longer than right. Left cheliped with hairs on inner surfaces only; outer ventral, medial and dorsal surfacew with parallel rows of spines; spines largest along dorsal margin. Right cheliped with small, elongate hand; all segments less spinose than left cheliped. All surfaces of right cheliped without hairs. Tips of fingers of both chelae corneous. Second and third periopods similar; all segments smooth on outer surfaces, spinose dorsally with hairs on dorsal, inner, and ventral surfaces only. Right and

left third periopods similar except for dactyls; outer surface of the left periopod three dactyl is flattened, more than that of the right. Right third periopod is like the second periopods. Claws of second and third periopods curved, corneous. Telson with left lobe longer than right.

HABITAT:

This species is apparently nocturnal; all specimens, except one small individual which was found under a rock, were found at night moving quickly across the reef flat. All of the specimens were found in Tonna perdix shells with attached sea anenomes Calliactis polypus and Sagartiomorpha paguri. All specimens were collected on reef flat which are never exposed, even at the lowest tides, and the water is always clean and moving. At night the animals are quite difficult to catch because of their speed and the long stinging filaments released by the anenomes. This protection enables the animals to use the light, fragile Tonna shells.

Family Paguridae

Formerly, the families Paguridae and Parapaguridae were included under the subfamily Eupagurinae. So far, in the Mariana Islands, specimens of Parapaguridae have only been collected by trapping in deep water. In the family Paguridae there are two small, inconspicuous species known from shallow water in the Mariana Islands. One, Orthopagurus harmsi, is quite common and lives a sessile life in serpulid worm tubes on living coral heads; the other is rare, only one specimen has been found. The family Paguridae can easily be separated from the other family of shallow water hermit crabs from the Marianas (Diogenidae) by the position of the third maxillipeds, which are widely separated at their bases, and by the right cheliped, which is larger than the left. The two species of Paguridae can be easily separated from one another by the setose antennal flagella and straight abdomen of O. harmsi compared to the typical hermit crab antennal flagella and abdomen of P. zebra.

Genus Orthopagurus

According to McLaughlin (1974) there are only two species of Orthopagurus; O. minimus from the west coast of North America and O. harmsi from the tropical Pacific and Indian Oceans. O. harmsi can easily be differentiated from O. minimus by its setose antennal flagella and the lack of pleopods in the male. In the Mariana Islands O. harmsi is quite small and lives a sessile life, occupying the tubes of serpulid worms in live coral heads.

Both species of this genus have the carapace shield well calcified, the posterior carapace membranous. The right cheliped is operculate and much larger than the left. Both sexes have paired gonopores: there are no sexual tubes in the males. There are eleven pairs of gills, the abdomen is straight and there are no paired pleopods in either sex. The uropods are symmetrical, or nearly so. The telson has a median transverse constriction; the terminal margin with a shallow or deep median cleft.

Orthopagurus harmsi Gordon, 1935

Orthopagurus harmsi

Gordon, 1935:630, figs. 1, 2.

McLaughlin, 1974:361-363.

Paguritta gracilipes

Melin, 1939:51, figs. 30, 31.

Orthopaguropsis harmsi

Serene, 1957:107-119, 3 figs.

Paguritta harmsi

Forest, 1961:239.

MATERIAL:

2 males - CL 2.6, 2.7 mm; 3 females (2 ovigerous) - CL 2.3 to 3.4 mm. Shells; polychaete worm tubes, see habitat. From - Guam (Stat. 13).

DISTRIBUTION:

This species has been reported from Christmas Island (Indian Ocean) to the Philippines, and north to Viet Nam, and the Bonin Islands. The new record from Guam is a considerable eastward extension of the known range of this species.

COLOR IN LIFE:

Ground color of carapace shield transparent yellowish, darker on forward middle and along posterior at midline. Posterior carapace transparent, darker yellowish along midline; transparent orange stripe below lateral margins of entire carapace and two orange stripes running parallel to midline behind the antennal peduncles.

Lateral plates below shield with whitish ground color becoming green towards mouth parts, there are many small, irregularly spaced dark red spots on anterior of plates thinning out anteriorly. Ocular acicles brownish yellow. Eyestalks with alternate parallel stripes of brown and yellow. Corneas black with many yellow spots. Antennal acicles and peduncles transparent greenish. Antennal flagella dark orange; dorsal proximal third may be lighter yellow. Hairs on antennal flagella transparent yellow. Basal segments of antennular peduncles metallic green, distal segments and flagella transparent whitish. All mouth parts dark green, fading distally. Ground color of chelipeds transparent yellow. A few fine darker orange stripes may run longitudinally from carpi to finger tips which are dark orange. Periopods two, three, four, and five transparent yellowish with some pale white mottling. Distal segments of periopods two and three with orange tint along dorsolateral margins and near claws. Claws of periopods two and three sharp, transparent, dark brown yellow. Abdomen transparent yellowish dorsally, whitish ventrally. Some white areas may be present dorsally. Terga may be greenish white or transparent. Female pleopods transparent whitish with dark brown eggs. Three narrow stripes of transparent orange may run length of dorsal surface of abdomen. Tail segments transparent white with orange tint on dorsal surfaces; fine orange spots on dorsal surfaces of uropods.

COLOR IN ALCOHOL (after four months):

Corneas black. Finger tips of the large right cheliped with a light orange brown tint. The rest of the animal faded to transparent cream white; abdomen yellow white.

DESCRIPTION:

Carapace shield well calcified, posterior carapace membranous; shield longer than wide, roughly triangular; rostrum obtusely triangular with terminal point exceeding lateral projections which are close set and blunt; anteriolateral margins of shield slope outwards from lateral projections to the widest part of shield which is approximately in the middle, then slope inwards to narrow, almost pointed, posterior shield which is smooth, without hairs. Ocular scales small but distinct, acutely triangular, curve slightly inwards towards midline, with sharp terminal spines. Eyestalks equal, long and slender; slightly inflated basally; approximately five times longer than the minimum diameter of stalks; corneas occupy less than one-third of total length of stalks. Antennal acicles long curved, with sharp terminal points with many fine hairs; distally reach, when fully extended, nearly to base of corneas; peduncles smooth, large, inflated slightly; exceed corneas. Flagella long and tapering; each segment of flagella with long fine hairs extending perpendicularly to axis of flagella. Right cheliped operculate, vastly larger than the left; propodus flattened with many hairs on outer surface and with sharp, outward curving spines on dorsal and ventral margins; movable finger slightly inward curving; left cheliped small, hairy on outer surface of hand which is smaller but more elongate than right. Periopods two and three very small, thin and delicate, nearly transparent. Abdomen large and nearly straight; curves slightly downwards; on the males there are no abdominal appendages (except tail parts); on the females there are three biramous unpaired pleopods on the left

side; the first four terga occupy less than the first half of the abdomen; the fifth is elongate and the sixth is more calcified than the preceding segments. The tail fan is symmetrical or nearly so. The telson is armed along its terminal margin with a shallow but well-defined cleft separating the two lobes; in the middle of the lateral margins of the telson is a constriction that makes the telson appear to be composed of two separate plates.

HABITAT:

In Guam the animals are fairly common and have probably been overlooked elsewhere because of their unique adaptation to a sessile, filter feeding life, living in empty serpulid worm tubes on live coral heads. According to Schumacher (1977), the animal uses its long plumose antenna to filter feed with. In Guam the animal is found on the reef front in water approximately three to ten meters deep. The species of serpulid worm that made the tubes has not been determined; the tube, with crabs, has been found on live colonies of Millepora, Porites and Montipora corals.

Genus *Pylopaguropsis*

This genus is characterized by the presence of a small pair of pleopods on the first abdominal segment of female specimens only. On both males and females there are three other unpaired pleopods. The right cheliped is vastly larger and longer than the left which is small and slender. The right hand is quite broad and operculate. There are thirteen pairs of gills. Only one specimen of a single species, *P. zebra*, has been found so far from the Mariana Islands.

Pylopaguropsis zebra (Henderson, 1893)

Pagurus zebra

Henderson, 1893:425, pl. 39 figs. 12-15.

Alcock, 1905:126-128, pl. 11, fig. 5.

Barnard, 1950:459, 460.

Pylopaguropsis zebra

Forest, 1955:107.

MATERIAL:

1 female - CL 4.6 mm. Shell - Latirus gibbulus (Gmelin 1791), a new record for Guam. From - Guam (Stat. 13).

DISTRIBUTION:

This species is known from the east coast of Africa, the Indian Ocean and Persian Gulf to northwest Australia and Guam. The Guam record is a considerable eastwards extension of the range of this species.

COLOR IN LIFE:

Carapace shield white with transparent brownish mottling and yellow brown specks behind the ocular scales; a large brownish area in center of shield. Posterior carapace light brown with white spots. Ocular scales white. Eyestalks and corneas bright yellow; a greenish brown spot in the center of the dorsal surface of each cornea. Antennal acicles with parallel stripes of red and white; first segments of peduncles white, distal segments with parallel red and white stripes; flagella red dorsally, lighter ventrally, hairs yellow. Antennular peduncles and flagella pale bluish purple. Right cheliped

merus with parallel red and white stripes; inner surface of carpus with parallel red and white stripes, other surfaces whitish; palm white with a few pale yellow spots. Left cheliped merus and carpus with parallel red and white stripes, palm reddish white, finger tips brown. Periopods two and three all segments with parallel red and white stripes, brown finger tips, yellow hairs. Periopods four and five whitish yellow. Abdomen transparent yellow with white mottling, red stripe of internal organs visible on right side. Eggs large, bright red. Telson and uropods transparent white with darker white mottling.

COLOR IN ALCOHOL (after 21 months):

Animal faded a great deal to a fairly uniform pale yellow white. There is a darker brownish patch on the center of the shield and along the ventral surface of the abdomen. Corneas black. The dorsal surfaces of the left cheliped and periopods two and three are a bit darker, pinkish.

DESCRIPTION:

Carapace roughly triangular, truncate at posterior. Rostrum large, triangular, greatly exceeds low lateral projections in length. Ocular scales large, acutely triangular with sharp terminal spines. Eyestalks slender, shorter than both the antennal and antennular peduncles. Antennal acicles long and slender, curve inwards, and extend approximately to the middle of the last segment of the antennal peduncles. Left cheliped short, slender and hairy with a few spines along the dorsal, lateral and middle, outer margins of the carpus; smaller spines on the palm. Palm and fingers elongate.

Right cheliped large, hairy along dorsal and ventral margins of palm; inner ventral margin of merus, outer surfaces of carpus, and dorsal and ventral outer margins of palm spinose. Outer surface of palm granulate, rounded, with outward-curving spines; finger tips curve inward. Periopods two and three smooth, slender, with only a few fine hairs and small spines along ventral margins of dactyls; claws sharp, corneous. Left lobe of telson a bit more pronounced than right.

HABITAT:

Only one specimen has been found so little is known. The animal was found in approximately ten meters of water on a moderately exposed reef front on a coral rubble substrate. It inhabited a Latirus gibbulus shell. The animal was not associated with a similarly colored hydroid, as presumed by Henderson.

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