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HERMIT CRABS FROM THE TROPICAL EASTERN PACIFIC. I. DISTRIBUTION, COLOR, AND NATURAL HISTORY OF SOME COMMON SHALLOW-WATER SPECIES

ELDON E. BALL[1] AND JANET HAIG[2]

ABSTRACT: Observations on distribution, natural history, and color in life are presented for 12 species of hermit crabs (Diogenidae and Paguridae) collected from the intertidal and shallow subtidal between Paita, Perú and Bahía de la Magdalena, Baja California, México.

The present paper is based on hermit crabs collected by the first author from April to June 1968 during Stanford Oceanographic Expedition 18 aboard R/V "Te Vega." The expedition, under the leadership of Donald Abbott, sampled the intertidal and shallow water subtidal from Paita, Perú to Bahía de la Magdalena, Baja California, México. This area covers the entire tropical region of the Eastern Pacific (Panamic faunal province) with the exception of Golfo de California and various offshore islands; it also includes the extreme northern portion of the southern warm-temperate region (Peruvian faunal province), an overlap area within which many tropical animals reach the southern limit of their distribution. A map showing the collecting stations of the expedition, and a station list, are presented in figure 1 and table 1, respectively.

During the expedition special attention was paid to the biology of the hermit crabs collected and to their colors in life. Although the literature on hermit crabs of the tropical Eastern Pacific is fairly extensive, few papers have been published dealing with the natural history of pagurids from this area. Futhermore, very little information has been available on the color of living hermit crabs from the tropical Eastern Pacific; almost all the systematic work has been done on material with its color lost or changed subsequent to preservation. Since color and color pattern often provide one of the easiest ways to distinguish hermit crabs in the field, the lack of such information can make the work of the field biologist much more difficult. Data on color in life also frequently provide a very useful tool to the systematist for the initial separation of species that are difficult to distinguish on morphological grounds alone.

Twenty-seven species of hermit crabs were collected during the expedition. Originally, the objective of our study was to set forth the information obtained on their color and biology, otherwise merely enumerating the species with a few pertinent references and data on collecting localities and general distribution. However, the collection proved to include several new and little-known species of *Pagurixtes* and *Pagurus* which, for practical reasons, are best treated separately; they will be the subject of two additional papers (Haig and Ball, in preparation). Data on *Coenobita compressus* have been published elsewhere (Ball, 1972). The remaining 12 species, which are the subject of this first part of our study, include many of those most commonly encountered in shallow water within the geographical area covered. This paper is contribution No. 349 from the Allan Hancock Foundation.

METHODS

Collections were made intertidally and by SCUBA diving; an otter trawl was used at station 20c. The most efficient method found for removing the animals from their shells was to add a small amount of magnesium chloride ($MgCl_2$) to the seawater covering them and then allow them to asphyxiate. Their usual response to low oxygen levels was to at least partially leave the shell, and thus their removal was greatly facilitated. Color descriptions and color photographs were made as soon as possible after the animals were removed from their shells.

Feeding was studied by field observation and

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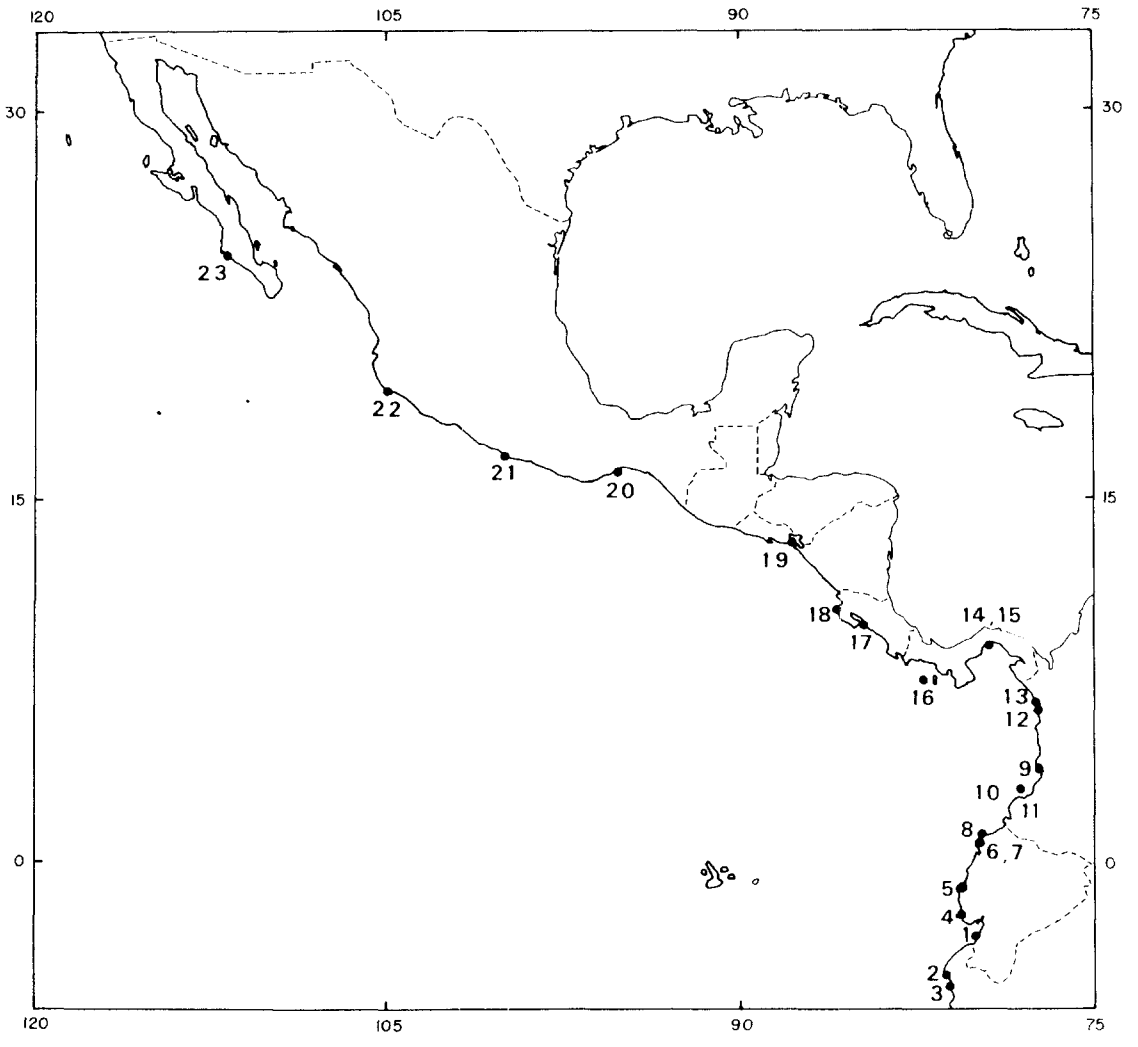

Figure 1. Collecting stations of Stanford Oceanographic Expedition 18.

by examination of gut contents. Intertidal species which were to be used in feeding studies were fixed immediately in the field. Specimens obtained by SCUBA diving were fixed as soon as possible, but in some cases up to six hours elapsed between collection and fixation.

Following the termination of the cruise, the collections were taken to the Allan Hancock Foundation where final determinations were made by the second author. The crabs are housed in the Allan Hancock Foundation.

Measurements given in this report refer to carapace length. References given with each species are to original descriptions; papers giving good illustrations and information on color and biology; and recent papers citing extensions of range. Our authority for the spelling of Spanish place-names is *Index to Map of Hispanic America* ("Millionth Map") (U.S. Government Printing Office, 1945).

SPECIES COLLECTED

FAMILY COENOBITIDAE

Coenobita compressus H. Milne-Edwards

Cenobita compressa H. Milne-Edwards, 1837:241.
Cenobita intermedia Streets, 1871:241.
Cenobita panamensis Streets, 1871:241.
Coenobita compressus: Boone, 1931:145, text-fig. 3; Glassell, 1937:242; Holthuis, 1954:16, text-figs. 4a,b; Bright, 1966:188, 189, text-figs. 4A-C; Haig, Hopkins, and Scanland, 1970:15, 27; Ball, 1972: 265 *et seq.*

TABLE 1. Station Data, Stanford Oceanographic Expedition 18.

STATION	LOCALITY	DATE (1968)	POSITION
1	Isla de Santa Clara, Golfo de Guayaquil, Ecuador	5–7 Apr	3°10′S—80°26′W
2	Talara, Perú	8–9 Apr	4°34′S—81°17′W
3	Paita, Perú	10–13 Apr	5°05′S—81°07′W
4	Salinas and vicinity, Ecuador	15–18 Apr	2°11′S—80°59′W
5	Manta, Ecuador	19–20 Apr	0°56′S—80°43′W
6	Punta Galera, Ecuador	22 Apr	0°50′N—80°05′W
7	Punta Sua, Ecuador	23 Apr	0°52′N—79°55′W
8	Atacames Reef, Ecuador	23 Apr	1°00′N—79°54′W
9	Punta Barca, Bahía de Buenaventura, Colombia	26 Apr	3°50′N—77°16′W
10	Punta Mono, Isla Gorgona, Colombia	27 Apr	2°57′N—78°12′W
11	Straits between Islas Gorgona and Gorgonilla, Colombia	28 Apr	2°56′N—78°13′W
12	Bahía de Solano, Colombia	30 Apr–1 May	
	a. Punta San Francisco Solano		6°18′N—77°29′W
	b. Punta Cotudo		6°16.4′N—77°26′W
	c. Punta Nabugá		6°22.8′N—77°23.7′W
	d. Muntas		
13	Bahía de Cupica, Colombia	2 May	
	a. Punta Cruces		6°39.3′N—77°30.6′W
	b. Bahía Chicocoro		6°41′N—77°24.5′W
14	Balboa, Canal Zone and Panama City, Panamá	5–6 May	
	a. Islas Naos and Culebra, Canal Zone		8°54.8′N—79°31.9′W
	b. Punta Paitilla, Panama City		8°58.1′N—79°31′W
15	Isla Taboguilla, Bahía de Panamá, Panamá	7 May	8°48′N—79°31′W
16	Isla Montuosa, Panamá	9 May	7°28′N—82°14′W
17	Area of Islas Negritos and Cedro, Golfo de Nicoya, Costa Rica	11–12 May	
	a. Isla Negrito-adentro		9°49′N—84°52′W
	b. Isla Cedro		9°50.5′N—84°52.2′W
	c. Puntarenas		9°59′N—84°50′W
18	Bahía Brasilito, Costa Rica	13 May	10°25′N—85°49′W
19	Punta Chiquirin and vicinity, Golfo de Fonseca, El Salvador	15–16 May	
	a. La Unión		13°20′N—87°50′W
	b. Punta Chiquirin		13°18′N—87°47′W
	c. Isla Chuchito		13°19.2′N—87°45.6′W
20	Salina Cruz and vicinity, Oaxaca, México	20–22 May	
	a. Bahía Ventosa		16°10.1′N—95°09′W
	b. Salina Cruz harbor		16°9.5′N—95°12.6′W
	c. Tartar Shoals		16°18.8′N—98°39′W
21	Acapulco and vicinity, Guerrero, México	23–24 May	16°50′N—99°55′W
22	Bahía Tenacatita, Jalisco, México	27 May	19°17′N—104°50′W
23	Bahía de la Magdalena, Baja California, México	2 Jun	24°24′N—112°04′W

Remarks: Specimens of *Coenobita compressus* collected and observed during Stanford Oceanographic Expedition 18 were the subject of a separate report (Ball, 1972).

Distribution: Several Chilean records, Estrecho de Magallanes and northward, require confirmation. Paita, Perú, to Santa Rosalía, Golfo de California, México; Bahía de la Magdalena on the outer Baja California peninsula; offshore islands including Galápagos, Isla del Coco, and Revillagigedos.

FAMILY DIOGENIDAE

Dardanus sinistripes (Stimpson)

Pagurus sinistripes Stimpson, 1859:82.

Dardanus sinistripes: Rathbun, 1910:556, 597, pl. 49 fig. 2; Glassell, 1937:251; Haig, Hopkins, and Scanland, 1970:16, 27.

Dardanus imbricatus Rathbun, 1910:556, 597, pl. 49 fig. 3.

Dardanus peruensis Balss, 1921:21.

Localities: Paita (sta. 3); Punta Galera (sta. 6); off Isla Gorgona (sta. 11); Punta Cotudo (sta. 12b); Isla Taboguilla (sta. 15); Bahía Brasilito (sta. 18); Salina Cruz (sta. 20b); Tartar Shoals (sta. 20c); El Morro and NE corner of La Roqueta, Bahía de Acapulco (sta. 21); La Manzanilla, Bahía Tenacatita (sta. 22); Bahía de la Magdalena (sta. 23).

Measurements: Males 6.1 to 22.7 mm, females 8.8 to 29.0 mm.

Color description: Carapace varies from mottled salmon to tan. Eyestalks salmon, with a tuft of white setae just proximal to golden cornea; ventral side of stalk white, sometimes with two salmon-colored bands. Antennules white to light tan. Antennae uniform pale salmon. Chelipeds red with purplish tones and many purplish tubercles; merus with a dark red band distally; smaller cheliped with coarse red and white hairs. Cutting edge of fingers white, with a narrow longitudinal line of red. Walking legs salmon or mottled salmon and white, with scattered purple tubercles; merus and carpus paler than the two distal segments. Second left walking leg with transverse ridges of purple crossing flattened surface of propodus and dactyl.

Distribution: Bahía de Sechura, Perú, to Isla Tiburón, Golfo de California, México; outer Baja California peninsula as far north as Boca de Santo Domingo. Distribution for this species is subject to revision, however, since there is evidence that two closely related forms have been confused under the name *D. sinistripes* (Biffar and Provenzano, 1972: 799–800).

Natural history: This species is widely distributed both geographically and vertically. During Stanford Oceanographic Expedition 18 it was found in the littoral and to depths of 100 feet, usually on bottoms which were a mixture of sand and gravel. It may be locally very abundant (*e.g.*, at sta. 18). The shells inhabited by this species are often enormous in relation to the size of the crab and it is sometimes difficult to imagine how the crab manages to move its shell. A variety of shells are occupied, although at depths greater than 50 feet there appears to be considerable uniformity in the type of shell occupied at a given locality. Commensal anemones were frequently present on the shell (stas. 15, 18, 20c, 21, 22). At Bahía de la Magdalena (sta. 23) a small specimen had part of its shell coated with orange sponge, while the shells of three larger animals from the same locality bore a dense growth of a hydroid (*Hydractinia sp.*). This hydroid was in the area of the aperture on all three shells and entirely covered one of them. The zooids near the aperture are continuously moved around in the crab's respiratory current when the crab is withdrawn; this would presumably make the aperture a favorable place for the hydroid to grow. A large polynoid worm was living in one of the shells from sta. 23, and a porcelain crab, *Porcellana paguriconviva* Glassell, was living in the shell with a hermit from sta. 22.

Petrochirus californiensis Bouvier

Petrochirus californiensis Bouvier, 1895:6; Glassell, 1937:251; Steinbeck and Ricketts, 1941:454, pl. 12 fig. 1; Haig, Hopkins, and Scanland, 1970:25, 27; del Solar, Blancas, and Mayta, 1970:24.

Petrochirus granulatus californiensis: Bott, 1955:53, pl. 5 figs. 7a,b.

Localities: Isla Taboguilla (sta. 15); Isla Cedro (sta. 17b); Bahía Brasilito (sta. 18).

Measurements: Males 23.8 and 29.5 mm, females 31.8 mm.

Color description: Carapace pale, with a dark reticulate pattern. Eyestalks uniform reddish-brown with a hint of purple; distally a dark brown chevron, and a white band just proximal to the dark cornea. Antennules white with a longitudinal brown stripe laterally and mesially; brown at the base of the flagellar setae. Antennal flagella alternately banded brown and white, usually three to five brown segments alternating with three to five white segments. Chelipeds reddish-purple; cutting edge and tip of fingers white; mesial surface of both meri with two large maculations of deep purplish-brown at distal end, lateral surface with one such blotch at lower distal corner. Dactyl of walking legs dark reddish-brown, with abundant reddish-brown hairs on margins. Other segments of walking legs pale reddish-purple; merus with a large maculation of dark purplish-brown midway along dorsal margin.

Distribution: Caleta La Cruz, Perú, to Punta Peñasco, Golfo de California, México; north to Bahía de Santa María on the outer Baja California peninsula.

Natural history: This species was found on bottoms of sand and gravel to a depth of 35 feet. It often carries a number of commensals within its shell. For example, one individual from sta. 15 with a carapace length of 31.8 mm, living in a shell of *Vasum cestus* (Broderip), shared it with two pairs of porcelain crabs, *Porcellana cancrisocialis* Glassell; a number of polychaetes; and several red polyclad flatworms, *Emprosthopharynx opisthophorus* Bock, ranging up to 20 mm in length. On the outside of the shell were barnacles, bryozoans, and algae. In the shell with a 23.8 mm *Petrochirus* from sta. 17b were two juvenile porcelain crabs, *Porcellana paguriconviva* Glassell, and a polyclad flatworm, *Stylochus sp.* A specimen from sta. 18 bore several large commensal anemones on its shell.

Aniculus elegans Stimpson

Aniculus elegans Stimpson, 1859:83; Boone, 1931: 140, text-fig. 1; Walton, 1950:192; Haig, Hopkins, and Scanland, 1970:16, 27.

Aniculus longitarsis Streets, 1871:240.

Localities: Salinas off Punta Mandinga (sta. 4); Manta (sta. 5); Atacames Reef (sta. 8); Punta Barca (sta. 9); Punta Cotudo (sta. 12b); Isla Taboguilla (sta. 15); Isla Naos (sta. 14a); Punta Paitilla (sta. 14b); Bahia Brasilito (sta. 18); Tartar Shoals (sta. 20c); Bahia de la Magdalena (sta. 23).

Measurements: Males 19.9 to 51.1 mm, non-ovigerous females 20.7 to 35.1 mm, ovigerous female 31.4 mm.

Color description: Carapace shield with distinct grooves marking the various areas; protogastric and branchial areas deep red, others pink. Posterior carapace deep red with white splotches. Eyestalks uniform light tan; corneas dark brown. Eyescales reddish. Antennules uniform tan. Antennae uniform reddish-brown. Chelipeds mottled red and pink; transverse rings bordered with a fine red line and with a fringe of fine white hairs along their distal edge. Fingers with small, black, corneous spinules and tufts of coarse, dark red, white-tipped hairs. Walking legs mottled red and pink, dactyl red, propodus with a subdistal red band; transverse rings bordered with a fine red line and with long, red, white-tipped hairs.

Distribution: Cabo de San Francisco, Ecuador, to Golfo de California, México (no precise locality in the Gulf has been specified, but the species occurs there at least as far north as Bahia de San Carlos); north to Bahia de la Magdalena on the outer Baja California peninsula. The known range is now extended southward in Ecuador from Cabo de San Francisco to Punta Mandinga.

Natural history: This species was collected by dredging in 13 fathoms (24 m) and by diving to depths of 35 feet, on a variety of substrates including sand and gravel, mixed rock and sand, rocky outcrops, and *Pocillopora* coral. Several times these animals were found clustered together in groups of two or three. The crab is frequently very small in proportion to the size of shell it occupies. Gut contents of three specimens from stas. 14a and 14b were examined and found to include unidentifiable organic matter and parts of a small crustacean. A 51.1 mm specimen from Isla Taboguilla had a pair of commensal porcelain crabs, *Porcellana paguriconviva* Glassell, and a 35.1 mm specimen from Bahia de la Magdalena harbored one crab of the same species.

Trizopagurus magnificus (Bouvier)

Clibanarius magnificus Bouvier, 1898:378.

Clibanarius chetyrkini Boone, 1932:29, text-fig. 8.

Trizopagurus magnificus: Forest, 1952:4, 12, text-figs. 2, 11, 18; Haig, Hopkins, and Scanland, 1970: 17, 27.

Localities: Manta (sta. 5); Punta Cotudo (sta. 12b); Isla Montuosa (sta. 16); Isla Taboguilla (sta. 15); Isla Naos (sta. 14a); Isla Negrito (sta. 17a); Bahia Brasilito (sta. 18); El Morro, Bahia de Acapulco (sta. 21); Bahia de la Magdalena (sta. 23).

Measurements: Males 8.0 to 20.8 mm, non-ovigerous females 6.3 to 15.2 mm, ovigerous females 6.4 to 17.1 mm.

Color description: Shield brown with white spots; posterior part of carapace salmon with white spots. Eyestalks brown with white spots; cornea red. Proximal segment of antennules brown with white spots, distal segment and flagellum uniform bright orange. Antennae bright orange. Chelipeds brown with large white tubercles; cutting edge of fingers black. Walking legs brown with large spots varying from white to bright orange.

Distribution: Isla de la Plata, Ecuador, to Golfo de California, México (apparently the southernmost part only); north to Bahia de la Magdalena on the outer Baja California peninsula; Archipiélago de Galápagos.

Natural history: *Trizopagurus* was found mainly on rocky outcrops and on living heads of *Pocillopora* coral, from the intertidal zone to 30 feet. They seemed rather gregarious, with groups of seven or eight frequently observed. The crabs were sometimes so tightly wedged among the *Pocillopora* branches that it was very difficult to imagine how they were able to move. They occurred in a variety of shell types.

At sta. 14a several *Trizopagurus* were observed feeding by scraping at the rocks with both chelipeds. They appeared to be eating fine algae. Gut contents of 11 individuals from five localities included coarse sand and shell fragments, unidentifiable fine organic matter and small pieces of algae, two of which appeared to be *Gelidium pusillum* (sta. 12b) and *Polysiphonia sp.* (sta. 21).

Clibanarius panamensis Stimpson

Clibanarius panamensis Stimpson, 1859:84; Steinbeck and Ricketts, 1941:454, pl. 16 fig. 1; Holthuis, 1954:23, text-figs. 7, 8; Bott, 1955:53, pl. 5 figs. 6a,b; Haig, Hopkins, and Scanland, 1970:17, 27.

Localities: Punta Barca (sta. 9); Muntas (sta. 12d); Isla Chuchito (sta. 19c).

Measurements: Males 11.0 to 22.8 mm, non-ovigerous females 11.5 to 17.3 mm, ovigerous female 11.9 mm.

Color description: Carapace mottled olive drab and white. Eyestalks uniform light tan with hints of green. Antennules olive drab; flagellum with a longitudinal stripe of bright orange at base of setae.

Antennae uniform olive drab. Chelipeds brown with longitudinal orange stripes; manus and fingers covered with white tubercles. Ground color of walking legs dark brown, with stripes, varying in color from orange to white, running the entire length of each segment; outer surface with four or five light stripes on merus, four on carpus, propodus, and dactyl. On the propodus the dark and light stripes are subequal in width.

Distribution: Isla de la Correa near Capón, Perú, to Santa Rosalía, Golfo de California, México; north to Bahía de Santa María on the outer Baja California peninsula.

Natural history: This species was found intertidally on fine sediment in protected areas. At Punta Barca several crabs were observed on the bottom of an intertidal stream, moving their chelipeds rapidly back and forth over the sandy bottom while apparently feeding. Periodically a cloud of particles was shot out anteriorly. The gut of one of these animals was packed solidly with mud and fine organic matter cementing some larger particles of sand. A few small fragments of algae were present.

Clibanarius albidigitus Nobili

Clibanarius albidigitus Nobili, 1901:24; Holthuis, 1954:25, text-fig. 9; del Solar, Blancas, and Mayta, 1970:23.

Localities: Paita (sta. 3); Isla de Santa Clara (sta. 1); Punta Brava near Punta Mandinga (sta. 4); Manta and nearby Punta Mal Paso (sta. 5); Punta Galera (sta. 6); between Islas Gorgona and Gorgonilla (sta. 11); Punta Mono (sta. 10); Punta Barca (sta. 9); Isla Montuosa (sta. 16); Isla Taboguilla (sta. 15); Punta Paitilla (sta. 14b); Isla Chuchito (sta. 19c).

Measurements: Males 3.2 to 10.8 mm, nonovigerous females 3.5 to 7.5 mm, ovigerous females 3.1 to 7.1 mm.

Color description: Carapace mottled olive drab and tan. Eyestalks olive drab, cornea black. Antennular peduncles olive drab, flagellum orange. Antennae orange. Chelipeds olive drab with white tubercles. Walking legs olive drab with white tubercles; outer and inner sides of dactyls white.

Holthuis (1954:27), describing the color of specimens from El Salvador, noted that they had a longitudinal white stripe on the propodus, carpus, and merus of the walking legs (fig. 9c) in addition to the characteristic broad, longitudinal white stripe on the dactyl. He added that in adults the white stripe was often lacking on the propodus, carpus, and merus (fig. 9b). In a series of more than 20 specimens from El Salvador collected during Stanford Oceanographic Expedition 18, the situation is exactly as described and illustrated by Holthuis, with most, although not all, of the crabs longitudinally striped with white on all four segments. On the other hand, specimens collected further south, almost without exception, have only the very characteristic broad white stripe on the dactyl and no trace of it on any other segments of the walking legs. In a series of 56 specimens from Punta Paitilla a few very small individuals show some lack of dark pigment on the propodus.

Distribution: Caleta La Cruz, Perú (del Solar, Blancas, and Mayta, 1970; other records listed by these authors are in error) to La Libertad, El Salvador. The known range is now extended southward in Perú from Caleta La Cruz to Paita.

Natural history: This species appears to be highly adaptable, being found higher in the intertidal than any other of the marine hermits encountered, and existing over a considerable range of temperatures. It is typically found in rocky tidepools and seems to be especially abundant on rocky intertidal flats. A wide variety of mollusk shells is occupied at various localities. *Calcinus obscurus* Stimpson is usually found in the same environment, although its distribution is centered slightly lower in the intertidal; within the area of overlap the two species are usually found grouped together. At times when the *Clibanarius* are inactive they form piles consisting of up to a few hundred individuals under rocks or out in the open. Feeding is done by scraping at the surface of rocks with the chelipeds. Gut contents of 35 specimens from six localities were examined. In almost all cases the gut was packed with fine sediment and algal fragments (*Bostrychia radicans* being the only identifiable alga); diatom frustules and one copepod exoskeleton were also found. In the field this species was seen feeding on *Enteromorpha* and on *Padina* or something encrusting it.

Clibanarius digueti Bouvier

Clibanarius digueti Bouvier, 1898:379.

Locality: Bahía de la Magdalena (sta. 23).

Measurements: Male 10.0 mm, ovigerous female 8.5 mm.

Color description: Carapace mottled tan. Eyestalks olive drab to dark green; cornea with white spots on a dark background. Antennules olive drab to dark green, with bright orange flagellum. Antennal peduncles red, flagellum orange. Chelipeds brown with abundant bluish-white tubercles; fingers orange. Walking legs brown with many white spots; dactyl reddish-orange distally, shading to brown at base of segment.

Distribution: Throughout Golfo de California, México. It is now recorded for the first time from the outer side of the Baja California peninsula.

Habitat: This species was found in rocky pools in the lower intertidal.

Calcinus obscurus Stimpson

Calcinus obscurus Stimpson, 1859:83; Nobili, 1901: 26; Holthuis, 1954: 20, text-figs. 5, 6.

Localities: Isla de Santa Clara (sta. 1); Salinas and vicinity (sta. 4); Punta Galera (sta. 6); between Islas Gorgona and Gorgonilla (sta. 11); Punta Mono (sta. 10); Punta Barca (sta. 9); Punta San Francisco Solano (sta. 12a); Punta Cruces (sta. 13a); Isla Montuosa (sta. 16); Isla Taboguilla (sta. 15); Isla Naos (sta. 14a); Punta Paitilla (sta. 14b); Isla Negrito (sta. 17a); Bahía Brasilito (sta. 18); Punta Chiquirin (sta. 19b).

Measurements: Males to 18.0 mm, non-ovigerous females to 14.0 mm, ovigerous females 5.6 to 10.8 mm.

Color description: Carapace shield olive green with punctae varying from light blue to white. Posterior carapace tan and white. Eyestalks olive green with a broad white ring just proximal to black cornea. Eyescales orange. Antennules olive green proximally; distal segment of peduncle and flagellum orange. Antennae uniform bright orange. Chelipeds olive drab; margins orange; cutting edge of fingers white. Walking legs vary from olive drab to brown, with whitish punctae; dactyl with a distal orange patch at base of nail and often with varying amounts of orange subproximally (in small specimens the dactyl generally has a proportionately greater area of orange than in large individuals).

Distribution: Bahía de Santa Elena, Ecuador, to La Libertad, El Salvador.

Natural history: This species is widely distributed and often very abundant in the lower intertidal. Its intertidal distribution overlaps that of *Clibanarius albidigitus*, and the food and habitat requirements of the two species appear quite similar. Many types of mollusk shells are occupied by *Calcinus obscurus*.

At several stations (especially 9 and 10) many large *C. obscurus* were out on the upper surface of rocks with the aperture of the shell facing upward and the crab withdrawn inside. Reese (1969:349, text-fig. 3A,B) reported similar behavior for *Calcinus laevimanus* (Randall) and *Clibanarius corallinus* (H. Milne-Edwards) at Eniwetok Atoll, Marshall Islands.

Feeding usually appears to involve scraping fine algae and detritus from the rocks. Most of the work is done by the small right cheliped while the much larger left cheliped is used mainly as a support. These crabs were observed feeding on *Padina* or the material encrusting it (sta. 1), and on *Gelidium pusillum* (sta. 12a). Gut contents of 23 crabs from five localities were examined. Most of the guts were tightly packed with fine sand and unidentifiable organic matter with some recognizable algal fragments. Identifiable material included *Monostroma ecuadorcanum* (sta. 1), *Gelidium sp.* (sta. 4), and what appeared to be fragments of small crustaceans (stas. 1 and 4).

Calcinus californiensis Bouvier

Calcinus californiensis Bouvier, 1898:380; Glassell, 1937:252; Haig, Hopkins, and Scanland, 1970:16, 27.

?Calcinus californiensis: Chace, 1962:627, text-figs. 5, 6.

Localities: NE corner of Isla Roqueta, SW of Bahía de Acapulco (sta. 21); La Manzanilla, Bahía de Tenacatita (sta. 22); Bahía de la Magdalena (sta. 23).

Measurements: Males 4.2 to 13.7 mm, non-ovigerous females to 11.4 mm, ovigerous female 4.2 mm.

Color description: Carapace shield olive drab with bluish punctae and orange margins. Posterior carapace mostly white. Eyestalks olive drab with a broad white ring just proximal to black cornea. Eyescales white. Antennules olive drab proximally; distal segment of peduncle and flagellum orange. Antennae reddish-orange. Chelipeds olive drab with bluish punctae; margins reddish-orange; cutting edge of fingers white. Walking legs bright reddish-orange; dactyl solid reddish-orange, without rings or patches of another color; merus of first walking legs with a large olive spot laterally.

Distribution: México: Acapulco to Isla San José, Golfo de California, and to Bahía de la Magdalena, west coast of Baja California; Isla Clipperton.

Habitat: This species was found on boulders interspersed with sand, from the lower intertidal to a depth of approximately 10 feet.

Isocheles, sp. indet.

Localities: Salinas at Punta Mandinga (sta. 4); near Puntarenas (sta. 17c).

Measurements: Males 12.0 and 12.8 mm (sta. 4); male 8.2 mm, females 6.5 and 10.0 mm (sta. 17c).

Color description: Carapace shield mottled brown and white. Eyestalks white with two longitudinal brown stripes, one dorsal and the other mesial; cornea black. Antennules white with two longitudinal brown stripes, one dorsal and the other ventral, on the distal segment of the peduncle. Antennal flagella with a greenish band on each segment. Merus of chelipeds mottled brown and white, carpus white with broad elongate areas of brown, chela reddish-brown. Merus and carpus of walking legs brown,

propodus brown dorsally and white ventrally, dactyl brown and white.

The above notes were taken on specimens from Punta Mandinga. The color and markings of the individuals from Puntarenas are much the same, with the following exceptions: the longitudinal stripes on the eyestalks appear black instead of brown; the walking legs are tan with some green, and there is a broad white band at the distal end of the propodus and a little white at the proximal end of the dactyl.

Habitat: Low intertidal, sand and scattered rocks (sta. 4). At the water's edge on a gently sloping sandy beach, low in the intertidal (sta. 17c).

Remarks: Three species of *Isocheles* are currently recognized from the eastern Pacific, and still others are to be described by J. Forest of the Muséum National d'Histoire Naturelle (Paris), who is revising the genus (Forest and Saint Laurent, 1968:107). Until this revision is completed the status of the "Te Vega" specimens must remain uncertain.

Pagurisles spp.

Pagurisles perrieri Bouvier, *P. anahuacus* Glassell, and five undescribed species of this genus were collected during Stanford Oceanographic Expedition 18. These will be treated in the second part of the present study.

FAMILY PAGURIDAE

Pagurus perlatus H. Milne-Edwards

Pagurus perlatus H. Milne-Edwards, 1848:60; Haig, 1955:18, 21, text-figs. 3, 4; Haig, 1968:21; del Solar, 1970:46 [*Pagarus*].

Bernhardus obesocarpus Dana, 1852:445; Dana, 1855: pl. 27 figs. 5a-d.

Locality: Paita Harbor (sta. 3).

Measurements: Small male 5.5 mm.

Color description: Carapace mottled reddish-brown and white. Eyestalks olive with fine yellow spots; cornea brown with gold flecks. Antennules with yellow spots on a transparent background; a large, dark green spot on distal part of terminal segment of peduncle, and a similar spot on flagellum. Antennal scale and peduncle with fine yellow spots on a tan background; flagellum irregularly ringed, usually with three brown segments alternating with a white segment. Proximal articles of chelipeds mottled brown and white; chela mostly white with some tan. Merus and carpus of walking legs mottled tan and white, changing to mostly white on propodus; dactyl white.

Distribution: Puerto Corral, Chile, to department of Tumbes, Perú. Unlike the other hermit crabs treated in this paper, *Pagurus perlatus* is a warm-temperate rather than tropical species.

Habitat: This species was collected on a bottom of fine sand at a depth of approximately 10 feet.

Pagurus spp. (*miamensis* group)

Forest and Saint Laurent (1968:116) designated as the "*miamensis* group" a number of species of *Pagurus* with close affinities to *P. miamensis* Provenzano of the tropical West Atlantic. Seven species belonging to this group were collected during Stanford Oceanographic Expedition 18: *Pagurus lepidus* (Bouvier), *P. benedicti* (Bouvier), *P. galapagensis* (Boone), *P. villosus* Nicolet, and three undescribed species. We shall treat these forms in the third part of the present study.

Pylopagurus varians (Benedict)

Eupagurus varians Benedict, 1892:24.

Pylopagurus varians: Glassell, 1937:253; Walton, 1954:141, 152, pl. 42 E-H.

"Stag-horn": Smith, 1966:30, 2 text-figs.

Locality: Bahía de la Magdalena (sta. 23).

Measurements: The single specimen, which had been kept alive in an aquarium, was eaten by another aquarium animal before it could be preserved and measured.

Color description: Shield orange; posterior carapace with reddish-brown spots on an orange background. Eyestalks reddish-brown; cornea bright orange. Basal segments of antennules clear, distal segment of peduncle with alternating reddish-brown areas and dorsal white spots; flagellum reddish-brown. Antennal peduncle transparent except acicle, which has alternating transverse bands of white and reddish-brown; flagellum with three to five reddish-brown segments alternating with a white segment. Merus of large cheliped mottled red and white, carpus pink with a few deep red tubercles, chela reddish-brown to orange. Merus and chela of small cheliped mottled red and white, carpus with distinct transverse red and white bands. Walking legs mostly reddish-brown with a white area at distal end of each segment.

Distribution: Islas Secas, Panamá, to Bahía de Tepoca on the east side of Golfo de California, México, and Arena Bank to Isla Angel de la Guarda on the west side of the Gulf. It is now recorded for the first time from the outer side of the Baja California peninsula, and also in somewhat shallower water than previously; the recorded bathymetric range is 6 to 100 fathoms (11 to 183 meters).

Natural history: The specimen was taken on a mixed bottom of sand and rock at a depth of approximately 20 feet. The shell of this animal had been covered, and perhaps replaced, by a

white hydrocoral which formed five antler-shaped branches. When turned completely upside down on these branches, the crab seemed to be unable to right itself. The hydrocoral had a number of amphipods associated with it.

The association of *Pylopagurus varians* with a hydrocoral was briefly mentioned by Walton (1954), and also by Glassell (1937) who referred to it as a "bryozoan growth." Smith (1966) discussed the association in more detail and illustrated the crab with its carcinoecium. His specimen from Golfo de California, living with a many-branched hydrocoral, was not mentioned by name but one of us (J. Haig) has seen it and confirmed its identity.

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