

**CARIDEAN SHRIMPS FOUND IN LAND-LOCKED  
SALTWATER POOLS AT FOUR INDO-WEST PACIFIC  
LOCALITIES (SINAI PENINSULA, FUNAFUTI ATOLL, MAUI  
AND HAWAII ISLANDS), WITH THE DESCRIPTION  
OF ONE NEW GENUS AND FOUR NEW SPECIES**

by

**L. B. HOLTHUIS**

Rijksmuseum van Natuurlijke Historie, Leiden

With 13 text-figures and 7 plates

At several occasions red coloured caridean shrimps have been reported from tropical land-locked saltwater pools. These pools are situated at some distance from the sea, but, because the level of the water rises and falls with the tides, must have subterranean connections with the sea. The shrimps belong to species that so far have not been found outside this special type of habitat, although some have a rather extensive geographical distribution. Apart from the peculiar habitat in which they are found and apart from their red coloration, there is very little that these species have in common. The 11 species so far found exclusively in these pools belong to 9 different genera and to 5 different families (see also Holthuis, 1963; Chace & Manning, 1972). It is suggested now to use the term "anchialine" (from the Greek anchialos, near the sea) to indicate this type of habitat, rather than to have to define it each time as "pools with no surface connection with the sea, containing salt or brackish water, which fluctuates with the tides".

Recently, I received unusually interesting caridean material taken from several of such anchialine pools in the Indo-West Pacific region. This material was provided by various persons. In November 1971 and again in March 1972 Dr. Ch. Lewinsohn, Zoology Department, Tel-Aviv University, Tel-Aviv, Israel, and Dr. F. D. Por, Zoology Department, Hebrew University, Jerusalem, Israel, submitted to me a number of shrimps collected in a saltwater pool near the southern tip of Sinai Peninsula near Ras Muhammad. This material contained a new species of *Periclimenes* and a new genus and species of Hippolytidae. To my great surprise, the latter new genus and species of Hippolytidae was also represented in Pacific material from Maui Island (Hawaiian Archipelago) and Funafuti (Ellice Islands) sent me by Mrs. Dora M. Banner, Hawaii Institute of Marine Biology, Coconut Island, Kaneohe, Hawaiian Islands. Further material from Maui and also from Hawaii received in March, August and November 1972 from

Dr. J. A. Maciolek, Hawaii Cooperative Fishery Unit, Honolulu, not only included the new Hippolytid and a new species of *Palaemonella*, but also an undescribed species of the recently discovered, highly aberrant genus *Procaris*, so far known only from a single species from Ascension Island in the Central Atlantic Ocean.

The present paper deals with the material collected at the four just mentioned Indo-West Pacific localities.

I am most thankful to Drs. F. D. Por and Ch. Lewinsohn for the Sinai material, for a detailed description of the locality and habitat where this was caught, and for colour photographs of Sinai specimens of the two new shrimps. Due to both gentlemen, I was able in April 1973 to visit the Ras Muhammad Crack personally, during a most pleasant visit to Israel where I enjoyed the hospitality of both the Lewinsohn and Por families. I would like to thank here both Mrs. and Dr. Lewinsohn and Mrs. and Dr. Por for their kindnesses, and to extend especial thanks to Mrs. Lewinsohn, who did all the driving in Sinai. Mr. I. Karplus managed at that occasion to collect a specimen of both new species.

To Mrs. Dora M. Banner I am most indebted for sending me the Funafuti material and the first specimens from Maui, and also for providing me with a detailed colour description and a colour slide of the hippolytid from Maui. The Funafuti specimens sent by her were collected by Mr. S. P. Rawlins, Gilbert and Ellice Islands Fisheries Officer, who provided a most useful description of the locality, which is gratefully acknowledged here. Dr. John A. Maciolek, not only collected the interesting material from Maui and Hawaii, but also provided extensive accounts and detailed photographs of the pools in which the various shrimps were found, notes on the habits and habitat of the animals, as well as color slides of living specimens of various species. Finally I owe a debt of gratitude to Drs. Fenner A. Chace and Raymond B. Manning of the Smithsonian Institution, for allowing me to consult the then unpublished manuscript of their paper on *Procaris* and *Typhlatya* from Ascension, for providing me with comparative material of the Ascension *Procaris*, and for helpful discussions.

Before dealing with the systematic treatment of the eight species of Caridea from the anchialine pools of Sinai, Funafuti, Hawaii and Maui, a description of the localities where they were obtained is provided.

It is interesting to note that two of these localities (Ras Muhammad Crack, Sinai Peninsula, and Cape Kinau Peninsula, Maui, Hawaiian Islands), since the discovery of the peculiar shrimp fauna, but before the new species were described, have been declared protected areas, and that actually the presence of the interesting shrimps helped to get this accomplished.

The Ras Muhammad Crack area has been made a protected area in 1972 by the Israel authorities. It is now fenced in and a sign explains its peculiarities (pl. 3).

The efforts to make Cape Kinau a natural reserve area date from the fall of 1971; at first they met with strong opposition. But thanks to the convincing arguments and persistence of various persons interested in the project, foremost among whom Dr. J. A. Maciolek, and to the farsightedness of the Governor of the State of Hawaii, the Honorable John A. Burns, the Ahihi-Kinaiu Natural Area Reserve was established on 19 June 1973, being the first natural reserve on Maui Island. It covers 2,000 acres and includes the far larger part of Cape Kinaiu, with all of the anchialine pools.

#### DESCRIPTION OF THE LOCALITIES

1. Ras Muhammad's Crack, Sinai Peninsula (text-figs. 1, 2, pls. 3, 4).

Ras Muhammad's Crack is situated at the tip of the southern cape of Sinai Peninsula called Ras Muhammad ( $27^{\circ}44'N$   $34^{\circ}15'E$ ) (fig. 1). It is a

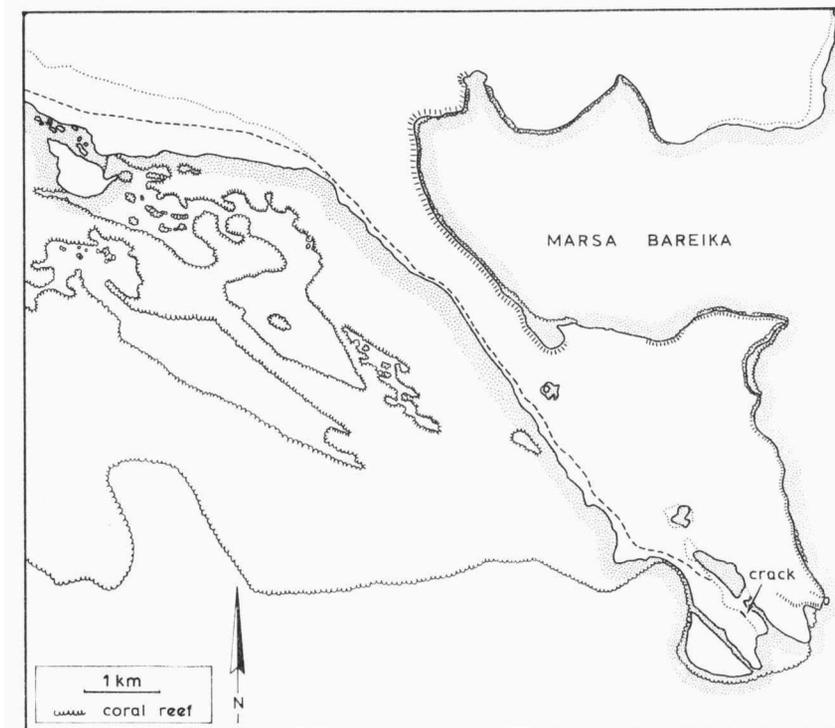


Fig. 1. Map of Ras Muhammad at the southern tip of Sinai Peninsula, showing the situation of Ras Muhammad Crack.

narrow open crack in an elevated fossil reef. This crack, which was formed by an earthquake in 1968, is about 40 m long and 0.2 to 1.5 m wide. It is about 150 meters distant from the nearest sea inlet and has no external connection with the sea. The surface of the water is about 1 m below that of the land. The water depth at places is over 14 m. The rocky walls are caved in and have overhanging ledges (fig. 2); hereby extensive areas of shade and semi-obscurity are formed in the crack, especially along the walls, which are covered with algae (*Valonia* and *Bothriocladium*). The water in the crack must have some underground connection with the sea as its level falls and rises with the tides. The temperature of the water, measured on 27 October 1971 at 9 a.m. was 25.5°C its chlorinity 23.60‰. At the landward end, the bottom of the crack consists of sand in which a rich meiofauna was discovered. Apart from the two species of shrimp (*Periclimenes pholeter* and *Callinectes pholidota*) described here as new the fauna of the water in the crack consisted of three species of Mollusca, one being a key-hole limpet, one a chitonid, the third a lamellibranch of the family Carditidae. A species of Sphaeromatid isopods (probably *Cymodoce*) was conspicuous, while also sponges and tubicolous Polychaeta were observed. A sketch map of the area is given here as fig. 1. The crack was

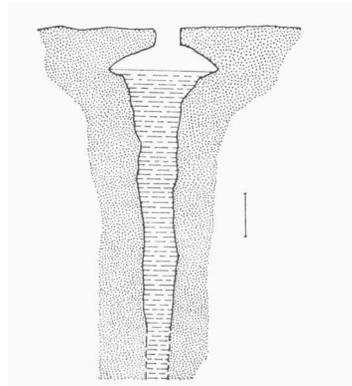


Fig. 2. Ras Muhammad Crack, schematic vertical section. Scale = 2 m. (courtesy Dr. F. D. Por).

recently described and figured by Por & Tsurumal (1973). At present the area is protected (pl. 3 fig. 1) and signs indicate its peculiar features (pl. 4 figs. 1, 2). On 27 April 1973 during our visit to the crack, a new opening in the area at about 20 meters to the east of the original crack was discovered. Here too red shrimps were seen in the water. This new opening was about triangular. It is possible that the elevated fossil reef of Ras Mu-

hammad is honey-combed with subterranean passages that have connection with the sea.

2. Pool at Fangafale Islet, Funafuti.

“The pool in Funafuti is rather large and is located on the north end of Fangafale Islet; on the east side it is bordered by the coral of the island, but on the west by what appears to be a boulder ridge thrown up possibly by previous hurricanes; both sides are somewhat porous and the water rises and falls with the tides outside” (Mrs. A. H. Banner, in litt., 10 January 1972). Together with the Hippolytid *Calliasmata pholidota* new genus, new species, the pool was found to be the habitat for another hippolytid, *Ligur weae* (Borradaile) and an Alpheid *Metabetaeus minutus* (Whitelegge); it actually is the type locality for Whitelegge’s species.

3. Pools on Cape Kinau, Maui Island, Hawaiian Archipelago (text-fig. 3, pls. 5, 6).

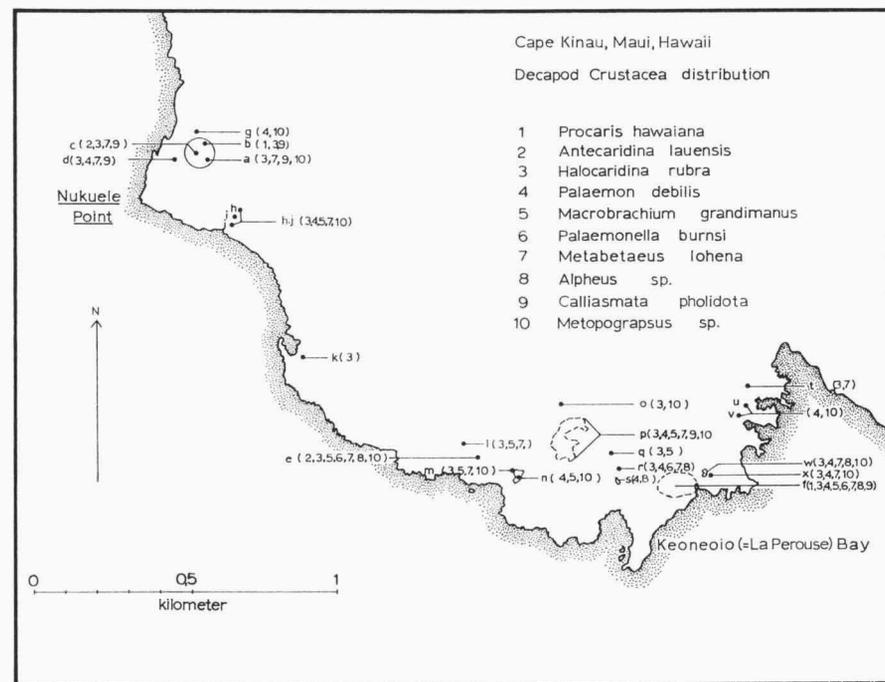


Fig. 3. Map of Cape Kinau, showing the location of the various pools in which Decapod Crustacea were found. The letters correspond to the letter under which the pools are described in the text; the numbers in parentheses after the letters indicate the species found in the pools: 1, *Procaris hawaiana* n.sp.; 2, *Antecaridina lauensis* (Edmondson); 3, *Halocaridina rubra* Holthuis; 4, *Palaemon debilis* Dana; 5, *Macrobrachium grandimanus* (Randall); 6, *Palaemonella burnsi* n.sp.; 7, *Metabetaeus lohena* Banner; 8, *Alpheus* sp.; 9, *Calliasmata pholidota* n.sp.; 10, *Metopograpsus* sp.

Cape Kinau lies at the S.W. point of Maui Island and is formed mainly by basaltic lava emanated about the year 1790 from a vent (Kalua o Lapa) located a few kilometers inland from the present shoreline. The rough clinkery lava (aa) shows considerable fracturing and deformation, resulting in strong surface relief. In his description of a proposed natural area reserve for the Cape Kinau region, Mr. Maciolek (unpublished) characterized the pools in the lava flow as follows: "Irregular porous lava provides another class of aquatic ecosystems intermediate between open seashore and freshwater. These are the numerous tidepools and ponds, maintained as sea-level exposures of mixohaline water within the lava flow by restricted subterranean connection to the sea. This water varies in salinity from almost fresh to euhaline. Nearly always, vertical stratification of salinity is apparent. Invariably, these ponds display a damped tidal fluctuation indicative of their sea water table influence.

Biota in these systems vary with the degree of connection to the sea and salinity. Nearshore ponds are marine-like, showing diverse species of algae, invertebrates and fishes. Progressing inland, fewer and more unusual species are present. Fishes and marine algae disappear in the most restricted ponds. Macrofauna in the latter is ultimately represented only by two species of crustaceans, the endemic small red shrimp or opaeula (*Halocaridina rubra*) and an alpheid shrimp *Metabetaeus lohena*, heretofore known only from 3 other localities in the Pacific. Opaepula often occur in great abundance. Both species are cryptic and are presumed to exist throughout the lava flow in subterranean interstitial water. Many ponds contain unusual ecological growth forms of the blue green alga *Schizothrix calcicola* that precipitate marl in some areas. Several ponds contain lush growths of the aquatic phanerogam, *Ruppia maritima*. The Cape Kinau ponds represent the only extensive habitat for this uncommon species on Maui. The larger, more open ponds also provide habitat for various water birds. Aeo (Hawaiian Stilt), sanderlings, curlews, plovers, turnstones and migratory ducks have been observed.

The ponds and pools are distributed variously on that part of the Cape seaward from the Makena-Keoneoio Road, with all of them occurring on the southerly (Kalua o Lapa) portion. A total inventory has not been made, but they number in the dozens. Such pond systems occur only on Maui and Hawaii Islands. The better ones on Hawaii's lava have already been degraded or are imminently threatened with development. Cape Kinau ponds are relatively untouched and show remarkable biota and environmental diversity. Freshwater input is essential for their unusual character. Presumably freshwater arrives by percolation through lava from higher elevation."

Fig. 3 provides a map of Cape Kinau showing the pools where Decapod Crustacea were found, with indication of the species noted in each.

a. (pl. 6 fig. 1). Mr. Maciolek (in litt., 17 February 1972) provided the following description of the largest of the four pools near Nukuele Point ( $20^{\circ}37'N$   $156^{\circ}26'W$ ) in which *Calliasmata pholidota* was found; *Calliasmata* occurred there together with *Halocaridina rubra* and *Metabetaeus lohena*. "This pool is located about 100 m from the ocean shore in dark brown lava of rough topography. Loose clinkery slopes extend at an angle of about  $45^{\circ}$  from the edges of the pond to ridges that are situated 5 to 10 m higher. The pond is 3 to 4 m across, 6 to 7 m long, and no more than 1 m deep at low tide. The tidal range in the pond is about  $\frac{1}{2}$  meter. The water is clear, its surface salinity was 27 to  $29^{\circ}/_{00}$  in December 1971, but may be lower during winter storm rainfall. Vertical salinity stratification was evident: the bottom water may be euhaline. The surface temperature in December 1971 was  $22^{\circ}C$ . The bottom and sides consist mainly of loose lava with some calcareous sediments in the deeper areas.

The unusual fauna and flora of this pool are mainly of marine origin. The only plants readily apparent were coarse tufts of the red alga *Ahnfeltia concinna* and a filamentous cyanophyte (*Schizothrix*). The undisturbed pool showed abundant specimens of the Atyid shrimp *Halocaridina rubra* and an occasional *Calliasmata*. The disturbance made by wading around in the pond, however, caused many large polychaete worms (*Eurythoe complanata* (Pallas)) to appear crawling about on the surface of the rocks. Close inspection of the pond revealed the presence of a yellow sponge (? *Tethya diploclerma* Schmidt) and a serpulid worm (*Salmacina dysteri* (Huxley)) under some rocks. An occasional Alpheid shrimp, *Metabetaeus lohena* Banner, appeared near shaded recesses or in crevices. A few small amphipods were found on rocks removed from the water for close inspection. No other larger members of this biocoenosis were evident in that pool."

b. In a second pool close by the first, *Procaris hawaiana*, *Calliasmata pholidota* and *Halocaridina rubra* were taken. This pool is in a cave-like setting, being actually a collapsed lava bubble, having a very dim natural illumination under a lava outcropping. The water is clear with a salinity of 19 to  $25^{\circ}/_{00}$  and a surface temperature of  $21.5^{\circ}C$ . All three species of shrimp are scarce there.

c. A third pool, not far from the previous two, housed *Antecaridina lauensis* and *Metabetaeus lohena* together with *Calliasmata pholidota* and *Halocaridina rubra*. The shrimps are rather few and the total visible population is no more than a score of individuals. The pool has a tiny surface exposure in the lava: at high tide the exposure was about 0.25 m wide and

1 m long, at low tide the water is hardly noticeable at all. The depth is 0.6 m on a rising tide. The water is clear with a salinity of 25 to 30<sup>0</sup>/00. The pool contained at least three species of epilithic algae, one of these of a striking calcareous type that forms thin subcircular plates, similar in appearance to shelf fungi (? *Lithophyllum*).

These three pools (a, b, and c) are situated within a circle of much less than 100 m in diameter. It seems that these, as well as adjacent mixohaline waters, must have subterranean connection through interstitial lava fractures.

d. The fourth pool, situated nearer to the coast, contained also *Halocaridina rubra* and *Metabetaeus lohena*; later also *Calliasmata* was discovered here. The only other Decapod in it was *Palaemon debilis*.

e. Another interesting pool was found near the SW coast of Kinau Peninsula, somewhat closer to Keoneoio Bay than to Nikuele Point (see map, fig. 3, under e). This pool is a small exposure of water in the lava flow about 60 m from the sea; its exposed surface measures about 1 × 0.3 m. It is an unimpressive bit of water under a slight overhang of lava. Its bottom consists mostly of fractured rock with some fine marl sediment (where *Alpheus* burrows) and is less than a meter deep at high tide. The salinity was 9<sup>0</sup>/00 and the temperature of the water was 24.5°C. Apart from the Decapods no larger animals or plants were observed, but some algae probably are present. The Decapod Crustacea found here were *Antecaridina lauensis*, *Halocaridina rubra*, *Palaemonella burnsi*, *Macrobrachium grandimanus*, *Metabetaeus lohena*, *Alpheus* sp. and *Metopograpsus* sp.

f. Also at the other (S.E.) end of the peninsula near the coast of Keoneoio (= La Perouse) Bay an interesting area with many small water exposures in close proximity is found. In this restricted area practically all the shrimps known from this habitat on the peninsula are found: *Procaris*, *Halocaridina*, *Metabetaeus*, *Palaemonella burnsi*, *Calliasmata*, and two species of *Alpheus*.

g. Also the numerous other pools on the rest of Kinau Peninsula have been explored by Dr. Maciolek (pl. 6 fig. 2).

By 18 August 1972, in more than 20 of the pools in the area (inclusive the ones mentioned above) shrimps were found, viz. *Procaris hawaiiiana* in 2, *Antecaridina lauensis* in 2, *Halocaridina rubra* in 16, *Metabetaeus lohena* in 13, *Palaemonella burnsi* in 3, *Palaemon debilis* in 11, *Macrobrachium grandimanus* in 8, and *Calliasmata pholidota* in 6. Most of these pools resembled the ones near Nukuele Point.

4. Pool at Lua o Palahemo at Ka Lae (South Cape), the southernmost point of Hawaii Island, Hawaii Archipelago (pl. 7).

This pool is situated in ancient lavas of South Cape, Hawaii Island at

18°55'N 155°40.8'W and within 1 km of South Point itself. It is a deep pool with an almost circular opening, about 6 m in diameter. The walls of the opening descend vertically for a few meters and then extend outward at a sharp angle forming a massive overhang of rock on the west and south (seaward) sides of the pool, supporting the contention that this is a collapse point of a large lava tube. A mound of fine whitish sediment rises steeply to form a pointed ridge in the center of the pool. The top of the ridge lies 10 meters below the water's surface. Because the rock slopes downward at an angle more nearly vertical than the sediment, the water column becomes too narrow to accommodate a diver below a total depth of about 13 or 14 meters. Rock overhang and moderate turbidity attenuate daylight rapidly below 10 meters water depth. Artificial light was necessary to examine the deepest accessible parts of this environment. At the time of collecting the salinity at the surface was 22<sup>0</sup>/<sub>00</sub> that at 3 m depth 21.5<sup>0</sup>/<sub>00</sub>, the temperature at the surface 26°C and at 3 m depth 25.5°C. The water was somewhat turbid with phytoplankton. Collecting was done at a depth of about 3 to 4 meters. The sides of the pool are formed by rough lava. *Procaris hawaiana* and *Calliasmata pholidota* as well as scattered *Antecaridina lauensis* occur here on or near the upper lava walls but not nearer to the surface than about 2 meters. A few *Calliasmata* were seen scurrying across the top part of the sediment mound (depth 10 to 11 m), but no shrimp were seen in the deepest recesses (area below 12 meters). The green algae *Valonia aegagropila* and *Chaetomorpha* prob. *pacifica* carpet the rock walls to a depth of 5 or 6 meters. Below that, only the red epilithon film of *Hildenbrandia* occurs. *Halocaridina rubra* was very abundant, especially in midwater (at a depth of about 1 meter), presumably grazing on phytoplankton. Isopods (unidentified) were abundant; the only other animal seen was a small (25 cm) eel at a depth of about 12 meters, probably a muraenid (J. A. Maciolek in litt., 5 March 1973).

5. Pool in a fissure a few km north of Lohena Rock, Kau District, Kahuku Land Division, Hawaii Island, 18°59.9'N 155°47.0'W.

The fissure containing the pool is in pahoehoe lava. It is unusually long and deep for Hawaii, having a length of nearly half a kilometer and a width of up to a meter or more. It extends obliquely and northerly inland from a rocky beach. The water level is considerably below the land surface, the difference between the two being about 10 meters at the collecting site. The water depth varies from a few centimeters to more than 6 meters. The water itself is very clear and is of low salinity (2 to 3<sup>0</sup>/<sub>00</sub>). Weak illumination supports only a spotty meager epilithic film of green algae.

The fauna is correspondingly scarce: besides a few *Antecaridina lauensis*, several *Halocaridina rubra*, three *Macrobrachium grandimanus* and a single neritid limpet (*Theodoxus cariosa*) were observed (J. A. Maciolek, in litt. 5 March 1973).

#### SYSTEMATIC ACCOUNT

##### PROCARIDIDAE Chace & Manning, 1972

This family, as well as the superfamily Procaridoidea, was proposed very recently for a single species *Procaris ascensionis* Chace & Manning (1972), found in a land-locked saltwater pool in an old lava stream near the coast of Ascension. The present material from Hawaii contains a second species of this highly aberrant group.

##### ***Procaris hawaiana* new species (text-figs. 4-6, pl. 2 fig. 2)**

Near Nukuele Point, Cape Kinau, Maui, Hawaiian Islands; in lava pool (locality no. 3b described on p. 9), 26 February 1972, J. A. Maciolek, K. W. 7; 5 specimens, cl. 4-8 mm (1 holotype, RMNH Crust. D. 28945, 4 paratypes Crust. D. 28946). — Same locality; 18 March 1972; J. A. Maciolek, K.W. 8; 3 paratypes cl. 5-8 mm (RMNH Crust. D. 28947).

Cape Kinau, Maui, small lava pool near coast of Keoneoio (= La Perouse) Bay, at the extreme east end of the cape; collected at high tide; 7 June 1972; J. S. Lenic, K-dc-1, 4; 2 paratypes cl. 6 and 6 mm (RMNH Crust. D. 28949).

Lua o Palahemo, 1 km from Ka Lae (= South Cape) at the southern tip of Hawaii Island, 18°55'N 155°40.8'W; pool in lava field (loc. 4, p. 10), 3-8 m deep, 20 October 1972; J. A. Maciolek and R. E. Brock; 2 paratypes cl. 6 and 6 mm (RMNH Crust. D. 28948).

Description. — The rostrum is short and pointed, it reaches just beyond the eyes. In lateral view it is slender, and tapers regularly towards the tip, which is slightly curved down. In dorsal view it is elongate triangular and its lateral margins merge gradually with the orbital margin. The lower orbital angle is broadly rounded without a sign of an antennal spine. A short distance below the lower orbital angle the margin of the carapace curves strongly backward and then, with a gradual curve down, reaches the lateral margin. The carapace bears no spines or carinae, only a narrow and shallow cervical groove is visible, which does not reach the dorsum. The posterior margin of the carapace is ridge-like.

The abdominal somites are smooth. The first has the pleura large and rounded. The pleura of the second overlap both those of the first and third; they are large and rounded with the distal margin somewhat emarginate in the middle. The third somite is remarkable by that the posteromedian part is hood-like prolonged posteriorly and reaches beyond the middle of the fourth somite; in lateral view it shows as a broad tooth which breaks the regular contour line of the back. The fourth somite has the pleura

rounded, those of the fifth end in a bluntly rounded top. The sixth somite is about 1.5 times as long as the fifth, both its pleura and posterolateral angles are rounded. The telson is distinctly longer than the sixth abdominal somite. It is elongate triangular and bears two pairs of dorsal spines, the anterior of which is placed slightly behind the anterior third of the telson, the posterior is placed halfway between the anterior pair and the posterior margin of the telson. The posterior margin of the telson is broadly trian-

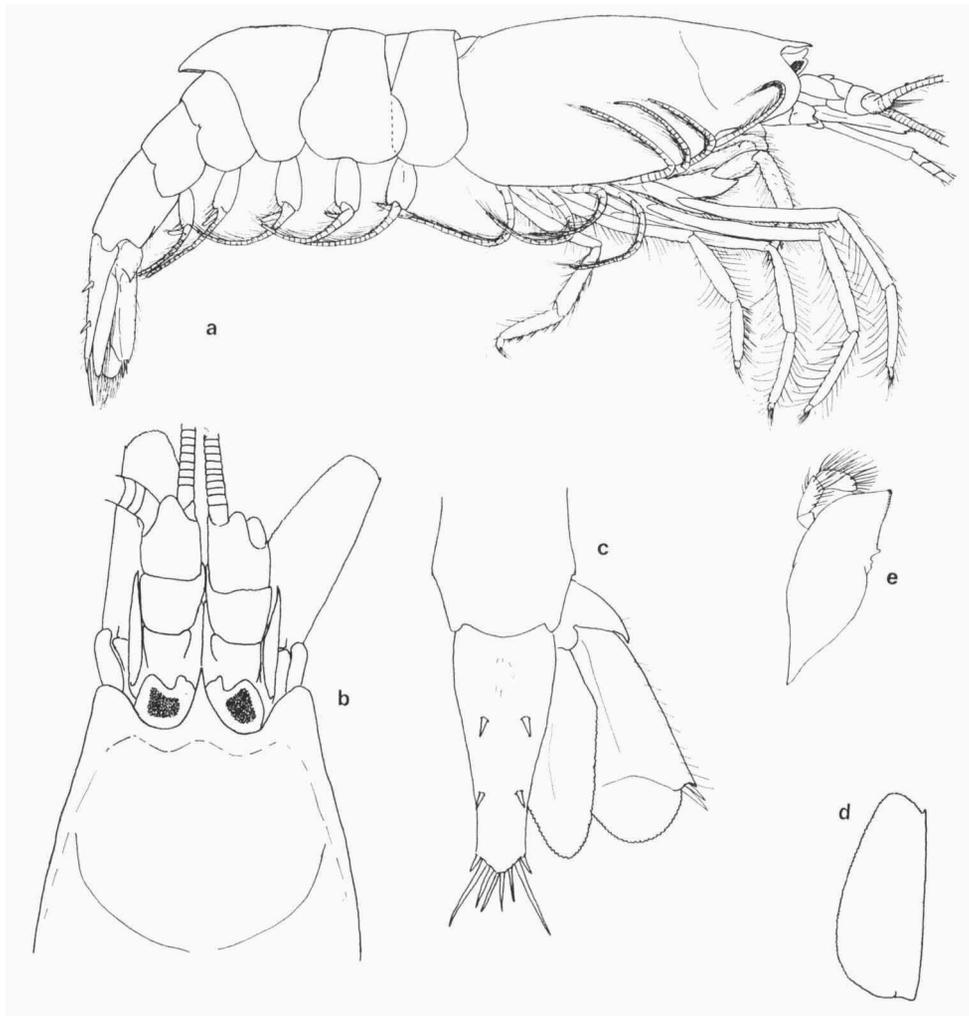


Fig. 4. *Procaris hawaiiensis* new species, from Nukuele Point. a, animal, lateral view; b, anterior part of body, dorsal view; c, telson and uropod; d, scaphocerite; e, mandible. a,  $\times 6$ ; b-e,  $\times 12$ .

gular with a blunt top. It bears 4 pairs of spines, of which the outer are the shortest, the next pair by far the longest, and the two inner pairs of intermediate length.

The eyes are broad and have at the inner half of their anterior margin a conical process which is directed forwards and upward and reaches beyond the eye itself. The rest of the eye is broadly and bluntly triangular in dorsal view and bears an irregular pigment spot. Like in *P. ascensionis* no distinct corneal elements are visible

The antennula has a large pointed stylocerite, which reaches about to the end of the second segment of the antennular peduncle. In lateral view it is oval and ends in a small point. The distal two segments are short and broad, the third is longer than the second. Two simple antennular flagella are present, both are very long. The outer flagellum has the basal part widened and provided there with long hairs.

The scaphocerite is twice as long as wide. It just fails to reach the end of the antennal peduncle. The outer margin is almost straight, naked and ends in a minute tooth, which is overreached by the wide anterior margin. The inner anterior angle is broadly rounded. The ultimate segment of the antennal peduncle is long and slender and reaches somewhat beyond the scaphocerite. The peduncle shows a small but distinct tooth below the outer end of the base of the scaphocerite.

The mandible consists of a single molar process, which is pointed and has a cutting edge which is dark coloured and shows a few small teeth; there is a distinct three-segmented palp. The maxilla has two endites, the lower is oval to quadrangular, the upper is truncate and has the distal margin with strong spines; there is a single undivided palp. The maxilla has the two endites both divided in two by an incision; of the four laciniae that are formed that way, the inner two are narrowest; the palp is well developed and slender distally; the scaphognathite is distinct. The three maxillipeds all have a well developed exopod with a multi-articulated flagellum. The first maxilliped has the 2 endites separated by a distinct notch. The palp has a broad base and suddenly narrows to an elongate appendage, which from the base gradually widens distally, to taper in the upper third to a blunt top; the exopod has a narrow caridean lobe; the epipod is oval. The second maxilliped is pediform. The dactylus is elongate and is attached with one of its longer sides to the propodus. The carpus is short and the merus more than twice as long as the carpus. The epipod is oval. The third maxilliped reaches slightly beyond the scaphocerite. The dactylus is a small oval segment carrying long and strong spine-like hairs. The propodus is about 9 times as long as the dactylus and slightly longer than the carpus. The merus

is somewhat shorter than the carpus and  $\frac{3}{5}$  of the length of the ischium. The ischium is wider than any of the other segments and its posterodistal end reaches beyond the base of the merus. The exopod is large and provided with a multi-articulated flagellum. The epipod is well developed.

The branchial formula is as follows:

	maxillipeds			pereiopods				
	1	2	3	1	2	3	4	5
pleurobranchs	—	—	—	1	1	1	1	—
arthrobranchs	—	—	—	—	—	—	—	—
podobbranchs	—	—	—	—	—	—	—	—
epipods	1	1	1	1	1	1	1	1
exopods	1	1	1	1	1	1	1	1

The pereiopods all have a large epipod and a well developed multi-articulated exopod. None of the legs shows a chela, in all the dactylus is a short oval segment placed on top of the propodus. The first leg reaches with part of the carpus beyond the scaphocerite. The propodus is about 6 times as long as the dactylus, slightly shorter than the carpus and somewhat more than half as long as the merus. The ischium is short. The dactylus ends in some strong spine-like bristles and all the segments are provided with long firm posteriorly directed hairs along the longer margins of the posterior surface. The anterior surface is naked. In the merus there are several transverse rows of hairs across the posterior surface. The ischium bears a large movable spine. The first four legs are remarkably alike in shape, setation and spinulation. They are longer and distinctly narrower than the third maxilliped. All have a large exopod and epipod, and a pleurobranch. The fifth leg is shorter than the others and fails to reach the base of the scaphocerite. Like in the other legs the dactylus is oval, the spine-like bristles are shorter than in the other legs. The propodus and carpus are slightly, the merus considerably shorter than in the other legs. The setation is similar, but the spine on the ischium is absent; however, a coxal spine is present behind the base of the leg.

The pleopods are all very similar. The exopod is long and slender, the endopod less than  $\frac{1}{3}$  of the length of the exopod and elongate oval. No appendices are present on any of the pleopods. The uropod has the outer dorsal lobe of the protopodite ending in a sharp point, the inner lobe is rounded. The exopod has the outer margin straight and ending in a tooth, to the inner side of which there are two movable spines. The diaeresis is present. The endopod is oval without teeth.

The sternite of the first abdominal somite has a median tooth, in the

following somites this tooth is very indistinct. The sternite of the fifth somite shows a median carina.

Size. — The carapace lengths of the 12 examined specimens range between 4 and 8 mm, the total length between about 10 and 30 mm.

Colour. — Live specimens were described by Dr. Maciolek as follows “there is slight red pigmentation of the exoskeleton, particularly along the midline . . . the apparent color is mostly internal” and “there is some black pigment associated with the eyes”. Colour slides of living specimens from



Fig. 5. *Procaris hawaiana* new species, from Nukuele Point. a, maxillula; b, maxilla; c, first maxilliped; d, second maxilliped; e, third maxilliped; f, dactylus of third maxilliped. a-c, f,  $\times 25$ ; d, e,  $\times 12$ .

Nukuele Point, Maui (pl. 2 fig. 2), show the species as a pale slightly purplish pink shrimp with the carapace yellow or whitish by the presence of the internal organs shining through. The carapace shows a darker red spot immediately behind the rostrum, and a less distinct one near the middle of the posterior margin. The abdomen is pink with a distinct transverse orange-red band over the first tergite, and a conspicuous narrow median longitudinal streak on the fourth somite. There is a faint longitudinal median darker pink line over the entire abdomen and along the posterior

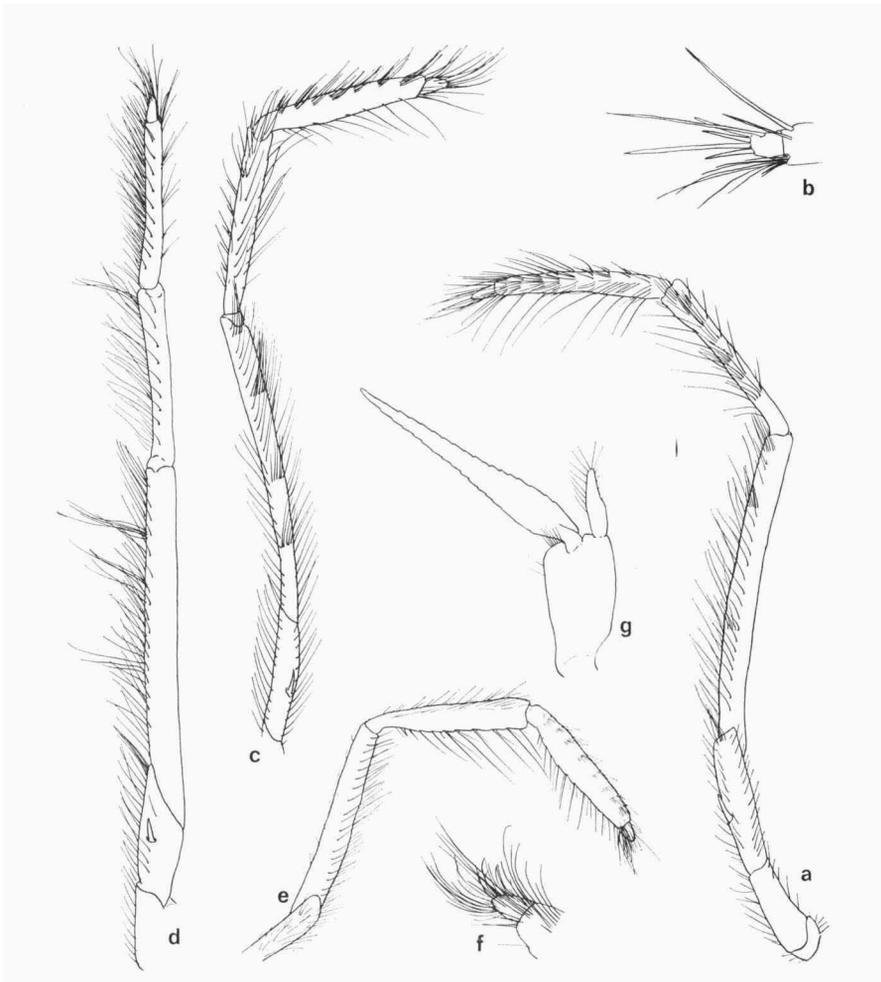


Fig. 6. *Procaris hawaiiana* new species, from Nukuele Point. a, first pereiopod; b, dactylus of first pereiopod; c, second pereiopod; d, third pereiopod; e, fifth pereiopod; f, dactylus of fifth pereiopod; g, first pleopod. a, c-e, g,  $\times 12$ ; b, f,  $\times 25$ .

margins of the somites. On the tailfan there are several red spots, one in the middle of the endopod being most conspicuous. In one of the pictures the darker pink lines along the posterior margins of the abdominal somites are rather distinct and the tailfan there shows a broad transverse red posterior band. The lower surface of the body is rather uniformly pink, that of the thorax being brighter than that of the abdomen. The appendages are very pale pink or colourless.

Two specimens from Lua o Palahemo, Hawaii, kept in formalin and ionol were examined about one month after their capture and showed the following colour: The carapace and dorsal part of the abdomen are rather uniformly pale reddish orange. An irregular longitudinal band of dark chromatophores extends over the middle of the carapace and abdomen. On the carapace this band is widely interrupted here and there, and in some places is widened to a median narrow transverse band. On the abdominal somites this irregular median longitudinal band is present, but there are additional chromatophores on the rest of the dorsal surface also. These additional chromatophores form a conspicuous broad transverse band on the first somite, which occupies almost the full width of its tergite, and in the other somites are placed along the posterior margins of the tergites and over the bases of the pleura. On the sixth abdominal somite the dorso-median band is V-shaped in the anterior part with the base of the V pointing backward and ending in a single median line in the posterior half. A transverse band of dark red chromatophores extends over the posterior part of the tailfan, while one or two chromatophores are present in the basal part of the telson and the uropods.

Red chromatophores are also present in the middle of the ventral surface of the fourth and fifth abdominal somites, and some scattered ones on the ventral surface of the sixth.

The eyes show some red colour around the black pigment. A reddish colour is also visible in the inner part of the base of the antennular peduncle. The other appendages show no colour except for a diffuse pale orange colour in their basal parts. One of the pleopods in one of the specimens has a small red chromatophore in the protopod.

This colour pattern checks quite well with what was visible in the other specimens.

Biology. — The following observations on the living animals were made by Dr. Maciolek (in litt., 19 April 1972): "The animal always swims with its legs extended fan-like and symmetrically in a plane below the body. Usually it "cruises" close to the substrate (lava), occasionally in midwater, and sometimes along the underside of the surface film. A specimen kept

three weeks in an aquarium fed initially on crushed *Halocaridina rubra* and subsequently on frozen brine shrimp, both of which it ingested slowly. Eventually it stopped feeding and moulted. Following the moult, it did not feed well and died a few days later".

Habitat. — *Procaris hawaiana* has been taken at only three localities, two at Cape Kinau, one on Hawaii Island. These localities are described here in detail on pp. 9 to 11 under no. 3b, 3f and 4. All are small anchialine lava pools, and in all three *Procaris* was found together with *Calliasmata*.

Remarks. — The species is extremely similar to *Procaris ascensionis* Chace & Manning, recently described from Ascension Island in the Central Atlantic. In *P. ascensionis* the integument is less firm, the rostrum is shorter, the cervical groove is more distinct, and the third abdominal somite does reach less far posteriorly over the fourth; also the scaphocerite has the final tooth still less distinct than in *P. hawaiana*, and the last segment of the antennal peduncle is less slender.

The discovery of *Procaris hawaiana* in the Hawaiian Archipelago so soon after the discovery of *Procaris ascensionis* in Ascension is most remarkable: the present description, namely, was made before Chace & Manning's paper was published, and through the kindness of Drs. Chace and Manning I was able to use their manuscript and their specimens in writing the present report. The find of the most unusual and highly aberrant *Procaris ascensionis* which was so different from any other then known Caridean that a new family and superfamily had to be erected for it, was extremely unexpected and the almost simultaneous find of a very similar form at the other side of the globe is even more surprising. The two species occur in very similar habitats. *Procaris ascensionis* was collected from pools "situated on a rough lava flow", "in fractured and jagged basalt, they connect by percolation with the adjacent ocean" and "are situated from 55 to 90 meters inland from the beach proper". It would be interesting to thoroughly investigate similar habitats in other areas of the world.

#### ATYIDAE De Haan, 1849

##### ***Antecaridina lauensis* (Edmondson, 1935)**

*Mesocaris lauensis* Edmondson, 1935, Occ. Pap. Bishop Mus. Honolulu, 10 (24): 13.

*Antecaridina lauensis* Holthuis, 1963, Zool. Meded. Leiden, 38 (16): 267 (older literature); Holthuis, 1965, Mém. Mus. Hist. nat. Paris, (n. ser. A) 33 (1): 4, fig. 2.

Pool with a tiny surface exposure in lava near Nukuele Point, Cape Kinau, Maui, Hawaiian Archipelago (loc. 3c), 18 March 1972, J. A. Maciolek (no. K-W-7), 1 ♀ cl. 6 mm. — same locality, 15 April 1972, J. A. Maciolek, 2 ♂ ♂ cl. 4.5 mm, 3 ♀ ♀ cl. 4.5-6.5 mm.

Small pool in lava on S.W. coast of Cape Kinau (loc. 3e), 12 August 1972, J. A. Maciolek (no. K-Z-NP), 2 specimens cl. 6 and 7 mm.

Size. — The species is about 10 to 15.5 mm long in total length. The carapace length varies between 4.5 and 7 mm.

Colour. — The specimens from near Nukuele Point were observed by Dr. Maciolek (in litt., 19 April 1972) in life to be "light to bright red, much the same as *Halocaridina rubra*. Live specimens have undergone several color reversals, from red to white-translucent and back. These changes require many minutes to complete and appear to occur in response to light and disturbance". In specimens from Entedebir Island, southern Red Sea, a similar phenomenon was observed, some specimens being deep bright red, others almost transparent colourless or slightly yellowish. Evidently these changes are caused by expansion and contraction of the red chromatophores.

The following colour description was made after a freshly preserved specimen: The animals are entirely red. The carapace is laterally lighter than dorsally, also the abdominal somites are darkest dorsally; the dark colour furthermore extends somewhat along the posterior margins of the somite and along the margins of the pleura. The tailfan has a broad dark band over the distal part, while the distal hairs are white. The antennular peduncle is red, the antennal peduncle has the last two segments white. There is a white spot in the middle of the scaphocerite. The oral parts and legs are pink or red. The chelae and the dactyli of the pereiopods are white, as is also the propodus of the fifth pereiopod. The pleopods are pink.

Colour notes on the species are also given by Holthuis (1963: 267, 268).

Biology. — In both pools at Cape Kinau the species was observed at night, a small population was present; during the day they were seen in dimly illuminated recesses. The specimens were found resting on the bottom of the very small pool; because of the small size of the hole in which they were found, "securing the seven specimens required a certain amount of patience (two hours) and dexterity" in manipulating the small nets. The animals do not move much (in contrast to *Calliasmata*, *Metabetaeus* and *Procaris*), but seem to pluck at the substrate similar to the way other atyids feed in quiet water (J. A. Maciolek in litt., 19 April 1972).

Habitat. — At Cape Kinau the species was found in two of the lava pools, these have been described above (pp. 9, 10) under no. 3c and 3e. Both have a very small exposure with clear water of a salinity between 25 and 30<sup>0</sup>/<sub>00</sub>. In the Nukuele habitat it was found together with *Halocaridina rubra*, *Calliasmata pholidota* and *Metabetaeus lohena*. In the second locality *Calliasmata* was not found, but *Macrobrachium grandimanus*, *Palaemonella burnsi* and *Alpheus* were observed, as well as *Halocaridina* and *Metabetaeus*. Dr. Maciolek also observed the species in two localities on the island of Hawaii, viz., in the pool at Lua o Palahemo (loc. 4) and in the pool in the

fissure near Lohena Rock (loc. 5); in both places the species was rather scarce. The descriptions of these two localities are given on pp. 10 and 11. The habitat in localities from where the species has been reported previously have been discussed by Holthuis (1963: 268).

Distribution. — The species has not been reported before from the Hawaiian Archipelago, although its known range was already quite considerable. Its type localities are Namuka and Wangava Islands in the Lau Archipelago, Fiji Group. Later the species has been found in Devil's Crack, Entedebir Island, Dahlak Archipelago, southern Red Sea, and in a pool on Europa Island, between Madagascar and the African continent.

### ***Halocaridina rubra* Holthuis, 1963**

*Halocaridina rubra* Holthuis, 1963, Zool. Meded. Leiden, 38 (16): 262, fig. 1 (with older literature).

This species is the most common shrimp in the lava pools of Cape Kinau, Maui, Hawaiian Archipelago. Dr. Maciolek noted it in no less than 17 pools on the Cape Kinau Peninsula (fig. 2).

Also on the island of Hawaii Dr. Maciolek observed the species in great numbers, viz., in the pool at Lua o Palahemo (loc. 4), and the one north of Lohena Rock (loc. 5). He furthermore found it extremely abundant in a pond system situated in the vicinity of Kawikohale Point near Makalawena, in the northern half of the westcoast of Hawaii Island. This pond system lies in a lava flow and has only subterranean connections with the sea; it is very similar to the Cape Kinau pond system.

In a solution hole at Popoia Islet, Oahu, Dr. Maciolek also encountered *Halocaridina rubra*.

Colour. — The shrimps are red in colour, the records in the literature speak of "vermillion" and "scarlet vermillion". Dr. Maciolek described them as "small red shrimps", and (in litt., 19 April 1972) gave the colour as light to bright red, and subject to changes from red to white-translucent and back, like in *Antecaridina lauensis*. The changes in intensity of the red colour are probably due (like in *Antecaridina*) to expansion and contraction of the red chromatophores. The eggs were described by Dr. Maciolek (in litt., 2 June 1972) as "greenish".

Biology. — So far no ovigerous females have been reported in the literature and they have not been observed in nature either. Dr. Maciolek, however, in specimens kept in captivity observed the presence of greenish eggs in the posterior part of the thorax in several females in May 1972. Only one of these females actually produced these eggs (12 in number) which were carried in the usual fashion under the abdomen, attached to the

pleopods. All eggs of this specimen hatched and two weeks later the first postlarval stage was reached.

In contrast to several other species, *Halocaridina rubra* is also apparent during the day. On a darkly overcast day, in Lua o Palahemo (locality 4), Dr. Maciolek at one occasion noted a swarm of *H. rubra* near the surface and made a most impressive colour photograph of this phenomenon, showing innumerable individuals of this species, which by their presence gave the water a red colour. Dr. Maciolek (letter of 5 March 1973) stated "I had not seen this phenomenon before and believe it relates to Hawaiian legends about "water turning red with blood" ".

As to the salinity tolerance of this species Dr. Maciolek remarked (in litt., 5 March 1973) that Edmondson (1935: 16) was in error when he described the species (which he indicated as *Caridina brevirostris*) as a typically brackish water form, both seawater and fresh water being fatal to it. Dr. Maciolek has "kept *H. rubra* for months in tap water and recent tests indicate tolerance to hypersaline water (50<sup>0</sup>/00) when acclimated slowly".

*Halocaridina rubra* is often found together with *Metabetaeus lohena*, by which it is preyed upon (see p. 36).

Habitat. — So far *Halocaridina* is only known from anchialine lava pools, and has been found in all the Cape Kinau pools (no. 3 a-f) described here on pp. 9 and 10 as well as in the two other Hawaiian pools (at Lua o Palahemo, loc. 4; and the one north of Lohena Rock, loc. 5) described more extensively on pp. 10 and 11. Near Makalawena, Hawaii, where the species also occurs in lava pools, it was observed "only in very sheltered areas (along shore under dense kiawe [= *Prosopis pallida*], under overhanging rocks), possibly as a result of bird predation" (Maciolek, unpublished, p. 4).

Distribution. — The species seems to be restricted to the Hawaiian Islands. In the literature, it has been reported from the islands of Hawaii (Puako Bay on the central west coast; Pohoiki, Lower Puna in the extreme eastern part; Lohena Rock, W. of Ka Lae, South Cape) and Oahu ("from widely separated localities"). The present records not only increase the number of known localities of the species on the islands of Hawaii and Oahu, but also show it to be present on Maui Island.

PALAEEMONIDAE Rafinesque, 1815

Palaemoninae Rafinesque, 1815

**Palaemon debilis** Dana, 1852

*Palaemon debilis* Dana, 1852, Proc. Acad. nat. Sci. Philadelphia, 6: 26; Chace, 1972, Crustaceana, 23 (1): 12.

*Palaemon debilis* has been found in many of the anchialine lava pools, but is not a typical inhabitant of these. The species occurs in a great diversity of habitats, ranging from freshwater to pure marine environments. Chace (1972) commented upon a form with a short rostrum found in lava pools near Makalawena, Hawaii Island.

Dr. Maciolek found this species at Cape Kinau Peninsula in 11 of the pools (see pp. 9, 10 and fig. 2) and for this reason it is mentioned here.

Distribution. — *Palaemon debilis* has a very wide distribution in the Indo-West Pacific region, its range extending from the Red Sea to Hawaii and the Tuamotu Islands.

**Macrobrachium grandimanus** (Randall, 1840) (text-fig. 7)

*Palaemon grandimanus* Randall, 1840, Journ. Acad. nat. Sci. Philadelphia, 8: 142.

*Macrobrachium grandimanus* Holthuis, 1950, Siboga Exped. Monogr., 39 (a 9): 230 (with older literature).

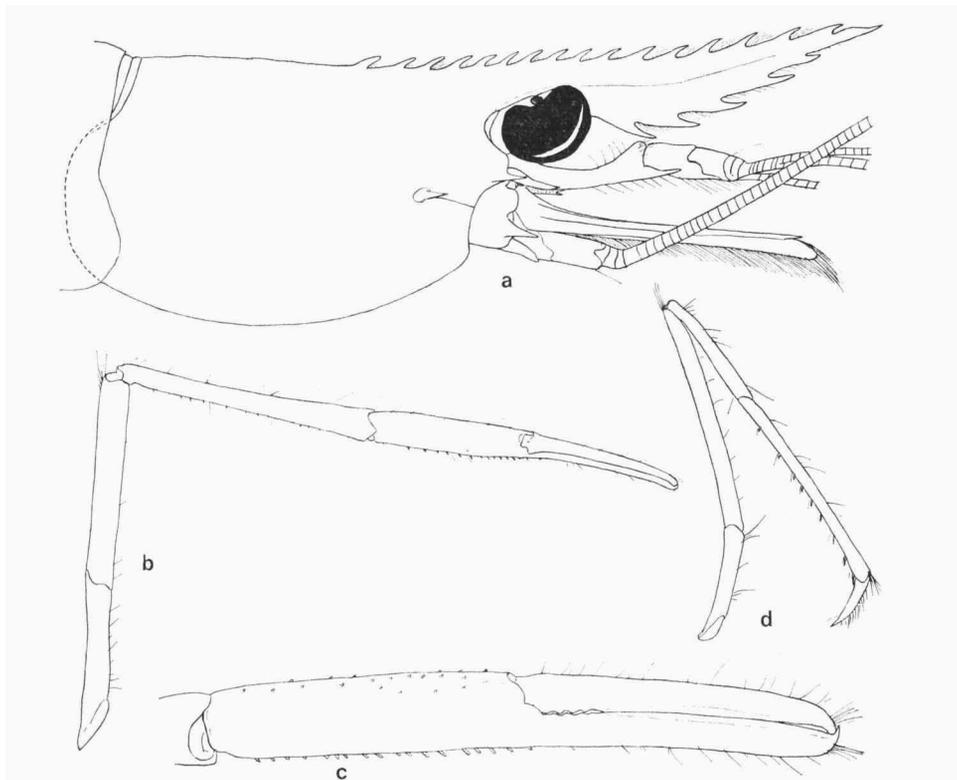


Fig. 7. *Macrobrachium grandimanus* (Randall), ovigerous female from lava pool, Cape Kinau. a, carapace and cephalic appendages, lateral view; b, second pereiopod; c, chela of second pereiopod; d, third pereiopod. a, b, d,  $\times 6$ ; c,  $\times 12$ .

Pool in lava flow, Cape Kinau, Maui, Hawaiian Islands, January 1972, J. A. Maciolek, 2 ovigerous females, 1 juvenile.

Like *Palaemon debilis*, the present species is not a typical inhabitant of the anchialine lava pools. Actually it is the common freshwater shrimp of the Hawaii Islands, and occurs here outside its normal habitat. The specimens examined, again like the specimens of *Palaemon debilis* from this habitat, show some differences from normal specimens, which differences are not sufficiently important to consider them of specific or even subspecific rank.

The present ovigerous specimens, although sexually mature, are small for the species and show a number of juvenile (?) characters. The rostral formula in the two adults is 5)15-16/5 in the juvenile 4)14/4. The rostrum is slender, reaches distinctly beyond the antennular peduncle and is slightly curved up distally. The teeth are regularly divided over the dorsal part of the rostrum, the distal being somewhat more widely spaced than the proximal.

The legs are unusually slender. The second pereopods reach with part of the palm beyond the scaphocerite. The fingere are about as long as the palm. The relation chela: carpus: merus: ischium is about 11-12:9:7:5. The chela is about 9 times as long as high and the carpus about 7½ times. The legs are thus more slender than in the normal form, and the carpus is relatively much longer. The third leg reaches with the dactylus beyond the scaphocerite. The propodus is fully three times as long as the dactylus and 1.75 times as long as the carpus. The merus is about as long as the propodus.

The eggs are numerous and small, measuring 0.5 × 0.7 mm in diameter.

Biology and habitat. — Very little is known about the ecology and biology of the species. It would be interesting to compare material from the lava pools with such obtained in fresh water habitats. That the species is not rare in the lava pools is shown by the fact that it has been taken in no less than 8 of these pools (see fig. 2). Dr. Maciolek (in litt., 17 February 1972) indicated that *M. grandimanus* of the normal type has been found by him in other mixohaline pond systems on both Hawaii and Maui Islands.

Distribution. — *Macrobrachium grandimanus* is known from fresh, brackish and salt water in the Hawaiian Islands, and has also been reported from the Riukiu Islands.

Pontoniinae Kingsley, 1878

***Palaemonella burnsi*** new species (text-figs. 8, 9)

Cape Kinau Peninsula, Maui, Hawaiian Islands; small lava pool near coast of Keoneoio (= La Perouse) Bay, at the extreme east end of the Cape (loc. 3f); 12 June 1972, J. A. Maciolek (no. K-dc-1,4); 7 females (2 ovigerous). The largest ovigerous

♀ is the holotype (RMNH Crust. D. 28955); the other specimens are paratypes (RMNH Crust. D. 28956).

Kaloko Fish Pond, North Makai Corner, Kona Coast, Hawaii; 26 August 1972; R. E. Brock and J. A. Maciolek; 2 ovigerous female paratypes (RMNH Crust. D. 28957).

Description. — The rostrum is high and rather straight. It reaches distinctly beyond the antennal peduncle and slightly beyond the scaphocerite. The upper margin bears 8 teeth. The first tooth stands at  $\frac{2}{5}$  of the length

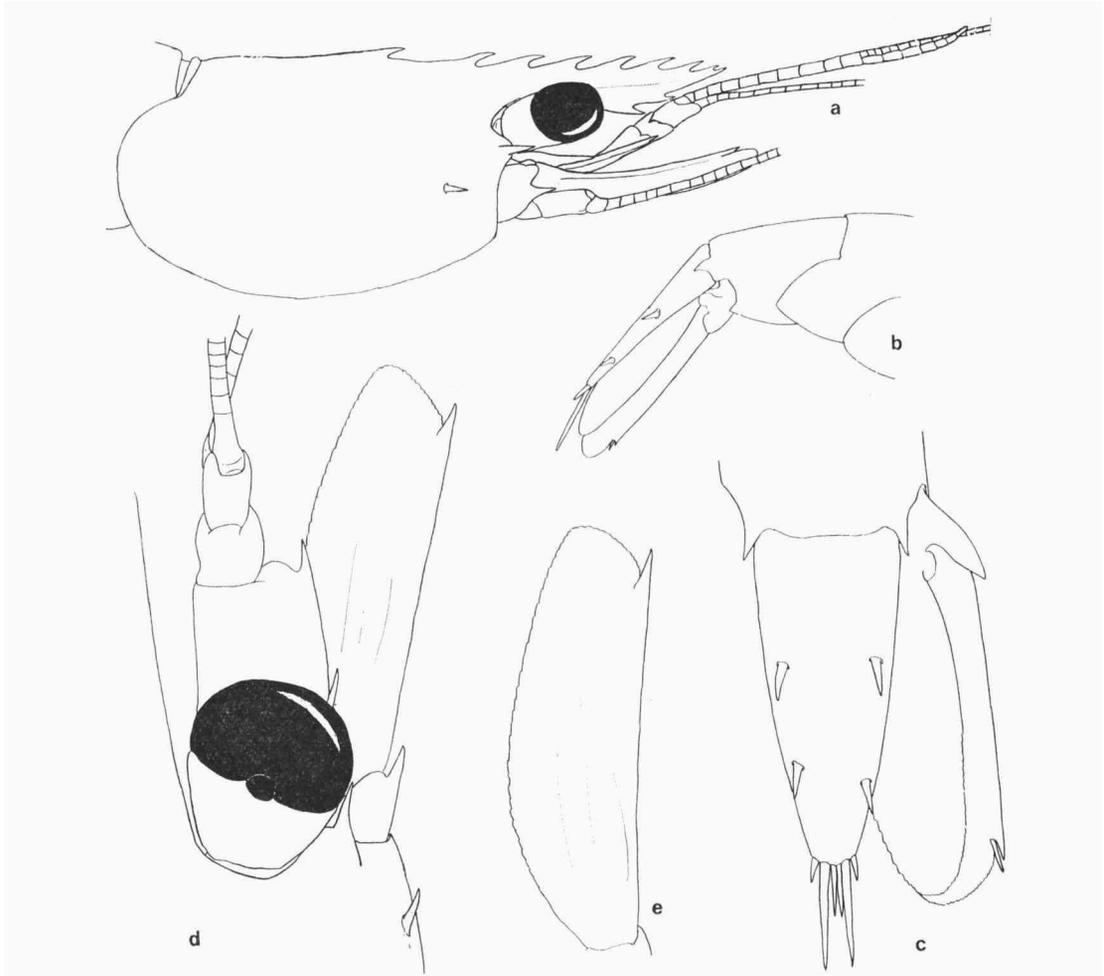


Fig. 8. *Palaemonella burnsi* new species, specimen from Maui. a, carapace and cephalic appendages, lateral view; b, posterior part of abdomen, lateral view; c, telson and uropod, dorsal view; d, cephalic appendages dorsal view; e, scaphocerite. a, b,  $\times 12$ ; c-e,  $\times 25$ .

of the carapace (rostrum excluded) behind the orbit. The distance between the first and second tooth is distinctly larger than those between the other teeth. The distal dorsal tooth stands just behind the tip of the rostrum, which becomes bifid thereby. The lower margin has 2 teeth. The midrib extends over the middle of the rostrum. The carapace shows a sharp antennal spine just below the very broadly and shallowly rounded lower orbital angle. The hepatic spine is distinct and is placed far behind and below the antennal. No supraorbital spine nor post-orbital groove is present. The pterygostomian angle is rounded.

The first 4 abdominal pleura are broadly rounded, the fifth ends in a blunt angle. The sixth somite is 1.5 times longer than the fifth and is about  $\frac{3}{4}$  as long as the telson. Its pleuron is bluntly rectangular. Its posterolateral angle is produced as a truncated lobe over the base of the telson, the outer angle of this process is rounded, the inner acutely pointed and produced slightly backwards. The telson is elongate triangular, ends in a narrow rounded posterior margin which bears the usual 3 pairs of spines. The outer spines are shortest but rather strong, the intermediate are longest, being almost 4 times as long as the outer spines. The inner spines are less than half as long as the intermediate and quite slender. The dorsal surface of the telson bears two pairs of spines, which divide the length of the telson into 3 parts, the basal of which is slightly the longest, the distal slightly the shortest.

The eyes are well developed, have the cornea wider than the stalk, and an ocellus is fused to the cornea.

The antennular peduncle bears a slender stylocerite on the basal segment, which reaches somewhat beyond the middle of the segment. The outer margin of the segment ends in a slender spine which almost reaches the anterior margin of the second segment. The anterior margin of the first segment, between this spine and the base of the second segment, is rounded, but does not reach as far as the spine. The last two segments are short, together they are shorter than the basal segment. The upper antennular flagellum has the two rami fused for 8 to 12 segments. The free part of the shorter ramus consists of 8 or 9 segments and is more than half the length of the fused part.

The scaphocerite reaches distinctly beyond the antennular peduncle and overreaches the antennal peduncle with more than  $\frac{2}{3}$  of its length. It is about three times as long as wide. The outer margin ends in a sharp strong tooth which does not reach the end of the lamella. The lamella is of about equal width in the distal half and does not noticeably narrow near the top. A strong external spine is present near the base of the scaphocerite.

The mandible bears a distinct 2-segmented palp. The incisor process

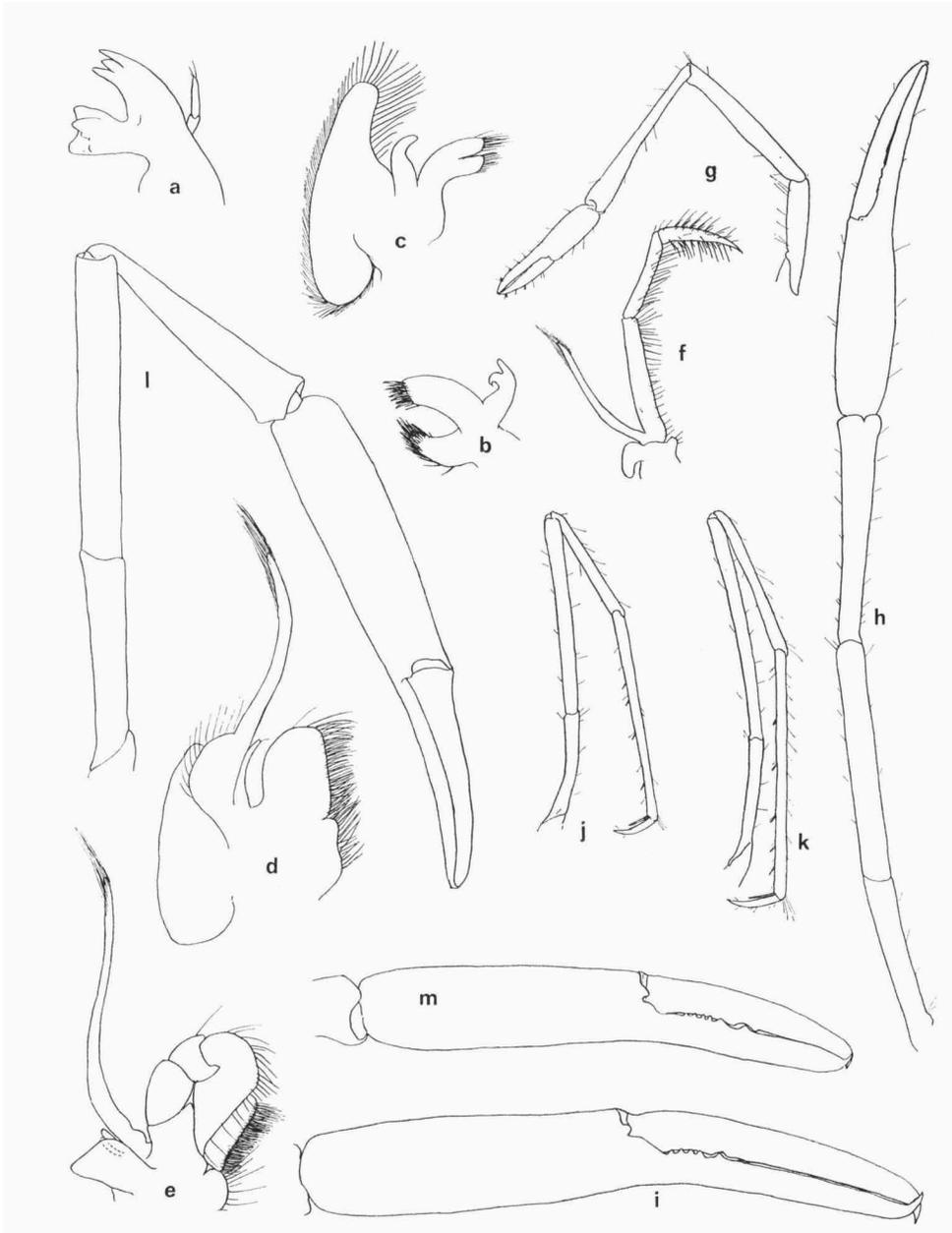


Fig. 9. *Palaemonella burnsi* new species. a-k, specimen from Maui; l, m, specimen from Hawaii. a, mandible; b, maxillula; c, maxilla; d, first maxilliped; e, second maxilliped; f, third maxilliped; g, first pereopod; h, second pereopod; i, chela of second pereopod; j, third pereopod; k, fifth pereopod; l, second pereopod; m, chela of second pereopod. a-e, i,  $\times 25$ ; f-h, j-l,  $\times 12$ .

ends in 3 strong teeth. The molar process shows several blunt knobs. The maxillula has both laciniae slender and ending in bristles and spines; the palp is distinctly bifid. The maxilla has the inner lacinia deeply bilobed; the palp is distinct and the scaphognathite large. All maxillipeds have large well developed exopods. The two endites of the first maxilliped are separated by a deep notch; the palp is slender; the epipod large. The second maxilliped is of the usual shape; the epipod bears a rudimentary podobranch consisting of a few lamellae. The third maxilliped reaches with the dactylus beyond the antennal peduncle. It is slender and no pleuro- or arthrobranch could be seen.

The first leg reaches with the chela beyond the scaphocerite. The fingers are slender and unarmed, they are about as long as the palm. The chela is about  $\frac{3}{4}$  as long as the carpus, which is about as long as the merus. The second legs are equal in shape, sometimes somewhat unequal in size; they reach with the chela or part of the (in some specimens with almost the entire) carpus beyond the scaphocerite. The fingers are  $\frac{3}{4}$  to fully as long as the palm, they are long and slender with the tips curved and crossing. The cutting edge of the fixed finger has a number (5 or 6) of small but distinct teeth in the basal half, that of the dactylus has two indistinct teeth there. The palm is slightly swollen. The carpus bears no teeth on the anterior margin. It is slender, and somewhat longer or somewhat shorter than the palm. The merus is slightly longer than the carpus and likewise unarmed. The third leg reaches with about half the propodus beyond the scaphocerite. The dactylus is simple and slender, it is less than  $\frac{1}{4}$  of the length of the propodus. The propodus is slender and has a few (about 5) spinules along the posterior margin. The distal of these spinules is placed at the base of the dactylus, and while the other spinules are small, this one is unusually long, being about half as long as the dactylus. The carpus is more than half as long as the propodus. The merus is only slightly shorter than the propodus. The fifth leg reaches with about half the propodus beyond the scaphocerite. The dactylus is slender. The propodus is about 4 to 4.5 times as long as the dactylus and about 1.5 times as long as the carpus; like in the third leg, it bears a few posterior spinules, the distal of which is extremely long. The merus is distinctly shorter than the propodus.

The pleopods of the present specimens, all of which are females, are normal. The uropods show a blunt tooth at the outer margin of the protopod near the base of the exopod. The exopod has the outer margin straight, ending in a sharp tooth, with a movable spinule to its inner side. The endopod is elongate oval and shorter than the exopod.

The eggs are rather numerous and small, measuring 0.4 to 0.7 mm in diameter.

Size. — The carapace lengths of the specimens examined (all females) varied between 6 and 9 mm. In the ovigerous females it was 6, 8, and 9 mm.

Colour. — The following description is based on a colour slide taken in the laboratory of a living specimen in which the red chromatophores were evidently contracted and which gave the general impression of a greyish green shrimp. The body is transparent and sprinkled all over with chromatophores. The carapace shows a short and broad transverse white median band in the middle consisting of irregularly arranged bright white chromatophores. A white line or spot is also visible on the eye stalk. A less distinct transverse white median band is visible in the anterior half of the fourth abdominal somite. The legs, like the body are greenish transparent. The large chelipeds are greenish with the fingers brownish orange, while the articulations between palm, carpus and merus are brownish.

In preserved specimens most teeth and spines, including those of the rostrum, carapace, tailfan and scaphocerite, show brownish tips. On the carapace red chromatophores are visible behind the orbit and in the area of the hepatic spine, as well as in the pterygostomian and posterolateral regions. On the abdomen distinct red transverse bands are visible on the terga, viz. along the anterior margin of the first somite, and along the posterior margin of all somites. The pleura of the first five abdominal somites also show red chromatophores, these are the most conspicuous on the pleura of somites 1 to 3. There are scattered chromatophores over the tailfan. The eyestalks are reddish, and some chromatophores are visible on the antennular peduncle. Also the lower surface of the body shows a reddish colour. Red chromatophores were observed in the extreme basal part of the pereopods (basis and coxa), and a few on the protopod of some of the pleopods.

Biology. — The shrimps were collected at night and were not evident during the day.

Habitat. — The species has been found at three different pools of Cape Kinau, viz., those described on p. 10 under 3e and 3f and a small pool to the west of the complex of 3f. Also it was taken at the Kona coast (west coast) of the island of Hawaii, in Kaloko Fish Pond; here the water has a salinity of 24-27<sup>0</sup>/<sub>00</sub>, a temperature of 28-30.5°C and an oxygen content of 16.3 ppm (measurements taken on 24 August 1972 at 10:40 am, 2 days before the capture of the specimens dealt with here).

Remarks. — *Palaemonella burnsi* new species is closest to *Palaemonella lata* Kemp, 1922, which it resembles in the broad scaphocerite in which the

lamella overreaches the final tooth, and in the unarmed merus of the second pereopods. It differs from *P. lata* in the much longer fused part of the two branches of the upper antennular flagellum, in the relatively much longer fingers and shorter palm of the second legs, in the unarmed carpus of the second legs, which in *P. lata* moreover is much shorter than the palm.

The specimens from Kaloko Fish Pond had the second legs (fig. 9 l, m) somewhat more robust than the specimens from Maui (fig. 9 h, i) but otherwise resembled them in practically all respects.

Dedication. — It is a pleasure to name this species for the Honorable John A. Burns, Governor of the State of Hawaii, as a token of deep appreciation for his action to declare the Ahiki Kinau area a natural area reserve. By this action the unique habitats of the Cape Kinau area housing the peculiar red shrimp fauna are protected and saved for posterity.

***Periclimenes pholeter* new species (text-figs. 10, 11, pl. 1 fig. 1)**

“A new species of *Periclimenes*” Por & Tsurumal, 1973, *Nature*, London, 241: 43.

Ras Muhammad Crack, Ras Muhammad, southern tip of Sinai Peninsula; in pool in crack in coral rock about 150 m from the sea, in salt water (locality no. 1 described on p. 5), 27 October 1971, F. D. Por No. 214f, 3 males and 2 females (1 ♂ holotype, RMNH no. 28119; rest paratypes RMNH 28120); same locality, 19 December 1971, F. D. Por, No. SLR 3336, 10 paratypes (RMNH no. Crust. D. 28944); same locality, 27 April 1973, I. Karplus, 1 paratype (RMNH no. Crust. D. 29242).

Description. — The rostrum reaches to or slightly beyond the end of the antennular peduncle, but fails to reach the tip of the scaphocerite. It is straight, with the tip directed slightly upward. The upper margin bears 9 or 10 teeth, 4 of which are placed behind the orbit, the others are concentrated in the basal  $\frac{2}{3}$  of the rostrum, the distal third (or somewhat less) of the upper margin is devoid of teeth. A small epigastric tooth is present on the dorsal margin of the carapace at about  $\frac{1}{3}$  of the length of the carapace (rostrum excluded) behind the orbit. The rostrum is rather high. In its proximal half the rostrum is of almost uniform height, in the distal half it narrows to the acute tip. The lower margin of the rostrum bears 2 to 4 teeth in the distal part; however, no teeth are placed close to the apex. The lateral carina of the rostrum merges with the orbital margin. The lower orbital angle is blunt and rather irregular in outline. The antennal spine is small and placed on the anterior margin of the carapace at some distance below the lower orbital angle. A slightly larger immovable hepatic spine is placed below and a considerable distance behind the antennal. No other spines are present on the carapace. The pterygostomial angle is bluntly rounded.

The abdominal somites are smooth and their pleura are rounded. The

sixth somite is about twice as long as the fifth, its pleura are triangular and bluntly pointed; the posterolateral angle ends in a somewhat curved sharp tooth. The telson is 1.5 times as long as the sixth somite. The dorsal surface of the telson bears two pairs of spinules, the anterior of which lies just behind the anterior third of the telson, the posterior is placed halfway between the anterior pair and the posterior margin of the telson. This posterior margin bears three pairs of spines. The outer pair is short and robust, the intermediate pair is four times as long as the outer and very

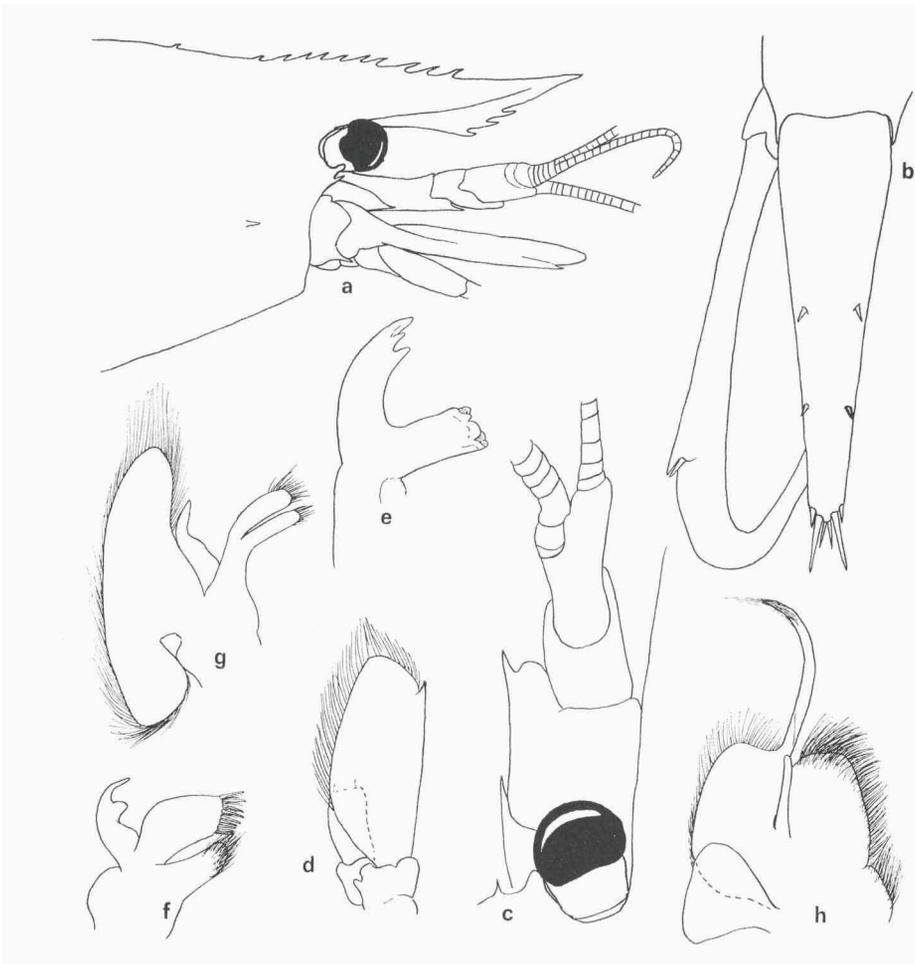


Fig. 10. *Periclimenes pholeter* new species, from Sinai Peninsula. a, anterior part of body, lateral view; b, telson and uropod, dorsal; c, eye and antennula, dorsal; d, scaphocerite; e, mandible; f, maxillula; g, maxilla; h, first maxilliped. a, d,  $\times 6$ ; c, e-h,  $\times 12$ .

strong. The inner pair is placed in the central part of the posterior margin which is bluntly produced backward beyond the base of the intermediate spines; the inner spines are slightly longer and much slenderer than the outer.

The eyes are well developed, but relatively small; they reach only slightly beyond the middle of the basal segment of the antennular peduncle. The cornea is rounded, it is about as long as and slightly wider than the stalk; it is well pigmented.

The first segment of the antennular peduncle is longer than the second and third taken together. The stylocerite is short and sharply pointed; it reaches somewhat beyond the middle of the basal antennular segment. The external anterolateral part of the basal segment is produced beyond the base of the second segment of the peduncle; its anterior margin is rounded and reaches beyond the middle of the second segment; its outer margin bears a slender sharp spine which attains the base of the third segment. The second segment of the peduncle is distinctly shorter than the third and has both the external and internal anterolateral angles produced beyond the base of the third segment. The third segment widens slightly distally. The upper antennular flagellum has the two rami fused for about 6 or 7 segments, the free part of the shorter ramus is 2.5 to 3 times as long as the fused part, it consists of about 16 to 20 segments.

The scaphocerite reaches distinctly beyond the antennular peduncle, it is somewhat more than twice as long as wide. The outer margin is slightly convex and ends in a distinct, but not very large tooth, which is far overreached by the widely rounded anterior margin of the lamella. The antennal peduncle reaches about to the middle of the scaphocerite. A sharp spine is placed on the outer margin of the antennal peduncle near the base of the scaphocerite.

The mandible bears no palp; the incisor process ends in three or four teeth, the outer of which are the larger; the molar process bears some rounded teeth distally. The maxillula has the two laciniae reasonably slender, the palp is deeply bilobed. The maxilla bears a single endite which is deeply cleft; the palp and the scaphognathite are well developed. The maxillipeds all have well developed exopods with a multi-articulated flagellum. The first maxilliped has the endites separated by a deep notch; the palp is long and simple; the exopod has a distinct caridean lobe; the epipod is distinct but not bilobed. The second maxilliped is of the normal shape; the epipod is well developed, but bears no podobranch. The third maxilliped reaches about to the end of the antennular peduncle. The last segment is almost  $\frac{2}{3}$

as long as the penultimate. The exopod is well developed and an epipod is present; there is no arthrobranch.

The branchial formula runs as follows:

	maxillipeds			pereiopods				
	1	2	3	1	2	3	4	5
pleurobranchs	—	—	—	1	1	1	1	1
arthrobranchs	—	—	—	—	—	—	—	—
podobranchs	—	—	—	—	—	—	—	—
epipods	1	1	1	—	—	—	—	—
exopods	1	1	1	—	—	—	—	—

The first pereiopods reach with the chela beyond the scaphocerite. The fingers are long and slender, being about twice as long as the palm, their cutting edges are unarmed. The carpus is practically twice as long as the chela and slightly longer than the merus. The second legs are equal, they reach with the carpus beyond the antennular peduncle. The fingers are long and slender, and have the cutting edges unarmed. The palm measures about  $\frac{3}{4}$  of the length of the fingers and is slightly swollen. The carpus is about as long as the fingers, and bears no spines or teeth, neither does the merus. The merus is about as long as the carpus and somewhat longer than the ischium. The third leg reaches with the propodus beyond the scaphocerite. The dactylus is slender and distinctly bifid, it has less than  $\frac{1}{5}$  of the length of the propodus. The propodus bears about 7 spinules on the posterior margin, the distal ones are placed closer together than the proximals. The carpus has about  $\frac{5}{8}$  of the length of the propodus. The merus is distinctly longer than the propodus, less than twice as long as the carpus and more than twice as long as the ischium. The fourth leg is similar to the third, but the propodus and carpus are relatively longer. The fifth leg reaches with part of the carpus beyond the scaphocerite, it is much more slender than the foregoing two legs. The dactylus resembles that of the third leg. The propodus is more than 8 times as long as the dactylus; its posterior margin bears a few minute spinules, but in the distal part shows a dense fringe of hairs. The propodus is more than 1.5 times as long as the carpus. The merus is distinctly shorter than the propodus and about twice as long as the ischium. In comparison to the previous legs, the propodus and carpus have become still more elongate.

The endopod of the fifth pleopod of the male is widened distally and has there an irregularly rounded outline. The second male pleopod has the appendix masculina about as slender, but slightly longer than the appendix interna; it ends in a number of strong setae or slender spines. The exopod

of the uropod has the outer margin straight and ending in a tooth, which at its inner side bears a movable spine. The endopod is oval.

Size. — The total length of the males is 28 to 33 mm, of the females 35 and 36 mm. The males have a carapace length of 13 to 14 mm, the females of 14 and 15 mm (inclusive of the rostrum). The carapace length without the rostrum is 8.5 to 9.0 mm in the males, 9.0 and 9.5 mm in the females.

Colour. — The general impression living specimens give is that of pink animals (pl. 1 fig. 1), as I noticed myself. The colour is far less intensely red than that of *Calliasmata* collected under the same circumstances. The

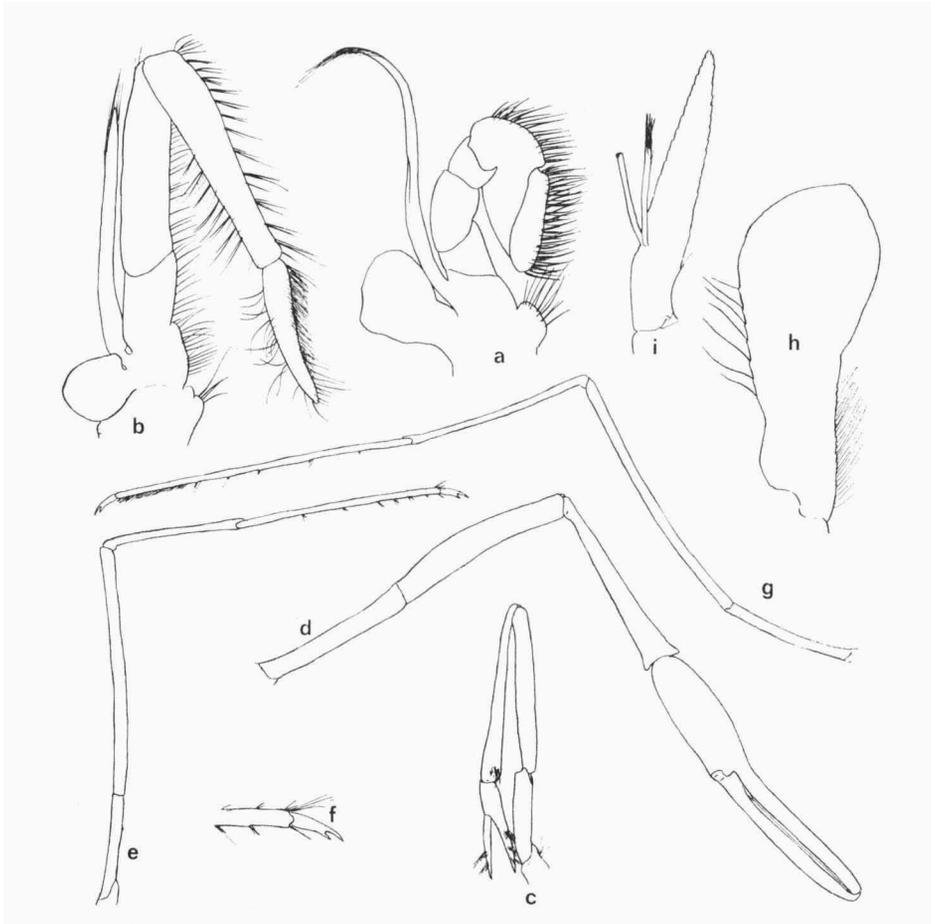


Fig. 11. *Periclimenes pholeter* new species, from Sinai Peninsula. a, second maxilliped; b, third maxilliped; c, first pereopod; d, second pereopod; e, third pereopod; f, dactylus of third pereopod; g, fifth pereopod; h, endopod of first male pleopod; i, endopod of second male pleopod. a, b, f,  $\times 12$ ; c-e, g,  $\times 6$ ; h, i,  $\times 25$ .

following detailed description is made after a colour slide of the living animal provided by Dr. Por. The colour of the body is pale yellowish green with many red chromatophores. These chromatophores are rather evenly distributed over the carapace, being somewhat more distinct in the posterior half, while the posterior margin is conspicuously darker. The abdomen also is covered with red chromatophores. These chromatophores are most distinct, and form actual red bands, along the anterior margin of the first and the posterior margins of all somites. The bands are darkest near the margins. The tailfan is of a light colour. The appendages of the body also are pale pink, only the fingers of the large chelipeds are somewhat darker, slightly more brownish.

Habitat. — The species is only known from Ras Muhammad Crack, described on pp. 5 to 7 above. The collectors have not made any special observation on the biology of this species.

Remarks. — The present new species belongs to the typical subgenus of *Periclimenes* as understood by Kemp (1922), and is closest to *Periclimenes indicus* Kemp, *P. obscurus* Kemp, and *P. toloensis* Bruce, resembling these species in the presence of an epigastric tooth on the carapace, the shape of the abdomen, the spinulation of the carapace, and the unarmed fingers of the first chelipeds. *P. pholeter* most strongly resembles *P. indicus* by the elongate carpus and long fingers of the second pereopods, differing in these features from *P. toloensis* which has the fingers slightly less than half as long as the palm, and the carpus  $\frac{1}{4}$  of the length of the chela. In *P. obscurus* the fingers are shorter than the palm, but the carpus is about as long as the palm. From *P. indicus* the new species differs: (1) by the greater size: the largest specimen of *P. indicus* recorded had a total length of 16 mm, (2) by the much higher rostrum and the greater number of ventral rostral teeth, which are placed more posteriorly, (3) by the shorter eye, (4) by the less slender antennular peduncle, the first segment of which reaches farther beyond the base of the second, (5) by the more deeply cleft upper antennular flagellum, (6) by the more robust scaphocerite, (7) by the fingers of the first pereopods, which are much longer than the palm, (8) by the more slender pereopods, especially the fifth, which has the carpus more than half as long as the propodus and much longer than the ischium.

#### ALPHEIDAE Rafinesque, 1815

##### **Metabetaeus lohena** Banner & Banner, 1960

*Metabetaeus lohena* Banner & Banner, 1960, Pacif. Sci., 14: 290, fig. 1.

Near Nukuele Point, Cape Kinau, in lavapool, January 1972, J. A. Maciolek, 10 specimens; same locality, area "E". 17 March 1972, J. A. Maciolek, 10 specimens.

Biology. — Dr. Maciolek (in litt. 19 April 1972) indicated that this species moves around much more than *Antecaridina*. *Metabetaeus lohena* preys upon *Halocaridina rubra* (see Banner & Banner, 1960: 302); this is confirmed by Dr. Maciolek, who further (in litt.) gave the following details: "it preys on *H. rubra*, although it does not appear to do so efficiently. With few exceptions, *M. lohena* co-occurs with *H. rubra* and spends nearly all of its time crawling or swimming in a forward direction with chelae extended anteriorly, indiscriminately chasing the smaller shrimps which nearly always are just out of reach. In fact, the easiest way to detect *M. lohena*'s presence in a pool with *H. rubra* is to watch for sudden localized movement of the latter shrimps as they scatter from the path of an oncoming *Metabetaeus*. After much time spent observing this, I can report seeing only two captures — in both cases *M. lohena* immediately carried its prey out of view into a dark crevice. *M. lohena* also feeds on other small animals (one was captured with an insect larva in its grasp). *M. lohena* is also attracted to bait (pieces of fish) placed in pools as attractants".

Habitat and Distribution. — Like *Halocaridina rubra*, the present species is one of the commoner inhabitants of the anchialine lava pool habitat, and has not been found outside this kind of habitat. Dr. Maciolek (in litt., 19 May 1972) called it ubiquitous in the lava pond system. In the Cape Kinau area it has been found in 13 ponds, while it also was encountered in similar lava pools on the Kona Coast (west coast) of Hawaii. The previous records of the species are from Hawaii Island, the type locality being in fissures of Lohena Rock, a literal volcanic cone near the southern tip of the island.

#### **Alpheus spec. ?**

In four of the pools on the eastern end of Cape Kinau an Alpheid shrimp, presumably belonging to the genus *Alpheus* was observed and collected. The material will be studied by Mrs. Dora M. Banner.

#### HIPPOLYTIDAE Bate, 1888

#### **Ligur uveae** (Borradaile, 1899)

*Parhippolyte uveae* Borradaile, 1899, in Willey, Zool. Res. Material New Britain, New Guinea, Loyalty Ids., 4: 414, pl. 38 fig. 11.

*Ligur uveae* Holthuis, 1963, Zool. Meded. Leiden, 38(16): 271 (here older literature); Monod, 1968, Bull. Mus. Hist. nat. Paris, (2) 40: 772, figs. 1-8.

North end of Fangafale Islet, Funafuti Atoll, Ellice Islands; land-locked saltwater pool; 1 March 1972; S. P. Rawlins, 7 specimens (1 ovigerous).

Habitat. — This is again one of the species found only in anchialine pools. The habitat of the present specimens has been described under no. 2 on p. 7

of this paper. Monod's (1968) material came from "une mare d'eau saumâtre dont le niveau est apparemment un peu au-dessus de celui de la mer et où il tombe des feuilles de palétuvier qui y pourrissent".

Distribution. — The species has a very wide distribution (see Holthuis, 1963: 272) to which now also Funafuti can be added. Monod (1968) gave a description and extensive figures of the species based on two specimens from Sayawa Islet near the type locality of the species *Uvea* (or *Ouvea*), Loyalty Islands.

### **Calliasmata** new genus

Definition. — A hippolytid genus with the rostrum short and unarmed. The body is covered by minute scales. Apart from an antennal spine, no spines are present on the carapace, nor are there any carinae. The abdomen has the tergites unarmed and rounded. The pleura of the last four somites carry a strong spine each. No articulated plate is present at the postero-lateral angle of the sixth somite. The telson carries two pairs of dorsal and three pairs of posterior spines.

The eyes are degenerate and somewhat similar to those of species of the genus *Callianassa*. The upper antennular flagellum has the free part of the shorter ramus reduced to a single segment. The antennular peduncle bears no movable plate.

The mandible bears no incisor process and no palp. Well developed exopods are present on the three maxillipeds. Epipods are found on the maxillipeds and the first four pairs of pereopods. An arthrobranch is present on the third maxilliped, but not on the pereopods, all of which are provided with a pleurobranch.

The first pereopods have well developed chelae. The second pereopods are equal and have the carpus multiarticulated. The dactyli of the last three pereopods end in a single tooth and carry 4 or 5 spinules on the posterior margin.

Type species. — *Calliasmata pholidota* new species.

Affinities. — The genus is most closely related to *Lysmata*, from which genus it differs in the short and unarmed rostrum, the peculiar shape of the eyes and the strong armament of the last abdominal pleura.

The only known species is

### **Calliasmata pholidota** new species (text-figs. 12, 13,

pl. 1 fig. 2, pl. 2 fig. 1)

"A new genus of the family Hippolytidae" Por & Tsurumal, 1973, *Nature*, London, 241: 43.

Ras Muhammad Crack, near Ras Muhammad, southern tip of Sinai Peninsula; in pool

in narrow crack in elevated coral rock, about 150 m from the sea, in salt water (locality no. 1 described on p. 5), 27 October 1971, F. D. Por no. 219 FXI, 1 male holotype (RMNH no. Crust. D. 28117), 1 female paratype (RMNH no. Crust. D. 28118); same locality, 19 December 1971, F. D. Por no. SLR 3337, 4 female paratypes (RMNH no. Crust. D. 28950; and Zoology Department Tel Aviv University); same locality, 27 April 1973, I. Karplus, 1 paratype (RMNH no. Crust. D. 29240).

N. end of Fangafale Islet, Funafuti Atoll, Ellice Islands, saltwater pool at some distance from the sea (locality no. 2 described on p. 7), 26 December 1971, S. P. Rawlins, 1 female paratype (RMNH no. Crust. D. 28954); same locality, 1 March 1972, S. P. Rawlins, 1 male, 8 females, all paratypes (RMNH no. Crust. D. 28942).

Near Nukuele Point, Cape Kinau, Maui, Hawaiian Archipelago, in lava pool (locality no. 3a described on p. 9), 31 December 1971, J. A. Maciolek, 2 female paratypes, 1 moult (RMNH no. Crust. D. 28951).

Eastern part of Cape Kinau near the coast of Keoneoio Bay (= La Perouse Bay), Maui, Hawaiian Archipelago, in lava pool (locality no. 3f, described on p. 10), 17 August 1972, J. S. Lenic no. K-dc-5, 1 male, 2 females, all paratypes (RMNH no. Crust. D. 28952).

Lua o Palahemo, 1 km from Ka Lae (South Cape), southern tip of Hawaii Island, Hawaiian Archipelago, 18°55'N 155°40.8'W, pool in lava field (locality no. 4 described on p. 10), 3-8 m deep, 20 October 1972, J. A. Maciolek and R. E. Brock, 1 male, 1 female, paratypes (RMNH no. Crust. D. 28953).

**Description.** — The rostrum is short and simple and fails to reach the end of the eyes. In lateral view the upper margin is straight and forms a continuation of the dorsal line of the carapace; the ventral margin is oblique, it is slightly curved in the middle; the apex is sharply pointed. In dorsal view the rostrum is sharply triangular, its lateral margin passing into the orbital margin without interruption.

The carapace has the surface finely pitted, each pit is the place where a minute scale is implanted. These scales are directed anteriorly and are very small (about 0.06 mm long); they have an oval body and end in a very slender and long tapering tip; at each side of the basis of this distal part the scale is somewhat shoulder-like produced. Apart from a distinct but rather small antennal spine, which is placed on the lower angle of the orbit, the carapace shows no spines, teeth, or carinae. The anterolateral angle of the carapace is widely rounded. The posterior margin does not show a cardiac notch.

The abdomen is smooth. The surface of the integument is finely pitted like that of the carapace and bears similar scales, which are directed posteriorly. The pleuron of the first somite is rather broad, with the anterior angle broadly rounded, and the posterior produced to a bluntly topped rectangle. The pleuron of the second somite is wide and rounded with a short blunt lobe in the posterior half of the distal margin. The third, fourth and fifth somites each have a strong and sharp posteriorly directed spine on the distal margin. The pleuron of the sixth somite is bluntly triangular,

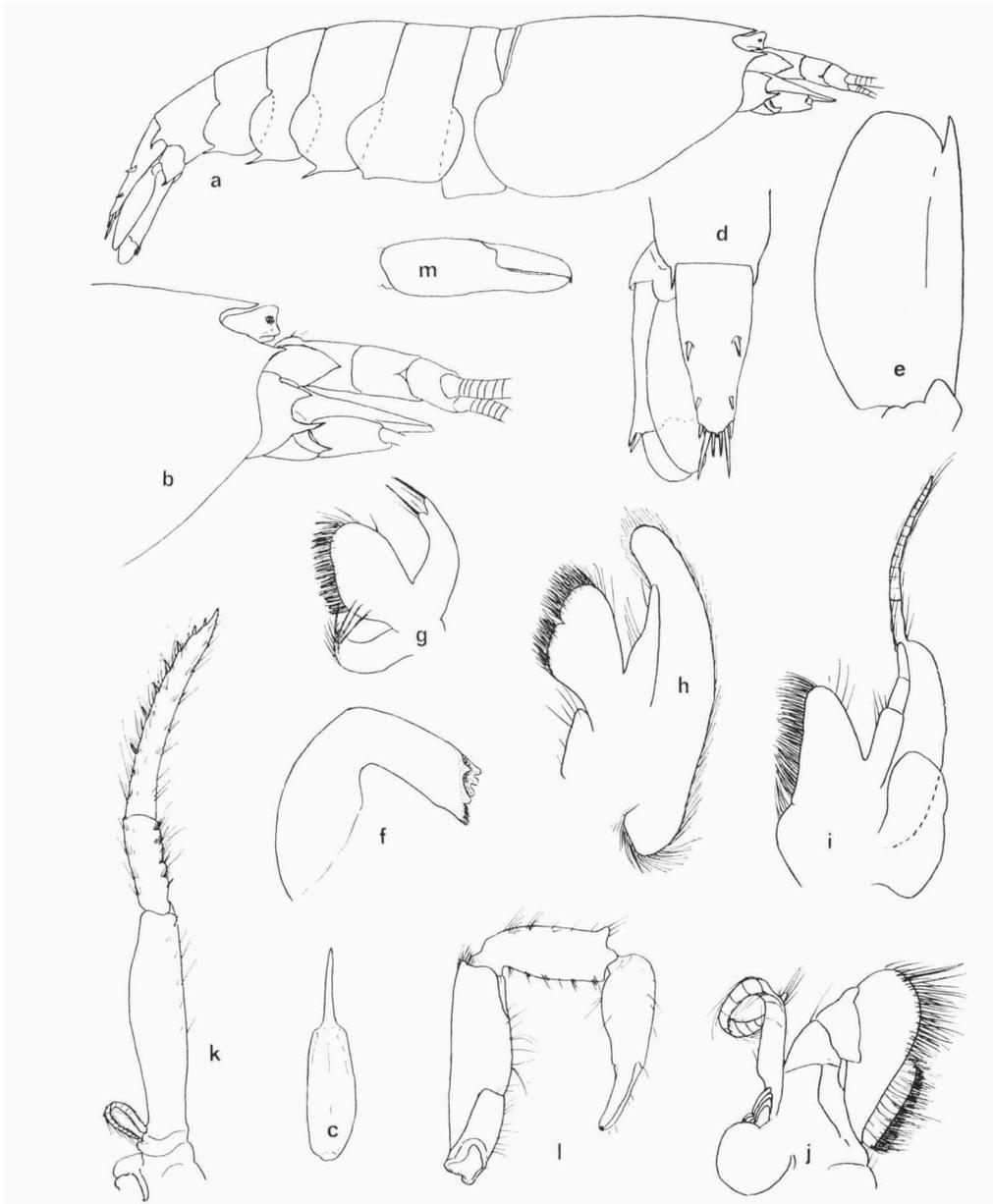


Fig. 12. *Calliasmata pholidota* new genus, new species, specimen from Sinai Peninsula. a, animal in lateral view (legs omitted); b, anterior part of carapace and cephalic appendages, lateral view; c, scale of carapace; d, telson, dorsal view; e, scaphocerite; f, mandible; g, maxillula; h, maxilla; i, first maxilliped; j, second maxilliped; k, third maxilliped; l, first pereopod; m, chela of first pereopod. a,  $\times 3$ ; b, d, k, l,  $\times 6$ ; c,  $\times 50$ ; e-j,  $\times 12$ .

there is no movable plate, the posterolateral angle is rounded, with a very strong, slightly curved and posteriorly pointed sharp spine on its dorsal side. The sixth abdominal somite is slightly longer than the fifth and about  $\frac{2}{3}$  as long as the telson. The telson is elongate triangular with the posterior margin truncate and provided with a sharp but short median spine. The upper surface of the telson bears two pairs of good-sized spines: the first pair is placed in the anterior half of the telson, the last pair lies closer to the posterior margin of the telson than to the anterior pair. The posterior margin of the telson bears three pairs of spines the outer of which is short, the intermediate very long and strong, and the inner of medium size.

The eyes are short and broad, they fail to reach the end of the antennal spine of the carapace. The left and right eye are pressed against each other, and are immovable. The upper surface is rather flat, slightly convex and provided with scales like those on the carapace. The lower surface of the eye is oblique. The anterior margin slopes outward and somewhat backward. The general shape of the eyes strongly resembles that of some species of *Callianassa*, where it not for the presence of a compressed lobe at the outer anterolateral angle of the eye, which extends backward toward the base of the eye. Through this lobe the anterior margin of each eye becomes seemingly concave in the middle. Like in *Callianassa* the cornea is restricted to a small rounded area, which here lies just behind the anterior margin, near the base of the lobe. Some small black spots which persist in alcohol are seen in several places on the eyestalk, mostly so in the basal part of the lobe, while on the inner margin of the lower surface of the eye a conspicuous almost quadrangular dark spot is visible, the spots of the right and left eye lying practically side by side.

The first segment of the antennular peduncle is long, being longer than the distal two segments combined. The stylocerite is flat and high, it is oval in lateral view and ends in a sharp point, which fails to reach the end of the first segment. The second segment is somewhat shorter than the visible part of the first, but is clearly longer and higher than the third. The upper flagellum has two rami which are fused for the basal 24 or 25 segments. The free part of the inner ramus is very short and consists of a single segment, that of the outer is long and multi-articulate. The free part of the inner ramus is so short that at first view the flagellum seems to be uniramous. The lower flagellum is long, single and narrower than the upper.

The scaphocerite is well developed and almost reaches the end of the antennular peduncle. It is about twice as long as wide. The outer margin is almost straight and ends in a strong final tooth. The lamella is wide, ends

in a broadly rounded top, which reaches practically as far as the final tooth. The antennal peduncle reaches about  $\frac{2}{3}$  of the length of the scaphocerite. The basal part of the peduncle bears two teeth in its external part: one above and one below the base of the scaphocerite.

The mandible lacks the palp and the incisor process. The molar process ends in some blunt teeth and a group of short hairs. The maxillula has the lower lacinia slender, the upper is much higher; the palp is distinctly bilobed. The maxilla has the lower endite short, the upper is much better developed and divided in two by a shallow notch; the palp is well developed and single; the epipod is long and slender. The maxillipeds are all provided with well developed multi-articulated exopods. The first maxilliped has the two endites separated by a shallow notch; the palp is well developed and three-segmented; the exopod has a flagellum and a narrow caridean lobe; a large epipod is present. The second maxilliped has the last segment attached to the penultimate by its long side. The exopod is well developed, an epipod and a podobranch are present. The third maxilliped is easily detached, it reaches with the last segment beyond the antennal peduncle. The last segment is more than twice as long as the penultimate, it ends in a sharp point, and bears about 7 movable spines in the distal  $\frac{3}{4}$  of its outer margin. The antepenultimate segment is about as long as the ultimate. A small exopod, an epipod and an arthrobranch are present.

The branchial formula runs as follows:

	maxillipeds			pereiopods				
	1	2	3	1	2	3	4	5
pleurobranchs	—	—	—	1	1	1	1	1
arthrobranchs	—	—	1	—	—	—	—	—
podobranchs	—	1	—	—	—	—	—	—
epipods	1	1	1	1	1	1	1	—
exopods	1	1	1	—	—	—	—	—

The first pereiopods are equal and short. The fingers are somewhat shorter than the palm, they end in sharply pointed, dark coloured tips, which are crossing. To the inside of the tip of the dactylus there is a much smaller dark coloured tooth against which the tip of the fixed finger rests when the chela is closed. The carpus has about  $\frac{4}{5}$  of the length of the chela. The merus is about as long as the chela. The second legs are long and slender, and reach with the entire carpus and part of the merus beyond the antennular peduncle. The chela is narrow and elongate. The carpus is about 10 times as long as the chela and is subdivided into about 26 to 50 (usually 30 to 40) segments. The merus is about half as long as the carpus and shows

about 15 to 30 annulations. The ischium is about as long as the merus, has about 3 to 9 annulations in the distal half, and in the basal part of the inner margin shows a row of curved stiff hairs. The third pereiopods reach with the carpus beyond the antennal peduncle. The dactylus is slender, it ends in a sharp, somewhat curved tip and bears three or four spines on the posterior margin. The propodus is about four times as long as the dactylus and bears about 20 small spinules along the posterior margin. The carpus

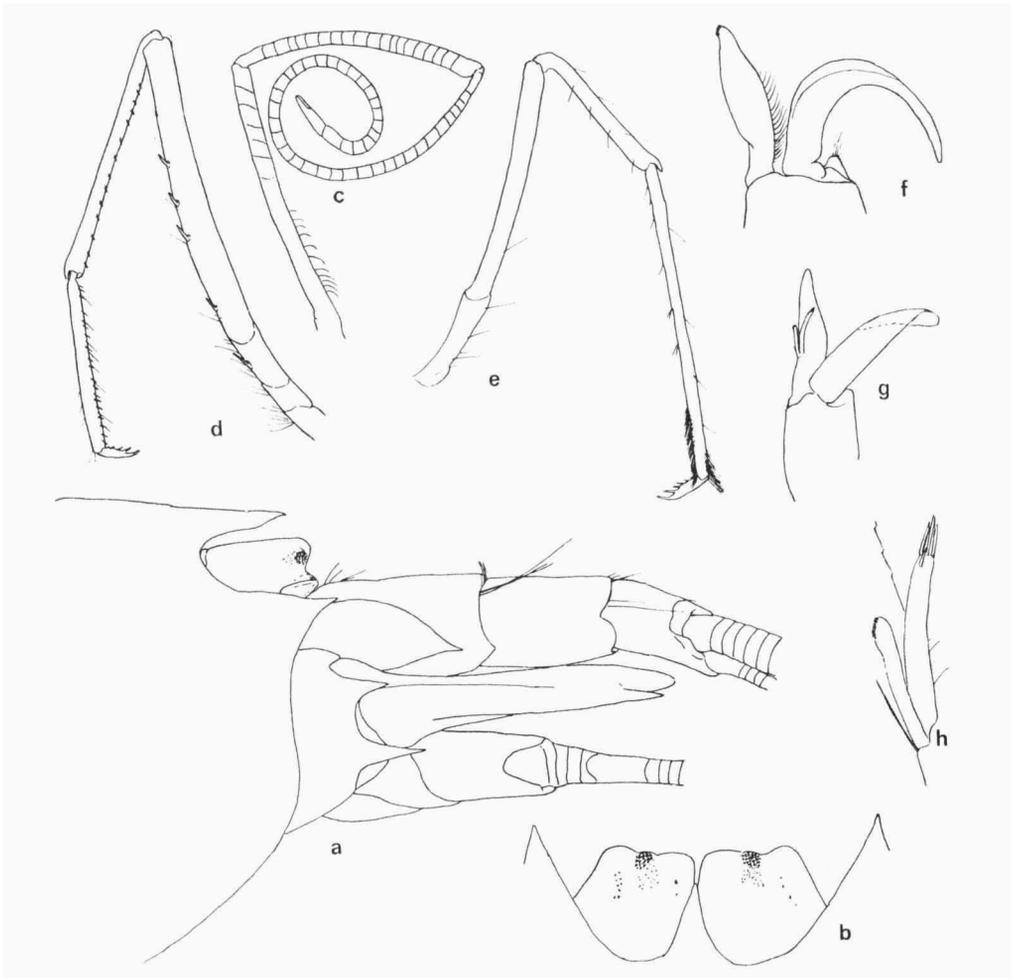


Fig. 13. *Calliasmata pholidota* new genus, new species, a, b, specimen from Funafuti; c-h, specimen from Sinai Peninsula. a, b, anterior part of carapace and cephalic appendages, lateral view; b, anterior part of carapace and eyes, dorsal view; c, second pereiopod; d, third pereiopod; e, fifth pereiopod; f, first male pleopod; g, second male pleopod; h, appendices of second male pleopod. a, b, f,  $\times 12$ ; c-e, g,  $\times 6$ ; h,  $\times 25$ .

is distinctly longer (about 1.3 to 1.4 times) than the propodus, it has likewise numerous (about 12 to 15) spinules along the posterior margin. The merus is longer and broader than the carpus, it bears 3 to 5 strong movable spines in the proximal part of the posterior margin. One or two such spines are present on the short ischium. The fourth leg differs from the third in the proportion of the various segments, the spinulation is very similar in the two. The propodus of the fourth leg is somewhat more than four times as long as the dactylus, somewhat more than  $\frac{3}{4}$  of the length of the carpus, and somewhat more than half as long as the merus. The latter is narrower than in the third leg and usually has fewer spines. The fifth leg reaches with the propodus beyond the antennal peduncle. The dactylus is slender, ends in a curved tip and bears 4 or 5 posterior spinules. The propodus is very long, being much more than five times as long as the dactylus; it bears about 20 to 25 small spinules on the posterior margin, which are placed closer together distally than proximally. There are also hairs on this margin, these hairs are especially dense in the extreme distal part, obscuring the spinules there; a dense tuft of hairs is also present in the distal part of the anterior margin. The carpus is slightly more than half as long as the propodus and bears no spinules. The merus is about 1.5 times as long as the carpus and, like the ischium, lacks the large spines present in the fourth and third legs.

In both sexes the endopod of the first pleopod is oval and more than half as long as the exopod; it bears retinacula at its tip. The second pleopod of the male carries a distinct appendix masculina which ends in a number of spines and is distinctly longer than the appendix interna. The uropods reach beyond the telson. The exopod has the outer margin ending in a strong tooth, to the inner side of which a strong movable spine is placed; a diaeresis is present. The endopod is oval.

Size. — The carapace length of the examined males ranges between 10 and 13 mm, that of the females between 8 and 14 mm. The specimens of the Sinai Peninsula on the average are slightly larger ( $\delta$  13 mm;  $\text{♀♀}$  11-14 mm), than those of Funafuti ( $\delta$  10 mm;  $\text{♀♀}$  8-12 mm), or those from the Hawaiian Archipelago ( $\delta$  8-10 mm;  $\text{♀♀}$  10-12 mm).

Colour. — The general impression is that of a bright red shrimp with pale legs (pl. 1 fig. 2, pl. 2 fig. 1). Dr. Maciolek (in litt., 17 February 1972) described the living specimens from Nukuele Point as follows: "Although some color is always present, individual shrimps vary from nearly white to brilliant red ("banded")". In a letter of 17 November 1972 Dr. Maciolek wrote that the colour of the Lua o Palahemo animals "was generally similar to that [of the specimens taken] at Cape Kinau, except the carapace . . .

was yellower". The latter probably is due to the colour of the internal organs shining through. The different intensity of the red colour in different specimens evidently is due to expansion and contraction of the red chromatophores. The colour photographs reproduced here show the animals with the chromatophores expanded. Dr. Maciolek also provided me with a colour photograph of a specimen in which evidently most of the chromatophores were contracted. This photograph was taken with flash several meters below the surface in Lua o Palahemo and shows an almost white shrimp with pink bands along the posterior margins of the third to sixth abdominal somites, and a strikingly red broad transverse band over the basal half of the tailfan; some pink colour is also visible on the antennular peduncles.

I am much indebted to Mrs. Dora M. Banner for the following colour description of a live specimen from Nukuele Point: "Red pigment on the dorsal side of all three antennular articles and stylocerite; some also on medioventral side of second antennular article. Occasional scattered chromatophores on basal third of superior antennular flagellum. Large patches on lateral superior surface of scaphocerite and on superior lateral side of basicerite; small patch on ventrolateral side of basicerite. Eyes covered with heavy reticulum of deep red pigment; small faceted area in middle of anterior margin of eye white with some black pigment splotches near white area and on upper surface toward rostrum. Antennal flagella and pereopod legs devoid of coloration except lateral side protopod and ischium of chelae. Third maxilliped, however, with pigment on base, on superior surface of basal article, heavy patches on second article, particularly on lateral side; on entire third article, especially on lateral side. Carapace with numerous stellate chromatophores on rostrum, around orbits and as a broad irregular band on lateral margins; narrow middorsal band extending toward cardiac region where it expands into a broad saddle; a strong patch mediolaterally and scattered tracery over anterolateral region. Pleura of abdominal segments broadly rimmed with chromatophores, with an irregular band mid-dorsally and irregular concentrations at posterior portion of each abdominal tergum. Telson with dorsal and lateral bands converging and expanding so that tip is of solid color. Proximal portions of both uropods with solid color; distal portion transparent. Pleopods transparent". The colour figures (pl. 1 fig. 2, pl. 2 fig. 1) reproduced here give an excellent idea of the colour pattern.

The specimens from Lua o Palahemo were first preserved in formalin with ionol added to retard the colour change and were examined by me about 1 month after their capture. The colour in these specimens was then

as follows: In the male the third antennular segment showed a red band which continued on the outer ventral half; the second segment was of an even orange red colour, its lower surface being orange; the first segment had red colour along the anterior and lateral margins, the inner ventral half was red. In the female only the distal segment was red, the other two being uncoloured. In the male the scaphocerite and the outer lobe of the basicerite were red, the antennal peduncle otherwise uncoloured; in the female the scaphocerite had a red band along the anterior and outer margins.

The eyes had some red at the base of the peduncle (♀) or were uncoloured (♂) apart from the black pigment.

The carapace was uncoloured in the male, in the female the anterolateral area and the antennal spine were red.

The first abdominal somite (in both specimens) was uncoloured, while a broad red band extended along the posterior margin of tergum and pleura of somites 2 to 6. A broad median band extended over the middle of the abdomen from the center of the second somite to the end of the sixth. The telson was uncoloured in the male, red in the female. The uropods were red, being lighter at the tips of exo- and endopod.

The mouthparts and appendages were uncoloured in the male; in the female, the distal two segments of the third maxilliped, the fingers of the first pereopod and the distal part of the carpus were red.

Biology. — Dr. Maciolek, who observed these animals both in their natural surroundings and in an aquarium (in litt., 17 February 1972) described them as follows: "The hippolytids move almost constantly around on the substrate, even in bright sunlight. They seem to be totally blind (do not respond to shading or any near foreign object), and insensitive to vibrations or gentle water motions. They are most sensitive to tactile stimuli, however. In situ, one hippolytid was seen carrying a writhing *Eurythoe* [polychaete worm]. I have kept one shrimp alive in my laboratory for several weeks. It has readily devoured frozen brine shrimp (which appear virtually un-masticated in the stomach, as seen through the transparent carapace), moribund *Halocaridina*, and freshwater polychaetes (*Lycastis hawaiiensis* Johnson). At times, it appears ravenous (ingested a *Lycastis* much longer than itself within a few seconds). At other times, it will hold prey at a distance, tearing off pieces with the chelae and transferring them to the mouth. The second pair of legs are always carried doubled back on themselves while it moves across the bottom or rests. A week ago, it stopped eating and molted after two days' fasting. It has since resumed feeding". "I have noticed... the hippolytid carrying off geometrid moths that had

fallen on the water's surface" [of a lava pool] (J. A. Maciolek in litt., 19 April 1972). "The total epigean population [of pool 3a], as we know it, is no more than a couple dozen individuals — presumably there are more in the subterranean interstitial water" (J. A. Maciolek, in litt., 17 February 1972).

Habitat. — The several localities in the Indo-West Pacific region in which the present species is found are all anchialine, they resemble each other in that the habitat is a smallish pool, either in coral rock or lava, at some distance from the sea and only with an underground connection with the sea. The water is salt and moves with the tides. In Ras Muhammad, Sinai Peninsula (locality 1, described on p. 5) the pool is in a crack in elevated coral rock in a barren area. In Funafuti the pool is rather large and also situated in coral rock (locality 2, described on p. 7). The pools at Cape Kinau, Maui Island (localities 3a, b, c, d, f, described on pp. 9-10) are small exposures in lava rock, an area as barren as that of Sinai Peninsula. At Hawaii Island (locality 4 described on p. 10) the pool is rather large and also situated in an old lava flow, which shows very little vegetation. Like the genera *Procaris*, *Halocaridina*, *Antecaridina*, *Metabetaeus*, *Barbouria*, and the species *Ligur uveae*, the new genus *Calliasmata* seems to be restricted to this peculiar type of habitat, and increases the number of caridean genera endemic to this anchialine habitat to 6 and the number of species to 11. Like the other species of this ecological group, *Calliasmata pholidota*, is also coloured bright red.

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## Plate 1

Fig. 1. *Periclimenes pholeter* new species, from Ras Muhammad Crack, 22 June 1972, F. D. Por.

Fig. 2. *Calliasmata pholidota* new genus, new species, from Ras Muhammad Crack, 22 June 1972, F. D. Por.

## Plate 2

Fig. 1. *Calliasmata pholidota* new genus, new species, from Cape Kinau, Maui, Hawaiian Islands, December 1971, J. A. Maciolek.

Fig. 2. *Procaris hawaiana* new species from Cape Kinau, Maui, Hawaiian Islands, February 1972, J. A. Maciolek.

## Plate 3

Fig. 1. Ras Muhammad Crack, Sinai Peninsula. The fenced in protected area around the crack in the foreground left. The lagoon, with the Sinai mountains behind it, in the background.

Fig. 2. Close up of Ras Muhammad Crack.

## Plate 4

Sign at the protected area of Ras Muhammad Crack. Fig. 1, front of sign with the English inscription: "Underwater Creek. First exposed in 1968 earthquake. This creek has a subterranean connection with the sea, but a special type of animal life. Here several species were discovered, among them new species of shrimps, of which relatives are known from

similar creeks in the Indian Ocean. Such special habitats serve as a refuge to special types of fauna". Fig. 2, back of the same sign, saying: "This place is a rare phenomenon and has a high scientific value. Preserve it and don't damage anything. Thanks".

Plate 5

Pools near Nukuele Point, Cape Kinau, Maui, Hawaiian Islands, February 1972, J. A. Maciolek.

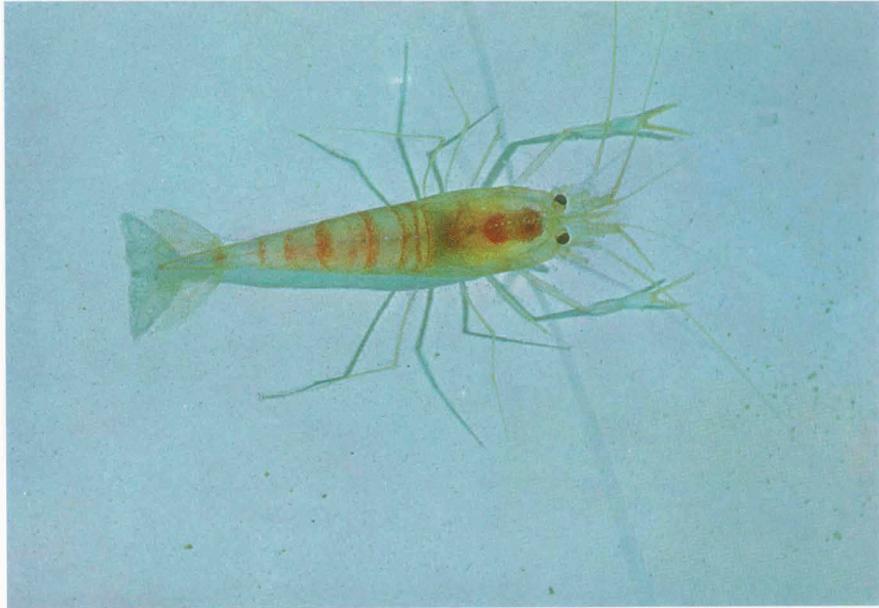
Plate 6

Fig. 1. Pool "a" near Nikuele Point, Cape Kinau, Maui, Hawaiian Islands, 1972, J. A. Maciolek.

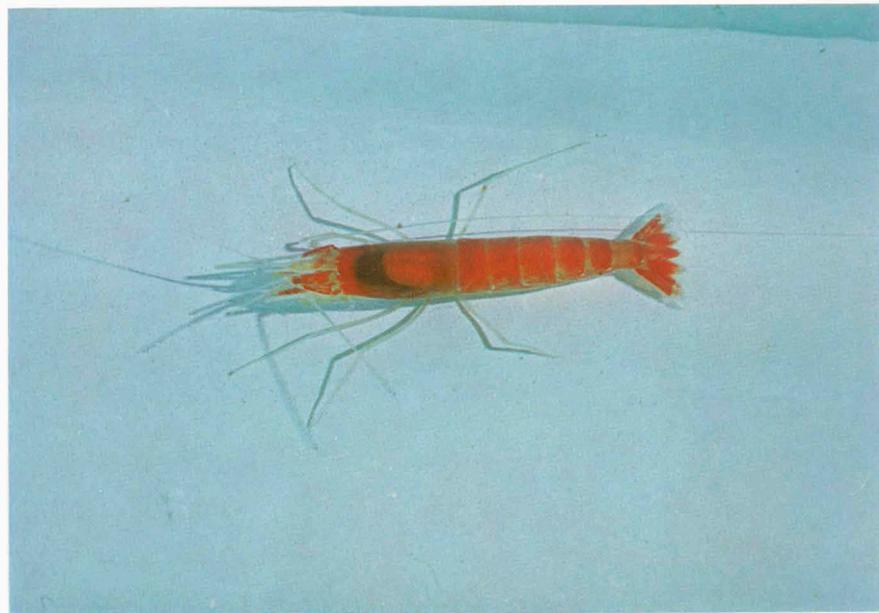
Fig. 2. Pool complex "p", Kauhioaiakini, Cape Kinau, Maui, Hawaiian Islands, 1972, J. A. Maciolek.

Plate 7

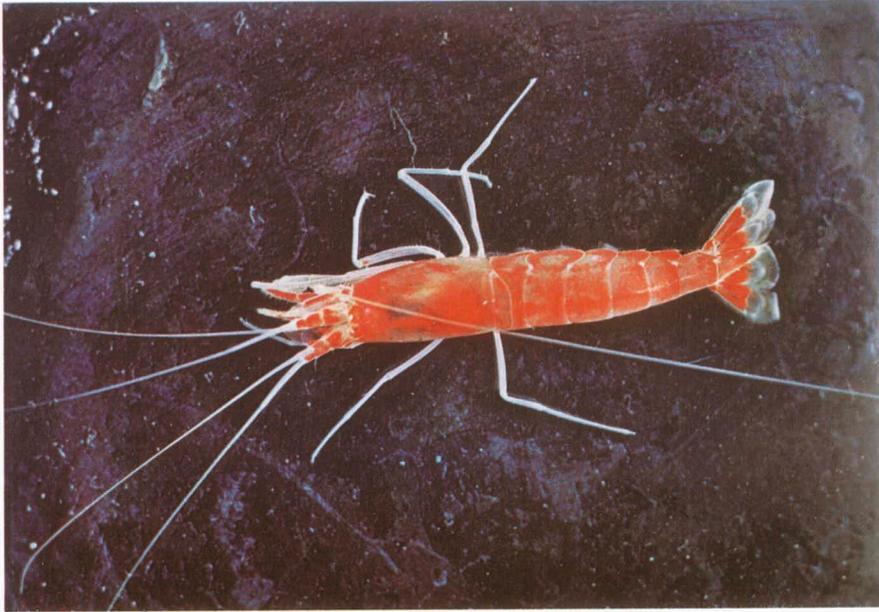
Figs. 1, 2. Pool "4" at Lua o Palahemo at Ka Lae, Hawaii Island, 20 October 1972, J. A. Maciolek.



1



2



I



2



