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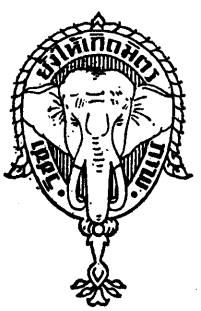
THE ALPHEID SHRIMP OF THAILAND

by

Albert H. Banner

and

Dora M. Banner



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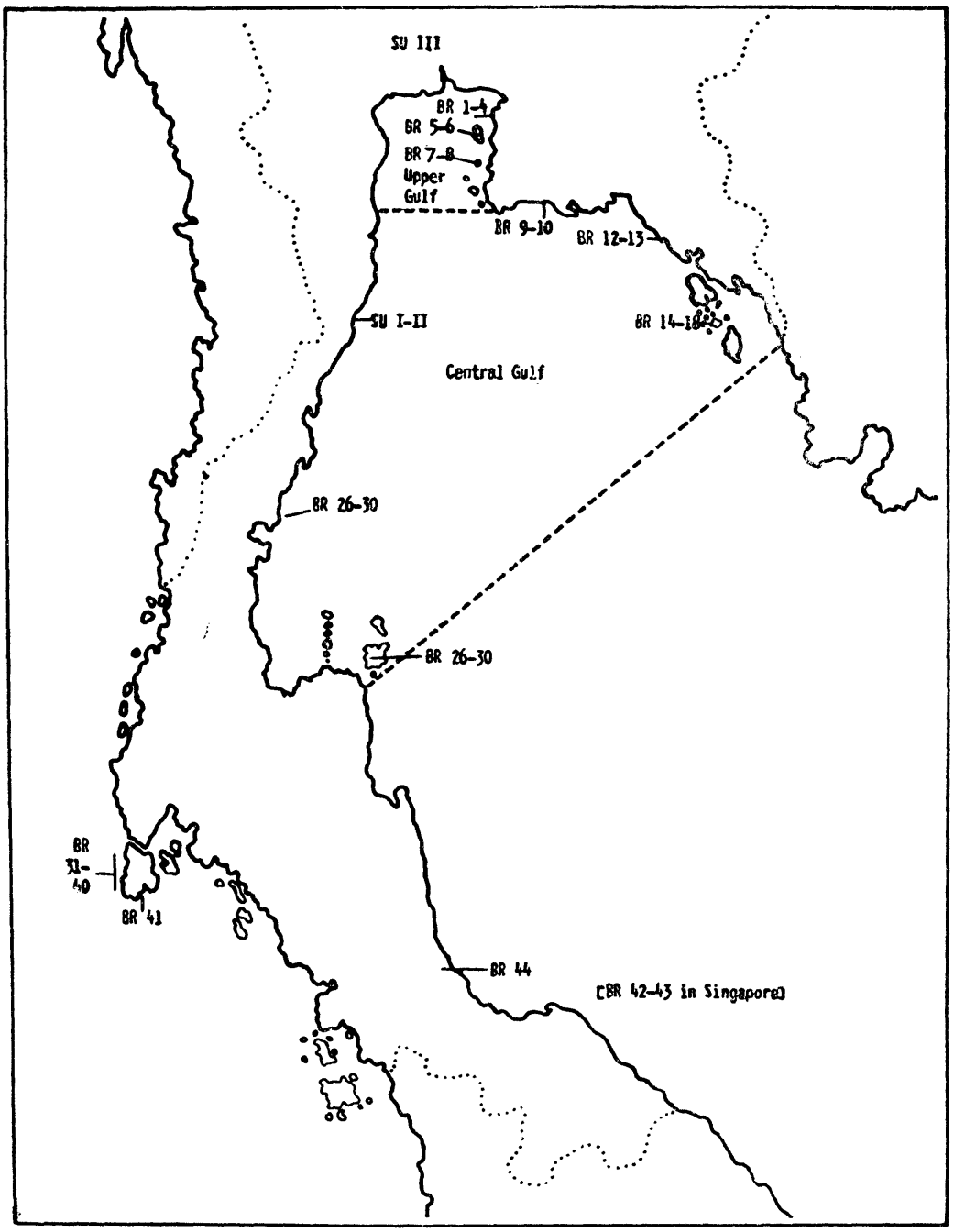

FIGURE 1
Map showing location of collecting sites in Thailand.

THE ALPHEID SHRIMP OF THE GULF OF THAILAND AND ADJACENT WATERS[1]

Albert H. and **Dora M. Banner**[2]

INTRODUCTION

During 1960-61, while the senior author was a recipient of a Fulbright Grant through the U.S. Educational Foundation (Fulbright) in Thailand, and the junior author was aided, in part, by Grant No. 13401 from the U.S. National Science Foundation, we were able to study the alpheid shrimp of the inshore waters of Thailand, from Trad in the eastern portion of the Gulf of Thailand, to Songkla in the western; in addition, we made collections from Phuket on the Indian Ocean side of the Isthmus of Thailand and from Singapore. These were supplemented by the alpheids collected by the Naga Expedition by bottom grabs and dredge hauls, and by a collection loaned by the Malayan National Museum at Singapore.

These species were described, depicted and keyed during the year we were in Thailand; the specimens and the manuscript were returned to the Hawaii Marine Laboratory of the University of Hawaii in the summer of 1961 for final library research and typing. In December, 1961 a fire burned the laboratory building to the ground; all specimens, all notes, the nearly completed manuscript, and all except a few of the drawings were destroyed.

Through a special fund granted by the University of Hawaii, additional aid from the National Science Foundation (Grant G.B. 796) and some aid in transportation from the U.S. Office of Naval Research, we were able to visit Thailand for two months during the spring of 1963 to remake the collections; continuing support from the National Science Foundation has enabled us to rewrite the manuscript; its

1. Contribution number 236, Hawaii Marine Laboratory. Manuscript received April 1965.

2. Department of Zoology and Entomology, University of Hawaii, Honolulu, Hawaii.

publication is in part being financed by the same grant. During the second visit we collected from all of the sites of the first visit as well as some additional areas.

As we lost all of our earlier material and notes in the fire, we cannot say that the later collection exactly duplicated the first; however, it is our impression that almost all species that we had in the first collection appeared in the second. We could not replace the specimens from the Naga Expedition, although some additional specimens, found later, were loaned to us by Scripps Institute of Oceanography, and we could not replace the collection on loan from the Malayan National Museum.

We wish to acknowlege our appreciation for the aid rendered to us by the following institutions: The U.S. Educational (Fulbright) Foundation in Thailand, for support for the first collection and aid in the second; the U.S. National Science Foundation, for financial aid in both studies and for funds to help defray the cost of this publication; the University of Hawaii for granting the senior author leave with pay for the second trip to Thailand; Chulalongkorn University for making the Ang Sila field laboratory available, and for assigning to us a research assistant and interpreter for our second trip; the Office of Naval Research, for making a jeep available to us through Joint U.S. Military Advisory Group for the second trip; the Naga Expedition and the Malayan National Museum for the loan of specimens.

We also wish to extend our deep thanks to the following individuals who each, in his own way, aided our studies: at Chulalongkorn University, the Secretary-General, Dr. Supachai Vanij-Vadahana, and our assistant, Suraphol Sudara; at the Fulbright Foundation, Mr. James Miyake; at the University of Singapore, Dr. C.H. Chuang; at the National Museum of Malaya, Mr. Eric Alfred; at the University of Hawaii, the Vice President, Mr. William Wachter; at the National Science Foundation, Drs. Albert C. Smith and J. Frances Allen; at the Office of Naval Research, Dr. Sidney Galler and Mrs. Helen Hayes.

But above all, we wish to extend our greatest appreciation to all of the Thai people that we met, from fishermen to governmental

officials, from auto repairmen to our colleagues on the staff of Chulalongkorn University, who through their cooperation facilitated our studies, and who through their courtesy, friendliness and unfailing good humor, made our work in Thailand continuously a pleasure and a never-to-be-forgotten experience.

ASSESSMENT OF ADEQUACY OF THE COLLECTION

We make no claim that this monographic study truly covers the alpheid shrimp fauna of the area under study. For example, we are sure that when better methods are found to sample the species that burrow into the sandy-muddy substrate, many more species will be found. We are also aware of the inadequacy of our sampling in southern Thailand and Malaya. We were able to collect only at one island, that off Singapore, in the 1500 miles of coast line from Koh Samui to Phuket. But in spite of these limitations we believe our collections, containing over 2800 specimens, represent the great majority of species likely to be found by routine collecting on coral reefs and shores in Thai and Malayan waters. For this reason we are presenting the study as a monograph.

ZOOGEOGRAPHIC CONSIDERATIONS

Of the 63 species and subspecies of alpheids reported upon here, 3 have not been named because of fragmentary condition, and 8 are new (but one of the new species is also known from other waters); this leaves 53 that have been reported from elsewhere. Twenty-two of these, or 41%, are known from the whole span of the Indo-Pacific, from the central Pacific islands to the coast of Africa; of the remaining, another 16, or 30%, are known only from the Pacific and not the Indian Ocean, while only 3, or 6%, are known from the Indian Ocean and not the Pacific. Thus the fauna has greater affinities to the Pacific regional fauna than to that of the Indian.

TABLE I
DISTRIBUTION OF MALAYO–THAI ALPHEIDS*

	Central Pacific	Western Pacific	Brackish and Fresh Water	Upper Gulf	Central Gulf	Phuket Island	Singapore	Eastern and Central Indian Ocean	Red Sea and Persian Gulf	East and South Africa
Athanas										
near *polymorphus*				x						
naga					x					
dimorphus seedang				x	x	x				
species 1						x				
Alpheopsis										
equalis	x	x				x		x	x	
chalciope		x				x				
Automate										
gardineri	x			x	x	x		x	x	
Salmoneus										
brevirostris	x					x				
cristatus						x			x	
bruni					x					
Synalpheus										
stimpsoni	x	x				x				
gravieri		x			x			x		
streptodactylus										
streptodactylus	x	x		x	x		x	x	x	
bakeri stormi		x				x				
heroni						x			x	
tumidomanus	x	x		x	x	x	x	x	x	
acanthitelsonis		x		x	x	x	x	x		
thai				x	x					
coutierei	x					x	x	x	x	
pachymeris	x				x			x	x	

TABLE I cont.–2

	Central Pacific	Western Pacific	Brackish and Fresh Water	Upper Gulf	Central Gulf	Phuket Island	Singapore	Eastern and Central Indian Ocean	Red Sea and Persian Gulf	East and South Africa
bituberculatus		x		x	x		x	x		
laticeps	x			x				x		
theano		x					x			
near *theano*							x			
Alpheus										
deuteropus	x				x	x		x	x	x
collumianus										
probabilis	x					x				
crockeri	x				x	x				
acutofemoratus	x	x			x	x				
supachai					x					
lottini	x	x		x	x	x	x	x	x	x
pomatoceros					x	x	x			
facetus		x			x	x				
gracilis simplex	x			x	x					
microstylus	x	x				x		x	x	
obesomanus	x	x		x	x	x	x	x	x	x
malleodigitus	x	x		x	x	x		x	x	
alcyone	x	x				x		x	x	
paralcyone	x	x		x	x		x	x		
bucephalus	x	x		x	x	x	x	x		
gracilipes	x	x		x	x			x	x	x
ehlersi	x				x	x				
paracrinitus	x	x		x	x	x	x	x	x	
rapacida		x			x					
acutocarinatus		x			x					
rapax	x	x	x		x	x		x	x	
cythereus	x					x				

TABLE I cont.—3

	Central Pacific	Western Pacific	Brackish and Fresh Water	Upper Gulf	Central Gulf	Phuket Island	Singapore	Eastern and Central Indian Ocean	Red Sea and Persian Gulf	East and South Africa
bisincisus		X					X	X		X
proseuchirus		X			X					
leviusculus	X	X		X					X	X
euphrosyne		X	X			X				
microrhynchus		X	X							
audouini		X		X	X	X	X	X	X	
crassimanus	X	X	X	X	X	X	X	X	X	X
strenuus	X	X		X		X		X	X	X
pacificus	X	X		X	X	X		X	X	X
malabaricus malabaricus			X		X	X		X		
malabaricus songkla			X	X	X					
parvirostris	X	X		X	X	X	X	X	X	
hippothoe	X	X		X	X	X	X	X		X
sudara					X	X				
funafutensis	X	X				X				
edamensis	X	X					X			X
Racilius compressus						X	X		X	X
Total:	34	37	6	25	38	40	20	29	24	12

* *Definitions of areas listed:*

Central Pacific: The waters to the east of Japan, the Phillipines and Indonesia, including Hawaii and other Polynesian islands.

Western Pacific: The archipelagoes of Japan, the Phillipines and Indonesia, and the Great Barrier Reef of Australia and associated asiatic waters.

Brackish and Fresh Water: Wholly fresh water localities, as well as mangrove swamps and Lake Songkla.

Upper Gulf: The Gulf of Thailand to the north of 12°40′ N, or a line drawn approximately from Sattaheeb in the east to Hua Hin on the west.

Central Gulf; The Gulf of Thailand lying to the south of 12°40′ N, and to the north of a line extended between the Thai-Cambodian border to the east and Surat Dhani to the west.

Eastern and Central Indian Ocean: The Indian Ocean from the Malayo-Thai Peninsula to the Maldives and Laccadives, exclusive of Phuket Island.

East and South Africa: The Indian Ocean coast from Cape of Good Hope to the mouth of the Red Sea, including all offshore islands.

De Man (1888a: 261) reported 6 species from the Mergui Archipelago of southeastern Burma: *S. minor neptunus* (Dana); *S. minor biunguiculatus* (Stimpson); *A. brevirostris* Olivier; *A. rapax* Fabricius; *A. edwardsii* Audouin; *A. hippothoe* de Man. We have found only *A. rapax* and *A. hippothoe* in our study. However, the four we do not report are closely related to ones we did find, and the difference in record may rest on interpretation of specific characteristics.

The small number of species (19) reported from Singapore does not reflect an impoverished fauna there but rather the fact that in the Singapore area our collections were limited.

Of the reported species and subspecies, 6 occur in brackish to fresh water; these evidently are euryhaline, and all 6 are known from water approaching the salinity of the sea.

The Naga collected 11 of the reported forms from deeper parts of the Gulf, and we collected and additional subspecies with a hand dredge at Chumporn; of these 12, 6 were also collected in the shallow waters along the reefs and beaches.

On the distribution of the shallow water reef and beach specimens in Thai waters two things are apparent: First, the brackish and muddy waters of the upper Gulf do not represent a separate faunal area. Here we found only one species that does not occur in the central Gulf or at Phuket as well. Rather, the fauna of the upper Gulf represents a marked attenuation from that of the central Gulf, with 34% reduction in the number of species. Second, there appears to be a marked difference between the fauna on the Gulf side and the Indian Ocean side of the Thai peninsula. Intensive collections were made at Chumporn and Koh Samui on the Gulf, and equally intensive collections were made at Phuket Island in the Indian Ocean. The areas collected were roughly equivalent, with the same types of reefs and the same types of beaches being studied. A species by species contrast between the shrimp found at Phuket and (I) the collections from entire central Gulf (deeper water specimens excluded), and (II) the Chumporn and Koh Samui collections are given in Table II. The marked differences in the fauna are obvious and are far greater than differences which could be attributed to chance or to collecting techniques.

TABLE II

Comparison of Alpheid Fauna on the Two Sides of the Thai Peninsula

			Number	*Percentage*
I.	A.	Total number of species found at Phuket and in Central Gulf (deep water records omitted).	48	100
	B.	Number of species found at Phuket but not in Central Gulf.	17	35
	C.	Number of species found in Central Gulf but not at Phuket.	5	10
II.	A.	Total number of species found at Phuket and at the combined collections from Chumporn and Koh Samui (deep water records omitted).	43	100
	B.	Number of species found at Phuket and not at Chumporn or Koh Samui.	22	51
	C.	Number of species found at Koh Samui or Chumporn, but not at Phuket.	3	7

We have no data that would account for this faunal difference. The Isthmus of Kra, the narrowest and lowest part of the Malayo-Thai peninsula lies in this region. It is approximately 50 km.broad and 80 m. high. While it is geologically very old and while we could find no reports of it being submerged in recent geological times, waters from the Gulf may have flowed into the Indian Ocean during the eustatic rise in sea levels during the interglacial periods of the Pleistocene. In any case, the two sides of the peninsula are presently separated by more than 2000 km. of ocean. This may account for the differences in the fauna.

However, if the difference in the fauna is the result of this separation and isolation, there should be sub-specific and specific differences between the individuals on either side of the barrier. In neither population was there any indication of endemism, such as is found to a small degree in the Hawaiian fauna. Nor did a point by point comparison between characteristics of the individuals on the two sides show any differences that could even be leading to sub-specific differentiation.

Therefore, the difference in the fauna must stem from hydrographic conditions. In general, the Gulf fauna is attenuated, presumably from the effects of fresh water, silt, and perhaps the higher temperatures reached at times along the shores; this attenuation was noticeable not only in the shrimp but in the vigor and diversity of the coral reefs themselves. The attenation was noticed not only as one proceeded towards the head of the Gulf, as indicated above, but also near the mouths of the larger rivers, as at Chantaburi. At Phuket, especially on its western side, the water is clearer and there appears to be a far less chance of fresh water contamination. We know of no hydrographic studies yet published on this section of the Andaman Sea, but it would be logical to expect that there may be seasonal enrichment of the waters at the times of the northeast monsoons by upwelling along the coast line. In any case, the reefs are more diverse and more flourishing at Phuket than any other section of the Thai coastline that we were able to visit. As shown in Table II, this is reflected in the increased number of species of alphied shrimp.

We therefore believe that the shrimp fauna at Phuket is a more extensive representation of the Indo-Pacific fauna than that found in the Gulf of Thailand, and that this better representation is due to the ecological conditions of the waters.

HABITATS OF THE ALPHEID SHRIMP

With few exceptions, alpheid shrimp are found in four major types of habitats:

I. *In the coral, living and dead, of coral reefs.* This, from our observations, is by far the most important environment for the shrimp.

A few species, like *A. lottini,* are associated with living coral; some construct tubes of algae, like species in the Crinitus group of *Alpheus;* some make a series of ramifying galleries under the living crust of coralline algae, like species in the Obesomanus group; but most apparently live in the small spaces and holes between the dead fronds of coral.

II. *In tide pools and "micro-tide pools".* A few species are found in small pockets of water around the edges of rocks as the tide retreats on sandy or muddy beaches, and at times swim freely in shallow tidal pools. The most common forms in this environment are the small species of the genus *Athanas.*

III. *In burrows in the substrate.* Apparently almost all of the species of the Brevirostris group, and many species of the Edwardsii group construct burrows into sandy and muddy substrate. Some burrows are under rocks; other burrows are directly in the substrate, unassociated with rocks or debris, even into the thick mud of mangrove swamps.

IV. *As symbionts.* In the literature, many species are recorded in symbiotic association: in sponges and on crinoids; on the spines of, and in the excavations of, echinoids; in association with annelids in tubes and borrows. Some species were found in symbiotic associations in Thai waters, but apparently not as commonly as elsewhere.

As would be expected from the association with coral reefs, most alpheids are stenohaline and live in relatively clear waters. However, some species tolerate wide ranges in salinity; thus, the intertidal species at Ang Sila exist in almost fresh water at times of flooding of the Bang Pakong river. Other species are found in mangrove swamps which also may be flooded with fresh water; one species has penetrated the Chao Phya to Bangkok. The rivers carry thick mud into the Gulf and some species have adjusted to turbid waters and a very soft substrate; *A. malabaricus malabaricus,* making up part of the commercial shrimp catches from the lake at Songkla is adapted to turbid water, a muddy bottom and waters of low salinity.

COLLECTING STATIONS

All collections were made between 2 February and 27 March 1963. Unless otherwise specified, specimens were collected by breaking up heads of coral, mostly dead, from zones indicated. Depths refer to approximate 0.0 Thai tidal datum line in meters.

BR 1. Lam Tan (Between Ang Sila and Bang Saen), Cholburi. Under rocks on bottom of sand-silt; 0.6 m.

BR 2. Ang Sila, Cholburi. Under rocks on a sandy-muddy beach; about 0 m. and higher.

BR 3. Same, but lower in tide zone, with muddier substrate; otherwise similar to BR 2; none in thick mud. (Note: during extremely low water, holes were seen in the thick mud flats in front of the Ang Sila laboratory; these holes were possibly of alpheids but no specimens could be collected).

BR 4. Same. Mangrove swamp, thick mud bottom (collected by children of the village by treading on mud and floating out specimens).

BR 5. Koh Sichang, Cholburi. South end of island, both on east and west side of island (Koh Yai Thao); about 0 to -3 or -4 m; 5a, from a sponge.

BR 6. Same. Middle of western side of island, south of Laem Khao Khat; -1 to about -7 m; substrate of granite and sand, few corals.

BR 7. Koh Sak, Cholburi. In cove on northern side of island, coral and sand bottom; about 2 m.

BR 8. Same. Northeastern side of island, between two rocky points; strong currents and much live coral; 0 to -5 or -6 m; few specimens.

BR 9. Fisheries Station, Ban Pe, Rayong. Under rocks on sandy beach high in intertidal zone; specimens both from slight pools around rocks and in burrows under rocks; BR 9a. Same, at a lower tide zone.

BR 10. Prao Bay, Koh Samet, Rayong. From coral heads standing alone in sandy bottom; 0 to -1 m. BR 10a, from a sponge; BR 10b, from a tube under a coral

BR 11. Same, but at outer edge of reef; -3 to -5 m, sandy bottom.

BR 12. Koh Namsai, Chantaburi. Off southwest side of island; coral growth extensive, but not forming a coherent reef; -2 to -5 m. BR 12a, b, from sponges.

BR 13. Same. Off northwest side of island; outer edge of broad, mostly dead, reef; -2 to -3 m. BR 13a, from a sponge.

BR 14. Koh Kradard, Trad. North side of island, middle reef area; about 0.7 m.

BR 15. Same reef, in small channel found in middle reef area; about -3 m.

BR 16. Same reef, outer edge; -3 to -5 m.

BR 17. Same reef; on beach above 0 tide, under non-coralline boulders (apparently basaltic stone) on muddy-sandy bottom; shrimp in apparent zonation, with *A. crassimanus* Heller in the uppermost zone, *A. rapax* Fabricius in the middle zone and *A. paracrinitus* Miers in the lowest zone.

BR 18. Same. Southwest side of island; the reef most exposed to wave action on island; outer edge. from 0 to -2 m.

BR 19. Koh Samui, Surat Dhani. Reef off Lam Yai (North of Nathorn); reef protected from prevailing winds; collection made on shoreward edge, under rocks; about half-tide or below.

BR 20. Same reef, reef flat, rather unconsolidated with much dead coral; about 0 m.

BR 21. Same reef, outer edge, region of moderately vigorous coral growth; 0 to -4 m.

BR 22. Same. Off Lam Chongklam (the first point south of Nathorn); point exposed to currents and surf from most directions; reef vigorous; outer face, from -1 to -4 m; BR 22a, b, from sponges.

BR 23. Same. Same reef as BR 22 but from unconsolidated reef flat immediately behind growing front; from -1 to -2 m.

BR 24. Same reef, middle of reef flat; about 0 m. (Note: Sandy inner reef area with many burrows of alpheids, but none could be collected).

BR 25. Same. Sandy beach in front of Nathorn; under rocks in fine clean sand (some plant debris around rocks); about 0.5 to 1 m.

BR 26. Koh Samit, Chumporn. Reef off southern edge of western point of island; near edge from -2 to -3 m.

BR 27. Same reef, middle and inner areas; about 0 m. 27a, from sponges; b, from a small tube in living coral; c, in association with a brittle star living in holes in the coral.

BR 28. Same reef, outermost edge; -2 to -5 m. 28a, associated with brittle star; b, in holes in *Porites* sp.; c, in grooves in coral; d, associated with sponge.

BR 29. Chumporn. Dredge hauls from Chumporn harbor almost to Koh Samit, in water from 3 to 10 m. deep (72 individual casts made with clam-shell dredge); bottom mostly fine mud.

BR 30. Koh Samit. Same as BR 28, reef off northwest coast; vigorous coral growth; -1 to -7 m.

BR 31. Phuket. Reef at Rawai Beach; outer edge, exposed at low tide; BR 31a, from passages in surface of live *Acropora*; b, same.

BR 32. Same reef, middle zone, with sand and small heads of *Porites*.

BR 33. Same reef, inner sand flats exposed by extremely low tide; from under dead coral heads, resting on a sand to mud substrate.

BR 34. Phuket, Saku Beach, reef near point south of airport, near mouth of stream; reef edge, -1 to -5 m.

BR 35. Same reef, middle and outer reef flat; 0 m.

BR 36. Same reef, inner portion; from under coral rocks and rubble lying on a sand to mud substrate; 0 to 1 m.

BR 37. Phuket, Patong Beach. From *Heliopora* on reef flat and outer margin.

BR 38. Same beach. Reef at south end of beach; reef edge not consolidated, gradually dropping to sand bottom at about 6 to 7 m. BR 38a, from living crinoids.

BR 39. Same beach. Reef flat, from dead and dying coral, mostly *Porites*.

BR 40. Same beach, reef flat, from under dead coral heads resting on sandy mud or mud.

BR 41. Small island south of Phuket. Vigorous reef, outer face; -1 to -3 m.

BR 42. Puala Hunta, Singapore Harbor. Beach collecting at low tide, from under bedded dead coral heads in sand and from small tide pools. BR 42a, from purple sponge.

BR 43. Same, from reef face; -1 to -7 m. BR 43a, from sponges; b, from crinoids; c to j, from various sponges.

BR 44. Lake Songkla. Songkla. From catches of commercial shrimp trawls made in the lake.

Collections made by Suraphol Sudara :

SU I. Koh Hao Lam Mah, Prachuab Khirikan. Shore collecting under rocks.

SU II. Koh Charn, Prachuab Khirikan. West side of island in 1-2 m. water.

SU III. Bangkok Noi, Dhonburi.

(It should be noted that we attempted to collect in other areas. On both trips to Thailand the strong onshore monsoon winds precluded collecting at Prachuab Khirikan and Songkla; permission was not received from the Royal Thai Navy to collect on the islands off Sattaheeb; the waters within reach on a one day boat trip from Ranong were too brackish and no shrimp were found; the government of Burma would not permit us to visit the southern Mergui Archipelago from Ranong to Victoria Point, but insisted that we reach the area via Bangkok and Rangoon; finally, time did not permit the planned collection from the more or less isolated islands on the eastern coast of Malaya.)

Naga Stations :

59-131 (40′ Otter Trawl); 15 Dec. 59; 13°1′45″ N, 100° 50′30″ E; depth 25 m.

60-175 (6′ Beam Trawl); 30 Jan. 60; 12°7′5″ N, 100°46′0″ E; depth 29 m.

60-563 (Trawl line); 2 Aug. 60; 12°59′30″ N, 100°35′15″ E; depth 24 m.

60-845 (6′ Beam Trawl); 9 Nov. 60; 12°54′45″ N, 100°26′5″ E; depth 19 m.

60-852 (Petersen Grab sample); 10 Nov. 60; 10°4′10″ N, 100° 19′10″ E; bottom : green, soft mud; depth 52 m.

60-895 (6′ Beam Trawl); 13 Nov. 60; 10°12′48″ N, 103°32′30″ E; bottom : coarse and fine sand, some mud; depth 27-30 m.

60-900 (Petersen Grab Sample); 14 Nov. 60; 9°48′2″ N, 103° 54′4″ E; bottom : sandy mud with few dead shells; depth 37 m.

60-961 (Petersen Grab Sample); 20 Nov. 60; 10°58′36″ N, 100° 41′42″ E; bottom: greenish, grey mud, some shells; depth 60 m.

60-1020 (Petersen Grab Sample); 8 Dec. 60; 12°27′5″ N, 100° 28′30″ E; bottom: sandy mud; depth 30 m.

60-1068 (16′ Otter Trawl); 12 Dec. 60; 11°30′00″ N, 99°47′12″ E; bottom: sandy mud with few shells; depth 27 m.

60-1075 (Petersen Grab sample); 12°14′6″ N, 101°4′00″ E; bottom: muddy sand with broken shell; depth 32 m.

60-1097 (16′ Otter Trawl); 13 Dec. 60; 12°3′25″ N, 100°15′45″ E; bottom: muddy sand; depth 33 m.

NOTES ON ANATOMICAL PARTS

In the following notes, only those anatomical parts used in the identification of the species that are reported upon in this study are discussed; if the complete discussion of the anatomy is desired, the worker is referred to Coutière (1899).

Anterior carapace: Characteristic of most genera of the family is the growth of the anterior portion of the carapace to protect the eyes. Only in the genus *Automate*, among those found in Thailand, are the corneas and peduncles fully exposed (fig. 8A). In the other lower genera the anterior carapace may be developed as anterior teeth as in *Athanas* or as a flat roof-like extension reaching beyond the corneas as in *Alpheopsis* and *Salmoneus* (fig. 6A, 9B). In *Athanas* three pair of teeth may be developed; the supraorbital, above the cornea and lateral to the rostrum (lacking in all Thai species); the extracorneal, dorsolateral to the cornea; and the infracorneal, lateral to the ventral portion of the cornea (fig. 2B). In the remaining genera, *Synalpheus*, *Alpheus* and *Racilius*, the anterior carapace forms and actual hood over the eyes. The hood may or may not be set apart from the surrounding carapace by abrupt margins (fig. 39A); most commonly there are grooves between the medial bases of the hoods and the lateral margins of the rostrum, the orbitorostral grooves (fig. 61A). The anterior margins of the orbital hoods may bear teeth of varying development, or anterior keels, or be rounded (fig. 22A, 26A, 44A).

The rostrum is always present except in the genus *Automate*, and even there it persists as a slight medial projection. In all other genera the rostrum is prominent, narrow in *Athanas* (fig. 3A), broad

in *Salmoneus* (fig. 10A) and of varying development in *Alpheus* (fig. 50A, 61A).

The anterolateral margin of the carapace below the base of the antenna, the pterygostomial angle, may be rounded as in *Alpheus* (fig. 53B) or angular as in *Synalpheus* (fig. 19B).

Antennules: The antennular peduncle consist of three articles, not named but numbered. The basal segment bearing a shield, the stylocerite, over the statocyst; the stylocerite almost always carries an acute lateral tooth (fig. 59B).

Antennae: Three parts of the antennal base are taxonomic significance; the basicerite, scaphocerite, and carpocerite. The basicerite is the large basal article, visible in dorsal and lateral view; it may carry a strong lateral tooth, (fig. 57 A) or a superior and lateral tooth (fig. 21A). The flattened exopodite or scaphocerite consists of a single article of two portions, the lateral spine, usually strong, and the medial flattened portion. (fig. 49A; rudimentary in fig. 35A). The first two articles of the endopodite are not considered in this paper, but the relative length and development of the third article, the carpocerite, is often an aid in diagnosis.

Mouth parts: The mandibles, two pair of maxillae (the third to fifth cephalic appendages), and three pair of maxillipeds (the first three thoracic appendages), are not discussed in this paper.

Large cheliped: The large cheliped, located on the first pereiopods (fourth thoracic appendage) is probably the most important single characteristic for the identification of the species of the Alpheidae. In the lower genera it may or may not be enlarged and of asymmetrical development (fig. 2C-G); often the development of the appendage in this group will vary with age and sex (Banner and Banner, 1960). In these lower genera the chela may be carried extended from the carpus, or flexed back against the merus (fig. 3E) with a corresponding varying development of the carpus; the dactylus and fixed finger may be smooth (fig. 7C) or serrate (fig. 2D).

Synalpheus and *Alpheus* always have, except in the post-larval stages, a marked differentiation in form between the large and small cheliped (fig. 34 B, D). The large chela may be on either side of the body, for when it is lost it is replaced by the growth of the small

chela, while the new cheliped will develop into a small chela (Darby, 1934). In the large cheliped, the ishio-meral articulation is fused, the combined article is usually called the merus; the article may bear movable spinules and fixed teeth (fig. 33C). The carpus is always short and somewhat cup-shaped. The chela itself consists of the propodus, a huge palm and fixed finger, and the dactylus or movable finger.

The form and sculpturing of the palm varies between the typical members of the seven sub-generic groups of *Alpheus* (compare fig. 28B for Megacheles, fig. 31B for Macrochirus, Fig. 35B for Obesomanus, fig. 37B for Crinitus, fig. 40B for Diadema, fig. 42B for Brevirostris, fig. 54B for Edwardsii).

The dactylus usually has a rounded tooth near its base that fits with plunger-like nicety into a corresponding cavity of the fixed finger; on its superior surface in the genus *Alpheus* is a disc of smooth chitin that meets with a corresponding disc on the palmar surface above the articulation. These discs, the so-called "adhesive plaques", and the plunger and socket are the device that permits the shrimp to make their characteristic snapping sound: the finger is flexed and the two plaques evidently adhere by some as yet unknown mechanism; then the powerful muscle is tightened against the adherance of the plaques until they finally release, permitting the plunger to snap violently into its cavity. In *Synalpheus* the palmar surface may bear a chitinous "catch" that appears to serve the same function as the plaques in *Alpheus*.

Small cheliped: The form of the small cheliped of *Alpheus* and *Synalpheus* may parallel the form of the large, but the sculpturing is less pronounced (fig. 26D). In most, however the small chela is markedly different in form, usually quite simple (fig. 38F). At times the dactylus exhibits sexual dimorphism, most marked in those with a "balaeniceps-shaped" dactylus, so called because of its resemblance to a jaw of a whale-bone whale. In the balaeniceps condition, the dactylus is basally broadened and bears a fringe of strong setae on either margin; beyond the middle, the dactylus starts to narrow, and the fringes of setae meet over the rounded top of the article; the dactylus then narrows to an acute tip (fig. 59E). In some species

its full development is not reached and the condition is called subbalaeniceps (fig. 47E). With the exception of three species in the Edwardsii group where both males and females exhibit the condition, the balaeniceps dactylus is found only in the males.

Second legs : The second pereiopods are chelate, and the carpus may be divided into three to five secondary articles (all Thai species have five articles, figs. 2 H and 35 D). The ratio of these articles is of taxonomic significance and throughout this paper is expressed as a multiple proportion in which the length of the first article is assigned to 10 (ex. 10:20:5:5:7).

Third legs : The articles of the endopod of the third legs are of taxonomic significance. In this study they are named in the shortened form (from the base outward): ischium, merus, carpus, propodus, and dactylus (rather than ischiopodite, meropodite, etc.). Both the proportions and armature—spines, teeth, etc.—are used in the identification of the species. Especially important is the development of the dactylus which may have a single tip (fig. 26 F) or a double or even triple tip or unguis (biunguiculate or triunguiculate) (fig. 20 H and fig. 15 F); the article may be blunt and rounded (fig. 31 F) or flattened and laterally expanded (fig. 45 I).

Fourth and fifth legs : These are not ordinarily used in definition of the species; the fourth legs are similar to the third, but often lack some of its armature; the fifth legs are smaller, and bear a "brush" of varying development on the inner side of the propodus.

Branchial formula : As with other shrimp, the branchial formula is useful at the generic level, but in some genera it has been found to be variable (Banner and Banner, 1960, and elsewhere). In all genera there are five gills proper, the pleurobranchs, located on the side of the thorax; the arthrobranch, when present, is usually reduced or rudimentary; the epipodites, in addition to those of the broad, typical shape found on the bases of the maxillipeds (named "epipodites" in the table below), may be in the form of a narrow arm or mastigobranch, reaching posteriorly to engage a small rounded prominence, or setobranch, on the base of the next leg. The formula usually found in each of the genera herein reported is given in table III.

TABLE III

Normal Branchial Formula of
Genera of Alpheids in Malayo-Thai Waters

	Athanas	*Alpheopsis*	*Automate*	*Salmoneus*	*Synalpheus*	*Alpheus*	*Racilius* (?)
First thoracic leg							
Epipodite	x	x	x	x	x	x	x
Second thoracic leg							
Epipodite	x	x	x	x	x	x	x
Third thoracic leg							
Pleurobranch						(x)	
Arthrobranch		x	x	x	x	x	x
Mastigobranch	x	x	x	x		x	x
Fourth thoracic leg							
Pleurobranch	x	x	x	x	x	x	x
Mastigobranch	x	x	x	x		x	x
Setobranch	x	x	x	x		x	x
Fifth thoracic leg							
Pleurobranch	x	x	x	x	x	x	x
Mastigobranch	x	x	x	x		x	x
Setobranch	x	x	x	x		x	x
Sixth thoracic leg							
Pleurobranch	x	x	x	x	x	x	x
Mastigobranch	(x)	(x)	x	x		x	x
Setobranch	x	x	x	x		x	x
Seventh thoracic leg							
Pleurobranch	x	x	x	x		x	x
Mastigobranch		(x)	x	x		x	x
Setobranch	(x)	(x)	x	x		x	x
Eighth thoracic leg							
Pleurobranch	x	x	x	x	x	x	x
Setobranch		(x)	x	x		x	x

Abdominal somites: The anterior abdominal pleura are not normally used in specific descriptions; they are large, with the pleura of the second abdominal somite overlapping both the first and third, and they show sexual differentiation with those of the female large and rounded, while those of the male are smaller and often with tooth-like extensions (fig. 19 C and D). The pleura of the sixth abdominal somite is developed as a small articulated flap lying next to the base of the uropods in the genera *Athanas* and *Alpheopsis*; in the others it is rudimentary. The sixth abdominal segment may also bear teeth that project over the telson (fig. 37 H).

Pleopods: The second pleopods show sexual dimorphism: on the medial side of the endopod, about half-way towards the tip, there is a shoulder. In the females a single projection grows from this shoulder, while in the males of all genera, except *Automate*, the shoulder bears two projections, the inner one being armed with many small hooks at its end. There are also differences in size and development between the other pleopods of the two sexes.

Uropods and Telson: In the species considered in this study, little significance is attached to the form of the uropods; the outer uropod (anatomically the endopod) is articulated near its end, and bears a spine and a tooth at this articulation; the inner uropod is rounded; the basal article bears one or more teeth of varying size.

The telson varies considerably in proportion from one species to another, but it also varies noticeably within a single species, so too much reliance should not be placed on its exact proportions. It is of a triangular truncate form, with the terminal truncation being straight to convex in all genera except *Salmoneus* where it is cleft into a narrow or broad and shallow "v". The ventral side of the telson in some genera bears two rounded tubercles, the anal tubercles, on either side of the anus which fit into corresponding fossae on the inner branch of the uropods.

Most authors have followed the lead of Coutière in using relative proportions of articles of the appendages to separate the species; at times the proportions have been expressed in two, three or even four significant figures. The worker is cautioned not to rely

upon proportion in all species, for in some the variation in a single population may be extremely great (see under Obesomanus group, p. 101) but in others the proportions may be very constant over wide geographic ranges (see Banner and Banner, 1960) but even in these it is doubtful if the second figure of a proportion is of great significance.

COLLECTION AND PRESERVATION OF ALPHEIDAE

The alpheids, as indicated in the discussion of habitats, are easily collected in the intertidal zone and water of shallow depths. Few species live in the actively growing parts of coral, but many live in dead and overgrown portions that have holes and chambers; if these are broken up with a small collecting pick, the alpheids may be found. Similarly those living in sponges can be collected by breaking up sponges. From pools they may be collected by hand nets or by bailing with small containers; from sandy beaches, by rolling over rocks or by digging; from soft mud, as in mangrove swamps, by treading the mud into a fluid consistancy and letting the burrowing forms swim to the surface.

In preservation it is most important to handle the shrimp gently, for they will spontaneously break off their chelae—a most important taxonomic characteristic—under any type of stress. To prevent this, we put them in a small container of sea water to which a few drops of Oil of Cloves has been added; the oil is largely immiscible with the water, but if suspended in fine droplets, as by stirring, enough goes into solution to anaesthetize the shrimp in a few minutes. In a half hour the shrimp may be preserved in the usual 4% formaldehyde in sea water (a 9-1 dilution of commercial formalin). For subsequent preservation and study, we use a solution of 70 : 10 : 20 ratio of ethanol-glycerine-water, which keeps the articulations soft and pliable, but unfortunately decolorizes the specimens.

DISTRIBUTION OF THE TYPE MATERIAL

Holotypes and allotypes will be deposited in the Smithsonian Institution, Washington, D.C., U.S.A., and allotypes will be divided between the Bernice P. Bishop Museum, Honolulu, and Chulalongkorn University, Bangkok. An identified series of specimens will be deposited with the latter two institutions.

Family ALPHEIDAE Fabricius

Carapace smooth, provided with cardiac grooves; rostrum reduced, antennal and branchiostegal spines always absent; in most genera the entire eyes, or their bases only, are covered by an anterior projection of the carapace. Antennular base cylindrical, with the basal article not longer than sum of other two; palpus of the two articles except in *Prionalpheus* (Banner and Banner, 1960b : 293). Distal article of maxillule bifurcate at its extremity except in *Prionalpheus*. Epipodites of first and second maxillipeds always undivided. Chela of first thoracic legs predominant, always large, usually asymmetrical in development. Carpus of cheliped usually short, cup-shaped or hemispherical. Second legs chelate, with chela weakly developed and carpus of three to five articles. Following legs short, compressed, with spinous propodi and dactyli with one to three ungui. Propodus of the fifth leg with more or less well developed "brush" of bristles placed in transverse-oblique rows. Abdomen usually with gradual curve, without any pronounced bending at third segment; sixth segment broad and short; size and shape of pleura showing sexual dimorphism. The branchial formula always includes five pleurobranchs.

KEY TO THE GENERA OF ALPHEIDAE IN MALAYO-THAI WATERS

1. Corneas of eyes at most only partially concealed from anterior or lateral view by carapace; dactylus of large chela without plunger fitting into socket of fixed finger and often bearing teeth 2

   Corneas of eyes entirely covered in dorsal lateral and anterior view by orbital hoods, an overgrowth of the anterior carapace; dactylus of large chela usually with a plunger that fits into a socket of the fixed finger, never serrate 5

2. Entire eye stalks exposed; corneas reduced . . . . . *Automate* (p. 36)

   Peduncles of eyes covered; corneas usually well developed 3

3. Corneas of eyes exposed in dorsal and lateral view . . . . . *Athanas* (p. 23)

   Corneas largely or entirely concealed in dorsal view, partially or entirely concealed in lateral view 4

4. Rostral front broadly triangular; large chela carried folded back against the merus; tip of telson with "v"-shaped notch . . . . . *Salmoneus* (p. 38)

   Rostral front narrow; large chela carried extended; tip of telson truncate to convex . . . . . *Alpheopsis* (p. 32)

5. Carapace strongly compressed, with elongate dorsal keel that is interrupted by a deep notch immediately behind the orbital hoods . . . . . *Racilius* (p. 159)
   Carapace not compressed; dorsal keel, if present, not strong and without a deep notch behind the orbital hoods 6
6. With pterygostomial margin produced into a definite angle; without anal tubercles; without mastigobranchs and setobranchs . . . . . *Synalpheus* (p. 44)
   With pterygostomial margin rounded, never angular; with anal tubercles; bearing mastigobranchs and setobranchs at least on anterior thoracic legs . . . . . *Alpheus* (p. 74)

ATHANAS

Athanas Leach, 1814. Edinb. Encycl. 7(2):432. (Confer: Banner and Banner 1960a:134).

Arete Stimpson, 1861. Acad. Nat. Sci. Philadelphia, Proc. 12:32.

Type Species: *Palaemon nitescens* Leach

Definition: Rostrum well developed; supra-, extra- and infracorneal spines usually present with varying degrees of development; corneas of eyes exposed anteriorly and largely dorsally and laterally; chelae of the first legs well developed, either carried extended or flexed against an expanded merus, usually asymmetric and sexually dimorphic, always without the cylinder and plunger characteristic of *Alpheus;* carpus of second leg with four or five articles; dactylus of third legs simple or biunguiculate; pleura of sixth abdominal segment articulated; telson without anal tubercles, tip arcuate. Branchial formula variable.

KEY TO SPECIES OF ATHANAS IN MALAYO-THAI WATERS[3]

1. Infracorneal projection acute, female chela asymmetrical . . . . . A. near *polymorphus* (p. 24)
   Infracorneal projection round, female with symmetrical chelae 2
2. Chela in female 0.5 as long as merus; chela in male with tubercles on palm; propodus of third legs with only terminal spinules . . . . . A. *dimorphus seedang* (p. 28)
   Chela in female 2.2 times longer than merus; chela in male with palm smooth; propodus of third leg with about 6 movable spinules . . . . . A. *naga* (p. 26)

3. *Athanas* species No. 1 omitted from this key, see page 31.

Athanas near *polymorphus* Kemp—Figure 2

Athanas polymorphus Kemp 1915. Indian Mus., Mem. 5:295, figs. 31, 32.

Specimen Drawn: A 11 mm. male from BR 9a, collected from Ban Pe near Fisheries Station at Rayong, under rocks on a gravel-sand beach. Also available, 1 complete female and three fragmentary specimens, 9-11 mm. in length.

Description: Rostrum reaching to near end of second antennular article. Rostral carina slight, reaching 0.4 length of carapace. Carina bearing row of short stiff setae. Supracorneal teeth lacking. Extracorneal teeth reaching to middle of cornea, infracorneal teeth a little broader but almost as long. Pterygostomial angle acute and projecting, similar in size to extracorneal teeth.

Second antennular article 1.3 times as long as broad. First, second and third antennular articles of subequal length when seen in dorsal view, with first slightly longer. Acute spine of stylocerite reaching almost to end of second antennular article. Scaphocerite with lateral margin straight and lateral spine only a little longer than squamous portion which reaches just beyond end of antennular peduncle. Spine of basicerite acute.

Chelipeds sexually dimorphic and asymmetrical in both sexes. Ischium of male cheliped 0.4 as long as merus and carrying one superior distal spine. Merus 4.2 times as long as broad, with internal margin armed with two sharp distal teeth and three smaller rounded teeth near middle. The inferior surface excavate to allow for palm when carpus is flexed, with lamella of internal margin being thinner than that of external margin. The carpus cup-shaped, only 0.2 as long as merus, fluted distally, like a corolla, to accommodate base of chela. Chela subcylindrical, flattened on its outer face, three times as long as wide, not markedly inflated at midsection. Dactylus broadly arched; inner side of opposing face of both dactylus and fixed finger beset with rows of stiff bristles and both bearing characteristic teeth (see fig. 2C), tips acute and crossing. Merus of small cheliped of male thinner than that of large cheliped and bearing only two prominent teeth and one small tooth on inferior margin. Carpus 0.3 as long

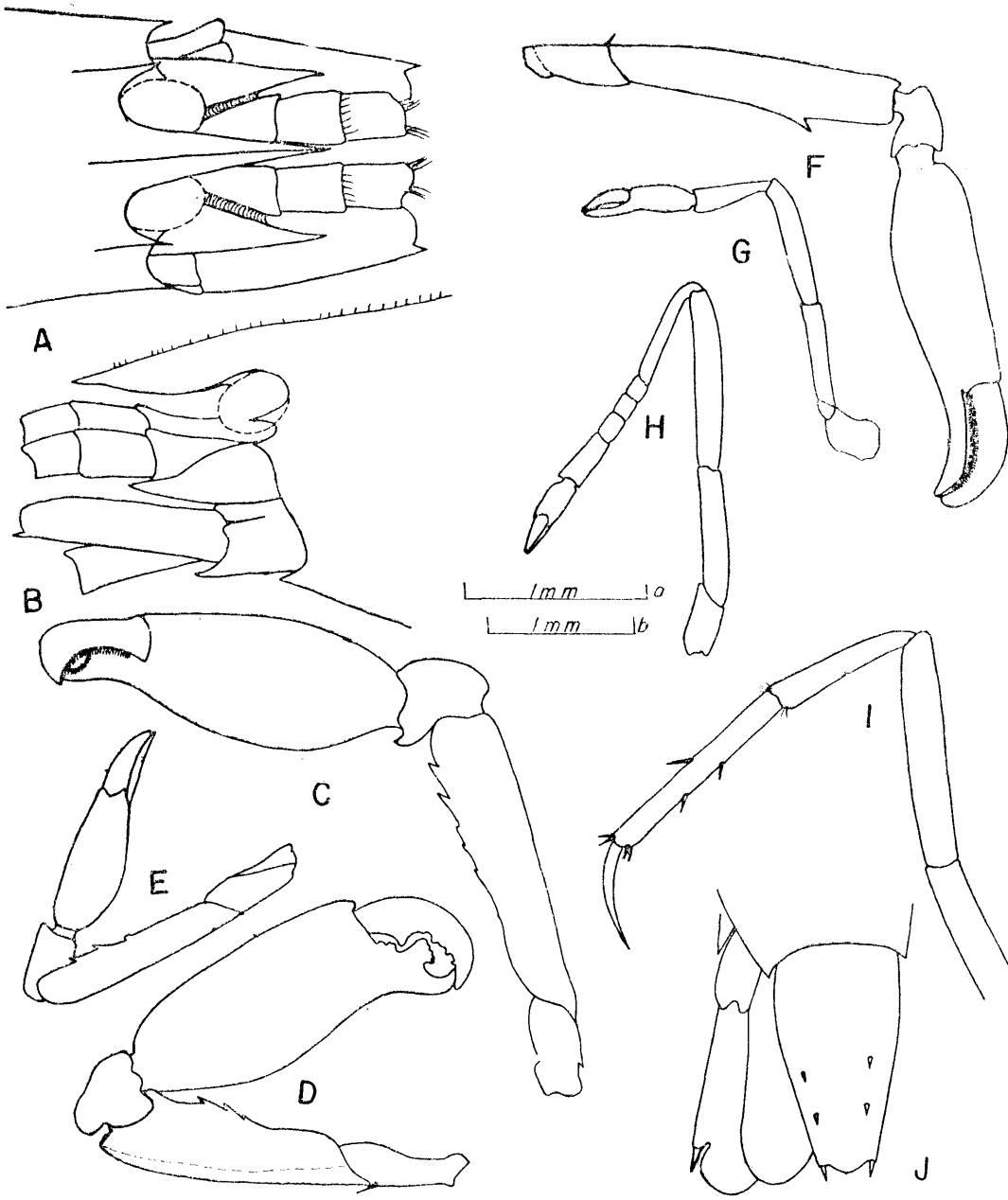

FIGURE 2

Athanas near *polymorphus*. A, B, Anterior region, dorsal and lateral aspect; C, large cheliped, right side, inside face of male; D, outside face, right side; E, small cheliped, left side, male; F, large cheliped, right side, female; G, small cheliped, left side. female; H, second leg; I, third leg; J, telson and uropods. (A, B, H, I, J, scale a; C, D, E, F, G scale b).

as merus, compressed, inflated at midsection, three times as long as wide. Fingers 0.5 as long as palm, without teeth on cutting surfaces.

Female chelipeds asymmetrical, smaller than male chelipeds. Ischium of large chela 0.2 as long as merus, bearing one superior distal spine. Merus slender, five times as long as broad, bearing one acute tooth on inferior internal margin two-thirds distance to end; excavate on its inferior surface to accommodate palm. Carpus cup-shaped, as long as broad distally, fluted on upper margins and fitting over palm like a corolla. Chela five times as long as broad, subcylindrical, slightly broadened near posterior end with finger occupying distal 0.3. Dactyl not extremely arched, closing without gape. Fixed finger concave on inferior margin. Stiff setae on opposing surfaces of both fingers. Small cheliped only half as long as large cheliped. Ischium only a little shorter than merus, without spine. Merus slender, 6 times as long as wide, unarmed. Carpus 0.6 as long as merus, broadened distally. Chela 0.9 as long as merus, fingers as long as palm.

Ratio of carpal articles of second leg: 10:1:1:2:4.

Third leg slender, merus five times as long as broad, ischium 1.5 times longer than merus, propodus only a little shorter than ischium and bearing on its lower surface two pair of spinules medially and one pair distally. Superior margin bearing one spinule medially. Dactylus simple, slender, gradually curved, almost 0.5 as long as merus.

Telson four times as long as wide at posterior margin. Anterior margin 2.3 times wider than posterior margin. Uropods only a little longer than telson.

Discussion: This species is closely related to *A. polymorphus* Kemp and may actually prove to be the same (confer: Kemp, 1915:290, fig. 31). Certainly the male chelipeds almost exactly duplicate those of form II in Kemp's discussion (fig. 31D) of the three cheliped forms of *A. polymorphus*. However, the chelipeds of our ovigerous female do not resemble the almost symmetrical chelipeds of *A. polymorphus*. Even the small cheliped, which roughly resembles one of the symmetrical pair of *A. polymorphus*, has a chela longer, not shorter, than the

carpus as in *A. polymorphus*. The other differences are slight and of less importance. In Kemp's form the spine of the stylocerite extends only just a little beyond the first antennular article instead of almost to the end of the second antennular article as in our specimens. The carpocerite is shorter in relation to the antennular peduncle in our specimens. Finally, the pterygostomial angle in the Thai specimen is produced into a strong tooth while in Kemp's figure (32a) the angle itself is rounded and the tooth is found dorsal to it, arising not from the frontal margin, but from the lateral surface of the carapace.

This species also shows morphological developments similar to *A. sibogae* de Man (1911:151). It can be separated by the presence of sharp teeth on the merus of both the large and small chela, by having only 1 spine on the ischium and especially by the lack of a secondary unguis on the dactyl of the thoracic legs. It is also near *A. jedanensis* de Man (1911:154) but may be separated from this by the presence of infracorneal teeth and the lack of a secondary unguis on the dactyls of the thoracic legs.

As this species is known to be so polymorphic, we have tentatively included the Thai form in Kemp's species, although these specimens came from a marine beach and Kemp's from the almost landlocked Chilka Lake in India. It has apparently not been collected from other than the type locality.

Athanas naga species nov.—Figure 3

Type Specimen: A 7 mm. female from Naga Expedition in the Gulf of Thailand, dredged from 30 metres. Naga Station 60-895. Allotype: a 9 mm. male from the same dredge haul. Paratypes: Naga Station 60-895, 5 females from 7-9 mm. in length.

Description: Rostrum acute, sides evenly tapered, tip reaching to near end of second antennular article, and bearing slight carina in anterior portion. Supracorneal teeth lacking; extracorneal teeth acute, not reaching end of cornea. Infracorneal projection and pterygostomial corner rounded. Corneas of eyes only slightly covered in posterior portion.

Second antennular article a little wider than long, shorter than visible part of first and third article; visible portion of first longer

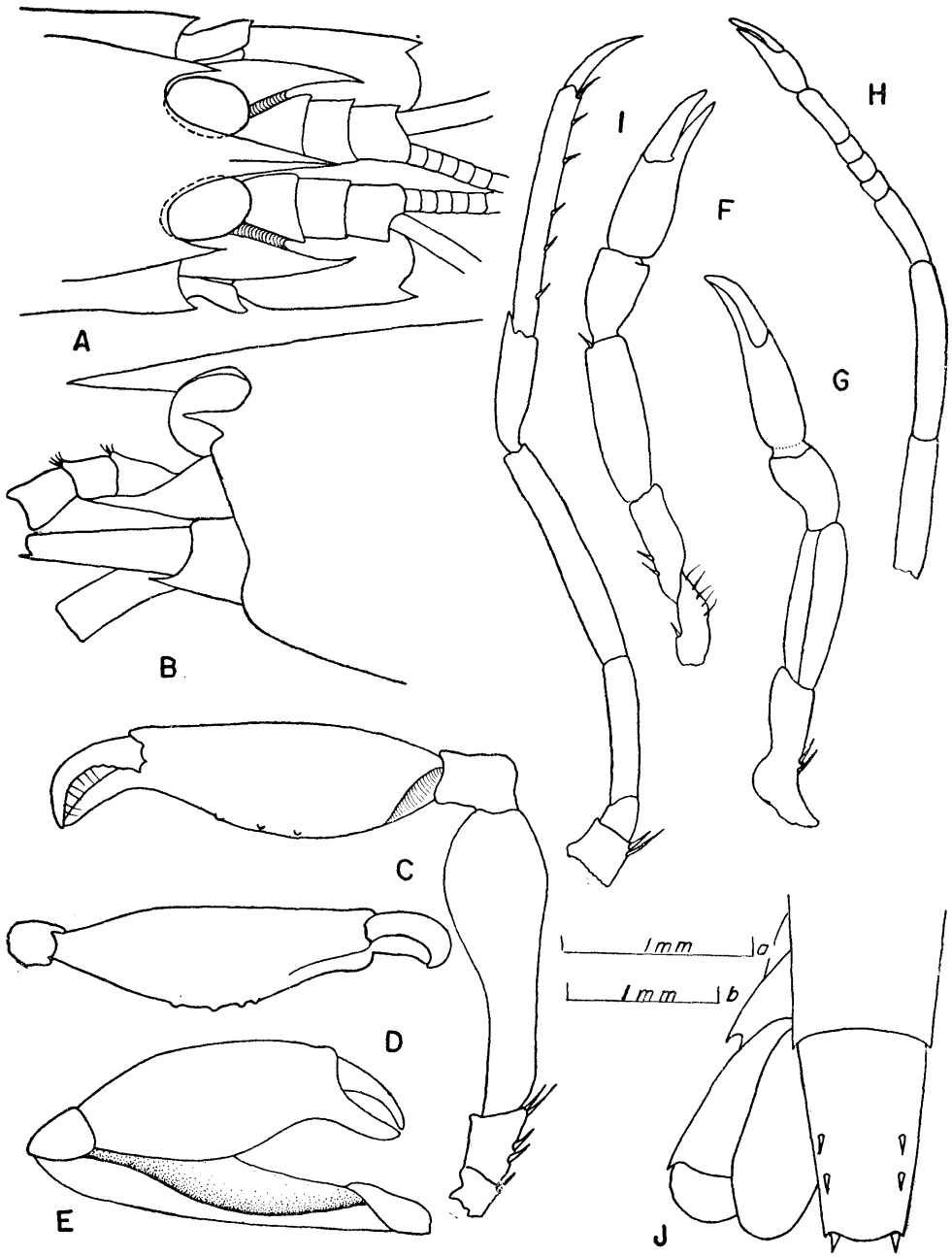

FIGURE 3

Athanas naga sp. nov. A, B, Anterior region dorsal and lateral aspect; C, large cheliped, outer face,male; D, male chela, inner face; inferior aspect; E, male chela, inner face; F, G, chelipeds, female; H, second leg; I, third leg; J, telson and uropods. (A, B, F, G, H, I, J scale a; C, D, E scale b).

than third. Stylocerite reaching just past end of second antennular article. Scaphocerite broad and reaching past end of antennular peduncle; lateral spine and squame of equal length. Carpocerite reaching to middle of third antennular article. Spine on basicerite small.

Chelipeds sexually dimorphic, symmetrical in both sexes. Female cheliped shorter than following thoracic legs. Ischium as long as merus bearing 2-4 movable spinules on superior margin. Merus 3.3 times as long as broad with short movable spinule on superior distal margin. Carpus 0.5 as long as merus, distally broadened. Chela slightly longer than merus, with finger a little shorter than palm.

Male chelipeds longer than posterior legs, symmetrical. Ischium 0.2 as long as merus, 1.3 times as long as broad at its distal end, bearing four movable spinules on superior margin. Merus narrow, proximally broadening with leaflike extensions distally, leaving inferior face deeply excavate to accommodate flexure of chela. Merus 3 times as long as broad at its widest part. Carpus short, 0.2 as long as merus, cup-shaped, enclosing proximal end of chela like a corolla. Chela 1.2 times length of merus, 3.6 times as long as broad at its widest point. Lower margin of inflated portion of chela bearing 4 small papillae. Proximal portion of lateral surface of palm bearing a deep indentation to fit precisely with expanded portion of merus. Finger 0.2 as long as chela with dactylus strongly arched, fitting against convex immobile finger.

Ratio of carpal articles of second leg: 10:2:2:2:10.

Third legs longer than second, bases bearing two strong movable spines, similar to those of chela. Ischium 0.6 as long as merus. Merus 6.7 times as long as broad, inermous. Carpus 0.5 as long as merus, distal end of superior margin armed with strong acute tooth. Propodus a little longer than merus, 10 times as long as broad, inferior margin armed with 6 movable spinules. Dactylus simple, 0.3 as long as merus.

Telson three times as long as posterior margin is broad. Anterior margin 1.6 times wider than posterior. Posterior margin gradually arcuate.

Discussion: This specimen is most closely related to *A. lamellifer* Kubo from Kominato, Japan. The major differences are as follows:

1. In *A. lamellifer* the lamella on the inner edge of the merus of the large cheliped of the male is sinuate and tapers uniformly to the base, while in this species the lamella has a smooth and uniform curvature but is greatly expanded distally.

2. The small chelipeds of the mature female in *A. lamellifer* resemble those of the male, while in this species if we may presume that the ovigerous females show full maturity, the chelipeds resemble those of the immature female of *A. lamellifer*. However, between the immature females of *A. lamellifer* and this species there is a further difference, for in this species the carpus is shorter in relation to the merus.

3. In the second leg in this species the first and last carpal articles are equal but in the Japanese species the fifth article is only half as long as the first.

4. The merus of the third leg in *A. lamellifer* is 5 times as long as broad, in this species the ratio is 1 : 6.7. In Kubo's species the carpus is almost as long as the merus while in *A. naga* it is only half as long.

This species also resembles *A. jedanensis* de Man but can be separated by the lack of secondary unguis on the dactylus of the thoracic legs. The only other species in this genus which have been described as having papillae on the lower portion of the palm of the large chela is *A. verrucosus* Banner and Banner (1960a: 148). However, in that species there are many papillae while in this species there are only four.

Distribution: The 7 specimens collected were all taken in a beam trawl from about 27 meters of water in the Gulf of Thailand. They were in good condition and fully mature.

Athanas dimorphus seedang subspecies nov.--Figure 4

Athanas dimorphus Ortmann, 1894. V. Denkschr. Med. Naturw. Ges. 8 : 12, pl. 1, fig. 1. Coutière, 1903. Soc. Philomath. Paris IX, 5(2):6, fig. 12 (*passim in texto*). Tattersall, 1921. Linn. Soc. Zool., Journ. 34(229):371, pl. 28, figs. 23-24.

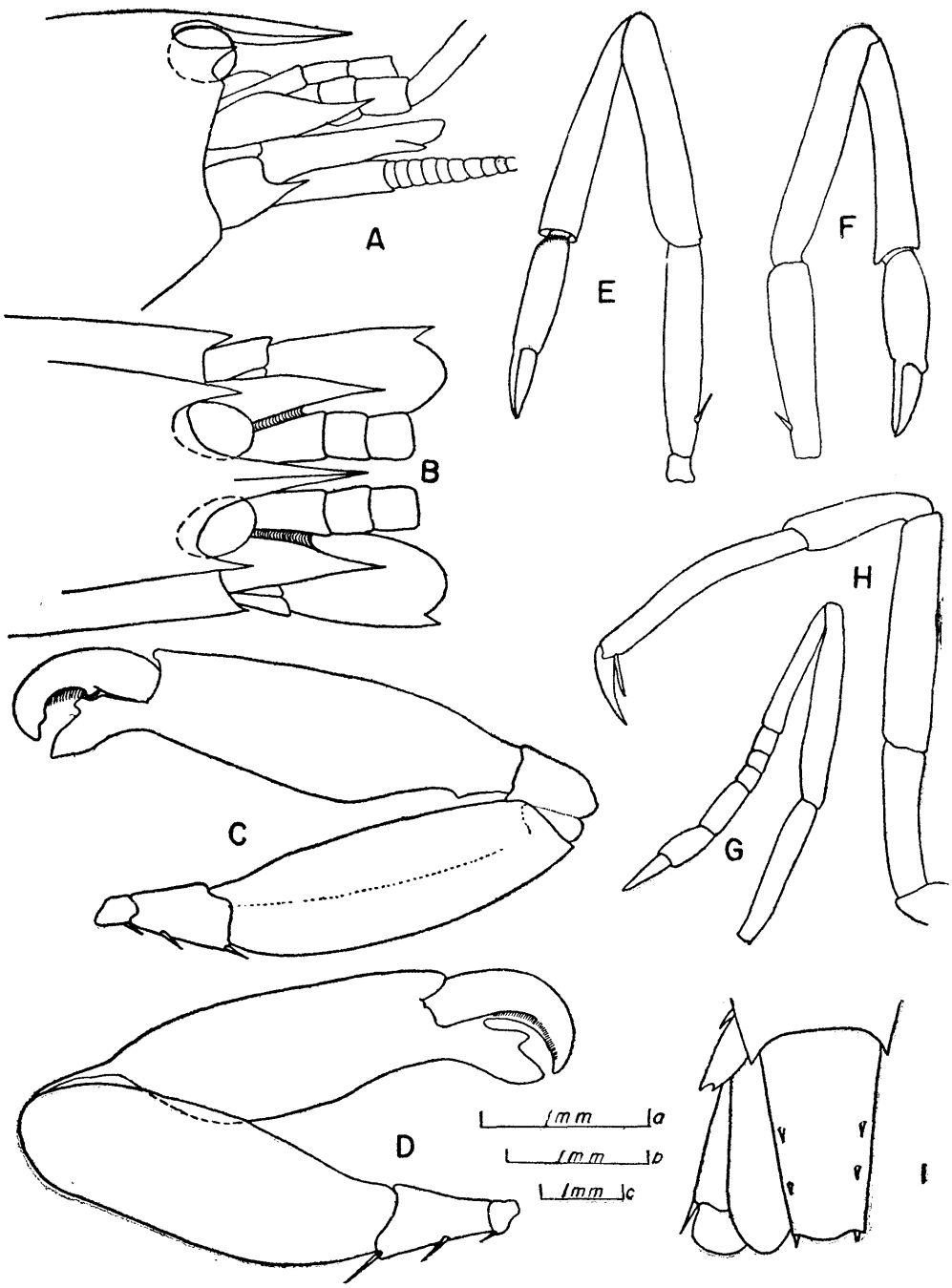

FIGURE 4

Athanas dimorphus seedang subspecies nov. A, B, Anterior region dorsal and lateral aspect; C, D, chelipeds outer and inner face, male; E, F, right and left chelipeds, female; G, second leg, H, third leg; I, telson and uropods. (A, B. E, F, G, H scale a; C, D, scale b; I, scale c).

Type Specimen: 9 mm. ovigerous female from Koh Kradard (BR 18) collected from head of dead coral in about 1.5 meters of water. Allotype: a 10 mm. male specimen from same location. Paratypes: Listed below under distribution.

Description: Rostrum acute, sides evenly tapered, tip reaching to end of second antennular article, bearing slight carina on anterior portion. Supracorneal teeth lacking; extracorneal teeth acute, reaching to end of cornea. Infracorneal projection short and rounded, pterygostomial corner rounded. Corneas of eyes concealed in posterior portion by extra–and infracorneal projections.

Visible part of first antennular article 1.6 times longer than second, second and third article subequal; second article as long as wide. Stylocerite reaching to middle of third antennular article. Scaphocerite broad, reaching well past end of antennular peduncle, with lateral spine and squamous portion almost equal. Carpocerite reaching to middle of third antennular article. Basicerite armed with strong lateral tooth.

Chelipeds sexually dimorphic, but of nearly symmetrical development in both sexes. Ischium in females bearing a single spine on superior margin, 0.8 as long as merus. Merus flattened, but not excavate on its inner surface, unarmed, 6 times as long as broad, straight sided. Carpus almost as long as merus, five times as long as broad, slightly broadened distally. Chela 0.7 as long as merus, fingers 0.7 as long as palm. Inner edge of dactylus without teeth, bearing only a narrow ridge and closing without gape.

Large chela of male cylindrical. Ischium 1.4 times as long as broad at point of articulation with merus, bearing two strong spines on superior margin. Merus three times as long as broad, unarmed, with inner margin expanded at midsection. Inferior surface deeply excavate to accomodate propodus, normally carried flexed. Palm subcylindrical, three times as long as broad at midsection, a little longer than merus, tapering slightly toward fingers. Dactylus curved, 0.4 as long as palm, with irregular large rounded tooth matching exactly with tooth on fixed finger.

Carpal articles of second leg with ratio: 10:1:1:1:4.

Ischium of third leg 0.6 as long as merus. Merus 4.6 times as long as broad. Carpus 0.5 as long as merus. Propodus as long as merus, bearing one movable spinule on distal end. Dactylus simple.

Telson three times as long as posterior margin is broad; anterior margin 1.6 times as long as posterior margin. Uropods a little longer than telson.

Thai specimens reaching 10 mm. in length.

Discussion: This species varies in the length of the squame in relation to the antennular peduncle. In some it reaches just to end of antennular peduncle, while in others it is as shown in fig. 4 B. Also in the immature males the large cheliped bears a relatively longer carpus, the large teeth on the cutting edges of the dactyli are absent or poorly developed, and chelipeds show greater asymmetry.

This species is very closely related to *Athanas dimorphus* Ortmann. The only difference is that the chela of the female in *A. dimorphus* is 0.5 as long as the merus while in our specimens the chela and merus are almost equal. This characteristic is not mentioned in Ortman's description but shows plainly in the figure. *A. dimorphus* is based on a specimen from East Africa. Coutière cited collections that were made from Perim, Suez, Djibouti, New Caledonia and Fiji. If these identifications were correct then this subspecies lies within the range of the parent species. It may be however that these earlier identifications did not consider the more subtle differences in the form of the chelipeds. In any case, the morphological distinction cited leads us to believe that the specimens from Thai waters are a separate geographical race and for that reason a separate subspecies.

The fact that the carpus and the merus in the female are at least 6 times as long as broad and nearly equal in length, separated this species from *A. lamellifer* Kubo in which the merus in immature forms is only 4 times as long as broad; it is separated from *A. rhothionastes* Banner and Banner and *A. marshallensis* Chace by similar differences. From *A. polymorphus* Kemp it differs in that the third leg and third leg dactylus are much thicker and the inferior internal margin of the merus of the male cheliped is smooth instead of serrate as in *A. polymorphus*. From *A. minikoensis* Coutière and *A. japonicus* Kubo it can be separated by the lack of the extracorneal teeth.

The subspecific name *seedang*, which in Thai means red, refers to the usual red color of these specimens.

Distribution: These specimens were found on both sides of the Gulf of Thailand and at Phuket. Most of them were found at low tide under heads of dead coral and in detritis after the rocks were moved away. They were also found in heads of coral collected in no more than six feet of water. They were usually bright red in color.

Collection data: 2 specimens from BR 1; 2, BR 4a; 1, BR 7; 2, BR 18; 2, BR 21; 2, BR 23; 1, BR 27; 1, BR 31; 10, BR 33; 9, BR 36.

Athanas species #1—Figure 5

Specimen Drawn: An 8 mm. female from Phuket (BR 38), taken from a head of dead coral in about 2.4 meters of water. Sole specimen.

Description: Rostrum acute, reaching to middle of third antennular article. Supracorneal teeth lacking. Extracorneal teeth pronounced, reaching beyond cornea. Infracorneal teeth rounded, pterygostomial angles rounded. Cornea of eye largely concealed by carapace and laterally shielded by extra- and infracorneal projections.

All antennular articles of subequal length in dorsal view. Second antennular article 1.3 times as long as wide. Stylocerite reaching to end of second antennular article. Scaphocerite with squamous portion broad, lateral spines reaching past end of antennular peduncle and only a little longer than squame. Carpocerite reaching to middle of third antennular article. Spine of basicerite not strong.

Chelipeds of female small and symmetrical. Ischium 0.6 as long as merus with hairs on inferior margin. Merus 4.3 times as long as broad. Carpus 0.6 as long as merus, cup-shaped, widened at distal end, with spine on inferior distal margin. Palm 0.7 as long as merus, fingers occupying 0.7 of entire chela.

Merus of third leg unarmed, 7.5 times as long as broad. Ischium a little less than half as long as merus with two spines on inner margin. Carpus 0.5 as long as merus, bearing single feeble spine on

inferior distal margin. Propodus 10 times as long as wide, 0.8 length of merus, with 5 slender spines along inferior margin and one pair distally. Dactylus simple, 0.4 as long as merus.

Telson 3.6 times as long as broad at the posterior end, anterior margin three times as wide as posterior margin.

Discussion: This species is closely related to *A. jedanensis* de Man and *A. rhothionastes* Banner and Banner. In both of these species the female chelae can be symmetrical and are similar in shape to those of this specimen. However the following differences were noted: There are no spines on the ischium of the chela and also this species lacks the secondary unguis on the thoracic legs that is found in *A. jedanensis.* Further the third leg of our specimen has two movable spinules on the ischium instead of one as in *A. jedanensis.* In *A. rhothionastes* the rostrum is shorter and the second and third thoracic legs are much thicker, the merus of the third leg being 5 times as long as broad instead of 7.5. Moreover, *A. rhothionastes* is only known as an inhabitant of the surf zone on the outer edge of oceanic coral reefs, a far different environment than the waters of Phuket.

As in this genus the separation of species is based upon the form of the cheliped which change both with sex and maturity, as we lack a male and as we do not know whether this small non-ovigerous female represents a fully mature condition for the sex, we have decided to leave it unnamed until adult forms may be collected.

ALPHEOPSIS

Alpheopsis Coutière, 1896. Paris Mus. d'Hist. Nat., Bull. 2(8):382.

Type Species: *Betaeus trispinosus* Stimpson

Definition: Frontal border of carapace produced into rostrum and projecting flange that screens eyes from above; orbital teeth present or absent. Cornea of eyes always visible from front and in some species from sides.

Antennular peduncle short and stout; stylocerite variable. Scaphocerite usually broad, without heavy lateral spine. Carpocerite long.

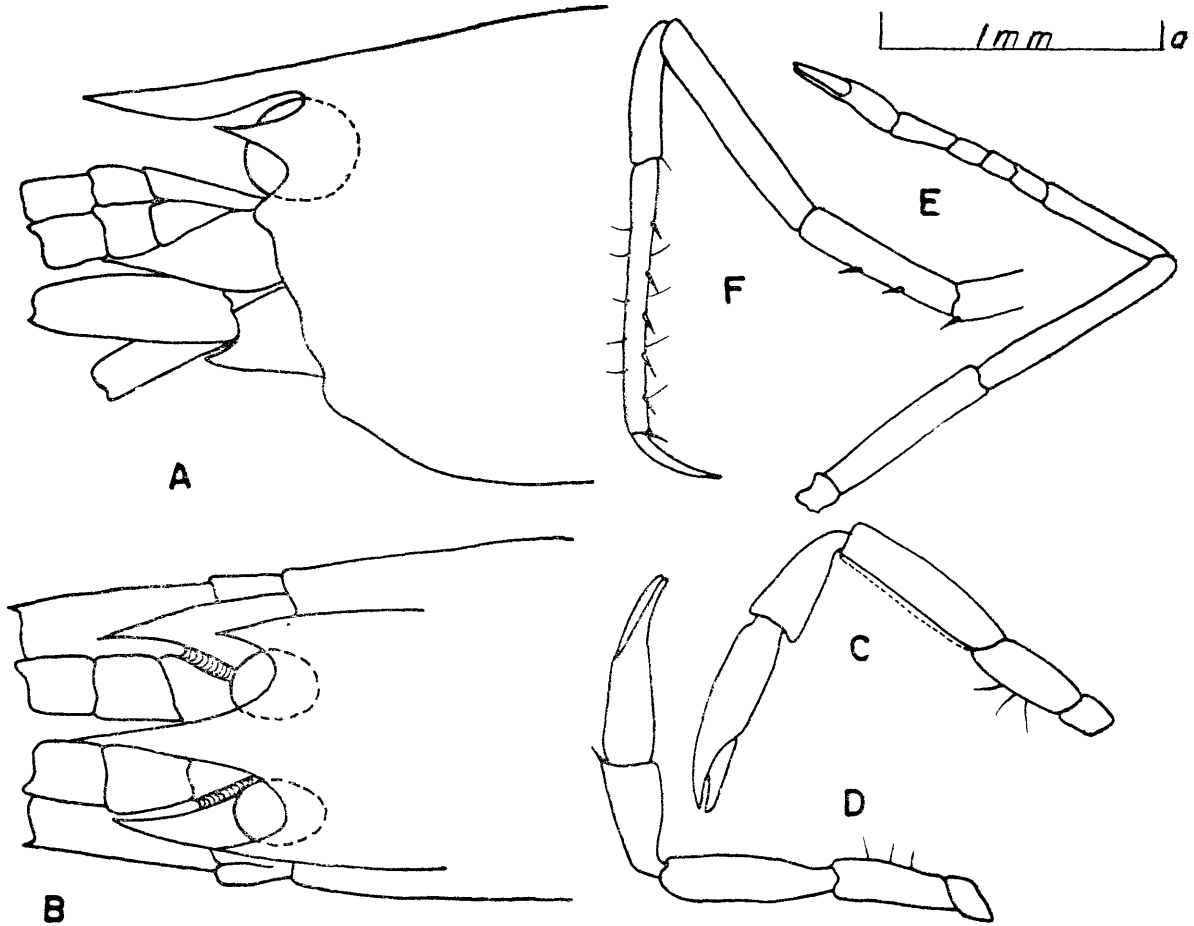

FIGURE 5

Athanas species #1. A, B, Anterior region, dorsal and lateral aspect; C, D, chelipeds, right and left side, female; E, second leg; F, third leg. (All drawings scale a).

Chelipeds showing slight asymmetry. Large chela carried extended, without grooves or sheaths. Carpus globular, merus roughly triangular, Palm either entire and subcylindrical or with lines and depressions. Fingers compressed, either without teeth or with simple arrangement of exactly fitting teeth.

Second thoracic legs with carpus of three (*A. idiocarpus* Coutière), four (*A. tetrarthri* Banner), or five secondary articles.

Following legs robust, without teeth on merus; propodus weakly spinose; dactylus biunguiculate or simple. Propodus of fith legs with or without "brush" of bristles.

Sixth abdominal segment lacking articulated pleura only in *A. biunguiculatus* Banner. Posterior border of telson rounded.

Branchial formula: 5 pleurobranchs, 0-1 arthrobranchs, 6, 7, or 8 epipodites.

KEY TO SPECIES OF ALPHEOPSIS IN MALAYO-THAI WATERS

1. Without orbital teeth . . . . . *A. equalis* (p. 33)
   With orbital teeth . . . . . *A. chalciope* (p. 35)

Alpheopsis equalis Coutière–Figure 6

Alpheopsis equalis Coutière, 1896. Paris Mus. d'Hist. Nat., Bull. 2(8):382. 1905. Fauna and Geog. Mald. and Laccad. 2(4): 869, fig. 138 a-b. Armstrong, 1941. American Mus. Nov. (1137):5, fig. 1, Table X. Banner, 1953. Pacific Sci. 7(1):15, fig. 4 a-o.

Alpheopsis equalis truncatus Coutière, 1903. Soc. Philomath. Paris. IX, 5(2):89, figs. 37, 38.

Alpheopsis consobrinus de Man, 1910. V. Ned. Dierk. Ver. Tijdschr. 11(5):305.

Specimen Drawn: 10 mm. female from Phuket (BR 38).

Description: Rostrum acute, reaching to last quarter of first attennular article. Termination of rostrum, in lateral view, varying from acute to obliquely truncate. Frontal border projecting beyond corneas of eyes, only slightly curved. Pterygostomial angle rounded or produced into acute tooth.

Antennular peduncle short and heavy with first, second and third articles subequal in length, second article 1.5 times longer than broad. Tip of stylocerite extending almost to end of second article. Scaphocerite short and broad, as long as antennular peduncle, lateral spine with tip extending only a little further than broad squamous portion. Carpocerite equal to squame. Lateral spine of basicerite acute but not well developed.

Chelipeds symmetrical in shape and size. Chela of male four times as long as broad with finger a little shorter than palm. Fingers compressed, proximally with 6-8 obtuse saw-like teeth intermeshed and distally bearing short stiff bristles. Carpus elongate with outstanding flange into which fits proximal end of propodus; slight constriction proximal to flange. Merus three times as long as broad with inferior internal edge carrying three spines, superior margin with two spines proximally and an obtuse tooth distally. Ischium as long as carpus, bearing three spines on superior margin. Female chelipeds of similar proportions but two-thirds as large as those of a male of similar body length.

Carpal articles of second leg with ratio: 10:5:5:5:6.

Third legs relatively long and slender with ischium 0.7 as long as merus, bearing two spines on internal margin. Merus 6.6 times as long as wide. Carpus 0.6 as long as merus. Propodus slightly longer than merus and bearing four or five spines on inner margin. Dactylus with slight curve, 0.8 as long as carpus.

Telson 3.7 times as long as posterior margin is broad. Posterior margin slightly arcuate.

Thai specimens reaching 12 mm. in length.

Discussion : This species is known to vary in length of rostrum, size and armature of the chelae, and the presence or absence of a tooth on the pterygostomial angle. All of the Thai specimens agree with Coutière's figure of 1905 with the exception of a longer stylocerite and the presence of a tooth on the pterygostomial angle.

Distribution : We collected 10 specimens from Phuket, 9 from BR 38, 1, BR 31.

This species is wide spread. It has been collected from the Red Sea and the Indian Ocean. In the Pacific it has been reported as far north as Saipan and as far south as Tonga, and east to Hawaii.

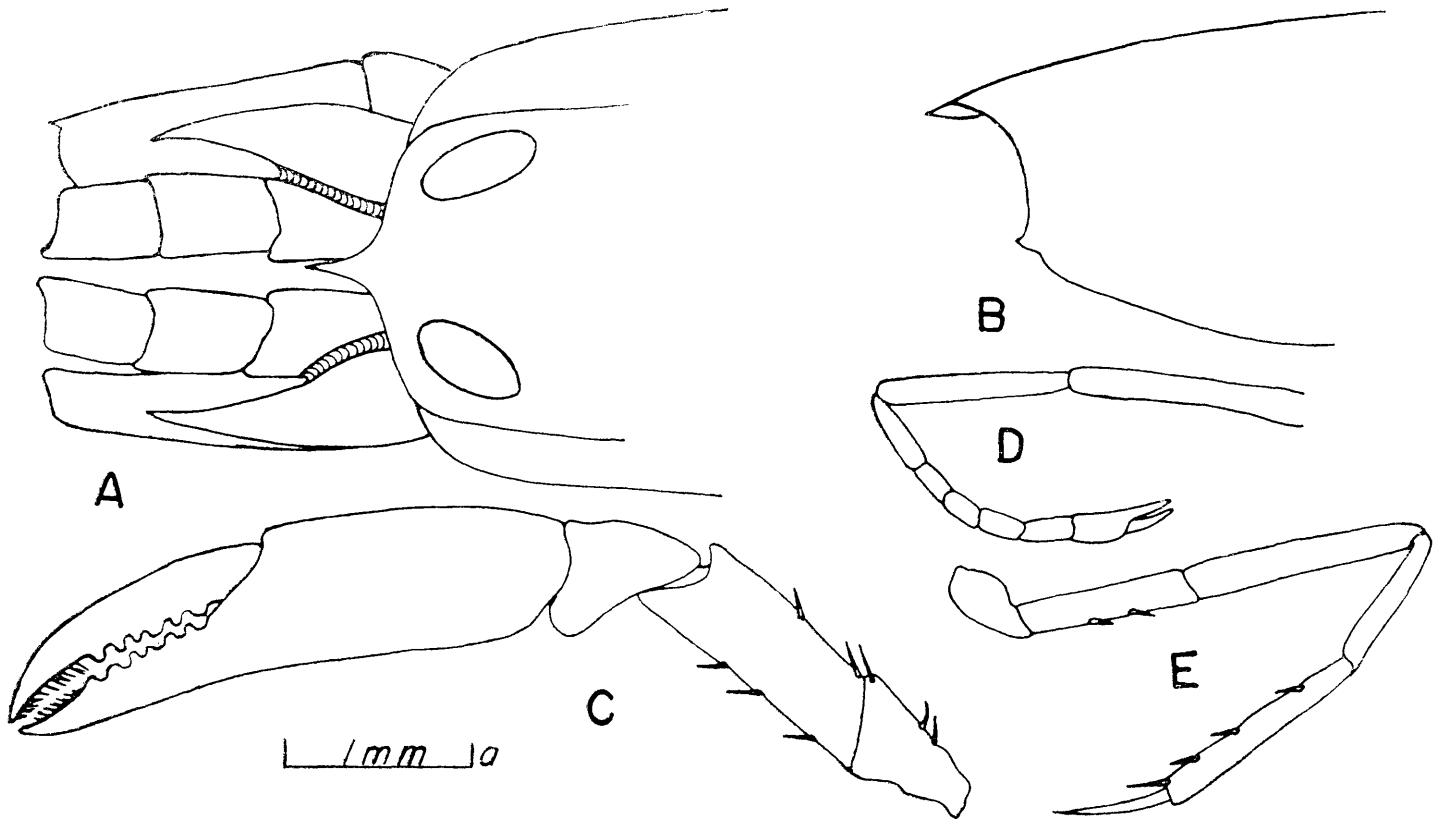

FIGURE 6

Alpheopsis equalis Coutière. A, Anterior region, dorsal aspect; B, carapace, anterior region, lateral aspect; C, cheliped, right side; D, second leg; E, third leg. (All drawings scale a).

Alpheopsis chalciope de Man–Figure 7

Alpheopsis chalciope de Man, 1910. V. Ned. Dierk. Ver., Tijdschr. 11(5):306. 1911. Siboga Exped. 39a1(2):179, pl. 5, fig. 17.

Specimen Drawn : 9 mm. female from Phuket (BR 38).

Description : Rostrum slender, reaching to end of first antennular article with lateral margins regularly curving to acute orbital teeth; teeth directed straight forward. Pterygostomial angle carrying small acute tooth which curves dorsally. Second antennular article longer than visible part of first, and slightly longer than broad, longer than third article. Stylocerite reaching beyond middle of second antennular article. Scaphocerite with lateral spine reaching to end of antennular article, and exceeding broad squamous portion. Carpocerite as long as squame.

Chelipeds of female almost symmetrical. Right chela four times as long as wide, fingers a little shorter than palm. Inferior margin slightly concave at level of articulation of dactylus. Carpus slightly elongate with outstanding flange into which proximal end of propodus fits, with slight constriction proximal to flange. Merus 3.3 times as long as broad, bearing four spines on inferior internal margin and three on superior margin. Ischium 0.5 as long as merus with three spines on superior margin. Left chela a little smaller and more slender, without spines on merus, but bearing one small spine on distal end of inferior margin of carpus. Male chelipeds unknown.

Second leg with ratio of carpal articles 10:4:3:3:5.

Third leg long and slender. Ischium 0.8 length of merus bearing two spines on the inferior margin. Merus 8 times as long as wide, unarmed. Carpus 0.5 as long as merus, with superior margin projecting as an acute tooth. Propodus as long as merus, bearing 4 spines on inferior margin and one pair distally. Dactylus gradually curved, 0.5 length of carpus.

Telson 2.6 times as long as posterior margin is broad. Posterior margin only slightly arcuate.

Discussion : Our specimen agrees with de Man's with the exception of the visible part of the first antennular article. In his

specimen the first article is longer than the second, in ours it is shorter. This may be because the antennules in our specimen are bent upward towards the rostrum. We have only one female specimen and de Man had only two females, only one with a cheliped attached; the degree of sexual dimorphism in the cheliped cannot be predicted except to remark that the male and female chelipeds are often of similar form, but with those of the female somewhat smaller.

Distribution : Our specimen was from Phuket (BR 38) taken from a head of dead coral from 2 meters of water. It was one in a collection which contained 9 specimens of *Alpheopsis equalis* Coutière. De Man's specimens were from Indonesia. These are the only specimens known.

AUTOMATE

Automate de Man, 1888b. Archiv. f. Naturgesch. 53(1):529.

Type Species : *Automate dolichognatha* de Man

Definition : Carapace laterally compressed, rostrum if present, only slight without orbital teeth. Eyes not covered by carapace, free, with reduced corneas.

Antennular peduncles extremely elongate with second article frequently the longest. Stylocerite reduced, scaphocerite reduced, carpocerite elongate. Third maxillipeds longer than antennular peduncles.

Chelipeds carried extended, asymmetrical and sexually dimorphic, compressed, with surfaces smooth and without sculpture; dactyls without cylinder and plunger characteristic of *Alpheus*.

Second legs with five articles on the carpus. Following thoracic legs unarmed, with simple dactyl.

Pleura of sixth abdominal somite not articulated. Telson of normal form, without anal tubercles.

Branchial formula : 5 pleurobranchs, 1 arthrobranch and 8 epipodites.

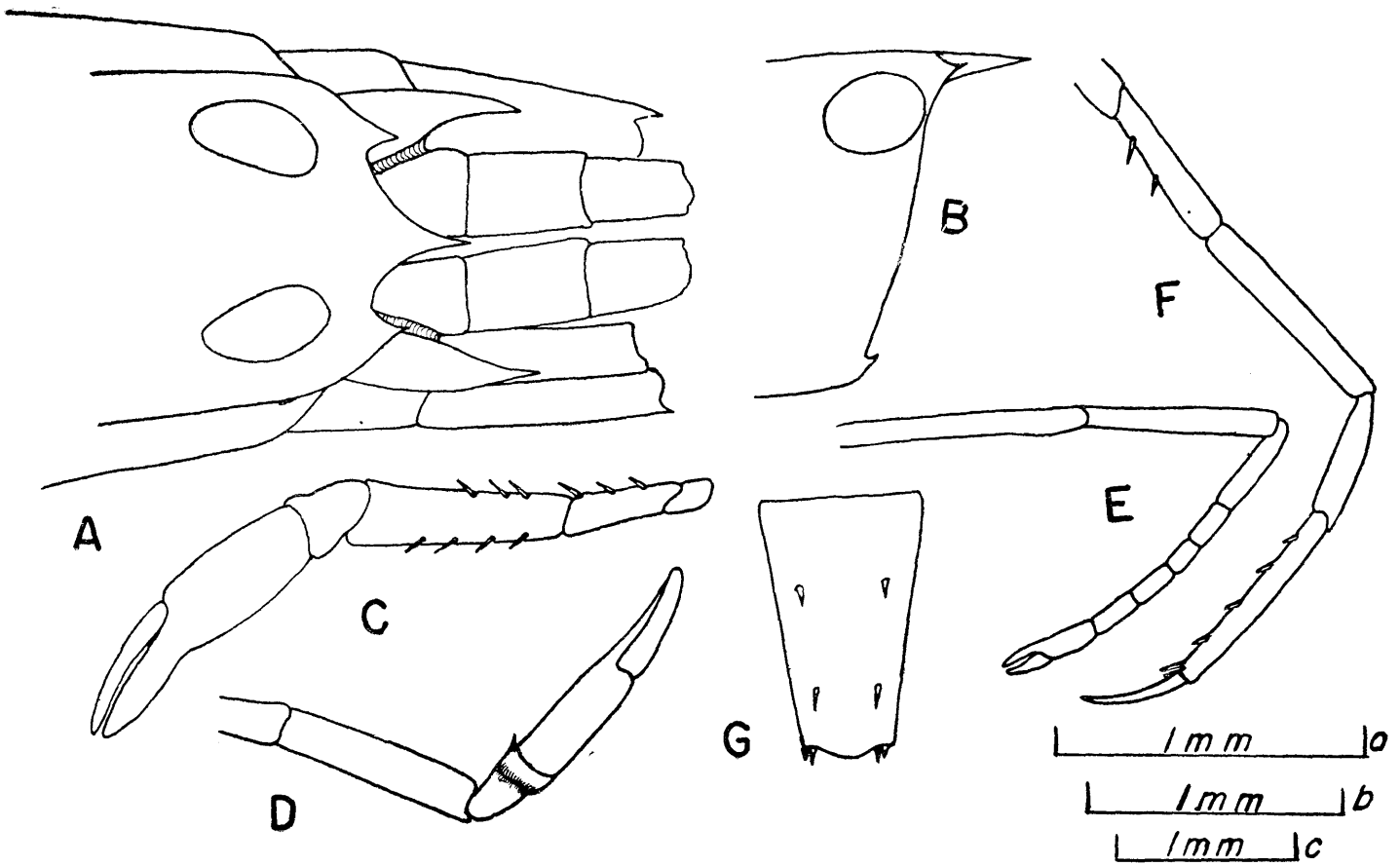

FIGURE 7

Alpheopsis chalciope de Man. A, Anterior region, dorsal aspect; B, carapace, anterior region, lateral aspect; C, cheliped, left side, inner face, female; D, cheliped, right side, outer face, female; E, second leg; F, third leg; G, telson. (A, scale a; B, G, scale b; C, D, E, F, scale c).

Automate gardineri Coutière–Figure 8

Automate gardineri Coutière, 1902. Paris Mus. Hist. Nat., Bull. 8(5):337; 1903. Soc. Philomath Paris, Bull. 5(2):72, figs. 1-8; 1905. Fauna and Geog. Mald. & Laccad. 2(4):854, fig. 127. Suvatti, 1937. Check list of the Aquatic Fauna of Siam, p. 47.

Automate johnsoni Chace, 1955. U.S. Nat. Mus., Proc. 105(3349): 13, fig. 7.

Specimen Drawn : An 18 mm. male from Phuket (BR 36).

Description : Central section of orbito-rostral margin an seen in dorsal view recessed above eye stalks, exposing them to near base; small rounded triangular rostrum not reaching to level of frontal margin of carapace. Exposed portion of ocular peduncles longer than visible part of first antennular article.

Second antennular article over twice as long as visible part of first, varying from 2.5 to 4.0 times as long as broad. Third article 0.3 as long as second. Stylocerite with acute lateral spine reaching to end of first antennular article. Scaphocerite reaching variously from middle to end of second antennular article; squamous portion shorter than lateral spine. Carpocerite a little longer than antennular peduncle. Small spine on basicerite.

Large chela compressed, 1.7 times as long as broad with fingers occupying distal 0.4. Superior margin smooth, inferior margin with gradually rounded concavity opposite articulation of dactylus. Dactylus slender, extending as continuation of regular curve of palm; both fingers armed with three strong rounded teeth; tips of fingers rounded, crossing. Carpus broadened at distal end, corolla-shaped, distally divided into three heavy lobes. Merus widening at mid-line, 1.8 times as long as wide. Ischium distally broadened and bearing two strong movable spines on superior margin.

Small chela slightly more than half length of large chela, twice as long as wide, with fingers subequal to length of palm; carpus similar to that of large chela but less heavy. Merus in mid-section 0.8 as wide as breadth of palm, 2.3 times as long as wide. Ischium as long as carpus, slender, bearing strong movable spine on superior distal margin.

Ratio of carpal articles of second leg as 10:12:7:6:7.

Ischium of third leg unarmed. Merus 3.4 times as long as broad, also unarmed. Carpus 0.5 as long as merus with superior margin projecting distally in heavy tooth. Propodus equal in length to carpus and bearing 5 movable spines on inferior margin. Dactylus simple, 0.4 as long as propodus.

Telson 3 times as long as broad at posterior end. Lateral margins slightly concave.

Thai specimens reaching 18 mm. in length.

Discussion : The specimens are extremely variable in the reletionship of the scaphocerite to the second article, the ratio of length to breadth in the second antennular article, and the ratio of the first two articles of the second leg. A resumé of these differences will be discussed in our paper on the Alpheidae of Fiji, Tonga and Samoa, now in press, together with an explanation of the placement of *A. johnsoni* Chace in synonymy.

Distribution : All of these 10 specimens were found under rocks at low tide. Two collections came from the Gulf of Thailand and two from Phuket in the Indian Ocean.

Collection data: 2 specimens from BR 9a; 2, BR 17; 3, BR; 33; 4, BR 36.

This species has been reported from Djibouti and the Maldive and Laccadive Archipelagoes in the Indian Ocean. In the Pacific it has been collected from the Marianas Islands to as far east as Samoa.

SALMONEUS

Salmoneus Holthuis, 1955. Zool. Verhandl. (26) : 88.

Jousseaumea Coutière, 1896. Paris Mus. d'Hist. Nat., Bull. 2(8):381.

Type Species : *Jousseaumea serratidigitus* Coutière

Definition : Carapace anteriorly projecting far beyond eyes as a broad triangular rostrum, and usually with shorter orbital teeth. Eyes usually completely concealed dorsally and laterally but entirely free in front.

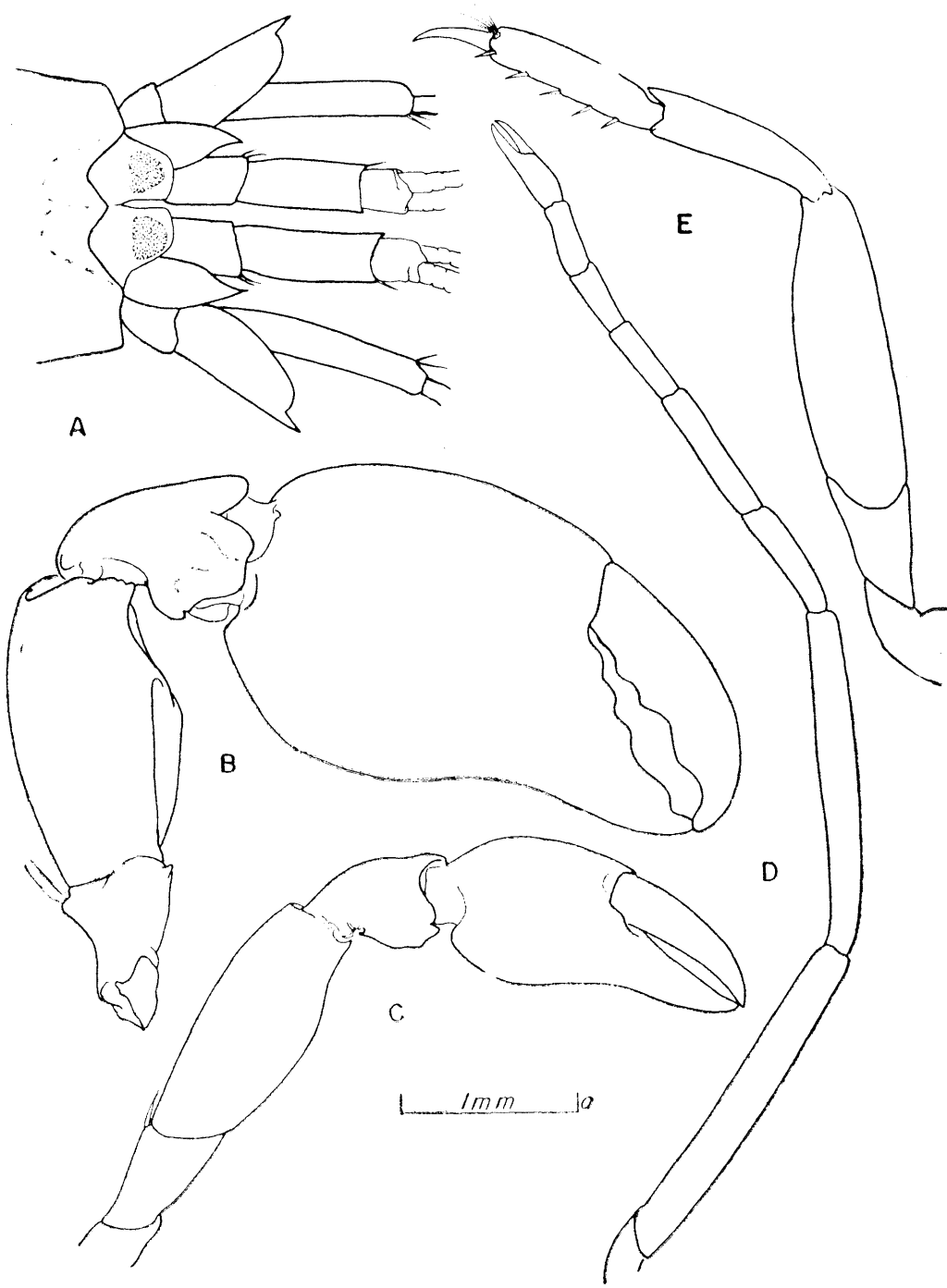

FIGURE 8

Automate gardineri Coutière. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, small cheliped, outer face; D, second leg; E, third leg. (All drawings scale a).

Chelipeds markedly asymmetrical. Large chela massive, carried under the body, flexed at meral-carpal articulation. Carpus of large cheliped cyanthiform, anterior border trilobate, merus or palm of chela excavate to accommodate flexion. Small chela reduced, diminutive, with chela shorter than carpus; carpus elongate and slender.

Second legs with carpus of five articles. Posterier thoracic legs as usual for *Alpheus,* dactyli simple.

Pleura of sixth abdominal segment not articulate. Telson attenuated, no anal tubercles, posterior border usually emarginate.

Branchial formula : 5 pleurobranchs; 1 arthrobranch; 8 epipodites.

KEY TO SPECIES OF SALMONEUS IN MALAYO-THAI WATERS

1. Without cleft in posterior end of telson . . . . . *S. brumi* (p. 42)
   With cleft in posterior end of telson. 2
2. With posterior lateral margin of rostrum merging with orbital hoods and margin; orbital teeth confluent with margin of rostrum. . . . . *S. brevirostris* (p. 39)
   With posterior lateral margin of rostum extended over orbital hoods; orbital teeth distinct from rostral base. . . . . *S. cristatus* (p. 40)

Salmoneus brevirostris (Edmondson)–Figure 9

Jousseaumea brevirostris Edmondson, 1930. Bishop Mus., Occas. Papers 9(10):7, fig. 2a-e. Banner, 1953. Pacific Sci. 7(1):12. fig. 3a-g.

Specimen Drawn : 9 mm. female from Phuket (BR 31).

Description : Rostrum broad at its base, acute, reaching to end of second antennular article, slight rostral carina reaching almost to middle of carapace. Orbital hoods continued as small acute orbital teeth, twice as long as rostrum. Area between base of orbital teeth and dorsal carina slightly concave.

Antennular peduncle short and heavy, with visible portion of first and second articles subequal in length, almost as long as broad. Heavy stylocerite with acute tip reaching almost to end of second antennular article. Scaphocerite with lateral spine equal to squamous

portion and reaching to end of antennular peduncles. Carpocerite reaching to middle of third antennular article. Basicerite with acute lateral tooth.

Large chela 3.3 times as long as broad, with fingers a little shorter than palm. Dactylus and fixed finger with 8 obtuse teeth that intermesh, tips acute and crossing. Carpus cup-shaped, distal margin being a three lobed flange into which fits the base of palm. Merus slightly longer than palm, excavate on its inner margin to accommodate palm when appendage is flexed. Small cheliped 0.6 as long as palm of large chela. Ischium and merus subequal, merus 8 times as long as wide. Carpus broadened at its distal end and equal in length to merus. Chela 4.5 times as long as broad, palm and fingers equal in length.

Carpal articles of second leg with ratio : 10:1:1:1:2.

Merus of third leg 4.5 times as long as broad, inermous. Carpus almost as long as merus, armed distally with blunt tooth on superior margin and movable spinule on inferior. Propodus as long as carpus, bearing 3 spines on inferior margin and a pair of spinules distally. Dactylus 0.4 as long as carpus.

Telson 4 times as long as broad at posterior margin, anterior margin 2 times as wide as posterior margin. Terminal cleft of telson triangular, small with distal end occupying about one third of telsal tip. Two strong spines on either side of terminal cleft.

Discussion : Only one specimen was collected. We compared it with the type in Bishop Museum and except for a slightly longer rostrum and a shallower cleft in the posterior end of the telson it exactly resembles the type.

Distribution : Our specimen was taken from a head of coral from the outer reef edge at Phuket. The only other specimens reported came from Hawaii.

Salmoneus cristatus (Coutière)—Figure 10

Jousseaumea cristata Coutière, 1897b. Paris Mus. d'Hist. Nat., Bull. 3(6) : 233.

Salmoneus cristatus Holthuis, 1958. Contri. Knowl. Red Sea Bull. 17, pp. 18-20, fig. 7.

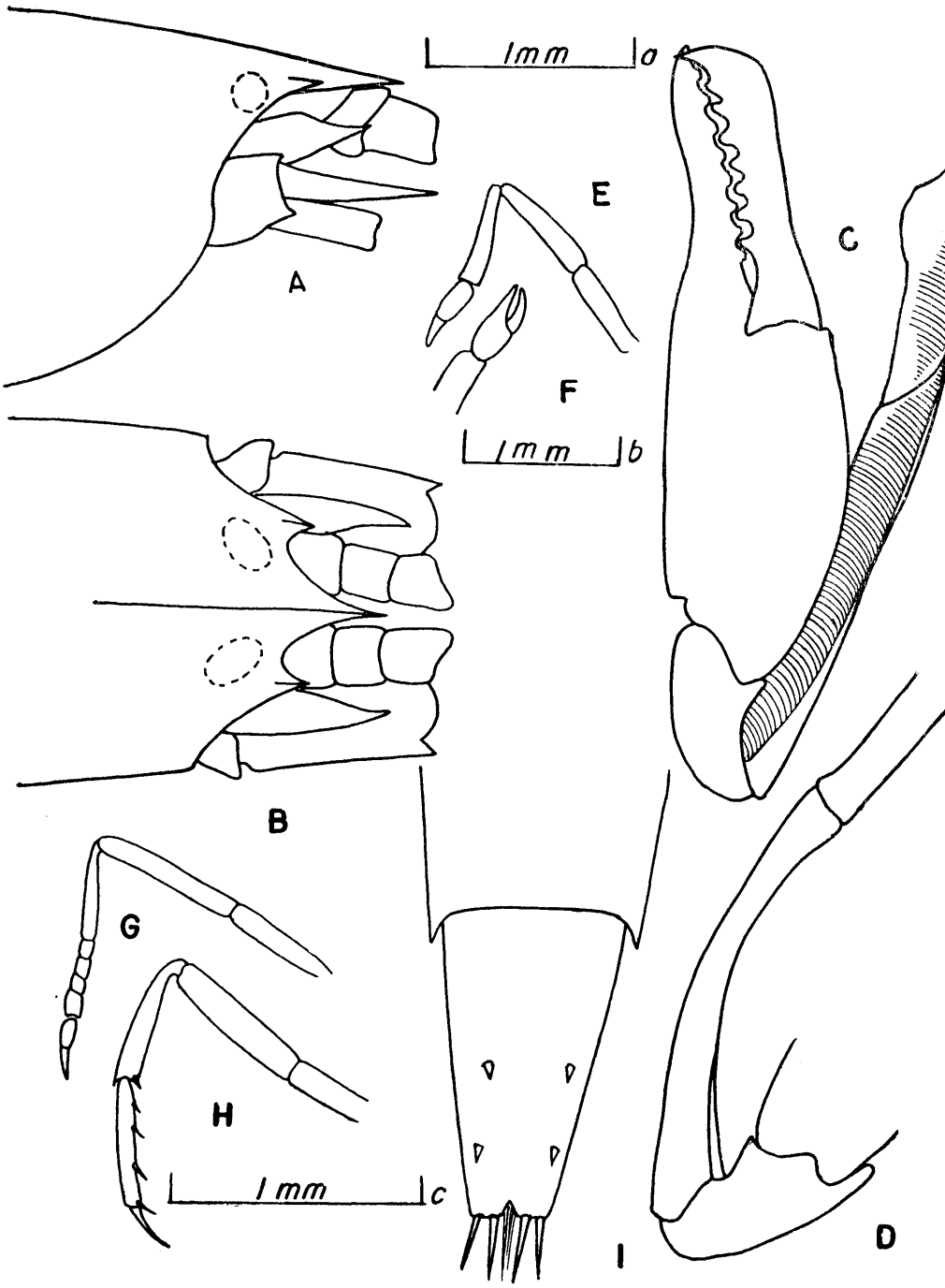

FIGURE 9

Salmoneus brevirostris (Edmondson). A, B, Anterior region dorsal and lateral aspect; C, large cheliped, inner face; D, merus, inner face; E, F, small cheliped; G, second leg; H, third leg; I, telson. (A, B, C, D, scale a; E, F, G, H, scale b; I, scale c).

Specimen Drawn : 10 mm. female from BR 39. Sole specimen.

Description : Rostrum triangular, margins concave, tip reaching almost to end of antennular peduncle, base broad. Lateral margins of rostrum continued on carapace to posterior of level of eyes as strong lateral ridges or keels, giving rostral base a plateau-like appearance. Rostral carina extending posteriorly to almost middle of carapace. Short acute triangular orbital teeth lie lateral to keel and are directed straight forward. Eyes completely covered by rostral base and orbital teeth in both dorsal and lateral views.

Articles of antennular peduncle short and broad, subequal in length; second article slightly broader than long. Stylocerite heavy, curved, reaching to tip of rostrum. Scaphocerite with lateral spine short, equal in length to broad squamous portion and reaching to end of antennular peduncle. Carpocerite reaching just past end of second antennular article. Basicerite with short, sub-acute, lateral tooth.

Large chela with both upper and lower margins depressed, flattened. (This appears to be an artifact, possibly from preservation; we believe these margins to be normally rounded and the palm to be a smooth oval in section.) Fingers a little shorter than palm. Opposing edges of fingers lined with eight meshing obtuse saw-like teeth, plus 3 additional teeth on the proximal end of fixed finger which meet against sharp ridge of dactylus. Distal quarter to fifth of fingers without teeth; tips of both fingers curved, acute, crossing. Medial side of basal portion of palm with strong excavation to accommodate collar of carpus when the carpal-propodal articulation is flexed; excavation demarked by heavy rounded projection of medial margin of palm (see fig. 10 C, D). Merus slender, 4.5 times as long as broad, triangular in cross section. Inner surface slightly excavate and concave to accommodate palm when flexed; internal margin armed distally with rounded tooth.

Small cheliped slender, shorter than following thoracic legs, one-half as long as large cheliped. Merus seven times as long as broad. Carpus as long as merus, slightly expanded distally. Chela three times as long as broad with fingers equal to palm.

Second legs with ratio of carpal articles: 10:1.7:1.7:1.7:2.7.

Third leg with ischium 0.6 as long as merus; merus 4.5 times as long as broad, both unarmed. Carpus slender, 0.8 as long as merus, superior margin terminating in obtuse projection, inferior margin with short spine. Propodus as long as carpus, carrying on its inferior margin 4 movable spinules and one pair distally. Dactylus 0.5 as long as carpus, slightly curved.

Telson 3 6 times as long as posterior margin is broad; anterior margin 2 times as wide as posterior margin, sides with uniform taper. Terminal cleft slight, triangular, about one-fifth as broad posteriorly as tip is wide. In this sole specimen posterior margin armed on one side with three strong spines and on other side with two spines (each side probably normally carrying three spines) and two pair of setiferous bristles in terminal cleft.

Discussion: We believe this to be the same species that Coutière described from Djibouti. His description was most inadequate and his only figure was that of the rostral front (1899:71, fig. 22). Holthuis collected what appears to be this species from Israel. His description and figures are most adequate and our specimen agrees very well with his. The nature of the crests formed by the continuation of the rostrum into the carapace in unique in the genus and is shown plainly by both Coutière and Holthuis.

This species differs from the two others of this genus found in Thai waters by the nature of the rostrum.

Distribution: Coutière's specimens came from Djibouti in the Red Sea and Holthuis from Eylath, Israel; this is the third record for the species.

Salmoneus bruni species nov.—Figure 11

Type Specimen: 7 mm. male from the Gulf of Thailand collected by the Naga Expedition from a dredge haul in muddy sandy bottom in 28 meters of water. Naga Station 60-1021, Only one specimen in collection.

Description: Rostrum acute, in form of an equilateral triangle with concave sides, tip not reaching to end of first antennular article,

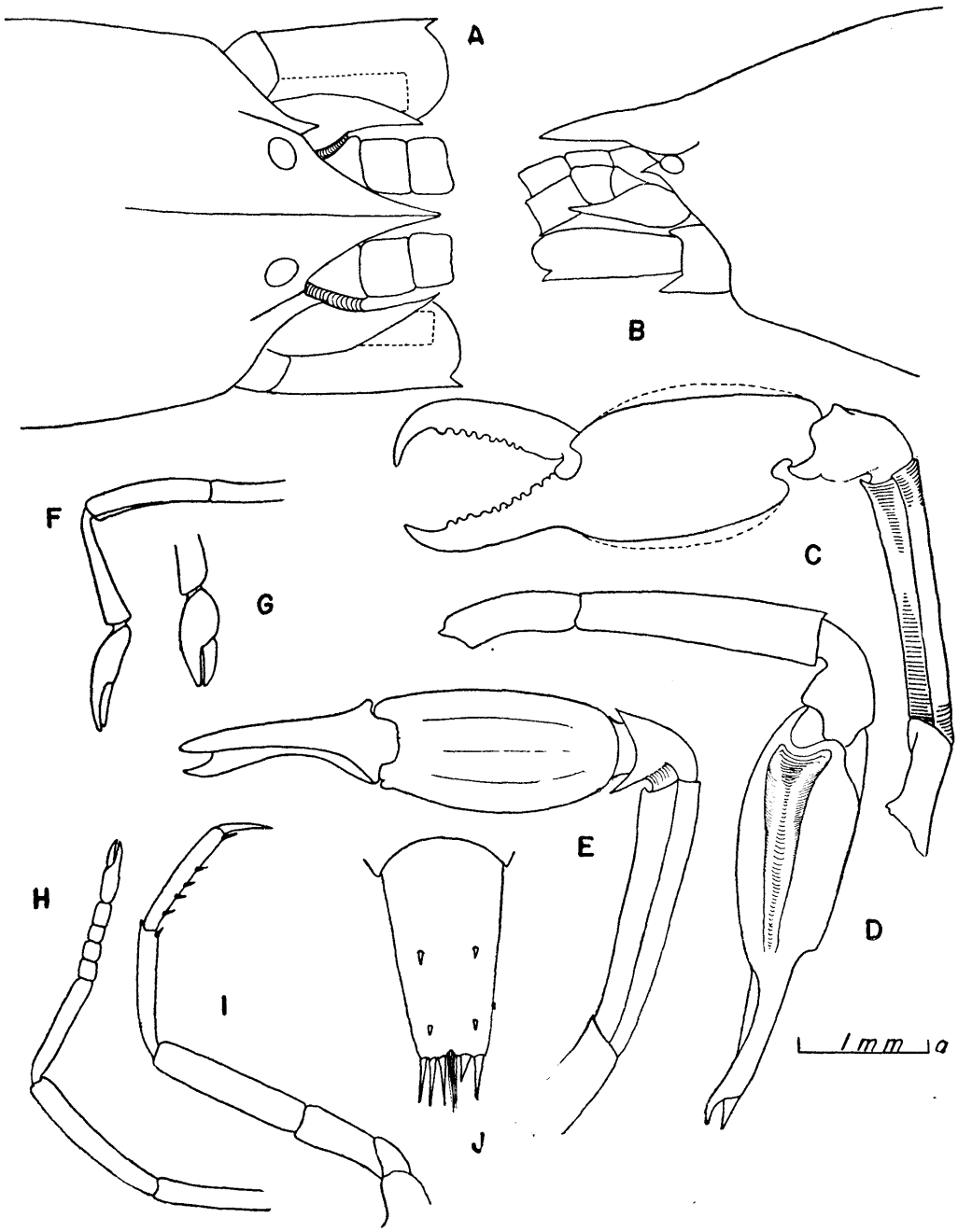

FIGURE 10

Salmoneus cristatus (Coutière). A, B, Anterior region, dorsal and lateral aspect; C, large cheliped, inner face; D, large cheliped, inferior face; E, large cheliped, superior face; F, G, small chelipeds; H, second leg, I, third leg; J, telson. (All drawings scale a).

without carina and appearing arched in lateral view. Orbital teeth small directed slightly inward and reaching ends of cornea of eyes with about half of corneas exposed.

Antennular articles subequal in length, second article 1.5 times as long as broad. Stylocerite reaching past middle of second antennular article. Scaphocerite with lateral margin straight. Lateral teeth equal to squamous portion and reaching to end of antennular peduncle. Carpocerite only a little longer than second antennular article. Lateral tooth on basicerite subacute.

Large chela with palm basically cylindrical, with inferior margin smooth, but with superior margin bearing a smooth crest and flanked by longitudinal grooves that extend three-fourths the length of chela. Medial surface, below longitudinal groove and proximal to dactylar articulation, bears a slight protrusion extending proximally to middle of palm. Fingers curved inward distally and bearing four strong obtuse teeth that intermesh; distal portions of fingers with narrow cutting ridge. Tip of dactylus acute, abruptly curved and crossing tip of fixed finger; fixed finger also acute but shorter and gradually curved. Carpus short, in the form of a three-lobed corolla. Merus slender, curved, nine times as long as broad at the distal end, more narrow in mid-section and slightly excavate to accommodate palm. Ischium 0.5 as long as merus, without spines.

Small cheliped as small as thoracic legs. Ischium slender, only slightly shorter than merus. Merus 7 times as long as broad. Carpus elongate, as long as merus and broadened distally. Chela 0.8 as long as carpus with fingers and palm almost equal in length.

Second leg longer than small cheliped, with ratio of carpal articles: 10:2:2:2:3.

Third leg slender. Ischium inermous, 0.6 as long as merus. Merus unarmed, 9 times as long as wide. Carpus 0.7 as long as merus and distally carrying obtuse projection on upper margin and one stiff seta on lower margin. Propodus a little longer than merus without spines but with scattered stiff setae. Dactylus thin, curved and elongate, 0.6 as long as carpus.

Telson 5 times as long as broad at posterior margin. Anterior margin 2.5 times wider than posterior margin. Tip with two long spines on either side of the middle. Middle section without notch and bearing two setiferous bristles which are longer than posterior spines.

Discussion: From all species of *Salmoneus* this species may be distinguished by the lack of any trace of posterior emargination on the telson thereby requiring a modification of the generic description of Coutière. However, similarity of all structures leave no doubt that this species is closely related to the other members of the genus. It appears to be most closely related to *S. serratidigitus* (Coutière) because of the similarity in the rostrum and rostral teeth and the serrate nature of the cutting edges of the dactyl of the large chela. However, in *S. serratidigitus* the teeth are acute and occur on the full length of the dactyl (Coutière, 1899, fig. 216). instead of being obtuse and located only in the proximal half as in our specimen; also in our specimen the merus of the large chela is more slender. Further the palm of the large chela in *S. serratidigitus* bears a similar protrusion to that of our specimen. From *S. mauiensis* (Edmondson), *S. brevirostris* (Edmondson), *S. cristatus* (Coutière), *S. hilarulu* (de Man) and *S. sibogae* (de Man) it may be distinguished by the more slender antennular articles as well as the lack of an emargination on the telson.

The species has been named in honor of Anton Brun, the director of the Naga Expedition.

SYNALPHEUS

Synalpheus Bate, 1888. Challenger Rpts. 24:572.

Type Species: *Synalpheus falcatus* Bate

Definition: Anterior portion of carapace with rostrum and orbital hoods which completely envelop eyes except on anteroventral side. Anterolateral margin of carapace produced as distinct pterygostomial angle or tooth.

Antennules with basal articles preponderant, stylocerites large and well formed. Antennular flagellum with weak bifurcation. Squamous portion of scaphocerite shorter than lateral spine. Basicerite bearing one or more teeth.

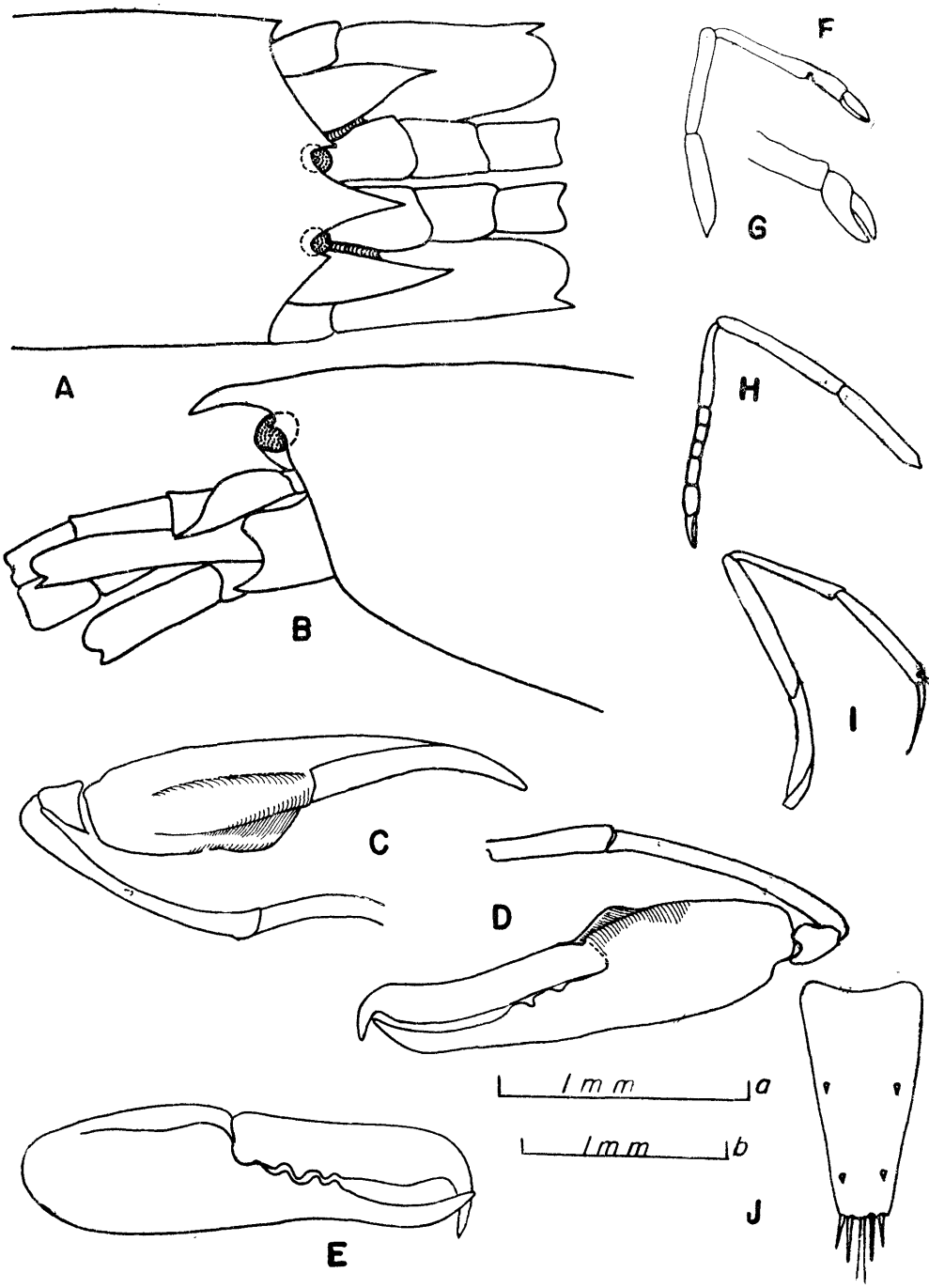

FIGURE 11

Salmoneus bruni sp. nov. A, B, Anterior region, dorsal and lateral aspect; C, large cheliped, superior aspect; D, large cheliped, outer face; E, large chela, inner face; F, G, small cheliped; H, second leg; I, third leg; J, telson. (A, B, J, scale a; C, D, E, F, G, H, I, scale b).

Large chela carried extended, entire and smooth, ovaloid, much larger than small chela; dactylus short, with cylindrical process that penetrates into corresponding cavity on fixed finger. Small chela simple, with fingers joining exactly, palm entire, carpus frequently elongate.

Second pereiopods with carpus composed of 4 or 5 articles. Following legs short and compressed. No anal tubercles.

Pleura of sixth abdominal segment not articulated. Telson entire, normal.

Branchial forumal: 5 pleurobranchs, 1 arthrobranch, 2 epipodites.

KEY TO THE SPECIES OF SYNALPHEUS IN MALAYO-THAI WATERS

1. Posterior lateral margins of telson projecting as teeth half as long as, to much longer than, adjacent spines 2
   Posterior lateral margins of telson either not projecting or at most as teeth much shorter than adjacent spines 3
2(1). Posterior lateral teeth of telson at most as long as adjacent spines . . . . . *S. acanthitelsonis* (p. 58)
   Posterior lateral teeth of telson many times longer than adjacent spines . . . . . *S. thai* (p. 61)
3(1). Merus of third leg armed with movable spinules 4
   Merus of third leg without movable spinules 7
4(3). Superior unguis of dactylus of third legs markedly shorter than inferior . . . . . *S. gravieri* (p. 48)
   Superior unguis of dactylus of third leg either equal in length to or longer than inferior 5
5(4). Superior unguis of dactylus of third leg equal in length but thinner than inferior . . . . . *S. streptodactylus streptodactylus* (p. 50)
   Superior unguis of dactylus of third leg longer and thicker than inferior 6
6(5). Palm of large chela bearing two round teeth above dactylar articulation . . . . . *S. bituberculatus* (p. 66)
   Palm of large chela bearing a single rounded tooth above dactylar articulation . . . . . *S. pachymeris* (p. 65)
7(3). Dactylus of third leg with three ungui 8
   Dactylus of third leg biunguiculate 9

8(7). Inferior unguis of dactylus of third legs strong and acute; carpocerite shorter than scaphocerite . . . . . *S. bakeri stormi* (p. 53)
Inferior unguis of dactylus of third legs low and obtuse; carpocerite markedly longer than scaphocerite . . . . . *S. heroni* (p. 55)

9(7). Propodus of third leg with more than 10 spinules; merus with distal inferior tooth . . . . . *S. stimpsoni* (p. 46)
Propodus of third leg with 6-8 spinules; merus unarmed 10

10(9). Dactylus of small chela laterally broadened and flattened with tip recessed to accommodate tooth on tip of fixed finger . . . . . *S. laticeps* (p. 68)
Dactylus of small chela rounded or subconical but not laterally broadened; tip normal 11

11(10). Superior angle of basicerite only slightly projecting and rounded 12
Superior angle of basicerite projecting as a strong and acute tooth 13

12(11). Rostrum not reaching to one-third the length of visible portion of first antennular article; medial portion of tip of telson almost a semicircle . . . . . *Synalpheus* near *theano* (p. 72)
Rostrum reaching about two-thirds length of visible portion of first antennular article; medial portion of tip of telson a shallow arc . . . . . *S. theano* (p. 69)

13(11). Palm of large chela bearing a heavy acute tooth above dactylar articulation at angle of about 30° to palm; inferior unguis of dactylus of third leg almost parallel to superior unguis . . . . . *S. coutierei* (p. 62)
Palm of large chela either rounded above dactylar articulation or bearing slight acute tooth which continues line of superior margin; inferior unguis of dactylus of third leg diverging at about 60° from superior unguis . . . . . *S. tumidomanus* (p. 56)

Synalpheus stimpsoni (de Man)–Figure 12

Alpheus stimpsoni de Man, 1888b. Arch. F. Naturgesch. 53(1): 513, pl. 22, fig. 3.

Synalpheus consobrinus de Man, 1909a. V. Ned. Dierk. Ver., Tijdschr. 11(2):111; 1911. Siboga Exped. 39a^1(2):204, fig. 21.

Specimen Drawn : 21 mm. male from Phuket (BR 38a).

Description : Rostrum broadly triangular, concave lateral margins, slender acute tip reaching to end of first antennular article

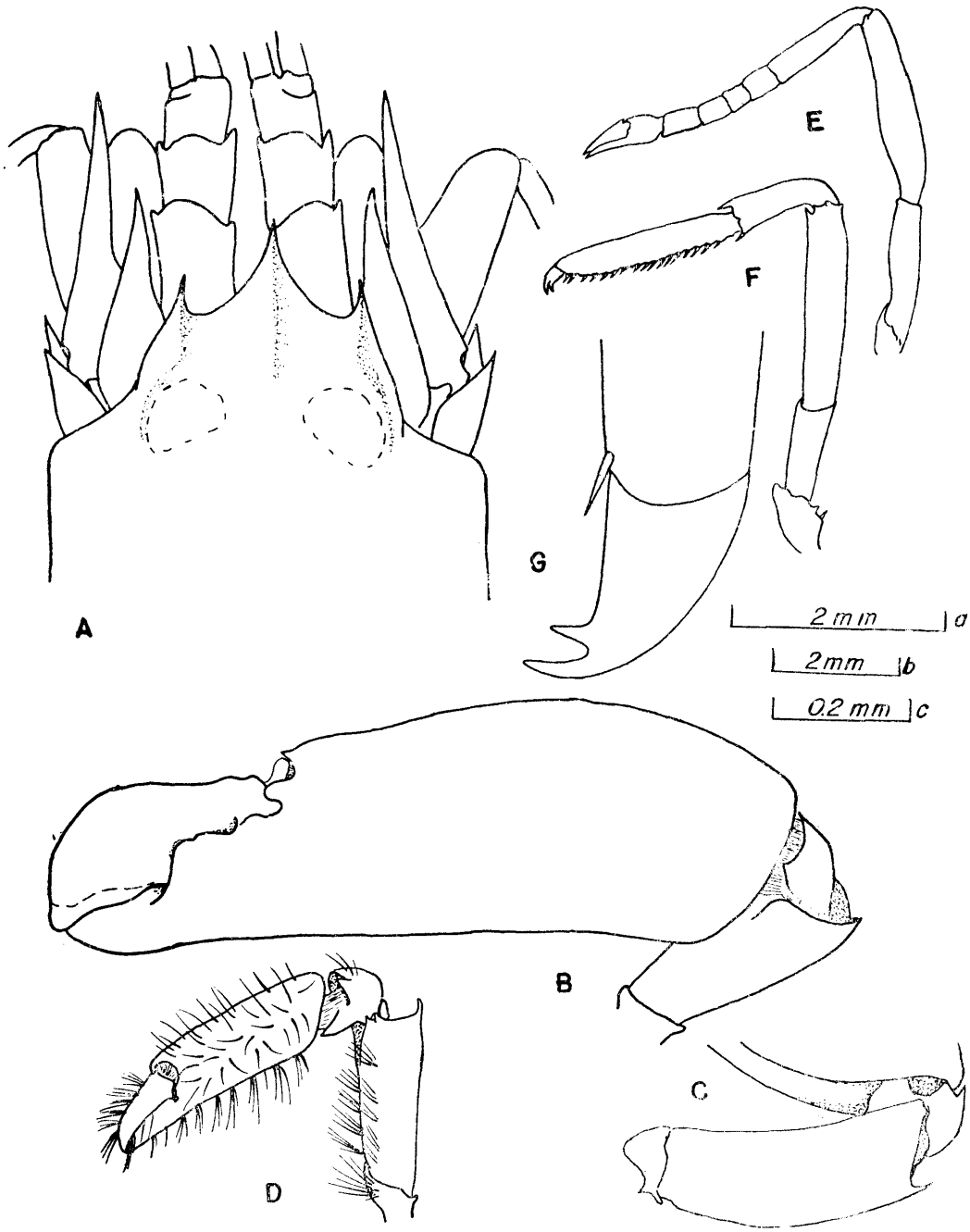

FIGURE 12

Synalpheus stimpsonii (de Man). A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, merus large chela; D, small cheliped, inner face; E, second leg; F, third leg; G, dactylus. (A, scale a; B, C, D, E, F, scale b; G, scale c).

and with slight carina reaching to middle of eyes. Orbital teeth slender, much longer than broad at base, with axis parallel to that of rostrum; half as long as rostrum.

Visible part of first antennular article 1.5 as long as second article, third article shorter than second; second article as long as broad. Stylocerite acute, reaching beyond end of first antennular article. Scaphocerite with lateral margins straight, tip reaching to end of antennular peduncle; squamous portion shorter, reaching past end of second antennular article. Lateral spine of basicerite shorter than usual, broad at base, not reaching to level of tips of orbital teeth. Superior spine parallel to lateral spine, about one third as long.

Large chela sub-cylindrical, 3.3 times as long as broad with fingers occupying distal 0.3. Palm slightly constricted proximal to dactylus and bearing acute tooth above dactylar articulation and a prominent rounded projection on inner side below acute tooth. Merus 2.8 as long as broad, distally bearing acute inward curving tooth on superior margin and small acute tooth on inferior internal margin.

Small chela 3.8 times as long as broad, fingers conical, shorter than palm, outer surface of chela somewhat hirsute. Merus 3 times as long as broad bearing tufts of long hairs and small acute tooth distally on both inferior internal and superior margin.

Second leg with ratio: 10:2:2:2:3.

Third leg slender and covered with moderately thick setae on all articles save the ischium. Ischium inermous, 0.4 as long as merus. Merus 5.2 times as long as wide, bearing small acute tooth distally on inferior margin. Carpus 1.5 times as long as merus bearing distally strong tooth on superior margin and movable spinule on inferior margin. Propodus almost as long as merus, 6 times as long as broad, bearing on inferior surface 5 pairs of movable spinules and 9 single spinules. Dactylus biunguiculate 0.3 as long as carpus; superior hook one-third longer than inferior and broader at its base; inferior unguis directed at right angle to propodus.

Telson 2.7 times as long as posterior margin is broad. Anterior margin 2.2 times wider than posterior.

Thai specimens reaching up to 21 mm. in length.

Discussion : This species does vary in some characteristics. In death the position of the rostral front varies in the angle it makes to the antennular peduncle, causing a difference in the relative length of the visible part of the first article to the second. In two specimens there was a small obtuse tooth near the end of the external part of the cutting edge of the dactylus of the large chela. This characteristic also occured in the closely related species de Man called *S. consobrinus.* In a future paper using a larger number of specimens we will show that *S. consobrinus* is a synonym of *S. stimpsoni.*

Distribution : Our specimens were found at Phuket and Singapore where they were living commensally on a comatulid crinoid. Other species of this group are also found to be commensal with crinoids. Collection data : 2 specimens from BR 38; 6, BR 43.

De Man's original specimen was collected at Amboina. It has also been collected in the Torres Strait. We have found specimens in the Marshall ank Gilbert Islands.

Synalpheus gravieri Coutière–Figure 13

Synalpheus gravieri Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):870, pl. 70, fig. 2. Pearson, 1905. Pearl Oyster Fish. 4(24):82; 1911. Spolia Zeylandica 7(28):173. De Man, 1911. Siboga Exped. $39a^1$(2):216, pl. 6, fig. 25.

Alpheus prolificus Ortmann, 1890. Zool. Jahrb. 5:484.

Specimen Drawn : 16 mm. male from Naga Station 60-563.

Description : Rostrum awl-shaped, a little longer than first antennular article. Orbital teeth acute, as long as rostrum, 1.5 times as long as broad at base, with axis parallel to that of rostrum. Both teeth and rostrum somewhat upturned in lateral view. Orbital hoods only slightly inflated.

Second antennular article 1.5 times as long as broad, equal to visible part of first; third article 0.6 as long as second. Distal end of articles bearing heavy setae. Stylocerite reaching to middle of second antennular article, tip tilted upward and bearing a few setae. Scaphocerite with outer margin concave, tip reaching just beyond antennular

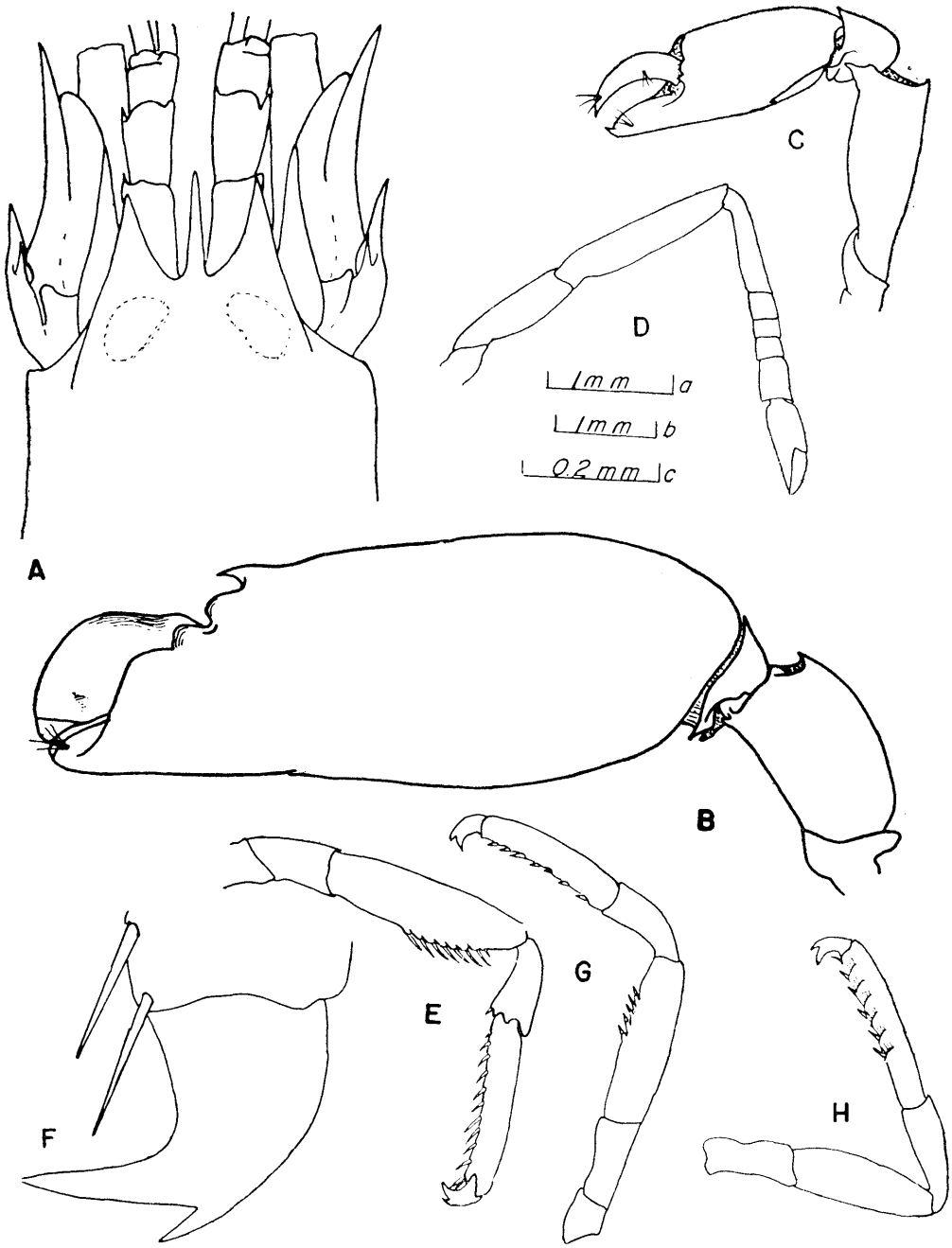

FIGURE 13

Synalpheus gravieri Coutière. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, small cheliped, inner face; D, second leg; E, third leg, F, dactylus; G, fourth leg; H, fifth leg. (A, scale a; B, C, D, E, G, H, scale b; F, scale c).

peduncle; squamous portion somewhat reduced. Inferior tooth of basicerite heavy and reaching to level of end of first antennular article. Upper tooth acute and reaching half the length of inferior tooth.

Large chela cylindrical, 2.8 times as long as broad, with fingers occupying the distal 0.2, bearing strong acute tooth above dactylar articulation. Dactylus strongly arcuate, tip not crossing that of fixed finger. Carpus bearing a strong, forward directed tooth on outer margin just proximal to inferior margin of chela. Merus 1.5 times as long as wide bearing very small tooth terminally on both the superior and internal margins.

Small chela cylindrical, 2.7 times as long as broad with fingers occupying distal 0.3. Finger with strong tufts of setae. Carpus almost as long as fingers. Merus 2.7 times as long as broad, bearing small tooth distally on inferior internal margin.

Carpal article of second leg with ratio : 10:2.6:2:2:4.

Third leg with ischium unarmed, 0.4 as long as merus. Merus 3.6 times as long as broad, bearing on inferior margin 6-8 strong movable spinules medially, distal end without tooth. Carpus as long as ischium, carrying a small spine on the distal end of its inferior margin; superior margin projecting but rounded. Propodus a little shorter than merus and bearing on its inferior margin 11 spinules. Dactylus biunguiculate, 0.6 as long as carpus. Inferior hook almost 3 times as long as wide at base, strongly curved and lying at 90° angle to axis of base of article. Superior hook short, about one-fourth as long as ventral, about 2.5 times as long as broad at its base.

Telson a little longer than wide at anterior end, 2 times as wide anteriorly as at posterior end. Outer angles acute, posterior margin strongly arcuate.

Discussion : Our specimens agree well with Coutière's description and de Man's later remarks with few exceptions. Coutière (1905:870, fig. 2) states that the scaphocerite is shorter than the carpocerite but in ours they are almost equal. Our specimens agree with de Man's in that the superior unguis on the dactyl of the third thoracic leg is a little thicker at its base than that shown by Coutière.

The small chela is stouter in our specimens, being 2.7 times as long as wide instead of 4.0.

This species might at first glance be confused with *Synalpheus streptodactylus streptodactylus* Coutière. The chelae and the rostral front are alike but the dactylus of the third leg is entirely different. In *S. gravieri* the superior unguis is at most 1/3 as long as the inferior unguis and in *S. s. streptodactylus* it is at least two thirds as long. Furthermore the inferior unguis is much broader in relation to the superior unguis in *S. gravieri*.

Distribution : The 2 specimens in our collection were taken in the Gulf of Thailand by the Naga Expedition in 25 meters of water on a muddy sandy bottom. 1 specimen from station 60-563 and 1, 59-131 (18 mm. in length).

Specimens have been reported from the Maldive and Laccadive Archipelago, from Indonesia and from Japan.

Synalpheus streptodactylus streptodactylus Coutière—Figure 14

Synalpheus neomeris streptodactylus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):870, pl. 70, fig. 1.

Synalpheus neomeris de Man, 1897. Zool. Jahrb. 9:734 [partim]. 1902. Sencken. Naturf. Gesell., Abhandl. 25:891.

Synalpheus streptodactylus de Man, 1911. Siboga Exped. 39a[1] (2):226, pl. 7, fig. 26.

Synalpheus metaneomeris streptodactylus Coutière, 1921. Linn. Soc. Zool., Journ. 17(4):414, pl. 60, fig. 4.

Synalpheus streptodactylus streptodactylus Banner and Banner, 1966. Pacific Sci. [in press].

Specimen Drawn : 8 mm. male from Koh Saak on the eastern side of the Gulf of Thailand (BR 7). Third leg from female specimen from same collection.

Description : Rostrum narrow and acute, reaching to end of antennular peduncles. Orbital teeth much broader at base than rostrum but not as long. Depression between rostrum and orbital hoods not extensive, but lateral margin of rostral base so abrupt that rostrum in dorsal view appears separated from anterior carapace.

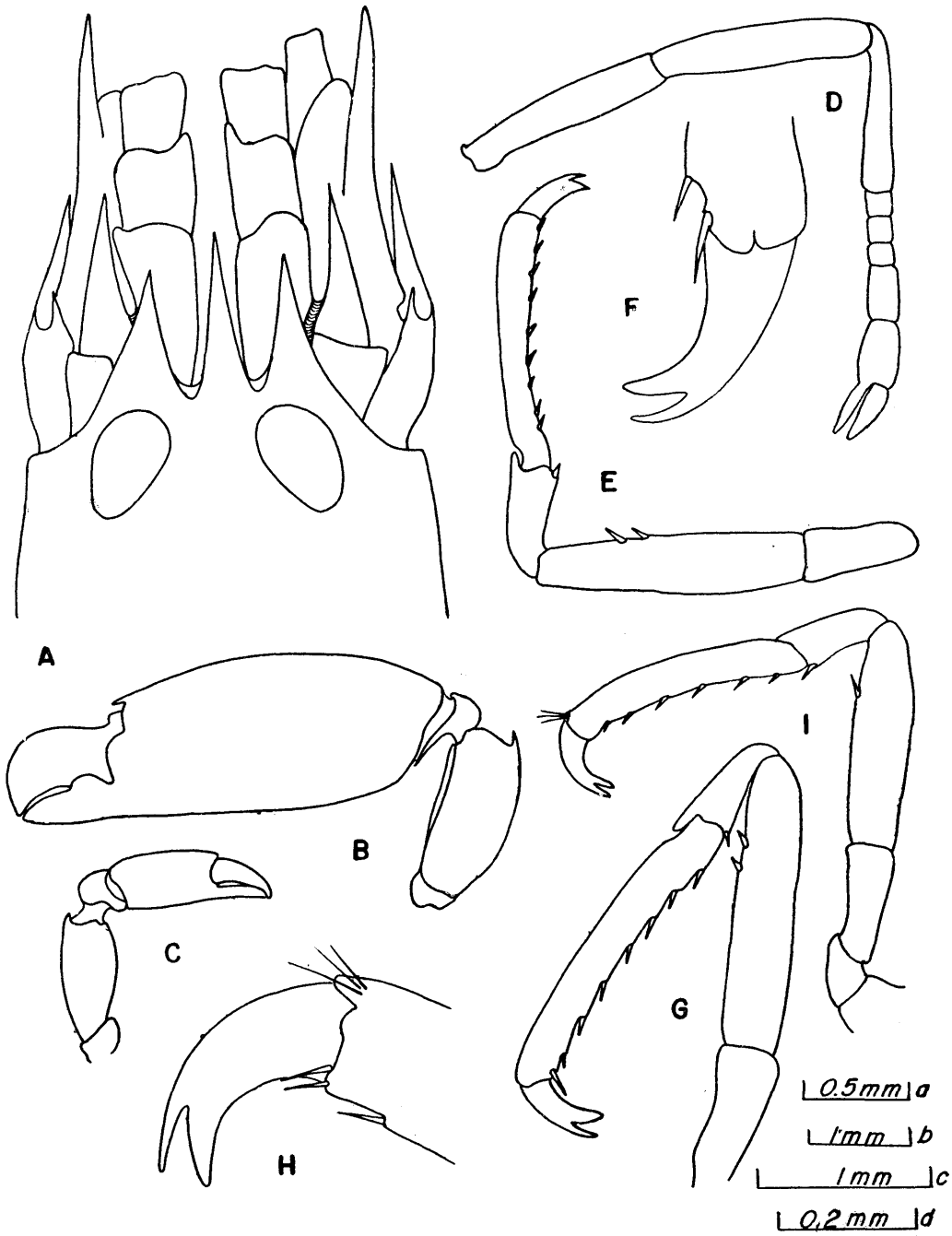

FIGURE 14

Synalpheus streptodactylus streptodactylus Coutière. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, small cheliped, inner face; D, second leg; E, third leg; F, dactylus; G, third leg; H, dactylus; I, third leg. (A, scale a; B, C, scale b; D, E, G, I, scale c; F, H, scale d).

Visible part of first article of antennular peduncle 1.5 times longer than second article; second article slightly longer than broad; third article almost equal in length to second. Stylocerite acute, reaching to middle of second antennular article. Scaphocerite with slender lateral spine reaching well beyond end of antennular peduncle; squamous portion shorter, reaching only to end of antennular peduncle. Carpocerite almost as long as scaphocerite. Lateral tooth of basicerite as long as stylocerite; upper angle produced into small acute tooth reaching about middle of visible part of first antennular article.

Large chela only slightly compressed, 2.9 times as long as broad with fingers occupying distal 0.2. Merus curved, 2.4 times as long as broad with superior margin projecting as an acute tooth, inferior margin without spines or teeth.

Small chela 0.3 length of large chela. Chela 3 times as long as broad, with fingers shorter than palm. Merus similar in form to that of large chela.

Ratio of carpal articles of second leg:10:1:1:1:3.

Ischium of third leg unarmed, 0.4 as long as merus. Merus of third leg 4.6 times as long as broad, with inferior margin bearing 2-5 spines near middle, none terminally. Carpus 0.3 as long as merus, distal end of upper margin terminating in an obtuse tooth, inferior distal margin bearing one small spine. Propodus only a little shorter than merus, 8 times as long as broad, carrying on its inferior margin 7 spines. Dactylus biunguiculate, 0.2 as long as propodus. Inferior unguis 2 times as thick at base as superior unguis, but almost as long. Fourth leg usually with 2 spines on merus and fifth leg with merus inermous.

Telson 2.2 times as long as broad at posterior margin. Anterior margin 1.7 times wider than posterior margin, outer angles acute.

Thai specimens reaching to 11 mm. in length.

Discussion : This species varies on a few points. The rostrum may occassionally reach to the middle of the second antennular article and be sometimes longer in relation to the orbital teeth than

the one figured. The visible part of the first antennular article varies from 1.3 to 2.0 times as long as the second article, and the third article may be sometimes shorter than the second.

The superior unguis of the dactylus of the third leg varies from 2/3 as long as inferior to equal, and the thickness of the base of the superior unguis may be thinner in relation to the base of the inferior unguis than has been previously described (see fig. 14).

This species seems most closely related to *Synalpheus neomeris* de Man, the differences in the two species are shown in Table IV.

TABLE IV

Comparison of *S. neomeris* and *S. s. streptodactylus*

S. neomeris de Man	*S. streptodactylus streptodactylus* Coutière
1. Second antennular article a little shorter than visible part of first.	1. First antennular article almost 1.5 longer than second; third article subequal to second.
2. Scaphocerite shorter than carpocerite, equal to antennular peduncle.	2. Scaphocerite and carpocerite subequal, much longer than antennular peduncle.
3. Small chela 3.4-4.3 times as long as wide.	3. Small chela 2.9-3.2 times as long as wide.
4. Dactylus of third leg with superior hook 1/3 as thick as inferior hook at base; superior hook at most 1/2 length of ventral hook.	4. Dactylus of third leg with superior hook 1/2 as thick as inferior hook at base; superior hook 2/3 as long as inferior hook.
5. Telson 3.7 times as long as posterior margin is broad.	5. Telson 2.9 times as long as posterior margin is broad.

As these differences appear to be minor and variable, we measured and studied a number of our specimens in an attempt to ascertain if the two species were truly separate. However, neither in our series of 81 specimens, nor, evidently, in de Man's series of 33 specimens was there any truly intermediate forms. We must presume that *S. s. streptodactylus* is validly separated from *S. neomeris*. A similar

study (Banner and Banner 1966 : in press) shows the separation between *S. s. streptodactylus* and *S. s. hadrungus* (= *S. metaneomeris streptodactylus* Coutière, 1921), a separation based solely upon the characteristics of the dactyls of the third leg, also to be valid.

Distribution : Our specimens were collected from both side of the Gulf of Thailand and from Singapore. They were found in dead coral heads in water up to 5 meters deep. A few were associated with sponges. The Naga specimens were collected with a trawl in water up to 30 meters deep.

Locality data : 1 specimen from BR 3; 18, BR 5; 2, BR 10; 6, BR 11; 6, BR 12; 5, BR 13; 6, BR 16; 16, BR 18; 8, BR 22; 6, BR 23; 2, BR 27; 1, BR 27a; 1, BR 28; 2, BR 43. From the Naga Expedition : 30 specimens from 60-895; 2, 60-175; 36, 60-845.

Specimens have been found in the Red Sea and in the Indian Ocean to as far east as Indonesia. In the Pacific we have found it in Tonga, Samoa and Hawaii. In Hawaii the subspecies is found in the spongocoel of a large sponge (*Zygomycale parishei* (Bowerband)) as well as in dead coral.

Synalpheus bakeri stormi de Man--Figure 15

Alpheus sp., varietas B. de Man 1897. Zool. Jahrb. 9:741, pl. 35, fig. 62c, 62cc.

Synalpheus bakeri Coutière, 1908. Soc. Philomath. Paris, Bull. 11(5):199.

Synalpheus bakeri stormi de Man, 1911. Siboga Exped. 39a^1(2): 253, pl. 9, fig. 40.

Specimen Drawn : 11 mm. male from Phuket (BR 41).

Description : Rostrum slender, 3.5 times as long as broad at base, tip reaching to end of first antennular article. Orbital teeth acute, reaching to middle of visible part of first antennular article. Rostrum and orbital teeth parallel, acute and bearing a few setae at tips.

Second antennular article 2 times as long as wide, 0.6 as long as visible part of first, 1.5 times length of third article. Stylocerite reaching well past middle of second antennular article. Scaphocerite

with lateral margin slightly concave, spine reaching slightly beyond antennular peduncle. Carpocerite a little shorter than lateral spine of scaphocerite. Inferior spine of basicerite reaching to first half of second antennular article; superior spine acute and reaching to near end of orbital teeth.

Large chela inflated, 2.6 times as long as broad, with fingers one quarter length of entire chela. Merus 2.4 as long as wide, with acute projection on superior margin. Inferior internal margin with rounded prominence on distal end.

Small chela 3.8 times as long as broad, with palm 1.5 times longer than fingers. Merus similar to large chela with acute distal tooth on superior margin.

Ratio of carpal articles of second leg : 10:1:1:1:4.

Ischium of third legs 0.3 of merus, unarmed, merus also inermous, 4.5 times as long as broad. Carpus 0.4 as long as merus, superior distal margin projecting as strong, sub-acute tooth and inferior distal margin bearing heavy movable spinule. Propodus slender, as long as merus, carrying on its inferior margin 6 movable spines and 2 distally. Dactylus 0.6 as long as carpus, triunguiculate. Middle unguis thickest, 1.5 times as long as thick at base and curved to make obtuse angle with longitudinal axis of article. Proximal hook parallel to middle hook but much shorter. Distal hook 3.0 times as long as broad at base and equal in length to middle hook.

The telson is 2.3 times as long as broad at its posterior end, with tip strongly arcuate. Anterior end 1.5 times wider than posteior.

Discussion : Our specimens agree very well with de Man's description and figures. This species can be separated from *S. heroni* Coutière, the only other species in Thai waters bearing a triunguiculate dactylus on the third leg by the fact that in this species the proximal hook is longer and that this has a much longer scaphocerite.

The subspecies was separated from the parent species by a longer and more slender rostrum and by a more slender merus of the third leg.

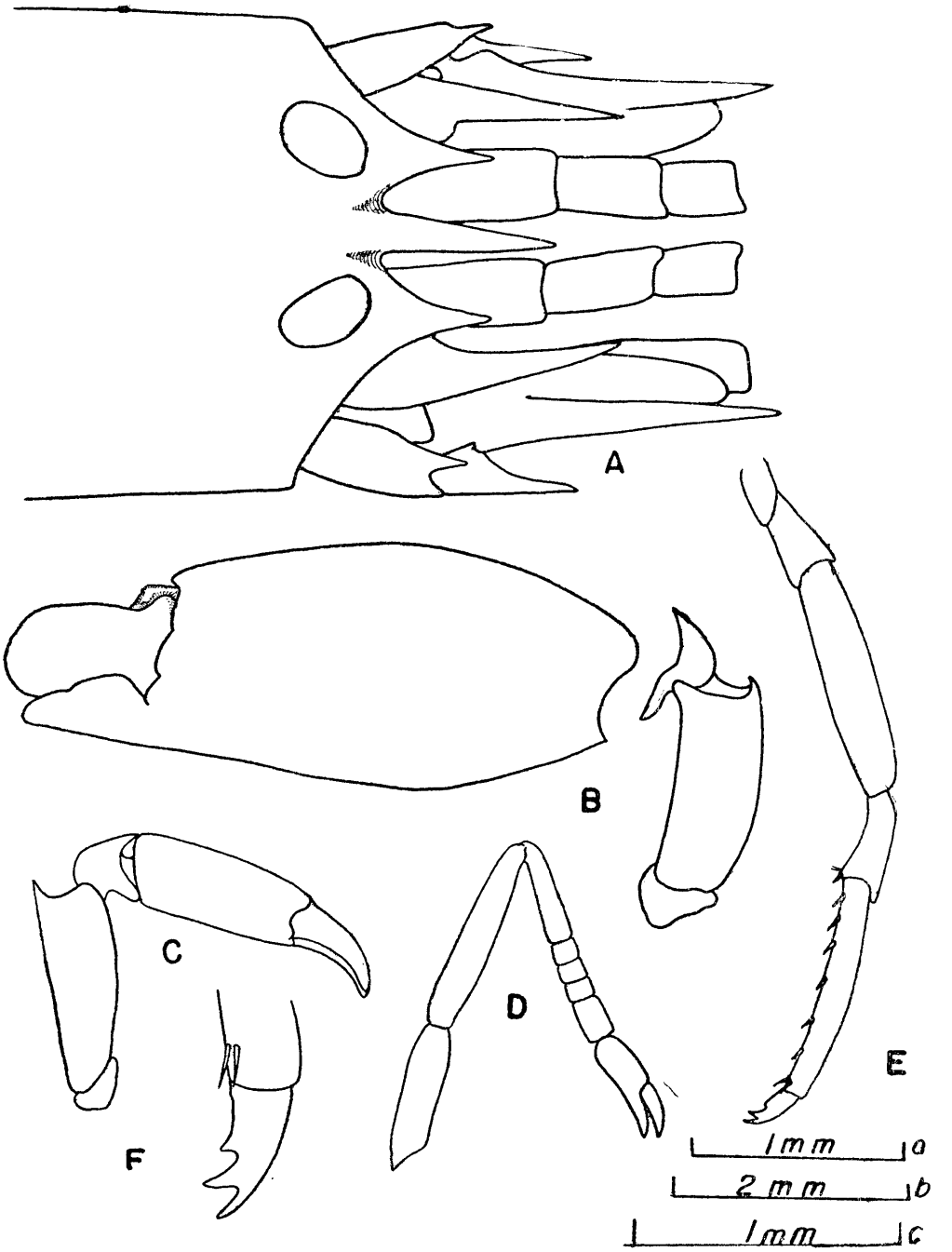

FIGURE 15

Synalpheus bakeri stormi de Man. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, small cheliped, inner face; D, second leg; E, third leg; F, dactylus. (A, scale a; B, C, D, E, scale b; F, scale c).

Distribution: We have only 2 specimens, a male and an ovigerous female from Phuket (BR 41) collected from head of dead coral in almost 3.0 meters of water.

De Man's specimens were collected in Indonesia and the only other report of their capture was from South Australia.

Synalpheus heroni Coutière—Figure 16

Synalpheus heroni Coutière. 1909, U.S. Nat. Mus., Proc. 36 (1659):42, fig. 24. De Man 1911. Siboga Exped. $39a^1$(2): 256, fig. 41.

Specimen Drawn: 8 mm. male from the Indian Ocean at Phuket, Thailand (BR 38), only specimen collected.

Description: Rostrum narrow, acute, reaching past middle of visible part of first antennular article. Orbital hoods slightly inflated; orbital teeth acute, almost as long as rostrum but broader at base.

Second antennular article 0.6 as long as visible part of first and 1.3 times as long as broad; third antennular article 0.6 as long as second. Tooth of stylocerite reaching to near middle of second antennular article. Inferior lateral spine of basicerite almost as long as stylocerite; superior spine acute, slightly longer than rostrum. Scaphocerite with lateral spine reaching slightly beyond end of antennular peduncle, squamous portion narrow, reaching to middle of third antennular article. Carpocerite much longer than antennular peduncle.

Large chela only slightly compressed, margins rounded, 2.6 times as long as broad, with fingers occupying 0.3 of total length. Palm bearing low, rounded tubercle above dactylar articulation. Dactylus heavy, with curved acute tip crossing beyond tip of fixed finger. Merus 1.8 times as long as broad, unarmed.

Small chela 3.2 times longer than broad, palm 1.4 times longer than fingers. Superior margin of dactylus bearing about 9 stiff setae. Palm bearing sparse but heavy setae. Merus a little shorter than chela, 3.6 times as long as broad, inermous.

Carpal articles of second leg with ratio: 10:2:2:2:4.

Third leg with merus 3.6 times as long as broad, with inferior margin projecting as rounded tooth. Carpus 0.3 as long as merus, superior margin ending in acute tooth, inferior distal end bearing single movable spine. Propodus almost as long as merus, 6 times as long as broad, inferior margin bearing 8 movable spinules. Dactylus triunguiculate, 0.2 as long as propodus. Distal unguis twice as long as thick at its base, sharply curved; middle hook equal in length to distal, a little thicker at its base and curved to lie at right angles to inferior margin of article; proximal unguis projecting only slightly, forming merely an obtuse angle.

Telson 2.2 times as long as distal margin is broad; proximal margin 2 times wider than distal.

Discussion: Our one specimen agrees well with Coutière's original description. The only other specimen in Thai waters with a triunguiculate dactylus on the third leg is *S. bakeri stormi* but it can be separated from this species by the fact than in this the proximal unguis is much smaller, in fact, it is often difficult to see.

Distribution: Coutière's specimen was collected at Djibouti; de Man reported specimens from Indonesia and it has also been reported from the Red Sea. In our previous Thai collection we had several specimens, but we cannot recall the collection data for them.

Synalpheus tumidomanus (Paulson)—Figure 17

Alpheus tumidomanus Paulson, 1875. Invest. Crust. Red Sea. (1):101, pl. 13, fig. 2.

Synalpheus tumidomanus Coutière, 1909. U.S. Nat. Mus., Proc. 36(1659):24, fig. 5. De Man, 1911. Siboga Exped. $39a^1(2)$: 258, fig. 43.

Specimen Drawn: A 13 mm. male from Koh Saak (BR 7).

Description: Rostrum narrow, acute, reaching to end of first antennular article. Orbital hoods produced into teeth that reach almost to end of rostrum. Depression between rostrum and orbital hoods not extensive, but lateral margins of rostral base so abrupt that rostrum appears separated from anterior carapace in dorsal view.

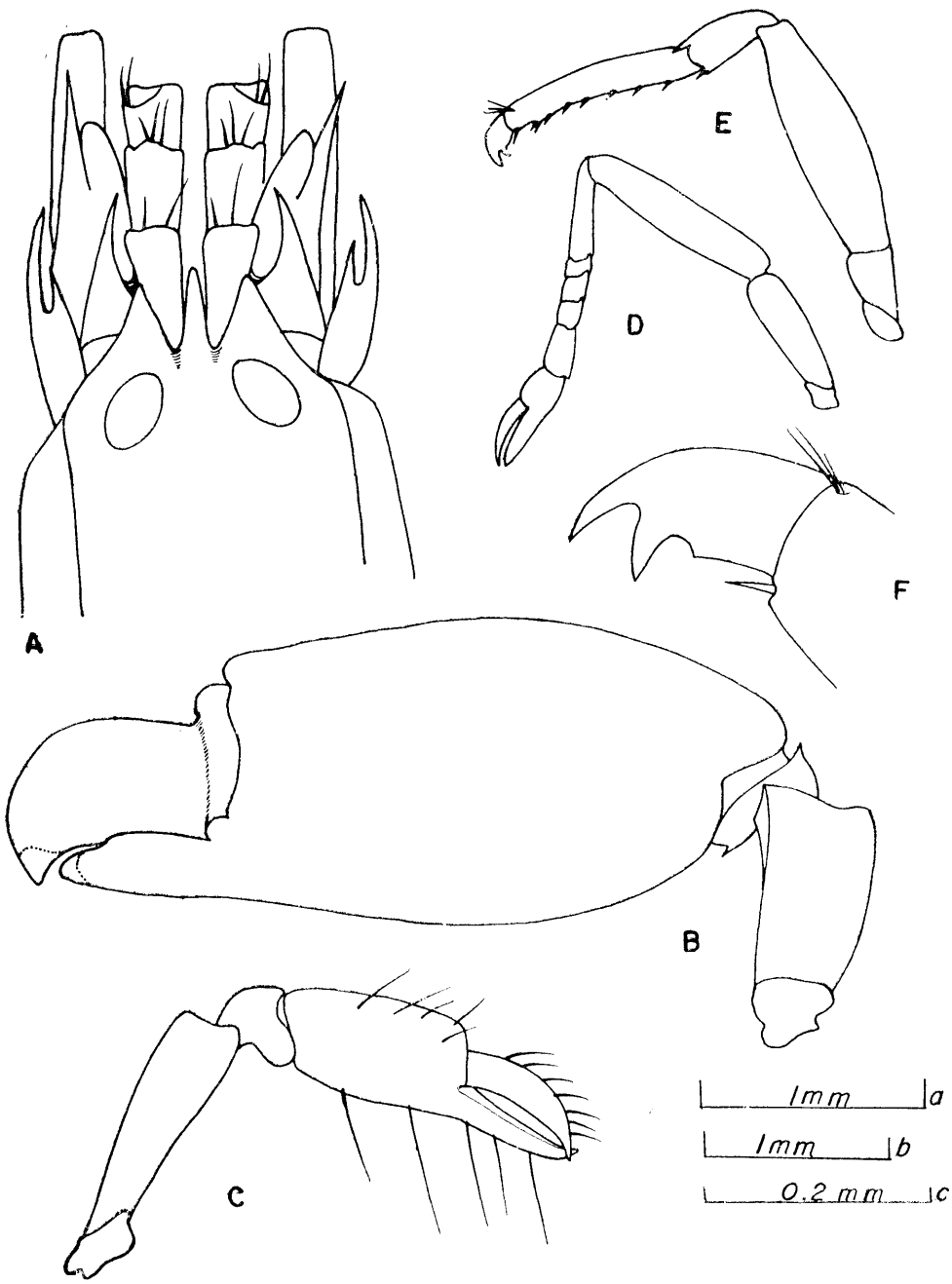

FIGURE 16

Synalpheus heroni Coutière. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, small cheliped, inner face; D, second leg; E, third leg; F, dactylus, (A, B, C, scale a; D, E, scale b; F, scale c).

Visible part of first antennular article 1.5 times longer than second article; second article a little longer than wide, third article 0.5 as long as visible part of first. Stylocerite reaching to end of second antennular article. Scaphocerite with outer margin straight; lateral spine reaching well past end of antennular peduncle, but with squamous portion reaching only to end. Carpocerite a little longer than antennular peduncle. Inferior spine of basicerite reaching to end of first antennular article, upper angle of basicerite acute, one third as long as inferior spine.

Large chela slightly compressed, 3.3 times as long as broad with fingers occupying distal 0.3. Projection of superior margin of palm above dactylar articulation varying from slight rounded protrusion to acute spine. Merus 2.6 times as long as wide, with superior margin terminating in an acute tooth.

Small chela 3.4 times as long as broad, with palm a little longer than fingers. Merus 2.3 times longer than wide, with terminal tooth of superior margin similar to large chela.

Second leg with ratio of carpal aritcles: 10:1:1:1:3

Ischium of third leg 2 times as long as broad, unarmed. Merus 4.6 times as long as broad, inermous. Carpus 0.4 as long as merus, superior margin terminating in a strong subacute tooth, inferior margin distally carrying movable spine. Propodus as long as merus, but much more slender, carrying on its inferior and distal margin 6 spines. Dactylus 0.6 as long as carpus, biunguiculate, superior unguis usually longer than inferior, and a little thicker at base, margin between ungui "U"-shaped.

Telson as long as broad at base, posterior margin half as broad as anterior margin. Posterior lateral angles acute, posterior margin deeply arcuate.

Discussion: This species is exceedingly variable and in a future paper we will discuss our findings on a large number of specimens and will place 4 species in synonymy. In the Thai specimens the main points of variation are: 1. The difference in the length of the protrusion at the end of the palm of the large chela, mentioned above (see fig. 17 B, C). 2. The superior spine of the basicerite, which

varies from a sharp angle to a strong tooth. 3. The outer angles of the telson, which vary in length but never approach the length found in *S. hastilicrassus* Coutière. 4. The dactylus of the third legs, in which the superior unguis is usually longer but at times is equal to, the inferior.

Thai specimens reaching 14 mm. in length.

Distribution: This species was found in heads of dead coral at almost all collecting sites in the Gulf of Thailand and in Phuket. Specimens were also found living commensally with a brittle star and a sponge.

Locality data: 5 specimens from BR 5; 1, BR 11c; 5, BR 12; 1, BR 15; 1, BR 16; 8, BR 18; 22, BR 23; 1, BR 26; 5, BR 27; 2, BR 28; 16, BR 31; 6, BR 34; 1, BR 35; 11, BR 38; 4, BR 41; 4, BR 43; 4, SU II; 1, Naga Sta. 60-885.

As there has been so much confusion in the literature on the identity and nomenclature of this species it is difficult to ascertain its range. Paulson's original specimen came from the Red Sea. We have collected if from many Pacific Islands including the Marshalls, the Phoenix, and Samoa.

Synalpheus acanthitelsonis Coutière–Figure 18

Synalpheus acanthitelsonis Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):875, pl. 72, fig. 13.

Specimens Drawn: A 13 mm. male from BR 26 and 10 mm. male from BR 5.

Description: Rostrum awl-shaped, almost 5 times as long as broad at base, reaching at least to end of second antennular article. Orbital teeth broad and short, 2.3 times as long as broad at the base, reaching to middle of second antennular article. Both rostrum and teeth bearing setae on tips and slightly tilted upward when seen in lateral view.

Ratio of visible part of first antennular article and two succeeding articles as 10:8:7. Second antennular article 1.5 times as long as broad. Stylocerite acute, longer than orbital teeth.

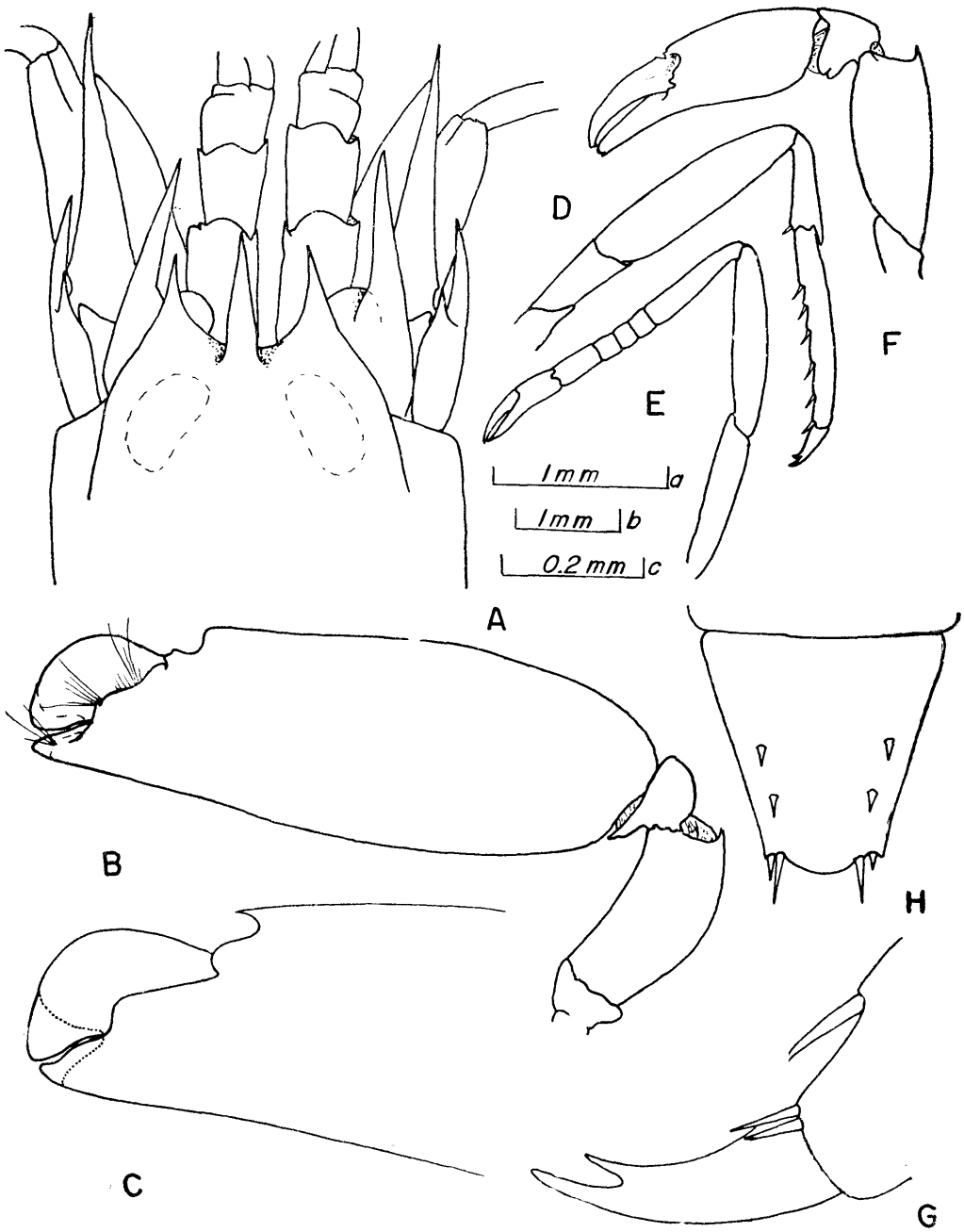

FIGURE 17

Synalpheus tumidomanus (Paulson). A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, distal end of large chela of a different specimen; D, small cheliped; E, second leg; F, third leg; G, dactylus; H, telson. (A, C, H, scale a; B, D, E, F, scale b; G, scale c).

Scaphocerite with lateral margin straight, lateral spine reaching well beyond end of antennular peduncle. Carpocerite a little longer than scaphocerite. Inferior spine of basicerite reaching to level of tip of rostrum. Superior spine present or not; if present, reaching to middle of orbital teeth.

Large chela 3.6 times as long as broad, fingers occupying 0.3 of total length. Palm terminating in rounded tooth above dactylar articulation. Merus 2.3 times as long as broad; inferior internal margin terminating in a small obtuse tooth; superior margin with or without short, inward-curving, acute tooth.

Small chela 3 times as long as wide with fingers occupying distal 0.4. Merus 3 times as long as wide. Inferior margin inermous. Distal end of superior margin either with or without short, inward-curving, acute tooth.

Second leg with ratio of carpal articles as:10:1:1:1:3.

Third leg with ischium unarmed. Merus inermous, 4.5 times as long as broad. Carpus 0.3 as long as merus and armed distally on superior margin with a subacute tooth and on inferior margin with movable spine. Propodus as long as merus, bearing 9 spines on inferior margin. Dactylus biunguiculate, 0.5 as long as carpus, superior and inferior ungui of similar length but with inferior unguis a little thicker at base.

Telson with breadth of anterior margin equal to length and 1.5 times wider than posterior. Posterolateral angles projecting as acute teeth, reaching variously from half as long to almost as long as posterior lateral spinules. Posterior margin strongly convex. Spinules of dorsal surface prominent, usually about as long as posterior spinules.

Thai specimens reaching up to 15 mm. in length.

Discussion: Coutière in the Maldive and Laccadive report (1905:875) describes as new two closely related forms. *S. hastilicrassus* and *S. acanthitelsonis*. In *S. hastilicrassus* the upper angle of the basicerite is truncate, in *S. acanthitelsonis* it carries a sharp tooth; in *S. hastilicrassus* the superior margin of the meri of both the large and small chela are inermous, while in *S. acanthitelsonis* both are armed

with teeth; and finally in *S. hastilicrassus* the superior lateral angles of the telson do not extend past the convex posterior margin, while the outer angles of the telson of *S. acanthitelsonis* reach beyond both the posterior border and the posterior lateral spines.

We carefully examined 60 specimens of what surely are *S. acanthitelsonis* and found the inconsistencies listed in Table V.

TABLE V

Analysis of Certain Characteristics of *S. acanthitelsonis*

	Present	Absent
Superolateral spine of basicerite	33	27
Distosuperior spine of merus of large chela	32	2
Distosuperior spine of merus of small chela	50	1

The projecting angles of the outer edge of the telsons in our specimens varied considerably in length (figs. 18 I J), but while all reached beyond curve of the tip, none extended beyond the tip of the inner spinules.

Inasmuch as these specimens are more like *S. acanthitelsonis* in the three characteristics tabulated above, and approach it in the length of the posterior lateral teeth of the telson, the specimens have been assigned to that species, with reservations. While our rather large collections cannot establish a firm connection between the two species, we believe that when enough specimens from other areas are examined, it will be found that both of Coutière's species will be merely extreme variations of a normally variable species.

Distribution: This is one of the most common species of this genus in Thailand and was found at almost all collecting sites. At least 7 specimens were found living in sponges. It was collected from all parts of the reef in heads of dead and living coral.

Collection data: 11 specimens from BR5; 11, BR 7; 6, BR 8; 1, BR 10; 3, BR 11; 2, BR 11b; 6, BR 12; 4, BR 13; 2, BR 15; 11, BR 16; 6, BR 18; 7, BR 21; 7, BR 22; 1, BR 22b; 7, BR 23; 8, BR 26; 12, BR 27; 3, BR 27a; 1, BR 28; 3, BR 30; 1, BR 34; 1, BR 36; 36, BR 43; Naga stations: 1, 41-1314; 4, 60-895; 1, 59-131; 9, 60-875.

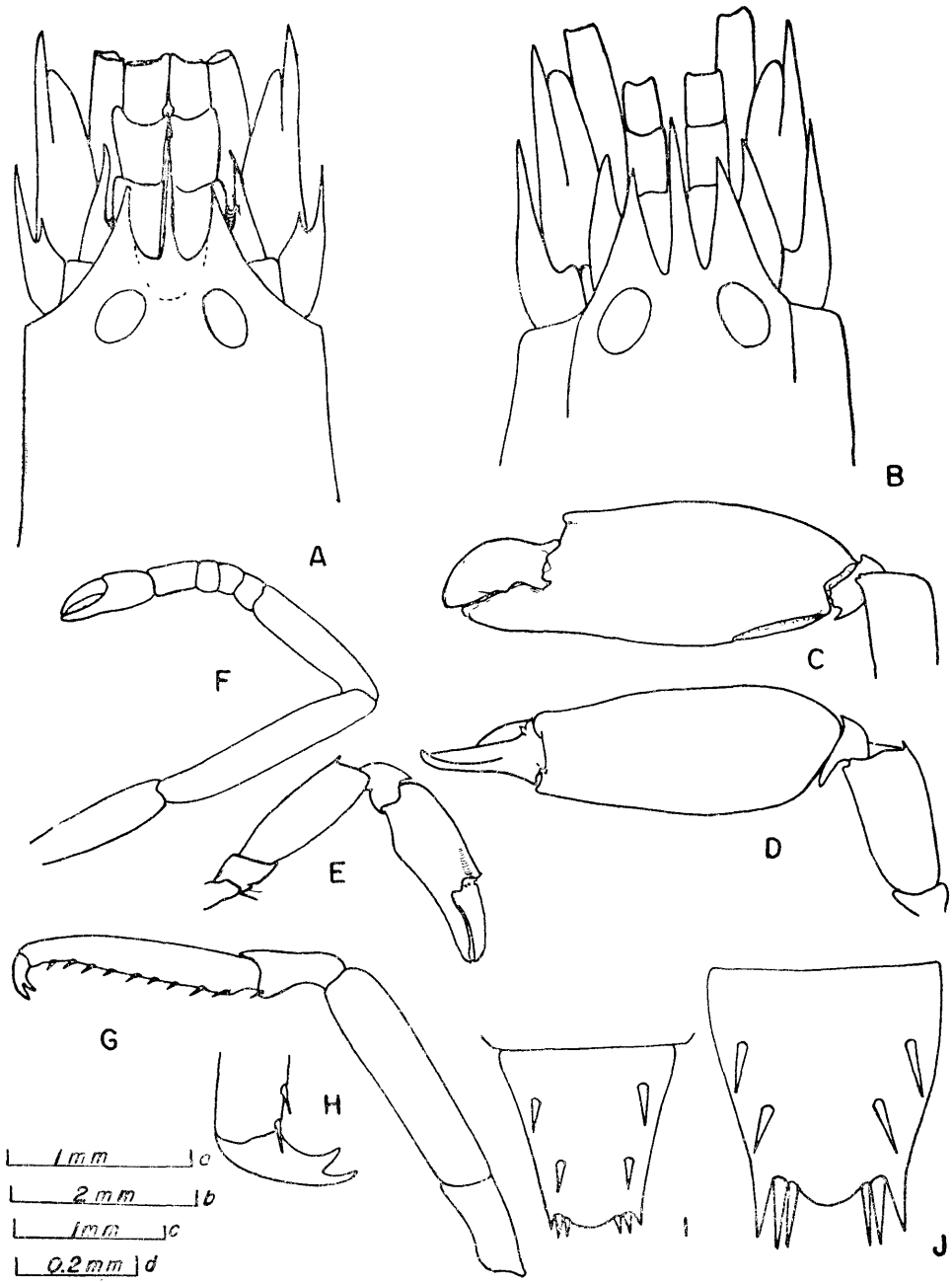

FIGURE 18

Synalpheus acanthitelsonis Coutière. A, B, Anterior region, dorsal aspect of two different specimens; C, large cheliped, inner face; D, large cheliped, superior aspect; E, small cheliped; F, second leg; G, third leg; H, dactylus enlarged; I, J, telsons of two different specimens. (A, B, I, J, scale a; C, D, E, scale b; F, G, scale c; H, scale d).

Specimens have been collected in the Maldive Archipelago and Indonesia.

Synalpheus thai species nov.—Figure 19

Type Specimen: 10 mm. male from dead coral collected in approximately 2 meters of water off Koh Samet, Rayong, Thailand (BR 16). **Paratypes**: 5 males and 5 females from 10-18 mm. long, collected from the same zone as the type from Koh Namsao, Chantaburi, Thailand (BR 11).

Description: Rostrum awl-shaped, but with tip rounded, reaching slightly beyond middle of visible part of first antennular article. Slight carina broadened at base of rostrum, extending posteriorly to about middle of eyes. Orbital teeth with triangular base and rounded tip reaching almost to end of rostrum. Tip of orbital teeth and rostrum bearing short setae, strongly up-turned when seen in lateral view. Orbital hoods slightly inflated.

Visible part of first antennular article 1.6 times length of second article; second article 1.4 times as long as wide; third article 0.7 length of second. Stylocerite slender, reaching past end of first antennular article. Scaphocerite with outer margins concave. Lateral spine reaching to end of antennular article, squamous portion very narrow, reaching to middle of second antennular peduncle. Inferior spine of basicerite relatively broad at base, tip reaching to middle of second antennular article, also upturned distally. Superior spine acute, reaching just past middle of first antennular article.

Cheliped not sexually dimorphic. Large chela 2.5 times as long as broad with fingers occupying distal 0.3. Superior margin bearing proximal to dactylus an obtuse projection directed upward and forward. Below projection on inner face, another projection composed of two rounded cusps. Dactylus strongly rounded, bearing acute ridge along superior margin, longer than fixed fingers. Merus 1.7 as long as broad with slight tooth distally on superior margin.

Small chela 2.6 times as long as broad. Fingers 0.7 as long as palm, bearing setae along opposing faces. Merus inermous, slender, 4 times as long as palm. Merus constricted proximally and broadened at distal end.

Carpal articles of second leg with ratio: 10:2:2:2:5; second to fourth articles broader than long.

Third leg stout. Ischium unarmed. Merus inermous, 3 times as long as broad. Carpus 0.4 as long as merus, superior margin ending in an obtuse tooth; inferior, in movable spine. Propodus 0.7 as long as merus, bearing 9 spines on its inferior margin. Dactylus biunguiculate. Superior unguis gradually curved inward, 2.5 times as long as broad at its base; inferior unguis 0.4 as long as superior unguis. Area between the ungui in the form of a "U".

Abdominal pleura showing sexual dimorphism with those of female expanded and rounded; male pleura shorter and bearing angular projections.

Telson 1.5 times as long as posterior margin is wide, anterior margin 1.5 times wider than posterior margin. Lateral margins anteriorly convex. Lateral angles extended as acute teeth, almost 0.5 as long as entire telson, anteriorly straight, posteriorly turned slightly medially. Margin between telsal teeth slightly arcuate, posterior lateral spines small. Superior spines of telson prominent, half as long as posterior lateral teeth.

Discussion : This species is almost identical to *S. bituberculatus* in the appearance of the rostral front; it is similar to *S. coutierei* in the prominent tooth on the large chela; *S. hastilicrassus* has similarly located teeth on the posterior lateral margin of the telson; from these, and from all members of the genus it may be distinguished readily by the extraordinarly long posterior lateral teeth of the telson.

Distribution : Our eight specimens were taken from dead heads of coral in water up to 5 meters deep. The two collecting sites were not far apart on the eastern side of the Gulf of Thailand.

Locality data : 8 specimens from BR 11; 2, BR 16.

Synalpheus coutierei Banner—Figure 20

Synalpheus coutierei Banner, 1953. Pacific Sci. 7(1):36.

Alpheus biunguiculatus de Man, 1888b. Arch. für Naturgesch., 53(1):502, pl. 21, fig. 6. Bate, 1888. Challenger Rept. 24:562, pl. 101, fig. 4.

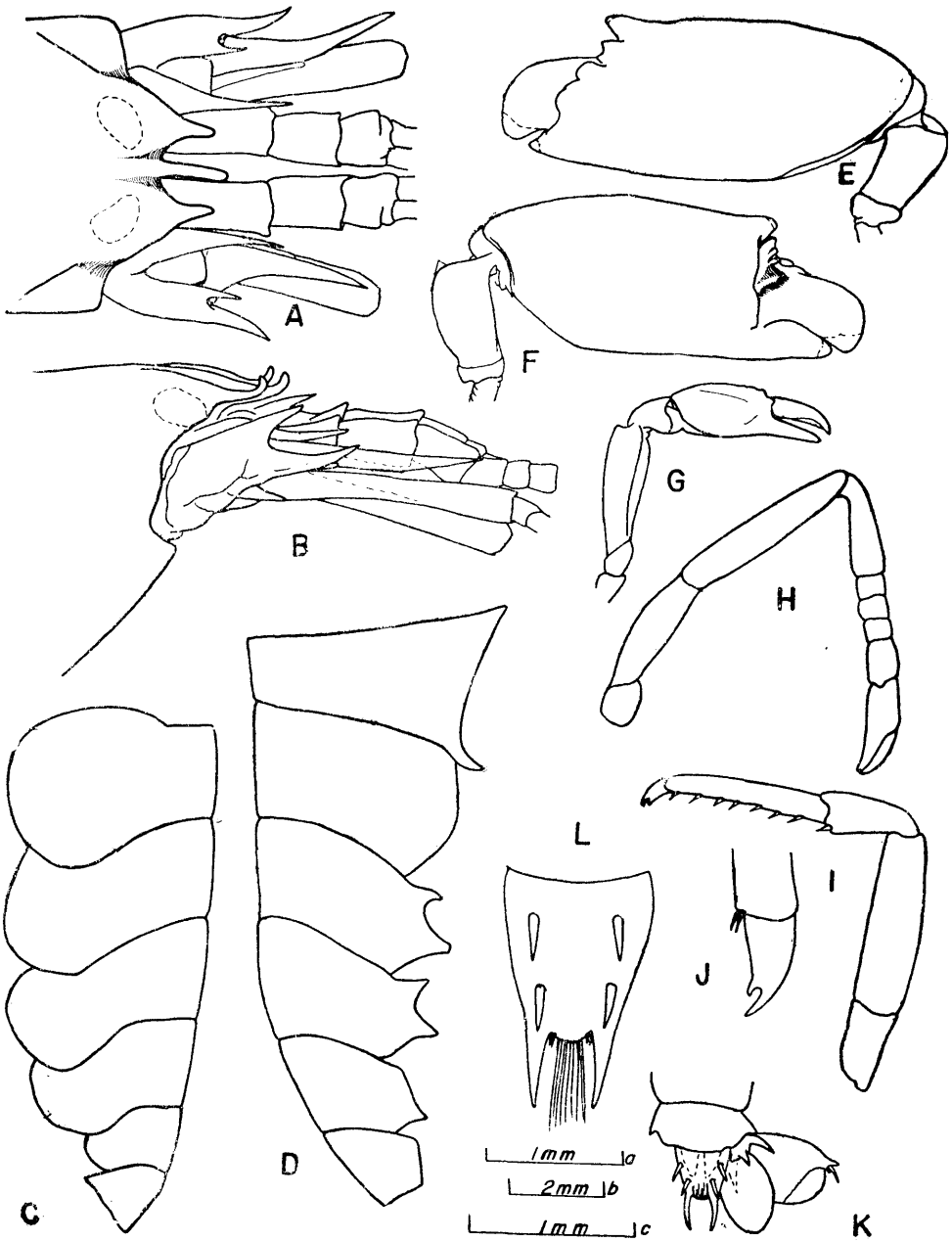

FIGURE 19

Synalpheus thai sp. nov. A, B, Anterior region, dorsal and lateral aspect; C, abdominal somites, female, lateral view; D, abdominal somites, male, lateral view; E, large cheliped, inner face; F, large cheliped, outer face; G, small cheliped; H, second leg; I, third leg; J, dactylus; K, telson and uropods; L, telson. (A, B, C, D, H, I, K scale a; E, F, G, K, scale b; J, scale c).

Synalpheus biunguiculatus Coutière, 1898c. Soc. Ent. France 1898(11):232, figs. 1-4. 1905. Fauna and Geog. Mald. and Laccad. 2(4):873, pl. 71, fig. 8.

[*Nec : Synalpheus biunguiculatus* (Stimpson), 1860. Acad. Nat. Sci. Phila., Proc. 1860:31.]

Specimen Drawn : 10 mm. male from Phuket (BR 41).

Description : Rostrum thin, reaching past middle of visible part of first antennular article. Orbital teeth over two times broader at their bases than rostrum, tips reaching to near end of rostrum. Orbital teeth and rostrum carrying setae and in lateral view tilted upward. Orbital hoods only slightly inflated with outer margin convex, inner margins slightly concave and separated from base of rostrum by shallow depression.

Antennular peduncle with visible portion of first antennular article 1.5 times as long as second article, 2.5 times as long as third article. Second article 1.5 times as long as broad. Stylocerite with narrow lateral spine reaching to middle of second antennular article. Lateral spine of scaphocerite reaching to end of antennular peduncle. Squamous portion narrow, reaching to end of second antennular article. Carpocerite reaching past end of antennular peduncle. Outer spine of basicerite almost as long as stylocerite, superior spine acute, reaching to end of rostrum.

Large chela 2.6 times as long as broad, with fingers occupying distal 0.3. One large sub-acute tubercle on palm above dactylar articulation. Second, shorter tubercle on inner face, abutting superior margin of dactylar articulation. Dactylus heavy, longer than fixed finger. Merus 2 times as long as wide; superior margin convex, with blunt tooth distally; inferior margin inermous.

Small chela 3.1 times as long as broad, palm only a little longer than fingers. Merus 3.4 times as long as broad, inermous.

Second legs stout. Carpal articles with ratio: 10:2:2:2:4; second to fourth articles broader than long.

Merus of third leg 3.0 times as long as wide, unarmed. Carpus 0.3 as long as merus, superior margin terminating in heavy obtuse

tooth, distal inferior margin bearing 1 movable spine. Propodus 0.7 as long as merus with 7 spines on inferior margin. Biunguiculate dactylus 0.18 as long as propodus; ungui of similar length, but with inferior unguis thicker at base, and at a right angle to axis of article; superior unguis less abruptly curved.

Telson 2.2 times as long as posterior margin is broad; lateral margin convex; anterior margin 2 times as wide as porsterior.

Thai specimens reaching 13 mm. in length.

Discussion: This species was given a new name by Banner in 1953 when he redefined *S. biunguiculatus* Stimpson on the basis of a neotype from the type locality, Hawaii. The records of de Man, Coutière, Bate and others of *S. biunguiculatus* were thus actually this species, *S. coutierei*.

Our specimens agree well with Coutière's excellent plate and description (1898c: 232). Variation was noted in the general appearance of the rostral front. Very often the margin between the rostrum and the orbital teeth was more rounded and the whole front appears a little more constricted that the one figured. In a few specimens the upper spine of the basicerite is not nearly as acute as the one figured. One specimen from BR 43 (fig. 20 I) appeared to have a longer carpus of the small cheliped than did the typical form. This species bears a similarity to *S. thai*, particularly in the large chela but it can be readily separated by the teeth on the outer angles of the telson.

Distribution: Our specimens came from Singapore and Phuket in the Indian Ocean. The Naga specimens were collected by trawl in the Gulf of Thailand. One of the specimens from Singapore was found inhabiting a sponge.

Collection data: 2 specimens from BR 41; 6, BR 43; 1, Naga 59-131.

This species appears to be wide-spread. It has been collected from the Red Sea, the Persian Gulf, from localities in the Indian Ocean, and in the Pacific from the Phillipine Islands to Samoa; it does not occur in Hawaii.

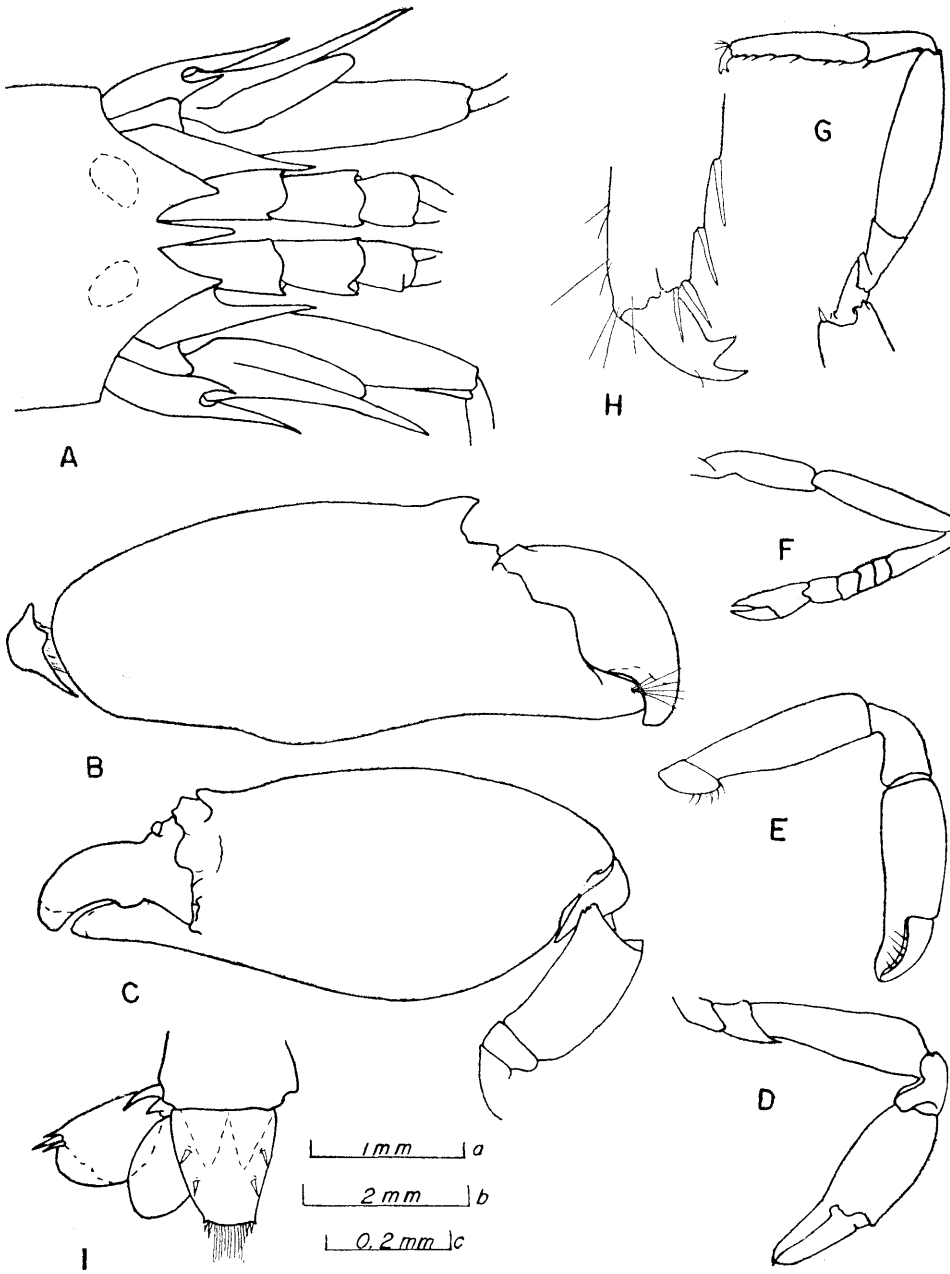

FIGURE 20

Synalpheus coutierei Banner. A, Anterior region, dorsal aspect; B, large chela, inner face; C, large cheliped, superior face; D, small cheliped of specimen from BR 41; E, small cheliped of specimen from BR 43; F, second leg; G, third leg; H, dactylus; I, telson and uropods. (A, scale a; B, C, D, E, F, G, I, scale b; H, scale c).

Synalpheus pachymeris Coutière–Figure 21

Synalpheus biunguiculatus pachymeris Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):873, pl. 71, fig. 9.

Synalpheus pachymeris de Man, 1911. Siboga Exped. 39a^{1}(2): 277.

Specimen Drawn: 9 mm. male from head of coral collected in 3.0 meters of water at Koh Kradard.

Description: Rostrum short, reaching past middle of visible part of first antennular article; acute carina reaching posteriorly to middle of eyes. Orbital teeth broad at base, a little shorter than rostrum. Rostrum and teeth tilted upward and with setae on ends.

Visible part of first antennular article 1.5 times as long as second article; second article as long as broad; third article as long as second. Stylocerite reaching just past middle of second antennular article. Scaphocerite with outer margin slightly concave, lateral spine reaching past end of antennular peduncle, squamous portion narrow, not reaching end of antennular peduncle. Carpocerite a little longer than scaphocerite. Lateral spine of basicerite almost as long as stylocerite, superior spine half as long as stylocerite.

Large chela 2.7 times as long as wide, fingers occupying distal 0.3. Palm terminating above dactylar articulation in large rounded tubercle directed forward. Merus 2.5 times as long as broad, and bearing small rounded tooth distally on inferior internal margin.

Small chela 3 times as long as broad; fingers normal, shorter than palm. Merus 2.6 times longer than broad, small acute tooth on distal end of inferior margin.

Second leg with ratio of carpal articles: 10:2:2:2:5.

Third leg stout, ischium unarmed. Merus 3 times as long as wide, with inferior margin armed with 3-5 movable spinules. Carpus 0.2 as long as merus, distally armed on superior margin with strong tooth, movable spinule on inferior margin. Propodus 0.7 as long as merus bearing 8 spines on its inferior margin. Dactylus biunguiculate, superior unguis almost twice as long as inferior unguis and much heavier. Apex between ungui "U"-shaped.

Telson 2.2 times as long as posterior margin is broad. Anterior margin 2 times wider than posterior. Terminal spines normal, posterior lateral corners slightly produced.

Discussion: This species most closely resembles *Synalpheus bituberculatus* de Man. However it differs in that the palm of the large chela terminates distally in only one tubercle which is directed straight forward, not obliquely upward as in *S. bituberculatus*. Without the chela it would be indeed difficult to distinguish the two species. Our sole specimen differs from Coutière's in having the orbital teeth more acute, and the scaphocerite, stylocerite and lateral spine of the basicerite longer in relation to the antennular peduncle than those of Coutière's.

Distribution: This species has been captured in the Maldive Archipelago and the Red Sea. We have also collected it at Onotoa in the Gilbert Islands.

Synalpheus bituberculatus de Man—Figure 22

Synalpheus bituberculatus de Man, 1910. V. Ned. Dierk. Ver. Tijdschr., 11:294; 1911. Siboga Exped. 39a[1](2):276, pl. 11, fig. 53.

Specimen Drawn: 13 mm. male from Koh Nangsao, Chantaburi, Thailand (BR 12).

Description: Rostrum acute, with tip curved upward, reaching to near middle of visible part of first antennular article. Orbital teeth broad, extending past middle of rostrum and directed inward near tip. Separation between rostrum and orbital teeth in the form of a constricted "U". Orbital hoods only slightly inflated.

Second antennular article 1.4 times as long as broad, 0.7 as long as visible part of first and only a little longer than third article. Stylocerite usually bearing one strong setae on inflated section of base near orbital teeth; lateral spine reaching past middle of second antennular article. Lateral margin of scaphocerite strongly concave; lateral spine reaching length of third article past that article. Squamous portion slender, reduced, reaching just past end of second antennular article. Basicerite with inferior spine a little longer than scaphocerite, slightly turned outward; superior spine acute, reaching

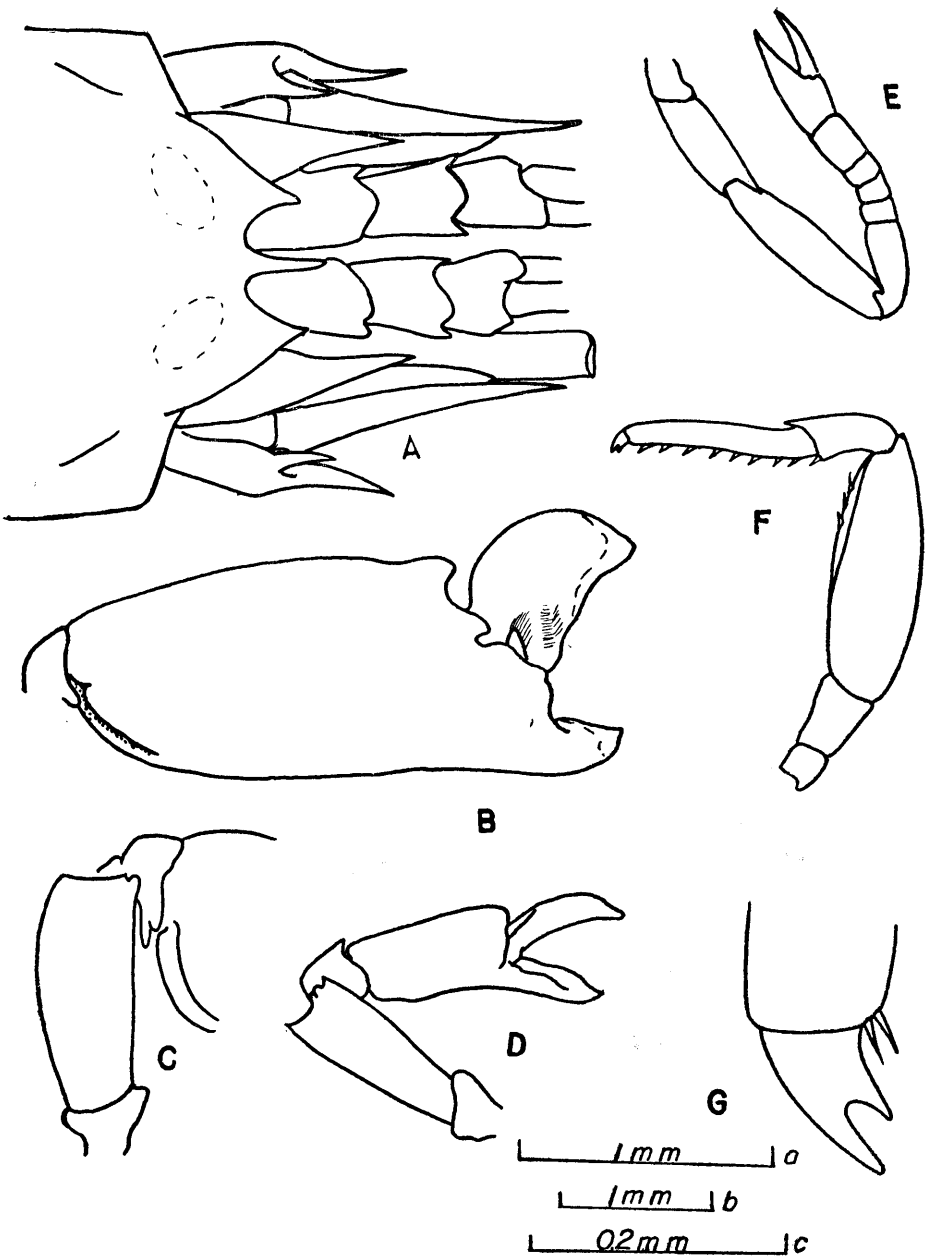

FIGURE 21

Synalpheus pachymeris Coutière. A, Anterior region, dorsal aspect; B, large chela, inner face; C, merus, large chela; D, small cheliped; E, second leg, F, third leg; G, dactylus. (A, scale a; B, C, D, E, F, scale b; G, scale c).

to middle of first antennular article. Carpocerite as long as lateral spine of scaphocerite.

Large chela with palm inflated, 2.8 times as long as broad. Palm terminating above dactylar articulation in two conical, obtuse, tubercles placed side by side; tubercles directed forward and upward. Finger occupying 0.3 length of entire chela. Dactylus thin with full length of upper margin produced into curved knife-like ridge giving the finger a twisted look; tip of fingers crossing slightly. Merus 2.2 times as long as broad, terminating distally as an acute angle. Large cheliped of female of similar proportions.

Small chela 3 times as long as broad with palm 1.2 times longer than fingers. Carpus 0.3 as long as chela. Merus 3 times as long as broad, subequal to chela in length, and bearing small acute tooth distally on inferior internal margin.

Second leg stout, second to fourth carpal articles broader than long, but with first over 3 times as long as broad. Carpal articles with a ratio: 10:2:2:2:6.

Thoracic legs stout. Ischium of third leg unarmed; merus 3 times as long as broad, bearing on inferior margin 5-7 strong movable spines, but without distal tooth. Carpus 0.3 as long as merus with superior margin ending in strong tooth, inferior margin ending in acute spine. Propodus 0.6 as long as merus, with inferior margin bearing 7 movable spinules. Dactylus biunguiculate, 2 times longer than wide at base. Ventral unguis slightly longer and more slender at base than dorsal. Area between ungui "V"-shaped with rounded apex. Merus of fourth and fifth legs lacking spines.

Telson 2.3 times as long as posterior margin is broad; anterior margin twice as wide as posterior margin; outer angles acute, lateral margins slightly arcuate; spines on upper surface quite prominent.

Thai specimens reaching 14 mm. in length.

Discussion: This species can readily be distinguished from all others in Thai waters by the 2 tubercles on the distal end of the palm of the large chela. However, like other members of the genus, it is variable to some degree in relative lengths of the parts of the antenna to the antennular peduncle. In some specimens the separation between

the rostrum and the orbital teeth is considerably broader than in the one figured.

Distribution : This species was found in broken-up coral heads at practically all collecting sites. It was found on both sides of the Gulf of Thailand, in the Indian Ocean at Phuket and at Singapore. It was found on all sections of the reef in water up to 6 meters deep. Several times it was found in passages in sponges, usually living in pairs. This is the first time this species has been reported since de Man's original specimens were described from Indonesian waters.

Collection data : 3 specimens from BR 5; 2, BR 7; 4, BR 8; 2, BR 11; 8, BR 12; 1, BR 13; 9, BR 13a; 3, BR 14; 4, BR 16; 23, BR 18; 2, BR 23; 6, BR 26; 6, BR 27; 3, BR 28; 3, BR 28a; 3, BR 30; 1, BR 42; 15, BR 43.

Synalpheus laticeps Coutière–Figure 23

Synalpheus laticeps Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):874, pl. 72, fig 11. Pearson, 1905. Pearl Oyster Fish. 4(24):82.

Specimen Drawn : A 10 mm. male from Koh Sichang (BR 5)

Description : Rostrum and orbital teeth short and almost equal in length, reaching only to near middle of visible part of first antennular article. Orbital teeth wider at base than rostrum.

Visible part of first antennular article only a little longer than second article; third article shorter than second; second article as broad as long. Stylocerite reaching almost to middle of second antennular article. Scaphocerite with outer margin concave, lateral spine reaching to end of antennular peduncle, squamous portion narrow and reaching only to end of second antennular article. Carpocerite reaching past antennular peduncle by length of third article. Inferior spine of basicerite reaching past middle of second antennular article, superior spine reaching to middle of visible part of first.

Large chela 2 times as long as broad with slight protrusion above dactylar articulation. Dactylus almost 0.3 as long as entire chela, truncate on distral end. Merus 2.1 times as long as broad, without spines or teeth.

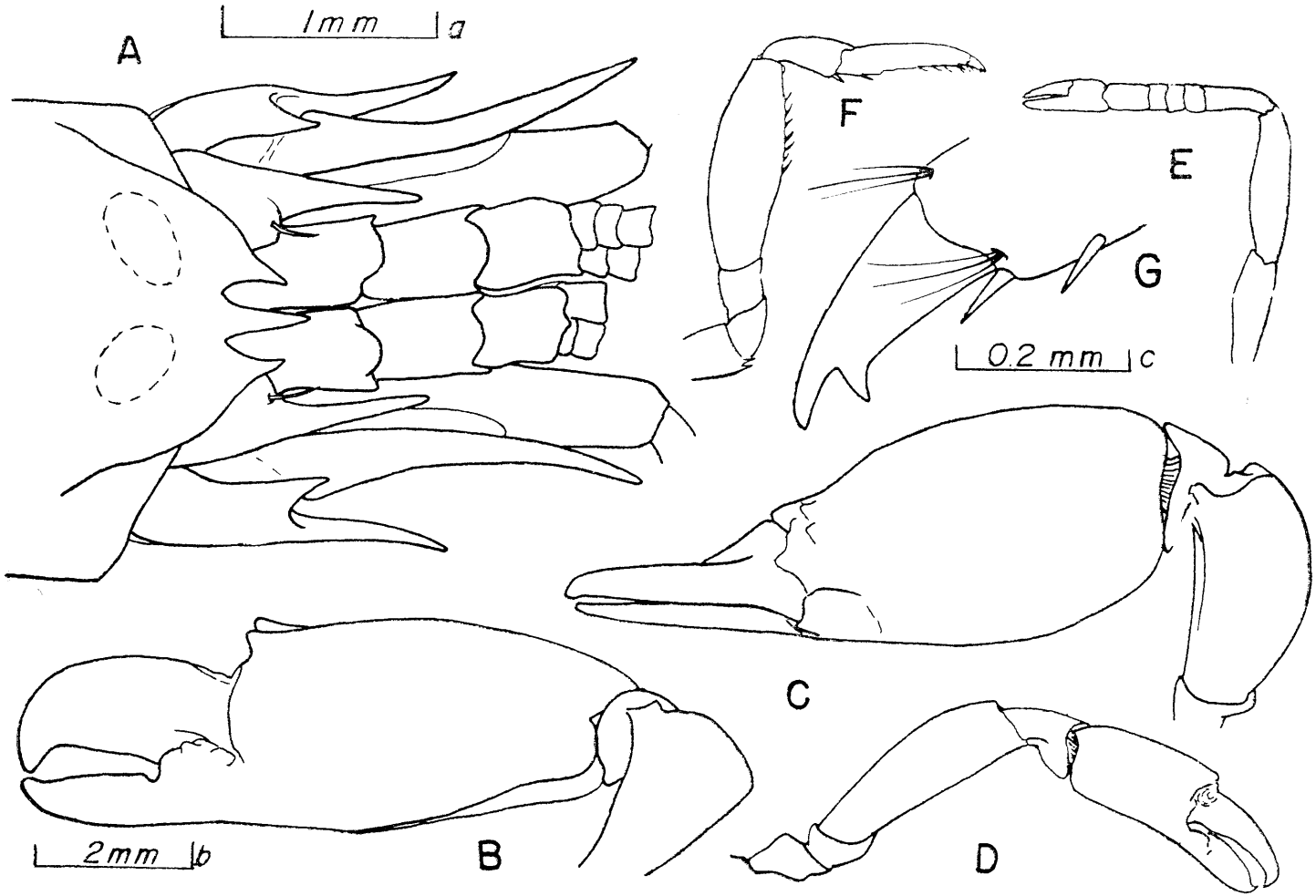

FIGURE 22

Synalpheus bituberculatus de Man. A, Anterior region, dorsal aspect; B, large chela, inner face; C, large chela, superior aspect; D, small cheliped; E, second leg; F, third leg; G, dactylus. (A, scale a; B, C, D, E, F, scale b; G, scale c).

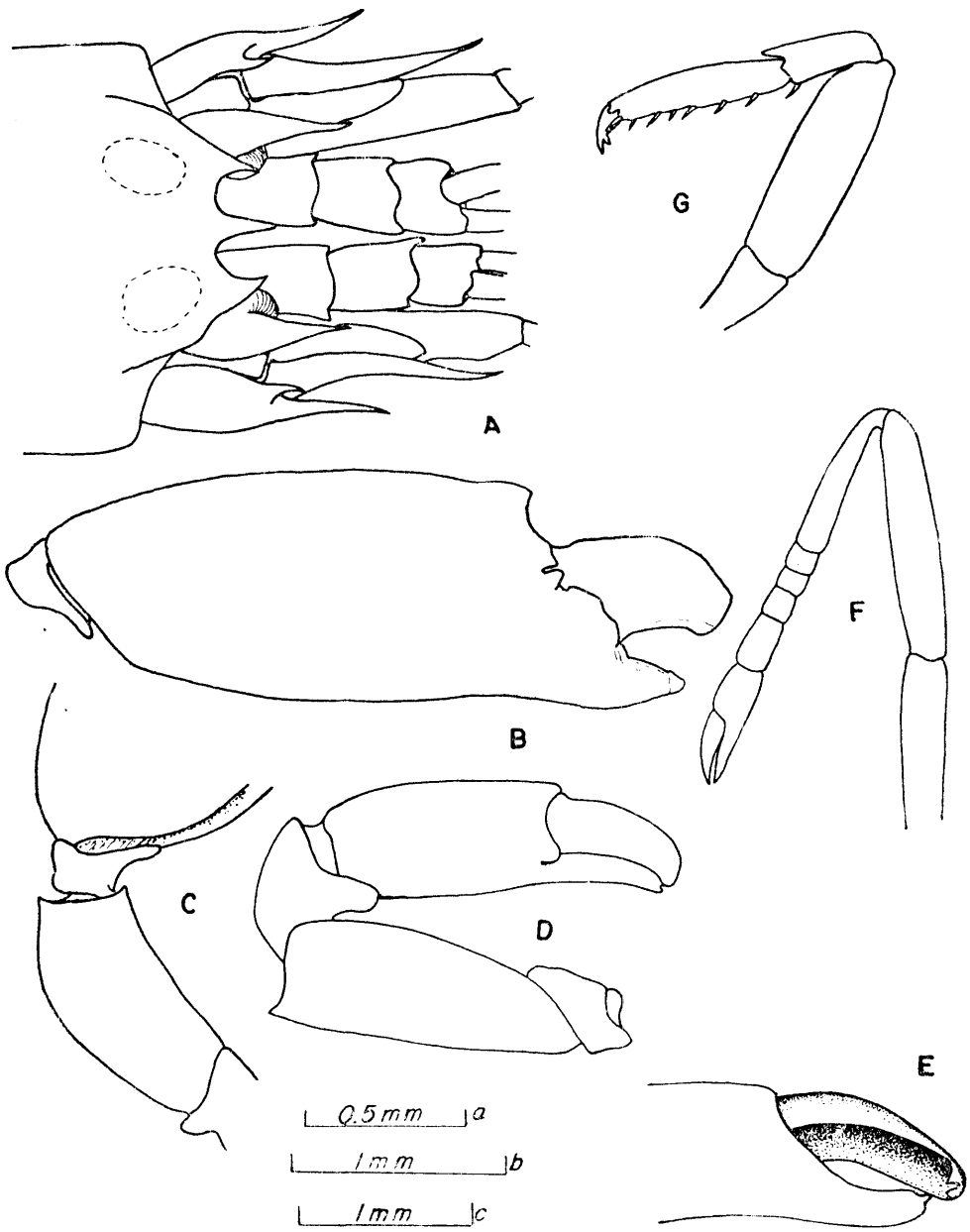

FIGURE 23

Synalpheus laticeps Coutière. A, Anterior region, dorsal aspect; B, large chela, inner face; C, merus large chela; D, small cheliped; E, dactylus, small chela, enlarged; F, second leg; G, third leg. (A, E, scale a; B, C, D, E, G, scale b; F, scale c).

Small chela 2.6 times as long as broad with fingers occupying distal 0.3. Dactylus spatulate, excavate and spoon-shaped inferiorly, and terminating in front by two blunt teeth. The fixed finger is also excavate on its distal half, where the margin is thin and sharp-edged, and is terminated by 1 tooth which fits into the excavation between the two dactylar teeth.

Third leg stout. Ischium and merus unarmed, merus 3.3 times as long as broad. Carpus 0.4 as long as merus, armed distally with heavy, acute tooth on superior margin, movable spine inferiorly. Propodus 0.7 as long as merus, bearing on inferior margin 8 movable spines. Dactylus biunguiculate, superior unguis a little longer than inferior and less thick at base.

Telson 3.5 times as long as posterior margin is wide. Anterior margin 2.4 times wider than posterior.

Discussion: The most characteristic structure of this species is the form of the dactyl of the small chela, which terminates in the finger-and-slot device; this stucture is unkhown among the Thai members of the genus. (After our sole Thai specimen was identified the small chela was lost; for fig. 23 D and E the appendage of a Samoan specimen was used.) In the absence of the small chela this species could be confused with *S. coutierei* but the large chela lacks the large tooth at the distal end of the palm.

Distribution: Our specimen was taken from a head of coral from about 3 meters of water at Koh Sichang on the eastern side of the Gulf of Thailand.

Coutière's original two specimens were taken from the Maldive Archipelago; it was also reported at Ceylon in the Indian Ocean. We have collected it from Samoa.

Synalpheus theano de Man--Figure 24

Synalpheus theano de Man, 1910. V. Ned. Dierk. Ver., Tijdschr. 11(5):296. 1911. Siboga Exped. 39a^1(2):293, pl. 13, fig. 61.

Specimen Drawn: 12 mm. male from Singapore (BR 43a) found living commensally with a sponge.

Description: Rostrum narrowly triangular, over half as long as visible portion of first antennular article. Orbital teeth broad at base, triangular, reaching almost to end of rostrum.

Second antennular article 0.7 as long as visible part of first, 1.5 times as long as broad; third article 0.6 length of second. Stylocerite reaching to near end of first antennular article. Scaphocerite with outer margin straight, lateral spine reaching just past end of second antennular article; squamous portion thin, reaching to middle of second antennular article. Carpocerite slender, reaching past end of antennular peduncle. Inferior spine of basicerite a little longer than stylocerite; superior margin with slight rounded projection.

Large chela compressed, 2.4 times as long as broad with fingers occupying 0.3 of total length. Superior margin of palm projecting above dactylar articulation as an acute tooth. Fingers broad, obtuse on ends. Merus 2.2 times as long as broad, inferior internal margin terminating in obtuse projection.

Small chela 3 times as long as wide; fingers about 0.6 length of palm. Both fingers broadened, excavate on their opposing surfaces, tips acute and at times crossing. Dactylus bearing 6 or 7 coarse setae on inferior margin. Carpus longer than usual, about 0.7 as long as palm, broadened distally. Merus unarmed, slender, 3.8 as long as broad.

Second leg with ratio of carpal articles: 10:2:2:2:6.

Ischium of third leg unarmed. Merus 3.5 times as long as broad. Inferior margin armed with sparse setae. Carpus 0.4 as long as merus, superior margin armed distally with broad tooth, inferior with movable spinules. Propodus 0.6 as long as merus, armed on inferior margin with 6 spinules. Dactylus biunguiculate, 0.2 as long as carpus. Dorsal and ventral unguis of equal length, ventral unguis thicker at base than dorsal unguis, both ungui gradually curved.

Telson 3.0 times as long as posterior margin is broad. Anterior margin 2 times as wide as posterior. Spines on superior surface prominent and placed on anterior half of telson.

Thai specimens reaching 14 mm. in length.

Discussion : This species appears to be closely related to *S. neptunus* (Dana). Our specimens appear to be *S. theano* de Man, but there are some differences. We have contrasted in Table VI the significant characteristics of *S. neptunus, S. theano* as described by de Man, and our specimens.

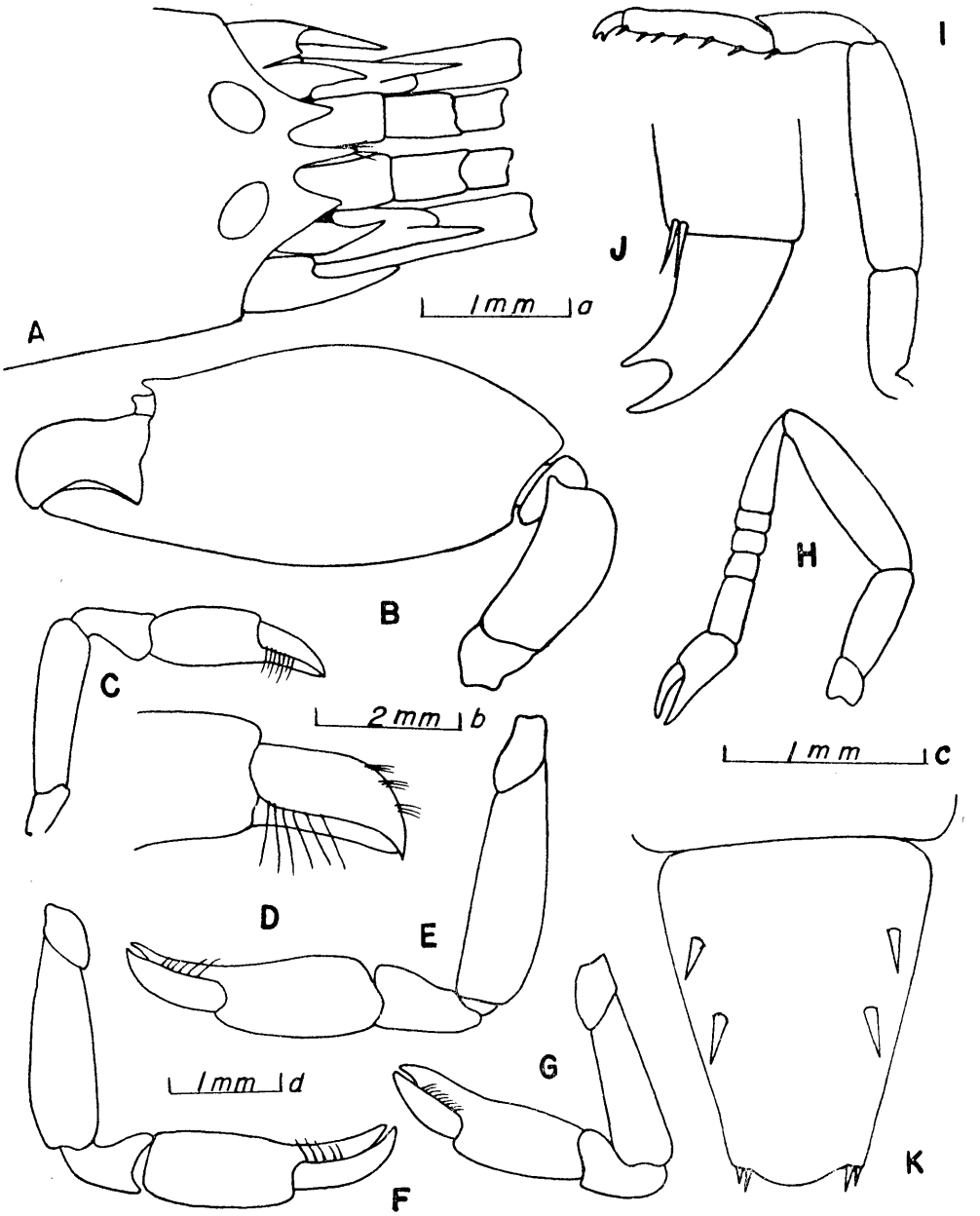

FIGURE 24

Synalpheus theano de Man. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, small cheliped; D, dactylus small chela, enlarged; E, F, G, small cheliped of three different specimens; zH, second leg; I, third leg; J, dactylus; K, telson. (A, J, scale a; B, C, scale b; D, K, scale c; E, F, G, H, I, scale d).

TABLE VI

Contrast of 7 Characteristics of 3 Members of the Genus *Synalpheus*

	S. neptunus (Dana)	*S. theano* de Man	Variations in our specimens
Scaphocerite	To middle of second antennular article.	To end of third antennular article.	From proximal quarter to end of third antennular article.
Squame	To middle of second antennular article.	To end of second antennular article.	From end of first to end of third quarter, second antennular article.
Lateral spine of basicerite	To end of first quarter of second antennular article.	To end of second antennular article.	From end of first antennular article to middle of second antennular article.
Small chela	Fingers equal to palm.	Fingers a little shorter than palm.	Fingers a little shorter than palm.
Carpus of small chela	0.4 as long as palm.	0.4 as long as palm.	0.5-0.7 as long as palm. (see fig. 24 C-G)
Second leg	First carpal article equal to fifth.	First carpal article 1.5 longer than fifth.	First carpal article 1.5-2.0 longer than fifth.
Telson	3.5 times as long as width of posterior margin.	4.0 times as long as width of posterior margin.	2.8-3.0 times as long as width of posterior margin.

Thus our specimens agree well with the description given by de Man for *S. theano* with the exception of a slightly longer carpus in the small chela and a shorter telson. Considering the amount of variation in these four specimens, and considering the next specimen, listed separately below, we believe that when enough specimens of this species are collected *S. theano* will prove to be a synonym of the closely related *S. neptunus*.

Distribution: De Man's only specimen was taken in Indonesia. Our four specimens were taken from sponges attached to a head of dead coral in about 10 feet of water at Singapore (BR 43). [The type locality for *S. neptunus* is the Sulu Sea].

Synalpheus species near *theano*—Figure 25

Synalpheus theano de Man, 1910. V. Ned. Dierk. Ver., Tijdschr. 11(5):296; 1911. Siboga Exped. 39a [1] (2):293, fig. 61.

Confer: *Synalpheus neptunus* Coutière, 1909. U.S. Nat. Mus., Proc, 36:88, fig. 53.

Specimen Drawn: A 20 mm. female from Singapore (BR 43), commensally living in a sponge that was growing in a head of dead coral.

Description: Rostrum very short, reaching only 0.2 length of visible portion of first article of antennular peduncle, narrowly triangular with tip rounded. Orbital teeth of same length but much broader at bases.

Second antennular article 0.5 as long as visible part of first antennular article; 1.2 times as long as broad; third article 0.7 as long as second. Stylocerite reaching to end of first antennular article. Scaphocerite with outer margin straight, lateral spine reaching almost to end of antennular peduncle; squamous portion thin, reaching past middle of second antennular article. Carpocerite slender, reaching considerably past end of antennular article. Inferior spine of basicerite a little longer than stylocerite, upper angle obtuse.

Large chela cylindrical, 2.5 times as long as broad with fingers occupying distal 0.25. Superior distal margin of palm bearing acute tooth above dactylar articulation. Fingers laterally broadened, obtuse

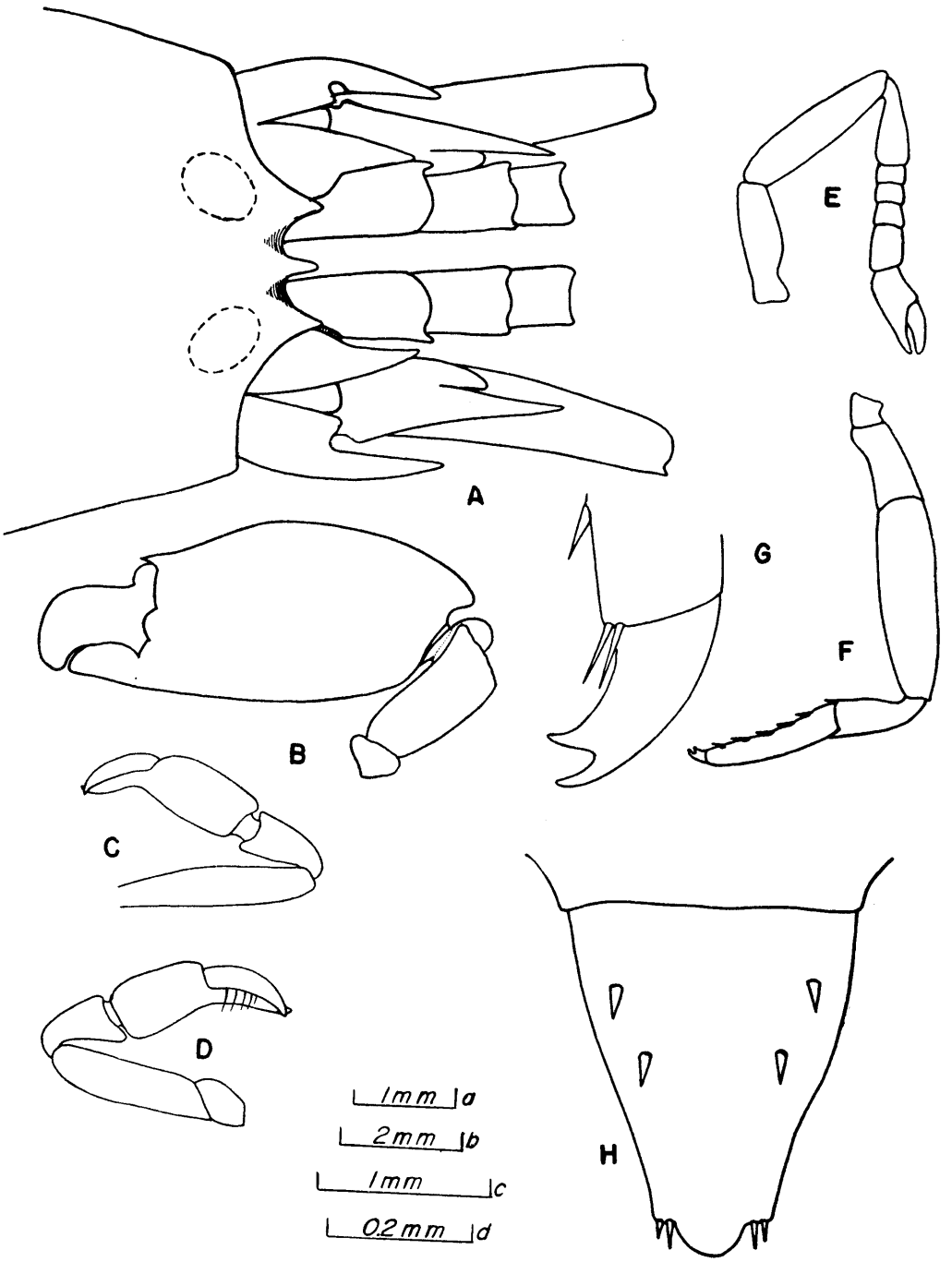

FIGURE 25

Synalpheus species near *theano*. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, D, small cheliped, outer and inner face; E, second leg; F, third leg; G, dactylus, H, telson. (A, E, F, scale a; B, C, D, scale b; H, scale c; G, scale d).

on ends. Merus twice as long as broad, superior distal margin inermous, inferior internal margin with distal angle acute.

Small chela 2.7 times as long as wide; fingers a little shorter than palm. Dactylus and fixed finger broadened, excavate on their opposing interior surfaces, tips of fingers slightly crossing, inferior edge of dactylus bearing a few heavy setae; carpus 0.7 as long as palm. Merus 4.3 times as long as broad, without spines.

Second leg with ratio of carpal articles: 10:2:2:2:5. First carpal article not quite as long as sum of four following.

Ischium of third leg without spine. Merus 3.6 times as long as broad. Inferior internal margin armed with sparse setae. Carpus 0.4 as long as merus, superior distal margin armed with blunt tooth and inferior distal margin with movable spinule. Propodus 0.7 as long as merus, armed on inferior margin with 5 spinules. Dactylus biunguiculate, 0.3 as long as carpus. Dorsal and ventral unguis of equal length, ventral unguis almost twice as thick at the base as dorsal unguis, both ungui gradually curved.

Telson 3 times as long as broad at the posterior margin. Lateral margins convex and rapidly tapering in anterior portions, but concave and approaching a parallel condition posteriorly. Posterior margin between spines extended in a uniform arc reaching beyond tips of lateral spines.

Discussion : This species is closely related to *S. neptunus* (Dana) and to the species reported above as *S. theano* de Man. From *S. neptunus* it differs in the relative measurements of the first and fifth carpal articles of the second leg, in the rostral front which is shorter in relation to the first antennular article and in the posterior margin of the telson which is further extended. From *S. theano* it may be separated by the abbreviated rostral frontal region, by a longer carpocerite in the small chela and again by the posterior margin of the telson.

This sole specimen was collected with the 4 specimens listed under *S. theano* above from a single sponge from near Singapore (BR 43a). The morphology is sufficiently distinct to warrant considering this as a separate and new species; however, we are not naming it as

new because we believe it to be merely an extreme variation of a variable species. We suspect that within the protection of the sponogcoel, morphological variation has no great survival value, and the differences in rostral fronts and in telsons may occur without impairing the reproductive potential of the animal. Similar wide variation is found in species of the Crinitus group of *Alpheus,* a group that also inhabits sponges. Thus we believe that when enough specimens from these sponges are studied, the variation will not only encompass this form and de Man's *S. theano,* but also the form that Dana described as *S. neptunus.*

Distribution: *S. neptunus* is widespread. It has been reported from as far south as Northern Australia and also from the Red Sea, Indonesia, Hongkong, China, Japan, Galapagos Island and the west coast of Central America. We have collected it from Fiji and from the Gilbert Islands.

ALPHEUS

Alpheus Fabricius, 1798. Suppl. Ent. Syst. p. 380, 404

Crangon Weber, 1795. Nomencl. Entomol. p. 94.

Type Species: *Alpheus avarus* Fabricius

Definition: Carapace anteriorly developed into orbital hoods which completely enclose eyes except on ventral side. Orbital hoods frequently with spiniform apex and usually demarked from rostral base by more or less pronounced depressions. Rostrum usually present and carapace often with at least slight rostral carina. Pterygostomial margin of carapace rounded.

Antennules usually short, frequently with basal peduncular article and stylocerite reduced. Scaphocerite frequently reduced; basicerite either armed with inferolateral spine or rounded; carpocerite usually reaching to or beyond end of scaphocerite.

Chela of first legs of very asymmetrical development. Large chela of variable form, from subconical to compressed and twisted, surfaces from smooth and entire to deeply sculptured with grooves and pronounced "alpheopsidean" lobes. Dactylus usually with pis-

tonlike process that fits into cavity on fixed finger and always with digital and palmar adhesive plaques. Chela always carried extended from body. Large cheliped with hemispherical carpus, with merus at least somewhat triangular in section. Small chela of simple form, at times showing marked sexual dimorphism.

Carpus of second legs of five articles of variable proportions.

Third and following legs robust, compressed; armature and proportions of merus, carpus, and propodus various, dactylus simple or biunguiculate. Fifth legs with "brush" on propodus.

Abdomen usually without lateral compression, with pleura in females larger than those of males and usually without acute projections on margins. Pleura of sixth abdominal segment not jointed. Telson usually with posterior margin convex and lateral angles distinct but not acute. Anal tubercles almost always well developed.

Branchial formula: 5 pleurobranchs, 1 arthrobranch, 8 epipodites, and sometimes a supplementary arthrobranch on first thoracic legs (except in *A. paragracilis* Coutière and *A. clippertoni* Schmitt).

Discussion: This genus was divided into five major subgeneric "groups" by Coutière in 1899, and subsequently one of the groups was further divided into three "subgroups" by Coutière in 1905. As originally defined to contain the limited number of species then known, the "groups" were distinct. However, the subsequent addition of new species demanded the redefinition of the groups so that no one group can be clearly separated from any other by more than a few ambiguous characteristics. Moreover, Coutière's method of naming the subgeneric groups after a "typical species" is at odds with the modern rules of nomenclature. Thus the "groups" have no true status.

Nevertheless, we have continued to use them as a device to separate the large number of species in this genus, for in most cases a species can be placed in the correct group by rather superficial and rapid examination, and it is only an occasional species that violates the characteristics used in the definition of the group. We have ignored the category of "subgroup", elevating the three to equal status of the other groups.

The definitions adapted from de Man (1911) will be given in the text under each group.

While we have arranged the species in the text according to these groups, and within the group somewhat according to the arrangements in de Man's 1911 keys, we have not attempted to use characters in the following key to the species which would make them follow this arrangement. Rather we have tried to use characteristics that would facilitate the use of key, deemphasizing the easily-lost chelae and sexually dimorphic traits as much as possible.

KEY TO THE SPECIES OF THE ALPHEUS IN MALAYO-THAI WATERS

1. With orbital teeth 2
   Without orbital teeth 9

2(1). With strong and acute tooth on merus of third leg 3
   Without tooth on merus of third leg 4

3(2). Inner face of both chelae obscured by dense hair; dactylus of third leg simple, merus without movable spinules . . . . . *A. deuteropus* (p. 80)
   Inner face of both chelae with only scattered hairs; dactylus of third leg biunguiculate, merus with movable spinules . . . . . *A. collumianus probabilis*[4] (p. 83)

4(2). With movable spines on inferior internal margin of merus of large cheliped 5
   Without movable spines on inferior internal margin of merus of large cheliped 8

5(4). Dactylus of third leg simple, slender and with acute tip 6
   Dactylus of third leg either with accessory tooth on superior margin or with heavy and blunt tip 7

6(5). Merus of large cheliped only slightly longer than broad, with inferior internal tooth terminal . . . . . *A. gracilis simplex* (p. 97)
   Merus of large cheliped about 4 times as long as broad, with inferior internal tooth subterminal . . . . . *A. supachai* (p. 89)

7(5). Rostral carina separated from orbital hoods by deep grooves; dactyl of third leg heavy and blunt . . . . . *A. lottini* (p. 91)
   Without rostral carina or deep orbitorostral grooves; dactyl of third leg slender, acute and with accessory tooth on superior margin . . . . . *A. crockeri* (p. 84)

4. The other two subspecies of this species are without the spinules on the merus of the third legs, and one has a simple dactylus (Banner, 1956 : 338).

8(4). With orbital teeth arising from frontal margin of orbital hoods; merus of large cheliped with acute tooth . . . . . *A. facetus* (p. 96)

With orbital teeth arising from curved surface of orbital hood itself, above frontal margin; merus of large cheliped unarmed . . . . . *A. pomatoceros* (p. 93)

9(1). Palm of large chela with shoulders, depressions, grooves or other sculpture, usually pronounced; if slight, then with hammer-shaped dactylus 10

Palm of large chela with surfaces smooth and entire, without sculpturing; never with hammer-shaped dactylus 34

10(9). With acute tooth on merus of third leg 11

Without tooth on merus of third legs 18

11(10). With dactylus of large chela hammer-shaped 12

With dactylus of large chela usually heavy but not hammer-shaped 14

12(11). Scaphocerite reaching only to distal portion of second antennular article, carpocerite to proximal portion of third; second carpal article of second leg usually less than 1.5 times first . . . . . *A. malleodigitus* (p. 103)

Scaphocerite and carpocerite reaching to or beyond end of antennular peduncle; second carpal article usually 3 times as long as first 13

13(12). Squamous portion of scaphocerite reaching to near middle of third antennular article . . . . . *A. microstylus* (p. 105)

Squamous portion of scaphocerite reaching only to near middle of second antennular article . . . . . *A. obesomanus* (p. 101)

14(11). First carpal article of second legs less than half length of second . . . . . *A. acutofemoratus* (p. 87)

First carpal article of second legs from slightly shorter to much longer than second article. 15

15(14). Inferior internal margin of merus of large cheliped with movable spines 16

Inferior internal margin of merus of large cheliped without movable spines 17

16(15). Merus of third legs bearing dense setae; first carpal article of second legs about 2/3 length of second article . *A. edamensis* (p. 157)

Merus of third leg without setae; first carpal article of second leg about 1.5 times length of second article . . . *A. hippothoe* (p. 151)

17(15). With lateral spine of basicerite reaching to near middle of second antennular article; outer face of palm of chela with only a slight longitudinal groove . . . . . *A. parvirostris* (p. 149)

With lateral spine of basicerite not reaching to end of first antennular article; outer face of palm of large cheliped with extensive saddle-shaped depression . . . . . *A. fumafutensis* (p. 155)

18(10). Dactylus of third legs flattened on inferior surface, subspatulate in form 19

Dactylus of third legs simple and conical 23

19(18). Superior margin of palm of large chela only with narrow notch; palm without extensive depressions 20

Notch of superior margin of large chela broad and continuous with extensive saddle-shaped depression on palm 21

20(19). Fingers of large chela with tips acute and strongly curved inwardly toward midline of body . . . . . *A. cythereus* (p. 123)

Fingers of large chela heavy, blunt and in line with axis of chela . . . . . *A. rapax* (p. 121)

21(19). Small chela of both sexes with fingers equal to or shorter than palm; propodus of third leg with several movable spinules but without heavy setae . . . . . *A. euphrosyne* (p. 130)

Small chela with fingers markedly longer than palm; propodus of third leg without spines but bearing heavy setae 22

22(21). Small chela with fingers straight and 3 times length of palm . . . . . *A. malabaricus malabaricus* (p. 145)

Small chela with fingers hooked and crossing, about 1.5 times as long as palm . . . . . *A. malabaricus songkla* (p. 147)

23(18). Rostral base between orbital hoods flattened, with margins overhanging orbito-rostral grooves 24

Rostral base between orbital hoods rounded to carinate with curve of margins continuous with orbitorostral grooves, not overhanging 26

24(23). Orbital hoods produced anteriorly into a rounded vertical keel; rostral base broad . . . . . *A. gracilipes* (p. 112)

Orbital hoods anteriorly rounded; rostral base narrow 25

25(24). Rostrum awl-shaped; depression on faces of large chela parallel to superior margin . . . . . *A. proseuchirus* (p. 126)

Rostrum a narrow triangle; depression on faces of large chela saddle-shaped . . . . . *A. bisincisus* (p. 125)

26(23). With lateral spine of basicerite reaching to near middle of second antennular article; outer face of palm of large chela with only slight longitudinal groove . . . . . *A. parvirostris* (p. 149)

With lateral spine of basicerite, if present, small, and not reaching to end of first antennular article; sculpturing of outer face of palm of large chela various or absent, but never with slight longitudinal groove 27

27(26). Depression on inferior margin of large chela proximal to dactylar articulation rounded and not associated with any depression on palmar face . . . . . *A. ehlersi* (p 114)

Depression on inferior margin of large chela extending into palmar face and demarked proximally by a more or less abrupt shoulder 28

28(27). Proximal margin of transverse groove of superior margin of large chela rounded or at most at right angles to margin 29

Proximal margin of transverse groove of superior margin overhanging floor of groove 32

29(28). Rostrum slight, reaching but slightly beyond end of orbital hoods; first carpal article of second legs about 3 times length of second article . . . . . *A. microrhynchus* (p. 133)

Rostrum narrowly triangular and reaching to or beyond middle of visible part of first antennular article; first carpal article of second legs at most 2 times length of second article 30

(30)29. Upper depression on inner palmar face of large chela short and "U"-shaped, depression on outer face small and triangular . . . . . *A. leviusculus* (p. 128)

Upper depression on inner palmar face triangular, depression on outer face extensive and roughly quadrangular 31

31(30). Outer margin of scaphocerite deeply concave; depression on outer palmar face of large chela restricted to distal half; fingers of small chela of both male and female definitely longer than palm . . . . . *A. sudara* (p. 153)

Outer margin of scaphocerite slightly concave; depression on outer palm of large chela extending into proximal half; fingers of small chela of female roughly equal in length to palm, those of male definitely shorter . . . . . *A. crassimanus* (p. 138)

32(28). Small chela of neither males nor females with balaeniceps dactylus; with short bristles on either side of the rostrum . . . . . *A. pacificus* (p. 143)

Small chela of mature males at least with balaeniceps dactylus; no short bristles on rostrum 33

33(32). Dactylus of small chela of female normal, that of male balaeniceps; inferior internal margin of merus of large chelipeds without movable spinules . . . . . *A. audouini* (p. 135)

Dactyls of both male and female balaeniceps; inferior internal margin of merus of large cheliped armed with short movable spinules . . . . . *A. strenuus* (p. 140)

34(9) Dactylus of third leg biunguiculate 35

Dactylus of third leg simple 36

35(34). Inferior margin of merus of third legs bearing a number of strong movable spinules; without teeth on the medial posterior margin of the sixth abdominal segment . . . . . *A. alcyone* (p. 107)

Inferior margin of merus of third legs armed only with setae; sixth abdominal segment with several acute teeth above articulation of telson . . . . . *A. paralcyone* (p. 108)

36(34). Merus of third legs with strong tooth . . . . . *A. bucephalus* (p. 110)

Merus of third legs unarmed 37

37(36). Margins of large chela without setae; merus of chelipeds usually with a strong subterminal tooth; dactyls of third leg conical . . . . . *A. paracrinitus* (p. 115)

Margins of large chela bordered with heavy setae; merus of chelipeds always without subterminal tooth; dactyls of third legs subspatulate 38

38(37). Rostrum bearing sharp carina continuing posteriorly to and beyond acute mid-dorsal tooth; all legs elongate and thin (merus of third leg about 20 times as long as broad) . . . . *A. acutocarinatus* (p. 120)

Rostrum and anterior carapace with neither sharp carina nor mid-dorsal tooth; legs of more normal proportions (merus of third legs less than 5 times as long as broad) . . . . . *A. rapacida* (p. 118)

MEGACHELES GROUP

Orbital teeth present except in *A. collumianus inermis* Banner. Large chela moderately compressed, twisted and bearing heavy crest leading to adhesive plaque and dactylar articulations; almost always with transverse groove in superior crest. Merus and dactylus of third legs variable.

Alpheus deuteropus Hilgendorf–Figure 26

Alpheus deuteropus Hilgendorf, 1878. K. Akad. Wiss. Berlin, Monats. 1878:834, pl. 4, fig. 8-10. Coutière, 1899. Les Alpheidae p. 215, fig. 254, 255 (fig. of large chela). Banner & Banner, 1964. Pacific Sci. 17(1):88.

Crangon deuteropus Banner, 1953. Pacific Sci. 7(1):70-72, fig. 22 a-g.

Specimen Drawn: 25 mm. male from BR 31.

Description: Rostrum acute, curved upward, reaching to middle of first antennular article. Rostral carina sharp, narrow, constricted

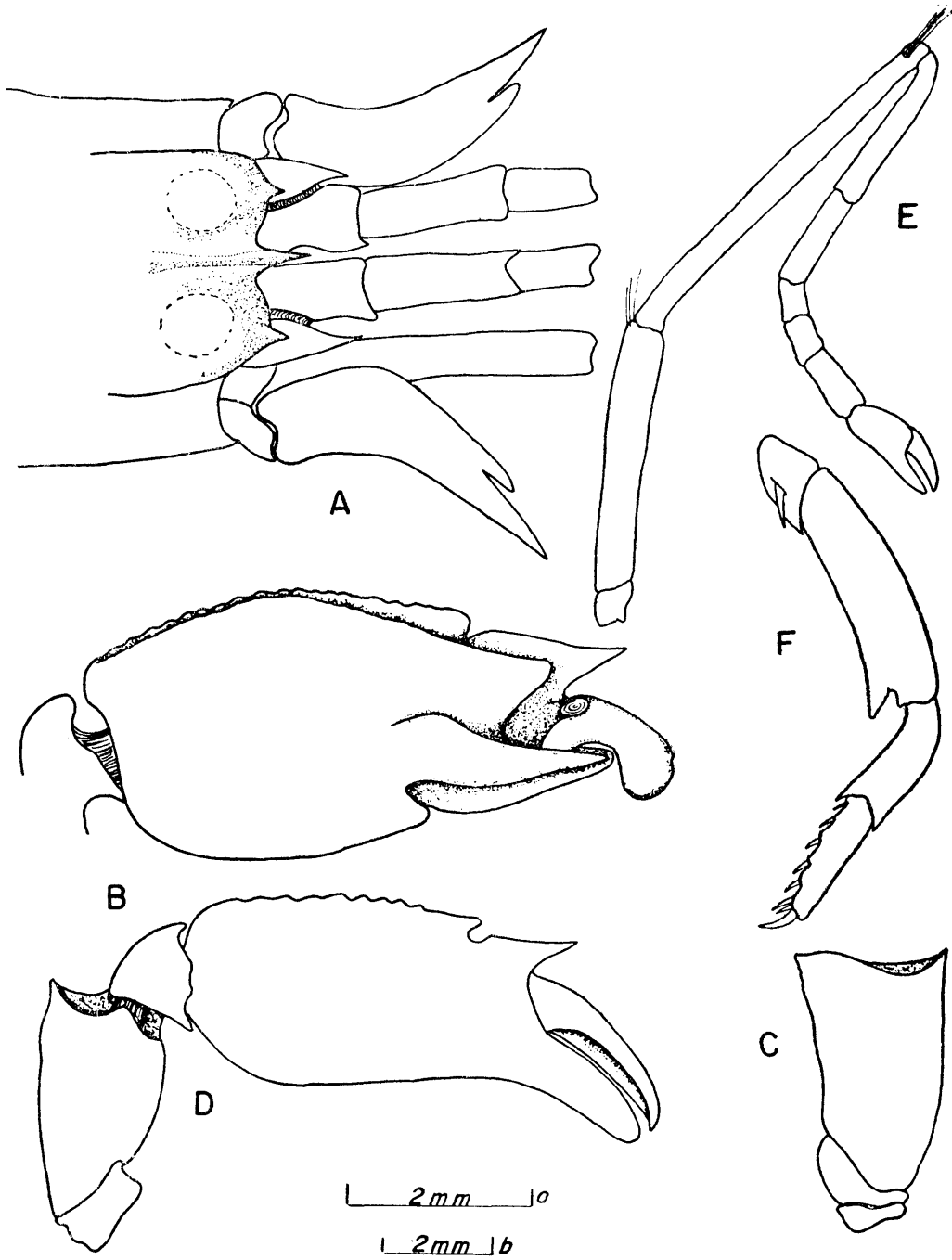

FIGURE 26

Alpheus deuteropus Hilgendorf. A. Anterior region, dorsal aspect; B, Large chela, outer face; C, merus, large chela; D, small chela, inner face; E, second leg; F, third leg. (Dense setae of appendages not shown). (A, scale a; B–F. scale b).

near middle, extending just posterior to base of eyes. Tips of acute orbital teeth reaching almost to middle of rostrum. Margin between orbital teeth and rostrum evenly curved, forming narrow shelf. Orbitorostral grooves deep anteriorly, disappearing at level of end of carina.

Second article of antennular peduncle slender, 3 times as long as broad, 1.5 times as long as visible portion of first and about twice as long as third article. Lateral spine of stylocerite almost as long as visible portion of first and about twice as long as third article. Lateral spine of stylocerite almost as long as first antennular article. Lateral spine of scaphocerite strong, reaching to end of antennular peduncle; squamous portion reaching to or slightly beyond second antennular article. Carpocerite as long as antennular peduncle. Lateral spine of basicerite strong, as long as rostrum. Bases of antennules and antennae densely hirsute.

Large chela densely hirsute and papillate on inner face and upper margin with the hairs arising from the papillae. Chela about two times as long as high with fingers approximately a quarter the length of entire chela. Upper margin bearing a deep transverse groove proximal to dactylus and distally projecting as a long subacute tooth. Superior groove deep but short. Plaque crest heavy, soon merging with face of palm. Inferior crest heavy, well defined, but not extending proximal of shoulder of inferior depression, distally ending in strong acute tooth. Inferior depression shallow; shoulder slight and rounded. Fixed finger short and emarginate at tip to receive dactylus. Dactylus rotated to close laterally and distally across end of chela, compressed and sharply carinate. Carpus relatively large. Merus heavy, 1.6 times as long as broad, with superior distal angle subacute.

Small chela 2.6 times as long as wide, densely hirsute in a manner similar to large chela. Superior margin irregular, bearing a deep transverse groove proximal to dactylar articulation over which the upper margin projects as a rounded tooth, margin terminating in a long projecting tooth. Fingers laterally compressed, thin at cutting edge. Merus heavy, twice as long as wide, without teeth.

Second leg with ratio of carpal articles: 10:6:2:2:4.

Ischium of third leg with spine. Merus 3.5 times as long as wide, armed with strong tooth distally on inferior internal margin; superior margin bearing sparse but long setae. Carpus and propodus subequal in length, propodus carrying on its inferior margin 6 short, heavy movable spines. Dactylus short, simple, acute, strongly curved.

Telson 2.6 times as long as posterior margin is wide. Outer margin of anterior half evenly convex, lower half straight-sided, posterior margin broadly arcuate.

Thai specimens reaching up to 30 mm. in length.

Discussion: This species is variable in its relative measurements: in some the orbital teeth and the rostrum are subequal in length; the stylocerite, relative lengths of the scaphocerite to carpocerite, and antennular peduncle, all vary. However, it can be readily recognized by the extremely hirsute condition of the inner face of the chela. At first glance it might be confused with *A. acutofemoratus* Dana which also occurs in Thai-Malayan waters and possesses a hairy chelae, but this species does not have orbital teeth and the large chela is without the heavy sculpturing.

Throughout the Pacific (and presumably the Indian Ocean) this species is always found in pairs in branching fissures of many genera of the more massive living corals. The fissures, which are open to the surface of the coral, are often several centimeters deep and have yet deeper pockets into which the shrimp may retire. The fissures are usually lined by a fine filamentous algae (Banner and Banner, 1964:88).

Distribution: All specimens in the present collection came from Phuket island. The specimens from BR 31 were from a sparsely branching and flattened form of *Acropora sp.* which was exposed at low tide. In this species of coral, the winding fissures had edges colored light blue. The other specimens were collected from massive living heads of *Porites* sp. In this species fissures were shorter and deeper than those in the *Acropora*. These fissures were seen in some of the massive *Porites* in the Gulf of Thailand but we were unable to collect them because of the great size of the heads. Collection data: 5 specimens from BR 31; 5, BR 35; 13, BR 38; 1, BR 39.

This species has been collected at Djibouti and Zanzibar on the African coast, and in the Maldives and Laccadives in the Indian Ocean. In the Pacific it has been collected from the Mariana, Marshall, Christmas, Samoa and Hawaiian Islands.

Alpheus collumianus probabilis Banner–Figure 27

Alpheus collumianus Stimpson, 1861. Acad. Nat. Sci. Philadelphia, Proc. 12:30.

Alpheus collumianus probabilis Banner, 1956. Pacific Sci. 10(3): 338, fig. 10.

Specimen Drawn: 17 mm. male from BR 38.

Description: Rostrum acute, reaching almost to end of first antennular article. Rostral carina strong, extending posteriorly to base of orbital hoods. Orbital hoods inflated and bearing short acute orbital teeth; orbitorostral grooves rounded and of medium depth. Anteromedial margin of orbital hoods extended as a flattened, rounded prominence.

Antennular peduncle with second article 3 times as long as broad. Visible part of first article and third article subequal, each about half as long as second. Stylocerite with well-developed spine reaching almost to end of first antennular article. Lateral margin of scaphocerite strongly concave. Spine as long as antennular peduncle; squamous portion reduced, reaching only slightly beyond end of second antennular article. Carpocerite as long as antennular peduncle. Basicerite with strong lateral spines reaching almost to end of first antennular article.

Large chela heavy, compressed, 2.4 times as long as broad, with dactylus slightly over 0.2 as long as entire chela. Superior crest distal to transverse groove strong, narrow, ending in a strong tooth, but crest proximal to transverse groove indistinct. Plaque crest heavy and rounded; superior and palmar grooves deep and distinct on distal third of face of palm. Inferior crest well developed and acute. Inferior depression deep and sharply delimited; shoulder rounded. (For explanation of these terms see Banner: 1953, fig. 17e). Chela bearing scattered setae. Merus 1.4 times as long as internal face is

broad at point of maximum width; inferior internal margin bearing 6 short strong spines and terminating distally in strong acute tooth.

Small chela 2.8 times as long as broad with curved, heavy fingers occupying half of its length. Superior crest present, terminating distally in strong tooth, proximally at transverse groove; palmar crest and associated groove poorly demarked. Merus 1.8 times as long as wide; armed with 6 movable spines on the inferior internal margin and small, sharp tooth distally.

Carpal articles of second leg: 10:8:3:3:4.

Third leg with ischium bearing strong movable spine. Merus 3.8 times as long as broad with inferior margin bearing 5 strong spines and terminating distally in strong acute tooth. Carpus heavy, 0.4 as long as merus, often bearing 1 or 2 movable spinules at mid-section. Superior margin terminating in rounded tooth, inferior margin with movable spinule. Propodus 0.6 as long as merus bearing 7 movable spines. Dactylus biunguiculate.

Telson 3.3 times as long as broad at posterior end.

Thai specimens reaching up to 18 mm. in length.

Discussion: 5 specimens of this subspecies were collected at Phuket (BR 38). It is related to *A. collumianus inermis* Banner and *A. collumianus medius* Banner which are known to coexist in the Pacific, but these latter subspecies have not appeared in our present collections. There is some question about the validity of the subspecies.

Distribution: The original subspecies was collected in the Mariana Islands. It is also known from the Marshall, Fiji, Tonga, and Samoa Islands.

The parent species is known from as far north as Japan (the type locality), and as far south as Northern Australia and New Caledonia. It was found in Indonesia and the Ellice Islands. It has also been collected at Djibouti and the Maldive and Laccadive Archipelagoes.

Alpheus crockeri (Armstrong)–Figure 28

Crangon crockeri Armstrong, 1941. American Mus. Nov. (1137): 8, fig. 2,3.

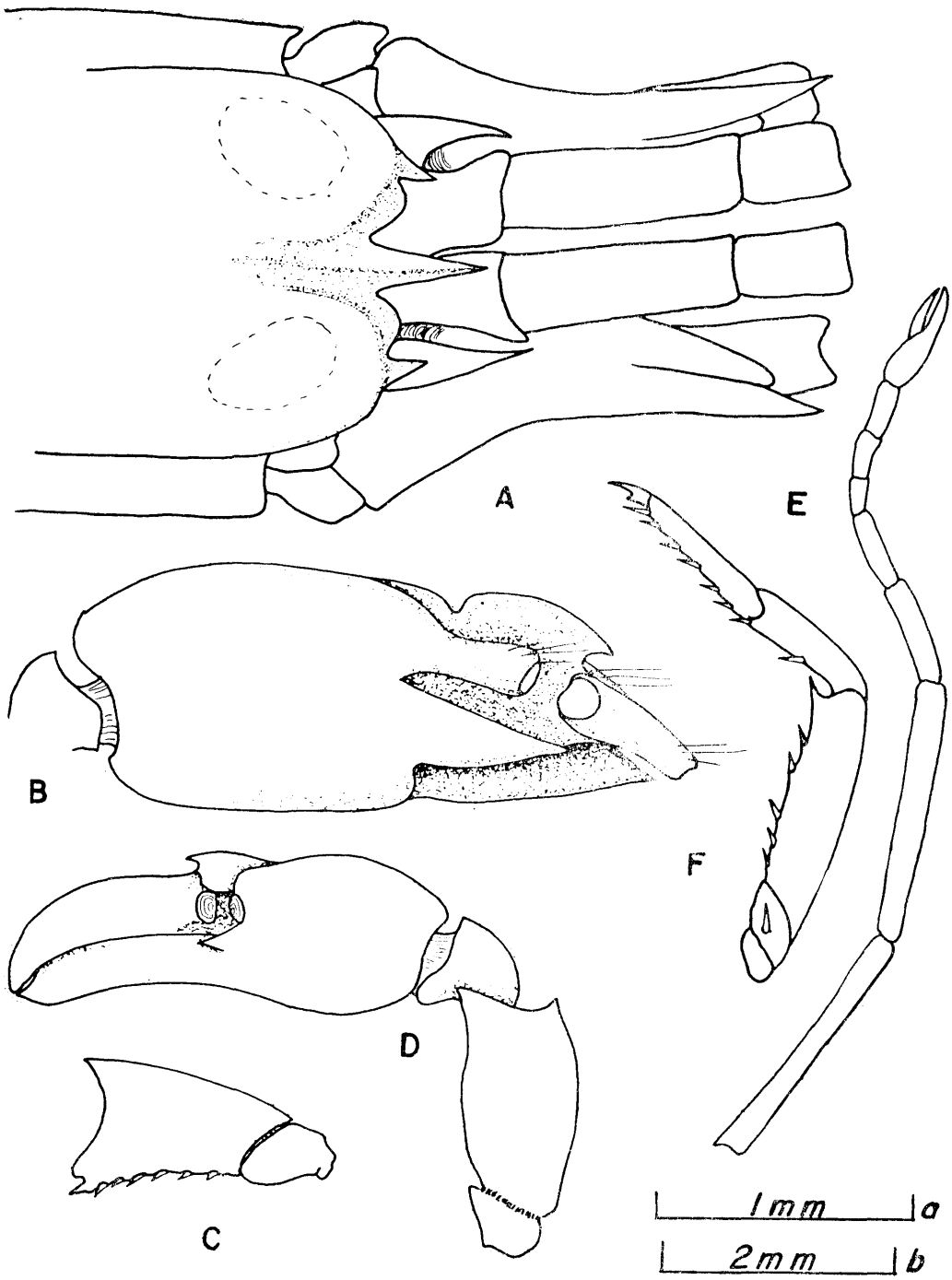

FIGURE 27

Alpheus collumianus probabilis Banner. A, Anterior region, dorsal aspect; B, large chela, outer face; C. merus, large chela; D, small chela, outer face; E, second leg; F, third leg. (A, scale a; B-F, scale b).

Crangon tuthilli Banner, 1953. Pacific Sci. 7(1):63, fig. 19.
Alpheus tuthilli Banner, 1956. Pacific Sci. 10(3):338, fig. 9.

Specimen Drawn : 15 mm. male from BR 28, small cheliped of female from BR 34.

Description : Rostrum slender, reaching to middle of visible part of first antennular article, anterior carapace smoothly rounded, without trace of orbitorostral grooves. Orbital teeth short, reaching about 0.7 the length of rostrum, directed inwards.

Second antennular article 2 times as long as wide, a little longer than visible part of first; third antennular article 0.6 length of second. Stylocerite reaching to end of first antennular article. Lateral margin of scaphocerite very slightly concave, tip of lateral spine reaching end of antennular peduncle and only slightly longer than squamous portion. Squamous portion broad in middle, tapering distally. Carpocerite a little longer than antennular peduncle. Lateral spine of basicerite pronounced, reaching to end of rostrum.

Large chela compressed, only moderately heavy, 3.3 times as long as broad, and with distal sculpturing reduced. Superior crest low, rounded, terminating as relatively small acute tooth above dactylar articulation. Transverse groove lacking. Superior groove shallow and broad. Plaque crest low, rounded but merging with superior margin of palm. Palmar groove rounded, more narrow than superior groove. Inferior ridge slight, rounded, distally ending as an acute tooth below dactylar articulation. Inferior depression slight, shoulder low, gradual, and rounded. Dactylus highly compressed and twisted with proximal portion narrow and crested, distal portion expanded and bulbous. Carpus of usual form. Merus 2.3 times as long as broad, inferior internal margin armed with 9 small movable spinules and large terminal tooth. Ischium with 4 spines on inferior margin and 1 on the distal end of superior margin.

Small chela 5.4 times as long as wide, with fingers a little shorter than palm, bearing sharp tooth on either side of articulation of dactylus. Fingers long and thin, slightly curved, with crossing tips. The opposing faces of fingers produced as a cutting edge, flanked on inner side by row of short, stiff setae. Dactylus crested,

thin, with inner face concave, giving article a leaf-like appearance. Merus 3.5 times as long as broad, inferior internal margin bearing 6 movable spines and one small tooth distally. Ischium with 3 spines on internal margin.

Second leg with ratio of carpal articles: 10:5:2:2:4.

Third leg slender. Ischium with movable spine; merus unarmed, 7.5 times as long as broad. Carpus 0.5 as long as merus with both distal angles rounded. Propodus 0.7 length of merus, armed with 6 movable spines on inferior margin and a pair at distal extremity. Dactylus slender, 6 times as long as wide at base with superior margin bearing an auxiliary tooth about two-thirds length from base.

Telson 3 times as long as posterior margin is wide; lateral margins slightly convex in anterior portion, posterior portion straight. Posterior margin truncate.

Thai specimens reaching 18 mm. in length.

Discussion : The species from Hawaii named *A. tuthilli* (Banner) is being placed in synonymy in a forthcoming paper.

Of the species from Thailand, at first glance this may be confused with *A. supachai sp. nov.* However the large chela bears definite grooves and crests in this species, and in *A. supachai* it is smooth. From the closely related *A. collumianus probabilis* it can be separated most easily by its possession of a more slender large chela which carries a distally expanded and bulbous dactylus; there are also differences in the orbitorostral grooves and proportions of the thoracic legs.

The only major difference noted between the Thai specimens and those from Samoa (the type locality) and Hawaii is the appearance of the small chela. In the Central Pacific specimens the fingers of the small chela were longer than the palm and in the Thai specimens they are shorter. There is a difference in the number of spinules on the meri of the large and small chela but this is known to be a variable character in other species.

Distribution : The 8 specimens were all found in dead coral heads taken from the outer reef edge in about 2 meters of water.

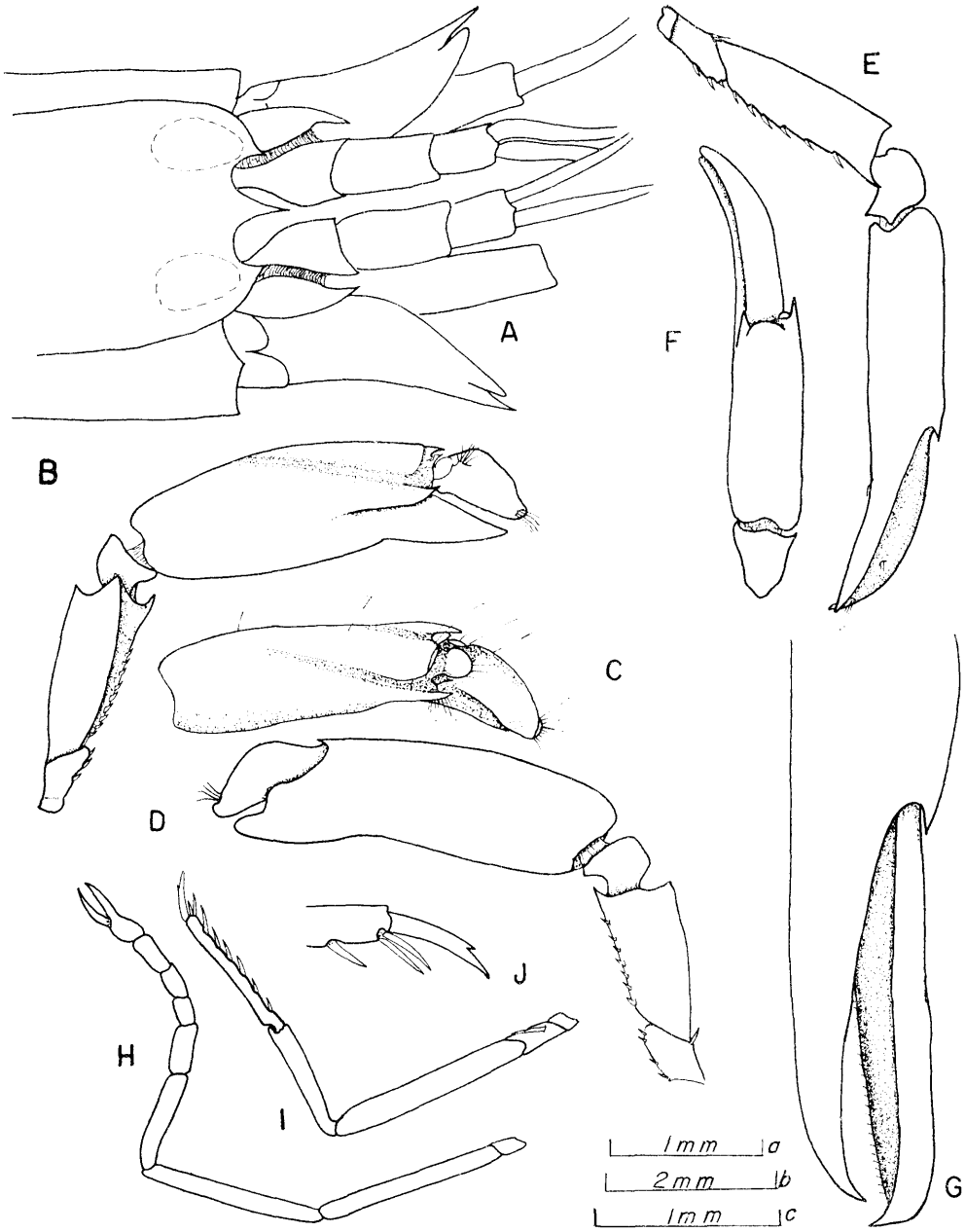

FIGURE 28

Alpheus crockeri Armstrong. A, Anterior region, dorsal aspect; B, large cheliped; C, superior margin; D, inner face; E, small cheliped of female, lateral view; F, small chela, superior margin; G, enlarged view of dactylus; of small chela; H, second leg; I, third leg; J, dactylus. (A, G, scale a; B, D, H, I, scale b; C, E, F, J, scale c).

2 were found in the Gulf of Thailand near Koh Samit, Chumporn and the others were found at Phuket. Collection data: 2 specimens from BR 28; 3, BR 31; 3, BR 34.

The type locality is Samoa; we also have specimens from Hawaii and Saipan.

MACROCHIRUS GROUP

Orbital teeth usually present. Large chela usually moderately compressed, margins rounded, with longitudinal grooves but transverse groove lacking. Merus and dactylus of third leg variable. External spine of uropod usually black.

Alpheus acutofemoratus Dana–Figure 29

Alpheus acutofemoratus Dana, 1852. U.S. Explor. Exped. 13:550, pl. 35, fig. 2. De Man, 1902. Sencken. Naturf. Gesell., Abhandl. 25:886, pl. 27, fig. 63.

Alpheus parabrevipes Coutière, 1898b. Soc. Ent. France, Bull. (6):151.

Nec Alpheus acutofemoratus Spence Bate, 1888. Challenger Rpts. 24:545, pl. 97, fig. 2.

Specimen Drawn: 15 mm. female from BR 18.

Description: Rostrum triangular, acute, reaching to middle of first antennular article, distally tilted upward. Rostral carina sharp, straight sided, reaching posteriorly to beyond end of orbital hoods. Orbital hoods inflated, rounded anteriorly, posteriorly merging with carapace, separated from rostrum by deep grooves. Anterior margins of orbital hoods uniformly rounded.

Second antennular article 2.4 times as long as broad, about 2.0 times as long as visible part of first antennular article; third article equal in length to first. Stylocerite with spine acute, not reaching to end of first antennular article. Scaphocerite with outer margin strongly concave, lateral spine longer than antennular peduncle; squamous portion narrow, reaching only to end of antennular peduncle. Carpocerite equal in length to antennules. Lateral spine of basicerite acute, a little shorter than spine of stylocerite.

Large chela of male massive, somewhat flattened on outer face and markedly rounded on inner surface Inner surface densely hirsute with bases of hairs forming a papillate surface. Upper margin bearing sharp transverse groove proximal to dactylus, directed obliquely toward outer face; groove joining narrow but deep longitudinal groove located on upper fourth of outer face; longitudinal groove extending proximally towards middle of palm. Dactylus bearing sharp ridge on superior margin. Merus thick, 1.3 times as long as broad. Inferior internal margin armed with strong subterminal tooth; upper margin unarmed but beset with short setae. Cheliped of female smaller but of similar proportions.

Small chela 3.0 times as long as broad, fingers occupying 0.4 of entire chela; articulation of dactylus armed with strong tooth. Inner surface hirsute, similar to large chela. Merus 3.0 times as long as broad with strong tooth on distal end of inferior internal margin.

Ratio of carpal articles of second leg: 10:30:9:9:18.

Ischium of third leg bearing movable spine. Merus 3 times as long as broad with strong subterminal tooth on inferior margin. Carpus 0.4 as long as merus, bearing strong tooth on distal end of inferior margin; propodus 0.5 as long as merus, bearing 6 pairs of movable spines on inferior margin. Dactylus simple.

Telson 2 times as long as its posterior margin is broad; anterior margin 1.6 times as broad as posterior end, lateral margins straight, slightly tapering toward the posterior end. Posterior margin arcuate.

Thai specimens reaching 20 mm. in length.

Discussion : This species can be easily recognized by the narrow, oblique groove proximal to the dactylus on the large chela and the hirsute condition of the inner face of the chelae. Notable variation occurs in the ratio of the first 2 secondary carpal articles of the second legs, which varies from 10:25 to 10:35. Other proportions, except the size of the sexually dimorphic large chela, are relatively constant.

This species was found in heads of dead coral in both the Gulf of Thailand and the Indian Ocean. Collection data : 4 specimens from BR 18; 2, BR 32; 1, BR 34; 2, BR 38.

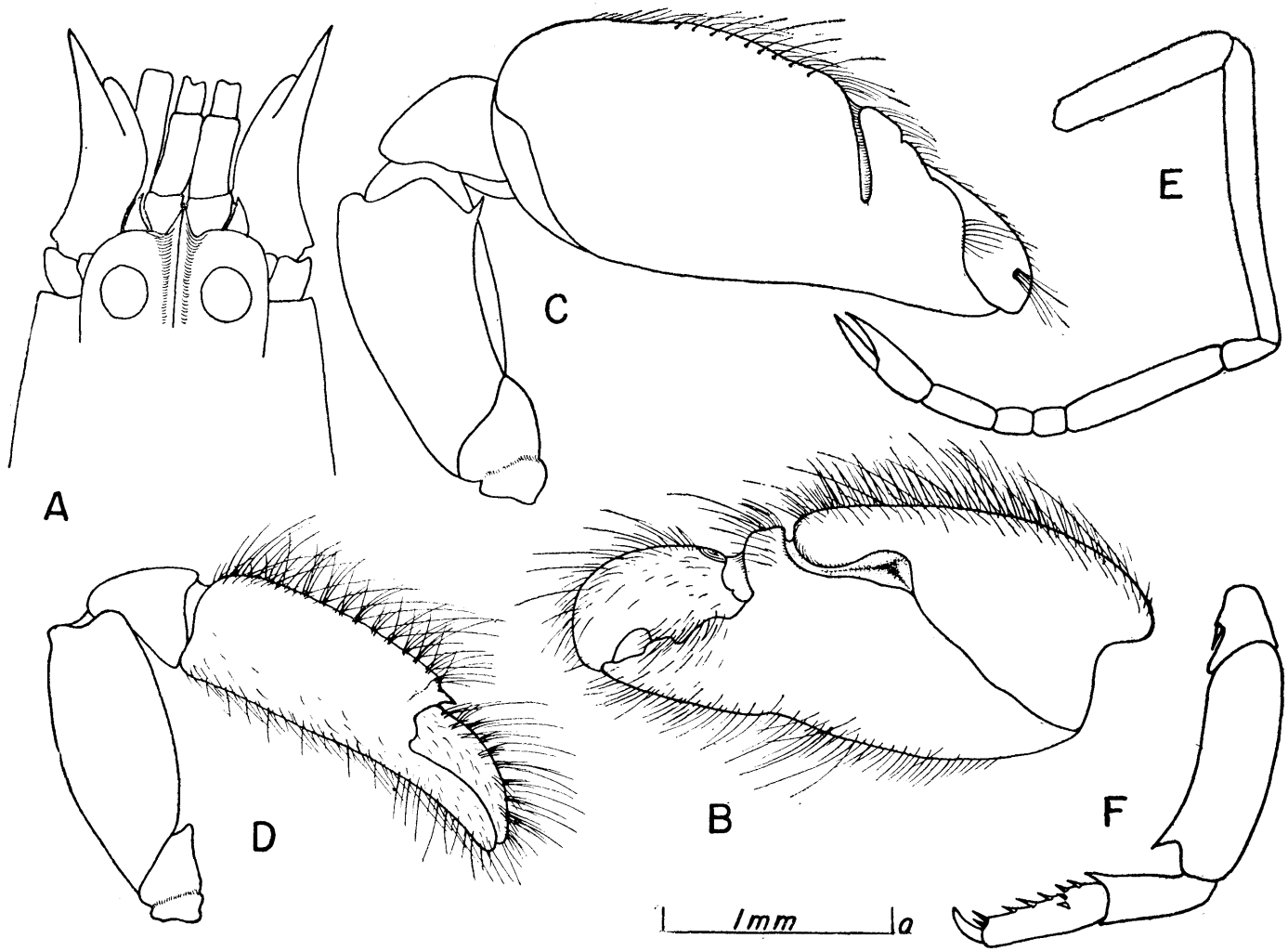

FIGURE 29

Alpheus acutofemoratus Dana. A, Anterior region, dorsal view; B, large chela, outer face; C, large cheliped, inner face; D, small cheliped; E, second leg; F, third leg. (All figures scale a).

This species has been collected in Indonesia and the Philippines. We have collected it from Samoa and Fiji.

Alpheus supachai species nov.—Figure 30

Type Specimen : A 15 mm. male from BR 30. Collected from dead coral head in 3 m. of water at Koh Samui on the west side of the Gulf of Thailand. **Paratypes :** 2 males and one female from the same locality.

Description : Rostrum triangular, 1.7 times as long as broad at its base; tip reaching almost to end of first antennular article; slightly rounded dorsally, without carina. Orbital teeth dorsally flattened, short and acute. Margin between orbital teeth and rostrum broadly curving. Slight rostral grooves not reaching posteriorly to middle of eyes.

Second antennular article 1.5 times as long as broad, with length equal to visible part of first and almost 1.5 times length of third article. Stylocerite broad, with spine reaching to end of first antennular article. Scaphocerite with lateral margins almost straight, lateral spine reaching to end of antennular peduncle and only a little longer than moderately slender squame. Carpocerite a little longer than antennular peduncle. Lateral spine of basicerite acute, not reaching end of stylocerite.

Large chela elongate, 4 times as long as broad, without ridges or grooves but with lower margin slightly concave opposite articulation of dactylus. Fingers occupying distal 0.3 of entire chela; dactylus compressed, upper margin bearing sharp ridge its entire length. Merus 4.4 times as long as broad; strong subterminal tooth on inferior internal margin and with two movable spinules proximally on the same margin.

Small chela slender, showing sexual dimorphism. In both sexes chela 5 times as long as broad, with fingers a little shorter than palm. In male, dactylus sub-balaeniceps in form; dactylus in female slender, without fringe of setae. Merus 5 times as long as broad with strong subterminal tooth, similar to large chela but without spines.

Second leg with ratio of carpal articles : 10:6:3:3:4.

Third leg with ischium elongate, unarmed. Merus 2.2 times as long as ischium, 6 times as long as broad, unarmed. Carpus a little longer than ischium. Propodus 0.9 length of merus, bearing 5 strong spines on inferior margin. Dactylus simple, curved, 0.3 length of merus, and 6 times as long as broad at base.

Telson 3.4 times as long as posterior margin is broad. Sides gradually tapering, tip slightly arcuate.

Thai specimens reaching 15 mm. in length.

Discussion : This species has been placed in the Macrochirus Group because of the shape of the large chela and the presence of orbital teeth. Within the group, the presence of orbital teeth places it near *A. lottini* Guérin, *A. facetus* de Man, *A. splendidus* Coutière, *A. pomatoceros* Banner & Banner (*vide infra*), and *A. edmondsoni* (Banner). It differs from *A. lottini* by lacking deep orbito-rostral grooves and a thickened dactylus on the walking legs; from *A. facetus* by the lack of a longitudinal ridge on the superior margin of the large chela; from *A. splendidus* and *A. pomatoceros* in the orbital teeth, which extend from the frontal margin of the carapace in this species instead of the surface of the orbital hoods as in the other two. It is very close to *A. edmondsoni* (Banner, 1953:78, fig. 26). It can be distinguished from this species by three major differences: First, the small chela of the male of this species is definitely sub-balaeniceps, while mature male and female specimens of *A. edmondsoni* show no sexual dimorphism. Second, the meri of both chelipeds in *A. edmondsoni* carry numerous fine movable spines, while in this species the large cheliped carries only two strong movable spines which are lacking on the small cheliped, but both are armed with a strong subterminal tooth. Third, the dactylus of the third legs is 5 times as long as broad at the base in this species, and only 3 times as long as broad in *A. edmondsoni*. In addition there are slight differences in the proportions of the large chela, 3.4 times as long as broad in *A. edmondsoni* and 4.0 times as long as broad in *A. supachai*, and in the length of the spine of the stylocerite which in *A. edmondsoni* reaches to the middle of the second antennular article.

The specific value of these characteristics is questionable. If the species occurred in other of the rather extensive collections from

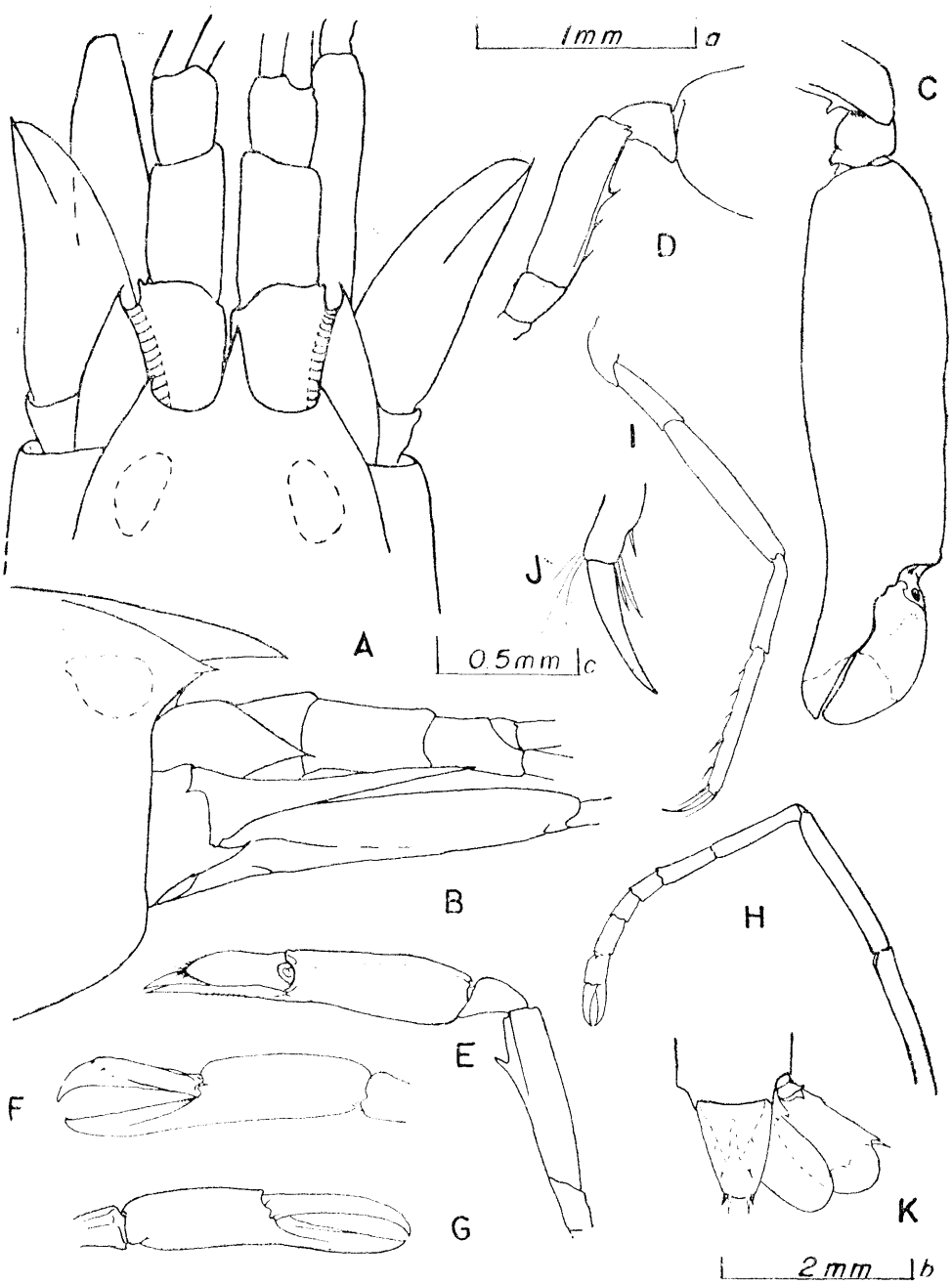

FIGURE 30

Alpheus supachai sp. nov. A, B, Anterior region, dorsal and lateral aspect; C, large chela, outer face; D, merus; E, small cheliped, male, superior surface; F, inner face; G, small chela, female, outer face; H, second leg; I, third leg; J, dactylus; K, Telson and uropods. (A, B, scale a; C, D, E, F, G, H, J, K, scale b; I, scale c.)

the Pacific, and if they showed variation from archipelago to archipelago as do the species in the Crinitus group, this would be considered a geographically isolated subspecies at most. But as no specimens other than from Hawaii and from the Gulf of Thailand have been reported, these must be considered as isolated, and probably speciated populations. Therefore, in spite of many similarities, we erect this as a species separate from *A. edmondsoni*.

The species is named in honor of Dr. Supachai Vanij-Vadahana, Secretary General, Chulalongkorn University, Bangkok, in appreciation for all he did to make out study possible.

Alpheus lottini Guérin—Figure 31

Alpheus lottini Guérin, 1830. Voy. de la Coquille, Atlas, Crust. 5(2):38, pl. 3, fig. 3. Stebbing 1915. S. African Mus., Ann. 15:82, Barnard, 1950. S. African Mus., Ann. 38:748, fig. 141 e-j. Holthuis, 1958. Contri. Know. Red Sea Bull. 17, p. 22.

Alpheus ventrosus H. Milne-Edwards, 1837. Hist. Nat. Crust. 2:352.

Alpheus laevis Randall, 1839. Acad. Nat. Sci. Philadelphia, Journ. 8(1):141.

Alpheus obesomanus Boone, 1935. Vanderbilt Mar. Mus., Bull. 6:135 (*partim*).

Crangon ventrosa Banner, 1953. Pacific Sci. 7(1):84, fig. 28.

Crangon latipes Banner, 1953. Pacific Sci. 7(1):82, fig. 27.

Specimen Drawn : 20 mm. male from BR 31.

Discussion : Rostrum slender, acute, reaching almost to end of first antennular article. Rostral base broad, flattened, not carinate dorsally, continuing to well behind eyes and separated from carapace by deep and narrow grooves on each side. Anterior margin of orbital hoods evenly rounded; short, acute orbital teeth about 0.3 times the length of rostrum, arising from upper surface of hoods directly above the eyes; teeth directed slightly inward.

Antennular peduncle with visible part of first and second antennular article subequal, second article 1.7 times as long as broad.

Third article 0.6 as long as second. Stylocerite well developed with spine reaching almost to middle of second antennular article. Scaphocerite with spine reaching a little past antennular peduncle, squamous portion narrow and markedly shorter. Carpocerite equal to length of scaphocerite. Lateral spine on basicerite acute, equal to length of stylocerite.

Large chela compressed, smooth, without ridges or grooves, 2.5 times as long as broad, with fingers occupying distal 0.3. Merus with superior and inferior internal angles obtuse, although projecting, inferior internal margin with 4-5 spines. Small chela almost as long as large chela, 3 times as long as broad. Palm bearing an obtuse tooth on inner side above articulation of dactylus. Fingers only slightly shorter than palm; dactylus strongly curved at tip and crossing fixed finger when closed. Merus with superior distal projection subacute, inferior internal margin bearing several movable spines.

Carpal articles of second leg with ratio of 10:5:4:4:8; carpus heavy, with third and fourth article broader than long.

Third leg stout. Ischium armed with movable spine. Merus unarmed, 3.0 times as long as broad. Carpus 0.4 as long as merus, with inferior margin continued as a tooth. Propodus 0.8 length of merus with 5-7 movable spines on inferior margin. Dactylus heavy, blunt, laterally compressed with thick longitudinal ridge on inner face continuing around the tip as a transparent flange; inferior surface of tip of soft chitin.

Thai and Malayan specimens reaching 35 mm. in length.

Discussion : This species is readily recognized by the unusual dactyli of the thoracic legs. The body in general is strongly compressed. It is found consistently in the branching heads of the living coral, *Pocillopora,* with the larger heads providing habitation for several pairs of shrimp. In life the shrimp is almost always orange-red in color, at times longitudinally striped with black along the dorsal surface of both the carapace and abomen, and with the superior and superolateral portions of the chelae mottled with spots of deep red.

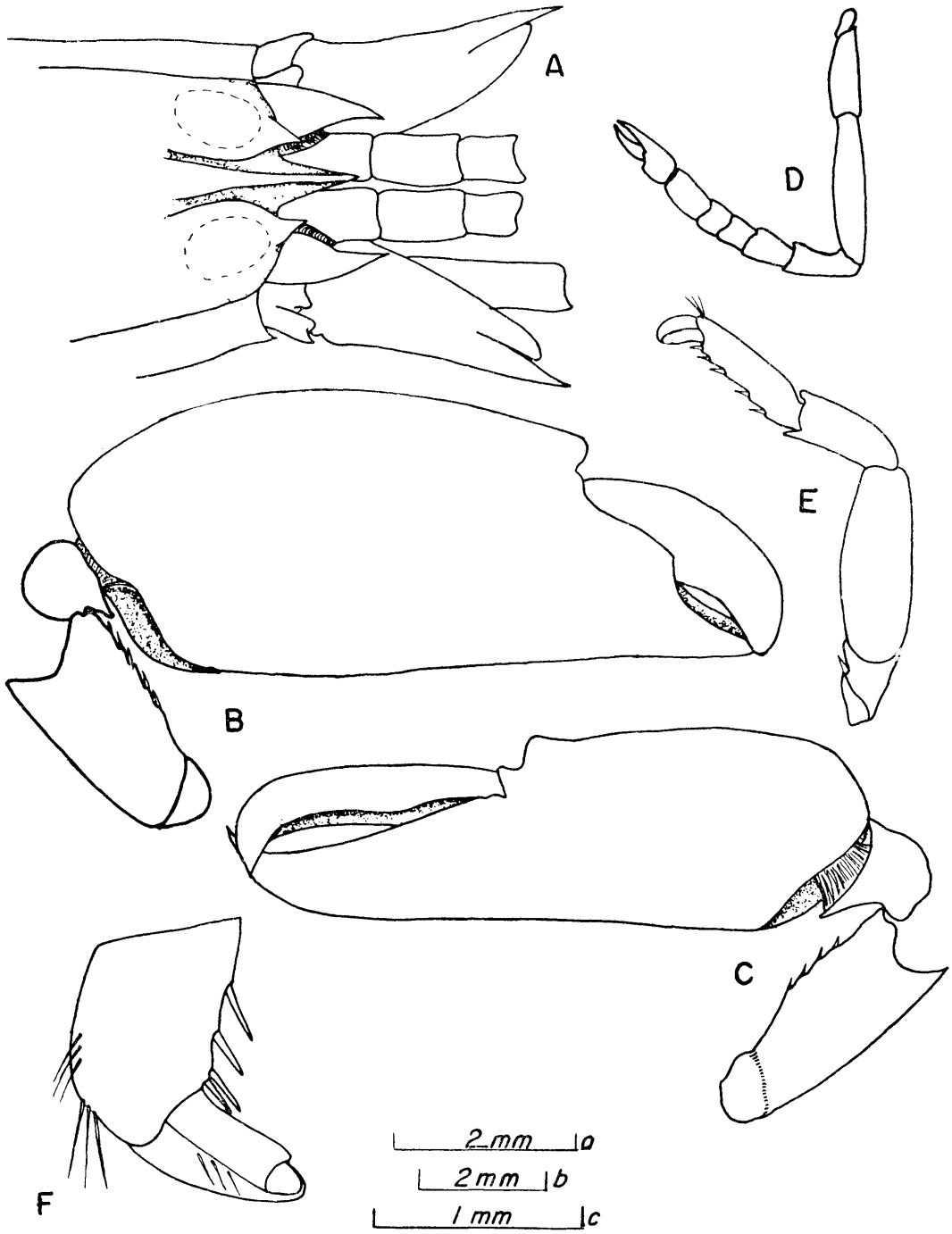

FIGURE 31

Alpheus lottini Guérin. A, Anterior region, dorsal view; B, large cheliped, inner face; C, small cheliped, inner face; D, second leg; E, third leg; F, dactylus. (A, scale a; B, C, D, E, scale b; F, scale c.)

Distribution : Specimens were collected from coral heads in water up to 15 feet deep from Rayong to Koh Kradard on the eastern side of the Gulf of Thailand, and at Chumporn on the west side. Specimens were also found at Phuket and Singapore in the Indian Ocean. Collection data : 3 specimens from BR 10; 2, BR 11; 2, BR 18; 3, BR 22; 4, BR 27; 4, BR 31; 8, BR 34; 4, BR 43.

This large and spectacular species is very widespread and apparently occurs wherever the host coral is found. In the Indian Ocean it is found from Mozambique to Indonesia. It has been reported from the Red Sea. In the Pacific Ocean it spreads as far south as New Zealand and as far north as Japan. It spreads east across the Pacific to the Gulf of California.

Alpheus pomatoceros species nov.—Figure 32

Type Specimen : A 16 mm. male from BR 22, Lam Chongklan, Koh Samui, Thailand. From coral head at outer reef front, 2-3 meters deep. **Paretypes**: 2 females from BR 22; 1 male from BR 23; 1 female from BR 39; 2 females from BR 42; 5 females and 8 males from BR 43.

Description : Rostrum triangular, acute, reaching to end of first antennular article. Rostrum with rounded carina extending to posterior of base of orbital hoods. Orbitorostral grooves shallow, reaching to posterior margin of orbital hoods. Anterior margins of orbital hoods evenly rounded; short acute orbital teeth arising from upper surface of hoods directly above the eyes.

Antennular peduncle with second article 1.8 times as long as broad, and 1.5 times as long as visible part of first; third article a little shorter than first. Stylocerite acute, lateral spine reaching past end of first antennular article. Scaphocerite with lateral margin slightly concave, spine reaching slightly past end of antennular peduncle, squamous portion reaching to end of antennular peduncle. Carpocerite as long as spine of scaphocerite. Spine of basicerite broadened at base, tip reaching almost to end of first antennular article.

Large chela slender, compressed, 3.0 times as long as broad; lower margin smooth; upper margin with slightly depressed area proximal to dactylus. Fingers occupying one-third total length of chela; tip of dactylus obliquely truncate. Merus 2.2 times as long as broad, inferior internal margin distally projecting as small acute tooth. Anterior margin terminating as obtuse tooth which curves inwardly.

Small chela 4.3 times as long as broad, with finger slightly longer than palm. Tip of fingers crossing at their anterior end. Sharp teeth carried at distal end of palm on either side of dactylus. Merus 2.0 times as long as broad, with armature similar to that of large cheliped.

Carpal articles of second leg : 10:4:3:3:5.

Ischium and merus of third leg unarmed, merus 6 times as long as broad. Carpus slender, 0.5 as long as merus, bearing sparse setae, both distal angles rounded. Propodus 0.8 as long as merus and 8 times as long as broad at midpoint, armed on inferior margin with 4-7 movable spines.

Telson with lateral margins straight, 3.5 times as long as posterior margin is broad, 2 times as broad anteriorly as posteriorly.

Specimens reaching up to 21 mm. in length.

Discussion : This species is placed in the Macrochirus group because the configuration of the chela is similar to *A. gracilis* Heller, *A. lottini* Guérin and *A. edmondsoni* Banner. Within the group it is most closely related to *A. facetus* de Man and *A. splendidus* Coutière. The three species can be separated by differences set forth in Table VII.

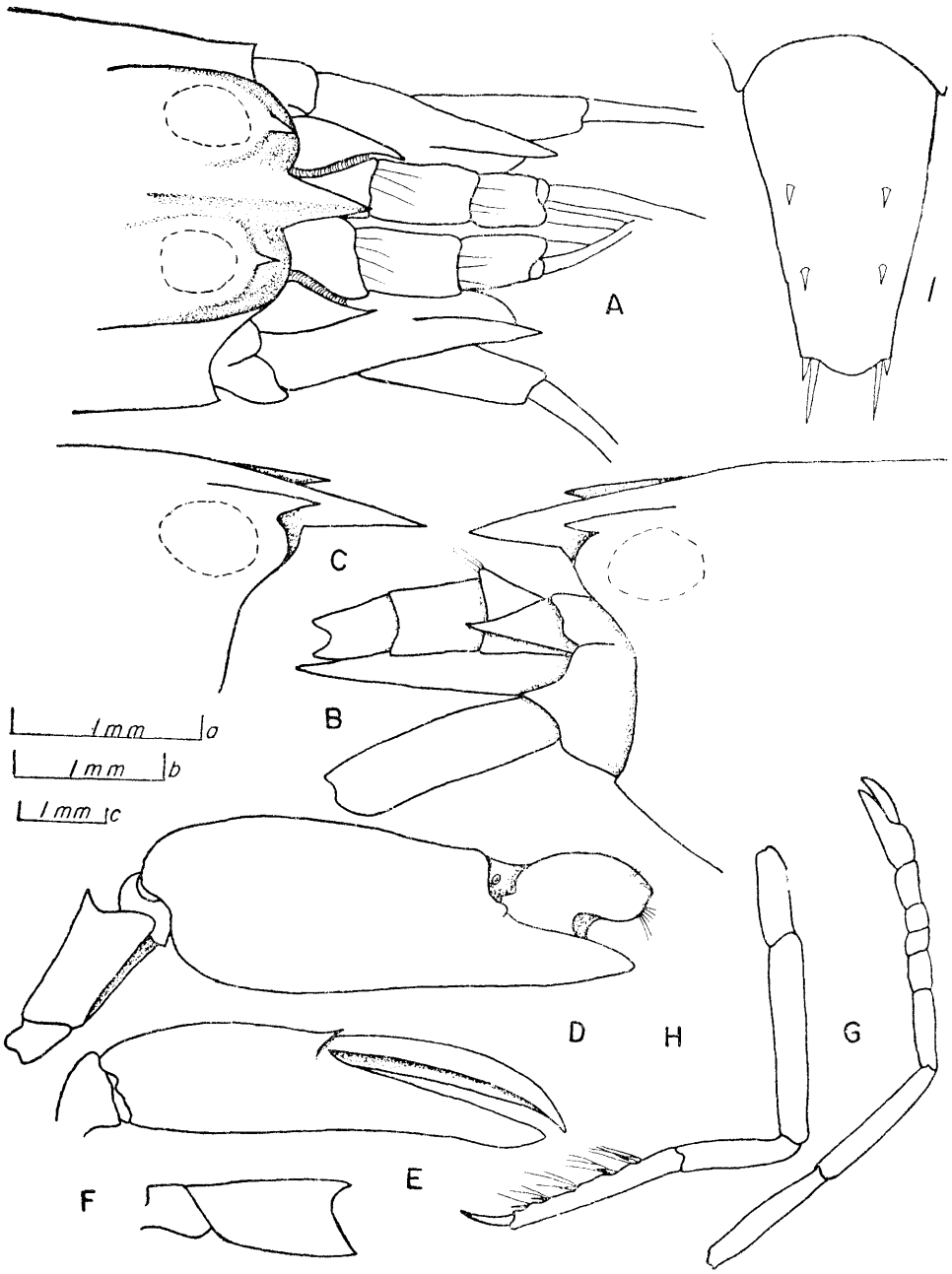

FIGURE 32

Alpheus pomatoceros sp. nov, type specimen. A, B, Anterior region, dorsal and lateral aspects; C, anterior region, carapace; D, large cheliped, outer face; E, small chela; F, merus; G, second leg, H, third leg; I, telson. (A, C, scale a; B, I, scale b; D, E, F, G, H, scale c.)

TABLE VII

Separation of *Alpheus pomatoceros sp. nov.*

	A. facetus	*A. splendidus*	*A. pomatoceros*
Rostrum and orbitorostral grooves.	Slight carina extending to mid-carapace. Orbitorostral grooves shallow.	Sharp carina extending to mid-carapace. and separated from orbital hoods by deep grooves.	Slight carina extending posteriorly to behind orbital hoods, with shallow orbitorostral grooves.
Orbital teeth	On front margin of orbital hoods.	Above margin on curvature of orbital hoods.	Same as *A. splendidus*
Large chela	Upper margin with longitudinal grooves; lower margin smooth.	Both upper and lower margins with transverse grooves.	Neither upper nor lower margin with grooves; upper margin with slight depression.
Merus, large chela	Tooth on superior margin, inferior internal with acute, subterminal tooth.	Superior margin unarmed; inferior internal margin armed subterminally with tooth.	Teeth on both superior and inferior internal margins.

It differs from the other members of this group that have orbital teeth in the following ways : from *A. villosus* (Olivier) by the different position of the orbital teeth and the lack of hair on the carapace; from *A. lottini* Guèrin by the slender condition of the dactyls of the thoracic legs; from *A. gracilis* and *A. edmondsoni* by the difference in the location of the orbital teeth.

The name *pomatoceros* is derived from Greek and refers to the spines which arise from the orbital hoods (*pomato*, lid or operculum; *ceros*, spine or horn).

Alpheus facetus de Man–Figure 33

Alpheus facetus de Man, 1908. Leyden Mus., Notes 30:100. 1911. Siboga Exped. 39a^1(2):340, pl. 14, fig. 67.

Specimen Drawn : 18 mm. male from BR 34.

Description : Rostrum narrow, acute, about 3 times as long as wide at base, tip reaching to end of first antennular article. Rostral carina rounded, somewhat broadening posteriorly and extending faintly almost to middle of carapace. Anterior lateral margins of orbital hoods armed with narrow acute teeth reaching half the length of rostrum and directed slightly medially. Anterior margin between rostrum and orbital teeth with a rounded prominence.

Second article of antennular peduncle 1.5 times as long as broad, equal to the visible part of first antennular article, third article 0.8 as long as second. Stylocerite acute, reaching almost to middle of second antennular article. Scaphocerite with outer margins slightly concave, spine reaching well beyond antennular peduncle, squamous portion reaching to end of antennular peduncle. Carpocerite as long as spine of scaphocerite. Lateral spine of basicerite prominent, broad at base, reaching almost to end of first antennular article.

Large chela almost 3 times as long as high, with fingers occupying distal quarter. Upper border of palm with longitudinal groove beginning near carpus, directed obliquely toward inner face at mid-line where it disappears. Outer face and lower border of chela

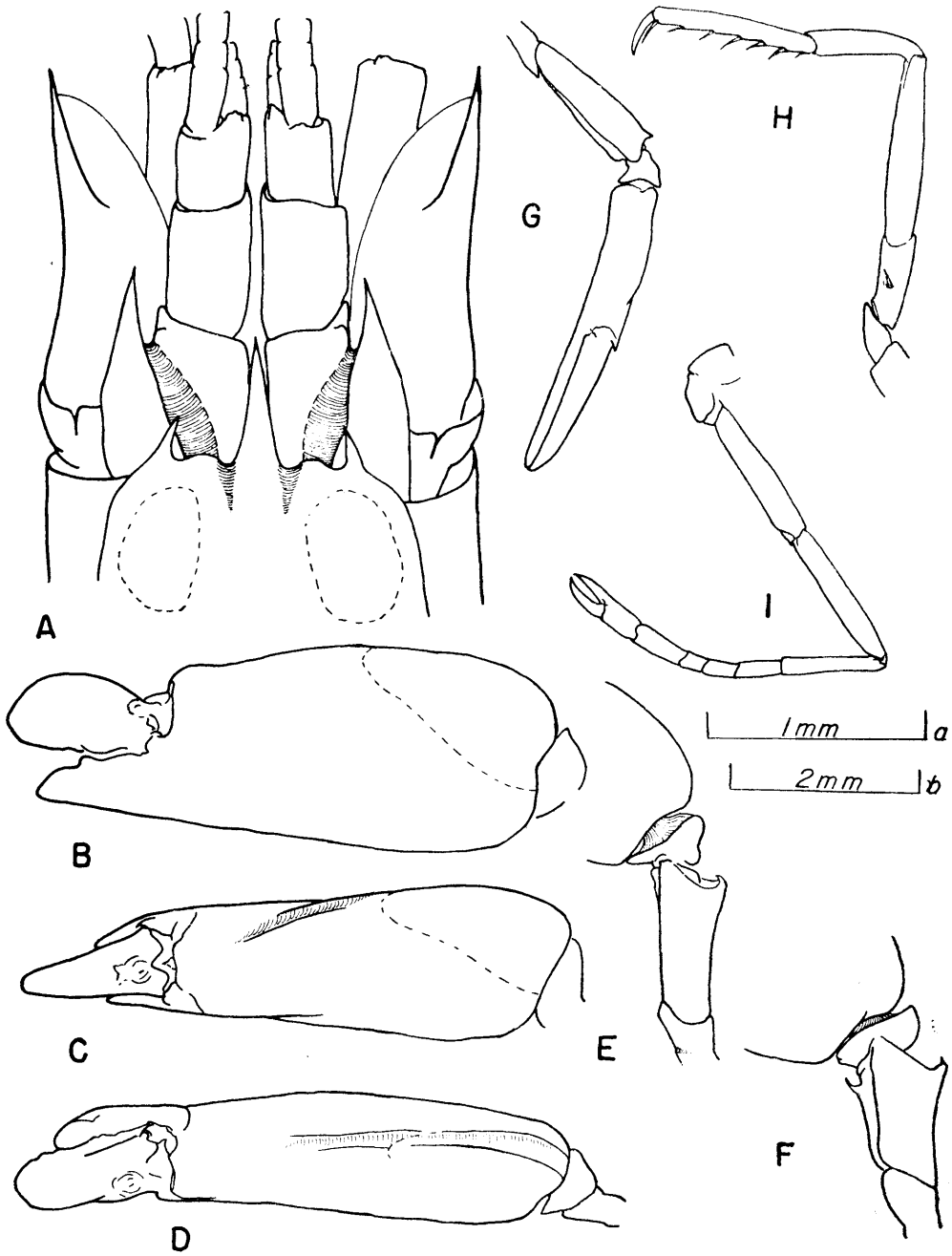

FIGURE 33

Alpheus facetus de Man. A, Anterior region, dorsal aspect; B, C, D, large chela, lateral and superior aspects; E, merus, large chela; F, same, rotated to show tooth; G, small cheliped, inner face; H, second leg; I, third leg. (A, scale a; B, C, D, E, F, G, H, I, scale b.)

without grooves or ridges. Dactylus truncate. Merus 2.4 times as long as broad; inferior internal margin with acute, curved, subterminal tooth; superior margin also terminating in acute tooth.

Small chela slender, 6.0 times as long as high, without grooves, palm and fingers equal in length. Inner face of palm bearing a small acute tooth above dactylar articulation. Merus 4 times as long as broad, with upper margin armed with curved tooth; small tooth terminally on inferior internal margin.

Second leg with ratio of carpal articles as: 10:4:3:2:5.

Ischium of third leg with movable spine. Merus almost 5 times as long as broad and unarmed. Carpus 0.5 length of merus; propodus almost as long as merus, inferior margin bearing 6-8 movable spines. Dactylus simple, regularly curved, 0.2 as long as propodus.

Telson with lateral margins straight, 3 times as long as posterior margin is broad.

Thai specimens reaching 20 mm. in length.

Discussion: For a separation of this species from its most closely related forms see the discussion under *A. pomatoceros sp. nov.*

Distribution: We found 2 specimens of this species in a head of dead coral collected at Phuket Island (BR 34). The only specimen collected in the Gulf of Thailand was from Koh Samui (BR 21).

The only other record of its capture was that of the original specimens described by de Man from Indonesia.

Alpheus gracilis simplex (Banner)—Figure 34

Alpheus gracilis Heller, 1861. K. Akad. Wiss. Wien, Sitzungber. 44:271, Taf. 3, figs. 19-20.

Crangon gracilis simplex Banner, 1953. Pacific Sci. 7(1):75, fig. 25.

Specimen Drawn: 22 mm. male from BR 7.

Description: Rostrum acute, rounded dorsally, separated from orbital hoods by shallow rounded depressions, reaching to end of first antennular article. Obital teeth acute, short, not reaching beyond middle of rostrum.

Antennular peduncles with second antennular article 1.6 times as long as broad and a little shorter than visible part of first; third article 0.7 as long as second. Stylocerite with tip acute, reaching to middle of second antennular article. Scaphocerite with outer margin slightly concave, spine reaching just past end of antennular peduncle, squamous portion subequal in length to antennular peduncles, narrow distally. Carpocerite extending beyond antennular peduncle by over half the length of third article. Lateral spine of basicerite triangular, acute, reaching at times to level of end of rostrum.

Large chela laterally compressed, 2.7 times as long as high, palm without ridges or grooves. Fingers occupying 0.3 length of chela. Inner side of articulation of dactylus flanked by acute tooth. Merus stout, slightly longer than broad; inferior internal margin armed with 3-5 heavy movable spines and distally with heavy acute tooth; superior margin terminating in acute but curved tooth. Small chela slender, 5 times as long as broad, with fingers occupying almost half total length; palm with well-developed tooth above articulation of dactylus. Merus more slender than that of large chela, but with similar armature.

Carpal articles of second legs with ratio: 10:4:2:2:3.

Third legs slender, ischium and merus unarmed. Merus 6 times as long as broad; carpus 0.6 length of merus; propodus 0.8 length of merus and bearing 7 movable spines on inferior margin; dactylus simple, elongate, curved.

Telson with sides slightly tapered, 2.0 times as long as posterior margin is wide. External spine of uropods almost always brown to black.

Thai specimens reaching up to 20 mm. in length.

Discussion: In these specimens the tooth on the inferior internal margin of the merus of the large cheliped is variable in development, but in the Hawaiian specimens it is always present; similarly the tooth above the dactylar articulation of the small chela varies in the Thai specimens, but is constant in the Hawaiian; finally the dactylus of the third leg is always uniform in taper in the Thai specimens while in the Hawaiian form there is a thickening on the inferior curvature of the dactylus, as if it were a remanent of the biunguiculate dactylus of the parent species. These 3 differences have been found to be variable and are therefore of no systematic importance.

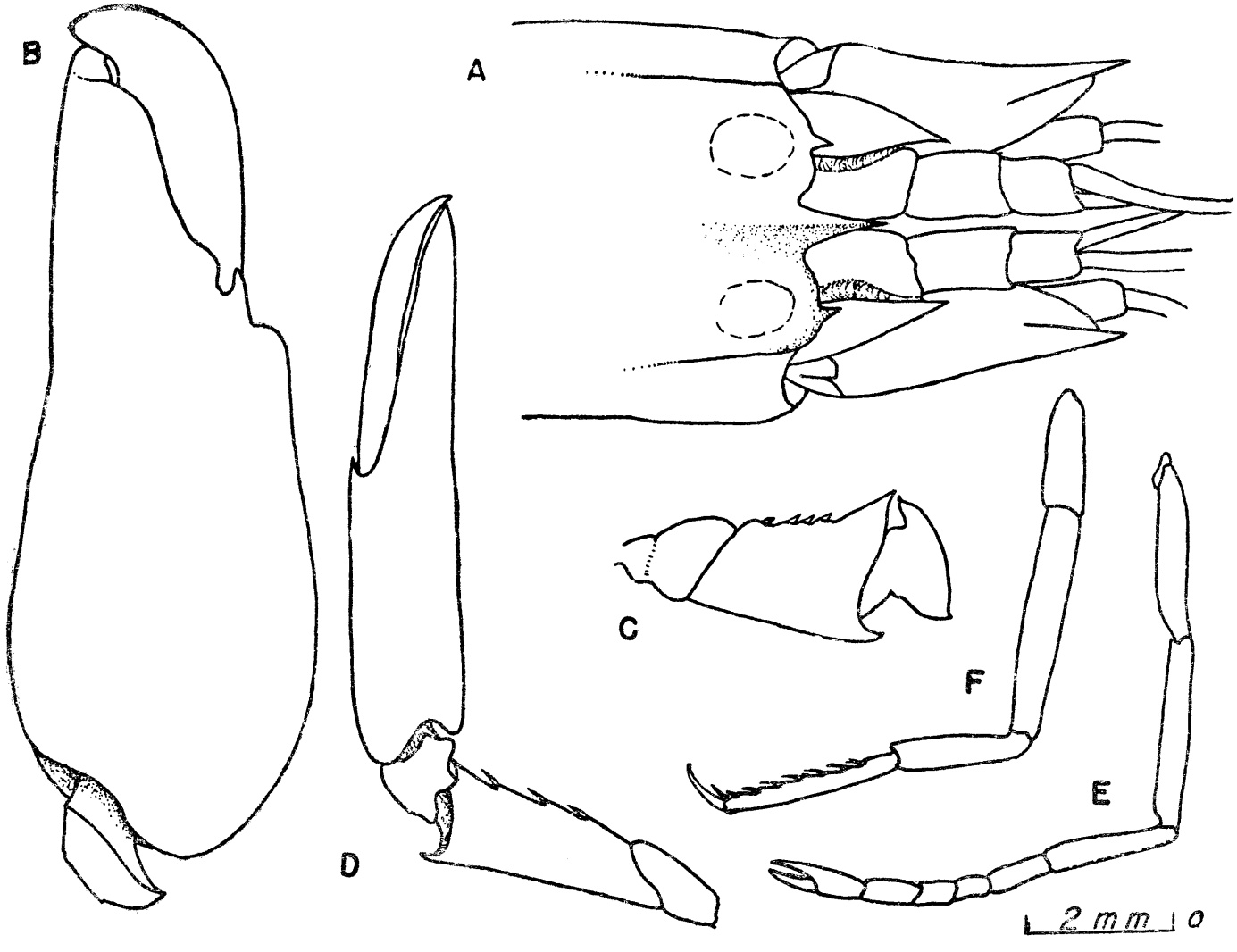

FIGURE 34

Alpheus gracilis simplex (Banner). A, Anterior region, dorsal aspect; B, large chela, inner face; C, merus, large chela; D, small chela; E, second leg; F, third leg. (All drawings scale a.)

The proper relationship of this subspecies to the parent species *A. gracilis gracilis,* will be discussed in a subsequent paper. Here it will suffice to state that the separation from the parent species is on the basis of the presence of the broad shallow orbitorostral grooves, the tooth above the dactylus of the small chela, and the simple dactylus of the walking legs in this subspecies.

Distribution: Specimens were collected from coral heads in water up to 3 meters deep from Pataya on the eastern shore of the Gulf of Thailand to Koh Samui on the west. Collection data: 4 specimens from BR 7; 6, BR 10; 10, BR 21; 19, BR 23; 3, BR 24.

Besides Banner's original specimens from Hawaii, this subspecies has been collected from Mariana, Marshall, Cook and Society Islands.

OBESOMANUS GROUP

Orbital teeth lacking. Stylocerite and scaphocerite often reduced. Large chela proximally rounded, tapering, with distal portions carrying moderate grooves and ridges; dactylus hammer-shaped and crossing end of fixed finger. Second legs often elongate. Merus of third leg usually armed, dactylus usually simple.

In a review of the Obesomanus group based on a large collection from the Central Pacific, now in press [Part X of our studies], we report the variation in characteristics normally considered of value for the separation of the species. The extent of variation forced us to combine some of the species previously described as separate. While the Thai specimens were not studied in detail, they appeared to parallel these variations. Here, we do not indicate the range of variation except in Table VIII; the figures in the individual descriptions merely indicate an approximate midpoint of the range. In the synonymy of the species that follow, the changes advanced in our other paper are shown but not discussed.

In Thai and Malayan waters we found only 3 species of this group, all closely related and somewhat similar in form. They may be separated however, by the series of characteristics given in Table VIII.

TABLE VIII

Characteristics separating three species of the Obesomanus Group

	A. obesomanus Dana	*A. malleodigitus* (Bate)	*A. microstylus* (Bate)
Scaphocerite reaching to :	3/4 to end, third antennular article	1/4 to 3/4, second antennular article	3/4 to end, third antennular article
Squame reaching to :	1/2, second antennular article	1/4 to 3/4, second antennular article	3/4 to end, third antennular article
Carpocerite reaching to :	End of third antennular article	End of second antennular article	End of third antennular article
Ratio of first two carpal articles of second legs	10:(22-46)	10:(10-22)	10:(19-30)

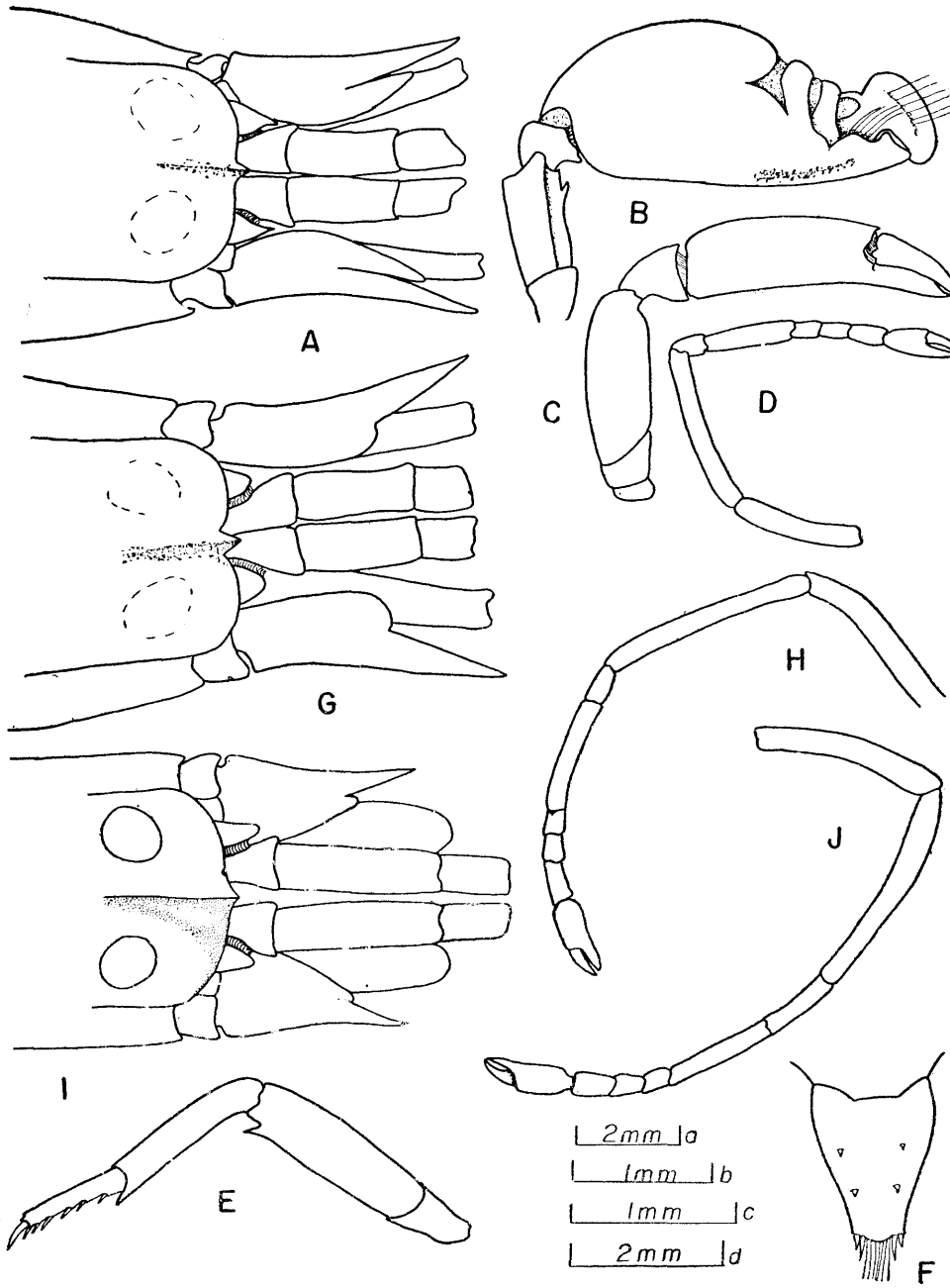

FIGURE 35

Obesomanus Group

Alpheus microstylus (Bate). A, Anterior region, dorsal aspect; B, large cheliped; C, small cheliped; D, second leg; E, third leg; F, telson; G, *A. obesomanus* Dana, anterior region, dorsal aspect; H, second leg; I, *A. malleodigitus* (Bate), anterior region, dorsal aspect; J, second leg. (A, B, C, D, E, F, H, J, scale a; G, scale b; I, scale c; F, scale d.)

The three species have similar habitats, living in branching galleries under coralline encrusting algae on heads of dead coral, usually in regions of wave action. The galleries communicate to the surrounding water by a series of uniform and often regularly placed holes or ports, each too small to permit the egress of the shrimp. In each set of galleries lives a single pair of shrimp, and each set is separated from the galleries of neighboring pairs. Of the pair within the burrow, the female is usually the larger and softer, with smaller chelae. No differences in habitat could be detected for the 3 species; indeed, on the western beaches of Phuket, all three species were taken from galleries on a single coral head.

In figure 35 only *A. microstylus* is drawn completely, while *A. obesomanus* and *A. malleodigitus* have only their anterior carapace and second legs shown. This was done because the chelipeds and walking legs are both sufficiently similar among the three species and sufficiently variable in any one species as to make additional drawings unnecessary.

Alpheus obesomanus Dana—Figure 35

Alpheus obesomanus Dana, 1852. Acad. Nat. Sci. Philadelphia. Proc. 6:21; 1852. U.S. Explor. Exped. Crust. 13:547, pl. 34, fig. 7. Boone, 1935. Vanderbilt Mar. Mus., Bull. 6:135, pl. 34.

Alpheus lutini Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):885, pl. 76, fig. 24.

Alpheus species ‡‖2 Banner, 1956. Pacific Sci. 10(3):351, fig. 15.

Specimen Drawn : 17 mm. male from Koh Kradard (BR 16).

Description : Rostrum short, triangular, reaching not more than one-fourth length of visible part of first antennular article. Carina slight, continued backwards to the base of eyes. Orbital hoods slightly inflated forming shallow orbitorostral grooves. Frontal margin gradually rounded.

Second antennular article 2.4 times as long as wide. Visible part of first antennular article and third article sub-equal in length, about half the length of second. Stylocerite without spine, reaching

only to middle of visible part of first antennular article. Scaphocerite with strong lateral spine reaching to or beyond end of antennular peduncle, outer margin concave. Squamous portion reaching to middle or a little past middle of second antennular article; margin bearing at most scattered setae. Carpocerite as long as antennular peduncle. Basicerite without lateral spine.

Large chela round, larger in diameter proximally, narrowing distally. Slight transverse groove proximal to palmar plaque disappearing on inner side well above midline; groove continuing on outer face as a short slightly oblique longitudinal groove disappearing at one-fourth the length of palm. Narrow groove close to inferior margin in distal portion of palm only about 0.2 as long as entire palm. Movable finger short, hammer-shaped, and closing over distal end of fixed finger. Merus without teeth, 2 times as long as broad.

Small chela without grooves or ridges, 3.7 times as long as wide; fingers occupying 0.3 entire length. Merus similar to that of large chela, but 2.7 times as long as broad.

Second leg with carpal articles with ratio of about 10:(22-46): 7:7:13. One leg up to 1.5 times longer than the other but with lengths of carpal articles of similar ratio.

Merus of third leg 3.5 times as long as wide, with strong tooth on distal end of inferior margin. Carpus without spines, 0.6 as long as merus, both inferior and superior margin terminating in strong tooth. Propodus a little shorter than carpus and armed on inferior margin with 5 movable spinules. Dactylus simple, evenly rounded.

Telson slender, 3.5 times as long as posterior margin is broad. Anterior margin 4 times as broad as posterior margin.

Thai and Malayan specimens reaching to 20 mm. in length.

Discussion : (See discussion under the Obesomanus Group, p. 99).

Distribuion : Specimens were found at almost all collecting sites. Besides living in the chambers in coral under encrusting algae they were found occasionally living in sponges. They were collected from all sections of the reef. Collection data : 3 specimens from BR 5; 7, BR 6; 3, BR 7; 1, BR 10; 2, BR 12; 32, BR 14; 4, BR 15; 25, BR 16;

5, BR 18; 3, BR 27; 12, BR 27b; 2, BR 28c; 1, BR 28d; 18, BR 31; 4, BR 34; 1, BR 35; 12, BR 38; 1, BR 41; 1, BR 43; 1, SU I.

This species has been collected from East Africa through Indonesia. In the Pacific it has been collected as far north as Japan and as far south as northern Australia. It will be reported as far east as the Society Islands. It is not known in Hawaii.

Alpheus malleodigitus (Bate)–Figure 35

Betaeus malleodigitus Spence Bate, 1888. Challenger Repts. 24: 565, pl. 101, fig. 5.

Alpheus malleodigitus de Man, 1902. Senckenb. Naturf. Gesells., Abhandl. 25:866.

Alpheus malleodigitus var. gracilicarpus de Man, 1909a. V. Ned. Dierk. Ver., Tijdschr. 11(2):99.

Alpheus phyrgianus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):886, pl. 77, fig. 25.

Alpheus persicus Nobili, 1906. Scientif. France et Belgique, Bull. 40:33.

Specimen Drawn : 18 mm. male from BR 31.

Description : Rostrum short, triangular, reaching not more than one-fourth the length of visible part of first antennular article. Carina slight, continued backwards to the base of eye hoods, orbital hoods slightly inflated forming shallow lateral grooves. Frontal margins gradually rounded.

Second antennular article 3 times as long as broad. Visible part of first antennular article and third article subequal, 0.4 as long as second article or less. Stylocerite without spine, reaching only to middle of visible part of first antennular article. Scaphocerite with outer margin concave; short but well-formed lateral spine reaching within distal quarter of second antennular article; squamous portion reduced and reaching no further than middle of second antennular article. Basicerite without lateral spine.

Large chela cylindrical in section, as long as broad proximally, and tapering strongly distally. Slight transverse groove proximal to dactylus disappearing abruptly on inner face, but on outer face con-

tinuing distally into an oblique longitudinal groove reaching 0.2 the length of the palm, extending distally as a slight curve. Movable finger short, hammer-shaped and closing over distal end of fixed finger. Merus unarmed, 2.5 times as long as broad.

Small chela cylindrical, smooth, 4 times as long as broad, finger occupying the distal 0.4. Merus similar to that of large chela.

Second leg with ratio of carpal articles as follows: 10:(10-22); 4:4:5. Legs asymmetrical in length, but of similar carpal ratios.

Merus of third leg 3.5 times as long as broad with strong tooth distally on inferior margin. Carpus 0.7 as long as merus; superior margin unarmed, strong tooth terminating inferior distal margin. Propodus slightly shorter than carpus, armed on its inferior margin with 6 pairs of movable spines. Dactylus simple, curved.

Telson 3 times as long as posterior margin is broad, anterior margin 2.6 times as wide as posterior margin. Lateral margin sinuate.

Discussion: See discussion on page 99.

Some of the grooving on the inner and outer faces of the large chela may be preservation artifacts for they have the appearance of deflated chitin. Perhaps in life the chela is almost completely inflated except for the slight transverse groove proximal to the dactylus, which is similar to the related species.

Thai specimens reaching up to 25 mm. in length.

Distribution: Specimens were collected on both the eastern and western side of the Gulf of Thailand and also at Phuket. They were taken from heads of dead coral at all localities on the reef. Collection data: 1 specimen from BR 7; 5, BR 8; 2, BR 11; 1, BR 15; 6, BR 16; 21, BR 31; 2, BR 33; 4, BR 34; 3, BR 35; 44, BR 38; 6, BR 39; 9, BR 41.

This species has been reported from the Persian Gulf (as *A. persicus* Nobili). In the Indian Ocean it was reported from Djibouti and the Maldives (as *A. phyrgianus* Coutière). It was also collected in Indonesia. In the Pacific it has been reported as far north as the Phillipines and as far south as Northern Australia. It has been found in the Central Pacific from Samoa, Tonga, Fiji, Societies, Marshall and Phoenix Islands. It has not been found in Hawaii.

Alpheus microstylus (Bate) --Figure 35

Betaeus microstylus Bate, 1888. Challenger Repts. 24:566, pl. 101, fig. 6.

Alpheus obesomanus de Man, 1888b. Arch. Naturg. 53:520; 1902. Senckenb. Naturf. Gesells., Abhandl. 25:867. (*nec. A. obesomanus* Dana).

Alpheus malleodigitus Coutière, 1899. Les Alpheidae, p. 223, 316, figs. 270-272, 400. (*nec A. malleodigitus* (Bate)).

Alpheus microstylus Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):884, pl. 76, fig. 23.

Specimen Drawn: 15 mm. female from BR 33.

Description: Rostrum short, triangular, reaching not more than one-quarter the length of visible part of first antennular article. Carina short and feeble, continuing posteriorly only to base of eyes. Orbital hoods slightly inflated, forming shallow orbitorostral grooves. Frontal margin gradually rounded.

Second antennular article 2.3 times as long as broad. Visible part of first and third antennular article equal in length, only 0.4 as long as second article. Stylocerite with small acute spine reaching a little past middle of first antennular article. Scaphocerite with outer margin concave, with strong lateral spine reaching to end of antennular peduncle, and with squamous portion narrow, reaching to middle of third antennular article. Carpocerite as long as antennular peduncle. Basicerite without lateral spine.

Large chela cylindrical in section, 2.5 times as long as broad proximally, with marked taper distally; finger occupying less than distal third. Transverse groove proximal to dactylus extending to outer face in the form of a saddle-shaped depression, on inner face disappearing near top one-fourth of palm. Near inferior margin lies another slight longitudinal groove extending from posterior of the superior groove to one-fourth length of fixed finger. Dactylus short, hammer-shaped and closing over end of immobile finger. Merus 2.5 times as long as wide, and bearing small tooth near distal end of inferior internal margin.

Small chela 3.8 times as long as broad with finger occupying distal third. Merus similar to that of large chela but unarmed.

Second leg with ratio of carpal articles: 10:(19-30):10:10:11. Legs of asymmetrical lengths, but with same general ratio of carpal articles.

Merus of third leg 3.3 times as long as broad, bearing a strong tooth distally on inferior margin. Carpus 0.7 as long as merus with lower and upper distal margin ending in strong tooth. Propodus 0.6 as long as merus and armed on its inferior margin with 6 movable spines. Dactylus simple, gradually curved.

Telson 3.5 times as long as posterior margin is broad, with lateral posterior spine half as long as medial spines. Anterior margin 3 times as wide as posterior margin. Posterior margin slightly arcuate.

Thai specimens reaching up to 18 mm. in length.

Discussion: Since only 9 specimens of this species were available for the study mentioned above, it appears to be more rare than *A. malleodigitus* or *A. obesomanus*. However the Thai specimens agree well with those studied previously; for a listing of the known variation see Table VIII.

Distribution: As in the Central Pacific, in Thai waters this is the most uncommon species of the three belonging to the Obesomanus group. It was collected only from Phuket Island; all came from heads of dead coral gathered from the outer reef edge or from coral heads on the reef flat that was exposed for the low tide. They were found in the same head of coral as both *A. malleodigitus* and *A. obesomanus;* differences in the micro-habitats were not detected. Collection data: 1 specimen from BR 31; 2, BR 33; 2, BR 34; 1, BR 39.

This species has been reported from the Red Sea and from the Maldives in the Indian Ocean. In the Pacific Ocean it has been collected from Indonesia, Northern Australia, and Samoa, Mariana and Marshall Islands.

CRINITUS GROUP

Orbital teeth lacking. Large chela cylindrical, entire, without grooves or ridges. Merus of third leg usually unarmed, dactylus variable.

Alpheus alcyone de Man,–Figure 36

Alpheus alcyone de Man, 1902. Sencken. Naturf. Gesell., Abhandl. 25: 87, pl. 27, fig. 61. 1911. Siboga Exped. 36a[1](2):351.

Alpheus aculeipes Coutière, 1905. Fauna and Geog. Mald and Laccad. 2(4): 892, pl. 79, fig. 31.

Specimen Drawn: 20 mm. male from BR 41.

Description: Rostrum small, extending only slightly beyond orbitorostral margin. Rostral carina sharp and extending posteriorly on carapace to slightly posterior of eyes. Orbital hoods somewhat inflated, overhanging lateral portion of carapace, anteriorly rounded. Orbitorostral grooves shallow, ill-defined. Frontal margin of carapace, anterior to orbital hoods and grooves, projecting as flattened shelf with lateral margins rounded.

Antennular peduncle short, with second article 2 times as long as wide, and about twice as long as either visible part of first article or third article. Stylocerite short, with lateral spine not attaining end of first antennular article. Scaphocerite with outer margins only slightly concave, strong outer spine reaching well past end of antennular article. Squamous portion narrow and reaching just past end of second antennular article. Carpocerite subequal to spine of scaphocerite. Basicerite without lateral spine.

Large chela subcylindrical, without ridges or grooves, with fingers occupying the distal third. Dactylus thick with rounded tip. Merus a little broader than long at its widest point. Superior distal margin bearing short acute tooth, distal end of inferior internal margin with heavy triangular tooth, very broad at base.

Small chela 3.7 times as long as wide, with fingers slender, only a little longer than palm and with tips crossing. Merus 2.7 times as long as broad, both margins without spines or teeth. Chelae exhibiting no sexual dimorphism.

Second leg with ratio of carpal articles: 10:30:6:7:12.

Ischium of third legs unarmed. Merus narrowly triangular in section, 4.6 times as long as wide, with inferior external margin carrying a strong acute tooth distally, and with inferior internal

margin carrying 10-12 movable spines along its entire length but without distal tooth. Carpus 0.3 length of merus carrying two strong spines on inferior edge. Propodus 0.5 length of merus and carrying six long movable spines on inferior margin. Dactylus 0.4 length of propodus, biunguiculate, with inferior unguis small.

Telson three times as long as posterior margin is wide, lateral margins slightly tapering, constricted posteriorly, posterior margin slightly arcuate.

Thai and Malayan specimens reaching 20 mm. in length.

Discussion: This species differs from the other two closely related forms that occur in Thai waters, *A. bucephalus* Coutière and *A. paralcyone* Coutière, by the presence of a series of movable spinules on the inferior external margin of the third leg.

Distribution: This species was found living in dead coral on both the middle and outer reef at Phuket and at Singapore, but none were found in the Gulf of Thailand. Collection data: 2 specimens from BR 32; 2, BR 34; 3, BR 41.

Specimens have been reported from the Red Sea and the Persian Gulf; also in the Indian Ocean from the Maldives to Indonesia. In the Pacific they have been collected from the Phillipines to as far east as the Tonga and Samoan Islands.

Alpheus paralcyone Coutière–Figure 37

Alpheus paralcyone Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):895, pl. 80, 81, fig. 34.

Crangon paralcyone Banner, 1953. Pacific Sci. 7(1):99, fig. 34.

Specimen Drawn: 10 mm. male from BR 5.

Description: Rostrum short, triangular, rounded dorsally, reaching to middle of visible part of first antennular article. Frontal margin forming a gradually rounded shelf-like projection. Orbito-rostral grooves short, rounded and shallow.

Second article of antennular peduncle 2.4 times as long as broad, approximately twice as long as visible part of first article and 1.5 times as long as third article. Stylocerite broadened at base, tip

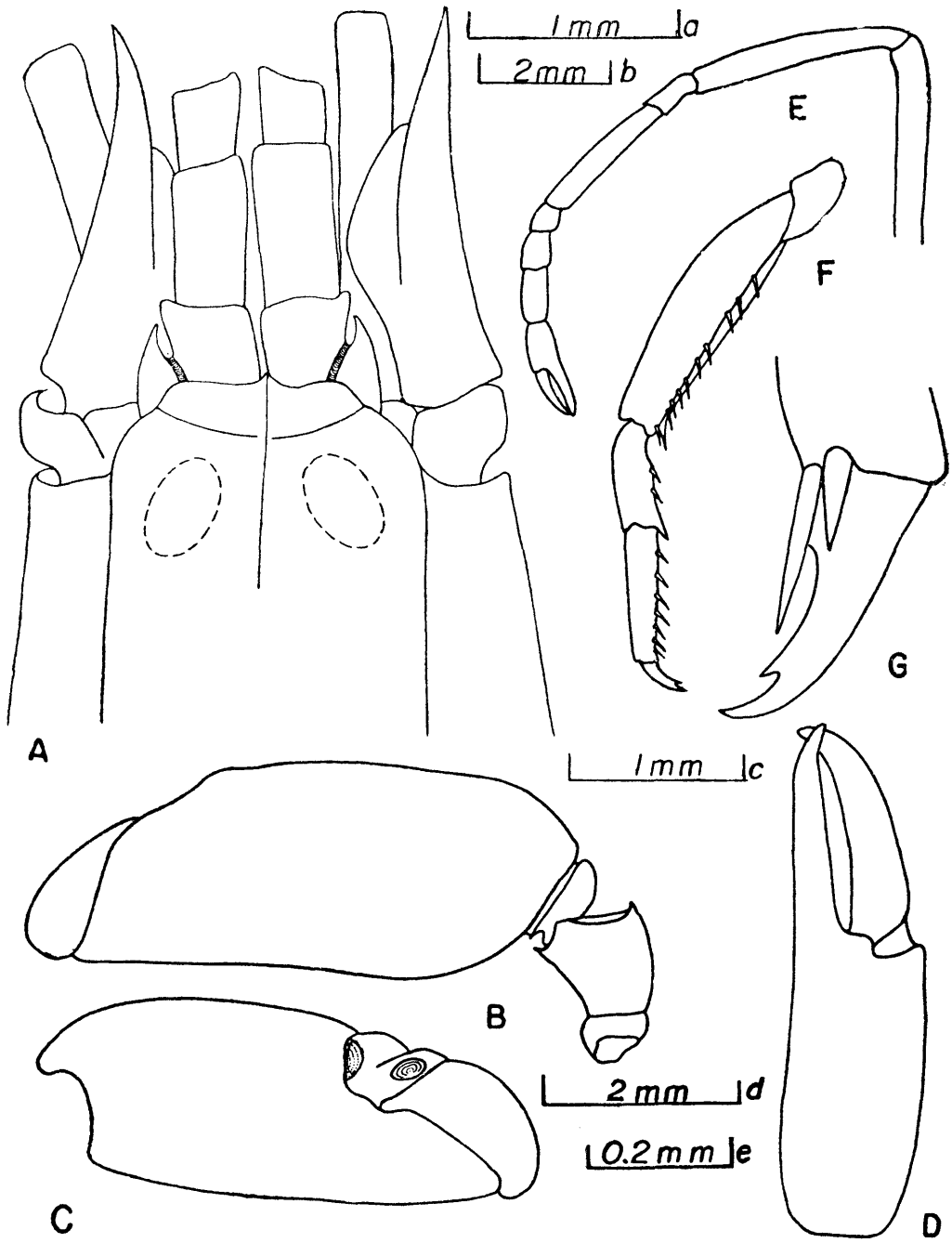

FIGURE 36

Alpheus alcyone de Man. A, Anterior region, dorsal aspect; B, large cheliped, inner face; C, large chela, outer face; D, small chela; E, second leg; F, third leg; G, third leg dactylus, (A, scale a; B, C, scale b; D, scale c; E, F, scale d; G, scale e).

of spine reaching end of first antennular article. Lateral spine of basicerite acute, reaching to middle of first antennular article. Scaphocerite with outer margins slightly concave with strong lateral spine reaching beyond end of third antennular article by length of that article; narrow squamous portion reaching only to end of antennular peduncle. Carpocerite equal in length to spine of scaphocerite. Basicerite with small, acute, lateral spine.

Large chela without notches or grooves, subcylindrical, tapering; dactylus heavy, 0.3 length of entire chela and rounded at tip. Merus broad, 1.3 times as long as wide, upper angle of superior margin projecting as small acute tooth; inferior internal margin without spines but with strong tooth subterminally.

Small chela more slender, 3.7 times as long as broad, fingers a little shorter than palm. Dactylar articulation bearing small rounded tooth on either side. Merus 2.0 times as long as broad, with superior margin distally unarmed, but with sharp tooth terminating inferior internal margin. Dactylus in female chela less broad than male.

Carpal articles of second legs with the ratio: 10:25:3:3:12.

Ischium of third leg bearing movable spine. Merus 4 times as long as broad, with inferior internal margin bearing a few heavy setae and distally a strong tooth. Carpus armed with 4 spines on inferior margin; distal end of superior and inferior margins projecting as strong acute teeth. Propodus with 6 strong spines on inferior margin Dactylus biunguiculate.

Posterior margin of 6th abdominal tergum bears about three pronounced acute triangular teeth grouped near median dorsal line.

Thai specimens reaching 12 mm. in length.

Discussion : The spines on the 6th abdominal somite are not consistent as to size, number, placement or in relation to midline. The number of teeth in the Thai specimens varied from 2-5, with more on one side of the median line than on the other in some cases. Banner (1953:99) found that the Hawaiian specimens had no teeth at all.

This species may be separated from the other two closely related species in Thai waters by the following characteristics: From

A. alcyone by the lack of movable spinules on the inferior internal margin of the third leg and from *A. bucephalus* by the presence of teeth on the 6th abdominal tergum.

Distribution : Our specimens were found in heads of dead coral in the outer zones of reefs on both the eastern and western sides of the Gulf of Thailand. 5 specimens from BR 5a were found living in sponges. We also collected 10 specimens from Singapore. Collection data : 5 specimens from BR 5a; 1, BR 5; 2, BR 7; 3, BR 11; 1, BR 16; 10, BR 43.

This species has been reported from the Maldive Archipelago and Indonesia. In the Pacific we have collected it from the Marshall, Fiji, Samoa, Cook and Hawaiian Islands.

Alpheus bucephalus Coutière—Figure 38

Alpheus bucephalus Coutière, 1905. Fauna and Geog. Mald. and Laccad. Arch. 2(4):890, pl. 78, fig. 29. Banner, 1957. Pacific Sci. 11(2):201, table 1.

Alpheus consobrinus de Man, 1908. Leyden Mus., Notes 30:101; 1911. Siboga Exped. 39a[1](2):360, pl. 16, fig. 75.

Specimens Drawn : 11 mm. male; chelae of 15 mm. male; chela of 12 mm. female; all from BR 11.

Description : Rostrum short, reaching to middle of visible part of first antennular article; dorsal carina high and thin ending abruptly at the base of the eyes. Orbital hoods inflated, projecting anteriorly as a rounded vertical keel. Orbitorostral grooves broad and shallow, projecting anteriorly as a flattened, rounded extension of frontal margin.

Second article of antennular peduncle 2.2 times as long as broad and twice as long as either the visible part of first or third antennular articles. Stylocerite short, not reaching the end of first antennular article. Scaphocerite with outer margin concave and with strong spine reaching well part end of antennular peduncle; squamous portion narrow, reaching almost to end of antennular peduncle. Basicerite usually without lateral spine.

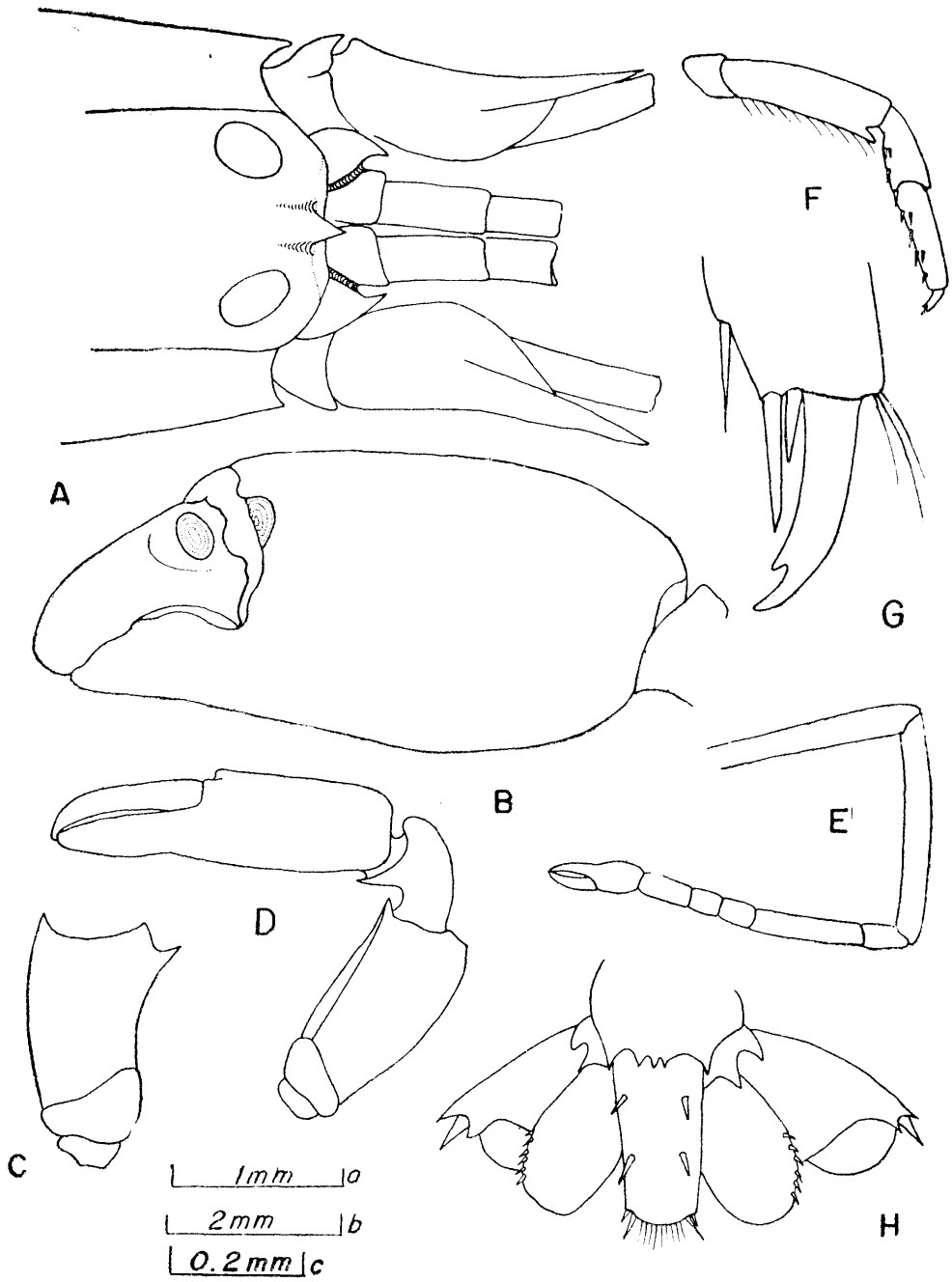

FIGURE 37

Alpheus paralcyone Coutière. A, Anterior region, dorsal aspect; B, large chela, outer face; C, merus; D, small chela, inner face; E, second leg; F, third leg; G, third leg dactylus; H, telson and uropods (teeth on sixth abdominal segment asymmetrical). (A, scale a; B, C, D, E, F, H, scale b; G, scale c.)

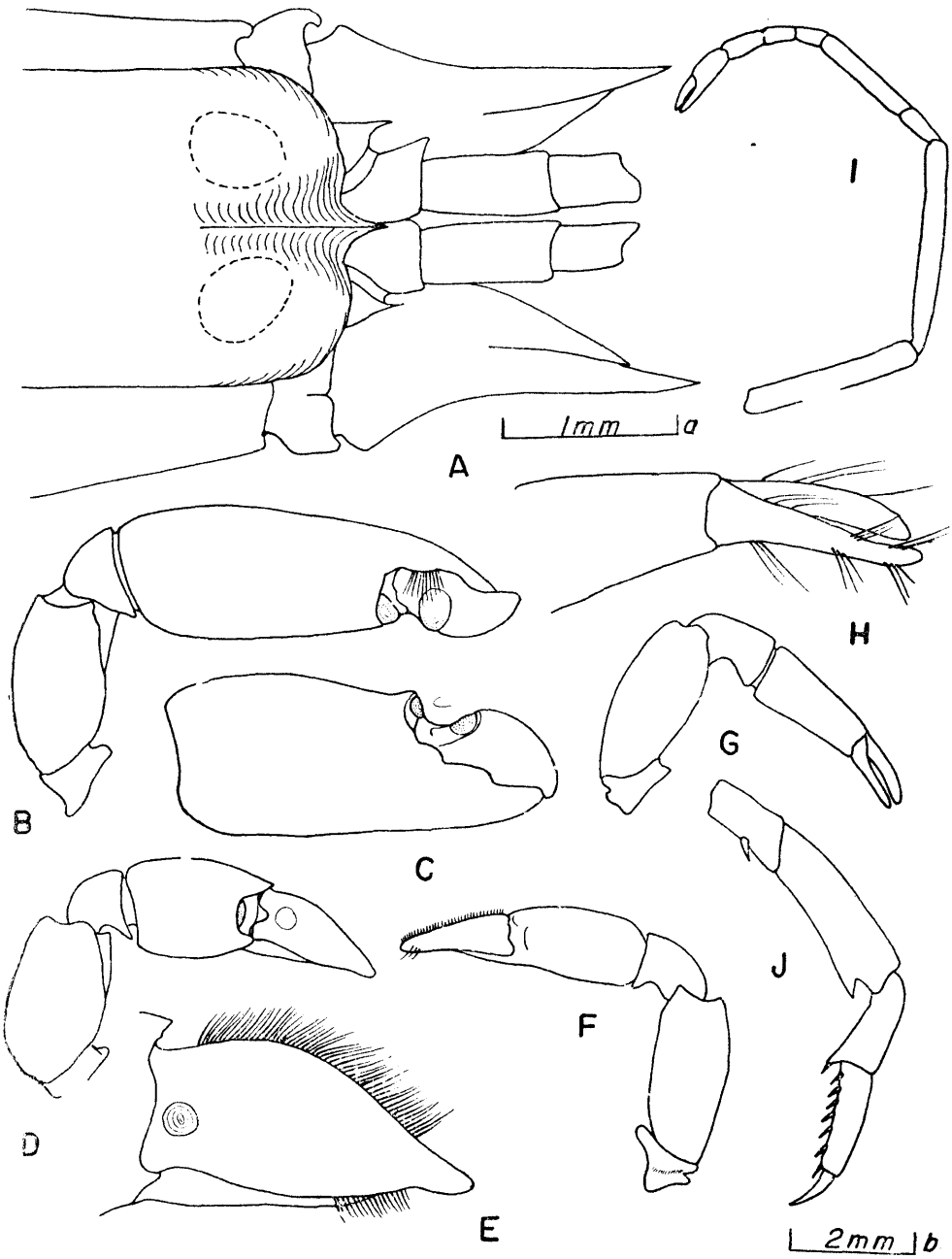

FIGURE 38

Alpheus bucephalus Coutière. A, Anterior region, dorsal aspect; B, male large cheliped superior aspect; C, outer face; D, male small cheliped; E, dactylus, (15 mm. male); F, small cheliped of another male; G, small cheliped, female; H, supero-lateral view of dactylus; I, second leg; J, third leg. (A, E, H, scale a; B, C, D, F, G, I, J, scale b).

Large chela without notches or grooves, sub-cylindrical, 2.3 times as long as wide, with fingers occupying distal 0.3 of total length. Dactylus heavy, rounded on end. Merus 1.5 times as long as broad, armed with broad, acute tooth on distal end of inferior internal margin. Large chela of female slightly more slender than that of male.

Small chela variable and showing sexual dimorphism. Male chela approximately 2.5 times as long as wide, palm broadest at middle. Dactylus usually expanded and flattened, with both margins fringed with hair except near tip, but without hairs continuing over superior surface as is found in true balaeniceps condition. Merus 1.7 times as long as broad, inermous. Female chela much more slender with palm broadest near carpus and gradually tapering towards fingers; fingers slender, never broadened nor fringed with heavy hair.

Carpal articles of second leg with ratio : 10:27:7:7:10.

Ischium of third leg bearing movable spine. Merus 3.2 times as long as broad with strong tooth distally on inferior internal margin. Carpus almost half as long as merus, bearing strong projection inset with movable spine on lower distal margin. Superior margin without tooth distally. Propodus as long as merus, armed with 6 movable spines on inferior margin and a pair at base of dactylus. Dactylus simple, well developed.

Tergum of 6th abdominal segment without teeth.

Telson 2.4 times as long as posterior margin is broad, sides straight and posterior margin slightly arcuate.

Thai specimens reaching 15 mm. in length.

Discussion : The considerable variation found in this species has been discussed by Banner (1957:201); here it will suffice to state that no great importance should be placed on the following variable points : The basicerite may be either armed or unarmed; the distal end of the inferior internal margin of the merus of the large chela may carry an acute tooth to a rounded projection; the small chela usually is sexually dimorphic but in some males the dactylus of the

small chela may be slender and tapering (contrast fig. 38 D and F). Finally the second carpal article of the second leg may be somewhat longer in relation to the first article than the one reported above. However, the lack of a biunguiculate dactylus will separate it from *A. alcyone* de Man and *A. paralcyone* Coutière, the other two closely related Thai species.

Distribution: This species was found living in coral on all parts of the reef in localities on both the east and west side of the Gulf of Thailand and the Indian Ocean. Collection data: 4 specimens from BR 5; 5, BR 7; 4, BR 8; 2, BR 11; 4, BR 14; 3, BR 15; 4, BR 16; 8, BR 18; 1, BR 22; 2, BR 28; 2, BR 34; 1, BR 42.

This species has been widely collected. It has been reported in the Indian Ocean from the Maldives. In the Pacific it has been reported from Indonesia and we have collected it from the Maiana Islands to as far east as Hawaii and as far south as the Tonga Islands.

DIADEMA GROUP

Orbital teeth present or not. Large chela usually subcylindrical with rounded margins, often with transverse groove. Dactylus of small chela of male at times balaeniceps. Merus of third legs variable, dactylus usually simple [Group known to earlier workers as Insignis group].

Alpheus gracilipes Stimpson—Figure 39

Alpheus gracilipes Stimpson, 1860. Acad. Nat. Sci. Philadelphia, Proc. 12:30. De Man, 1888b. Arch. für Naturgesch. 90 (A2):43, fig. 15.

Crangon gracilipes Banner, 1953. Pacific Sci. 7(1):115, fig. 41.

Specimen Drawn: 21 mm. male from BR 18.

Description: Rostrum narrow, triangular, acute, flattened dorsally, without carina, reaching almost to end of first antennular article. Rostral base separated from posterior portion of orbital hoods by deep narrow depressions, more anteriorly by wide flattened areas; abrupt sides of rostrum overhanging the groove. Orbital hoods

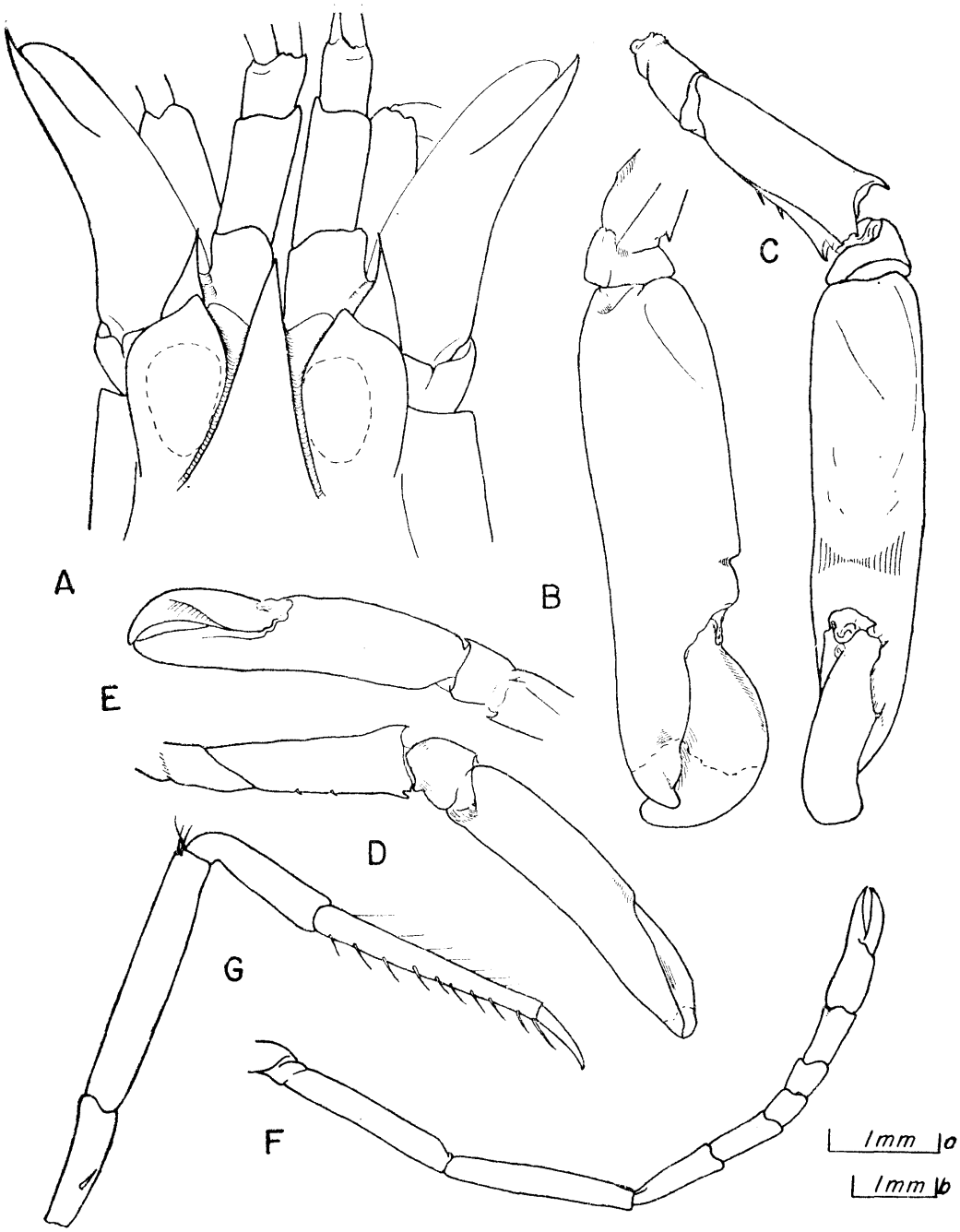

FIGURE 39

Alpheus gracilipes Stimpson. A, Anterior region, dorsal aspect; b, large chela, inner face; C, superior aspect; D, small cheliped, inferior aspect; E, chela, inner face; F, second leg; G, third leg. (A, scale a; B, C, D, E, F, G, scale b.)

inflated, large, with abrupt medial margin, posteriorly merging with carapace, anteriorly with a rounded dorsoventral keel.

Antennular peduncle with second article two times as long as broad, 1.4 times longer than visible part of first article and over twice as long as third article. Stylocerite reaching to or slightly beyond first antennular article. Scaphocerite laterally concave, bearing strong spine, reaching to end of third antennular article. Squamous portion narrow, slightly shorter. Carpocerite reaching only slightly past second article of antennular peduncle. Strong lateral spine of basicerite reaching level of tip of rostrum.

Large chela slender, sub-cylindrical, four times as long as wide with fingers occupying 0.4 of length. Palm with deep transverse groove proximal to articulation of dactylus. Dactylus heavy, compressed, strongly arcuate, longer than fixed finger. Merus 3.3 times as long as wide at widest point, superior distal end with strong tooth, inferior internal margin bearing 2-4 movable spines, terminating in strong acute tooth.

Small chela slender 5.0 times as long as broad. Dactylus in both male and female sub-balaeniceps with fringe of long setae running longitudinally from near point of articulation over crown of article before apex, but article not broadly expanded. Merus similar to that of large chela in shape and armature, but with spine and teeth less well developed.

Carpal articles of the second leg with ratio: 10:8:4:4:8.

Ischium of third legs with movable spine. Merus 5.7 times as long as broad, inermous. Carpus without spines, propodus with 9-11 slender spines. Dactylus simple, slightly curved.

Telson straight-sided, 3.2 times as long as wide at the posterior end. Posterior end broadly arcuate.

Thai specimens reaching 22 mm. in length.

Discussion : This species may be easily separated from the other two species of this group that appear in this collection, *A. paracrinitus* Miers and *A. ehlersi* de Man, neither of which have the flattened rostral base that is demarked by deep grooves, nor the deep transverse groove proximal to the dactylus on the large chela.

Distribution: We have 8 specimens all from the eastern side of the Gulf of Thailand (BR 7, BR 18). All were taken from dead coral heads from the outer reef area.

This species is very wide-spread in the Indo-Pacific. It has been reported from East Africa to the Hawaiian Islands.

Alpheus ehlersi de Man–Figure 40

Alpheus ehlersi de Man, 1909c. Zool. Soc. London, Proc. 1909: 663, pl. 70, fig. 1-6.

Specimen Drawn: 14 mm. male from BR 14.

Description: Rostrum triangular, acute, usually reaching almost to end of first antennular article. Anterior medial margins of rostral front with rounded prominence lateral to rostrum. Orbitorostral grooves shallow. Second antennular article 1.8 times as long as broad, equal in length to visible part of first antennular article and 1.5 times as long as third article. Stylocerite with acute spine reaching to basal portion of second antennular article.

Scaphocerite with outer margin only slightly concave; strong spine reaching beyond squamous portion by length of third antennular article; squamous portion slender and reaching to end of antennular peduncle. Carpocerite reaching to tip of spine of scaphocerite. Lateral spine of basicerite small but acute.

Large chela compressed, 2.7 times as long as broad, fingers occupying 0.3 total length; superior margin proximal to dactylus bearing shallow transverse groove that extends obliquely toward inner face; groove so faint that chela often must be rotated to discern it; margin without groove but showing concavity at base of fingers. Dactylus less heavy than usual, with acute tip crossing that of fixed finger. Merus 2.4 times as long as broad with inferior internal margin armed with 4-6 movable spinules and an acute distal angle; superior margin rounded distally. Merus of female 3.0 times as long as broad and of similar armature.

Small chela slender, 4.2 times as long as broad, fingers a little longer than palm. Merus three times as long as broad with inferior

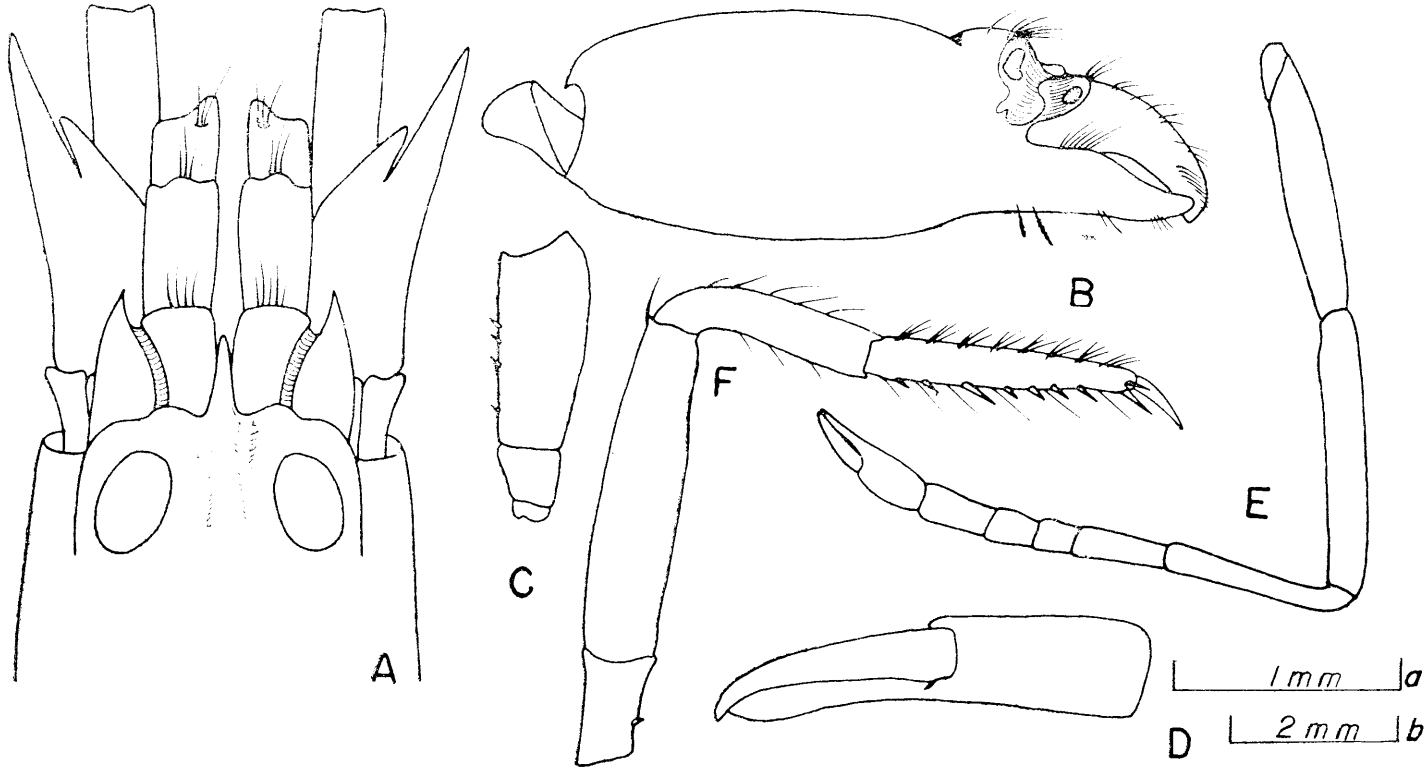

FIGURE 40

Alpheus ehlersi de Man. A, Anterior region, dorsal aspect; B, large chela, outer face; C, merus; D, small chela; E, second leg; F, third leg, (A, scale a; B, C, D, E, F, scale b).

internal margin armed with 5-6 movable spinules and inferior margin terminating in an acute angle.

Carpal articles of second leg with ratio: 10:5:2:2:4.

Ischium of third leg armed with minute spine. Merus 4.4 times as long as broad, unarmed, but bearing sparse hairs on inferior margin. Carpus 0.6 as long as merus, inferior and superior margins projecting as small teeth, propodus 0.7 as long as merus, bearing 9 spinules on inferior internal margin and sparse setae on superior margin. Dactylus simple.

Telson 1.3 times as long as its anterior margin is broad; anterior margin 3.3 times as broad as posterior margin. Lateral margins concave, slightly constricted towards posterior end; posterior margin almost straight.

Thai specimens reaching 17 mm. in length.

Discussion: This species can be separated from its closest relative in Thai waters, *A. paracrinitus* Miers, by the shallow oblique transverse groove on the superior margin of the large chela and by the relative lengths of the first two carpal articles of the second legs.

Distribution: We collected this species from dead coral heads found in both the middle and outer reef area. It was only collected from Koh Kradard on the east side of the Gulf of Thailand and at Phuket in the Indian Ocean. Collection data: 2 specimens from BR 14; 1, BR 16; 7, BR 18; 1, BR 35.

De Man's specimens came from Djakarta. Holthuis (1958: 25) reported 2 specimens from Eylath, Israel and we have collected specimens from Tonga and Samoa Islands.

Alpheus paracrinitus Miers–Figure 41

Alpheus paracrinitus Miers, 1881. Ann. and Mag. Nat. Hist. V, 8:365, pl. 16, fig. 6. Chace, 1962. U.S. Nat. Mus., Proc. 113 (3466):609.

Alpheus paracrinitus bengalensis Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):901, pl. 82, fig. 37.

Alpheus bengalensis Holthuis, 1958. Sea Fish. Res. Sta., Bull. 17, pl. 25.

Crangon paracrinitus bengalensis Banner, 1953. Pacific Sci. 7(1):110, fig. 40.

Specimen Drawn: 17 mm. male from BR 17.

Description: Rostrum triangular, acute, longer than wide at base, tip reaching slightly past middle of visible part of first antennular article, not carinate, separated from anterior orbital hoods by short, shallow and rounded depressions. Orbital hoods not conspicuously inflated, rounded anteriorly. Frontal margin between orbital hoods and base of rostrum concave.

Second antennular article 2 times as long as wide, 1.5 times longer than third article. Tip of stylocerite reaching just beyond end of first antennular article. Lateral spine of scaphocerite slender, acute, reaching to end of antennular peduncle; squamous portion a little shorter. Carpocerite as long as antennular peduncle. Lateral spine of basicerite small and acute.

Large chela compressed with margins and faces smooth except for slight concavity in upper margin proximal to articulation of dactylus and a longer, more gradual concavity on lower margin below articulation of dactylus. Chela 3.4 times as long as broad, fingers about 0.3 length of entire chela. Merus slender, over 4 times as long as wide, armed with strong tooth on inferior internal margin slightly distal of middle, and sometimes with a few small movable spines proximal to tooth.

Small chela sexually dimorphic. Male chela 4 times as long as wide, with fingers occupying half the entire length and with dactylus displaying typical balaeniceps condition. Female chela 4.6 times as long as wide. Meri in both sexes with subterminal spine on inferior internal margin similar to that of large chela.

Carpal articles of second leg with first and second article varying in relative lengths : 10:(8-20):3:3:4.

Ischium of third leg armed with small movable spinules. Merus 7 times as long as broad, unarmed. Carpus half as long as merus, distal corners projecting but rounded. Propodus 0.7 length of merus and armed with 6-8 movable spinules on the inferior margin. Dactylus simple, curved and elongate.

Discussion : In this species variations may be found in the following parts :

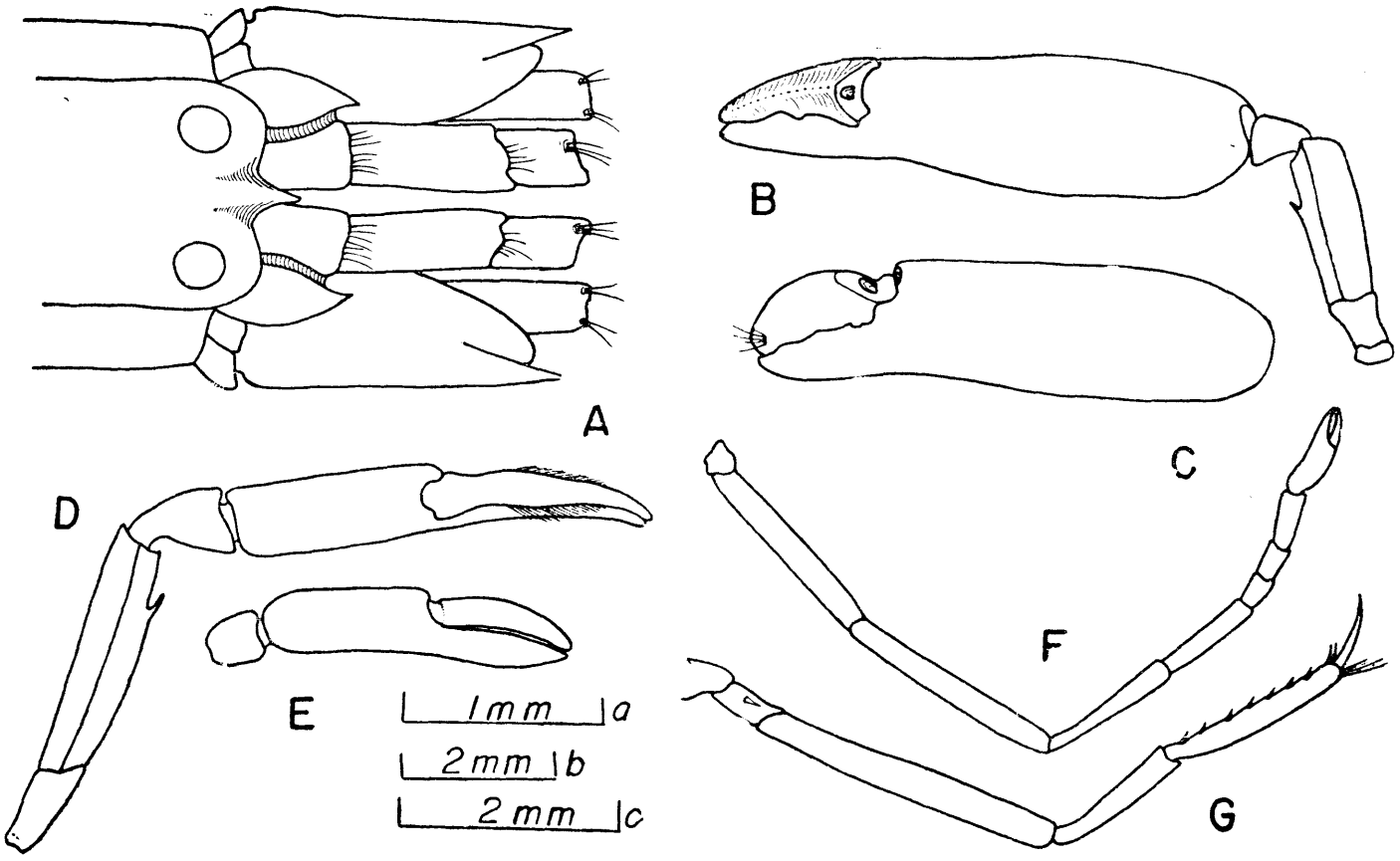

FIGURE 41

Alpheus paracrinitus Miers. A, Anterior region, dorsal aspect; B, large cheliped, superior aspect; C, large chela, inner face; D, small cheliped, male, supero-interior aspect; E, small chela, female; F, second leg; G, third leg. (A, scale a; B, C, scale b; D, E, F, G,scale c).

Rostrum : The tip may reach to the end of the first quarter of the visible part of the first antennular article, or to near the end of that article.

Meri of chelipeds : In this collection, almost all specimens have a strong tooth on the meri of both the small and large chela, and this tooth is located distal to the middle; proximally the meri may bear two or three small movable spines. However, occasionally the tooth approaches the distal end of the merus and very occasionally the tooth may be missing or greatly reduced. Further, the small movable spines may be absent (shown in fig. 17B).

Small chela : In most there is a blunt projection above the dactylar articulation; in a few the projection is an acute tooth.

Small chela of male : Almost always the lateral fringes of hair of the dactylus cross the upper surface of the dactyl, meeting about one-quarter the distance from the tip, but at times the dactyl in mature males is without this characteristic.

We have investigated the variability in this species on a large collection from the South Pacific islands; the analysis, as yet unpublished, will show that the subspecies *Alpheus paracrinitus bengalensis* cannot be separated validly from the parent species.

This species will be most readily confused with *A. ehlersi*. However, it may be separated by the lack of transverse groove proximal to the dactylus of the large chela, by a shorter stylocerite, and by a shorter second article of the second leg, a maximum of 1.8 times as long as the first in this species, with a minimum of 2.0 in *A. ehlersi*.

Thai specimens reaching 18 mm. in length.

Distribution : This species was collected from both sides of the Gulf of Thailand, at Phuket and Singapore. It was collected in dead coral heads from the middle and outer reef in water up to 3 meters deep. Locality data; 7 specimens from BR 7; 4, BR 8; 2, BR 12; 15, BR 17; 5, BR 18; 3, BR 23; 1, BR 26; 2, BR; 28; 2, BR 33; 1, BR 34; 8, BR 36; 2, BR 38; 9, BR 43.

This species was originally described from West Africa and it has been found in the Red Sea, Indian Ocean and throughout the tropical Pacific to as far east as Clipperton Island.

BREVIROSTRIS GROUP

Orbital teeth lacking. Large chela always compressed at times strongly compressed, quadrangular in section, with angles sharp; often with transverse groove on superior margin. Dactylus of small chela of male often of balaeniceps shape. Merus of third legs usually unarmed, dactylus always simple, at times laterally expanded and sub-spatulate.

Alpheus rapacida de Man—Figure 42

Alpheus rapacida de Man, 1908. Leyden Mus., Notes 30:105; 1911. Siboga Exped. 39a^1(2):394, pl. 20, fig. 91.

Specimen Drawn : 15 mm. female from Naga Expedition station 60-900. Collected with a Petersen Grab in 37 meters of water in the Gulf of Thailand by the Naga Expedition. Sand and gravel bottom.

Description : Rostrum short, triangular, reaching only to first quarter of visible part of first antennular article. Rostral carina angular between orbital hoods but rounding posteriorly. Orbital hoods inflated, orbitorostral grooves moderately deep. Frontal margin between orbital hoods and base of rostrum concave.

Second antennular article 2.5 times as long as broad, only slightly longer than visible part of first article, and twice as long as third. Stylocerite reaching almost to end of first antennular article. Scaphocerite with outer margins straight, spine reaching to end of antennular peduncle and somewhat longer than squamous portion. Squamous portion narrow. Carpocerite a little shorter than scaphocerite. Basicerite with short acute lateral spine.

Large chela highly compressed, 3.4 times as long as wide, with fingers occupying distal 0.3. Both margins smooth but carrying rows of fine setae, directed forward. Dactylus distally blunt and crossing fixed finger when closed. Plunger of dactylus reduced to a small tubercle that corresponds to depression of fixed finger. Merus slender, 3 times as long as broad; inferior internal margin bearing 4-6 movable spines and an acute distal tooth. Superior distal margin rounded.

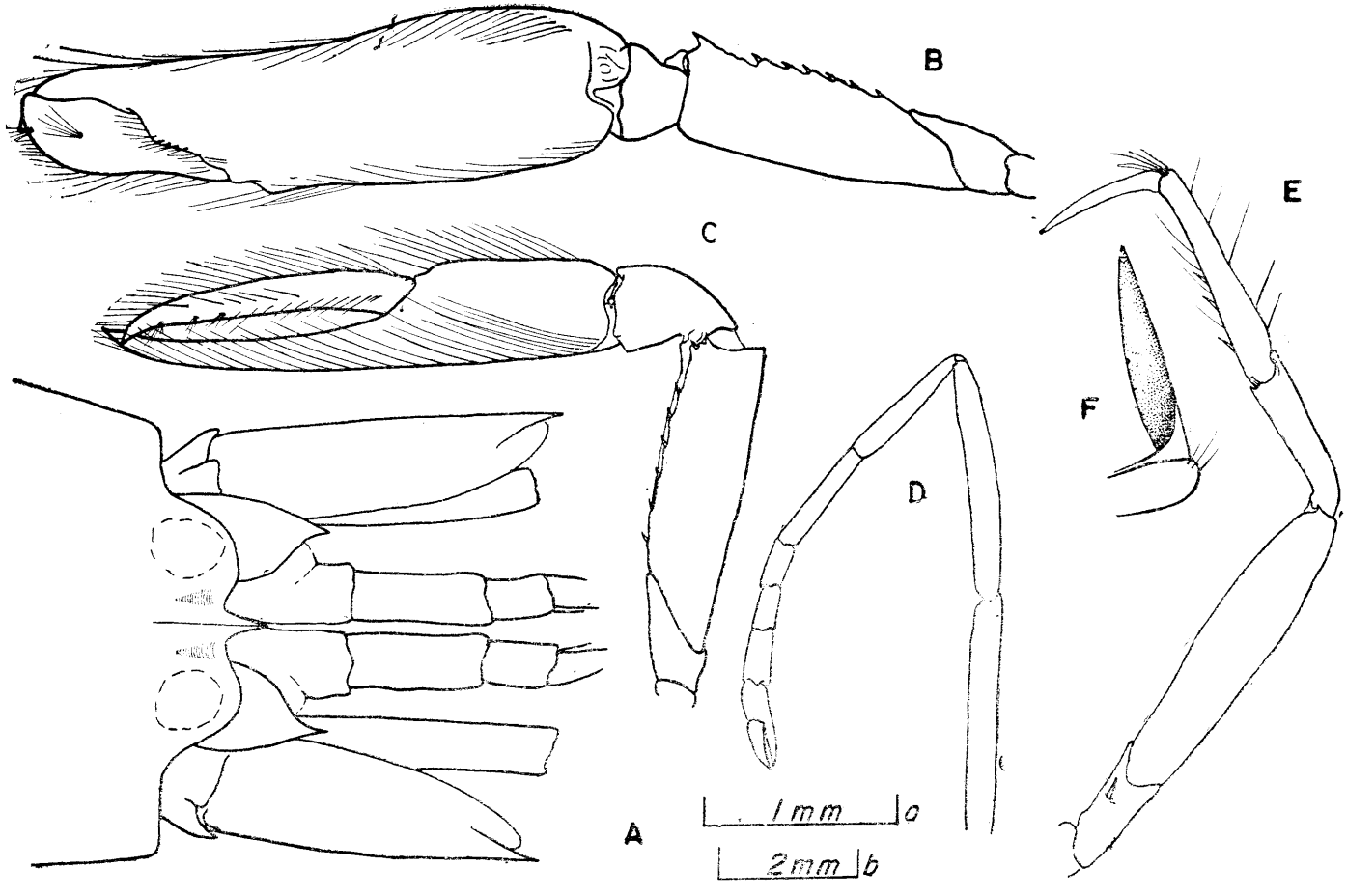

FIGURE 42

Alpheus rapacida de Man. A. Anterior region. dorsal aspect; B, large cheliped, inner face; C, small cheliped. female (male similar); D, second leg; E, third leg; F, dactylus. (A, F, scale a; B, C, D, E, scale b).

Small chela not sexually dimorphic, compressed, 5 times as long as broad. Fingers 1.5 times as long as palm with tips distally crossing. Superior and inferior margins of palm and fingers bearing long setae directed distally, similar to those of large chela. Merus slender, 3.5 times as long as broad; armature similar to large cheliped. Superior distal margin acute.

Carpal articles of second leg with ratio: 10:10:4:3:4.

Ischium of third leg 0.2 as long as merus and carrying movable spinule. Merus 5.4 times as long as wide, unarmed. Carpus 0.4 as long as merus; superior and inferior margin terminating distally in short tooth. Propodus 0.7 as long as merus, twice as broad proximally as distally, bearing three small spinules on its inferior margin. Dactylus 0.4 as long as merus; apparently normally carried at right angles to propodus, broadened and inferiorly excavate (subspatulate).

Telson 2.5 times as long as its posterior border is broad. Posterior margin strongly arcuate.

Thai specimens reaching 28 mm. in length.

Discussion: There are only two differences between our specimens and those of de Man's. In de Man's specimens (1911:396) the fingers of the small chela are 1.7-2.0 times the length of the palm, while in our specimens the fingers vary from 1.4-1.5 times the length of the palm; secondly, the superior margin of the merus of the large chela in de Man's specimens bears a small tooth which is lacking in ours. These differences may be within the range of individual variation, or may eventually be found to be of subspecific worth.

This species may be separated from most of the other species known from Thai waters by the lack of a transverse groove proximal to the dactylus of the large chela, a characteristic it shares only with *A. acutocarinatus* de Man. From this species it may be most easily distinguished by the lack of a mid-dorsal denticle at the posterior end of the rostral carina, behind the eyes (contrast fig. 42A and 43A).

Distribution: All but one of our specimens were collected by the Naga Expedition in the Gulf of Thailand. The depths were from

28-37 meters, and the bottom was sandy or muddy. We personally collected one male from Phuket in a sand beach under coral fragments at low tide. Collection data: 2 specimens from 60-1020, 2, 60-1021; 2, 60-900; 1, BR 40.

The only other specimens were the 8 that de Man reported from Indonesia.

Alpheus acutocarinatus de Man–Figure 43

Alpheus acutocarinatus de Man, 1909a. V. Ned. Dierk. Ver., Tijdschr. 11(2):104; 1911 Siboga Exped. 39a[1](2):401, pl. 21, fig. 94.

Specimen Drawn: Lost in the fire at the Hawaii Marine Laboratory.

Description: Rostrum acute, narrow, reaching slightly past middle of first antennular article. Carina sharp, continued to posterior third of carapace; carina interrupted posterior to eyes by small acute mid-dorsal denticle. Orbitorostral margin evenly rounded.

Second antennular article slender, 5 times as long as broad, visible part of first antennular article 0.6 as long as second and twice as long as third article. Stylocerite with short acute spine, not reaching end of first antennular article. Lateral margin of scaphocerite slightly concave, tip reaching slightly beyond end of squamous portion and, at most, slightly beyond end of second antennular article. Carpocerite reaching a litile past end of second antennular article. Lateral spine of basicerite small.

Large chela highly compressed, slender 5.6 times as long as wide, with fingers occupying distral 0.3. Margins entire and armed with numerous fine setae, directed forward. Dactylus heavy, with superior border carinate, distally rounded and a little shorter than fixed finger; plunger reduced to low eminence. Merus slender, 7 times as long as wide; inferior internal border carrying 2-4 movable spines and acute tooth terminally. Entire surface of merus granulose.

The small chela 9 times as long as wide, with fingers occupying the distal 0.4. Margins of palm and fingers fringed with setae similar to those of large chela. Dactylus balaeniceps-shaped in male and

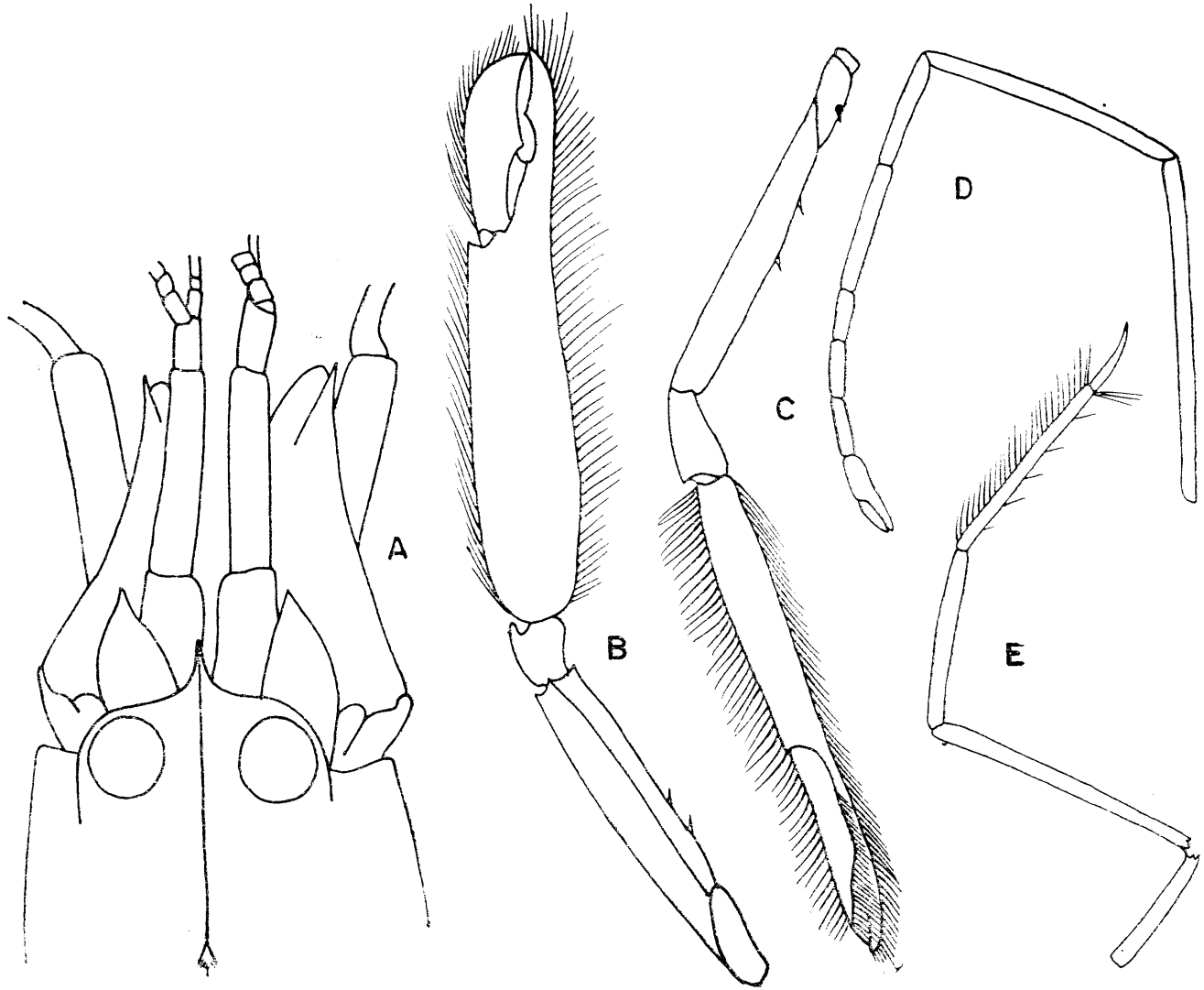

FIGURE 43

Alpheus acutocarinatus de Man. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, small cheliped; D, second leg; E, third leg (merus broken in specimen). (Specimen and scale of drawing lost in fire).

closing against fixed finger without gap. Merus 11 times as long as broad, inferior internal margin carrying two movable spinules but no tooth distally.

Second leg slender, ratio of carpal articles: 10:12:4:5:5.

Ischium of third leg armed with small spine. Merus 20 times as long as wide, unarmed. Carpus 0.4 as long as merus. Propodus 0.5 as long as merus, fine setae on both superior and inferior margin. Dactylus sub-spatulate, almost 0.2 as long as merus.

Discussion: The specimens and description of this species were lost in the fire at the Hawaii Marine Laboratory; fortunately the figure was saved. The foregoing description is based on the figure and de Man's description of his type. There are no major differences from the type. The separation of this species from *A. rapacida,* the only other Thai species lacking a superior transverse groove on the large chela, is discussed under that species.

Distribution: We recall that there were several specimens collected by the Naga Expedition, all from the Gulf of Thailand; they probably came from water between 20-30 meters deep from sand or mud bottoms.

De Man's original two specimens came from Indonesia and were collected in 32-72 meters of water. No other captures have been reported.

Alpheus rapax—Figure 44

Alpheus rapax Fabricius, 1798. Suppl. Ent. Syst. p. 405. De Man, 1909b. Soc. Zool. France, Mem. 22:147, pl. 7, figs. 1-8.

Alpheus malabaricus Hilgendorf, 1878. K. Akad. Wiss., Berlin, Monats. p. 832.

Alpheus brevirostris de Man, 1888a. Linn. Soc. London, Journ. 22:261.

Specimen Drawn: 30 mm. male from BR 44.

Description: Rostrum acute, reaching variously from first quarter of visible part of first antennular article to near end of that article. Rostral carina sharp, reaching posteriorly to base of orbital hoods. Orbital hoods inflated, forming deep orbitorostral grooves,

Antennular peduncles slender, second article 2.2-2.5 times as long as broad, 1.4 times longer than visible part of first, and 2.8 times longer than third article. Stylocerite flattened, leaf-like; lateral spine small, reaching near end of first antennular article. Lateral margins of stylocerite with fringe of short bristles. Scaphocerite with outer margins slightly curved, lateral spine only a little longer than squamous portion, subequal in length to antennular peduncle. Carpocerite reaching to end of antennular peduncle.

Large chela compressed, roughly quadrangular in section, almost 3 times as long as broad, fingers occupying distal 0.4. Superior margin of palm bearing transverse groove proximal to dactylus. Upper and lower inner margins of palm bearing rows of setae.

Medial face flattened and granulose. Dactylus heavy, distal end broadly rounded. Merus 2.8 times as long as broad, inferior internal margin armed with 4-7 movable spines and terminating in a strong tooth.

Small chela highly compressed, over 4.8 times as long as wide, fingers 1.3 times as long as palm. Fingers with opposing faces flattened and fringed with a dense row of bristles, both fingers strongly hooked at tip. Superior and inferior margins, particularly in dactylar region, bearing forward-directed hairs. Merus 3 times as long as wide, with armature similar to that of large chela. Male chela larger than female chela and bearing a short dense row of bristles on inferior margin of dactylus.

Carpal articles of second leg with ratio: 10:(10-7):3:3:5.

Ischium of third leg with small spine. Merus 5.5 times as long as wide, unarmed. Carpus 0.4 as long as merus. Propodus 0.7 length of merus and bearing on inferior margin 9 movable spinules. Dactylus 0.4 length of propodus, subspatulate, laterally expanded, with inferior surface slightly excavate.

Telson 2.6 times as long as posterior margin is broad; posterior margin strongly arcuate.

Thai specimens reaching 30 mm. in length.

Discussion : The following variations were found in this group of 16 specimens : The rostrum reached variously from the first third

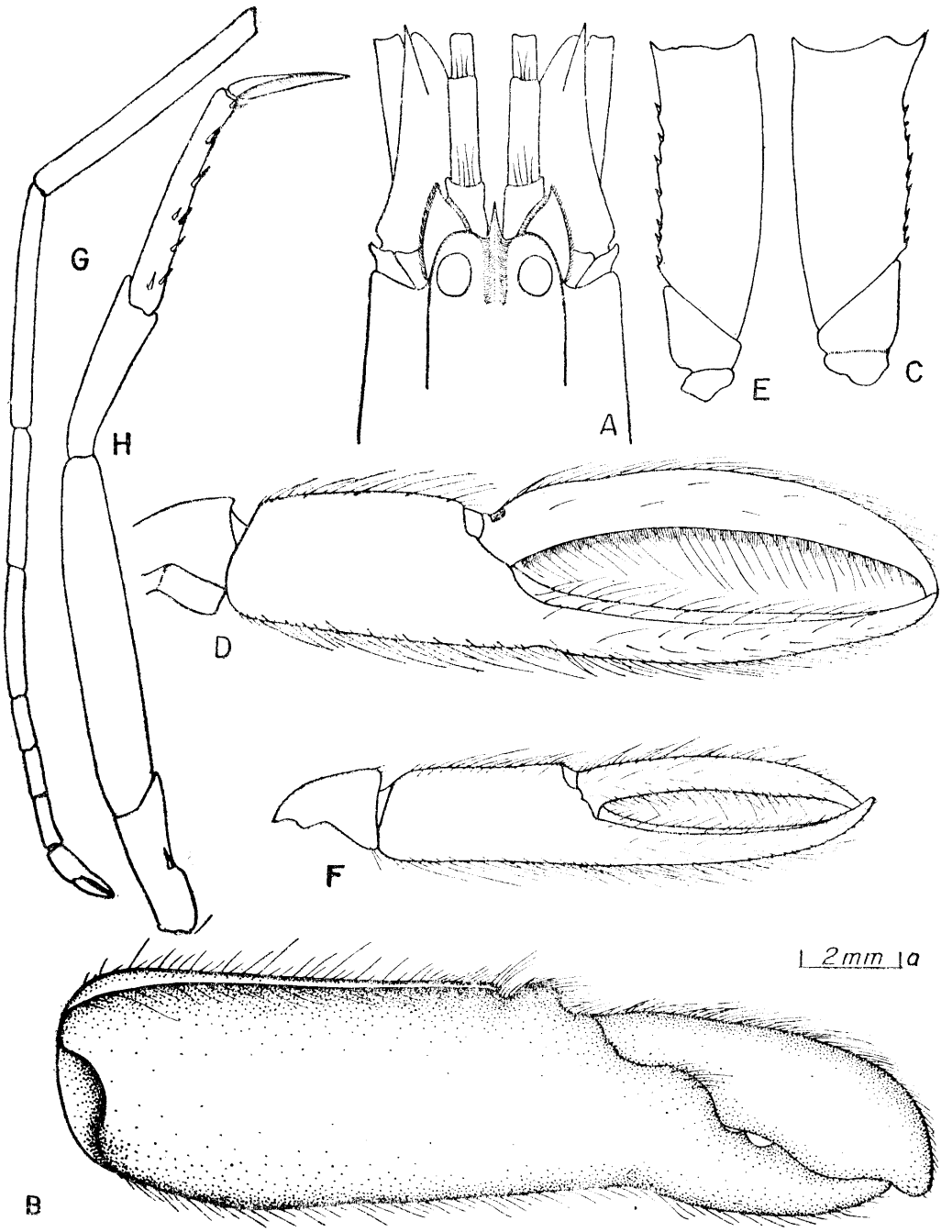

FIGURE 44

Alpheus rapax Fabricius. A, Anterior region, dorsal view; B, large chela; C, merus; D, small chela, male, outer face; E, merus, inner face; F, small chela, female, outer face; G, second leg; H, third leg. (All figures scale a).

of the visible part of the first antennular article to almost the end of that article. The second antennular article varied from 2.0 to 3.5 times as long as broad. The flattened areas of the superior and inferior margins of the large chela at times were rounded. The first and second carpal articles of the second leg varied from 0.7 to 1.0 times the length of the first.

Distribution: Our specimens were all collected from sandy to muddy intertidal areas. They may often be seen at the entrance to their burrow, but they scurry in when disturbed. The burrow is often also guarded by a gobie. Collection data: 2 specimens from BR 17; 5, BR 33; 9, BR 44.

This species has been collected from the Red Sea to Hawaii. It has been collected as far north as Japan and as far south as Northern Australia. De Man collected it in the Mergui Archipelago.

Alpheus cythereus species nov.–Figure 45

Type Specimen: 16 mm. male from Patong Beach, Phuket, Thailand. From head of dead coral collected from reef flat in about 2 m. of water.

Description: Carapace glabrous. Anterodorsal portion of carapace projecting only slightly; orbital hoods moderately inflated, rounded; rostrum slender, 1.5 times as long as broad at base, reaching almost to middle of first antennular article; rostral carina high and thin, slightly higher than orbital hoods, extending to behind orbital hoods; area between hoods and carina slightly rounded.

Antennular peduncle with second article a little more than 1.6 times as long as broad, 1.1 times as long as first article and 1.3 times as long as third article. Stylocerite with acute tip reaching almost to end of first article. Lateral spine of scaphocerite reaching beyond end of antennular peduncle, squamous portion reaching to distal half of third antennular article; carpocerite reaching beyond end of antennular peduncle. Lateral spine of basicerite small and acute. Peduncles bearing only normal setae.

Chela compressed and almost 3 times as long as broad, with abrupt transverse groove proximal to dactylar articulation; fingers

one-third length of entire palm when seen laterally, but fingers, especially dactylus, strongly curved medially so that total length is not measured in lateral view; tips of fingers calcified, acute and crossing. Outer face of merus of large chela 2.2 times as long as broad; superior margin unarmed; inferior external margin finely serrate, distally unarmed, inferior internal margin armed with four exceedingly heavy spines and strong terminal tooth.

Small chela 4 times as long as broad; fingers 1.2 times length of palm. Dactylus balaeniceps shaped, fingers with tips hooked and crossing. Lateral margins of immobile dactylus set with stiff setae. Merus 2.4 times as long as broad; inferior internal margin with armature similar to large cheliped.

Carpal articles of second leg with ratio: 10:15:5:5:6.

Ischium of third leg carrying movable spine on external face. Merus 5 times as long as wide, unarmed. Carpus approximately 0.5 length of merus, unarmed, bearing long setae. Propodus heavy, slightly curved, distally tapering, slightly longer than carpus, bearing 5 inferior spines and 2 distal spines, and numerous long setae on both margins; dactylus 0.4 as long as propodus, curved inferior surface flattened but not markedly broadened.

Telson 3.2 times as long as posterior margin is broad, 1.8 times as broad proximally as distally, lateral margins narrowing towards tip with uniform curve; tip slightly arcuate; dorsal spinules and posterior spines normal; tip bearing series of short spinules above bases of setae. Uropods normal.

Discussion: This species plainly belongs to the Brevirostris group and within that group to those with the transverse articulation behind the dactylus. Within this group only three species have the second carpal article of the second legs 1.5 to 2.0 times as long the first article. These are *A. pubescens* de Man, *A. savuensis* de Man, and *A. platyunguiculatus* (Banner). None of these three species or other species within the Brevirostris group have the strongly curved fingers of the large cheliped. It can also be separated from *A. pubescens* by the glabrous condition of the carapace; from *A. savuensis* and *A. platyunguiculatus* by the acute and crossing tips of the large chela, and the subspatulate condition of the dactylus of the third leg.

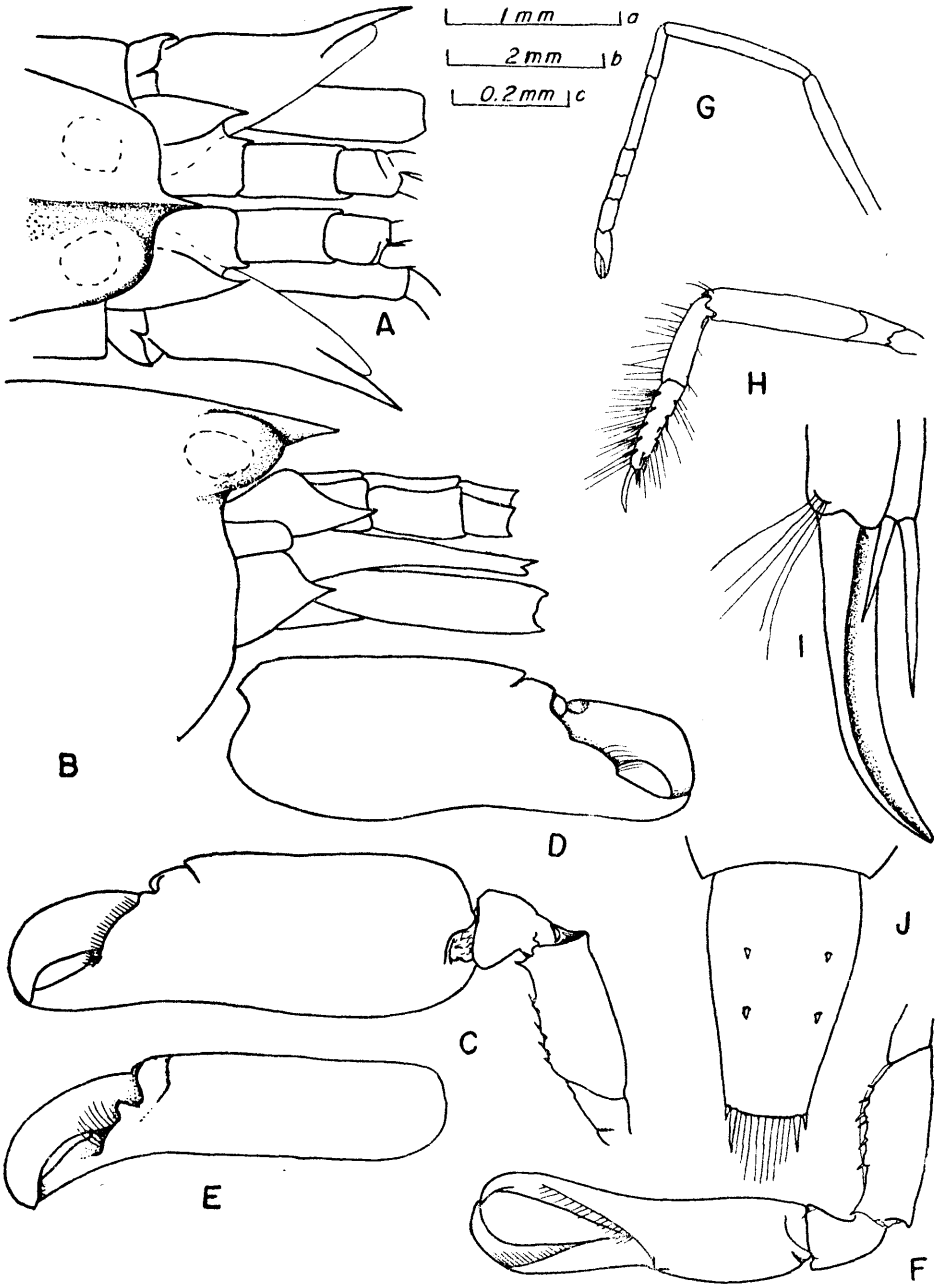

FIGURE 45

Alpheus cythereus sp. nov. A, B, Anterior region, dorsal and lateral aspects; C, large cheliped, inner face; D, large chela, outer face; E, large chela, superior surface; F, small cheliped; G, second leg; H, third leg; I, dactylus; J, telson. (A, B, J, scale a; C, D, E, F, G, H, scale b; I, scale c).

This specimen appears to be identical, except for minor variations in proportions, to a specimen the senior author collected in Arue, Tahiti, Society Islands, in 1954. It was recognized as a new species and was to be given the name *Alpheus cythereus* in honor of Bougainville's name of Tahiti, *Nouvelle Cythere*. The specimen and the figures were lost in the Hawaii Marine Laboratory fire of 1961, but the description remained. We have decided to retain the unpublished original name of this species, now with its type locality in Thailand, in remembrance to the lost Tahitian collection.

EDWARDSII GROUP

Orbital teeth always lacking (except possibly in *A. hoplites* Nobili, and *A. euchiroides* Nobili.) Large chela compressed, rounded with superior margin bearing transverse groove and usually with inferior shoulder and extensive depressed areas on palm. Dactylus of small chela of male often of balaeniceps shape. Merus of third leg usually unarmed, dactylus usually simple.

Alpheus bisincisus de Hann–Figure 46

Alpheus bisincisus de Haan, 1850. Fauna Japonica Crust. p. 179, pl. 45, fig. 3 (as *A. avarus* in text). De Man, 1911. Siboga Exped. 39a^1(2):405, pl. 22, fig. 95. Pearson, 1911. Spolia Zeyland. 7(28):182.

Specimen Drawn : A male specimen collected at Singapore, lost in the fire of the Hawaii Marine Laboratory.

Description : Rostrum flattened on top with lateral margins of base overhanging orbitorostral grooves and extending posteriorly to well past corneas, with width at base 0.37 of total length. Tip reaching to middle of visible portion of first antennular article. Frontal margins of orbital hoods flattened anteriorly, separated from rostrum by notch on anterior margin.

Second antennular article 2 times as long as wide, slightly exceeding visible part of first and over twice as long as third. Spine of stylocerite reaching to end of first antennular article. Scaphocerite with outer margin concave, spine reaching to end of antennular

peduncle; squamous portion narrow and shorter than spine. Carpocerite a little longer than antennular article.

Large chela 2.3 times as long as wide, with fingers occupying 0.4 total length. Transverse groove deep with proximal edge projecting and overhanging, forming a sharp tooth, distal margin rounded; groove continued on outer face as shallow well-defined triangular depressed area extending downward about 0.3 the breadth of face and posteriorly beyond middle of palm, continued on inner face as smaller but similarly depressed area. Shoulder on inferior margin strong, dentiform but rounded at tip; distal depressed area continuing with only slight curve to become lower margin of fixed finger. Dactylus heavy, narrow, slightly twisted. Merus 2.8 times as long as wide, with inferior internal margin armed by strong and sharp tooth.

Small chela of male 4.2 times as long as high; fingers a little shorter than palm. Upper margin with transverse groove proximal to dactylus, continuing into outer face as small triangular depressed area. Dactylar articulation flanked on inner side by small projection. Dactylus broadened and of balaeniceps shape.

Ratio of carpal articles of second leg: 10:7:3:3:5.

Ischium of third leg unarmed. Merus of third leg 6.3 times as long as wide, also inermous. Carpus 0.4 as long as merus, with both margins distally slightly projecting. Propodus 0.7 as long as merus and armed on its inferior margin with 11 movable spines. Dactylus simple, 0.3 as long as propodus.

Discussion : This sole specimen was found on reef at Raffles Light in Singapore, and was loaned by the National Museum of Malaya. The specimen and our original description were lost in the fire, but fortunately the plate remained.

Distribution : This species has been collected from Japan, Ceylon, Indonesia and South Africa. De Haan's original specimen came from Japan.

Alpheus proseuchirus de Man—Figure 47

Alpheus proseuchirus de Man, 1908. Leyden Mus., Notes 30:111. Siboga Exped. 39a[1](2):407, pl. 22, fig. 96.

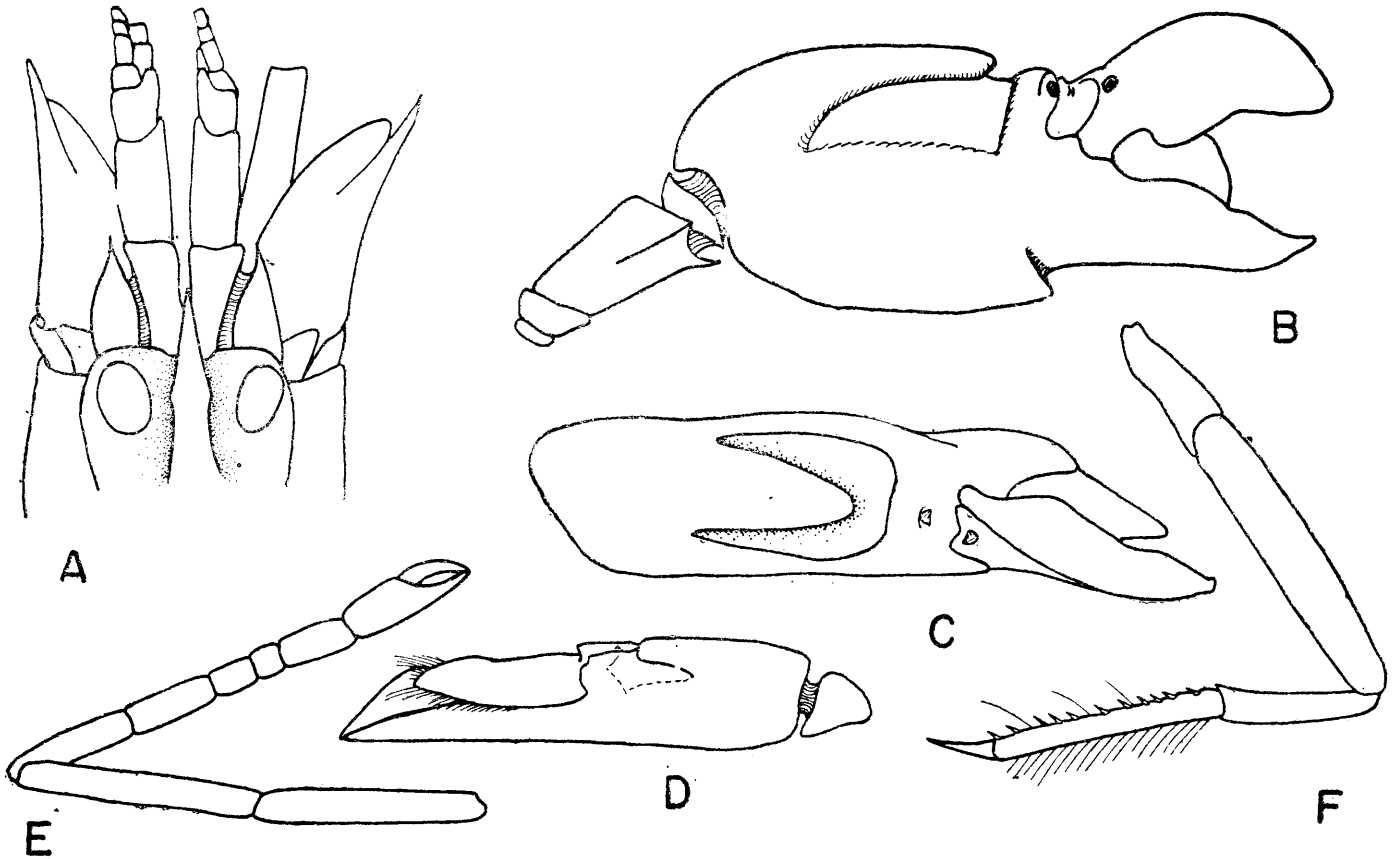

FIGURE 46

Alpheus bisincisus de Haan. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, large chela, superior aspect; D, small chela male; E, second leg; F, third leg. (Scale lost in fire).

Specimen Drawn : 15 mm. male from Naga Expedition 60-961, dredged at 60 meters from mud. Only specimen collected.

Description : Rostrum acute, narrow, reaching to end of first antennular peduncle; flattened on top, lateral margins sharp and slightly overhanging orbital grooves. Frontal margins evenly rounded. Orbital hoods not inflated.

Second antennular article 3 times as long as broad, only a little longer than visible part of first article; third antennular article equal to visible part of first. Stylocerite acute, reaching almost to end of first antennular article. Scaphocerite with outer margins slightly concave; lateral spine acute, curved, reaching just past end of antennular peduncle. Carpocerite as long as squame. Lateral spine of basicerite small and acute.

Large chela slender, 3.5 times as long as broad, with fingers occupying distal 0.2. Superior margin without transverse groove, but with marked shoulder proximal to dactylar articulation. External and internal faces of palm with marked depressions parallel to superior margin which run proximally from level of superior shoulder to proximal third of palm. Lower margin without normal strong shoulder but bearing slight depression proximal to dactylus. Merus 3.5 times as long as broad, with superior distal margin unarmed, but with inferior internal margin armed with two movable spines and heavy acute tooth distally.

Small chela 6 times as long as broad, fingers and palm equal in length. Dactylus of modified balaeniceps condition, with article, when seen in superior view, first constricting and then broadening; proximal portions on both sides bearing a fringe of strong setae which is continuous across top of finger; distal to fringe, dactylus narrowing to acute and curved tip which crosses curved and acute tip of fixed finger. Merus 5.3 times as long as broad with armature similar to that of large cheliped. (Merus of specimen drawn partially broken).

Carpal articles of second legs with a ratio: 10:6:2:2:4.

Third leg missing. Ischium of fourth legs with movable spine. Merus slender, 10 times as long as broad, unarmed. Carpus as long

as merus, also unarmed. Propodus slightly longer than merus, devoid of spine and hairs. Dactylus slender, simple, 0.3 as long as merus.

Telson 2.2 times as long as wide as the posterior margin is broad. Posterior end broadly arcuate.

Discussion : Our specimen agrees very well with that described by de Man. The chelae are very different from any other species in this group. Lacking the chelae it might be confused with *A. bisincisus* de Haan which also has flattened rostrum that overhangs the rostral groove, but in the latter the rostral base is broader. Further, the thoracic legs are much more slender in *A. proseuchirus*. De Man describes the third leg as similar to our fourth leg except it carries seven spines on the inferior margin of the propodus.

Distribution : This is the only other record of capture of this species since de Man's original description of a specimen from Indonesian waters.

Alpheus leviusculus Dana – Figure 48

Alpheus edwardsii leviusculus Dana, 1852. U.S. Explor. Exped. 13:543, pl. 34, fig. 3 a-f.

Alpheus leviusculus de Man, 1911. Siboga Exped. 39a (2):411, pl. 23, fig. 98 a-b.

Alpheus leviusculus Banner and Banner, 1964. Pacific Sci. 18(1):92, fig. 4.

Nec Alpheus leviusculus Bates, 1888. Challenger Repts. 24:549, pl. 93, fig. 4.

Alpheus bouvieri A. Milne-Edwards, 1878. Soc. Philomath. Paris, VII, 2:231.

Alpheus bouvieri bastardi Coutière, 1898a. Soc. Ent. France (5):132, fig. 1 a.

Nec Alpheus bouvieri hululensis Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):908, pl. 85, fig. 46.

Specimen Drawn : 15 mm. male from Ang Sila (BR 4a).

Description : Rostrum triangular, short, not reaching to middle of first antennular article, lateral margins slightly concave with curve continuous with orbitorostral front. Orbitorostral grooves shallow and broad, carina slight and rounded, merging with carapace

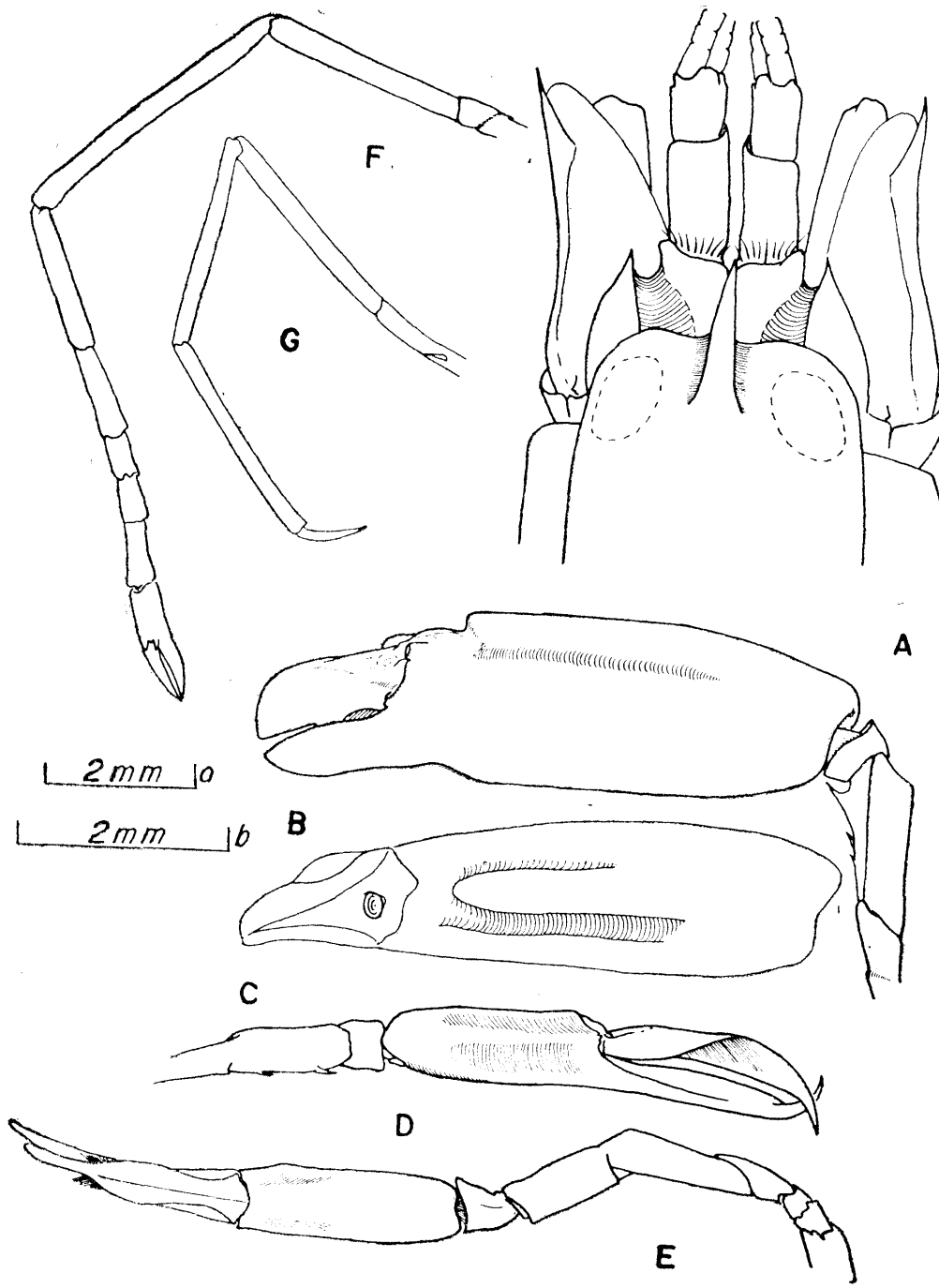

FIGURE 47

Alpheus prosecuchirus de Man. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, large chela, superior surface; D, small cheliped, inner face; E, small cheliped, superior surface (merus broken); F, second leg; G, fourth leg. (A, scale a; B, C, D, E, F, G, scale b).

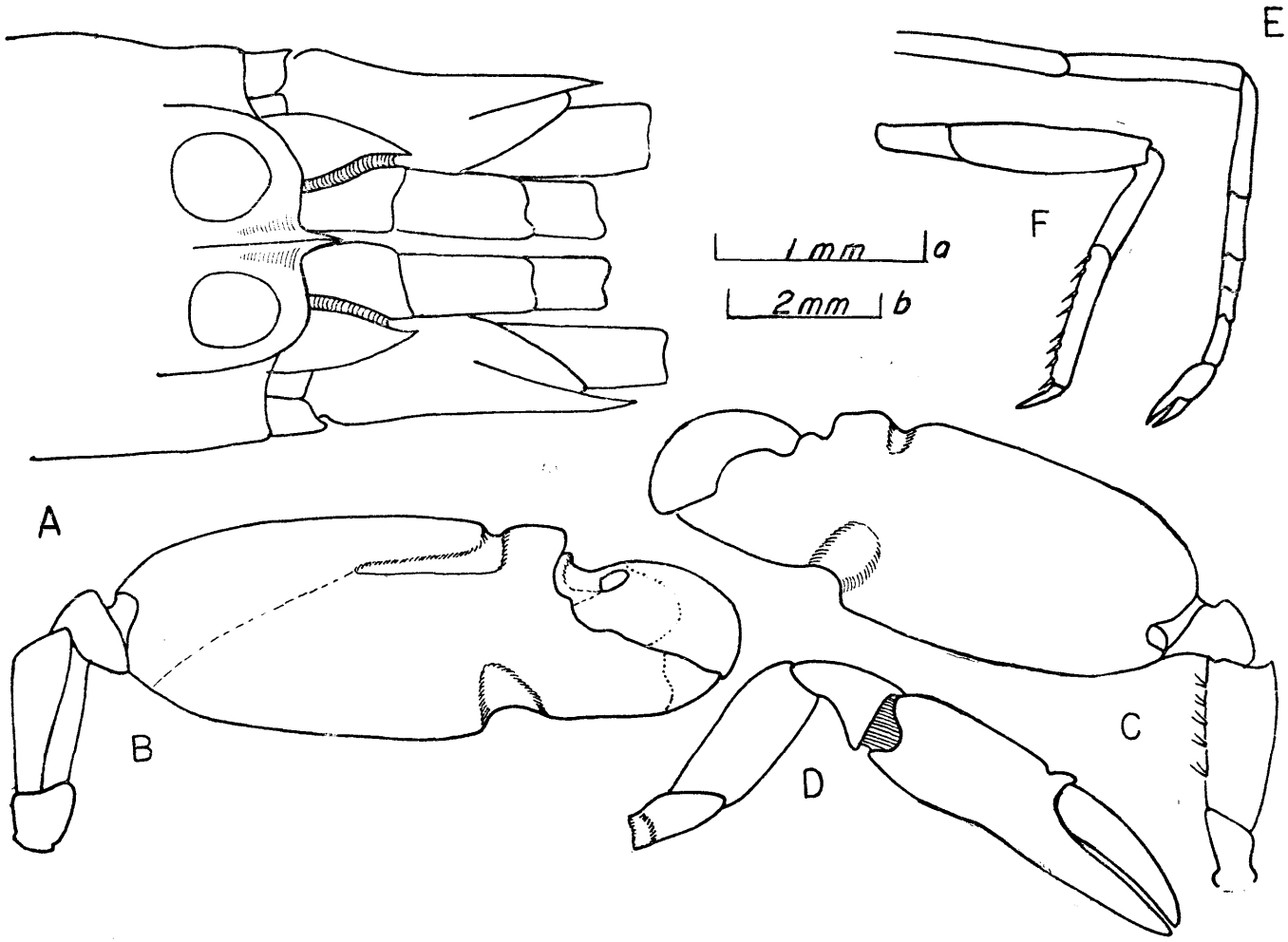

FIGURE 48

Alpheus leviusculus Dana. A, Anterior region, dorsal view; B, large cheliped, outer face; C, large cheliped, inner face; D, small chela; E, second leg; F, third leg. (A, scale a; B, C, D, E, F, scale b).

near posterior margin of eyes. Orbital hoods slightly inflated, frontal margin only slightly arcuate.

Second antennular article 1.8 times as long as broad, longer than visible part of first and third article. Second and third article subequal. Stylocerite short, acute, slightly exceeding first article. Lateral margin of scaphocerite almost straight; lateral spine slightly longer than antennular peduncle, squamous portion a little shorter. Carpocerite exceeding length of antennular peduncle almost by length of last article. Basicerite with strong lateral tooth.

Large chela 2.6 times as long as broad. Transverse groove shallow with rounded edges; outer palmar face bearing triangular depressed areas which extend proximally to middle of palm; transverse groove continued on inner face only as a slight "U"-shaped depression. Inferior shoulder, opposite transverse groove, well developed with distal depression reaching one-third distance up palmar face on both external and internal surfaces. Dactylus heavy, one-third length of entire chela, tip rounded. Merus 2 times as long as broad, inferior internal margin bearing small clusters of setae, and distally terminated by small tooth.

Small chela 3.7 times as long as broad. Palm without sculpturing, terminating in a small but distinct tooth above dactylar articulation. Fingers not balaeniceps; however, dactylus of male slightly broadened with slight row of setae on margin. Fingers equal in length to palm. Merus similar in shape and armature to that of large chela. Chela of female slightly smaller than that of male.

Carpus of second leg with ratio: 10:5:2:2:4.

Third leg with spine on ischium. Merus unarmed, 4.3 times as long as broad. Carpus 0.5 as long as merus with relatively small teeth terminating both superior and inferior margins. Propodus 0.7 as long as merus, bearing 9 movable spines on inferior margin. Dactylus simple, 0.2 as long as merus, slightly curved.

Telson 3 times as long as broad at posterior end; anterior end 2 times broader than posterior end.

Discussion : The synonymy and variations in this species have been discussed fully in Banner and Banner, 1964:92, fig. 4. The Thai

specimen agrees well with the Central Pacific specimens. This species may be separated from all others of the Edwardsii Group discussed in this paper by the depression on the superior internal surface of the large chela which is not triangular but "U"-shaped, the margins being at right angles to the upper margin of the palm.

Distribution : Our one specimen was taken from under rocks during the low tide at Ang Sila, Thailand.

It has been reported from the Red Sea, East Africa and Indonesia; from Johnson, Wake and Canton Islands in the North Central Pacific and from the Galapagos Island in the far eastern Pacific.

Alpheus euphrosyne de Man–Figure 49

Alpheus euphrosyne de Man, 1897. Zool. Jahrb. 9:745, pl. 36, fig. 6; 1898. Soc. Zool. France, Mem. 11:317, pl. 4, fig. 2.

Crangon euphrosyne (Suvatti), 1937. Check List Aquatic Fauna of Siam, p. 48.

Specimen Drawn : 35 mm. male from Songkla Lake (BR 44). Aberrant chela of male from Ang Sila (BR 4).

Description : Rostrum short, triangular, reaching to middle of visible part of first antennular article. Rostral carina slight, extending just past base of eyes; orbitorostral grooves shallow, at times non-existent. Second antennular article almost twice as long as broad; visible part of first antennular article 0.6 as long as third article, 0.5 as long as second article. Stylocerite broad, leaf-like, usually with short stiff setae on its lateral margins; lateral tooth almost rudimentary. Scaphocerite with outer margins almost straight, lateral spine usually epual to length of broad squame which is a little longer than antennular peduncle. Carpocerite as long as antennular peduncle. Basicerite bearing at most a slight tooth; usually unarmed.

Large chela 2.4 times as long as wide. Transverse groove of superior margin with both margins rounded, proximal margin oblique (about 65°) to the floor of groove. Groove continuous with triangular depressed area on both outer and inner face; that of outer face more pronounced. Shoulder on inferior margin opposite dactylar articula-

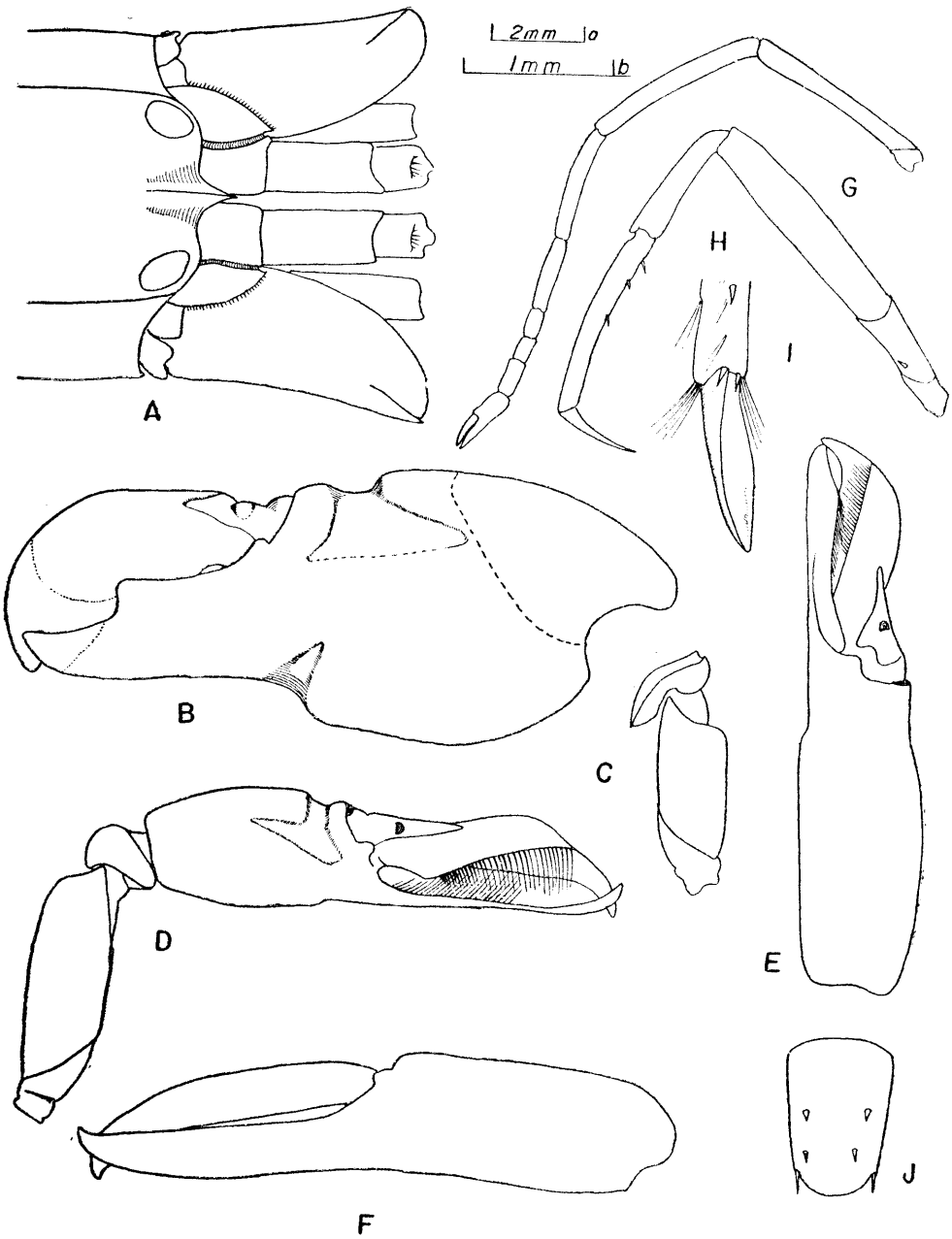

FIGURE 49

Alpheus euphrosyne de Man. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, merus; D, small cheliped, outer face, male; E, cheliped of male showing lack of sculpturing (BR 4); F, small chela female; G, second leg; H, third leg; I, third leg dactylus; J, telson. (All drawings except I, scale a; I, scale b).

tion strong but rounded; distal depressed area continuing on outer face as triangular groove for about a quarter height of chela; continuing on the inner side also as a triangle but deeper and extending further toward the midline. Dactylus heavy, compressed with superior crest reaching to tip; slightly crossing immobile finger. Merus 1.9 times as long as wide, rarely with tooth distally on inferior margin.

Small chela sexually dimorphic with male bearing typical balaeniceps dactylus. Male chela about 4 times as long as broad, palm almost cylindrical; fingers from slightly shorter than to slightly longer than palm. Sculpturing of palm of typical males similar in pattern to that of large chela, but less pronounced. Lateral margins of dactylus bearing thick stiff setae; rows of setae crossing superior surface of dactylus proximal to curved, acute tip. Area proximal and superior to finger on dactylus conspicuously traingular. Fixed finger bearing similar setae on proximal half. Acute tips of fingers crossing when closed. Merus 2.6 times as long as wide, usually with distal margins unarmed.

Female chela simple, 5.3 times as long as wide, fingers equal to palm in length; distally curved, tips acute and crossing. Palm without traces of sculpturing. Merus similar to that of large chela.

Second leg with ratio of carpal articles : 10:6:2:2:3.

Ischium of third leg with movable spine. Merus unarmed, 5.3 times as long as broad. Carpus 0.5 as long as merus with superior margin projecting but rounded. Propodus 0.8 as long as merus and bearing 3 movable spinules on proximal portion of inferior margin; distally unarmed. Dactylus subspatulate, 0.3 as long as merus.

Telson with lateral margins almost straight; anteriorly only 1.2 times as wide as posteriorly. Length 1.9 times breadth of posterior margin. Posterior margin strongly arcuate.

Thai specimens reaching to 76 mm. in length.

Discussion : Our specimens agree well with de Man's description but in our extensive collection we found wide variation. To determine the extent of this variation, we made a point by point comparison of 26 specimens ranging from 26 to 76 mm. in length.

These specimens were collected from mangrove swamps at Ang Sila; 14 were males and 12 were females. (The other 39 specimens from this locality were incomplete).

Antennular peduncle : The ratio of the first antennular article to the second varied from 10:15 to 10:20. The length : breadth ratio of the second antennular article varied from 1.7-2.5, the majority having a ratio of close to 2.0.

Tooth on basicerite : 8 of the specimens had a small tooth, 16 were devoid of any trace of tooth.

Scaphocerite : In a few specimens the squamous portion extended well beyond the tip of the spine but in general the tip of the lateral spine and the squame were the same length.

Large chela : The ratio of the length to the breadth of the chela varied from 2.1 to 3.1, with the majority in the middle ranges. The proximal edge of the transverse groove varied from gradually rounded to almost abrupt, but usually the difference was very insignificant; in no case did the proximal margin overhang the floor of the groove. In five of the specimens the inferior margin of the merus carried a small tooth, but 21 were inermous.

Small chela : The small chelae are sexually dimorphic with the male bearing a balaeniceps dactylus and slightly heavier than the female chela. However the length : breadth ratio ranged from 3.0 to 4.5, overlapping the ratio of the females which varied from 3.7 to 5.6. Most of the males also showed marked sculpturing of the palm, as shown in figure C, but a few were almost without sculpturing as shown in figure D. In the mangrove swamp collection 18 unattached male small chelae were examined in addition to those of the intact specimens; 6 chela were found without the typical grooves. In some of the members of the Edwardsii group the sculpturing appears only on the large males (see *A. crassimanus* Heller), but in these specimens a 76 mm. male, the largest in the collection, was without sculpturing.

Second legs : The second carpal article varied from 0.4 to 0.8 the length of the first.

Third leg : The merus of this leg varied from 4.0 to 6.4 times as long as broad.

This species is so similar to *A. crassimanus* that they can be easily confused. However, the almost complete lack of orbitorostral grooves and the broad squame will separate *A. euphrosyne* from that species; further *A. crassimanus* does not have a subspatulate dactylus on the walking legs. From *A. microrhynchus* de Man, another brackish water species, this species can be separated by its much longer rostrum and usually by the more pronounced sculpturing on the palm of the small chela of the male. This may also be confused with *A. audouini* Coutière, but the proximal margin of the transverse groove on the superior margin of the large chela overhangs the floor of the groove in *A. audouini,* and further the squamous portion of the scaphocerite is more narrow and the dactyli of the walking legs are simple, conical and not expanded.

Distribution: 65 specimens from BR 4 (mangrove swamp); 16, BR 40 (under rocks on sandy beach); 46, BR 44 (from commercial shrimp haul). De Man's type locality was the Java Sea; he also reported a specimen from Bangkok, presumably from a klong.

Alpheus microrhynchus de Man—Figure 50

Alpheus sp. de Man, 1897. Zool. Jahrb. Syst. 9:752, pl. 36, fig. 65.

Alpheus microrhynchus de Man, 1898. Zool. Soc. France, Mem. 11:318, pl. 4, fig. 3; 1911. Siboga Exped. $39a^1(2)$:413, pl. 23, fig. 99.

Crangon microrhynchus Suvatti, 1937. Check list of the Aquatic Fauna of Siam, p. 48.

Specimen Drawn: A 36 mm. male from Bangkok Noi, collected by Suraphol Sudara.

Description: Rostrum broadly triangular and short, reaching only slightly beyond frontal margins of orbital hoods. Slight and rounded carina extending past middle of eyes. Orbitorostral grooves shallow and indistinct. Frontal margin from rostrum to middle of orbital hoods almost straight. Second antennular article 1.8 times as long as wide, 1.2 times length of visible portion of first antennular article and 1.7 times length of third. Distal margins of all articles bearing heavy setae. Stylocerite broad, leaf-like with spine reaching

to end of first antennular article. Scaphocerite not reaching end of antennular peduncle, subequal to broad squamous portion. Carpocerite reaching to end of antennular peduncle. Basicerite unarmed.

Large chela heavy, 2.5 times as long as broad, laterally compressed, with fingers occupying distal 0.4. Superior margin of palm bearing a shallow, broadly rounded groove proximal to dactylus; groove continuous with irregular, ill-defined depressions with rounded edges on both inner and outer faces. Shoulder on lower margin, opposite upper groove, moderately strong but rounded; distal depression broad, rounded and shallow. Merus of large chela 2.2 times as long as wide, without spines or teeth.

Small chela in female slender, 4.7 times as long as wide, fingers and palm equal. Fingers close without gape, tips slightly crossing. Merus 3.6 times as long as wide. Small chela of male with fingers a little shorter than palm, balaeniceps shaped, with dactylus broadened in middle and bearing strong fringe of setae crossing over superior surface; tip constricted and acute. Palm bearing very slight sculpturing. Merus similar to that of female.

Carpal articles of second leg with ratio: 10:3:1:1:2.

Ischium of third leg armed with spine. Merus inermous, 4.6 times as long as wide. Carpus 0.5 as long as merus with neither distal margin projecting. Propodus 0.7 as long as merus, armed on inferior margin with 6 movable spinules. Dactylus conical, tapering, 0.3 as long as propodus.

Telson 0.8 as long as posterior margin is broad. Posterior margin broadly arcuate.

Discussion: This large species might be confused with many others of the Edwardsii group, but from all it can be distinguished by its extremely short rostrum. In Thai waters it is most closely related to *A. euphrosyne*, both bearing a broad squame, a shallow rounded transverse groove on the large chela, and a lack of armature on the meri of the chelipeds. However the first article of the second leg in this species is 3 times as long as the second while in *A. euphrosyne* it is not more than 1.5 times. Further the dactyli of the third legs in *A. microrhynchus* are simple while in *A. euphrosyne* they are subspatulate.

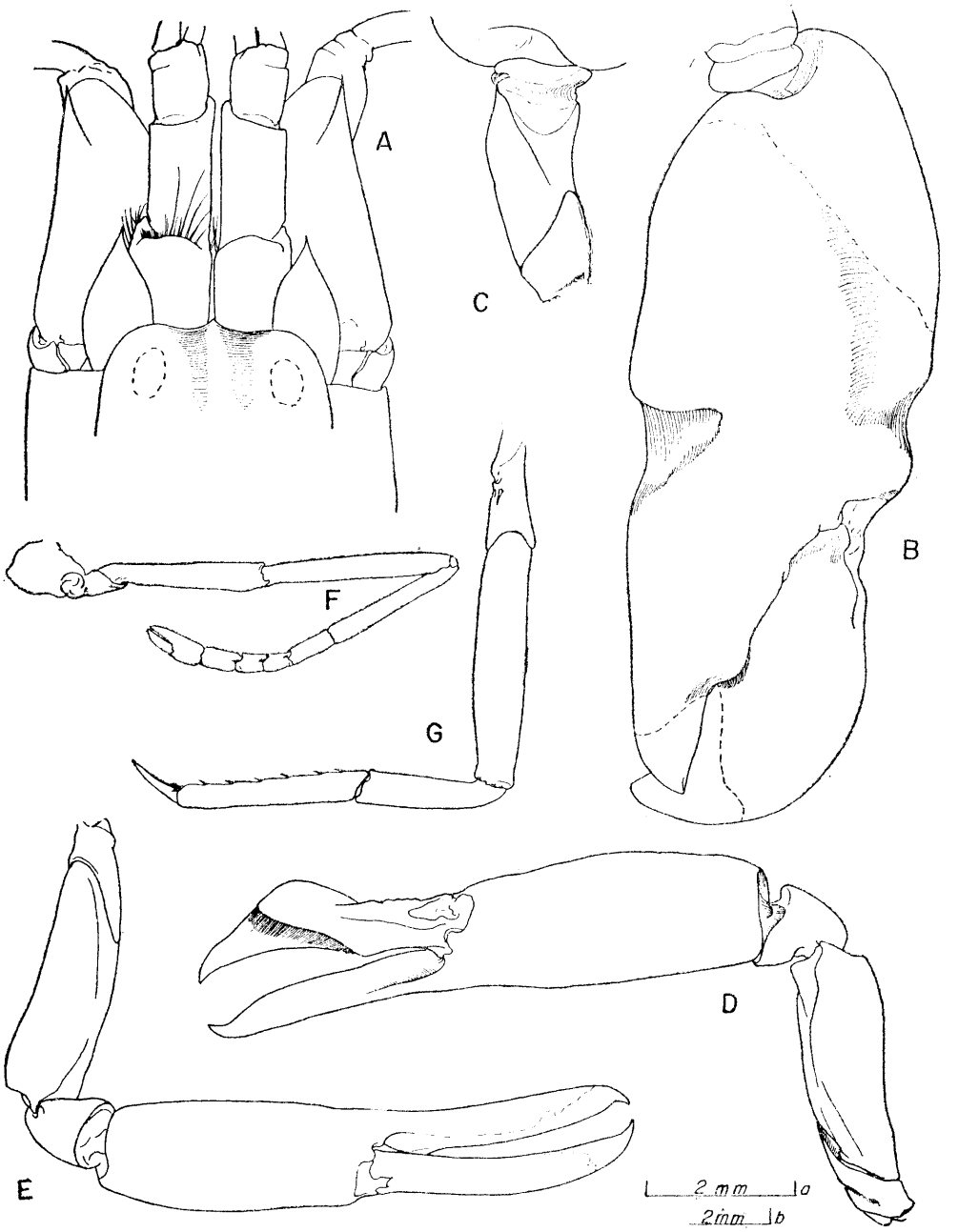

FIGURE 50

Alpheus microrhynchus de Man. A, Anterior region, dorsal aspect; B, large chela, inner face; C, merus of large chela; D, small cheliped, male; E, small cheliped, female; F, second leg; G, third leg. (A, scale a; B, C, D, E, F, G, scale b).

Distribution: This is the only purely fresh water species from Thailand, although others like *A. paludicola* Kemp, *A. malabaricus malabaricus* Fabricius, and *A. crassimanus* Heller and *A. euphrosyne* may live in brackish water. These specimens were collected in the klongs or canals of Bangkok about 15 miles from the river mouth where they are reported to be plentiful during the rainy season. De Man also reported specimens from Bangkok in his 1898 paper, which was the basis for the inclusion of the species in Suvatti's check list. Johnson (1965:5) reports its occurrence in the mangrove areas of Malaya. The extent of its penetration into the Chaophya drainage basin, or whether it occurs in other river systems is not known.

In addition to the Bangkok specimens, de Man reported the species from the wast coast of Borneo and from various places in Indonesia. Nobili (1900:479) also reported it from Indonesia.

Alpheus paludicola Kemp, a species closely related to *A. microrhynchus*, was reported by Johnson (1965:9) as appearing in waters of very low salinity in the Sedli Basin of South Johore, Malaya.

Alpheus audouini Coutière—Figure 51

Alpheus audouini Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):911, pl. 87, fig. 52. Pearson, 1911. Spolia Zeyland. 7:184, pl. 7, fig. 5. De Man, 1911. Siboga Exped. 39a[1](2):414, pl. 23, fig. 100.

Specimen Drawn: 25 mm. male from collection destroyed by Hawaii Marine Laboratory fire. Exact locality unknown, but from Peninsular Thailand. Rostral fronts from specimens from BR 8, 9a, and 11.

Description: Rostrum acute, tip reaching three-fourths of length of first antennular article. Rostral carina slight, orbital hoods only slightly inflated, orbitorostral grooves rather shallow.

Second antennular article 2 times as long as broad, subequal in length to visible part of first antennular article, and 1.3 times as long as third. Lateral spine of stylocerite strong, reaching definitely beyond end of antennular article. Outer margin of scaphocerite slightly concave, with spine reaching about half the length of third

antennular article past that article; squamous portion reaching to end of antennular peduncle. Basicerite with small but acute tooth.

Large chela 2.4 times as long as broad with fingers occupying 0.3-0.4 of total length. Transverse groove of superior margin with proximal margin slightly overhanging groove. Groove continues on outer face to form a roughly quadrangular depression extending proximally to first quarter of chela; groove continuing on inner face to form poorly defined depression. Shoulder on inferior margin strong but rounded; distal depression rounded, continuing on outer face as a marked groove, distally indefinite. Merus 2.4 times as long as broad, usually bearing acute tooth distally on inferior internal margin.

Small chela of male balaeniceps shaped, 4.3 times as long as broad; fingers almost as long as palm. Merus similar to that of large chela. Small chela of female of usual form.

Second leg with ratio of carpal articles : 10:7:3:3:4.

Ischium of third leg armed with weak movable spine. Merus of third leg 5 times as long as wide, unarmed. Carpus 0.5 as long, with distal end of superior and inferior margins projecting slightly. Propodus a little longer than carpus and carrying 10 movable spinules. Dactylus simple.

Thai specimens reaching up to 40 mm. in length.

Discussion : This species is quite variable. The rostrum at times is cone-shaped, and at times very slender, varying from 1.6 to 2.2 times as long as broad at the base (see Figs. 51 G, H, I). The first carpal article of the second leg varies from 1.2 to 2.0 times as long as the second article. In some cases the spine on the inferior internal margin of the large chela is missing.

There is no way of distinguishing this species from *A. crassimanus* if the chelae are missing. However, when they are present this species can be distinguished by the slightly overhanging shoulder on the proximal edge of the transverse groove, which is broadly rounded in *A. crassimanus*. Further, in the larger males of *A. crassimanus* the palm of the small chela bears marked grooves on its upper and lower margin, but in *A. audouini* there is at most only a slight depression;

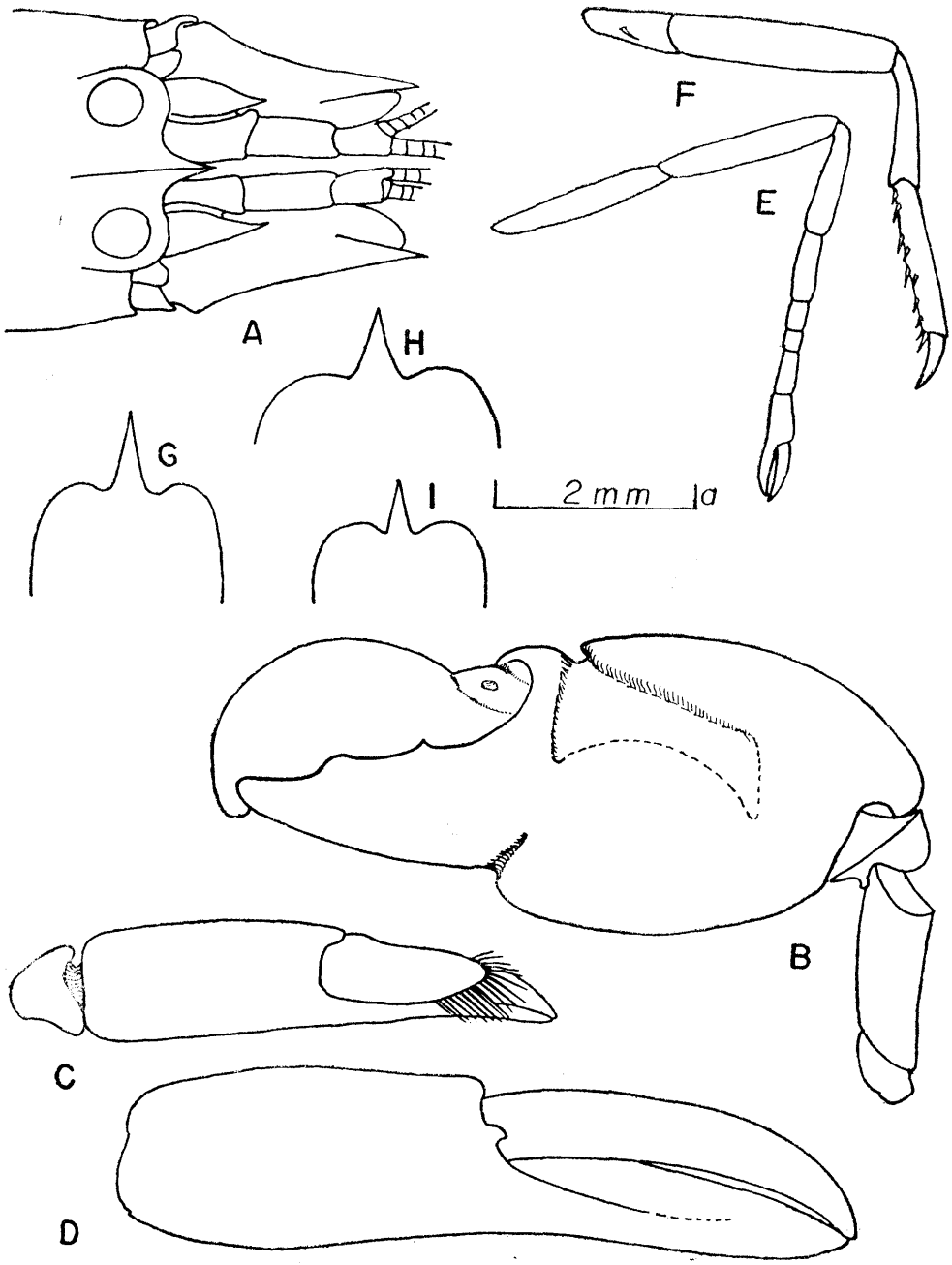

FIGURE 51

Alpheus audouini Coutière. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, small chela, male; D, small chela, female; E, second leg; F, third leg; G, H, I, showing variation in rostrums. (A, B, C, D, E, F, scale lost; C, H, I, scale a).

however, the smaller males of *A. crassimanus* are similar to mature *A. audouini*. We suspect that the two species might be synonyms, but careful examination could produce no truly intermediate forms; therefore, we must regard the species as distinct and valid.

This species is very similar to two other nominal species, *A. edwardsii* (Audouin) and *A. chiragricus* H. Milne Edwards. According to Coutière the three may be distinguished only by the narrowness of the rostral base and by the shape of the superior and inferior shoulders of the large chela. Coutière's distinctions are given in Table IX.

TABLE IX

Nature of Rostrum and Large Chela of 3 Members of the Edwardsii Group

Species	Rostrum	Large Chela	
		Proximal shoulder on transverse groove	Proximal shoulder on inferior margin
A. edwardsii	Shape of "blunt cone"	Lobe overhanging and spinose	Lobe projecting and spinose
A. chiragricus	Narrow and subulate	Similar to *A. edwardsii*	Similar to *A. edwardsii*
A. audouini	Similar to *A. edwardsii*	Lobe overhanging but rounded	Lobe projecting but rounded

De Man (1911:415) reported on 4 specimens from the Mergui Archipelago which had the "narrow subulate" rostrum of *A. chiragricus*, but in three specimens both overhanging lobes on the margins of the palm of the large chela were "more or less obtuse" while in the fourth they were spinose. He felt that the form of the lobes was an unreliable character.

We carefully measured and examined 25 specimens from various localities in this collection and found, as indicated above, that the rostral proportions were not consistent, and in none were the lobes of the margins of the large chela acute. We recall one specimen from the lost collection that did approach the condition of *A. edwardsii;* more details we cannot recall.

We suspect that the population in Thai waters is quite constant and can best be classified now as *A. audouini*. However, we also suspect that when large collections from other areas are studied, *A. audouini* and *A. chiragricus* will be found to be synonyms of *A. edwardsii*.

Distribution: We found specimens in almost all areas where we collected; most often they were found under rocks in sandy to muddy substrate at low tides. Collection data: 6 specimens from BR 1; 12, BR 4; 10, BR 5; 5, BR 6; 3, BR 9a; 12, BR 10; 1, BR 11; 3, BR 16; 12, BR 17; 14, BR 18; 1, BR 20; 2, BR 21; 2, BR 23; 2, BR 24; 1, BR 26; 2, BR 27; 2, BR 28; 4, BR 31; 14, BR 33; 2, BR 35; 14, BR 36; 12, BR 42.

This species is known only from the Indian and far western Pacific, with records from the Red Sea to Indonesia and the Great Barrier Reef of Australia. We have not collected them from the central Pacific.

Alpheus crassimanus Heller—Figure 52

Alpheus crassimanus Heller, 1865. Reise der Novara, Zool. Theil. 2(3):107, pl. 10, fig. 2. De Man, 1902. Sencken. Natur. Gesell., Abhandl. 25:880, pl. 27, fig. 61. Barnard, 1950. South African Mus., Ann. 38:756, fig. 144. Banner, 1959. Pacific Sci. 13(2):147, fig. 11.

Crangon crassimanus (Banner), 1953. Pacific Sci. 7(1):134, fig. 49.

Specimen Drawn: Male from collection that was destroyed by fire. Small chelae from BR 44 and BR 17.

Description: Rostrum acute, reaching variously from first quarter of visible part of first antennular article to near end, margins gradually curving out to merge with frontal portion of orbital hoods

and demarked from orbital hoods by broad shallow depressions. Acute rostral carina. Lateral spine of stylocerite reaching to end of first antennular article. Second antennular article 2.8 times as long as broad; 1.3 times longer than visible part of first article and almost twice as long as third article. Scaphocerite with outer margin slightly concave, lateral spine reaching half the length of third article past that article, squame as long as antennular peduncle. Carpocerite almost equal in length to scaphocerite. Basicerite with well-developed lateral tooth.

Large chela heavy, laterally compressed, 2.3 times as long as broad, with fingers occupying distal 0.4. Superior margin proximal to articulation of dactylus with strong transverse groove, with both proximal and distal margins rounded in profile. Inferior shoulder with distal depression marked and continuing superiorly to join extensive external palmar depression; on inner face, gradually diminishing but still visible beyond mid-line. Merus 2.6 times as long as broad, armed with small tooth on distal end of inferior internal margin.

Small chela of mature male 3.4 times as long as broad. Superior border with transverse groove, palmar depression and lower shoulder similar to large chela, but less pronounced. Palm bearing short acute tooth at point of articulation of dactylus, usually present but sometimes much reduced. Dactylus of typical balaeniceps shape. Merus 2.8 times as long as broad, bearing small tooth on distal end of inferior internal margin. Small chelae of female and immature males with slight depressions on palms but with slender dactyls.

Second leg with ratio of carpal articles: 10:7:2:2:4.

Ischium of third leg armed with movable spine. Merus inermous, 4.4 times as long as broad. Carpus 0.5 as long as merus with neither distal margin markedly projecting. Propodus 0.7 as long as merus, bearing on its inferior margin 7 movable spines. Dactylus simple.

Thai specimens reaching 40 mm. in length.

Discussion: Notable in this species is the variation in the sculpturing of the male small chela. From our Pacific studies (see

1959 : 147) we have shown that smaller but evidently mature male of 20 mm. or less in length may have a balaeniceps dactylus, but are almost without sculpturing on the palm. In these the upper and lower margins are marked by broad, shallow rounded depressions like the chelae of the female. As the males become larger the sculpturing becomes more pronounced, finally approaching the form of the large chela (compare fig. 52 D and E). Similar variation was noted in these specimens but none of those from Phuket or Singapore had heavy sculpturing. The small tooth above the articulation of the dactylus of the small chela varied from strong to reduced, but it was always present. The specimens from Singapore and Phuket also had a narrower, more awl-shaped rostrum.

Variation was noted in the first two carpal articles of the second leg whose ratios ranged from 10:7 to 10:12.

In a collection of 40 specimens of this species from BR 37 were 3 specimens that differed on two points. First, fully mature males did not exhibit the balaeniceps dactylus and, second, there was no tooth on the distal end of the inferior internal margin of the merus of the large cheliped.

Distribution : Most of our specimens were collected at low tide under rocks in sandy or muddy substrate. Only 8 were found in heads of dead coral, those from water 2 meters deep. Collection data : 26 specimens from BR 1; 40, BR 2; 20, BR 3; 4, BR 9; 12, BR 17; 6, BR 19; 10, BR 25; 9, BR 33; 3, BR 36; 1, BR 40; 8, BR 42; 11, BR 44.

Specimens have been reported in the Indian Ocean from the Red Sea to South Africa. Eastward, the species has been collected from Indonesia and from the Marshall, Gilbert, Tuamotu, Samoa, Tonga, Fiji, and Hawaiian Islands.

Alpheus strenuus Dana—Figure 53

Alpheus strenuus Dana, 1852. Acad. Nat. Sci. Philadelphia, Proc. 6:21; 1852. U.S. Explor. Exped. 13:543, pl. 34, fig. 4. Coutière, 1905. Fauna and Geog. Mald. and Laccad. 2(4):913, pl. 87, fig. 53. Pearson, 1911. Spolia Zeyland. 7(28):185, pl. 7, fig. 6. Banner & Banner (Pacific Sci.—in press).

Specimen Drawn : 28 mm. male collected under rocks at low tide at Phuket.

Description : Rostrum slender, reaching just beyond end of first antennular article. Rounded carina extending to base of orbital hoods. Orbital hoods only slightly inflated, forming moderate grooves between orbital hoods and carina. Rostrum joining frontal margin in curve reaching only slightly behind fronts of hoods.

Second antennular article 2.3 times as long as broad, 1.5 times as long as visible portion of first and 2 times length of third article. Spine of stylocerite reaching to, or slightly beyond end of, first antennular article. Scaphocerite well-developed, outer margins slightly concave with lateral spine reaching beyond end of antennular peduncle; squamous portion narrow, reaching to end of antennular peduncle. Carpocerite as long as lateral spine of scaphocerite. Lateral spine of basicerite with acute tooth.

Chela 2.5 times as long as broad, with fingers occupying distal 0.4, palm 1.2 times as broad as fingers. Superior margin distally projecting as a rounded tooth whose ridge overhangs transverse groove; distal margin of groove rounded. Transverse groove continued into triangular depressed area on outer face; depressed area with margins gradual and rounded, well defined only on inferior side. On inner face of palm transverse groove continued into two ill-defined depressions, one running inferiorly to form depression distal to lower shoulder, the outer continued proximally towards the middle of the palm face. Shoulder of inferior margin strong but rounded. Dactylus heavy, curved, with distal portion projecting beyond and crossing fixed finger. Scattered setae on distal portion of chela. Merus 2.6 times as long as broad, superior face without tooth; inferior internal margin armed with several small spines and bearing a strong acute tooth distally.

Small chela showing no sexual dimorphism, and both male and female chela with balaeniceps dactylus. Chela 4 times as long as broad with fingers occupying distal 0.4. Palm bearing slight rounded transverse groove comparable in location to that of large chela. On large specimens groove continues into slight and poorly defined palmar depressions. Inferior margin showing only slight concavity opposite

groove on superior margin. Dactylus broadened, with fringe of bristles well developed; narrowing to sharp, hooked tip, passing immobile finger when closed. Merus 2.3 times as long as broad, distal end of superior margin rounded; inferior internal margin armed with several small spines and bearing small acute tooth distally.

Carpal articles of second leg with ratio: 10:10:3:3:6.

Ischium of third leg armed with spine. Merus unarmed, 4.5 times as long as broad. Carpus more slender, 0.5 as long as merus, with superior distal margin projecting as a tooth. Propodus 0.7 as long as merus and bearing 5 movable spinules. Dactylus 0.4 as long as propodus, simple.

Specimens in Thailand reaching 46 mm. in length.

Discussion: Species in the Edwardsii group, especially the "giant" specimens which include *A. edamensis* de Man, *A. edwardsii* Audouin, *A. audouini* Coutière, *A. chiragricus* H.M. Edwards, *A. crassimanus* Heller and *A. euphrosyne* de Man, are separated by slight but seemingly constant and reliable characteristics. We had hoped to establish a neotype of *A. strenuus* from a specimen from Tongatabu, the type locality, but the specimen was destroyed in the fire. However the description and long discussion of its differentiation from closely related forms remains. This paper is now in press. Probably the most reliable single characteristic for its recognition is the *balaeniceps* dactylus of the small chela in both sexes. In most other species the male alone is provided with this development, but here it is also found in the mature female. A similar condition was reported for the female of *A. pareuchirus imatrix* de Man but this species and subspecies does not occur in Thai waters.

Distribution: Our specimens were all collected low in the intertidal zone on sandy beaches under rocks at Ang Sila and Phuket. Collection data: 5 specimens from BR 4a; 3, BR 33.

This species is of wide distribution. It has been collected from the Galapagos Islands off Peru to the Red Sea and South Africa, and from southern Japan to Queensland in Australia.

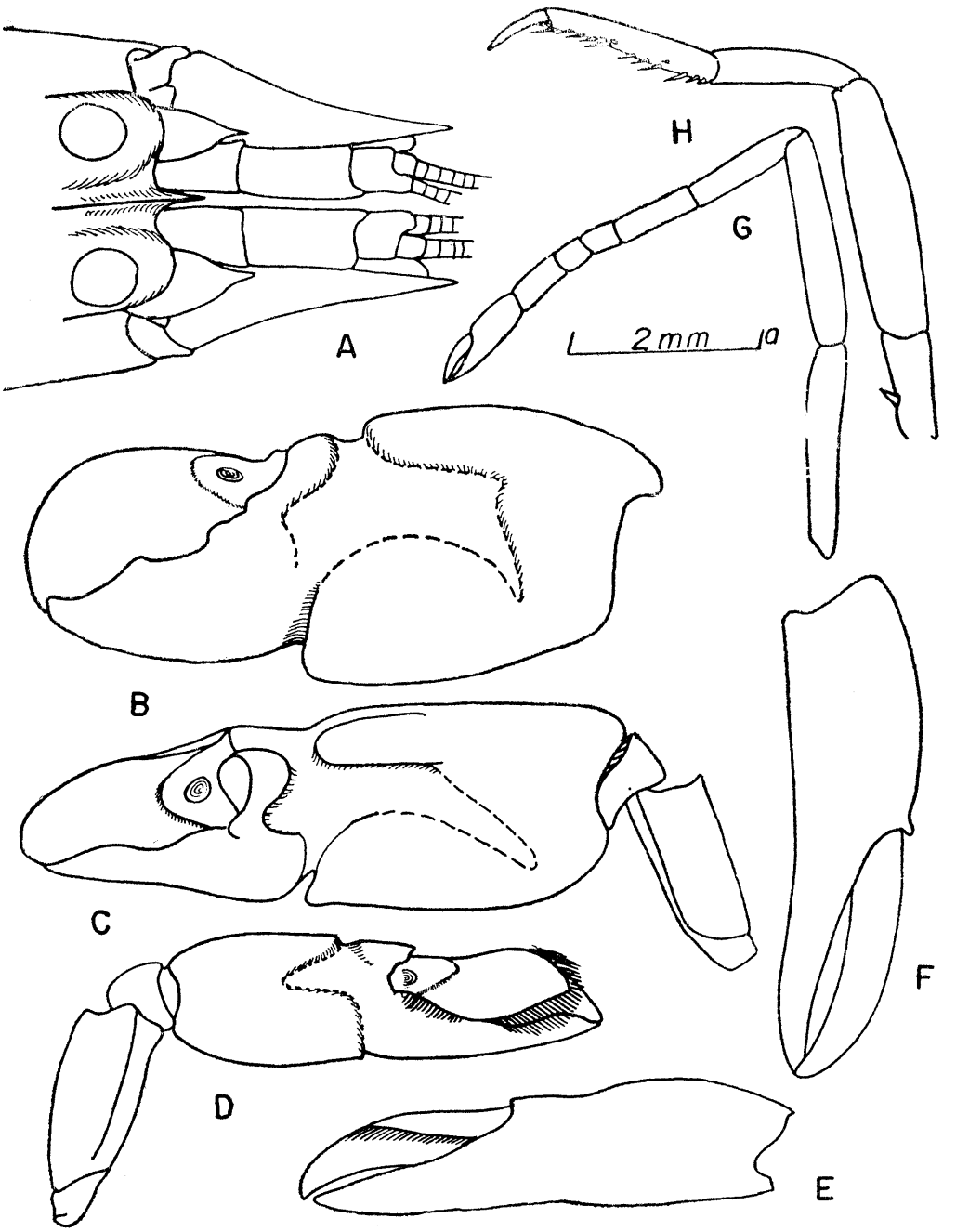

FIGURE 52

Alpheus crassimanus Heller. A, Anterior region, dorsal aspect; B, large chela, outer face; C, large cheliped, superior margin; D, small cheliped, male; E, immature male chela (BR 17); F, small chela, female; G, second leg; H, third leg. (A, B, C, D, G, H, scale lost; E, F, scale a).

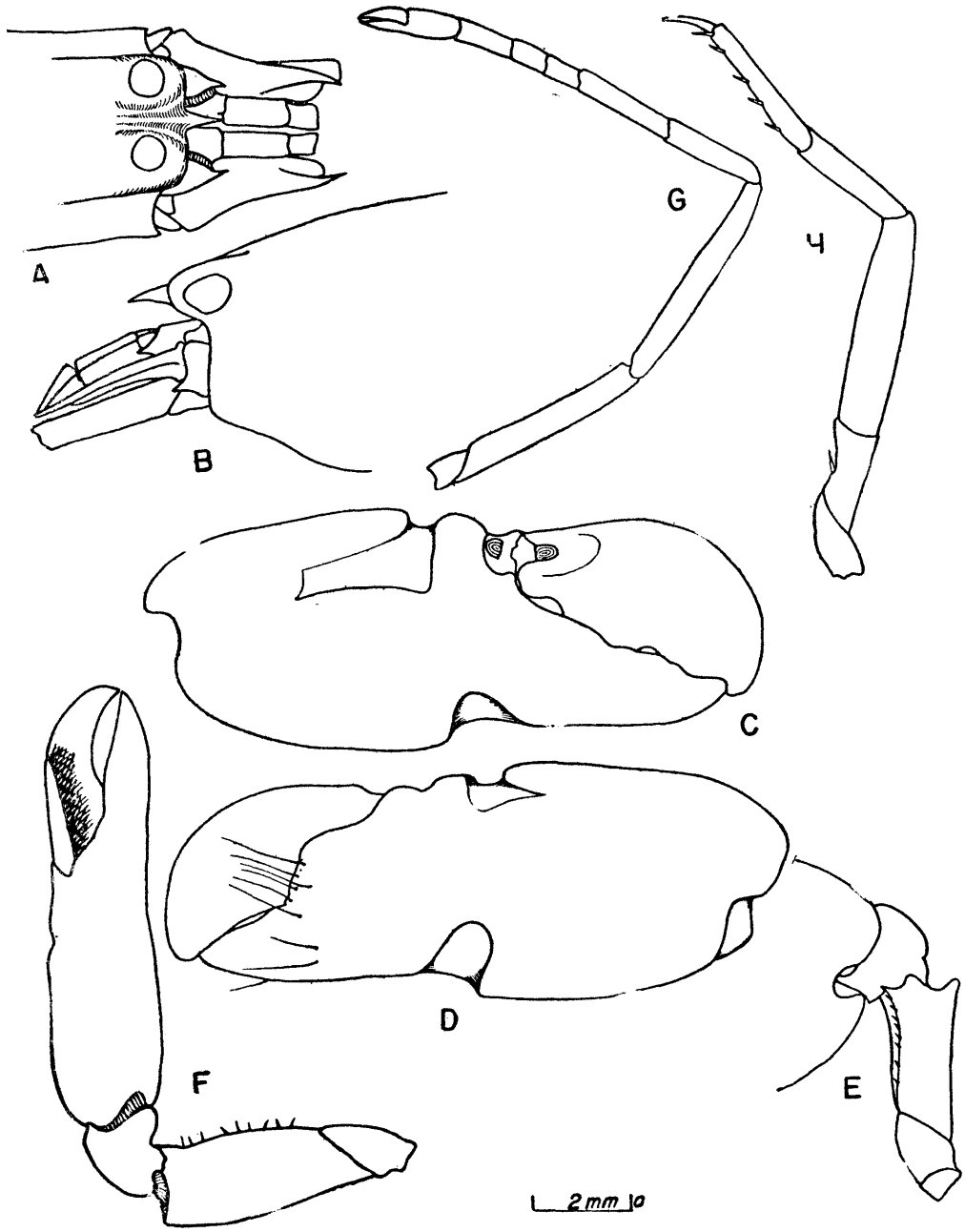

FIGURE 53

Alpheus strenuus Dana. A, B, Anterior region, dorsal and lateral aspect; C, large chela, outer face; D, large chela, inner face; E, merus large cheliped, inner face; F, small cheliped; G, second leg; H, third leg. (All scale a).

Alpheus pacificus Dana–Figure 54

Alpheus pacificus Dana, 1852. Acad. Nat. Sci. Philadelphia, Proc. 6:21. 1852. U.S. Explor. Exped. 13(1):544, pl. 34, fig. 5.

Alpheus gracilidigitus Miers, 1884. Report Voyage H.M.S. "Alert", p. 287.

Crangon pacifica Banner, 1953. Pacific Sci. 7(1):138, fig. 50 [Neotype established].

Specimen Drawn: A 25 mm. male from Gulf of Thailand. Specimen lost in Hawaii Marine Laboratory fire. Large and small chela of specimen from BR 36.

Description: Rostrum acute, triangular, 1.5 times as long as broad at base, reaching half the length of first antennular article. Lateral margins armed with sparse and short setae. Rostral carina low, rounded dorsally, extending to base of orbital hoods and separated from orbital hoods by shallow, narrow grooves. Orbital hoods somewhat inflated.

Second antennular article 2.5 times as long as broad and 1.3 times as long as visible part of first, with third article 0.8 as long as first. Stylocerite with spine acute, reaching to end of first antennular article. Scaphocerite with outer margins slightly concave, tip reaching beyond end of third antennular article by its length; squamous portion narrow, reaching to end of antennular peduncles. Carpocerite reaching variously from end of antennular peduncle to end of spine of scaphocerite. Lateral spine of basicerite prominent, broadened at its base, reaching almost to level of tip of stylocerite.

Large chela 2.3 times as long as broad, slightly compressed. Fingers heavy, almost as high as palm, occupying 0.4 to 0.5 total length of chela. Superior margin of palm projecting and overhanging deep transverse groove, distal margin abrupt but rounded. Groove continued on outer face as roughly quadrangular depressed area not extending below upper half of palm; on inner face groove continuous, shallower than outer, but having same general configuration. Notch of inferior margin much deeper than upper with proximal shoulder heavy but rounded, distal edge less abrupt; notch continuing more

than 0.3 distance up outer face with proximal edge well defined throughout but distal edge fading; depression on inner face similar to that of outer face but with both edges gradually rounded. Merus 2.3 times as long as broad, lacking tooth on inferior internal margin.

Small chela of male slender, 3.8 times as long as broad with palm occupying only 0.35 of total length. Fingers long and slender, curved distally, points crossing; both fingers bearing dense rows of marginal setae almost to tip. Carpus rounded with projection extending over base of propodus. Merus 2.2 times as long as broad, unarmed. Small chela of female of same proportions but relatively smaller. Dactylus of neither male nor female balaeniceps.

Carpal articles of second leg: 10:8:2:2:5.

Ischium of third legs armed with strong movable spines. Merus 4.3 times as long as broad, inferior margin bearing a few stiff setae. Carpus 0.4 as long as merus with both distal end of superior and inferior margin slightly extended and acute. Propodus 0.7 as long as merus, bearing on its inferior margin 9 movable spinules. Dactylus simple, 0.3 as long as propodus.

Telson almost 3 times as long as posterior margin is broad, with lateral margins convex, narrowing slightly in posterior third; posterior margin broadly arcuate.

Specimens in Thailand reaching 30 mm. in length.

Discussion: This species can be separated from *A. audouini* Coutière, *A. crassimanus* Heller, and *A. strenuus* Dana only if the large and small chelae are present, and final confirmation demands the small chelae of both mature males and females. If the male and female are present it can be readily separated because this is one of the few species of this group in which neither the male nor the female has a balaeniceps shaped dactylus (see fig. 59 for typical balaeniceps dactylus). Also typical are the very short setae on the lateral margins of the conical rostrum and, on the large chela, the overhang on the upper groove and the deeply incised groove on the lower margin.

In this species the rostrum may reach to the middle of the first antennular article or to its end. Also in the small chela the fingers may be from 1.3 to 2.0 times as long as the palm. (See fig. 54 C, E).

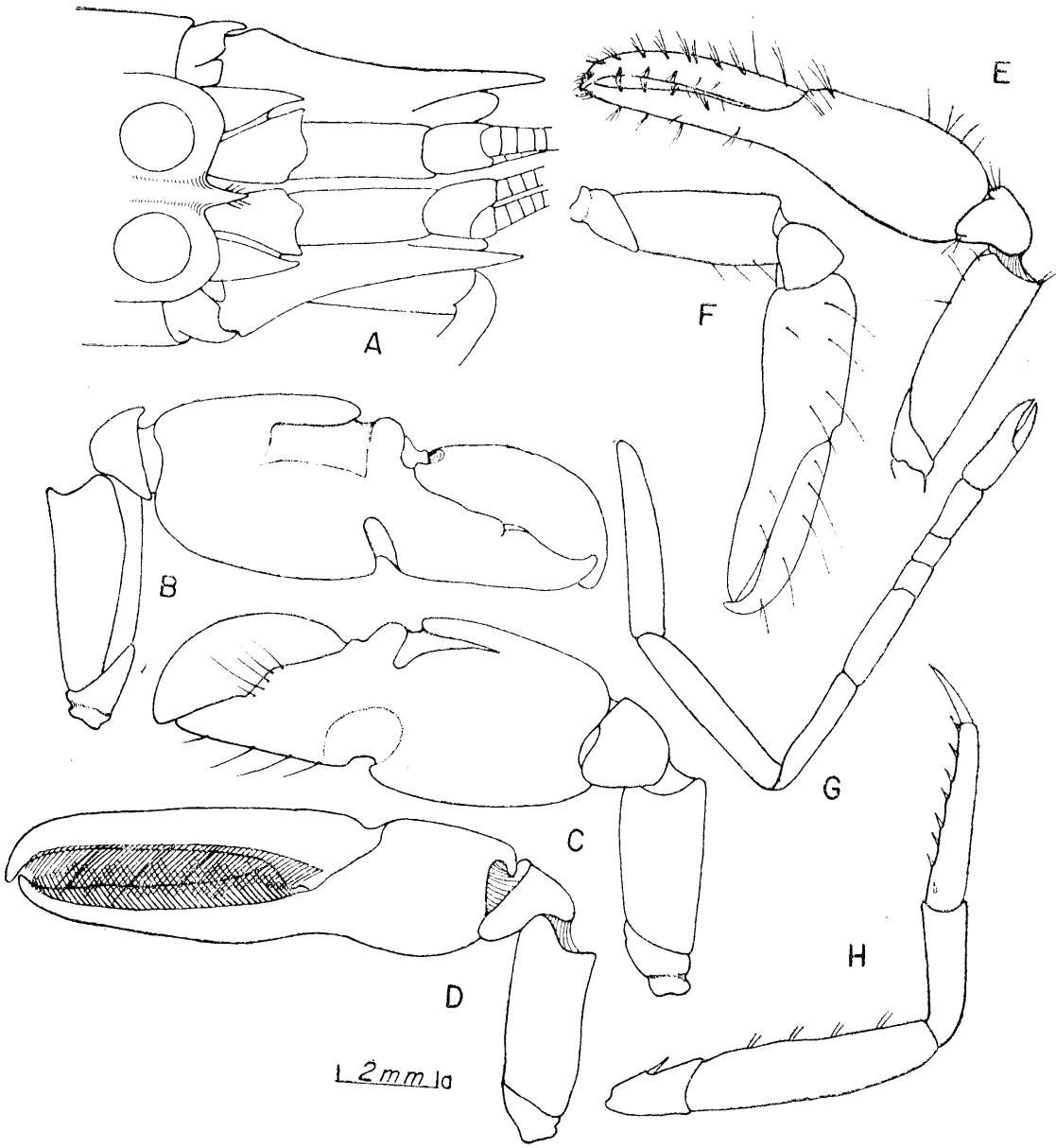

FIGURE 54

Alpheus pacificus Dana. A, Anterior region. dorsal aspect; B, large cheliped, outer face; C, large cheliped, inner face; D, E, F, small chelipeds showing variation in finger and palm ratio; G, second leg; H, third leg. (A, D, G, H, scale lost; B, C, F, scale a).

Distribution : This species was found living both in coral heads and in sandy bottom under coral heads. Collection data : 2 specimens from BR 4a; 3, BR 36; 1, SU 2.

This species has been collected across the Indo-Pacific from Zanzibar and the Red Sea to Clipperton Island. It has been collected as far north as the leeward Hawaiian Islands and as far south as New South Wales, Australia. In the Central Pacific islands it is more abundant than in Thai waters.

Alpheus malabaricus malabaricus (Fabricius)—Figure 55

Astacus malabaricus Fabricius, 1775. Ent. Syst. p. 415.
Alpheus malabaricus Henderson, 1893. Linn. Soc. London, Trans. II, 5:434, pl. 40, figs. 1-3. Kemp, 1915. Indian Mus., Mem. 5(3):301.

Specimen Drawn: A 25 mm. male from Songkla Lake, BR 44.

Description: Rostrum acute, reaching variously from middle of visible part of first antennular article to near end. Rostral carina moderately sharp, reaching posteriorly to base of orbital hoods. Orbital hoods slightly inflated, forming slight orbitorostral grooves. Margin of carapace between orbital hoods and rostrum slightly concave.

Visible portion of first and second antennular article almost equal in length, with third 0.6 as long as second; second article 8 times as long as broad. Stylocerite with short, acute spine not reaching to end of first anetnnular article. Scaphocerite with outer margin almost straight, lateral spine only slightly longer than squamous portion, reaching to end of antennular peduncles. Carpocerite equal in length to antennular peduncle. Short, acute spine on basicerite.

Large chela 3.0 times as long as broad with fingers occupying 0.4 entire length. Transverse groove of superior margin of palm with proximal shoulder abrupt but rounded, not protruding; groove continuing on both faces as ill-defined triangular depressions. Inferior shoulder relatively slight and rounded, distal depressed area slight and poorly defined. Merus of large chela 4 times as long as wide,

with superior margin projecting distally as slight tooth, inferior internal margin bearing a long narrow and acute tooth.

Small cheliped without sexual dimorphism. Fingers long, slender, over 3 times as long as palm with dense setae on both margins, setae crossing. Palm 2 times as long as wide, superior distal margin armed with very small tooth. Merus 5 times as long as broad, unarmed.

Carpal articles of second leg with ratio : 10:9:2:2:3.

Third leg with spine on ischium. Merus 5.2 to 7.5 times as long as wide, unarmed. Carpus 0.5 as long as merus with superior margin projecting distally, but rounded. Propodus without spinules but with long setae, 0.8 as long as merus, 8-9.5 times as long as broad. Dactylus simple, subspatulate, 0.4 as long as merus.

Telson 3 times as long as posterior margin is broad. Posterior margin slightly arcuate.

Specimens in Thai waters reaching 28 mm. in length.

Discussion: To date four forms of this species have been recognized: *A. malabaricus* (Fabricius), here given a subspecific name for the first time, which was redescribed by Henderson and Kemp; *A. m. dolichognatha* Ortmann; and *A. m. leptopus* de Man; and *A. m. mackayi* Banner. The specimens described above agree with the parent form, *A. malabaricus*, in that the fingers of the small chela are straight and meet along their entire length. In the other subspecies there is a gape. Furthermore, in our specimens there is a poorly developed tooth above the dactylar articulation similar to that of the parent form, also similar to *A. m. mackayi*. In the other two subspecies this tooth is entirely missing.

Other criteria used to separate the subspecies are more questionable. In his key de Man emphasizes the proportion of the lateral spine of the squamous portion of the scaphocerite and the proportions of the third legs. However, in our specimens the proportions of both are variable, and de Man in his text (p. 431) shows that even in his few specimens the ratios of the merus and propodus of the third legs of *A. m. leptopus* overlap those of *A. m. dolichognatha*. As we have

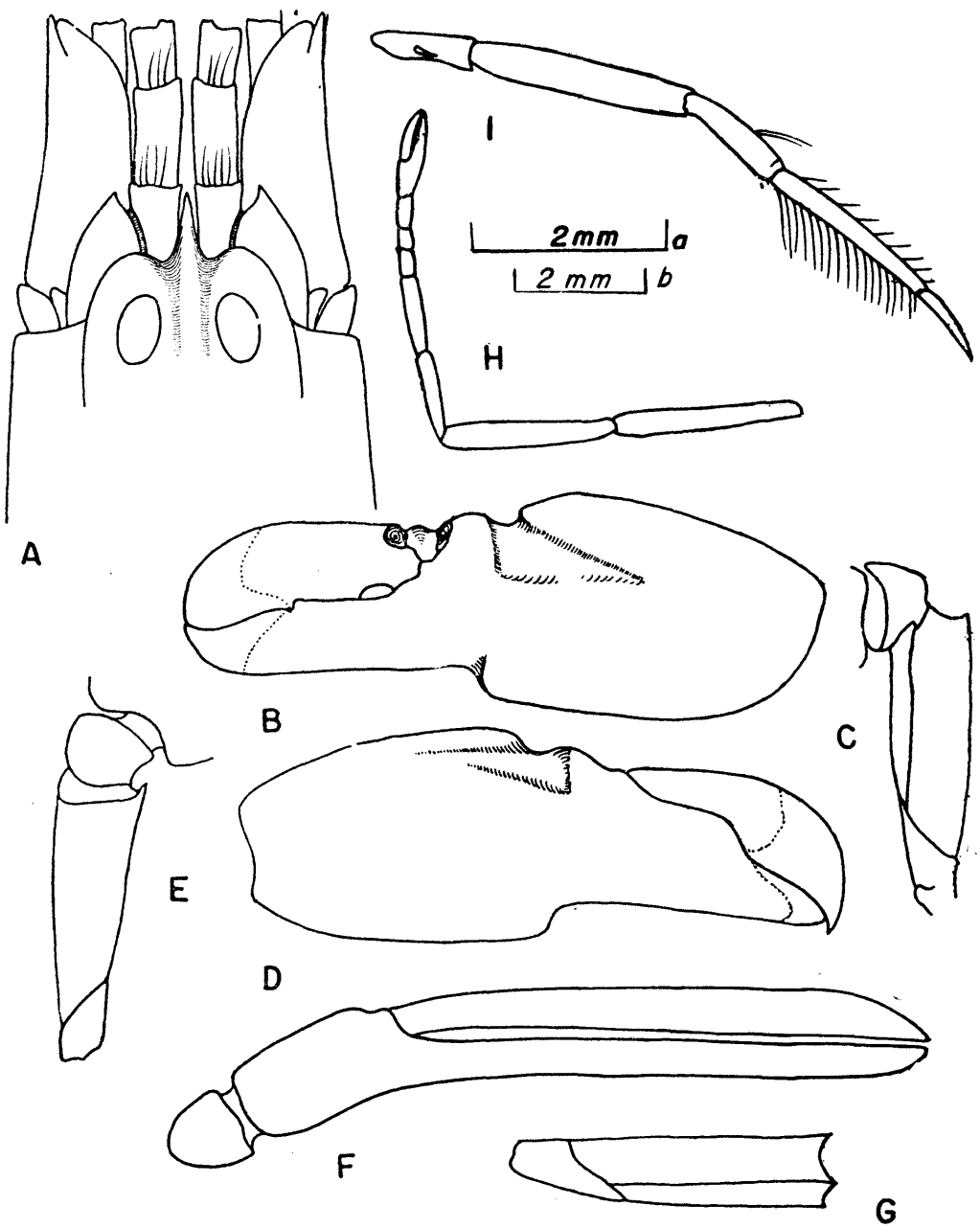

FIGURE 55

Alpheus malabaricus malabaricus Fabricius. A, Anterior region, dorsal view; B, large chela, outer face; C, merus, large cheliped, outer face; D, large chela, inner face; E, merus, large cheliped, inner face; F, small chela (setae not shown; dense enough to obscure opposing margins); G, merus, small cheliped; H, second leg; I, third leg. (A, scale a; B, C, D, E, F, G, H, I, scale b).

no representatives of either of these subspecies we will not consider further the validity of their separation.

Distribution: Some of our specimens were picked out of the haul of commercial shrimp trawl at Lake Songkla. We also found two under rocks at low tide at Phuket and one specimen from the Gulf of Thailand taken in 27 meters of water by the Naga Expedition. Collection data: 2 specimens from BR 40; 6, BR 44; 1, Naga 60-1068.

This subspecies has been reported from the Indian Ocean and Japan. We have not found it in our collections from the Central Pacific. The two other subspecies came from Japan and Indonesia.

Alpheus malabaricus songkla subspecies nov.—Figure 56

Type Specimen: 20 mm. female from BR 44, from commercial shrimp trawl at Lake Songkla made in approximately 1 meter of water on sandy bottom. PARATYPES: 10 other females from 15-20 mm. in length (BR 44); 1, BR 29; 3, BR 40.

Description: Rostrum acute, reaching to middle of visible part of first antennular article. Rostral carina rounded, not reaching to posterior base of orbital hoods. Shallow orbitorostral grooves.

Second antennular article 1.5 times as long as wide. Visible part of first antennular article equal in length to second, third antennular article 0.7 as long as second. Short acute spine of stylocerite not reaching to end of first antennular article. Scaphocerite with outer margin almost straight, spine reaching to end of antennular article; squamous portion not broad, only a little shorter. Carpocerite a little longer than antennular peduncle. Basicerite with minute lateral spine.

Large chela 2.7 times as long as broad with finger occupying 0.3 length of entire chela. Transverse groove of superior margin shallow, broad, with proximal margin rounded but at right angles to floor of groove, distal margin gradually rounded. Depressed areas of outer and inner face roughly triangular, shallow and poorly delimited. Inferior shoulder rounded and not heavy; distal depressed area shallow. Merus 2.4 times as long as broad, inermous.

Small chela 4.6 times as long as broad with fingers approximately 1.5 times as long as palm. Upper margin of palm projecting above dactylar articulation as a slight notch. Fingers with dense setae on opposing margins, setae crossing; tips of fingers hooked and crossing. Merus 2.6 times as long as broad, unarmed.

Carpal articles of second leg with ratio: 10:6:2:2:3.

Ischium of third leg bearing movable spinules. Merus 5.2 times as long as broad, unarmed. Carpus 0.4 as long as merus. Propodus 0.8 as long as merus, 8 times as long as broad at its proximal end, bearing strong setae but no spinules. Dactylus subspatulate, 0.3 as long as merus.

Telson 2.4 times as long as posterior margin is broad. Posterior margin strongly arcuate.

Thai specimens reaching up to 24 mm. in length.

Discussion: This subspecies can be separated from *A. m. malabaricus*, *A. m. dolichognatha* and *A. m. leptopus* (see discussion under *A. m. malabaricus*, p. 146) best by the difference in the fingers of the small chela which are three times as long as the palm in all three subspecies, but in *A. m. songkla* and *A. m. mcckayi* they are only 1.5 times as long; further in *A. m. dolichognatha* and *A. m. leptopus* the tips do not cross. This subspecies is separated from *A. m. mackayi* by a longer rostrum and lack of orbitorostral grooves. Further in this subspecies the fingers of the small chela are more slender and the crossing tips are much longer. This form also lacks the tooth on the merus of the large cheliped found in the other subspecies. The third leg is less slender than those of *A. m. dolichognatha* and *A. m. leptopus*, but agrees with *A. m. malabaricus* and *A. m. mackayi*.

All specimens in the collection were females. Most of the specimens were collected by commercial shrimp trawlers in Songkla Lake which also caught the *A. m. malabaricus* listed above. While this is no guarantee they were caught concurrently in exactly the same environment, this coincidence is enough to make us doubtful about the validity of the subspecies. Yet as the females of *A. m. malabaricus*, both adult and immature, from Songkla Lake did not show this type of small chela and as no intergrading specimens were found in this

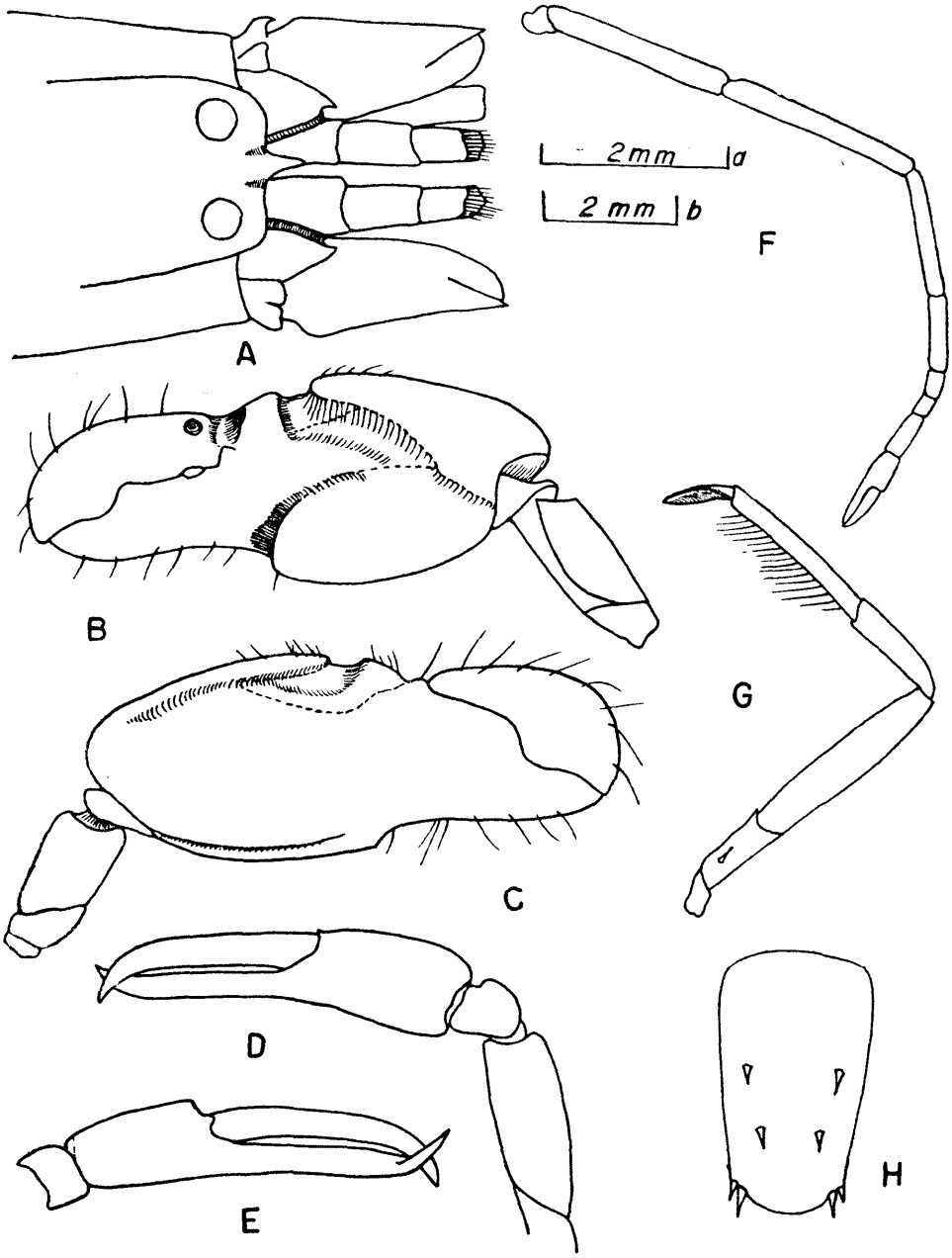

FIGURE 56

Alpheus malabaricus songkla subspecies nov. A, Anterior region dorsal aspect; B, large cheliped, outer face; C, large cheliped inner face; D, small cheliped inner face; E, small chela, outer face; F, second leg; G, third leg; H, telson. (A, H, scale a; B, C, D, E, F, G, scale b).

small collection, we have no alternative but to name this form as a subspecies. We cannot account for the lack of males.

Alpheus parvirostris—Figure 57

Alpheus parvirostris Dana, 1852. Acad. Nat. Sci. Philadelphia, Proc. 6:22; 1852. U.S. Explor. Exped. 13:551, pl. 35, fig. 3. De Man, 1911. Siboga Exped. 39a^1(2):432, pl. 25, fig. 106.

Specimen Drawn: 15 mm. male from Koh Kradard, BR 18.

Description: Rostrum acute, narrow, reaching almost to end of first antennular article, distally tilted upward, anterior medial margin of orbital hoods extended as flattened prominence, rounded at margin; strong rostral carina extending to base of orbital hoods; grooves between orbital hoods and rostrum of medium depth.

Second article of antennular peduncle 2.5 times as long as broad, about 1.4 times as long as visible part of first, and two times as long as third. Stylocerite with spine acute, reaching well beyond end of first antennular article. Scaphocerite with outer margin concave and with strong spine reaching almost length of third antennular article past that article. Squamous portion narrow and reaching at most to end of antennular peduncle. Carpocerite reaching slightly beyond end of antennular peduncle. Lateral spine of basicerite conspicuous, acute, long, with tip reaching variously from just past end of first antennular article to near end of second article.

Large chela compressed, 2.5 times as long as wide, fingers occupying 0 3 of total length, and somewhat hirsute on inner side. Upper margin bearing strong oblique, not transverse, groove proximal to dactylus; groove continuing into palmar depression, a deep narrow groove that extends to proximal quarter of palm. Lower margin of palm bearing an abrupt shoulder opposite superior groove, with strong distal depression, groove ending abruptly on outer face about 0.2 distance from lower edge, but on inner face gradually diminishing. Merus of males thick, 1.7 times as long as broad, with inferior internal margin bearing strong tooth on distal end and usually 2 or 3 short movable spines proximally. Merus of female more slender, 2.5 times as long as broad.

Small chela of male 2.8 times as long as broad, fingers a little longer than palm; palm bearing acute tooth above dactylar articulation. Merus 2.4 times as long as broad and bearing armature similar to that of large chela. Small chela of female 2.5 times as long as broad; merus correspondingly more slender.

Normal proportions of the carpal articles of second leg: 10:6: 3:3:5, with the proportions of the first two articles varying from 10:5 to 10:7.

Ischium of third leg armed with movable spine. Merus varying from 3.3 to 4.4 times as long as broad; inferior margin bearing several conspicuous bristles and terminal tooth of varying development, at times strong and at times absent (see fig. 57 E, F). Carpus 0.5 as long as merus. Propodus 0.7 as long as merus and bearing on inferior margin 10 movable spinules. Dactylus simple, 0.3 as long as propodus.

Telson 1.5 times as long as its posterior margin is broad; anterior margin 2.3 times as broad as posterior margin. Lateral margins concave, slightly constricted towards posterior end; posterior margin arcuate.

Discussion: This is a small species, our largest specimens being no longer than 15 mm. It does not vary much in its proportions and can be distinguished readily by three features: the flattened extensions of the anterior margin of the carapace between the orbital hoods and rostrum, the long and strong spine of the basicerite, and the deep, narrow and oblique groove proximal to the dactylus on the large chela. *Alpheus ehlersi* de Man bears a somewhat similar groove but it is much shallower.

Distribution: This species was found living in the coral in almost all of the collecting localities in the Gulf of Thailand and the Indian Ocean. There were even a few found associated with sponges. We have specimens from the following localities: 49 specimens from BR 5; 9, BR 6; 6, BR 7; 8, BR 8; 13, BR 10; 3, BR 11; 3, BR 12; 3, BR 13; 26, BR 14; 11, BR 15; 12, BR 16; 40, BR 18; 6, BR 21; 2, BR 22; 11, BR 23; 5, BR 24; 15, BR 27; 1, BR 27c; 1, BR 30; 22, BR 31; 7, BR 32; 1, BR 35; 1, BR 36; 10, BR 38; 6, BR 39; 7, BR 41; 13, BR 42; 26, BR 43; 1, SU 2.

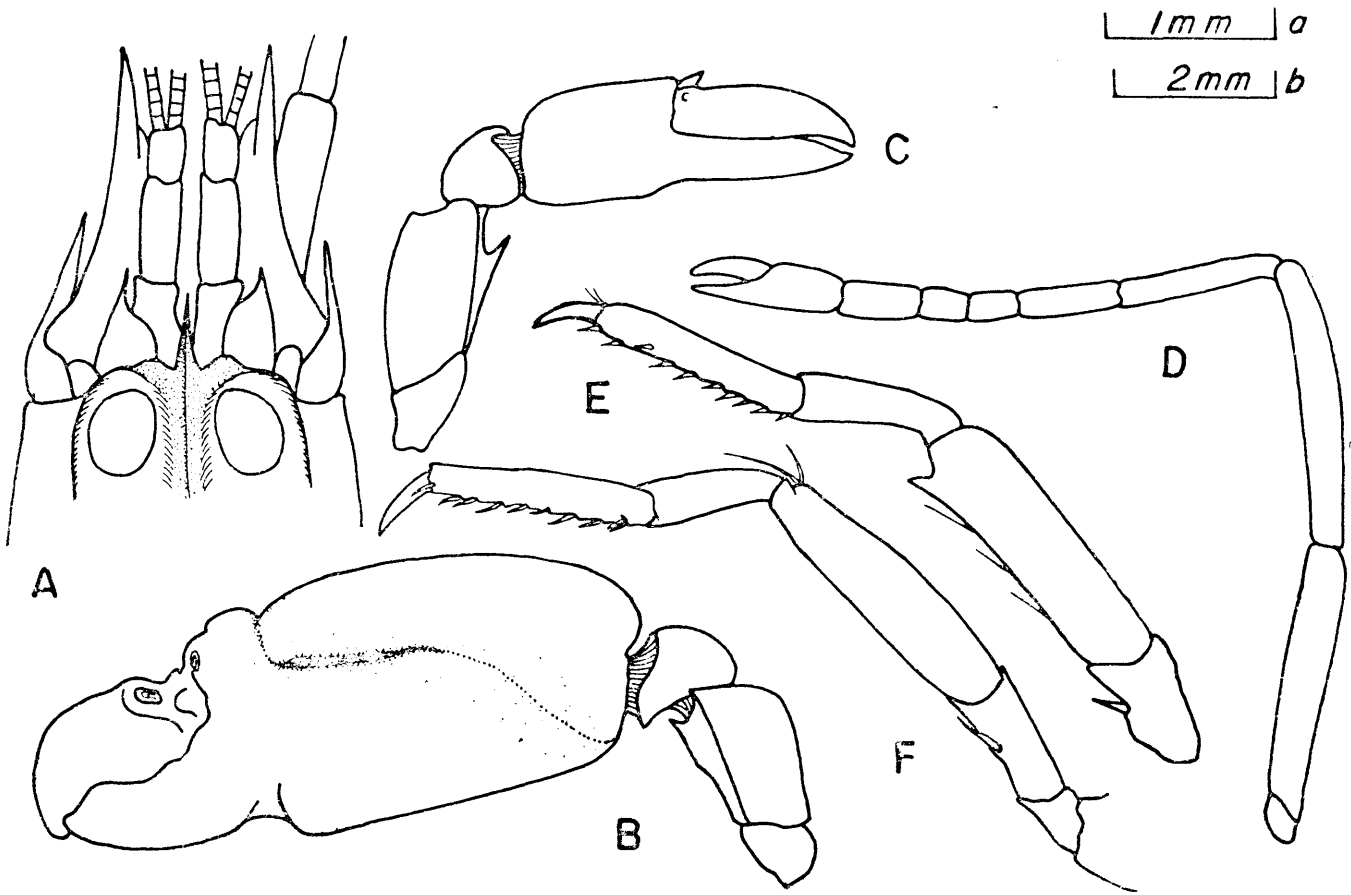

FIGURE 57

Alpheus parvirostris Dana. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, small cheliped, outer face; D, second leg; E, third leg with meral tooth; F, third leg without meral tooth. (A, F, scale a; B, C, D, E, scale b).

This species has been collected extensively in most studied areas in the tropical Pacific and Indian Oceans, from South Africa to Japan; it was probably the most abundant species in our Central Pacific collections, but it does not occur in Hawaii.

Alpheus hippothoe de Man–Figure 58

Alpheus hippothoe de Man, 1888a. Linn. Soc. London, Zool. Journ. 22:268, pl. 17, figs. 1-5. Henderson, 1893. Linn. Soc London, Trans. II, 5(10):436.

Alpheus hippothoe var. de Man, 1897. Zool. Jahrb. Syst. 9:754, pl. 36, fig. 68.

Specimen Drawn : 15 mm. male from Koh Sichang (BR 5).

Description : Rostrum slender, acute, reaching usually almost to end of first article of antennular peduncle, varying from 2 to 3 times as long as broad at base (the latter being more common); rostral carina sharp and continuing to posterior margin of orbital hoods. Orbital hoods inflated, separated from rostrum by deep grooves; anterior medial margins of hoods slightly produced into rounded projection.

Second antennular article 2.5 times as long as broad, about 1.3 times as long as visible part of first and 2 times as long as third. Stylocerite with tooth acute, reaching almost to end of first antennular article. Scaphocerite with outer margin concave and with strong spine reaching to about length of third antennular article past that article; squamous portion narrow, reaching to end of third antennular article. Carpocerite reaching to end of antennular peduncle. Lateral spine of basicerite short but acute.

Large chela compressed, 2.5 times as long as wide, fingers occupying 0.3 the total length. Proximal margin of transverse groove of upper margin overhanging, distal edge rounded; groove continuing on outer face as well-defined subtriangular depression, curved apex of triangle reaching to proximal quarter of palm, groove continuing on inner face to similar but less pronounced depression. Lower margin bearing strong rounded shoulder and distal notch. Dactylus heavy, upper margin slightly carinate, distal end somewhat

bulbous. Merus 2.3 times as long as broad; inferior internal margin serrate, bearing thin bristles and 2 or 3 movable spines; distally armed with small but acute tooth.

Small chela of male 3.5 times as long as broad, fingers 0.8 as long as palm. Superior margin of palm bearing strong tooth above and medial to dactylar articulation. Inner side of dactylus of male bearing fringe of short hairs from near point of articulation to crown of article proximal to tip. Outer side without fringe of hairs. Female small chela more slender and lacking fringe of hair on dactylus.

Carpal article of second leg with the ratio:10:5:2:2:4.

Ischium of third leg armed with movable spine. Merus 4.5 times as long as broad; inferior margin bearing sparse hairs along its margin and armed distally with strong tooth. Carpus 0.5 as long as merus, inferior margin ending in strong tooth and superior margin in rounded projection. Propodus 0.7 as long as merus with about 6 pair of movable spinules on inner side; dactylus simple, 0.2 times as long as propodus.

Telson 1.3 times as long as its anterior margin is broad; anterior margin 2.2 times as broad as posterior margin. Lateral margins concave, slightly constricted towards posterior end. Posterior margin arcuate.

Discussion : This species is common in this region and may reach 35 mm. in length. In Thai waters other members of the Edwardsii group which have a spine on the merus of the third leg include: *A. parvirostris*, *A. funafutensis*, and *A. edamensis*. This species may be distinguished from the latter two species by the ratio of the first two articles of the second leg with the first article markedly longer in this species; from *A. parvirostris* by the lack of a strong spine on the basicerite.

Distribution : This species was found living in the coral in almost all collecting localities of the Gulf of Thailand and the Indian Ocean. It was occasionally found associated with a brittle star. Locality data : 23 specimens from BR 5; 6, BR 6; 7, BR 7; 10, BR 8; 1, BR 10; 2, BR 11a; 7, BR 12; 11, BR 13; 5, BR 16; 3, BR 18; 6,

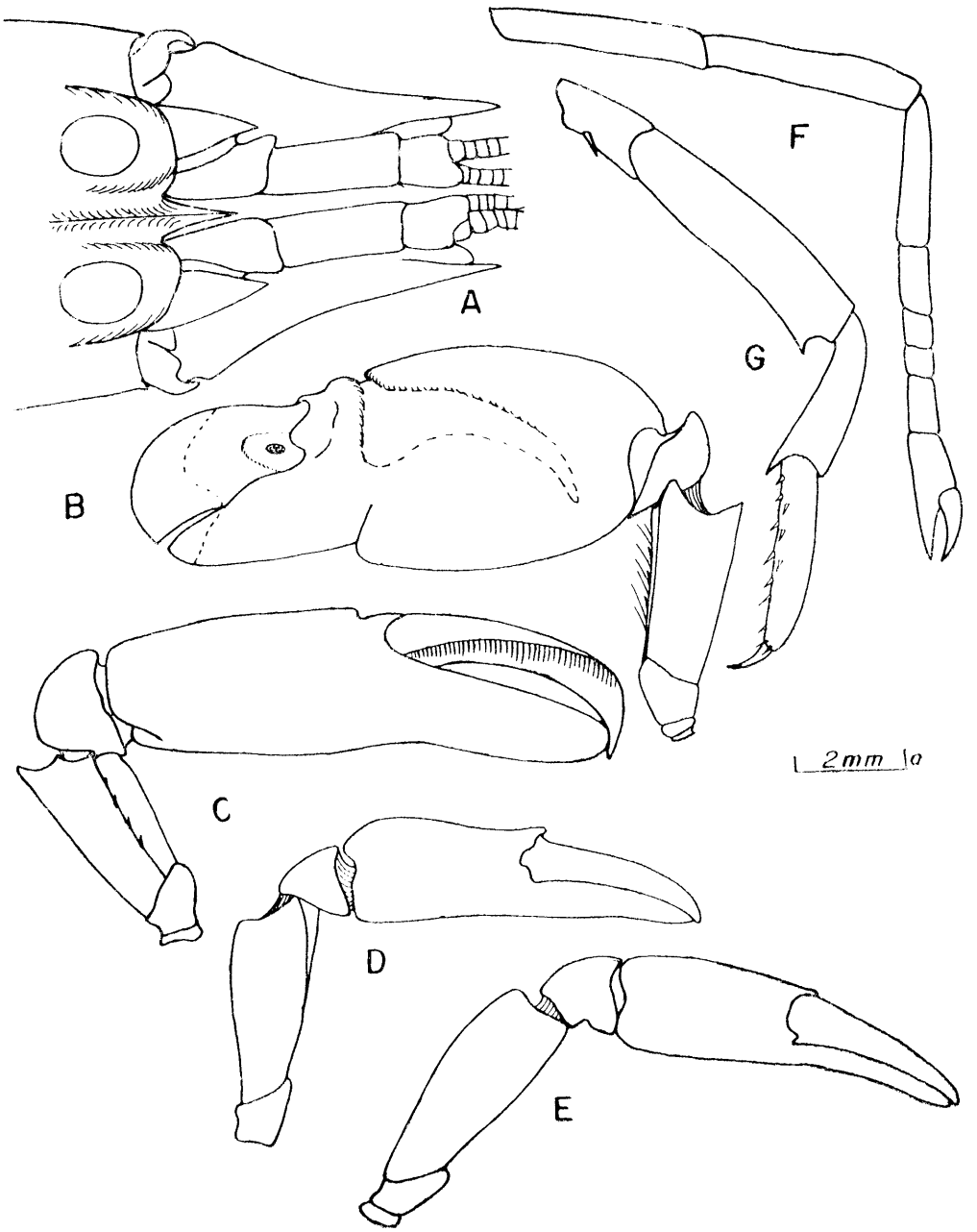

FIGURE 58

Alpheus hippothoe de Man. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, small cheliped, male; D, E, small chelipeds female; F, second leg; G, third leg. (A, B, G, F, scale lost; C, D, E, scale a).

BR 21; 7, BR 22; 1, BR 23; 11, BR 26; 5, BR 27; 1, BR 28; 2, BR 30; 5, BR 34; 2, BR 38; 4, BR 41; 6, BR 42; 30, BR 43; 2, BR 43f.

This species has been collected by other workers from Zanzibar, the Maldives and Laccadives and Indonesia. We have collected it from Tonga and Fiji. De Man's original specimen came from the Mergui Archipelago.

Alpheus sudara species nov.—Figure 59

Type: 15 mm. male from Phuket, Thailand (BR 35), collected from a head of coral in 2 meters of water on the outer reef edge. **Paratypes**: 18 mm. female from BR 35; 2, 13 mm. females and one 14 mm. male from BR 18; 1, 15 mm. female from BR 25.

Description: Rostrum short, not reaching to end of first antennular article, sharp rostral carina extending to base of eye hoods. Orbital hoods inflated, forming moderately deep grooves between carina and eye hoods.

Second antennular article 2.5 times as long as broad, 2.3 times length of visible portion of first; third only a little shorter than first. Stylocerite with lateral spine weak but reaching to end of first antennular article. Scaphocerite with outer margins markedly concave, lateral spine reaching well beyond antennular peduncles. Squamous portion thin, reaching to middle of third antennular article. Carpocerite reaching past end of antennular peduncle. Basicerite with strong lateral tooth.

Large chela compressed, 2.4 times as long as broad; fingers 0.8 as wide as palm and 0.3 of total length. Transverse groove of superior margin with posterior edge not overhanging the groove. Groove continuing on inner face as faint triangular depression which extends proximally to near middle of palm, but extending inferiorly only 0.15 width of palm; groove continuing on outer face into a firm quadrangular depression that extends proximally to middle of palm and almost one-third its width inferiorly. Inferior shoulder strong but rounded; distal depression an abrupt but rounded notch extending superiorly on outer face about 0.2 its breadth, but on inner face barely

extended into face. Merus 1.8 times as long as broad, with superior margin carrying several short stiff setae.

Small chela of male 3 times as long as broad, fingers 1.6 times as long as palm, superior margin entire, inferior margin with concavity opposite articulation of dactylus. Dactylar articulation flanked on inner side by slight toothlike projection. Dactylus balaeniceps, broad, and bearing heavy setae on margin which crosses superior surface to meet in distal quarter; tip narrowing, curved, acute and crossing fixed finger. Fixed finger also proximally broadened and bearing corresponding fringe of stiff setae almost to tip. Merus unarmed except for a few stiff setae on internal margin, 1.7 times as long as broad.

Small chela of female more slender, 3.8 times as long as broad with inner side of dactylus less hirsute and outer margin only bearing sparse hairs; tooth at dactylar articulation better developed. Merus also more slender.

Ratio of carpal articles of second leg: 10:6:2:2:4.

Ischium of third leg about 0.5 length of merus and unarmed. Merus 4.8 times as long as broad, unarmed. Carpus 0.6 as long as merus with neither margin distally extended. Propodus 0.7 as long as merus and carrying on its inferior border 4 single and 2 paired spines. Dactylus simple, 0.4 as long as merus.

Telson 2.3 times as long as broad at posterior end, anteriorly 1.6 times as wide as posterior end. Spines on upper surface of telson more prominent than usual for members of the Edwardsii tribe.

Discussion: In the five paratypes some variation was noted in the length of the rostrum, which in two reached almost to end of first antennular article, and in the second antennular article, which varied from 2.0 to 2.5 times as long as broad.

The species is easily recognized by the inflated orbital hoods and rostrum with its high, short carina. In de Man's key (1911) this species shows a relationship to *A. coutierei* de Man but it is plainly different, especially in the frontal border of the carapace. In *A.coutierei* the curve of the lateral margins of the rostrum flows into the curve

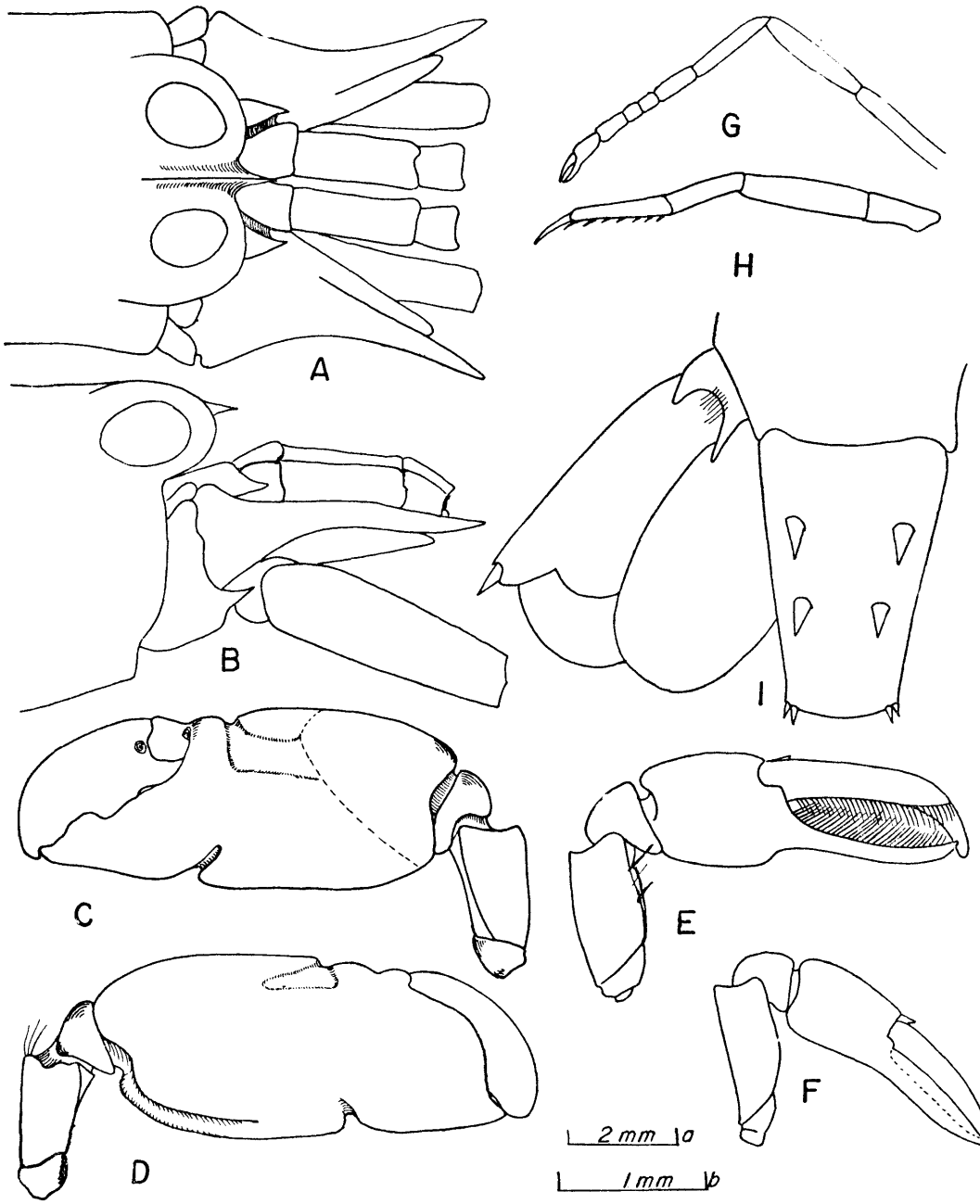

FIGURE 59

Alpheus sudara species nov. A, B, Anterior region, dorsal and lateral aspect; C, large cheliped, outer face; D, large cheliped, inner face; E, small cheliped, male; F, small cheliped female; G, second leg; H, third leg; I, telson and uropods. (A, B, I, scale a; C, D, E, F, G, H, scale b).

of the anterior and lateral margins of the orbital hood with no portion of the curve lying posterior to the tips of the hood, so that in outline the base of the rostrum appears to arise directly from the hood; in this species the rostrum is separated from the orbital hoods by a concave margin which definitely extends posterior of the frontal margins of the hoods.

Of the species in Thai waters this species resembles most closely *A hippothoe* de Man and *A. edamensis* de Man. From *A. hippothoe* it differs in that the proximal edge of the superior margin of the large chela does not overhang the groove, and that the merus of the third leg is unarmed. From *A. edamensis* it differs in that the first carpal article of the second leg is almost twice as long as the second instead of a little shorter and again by the lack of tooth on the merus of the third leg.

This species is named in honor of Mr. Suraphol Sudara, in appreciation of the great help he gave us as our assistant on our return trip to Thailand.

Alpheus funafutensis Borradaile–Figure 60

Alpheus funafutensis Borradaile, 1898. Zool. Soc. London, Proc. 1898: 1013, pl. 65, fig. 10 a-h. De Man, 1911. Siboga Exped. 39a^1(2):436.

Alpheus hippothoe de Man var. *edamensis* de Man, 1897. Zool. Jahrb. 9:757. 1902. Sencken. Naturf. Gesell., Abhandl. 25:891.

Alpheus acanthomeris Ortmann var. *inermis*. Lanchester, 1901. Zool. Soc. London, Proc. 1901: 564.

Specimen Drawn: A male from the collection that was destroyed at the Hawaii Marine Laboratory fire.

Description: Rostrum slender, acute, reaching past end of first antennular article. Sharp rostral carina extending to base of eye hoods. Orbitorostral grooves shallow with anterior margins extended and gradually rounded. Second article of the antennular peduncle about 2.0 times as long as broad, 1.3 times as long as visible part of first and two times as long as third article. Stylocerite with acute

tooth reaching to end of first antennular article. Scaphocerite with outer margin strongly concave, spine reaching well beyond antennular peduncle, squamous portion reaching to end of antennular peduncle. Carpocerite reaching the length of third antennular article past that article. Lateral tooth of basicerite rudimentary.

Large chela compressed, massive, 2.0 times as long as broad, fingers occupying 0.3 of total length. The upper margin proximal to dactylar articulation bearing broad, transverse groove with proximal margin rounded, not overhanging groove. Transverse groove continuous with quadrangular depressed area on either face; depression on outer face more pronounced than inner. Inferior shoulder strongly rounded; distal depression strong and continuing for 0.25 height of palm. Dactylus heavy, compressed, superior margin rounded. Merus 1.8 times as long as broad; inferior internal margin unarmed, upper margin projecting but rounded.

Small chela 2.6 times as long as broad, fingers 0.8 as long as palm. Superior margin with heavy rounded papillae; this and inner face setiferous; margin projecting as strong tooth above dactylar articulation. Inferior margin smooth and slightly concave opposite dactylar articluation. Small chela of male more hirsute than female. Merus without teeth.

Carpus of second leg with ratio:10:10:2:2:5.

Ischium of third leg bearing strong movable spine. Merus about 3.5 times as long as broad and armed with a strong tooth distally on inferior margin. Carpus with superior margin terminating distally in a rounded tooth, inferior margin terminating in strong acute tooth. Propodus 0.7 as long as carpus, bearing 12 spines on inferior margin. Dactylus simple, 0.3 as long as propodus

Discussion : This specimen was collected on the first visit to Thailand, but lost in the laboratory fire; no specimens were collected on the second trip. The collection number indicates it probably came from Phuket.

This species may be confused with *A. hippothoe* de Man, but may be separated by many characteristics, including the ratio of the first two carpal articles of the second leg (10:10 in *A. funafutensis*

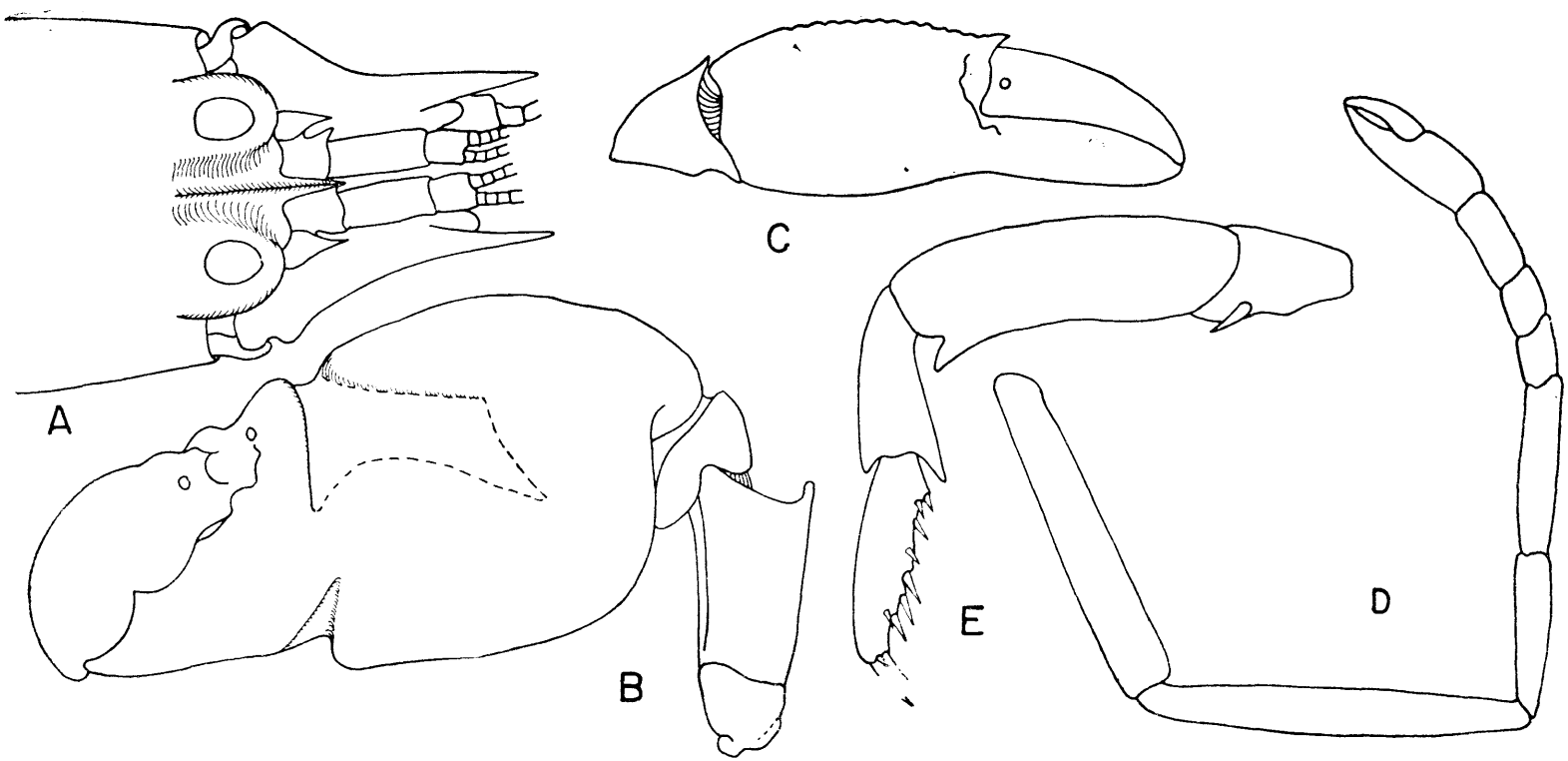

FIGURE 60

Alpheus funafutensis Borradaile. A, Anterior region, dorsal aspect; B, large cheliped, outer face; C, small chela; D, second leg; E, third leg. (Scale lost in fire).

and 10:5 in *A. hippothoe*); the lack of overhang of the proximal margin of the transverse groove of the large chela, and the heavier merus of the third legs.

Distribution: The type locality of this species is in the Ellice Islands. It has also been reported from Indonesia and is represented from the Central Pacific in our collections by specimens from the Phoenix and Tonga Inlands.

Alpheus edamensis de Man–Figure 61

Alpheus hippothoe var. *edamensis* de Man, 1888b. Archiv. für Naturgesch. 53(1):518. Zehntner, 1894. Rev. Suisse Zool. 2:201. Lenz, 1905. Senckenb. Naturf. Ges., Abhandl. 27:383.

Alpheus acanthomerus Ortmann, 1890. Zool. Jahrb. 5:474, Taf. 36, fig. 12. Coutière, 1897a. Leyden Mus., Notes 19:202.

Nec: *Alpheus hippothoe edamensis* de Man, 1897. Zool. Jahrb. 9:757. 1902. Senckenb. Naturf. Ges. 25:891.

Specimen Drawn: 26 mm. female from Singapore (BR 42); small chela of 19 mm. female from same collection.

Description: Rostrum slender, acute, reaching just past end of first antennular article. Sharp dorsal carina leading back to base of eyes. Orbital hoods inflated, forming deep orbitorostral grooves. Anterior margin of orbital hoods markedly convex and continuing to base of rostrum without projections.

Second antennular article 2.4 times as long as broad and twice as long as visible part of first antennular article; third article slightly shorter than first. Spine of stylocerite reaching to end of first antennular article. Scaphocerite with outer margin concave, with tip of heavy lateral spine reaching beyond third antennular peduncle by twice the length of that article. Squame much shorter than spine but longer than antennular peduncle. Basicerite with strong lateral spine.

Large chela slightly compressed, 2.8 times as long as broad, fingers 0.3 of total length; palm 1.7 times width of fingers. Superior margin with transverse groove proximal to dactylus; posterior margin

of groove rounded and not overhanging; anterior margin similar but less abrupt. Groove continues on outer face as quadrangular depression extending posteriorly to slightly past middle. Groove continued on inner face as faint elongate triangle, aplex of triangle reaching near superior margin to last third of palm. Proximal portion of inner face of chela sparsely hirsute, distally with more abundant hairs. Merus 2 times as long as broad, inferior internal margin armed with 7 movable spines and strong tooth distally.

Small chela without ridges or grooves. Fingers and palm equal in length. Superior margin projecting as small but acute tooth above dactylar articulation. Merus 2.7 times as long as broad, inner margin bearing 4 spines, small blunt tooth on distal end. Small chela of male not balaeniceps, but a little heavier than that of female and markedly hirsute near distal end of palm and on fingers.

Ratio of carpal articles of second leg : 10:14:4:4:8.

Ischium of third leg with movable spine. Merus 4 times as long as broad, inferior margin bearing setae and a strong distal tooth. Carpus 0.4 as long as merus, with inferior margin projecting as an acute tooth. Propodus as long as merus, inferior margin bearing 6 movable spines plus one pair distally. Dactylus simple, 0.2 as long as merus.

Telson 2.4 times as long as broad at posterior margin. Anterior margin 1.7 wider than posterior margin.

Specimens in collection reaching to 26 mm. in length.

Discussion : The spine on the merus of the third leg separates this species from all the members of the Edwardsii group discussed in this paper with the exception of *A. parvirostris, A. funafutensis* and *A. hippothoe*. From the first it may be separated by the shorter spine on the basicerite, from the second by the presence of a spine on the meri of the chelae, and from the last by the less hirsute inner side of the large chela.

Distribution : We have collected 4 specimens at Singapore (BR 42) at low tide under rocks.

Specimens have been collected from East Africa, Indonesia and the Society, Fiji and Samoan Islands.

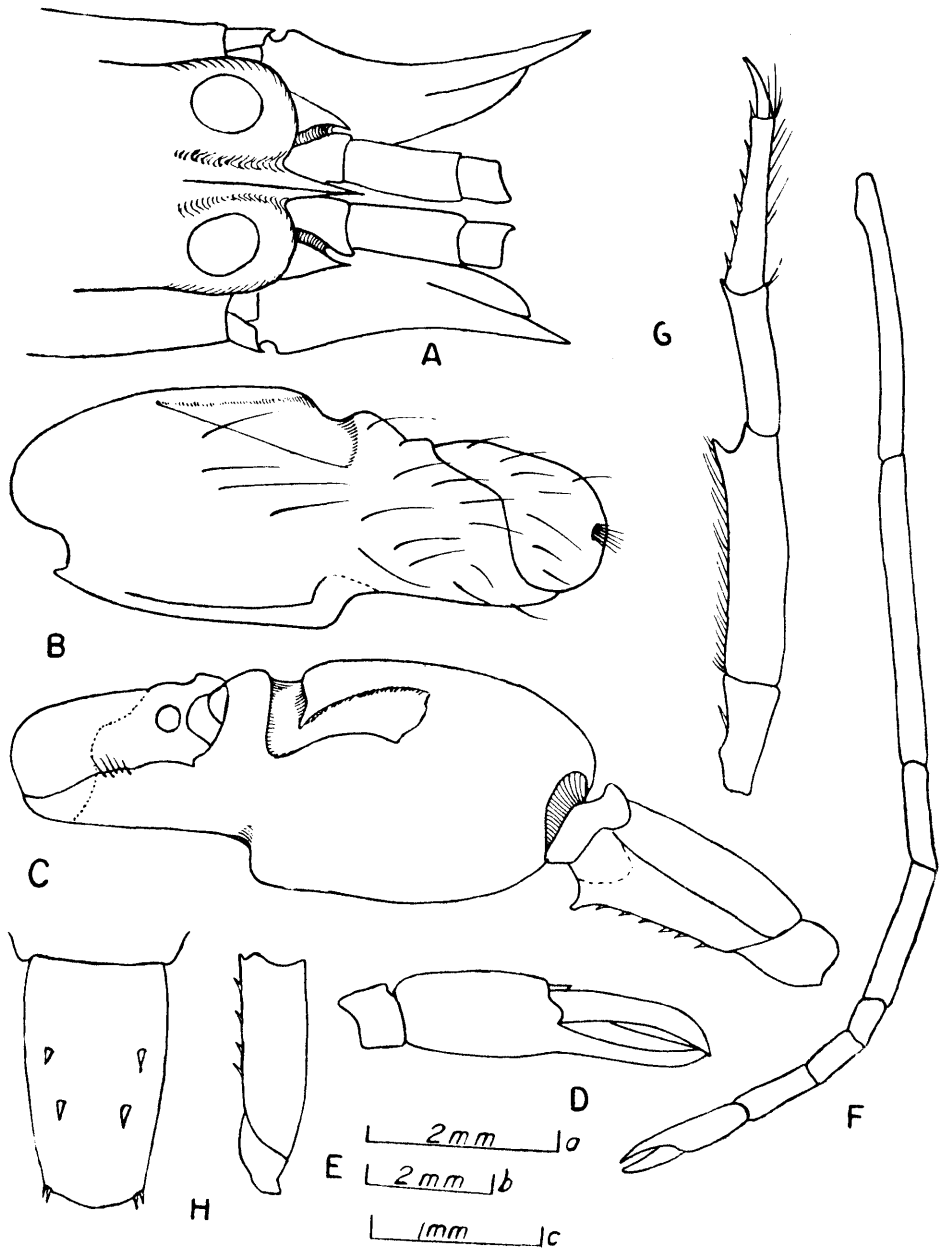

FIGURE 61

Alpheus edamensis de Man. A, Anterior region, dorsal aspect; B, large chela, inner face; C, large cheliped, outer face; D, small chela; E, merus small cheliped, inner face; F, second leg; G, third leg; H, telson. (A, H, scale a; B, C, D, E, scale b; F, G, scale c).

RACILIUS

Racilius Paulson, 1875. Invest. Red Sea Crust., (1):107.

Type Species: *Racilius compressus* Paulson

Definition: "The body is unusually compressed, in the form of a folded leaf with a sharp upper edge on the abdominal segments; on the carapace there is a ridge which goes into a forward protrusion [rostrum]. Eyes covered by orbital hoods, which have little whip-like projections [orbital teeth], covered by orbital hoods, like in *Alpheoides*. The chelipeds are similar in size with huge pinchers, the fingers of which move on a vertical plane. Carpocerite of the second pair of legs has five joints. The maxillipeds are similar to *Alpheus*. The terminal joint of the maxilliped is not as short as in *Alpheus*. The tail end [telson or caudal fan] is very different from that of *Alpheus* and *Alpheoides*. This species is very close to the general *Alpheus*, *Alpheoides*, *Arete* and *Betaeus*, and comprises with them a homogeneous group of the subfamily *Alpheinae*". [Translated from the Russian of Paulson].

To this description we should add that the pleura of the sixth abdominal segment are not articulated, and that in the type and only species the outer uropod bears a strong movable spine and an inner strong triangular projection.

We agree with both Paulson and Coutière (1899:337) that this genus is near to *Alpheus* and was probably drived from it. The second leg bears five articles as is true of all *Alpheus;* the chela, though extremely compressed, has the same general appearance and bears a plunger so typical of this genus.

Racilius compressus Paulson – Figure 62

Racilius compressus Paulson, 1875. Invest. Red Sea Crust. (1):107, pl. 14, fig. 2. Coutière, 1899. Les Alpheidae p. 87, fig. 46, p. 243, fig. 296 (description and figures after Paulson); Balss, 1927. Zool. Soc. London, Trans. 22(2):226 (a female without chelae). Barnard, 1958. Ann. Mag. Nat. Hist. XII, 10(118):732 (one female).[5]

5. While this paper was in press we received from Dr. A.J. Bruce, Hongkong, a photocopy of Régine Jacquotte, 1964. " Note de Faunistiques et de Biologie Marines de Madagascar ". Rec. Trav. St. Mar. End., 32(48): 175 in which she

Specimen Drawn : 14 mm. male from head of *Galaxea fascicularis* (L) located about mid tide level on a small island off Singapore. (Lateral view of carapace of three other specimens from same collection).

Description : Rostrum broad, triangular, reaching to middle of second antennular article. Rostral carina high, curved downward in profile, and continuing entire length of carapace as strong keel; keel with small notch near middle of carapace. Orbital teeth short, sharp and turning inward. Orbital hoods slightly inflated.

Second antennular article almost as broad as long; third article equal to length of second article and slightly exceeding the length of visible part of first. Stylocerite acute, reaching to near end of first antennular article, curved inward near tip and slightly longer than squame; squame narrow, reaching to first quarter of third antennular article. Basicerite with strong lateral tooth reaching to near end of second antennular article, thus only slightly shorter than squame. Carpocerite slightly longer than antennular peduncle. Flagella a little longer than carapace. Upper flagella simple, articles tapering to fine tip. Lower flagella a little longer than upper and much more slender.

Large chela compressed, leaf-like, 0.3 as thick as broad, 1.7 times as long as broad, with fingers occupying distal quarter. Chela smooth in outline, superior margin projecting as a rounded tooth above dactylar articulation, without grooves or ridges. Dactylar provided with plunger as in *Alpheus*, blunt and rounded at tip. Carpus rectangular, 0.5 as merus, but it has projections and an unusual carpal-propodal articulation. Merus 3 times as long as wide, strongly curved on superior surface and flattened on inferior surface. Inferior internal margin bearing 6-8 rounded serrations, each with a feeble seta.

reports this species from *Galaxea fascicularis* (L) from Tulear, Madagascar. In this genus of coral the polyps stand on columns above the coral head proper and Jacquotte states the species exist "exclusivement entre les murailles des polypes" and that the lateral compression in *Racilius* permits it to circle the polyps in the restricted spaces between them.

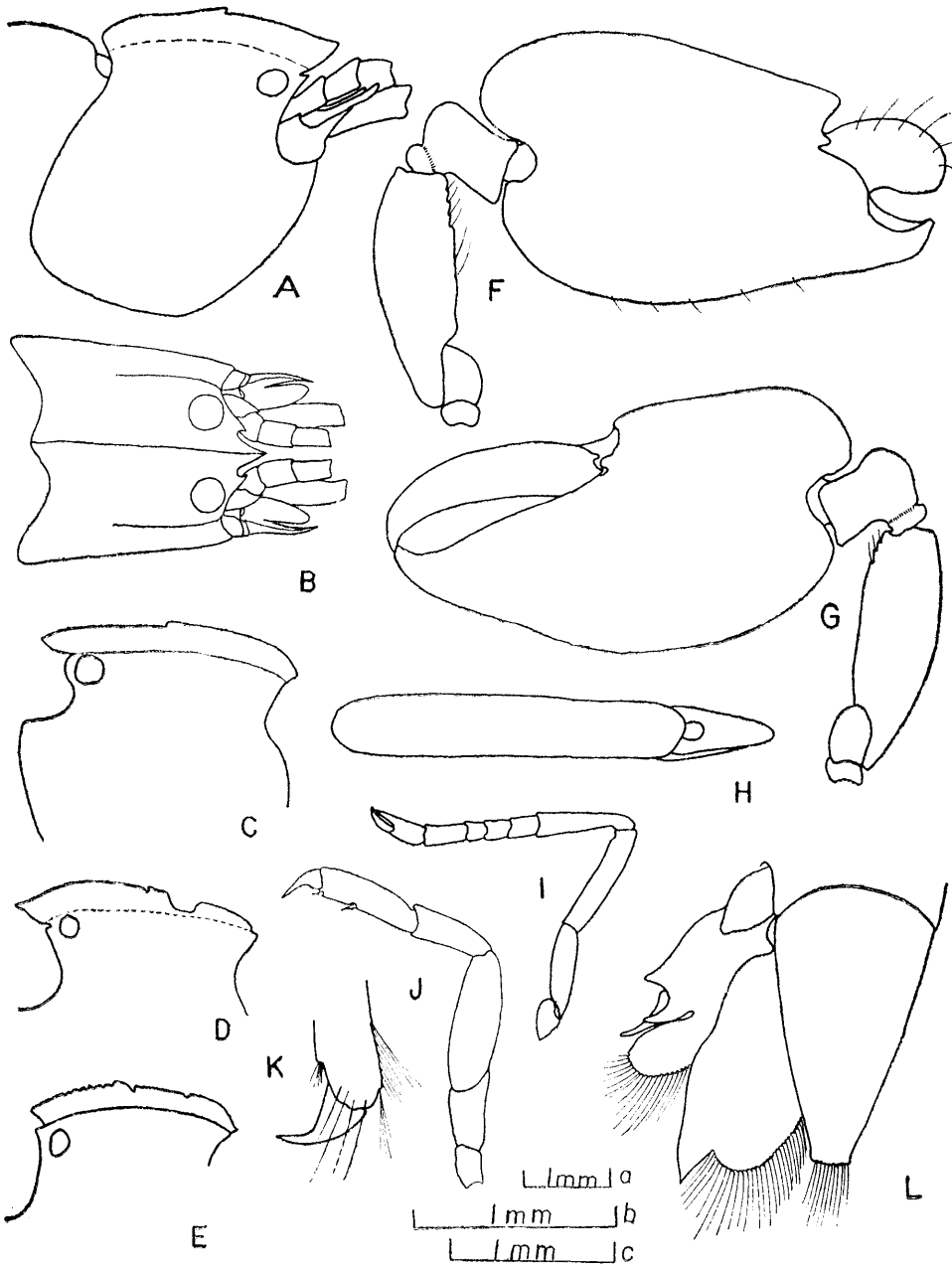

FIGURE 62

Racilius compressus Paulson. A, B, Anterior region, dorsal and lateral aspect; C, D, E, lateral aspect of carapace showing variation in carina and rostrum; F, large cheliped, inner face; G, small cheliped, inner face; H, large chela, dorsal aspect; I, second leg; J, third leg; K, dactylus. (A, B, C, D, E, F, G, H, I, J, scale a; K, scale b; L, scale c.)

Small chela similar in size to, and as compressed as, large chela; about 2 times as long as broad with finger occupying almost half its length. Superior margin of palm not projecting over dactylar articulation. Both fingers curved, tips acute and crossing fixed finger at dactylar articulation, 7 to 8 times as broad as dactylus at base. Carpus similar to that of large cheliped. Merus 3 times as long as broad bearing on the distal end of the inferior internal margin 2-4 rounded serrations similar to those of large cheliped.

Carpal articles of second leg with ratio 10:2:2:1:4.

Third leg with ischium unarmed, relatively elongate, 0.7 length of merus. Merus 2.9 times as long as wide, inermous. Carpus 0.6 as long as merus, distally rounded, projecting slightly. Propodus 1.4 times as long as carpus and armed on inferior margin with one inferior and one distal spine. Dactylus simple, abruptly tapering and curved to acute tip.

Telson 6.0 times as long as broad at its posterior margin, anteriorly 4 times as broad as posteriorly. Lateral margin slightly but uniformly convex, tip slightly arcuate, margin bearing stiff setae only. Outer uropod with heavy, acute, and slightly curved mobile spine, one-third as long as entire article; 1 spine flanked laterally by heavy triangular tooth and on superior side by a longer curved tooth; setiferous portion of distal portion relatively narrow. Inner uropod bearing an acute triangular tooth on distolateral angle; tooth as broad at base as is telson on posterior tip. No anal tubercles.

Discussion : The genus *Racilius* was created by Paulson in 1875 for one male specimen collected in the Red Sea which he named *Racilius compressus* (type species by monotypy). Since that time records of only 3 specimens of *R. compressus* have appeared in the literature; an 18 mm. female from the Suez Canal reported by Balss (1927:226), an other of the same sex and size from the Red Sea by Ramadan (1936:22) and a female from South Africa reported by Barnard (1958:732). No other species have been assigned to this genus.

Our specimens agree well with Paulson's description except for a few minor differences; In our specimens the lateral spine of the scaphocerite exceeds the squame while in Paulson's it was of the same length. He also stated that there are no spines on the inferior margin of the propodus but our specimens carry 2 or 3 near the distal end. Finally, in his specimen there was a deep notch in the carina at the level of the eye, but none of our specimens have an identical notch. However, in our specimens the notch is most variable, from a small notch at a short distance posterior to the eyes to a deep notch near the posterior end of the carina (see figs. 62c, d, e). Balss reports that in his specimen the notch is entirely lacking. The lack of a notch in Balss's specimen and the variation in these specimens leads us to believe that this character is too inconsistent to be of taxonomic significance. In other characteristics the 14 specimens we had available showed almost no variation.

Distribution: 1 specimen from BR 38 (Phuket, Indian Ocean). 14 specimens from Pulau Salu and Pulau Sudong, small islands slightly west of Singapore; all of the latter specimens were symbiotic with *Galaxea fascicularis* (L), and collected by R.U. Gooding, University of Singapore. A.J. Bruce of Agriculture and Fisheries Department Hong Kong wrote, in transmitting Dr. Gooding's specimens, "The Singapore specimens agree well with specimens I have seen many times in the western Indian Ocean, where the rostral crest is quite variable . . . all were obtained from *Galaxea fascicularis* (L) which was [also] the host in East Africa."

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