

# THE SWIMMING CRABS OF THE GENUS *CALLINECTES* (DECAPODA: PORTUNIDAE)

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## ABSTRACT

The genus *Callinectes* and its 14 species are reevaluated. Keys to identification, descriptions of species, ranges of variation for selected characters, larval distribution, and the fossil record as well as problems in identification are discussed. Confined almost exclusively to shallow coastal waters, the genus has apparently radiated both northward and southward from a center in the Atlantic Neotropical coastal region as well as into the eastern tropical Pacific through continuous connections prior to elevation of the Panamanian isthmus in the Pliocene epoch and along tropical West Africa. Eleven species occur in the Atlantic, three in the Pacific. *Callinectes marginatus* spans the eastern and western tropical Atlantic. *Callinectes sapidus*, with the broadest latitudinal distribution among all the species (Nova Scotia to Argentina), has also been introduced in Europe. All species show close similarity and great individual variation. Both migration and genetic continuity appear to be assisted by transport of larvae in currents. Distributional patterns parallel those of many organisms, especially members of the decapod crustacean genus *Penaeus* which occupy similar habitats.

The blue crab, *Callinectes sapidus* Rathbun, a staple commodity in fisheries of eastern and southern United States, is almost a commonplace object of fisheries and marine biological research, but its taxonomic status has been questionable for a long time. Other members of the genus also have questionable taxonomic status, and they are difficult to identify. In a time when expanding interest in species easily exploitable for food has generated new research, we can benefit from a fresh look at the component species of this important genus in order that major areas of study such as fisheries biology, ecology, zoogeography, embryology, and physiology can proceed on a stable nomenclatural basis. The purposes of this paper are to: 1) synonymize nomenclature, 2) characterize the species, 3) discuss variation in morphology, 4) provide illustrations and keys to identification, 5) delineate geographic distribution of species, 6) provide remarks on ecological associations, 7) contribute to resolution of the fossil record, and 8) document evidence and provide a list of identified specimens in major museums of the world.

## HISTORY

Crabs of the genus *Callinectes* have an anecdotal record dating from early explorations of the Western Hemisphere. Perhaps the earliest listing among natural assets in the New World is Thomas Hariot's (1588) mention of "Sea crabbes, such as

we have in England." A similar record is Marcgrave's account in 1648 (Lemos de Castro, 1962) of a South American *Callinectes* [= *danae* Smith (1869)], one of the common portunids used for food. D. P. de Vries in 1655 (Holthuis, 1958) referred to the eating qualities of blue crabs in the New York area and likened the white and orange color of their chelipeds [females] to colors of the House of Orange. Lawson (1714), recounting his years among the Indians in the Carolinas, may have initiated the tale of raccoons fishing for crabs in marshes with their tails, but more factually he wrote [undoubtedly of the blue crab, *C. sapidus* Rathbun (1896)], "the smaller flat Crabs I look upon to be the sweetest of all Species . . . the Breadth of a lusty Man's Hand . . . These are innumerable, all over the salts of Carolina . . . taken not only to eat, but are the best Bait for all sorts of Fish, that live in the Salt-Water."

Holthuis (1959) thought that de Geer (1778) probably represented *Callinectes bocourti* A. Milne Edwards (1879) under the name "Crab de l'ocean" when he described a swimming crab from Surinam in general terms as *Cancer pelagicus*. Ordway (1863) considered de Geer's species synonymous with *Lupa sayi* Gibbes (1850), and Rathbun (1896:350) stated "Figures 8, 9 and 11 correctly represent neither of these species, nor are they applicable to any species of *Callinectes*, while, on the other hand, Figure 10 shows the narrow abdomen characteristic of that genus." Since *C. bocourti* is the commonest portunid in Surinam, abundant enough to be marketed, and

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certain of de Geer's figures can be interpreted as *Callinectes*, Holthuis's conclusion seems reasonable.

Bosc (1802) gave a thumbnail natural history sketch for *C. sapidus* in South Carolina comparing crudely in its accuracy with some modern accounts, but he used the name *Portunus hastatus* along with a description taken from J. C. Fabricius which applied to a European species.

Thomas Say (1817) was the first naturalist to give a description of the common blue crab of the eastern United States, calling it *Lupa hastata*, in what he intended as a redescription of *Lupa hastata* (Linn.), a species known from the Mediterranean (Rathbun, 1896).

A few years later Latreille (1825) gave the name *Portunus diacantha* to the common blue crab of eastern United States accompanied by a poor description that applied to more than one species. Say and Latreille, plus perhaps De Kay (1844) who published a description and beautifully colored plate of what he called *Lupa dicantha* [= *C. sapidus*] from New York, account for the main early treatments of *Callinectes* by naturalists.

Search of newspaper and popular journal files could yield a harvest of fact and fiction about these crabs culminating perhaps in accounts of the "crab derbies" held in recent years to promote marketing in crab producing states of the eastern seaboard of the United States. Crab stories abound and crab fishing techniques are similar in all countries where *Callinectes* occurs. It is not surprising, therefore, that this profusion has carried over into the scientific literature where scholars have bequeathed a complex nomenclature in numerous contributions.

Scholarly systematic work on the whole genus was last presented by Rathbun in 1896 as a general revision and amended in 1897. There is no need to clutter the text here by recalling the parade of specific epithets employed in the game of taxonomic musical chairs played by a succession of authors. Each built on the foundation of previous work, usually as collections substantially increased in museums, but many minor papers were reports on expeditions extending the bounds of known geographic ranges for certain species. Details of these histories may be followed in the synonymies, but the principal studies should be placed in perspective as an introduction, and in reviewing them I repeat part of Rathbun's (1896) review.

William Stimpson (1860) created the genus *Cal-*

*linectes* to contain portunids in which the males have a T-shaped abdomen and the merus of the outer maxillipeds is short, sharply prominent, and curved outward at its antero-external angle. He regarded as one species "the common American *Lupa diacantha* (Latreille)" in his new genus, and doubtfully distinguished a second, *L.* (= *Callinectes*) *bellicosa*, which he had described (1859) from the Gulf of California. We now know that the second of Stimpson's generic characters is nearly valueless because other portunids have similar third maxillipeds, but the narrow sixth segment of the T-shaped abdomen of males holds and is reinforced by absence of an internal spine on the carpus of the chelipeds in *Callinectes*.

The limited view of the genus held by Stimpson was soon broadened by Ordway (1863) who recognized nine species distinguished in part by structure of the male first pleopods. Ordway restricted the name *diacanthus* to a Brazilian form described by Dana (1852) which we now know as *C. danae*. The common blue crab of the eastern United States was given Say's (1817) name *hastatus*, Stimpson's *bellicosus* retained, and six new species named. Ordway's study of crustaceans was diverted by the Civil War, and he remained in military life until his death in 1897. Poor communication may have led to Ordway's confusion in nomenclature, but his concept of species based on material then available was remarkably clear.

Latreille's (1825) *diacantha*, though valid, was never widely recognized because of its poor definition. Various "*diacanthas*" were employed for 139 yr finally ending in official suppression of Latreille's ill-starred name in 1964 for purposes of nomenclatural stability. Smith (1869) substituted *C. danae* for Dana's Brazilian *C. diacantha*.

Then followed an interval dominated by A. Milne Edwards's revision of the Portunidae (1861) and his review of the Crustacea of Mexico (1879). Milne Edwards at first did not recognize *Callinectes* as a distinct genus but later accepted it. He conservatively viewed *Callinectes* species as "varieties" of *diacanthus* (adding five new ones to Ordway's nine in 1879), and the influence of his ideas pervaded the field for a long time, leading eventually to Rathbun's revisionary papers. Milne Edwards's reasoning was not without merit for the genus is close to other portunids. Indeed, its validity as a distinct unit was again challenged for a time by Stephenson and Campbell (1959) and Stephenson (1962) during reassessment of

Indo-Pacific Portunidae, but later left intact (Stephenson, Williams, and Lance, 1968).

In 1896 Rathbun recognized the following numbers of species: western Atlantic, six species and one subspecies (Rathbun never treated the nominal subspecies as anything but a full species); eastern Pacific, four species; eastern Atlantic off Africa, one species and one subspecies. The list was almost immediately altered (1897) by name recombinations, elevation of subspecies, description of a new species, and extension of known geographic ranges. This brought the numbers to: western Atlantic, six species and one subspecies; eastern Pacific, four species; eastern Atlantic off Africa, four species. There the inventory rested until 1921 when Rathbun revised the African species, reducing them to three but noting a doubtful subspecies reported from Europe (Bouvier, 1901) greatly resembling *C. sapidus* of the United States. In 1930 Rathbun published the third of a four-volume work that serves as the standard reference on American crabs. In this she reduced the recognized species in the eastern Pacific by one. Collaterally she treated fossil members of the genus, describing three new species from the Oligocene and Miocene of Middle America (1919b), and two more species from similar ages in North America (1935). One of these from the Miocene (=?) of Virginia and Florida was considered identical with living *C. sapidus*.

By 1930 the genus seemed stabilized, but Rathbun herself had introduced confusion in 1907 by describing a juvenile *Portunus* from the South Pacific as *Callinectes alexandri*. This error bore fruit years later in helping to generate doubt concerning validity of the genus (Stephenson and Campbell, 1959). During the same year that Rathbun's cancrroid treatise appeared, Contreras (1930) described two new species in a little known paper, one from the Gulf of California and another from the Gulf of Mexico. Capart (1951) and Monod (1956) both supported Rathbun's analysis of West African forms, and in shedding more light on the introduction of *C. sapidus* into European waters (first noticed in 1901) erased Rathbun's doubts about a poorly documented subspecies from that area. They also pointed out difficulties in identifying some specimens. The introduction of *C. sapidus*, documented by numerous authors, was reviewed by Holthuis (1961, 1969). Following petition of Holthuis (1962), the International Commission (1964), to avoid confusion in nomenclature of such a well-known species, made *Cal-*

*linectes sapidus* Rathbun the type species of the genus and suppressed the long dormant *Portunus diacantha* Latreille, 1825. Garth and Stephenson (1966) confirmed Rathbun's interpretation of the eastern Pacific *Callinectes*, and Williams (1966) described a new species from the Carolinian Province of North America.

Such was the status of the species problem when the present study was undertaken. Numerous authors had expressed difficulty in making identifications, especially of juvenile material. Geographic limits for species seemed ill defined. Few attempts to analyze large series systematically had been attempted, but results of work in fisheries management indicated that populations within species might be distinct. Mindful of this and aware of series of specimens in museums, a review of the group seemed profitable. Simultaneously, Taissoun (1969, 1972) began study of *Callinectes* in Venezuela finding a form endemic to Lake Maracaibo. It is likely that new approaches such as ecological and larval studies may continue to elucidate variation in the genus.

## CHARACTERS OF SYSTEMATIC VALUE

The gross features of morphology having greatest usefulness in distinguishing species of *Callinectes* are (Figures 1, 2): viewing dorsally, 1) the number, shape, and arrangement of frontal teeth, 2) shape of the metagastric area, 3) shape and curvature of the anterolateral teeth and the lateral spine, 4) granulation of the dorsal surface; viewing ventrally, shape of male and mature female abdomen. Shape of the chelipeds is also useful, as are the colors in fresh specimens. In addition to gross features, male first pleopods (Figures 18-21) are diagnostic, and shapes of female gonopores (Figures 22-23) are aids to identification.

*Body proportions.*—Proportions of the body in both sexes change with growth until a characteristically male or female form develops. The carapace of males becomes relatively broader than that of females, with lateral spines accentuated; in especially large individuals of some species the metagastric region tends to be somewhat sunken at its side and rear margins. Females have a dorsally tumid appearance, with the carapace more uniformly inflated and granulated and relatively not so broad nor with lateral spines so accentuated

as in males. Body heights are alike in the two sexes.

*Spines.*—All spiniform characters, poorly developed and rounded at the apices in juveniles, gradually assume conformation characteristic of the species as growth progresses.

*Chelipeds.*—All species in the genus have the hands of the chelipeds (Figures 3-17) modified into a major chela (crusher, usually on right side) and a minor chela (cutter, usually on left side)—heterochelic and heterodont (Schäfer, 1954; Štević, 1971). Loss of the major chela induces a well-known reversal at the next molt with the new hand becoming a minor chela. A few individuals have two minors, but almost none exhibit two major chelae. Size and strength of the major hand vary a good deal, each species having a sometimes ill defined but characteristic shape. In all, especially among males, the dactyl of the major chela has a strongly developed proximal tooth which closes against a molariform complex on the propodus (Schäfer, 1954). A decurved lower margin near the base of the propodal finger opposite the proximal crushing apparatus on opposed edges of the fingers accompanies development of the complex, and in huge males of some species is a prominent feature. Teeth distal to the molariform complex of the major chela are more sectorial in structure, but not so sharp as those on the minor hand. Sectorial teeth of both hands tend to be arranged in triads, a large central tooth flanked by smaller ones, but there is much variation. In old individuals no longer molting or molting infrequently, the proximal crusher teeth become worn, occasionally almost obliterated. Size and wear vary with species and are undoubtedly associated with feeding habits. *Callinectes sapidus*, for example, is known to feed on the American oyster, *Crassostrea virginica*, and other mollusks. Other species of *Callinectes* probably have similar feeding habits, but these are not well documented.

*Secondary sexual structures.*—Immature females have a triangular abdomen (Figure 2) with most segments indistinguishably fused, but at the terminal maturation molt (Churchill, 1919) all segments become free. The abdomen of mature females has a variable but roughly characteristic shape in each species. Distal portions of the abdomen in immature males also have a developing shape which becomes characteristic of the species in adults.

*Primary sexual structures.*—The copulatory apparatus of male *Callinectes* has been recognized as a good separator of species since the time of Ordway (1863), but until recently no one used fine structure of these organs as serious aid to identification. Snodgrass (1936) and Cronin (1947) both described the external male sexual apparatus, and I here adopt Snodgrass's term "first gonopod" for the first male pleopod. The first gonopod is essentially a narrow flat plate rolled longitudinally into a cylinder that may be variously curved and twisted, terminating in a tip varying from nearly tubular to a simply flared trough. First gonopods of each species have characteristic shapes, but there is individual variation reinforced by age, molt stage, wear, and irregularity in preservation. The distal portion of each first gonopod is armed with retrogressive articulated spinules, exceedingly tiny and rather unevenly distributed in one set of species having short first gonopods—*C. gladiator* Benedict (1893), *marginatus* A. Milne Edwards (1861), *ornatus* Ordway (1863), and *similis* Williams (1966) (Figures 18a-d, 20a-d), as well as in a second set with relatively longer first gonopods—*C. arcuatus* Ordway (1863), *danae*, and *exasperatus* (Gerstaecker, 1856) (Figures 18e-g, 20 e-i), but larger and arranged in longitudinal bands among species with long curved first gonopods in a third set—*C. bellicosus*, *bocourti*, *latimanus* Rathbun (1897), *maracaiboensis* Taissoun (1972), *rathbunae* Contreras (1930), *sapidus*, and *toxotes* Ordway (1863) (Figures 18h-j, 19, 20j-p, 21). In the last group, the spinules are irregular in size showing evidence of breakage and replacement during growth. Moreover, first gonopods of certain species bear slender setae. In *C. arcuatus* and *danae*, with first gonopods of moderate length, the setae are subterminal (Figure 20e-h) but in others with longer first gonopods [*C. bellicosus*, *latimanus*, *maracaiboensis*, *rathbunae*, *sapidus*, and *toxotes* (Figures 20j-p, 21)] they are arranged along the shaft at levels between the fifth to seventh thoracic sternites in a single sternomesial row following the twist of the appendage. The setae are relatively largest in *bellicosus* (Figure 20j, k).

Structure of the female gonopores covered by the abdomen and located near the midline on the sixth thoracic somite (Snodgrass, 1936) is less useful as a specific character than that of the male first gonopod, but even here there are some conformational types. Each gonopore leads via a spermathecal duct (vagina) to a spermatheca

which in turn is connected to oviduct and ovary, but it is the gonopore alone that shows crude structural specificity. Hartnoll (1968) showed that the gonopore of portunids is an uncovered structure often rounded laterally and pointed mesially, whose margin is the "rigid integument of the sternum, while the lumen is normally blocked by bulges of the flexible integument which comprises the lining of the vagina." In the set of species having males with long first gonopods, the gonopores of females are paraboloid in outline (Figures 22i-l, 23a-c). Parallels with the other two sets of male gonopod types are less pronounced. Of the intermediate second set, female *C. arcuatus* and *danae* have asymmetrically ovoid gonopores (Figure 22e, f); *exasperatus* has an elongate sinuous gonopore with shelflike overgrowth on the cephalic border (Figure 22g), and *bellicosus* fits into this group (Figure 22h). Females corresponding to the set of males with short first gonopods

have gonopores varying from broadly open paraboloid in *C. ornatus* (Figure 22d) to increasingly narrowed openings in *C. gladiator* and *marginatus* (Figure 22b, c), culminating in the narrow transverse slit of *C. similis* (Figure 22a).

## MEASUREMENTS

The foregoing discussion shows that measurements must be taken from adults if they are to have systematic usefulness because the young are proportionally different from adults as well as being incomplete for secondary sexual characters. Some species are larger than others and certain proportions are considered useful in keys for identification (Rathbun, 1930; Garth and Stephenson, 1966). Certain populations within species may deviate from the "typical." Initially I thought that analysis of morphometric characters might help to define differences among species as well as among populations within species.

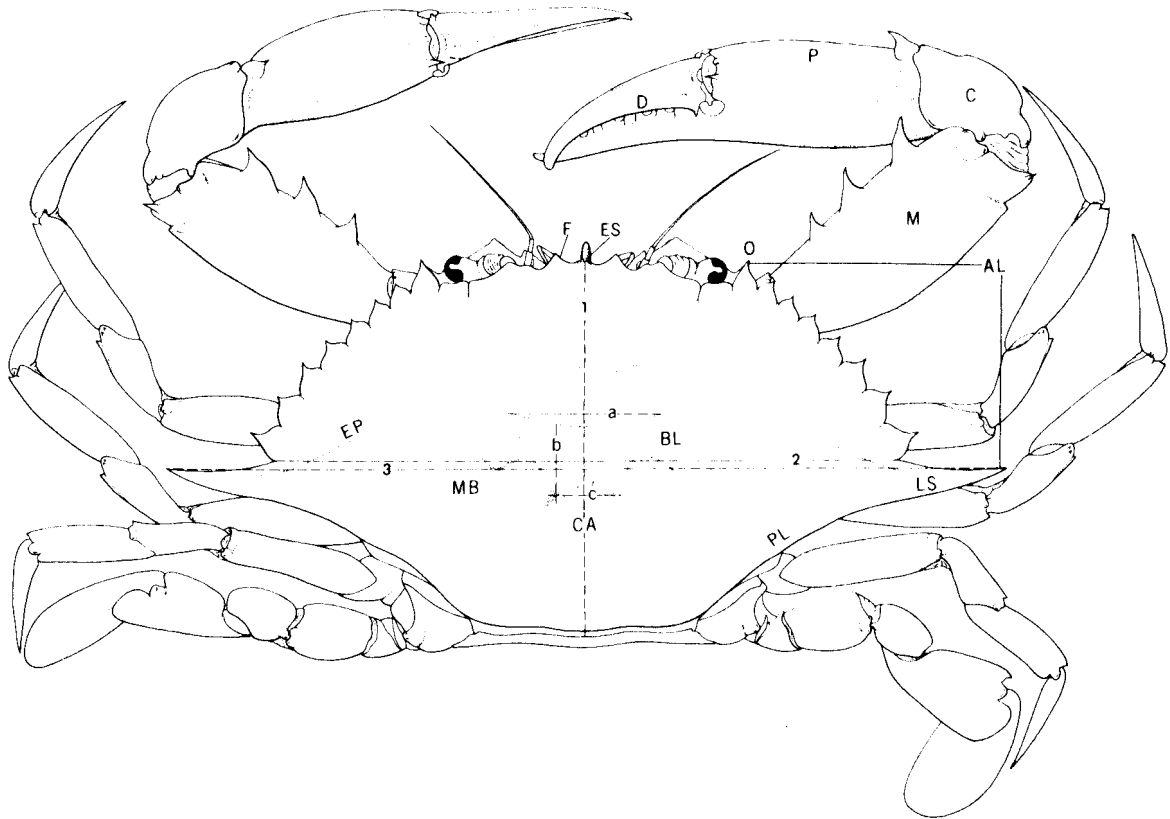


FIGURE 1.—Mature male *Callinectes sapidus* from North Carolina in dorsal view ( $\times 1$ ). Measured features indicated by numbered lines: 1, length; 2, width to base of lateral spines; 3, width including lateral spines; dimensions of metagastric area — a, anterior width, b, length, c, posterior width. Other features included in descriptions: (carapace) F, frontal teeth; O, outer orbital tooth; AL, anterolateral teeth; LS, lateral spine; PL, posterolateral margin; EP, epibranchial line; ES, epistomial spine; MB, mesobranchial area; CA, cardiac area; BL, branchial lobe; (cheliped) M, merus; C, carpus; P, propodus; D, dactyl.

Measurements taken included 18 characters for mature males, 21 for mature females (Figures 1, 2). These characters comprise two sets, one associated with the carapace or general body form, and another with sexual characters. Measurements for both sexes included:

1. Length of carapace including epistomial spine.
- 2.\* Length of carapace excluding epistomial spine.
- 3.\* Width of carapace including lateral spines.
- 4.\* Width of carapace at base of notch between lateral spine and preceding anterolateral tooth.
- 5.\* Width between tips of outer orbital spines (first anterolateral teeth).

6. Width between tips of suborbital spines.
7. Width between tips of lateral interorbital spines.
- 8.\* Maximum height of body.
- 9.\* Anterior width of metagastric area.
- 10.\* Posterior width of metagastric area.
- 11.\* Length of metagastric area.
- 12.\* Angular (lateral) length of metagastric area.

Measurements of elements in the T-shaped male abdomen included:

13. Greatest width of fused segments 3-5.
14. Median length of fused segments 3-5.
15. Median length of narrow segment 6.
16. Narrowest width of narrow segment 6.
- 17.\* Length of telson.
- 18.\* Width of telson.

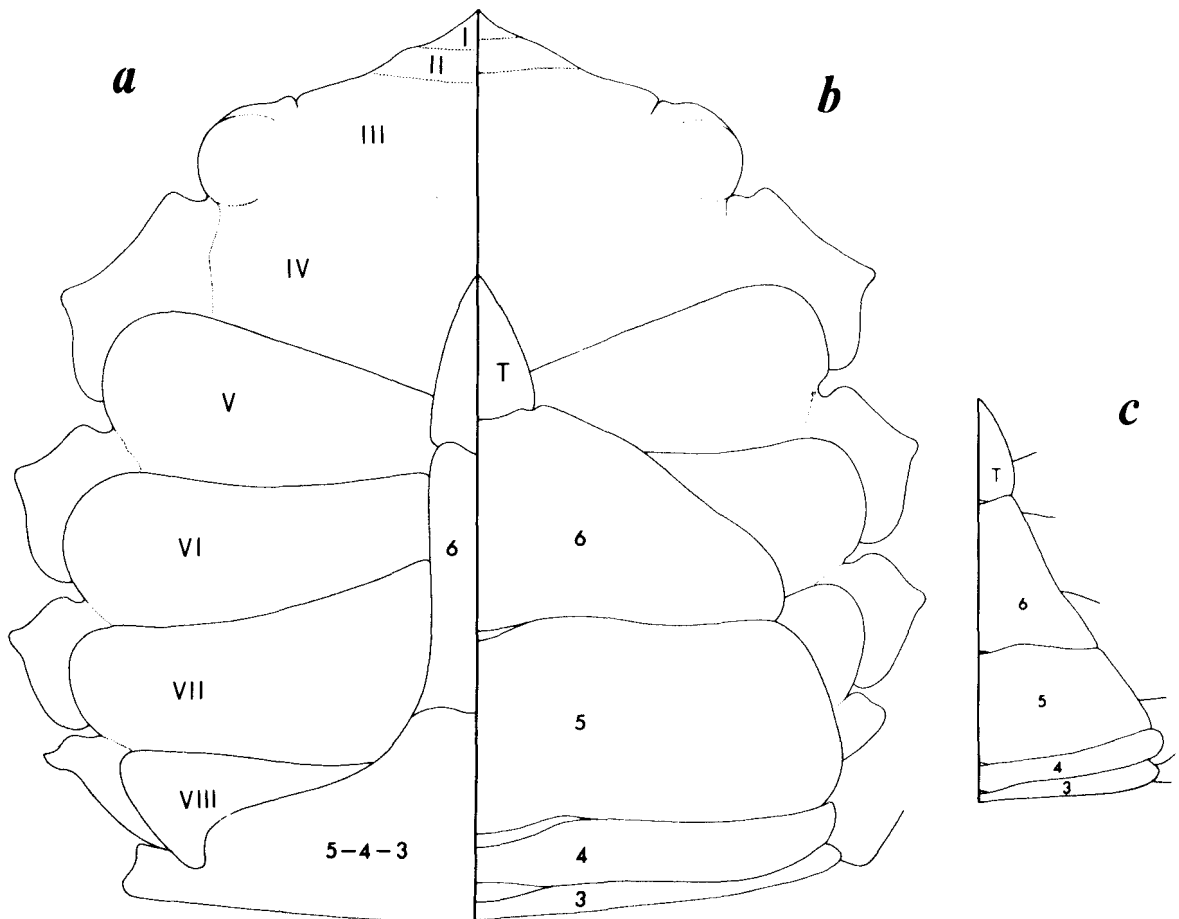


FIGURE 2.—Composite ventral view of thoracic sternites (roman numerals), abdomen (arabic numerals), and telson (T) in situ. a, mature male; b, mature female; c, immature female. Measurements: lengths in midline, widths maximal for structure.

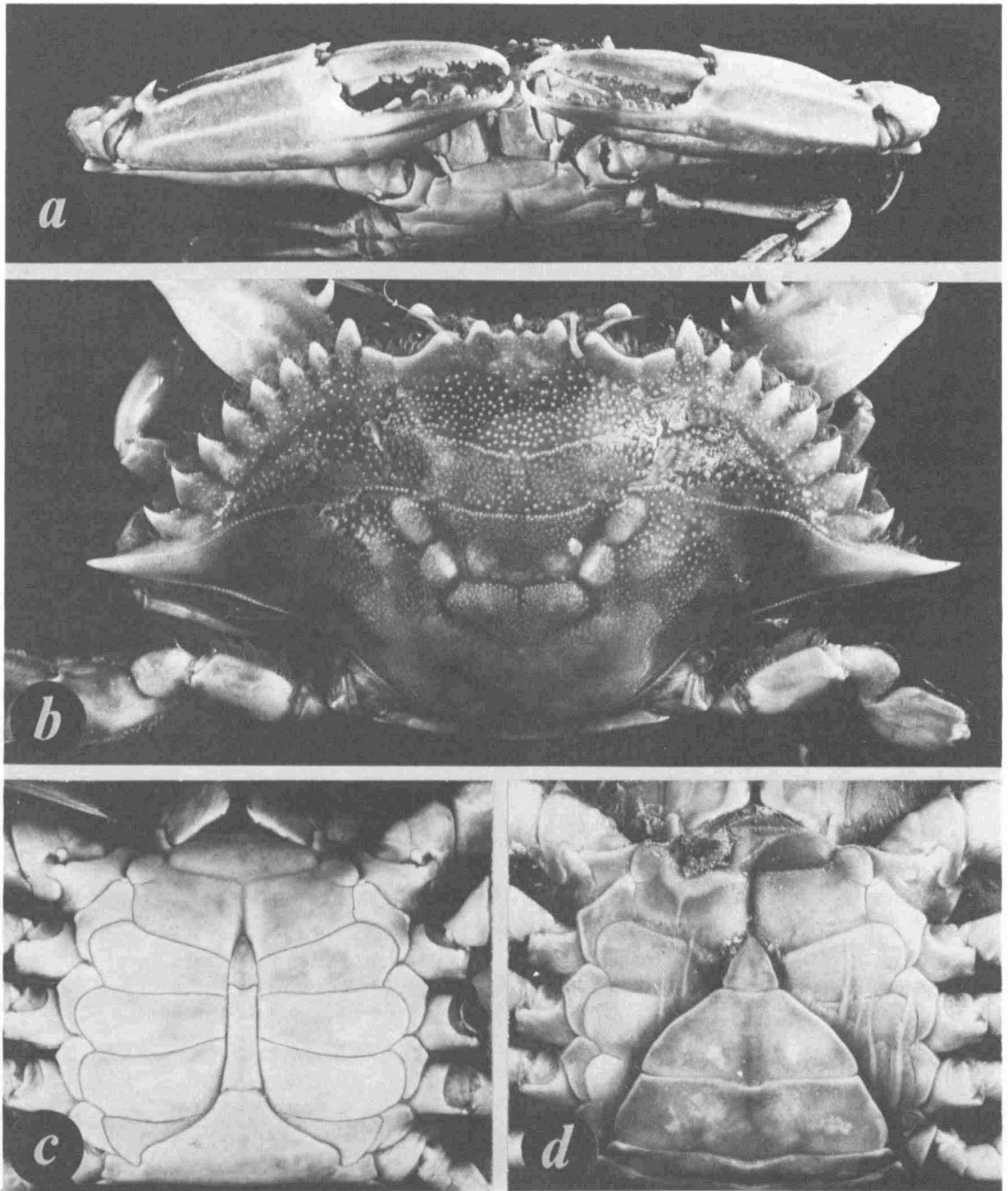


FIGURE 3.—*Callinectes marginatus* (A. Milne Edwards): a, chelae in frontal view; c, abdomen and sternal area, male, USNM 72351, Salt River Bay, St. Croix, V.I.; b, carapace; d, abdomen and sternal area, female, USNM 73285, W end San Juan Island near Ft. San Gerónimo, P.R.; a  $\times$  1; b  $\times$  1.5; c  $\times$  1.4; d  $\times$  1.7.

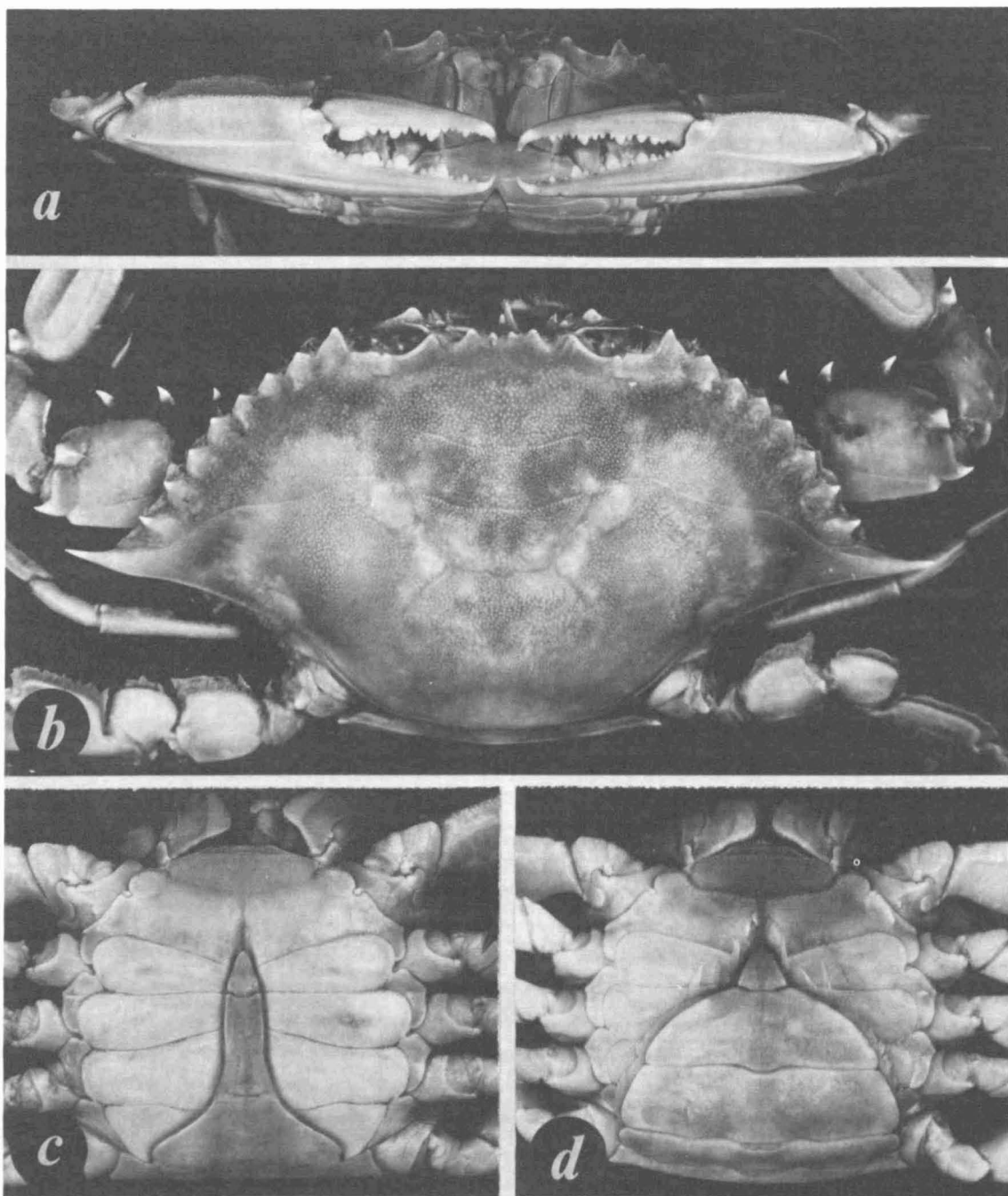


FIGURE 4.—*Callinectes similis* Williams: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male; d, abdomen and sternal area, female; paratypes, UNC-IMS 1556, Beaufort Inlet, Carteret County, N.C.; a  $\times$  1; b  $\times$  1.4; c  $\times$  1.2; d  $\times$  1.3.



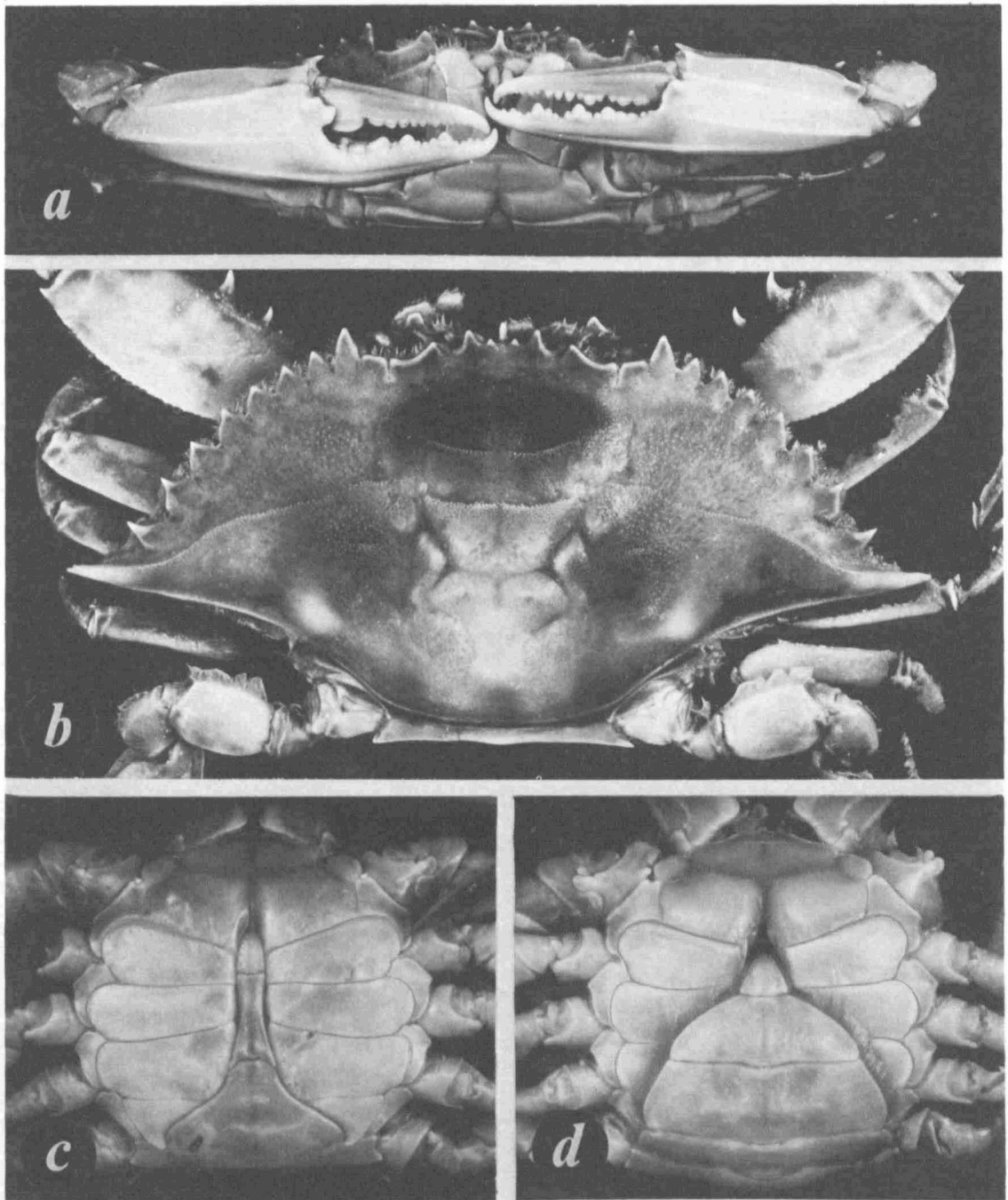


FIGURE 5.—*Callinectes gladiator* Benedict: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male; d, abdomen and sternal area, female, USNM 120940, Nigeria; a  $\times$  0.9; b  $\times$  1.4; c, d  $\times$  1.6.

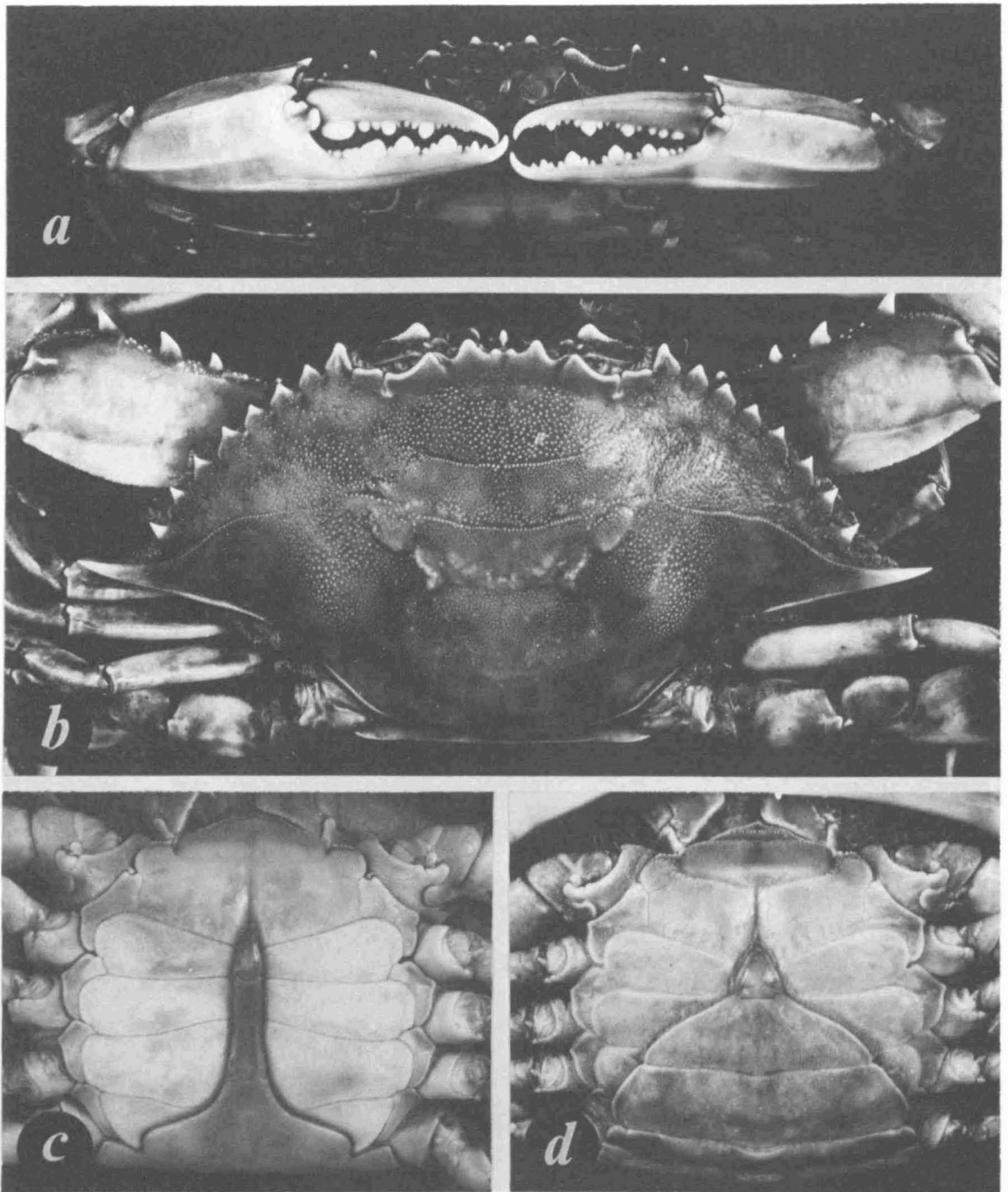


FIGURE 6.—*Callinectes ornatus* Ordway: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male, 48401, Punta [= Cabo] Cajón, Cuba; d, abdomen and sternal area, female, 7584, Curaçao; a  $\times$  1; b, d  $\times$  1.3; c  $\times$  1.5.

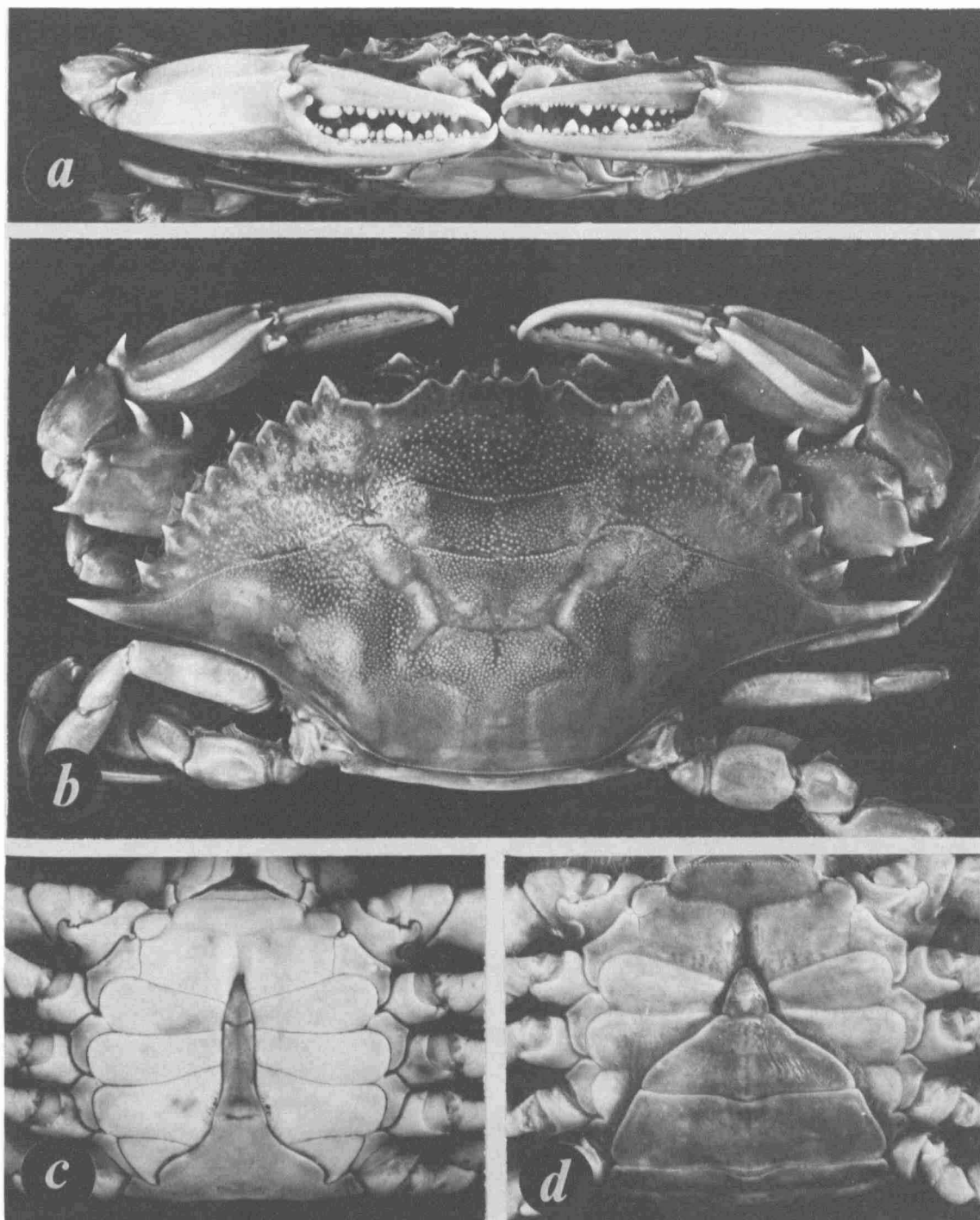


FIGURE 7.—*Callinectes danae* Smith: a, chelae in frontal view, male, USNM 60983, São Francisco, Niterói, Brazil; b, carapace; abdomen and sternal area, female, USNM 48400, Los Arroyos, Cuba; c, abdomen and sternal area, male, UNC-IMS 2128, Bahía de Mayagüez, P.R.; a, c  $\times$  1; b  $\times$  1.4; d  $\times$  1.5.

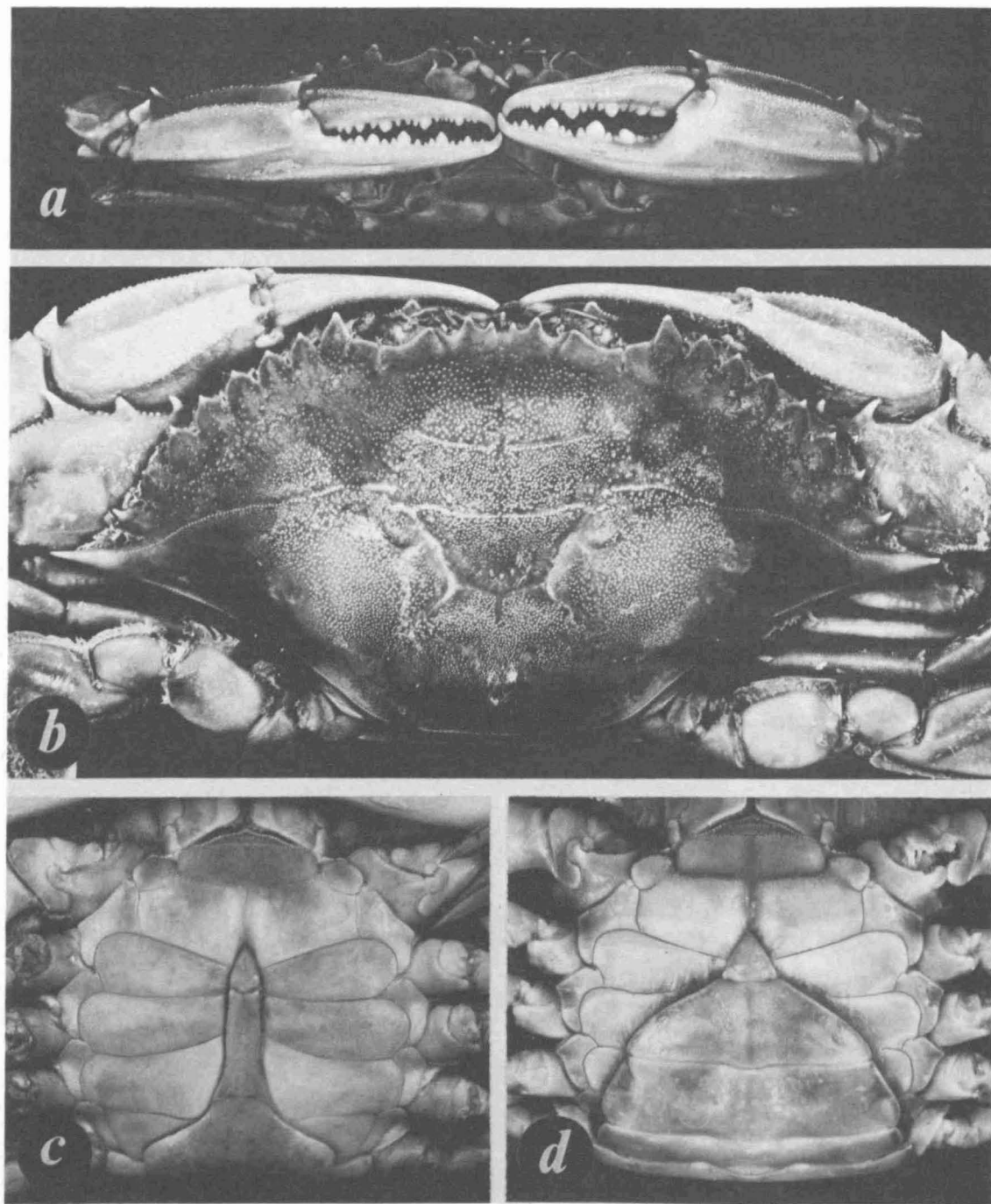


FIGURE 8.—*Callinectes arcuatus* Ordway: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male, USNM 33417, Isla Magdalena, Baja California, Mexico; d, abdomen and sternal area, female, USNM 15431, Estero de los Algodones, SE Guaymas, Sonora, Mexico; a  $\times$  1; b, c  $\times$  1.2; d  $\times$  1.4.

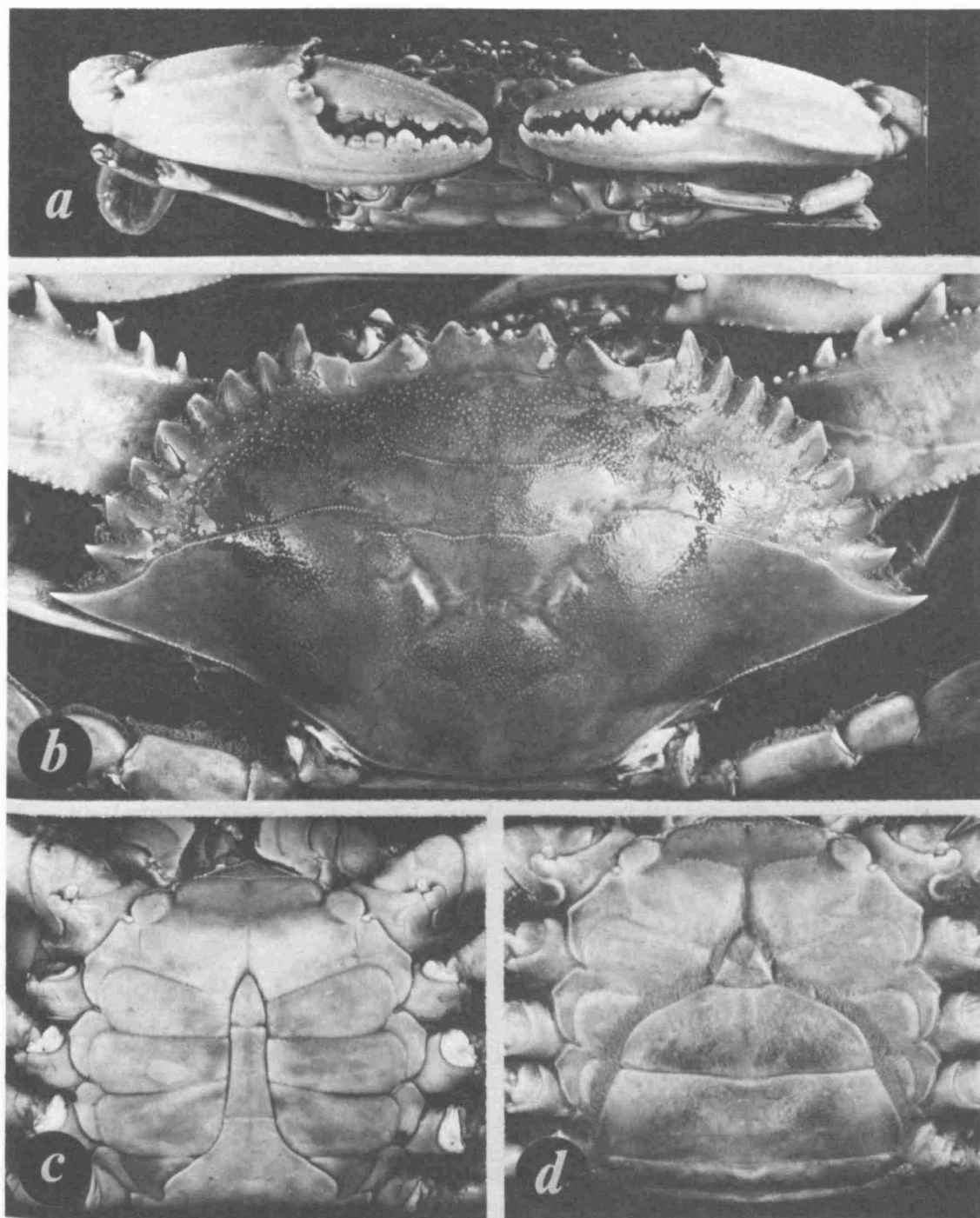


FIGURE 9.—*Callinectes exasperatus* (Gerstaecker): a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male, USNM 19428, Vitória, Estado Espírito Santo, Brazil; d, abdomen and sternal area, female, USNM 24467, Puerto Real, P.R.; a  $\times$  0.8; b  $\times$  1.1; c  $\times$  1; d  $\times$  1.4.

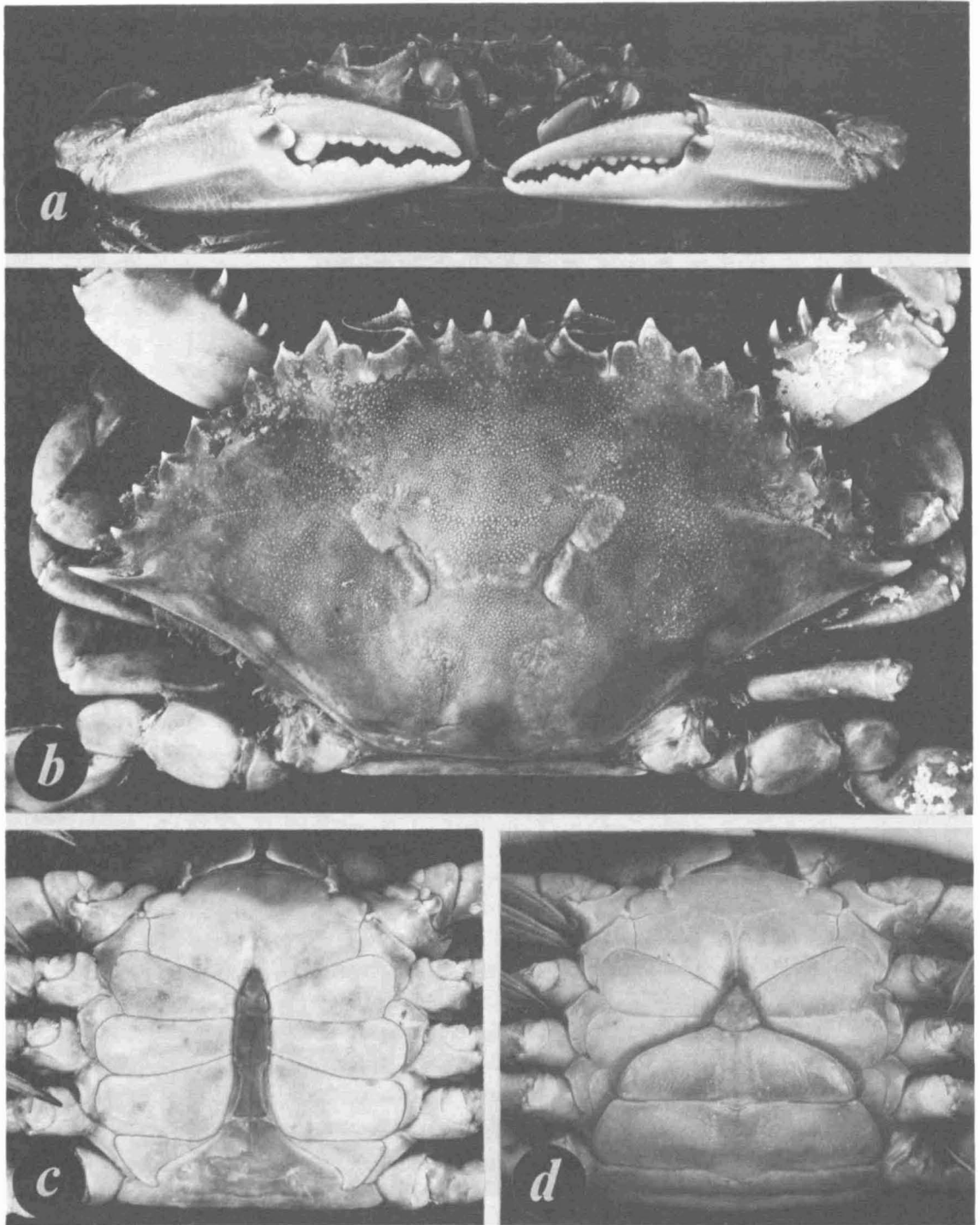


FIGURE 10.—*Callinectes bellicosus* (Stimpson): a, chelae in frontal view; d, abdomen and sternal area, female, USNM 60010, Pt. Abrejos, Bahía Ballenas, Baja California, Mexico; b, carapace; c, abdomen and sternal area, male, USNM 15436, La Paz Harbor, Baja California, Mexico; a, c,  $\times 1$ ; b  $\times 1.1$ .

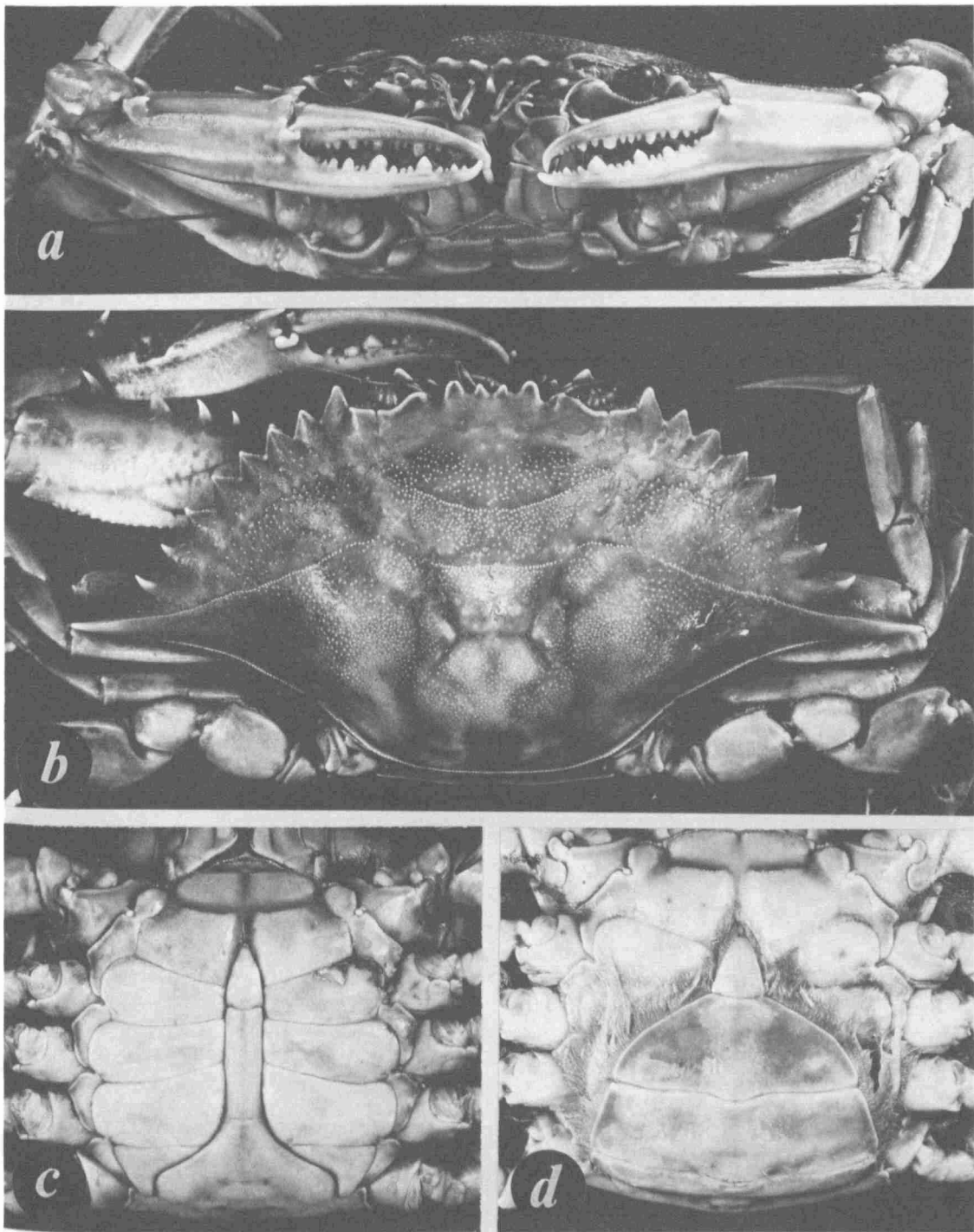


FIGURE 11.—*Callinectes toxotes* Ordway: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male; d, abdomen and sternal area, female, USNM 18507, Acapulco, Guerrero, Mexico; a  $\times 1.1$ ; b  $\times 0.8$ ; c, d  $\times 1$ .

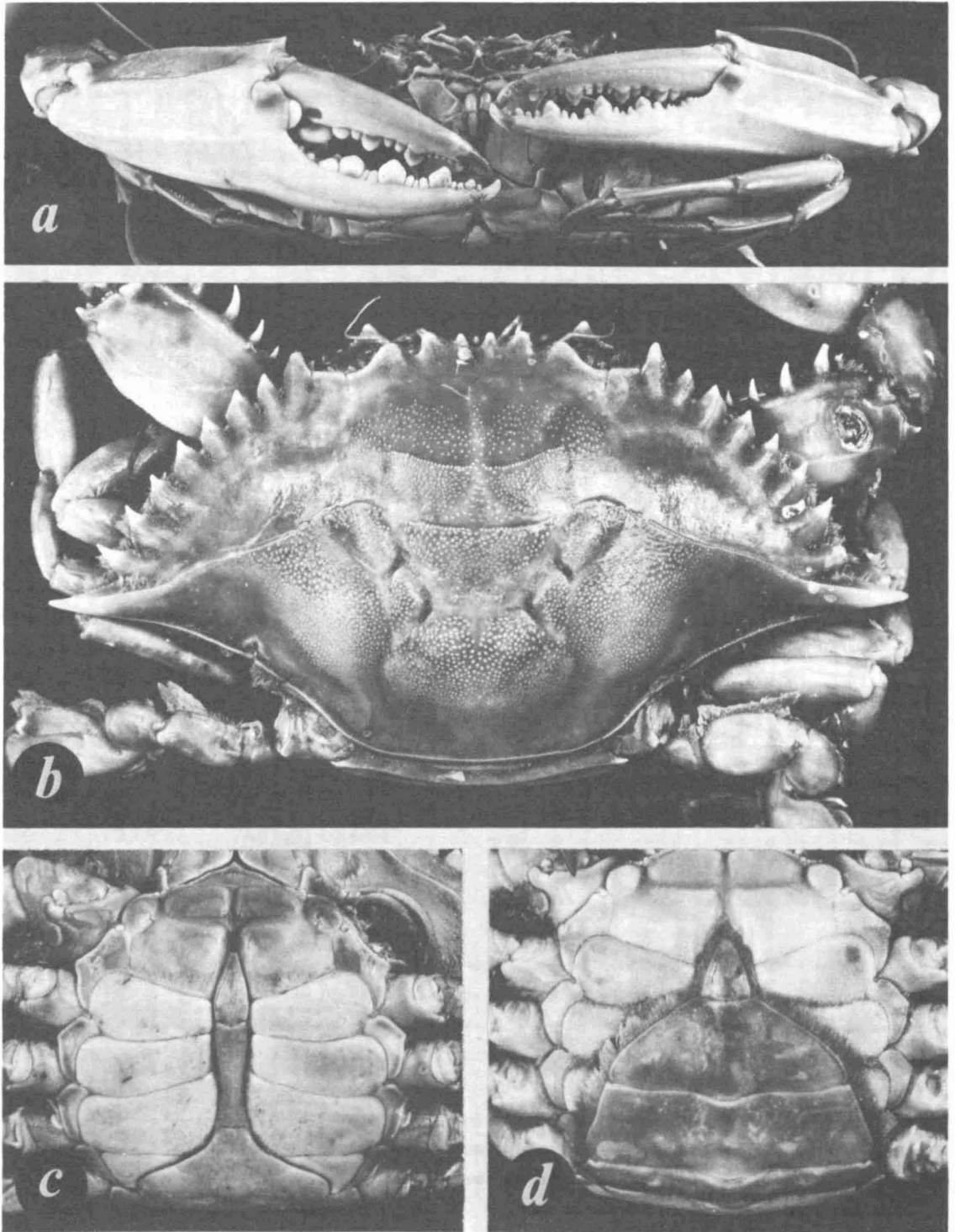


FIGURE 12.—*Callinectes bocourti* A. Milne Edwards: a, chelae in frontal view, male, USNM 72354, Fairplain stream above bridge, St. Croix, V.I.; b, carapace; d, abdomen and sternal area, female, USNM 18235, Sabanilla, Colombia; c, abdomen and sternal area, male, USNM 18233, São Luis, Estado Maranhão, Brazil; a, c  $\times 1$ ; b  $\times 1.2$ ; d  $\times 1.4$ .



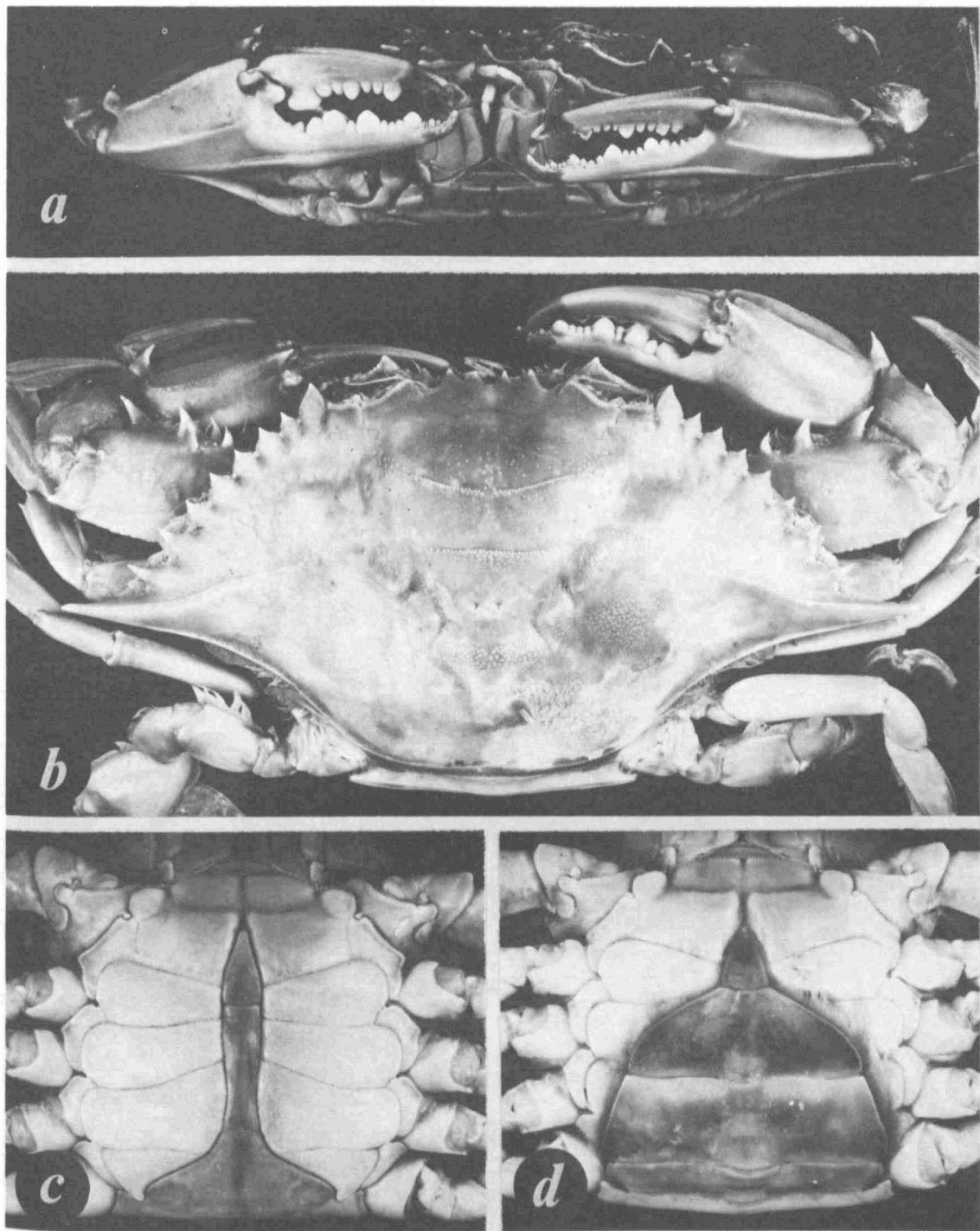


FIGURE 13.—*Callinectes rathbunae* Contreras: a, chelae in frontal view; b, carapace; d, abdomen and sternal area, female; c, abdomen and sternal area, male, USNM 122922, Laguna de Alvarado, Veracruz, Mexico; a, b  $\times 1$ ; c, d  $\times 1.1$ .

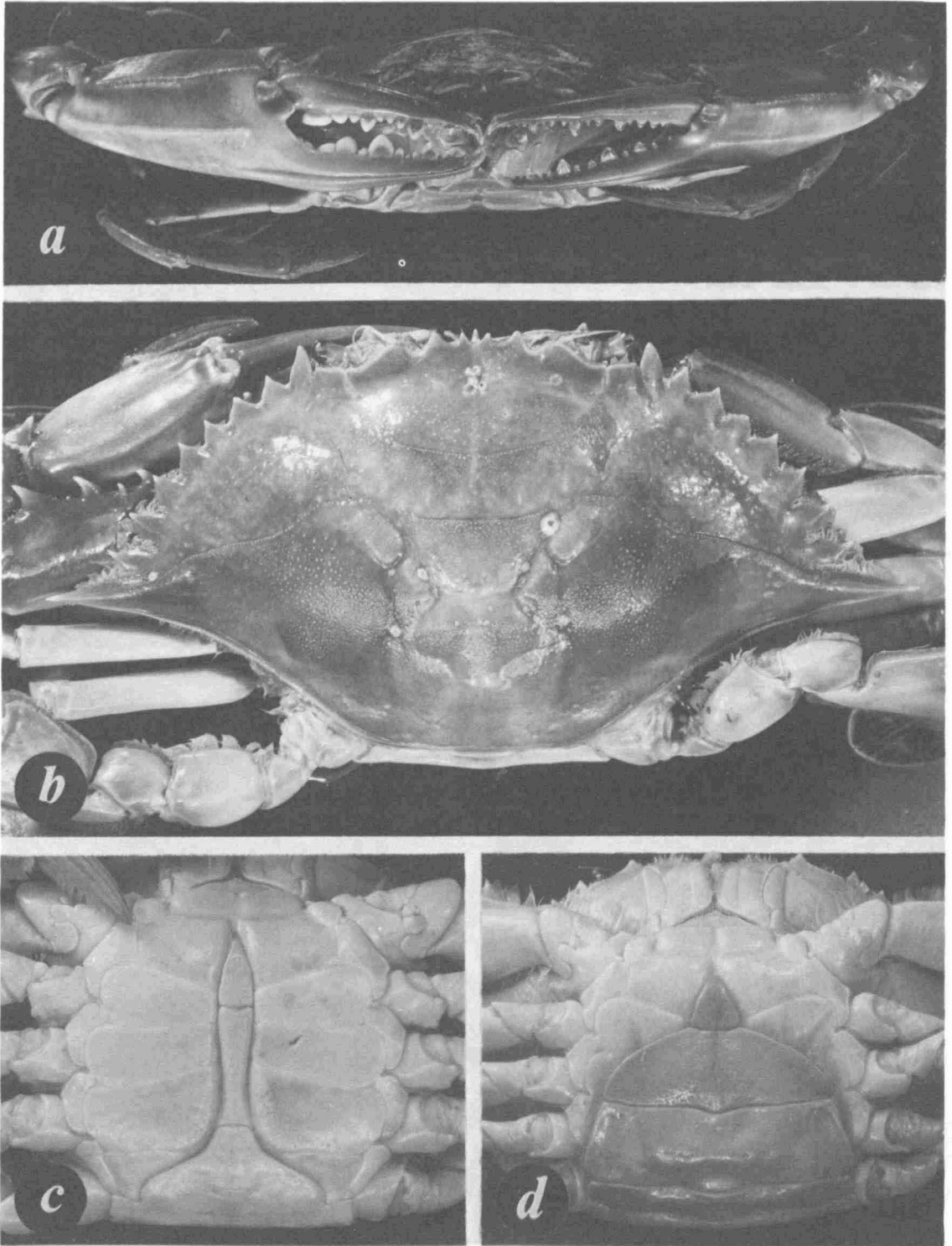


FIGURE 14.—*Callinectes maracaiboensis* Taissoun: a, chelae in frontal view, male, USNM 143392, Lago de Maracaibo; b, carapace, male, USNM 143393, Puerto Caballo, Maracaibo; c, abdomen and sternal area, male; d, abdomen and sternal area, female, USNM 139621, Lago de Maracaibo, Venezuela; a  $\times 0.95$ ; b  $\times 0.85$ ; c, d  $\times 1$ .

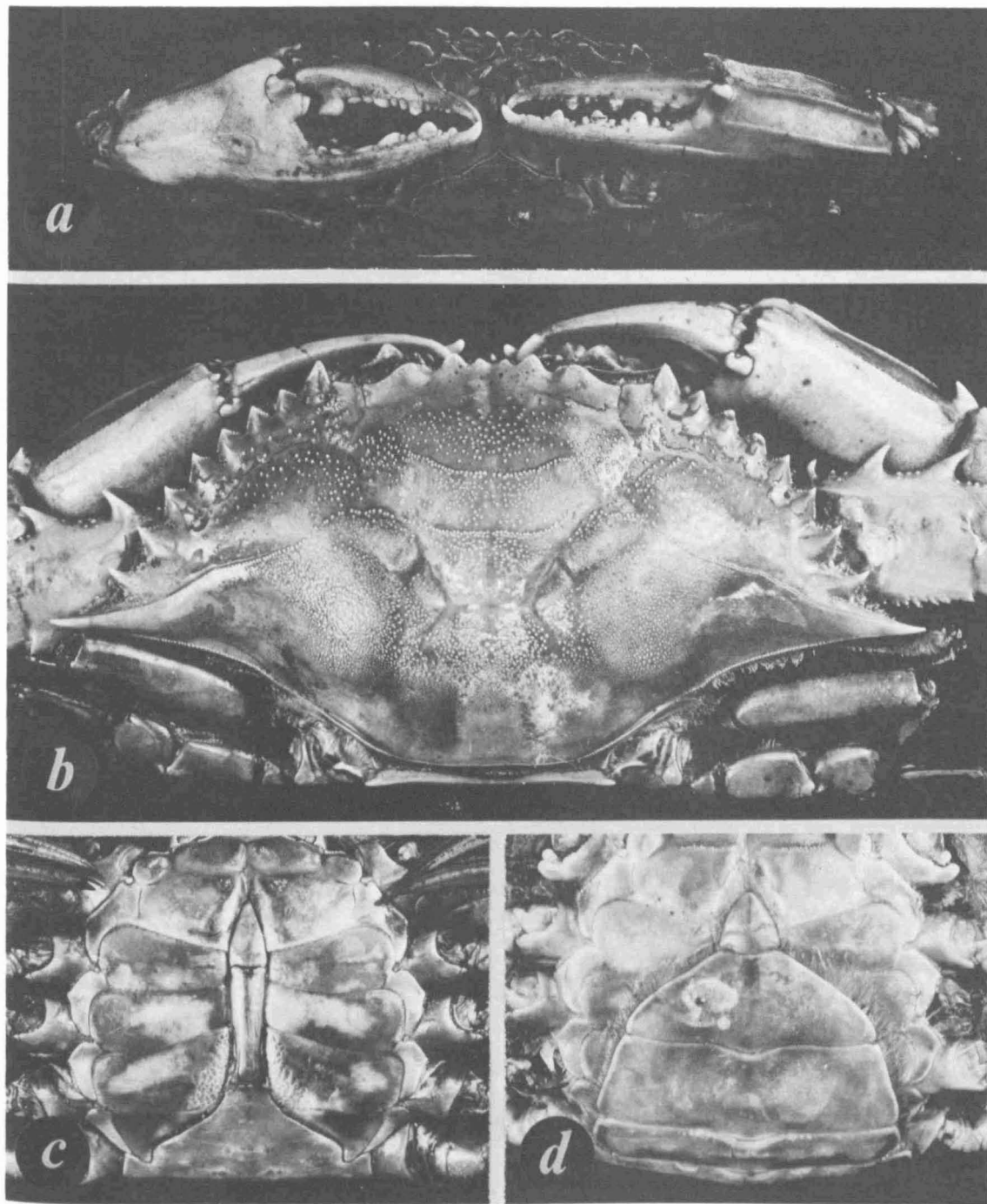


FIGURE 15.—*Callinectes latimanus* Rathbun: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male; d, abdomen and sternal area, female, USNM 54310, Banana, Zaire [= Belgian Congo] a  $\times 0.8$ ; b, c  $\times 1$ ; d  $\times 1.9$ .

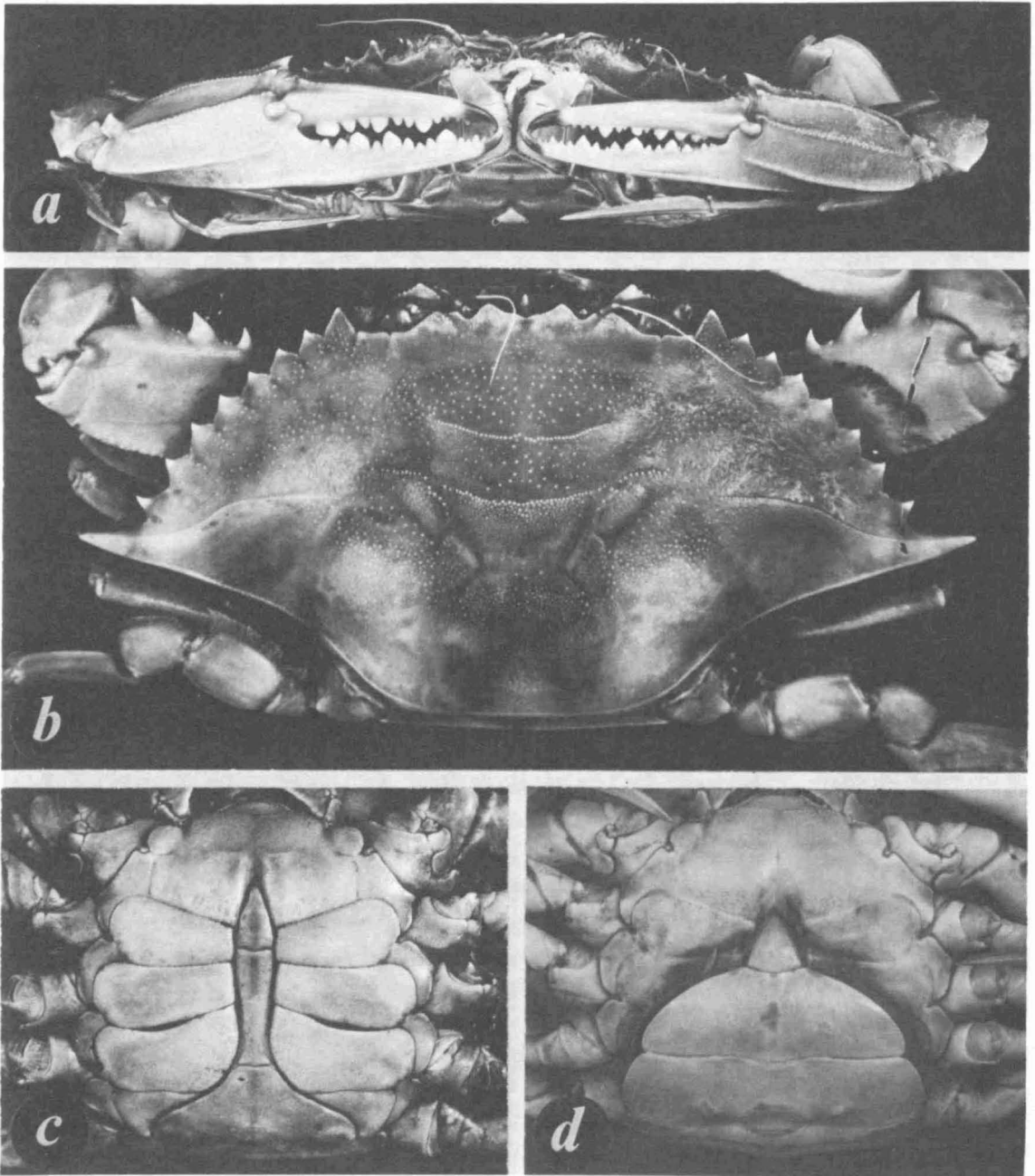


FIGURE 16.—*Callinectes sapidus* Rathbun, forma typica: a, chelae in frontal view, male, UNC-IMS 2136, 5 km S Lajas, P.R.; b, carapace, male, UNC-IMS 741, North River, Carteret County, N.C.; c, abdomen and sternal area, male, USNM 92452, Wye River, Md.; d, abdomen and sternal area, female, USNM 30567, Cameron, La.; a  $\times$  0.8; b  $\times$  1.3; c  $\times$  0.6; d  $\times$  0.85.

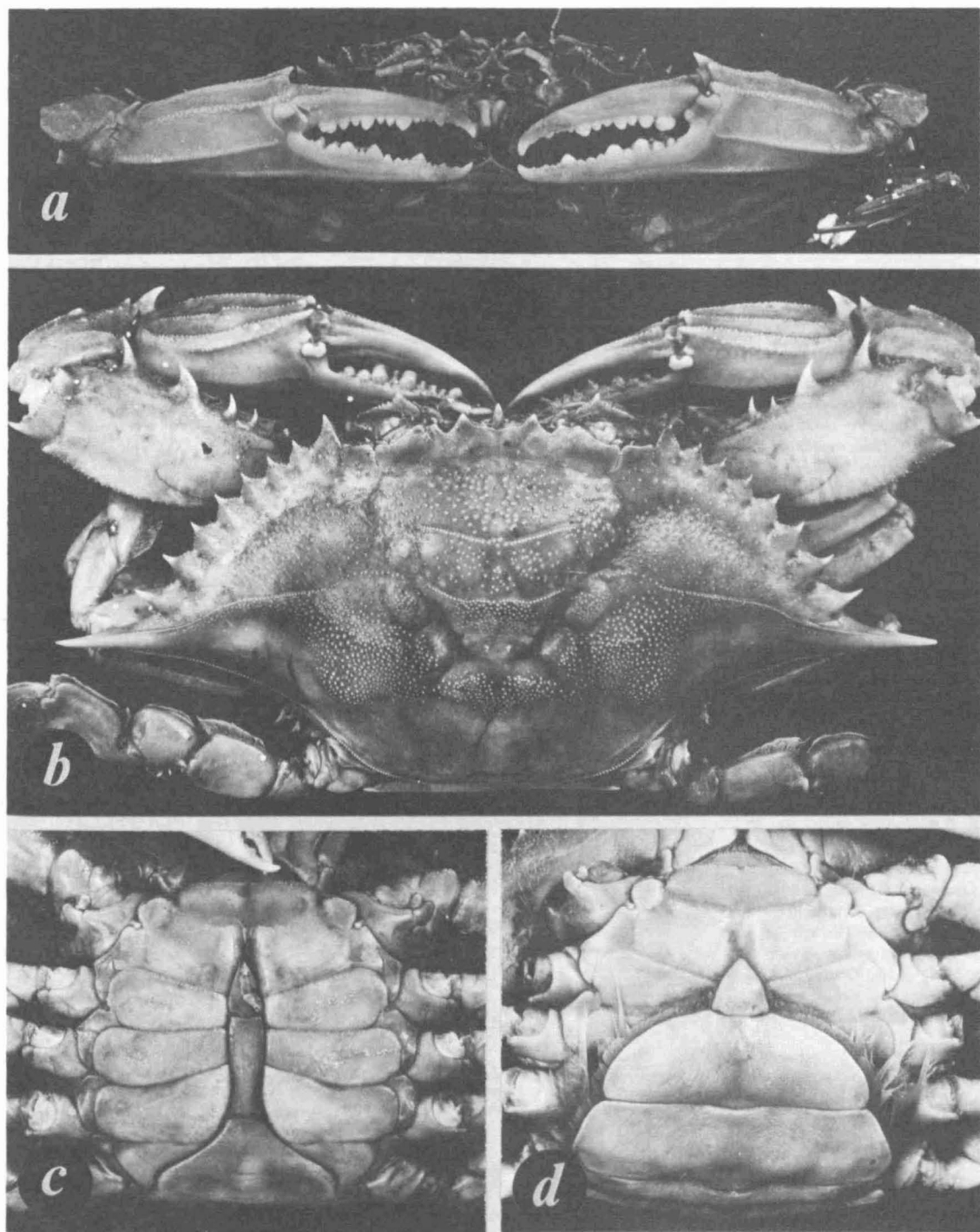


FIGURE 17.—*Callinectes sapidus* Rathbun, forma *acutidens*: a, chelae in frontal view; b, carapace; c, abdomen and sternal area, male, USNM 18630, Río Escondido, Nicaragua; d, abdomen and sternal area, female, USNM 99848, Roca Arroyo Balizas [= Arroyo de Valizes?], Uruguay; a  $\times 0.9$ ; b, c  $\times 1$ ; d  $\times 1.1$ .

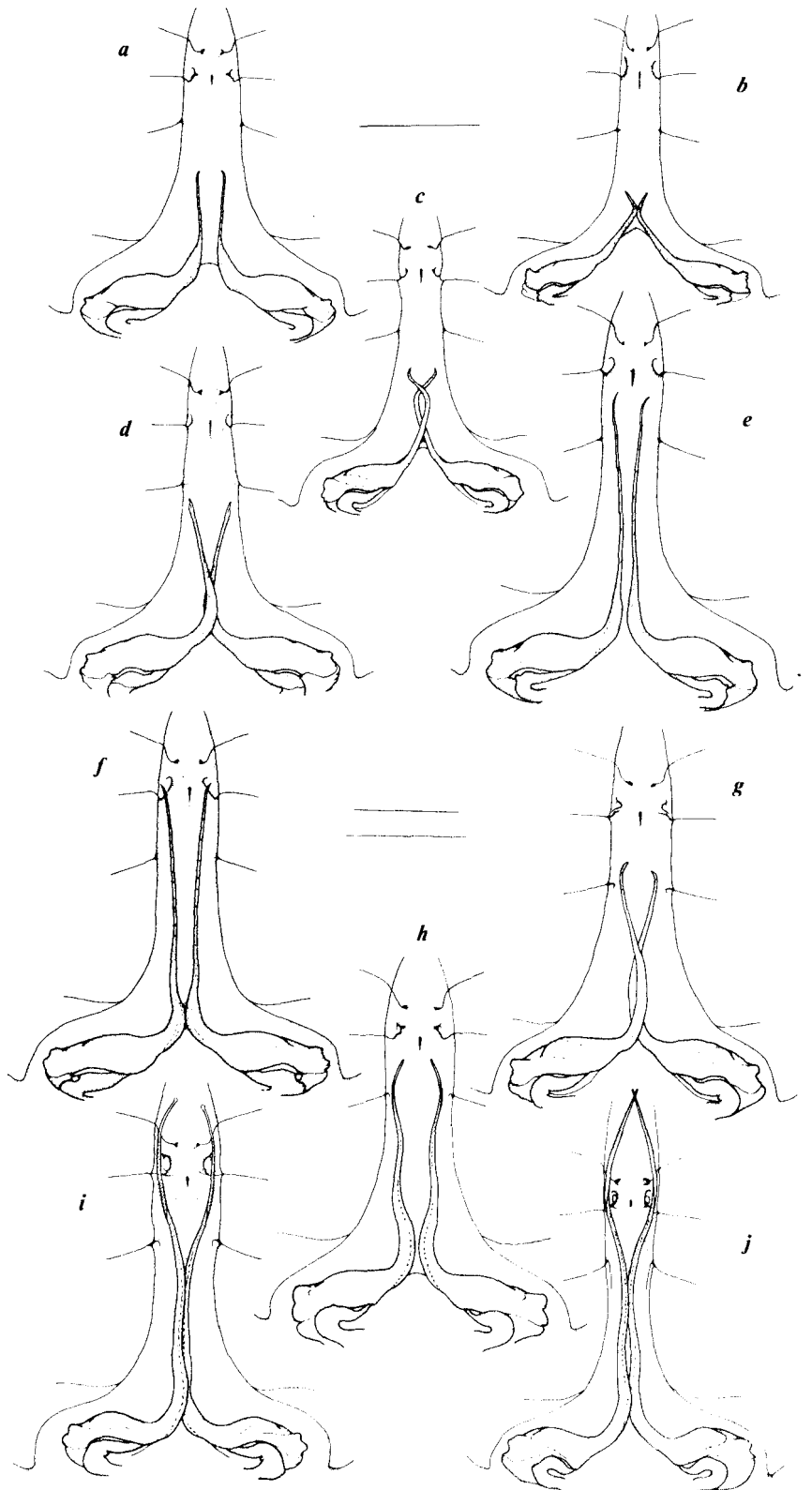


FIGURE 18.—Male, first gonopods in situ with abdomen removed; portions of thoracic sternites IV-VIII: a, *Callinectes marginatus* (A. Milne Edwards), USNM 72351, Salt River Bay, St. Croix, V.I.; b, *C. similis* Williams, paratype, UNC-IMS 1556, Beaufort Inlet, Carteret County, N.C.; c, *C. gladiator* Benedict, Côte du Dahomey, 6°19'N, 2°24'E; d, *C. ornatus* Ordway, USNM 48401, Punta [= Cabo] Cajón, Cuba; e, *C. danae* Smith, USNM 60983, São Francisco, Niterói, Estado de Rio de Janeiro, Brazil; f, *C. arcuatus* Ordway, USNM 33417, Isla Magdalena, Baja California, Mexico; g, *C. exasperatus* (Gerstaecker), UNM-IMS 2137, Bahía Fosforescente, P.R.; h, *C. bellicosus* (Stimpson), USNM 15436, La Paz Harbor, Baja California, Mexico; i, *C. toxotes* Ordway, USNM 18507, Acapulco, Guerrero, Mexico; j, *C. bocourti* A. Milne Edwards, USNM 72354, Fairplain stream above bridge, St. Croix, V.I. Scales = 1 cm; a-f have higher magnification.

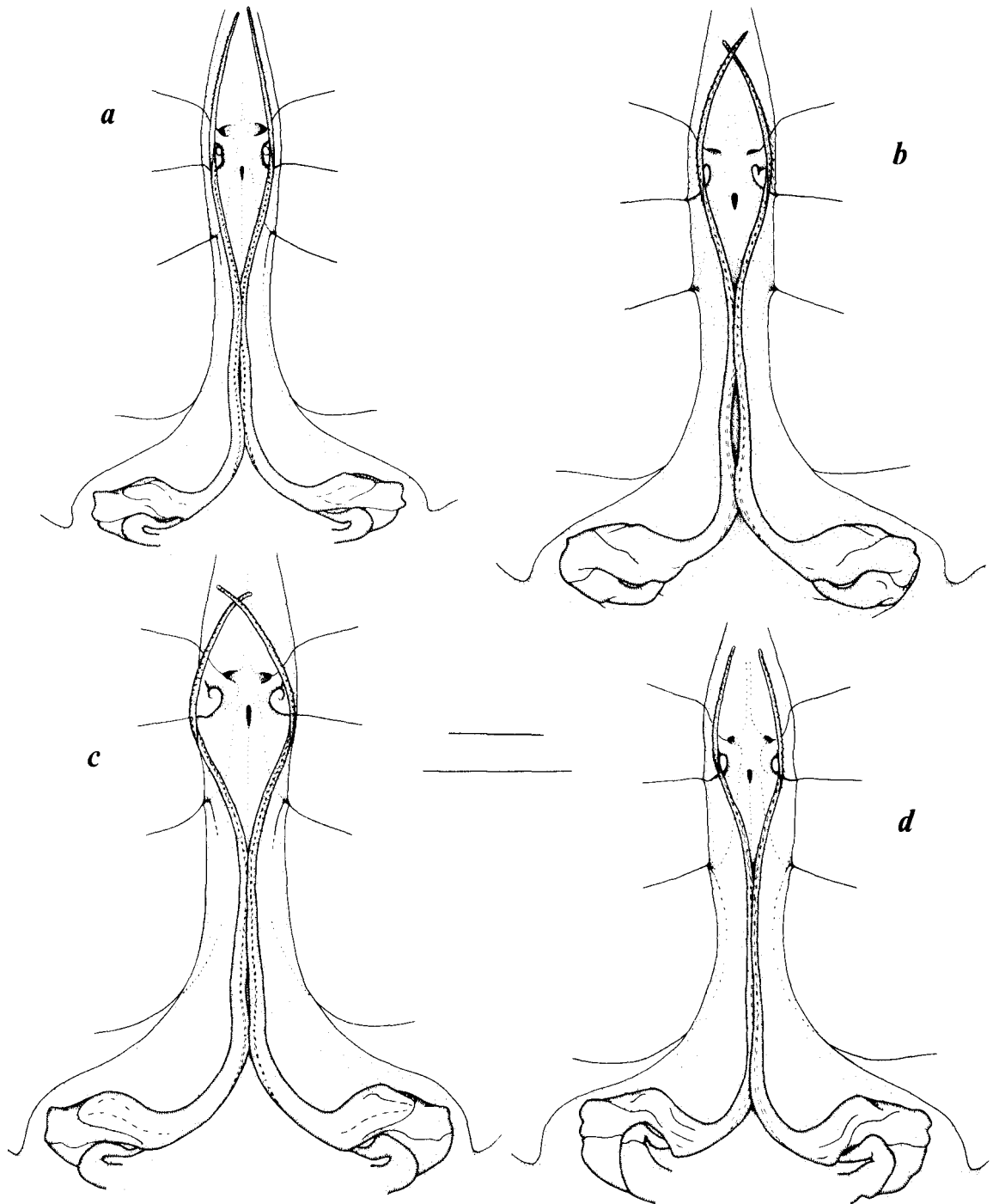


FIGURE 19.—Male, first gonopods in situ with abdomen removed; portions of thoracic sternites IV-VIII; a, *Callinectes rathbunae* Contreras, USNM 122922, Laguna de Alvarado, Veracruz, Mexico; b, *C. maracaiboensis* Taissoun, Lago de Maracaibo, Venezuela; c, *C. latimanus* Rathbun, Plage de Pointe Noire, Congo; d, *C. sapidus* Rathbun, USNM 92452, Wye River, Chesapeake Bay, Md. Scales = 1 cm; d has lower magnification.



FIGURE 20.—Male, right first gonopod, distal portion in posterior view unless otherwise indicated: a, *Callinectes marginatus* (A. Milne Edwards), USNM 72351, Salt River Bay, St. Croix, V.I.; b, *C. gladiator* Benedict, Coast of Dahomey, 6°19'N, 2°24'E; c, *C. similis* Williams, paratype, UNC-IMS 1556, Beaufort Inlet, Carteret County, N.C.; d, *C. ornatus* Ordway, USNM 7584, Curaçao; e, f, *C. danae* Smith, USNM 60983, São Francisco, Niterói, Estado de Rio de Janeiro, Brazil; g, h, *C. arcuatus* Ordway, USNM 33417, Isla Magdalena, Baja California, Mexico (reconstructed tip of h from USNM 60977, Salinas, Ecuador); i, *C. exasperatus* (Gerstaecker), UNC-IMS 2137, Bahía Fosforescente, P.R.; j, *C. bellicosus* (Stimpson), USNM 15436, La Paz Harbor, Baja California, Mexico; k, same, sternal view; l, *C. toxotes* Ordway, USNM 18507, Acapulco, Guerrero, Mexico; m, *C. bocourti* A. Milne Edwards, USNM 72354, Fairplain stream above bridge, St. Croix, V.I.; n, *C. rathbunae* Contreras, USNM 122922, Laguna de Alvarado, Veracruz, Mexico; o, *C. maracaiboensis* Taissoun, paratype, USNM 139621, Lago de Maracaibo, Venezuela; p, *C. latimanus* Rathbun, Plage de Pointe Noire, Congo. Scales = 1 mm; a-c have higher magnification.



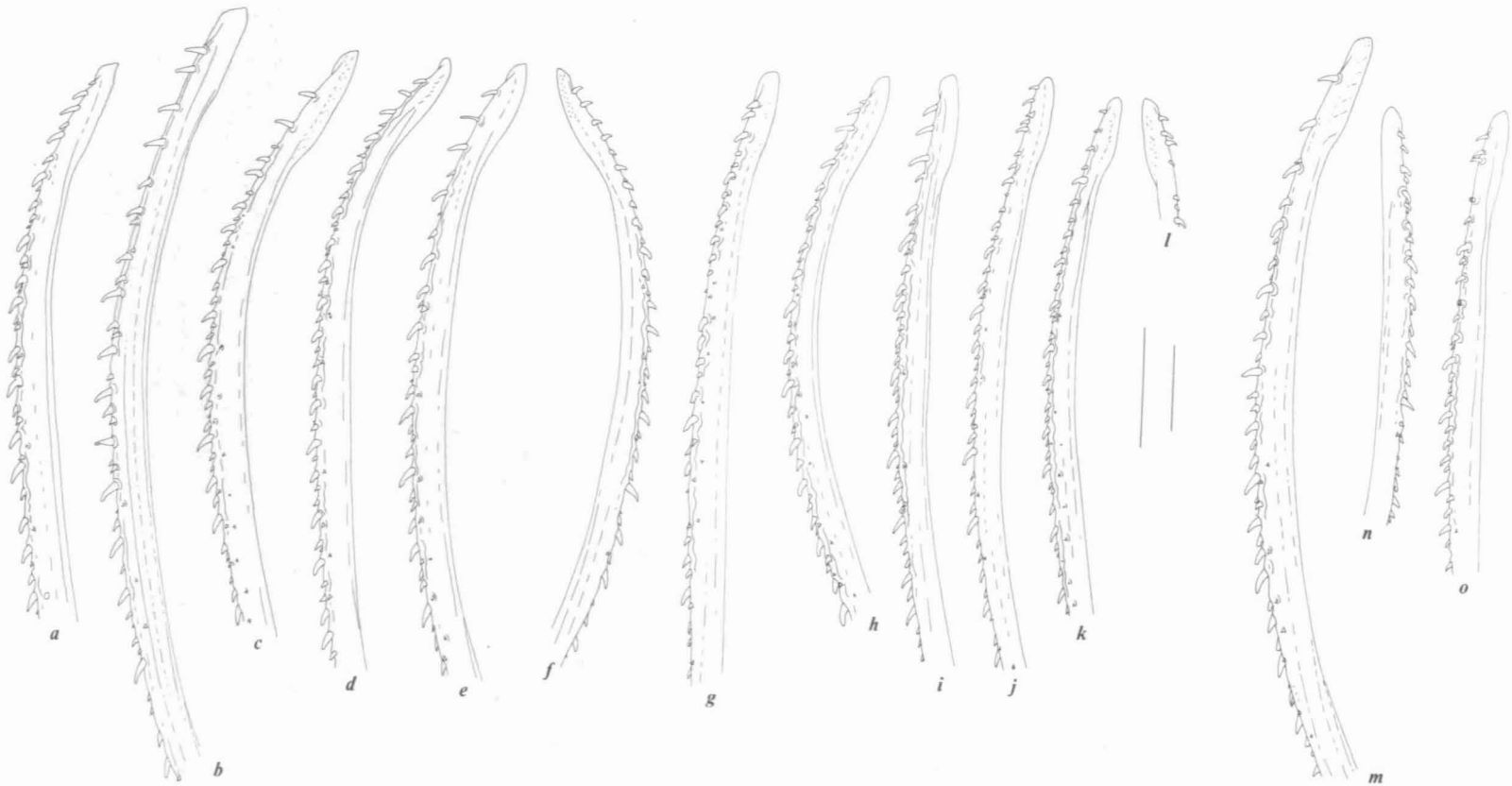


FIGURE 21.—*Callinectes sapidus* Rathbun, male, right first gonopod, distal portion in posterior view unless otherwise indicated: a, typical form, USNM 41457, Hudson River at West Point, N.Y.; b, typical form, USNM 92452, Wye River, Chesapeake Bay, Md.; c, d, typical form, USNM 60601, Cape Hatteras, N.C.; e, acutidens form, USNM 122944, Deep Lake, Miami, Fla.; f, typical form, right first gonopod, USNM 7679, Jamaica; g, acutidens form, USNM 72356, Fairplain stream below bridge, St. Croix, V.I.; h, acutidens form, USNM 113278, Tortuguero, Costa Rica; i, acutidens form, USNM 43921, Mindi Cut, C. Z., Panama; j, acutidens form, Lago de Maracaibo, Venezuela; k, typical form, USNM 80650, Lago de Maracaibo, Venezuela; l, same specimen, right side; m, acutidens form, holotype, MCZ 4696, Santa Cruz, Estado de Bahia, Brazil; n, acutidens form, paratype, right first gonopod, USNM 19083, Rio de Janeiro, Brazil; o, acutidens form, SADZ-B 3234, Praia de Torres, Estado de Rio Grande do Sul, Brazil (tip straightened in preservation). Scales = 1 mm; a, g, n have higher magnification.

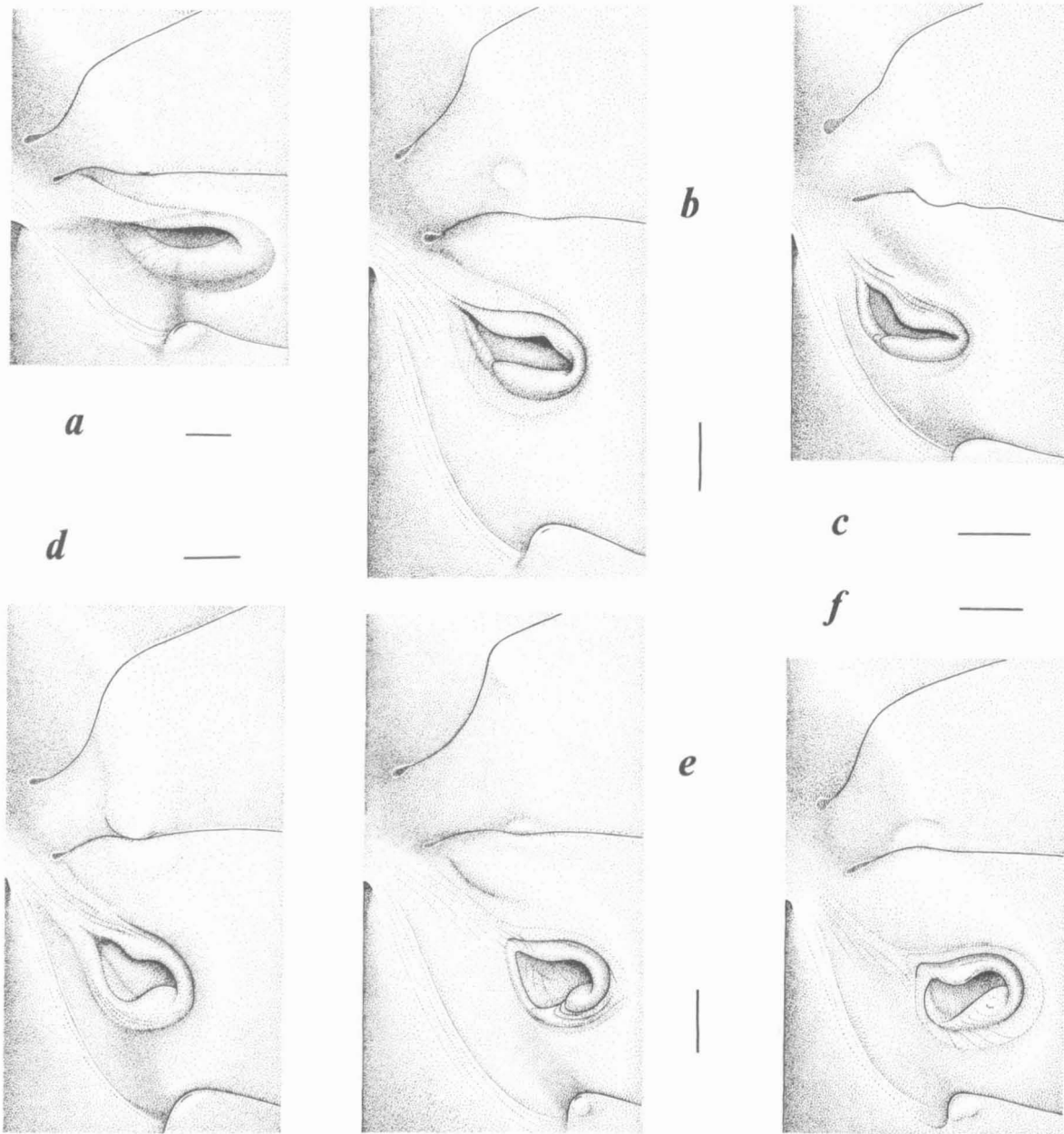
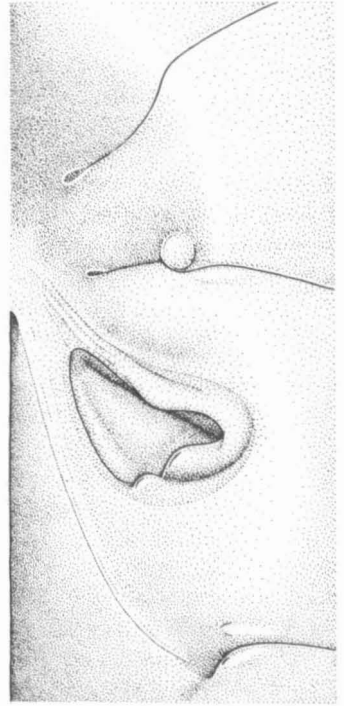
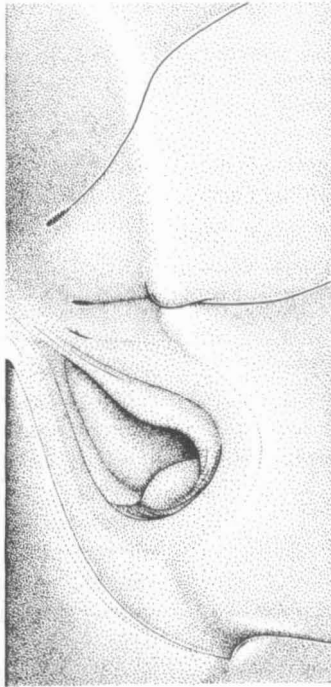
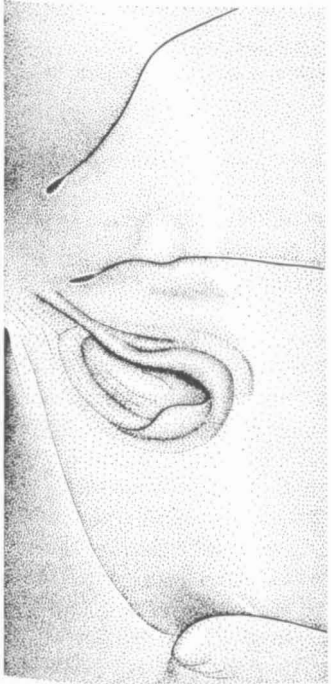
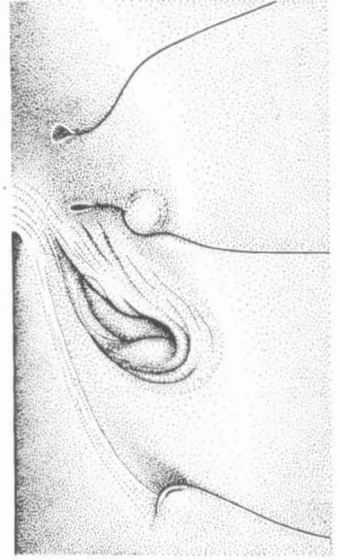
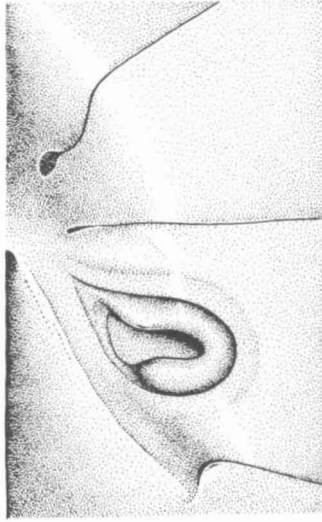
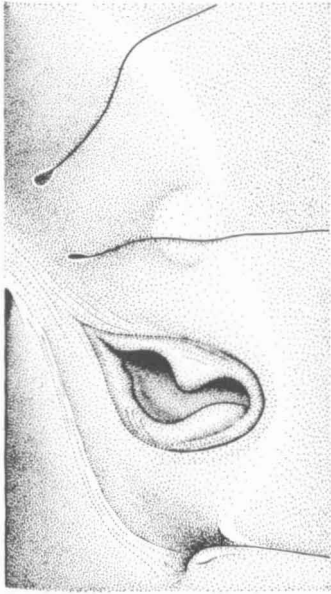


FIGURE 22.—Female, left gonopore and portions of thoracic sternites IV-VII: a, *Callinectes similis* Williams, paratype, UNC-IMS 1556, Beaufort inlet, Carteret County, N.C.; b, *C. marginatus* (A. Milne Edwards), USNM 73285, W end San Juan I. near Ft. Gerónimo, P.R.; c, *C. gladiator* Benedict, Coast of Cameroon, 3°32'N, 9°35'E; d, *C. ornatus* Ordway, USNM 7584, Curaçao; e, *C. danae* Smith, USNM 60983, São Francisco, Niterói, Estado de Rio de Janeiro, Brazil; f, *C. arcuatus* Ordway, USNM 15431, Estero de los Algodones near Guaymas, Sonora, Mexico; g, *C. exasperatus* (Gerstaecker), USNM 24467, Puerto Real, P.R.; h, *C. bellicosus* (Stimpson), USNM 60010, Pt. Abrejos, Bahía Ballenas, Baja California, Mexico; i, *C. toxotes* Ordway, USNM 18507, Acapulco, Guerrero, Mexico; j, *C. bocourti* A. Milne Edwards, USNM 18235, Sabanilla, Colombia; k, *C. rathbunae* Contreras, USNM 122922, Laguna de Alvarado, Veracruz, Mexico; l, *C. maracaiboensis* Taissoun, paratype, USNM 139621, Lago de Maracaibo, Venezuela. Scales = 1 mm.



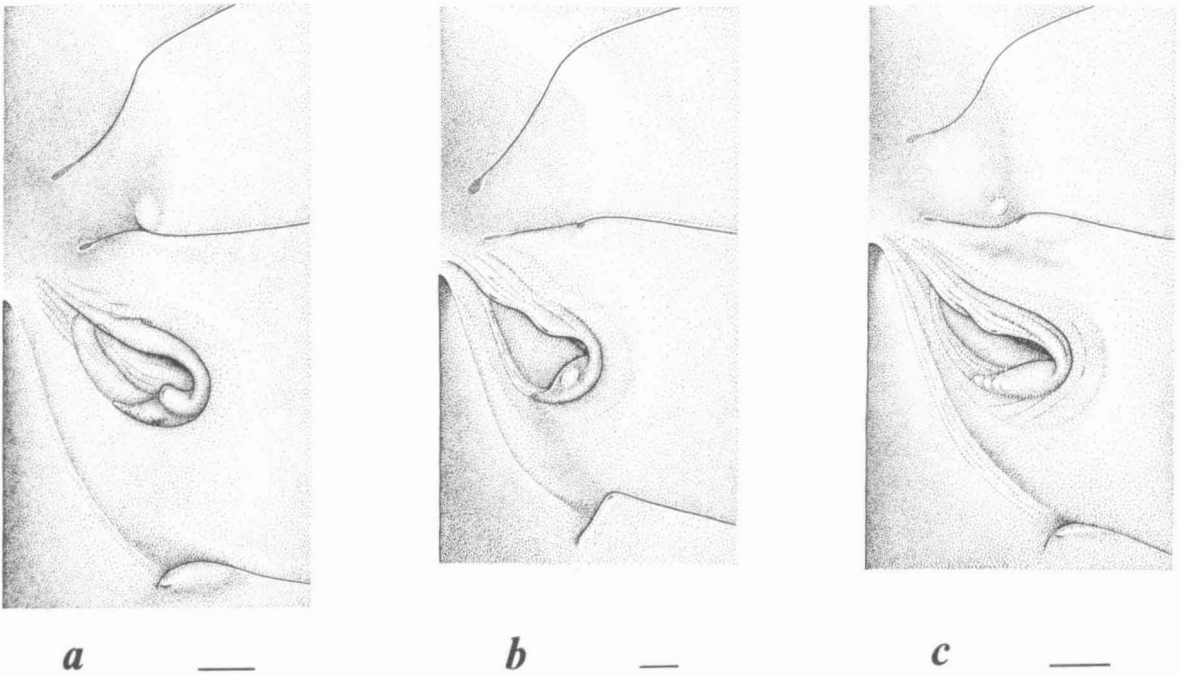


FIGURE 23.—Female, left gonopore and portion of thoracic sternites IV-VII: a, *Callinectes latimanus* Rathbun, Plage de Pointe Noire, Congo; b, *C. sapidus* Rathbun, typical form, USNM 30567, Cameron, La.; c, *C. sapidus* Rathbun, acutidens form, USNM 99848, Roca Arroyo Balizas [= Arroyo de Valizes?], Uruguay. Scales = 1 mm.

Measurements of elements in the broad apron-shaped abdomen of sexually mature females included:

13. Greatest width of segment 2.
14. Greatest width of segment 3.
15. Greatest width of segment 5.
16. Median length of segment 5.
17. Greatest width of segment 6.
18. Median length of segment 6.
19. Median length of segment 3 (proximal edge) to tip of telson.
- 20.\* Length of telson.
- 21.\* Width of telson.

*Analysis of selected nonsexual characters.*—Study showed that some of these measurements were more valuable than others at the specific level and 11 (marked with asterisks), generally considered useful in verbal description, were chosen for cluster analysis. Unfortunately, they neither clustered as species nor as species groups when analyzed. Results indicated that specific morphological differences in this genus are based on characters other than, or in addition to, those measured and analyzed in this test. Measure-

ments therefore were judged to have limited value in identification.

This finding is supported strongly by evidence other than results of the attempt at cluster analysis. Female *Callinectes* attain sexual maturity in a terminal metamorphic molt. Males attain an adult conformation at sexual maturity but may continue to molt at reduced frequency. Van Engel (1958) and others have shown that *C. sapidus* females molt 18 to 20 times in attaining maturity, males 18 or 19 before becoming mature and 3 or 4 times beyond that stage. The range of variation in number of molts may be much greater than this, for both dwarf and giant sexually mature individuals are known. Allometric changes accentuated at the two ends of this continuum attest to wide variability in form. Estévez (1972) emphasized variability in *C. arcuatus* and *C. toxotes*. Tables 1 and 2 show means, standard deviation, and sample size for selected characters from adult male and female *Callinectes* species. For almost all species the coefficient of variation ( $V = 100s/x$ ) is high for all characters shown, an indication that morphometrically there is great variation in the group. Simpson, Roe, and Lewontin (1960:91) stated that  $V$  values greater than 10

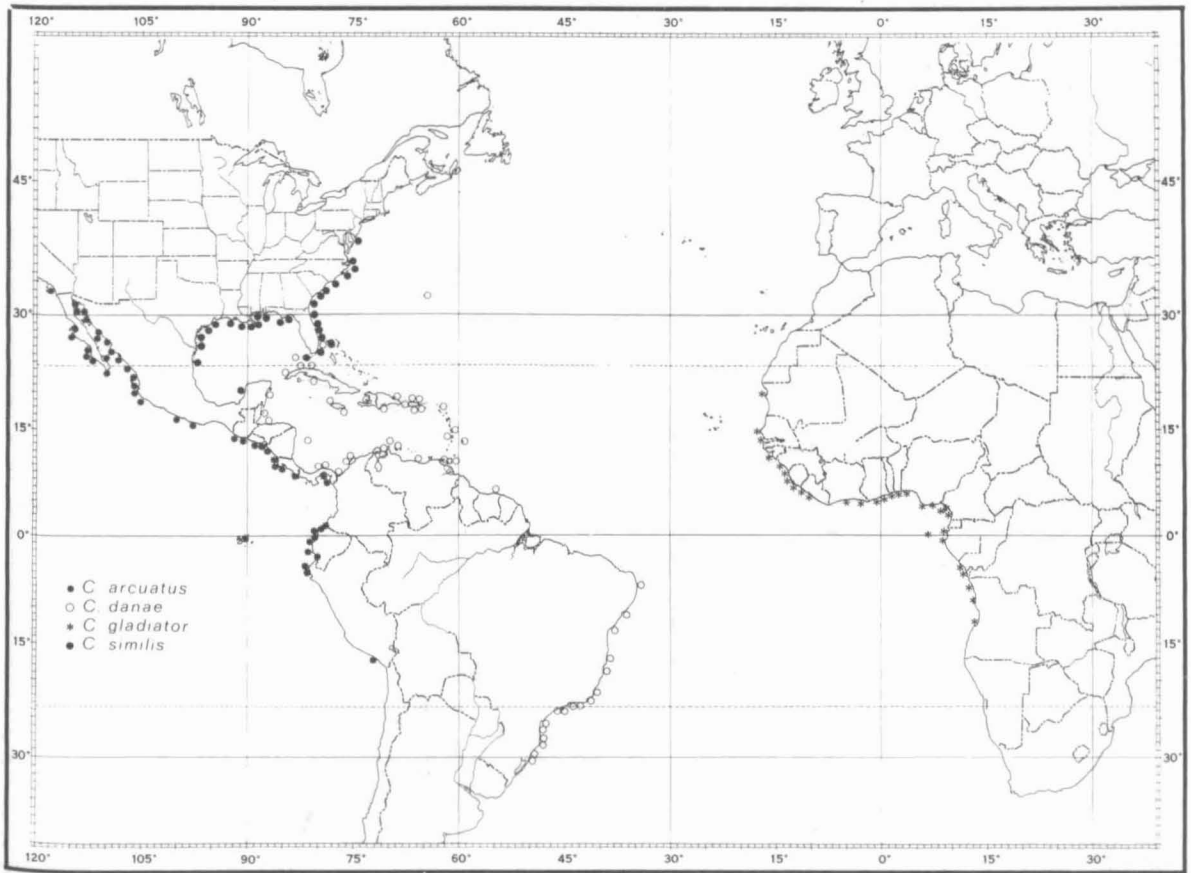


FIGURE 24.—Respective geographic distributions of *Callinectes arcuatus* Ordway, *C. danae* Smith, *C. gladiator* Benedict, and *C. similis* Williams in the Atlantic and eastern Pacific oceans based on specimens studied and verified published records.

indicate that a sample is not reasonably unified. Throughout the genus great variation in morphology of the body makes keys for identification involving proportions almost impossible to devise unless qualified by exceptions.

From a different viewpoint, Stephenson et al. (1968) applied methods of numerical analysis to 44 species and putative subspecies of *Portunus* (mainly from America, but certain Indo-Pacific species for comparison), *Callinectes*, *Arenaeus*, and *Scylla*, relying on presence or absence of 57 characters to build up a data matrix from which character assessments could be made. The method nicely demonstrates that *Callinectes* is a very homogeneous group, but the internal relationships implied do not correspond harmoniously with classical interpretation. This is not a matter of conflict, but simply one of judgment, the method seeming to be limited by interpretation of charac-

ter states, weighting being one serious problem and choice of characters another. Were the analysis run with different emphases, results might reflect those to some extent.

### LARVAL DEVELOPMENT

Among *Callinectes* species, larval development of only *C. sapidus* and *C. similis* has been determined by hatching eggs and rearing in the laboratory. Costlow, Rees, and Bookhout (1959) and Costlow and Bookhout (1959) described seven zoeal stages, atypically an eighth, and a megalopa for *C. sapidus*. Larvae and megalopae of the two species are apparently almost identical, the stages being similar to those of other portunids (Costlow and Bookhout, pers. commun.). Importantly, the megalopae of *Callinectes* lack an internal carpal spine on the chelipeds whereas megalopae of *Portunus* have a well-developed spine on this member

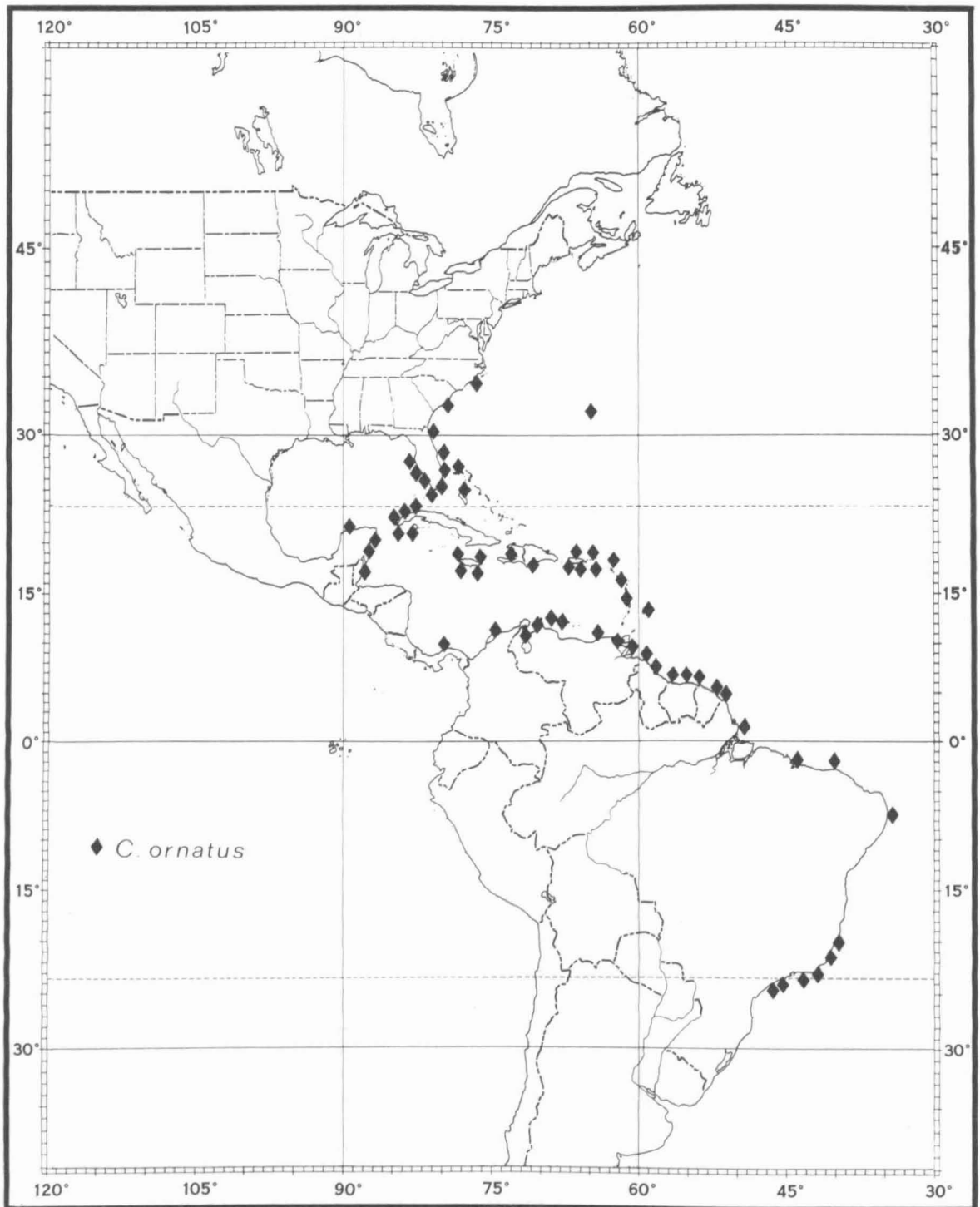


FIGURE 25.—Geographic distribution of *Callinectes ornatus* Ordway in the western Atlantic Ocean based on specimens studied and verified published records.

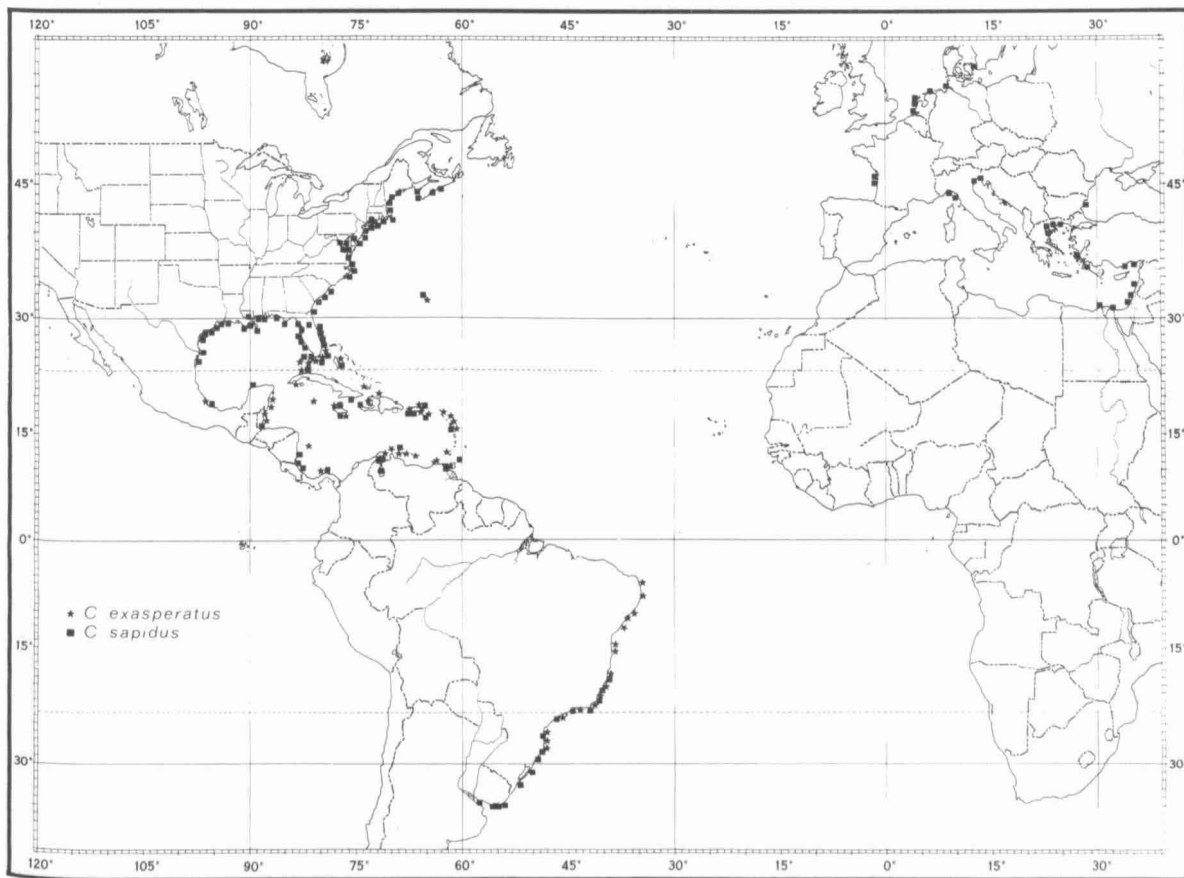


FIGURE 26.—Respective geographic distributions of *Callinectes exasperatus* (Gerstaecker) and *C. sapidus* Rathbun in the western Atlantic Ocean with introductions to the eastern Atlantic and Mediterranean Sea, based on specimens studied and verified published records.

(Williams, 1971), showing one of the generic distinctions at an early phase of development.

Costlow (1965, 1967) followed the early work on larvae with a series of experimental studies showing that development of *C. sapidus* is subject to variation both in staging and duration. Total development time of *C. sapidus* from hatching of egg to transformation of the megalopa to first crab stage has varied from 31 to 69 days in the laboratory in various combinations of salinity and temperature, but duration of individual stages is variable even in a single salinity-temperature combination. The stages are constant enough, however, that Van Engel (1958), Cargo (1960), Nichols and Keney (1963), Pinschmidt (1964), Tagatz (1968), More (1969), and Williams (1971) were able to identify zoeae or megalopae from nearshore oceanic and estuarine plankton. In nature as in experiments, development time may be extended

by environmental conditions. Megalopae have been found throughout the year in North Carolina estuaries.

## FOSSIL RECORD

Hard parts of portunids most abundant as fossils in Tertiary formations in eastern North and Middle America are portions of the chelipeds, usually the dactyls and portions of the propodi. Some deposits contain remains of carapaces and/or sterna, occasionally almost whole exoskeletons of crabs, but any of the remains are scarce. It was largely on the basis of cheliped fragments that Rathbun (1919a, b, 1926, 1935) listed and described *Callinectes* species from formations attributed to ages as old as the Oligocene. Withers (1924) described a fragment of chela from the Eocene of Jamaica as *Callinectes*, and Blake (1953) added information

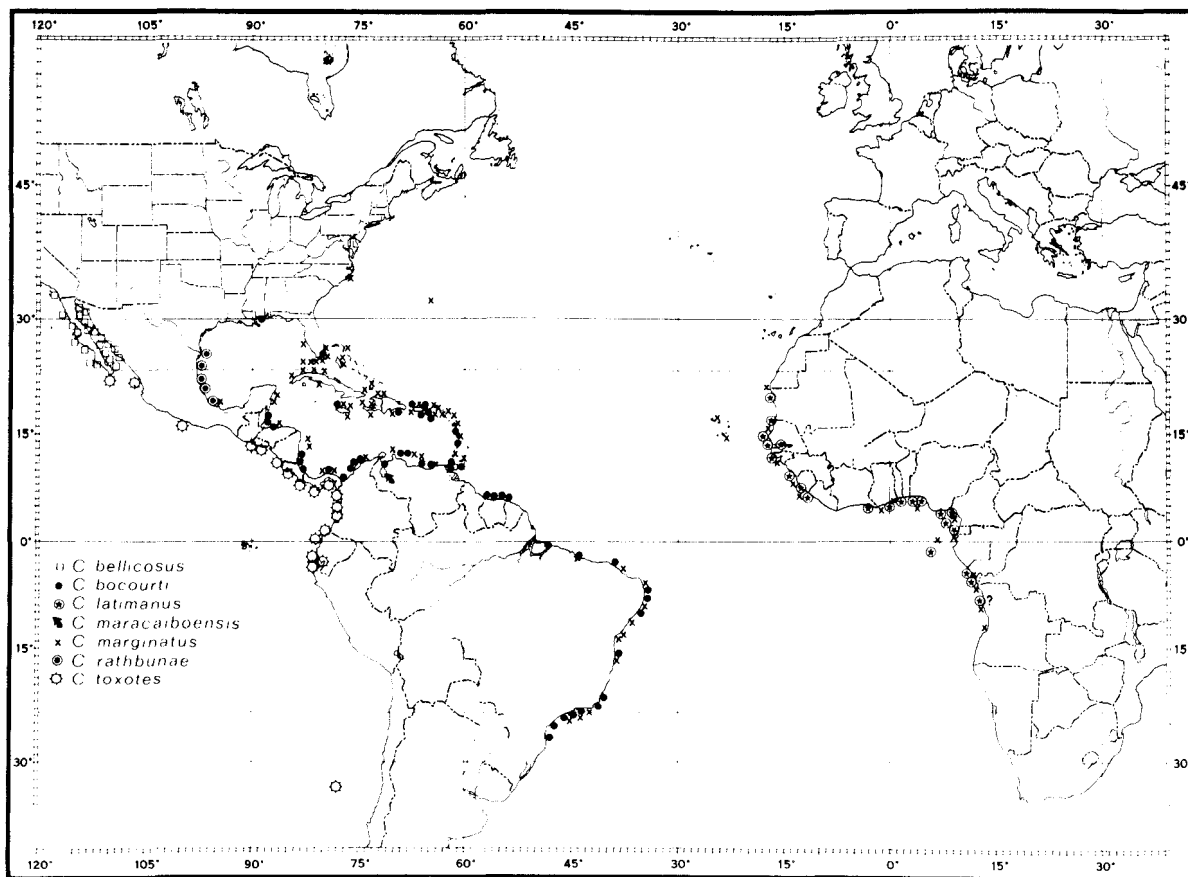


FIGURE 27.—Respective geographic distributions of *Callinectes bellicosus* Stimpson, *C. bocourti* A. Milne Edwards, *C. latimanus* Rathbun, *C. marginatus* (A. Milne Edwards), *C. maracaiboensis* Taisson, *C. rathbunae* Contreras, and *C. toxotes* Ordway in the Atlantic and eastern Pacific oceans based on specimens studied and verified published records.

on remains from the Quarternary. Williams (1965) uncritically accepted determinations for Atlantic and Gulf Coastal Plain records from the Miocene to Recent, but study of this material, even though its interpretation is beyond the scope of the present paper, leads to an attitude of restraint.

The characters by which *Callinectes* is distinguished from other portunid genera, shape of male abdomen and lack of an internal carpal spine on the chelipeds, are rarely evident in the fossil material, the only undoubted specimens (treated in species accounts below) coming mainly from Pleistocene and a few Miocene horizons. All others studied lack characters for positive first order identification and therefore their determinations rest on secondary features such as shape of the chelae or other nondiagnostic parts of the body. Although the numerous cheliped fragments most resemble these parts in living species of *Cal-*

*linectes*, they also resemble those of *Ovalipes* and certain *Portunus*, especially the large *P. pelagicus* and *P. sanguinolentus* distributed widely in the Indo-Pacific region today (Stephenson, 1962), as well as the robust *Arenaeus cribrarius* and *A. mexicana*, respectively from Atlantic and Pacific shores of the Western Hemisphere (Rathbun, 1930). A single propodal finger of a form attributed to *P. sayi* reported from the Miocene of Florida (Rathbun, 1935) greatly resembles other remains attributed to *Callinectes*. Margins of warmer seas of early and mid Tertiary (Ekman, 1953; Hazel, 1971) could have favored such forms or others like contemporary *Scylla* of Indo-Pacific waters, fossil representatives of which were described [=?] by Rathbun (1919b, 1935) from the Miocene of Florida, Dominican Republic, and Mexico. Judging by ecological requirements of living species, *Callinectes* would have been well



adapted to such an environment, but fossil evidence for its existence in the Paleocene remains indirect.

There are constant structural differences between the early fossil series and modern *Callinectes*. The palms of chelae of *C. jamaicensis* Withers, 1924 (Eocene), *C. alabamensis* Rathbun, 1935 (Oligocene), *C. declivis* Rathbun, 1919a (lower Miocene), and *C. reticulatus* Rathbun, 1919a (Oligocene-lower Miocene) are short and faceted more like *Callinectes* than other living genera of portunids, but they are relatively thinner than in living members of the genus. The fingers in these early forms have length-width proportions and tooth arrangements that resemble modern *C. sapidus*, but the tooth rows are relatively narrower proximally on propodal fingers and less inclined toward development of a molariform crushing surface. Of the four external facets on the palm, the upper mesial one in the fossil series is always inclined downward toward the inner surface in major chelae whereas in modern *Callinectes* species it is nearly horizontal in the major chela and noticeably inclined downward only in the minor one; moreover, the third or dorsolateral facet is relatively wider in living *Callinectes* species than in any of the early fossils. Compression and erosion may have altered relief but not uniform angle of inclination of facets in the fossils. Generally, fossils older than early-mid Miocene attributed to *Callinectes* have less powerful chelae than living species and these differences in structure seem significant enough to warrant generic separation of the two series when more material comes to light.

## MODERN DISTRIBUTION

Confined almost exclusively to shallow, often brackish coastal waters as adults, the genus *Callinectes* is represented by six species distributed (Figures 24-27) around the Caribbean Sea and southward to southern Brazil: *C. marginatus*, *ornatus*, *danae*, *exasperatus*, *bocourti*, and *sapidus*. A seventh species, *C. maracaiboensis*, is localized in estuaries of Venezuela. One of these species, *C. marginatus*, bridges the Atlantic, ranging with *C. gladiator* and *C. latimanus* from Mauritania to Angola in West Africa. It also reaches the Cape Verde Islands. Only three species occur in the Gulf of Mexico, exclusive of the southeastern part off Florida: *C. rathbunae*, an isolated relative of *C. bocourti* in the western Gulf, *C. similis*, an essen-

tially Carolinian form ranging northward along the coast, and *C. sapidus*, which ranges far beyond, occasionally to the Maritime Provinces of Canada. In the eastern Pacific, disregarding distant island occurrences, *C. arcuatus* is distributed from extreme southern California to Peru, sharing its range with *C. bellicosus* in the region of Baja California and with *C. toxotes* from there south.

If one relies on structure of male first gonopods alone for estimation of morphological similarity, the following zoogeographical associations emerge. The set of species with short first gonopods (*C. marginatus*, *gladiator*, *ornatus*, and *similis*) has separate eastern and western Atlantic components, and one member on both sides of the tropical Atlantic. The second set with longer first gonopods (*C. arcuatus*, *bellicosus*, *danae*, and *exasperatus*) occurs in the tropical western Atlantic and eastern Pacific. The third set with quite long first gonopods (*C. toxotes*, *bocourti*, *rathbunae*, *maracaiboensis*, *latimanus*, and *sapidus*) has representatives in all regions. Distributions of all species fit patterns accepted by Ekman (1953:30, ff.) as representative of many along the tropical-subtropical Atlantic and east Pacific coasts, but one, *C. sapidus*, has a latitudinal range that seems to exceed this pattern. In this species, development of a northern and southern form may be in progress.

The amphi-Atlantic distribution of *C. marginatus*, records of *C. exasperatus*, *marginatus*, *ornatus*, and *sapidus* from Bermuda, *C. arcuatus* from the Galápagos Islands, *C. toxotes* from Juan Fernández, as well as less removed northern marginal records for essentially southern species along the North American continent (*C. bocourti* in southern Florida and Mississippi; *C. marginatus* in North Carolina; *C. similis* in New Jersey; *C. sapidus* in Nova Scotia) all point to extensions of range by larval transport in currents (Verrill, 1908b; Garth, 1966). Investigators working with larval stages (reviewed in Williams, 1971) suggest that larvae and megalopae can move considerable distances; zoeae have been found off St. Johns River, Fla., at stations up to 160 km, and megalopae in the same area up to 128 km from shore. In Chesapeake Bay and Pamlico Sound, N.C., megalopae have been found 170 and 100 km respectively from presumed points of entry to the estuarine systems. Most of this off-and-onshore movement of larval stages appears to be a homeostatic developmental feature in the life

histories of the species. Among spiny lobsters, whose larvae are seemingly better fitted for temporary pelagic existence than crab larvae because of leaflike shape, up to 6 mo or greater duration of larval life occurs (Lewis, 1951; Austin, 1972). Phyllosomas of some spiny lobsters are rarely found beyond the latitudinal geographic limits of the coastal adult population. George and Main (1967) attributed this result to behavioral responses of the larvae, vertical migration, etc., within prevailing current systems which act to preserve integrity of distribution, but Austin (1972) held open the idea of long distance transport over considerable lengths of time. Some dispersal of larvae at the fringes of less pelagic *Callinectes* populations obviously occurs, but the wanderers are at a competitive disadvantage in establishing temporary range extensions. Nevertheless, larval dispersal of *Callinectes* coupled with movement of adults, judged to be minor except within an estuarine system (Fischler and Walburg, 1962; Tagatz, 1968), seems to assure genetic continuity over broad areas.

If one accepts the tenet that the center of evolution for a group contains the largest number of species, Neotropical Atlantic American shores seem to be the primary center in which the genus *Callinectes* developed and from which it radiated. Fossil evidence indicates that this radiation took place in the Tertiary, a period of time in which land-water relationships of that region diverged widely from their positional and areal extent today (Woodring, 1966, 1971). Olsson (1972) regarded the Miocene as the time when Panamanian molluscan biotas related to those of today evolved under conditions of general subsidence and when parts of present day Central America were reduced to an archipelago of large islands separated by straits between the Caribbean and east Pacific. Ekman (1953), Fell (1967), and others regarded the marine fauna that evolved in this region as an impoverished western outpost of the Tethyan fauna, related most closely to that of the eastern Atlantic and southern Europe. Though the tropical Atlantic and neighboring east Pacific regions both shared in the radiation of *Callinectes*, the conservatism of this offshoot contrasts remarkably with the far richer divergence of its parent stock. Stephenson (1962) considered the Indo-Pacific, with 175 living species, as the germinal center for the Portunidae. It seems reasonable to view *Callinectes* as a portunid group evolving at the geographic limits of the family,

specializing in occupation of estuaries, and paralleling in many ways the heavy-bodied Indo-Pacific *Scylla serrata* (Stephenson, 1962).

If *Callinectes* evolved mainly in the Caribbean faunal province, the present distribution of species in essentially three isolated centers raises questions concerning dispersal. Separation of the east Pacific from the Caribbean by elevation of the Panamanian isthmus near the close of the Tertiary understandably isolated certain elements of the genus and may have promoted further radiation, but close relationship of species in the two areas is emphasized by an obvious geminate pair—*danae-arcuatus*—similar in a number of morphological features, which occurs today on east and west coasts of Middle and South America. Separation of the east and west Atlantic fragments of the genus is harder to resolve because not only does one species bridge this gap, but two species groups (short and long first gonopods) are represented on both sides of the ocean, seemingly specialized along the same general lines. Which is the ancestral stock? Were pelagic larvae the mechanism of transport, as Fell (1967) proposed for analogous but cold-tolerant echinoderms, perhaps aided by island stepping stones in the mid Atlantic? (Fell rejected continental drift as a plausible explanation for transport, an idea more acceptable today than it was in 1967, but involving a time span greater than concerned here [McKenzie, 1972].) Length of life of the larvae of most species of *Callinectes* under pelagic conditions remains unknown. West Africa is upstream from the Western Hemisphere in prevailing equatorial surface currents. It seems unlikely that the larvae could move counter to this current from a center in the west or survive the much longer (and today, colder) northern transit from the West Indies via the Gulf Stream beyond Bermuda to the Azores, Canaries, and finally to west Africa. So far as known, all *Callinectes* utilize estuaries during part of their lives. Populations on small islands may be nonbreeding, transitory implants, or unsuccessful breeders. Means and paths of long-distance transport, and effectiveness of transients in colonization, among these forms will remain unknown until more data are collected.

Finally, the clustering of species by numerical methods employed by Stephenson et al. (1968) does not reflect the three groups suggested by first gonopod types, but it does support classical interpretation setting *C. marginatus* and perhaps *C. gladiator* aside as the most peripheral morpholog-

ically. It suggests that the three west American species, *C. arcuatus*, *bellicosus*, and *toxotes* differ appreciably from each other and that they arose from eastern American ancestors. It also supports the idea that most of the postulated "central" species occur in the Atlantic and that "it is conceivable that the group originated from an eastern American ancestor." Beyond this the results are less compatible with conclusions reached here, but the analysis was done without including *C. similis* which may be a linking form that would have changed the interpretation.

### SPECIES ACCOUNTS

In the species accounts that follow, the synonymies include only citations of works that primarily are concerned with descriptive, taxonomic, or zoogeographic information. The reason for this limitation is that commercially valuable species often have a voluminous literature. All inclusive synonymies for them become so unwieldy that the real purpose—taxonomic history of the species—becomes obscured. The descriptions also are limited because full descriptions are elsewhere in the literature.

Two features included in the descriptions need clarification. The term "metagastric area" is employed for the central trapezoidal area of the carapace in the sense Chace and Hobbs (1969) used it rather than the term "intramedial area" employed by others (cf. Rathbun, 1930; Williams, 1966). Strictly speaking, this region of the carapace includes the undifferentiated metagastric (over 90%) and at least part of the shortened urogastric (less than 10%) areas, but for all practical purposes the first term is sufficiently explicit. The number of anterolateral teeth in *Callinectes* is nine (Rathbun, 1930), but the first of the series is also known as the outer orbital tooth and the last as the lateral spine. This partition of the series is observed here. The first and last teeth are always named and the small teeth are numbered.

Abbreviations adopted for institutions loaning study material are: AHF, Allan Hancock Foundation, University of Southern California; AMNH, American Museum of Natural History, New York; ANSP, Academy of Natural Sciences of Philadelphia; BMNH, British Museum (Natural History), London; MCZ, Museum of Comparative Zoology, Harvard; MNB, Museu Nacional, Rio de Janeiro; MNHNP, Museum National d'Histoire Naturelle, Paris; RMNH, Rijksmuseum van Natuurlijke

Historie, Leiden; SADZ-B, Secretaria da Agricultura, Departamento Zoologia, São Paulo; UNC-IMS, University of North Carolina, Institute of Marine Sciences, Morehead City; USNM, National Museum of Natural History, Washington, D.C.; YPM, Peabody Museum of Natural History, Yale University, New Haven, Conn.

Supplementary literature records are occurrences not represented by specimens studied, but accepted on basis of supporting data.

### GENUS *CALLINECTES* STIMPSON, 1860

*Callinectes* Stimpson, 1860, p. 220 [92].- Rathbun, 1896, p. 349 (revision).- 1921, p. 394 (review of African species).- 1930, p. 98 (review of Western Hemisphere species).- not Chen, 1933, p. 95 (= *Portunus*?).- Monod, 1956, p. 204 (review of African species).- Garth and Stephenson, 1966, p. 42 (review of eastern Pacific species).

*Description.*—Portunid crabs lacking an inter-nal spine on carpus of chelipeds. Abdomen of males broad proximally, narrow distally, roughly T-shaped; first segment broad, almost hidden; second segment broad, slightly overlapping coxae of fifth pereopods at each side; third-fifth segments fused and tapering sinuously from broad third to distally narrow fifth; sixth segment elongate and narrow; telson ovate with acute tip. Abdomen of females exhibiting two forms: immature females with abdomen triangular from fourth segment to tip of telson, segments fused; mature females with abdomen broadly ovate (excluding telson), segments freely articulated; first segment almost hidden; second and third segments slightly overlapping coxae of fifth pereopods at each side; fifth and sixth segments with greatest sagittal length; sixth segment narrowing distally in irregular broad arc to articulate with triangular telson. Abdomen and telson of both sexes reaching anteriorly beyond suture between thoracic sternites IV and V.

*Type species.*—*Callinectes sapidus* Rathbun, 1896, by designation of International Commission of Zoological Nomenclature (1964:336).

*Gender.*—Masculine.

*Number of species.*—Fourteen, which may be distinguished by the following keys.

KEY TO SPECIES OF *CALLINECTES* (EXCLUDING JUVENILES)

## Figures 3-17

- |  |                        |
|--|------------------------|
| 1. Front with two prominent, broad based, triangular teeth between inner orbitals; each with or without rudimentary submesial tooth on mesial slope (Atlantic; Western Hemisphere, introduced in Europe) . . . . .   | <i>sapidus.</i>        |
| 1'. Front with four teeth between inner orbitals, or two prominent lobulate or narrowly triangular teeth separated by a nearly plane space often bearing a pair of rudimentary submesial teeth . . . . .   | 2                      |
| 2. Submesial pair of frontal teeth well developed and more than half as long as lateral pair (measuring from base of lateral notch between teeth) . . . . .  | 3                      |
| 2'. Frontal teeth decidedly unequal in size, submesial pair no more than half as long as lateral pair (measuring from base of lateral notch between teeth), or vestigial . . . . .   | 8                      |
| 3. Four frontal teeth reaching nearly common level . . . . .   | 4                      |
| 3'. Submesial frontal teeth definitely falling short of lateral pair . . . . .   | 7                      |
| 4. Four frontal teeth lobulate, not triangular (Pacific; Baja California-Juan Fernández)   | <i>toxotes.</i>        |
| 4'. One or both pairs of frontal teeth triangular . . . . .  | 5                      |
| 5. Four frontal teeth with rather rounded tips, lateral pair more broadly triangular than submesial pair and with mesial side having more oblique slope than lateral side . . . . .  | 6                      |
| 5'. Four frontal teeth acute, lateral pair usually broader than submesial pair (Atlantic; Mexican Gulf coast) . . . . .  | <i>rathbunae.</i>      |
| 6. Anterolateral teeth trending forward, their anterior margins shorter than posterior; vestiges of reddish color usually persisting in preserved specimens (except long-preserved ones); distal border of sixth abdominal segment in mature females broadly triangular (Atlantic; Caribbean-South America) . . . . .                                | <i>bocourti.</i>       |
| 6'. Anterolateral teeth directed outward, their tips acuminate and margins shouldered at least in anterior portion of row; vestiges of greenish color usually persisting in preserved specimens (except in long-preserved ones); distal border of sixth abdominal segment in mature females semiellipsoid (Atlantic; Venezuelan estuaries) . . . . . | <i>maracaiboensis.</i> |
| 7. Granules on ridges and crests of chelae coarse and well separated (Atlantic; Caribbean-South America) . . . . .   | <i>exasperatus.</i>    |
| 7'. Granules on ridges and crests of chelae moderate to fine and closely crowded, often worn smooth in adults (Atlantic; West Africa) . . . . .  | <i>latimanus.</i>      |
| 8. Carapace remarkably smooth, lines of granules visible but barely perceptible to touch (except epibranchial line variably prominent) . . . . .   | 9                      |
| 8'. Carapace not so smooth, scattered granules and lines of granules quite evident to sight and touch . . . . .  | 10                     |
| 9. Submesial pair of frontal teeth vestigial (Pacific; Baja California and Golfo de California)  | <i>bellicosus.</i>     |
| 9'. Submesial pair of frontal teeth small but definitely formed (Atlantic; United States-Gulf of Mexico) . . . . .   | <i>similis.</i>        |
| 10. Carapace coarsely granulated; all anterolateral teeth except first two curved forward, without shoulders (Atlantic; Bermuda-Florida-South America-West Africa) . . . . .   | <i>marginatus.</i>     |
| 10'. Carapace finely granulated; only last or last two anterolateral teeth curved forward, remainder with shoulders . . . . .  | 11                     |
| 11. Submesial pair of frontal teeth absent or vestigial (Atlantic; Bermuda-North America-South America) . . . . .  | <i>ornatus.</i>        |
| 11'. Submesial pair of frontal teeth never vestigial, but no more than half length of lateral pair . . . . .   | 12                     |
| 12. Lateral spine almost always less than three times length of preceding anterolateral tooth; tips of anterolateral teeth forming a decided arc; males with distal portion of first gonopods almost straight . . . . .  | 13                     |

- 12'. Lateral spine almost always three or more times length of preceding anterolateral tooth; at least second to fifth anterolateral teeth with tips in a nearly straight line; males with distal portion of first gonopods S-curved (Atlantic; West Africa) . . . . . *gladiator*.
13. First gonopods of mature males with subterminal dorsal setae never more than four in number, often inconspicuous or missing (Atlantic; Caribbean-South America) . . . . . *danae*.
- 13'. First gonopods of mature males with subterminal dorsal row of setae numbering more than four (Pacific; Southern California-Peru; Galápagos Islands) . . . . . *arcuatus*.

## KEY TO MATURE OR NEARLY MATURE MALE *CALLINECTES* BASED PRIMARILY ON FIRST GONOPODS

### Figures 18-21

1. Tips of gonopods falling well short of suture between thoracic sternite VI and mesially expanded sternite VII . . . . . 2
- 1'. Gonopods reaching to, almost to, or beyond suture between thoracic sternite VI and mesially expanded sternite VII . . . . . 5
2. Gonopods well separated from each other, never touching or crossed . . . . . 3
- 2'. Gonopods overlapping each other, often crossed . . . . . 4
3. Gonopods slender distally, nearly straight, tips bent slightly mesad (Atlantic; United States-Gulf of Mexico) . . . . . *similis*.
- 3'. Gonopods fairly stout distally, angled toward midline, then abruptly bent forward in a short slender terminal extension (Atlantic; Bermuda-Florida-South America-West Africa) . . . . . *marginatus*.
4. Tips of gonopods lanceolate, continuing in line with shaft, portion proximal to tip armed with short backward pointing spines quite visible at low magnification (Atlantic; Bermuda-North America-South America) . . . . . *ornatus*.
- 4'. Tips of gonopods not lanceolate, curved mesad, spines on S-curved shank exceedingly small at low magnification (Atlantic; West Africa) . . . . . *gladiator*.
5. Tips of gonopods curved abruptly mesad (Atlantic; Caribbean-South America) . . . . . *exasperatus*.
- 5'. Tips of gonopods not curved abruptly mesad . . . . . 6
6. Slender portion of gonopods almost straight, minutely spined (under magnification), tips almost always bent ventrolaterally, never extending beyond abdominal locking tubercle on thoracic sternite V . . . . . 7
- 6'. Slender portion of gonopods definitely curved or sinuous, variously spined, tips never bent ventrolaterally . . . . . 8
7. Gonopods with subterminal dorsal setae never more than four in number, often inconspicuous or missing (Atlantic; Caribbean-South America) . . . . . *danae*.
- 7'. Gonopods with subterminal dorsal row of setae numbering more than four (Pacific; Southern California-Peru; Galápagos Islands) . . . . . *arcuatus*.
8. Tips of gonopods reaching well beyond abdominal locking tubercle on thoracic sternite V . . . . . 9
- 8'. Tips of gonopods not reaching beyond abdominal locking tubercle on thoracic sternite V (Pacific; Baja California and Golfo de California) . . . . . *bellicosus*
9. Slender portion of gonopods with spinules small under magnification and most dense near middle, absent near tip (Pacific; Baja California-Juan Fernández) . . . . . *toxotes*.
- 9'. Slender portion of gonopods with spinules readily visible at low magnification and distributed to tip . . . . . 10
10. Gonopodal spines arranged in a broad dorsolateral band . . . . . 11
- 10'. Gonopodal spines arranged in a single, rather uneven dorsolateral row (a few tiny spines lying outside row) (Atlantic; Western Hemisphere, introduced in Europe) . . . . . *sapidus*.
11. Tips of all frontal teeth reaching same level . . . . . 12
- 11'. Submesial pair of frontal teeth definitely shorter than lateral pair (Atlantic; West Africa) *latimanus*.

12. Four frontal teeth with rather rounded tips, lateral pair more broadly triangular and with mesial side having more oblique slope than lateral side ..... 13
- 12'. Four frontal teeth acute, lateral pair usually broader than submesial pair (Atlantic; Mexican Gulf coast) ..... *rathbunae*.
13. Anterolateral teeth trending forward, their anterior margins shorter than posterior; vestiges of reddish color usually persisting in preserved specimens (except long-preserved ones); (Atlantic; Caribbean-South America) ..... *bocourti*.
- 13'. Anterolateral teeth directed outward their tips acuminate and margins shouldered at least in anterior portion of row; vestiges of greenish color usually persisting in preserved specimens (except in long-preserved ones); (Atlantic; Venezuelan estuaries) ..... *maracaiboensis*.

## CALLINECTES MARGINATUS

(A. MILNE EDWARDS)

Figures 3, 18a, 20a, 22b, 27

*Neptunus marginatus* A. Milne Edwards, 1861, p. 318, pl. 30, fig. 2 (syntypes: 3 ♀ dry, MNHNP 895-1S, 895-2S, 896, Gabon).

*Callinectes larvatus* Ordway, 1863, p. 573 [8] (syntypes: 1 ♂, MCZ 5147, Tortugas, Fla., USA; 3 ♂, 1 ♀, MCZ No. 5151, Key West, Fla., USA; 3 ♂ MCZ 5152, Bahamas; 1 ♂, 1 juv ♀ [not ♂], MCZ 5155, Jeremie, Haiti).- Smith, 1869, p. 9.- A. Milne Edwards, 1879, p. 225 (var. of *C. diacanthus*).- Rathbun, 1896, p. 358, pl. 18, pl. 24, fig. 5; pl. 25, fig. 4; pl. 26, fig. 4; pl. 27, fig. 4.- Rankin, 1898, p. 232.- Young, 1900, p. 188 (var. of *C. diacanthus*).- Doflein, 1904, p. 99.

*Neptunus diacanthus*.- Brocchi, 1875, pl. 16, fig. 76 [?].- de Man, 1883, p. 150.- Pfeffer, 1890, p. 5, pl. 1, figs. 5, 6.

*Callinectes africanus* A. Milne Edwards, 1879, p. 229 (var. of *C. diacanthus*) (syntypes: MNHNP, Cape Verde Islands, not found in 1968).- A. Milne Edwards and Bouvier, 1900, p. 71 (var. of *C. diacanthus*) (not pl. 4, fig. 5 = *C. sapidus*).

*Callinectes larvatus* var. *africanus*? Benedict, 1893, p. 537.

*Neptunus (Callinectes) diacanthus*.- Ortmann, 1894, p. 77 (part; specimen b, Cuba).

*Callinectes marginatus*.- Rathbun, 1897, p. 149.- 1900a, p. 291.- 1900b, p. 142.- 1901, p. 48.- 1921, p. 395, text-fig. 2, pl. 19, fig. 1; pl. 20, fig. 1.- 1930, p. 123, figs. 15e, 16d, 17d, 18c, pl. 53.- 1933, p. 49.- 1936, p. 383.- de Man, 1900, p. 41, pl. 1, fig. 5 (juv ♀, not ♂).- Nobili, 1906, p. 305.- Gruvel, 1912, p. 3, 6, pl. 2, fig. 1.- Balss, 1921, p. 58.- Odhner, 1923, p. 21.-

Boone, 1927, p. 32.- Contreras, 1930, p. 235, fig. 6.- Vilela, 1949, p. 59.- Capart, 1951, p. 134, fig. 48.- Chace, 1956, p. 154.- Chace and Hobbs, 1969, p. 131, fig. 37d.- Monod, 1956, p. 208, figs. 238, 239.- Rossignol, 1957, p. 82.- Guinot and Ribeiro, 1962, p. 48.- Forest and Guinot, 1966, p. 65.- Taissoun, 1973, p. 39, figs. 4A, 5B, photo 7.

*Callinectes diacanthus*.- Young, 1900, p. 186 (part).

*Callinectes marginatus* var. *larvatus*.- Verrill, 1908a, p. 368, text-fig. 22b, pl. 18, fig. 1.

*Description*.—Carapace (Figure 3) bearing four frontal teeth, submesial pair no more than half length of lateral pair. Central trapezoidal (metagastric) area short, anterior width about 2.4 times length, posterior width about 1.5 times length. Anterolateral margins arched slightly; anterolateral teeth exclusive of outer orbital and lateral spine without shoulders, usually trending forward and anterior margins of all except first two concave, last two teeth spiniform. Lateral spine moderately long and slender. Surface coarsely granulate anterior to prominent epibranchial line and over mesobranchial regions, more finely and closely granulate on proto- and mesogastric areas, prominent branchial lobes, and especially on cardiac lobes; posterior and posterolateral margins smooth.

Chelipeds with smoothly granulate prominent ridges on propodi and reduced ones on carpi; fingers compressed but broadened dorsoventrally producing a pointed spatulate shape; major chela with usual enlarged proximal tooth on dactyl opposing propodal molariform complex, propodus often with decurved lower margin.

Male abdomen and telson narrow, reaching slightly beyond suture between sternites IV and V; telson about 1.8 times longer than wide; sixth

TABLE 1.—Mean measurements ( $\bar{x}$ ) in mm, with standard deviations ( $s$ ) and sample sizes ( $N$ ), of selected characters for adult male *Callinectes*. Refer to Figures 1 and 2 for illustration of measurements.

Measurements	<i>arcuatus</i>			<i>bellicosus</i>			<i>bocourti</i>			<i>danae</i>			<i>exasperatus</i>			<i>gladiator</i>			<i>latimanus</i>		
	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$
Length	42.3	± 7.4	74	58.5	± 17.0	28	55.0	± 9.0	46	46.5	± 5.8	84	52.6	± 7.0	54	35.0	± 6.3	23	53.9	± 10.4	27
Width																					
incl. lat. spines	94.0	18.7	75	118.3	33.7	28	109.3	20.0	45	108.7	14.7	84	101.6	14.0	54	87.0	15.4	23	112.8	23.2	26
base lat. spines	74.5	13.9	75	104.5	31.0	28	94.5	15.7	45	83.4	10.7	84	89.2	12.2	54	65.3	11.7	23	96.3	22.6	27
Max. height	24.6	4.5	74	33.4	9.5	25	31.9	5.2	45	25.8	3.4	84	31.6	4.4	54	20.8	4.2	23	32.1	12.0	27
Metagastric																					
ant. width	17.18	3.08	74	24.59	7.22	25	19.73	3.48	46	18.91	2.48	84	21.40	2.96	54	14.4	2.70	23	20.10	4.28	27
length	7.08	1.38	74	8.97	2.85	25	9.95	1.74	46	7.71	1.12	84	9.03	1.39	54	5.52	1.10	23	9.74	2.12	27
post. width	9.41	1.72	74	14.16	3.96	26	10.42	1.85	46	10.92	1.50	84	11.25	1.66	54	8.34	1.65	23	10.35	2.13	27
Telson																					
length	5.12	0.89	66	6.97	1.88	27	9.82	1.84	44	5.51	0.83	82	6.63	1.04	52	4.39	0.72	23	9.72	1.88	26
width	3.37	0.51	67	4.57	0.92	27	4.86	0.61	44	3.73	0.62	81	4.40	0.82	52	2.73	0.41	23	5.13	0.83	26

Measurements	<i>maracaiboensis</i>			<i>marginatus</i>			<i>ornatus</i>			<i>rathbunae</i>			<i>sapidus</i>			<i>similis</i>			<i>toxotes</i>		
	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$	$\bar{x}$	$s$	$N$
Length	57.8	± 7.8	11	42.6	± 6.4	82	41.6	± 7.8	81	52.8	± 5.2	5	63.2	± 13.9	65	43.3	± 5.8	26	71.3	± 11.6	24
Width																					
incl. lat. spines	113.7	16.8	11	93.8	14.7	82	91.2	16.4	80	112.8	13.4	5	142.8	35.2	65	97.6	13.1	26	153.1	27.5	24
base lat. spines	97.8	12.7	11	77.5	12.5	82	72.5	14.0	81	92.2	9.4	5	115.1	26.3	65	75.7	10.4	26	125.9	21.9	24
Max. height	33.1	4.2	11	24.6	3.8	81	23.6	4.8	81	30.4	3.4	5	36.4	8.5	61	23.5	3.2	26	39.8	6.3	24
Metagastric																					
ant. width	21.21	2.64	8	17.05	2.74	82	18.75	3.95	81	18.92	2.73	5	23.60	5.32	65	18.64	2.94	26	25.53	4.25	24
length	8.81	3.66	9	7.11	1.22	82	6.57	1.30	81	9.30	1.09	5	10.60	2.59	65	6.81	1.04	26	12.14	2.07	24
post. width	8.15	4.04	8	10.60	1.49	82	11.49	2.07	81	9.80	1.54	5	12.85	2.89	65	11.09	1.55	26	12.11	2.12	24
Telson																					
length	14.08	1.23	11	5.74	1.18	79	4.99	1.02	78	9.56	0.95	5	9.95	2.42	65	5.25	0.75	26	10.91	1.71	23
width	6.07	0.44	11	3.19	0.59	79	3.04	0.54	78	4.74	0.44	5	5.66	1.23	65	3.65	0.37	26	5.93	0.68	23

TABLE 2.—Mean measurements ( $\bar{x}$ ) in mm, with standard deviations (s) and sample sizes (N), of selected characters for adult female *Callinectes*. Refer to Figures 1 and 2 for illustration of measurements.

Measurements	<i>arcuatus</i>			<i>bellicosus</i>			<i>bocourti</i>			<i>danae</i>			<i>exasperatus</i>			<i>gladiator</i>			<i>latimanus</i>		
	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N
Length	36.5	± 8.1	30	56.4	± 6.6	16	51.6	± 6.7	30	40.8	± 3.9	52	49.5	± 5.0	32	29.9	± 5.7	45	53.5	± 4.9	19
Width																					
incl. lat. spines	78.9	16.8	30	110.8	14.2	16	106.2	14.0	31	92.9	9.0	52	97.1	10.6	32	73.3	12.6	45	117.2	10.5	18
base lat. spines	62.9	14.0	30	97.0	12.1	16	88.1	11.3	31	71.7	7.1	51	82.8	8.6	32	54.8	10.1	45	94.5	9.0	19
Max. height	22.0	5.2	29	33.6	4.4	16	31.0	4.2	30	23.7	2.3	52	30.8	3.4	31	18.7	3.5	45	32.3	3.1	18
Metagastric																					
ant. width	16.02	3.34	29	24.70	2.85	15	19.76	2.90	30	17.57	1.78	52	21.90	2.18	32	13.03	2.11	44	20.94	3.99	19
length	6.34	1.46	29	9.43	0.96	15	9.72	1.27	30	7.00	0.81	52	8.85	1.01	32	4.93	1.10	44	10.05	1.06	19
post. width	9.14	1.98	29	14.38	1.30	15	10.90	1.75	30	10.47	1.13	52	11.85	1.30	32	7.65	1.21	44	11.67	1.10	19
Telson																					
length	4.19	1.01	30	6.92	0.97	16	7.76	1.19	29	4.94	0.56	50	6.25	0.79	31	3.65	0.94	45	8.03	0.97	19
width	4.39	0.95	30	7.02	0.75	16	6.53	0.83	29	5.04	0.50	50	6.54	0.80	31	3.77	0.92	45	7.12	0.63	19
Abd. seg. length																					
5th	7.04	1.75	30	11.84	1.69	16	10.70	1.56	30	8.03	1.37	51	10.63	1.28	32	6.14	1.59	45	11.09	1.18	19
6th	7.38	1.86	29	11.76	1.49	16	11.23	2.15	29	8.16	0.96	48	9.89	1.10	30	5.68	1.42	45	13.89	7.36	19

Measurements	<i>maracaiboensis</i>		<i>marginatus</i>			<i>ornatus</i>			<i>rathbunae</i>			<i>sapidus</i>			<i>similis</i>			<i>toxotes</i>		
	$\bar{x}$	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N	$\bar{x}$	s	N
Length	53.3	3	38.7	± 3.8	42	36.5	± 8.4	43	57.0	± 7.4	5	54.7	± 12.7	69	35.4	± 5.2	39	66.9	± 3.9	13
Width																				
incl. lat. spines	114.3	3	83.5	8.5	42	77.7	12.5	43	126.6	12.6	5	131.0	34.3	69	76.9	11.8	39	148.9	11.5	13
base lat. spines	91.7	3	68.9	6.9	42	29.5	4.8	43	101.6	12.0	5	99.4	24.1	68	60.9	9.0	39	117.9	7.6	13
Max. height	31.3	3	23.3	2.5	42	20.5	4.3	42	34.0	5.0	5	31.8	7.9	64	19.8	2.9	39	39.4	2.6	13
Metagastric																				
ant. width	20.40	3	16.23	2.46	41	16.86	2.96	42	22.88	3.36	5	21.66	4.97	69	15.77	3.09	39	25.80	1.92	13
length	9.53	3	6.69	0.80	41	5.88	1.04	42	10.12	1.34	5	9.38	2.39	69	5.70	0.89	39	12.00	0.69	13
post. width	11.23	3	10.24	1.33	41	10.46	1.97	42	12.64	2.46	5	12.13	2.67	69	9.67	1.41	39	13.10	1.03	13
Telson																				
length	8.20	3	5.11	0.56	40	4.24	0.86	43	8.24	1.51	5	7.94	1.91	67	4.08	0.70	39	9.48	0.64	13
width	7.10	3	4.91	0.53	40	4.27	0.81	43	7.36	1.06	5	7.03	1.52	67	4.48	0.55	39	8.16	0.76	13
Abd. seg. length																				
5th	11.27	3	7.93	0.93	41	6.70	1.46	43	12.52	1.86	5	12.09	2.99	66	7.10	1.11	39	13.88	1.32	13
6th	11.57	3	8.06	0.90	39	7.04	2.93	41	16.86	8.79	5	11.96	3.14	65	7.30	1.18	38	14.24	3.01	13



segment nearly parallel sided but somewhat broadened proximally. Mature female abdomen and telson reaching same level as in male, length slightly exceeding width (1.05 times); sixth segment longer than fifth. First gonopods of male (Figures 18a, 20a) short, reaching about mid-length of sternite VII, approximating each other or occasionally overlapping at level of sharp distal curve, distal portion abruptly curved laterad, tapered to a rather sharp point, twisted one-fourth turn on axis and, except for membranous spout-like tip, armed with minute scattered retrogressive spinules tending to arrangement in rows, a few spinules proximal to flexure. Gonopores of female (Figure 22b) ovate with apex on long axis directed anteromesad, aperture of each with margin irregularly rounded and sinuous except on mesial side where it slopes from surface laterad under superior anterior border.

*Size of carapace in mm.*—Largest male: length 67, width at base of lateral spines 118, including lateral spines 142. Largest female: length 49, width at base of lateral spines 82, including lateral spines 95. Mature size of females varies considerably, the smallest examined having a carapace length of 33 and width including lateral spines of 70. Summary of selected measurements is given in Tables 1 and 2.

*Color.*—Carapace brown with areas of bluish black. Chelae brown above; fingers dark on external face except for tips and proximal portion, internal face dark in distal two-thirds; dark color of fingers retained in preservation (in part from Rathbun, 1930, and pers. commun. from Charles A. Johnson). Milne Edwards and Bouvier (1900) gave essentially the same impression, characterizing the entire carapace, abdomen, external face of chelipeds, posterior legs, some areas of the walking legs with their marginal hairs as greenish brown and other parts of the appendages as a beautiful blue, but there is some confusion here because the colored plate accompanying this description (Plate 4, Figure 5) represents *C.apidus*. Rossignol (1957) described the carapace as marbled, and recently preserved material in alcohol sometimes does give an impression of mottled gray and white on the carapace.

*Variation.*—The carapace in *C. marginatus* shows a number of individual variations. The small anterolateral teeth generally trend forward,

but there is enough individual departure from this pattern to cause confusion. Teeth in the mesial part of the row trend forward more than those in the lateral part, the first three often being rounded while the last four are pointed. Small anterolateral teeth on syntype females in MNHNP do not definitely trend forward, and those on the syntype of *C. larvatus* (MCZ 5155) are well separated, with apices directed outward rather than hooked forward. There are differences, too, in width of the anterolateral teeth, a suggestion of narrower teeth in Brazil than in Florida, and broad teeth on some African material. Occasionally there is some iridescence along the anterolateral border, and often hairiness along the lower anterolateral border.

The inner orbital fissures are usually tightly closed, sometimes with a slight notch on the orbital border, but open in some African and Dutch West Indies (Aruba) material.

The anterolateral slopes have an arching concavity proximal to the bases of the anterolateral teeth and extending transversely behind the orbitofrontal region that is more pronounced than in other species of the genus. This is especially evident in mature females. The abdomen of immature males is flush with the sternum and relatively wider than in adults in which it is somewhat recessed. Among mature males, calcification is weak in the articulation between the fifth and sixth abdominal segments allowing definite flexure in this joint, but transverse ridges ("stops") on external exposed edges of the joint prevent doubling backward. The calcification pattern is well demonstrated in two mature males in USNM 4172 from Dominican Republic. Abdominal segment 6 is constricted at mid-length in some males. The abdomen of adult females resembles that of *C. ornatus*.

Sexual differences include a more tumid appearing body among females than males, an effect resulting partly from less produced lateral spines, as well as granulations on the carapace that are relatively more prominent than on males. Granules on the carapace sometimes are very coarse in front of the epibranchial line, but seldom as coarse behind as in front of this line. Inconspicuous spination on the male first gonopods in specimens from the Canal Zone of Panama, Honduras, Colombia, and Venezuela is not so strong nor dense as that in males from Florida where there is a suggestion that the scattered spines are in rows proximal to the distal bend; spination

seems entirely lacking in some Brazilian material.

This is the species that should be named "latimanus" because broad, spatulate, often strongly asymmetrical chelae occur on both juveniles and adults. The chelipeds often seem heavy for the size of the animal bearing them, but pronounced asymmetry is not universally present. Some individuals have both chelae basically alike except for size, and in almost all except juveniles the ventral side of the propodus (especially the major) is decurved in a wide sweep giving emphasis to the "spatulate" character. The proximal tooth on the dactyl of the major chela may be moderate but is often large in size and worn as shown in Figure 3a. Some juveniles with worn chelae have a gape between fingers of the minor as well as major chela along with development of a strong proximal tooth on the dactyls. Although similarity in chelae may indicate regeneration, there is no evidence that replacement has occurred.

*Habitat.*—Meager data recorded with specimens suggests that this species lives in a variety of shallow littoral environments probably seldom exceeding 15 m (rarely to 25 m [?]) and usually in much shallower water from intertidal pools to 3 m deep. Most specimens have been collected by hand, seine, dip net, etc., from sand and mud flats, algae and grass flats, sandy beaches, rocky pools, eroded coral bases, oyster bars, shallows at edge of mangroves, and at the surface under lights at night. A number of authors (Milne Edwards and Bouvier, 1900; Monod, 1956; Rossignol, 1957; Forest and Guinot, 1966; Coêlho, 1967a, b, 1970) have noted that *C. marginatus* is a coastal species limited to depths of a few meters, often in brackish water, but rather rare and never as abundant as other species of *Callinectes*. Capart (1951) found it on shallow mud bottoms in salinities varying from 7.43-14.85‰ at the surface to 19.29-32.56‰ in 5-m depths and in a bottom temperature range of 22.5° to 27.42°C; he never found it in the ocean. Buchanan (1958) similarly found it in 5.5-14-m depths in a temperature range of 27° to 30°C off Accra, Ghana, in what he termed the inshore fine sand community. Chace (1956) recorded it in 27.5°C water off Los Roques, Venezuela.

*Spawning.*—Both the museum material studied and records in literature yield only fragmentary evidence on spawning. Ovigerous females are re-

corded from December to July in various parts of the geographic range on both sides of the Atlantic. Specifically the records are: Congo and St. Thomas, December; St. Thomas, January; Grenadines and Cuba, March; Haiti, April; Jamaica and Senegal, May; Colombia, Curaçao and São Tomé (Forest and Guinot, 1966), June; Florida and Puerto Rico, July.

*Distribution.*—Off southern Florida through Caribbean Sea to south central Brazil off Estado de São Paulo; Bermuda and Cape Verde Islands; Senegal to central Angola (Figure 27). A recent record from North Carolina is regarded as a temporary range extension.

*Economic importance.*—Gravel (1912), describing fisheries for *C. latimanus* along the Gulf of Guinea, noted that *C. marginatus* is also caught all along the coast from Senegal to the Congo under a variety of local names.

*Remarks.*—The populations on each side of the Atlantic seem indistinguishable by means of external morphological characters. Different names applied to the populations on each side reflect the discontinuity of early collections, Verrill (1908a) for instance considering *larvatus* the American and *africanus* the African variety, but with the progress of exploration and inventory it is evident that the whole is a genetic continuum with minor local variations already pointed out. Most modern workers (Capart, 1951; Monod, 1956) accept this idea although deploring the difficulty in identifying juveniles.

Verrill (1908b) early recognized the significance of larval transport in oceanic currents, applying it to populations of *C. marginatus* in Bermuda that have their origin in the West Indies. It is tempting to make the generalization that this species in its moderate size, short, simply ornamented male first gonopods, and amphi-Atlantic pattern of geographic distribution possibly represents an unspecialized and primitive member of the genus, but such ideas are qualified by the specialization of chelae seemingly well adapted by their dorsoventrally broadened but rather thin fingers for reaching into crevices, perhaps into mollusk shells after they are cracked. In short, generalized structure is hard to assess.

Some specimens show evidence of massive fouling by the barnacle *Chelonibia*. A male (dry) from Brazil (BMNH 48.86) measuring 89 mm between

tips of lateral spines bears the basal disc of a barnacle measuring  $24.9 \times 26.2$  mm, or an oval area covering all of the metagastric and a portion of the right branchial lobe forward to the base of the frontal margin and edge of the right orbit. A second and still intact barnacle covers all of the left mesobranchial region ( $11.7 \times 13.0$  mm).

*Material*.—Total. 242 lots, 615 specimens.

Specimens listed in Rathbun (1930) from USNM (31091, 4172, 24445, 24446, 24447, 24448, 24449, 24450, 24454, 43905, 62684, 54255 not found; 32514 = *C. ornatus*, 33103 = *C. similis*, 61364 = *C. danae*) and MCZ.

USNM. 99 lots, 282 specimens, including the following not cited above:

#### UNITED STATES

Florida: 80624, Lake Worth, 1945, 1 ♂, A. H. Verrill. 113458, Pigeon Key, Monroe Co., 7 Aug. 1965, 1 ♂, R. B. Manning. 123063, Bahia Honda Key, Monroe Co., 14 June 1964, 2 ♂, 2 juv, Foster and Kaill, No. 64-11-I. 71635, Key West, 1934, 1 ♂, H. H. Darby. 76972, Key West, no date, 5 ♂, 1 ♀ (ov), C. J. Maynard. 123075, Key West, no date, 3 ♂, 2 ♀, U.S. Bur. Fish. The following from Dry Tortugas—62156, 25 July 1928, (juv) 2 ♀, A. S. Pearse. 76968, Fort Jefferson, Aug. 1930, 1 ♂, W. L. Schmitt. 62155, Loggerhead Key, 6 Aug. 1928, 2 ♂ (juv), A. S. Pearse. 76967 and 76970, Long Key, 25 June 1931, 1 ♂, 5 juv, W. L. Schmitt. 76969, Long Key-Bush Key, 18 June 1932, 1 ♂, W. L. Schmitt. 71636, Bush Key, 4 Aug. 1934, 1 ♀, H. H. Darby. 71655, Sarasota Bay, summer 1930, 1 juv, W. W. Wallis.

#### BAHAMAS

101130, Bimini Bay, 27 Nov. 1951, 1 ♂ (juv), F. Frieders.

#### CUBA

99977, E Xanadú, Hicacos Pen., Matanzas Prov., 24-27 Jan. 1957, 1 carapace, W. L. Schmitt.

#### JAMAICA

123060, N shore,  $18^{\circ}24.5'N$ ,  $77^{\circ}07'W$ , 20 May 1965, 1 ♀ (ov), Oregon Stn. 5405. 123062, Kingston Harbor, 17 May 1965, 1 ♀, B. B. Collette.

#### HAITI

65859, Ile a Vache, 29 Apr. 1930, 1 ♀ (ov), W. M. Parish. 81481, I. opposite Bayeaux, 23 June 1941, 1 ♂, H. H. Bartlett.

#### DOMINICAN REPUBLIC

62828, near Montecristi, winter 1928-29, 1 chela, H. W. Kreiger.

#### PUERTO RICO

73282, off Fort San Gerónimo, San Juan, 30 Apr. 1937, 3 ♂, W. L. Schmitt. 73285, near Fort San Gerónimo, W end San Juan I., 27 Mar. 1937, 1 ♀, W. L. Schmitt.

#### VIRGIN ISLANDS

St. Croix: 72351 and 72359, Salt River Bay, 1935-36, 2 ♂, H. A. Beatty. 73284, Christiansted, 9 Apr. 1937, 1 ♂, W. L. Schmitt. 76964 and 76965, Envy Bay, no date, 1 ♂, 2 ♀, H. A. Beatty. Prickly Pear I. 123070, Vixen Pt., Gorda Sound, 15 Apr. 1956, 1 ♀ (juv), Nicholson, Schmitt, and Chace.

#### BARBUDA

123069, near Oyster Pond Landing, 6 Apr. 1956, 1 ♂, Schmitt, Chace, Nicholson, and Jackson.

#### ANTIGUA

123068, Tank Bay, English Harbor, 3 Apr. 1956, 3 ♂, Schmitt, Chace, Nicholson, and Jackson.

#### GUADELOUPE

123067, between Monroux and Rat Is., Pointe à Pitre, 30-31 Mar. 1956, 21 ♂, 5 ♀, 13 juv, Chace and Nicholson.

#### ST. LUCIA

123066, shore of bay outside Marigot Lagoon, 21 Mar. 1956, 1 ♂, Chace, Nicholson, and crew.

#### GRENADINES

123064, Tyrrell Bay, Carriacou I., 15 Mar. 1956, 3 ♀ (ov), Schmitt and Nicholson. 123065, Tyrrell Bay, Carriacou I., 16 Mar. 1956, 1 ♀, D. V. Nicholson.

#### MEXICO

Quintana Roo: 123072, Cozumel I., near lighthouse at Punta Molas, 9 Apr. 1960, 5 ♂, Rehder and Bousfield. 123071, Bahía del Espíritu Santo, north shore near Lawrence Pt., 6 Apr. 1960, 1 ♂, Rehder, Daiber, and Haynes. 123073, Pt. Santa María [ $20^{\circ}19'N$ ,  $86^{\circ}59'W$ ], 22 Apr. 1960, 1 ♂, Schmitt and Rehder.

#### HONDURAS

78107, Utila I., Sept. 1938, 1 ♂, L. Mouquin.

## COLOMBIA

123061, Isla de San Andrés, 5 June 1964, 1 ♀ (ov), B. A. Rohr.

## PANAMA

61427, Margarita I. [09°23'N, 79°53'W], June 1924, 1 ♀, E. Deichmann.

## BRAZIL

Bahia: 123074, Plataforma, 1875-77, 1 ♂, 1 ♀ (ov), Hartt Exped. Rio de Janeiro: 123076, São Francisco, 25 Aug. 1925, 1 ♂, W. L. Schmitt.

## ZAIRE

54255, Banana, mouth of Congo River, July-Aug. 1915, 1 ♀, H. Lang.

AHF. 7 lots, 12 specimens.

## UNITED STATES

Florida: Key Largo S Gordons Landing at Rock Harbor, 19 Sept. 1950, 2 ♂, 1 ♀, Stn. LM52. Hawk Channel, Plantation Key, 3 mi S Tavernier bridge, 25 May 1949, 1 ♀, A126-49, Stn. LM20-49. Hawk Channel off Lower Matecumbe Key, 9 June 1949, 2 ♂, 1 ♀, A140-49, Stn. LM34-49. Hawk Channel, Lower Matecumbe Key, 23 Sept. 1950, 2 ♀, Stn. LM57. Long Key, Florida Bay, 10 June 1949, A141-49, Stn. LM35-49.

## TOBAGO

Bucco Bay, 11°10'42"N, 60°48'07"W, 20 Apr. 1939, 1 ♂, *Velero III*, Stn. A40-39.

## TRINIDAD

Port of Spain, 10°38'12"N, 61°32'08"W, 18 Apr. 1939, 1 ♀, *Velero III*, Stn. A37-39.

AMNH. 30 lots, 81 specimens.

## UNITED STATES

Florida: Lake Worth, July and Aug. 1945, 1 ♂ (juv), W. G. Van Name. 9789, Lake Worth, June 1945, 1 ♂, A. H. Verrill. 2290, Key Largo, no date, 1 ♂, C. W. Beebe.

## BAHAMAS

11222, North Bimini, June 1939, 7 ♂, W. Beebe Bermuda Exped. 11288 and 11289, Bimini, 5 Sept. 1947, 2 ♂, J. C. Armstrong. 9343, Nassau, Mar. 1930, 1 ♂, R. W. Miner. 3297, no date, 1 ♂, col. unknown. 11290, Dicks Point, New Providence, 1946-47, 1 ♂, H. Dodge. 11297, Octagon Point, New

Providence, 1946-47, 1 ♀, H. Dodge. 2252, Andros, no date, 3 ♂, B. E. Dahlgren and H. Müller. 959, Andros, Apr. 1908, 7 ♂, 1 ♀, B. E. Dahlgren and H. Müller.

## CUBA

3158, 6 mi SW Cienfuegos, off Cayo Carenas [22°05'N, 80°28'W], 18 June 1918, 1 ♂, B. Brown. 3165, Cayo Cristo [23°03'N, 80°00'W], 4 mi N Isabela, 2-3 July 1918, 1 ♀, B. Brown.

## HAITI

11219, Bizoton Reef [18°32'N, 72°23'W], 4 Mar. 1927, 1 ♂, 2 ♀, W. Beebe Exped.

## PUERTO RICO

2671, near San Antonio Bridge, San Juan, 10 July 1914, 1 ♂, 1 ♀, R. W. Miner. 2674, Landing place in Candado Bay, San Juan, 9 July 1914, 1 ♀, R. W. Miner. 2682, San Juan Harbor, 21 July 1914, 1 ♀ (ov), R. W. Miner. 2672, rocks at entrance of Condado Bay, San Juan, 14 July 1914, 1 ♀, R. W. Miner.

## ZAIRE

3455, no date, 1 ♂ (dry), H. Lang and J. Chapin. 3272 and 3329, Banana, Aug. 1915, 4 ♂, 5 ♀, H. Lang and J. Chapin. 3340, Banana, no date, 6 ♂, 5 ♀, H. Lang and J. Chapin. 3428, Manuba, Banana, July 1915, 2 ♂, H. Lang and J. Chapin. 3476, Banana, July 1915, 1 ♀ (juv), H. Lang and J. Chapin.

## ANGOLA

3443, Luanda, 23 Sept. 1915, 1 ♀, H. Lang and J. Chapin. 5895 [Angola?], 1925, 6 ♂, 2 ♀ (1 ov), Vernay Angola Exped. 5901, [Angola?], 1925, 3 ♂, Vernay Angola Exped. 5884, Lobito Bay, Apr. 1925, 1 ♀, H. Lang and R. Boulton. 5882, Lobito Bay, May 1925, 7 juv (frags.), H. Lang and R. Boulton.

ANSP. 4 lots, 4 specimens.

## UNITED STATES

Florida: 3569, Manatee R. [Manatee Co.], no date, 1 ♂, S. Ashmead.

## VIRGIN ISLANDS

St. Croix: 3485, no date, 1 ♀ (dry), R. E. Friffith.

## ST. MARTINS

1316, no date, 1 ♂, Van Rijgersma.

## [ST. BARTHÉLEMY]

621, Bartholemew I., no date, 1 ♂, A. Goes.

BMNH. 10 lots, 18 specimens.

## UNITED STATES

Florida: 1938.3.19.21, Dry Tortugas, 2 ♂, Colman and Tandy.

## JAMAICA

1960.8.25.1, Portland Bight, 18 May 1956, 1 ♀ (ov), H. M. S. Vidal.

## MEXICO

65.29, 2 ♂, (dry), vi/9.

## BRAZIL

48.86, 1 ♂, (dry), vi/6/7. Pernambuco, unreg. 1 ♂, D. Wilson Barker.

## GAMBIA

Unreg., Gunjur beach, 13 Nov. 1950, 1 ♂ (juv), M. H. Routh. 1952.9.9.21/22, 1 mi N Gunjur, 3 Mar. 1951, 1 ♀, and Rock pool N end Gunjur beach, 11 Dec. 1950, 1 juv, M. H. Routh.

## SIERRA LEONE

1920.9.21.1/5, Murray Town, 2 ♂, 3 ♀, W. P. Lowe.

## FERNANDO PÓO

53.1, 1 ♂ (dry), vi/9, Cuming.

## ANGOLA

1911.2.28.14/15, Luanda, 1 ♂, 1 ♀, W. P. Lowe.

MCZ. 27 lots, 71 specimens.

## UNITED STATES

Florida: 5208, July 1859, 1 ♀ (ov), Capt. Woodbury. 5148, 13 Feb. 1861, 2 ♂, Capt. Woodbury. 8747, no date, 1 ♂, Maynard. 5149, Key West, Feb. 1859, 1 ♂, T. Lyman. 5150, Key West, no date, 2 ♂, C. E. Faxon. 5209, Fort Jefferson, Tortugas, no date, 2 ♂ (part of Ordway's material).

## BAHAMAS

8665, E Great Abaco I., 1904, 1 ♀, Allen, Brant, and Barbour. 11672, Alicetown, North Bimini, May 1941, 1 ♂, 1 juv, R. W. Foster and J. Huntington. 8635 and 8646, Mangrove Cay, Andros I., 1 Aug. 1904, 1 ♂, 1 juv, O. Bryant. 9425, Simms, Long I., 7 July 1936, 1 ♂, Harvard Bahama Exped.

10359, Salt Pond canal, 1.5 mi SE Matthew Town, Great Inagua I., 24 June 1938, 1 ♂, R. A. McLean and B. Shreve.

## CUBA

2893, Bahía Honda, 1877-78, 2 juv, Blake Exped.

## HAITI

5156, near Jérémie, no date, 1 ♂, D. F. Weinland.

## DOMINICAN REPUBLIC

9841, Santa Barbara de Samaná, Aug. 1937, 1 ♀, W. J. Clench.

## VIRGIN ISLANDS

St. Thomas: 5153 and 8864, Dec. 1871, 20 ♂, 10 ♀ (2 ov), Hassler Exped.

## TOBAGO

9917, Pigeon Point, 17-18 Aug. 1937, 2 ♂ (juv), E. Deichmann.

## CAPE VERDE ISLANDS

6530, La Praia, July 1883, 1 ♀, *Talisman* Exped.

MNB. 4 lots, 8 specimens.

## BRAZIL

Ceará: 333, Fortaleza, Praia de Mucuripe, 1945, 1 ♀, A. Carvalho. Pernambuco: 55, [no other data], 3 ♂, 2 ♀. 331, Recife, Praia do Pina, Sept. 1944, 1 ♂. 330, Recife, Praia do Pina, Aug. 1944, 1 ♂.

MNHNP. 13 lots, 18 specimens.

## GUADELOUPE

No date, 2 ♂, (dry), M. Beaupertuis.

## CAPE VERDE ISLANDS

La Praia, July 1883, 1 ♂, *Talisman*, 41-42. No date, 1 ♂, M. Barboradu Bocage 587-66. No date, 1 ♀, M. Bouvier.

## SENEGAL

Beach at Dakar, May 1895, 1 ♀ (ov), M. Chaper.

## GUINEA

Fotoba, Isles des Guinée, [6 mi W Conakry], 9-10 Mar. 1947, 2 ♂, 1 ♀, Inst. d'Afrique Noire.

## SÃO TOMÉ

Golfe de Guinée, 1956, 1 ♀, *Calypso* Stn. T 28. Golfe de Guinée, 1956, 1 ♀ (ov), *Calypso* Stn. T 9.

## GABON

Types, 3 ♀ (dry). 3 juv, M. Duparquet 181.63 (dry).

## CONGO

1892-94, 2 ♀, Dybowski.

RMNH, 38 lots, 105 + specimens.

## UNITED STATES

Florida: 23268, Bear Cut, Key Biscayne, 1 Jan. 1965, 2 ♂ (juv), J. A. Cabrera and L. B. Holthuis. 18719, Bear Cut, Key Biscayne, 1-9 Sept. 1963, 1 ♂, L. B. Holthuis. 15003, Tortugas, July 1925, 1 ♂ (juv), H. Boschma.

## BAHAMAS

6911 and 11859, Nassau, New Providence I., 1887, 1 ♂, 1 ♀, A. de Haas. 1860, Bahama Is., 1887, many adults, A. de Haas.

## VIRGIN ISLANDS

15009, St. Croix, Krause Lagoon, 15 June 1955, 2 juv, P. W. Hummelinck.

## ST. MARTIN

11861, coast near Philipsburg, 16-17 Feb. 1957, 1 ♂, 4 juv, L. B. Holthuis. 11866, Freshwater pond W of Philipsburg. 17 Feb. 1957, 6 ♂, 2 ♀, 9 juv, L. B. Holthuis. Unnumbered, mouth freshwater pond W of Philipsburg, 17 and 20 Feb. 1957, dry carapace, L. B. Holthuis. 10720, Great Bay, 7 June 1950, 1 ♂, T. W. Hummelinck. 8121, Great Bay, Ft. Blanche, 26 June 1949, 1 juv, T. W. Hummelinck. 11864, Oyster pond on E coast, 22 Feb. 1957, 1 ♂, 1 ♀, L. B. Holthuis. 1128, NE shore Great Bay, 16 May 1949, 2 ♀, P. W. Hummelinck.

## GUADELOUPE

23423, Grande Anse by bridge, La Desirade, 23 Jan. 1964, 1 ♂, P. W. Hummelinck.

## ARUBA

11863, Lagoon W Savaneta, 19 Mar. 1957, 2 ♂, L. B. Holthuis. 15008, Lagoon NW Savaneta, 21 Mar. 1957, ♂ juv, L. B. Holthuis. 557, 1881-1882, 6 ♂, 3 ♀, A. J. van Koolwijk. 11862, 1883, 1 ♀, K. Martin. 1872, July 1883, 3 ♂, 1 ♀ (juv), de Haas. 2273, June 1920, 1 ♂ (juv), Prof. col.

## CURAÇAO

15006, Santa Cruz Baai, 13 Nov. 1956, 1 ♀ (juv), L. B. Holthuis. 15004, Piscadera Baai, 14 Nov.

1957, 2 ♀ (juv), L. B. Holthuis. 11865, Piscadera Baai, 11-13 Feb. 1957, 2 ♂, 1 ♀, L. B. Holthuis. 23422, SE part Piscadera Baai, 25 Oct. 1963, 1 ♂, P. W. Hummelinck. 23401, S part Piscadera Baai, 25 Oct. 1963, 1 ♀, P. W. Hummelinck. 11860, Mouth of Piscadera Baai, 19 Dec. 1956, 1 ♀, 2 juv, L. B. Holthuis. 23459, Mouth of Piscadera Baai, 14 Dec. 1963, 1 ♀ (paper shell), P. W. Hummelinck. 15015, Mouth of Spanish Water near Nieuwpoort, Santa Barbara beach, 25 Nov. 1956, 1 ♂, L. B. Holthuis. 15005, Mouth of Spanish Water near Nieuwpoort, Santa Barbara beach, 8-13 Nov. 1957, 1 ♂, 4 juv, L. B. Holthuis. 18644, Boca Grandi, St. Jean, 6 Feb. 1955, 2 ♂, J. S. Zaneveld. 15007, S shore St. Joris Baai near Choloma, 3 Jan. 1957, 2 ♂, 1 ♀, 1 juv, L. B. Holthuis. 18646, back part Playa Grandi, Boca Wacao, 30 Jan. 1955, 1 ♂, juv, J. S. Zaneveld. 15010, Spanish Water near Jan Zoutvat, 18 Nov. 1956, 1 ♂, juv, L. B. Holthuis. Unnumbered, reefwater, June 1920, 1 ♀ (ov?), Boeke.

## BONAIRE

Lagoon, 27 Mar. 1955, dry carapace, mature, J. S. Zaneveld and R. W. Hummelinck. 11867, Lagoon on E coast, 10 Mar. 1957, 3 ♂, 1 ♀, 4 juv, L. B. Holthuis.

## NIGERIA

Lagos Harbor, 23 May 1964, 1 carapace (dry), Pillsbury Stn. 1.

SADZ-B. 7 lots, 11 specimens.

## UNITED STATES

Florida: 878, Key West, 1885, 1 ♂, Smithsonian.

## BRAZIL

Ceará: 3231, Fortaleza, Praia de Iracema, 21 Jan. 1964, 3 ♂, A. L. Castro. Bahia: 3215, Ilha Madre de Deus [12°44'S, 38°37'W], 1932, 1 ♂, Oliveira Pinto. 1731, Ilha Madre de Deus, Jan. 1933, 1 ♂, Pinto e Camarão. 3224, Ilhéus, 1919, 3 ♂, E. Garbe. Rio de Janeiro: Unnumbered, Angra dos Reis, Praia Mombaca, 1 ♀. São Paulo: 890, São Sebastião, 1915, 1 ♂, E. Garbe.

UNC-IMS. 4 lots, 6 specimens.

## UNITED STATES

North Carolina: Back Sound off mouth of Taylor Creek, Carteret Co., 20 Nov. 1971, 1 ♀, C. A. Johnson III.

## CONGO

2740, Pte. Indienne, env. de Point-Noire, 12 May 1964, 1 ♂, 1 ♀, A. Stauch. 2741, Pte. de Tchitembc, 31 Dec. 1963, 1 ♀ (ov), A. Stauch. 2742, W de Pointe-Noire, 1 ♂, 1 ♀, A. Crosnier.

*Supplementary literature records.*—Bermuda (Verrill, 1908a); Veracruz, Mexico (Contreras, 1930); Aruba (de Man, 1883); Los Roques and La Orchila, Venezuela (Chace, 1956); Barra das Jan-gadas, S of Recife, Brazil (Coêlho, 1966); near Rio de Janeiro, Brazil (Oliveira, 1956); Ilha da São Sebastião, Brazil (Luederwaldt, 1929); Port Etienne, Mauritania, and Apam, [Ghana], plus a long list of localities duplicated in material examined and other literature (Monod, 1956); Cape Verde Islands (2 localities), and Angola (3 localities) (Guinot and Ribeiro, 1962); Bissau, Portuguese Guinea (Osorio, 1887, 1888, 1898); Gold Coast (Buchanan, 1958); São Tomé (Forest and Guinot, 1966); Pointe Noire, Congo (Rossignol, 1962).

## *CALLINECTES SIMILIS* WILLIAMS Lesser Blue Crab

Figures 4, 18b, 20c, 22a, 24

- Callinectes ornatus*.—Ordway, 1863, p. 572 (part, the Texas specimen).—Rathbun, 1896, p. 356 (part).—1930, p. 114 (part).—Hay and Shore, 1918, p. 433, pl. 34, fig. 2.—Contreras, 1930, p. 231 (part), fig. 4 (?).—Pounds, 1961, p. 42, pl. 7, fig. 2c.—Williams, 1965, p. 172, fig. 152.
- Callinectes danae*.—Rathbun, 1930, p. 118 (part).—Pounds, 1961, p. 42, pl. 7, fig. 2b.
- Callinectes similis* Williams, 1966, p. 87, figs. 3, 4E, F (type: ♂, USNM 113341, 2-3 mi off beach between St. Johns River jetties and Jacksonville Beach, Fla.).

*Description.*—Carapace (Figure 4) with four frontal teeth, submesial pair small but definitely formed. Central trapezoidal (metagastric) area short and wide, anterior width about 2.75 times length, posterior width about 1.6-1.7 times length. Anterolateral margins broadly arched; anterolateral teeth exclusive of outer orbital and lateral spine short and broad, tips of first five nearly rectangular, sixth and especially seventh acuminate; first five teeth with anterior margins shorter than posterior and separated by narrow based rounded

notches. Lateral spine strong, slender, and curved forward. Surface of carapace even, lightly and quite uniformly granulate except smooth along posterolateral and posterior slopes, and nearly smooth along anterolateral and anterior margins, especially between teeth and along orbits; smooth areas with tendency to iridescence.

Chelipeds with very fine granulations on ridges; carpus bearing two obsolescent granulate ridges and suggestion of others, inferior lateral ridge terminating anteriorly in a low tooth occasionally followed by a low flattened eminence; chelae strong, not greatly dissimilar in size.

Male telson longer than wide; sixth segment of abdomen slightly sinuous sided but broader at all levels than telson, proximal half slightly constricted laterally and less indurated than other parts, flush with sternum in retracted position. Mature female telson slightly wider than long. First gonopods of male (Figures 18b, 20c) reaching anteriorly two-thirds length of sternite VII, or beyond; distal portion slender, extending straight to tips curved slightly mesad, armed with scattered minute retrogressive spinules, most dense distally and laterally and largest distally. Gonopores of female (Figure 22a) narrowly ellipsoid with long axis in transverse plane; aperture of each with simple rounded borders except at mesial end where it slopes from surface laterad under superior anterior margin.

*Size of carapace in mm.*—Largest male: length 55, width at base of lateral spines 97, including lateral spines 122. Largest female: length 45, width at base of lateral spines 76, including lateral spines 95. Summary of selected measurements is given in Tables 1 and 2. Franks et al. (1972) reported an individual with carapace width of 171.

*Color.*—Adult male: "Carapace green dorsally, irregular areas of iridescence at bases of, and between, anterolateral teeth, and on posterior and posterolateral borders. Chelipeds and portions of legs similar in color or more tannish green dorsally, with iridescent areas on outer and upper edges of carpus and hands; chelae white on outer face, blue to fuchsia on inner surface, with fuchsia on tips of fingers and teeth of opposed edges. Lateral spines and some anterolateral teeth, as well as spines on chelipeds, white tipped. Walking legs grading from fuchsia distally through violet blue to light blue mottled with white proximally,

pubescence on legs beige. Swimming legs variably mottled with white; all legs with stellate fuchsia markings at articulations. Underparts white and blue." (Williams, 1965).

Ovigerous female: "Similar to male except with more violet blue on inner surface of chelae; fingers either with white teeth or fuchsia colored teeth. Legs with dactyls reddish orange grading abruptly to blue on propodi, pubescence brown to beige. Abdomen with iridescent areas." (Williams, 1965).

Carapace of juveniles sometimes with a maculate light olive pattern.

*Variation.*—Borders of the metagastric area are somewhat more deeply defined on young individuals than adults, and the shape of this area tends toward that in *C. danae* (USNM 123015, Mississippi) in the young. Differentiation of the major and minor chelae resembles that in other members of the genus although the two chelae on most individuals tend to be similar sized. In some specimens the major chela has a strong proximal tooth on the dactyl.

*Habitat.*—Franks et al. (1972) gave a good summary of habitat for this species. In Mississippi they caught it year round in trawl samples from 9- to 92-m depths at temperatures ranging from 13.2° to 29.0°C and in salinities ranging from 24.9 to 37.4‰, but it was most abundant in 37-m depths and showed a slight preference for 29.0 to 31.9‰ salinities. The same environment exists in northeastern Florida where Tagatz (1967) found the species most abundant in the ocean near shore and in the lower 25 miles of St. Johns River, mainly in salinities greater than 15‰; also in North Carolina it is seldom found in estuaries beyond lower limits of 15‰ salinity. In all areas studied the species is associated with *C. sapidus*, often in large numbers, but it is usually culled out of commercial catches because of its small size (Lunz, 1958; Pounds, 1961; Williams, 1966; Franks et al., 1972).

*Spawning.*—Published data on spawning in Texas and South and North Carolina summarized by Williams (1966) suggested a spring and fall spawning season for *C. similis*, and Tagatz (1967) found this true for northeastern Florida as well where females spawn in the ocean from March to July, peaking in May when 75% of them are ovigerous, and again from October to November.

Ovigerous females in the collection of the USNM indicate that these limits are somewhat broader elsewhere and may be correlated with temperature, for there are representatives from Louisiana and Texas in February and Campeche Banks in December.

*Distribution.*—Off Delaware Bay to Key West, Fla.; northwestern Florida around Gulf of Mexico to off Campeche, Yucatán (Figure 24).

*Remarks.*—Small- to medium-sized juveniles are extremely difficult to identify in parts of the range where *C. danae* and *C. ornatus* also occur (southern Florida).

The few specimens from off Delaware Bay are all juveniles, suggesting that northern limits for this species, as for many others from the Carolinian Province, vary seasonally and are extended northward during favorable warm years.

Among unusual specimens seen, a female taken off Cape San Blas, Fla. (USNM 101429) with carapace measuring 37 mm long × 64 mm wide, exclusive of lateral spines, bears dorsally the largest *Chelonibia* seen fouling the species. The barnacle measures 18.5 × 21.3 mm at base × 18.3 mm height of sidewall. An immature female crab taken off Timbalier Bay, La. (USNM 123026) has that part of the front bearing frontal teeth produced forward.

Closely resembling *C. danae* and *C. ornatus*, *C. similis* seems to be the Carolinian member of the complex. *Callinectes similis* has the smoothest and most uniformly granulated carapace among the three, and the shortest, broadest anterolateral teeth. These teeth are not equilaterally triangular, having shorter anterior than posterior borders, and are more directed forward in the anterior portion than in the remainder of the row. Central teeth in the row have the anterior border extending almost straight laterad. The carapace of mature females has very little sculpture and remarkably uniform granulation overall. Granulations on the ridges of the chelipeds are among the finest of any species of *Callinectes*. Because of simplicity in structure of the male first gonopods, the relatively broad male abdomen and relatively generalized structure of the chelae and frontal teeth, it is tempting to regard this species as one of the most primitive or unspecialized members of the genus and I have arranged it so in the order of presentation, knowing full well that such evidence is highly subjective.



*Material*.—Total: 117 lots, 354 specimens.

USNM. 104 lots, 329 specimens, including the following listed in Rathbun (1930) as *C. danae* (20115, 22817), *C. marginatus* (33103), and *C. ornatus* (8863, 62460, 58366, 3185, 51029, 61428, 21631).

#### UNITED STATES

New Jersey: 62674, Cape May, 8 Sept. 1928, 1 ♂ (juv), H. G. Richards. 64257, near Brandywine Lightship, Delaware Bay, 29 July 1930, 1 ♂ (juv), H. G. Richards. 77009, off New England Creek, Delaware Bay, 25 Aug. 1931, 1 ♀ (juv), H. G. Richards.

Delaware: 77008, off Slaughter Creek, 4 Aug. 1931, 1 juv, H. G. Richards.

North Carolina: 123058, Beaufort, recd. 19 Nov. 1959, 1 ♀ (ov), J. D. Costlow, reared larvae. 123059, Beaufort Harbor, Aug. 1946, 1 ♂, D. H. B. Ulmer.

South Carolina: 97699, N Edisto R., 22 Apr. 1953, 1 ♂, 7 ♀, G. R. Lutz. 123012, S Creek near entrance into N Edisto R., 31 May 1966, 1 ♂ (juv), J. C. McCain. 123011, off mouth N Edisto R., 31 May 1966, 1 ♀, J. C. McCain.

Georgia: 123054, Jointer R. [near Jekyll I.], 17 Mar. 1932, 2 ♀, W. W. Anderson.

Florida: 123034, [off mouth St. Johns R.], 30°26.5'N, 81°23'W, 17 Apr. 1940, 9 ♂, 9 ♀ (6 juv), *Pelican* Stn. 215-1. 123047, [off mouth St. Johns R.] 30°26'N, 81°20.5'W, 17 Apr. 1940, 1 ♂, 1 ♀, *Pelican* Stn. 215-2. 113345, off St. Johns R. jetties, 14 Aug. 1962, 8 ♂, 6 ♀, M. E. Tagatz and G. P. Frymire. 113341, 113342, 113343, 113344, 2-3 mi off beach between St. Johns R. jetties and Jacksonville Beach, 18 June 1962, 8 ♂, 9 ♀, A. B. Williams et al. 123014, [off Jacksonville Beach] 30°21'N, 81°20.5'W, 19 Nov. 1963, 2 ♂, 2 ♀, *Silver Bay* Stn. 5381. 123101, [off St. Augustine] 29°54.5'N, 10°10'W, 9 Feb. 1965, 2 ♀, *Oregon* Stn. 5234. 123018, [off SE St. Johns Co.] 29°28.5'N, 81°04.5'W, 28 Mar. 1940, 2 ♂, *Pelican* Stn. 202-6. 99917, Matanzas R. at Crescent Beach, 1 Dec. 1954, 1 ♂, D. K. Caldwell. 123017, [N Daytona Beach] 29°18.5'N, 81°01.5'W, 6 Apr. 1940, 1 ♀, *Pelican* Stn. 212-3. 123046, [off Daytona Beach] 29°14.5'N, 80°59.5'W, 6 Apr. 1940, 1 ♂, 1 ♀ (ov), *Pelican* Stn. 212-2. 123020, [off Daytona Beach] 29°07.5'N, 80°55'W, 5 Apr. 1940, 5 ♂, 2 ♀, *Pelican* Stn. 211-5. 123021, [off Daytona Beach] 29°11'N, 80°43'W, 19 Jan. 1940, 1 ♀, *Pelican* Stn. 172-3. 123008, 123009, Ponce de Leon Inlet, Volusia Co., 13 Apr. 1946, 2 ♂ (juv), DePalma and Strickland.

123045, [off New Smyrna] 29°00'N, 80°47.5'W, 19 Jan. 1940, 1 ♂, *Pelican* Stn. 171-7. 101686, NE off Cape Canaveral, 29°15'N, 80°13'W, 1 June 1957, 2 ♀ (1 ov), *Combat* Stn. 334. 123016, [off Cape Canaveral] 28°24'N, 80°32.5'W, 4 Apr. 1940, 1 ♂, *Pelican* Stn. 207-3. 123022, [SE Cape Canaveral] 28°23'N, 80°27.5'W, 18 Jan. 1940, 1 ♂, *Pelican* Stn. 169-2. 99902, Sewall Point, Martin Co., 27 Feb. 1955, 2 juv, D. K. Caldwell et al. 113460, Bear Cut Key, Biscayne side Miami, 17 Aug. 1965, 1 ♂, 1 ♀ (juv), R. B. Manning. 77103, Coral Gables, 7 July 1932, 1 ♂, J. F. W. Pearson. 76984, Key West, 26 May 1918, 1 ♂ (ov), 3 juv., D. R. C. 76980, Key West, no date, 2 ♀, C. H. Maynard. 123103, mud cove 2 mi from tip of Alligator Harbor, Franklin Co., 27 Oct. 1967, 4 ♂, 5 ♀, C. Swift and J. Rudloe. 101429, off Cape San Blas, 29°16'N, 85°08'W, 15 July 1957, 1 ♀ (ov), *Oregon* Stn. 1755. 123102, St. Andrews Bay Shipyard area, Bay Co., 18 Aug. 1967, 1 ♂, L. Abele and C. Swift. 99914, Choctawhatchee Channel, Okaloosa Co., no date, 1 ♀, K. Caldwell. 99896, Intracoastal Waterway 3.5 mi E Interarity Point, Pensacola, 15 Aug. 1953, 1 ♂, F. Berry and A. Mead.

Alabama: 92425, 30°15.5'N, 88°10'W, 22 June 1951, 3 ♂, 1 ♀, 1 juv., H. M. Hefley, *Oregon* Stn. 387.

Mississippi: 123015, inside Petit Bois Island, Mississippi Sound, 20 Apr. 1967, 27 ♂, 10 ♀, *George M. Bowers* Stn. 4. 123010, off N side Little Deer Island, Ocean Springs, 1 Sept. 1965, 3 juv, J. C. McCain.

Louisiana: 123040, 28°22.5'N, 91°44.5'W, 12 July 1938, 1 ♂, *Pelican* Stn. 84-1. 123057, 28°31'N, 91°09'W, 13 July 1938, 3 ♂, 1 ♀ (juv), *Pelican* Stn. 86-4. 123029, 28°38'N, 91°05'W, 18 Mar. 1938, 1 ♂, *Pelican* Stn. 31. 123019, 28°39.5'N, 91°06'W, 11 Nov. 1938, 1 ♂, 2 ♀ (1 juv), *Pelican* Stn. 90-2. 123039, 28°40'N, 90°51.5'W, 10 July 1938, 1 ♂ (juv), *Pelican* Stn. 80-7. 123035, 28°41.5'N, 91°10'W, 11 Nov. 1938, 2 ♂, 2 ♀ (1 juv), *Pelican* Stn. 90-3. 123050, 28°42'N, 92°15.5'W, 13 Nov. 1938, 4 ♂, 4 ♀, *Pelican* Stn. 93-6. 101428, 28°46'N, 90°47'W, 6 Mar. 1957, 7 ♀ (ov), *Oregon* Stn. 1749. 123033, 28°46.5'N, 91°18.5'W, 11 Nov. 1938, 1 ♂, *Pelican* Stn. 90-5. 123037, 28°48'N, 89°51'W, 13 May 1938, 3 ♀ (2 ov), *Pelican* Stn. 69-6. 123048, 28°49'N, 91°23'W, 11 Nov. 1938, 3 ♂, 1 ♀, *Pelican* Stn. 90-6. 92350, 28°50'N, 89°33'W, 7 May 1951, 1 ♂, *Oregon* Stn. 342. 91432, 28°53.3'N, 89°36.5'W, 13 Sept. 1950, 1 ♀ (juv), *Oregon* Stn. 107. 123038, 25 mi S Grand Isle, 28°55'N, 90°02'W, 17 Feb. 1938, 1 ♂, *Pelican* Stn. 22. 123041, 28°55'N, 92°15.5'W, 13 Nov. 1938, 3 ♂, *Pelican* Stn. 93-3.

123025, 28°55.5'N, 89°59'W, 10 Nov. 1938, 2 ♀ (1 ov), *Pelican* Stn. 87-7. 123028, 28°56'N, 91°52'W, 29 Mar. 1938, 1 ♂, 2 ♀, *Pelican* Stn. 37. 123056, 28°56.5'N, 91°50'W, 11 July 1938, 2 ♂, 2 ♀, *Pelican* Stn. 82-5. 91939, 28°57'N, 89°36'W, 14 Sept. 1950, 1 ♀, *Oregon* Stn. 110. 123036, 28°57'N, 89°43'W, 10 Nov. 1938, 4 ♀ (1 ov), *Pelican* Stn. 87-4. 123024, 28°58'N, 89°28.5'W, 10 Nov. 1938, 1 ♂, *Pelican* Stn. 87-1. 123026, 28°58'N, 90°17'W, 10 July 1938, 1 ♀ (juv), *Pelican* Stn. 79-7. 123023, 28°59'N, 92°15.5'W, 13 Nov. 1938, 1 ♂, 2 ♀ (juv), *Pelican* Stn. 93-2. 123049, 28°59.5'N, 91°44.5'W, 12 Nov. 1938, 1 ♂, *Pelican* Stn. 91-4. 64148, off Breton Island, Nov. 1930, 1 ♂, Stewart Springer. 91954, 29°22'N, 88°49'W, 24 Sept. 1950, 3 ♂, *Oregon* Stn. 132. 123027, 29°01.5'N, 89°33'W, 8 July 1939, 1 ♂, 1 ♀, *Pelican* Stn. 77-2. 91433, 29°12'N, 88°50'W, 12 Sept. 1950, 1 ♂, *Oregon* Stn. 103. 123055, 3-6 mi ESE SW Pass, 16 Feb. 1934, 1 ♀ (ov), T. C. P., M. J. Lindner, and W. W. Anderson.

Texas: 123030, 29°00'N, 94°38.5'W, 21 Jan. 1939, 1 ♀, *Pelican* Stn. 104-5. 123031, 29°10.5'N, 94°50.5'W, 3 May 1938, 5 ♂, 2 ♀, *Pelican* Stn. 56-5. 123005, Galveston, 11 Aug. 1940, 4 ♂, 1 ♀, from J. L. Baughman. 123006, Galveston, 7 July 1940, 1 ♂, 2 ♀ (juv), from J. L. Baughman. 123007, Galveston, 11 Aug. 1940, 9 ♂, 2 ♀ (1 soft), from J. L. Baughman. 80662, Galveston, no date, 5 ♂, 4 ♀, J. L. Baughman. 123013, 17 mi S, 7 mi E Alvin, Brazoria Co., 28 July 1952, 1 ♀ (juv), S. Alvin. 22817, Alligator Head, Matagorda Bay, no date, 1 ♂ (dry), from J. D. Mitchell. 123051, 27°59'N, 95°20.5'W, 22 Jan. 1939, 1 ♀, *Pelican* Stn. 107-3. 123032, 28°20.5'N, 96°13'W, 2 May 1938, 1 ♀ (juv), *Pelican* Stn. 54-2. 101678, 28°20'N, 94°97'W, 25 Sept. 1957, 2 ♀, *Silver Bay* Stn. 187. 123044, 27°40'N, 96°34'W, 22 Apr. 1938, 1 ♂, 2 ♀ (ov), *Pelican* Stn. 42. 123043, 27°51'N, 96°55.5'W, 2 May 1938, 3 ♂, 2 ♀ (1 ov), *Pelican* Stn. 53-1. 80663, Port Aransas Pass, 5 June 1941, 1 ♀, G. Gunter. 80664, Port Aransas Pass, no date, 10 ♂, 11 ♀, G. Gunter. 123042, 26°48.5'N, 96°40'W, 4 Feb. 1939, 1 ♀ (ov), *Pelican* Stn. 115-3. 123052, 26°05'N, 97°05'W, 5 Feb. 1939, 1 ♀ (juv), *Pelican* Stn. 118-4.

## MEXICO

Tamaulipas: 94452, 24°12'N, 97°17'W, 13 Oct. 1952, 1 ♀, *Oregon* Stn. 662. 123053, off Soto la Marina, 140 mi S Rio Grande R., 15 Mar 1947, *Pelican*. Campeche Bank: 94453, 19°54.1'N, 91°43'W, 10 Dec. 1952, 1 ♀ (ov), *Oregon* Stn. 719. 94454, 20°12'N, 91°40'W, 11 Dec. 1952, 2 ♂, 1 ♀ (ov), *Oregon* Stn. 720.

AHF. 4 lots, 13 specimens.

## UNITED STATES

Florida: Choctawhatchee Bay entrance W end Destin bridge [Okaloosa Co.], 19 June 1949, 6 ♂, 4 ♀, LM42-49.

Louisiana: Breton Sound, Mississippi Delta, 21 Oct. 1951, 1 ♂, R. H. Parker.

Texas: 1.25 mi off Mustang Island, 31 Aug. 1951, 1 ♀, E. Puffer, J498. Off Padre Island, 9 June 1956, 1 ♀, R. H. Parker, J482.

AMNH. 3 lots, 4 specimens.

## UNITED STATES

Florida: 11298, Lake Worth, July and Aug. 1945, 1 ♀, W. G. Van Name and A. H. Verrill.

Texas: 2755, Galveston, no date, 2 ♂ (juv), col. unknown.

## BAHAMAS

2445, Nassau, 1899, 1 ♂, R. P. W.

BMNH. 1 lot, 1 specimen.

## UNITED STATES

Texas: 11.1.1946, 1 ♀, Baughman.

MCZ. 4 lots, 5 specimens.

## UNITED STATES

North Carolina: 11352, 2 mi SE Roanoke Island, 19 Dec. 1940, 1 ♂ (juv), R. Foster.

Florida: 5207, 1859, 2 ♂, G. Wurdemann. 5129, Cape Florida (S end Biscayne Bay), no date, 1 ♂ (juv), G. Wurdemann.

Texas: 5134, 13 Feb. 1861, 1 ♂, G. Wurdemann.

RMNH. 1 lot, 2 specimens.

## UNITED STATES

Mississippi: 17825, 29°38.5'N, 88°30'W, 21 Aug. 1962, 1 ♂, 1 ♀, *Oregon* Stn. 3713.

UNC-IMS. 7 lots, 74 specimens + many uncatalogued.

## UNITED STATES

North Carolina: 1556, (Paratypes), off Beaufort Inlet, Carteret County, 31 Oct. 1962, 5 ♂, 4 ♀ (2 ov), E. Bayer, from *Ensign*.

Florida: 2140, Clapboard Creek, trib. of St. Johns River, 7 June 1964, 7 juv, col. unknown.

2237, Sisters Creek at Fort George River?, Duval County, 2 ♂, 2 ♀, G. P. Frymire and G. C. Williams. 2138, Mouth of Sisters Creek off St. Johns River, M. E. Tagatz and G. P. Frymire. 1995 (Paratypes), off St. Johns River jetties, 5 ♂, 4 ♀, 3 juv, M. E. Tagatz and G. P. Frymire. 1990 (Paratypes), 2 to 3 mi off beach between St. Johns River jetties and Jacksonville Beach, 17 ♂, 16 ♀ (10 ov), 8 juv, G. P. Frymire, M. E. Tagatz, and G. C. Williams.

Texas: 2139, Galveston Bay, June 1964, 1 ♂, col. unknown.

*Supplementary literature records.*—Laguna Madre de Tamaulipas (as *danae*, Hildebrand, 1957).

## **CALLINECTES GLADIATOR BENEDICT**

### **Marine Blue Swimming Crab**

**Figures 5, 18c, 20b, 22c, 24**

*Lupa smythiana* Leach (nomen nudum) in White, 1847, p. 27.

*Callinectes tumidus* var. *gladiator* Benedict, 1893, p. 537 (type: ♂, USNM 14879, Baya River, Elmina, Ashanti [Ghana]).

*Callinectes tumidus gladiator*.—Rathbun, 1896, p. 360.

*Callinectes gladiator*.—Rathbun, 1897, p. 150.-1900a, p. 291.-1921, p. 397, fig. 3; pl. 19, fig. 2.-Balss, 1921, p. 58.-Monod, 1927, p. 606.-1956, p. 205, figs. 236-237.-Irvine, 1932, p. 15, fig. 9.-1947, p. 298, fig. 203.-Vilela, 1949, p. 58, fig. 6.-Capart, 1951, p. 130, fig. 46.-Rossignol, 1957, p. 82.-1962, p. 116.-Guinot and Ribeiro, 1962, p. 48.-Crosnier, 1964, p. 32.-Forest and Guinot, 1966, p. 64.

*Description.*—Carapace (Figure 5) bearing four frontal teeth, submesial pair almost never more than half length of lateral pair. Metagastric area short, anterior width about 2.5 times length, posterior width about 1.5 times length. Anterolateral margins arched slightly; teeth, exclusive of outer orbital and lateral spine, with tendency to arrangement in a 3-2-2 pattern; proximal three narrow-acute and separated by narrow sinuses; middle two broader, acuminate, and more widely separated; lateral two spiniform and trending forward. Lateral spine usually long and slender. Surface finely or moderately and evenly granulate

except for variably smooth portions at periphery, especially on posterior and posterolateral slopes. Tendency toward ridging or heaping of granules on branchial and cardiac lobes. Epibranchial line prominent and nearly uninterrupted.

Chelipeds with propodus sharply ridged, ridges granulated; carpus often with granulated ridges evident dorsally; major chela with strong tooth at base of dactyl.

Male abdomen and telson narrow, reaching slightly beyond suture between thoracic sternites IV and V; telson about 1.6 times longer than wide; sixth segment constricted at midlength, sides markedly divergent proximally. Mature female abdomen and telson reaching same level as in male, telson a bit wider than long, sixth segment slightly shorter than fifth. First gonopods of male (Figures 18c, 20b) reaching slightly beyond midlength of thoracic sternite VII; curved sigmoidally in distal half, overlapping, divergent except at extreme tip and twisted mesioventrally on axis; armed distally with minute retrogressive spinules, scattered or occasionally arranged in rows. Gonopores of female (Figure 22c) irregularly lunate with superior limb of each directed anteromesad; aperture of each with rounded margin becoming lowest mesially where it slopes from near surface level laterad under posteriorly arched anterior border.

*Size of carapace in mm.*—Largest male: length 48, width at base of lateral spines 92, including lateral spines 117. Largest female: length 60, width at base of lateral spine 108, including lateral spines 138. Summary of selected measurements is given in Tables 1 and 2.

This species shows considerable variability in size but is, on the whole, the smallest in the genus. Females are often quite delicate, maturing at sizes as small as a length of 23, width at base of lateral spines 41, and width including lateral spines of 54. Irvine (1947) noted that large individuals measure 6 inches or more (155 mm) across the carapace.

*Color.*—Uniform gray-green or gray-blue with spot of blue on palm and proximal internal part of fingers of chela (Rossignol, 1962). Beautiful mottled carapace with bright blue legs, called the marine or deep sea blue swimming crab (Irvine, 1932, 1947). Preserved specimens often have an oval dark mahogany colored spot, variable in size, on the gastric and metagastric areas.

*Variations.*—In some ways *C. gladiator* resembles the "acutidens" form of *C. sapidus*, surpassing it in development of even more acute, slender spination, and showing variable ridging or cresting of granulations on branchial lobes and mesobranchial regions as well as formation of a transverse ridge of granules on each cardiac lobe. The peaking of granules is apparent at quite small size. In addition, these lobes and regions are often prominent and thrown into somewhat angular planes bordering the contrastingly sunken metagastric area. The second abdominal segment terminates laterally in a spine usually sharper and more prominent than in other species of the genus, especially in young or freshly molted individuals.

The lateral spines of most individuals are relatively the longest among species in the genus. Anterolateral teeth may be bilaterally asymmetrical in number. Tips of the teeth may lie in a nearly straight line providing relatively flat anterolateral arcs. All older individuals have a rounded notch between the first two anterolateral teeth. The lower side of each anterolateral margin becomes hairy at an early age.

Openness of the inner orbital fissure is random, bearing no relationship to age or width of carapace. When the fissure is closed, a V-shaped notch usually remains open on the orbital margin.

First gonopods of males are not completely S-shaped and not overlapping in juveniles; in a few males they extend to the level of a suture between thoracic sternites VI and VII. The first gonopods may be unnaturally splayed in preserved specimens. Abdominal segment 6 is often poorly calcified at midlength in males.

*Distribution.*—West Africa from Baie de Saint-Jean, 19°27'N, 16°22'W, Mauritania, to Baia do Lobito, Angola (Figure 24).

*Habitat.*—Longhurst (1958) provided an excellent ecological summary of the West African marine benthos primarily in and off the Sierra Leone River, but elsewhere as well. He found that in shelf regions under the influence of tropical shelf water a characteristic fauna was revealed by otter trawls in each sector investigated; the most important species were the swimming crabs *C. gladiator* and *Portunus validus* Herklots which occur in most hauls together with *Penaeus duorarum notialis* Burkenroad, *P. kerathurus* (Forsskål), *Parapenaeus longirostris* (Lucas),

*Panulirus rissonii* (Desmarest), and *Sepia officinalis* Linn. Off the Sulima River [=Moa River, Sierra Leone] occurrence of this fauna corresponded with the inshore *Cynoscion* fauna of demersal fish, with the thermocline as its lower limit. In samples, this fauna extended from Senegal to the Bight of Biafra, the genera *Callinectes*, *Portunus*, and *Panulirus* occurring in a high proportion of hauls from shallowest to 50 m. Irvine (1947), Rossignol (1962), and Crosnier (1964) essentially said the same, that this coastal marine species lives on the bottom from shore to depths of 30 m on sand, sandy mud, or gravel, sometimes with a mixture of shell fragments (Sourie, 1954a) in warm water.

Both Monod (1927) and Rossignol (1957) remarked on the small size and abundance as well as the rapidity and aggressiveness with which *C. gladiator* moves, the latter saying that it often rests three-fourths buried in a predatory position with only antennae and pincers exposed. In addition to trawl hauls, the crab is captured in nets allowed to hang a few feet from the bottom (Irvine, 1947) and at the surface with dip nets under lights at night.

Though found in estuaries to some extent, these accounts imply that *C. gladiator* is much like *C. similis* of the western Atlantic in ecological association and behavior, and less estuarine than *C. latimanus*.

*Spawning.*—Museum records provide only an outline of spawning that may go on all year. Records of ovigerous females are: December, Angola; January, Guinea, Liberia, and Cameroon; February, Cameroon; March, Sierra Leone, Congo; April, Ghana; May, Senegal, Sierra Leone, and Nigeria; June, São Tomé; October, Congo.

*Economic importance.*—No direct statements of economic importance are made in literature. Irvine (1947) reported the flesh and eggs edible and of good quality.

*Remarks.*—Aside from taxonomic accounts and faunal lists, there is less published information on *C. gladiator* than most *Callinectes*. Like others, larger or older specimens often bear one or more barnacles of the genus *Chelonibia* on the carapace. Teeth of fingers on the major chelae are often worn, and the major hands often seem disproportionately large for the size of the animal. One ovigerous female in the BMNH (unregistered)

from Victory Bay, Cameroon, has two major chelae.

The holotype is an immature male somewhat the worse for wear. The left chela is present but dismembered from the body, as are other legs or parts of legs and the abdomen. The left lateral spine is broken about halfway along its length, and only the left first gonopod remains.

Figures provided by Irvine (9 and 13, 1932; 202 and 203, 1947) are difficult to assign to synonymy with confidence, and both Capart (1951) and Monod (1956) had trouble with them. Figures 13 and 202 could represent either *C. gladiator* or *marginatus*, but 9 and 203 are labelled as *C. gladiator*, yet internal carpal spines on the latter indicate a species of *Portunus*. Since the features are sketchy, it is best to accept the author's designation with allowance for error.

The specimen named by Leach (in White, 1847) is an immature female with prominently ridged areas on the carapace and straight lateral spines typical of *C. gladiator*. There is a small mature female in this same collection.

*Material*.—Total: 80 lots, 412 specimens.

USNM. 18 lots, 95 specimens.

#### SENEGAL

21384, Dakar, 3 May 1892, 1 ♂, O. F. Cook. 119469, Dakar Harbor, 25-26 July 1964, 2 ♂, 2 ♀, *Geronimo*.

#### LIBERIA

20670, Mouth of Mesurado, Monrovia, no date, 1 ♀ juv, O. F. Cook. 87395, Farmington River at Snafu Docks, Nov. 1946, 3 ♂, 1 ♀, H. A. Beatty. 97861 and 97862, off St. Paul River mouth, Monrovia, 6 Jan. 1953, 2 ♀ (ov), G. C. Miller. 97863, off St. Paul River mouth, Monrovia, 4 Mar. 1953, 1 ♂, G. C. Miller.

#### IVORY COAST

120937, 05°02.5'N, 03°49.5'W, 30 May 1964, 2 ♀, *Pillsbury*.

#### GHANA

14879, Baya River, Elmina, Ashantee, 1889, 1 ♂, W. H. Brown, Jr., (Type).

#### NIGERIA

120938, Lagos, 9 May 1965, 1 ♂, *Pillsbury* Stn.

226. 123094, Lagos, 23 May 1964, 18 ♂, 22 ♀, 1 juv, *Pillsbury* Stn. 2. 120939, Lagos, 10 May 1965, 4 ♂, 6 ♀, *Pillsbury* Stn. 229. 120940, 04°06'N, 05°58'E to 04°02'N, 06°04'E, 14 May 1965, 9 ♂, 11 ♀, 1 juv, *Pillsbury* Stn. 250. 120941, 04°04'N, 06°18'E, 14 May 1965, 1 ♀, 1 juv, *Pillsbury* Stn. 252.

#### FERNANDO PÓO

120942, 03°35'N, 08°48'E, 15 May 1965, 1 juv, *Pillsbury* Stn. 258.

#### ZAIRE

54251, Banana, mouth of Congo River, Aug. 1915, 1 ♂, 1 ♀, H. Lang. 54252, Banana, mouth of Congo River, no date, 1 ♂, H. Lang.

AMNH. 4 lots, 7 specimens.

#### ZAIRE

3403 and 3470, Banana, Aug. 1915, 3 ♂, 1 ♀, H. Lang and J. Chapin.

#### ANGOLA

3385 and 3463, Santo Antonio do Zaire, Aug. 1915, 2 ♂, 1 ♀, H. Lang and J. Chapin.

BMNH. 19 lots, 64 specimens.

#### GAMBIA

1927.1.27.1, Cape St. Mary, 1 ♂, T. R. Hayes, Sir C. H. Armitage. 1952.9.9.19/20, 1 mi N Gunjur on coast, 1 ♂, 1 ♀, M. H. Routh.

#### SIERRA LEONE

1955.10.7.35, Rokel estuary [NE Freetown], 1 ♀ juv, T. S. Jones. 1957.5.26.76/78, Banana I., 2 ♂, 2 ♀, A. R. Longhurst. 1922.0.13.1/5, Sherbro I., 5 ♂, 5 ♀ (juv), C. H. Allan.

#### GHANA

1931.5.21.1, Accra, 1 ♂, F. R. Irvine. Two unreg. lots, Accra, 2 ♂, 3 ♀ (1 ov), F. R. Irvine.

#### NIGERIA

1966.10.17.3/4, 1 ♂, 1 ♀, Ejike. 1938.8.15.47/48, 5 juv, A. G. Taylor.

#### CAMEROON

1967.11.4.1/2, Ambas Bay [4°N, 9°10'E], Feb. 1966, 2 ♂, T. S. Jones. 1962.2.1.24/27, Victoria Bay, 4 ♂, 1 ♀, J. T. Swarbrick. Unreg., Victoria Bay, 16 ♀ (3 ov), J. T. Swarbrick. Unreg., Cameroon coast, Mar. 1962, 1 ♂, 1 ♀, R. C. Ward.

## WEST AFRICA

Unreg., 22, 1 ♀. Dry coll. vi/9, 1 ♀, Congo Exped., I. Cranch. Unreg., 1 ♀, *Lupa smythiana* Leach MS, *Neptunus sanguinolentus* in White Catalogue, 1847, J. Cranch.

MNHNP. 11 lots, 27 specimens.

## SENEGAL

Rufisque, 11 and 13 May 1947, 2 ♂, T. Monod. M'bour, 1948, 1 ♀, Dekeyser-Villiers. Off M'bour-N'gaparou, May 1949, 2 ♀ (ov), *G. Tréca*, Crémoux.

## SIERRA LEONE

Gulf of Guinea, 07°20'15"N, 12°39'W, 1956, 1 ♀ (juv), *Calypso* Stn. 11.

## IVORY COAST

Off Abidjan, 05°16'12"N, 04°0'20"W, 1956, 9 juv, *Calypso* Stn. 20.

## CAMEROON

Longji (Kribi)?, 30 May 1956, 1 ♂, *Calypso* Stn. 34. Mouth of the Kienke, Kribi, 1 ♀, T. Monod. Souelaba, 1932, 3 ♂ (juv), T. Monod.

## SÃO TOMÉ

Gulf of Guinea, 1956, 1 ♀ (ov), *Calypso* Stn. T27. 3 ♂, 3 juv, *Calypso* Stn. T9.

RMNH. 13 lots, 95 specimens.

## LIBERIA

1871, Grand Cape Mount, 1881, 1 ♂, 2 ♀, J. Büttikofer and J. A. Sala.

## NIGERIA

24186, Gulf of Guinea, 03°45'N, 08°03'E, 03°45'N, 08°02'E, 14 May 1965, 1 ♀, *Pillsbury* Stn. 256. 23520, off Nigeria, 04°03'N, 06°03'E, 04°04'N, 06°04'E, 14 May 1965, 3 ♂, 5 ♀ (1 ov), *Pillsbury* Stn. 251. 20597, Lagos Harbor, 23 May 1964, juv 5 ♂, 14 ♀, *Pillsbury* Stn. 2. 23519, Lagos Harbor, 10 May 1965, 1 ♂, 2 ♀, *Pillsbury* Stn. 228. 15532, Port Harcourt, Niger Delta, May-Aug. 1960, 4 ♂, H. J. G. Beets.

## FERNANDO PÓO

24185, 03°45'N, 08°48'E, 15 May 1965, 1 ♂ (juv), *Pillsbury* Stn. 257.

## CAMEROON

21572, Kribi, 9 Aug. 1964, 30+ (juv), B. de

Wilde-Duyfies. 21149, Kribi, 9 Mar. 1964, 11 ♂, 4 ♀, B. de Wilde-Duyfies. 21178, Doula, 10 Feb. 1964, 1 ♂, B. de Wilde-Duyfies.

## GABON

14995, Port Gentil, 1 juv, J. H. Logeman

## CONGO

374, 1880, 1 ♀, 2 juv, T. Kamerman.

## ANGOLA

1876, Musserra, 1882, 1 ♂, 1 ♀, T. Kamerman.

UNC-IMS. 15 lots, 125 specimens.

## TOGO

2717, 06°06'30"N, 01°37'30"E, 16 Oct. 1963, 1 ♀, A. Crosnier.

## DAHOMÉY

2718, 06°19'N, 02°24'E, 20 July 1964, 1 ♂, 2 ♀, A. Crosnier.

## CAMEROON

2719, 03°55'N, 09°00'E, 5 Jan. 1963, 3 ♀ (2 ov), A. Crosnier. 2720, 03°32'N, 09°35'E, 24 Aug. 1963, 5 ♂, 5 ♀, A. Crosnier.

## GABON

2721, Baie de Corisco, near Libreville, 3 July 1960, 1 ♂.

## CONGO

2722, off Pointe-Noire, Mar. 1962, 4 ♂, 1 ♀ (ov), A. Crosnier. 2723, Beach and Bay at Pointe-Noire, Oct. 1963, 6 ♂, 10 ♀ (5 ov), A. Crosnier. 2724, 3 June 1964, 2 ♂, A. Stauch. 2725, 27 May 1964, juv 29 ♂ (1 adult), 13 ♀, A. Stauch. 2727, Nov. 1962, 9 ♂, 12 ♀, A. Crosnier. 2728, 26 June 1964, 1 ♂, 1 ♀, A. Stauch. 2729, 27 May 1964, 2 ♂, A. Stauch. 2730, July 1963, 2 ♀, A. Crosnier. 2731, Estuaire de la Songolo, near Pointe-Noire, 1 ♀, A. Stauch.

## ANGOLA

2732, off Cabinda, Dec. 1962, 6 ♂, 8 ♀ (1 ov), A. Crosnier.

*Supplementary literature records.*—Baie de Saint-Jean [19°27'N, 16°22'W], Mauritania; Hann, Gorée, M'bour, and Joal, all S of Dakar, Senegal; Baixos das Galinhas, Ilha de Bissau, Portuguese Guinea; Iles de Los, 1 and 3 mi W and NW Tamara, near Cap Matakong, all near Conakry,

Guinea; Grand Lahou, Ivory Coast (Monod, 1956); Gold Coast shelf (Longhurst, 1958); Fernando Póo (Crosnier, 1964); 7°20'N, 12°39'W, Sierra Leone; lagoon at Abidjan, Ivory Coast; Kribi, Cameroon; Morro Peixe, São Tomé (Forest and Guinot, 1966); Cabinda, Luanda, and Baía do Lobito, Angola (Guinot and Ribeiro, 1962).

## *CALLINECTES ORNATUS* ORDWAY

Figures 6, 18d, 20d, 22d, 25

*Callinectes ornatus* Ordway, 1863, p. 571 (syn-types: labelled "types," 2 ♀, MCZ 5120, Charleston, South Carolina; 1 ♂, 2 ♀, MCZ 5128, Charleston, South Carolina; ♂ [dry], MCZ 5137, Gonaives, Haiti; ♂, MCZ 5136, Cumaná, Venezuela; those from Tortugas and Bahamas not found).- Smith, 1869, p. 8.- Rathbun, 1896, p. 356 (part), pl. 15; pl. 24, fig. 3; pl. 25, fig. 2; pl. 26, fig. 2; pl. 27, fig. 2.- 1898, p. 596.- 1901, p. 48.- 1930, p. 114 (part), text-figs. 15b, 16a, 17a, 18b, pl. 50.- 1933, p. 48, fig. 40.- Young, 1900, p. 188 (var. of *C. diacanthus*).- Verrill, 1908a, p. 366, text-figs. 22c, 23b; pl. 17, fig. 1; pl. 21, fig. 3.- Boone, 1927, p. 32.- Contreras, 1930, p. 232 (part), fig. 4.- Chace, 1940, p. 33.- 1956, p. 154.- Chace and Hobbs, 1969, p. 132, fig. 37e.- Balss, 1957, p. 1692 (part).- Holthuis, 1959, p. 200.- Guinot-Dumortier, 1960, p. 514, figs. 13a, b.- Williams, 1965, p. 172 (part).- 1966, p. 84, figs. 1A, B, 4A, B.- Taisoun, 1969, p. 69, fig. 25A-D, photo 9.- 1973, p. 22, figs. 4D, 5A, photo 1.

*Callinectes diacanthus*.- A. Milne Edwards, 1879, p. 225 (var. of *C. diacanthus*).- Young, 1900, p. 186 (part).

*Neptunus (Callinectes) diacanthus*.- Ortmann, 1894, p. 77 (part; specimens c, k, n<sub>3</sub>, West Indies; d, e, Brazil).

*Callinectes acutidens*.- Boschi, 1964, p. 45, pl. 2, figs. e, f, g; pl. 12, figs. 1, 2.

?*Callinectes humphreyi* Jones, 1968, p. 187.

*Description*.—Carapace (Figure 6) with lateral pair of frontal teeth prominent but submesial pair small, often almost completely rudimentary. Metagastric area of adults not deeply sculptured, anterior width about 2.8-2.9 times length, posterior width about 1.75 times length. Antero-lateral margins broadly arched, teeth exclusive of outer orbital and lateral spine progressively

more acuminate laterad; first five teeth with posterior margins longer than anterior margins, shouldered, distinctly separated by narrow-based, rounded notches; last two teeth with margins approximately equal in length, separating notches broad, next to last tooth distinctly more acuminate than spiniform last one. Lateral spine trending forward. Surface of carapace with granulations most prominent on anterior half and on mesobranchial regions, granulations smaller and more closely crowded on meso-metagastric and cardiac regions, nearly smooth along posterolateral and posterior borders.

Chelipeds with smoothly granulated ridges on chelae, carpus almost smooth dorsally, inferior lateral ridge terminating in a low tooth occasionally followed by an inconspicuous eminence. Major chela usually with strong basal tooth on dactyl and, especially in adult males, lower margin of propodal finger often decurved near base.

Male abdomen and telson reaching beyond suture between thoracic sternites IV and V, usually with distal portions recessed below plane of sternum in retracted position; telson slightly longer than broad with somewhat inflated sides; sixth segment of abdomen relatively narrow, sides slightly constricted, not parallel. Mature female abdomen and telson reaching as far forward as in male, telson as broad as long. First gonopods of male (Figures 18d, 20d) reaching almost to suture between thoracic sternites VI and VII, overlapping each other completely near base but diverging distally and tapering to usually lanceolate membranous tip; armed subterminally with short retrogressive spinules quite visible at low magnification, somewhat more numerous and longer distally than proximally with tendency to arrangement in rows near tip on ventral and mesial margin. Gonopores of females (Figure 22d) irregularly ovate with apex on long axis directed anteromesad; aperture of each irregularly and broadly lunate, sloping from surface on mesial side under rounded crenate anterior border and rounded eminence on posterior border.

*Size of carapace in mm*.—Largest male: length 60, width at base of lateral spines 105, including lateral spines 130. Two largest females: length 58, width at base of lateral spines 84, including lateral spines 107—length 69, width at base of lateral spines 83, including lateral spines 99. These two females demonstrate variability in mature form that is characteristic of all species in the

genus. Summary of selected measurements is given in Tables 1 and 2.

*Color*.—Adult males with carapace dull olive to dark brown, usually with a large, ill-defined, roundish spot of orange or orange-red on each side posteriorly; lateral spines and anterolateral teeth maroon, light blue or whitish, white tipped. Eye-stalks purple. Chelipeds proximally similar to carapace, spotted with blue or soft purple and with spines paler, joints red; inner surface of palm white, but with a large bright red patch bordered with purple; fingers mostly purple, tipped with red. Walking legs bright blue above, with a band of scarlet at each joint and a patch of paler blue or green on posterior and lower side of each article; dactyls red or violet. Swimming legs similar in color, but with red articular bands wider, a patch of orange or yellow on each article; dactyl with proximal blue band separated from distal scarlet band by an orange band. Abdomen light blue posteriorly. Females similar to males except upper surface of chela more violet; fingers with white or fuschia colored teeth.

Many individuals less brilliantly colored, juveniles often dull or plain olive-yellow to greenish above. Some males more melanistic, exhibiting shades of dark brown and purple with accents of yellow and brownish red. Albinistic (or light hued) forms not uncommon (Verrill, 1908a as condensed in Williams, 1966; Taissoun, 1969).

*Variation*.—A close relative of *C. danae* and *C. similis* (shape of carapace, metagastric area, and reduced submesial frontal teeth), *C. ornatus* is perhaps most often confused with *C. danae* because of their broad sympatric geographic ranges. *Callinectes ornatus* has the most obsolescent submesial frontal teeth of the three species, they being entirely absent in many individuals but developed somewhat in others. Within a single lot of equal-sized specimens both extremes may be seen (USNM 48401, Cuba; 18227, Jamaica) and keys to identification based on this character alone are of limited usefulness. The lateral pair of frontal teeth may have either rounded or quite sharp tips in the same lot of specimens (USNM 48401). Both types of variation in frontal teeth may be seen anywhere in the geographic range.

The anterolateral teeth are more acuminate, forward pointing, and longer than in *C. similis*. Brazilian and some Guianian juveniles in samples have erect anterolaterals, relatively longer for

their width, and more cleanly separated than teeth on those from Florida, whereas adult specimens from Brazil (also North Carolina and some from Bermuda and Jamaica) tend to have narrower sharper anterolateral teeth than those from Venezuela, Curaçao, Cuba, and especially Florida. A line of iridescent patches occurs along the bases of anterolateral teeth in some individuals. One specimen from Trinidad (BMNH) has coalesced third and fourth teeth on the right side.

Major chelae may be broad, even on moderate sized juveniles (Florida).

The abdomen of males usually is recessed, but may be flush with the sternum as in immature male *C. similis* and *C. danae*, but is never as broad as in *C. similis*.

First gonopods of males usually extend forward to the anterior one-fourth of thoracic sternite VII, but may reach beyond the suture between thoracic sternites VI and VII among individuals in the same lot. Usually overlapping at the base, at least one specimen was seen in which no gonopod overlap occurred. The lanceolate tip is not always well developed in juveniles, and the membranous extreme tip tends to be longer in Brazilian (and North Carolinian) material than through most of the range.

*Distribution*.—Bermuda; North and South Carolina through southern Florida; northwestern Yucatán to Estado de São Paulo, Brazil (Figure 25).

*Habitat*.—Essentially a tropical species found mainly on sandy or muddy bottom from shore to about 75 m, the young have also been collected on shell and sponge bottoms. Occurrence in bays and river mouths (Holthuis, 1959; Rouse, 1970; in addition to collection data presented here), as well as entrapment in fresh water (Brues, 1927), indicate tolerance of a broad range of salinity (recordings of 0-50‰ in temperatures ranging from 18° to 31°C); nevertheless, most collections have come from waters of relatively high salinity. Taissoun (1969) reported occurrence in a temperature of 9°C, but this is perhaps a reference to *C. similis* which occurs in colder water.

*Spawning*.—The spawning season probably extends year round. Museum collections studied include ovigerous females as follows: January, Puerto Rico; April, Guyana, Estado de Rio de Janeiro, Brazil; May, Estado de São Paulo, Brazil;



July, Estado de Rio de Janeiro, Brazil; August, Trinidad, Guyana, Surinam; September, Venezuela, the Guianas; December, St. Thomas, Estado de Rio de Janeiro, Brazil. Taissoun (1969) reported ovigerous females from the Golfo de Venezuela in January and May. Undated collections are recorded from southern Florida, Margarita Island, Venezuela, and Estado de São Paulo, Brazil.

*Remarks.*—It is difficult to distinguish some juveniles, immature males, and adult females of *C. ornatus* from *C. danae* and *C. similis*. Helpful distinguishing comparisons are the following: males have a narrower abdomen than *C. danae*; mature females have a smaller abdomen than *C. danae*; identification of small- to moderate-sized juveniles is often a matter of judgment based on shape of anterolateral teeth, length of obsolescent submesial frontal teeth, and width of the metagastric area.

Width of the metagastric area approaches that of *C. similis* in some individuals and is a good separating character from *C. danae* for juveniles in regions where no confusion with *C. similis* can occur. Borders of this area are more prominently defined than in *C. similis*, but become indistinct with age; in that condition they approach the smoothness of young *C. similis*. *Callinectes ornatus* apparently shows less variation than *C. danae*.

*Callinectes humphreyi* Jones, 1968, was based on an albinistic immature female from Barbados (carapace length 29, total width 60 mm). Though its status must remain an enigma because the type was lost through accident in 1969 (dried specimen destroyed by a bloodhound pup; Jones, pers. commun.) and no illustration was furnished with the description, it was characterized as, "nearest to *C. ornatus*, from which it may be immediately distinguished by its very different coloring . . . . *C. humphreyi* is pure white, except for a band of intense violet-purple on the inner surface of each cheliped, which fades to light red in dried specimens. *C. humphreyi* is also distinguished by its smaller size, the deeper, more conspicuous sinuses between the anterolateral teeth, the relatively longer intramedial area and the distinctly triangular shape of the abdomen." The form was found to be quite common along the southwestern coast of the island where it was usually seen quite near shore at low tide, the white color camouflaging the animals well on the area's sandy bottom. In view of the obvious similarity to

*C. ornatus*, endemic occurrence, and coloration falling within the range recognized by Verrill (1908a), it seems likely that this is a color variant of *C. ornatus*.

Williams (1966), in restricting *C. ornatus*, noted that syntypes from Charleston, S.C. were from a locality representing an apparent extreme northern limit of geographic range. At that time no other specimens were known from the Carolinas, although the species is abundant in southern Florida. Other material from northeastern Florida as well as North Carolina is now available. There is little doubt that these northern records still represent peripheral localities, as do those from southwestern Florida between Charlotte Harbor and Tampa Bay. Records for *C. ornatus* in New Jersey (Chace and Hobbs, 1969; Taissoun, 1969) represent *C. similis*, the Carolinian congener of *C. ornatus*. Collections from Bermuda are large, and it was primarily on the basis of these that Verrill (1908b) postulated drift of larvae in oceanic currents as island colonizers for the genus.

Locality data for specimens 30-6 and 30-8 in MNHNP (M. Fontaines) from "Chili" identified as *Neptunus diacanthus* Latr. (identified as *C. ornatus* by Rathbun, 1896) are in error.

*Material.*—Total: 351 lots, 1,260+ specimens.

Specimens listed in Rathbun (1930) from USNM and MCZ (listings from New Jersey, North Carolina, South Carolina, Louisiana, and Texas = *C. similis*).

USNM. 161 lots, 646 specimens, including the following not cited above:

#### BERMUDA

65644, Hungry Bay, Apr. 1928, 1 ♂, E. Deichmann.

#### UNITED STATES

North Carolina: 77013, Sea Buoy, Beaufort, 10 Oct. 1935, 1 ♂, 1 ♀, J. S. Gutsell.

Florida: 122995, 28°21.5'N, 80°33.5'W, 4 Apr. 1940, 1 ♂, Pelican Stn. 207-1. 122987, shoreline, W side Norris Cut, N end Virginia Key, Miami, 23 Aug. 1966, 1 ♀ (juv), col. unknown. 76989, Coral Gables, no date, 1 ♀, 1 juv, J. F. W. Pearson. 76966, Coral Gables, no date, 1 ♀ (parasitized), J. F. W. Pearson. 122994, Biscayne Bay, 5 Sept. 1938, 5 ♂, 5 ♀, USFWS Launch 58. 113459, Pigeon Key, Monroe Co., 7 Aug. 1965, 6 ♂, 4 ♀ (parasitized), R. B. Manning. 122988, beach area and tidal flats SW

end Bahia Honda Key, Monroe Co., 14 June 1964, 2 ♀ (juv), Foster and Kaill. The following from Key West—45805, no date, 1 ♂, H. Hemphill. 71638, 1934, 1 ♀, H. H. Darby. 76992, no date, 6 ♂, 5 ♀, col. unknown. 76988, front of Biol. Stn., 31 Oct. 1922, 7 juv, USBF, S. and F. 76987, no date, 1 ♂, USBF. 76986, front of Biol. Stn., 25 Nov. 1922, 1 ♀ (juv), USBF, F. and S. 76985, Little Salt Pond Key, 7 Nov. 1922, 1 ♂, 1 ♀, (juv), USBF. 76983, 26 Feb. 1919, 1 ♂, 1 ♀ (juv), USBF, H. and S. 76982, no date, 2 ♂, 1 ♀ (juv), USBF. 76981, Marquesas Keys, no date, 4 ♂, 2 ♀, A. S. Pearse. 122997, Marquesas Keys, 11 Aug. 1931, 8 juv, A. S. Pearse. The following from Dry Tortugas—76976, 5 Aug. 1930, 1 ♀ (juv), W. L. Schmitt. 76977, Long Beach, 7 Aug. 1930, 1 ♂, 1 ♀ (juv), W. L. Schmitt. 76978, Long Key, 25 June 1931, 1 ♂, W. L. Schmitt. 76995, from Long Key to Bush Key, 5 Aug. 1930, 1 ♂, 2 ♀ (1 ov), W. L. Schmitt. 77011, Long Key, 25 June 1931, 1 ♂, 1 juv, W. L. Schmitt. 76997, Long Key, Aug. 1930, 3 ♂, 1 ♀, W. L. Schmitt. 77012, Long Key, 24 June 1932, 3 juv, W. L. Schmitt. 76979, Fort Jefferson moat, 26 June 1931, 1 ♂, 1 ♀ (juvs), A. S. Pearse. 71637, Bush Key, 4 Aug. 1934, 1 ♂, 1 ♀, H. H. Darby. 113009, Charlotte Harbor, 30 July 1964, 4 ♀ (juv), from C. H. Saloman, USFWS, Stn. X-9A. 113010, Charlotte Harbor, 27 Jan. 1964, 1 ♂, 2 ♀ (juv), C. H. Saloman, USFWS, Stn. X-9A. 122989, oyster bed, Cape Haze Marine Lab., Sarasota, 21 July 1965, 1 ♂ (juv), R. Cressey. 113007, Tampa Bay, 9 Oct. 1964, 1 ♂ (juv), from C. H. Saloman, USFWS, Stn. B-13. 113008, Tampa Bay, 16 Sept. 1964, 1 ♀ (juv), from C. H. Saloman, USFWS, Stn. B-13.

Unknown locality "South Atlantic and Gulf Coasts of the United States": 2157, no date, 3 ♂, 2 ♀, col. unknown.

#### BAHAMAS

88653, Bimini, 13 Nov. 1948, 2 ♀ (juv), A. S. Pearse. 88654, Bimini, Nov. 1948, 1 ♀ (juv), A. S. Pearse. 122990, Clifton Bay, Lyford Cay, Nassau, 14 Aug. 1961, 1 ♂, 2 ♀ (juv), W. L. Schmitt. Uncatalogued, Great Inagua Island just N Matthewtown, 20 Jan. 1968, 1 ♂, Gosner. 76994, no date, 1 ♂, Owen Bryant. 122991, British West Indies, no date, 1 ♂, 1 ♀ (juv), R. Robbins.

#### CUBA

73306, Bahía de la Habana, 11 May 1937, 2 ♂, 5 ♀, W. L. Schmitt. 76481, Siguanea Bay, 12 Apr. 1937, 1 ♂, (juv), Paul Bartsch. 76485 and 76493, Isla de Pinos, opposite Siguanea I., 11 Apr.

1937, 50 juv, Paul Bartsch, R113 and R114. 76492, Isla de Pinos, opposite Siguanea I., 11 Apr. 1937, 2 ♂, Paul Bartsch, R115 and 116.

#### JAMAICA

122976, 17°53'N, 77°48'W, 18 May 1965, 2 ♂, 1 ♀, Oregon Stn. 5396. 73287, Jamaica or Cienfuegos, Cuba, 4 May 1937, 1 ♀, W. L. Schmitt, Stn. 76.

#### DOMINICAN REPUBLIC

122996, Bahía de Calderas, 1 ♀ (juv), through I. B. de Calventi and S. Jakowska, 10 July 1967.

#### PUERTO RICO

73286, San Juan, 27 Apr. 1937, 1 ♂, 1 ♀, W. L. Schmitt. 122999, off Fort San Gerónimo, San Juan, 30 Apr. 1937, 1 ♂, W. L. Schmitt.

#### VIRGIN ISLANDS

St. Thomas: 2457, no date, 1 ♂ (dry), A. H. Riise. St. Croix: 73288, Christiansted, 7 Apr. 1937, 1 ♀ (juv), W. L. Schmitt, Stn. 31. 73289, same, 9 Apr. 1937, 1 ♂, Stn. 34. 76470, Christiansted Harbor, Dec. 1937, 1 ♀, H. A. Beatty, No. 214. Prickly Pear Island: 122981, Vixen Point, Gorda Sound, 15 Apr. 1956, 2 ♂, Nicholson, Schmitt, and Chace, Stn. 111-56, *Freelance*.

#### BARBUDA

122982, Oyster Pond Landing, lagoon side, 25 Apr. 1959, 6 ♂, 3 ♀ (immat), W. L. Schmitt, et al., Stn. 92-59. 122980, near Oyster Pond Landing, W shore lagoon, 6 Apr. 1956, 4 ♂, 6 ♀ (immat), Schmitt, Chace, Nicholson, and Jackson, Stn. 85-86, *Freelance*. 122978, 6 Apr. 1956, 1 ♂, Stn. 88-56, *Freelance*.

#### GADELOUPE

122977, Pointe à Pitre, between Monroux and Rat Is., 30-31 Mar. 1956, 10 (juv), Chace and Nicholson, Stn. 68-56, *Freelance*.

#### ST. LUCIA

122979, Marigot Lagoon, shore of bay outside, 21 Mar. 1956, 1 ♂, Schmitt, Chace, Nicholson, and crew, Stn. 38-56, *Freelance*.

#### BARBADOS

76993, 1918, 1 ♀, Barbados-Antigua Exped.

#### MEXICO

Yucatán: 12992, ocean beach at Progreso, 400 yd W steamship wharf, 30 Mar. 1936, 1 ♂, M. B.

Trautman. 12993, same, 600 yd W steamship wharf, 8 ♂ (6 juv), 1 ♀ (juv), Trautman, Patton, and Costello.

Quintana Roo: 122984, Bahía de la Ascensión, about 1/3 mi W Allen Pt. light, 13 Apr. 1960, 1 ♂, 3 ♀ (juv), Daiber and Rehder, Stn. 66-60, *Blue Goose*. 122983, Bahía de la Ascensión, shore in front Allen Pt. light, 13 Apr. 1960, 1 ♂, 2 ♀ (1 parasitized), 6 juv, Daiber, Stn. 65-60, *Blue Goose*. 122986, Bahía del Espíritu Santo, N shore, 5 Apr. 1960, 2 ♂, 2 ♀ (juv), Bousfield, Stn. 37-60, *Blue Goose*. 122985, Bahía del Espíritu Santo, N shore near Lawrence Pt., 6 Apr. 1960, 1 ♀ (juv), Rehder, Daiber, and Haynes, Stn. 42-60, *Blue Goose*.

#### BRITISH HONDURAS

76990, Belize, Sergeants Caye, no date, 2 ♀ (juv), P. W. Shufeldt.

#### VENEZUELA

101824, Estado Falcón, Bahía de Amuay, Península de Paraguaná, May 1957, 1 ♀, F. A. Aldrich. 122965, SE Trinidad and off Orinoco Delta, 09°55'N, 60°53'W, 26 Aug. 1958, 3 ♀ (1 ov, 1 juv), *Oregon* Stn. 2208. 122966, 09°32'N, 60°24'W, 20 Sept. 1958, 4 ♂, 5 ♀ (3 ov), *Oregon* Stn. 2348.

#### GUYANA

122970, 08°30'N, 58°56'W, 28 Aug. 1958, 1 ♀, *Oregon* Stn. 2228. 122969, 08°20'N, 58°30'W, 29 Aug. 1958, 4 ♀ (2 ov), *Oregon* Stn. 2234. 122975, 06°54'N, 57°47'W, 25 Mar. 1963, 1 ♂, *Oregon* Stn. 4306.

#### SURINAM

103177, 06°15'N, 55°54'W, 6 June 1957, 1 ♂, *Coquette* Stn. 182. 103178, 06°22'N, 55°03.5'W, 4 June 1957, 37 juv, *Coquette* Stn. 157. 103179, 06°22'N, 55°06'W, 11 May 1957, 1 ♂, *Coquette* Stn. 1. 103180, 06°23'N, 55°05.5'W, 11 May 1957, 1 ♂, 1 ♀ (juv), *Coquette* Stn. 2. 103181, 06°28'N, 54°57.5'W, 11 May 1957, 1 ♂ (juv), *Coquette* Stn. 20. 122968, 06°26'N, 54°20'W, 15 Sept. 1958, 1 ♂, *Oregon* Stn. 2327. 103454, 07°12'N, 57°22'W, 18 Sept. 1958, 1 ♀ (ov), *Oregon* Stn. 2339. 122967, off the Guianas, 1958, 1 ♀ (ov) *Oregon*.

#### FRENCH GUIANA

122971, 05°56'N, 52°20'W, 11 Sept. 1958, 1 ♀ (ov), *Oregon* Stn. 2307. 122972, off Cayenne, 05°30'N, 52°10'W, 12 Sept. 1958, 1 ♀ (ov), *Oregon* Stn. 2310.

#### BRAZIL

122973, off N mouth Amazon R., 02°29'N, 48°58'W, 14 Nov. 1957, 2 ♂, (1 juv), *Oregon* Stn. 2058. 122974, off Ceará, 02°23'S, 40°31'W, 12 Mar. 1963, 1 ♀, *Oregon* Stn. 4250. 72313, Villa Bella, São Sebastião, 18 Sept. 1925, 3 carapaces (dry), W. L. Schmitt. 122998, Barro, Santos, 12 Sept. 1925, 5 ♂, 1 ♀, W. L. Schmitt.

AHF. 13 lots, 26 specimens.

#### UNITED STATES

Florida: Hillsboro Inlet, Sept. 1943, 1 ♂, 2 ♀, (immat), E. R. T. Hillsboro Inlet, 15 May 1945, 1 ♂, 2 ♀, J. S. Garth, No. 8-45. Pompano Beach, Sept. 1944, 1 ♀ (juv), E. R. J. Hawk Channel, Key Largo North, 7 June 1949, 1 ♀ (juv), Stn. LM32-49. Same, 29-31 May 1949, 3 ♂, 3 ♀ (immat), Stn. LM25, LM-27. Key Largo, Florida Bay, 0.8 km SW "My Place" near Hamper Pt., 23 May 1949, 2 parasitized apparent ♀♀, Stn. LM18-49. Hawk Channel, Plantation Key near Tavernier Creek, 26 May 1949, 1 ♂ (juv), Stn. LM21-49. Lower Matecumbe Key, Hawk Channel, 5.3 km SW Indian Key Drawbridge, 23 Sept. 1950, 1 ♀ (juv), Stn. LM-57. Hawk Channel, Grassy Key, E coast 1.6 km S "Seaside Cabins," 24 May 1949, Stn. LM19-49. Margo Island near channel S Big Marco Pass, 14 June 1949, 1 ♂ (juv), Stn. LM39-49.

#### CURAÇAO

Schottegat, Santa Anna Harbor, 12°07'03"N, 68°55'34"W, 23 Apr. 1939, 2 ♀, *Velero III* Stn. A47-39.

#### VENEZUELA

Isla Cubagua, 10°48'48"N, 64°13'30"W, 30 Apr. 1939, 2 ♂, 1 frag., *Velero III* Stn. A30-39. Isla Cubagua, 10°49'25"N, 64°16'W, 15 Apr. 1939, 1 ♀ (juv), *Velero III* Stn. A28-39.

AMNH. 26 lots, 73+ specimens.

#### BERMUDA

11252, 2 Sept. 1932, 1 ♀ (juv), W. Beebe Bermuda Exped. 11223, 1939, 6 ♂, 2 ♀, (juv), W. Beebe Bermuda Exped. 295, no date, 1 ♂, W. M. Rankin. 11220, 1939, 1 ♂, W. Beebe Bermuda Exped. 11250, 1930, 1 ♀ (juv), W. Beebe Bermuda Exped. 11225, 1929, 1 ♂, W. Beebe Bermuda Exped. 11221, 29 Apr. 1937, 1 ♀, W. Beebe Bermuda Exped.

## UNITED STATES

Florida: 6684, Indian River, Nov. 1920, 2 ♂ (juv), Prince. 10367, Lake Worth, July and Aug. 1945, 3 ♂ (1 dry), 1 ♀ (juv), W. G. Van Name and A. H. Verrill.

## BAHAMAS

11222, North Bimini, June 1939, 1 ♀ (juv), W. Beebe Bermuda Exped. 11291, Bimini, 5 Sept. 1947, 1 ♀, J. C. Armstrong. 11292, Bimini, 1 ♀ (ov), J. C. Armstrong. 11634, Bimini, 14 June 1953, 1 ♀, W. D. Clarke. 11296, Bimini, 21 Oct. 1947, 3 ♂, 2 ♀, J. C. Armstrong. Nassau and Andros Islands, Mar.-Apr. 1930, 1 ♂ (juv), Bacon-Miner Exped. and International Exped. to Andros I. 10368, Andros I., 1926, 1 quart juv and immat, R. A. Miner.

## HAITI

1949-1950, 2 ♂, 2 ♀ (1 juv), A. Curtiss. 11219, Bizoton Reef [NW Port au Prince], 4 Mar. 1927, 2 ♂ (1 juv), W. Beebe Exped.

## DOMINICAN REPUBLIC

8641, W shore north half of El Cayo [Barahona Harbor], 7 July 1932, 1 ♂, 1 ♀ (juv), J. C. Armstrong. 9395, southern part La Piedra Prieta Reef, Barahona Harbor, 16 July 1932, 1 ♀ (juv), J. C. Armstrong.

## PUERTO RICO

2945, Bahía de Guanica, Ensenada, 14 June 1915, 3 juv, R. W. Miner and H. Mueller. 2999, yard at Miramar, Santurce Barrio, San Juan, 14 July 1914, 1 juv, R. W. Miner and L. Estrada.

ANSP. 3 lots, 8 specimens.

## UNITED STATES

4897, Lake Worth Inlet, Fla., no date, 1 ♂ (immat), 4 ♀ (immat), H. A. Pilsbry.

## BAHAMAS

3489, New Providence Island, no date, 1 ♂, 1 ♀, H. C. Wood, Jr.

## HAITI

5422, Port au Prince, 1950, 1 ♂ (dry), A. Curtis.

BMNH. 11 lots, 18 specimens.

## UNITED STATES

Florida: 1966.12.5.558/559, coast of Everglades Park, 1 ♂, 1 ♀, Univ. Miami Inst. Mar. Sci. 61.44,

south coast of United States, 2 ♂, 3 juv (dry), vi/9, W. Stimpson.

## CARIBBEAN SEA

1955.10.6.98/99, Stn. 28 (44), 1 ♂, 1 ♀ (juv), Oxford Univ. Cayman Exped.

## ANTIGUA

1967.4.4.136, 1 ♀ (juv), F. H. Mansell, H. M. S. *Dorsetshire*. 1928.12.1.57, 1 ♂, W. R. Forrest.

## BARBADOS

1963.5.16.33, 1 ♀, H. M. S. *Frobisher*, 15 Feb. 1933.

## TRINIDAD

1962.12.12.2, Mayaro-Point Radix, Stn. 1125, 1 ♂, D. W. Richardson. Unregistered, San Fernanda, 1 ♀, N. Boutakoff.

## GUYANA

1958.11.12.27/28, 07°39'N, 57°44'W to 07°47'N, 57°32'W, 23-24 Apr. 1958, 1 ♂, 1 ♀ (ov), Trawler *Cape St. Mary*.

## BRAZIL

50.32, 1 ♀ (dry), vi/6.

MCZ. 32 lots, 106 specimens.

## BERMUDA

8377, July 1903, 2 juv, O. Bryant. 8459, Sinky Bay, 30 May 1916, 1 ♂, Bermuda Biol. Stn. 8460, Fairyland Bay in eelgrass, 14 Feb. 1916, 1 ♂, W. J. Crozier. 8890, 1 ♂, recd. from E. L. Mark, 19 Oct. 1920. 8891, Tom Woods Bay, 25 Apr. 1916, 1 ♂, 2 ♀ (juv), E. L. Mark. 8892, Sinky Bay, 11 Apr. 1916, 1 ♂ (immat), E. L. Mark. 9203, Richardsons Inlet, S side St. George Island, June 1936, 5 ♂, 6 ♀ (immat), F. A. Chace, Jr. 9256, Vaughns or Whites Bay, St. Davids Island, 18 June 1936, 4 ♂ (juv), F. A. Chace, Jr. 9447, July 1936, 2 juv, L. H. Kleinholtz.

## UNITED STATES

South Carolina: 5210, Charleston, no date, 2 ♀ labelled "Types," col. unknown.

Florida: 8749, 1 ♀ (ov), Maynard. 5130, Key West, no date, 1 ♀, C. E. Faxon. 1134, Tortugas, 1 ♀ (juv), Holder, recd. 8 June 1960. 8748, July 1859, 4 ♂, 2 ♀ (juv), Woodbury. 5131, Tortugas, 3 ♂, 1 ♀, Woodbury, recd. from Smithsonian. Inst., 13 Feb. 1861. 5206, Fort Jefferson, Tortugas, 3 ♂, part of Ordway's material.

## BAHAMAS

9481, N entrance Hawksbill Creek, Grand Bahama Island, 8 Apr. 1936, 1 ♂, W. J. Clench. 11673, Alicetown, North Bimini, May 1941, 1 ♀, R. W. Foster and J. Huntington. 9488, Governors Harbor, Eleuthera Island, 2 May 1936, 1 ♂, W. J. Clench. 9426, Simms, Long Island, 7 July 1936, 1 ♂ (juv), Harvard-Bahama Exped.

MNB. 4 lots, 17 specimens.

## BRAZIL

Pernambuco: 331, Praia do Pina, Recife, Sept. 1944, 3 ♀ (juv), col. unknown.

Rio de Janeiro: 49, no other data, 1 ♂. 82, Rio Guanabara, no other data, 2 ♂, 9 ♀ (3 juv). Praia do Fundao, Baía de Guanabara, Dec. 1951, 2 ♂, N. Santos.

MNHNP. 9 lots, 16 specimens.

## UNITED STATES

Florida: Tortugas, 4 ♂, from MCZ.

## FRENCH GUIANA

Stn. 354, 23 m, mud, 12 Aug. 1957, 2 ♂, 1 ♀, juv, J. Durand, ORSTOM II. Stn. 413, 48 m, dead shells-rocks, 24 July 1958, 1 juv, J. Durand, ORSTOM II. Îles du Salut, July 1957, 2 ♂, 1 ♀, J. Durand, ORSTOM II.

Following are a series of dry specimens with poor or questionable locality data that were also determined by M. J. Rathbun in 1896.

Guadeloupe: 1 ♂, 1 ♀, M. Beaupertuis. Chili: 1 ♂, 30-6, 1 ♀, 30-8, M. Fontaines. Côte de Amérique, 1 ♂, 30-19.

RMNH. 60 lots, 200+ specimens.

## UNITED STATES

Florida: Bear Cut, N point Key Biscayne, Miami, 15802, 15 Sept. 1960, juv. 15803, 4 Sept. 1960, juv. 15804, 14 Sept. 1960, juv. 15805, 15 Sept. 1960, juv. 18718, 2-9 Sept. 1963, 1 juv. 23385, 6 Dec. 1964, 1 ♀ (parasitized). 24372, 22 Nov. 1964, juv. 23366, 1 Jan. 1965, juv (parasitized). 23415, 9 Jan. 1965, 1 ♂, juv. 23418, Jan. 1965, 1 ♂, juv. 24371, 1 Jan. 1965, juv. 24373, 10 Jan. 1965, juv. 23430, 9 Jan. 1965, juv (parasitized). 23421, 1 Feb. 1965, 1 ♂ and juv (parasitized), all by J. A. Cabrera and L. B. Holthuis. 23271, 16 Jan. 1965, 2 ♀ (parasitized), L. B.

Holthuis. 18717, 1-9 Sept. 1963, 2 ♂, 1 juv, L. B. Holthuis. 23377, Pigeon Key, W Marathon, 30 Jan. 1965, 1 ♂, L. B. Holthuis and J. A. Cabrera. 4920, Tortugas, July 1925, juv, H. Boschma. 15632, Marco Beach S of Marco, 12 Sept. 1960, 1 ♀, beached after hurricane Donna, L. B. Holthuis.

## BAHAMAS

2853, Nassau, New Providence, 1887, 2 ♂, 1 ♀, A. de Haas. 1870, Bahama Islands, no date, 1 ♂, 1 ♀, Dr. de Haas.

## ST. MARTINS

23457, freshwater pond, 3 Oct. 1963, 2 ♀ (juv), P. W. Hummelinck. 14997, Great Bay, 23 June 1955, 2 juv, P. W. Hummelinck. 11870, Oyster Pond, E coast, 22 Feb. 1957, 4 juv, L. B. Holthuis. 11872, coast near Philipsburg, 16-17 Feb. 1957, 1 ♀, 2 juv, L. B. Holthuis. Simsons Bay, washed ashore on beach, 19 Feb. 1957, 1 carapace (dry), L. B. Holthuis. 11873, freshwater pond W Philipsburg, 17 Feb. 1957, 3 ♂, 1 ♀, 1 juv, L. B. Holthuis. 11875, Simsons Bay, 23 Feb. 1957, 20 juv, L. B. Holthuis.

## VENEZUELA

10721, Margarita Island?, possibly Caracas Bay, Curaçao, 1955, 2 ♀ (1 ov), P. W. Hummelinck. 1868, coast, no date, 1 ♂ (juv), T. Buitendijk.

## ARUBA

2372, Vaardenbaai (?), 1 June 1905, 1 ♂, Prof. Boeke. Pova Beach, NW coast of island, 27 Apr. 1955, 3 ♂ (dry), J. S. Zaneveld and P. W. Hummelinck. 1307, 1883, 1 ♂, K. Martin. 2261, lagoon, 3 July 1905, 1 ♂ (juv), Prof. Boeke. 1867, June 1883, 1 ♀ (juv), A. J. v. Koolwijk. 1869, July 1883, 1 ♂ (juv), Dr. de Haas.

## CURAÇAO

St. Kruis Baai, 7 Oct. 1948, 2 juv, P. W. Hummelinck. 23351, NW part Piscadera Baai, 25 Nov. 1963, 5 juv, P. W. Hummelinck. Piscadera Baai, 16 Mar. 1957, 1 carapace (beached, dry), L. B. Holthuis. 23393, S part Piscadera Baai, 15 Oct 1963, 1 ♀, col. unknown. 11874, Piscadera Baai, fish trap, 11-14 Feb. 1957, 1 ♂, 1 ♀, L. B. Holthuis. 3272, Schottegat, 10 Feb. 1939, 5+ ♂, 2 ♀, H. W. C. Cossee. 2234, reefwater (lagoon), 2 m, 26 July 1905, 1 ♂ (juv), Prof. Boeke.

## BONAIRE

NE coast of Cay, 1 Sept. 1948, 2 ♂, P. W. Hummelinck.

## GUYANA

22510, 06°54'N, 57°47'W, 25 Mar. 1963, 2 ♂, Oregon Stn. 4306.

## SURINAM

22518, 06°16'N, 55°56'W, 19 Feb. 1963, 2 ♂, 2 ♀ (juv), Oregon Stn. 4171. 21154, off coast between mouths of Suriname and Coppename Rivers, 25-27 Aug. 1964, 1 ♀ (ov), juv, *Coquette*. 11869, 10 mi N mouth of Suriname R., 6-9 May 1957, juv and subadult, *Coquette*. 14999, mouth Suriname R. near Resolutie, 22 Dec. 1942, 1 juv, D. C. Geijskes. 14996, near lightship *Suriname Rivier*, 3 May 1957, 1 juv, *Coquette*. 18672, 20 mi E lightship *Suriname Rivier*, 20 Feb. 1963, 1 ♂, *Coquette*. 11871, 20 mi from coast, NNW mouth Marowijne R., 8-12 Apr. 1957, 1 ♂ (juv), *Coquette*.

## FRENCH GUIANA

11868, 06°00'N, 53°29'W, 29 May 1957, 2 ♂, juv, *Coquette*. 14998, 05°56'N, 53°17'W, 21 May 1957, 1 juv, *Coquette*.

## BRAZIL

São Paulo: 21587, Ribeira Beach, Ubatuba, 18 July 1962, 1 ♂, L. Forneris. 21694, Enseada Palmas, Anchieta I., Ubatuba, 28 Feb. 1962, 1 ♂ (juv), L. Forneris. 21695, Pedra Andorinha, Ubatuba, 22 Jan. 1963, 1 juv, L. Forneris. 17536, Santos, 12 Sept. 1960, 3 juv, L. R. Tommasi. 17537, Santos, 20 Apr. 1961, 1 ♂ (juv), L. R. Tommasi.

SADZ-B. 27 lots, 125 specimens.

## UNITED STATES

Florida: 1466, Key West, 1883, 2 subadult carapaces (dry), Jordan.

## BRAZIL

Rio de Janeiro: 1728, Atafona, 1964, 2 ♂, 1 ♀, N. Meneses. 1959, Praia do Forma, Cabo Frio, July 1957, 1 ♂ (juv), Luiz Tommasi. 3255, Praia do Forte, Cabo Frio, Jan. 1964, 1 ♀, S. J. Rand, N. Papanen, S. Tocchetreu, and S. Tacla. 2336, Ilha Grande, Dec. 1965, 1 ♀ (ov), *Emilia* Stn. 14. 3084, Ilha Grande, 30 July 1966, 1 ♀ (ov), *Emilia* Stn. c-288. 2335, Ilha Grande, no date, 1 ♀, Stn. 12. 3226, S side Ilha Grande, 43 m, mud, 17.8°C, 26 Apr. 1968, 2 ♀ (1 ov), Hydrographic Stn. 283. 3247, 25 m, dredge, 11 Nov. 1956, 1 ♂, *Corvette Solimões* Stn. 99/56. 3249, Ilha Grande, Aug. 1960, 2 ♂, *Emilia* Stn. 1. 3261, 3228, Enseada das Estrêlas, Ilha Grande, 18 July 1966, 27 ♂, 5 ♀, 16 juv, G.

Melo. 3237, Enseada das Estrêlas, Ilha Grande, 26 Feb. 1966, 22 ♂, 5 ♀, col. unknown. 2339, Enseada das Estrêlas, Ilha Grande, 26 July 1966, 1 ♂, 1 ♀, G. Melo. 3082, Angra dos Reis, Ilha dos Conqueiros, 21 Apr. 1966, 1 ♂, G. Melo.

São Paulo: 3217, Ubatuba, 1905, 1 ♂, E. Garbe. 3259, Ubatuba, 1905, 1 ♀ (juv), E. Garbe. 1745, Ilha Bela, São Sebastião, Mar. 1962, 1 ♂, 1 ♀ (juv), P. E. Vanzolini. 3227, São Sebastião, 1895 [?], 1 ♀ (juv), H. Britski. 348, Ilha São Sebastião, 1915, 8 ♂, 2 ♀ (1 ov), Bicego. 1740, Praia Grande, São Sebastião, Feb. 1962, 2 ♂ (juv), H. Britski. 2109, Santos, 1959, 1 ♂, 1 ♀, Serviço Especial Pesca. 1673, Ilha da Moela [near Santos off Guarujá], 18 May 1962, 3 ♂, 2 ♀ (1 ov), C. Jesús. 1671, Baía do Guarujá, 22 May 1962, 1 ♂, 1 ♀, C. Jesús. Praia Grande, São Vicente, 4 Aug. 1954, 1 ♂, 1 ♀, L. Travassas, E. Dente, and Werner. 2064, unknown locality, July 1959, 2 ♂, 2 ♀, *Emilia* (first trip).

YPM. 5 lots, 25+ specimens

## BERMUDA

3850, 1901, 1 ♀ (juv), A. E. Verrill and party. 6397, April 1901, 5 ♂, 4 ♀, A. E. Verrill and party. 6398, 1901, 4 ♂, A. E. Verrill and party. 6392, 1901, 1 ♂, Bermuda Biol. Stn. 6394, 1901, several juv, A. E. Verrill and party.

*Supplementary literature records.*—Southern Florida (Rouse, 1970); Isla de Pinos, Cuba (Boone, 1927).

## CALLINECTES DANAE SMITH

Figures 7, 18e, 20e-f, 22e, 24

- Lupa dicantha.*- Dana, 1852, p. 272, (type: 1 ♂, dry, USNM 2371, Rio de Janeiro, Brazil).- 1855, pl. 16, fig. 7a-c.
- Callinectes diacanthus.*- Ordway, 1863, p. 575 [10].- A. Milne Edwards, 1879, p. 226 (var. of *C. diacanthus*).- Young, 1900, p. 186 (part).
- ?*Neptunus diacanthus.*- Heller, 1868, p. 26.- Doflein, 1899, p. 186 (part, the Colombia and Brazil specimens).
- Callinectes Danae* Smith, 1869, p. 7 (syntypes: 1 ♂, 1 ♀, MCZ 5143; 1 ♂, 1 ♀, YPM 824, Recife [=Pernambuco, Estado de Pernambuco], Brazil, C. F. Hartt). (Type locality restricted by Rathbun, 1930.)
- ?*Lupa (Neptunus) diacantha.*- von Martens, 1872,

p. 92, (part, the Rio de Janeiro specimens).

*Callinectes danae*.- Rathbun, 1896, p. 357, pl. 16; pl. 24, fig. 4; pl. 25, fig. 3; pl. 26, fig. 3; pl. 27, fig. 3.- 1898, p. 596.- 1901, p. 48.- 1930, p. 118 (part), text-figs. 15d, 16d, 17b, 18d, pl. 51.- 1933, p. 49.- Verrill, 1908a, p. 370, fig. 22e (not 22d).- Chace, 1940, p. 33.- Chace and Hobbs, 1969, p. 130, fig. 37b.- Holthuis, 1959, p. 201.- Lemos de Castro, 1962, p. 39, pl. 2, fig. 9.- Williams, 1966, p. 86, fig. 2A-D, 4C, D.- Jones, 1968, p. 187.- Taissoun, 1969, p. 75, fig. 28A-D, photo 10.- 1973, p. 33, figs. 4B, 5D, photo 4.

*Callinectes*.- Kretz and Bücherl, 1940, p. 173, unnumbered col. pl., figs. 1-22.

*Description.*—Carapace (Figure 7) bearing four frontal teeth, submesial pair no more than half length of lateral pair. Metagastric area of adults with anterior width about 2-2.5 times length, posterior width about 1.5 times length. Anterolateral margins somewhat arched, teeth exclusive of outer orbital and lateral spine varying from often convex sided with subacute tips at orbital end of row to sharper and more spiniform laterally, each with anterior margin shorter than posterior and separated from contiguous ones by narrow-based rounded notches. Surface of carapace rather evenly and smoothly granulate, except granules more widely spaced on epibranchial region and near anterolateral border, most crowded on gastric, mesobranchial, and cardiac regions; nearly smooth along frontoorbital, posterolateral, and posterior borders.

Chelipeds with granulate ridges, upper surface of carpus bearing slightly developed interrupted ridges trending longitudinally with axis of limb, ridges bearing obsolescent granules often better developed in males than in females, inferior lateral ridge terminating in a strong lateral spine or tooth often followed by a strong eminence. Male abdomen and telson reaching beyond suture between thoracic sternites IV and V; telson triangular, longer than broad with somewhat inflated sides; sixth segment of abdomen with sides nearly straight, diverging proximally, poorly calcified proximally except for variably indurated basal portion often connected to distal part by a narrow central column. Mature female abdomen and telson reaching as far forward as in male, sixth segment shorter than fifth, telson triangular with slightly inflated sides. First gonopods of male

(Figures 18e, 20e, f) reaching beyond midpoint of thoracic sternite VI, overlapping each other near base, or adjacent, and tapering to narrow membranous tips usually bent ventrolaterally; armed with scattered but mainly dorsal minute spinules and two to four subterminal sternomesial exceedingly slender elongate spinules. Gonopores of females (Figure 22e) broadly and irregularly ovate with apex on long axis directed anteromesad, aperture of each broadly open mesially, narrowing laterally, and sloping from surface on mesial side under curved and rounded superior border and a rounded prominence on posterolateral border.

*Size of carapace in mm.*—Largest male: length 58, width at base of lateral spines 104, including lateral spines 139. Largest female: length 48, width at base of lateral spines 84, including lateral spines 108. Summary of selected measurements is given in Tables 1 and 2.

*Color.*—Live males from Cubatão River near Santos, São Paulo, Brazil: Carapace olive, becoming indigo on edges of lateral spines and outer anterolateral teeth in some individuals, more uniformly olive in others; teeth and spines on chelae white tipped; a white patch in deepest part of depression above third walking leg. Cheliped with upper surface of palm, dactyl, part of carpus, and spined edge of merus indigo to purple, and same color in splashes on inside of fingers, distally on merus and laterally on carpus. Flat outer dorsal surface of palm and upper surface of merus reticulate blue and olive (but many crabs predominantly olive on this part). Walking and swimming legs predominantly china blue to azure blue, grading to greenish and olive in darker parts. Lower edge of chelae grading from purple to china blue or azure individually. Chelipeds with inner face of palm, outer face of palm and fingers, lower face of merus, as well as meri of remaining legs and ventral surface of cephalothorax, white.

Described above is a colorful male which should be called the "purple crab" if *C. sapidus* is called a "blue crab." Some individuals are duller and some have a reticulate pinkish-blue cast on the upper surface of chelipeds.

Color notes by Kretz and Bücherl (1940) and Taissoun (1969) emphasized the distal intense purple coloration of legs and a grayish-blue carapace on adult males.

*Variation.*—Individual variation of first gonopods outlined by Williams (1966) can be elaborated here. The first gonopods of males vary somewhat in length, being either a little longer or shorter than as described above (long in southern, short in northern parts of the range). Males from Rio de Janeiro, Brazil, southward tend to have first gonopods reaching near or beyond the suture between thoracic sternites V and VI, as do some specimens examined from St. Lucia in the Windward Islands, but some south Brazilian specimens have shorter first gonopods. Males from north of Rio de Janeiro, northeastern South America, and the West Indies tend to have first gonopods reaching from near the middle of thoracic sternite VI to the suture between thoracic sternites VI and VII. The ill defined shortening trend is accentuated in Cuban, Honduran, and a single lot of Floridian material, reaching extreme shortness in the Panamanian region of the Caribbean, especially in USNM lot 43931 in which male gonopods extend only to the suture between thoracic sternites VII and VIII. But in these areas, too, there is enough variation that groupings are hard to define.

The lower margin of the major chela is often decurved opposite the molar complex of the propodus and strongly developed proximal tooth of the dactyl.

*Distribution.*—Bermuda; southern Florida and eastern side of Yucatán Peninsula to Estado de Santa Catarina, Brazil (Figure 24).

*Habitat.*—*Callinectes danae* is a common species in Brazil where it occurs from muddy estuaries in mangroves and algae covered broken shell bottoms, to beaches and open ocean depths of 75 m. Specific limits of salinity tolerated are not well documented, but ranges indicated are from fresh to full sea water, and perhaps to hypersaline lagoons.

Kretz and Bücherl (1940) gave no specific designation to species of *Callinectes* studied, but they gave (p. 173) a fairly clear description of the first gonopods of *C. danae*, and their figures, especially 2 and 14, indicate this species. *Callinectes danae* is the most abundant member of the genus along beaches from Santos to Rio de Janeiro where they worked.

Park (1969) found *C. danae* only on or adjacent to the ocean side of islands in Biscayne Bay, usually on wave beaten shores. He reported it absent from the Florida Keys.

*Spawning.*—The spawning season probably extends year round. Museum collections studied include ovigerous females as follows: January, Surinam; February, Rio de Janeiro; March, Puerto Rico, Haiti, Panama; May, Haiti, Estado de São Paulo, Brazil; June, Estado de São Paulo, Brazil; July, Colombia, Rio de Janeiro; August, Estados de Rio de Janeiro and Santa Catarina, Brazil; November, Curaçao, St. Lucia. Undated collections are from Estados de Bahia, Rio de Janeiro, São Paulo, and Santa Catarina, Brazil. Taissoun (1969) reported an abundance of ovigerous females from May to July in the Golfo de Venezuela, implying an even longer spawning season.

*Economic importance.*—Literature available does not deal with commercial exploitation of this species except that incidental reports of purchase in markets and capture on fishing vessels imply fairly general usage.

Vendors along roads NW of Santos, Estado de São Paulo, Brazil, near mangrove swamps sell the crabs alive, displaying bunches of a dozen or so each suspended on strings to which the crabs cling by the chelae when they are out of water.

*Remarks.*—Closest structurally to *C. arcuatus*, its Pacific counterpart (shape of carapace, metagastric region, male first gonopods, and frontal teeth), *C. danae* also shows similarity to *C. marginatus*. The metagastric area is much alike in all three species. In *C. marginatus* the well separated anterolateral teeth trend forward, and the portion of carapace anterior to the epibranchial line is coarsely granulate. In both *C. arcuatus* and *C. danae*, although anterior borders of the anterolateral teeth are shorter than posterior borders, the teeth point outward rather than sweep forward. *Callinectes danae* is quite smoothly granulate over most of the carapace; *C. arcuatus* is much the same but shows more sculptured relief. Among males of the three, *C. marginatus* has much the slenderest abdomen for its length. The telson of *C. danae* males is relatively longer than in *C. arcuatus*.

Width of the sixth abdominal segment in adult female *C. danae* is relatively greater than in adult female *C. ornatus*, a character valued by Rathbun (1930) but one that requires practice to assess. Williams (1966) misnumbered the sixth abdominal segment as the fifth in discussing this character.



Specimens of *C. danae* reported from Chile in literature must be regarded as of uncertain origin, either mistakenly identified with this Atlantic species by early naturalists unfamiliar with similar Pacific forms, or carried from the Atlantic to Pacific sides of South America by sea captains or collectors who recorded destination of voyages as country of origin rather than source of collection (Garth, 1957). Locality data for USNM 20270 (1 ♂), and MNHNP 30.3, 30.2, 30.10, 30.11, 3 [?], S31 (dry, 5 ♂, 1 ♀) listed as "Chili," and 30.20 (1 ♂, dry) as "Amerique" [labelled as *Neptunus diacanthus*], col. Fontaines, are erroneous or incomplete. Corrected identifications were also made by Rathbun in 1896.

A carapace and abdomen of an immature male from the Pleistocene of Maryland (Wailes Bluff, Bed 1) reported as *Callinectes ornatus* by Blake (1953) is probably *C. danae*. Shape of the abdomen is nearer to *C. danae* or *C. similis* than *C. ornatus*, and the metagastric area in both proportions and granulation is most like the average condition for modern *C. danae*, next nearest to *C. sapidus*, and not like *C. ornatus*.

*Material.*—Total: 202 lots, 782+ specimens.

Specimens listed in Rathbun (1930) from USNM (24427, 24428, 24429, 22044, not found; 20115, 22817 = *C. similis*; 60984 = *C. ornatus*; 1 ♂, 1 ♀ 40591 = *C. marginatus*) and MCZ (4278 not found).

USNM. 86 lots, 310+ specimens, including the following not cited above:

#### UNITED STATES

Florida: 77087, Long Key, Tortugas, 5 Aug. 1930, 1 ♂ juv, W. Bullington. [?] Uncatalogued, Pompano Beach, Sept. 1943, 1 ♂, E. R. Tinkham.

#### CUBA

123003, Bahía del a Habana, 11 May 1937, 2 ♂, W. L. Schmitt. 99862, Playa Baracoa, 16 Nov. 1954, 1 ♂ juv, K. K. Caldwell et al. 99916, Playa Baracoa, Fisheries Lab., 16 Nov. 1954, 1 ♀, H. H. Hobbs, Jr. 99937, E Xanadú, Hicacos Pen., Matanzas Prov., 24-27 Jan. 1957, 1 ♂, W. L. Schmitt.

#### JAMAICA

42854, Montego Bay, 20 July 1910, 1 ♂ juv, C. B. Wilson. 46246, Montego Bay, 12 Nov. 1910, 1 ♂, A. E. Andrews. 61364, 4 Feb. 1928, 2 ♀ juv, C. R. Orcutt.

#### PUERTO RICO

24421, Palo Seco, Bahía de San Juan, 13 Jan. 1899, juv 2 ♂, 1 ♀, *Fish Hawk*. 123004, Bahía de San Juan, 29 Mar. 1937, 1 ♀, W. L. Schmitt. 73280, Boca de Cangrejos, 7 mi E San Juan, 31 Mar. 1937, 1 ♀ (ov), W. L. Schmitt.

#### VIRGIN ISLANDS

St. Croix: 77101, Rust-op-Twist, on sea coast, no date, 1 ♂, 2 juv, H. A. Beatty. 72833, St. Croix, Salt River, no date, 8 juv, H. A. Beatty.

#### ST. LUCIA

22044, Port Castries, 29 Nov. 1887, 5 ♂, 6 ♀, *Albatross*.

#### MEXICO

Quintana Roo: 123002, Bahía del Espíritu Santo, N shore, 5 Apr. 1960, 1 ♂ (parasitized), E. L. Bousfield.

#### HONDURAS

78099, Utila I., 25 mi off coast, Sept. 1938, 1 ♂, Louis Mouquin.

#### PANAMA

59283, 1912, 2 ♂, 2 ♀, 4 juv, Meek and Hildebrand. 59344, no date, 1 ♀, Meek and Hildebrand. 77089, Fox Bay, Colón, 23 Feb. 1935, 2 ♂ juv, S. F. Hildebrand. 89575, Galeta Pt., Ft. Randolph, C. Z., 1949, 2 ♀, 1 juv, V. Walters.

#### COLOMBIA

105034, Golfo del Darién, 7°56.8'N, 76°47'W to 7°56.5'N, 76°47'W, 8 Feb. 1960, 1 ♀ juv, *Atlantis*.

#### VENEZUELA

Falcón: 101825, Bahía de Amuay, Península de Paraguaná, May 1957, 1 ♂, F. A. Aldrich. Miranda: 89645, Tacarigua de la Laguna, 1 Mar. 1949, 1 ♂, Soc. Cienc. Nat. La Salle, Stn. C-4. Sucre: Gulf of Paria, 10°29'N, 62°30'W, 24 Oct. 1963, 1 ♂, *Oregon* Stn. 4495. Delta Amacuro: 123001, off Orinoco Delta, 09°39'N, 60°49'W, 26-27 Aug. 1958, 1 ♀, *Oregon* Stn. 2211.

#### BRAZIL

40590, 1875-77, 1 ♀ juv, Hartt. Rio de Janeiro: 77086, São Francisco, 25 Aug. 1925, 1 ♂, 2 ♀ juv, W. L. Schmitt. 77107, Porto da Inhauma, May 1935, 11 ♂, 12 ♀, Doris Cochran. Paraná: 77095, 77096, Paranaguá, 3 Oct. 1925, 4 ♂, 1 ♀ juv, W. L. Schmitt.

AHF. 3 lots, 3 specimens.

#### CURAÇAO

Schottegat, Santa Anna Harbor, 23 Apr. 1939, 1 ♂, *Velero III* Stn. A47-39.

#### TRINIDAD

West Manzanilla, 10°30'N, 61°02'W, 18 Apr. 1939, 1 ♀, *Velero III* Stn. A36-39. Port of Spain, 18 Apr. 1939, 1 ♂, *Velero III* Stn. A37-39.

AMNH. 13 lots, 57 specimens.

#### HAITI

11219, Bizoton Reef, 4 Mar. 1927, 1 ♀ (ov), W. Beebe Exped. 11224, 21 May 1927, 2 ♀ (ov), W. Beebe. 11242, 1927, 1 ♀, W. Beebe. Unreg. 1949-50, 1 ♂, A. Curtiss.

#### SANTO DOMINGO

9393, NW corner Bahía de Neiba, Bahía de Barahona, 6 July 1933, 23 juv, J. C. Armstrong. 9394, N half of El Cay, Bahía de Barahona, 7 July 1933, 1 ♂, J. C. Armstrong.

#### PUERTO RICO

2681, Ensenada, 17 June 1915, 1 ♀, R. W. Miner. 2695, Ensenada, June 1915, 2 ♀, Mayer. 2665, San Juan, Palo Seco Pt., 18 July 1914, 7 ♂, 5 ♀, R. W. Miner. 2899, San Juan, 17 July 1914, 1 ♂, R. W. Miner. 2687, San Juan, 1 Aug. 1914, local boys. 2680, Id. S Catano R. mouth Cano de San Fernando, San Juan, 11 July 1914, 1 ♂, 1 ♀, R. W. Miner and J. T. N..

#### PANAMA

11241, Bahía de Colón, no date, 4 ♂, 5 ♀, *Arc-turus* Exped.

ANSP. 2 lots, 3 specimens.

#### UNITED STATES

3394, America, no date, 1 ♂, 1 ♀, E. Wilson and I. Lea [listed in catalogue as N. America].

#### CUBA

4697, Cojímar near La Habana, 10 July 1940, 1 ♂, R. A. McLean.

BMNH. 13 lots, 20 specimens.

#### BARBADOS

72.28, no date, 2 ♂ juv, F. G. Beckford.

#### WEST INDIES

43.7, no date, 1 ♀ (dry) vi/9.

#### TRINIDAD

1962.12.12.1, Tapora Point, 1 ♂, D. W. Richardson, Stn. 1123. Unreg., San Fernando, 2 ♂, N. Boutakoff. 1962, Tapora Point, 9 Feb. 1962, 1 ♂ juv, D. W. Richardson, Stn. 1121/3.

#### BRAZIL

919b, 2 ♂ (dry) vi/6/7, C. Stewart. 919a, 1 ♂ (dry) vi/7, C. Stewart. Pernambuco: 80.37, juv. 1 ♂, 1 ♀, W. Forbes. Bahia: unreg., 1 ♂ (dry) vi/6. Rio de Janeiro: 1952.3.6.12, 1948, 1 ♂, P. Drach. 74.20, 3 ♀ (2 ov), A. Fry. 50.32, Rio de J. market, 2 ♂, juv (dry) vi/6/7, Rothesay.

MCZ. 10 lots, 102 specimens including the following not cited above.

#### CUBA

10886, Cienfuegos, 29 Mar.-1 Apr. 1939, 3 ♂, 2 ♀, Harvard-Havana *Atlantis* Exped.

#### COLOMBIA

5135, Cartagena, no date, 1 ♂ juv, A. Schott.

#### TRINIDAD

9975, Otheite, 9 mi N La Brea, 22 Aug. 1937, 1 ♂, 1 ♀, 2 juv, E. Deichmann. 9958, Caroni Swamp, 8 Aug. 1937, 1 ♂, 3 ♀, E. Deichmann.

#### BRAZIL

Rio de Janeiro: 5145, no date, 61 specimens. Thayer Exped. 5146, recd. 1 Dec. 1863, 4 ♂, G. N. Davis. São Paulo: 5142, Santos, no date, 4 ♂, 1 ♀ juv, Coutinho, Thayer Exped.

MNB. 7 lots, 44 specimens.

#### BRAZIL

Pernambuco: 60, no date, 24 ♂, 5 ♀. Rio de Janeiro: 65, Rio-Guanabara, 2 ♂. Unnumbered, Praia do Fundão, Baía de Guanabara, Dec. 1951, 1 ♂, N. Santos. 51, Rio-Guanabara, 5 ♂, 3 ♀. 260, Recreio dos Bandeirantes-Guanabara, 24 May 1953, 1 ♂, N. Santos. São Paulo: 54, Santos, 1 ♀ (ov). Santa Catarina: 53, São Francisco do Sul, no date, 1 ♂, 1 ♀, L. Jualberti.

MNHNP. 3 lots, 6 specimens.

#### BRITISH HONDURAS

Belize, 1 ♂ (dry), date, col. unknown.

## BRAZIL

30-21, 1 ♂ (dry), date, col. unknown. Santa Catarina, 1875, 1 ♂, 1 ♀ (ov), Vignes 1129. 202.64, Desterro [= Florianópolis], 1 ♂ (dry), M. Müller.

## ARGENTINA [?]

Suitré [?], 1922, 3 ♂ (dry), from Museo de Historia, Nat., Buenos Aires. Incomplete data or erroneous localities: 6 ♂, 1 ♀ (dry) from "Chile" and "Amerique" by M. Fontaines and col. unknown. (No. 30.3, 30.2, 30.10, 30.11, 30 [?], 30.20, and S31).

RMNH. 21 lots, 49+ specimens.

## ST. MARTIN

Great Bay, 7 June 1955, 1 ♂, P. W. Hummelinck. 10716, freshwater pond, 27 July 1955, 1 ♀, P. W. Hummelinck. 11850 and 1112, freshwater pond W Philipsburg, 17 Feb. 1957, 2 ♀, juv., L. B. Holthuis.

## MARTINIQUE

3273, Fort de France, 6 Feb. 1939, 1 ♀, H. W. C. Cossee.

## PANAMA

Canal Zone, Bahía de Limón, N Limón Point, 5 July 1966, 6 juv., Pillsbury Stn. 322.

## COLOMBIA

23518, Golfo de Urabá, 08°0.1'N, 76°50.3'W to 08°1.2'N, 76°47.7'W, 12 July 1966, 3 ♂, 2 ♀ (1 ov), 2 juv., Pillsbury Stn. 357.

## NETHERLANDS ANTILLES

Aruba: 15040, Lagoon NW Savaneta, 21 Mar. 1957, 2 juv., L. B. Holthuis.

Curaçao: St. Kruis Baai, 7 Oct. 1940, 1 carapace, P. W. Hummelinck. 15038, within St. Martha Baai, near St. Nicolaas, 3 Nov. 1957, 1 juv., L. B. Holthuis. 11852, Piscadera Baai, 11 Feb. 1957, 2 ♂, 1 ♀, L. B. Holthuis. 15039, Piscadera Baai, mudflat behind mangroves, Caraibisch Mar. Biol. Inst., 24 Jan. 1957, 1 ♀ juv., L. B. Holthuis. 10717, Caracas Baai, Nov. 1954, 1 ♀ (ov), J. S. Zaneveld. 11849, Waaigat, Willemstad, 30 Jan. 1957, 3 ♂, 3 ♀, L. B. Holthuis. 11851, South shore St. Joris Baai at Choloma, 3 Jan. 1957, 3 ♂, 1 ♀, L. B. Holthuis.

## TRINIDAD

23368, and unnumbered, Diego Martin River, 1965-66, 2 ♂, H. O. von Hagen.

## SURINAM

11848, near lightship *Suriname Rivier*, 12-13 Jan. 1953, 1 ♀ (ov), H. W. Lijding.

## BRAZIL

Cat. a, no date, 2 ♂ (dry). 375, Bahia, 1909, 5 juv ♂ and ♀, J. A. Bierens de Haan.

## ATLANTIC OCEAN

1859, 1 ♂ juv., R. Conradsen.

SADZ-B. 43 lots, 186+ specimens.

## BRAZIL

Bahia: 2098, Ilha de Itaparica, July 1959, 1 ♂, Tagea Bjornberg. 350, June 1896, 1 ♂, 1 ♀, Bicego. 3225, Ilhéus, 1919, 4 ♂, 1 ♀, E. Garbe. 1725, Ilha Madre de Deus, 1932, 1 ♂, Oliviera Pinto. Rio de Janeiro: 401, São João da Barra, 1911, 2 ♂, E. Garbe. 3239, Atafona, 12 July 1963, 5 ♂, 6 ♀, N. Meneses. 3213, Atafona, lagoon, 3 ♂, 6 ♀, N. Meneses. 1730, S. J. Barra, 1963, 1 ♂, N. Meneses. 3232, Macaé, 24 Oct. 1942, 1 ♂, A. Castro and J. Feio. 370, Rio de Janeiro, 1898, 1 ♂, Bicego. 3252, Ilha Grande, 17 May 1966, 1 ♀ juv. 3256, Angra dos Reis, 27 July 1966, juv. 3257, Praia do Baia, Angra dos Reis, 20 May 1966, 1 ♀, G. Melo. 3258, Praia Grande, Angra dos Reis, 18 May 1966, 1 ♂, G. Melo. 1734, Angra dos Reis, 1945, 1 ♂, 1 ♀, 1 juv., L. T. Filho. 3083, Ilha Grande, 14 May 1966, 1 ♀, *Emilia*. 3238, Enseada das Estrêlas, Ilha Grande, 26 Feb. 1966, 13 ♂, 10 ♀ (2 ov). 3260 and 3229, Enseada das Estrêlas, Ilha Grande, 18 July 1966, 26 ♂, 24 ♀ (8 ov), G. Melo. 3248, [off Rio de J.?], 11 Nov. 1956, 1 ♂, Corvette *Solimoés*, Stn. 99/56.

São Paulo: 891, São Sebastião, 1915, 3 ♂, 4 ♀, E. Garbe. 1724, São Sebastião, no date, 2 ♂, 2 ♀, P. E. Vanzolini. 1741, Praia Grande, São Sebastião, Feb. 1962, 1 ♀, H. Britski. 2108, São Sebastião, July 1959, 2 ♂, H. R. Costa. 1737, 3253, Estrada Caraquatoba, São Sebastião, no date, 1 ♂, 2 ♀, 1 carapace. 3251, Farol da Moela, Aug. 1965, 1 ♀, Inst. Pesca Santos. 1662, Farol da Moela, Mar. 1964, 4 ♀ (1 ov), Inst. Pesca Santos. 522, Piassaquera, Jan. 1914, large left merus of chela. 398, Piassaquera, Sept. 1910, 3 ♂, 3 ♀. 359, Piassaquera, June 1903, 5 ♀ (2 ov), Luederwaldt. 1813, Santos, 11 Sept. 1962, 2 ♂, 6 ♀, G. Melo. 1732, Santos, no date, 2 ♀, E. Rabello. 1735, Porto Novo, Santos, Nov. 1947, 2 ♂, L. Damico. 1403, Itanhaen, May 1926, 1 ♂, R. Spitz. 1407, Itanhaen, May 1927, 1 ♂, 1 ♀ (ov), R. Spitz. 1302, Itanhaen, July 1935, 1

♀, R. Spitz. 3236, Praia da Trincheira, Cananéia, 27 June 1964, 6 ♂, Cory and Isauro.

Santa Catarina: 665, Itajá, 1900, 3 ♂, Luederwaldt. 3235, Praia de Itapema, Itapema, July 1965, 1 ♂, Dep. Zool. Exped. 3244, 27°15'S, 48°47'W, 70-75 m, sand-shell, 21 Aug. 1966, 3 ♂, 2 ♀ (1 ov), M. Iwai. Rio Grande do Sul: 3233, Praia de Torres, 5 Oct. 1964, 2 ♂, J. Bertoletti. 3250, Praia na desembocadura, Rio Tramandai, 8 Apr. 1965, 2 ♂ juv., R. P. Leal.

YPM. 1 lot, 2 specimens.

#### BRAZIL

824, Pernambuco, 1867, 1 ♂, 1 ♀, C. F. Hartt.

*Supplementary literature records.*—Bermuda (Verrill, 1908a); Florida (Futch, 1965; Park, 1969); Golfo de Venezuela and Estr. de Maracaibo, Venezuela (Taisoun, 1969); Curaçao (Nobili, 1897); Barbados (Jones, 1968); Barra das Jangadas [S Recife], and estuaries, Pernambuco, Brazil (Coelho, 1966, 1970, 1971); Ilha de São Sebastião and ocean beaches, Estado de São Paulo, Brazil (Luederwaldt, 1929; Lavallard, 1960).

### CALLINECTES ARCUATUS ORDWAY

Figures 8, 18f, 20g-h, 22f, 24

*Callinectes arcuatus* Ordway, 1863, p. 578 [13] (type: ♂, USNM 61833, Cape San Lucas [Baja California]).—A. Milne Edwards, 1879, p. 228 (var. of *C. diacanthus*).—Rathbun, 1896, p. 362, pl. 20; pl. 23, fig. 1; pl. 24, fig. 8; pl. 25, fig. 7; pl. 26, fig. 7; pl. 27, fig. 7.—1898, p. 596.—1910, p. 537, 577, pl. 56.—1930, p. 121, text-figs. 15h, 16h, 17f, 18g, pl. 52.—Young, 1900, p. 190 (var. of *C. diacanthus*).—Nobili, 1901, p. 31.—Boone, 1929, p. 564, text-fig. 3.—Contreras, 1930, p. 233, text-fig. 5.—Garth, 1948, p. 35.—1957, p. 36.—1961b, p. 141.—Garth and Stephenson, 1966, p. 43, pl. 5, fig. A; pl. 8, fig. A; pl. 10, fig. A; pl. 12, fig. D.—Buitendijk, 1950, p. 275.—Bott, 1955, p. 56.

*Callinectes pleuriticus* Ordway, 1863, p. 578 [14] (syntypes: 2 ♂, 1 ♀, MCZ 4701; ♂, MCZ 987; Panama, A. Agassiz).—A. Milne Edwards, 1879, p. 228 (var. of *C. diacanthus*).—Young, 1900, p. 190 (var. of *C. diacanthus*).

*Callinectes* sp. Smith, 1871, p. 91.—Lockington, 1876, p. 107 [13].

?*Neptunus diacanthus* Brocchi, 1875, p. 54, pl. 16, fig. 82.—Cano, 1889, p. 90, 99, 100, 102, 211.—Doflein, 1899, pl. 186 (part; the Ecuador specimen).

*Callinectes nitidus* A. Milne Edwards, 1879, p. 228, explan. pl. 41 (var. of *C. diacanthus*) (syntype: ♂, USNM 20269, Tanasco [= Tahuesco, 14°01'13"N, 91°07'03"W] Guatemala, on the borders of the Esteros).—Young, 1900, p. 190 (var. of *C. diacanthus*).

*Callinectes diacanthus*.—A. Milne Edwards, 1879, pl. 41 [var. *nitidus*].

*Callinectes dubia* Kingsley, 1879, p. 156 (type: ♂, MCZ 5178, Gulf of Fonseca, west coast of Nicaragua, J. A. McNeil).—Young, 1900, p. 191.

?*Neptunus (Callinectes) diacanthus* Ortmann, 1894, p. 77 (part; the S. Chile specimen).

*Callinectes diacanthus*.—Young, 1900, p. 186 (part).

*Description.*—Inflated carapace (Figure 8) bearing four triangular frontal teeth, submesial pair no more than half length of lateral pair. Metagastric area of adults with anterior width about 2.5 times length, posterior width between 1.3 and 1.5 times length. Anterolateral margins arched, teeth exclusive of outer orbital and lateral spine well separated and varying from convex-sided with subacute tips at orbital end of row to sharper and more spiniform laterally, each with anterior margin shorter than posterior. Surface of carapace with granulation fairly uniform, most crowded on gastric, mesobranchial, and cardiac regions, more scattered near anterolateral margins, and smooth along frontoorbital, posterolateral, and posterior borders. Epibranchial line prominent, interrupted slightly at corner of mesogastric area.

Chelipeds with sharply granulate ridges on propodus, basal portion of dactyl, and exposed surfaces of carpus. Dactyl of major chela with large basal tooth closing against molariform complex at base of propodal finger, lower margin of propodal finger often decurved near base in adults.

Male abdomen and telson reaching beyond suture between thoracic sternites IV and V; telson triangular, longer than broad; sixth segment of abdomen with sides nearly straight distally, diverging proximally, segment poorly calcified proximally except for triangular basal portion connected to distal half by a narrow (sometimes obsolescent) central indurated column. Mature female abdomen and telson reaching as far forward as in

male, last two segments nearly equal in length, telson triangular with slightly inflated sides, apices acute. First gonopods of male (Figures 18f, 20g, h) reaching about to abdominal locking tubercles on fifth sternite, often partially overlapping near base, tapering to narrowly flared tips bent ventrolaterally and opening mesioventrally, armed with scattered minute spinules sternally and laterally and with a subterminal sternomesial row of elongate slender spinules. Gonopores of females (Figure 22f) elliptical with long axis in transverse plane, sinuous aperture of each with rounded margins except mesial side sloping from surface under overhanging anterior and inferior bulbous posterolateral border.

*Size of carapace in mm.*—Largest male: length 54, width at base of lateral spines 93, including lateral spines 123. Largest female: length 55, width at base of lateral spines 96, including lateral spines 114. Summary of selected measurements is given in Tables 1 and 2. Estévez (1972) judged females to attain sexual maturity at a length of 28-34 mm, but smaller ones are known (see Spawning).

*Color.*—Male: "Carapace dull olive gray-green. Chelipeds olive green dorsally, whitish ventrally, washed with bluish-violet and chelae tipped with pale yellow-brown. Legs turquoise washed with olive; hairs straw gold; swimming legs olive green with suggestion of turquoise, paddles washed with black; hairs straw; tubercles at leg joints golden orange; eyes straw with brownish streaks; underparts pure white" (Garth, 1961b; Garth and Stephenson, 1966).

Female: Carapace generally blue, central portion blue violet; anterolateral portions deep purplish-vinaceous. Chelipeds with base of merus olive, inner portion of hands blue-violet, remainder purplish but varied, fingers barred with purple, propodal fingers usually white tipped. Remaining legs Italian blue, hairs olive, swimming legs with articulations and margins narrowly violet, paddles sometimes turquoise. Abdomen violet, joints and sternum white (Garth, 1961b).

*Variations.*—Lateral spines in *C. arcuatus* vary considerably, some being relatively no longer than in *C. exasperatus*. Inner orbital fissures are open in some individuals. Chelipeds often have smooth ridges rather than granulate ones, and the propodal molariform complex of the major chela is

often worn. The proximal portion of abdominal segment 6 may be almost completely uncalcified in males.

Variations in *C. arcuatus* are often those associated with proportional growth changes. These are pronounced enough to make identification difficult, especially among juveniles. *Callinectes pleuriticus* and *C. dubia* were based on immature *C. arcuatus*. The mesogastric area grows relatively broader with the maturing carapace. Adult females have a more arched carapace than the immature, and seemingly more females than males have a hairy growth under the anterolateral border. First gonopods of juvenile males are short; those of adult males range in length from short, with tips terminating at level of the suture between thoracic sternites VI and VII, to long, terminating near the suture between thoracic sternites IV and V. The tips of these appendages usually curve ventrolaterally but may curve ventrally, mesially, or asymmetrically, and the slender distal portions occasionally are sinuous rather than straight. Subterminal dorsal spinules may be worn off of first gonopods.

An ovigerous female from Panama (AHF, Stn. 111-33) has seven anterolateral teeth on the left side.

*Distribution.*—Los Angeles Harbor, Calif., to Mollenda, Peru; Galápagos Islands (Figure 24). The record from southern Peru is an immature male. A record from the Galápagos Islands in April 1941, is a soft mature male, and two other records in February 1964, are an immature male and female.

*Habitat.*—Garth and Stephenson (1966) summarized habitat as sand or mud bottom, oyster beds, lagoons, estuaries, channels among mangroves, or river mouths. Recorded depth range is shoreline to 27.5 m, with many occurrences limited to shallows less than 1 or 2 m along shore, but Estévez (1972) reported common occurrence in Colombia on sand or sand-mud bottom, preferentially between 10 and 20 m in salinities 22‰ or higher. Estévez found the diet included mainly crustaceans, bivalves, fishes, inorganic remains, gastropods, and cephalopods in order of precedence (330 stomachs examined).

*Spawning.*—The spawning season extends year round. Museum records include ovigerous females as follows: January, Costa Rica; March, Oaxaca,

Mexico, Panama; April, between San Felipe and mouth of Colorado River, Mexico, Peru; May and June, Sinaloa, Mexico; July, Panama; August, Jalisco, Mexico; September, Guerrero, Mexico; November, Sonora and Jalisco, Mexico; December, Sonora, Mexico. A female from near the mouth of the Colorado River (AHF, Golfo de California, 6-9 April 1947, Stn. H47-53) is the smallest egg bearer seen in this species, the carapace having a length of 23, and width at base of lateral spines 39, or including lateral spines of 52 mm. Month of collection is unknown for an ovigerous female from Anaheim Slough, Calif., in 1928. Estévez (1972) considered ovigerous females rare.

*Remarks.*—The cognate species *C. arcuatus* and *C. danae* are so similar that differentiation is difficult except on grounds of male first gonopod morphology or geographic distribution. In general, *C. arcuatus* is the more robust species, having a tumid carapace emphasized in the arched anterolateral border and inflated branchial regions. Anterolateral teeth stand up from the surface, as if each is reinforced with an axial rib extending from the borders of the anterolateral area, but almost never are shoulders developed on their margins, whereas in *C. danae* there is less prominent central reinforcement in the teeth but a tendency to development of shoulders. Such differences are inconsistent.

Distribution of *C. arcuatus* along the Pacific side of Baja California parallels, but is more extensive than, that of *C. bellicosus*. In this region, marine climate that is transitional between tropical and dominant temperate extends from Punta Entrada (Bahía Magdalena) to Point Conception north of Santa Barbara Channel (Garth, 1961a). Here temperate and tropical faunas mingle, but tropical elements thin out in the north surviving only in protected areas or in favorable years. Records of *C. arcuatus* along this outer coast are less numerous than in the Golfo de California and southward, but occurrence of an ovigerous female at Anaheim Slough, Calif., indicates enough tolerance of temperate conditions to develop breeding populations, at least in favorable years. *Callinectes arcuatus* shows adaptation to a broader spectrum of marine climates than *C. bellicosus* in its much more extensive distribution from temperate southern California, through the essentially insular oceanic province at the tip of Baja California and tropical eastern Pacific, to

temperate fringes of the Humboldt Current along Peru.

*Callinectes arcuatus* is questionably listed from the Caribbean side of Colombia at Turbo on the Golfo de Urabá in MCZ lot 9666. I agree with the cataloger that this must be an erroneous locality for the collection.

A collection of *C. arcuatus* from Estero de los Algodones, SE of Guaymas, Sonora, Mexico (USNM 15431) contains a large female which has a broken male first gonopod inserted in the left genital opening. The gonopod fragment is 14 mm long, completely inserted, and is that of a male *C. arcuatus*.

Brocchi's (1875) discussion of male gonopods in *Callinectes* is a puzzle because there is no sure way to know which species he studied; neither his descriptions nor figures are accurate enough to allow certainty in forming synonymy. This would be of no real concern were it not for the relationship of his work to that of Milne Edwards (1879). Brocchi studied material obtained from Milne Edwards, and both considered gonopod structure of males to be among the diagnostic characters for species or "varieties" of *Callinectes*. Reasonable assessment of Brocchi's material rests on the geographic source of material then available, his discussion, and its probable influence on Milne Edwards's thinking. The evidence is present in both papers. Summarizing: species with short first gonopods came from the Antilles, coast of America, and Chile; those with long ones came from Cayenne and Guatemala. Chile must be regarded as an erroneous locality for species in this genus (Garth, 1957).

Milne Edwards (1879) described *C. cayennensis* (= *C. bocourti*) with long first gonopods from Cayenne and remarked on likeness of the male gonopods to those of *C. hastatus*. Brocchi (1875) may have worked with *C. bocourti* from Cayenne but more likely with *C. hastatus* (= *C. sapidus*) itself, for he remarked on its broad, strong frontal teeth and designated it as the *hastata* of Ordway (plate 16, Figure 81).

By designation "very long," Brocchi indicated that his illustration of male first gonopods from Guatemalan material (plate 16, Figure 82) must refer to *C. arcuatus*, a species regarded as having nearly straight gonopods (Milne Edwards, 1879).

Species with short male first gonopods from provenances listed by Brocchi (1875) and described in more detail by Milne Edwards (1879) were: Antilles, *C. ornatus* and *larvatus* (= *C.*

*marginatus*); coast of America, the same species; Chile, species undetermined by either Brocchi or Milne Edwards because of fragmentary information. Brocchi's illustration of a strongly curved gonopod (plate 16, Figure 76) seems closest to *C. marginatus*. Figure 78 depicting a short and straight gonopod seems closest to *C. ornatus* as does the undesignated Figure 79. Figure 77, though clearly called "short," resembles that of *C. bellicosus* in sinuosity. Milne Edwards (1879), making no mention of "long" or "short" gonopods for this species, was impressed with the double curvature, but listed *C. bellicosus* only from Cabo de San Lucas, Baja California. We must regard Figure 77 as possibly an illustration of *C. marginatus* because it seems closest to that species from geographic origins listed.

Following is an outline summary of first gonopod characters as understood by Milne Edwards (1879).

#### ATLANTIC

*hastatus* [= *sapidus*]: long, reaching to near end of abdomen; Nantucket to Mobile, perhaps on coast of Brazil.

*ornatus*: short and straight; Charleston-Cumaná, including Tortugas, Bahamas, also Santa Catarina, Brazil.

*larvatus* [= *marginatus*]: very short and curved; coast of Florida, Key West, Tortugas, Bahamas, Haiti, Veracruz, Mexico.

*tumidus* [= *exasperatus*]: long but moderate and distinctly hooked, approaches *hastatus*; Key West, Fla., Haiti.

*bocourti*: long, to end of abdomen as in *hastatus*; Honduras.

*cayennensis* [= *bocourti*]: long and reach end of abdomen as in *hastatus*; Guyana.

*danae*: long and straight; Rio de Janeiro (*diacanthus*).

#### PACIFIC

*toxotes*: very long, end of abdomen; Cabo de San Lucas.

*robustus* [= *toxotes*]: very long as above; Colombia.

*bellicosus*: "the verges reach almost the middle of the penultimate article, they are incurved strongly and outward near the extremity, then inward similarly and finally the point is directed externally" [sinuous]. Golfo de California; Cabo de San Lucas.

*arcuatus*: long and straight, resembles *diacanthus*

of Rio de Janeiro; but more slender; Cabo de San Lucas.

*pleuriticus* [= *arcuatus*]: long and straight; Panama.

*nitidus* [= *arcuatus*]: slender, straight and long; Guatemala, Tanesco.

In addition, those from Chile resemble the Guatemalan forms.

*Material*.—Total: 199 lots, 655 specimens.

Specimens listed in Rathbun (1930) from USNM [correction, USNM 62050=62051] and MCZ; Garth and Stephenson (1966) from AHF and USNM.

USNM. 76 lots, 316 specimens, including the following not cited above:

#### MEXICO

Baja California: 64119, Isla San Lucas, 15 Jan. 1930, 1 ♂ juv, M. Valerio. Sonora: 111769, Golfo de Calif.? no date, 1 ♂, T. H. Bullock, Stn. W53-289.

Nayarit: 123089, Estero de San Blas, 7.5 mi by road NNE San Blas, 14 Feb. 1955, juv 6 ♂, 2 ♀, Miller and Greenbank, M55-18. 123090, slough at N end Laguna de Mexaltitán, 28 Mar. 1955, 1 ♂ juv, Miller and Greenbank, M55-74.

#### GUATEMALA

20269, Tanesco [= Tahuesco, 14°01'13"N, 91°07'33"W] on the borders of the Esteros, 1 ♂ (dry). 123088, Iztapa, 5 Apr. 1950, 1 ♂.

#### NICARAGUA

77085, El Realejo, no date, 1 ♂ juv, Kingsley.

#### COSTA RICA

61034, Puntarenas, Mar. 1927, 1 ♂ (dry), M. Valerio. 76137, San Lucas [= Isla San Lucas], 15 Feb. 1931, 2 juv, M. Valerio. 76685, Golfo Dulce, 2 Feb. 1933, 1 ♀ (dry), M. Valerio.

#### PANAMA

77090, Balboa, C.Z., 4 Feb. 1937, 1 ♂ juv, 1 ♀, S. F. Hildebrand. 77094, Drydock, Balboa, C.Z., 8 Feb. 1937, 1 ♂, S. F. Hildebrand. 76917, Miraflores Locks, C. Z., no date, 2 juv, S. F. Hildebrand. 77081, Farfán Beach, C. Z., 23 Feb. 1937, 1 ♂ juv, S. F. Hildebrand. 77082, Venado Beach, 26 Feb. 1937, 1 ♂ juv, S. F. Hildebrand. 77083, Puerto Pilon, 2 Mar. 1937, 1 ♀ juv, S. F. Hildebrand. 77093, Taboga I., 8 Feb. 1937, 1 juv, H. C. Clark. 82134, Miraflores Locks (Lower Chamber), 4 juv,

S. F. Hildebrand. 82135, Dry Dock, Balboa, C.Z., 18 Mar. 1937, 1 ♂ juv, S. F. Hildebrand. 82136, Miraflores Locks (Lower Chamber), C.Z., 26 and 29 Mar. 1937, 1 juv, S. F. Hildebrand. 111779, Río Antón, Golfo de Panamá, 2 Apr. 1957, 2 ♂, W. L. Klawe. 119846, Punta Paitilla, 24 Feb. 1964, 1 ♂, R. Dutary. 123091, Bahía Piñas, near mouth of estuary at Santa Dorotea, 07°34.5'N, 78°11.5'W, 9 Sept. 1961, 7 juv, *Argosy* Stn. 10. 123092, Bahía Piñas, shallow end along crescent beach to E end at Santa Dorotea, 9 Sept. 1961, 3 juv, *Argosy* Stn. 9.

#### COLOMBIA

68552, Tumaco, no date, 2 ♂.

#### ECUADOR

123093, Esmeraldas, in harbor and fish market, 0°57.5'N, 79°42.5'W, 25 Sept. 1961, 1 ♂, *Argosy* Stn. 41. 70990, Salada, Guayaquil, 1 and 2 Oct. 1926, 1 ♂, W. L. Schmitt. 97899, Manta, Prov. Manabí, 0°56'30"S, 80°44'W, Aug. 1949, 1 ♂ (dry), T. Mena. 97930, supra cit., 1 ♀ (dry).

#### PERU

76574, Paita, 8 Oct. 1926, 1 ♂, W. L. Schmitt. Uncatalogued, Negritos, Apr. 1941, 1 ♂, 1 ♀, H. E. and D. L. Frizzell (160/433).

#### GALAPAGOS ISLANDS

111676, Conway Bay, 15 Apr. 1941, 1 ♂, W. L. Schmitt.

AHF. 66 lots, 221 specimens, including the following not cited above:

#### MEXICO

Sonora: Guaymas, tidal flats N of Motel Tular, 22 June 1966, 2 ♂, 1 ♀, R. Reimer and A. Alvarez, Stn. 2a.

Sinaloa: Topolobampo, 25 June 1966, 1 ♂, 1 ♀, R. Reimer and A. Alvarez, Stn. 4g.

Jalisco: Bahía Chamela, North Lagoon, 17 Nov. 1937, 1 ♂, 3 ♀ (2 ov), *Zaca* No. 37,142.

Guerrero: Acapulco Beach, 26-28 Nov. 1937, 1 ♀, *Zaca*-NYZS 37,277.

#### EL SALVADOR

Golfo de Fonseca, La Unión, 27 Dec. 1937, 1 ♀, *Zaca* Stn. 199, D-8 to D-16, 5-6 fm.

#### HONDURAS

Golfo de Fonseca, Cutuco and Potosí Lights 20 Dec. 1937, 4 ♂, 6 ♀, 3 juv, *Zaca* No. 37,666.

#### NICARAGUA

Corinto, 29 Dec. 1937, 1 juv, *Zaca* Stn. 200, D-7, 3.6 m. Corinto, Castenones Lagoon and mid-harbor, 6 Jan. 1938, 4 ♂, 4 ♀, *Zaca* NYZS 3814. Corinto, 7 Jan. 1938, juv 1 ♂, 1 ♀, *Zaca* 200, D-20 to D-26, 2.7-11.9 m.

#### COSTA RICA

Port Parker [= Golfo Elena], 13 Jan. 1938, 1 ♂, 3 ♀ (1 ov), 4 juv, *Zaca* No. 3859. Golfo Elena, 22 Jan. 1938, 2 ♂ juv, *Zaca* Stn. 203, D-9, 2.7-7.3 m. Puerto Culebra, 26 Jan. 1938, 8 ♂, 3 ♀, 2 juv, *Zaca* NYZS 38,115. Mata de Limón, 30 July 1964, 2 ♂, J. Mohr. Piedra Blanca [= Bahía Carrillo], 6 Feb. 1938, 2 ♂, 2 ♀, *Zaca* No. 38,195. Golfo de Nicoya, Isla Cedro, 12 Feb. 1938, 1 ♂, *Zaca* NYZS 38,302. Golfo Dulce, Golfito, 5 Mar. 1938, 1 ♂, 1 ♀, 4 juv, *Zaca* No. 38,472. Golfo Dulce, Golfito, 9 Mar. 1938, 1 ♀ juv, *Zaca* 218, NYZS 38,596. Supra cit., juv 1 ♂, 5 ♀, *Zaca* 218, D-4, D-5, D-8, 11 m.

#### PANAMA

Bella Vista, Panama City, 1944, 5 ♂, 2 juv, *Zaca*. Balboa, C.Z. 1940, 2 ♂, 1 ♀, 5 juv, *Zaca*. Balboa, C.Z., Apr. 1938, 3 ♂, 2 ♀, 8 juv Bahía Honda, 16 Mar. 1938, 3 ♂ juv, *Zaca* No. 38,701. Bahía Honda, 19 Mar. 1938, 1 ♂, *Zaca* NYZS 38,734.

#### ECUADOR

Puerto Bolivar, Apr. 1944, 1 ♂ juv, *Zaca*.

AMNH. 9 lots, 11 specimens.

#### MEXICO

Baja California: 5527, San José del Cabo, 21 Mar. 1911, 1 ♂, *Albatross*. Sinaloa: 7228, off Topolobampo, 17 Nov. 1935, 1 ♀, Templeton-Crocker Exped.

#### PANAMA

5405, 5408, 5419, 5434, Punta Paitilla, 26 Mar. 1926, 2 ♂, 1 ♀, 2 juv, W. G. Van Name. 5406, between Punta Paitilla and Panamá Viejo, 29 Mar. 1926, 1 ♂, W. G. Van Name. 10568, Santelmo Bay [= Ensenada Santelmo], Isla del Rey, Archipiélago de las Perlas, 15 Feb. 1941, 1 ♂, *Askoy* Exped.

#### PERU

Uncatalogued, Mollendo, 3 Dec. 1934, 1 ♂ juv.

BMNH. 4 lots, 8 specimens.



**COSTA RICA**

1892.6.7.14, Río Punta Mala, 1 ♂, H. Pittier.

**PANAMA**

67.77, 2 ♂, J. C. Dow.

**COLOMBIA**

1925.4.27.8/9, Tumaco, 1 ♂, 1 ♀ juv., R. H. Thomas.

**PERU**

1890.10.7.103/105, Santa Lucía, 2 ♂, 1 ♀, Stalzman collection, Warsaw Mus.

MCZ. 14 lots, 36 specimens, including the following not cited above:

**MEXICO**

Baja California: 5181, Cabo de San Lucas, no date, 1 ♂, J. Xantus. Guerrero: 5180, Acapulco, no date, 1 ♂, 1 ♀, *Hassler* Exped.

**NICARAGUA**

5178, Golfo de Fonseca, May 1869, 1 ♂, J. A. McNiel.

**HONDURAS**

5179, Golfo de Fonseca, recd. Nov. 1885, 5 juv., J. A. McNiel.

**PANAMA**

987, 15 Mar. 1869, 1 ♂, A. Agassiz. 4701, 15 Mar. 1860, 2 ♂, 1 ♀, A. Agassiz. 4702, July 1872, 1 ♂, *Hassler* Exped. 4703, recd. 13 Feb. 1861, 2 ♂, J. Rowell. 5175, Mar. 1860, 3 ♂, 2 ♀, A. Agassiz. 5176, recd. 10 June 1862, 2 ♂, 1 ♀, C. F. Davis. 5177, 4 ♂, 3 ♀, *Hassler* Exped. 8376, 12 Mar. 1891, 1 ♀ juv., *Albatross* Exped. 9669, no date, 3 ♂, Maack.

**COLOMBIA**

9666, Turbo?, no date, 1 ♂, Maack, Darien Exped. [Error?].

MNB. 1 lot, 4 specimens.

**PANAMA**

Bahía Honda, 10 Mar. 1933, 2 ♂, 2 ♀, *Velero III*, Stn. 111-33.

MNHNP. 1 lot, 6 specimens.

**GUATEMALA**

445a, 445d, Tanesco [= Tahuesco, 14°01'13"N, 91°07'33"W], 3 ♂, 3 ♀ (1 ov) (dry), Exp. du Mexique.

RMNH. 18 lots, 27 specimens.

**MEXICO**

Sonora: 7535, Guaymas, 20 May, 1945, 1 ♂, M. Cárdenas. 7529, Guaymas, 25 July 1946, 1 ♀ juv., M. Cárdenas. 7536, Yavaros, Bahía de Sta. Bárbara, 29 Nov. 1944, 1 ♂, 1 ♀ (ov), M. Cárdenas. 7532, coast of, 23 Nov. and 1 Dec. 1944, 1 ♂, 1 ♀ (ov), M. Cárdenas. Canjeme [?], 22 Nov. 1944, 1 ♀ (ov), M. Cárdenas.

Sinaloa: 7528, Ahome, 1 June 1945, 1 ♀, M. Cárdenas. 7537, Topolobampo, 21 June 1945, 1 ♀ (ov), M. Cárdenas. 7531, Macapule [Bahía de Navachiste], 22-23 Apr. 1948, 1 ♂, M. Cárdenas. 7533, Macapule, 7 May 1946, 2 ♀, M. Cárdenas.

Colima: 7534, Manzanillo, 13 Jan. 1943, 1 ♂, 1 ♀, F. Bonet.

**EL SALVADOR**

9839, W of Bocana Río Lempa at Isla Tasajera, San Vicente, 19 Mar. 1953, 1 ♂, 2 juv., M. Boeseman. 9840, coast at El Cuco, San Miguel, 19 Apr. 1953, 2 juv., M. Boeseman.

**PANAMA**

23516, Panama Canal, C.Z., 8°59.5'N, 79°30.5'W, Strand, Laagwater, 30 Apr. 1967, 1 ♂, *Pillsbury* Stn. 482. 23517, Golfo de Panamá, 8°14.3'N, 78°25.2'W-8°14.3'N, 78°25.5'W, 7 May 1967, *Pillsbury* Stn. 547.

**ECUADOR**

1 ♂, Frank, Cat-a.

**PERU**

23402, Puerto Pizarro, dept. Tumbes, Apr. 1966, 1 ♀ (ov), 1 juv., H. O. van Hagen. 23433, Paracas bight S of Pisco, 13 Apr. 1966, 2 ♂, H. O. van Hagen. 2699, 1 ♂ from Museo de Hist. Nat., Lima.

*Supplementary literature records.*—Bahía de Santa Elena, Ecuador (Nobili, 1901); a resume of records in Peru (Solar, Blancas, and Mayta, 1970); along Pacific coast of Colombia (Estévez, 1972).

***CALLINECTES EXASPERATUS*  
(GERSTAECKER)**

**Figures 9, 18g, 20i, 22g, 26**

*Lupea exasperata* Gerstaecker, 1856, p. 129 (type: ♂, Berlin Mus. 2104 [dry], Puerto Cabello, Venezuela, Appun).

*Callinectes tumidus* Ordway, 1863, p. 574 [9] (syn-types: 2 ♂, MCZ 5159, Key West, Fla., J. E. Mills; 1 mature ♀, MCZ 5162, Haiti, A. Hilchenbach).- A. Milne Edwards, 1879, p. 226 (var. of *C. diacanthus*).- Rathbun, 1896, p. 359, pl. 18; pl. 24, fig. 6; pl. 25, fig. 5; pl. 26, fig. 5; pl. 27, fig. 6.- Rankin, 1898, p. 232.- Young, 1900, p. 189 (var. of *C. diacanthus*).

?*Lupa (Neptunus) diacantha*.- von Martens, 1872, p. 92 (part, the Puerto Cabello, Venezuela, specimens).

*Neptunus (Callinectes) diacanthus*.- Ortmann, 1894, p. 77 (part, specimen n, Haiti).

*Callinectes exasperatus*.- Rathbun, 1897, p. 150.- 1901, p. 49.- 1930, p. 130, text-figs. 15f, 16f, 17e, 18e, pl. 56.- 1933, p. 49.- Contreras, 1930, p. 236, fig. 7.- Chace, 1940, p. 33.- 1956, p. 154, unnumbered fig.- Chace and Hobbs, 1969, p. 131, fig. 37c.- Taissoun, 1969, p. 81, fig. 31A-D, photo 11.- 1973, p. 37, figs. 4C, 5C, photo 6.

*Callinectes diacanthus*.- Young, 1900, p. 186 (part).

*Description*.—Carapace (Figure 9) bearing four well developed frontal teeth, submesial pair narrower and slightly shorter than lateral pair. Metagastric area with posterior width 1.2-1.3 times length, anterior width 2.3-2.5 times length. Anterolateral margins strongly arched with anterolateral teeth exclusive of outer orbital and lateral spine usually but not always curved forward; teeth progressively broader laterally with fifth tooth often largest. Lateral spine stout, usually less than twice length of preceding tooth. Surface of carapace conspicuously granulate with densest concentrations on central eminences, coarsest and most widely spaced granules in front of epibranchial line separated by smooth surfaces. Central sulci on carapace definite but not deep; epibranchial line rather flatly arched, slightly sinuous.

Chelipeds robust, ridges and crests of all articles coarsely granulate; fingers of major chela strong but not markedly gaping.

Male abdomen and telson reaching along posterior quarter of thoracic sternite IV; telson lanceolate with sinuous inflated sides, length 1.5 times basal width; basal portion of fused segments 3-4-5 truncate laterally. Mature female abdomen and telson reaching about same level as in male; telson triangular with inflated sides, length 1.2

times basal width; fifth segment longer than sixth. First gonopods of male (Figures 18g, 20i) reaching slightly beyond suture between thoracic sternites VI and VII, sinuously curved, overlapping in proximal half along midline then diverging distally, twisting on axis near tip and bending abruptly mesad; armed distally with scattered minute spinules, tip slightly broadened and opening posteromesially. Gonopores of female (Figure 22g) broadly and somewhat asymmetrically ovate in outline with orientation of long axis mainly in frontal plane but with apex directed anteromesad; aperture of each laterally elongate and sinuous, sloping from broadest area at surface on mesial side to narrower and deeper portion under rounded overhanging anterior border with prominent central projection and posterior border with elongate posterolateral eminence.

*Size of carapace in mm*.—Largest male: length 67, width at base of lateral spines 114, including lateral spines 129. Largest female: length 59, width at base of lateral spines 101, including lateral spines 124. Summary of selected measurements is given in Tables 1 and 2.

*Color*.—Carapace of adult male purplish red, more accented on proto-, meso-, and metagastric areas and at base of lateral spines and anterolateral teeth; branchial region and anterolateral teeth obscure maroon. Dorsal surface of all legs purplish red with intense orange red on articulations; inferior portion of merus, carpus, and fingers of chelipeds intense violet; internal and external portion of chelae as well as entire ventral portion of animal white with tints of soft purple (Taissoun, 1969).

*Variation*.—There is notable variation in anterolateral tooth pattern; the fifth, sometimes described as largest (Rathbun, 1930) may be exceeded by the fourth, sixth, or a combination of both, or there may be asymmetrical size and tooth number differences.

*Distribution*.—Bermuda; Veracruz, Mexico; southern Florida to Estado de Santa Catarina, Brazil (Figure 26). Reason for lack of collections from the Guianas and northern Brazil is unknown.

*Habitat*.—This species lives primarily in shoal marine, estuarine, and perhaps fresh water, espe-

cially in association with mangroves and around river mouths from water's edge to recorded depths of about 7.5 m (Rankin, 1900; Coêlho, 1967b, 1970; Chace and Hobbs, 1969; Taissoun, 1969).

*Spawning*.—Few dated collections contain ovigerous females: March, Puerto Rico and Guadeloupe; April, Barbuda and Panama; May, Jamaica; June, West Indies; August, Estado de Santa Catarina, Brazil. Other undated collections in museums are from Bermuda, southern Florida, Estados de Pernambuco and São Paulo, Brazil.

*Remarks*.—*Callinectes exasperatus* has a number of distinctive features. It has the roughest appearing carapace and chelipeds of any species in the genus because the granulations are coarser and sharper than in others. The median epistomial tooth is more widely separated from the front than among the congeners, perhaps a function of the vaulted carapace which contributes to deep-bodied form. Similar to *C. bocourti* in structure of frontal teeth, *C. exasperatus* has less prominent cardiac lobes and sulci bounding the metagastric area. The lateral spines are relatively shorter than among other species of the genus. A blunt anteromesial eminence on the carpus is pronounced. Narrowest width of the male abdomen is in the distal third of the sixth segment, the narrowed portion becoming increasingly distal with age together with progressive crossing of the pleopods.

Dahl (1954) worked at Cañango Beach, Venezuela, at or near the type-locality for *C. exasperatus* and published a photograph of the beach at Puerto Caballo together with a short description of the area, saying that the tidal difference is small and wave exposure very great on the rather steeply sloping beach.

Locality data for specimen 303-7 in MNHNP (M. Fontaines) from "Chili" identified as *Nep-tunus diacanthus* Latr. (= *C. exasperatus*) is an error.

*Material*.—Total: 97 lots, 372 specimens.

Specimens listed in Rathbun (1930) from USNM (24463, 24464, 18631 not found) and MCZ.

USNM. 38 lots, 282 specimens, including the following not cited above:

#### UNITED STATES

Florida: 77125, E of Bush Key, Tortugas, 29

July 1931, 1 ♂, Pearse. 80665, Key West, no date, 1 ♂, U.S. Bur. Fish.

#### CUBA

77127, Bahía Honda [Pinar del Rio, WSW Habana], 1 June 1893, Univ. Iowa.

#### JAMAICA

123077, Kingston Harbor, 17 May 1965, 1 ♀ (ov), B. B. Collette.

#### HAITI

71232, Muertos I., Seven Brothers group, Feb. 1929, 1 ♂, Poole and Perrygo.

#### PUERTO RICO

61563, Cataño [San Juan Harbor], 4 Jan. 1899, 1 ♂, *Fish Hawk*. 73281, Bahía de San Juan, 29 Mar. 1937, 1 ♂, W. L. Schmitt. 123084, Boca de Cangrejos, 7 mi E San Juan, 31 Mar. 1937, 1 ♂, 2 ♀ (1 ov), W. L. Schmitt.

#### VIRGIN ISLANDS

71639, St. Croix, no date, 1 ♂, H. A. Beatty. 72353, St. Croix, 1935-36, 2 ♂, H. A. Beatty. 76466, St. Croix, no date, 1 ♀, H. A. Beatty.

#### BARBUDA

123079, west shore of lagoon near Oyster Pond Landing, 6 Apr. 1956, 1 ♀ (ov), Schmitt, Chace, Nicholson, and Jackson, Stn. 85-56, *Freelance*.

#### GUADELOUPE

123080, between Monroux and Rat Is., Pointe a Pitre, 30-31 Mar. 1956, 3 ♂, 2 ♀ (1 ov), Chace and Nicholson, Stn. 68-56, *Freelance*.

#### GRENADINES

123078, Tyrrell Bay, Carriacou I., 16 Mar. 1956, 2 ♂, D. V. Nicholson, Stn. 17-56, *Freelance*.

#### MEXICO

Quintana Roo: 78391, Bahía de la Ascensión, 28 Mar. 1939, 1 ♂, Ralph Elliott. 123082, N end Bahía de la Ascensión, 15 Apr. 1960, 3 ♂, 1 ♀, Daiber and Schmitt. 123083, Bahía de la Ascensión behind Pta. Allen, 16 Apr. 1960, 1 ♂, Daiber and Haynes. 123081, Bahía del Espiritu Santo, near Pta. Lawrence, 6 Apr. 1960, 1 ♀, Rehder, Daiber and Haynes.

#### VENEZUELA

95713, Gran Roque, Los Roques Is., 7 Sept. 1950, 1 ♂, F. H. Weibezahn.

AHF. 3 lots, 4 specimens.

#### UNITED STATES

Florida: Key Largo, North Hawk Channel, 29-31 May 1949, 2 ♂, Stn. LM 25, 27. Hawk Channel, Plantation Key, 3 mi S Tavernier Bridge, 25 May 1949, 1 ♂, Stn. LM20-49.

#### TRINIDAD

Purchased from fisherman near Port of Spain, 17 Apr. 1939, 1 ♀.

AMNH. 4 lots, 4 specimens.

#### BERMUDA

11223, 1939, 1 ♀ (ov), W. Beebe, Bermuda Exped.

#### BAHAMAS

2286, Andros, 1908, 1 ♀, B. E. Dahlgren and H. Mueller.

#### PUERTO RICO

2673, San Juan, entrance of Bahía de Condado, 14 July 1914, 1 ♀, R. W. Miner. 2661, July-Aug. 1914, 1 ♂ (dry), R. W. Miner.

ANSP. 1 lot, 1 specimen.

#### BRAZIL

3514, no date, 1 ♀ (dry), T. B. Wilson.

BMNH. 7 lots, 12 specimens.

#### UNITED STATES

Florida: 1938.3.19.22, Dry Tortugas, 1 ♂, Colman and Tandy.

#### BRITISH HONDURAS

1967.7.1.49/50, Long Cay Island, 23/10/1941, 1 ♂, 1 ♀, I. Sanderson.

#### CAYMAN ISLANDS

1955.10.6.59, Stn. 33, 1 ♂, Oxford Univ. Exped.

#### JAMAICA

vi/8, no date, 2 ♂, 2 ♀ (dry), Banks.

#### BRAZIL

80.37, Pernambuco, no date, 2 ♂, W. Forbes. 61-44, vi/7, Rio de Janeiro, no date, 1 ♂ (dry), U.S. Explor. Exped. 919/C, vi/7, no date, 1 ♂ (dry), C. Stewart Banks.

MCZ. 14 lots, 26 specimens.

#### UNITED STATES

Florida: 5160, Key West, no date, 1 ♂ (juv), 1 ♀ (ov), J. E. Mills.

#### BAHAMAS

Bimini: 11671, Alicetown, May 1941, 1 ♂, R. W. Foster and J. Huntington. 11692, Nixons Harbour, May 1941, 1 ♂, R. W. Foster and J. Huntington. 10360, Great Inagua I., Salt pond canal 1½ mi SE Matthew Town, 24 June 1938, 1 ♂, 1 ♀, R. H. McLean and B. Shreve.

#### CUBA

10889, Bahía de Siguanea, Isla de Pinos, 14 Feb. 1938, 1 ♂, 1 juv, Harvard-Havana Exped.

#### BRAZIL

5167, Santos, Estado de São Paulo, no date, 1 ♀ (ov), Coutinho, Thayer Exped.

MNB. 6 lots, 9 specimens.

#### BRAZIL

56, Pernambuco, no date, 1 ♂, 2 ♀ (ov). 58, Rio Guanabara, no date, 1 ♂. 52, Rio Guanabara, no date, 2 ♂. 1380, Baía de Guanabara, 1948, 1 ♂, P. Drach. Estado de Santa Catarina: 59, São Francisco do Sul, 1901 (?), 1 ♀, L. Gralberto. 499, no data, 2 ♀.

MNHNP. 2 lots, 2 specimens.

#### QUESTIONABLE LOCALITIES

Suitrée(?), 1922, 1 ♂, from Museo de Historia Natural, Buenos Aires. Chili(?), 303-7, no date, 1 ♀ (dry), M. Fontaines.

RMNH. 17 lots, 26 specimens.

#### UNITED STATES

Florida: 15631, Key Biscayne, Miami, 14 Sept. 1960, 1 ♂, R. B. Manning and L. B. Holthuis.

#### WEST INDIES

2326, June 1920, 1 ♀ (ov), J. Boeke.

#### ST. MARTIN

11879, Baie Orient, 23 Feb. 1957, 1 ♂, L. B. Holthuis.

#### ARUBA

15044, 1882-1883, 2 ♂ (juv), A. J. van Koolwijk.

## CURAÇAO

St. Kruis Baai, 7 Oct. 1948, 1 carapace (dry), P. W. Hummelinck. 15056, shore of Piscadera Baai near Raphaël, 13 Nov. 1956, 1 (juv), L. B. Holthuis. 11877, Piscadera Baai, 27-28 Dec. 1956, 1 ♂, 2 ♀, 3 juv, L. B. Holthuis. Schottegat at Pasanggrahan, 22 Aug. 1948, 1 ♀ (dry), P. W. Hummelinck. South shore St. Joris Baai near Choloma, 3 Jan. 1957, 1 ♀ (dry), L. B. Holthuis. 11878, South shore St. Joris Baai near Choloma, 3 Jan. 1957, 1 ♂, 1 ♀, L. B. Holthuis.

## BONAIRE

11880, lake on E coast, 10 Mar. 1957, 1 ♂, 1 ♀, L. B. Holthuis. 11876, lake on E coast, 6 Mar. 1957, 1 ♂, L. B. Holthuis. Paloe Lechi, 6 Apr. 1955, 1 carapace (dry), Zaneveld.

## TRINIDAD

23413, Cocorite, 25 Aug. 1965, 1 ♂, 1 ♀, H. O. von Hagen.

## VENEZUELA

10719, Isla de Margarita, Feb. 1955, 1 ♂, J. S. Zaneveld. 23396, Punta Mangle, Isla de Margarita, 11 Jan. 1964, 1 ♂, P. W. Hummelinck.

## BRAZIL

4873, Bahia, 1909, 1 ♂, J. A. Bierens de Haan, Zool. Lab. Utrecht.

SADZ-B. 5 lots, 6 specimens.

## BRAZIL

Bahia: 3223, Ilhéus, 1919, 1 ♂, 1 ♀, E. Garbe. 3214, Ilha Madre de Deus, Jan. 1933, 1 ♂. Rio de Janeiro: 3242, Atafona, 12 July 1963, 2 juv, N. Meneses. 3246, Atafona, no date, 1 ♂, N. Meneses. Santa Catarina: 3245, 27°15'S, 48°47'W, near Florianópolis, 21 Aug. 1966, 1 ♀ (ov), M. Iwai.

UNC-IMS. 1 lot, 3 specimens.

## PUERTO RICO

2137, Mangrove channels behind Bahía Fosforescente, 2 May 1967, 2 ♂, 1 ♀, D. R. Torres and P. R. Ramos.

*Supplementary literature records.*—Southern Florida, Futch (1965); Biscayne Bay, Fla. (Park, 1969); Veracruz, Ver., Mexico (Contreras, 1930); Jamaica (White, 1847); Golfo de Venezuela (Tais-

soun, 1969); Gran Roque, Venezuela (Chace, 1956); Jangadas, south of Recife, and other localities in Pernambuco, Brazil (Coelho, 1966, 1967b); Texas ? (tentatively identified specimen not available for confirmation, Pounds, 1961).

***CALLINECTES BELLICOSUS***  
**(STIMPSON)**

Figures 10, 18h, 20j-k, 22h, 27

*Lupa bellicosa* (Sloat, MS) Stimpson, 1859, p. 57 [11] (type locality: Guaymas, Gulf of California, C. P. Stone, types not extant).- ? Lockington, 1876, p. 105 [11].

*Callinectes bellicus* Ordway, 1863, p. 577 [12].- Streets and Kingsley, 1878, p. 107.- A. Milne Edwards, 1879, p. 227 (var. of *C. diacanthus*).- Rathbun, 1896, p. 365, pl. 22; pl. 24, fig. 10; pl. 25, fig. 8; pl. 26, fig. 8.- 1898, p. 596.- 1926, p. 75 [Signal Hill Pleistocene].- 1930, p. 112, text-figs. 15k, 16i, 17g, 20, pl. 49.- Holmes, 1900, p. 73.- Young, 1900, p. 190 (var. of *C. diacanthus*).- Schmitt, 1921, p. 236, text-fig. 140.- Meredith, 1939, p. 108 [figure].- Steinbeck and Ricketts, 1941, p. 468, pl. 14, fig. 2.- Buitendijk, 1950, p. 275.- Garth and Stephenson, 1966, p. 47, pl. 5, fig. B; pl. 8, fig. B; pl. 10, fig. B; pl. 12, fig. B.- ? Contreras, 1930, p. 240, text-fig. 11.

*Callinectes diacanthus*.- Young, 1900, p. 186 (part).

*Callinectes ochoterenai* Contreras, 1930, p. 229, text-figs. 2, 3A-C (type localities: LaPaz, Baja California, and Punta Arena, Guaymas, Sonora [Mexico]).

*Description.*—Carapace (Figure 10) with two slender frontal teeth separated by a space often bearing a rudimentary submesial pair of teeth; median epistomial spine below front prominent and slightly exceeding frontal teeth. Metagastric area with lateral sulci fairly deep but anterior and posterior margins obsolescent, posterior width greater than length. Inner orbital fissure usually open. Anterolateral margins broadly arched, teeth exclusive of outer orbital and lateral spine relatively short and concave sided with acuminate tips directed outward more than forward; lateral spines short, about twice length of preceding tooth, longer in juveniles. Surface finely granulate and remarkably smooth except on anterolateral

region where granules are more widely spaced; sulci and lines of granules more prominent on young than on adults.

Chelipeds with prominent and sharply tuberculate or spiniform ridge on outer surface of propodus, other ridges lower and nearly smooth.

Male abdomen and telson reaching a bit beyond suture between thoracic sternites IV and V; telson triangular, longer than broad, sixth segment slightly constricted in proximal half. Mature female abdomen and telson reaching about same level as male, telson with inflated sides longer than wide, segments 5 and 6 almost equal in length. First gonopods of male (Figures 18h, 20j, k) reaching to midlength of thoracic sternite VI with tips slightly inclined mesad toward each other, not overlapping but thrown into sinuous curves, twisting on axis at level of suture between thoracic sternites VI and VII and armed at this level with a crowded lateral band of assorted short, rather blunt, retrogressive spinules becoming less numerous and more slender proximal and distal to this level, longer distally and shorter proximally; a subterminal row of rather prominent well separated exceedingly slender setae on sternomesial aspect. Gonopores of female (Figure 22h) asymmetrically ovate in outline with orientation of long axis mainly in frontal plane but with apex directed anteromesad; aperture of each laterally elongate and sloping from broadest area at surface on mesial side to narrower deeper portion under uniformly rounded borders on remaining sides.

*Size of carapace in mm.*—Largest male: length 76, width at base of lateral spines 135, including lateral spines 154 (from crab purchased in Mexico City fish market by Edgard Taissoun and Alfredo Vidal after statistical analysis was completed). Largest female: length 89, width at base of lateral spines 160, including lateral spines 178. Summary of selected measurements is given in Tables 1 and 2.

*Color.*—The only good published color description is that of Garth and Stephenson (1966), "Carapace mottled greenish yellow to brownish green, sometimes with dark spot on center of orbit and dark green areas roughly outlining epibranchial ridge. Arms generally greenish yellow to greenish brown, wrist articulations purple red. Hand with blotch at level of finger articulation, this blue-green in smaller and purple in larger

specimens. Similar internal blotch purple throughout. Inner surface hand and fingers centrally white to pale blue, dorsally purple to red-purple, and ventrally blue to purple-blue. Cheliped colors most vivid in largest male." Almost brown above, cream colored below, tubercles and ridges of hand tinged with red (Lockington, 1876).

Specimens purchased at a fish market in Mexico City and preserved in Formalin<sup>2</sup> about 21 June 1972, by Edgard Taissoun and Alfredo Vidal were seen by me on June 23. Colors were: male tannish purple overall; ridges of chelipeds, carpi, and front edge of meri having deepest purplish cast. Posterior areas of carapace grading through brownish cast to areas of beige on posterolateral slopes and swimming paddles. A round beige spot on posterolateral border just anterior to insertion of swimming legs. Upper surfaces of palms with a reticulate pattern of purple lines on beige to off-white background. Inner and outer surfaces of chelipeds and ventral aspect off-white with suggestion of yellow. Superior and inferior edges of fingers purple grading to blue on inner face of fingers, and a reticulate blue stripe along lower inner border of palm. Teeth of chelipeds oyster white at their crowns, but their bases light purple giving impression of a purple "gum" line.

Female similar to male but with a more tan to beige hue on carapace and upper surface of palms. Blue color confined to inner surface of propodal finger only.

Prominent tubercles and tips of spines oyster white in both sexes.

*Variation.*—Variation in *C. bellicosus*, as in other members of the genus, seems largely a matter of differential growth changes. Openness of the inner orbital fissures has been used as a key character for this species, but large series show the character to vary individually; though usually open, the fissure is often closed. The edge of the frontal area slopes upward from contact with the exposed median epigastric spine to a row or cluster of obsolescent granules which mark the site of obsolescent submesial frontal teeth. In all other species the front overhangs this spine to at least some extent. The species is notable for sharpness of teeth and spines. Anterolaterals pointing forward in the young are directed more outward in mature specimens. These teeth are often almost

<sup>2</sup>Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

rectilinear but still sharp tipped. Sub- and outer orbital spines become increasingly acuminate with age. The mesogastric area changes shape with age, the anterior border becoming increasingly sinuous and indistinct. Adjacent portions of the mesobranchial regions remain sharply outlined in old individuals. Some older specimens show "expansion scars" on the carapace as if stresses incurred while molting had stretched the carapace during the hardening process. Such "scars" seem to radiate from centers in the cardiac region.

The chelae sometimes have lower propodal margins slightly decurved in conjunction with development of a strong basal tooth on the opposing dactyl. Except for the sharply granulate outer propodal ridge, usually smooth remaining ridges on the chelipeds are occasionally as roughly granulate as in *C. exasperatus*.

In sternal view, males have a great resemblance to *C. similis* in that the abdomen and sternum are nearly plane and that the anterior curvature of fused segments 3-5 is shallow. Males may show a central proximal column of indurated exoskeleton in the 6th abdominal segment. The first gonopods of mature males may reach beyond the middle of sternite VI to the suture between V and VI.

*Distribution.*—San Diego, Calif., to Bahía Almejas (southeastern extension of Bahía Magdalena) Baja California; La Paz Harbor around Golfo de California to Topolabampo, Sinaloa, Mexico (Figure 27). The species is apparently absent from the extreme southern tip of Baja California, but was listed as the commonest large crab in the Golfo de California by Steinbeck and Ricketts (1941).

*Habitat.*—Garth and Stephenson (1966) summarized the little available ecological data noting that the known depth range is 0 to 18 m, usually over sand bottom, and that many crabs had been captured swimming under lights at night. From museum records it is clear that the species frequents estuarine areas. A few specimens from Espiritu Santo, Golfo de California (AHF) are covered with a red clay deposit.

*Spawning.*—Only one lot taken in September from Scammon Lagoon, Baja Calif., in water 0.6 m deep contained ovigerous females. This is curious in light of the fact that more mature females have

been collected than males (Tables 1 and 2), but the record is probably biased by times of collection. Of 94 lots for which collection date is recorded, the monthly frequency is: January 5, February 11, March 43, April 17, May 3, June 2, August 3, September 2, October 1, November 5, and December 2. Either spawners were beyond depths sampled (unlikely) or early spring is not the main spawning period for this species.

*Economic importance.*—No data are available on uses of this crab other than notes above on its availability in fish markets of Mexico City. Thirteen lots of fragments, mostly parts of fingers, from archeological sites near Municipio Caborca, La Cholla Bay, Sonora, Mexico, are recorded in the USNM as *Callinectes* (probably *C. bellicosus*) indicating pre-Columbian use of the large crabs by peoples of the area.

*Remarks.*—*Callinectes bellicosus* resembles *C. similis* of the Carolinian province of the Atlantic in that both are restricted in distribution at the northern fringes of the tropical homeland of the genus, but the analogy is a loose one for *C. bellicosus* is the more restricted, essentially endemic to the Golfo de California which is a transitional body of water with Panamanian relationships grading from tropical in the south to temperate (but warm in summer) in the north, and the Pacific coast of the Baja California peninsula whose marine climate is transitional between tropical and dominant temperate from Punta Entrada (Bahía Magdalena) to Point Conception north of Santa Barbara Channel (Garth, 1961a). Temperate and tropical faunas meet and mingle along this outer coast, but tropical forms thin out northward surviving only in protected shallows. Records of *C. bellicosus* are few north of Scammon Lagoon, northern extensions of range being favored by warm periods (Garth, 1961a). The southern tip of the peninsula, from which *C. bellicosus* is absent, is essentially an insular oceanic region distinct from adjacent coastlines and dependent on accidental transport for its marine fauna (Garth, 1961a).

Belonging to the group of species with moderately long first gonopods, *C. bellicosus* has diverged from the remainder of the group in having gonopods with rather straightened sinuosity and possession of prominent sternomesial setae. The form of the body bears some resemblance to *C. similis*, the distributional western Atlantic

analog, in having a smooth and finely granulate carapace, reduced submesial frontal teeth, shallow anterolateral teeth, nearly plane sternum and abdomen in males, and similar length-width proportions in mature males.

A Pleistocene record for *C. bellicosus* (USNM 372804) is represented by the distal two-thirds of a propodal finger from a minor left chela of a large crab from the upper San Pedro formation, Signal Hill, northeast of Long Beach, Calif. (Rathbun, 1926). Size and tooth pattern of this specimen are indistinguishable from the modern form.

*Material*.—Total: 87 lots, 322 specimens.

Specimens listed in Rathbun (1930) from USNM (4630 not found) and AMNH; Garth and Stephenson (1966) from AHF and USNM.

USNM. 32 lots, 137 specimens, including the following not cited above:

#### MEXICO

Baja California: 12464, [?] 3 ♂, col. unknown. 63280, S end Bahía Magdalena, 20 Mar. 1911, 4 ♂, *Albatross*. Uncatalogued, Ricason I., Bahía Concepción, 7 Apr. 1911, 3 ♂, *Albatross*. 60006, Bahía Concepción, mouth of Rio Mulegé, 4 Apr. 1911, 1 ♂, *Albatross*. 57909, Bahía de los Angeles, 1921, 1 ♂, Calif. Acad. Sci. Sonora: 80666, Bay at Guaymas, 31 Jan. 1923, 1 ♂, 2 juv., B. F. Yost. 97611, Estero de Agiabampo, no date, 1 ♂ (dry), E. F. Ricketts. 81926, 1 ♂, 2 ♀, 7 juv. 122921, Agiabampo, May 1939, 1 ♀, R. Hermosillo.

AHF. 44 lots, 158 specimens.

AMNH. 4 lots, 18 specimens, including the following not cited above:

#### MEXICO

Baja California: 5498, Bahía Tórtolo, Punta San Bartolomé, 14 Mar. 1911, 1 ♂, *Albatross*. 5508, Bahía Ballenas, 16 Mar. 1911, 2 ♂, 1 ♀, *Albatross*. 5524, Bahía Magdalena, 20 Mar. 1911, 6 ♂, 2 ♀, *Albatross*. 5504, Bahía Pichilique, 27 Mar. 1911, 3 ♂, 3 ♀, *Albatross*.

BMNH. 1 lot, 1 specimen.

79.1, off San Francisco, 1 ♂, E. Gerrard, Jr. [Error, or San Francisco I., 24°50'N, 110°35'W, G. de Calif.?].

MCZ. 1 lot, 3 specimens.

#### MEXICO

Baja California: 4253, Shoal Point, Colorado River, 29 Mar. 1889, 2 ♂, 1 ♀, *Albatross*.

RMNH. 4 lots, 4 specimens.

#### MEXICO

Baja California: La Paz, 15 Oct. 1945, 1 ♀, M. Cárdenas. Sonora: 7540, Guaymas, 25 Sept. 1945, 1 ♀, M. Cárdenas. Sinaloa: 7538, Ahome, 1 June 1945, 1 ♀, M. Cárdenas. 7539, Topolobampo, 21 Apr. 1945, 1 ♂, M. Cárdenas.

Los Angeles County Museum. 1 lot, 1 specimen.

#### MEXICO

Baja California: Bahía Santa María, Mar. 28, year unknown, 1 ♀, A. E. Colburn, A748.

*Supplementary literature record*.—Punta Santa Inés [Baja Calif.] (Crane, 1937).

### CALLINECTES TOXOTES ORDWAY

Figures 11, 18i, 20l, 22i, 27

- ?*Callinectes diacanthus* Stimpson, 1860, p. 220.  
*Callinectes toxotes* Ordway, 1863, p. 576 [11] (syn-types: ♂, USNM 2413; 2 ♂, MCZ 5182; ♂ [dry], MCZ 5183; Cape San Lucas [Baja California], John Xántus, col.).- A. Milne Edwards, 1879, p. 227 (var. of *C. diacanthus*).- Rathbun, 1896, p. 363, pl. 21; pl. 24, fig. 9; pl. 25, fig. 9; pl. 26, fig. 9; pl. 27, fig. 8.- 1910, p. 536, pl. 55.- 1930, p. 127, figs. 15i, 16g, 17i, 18h, pl. 54.- Young, 1900, p. 189 (var. of *C. diacanthus*).- Contreras, 1930, p. 237, fig. 8.- Garth, 1948, p. 35.- 1957, p. 37.- 1961b, p. 142.- Garth and Stephenson, 1966, p. 50, pl. 5, fig. C; pl. 8, fig. C; pl. 10, fig. C; pl. 12, fig. F.- Bott, 1955, p. 56.  
*Callinectes robustus* A. Milne Edwards, 1879, p. 227 (var. of *C. diacanthus*) (type locality: Colombia; type listed by Rathbun, 1930, in MNHNP, not found in 1968, considered lost, 1973, fide J. Forest).- Young, 1900, p. 189 (var. of *C. diacanthus*).  
*Callinectes diacanthus*.- Young, 1900, p. 186 (part).

*Description*.—Carapace (Figure 11) bearing four large, rounded frontal teeth; submesial pair narrower than, partially coalesced with, and reaching half the length or more of lateral pair.



Metagastric area with length approximately equal to posterior width, anterior width about 2 times length. Anterolateral margins moderately arched, teeth exclusive of outer orbital and lateral spine varying from triangular or inflated triangular at inner end of row through acuminate forward trending intermediate teeth to forward curving spiniform tooth at outer end of row, base of first and last tooth narrowest. Surface of carapace coarsely granulate and uneven, nearly smooth around margins and along regional sulci, more granulate over branchial and gastric areas, most closely crowded granules on cardiac, mesobranchial, and anterior half of mesogastric regions. Epibranchial line prominent and nearly uninterrupted.

Propodus and carpus of chelipeds with sharply and rather coarsely granulated ridges, especially on propodus, rarely worn smooth; dactyl of major chela with basal teeth (often a single strong tooth) closing against cusped molariform complex on propodus, both chelae with sectorial teeth.

Male abdomen and telson reaching beyond midlength of thoracic sternite IV; telson much longer than broad, triangular with inflated sides; sixth segment of abdomen narrowest in proximal third. Mature female abdomen and telson reaching no more than midlength of thoracic sternite IV; telson elongate triangular with inflated sides, sixth segment longer than fifth. First gonopods of male (Figures 18i, 20i) very long, reaching to or beyond suture between thoracic sternites IV and V; sinuously curved, overlapping proximally, diverging distally, twisting mesioventrally on axis at midlength of thoracic sternite V and recurving to termination near midline; armed distally with lateral band of retrogressive spinules thinning to absence near tip. Gonopores of female (Figure 22i) asymmetrically and narrowly ovate in outline with apex on long axis directed anteromesad; rounded borders with series of wrinkles conforming to contours; aperture of each sloping from surface on mesial side under anterolateral border superior to a rounded eminence on posterior border.

*Size of carapace in mm.*—Largest male: length 88, width at base of lateral spines 156, including lateral spines 193. Largest female: length 74, width at base of lateral spines 133, including lateral spines 174. Estévez (1972) reported a female with carapace 75 mm long estimated to have a width including lateral spines of 182 mm, and estimated general growth rate per molt to be 15%

in length, 24% in width. Summary of selected measurements is given in Tables 1 and 2.

*Variation.*—This species attains the largest size in the genus, but old individuals apparently do not show teeth or spines worn to an extent comparable with other species. Anterolateral teeth vary individually in degree of laterally progressive upturning in the row. Submesial frontal teeth vary considerably in length as well as acuity, but none are really sharp pointed. Chelae in seemingly old individuals retain basal teeth with well defined molariform structure on the major hand; sectorial tooth development seems more prominent on both right and left chelae than in other species. Females have granules more prominent and closely crowded on the carapace than males. Male first gonopods cross over each other at the tips in some individuals.

*Distribution.*—Cabo de San Lucas, Baja California, to extreme northern Peru; extraterritorial, Juan Fernández (Figure 27).

*Habitat.*—Ranging from shore to 27-m depths, *C. toxotes* has been characterized as a mangrove swamp crab (Estévez, 1972). It occurs from freshwater streams to open bays, and a number of collections come from lagoons or river mouths.

Stomachs of 521 specimens contained bivalves, gastropods, inorganic debris, crustaceans, fishes, and polychaetes in order of precedence (Estévez, 1972).

*Spawning.*—Material available for study includes only three ovigerous females: January, Panama; August, Acapulco, Mexico; a third undated specimen from Cabo San Lucas, Baja California, in MCZ was collected by John Xántus, perhaps with the type material.

Only one-third of the specimens of *C. toxotes* in museum collections are sexually mature, and among these males outnumber females 2:1. The small number of ovigerous females should therefore not cause surprise.

*Economic importance.*—The species is used as food and sold at the market of Buenaventura, Colombia. Crabs there are brought from Málaga Bay and others, many (mostly immature) being caught by shrimpers along the coast (Mario Estévez, pers. commun.). Collections from Estados de Sinaloa and Nayarit, Mexico; Tumaco, Colombia;

and Guayaquil, Ecuador; are from places where fishing is active or from fish markets.

*Remarks.*—The type locality lies at the extreme northern end of the distributional range, seemingly so far removed from the remainder of the range that one might question origin of the syntypes. Xántus (Madden, 1949) was an excellent and energetic collector for the Smithsonian Institution who lived and worked at Cabo de San Lucas from 4 Apr. 1859 to 7 Aug. 1861. Collectors then were not so precise about recording locality data as today, and Xántus was no exception. It is known that collections were brought to Xántus from Bahía Magdalena to the north and Revilagigedo Island to the south, etc., and that he visited Mazatlán on the mainland in summer, 1861, returning to Cape San Lucas on 1 Aug. Though no collection date is recorded with the types, MCZ received its specimens from the Smithsonian Institution on 13 Feb. 1861, which would seem to limit origin of the specimens to the tip of Baja California or at least rule out collection on the mainland closer to the rest of the range for the species. Moreover, an ovigerous female bearing a Cabo de San Lucas label (MCZ 5184), received with the mature types, suggests a breeding population and not an accidental occurrence.

Usual habitat of the species suggests that the Juan Fernández collection is extraterritorial. Set of currents between this isolate and the nearest known population in Peru suggest that if a breeding population does exist there, it is introduced. Further collecting both here and in the Cabo de San Lucas area would be useful.

*Material.*—Total: 30 lots, 120 specimens.

Specimens listed in Rathbun (1930) from USNM and MCZ; Garth and Stephenson (1966) from AHF and USNM.

USNM. 19 lots, 44 specimens, including the following not cited above:

#### MEXICO

Sinaloa and Nayarit: 61023, 1926, 1 ♂ (dry), C. Stansch, No. 33.

#### COSTA RICA

112356, Golfo de Nicoya, Jan. 1952, 2 carapaces (dry), S. E. Erdman.

#### PANAMA

73283, Bahía Honda, 9 Mar. 1933, 1 juv, W. L. Schmitt. 122920, no date, 1 ♂.

#### COLOMBIA

77045, Buenaventura, 18 Nov. 1934, 1 ♀ juv, R. Mensing.

AHF. 8 lots, 44 specimens, including the following not cited above:

[Nicaragua material Stn. 962-39 = a *Portunus* species].

#### COSTA RICA

Bahía Carrillo, 6 Feb. 1938, 1 ♂, Zaca Stn. 208, NYZS 38,194. Golfito, Golfo Dulce, 6 Mar. 1938, 1 ♂, Zaca, NYZS 38,525.

MCZ. 5 lots, 28 specimens, including the following not cited above:

#### MEXICO

Baja California: 5184, Cabo de San Lucas, no date, 1 ♀ (ov), J. Xántus. (recd. from Smithsonian Inst. 13 Feb. 1861). Guerrero: 5185 and 8755, Acapulco, Aug. 1872, 9 ♂, 15 ♀ (1 ov), Hassler Exped.

AMNH. 1 lot, 3 specimens.

#### COLOMBIA

10587, Tumaco, 19 Apr. 1941, 2 ♂, 1 ♀, Askoy Exped.

RMNH. 1 lot, 1 specimen.

Cat. a. South America, 1 ♂ (dry), Latreille.

*Supplementary literature records.*—Acapulco, Guerrero, Mexico (Contreras, 1930); Acajutla, Barra Ciega, La Libertad, La Unión, El Salvador (Bott, 1955); NW Corinto, Nicaragua (Garth and Stephenson, 1966); Baudó, Juanchaco, Catripe, Togoromá, Málaga, Buenaventura, Guapi, San Juan del Sur, Cabo Manglares, Punta Coco, and Tumaco, Colombia (Estévez, 1972).

### CALLINECTES BOCOURTI A. MILNE EDWARDS Siri (Brazil)

Figures 12, 18j, 20m, 22j, 27

*Cancer pelagicus.*— de Geer, 1778, p. 427, pl. 26, figs. 8-11.

- Callinectes bocourti* A. Milne Edwards, 1879, p. 226 (syntypes: 2 ♂, MNHNP, Mullins River, 20 miles south Belize, [British] Honduras, M. Bocourt).
- Callinectes Cayennensis* A. Milne Edwards, 1879, p. 226 (syntypes: 2 ♂, MNHNP [French] Guiana, M. Mélinon).
- Lupa diacantha*.- Kappler, 1881, p. 143.
- ?*Neptunus diacanthus*.- Thallwitz, 1892, p. 53.
- Callinectes bocourti*.- Rathbun, 1896, p. 369, pls. 19; 24, fig. 7; 25, fig. 6; 26, fig. 6; 27, fig. 6 [part].- 1897, p. 151 [part].- 1901, p. 49.- 1930, p. 128, text-figs. 15g, 16e, 17h, 18f, pl. 55.- 1933, p. 49.- 1936, p. 383.- Young, 1900, p. 192.- Bott, 1955, p. 56.- Holthuis, 1959, p. 201, text-fig. 47, pl. 5, fig. 2.- Chace and Hobbs, 1969, p. 127, text-figs. 35, 37a.- Taissoun, 1969, p. 57, figs. 20A-D, photo 7.- 1972, p. 31, figs. 1a-d, 2 [part], 3 [part], 9C, 10C-D; photos 4b, 5-6, (col.), 7.- 1973, p. 24, figs. 4G, 5G, photo 2.
- Callinectes diacanthus*.- Young, 1900, pls. 2, 3.
- Callinectes cayennensis*.- Young, 1900, p. 192.
- Callinectes danae*.- Tesch, 1914, p. 195 (fide, Holthuis, 1959, p. 205).

*Description*.—Carapace (Figure 12) bearing four triangular frontal teeth with tips reaching a nearly common level, lateral pair obtuse with mesial side having flatter angle than lateral side, submesial pair narrower than laterals. Metagastric area with length and posterior width about equal, anterior width 2 times length. Anterolateral margins moderately arcuate, anterolateral teeth exclusive of outer orbital and lateral spine swept forward, anterior margin of teeth shorter than posterior margin, teeth in lateral half of row always acuminate. Surface of carapace dorsally smooth and glistening around perimeter (when wet) and on epibranchial surfaces; central portion granulate, coarsest granules over mesobranchial and rear half of cardiac areas and lateral half of branchial lobes. Epibranchial line prominent and nearly continuous, sulci on central part of carapace deeply etched.

Chelipeds remarkably smooth except for usual spines and obsolescent granules on ridges; fingers of major chela heavily toothed, lower margin of propodal finger often decurved near base in adults.

Male abdomen and telson long, extending nearly to juncture between thoracic sternites III and IV; telson lanceolate, much longer than broad; sixth segment of abdomen broadened distally.

Mature female abdomen and telson reaching as far forward as in male, sixth segment nearly as long as fifth, its distal edge uniformly arched, telson elongate-triangular with inflated sides. First gonopods of male (Figures 18j, 20m) very long, often exceeding telson and crossed near tips; sinuously curved and overlapping in two places proximally, diverging distally, twisting mesioventrally on axis lateral to abdominal locking tubercle and recurving gradually to termination near midline; armed distally with a dorsolateral band of large and small retrogressive spinules. Gonopores of female (Figure 22j) asymmetrically ovate in outline with apex on long axis directed anteromesad; aperture of each sloping from surface on mesial side under rounded, sinuous anterolateral border superior to a low rounded eminence on posterior border.

*Size of carapace in mm*.—Largest male: length 76, width at base of lateral spines 132, including lateral spines 156. Largest female: length 70, width at base of lateral spines 121, including lateral spines 146. Summary of selected measurements is given in Tables 1 and 2. The species characteristically reaches fairly large size.

*Color*.—Complete color descriptions (Chace and Hobbs, 1969; Taissoun, 1969, 1972) and notes (Rathbun, 1896, 1930; Holthuis, 1959) give a range of color variations. These can be broadly summarized as: Overall cast olive green with prominent reddish markings. Carapace olive, grayish green, greenish chestnut, or forest green with variable purplish to red markings, especially on branchial, hepatic, cardiac, and gastric areas, individuals of large size sometimes being dark chestnut tinted blackish brown on gastric and metagastric areas, with an oblique spot on subbranchial region; anterolateral teeth olive green with brown to red tints and yellowish white tips. Chelipeds red to dark reddish brown above and whitish below with bluish tints, main colors being sharply separated on outer surface of palm; fingers red to reddish brown, a purplish cast on internal articulation of merus with carpus and this member with chela; tubercles, tips of fingers, and spines on articles cream. Remaining legs reddish above with shades of maroon, yellow, and olive green ventrally except distal articles scarlet to red or dark red distally; hairs olive-tan. Underparts of body mainly dirty white to purplish red with suffusion of blue marginally, first abdominal seg-

ment mainly reddish tan. Males tend to be reddish, females greenish.

*Variation.*—This species greatly resembles both *C. rathbunae* and *C. maracaiboensis* but generally has more obtuse frontal and anterolateral teeth as well as more pronounced smoothness on chelipeds and carapace. Considerable variation attributable to growth and age is evident. The submesial pair of frontal teeth become relatively more slender with age, but seldom extremely acute. Some young have quite lobate frontals, scarcely separated; an extreme case is represented by MCZ lot 5186 from Caruca, Rio Maria [= Rio Caraçua near Belem?] Brazil, in which an immature female has lobate frontal teeth partially coalesced while more mature males in the lot have fairly sharp submesial frontals. There is great variation in length of lateral spines, the relationship of spine length to that of the last anterolateral tooth as cited by Rathbun (1930) and Taissoun (1972) not holding up as a key character for large series of specimens. Anterolateral teeth vary from obtuse to acuminate, acuteness increasing somewhat with age, and edges of the teeth vary from smooth to granulate with greatest amount of granulation usually on the posterior margin. There is more apparent variation in chelipeds than among other species of the genus. A character accentuated with age, especially among males, is a major cheliped with gaping fingers in which the propodus is decurved along its lower margin. At one extreme is a heavy gaping hand with strong basal tooth on the dactyl, whereas at the other both chelae may be slender and almost symmetrical. Many individuals have a major chela that is halfway along this scale of development; others possess two minor chelae of nearly uniform size—evidence of regeneration.

From Rio de Janeiro south, specimens seen have stronger and more sharply granulate ridges on the chelae than those from other parts of the species' geographic range. Likewise on these southern forms, granules are bold on the posterior slope of the cardiac area and sometimes crowded into suggestion of a transverse ridge at summits of the cardiac and mesobranchial areas. Both developments are reminiscent of similar patterns found in the acutidens form of *C. sapidus*. Frontal teeth, mesogastric area, and first pleopods of these forms seem typical of *C. bocourti*.

More obscure are other variations which have bearing on the separation of *C. bocourti* from

*maracaiboensis*. A series of variant specimens from over the geographic range of *C. bocourti* demonstrate these.

Brazil: An ovigerous female from Praia Inglese, São Francisco (USNM 60978) has its sixth abdominal segment relatively narrow for its length with the distolateral edge angular (typical), not rounded as in *C. maracaiboensis*, the anterolateral teeth sharp and not curved forward, and the frontal teeth fairly sharp.

Puerto Rico: A mature female from Hucares (USNM 24460) has an abdomen as above but frontal teeth rather short and lobate, and anterolateral teeth short and not curved forward but with their anterior margin shorter than the posterior one. Another mature female (USNM 24457), from near Palo Seco, has its sixth abdominal segment shaped as in *C. maracaiboensis* (short, broad, rounded distally), short and rounded frontal teeth (mesial pair a bit sharper), and anterolateral teeth curved forward only in the lateral half of the row. A mature male from Cataño (USNM 24455) has anterolateral teeth short and not trending forward, first gonopods distorted in preservation but armed with spinules typical of *C. bocourti* (but a tip as in *maracaiboensis*), and short, lobulate frontal teeth (mutilated).

Trinidad: A mature female (USNM 137731) has the abdomen shaped as in *C. maracaiboensis*, and lobulate frontal and anterolateral teeth quite sharp and decidedly curved forward. Males in this lot have first gonopods typical of *bocourti* and anterolateral teeth moderately curved forward.

Venezuela: A mature female from Tacarigua de la Laguna, Estado Miranda (USNM 89644) has the sixth abdominal segment rounded distally and relatively short for its width, as in *C. maracaiboensis*, the mesial pair of frontal teeth moderately acute, lateral pair broader (both pairs fairly short), and sharply acuminate anterolateral teeth trending forward but not curved.

Costa Rica: A mature female (USNM 113279) has very lobate frontal teeth, erect anterolateral teeth strong and trending forward, and the sixth abdominal segment broken but rather indeterminate in shape (trending toward typical).

British Honduras: A mature female from near Belize (21377) has prominently lobulate frontal teeth, anterolateral teeth trending forward but sharp tipped only in the lateral half of the row, and the sixth abdominal segment halfway between the two extremes for the species (wide and broadly rounded distally).

Taissoun (1972) included some of these specimens in his comparative study. From this welter of conflicting trends, separation of *C. bocourti* from *maracaiboensis* was a weighted decision resting on characters prevalent in the Lago de Maracaibo populations plus environmental separation.

*Distribution.*—Jamaica and British Honduras to Estado de Santa Catarina, Brazil (Figure 27); extraterritorial occurrences in southern Florida and Mississippi, USA (both mature males).

*Habitat.*—*Callinectes bocourti* is associated with *C. sapidus* in many estuarine areas, but seems more tolerant of stagnant, polluted situations. Around the mouth of Lago de Maracaibo *C. bocourti* was found in the Golfo de Venezuela, Bahía de El Tablazo, Río Limón, and Estrecho de Maracaibo, but less abundantly in Lago de Maracaibo itself (Taissoun, 1969, 1972). Only adult females were found in the Golfo de Venezuela, but elsewhere both sexes in all stages of growth were common, abounding in Río Limón and mangroves around Puerto Caballo and in Bahía de El Tablazo, large males and juveniles being especially numerous around sewers of San Carlos and Punta de Palmas. Bottoms in this area vary from mud to sand. Griffiths, Cadima, and Rincón (1972) presented a similar account, showing that juveniles recruit to a fishery there in July and November, with mature males tending to remain in low-salinity water whereas females move to saltier water after mating. Coêlho (1967a) reported *C. bocourti* (called the blue crab there) abundant in a lagoon in Pernambuco that varies from 5‰ salinity in the rainy season to 29‰ in the dry season, and from other estuaries in north-eastern Brazil (1970).

The broad range of tolerance is emphasized by presence in places such as a pool inside porous old coral rubble on Bonaire (Rathbun, 1936), and dark somewhat stagnant, polluted water at mouths of the Mero, Indian, and Salisbury Rivers on Dominica where sand bars blocked river flow at the time of investigation (Chace and Hobbs, 1969). Here the crabs actively fed on garbage in daytime over a bottom of rock-strewn sand covered with silt. In other streams on Dominica whose mouths were open to flow, only *C. sapidus* was found.

*Spawning.*—In all of the museum collections

studied there are many containing mature females, but only five in which there are ovigerous specimens and only three of these are accurately dated: January, Puerto Rico, Panamá; February, Curaçao; November, São Francisco [Estado de Santa Catarina], Brazil. Taissoun (1969, 1972) found ovigerous females most abundant from March to August in the Golfo de Venezuela, and Griffiths et al. (1972) found them most abundant around the mouth of Lago de Maracaibo in July. These data suggest nearly year-round spawning (Taissoun, 1972) in one part or another of the range, perhaps with seasonal peaks associated with latitude.

*Economic importance.*—Holthuis (1959) described a fishery for *C. bocourti* in brackish waters of Surinam where it is the only portunid routinely caught, its tolerance of this habitat apparently favoring success there. The crabs are sold alive on the market in Paramaribo. A crab trap fishery around the mouth of Lago de Maracaibo started in 1969 and is increasing rapidly (Griffiths, et al., 1972). Though directed primarily at *C. sapidus*, a considerable number of *C. bocourti* are taken as well. Second half of the year is the season of highest catch per unit effort in a brackish area where males make up 90% of the take.

*Remarks.*—The collections examined contain an unusually large number of mature females.

The type series of *C. bocourti* in the MNHNP is somewhat confused by labels. No clear designation is given on labels of specimens which, by implication, can be associated with the original description. Two mature male specimens labelled "*Callinectes bocourti* A. M. Edw., Riviere de Mullins (12 m. NNW Stann Creek) au de Belize, Honduras, Coll. Bocourt" represent the types in the opinion of J. Forest. Identification, locality (excepting the parenthetic emendation), sex, and collector agree with Milne Edwards' description. The smaller specimen (size of carapace in mm: length 48, width at base of lateral spines 80, including lateral spines 90) has more granulate gastric, metagastric, cardiac, and branchial areas than the larger (length 60, width at base of lateral spines 102, including lateral spines 120). A small *Chelonibia* is affixed over the left epibranchial line on the anterolateral aspect of the mesobranchial area of the larger specimen. Both specimens lack right chelae, but have slender left minor hands with smooth rounded upper sides on the

propodus, that of the smaller specimen showing obsolescent granules; in both, the merus and carpus are smooth, with a very blunt outer spine on the carpus. The small specimen has a missing right third pereopod. In both, the first gonopods reach slightly beyond the telson.

Two male specimens labelled "*Callinectes cayennensis* A. M. Edw., Cayenne, Coll. Melinon" are possibly the types of *C. cayennensis*. Identification, locality, sex, and collector agree with Milne Edwards's description. Both dark in color, the specimens are obviously *C. bocourti*. The larger has only seven anterolateral teeth on the right side, the first tooth being enlarged. Both specimens have two apparent minor chelae, the larger of each smooth dorsally, and the smaller with obscurely granulate obsolescent ridges.

Finally, a dry male specimen labelled "*Callinectes bocourti* A. M. Edw., TYPE?, Honduras, Belize (Crust. Mexique, p. 226, 1881, Bocourt) A. Milne Edwards 1903" has a badly cracked carapace and bears the word "Belize" written obscurely in ink on the right mesobranchial eminence. The specimen, as shown by carapacic and pleopodal characters, is not *C. bocourti*, but rather *C. danae*, and was undoubtedly mislabelled subsequent to Milne Edwards's death in 1900, according to J. Forest. The broken abdomen exposes the tip of an intact first pleopod with tip turned ventrolaterally at the two-thirds level of sternite VI bearing a subterminal hair on the sternal aspect.

In the ANSP collection is a dry male specimen of *C. bocourti* (No. 2808 labelled *Lupa dicantha*) that is badly shrunken and distorted bearing the label "North America," but no date of collection nor indication of collector. The name and specimen suggest a collection made over a century ago representing a possible third record of the species from somewhere in the United States.

North American records may be explained by drift from the Caribbean, possible routes being suggested by drift bottle returns (Brucks, 1971).

Bott (1955) listed the species from the west rather than the east coast of Middle America by mistake.

*Material*.—Total: 117 lots, 290+ specimens.

Specimens listed in Rathbun (1930) from USNM (24459 not found) and MCZ, and in Holthuis (1959) from Surinam in RMNH.

USNM. 33 lots, 82 specimens, including the following not cited above:

#### PUERTO RICO

123085, 73279, Boca de Congrejos, 7 mi E San Juan, 31 Mar. 1937, 2 ♀, W. L. Schmitt. 77104, beach near Ponce, 17 Aug. 1932, 1 ♀, T. J. Barbour.

#### VIRGIN ISLANDS

St. Croix: 72354, Fairplain str. above bridge, 1935-36, 2 ♂, H. A. Beatty, No. 129. 76963, Altona str. 100 ft from sea, no date, 3 juv, H. A. Beatty, No. 199. 77100, Salt River reefs, no date, 17 juv, H. A. Beatty, No. 157.

#### BRITISH WEST INDIES

St. Lucia: 123086, Pigeon Island, 22 Mar. 1956, 3 ♂, 1 ♀, *Freelance*, Stn. 46-56.

#### COSTA RICA

113279, Limón Prov., Tortuguero R. about 2 mi above mouth at Leo's, 28 Apr. 1964, 1 ♀, 1 juv, D. P. Kelso.

#### COLOMBIA

78382, Puerto Colombia, no date, 1 ♀, Bro. Elias, No. 21.

#### VENEZUELA

89644, Estado Miranda, Tacarigua de la Laguna, 1 Mar. 1949, 1 ♀, Soc. Ciencias Nat. La Salle, Stn. c-3.

AHF. 1 lot, 1 specimen.

#### BRITISH WEST INDIES

Trinidad, West Manzanilla, 10°31'20"N, 61°02'37"W, 18 Apr. 1939, 1 ♂, *Velero III* Stn. A36-39.

AMNH. 4 lots, 4 specimens.

#### PUERTO RICO

2669, San Juan near San Antonio Bridge, 10 July 1914, 1 ♀, R. W. Miner. 5378, Culebra [18°18'N, 65°18'W], 1926, 1 ♂, H. E. Anthony.

#### BRITISH HONDURAS

Crique Salada [16°35'N, 88°37'W], Apr. 1951, 1 ♀, M. Gordon, Chable, and George.

#### PANAMA

11241, Harbor at Colón, no date, 1 ♀, *Arcturus* Exped.

ANSP. 3 lots, 9 specimens.

**NORTH AMERICA [?]**

2808. no date, 1 ♂ (dry).

**[DOMINICAN REPUBLIC]**

3519, Santo Domingo, no date, 2 ♀ (dry), W. M. Gabb.

**PANAMA**

1305, 5 ♂, 1 ♀, McNeil Exped.

BMNH. 9 lots, 12 specimens.

**BRITISH WEST INDIES**

1925.1.28.13, Tobago, 1 ♂, P. L. Guppy.  
1938.3.29.18, Tobago, 1 ♂, A. K. Totton.

**GUYANA**

1960.10.5.15/16, Georgetown, Kitty Jetty, 1 ♂, 1 ♀, R. H. McConnell. 44.82, Georgetown, 1 ♂ (dry), vi/9. 62.93, 2 ♂, Leadbeater. 1949.5.26.1/2, 2 ♀, V. Graham.

**SURINAM**

1959.3.20.1, Suriname River near Paramaribo, 1 ♂, I. T. Sanderson.

**BRAZIL**

1923.8.14.1, Marajó I. mouth of Amazon, 1 ♂, Erhardt. 80.37, Pernambuco, 1 ♀, W. Forbes.

MCZ. 9 lots, 22 specimens, including the following not cited above:

**PANAMA**

5472, Aspinwall [= Colón], no date (recd. 13 Feb. 1861), 1 ♀, J. Rowell.

**BRAZIL**

5172, 13 Oct. 1873, 1 ♂ juv, C. Linden.

MNB. 2 lots, 3 specimens.

**BRAZIL**

Pernambuco: 329, Manques de Olinda, 1945, 2 ♂, Berla. Rio de Janeiro: 48, Maricá, no date, 1 ♀.

MNHNP. 2 lots, 4 specimens.

**BRITISH HONDURAS**

148, Rivière de Mullins au Sud de Belize, no date, 2 ♂, Bocourt.

**FRENCH GUIANA**

69, Cayenne, no date, 2 ♂, Melinon.

RMNH. 45 lots, 130+ specimens.

**BRITISH WEST INDIES**

Barbados: 23456, Holetown river pool, 18 Feb. 1964, 1 ♂, P. W. Hummelinck.

**NETHERLANDS ANTILLES**

Curaçao: 23450, N part Piscadera Baai, 25 Nov. 1963, 1 ♂, P. W. Hummelinck. 8122, Zaquito Lagoon, 1 Feb. 1949, 1 ♂, P. W. Hummelinck. 3270, Schottegat, 10 Feb. 1939, 1 ♀ (ov), H. S. C. Cossee. Schottegat near Pasanggrahan, 22 Aug. 1948, 1 ♀ (dry), P. W. Hummelinck. 11855 and 11858, slough in mangroves, Santa Cruz, 11 Feb. 1957, 2 ♂, 2 ♀, L. B. Holthuis, No. 1099. 11857, Waaigat, Willemstad, 30 Jan. 1957, many ♂♂ and juv, L. B. Holthuis.

Bonaire: Paloe Lechi, Apr. 1955, 1 juv (dry), J. S. Zaneveld. Paloe Lechi, Dralendijk, 5 Mar. 1957, 3 adult carapaces, (dry), L. B. Holthuis, No. 1137. 11856, Paloe Lechi, N Kralendijke, 5 Mar. 1957, ♂♂, ♀♀, and juv, L. B. Holthuis.

**VENEZUELA**

Estado Miranda: 7613, Laguna de Tacarigua, 1948-49, 2 ♀ (ov), G. Marcuzzi. Estado Sucre: 7615, beach by airfield, Cumaná, Sept. 1948, 1 ♀, G. Marcuzzi.

**TRINIDAD**

23403, Diego Martin R., 1965-66, 1 ♂, H. A. van Hagen.

**SURINAM**

21163, coast off mouth of Suriname and Copenename R., 25-27 Aug. 1964, 2 ♀, M. Boeseman. 21573, mouth of Suriname R. at Leonsberg near Paramaribo, 27 Dec. 1963, 1 ♂ juv, P. Leentvaar. 5367, Swamp near Agricultural Experiment Gardens, Paramaribo, 10 June 1941, 1 ♀ juv, D. C. Geijskes. 22495, brackish water at Matappica near Paramaribo, 6 Nov. 1965, ♂♂ and ♀♀, G. F. Mees. 22598, shore at Matappica near Paramaribo, 8-13 Jan. 1966, 1 ♂ and juv, G. F. Mees.

SADZ-B. 9 lots, 23 specimens.

**BRAZIL**

Maranhão: 876, 1919, 1 ♂, F. E. Sawyer, Smithsonian Inst. Alagoas: Lagoa Jequia Mangebeira Camargo, Nov. 1952, 3 ♂, 3 ♀. Bahia: 1248, Ilhéus, 1919, 2 ♀, E. Garbe. Rio de Janeiro: 1729,

Atafona, no date, 2 ♂, 2 ♀, Meneses. 3241 Atafona, 12 July 1963, 3 juv, N. Meneses. 399, Serra de Macaé, 1912, 2 ♂, E. Garbe. São Paulo: 400, Ubatuba, 1905, 1 ♀, E. Garbe. 403, Piassaquera, 1905, 3 ♂, J. S. Fialho. 352, Iquape, 1901, 1 ♂, R. Krone.

Gulf Coast Research Laboratory. 1 lot, 1 specimen.

#### UNITED STATES

Mississippi: 172:1062, Biloxi Back Bay, No., 1971, 1 ♂, from commercial fisherman (Perry, 1973).

*Supplementary literature records.*—Biscayne Bay, Fla. (Provenzano, 1961); St. Croix (Beatty, 1944); Dominica (Chace and Hobbs, 1969); Puerto Cortez, Honduras (Bott, 1955); Lake Maracaibo vicinity, Venezuela (Taissoun, 1969); Forteleza, Ceará, Brazil (Fausto Filho, 1966).

### **CALLINECTES RATHBUNAE CONTRERAS JAIBA PRIETA (MEXICO)**

**Figures 13, 19a, 20n, 22k, 27**

*Callinectes rathbunae* Contreras, 1930, p. 238, text-figs. 9, 10 (type localities: Barras de Boca del Río, Buen País and Alvarado, Veracruz, Mexico).—Manrique Colchado, 1965, p. 30, figs. 10-15.—Taissoun, 1972, p. 35, figs. 1i-l, 2 (part), 3 (part), 9A, 10E-F, photos 8-11.

*Callinectes rathbuni* Pounds, 1961, p. 42, pl. 7, fig. 2d.

*Description.*—Carapace (Figure 13) bearing four acuminate frontal teeth with tips reaching a nearly common level, submesial teeth narrower and slightly shorter than laterals. Metagastric area with length and posterior width about equal, anterior width 2 times length. Anterolateral margins slightly arcuate, anterolateral teeth exclusive of outerorbital and lateral spine all acuminate with edges variably granulate, anterior margins of teeth a bit shorter than posterior margins, tendency to development of a shoulder on posterior margin of all except last tooth in row. Surface of carapace dorsally smooth and glistening around perimeter (when wet) and on epibranchial surfaces; central portion lightly and evenly granu-

late, cardiac area smooth anteriorly, granulate posteriorly. Epibranchial line prominent and sulci on central part of carapace deeply etched.

Chelipeds with sharply granulate ridges and usual spines; fingers of major chela heavily toothed but not gaping.

Male abdomen and telson long, extending nearly to juncture between thoracic sternites III and IV; telson lanceolate, much longer than broad; sixth segment of abdomen broadened distally. Mature female abdomen and telson reaching as far forward as in male, sixth segment nearly as long as fifth and with mesiodistal borders oblique, not markedly curved; telson elongate triangular with inflated sides. First gonopods of male (Figures 19a, 20n) reaching nearly to tip of telson beyond suture between sternites III and IV, overlapping in proximal half, diverging distally, twisting mesioventrally on axis lateral to abdominal locking tubercle on thoracic sternite V and recurving gradually to termination near midline; armed distally with a dorsolateral narrow band of large and small sharp retrogressive spinules. Gonopores of female (Figure 22k) ovate in outline with apex on long axis directed anteromesad; aperture of each sloping from surface along long mesial side under rounded, sinuous anterolateral border superior to prominent rounded eminence on posterolateral border.

*Size of carapace in mm.*—Largest male: length 61, width at base of lateral spines 107, including lateral spines 134. Largest female: length 66, width at base of lateral spines 116, including lateral spines 141. Summary of selected measurements taken from the small sample available is given in Tables 1 and 2. Manrique Colchado (1965) reported a male with length 62, width including lateral spines 144, and a female with length 62, width including lateral spines 150.

*Color.*—The only published descriptions of color are brief. Pounds's (1961) general account indicated that the colors are "clear shades of green and blue with tints of red, orange, and purple." Manrique Colchado (1965) characterized the carapace as obscure or dark green. Judging by greenish coloration of recently preserved specimens, both descriptions apply. Underparts are white.

*Distribution.*—Mouth of Rio Grande, Texas-Mexico border to southern Veracruz, Mexico (Figure 27).



*Habitat*.—Specimens available for study came from estuarine waters of ditches, lagoons, and river mouths, the type of environment reported by Manrique Colchado (1965) as coastal lagoons of varying salinity at depths of 1-3 m.

*Spawning*.—Although mature females are represented in the small study collection, none are ovigerous.

*Remarks*.—Apparently an isolate of *C. bocourti* stock confined to the western and southwestern Gulf of Mexico, *C. rathbunae* has various angularities on the body and legs more accentuated than in *C. bocourti*: 1) acute frontal spines contrasted with more rounded or lobate frontal spines (excepting juvenile *C. rathbunae* from Tamaulipas having rounded lobate frontals); 2) all anterolateral teeth acute (or acuminate) rather than anterior portion of series being rounded at tips; and 3) hand of chelae moderately ridged rather than smoothly rounded. First gonopods of mature male *C. rathbunae* are not crossed at the tips and fall a bit short of the telson tip whereas in mature *C. bocourti* they are crossed at the tips and slightly exceed the telson.

Specimens of neither species from Yucatán are available, thus areas of possible intergradation between seemingly close relatives have not been studied.

*Material*.—Total: 10 lots, 18 specimens.

USNM. 4 lots, 10 specimens.

#### MEXICO

Tamaulipas: 122925. Río Soto la Marina at Soto la Marina, 21 Jan. 1959, 1 ♀ (juv), R. R. Miller and R. J. Schultz, M59-1.

Veracruz: 122922, Laguna de Alvarado, 27 Apr. 1966, 1 ♂, 2 ♀, S. de la Campa, E. Ramirez and E. Chávez, L. B. 5093. 122923, Laguna de Pueblo Viejo off the corals, 4 Sept. 1964, 1 ♂, 1 ♀, J. A. Macías, L. B. 3333. 122924, Río Tuxpan, taken between Cobos and the Estero Quetumilco, 21 Nov. 1964, 2 ♂, 2 ♀, R. Márquez, L. B. 3632.

A ♂ with carapace 30 mm long collected from Río Grande by Trevino and sent to USNM for identification by H. Hildebrand, 4 Sept. 1956; identified by F. A. Chace, Jr., and returned to sender.

AHF. 2 lots, 3 specimens.

#### MEXICO

Veracruz: Boca del Río, seined in shallow water, 9 Aug. 1949, 1 ♂, 1 ♀, B. W. Halstead. Drainage ditch 5 mi W Veracruz, seined in brackish water, 19 Aug. 1949, 1 ♀ (juv), B. W. Halstead.

BMNH. 1 lot, 1 specimen.

#### MEXICO

65.29, 1 ♀, (dry), vi/7.

RMNH. 1 lot, 2 specimens.

#### MEXICO

Veracruz: 21814, Laguna de Pueblo Viejo, 25 Apr. 1964, 1 ♂, 1 ♀, F. A. Manrique Colchado.

Instituto Nacional de Investigaciones Biológico Pesqueras, Mexico, D. F. 2 lots, 2 specimens.

Tamaulipas: Laguna del Chairel y río Tamesí, 18 Aug. 1964, 1 ♂, J. A. Macías. Veracruz: Estero Jacome, 18 Dec. 1963, 1 ♀ (juv), S. García.

*Supplementary literature record*.—Mouth of Río Grande, Tex. (Pounds, 1961).

### *CALLINECTES MARACAIBOENSIS* TAISSOUN

Figures 14, 19b, 20a, 221, 27

*Callinectes* sp., Taissoun, 1969, p. 63, fig. 23, photo 8.

*Callinectes maracaiboensis* Taissoun, 1962, p. 12, 23, figs. 1e-h, 2 (part), 3 (part), 4, 9B, 10A-B; photos 1-2 (col.), 3, 4m (type: ♂, Museo de Ciencias Naturales, Caracas, Venezuela, Lago de Maracaibo, Venezuela).- 1973, p. 28, figs. 4F, 5E, photo 3.

*Description*.—Carapace (Figure 14) bearing four triangular frontal teeth with tips meeting a nearly common level, lateral pair moderately acute with mesial side having a flatter angle than lateral side, submesial pair much narrower, acute, sometimes slightly shorter than lateral pair. Metagastric area with length and posterior width about equal, anterior width 2 times length. Anterolateral margins slightly arcuate, teeth exclusive of outer orbital and lateral spine with tips directed outward, tending to be acuminate especially in outer portion of row, posterior margin of teeth usually longer than and more granulate

than anterior margin. Surface of carapace dorsally smooth and glistening around perimeter (when wet) and on epibranchial and posterolateral surfaces; granules scattered on epibranchial surfaces, progressively more crowded on proto-, meso-, and anterior portion of metagastric areas and branchial lobes and on cardiac area (especially posterior slope). Epibranchial line prominent and relatively uninterrupted, sulci on central part of carapace deeply etched.

Chelipeds granulate on ridges, fingers of major chela heavily toothed, lower margin of propodal finger often decurved near base in adults.

Male abdomen and telson long, extending to anterior quarter of thoracic sternite IV; telson lanceolate, much longer than broad; sixth segment of abdomen broadened distally. Mature female abdomen and telson reaching at least as far forward as in male, nearly to juncture between thoracic sternites III and IV, sixth segment as long as fifth and fully rounded at its distolateral corners, telson elongate-triangular with sides slightly inflated. First gonopods of male (Figures 19b, 20c) very long, often extending nearly to tip of telson and crossed near tips; sinuously curved and overlapping in two places proximally, diverging distally, twisting mesioventrally on axis lateral to abdominal locking tubercles on thoracic sternite V, and recurving gradually to termination near midline; armed distally with a dorsolateral band of large and small retrogressive spinules. Gonopores of female (Figure 22l) asymmetrically ovate in outline with apex on long axis directed anteromesad; aperture of each sloping from surface on mesial side under rounded sinuous anterolateral border superior to rounded lateral and much smaller mesial eminences on posterior border.

*Size of carapace in mm.*—Largest male available: length 78, width at base of lateral spine 134, including lateral spines 159. Largest female available: length 58, width at base of lateral spines 102, including lateral spines 124. Taissoun (1972) measured large samples made up of individuals whose mean sizes were comparable to the above specimens, males generally being larger than females. Summary of selected measurements for the few specimens available is given in Tables 1 and 2.

The following account is from Taissoun (1972), the only person who has studied the species in detail.

*Color.*—Adult male: carapace olive green with tints of light brown and blue toward central region, anterolateral region with light chestnut areas. Chelipeds with upper portion light chestnut and olive green with orange tints; distal portions of merus, internal portion of carpus, internal and external sides of fingers intense blue; spines of merus brownish orange distally with tips light chestnut and cream, bases obscure brown; distal tubercles on propodus orange and intense blue. Ambulatory legs cream proximally, blue distally, articulations with tubercles intense orange. Swimming legs intense blue and cream dorsally, terminal article blue, obscure brown and light orange, tubercles orange. Underparts cream and light yellow, except anterior portion and pereopods light blue.

Females: as males but with more intense blue on internal part of chelipeds. Taissoun (1972) included colored illustrations, but the female pictured is more reddish than as described above.

*Variation.*—Granulation of the carapace varies from nearly smooth to fairly marked, but is not so prominent as in some specimens of *C. bocourti*. Lateral spines of males are occasionally curved forward at the tips, but in females are often relatively longer and straighter. Meral spines on the chelipeds vary in number as usual in the genus (four or five) and all spines become worn in old individuals.

*Distribution.*—Confined to the Lago de Maracaibo estuarine system, roughly 120 km wide × 215 km long, extending from Bahía del Tablazo emptying into Golfo de Venezuela in north, through Estrecho de Maracaibo southward into Lake proper.

*Habitat.*—The species occurs on sandy and muddy bottoms, and among roots of mangroves, in brackish to occasionally fresh waters containing much silt and decomposing organic material. Both *C. maracaiboensis* and *bocourti* occur in the Lake and its outlet, apparently most abundantly near the mouth where all developmental stages of both are found, but the majority of these are adult males in salinities ranging from 0.35 to 15.12‰. Surface temperatures in the Lake are fairly uniform, ranging from 27.2° to 32°C, and undergoing a diurnal change of ± 1°C, but below depths of 10 m temperature remains even more uniform. Tem-

perature of surface water in the Golfo de Venezuela is less than in the Lake (28.6°C in October and 25.9°C in February were recorded by Taissoun (1972)).

*Spawning.*—Adaptation to the Lake environment is shown by spawning habits. Ovigerous *C. maracaiboensis* were occasionally taken in Bahía del Tablazo and Estrecho de Maracaibo from April to August where salinity ranged from 3.15 to 15.13‰. Ovigerous female *C. bocourti* were usually found in the Golfo de Venezuela where salinity varied between 23.9 and 34.6‰, and only occasionally in the fresher Bahía del Tablazo.

*Economic importance.*—A developing fishery in the Lago de Maracaibo region employing crab traps concentrates chiefly on *C. sapidus*, but includes *C. maracaiboensis* and *C. bocourti*.

*Remarks.*—Recognition of this new species from a restricted geographic range comes as some surprise in view of the broader distribution of other members of the genus. There is no doubt that *C. bocourti*, *maracaiboensis*, and *rathbunae* are very closely related, the widely ranging *bocourti* probably being the parent stock from which the isolates in peripheral areas have evolved. *Callinectes maracaiboensis* and *rathbunae* are similar in having somewhat less robust bodies than *bocourti*, smaller, sharper, outwardly directed anterolateral teeth and, in adults, more acuminate frontal teeth. In this regard, Taissoun's (1972:10) outlined median saggital sections of the three species do not seem to represent the average. Shape of abdomen in adult females is another useful character, that of *C. maracaiboensis* being somewhat smaller, having a sixth segment short and evenly rounded on the distal edge, but narrower than in *rathbunae*. Typically mature *C. bocourti* females have a relatively smaller abdomen than either of the others, with the distal edge of the sixth segment being somewhat angular distolaterally rather than broadly rounded.

Taissoun (1972) marshalled evidence for estuarine adaptations in *C. maracaiboensis*, which apparently parallels similar trends in engraulid fishes, the whole process presumably being associated with isolation of the Lake accompanying fall in sea level during the Pleistocene. The habitat of this species suggests interesting comparative experiments on larval development of a

form adapted to living in lowered salinity throughout life as contrasted with the other more catadromous species of the genus.

*Material.*—Total: 4 lots, 16 specimens.

USNM

#### VENEZUELA

139621, Lago de Maracaibo, 19 July 1970, 1 ♂, 1 ♀ (Paratypes), E. Taissoun. 143392, Lago de Maracaibo, no date, 5 ♂, 1 ♀, E. Taissoun. 143391, Lago de Maracaibo, 23 June 1972, 5 ♂, 1 ♀, E. Taissoun. 143393 Puerto Caballo, Maracaibo, Lago de Maracaibo, 17 June 1968, 1 ♂, 1 ♀, E. Taissoun.

### *CALLINECTES LATIMANUS* *RATHBUN*

Figures 15, 19c, 20p, 23a, 27

*Callinectes bocourti.*—Rathbun, 1896, p. 362 (part), fide Rathbun, 1921.—1897, p. 151 (part), fide Rathbun, 1921.—1900a, p. 290.—Balss, 1921, p. 58.

*Callinectes latimanus* Rathbun, 1897, p. 151, text-figs. 6-8 (syntypes: 4 ♂, 3 ♀, BMNH 91.4.1.63/69; 1 ♂, USNM 19877; Lagos, Bight of Benin, Guinea [Nigeria], A. Molony).—1900a, p. 291.—1921, p. 398, text-fig. 4, pl. XV, fig. 2, pl. XXI, pl. XXII, fig. 1.—Odhner, 1923, p. 22.—Monod, 1927, p. 606.—1956, p. 211, figs. 240-243.—Irvine, 1947, p. 297, fig. 202 [?].—Vilela, 1949, p. 58.—Capart, 1951, p. 132, fig. 47.—Rossignol, 1957, p. 82.—1962, p. 116.—Forest and Guinot, 1966, p. 65.

*Neptunus marginatus* var. *truncata* Aurivillius, 1898, p. 5, pl. 1, figs. 1-4 (type: 1 immature ♀ [not ♂], fide Rathbun, 1921, Cameroon).

*Callinectes diacanthus* var. *africanus*.—A. Milne Edwards and Bouvier, 1900, p. 71 (not col. pl. 4, fig. 5 = *C. sapidus*).—Lenz, 1910, p. 125 [5].—Gruvel, 1912, p. 3, 6, pl. 2, fig. 1.

*Callinectes marginatus.*—Odhner, 1923, p. 21.

*Callanectes* Sp. (?).—Irvine, 1932, p. 14, fig. 13.

*Description.*—Carapace (Figure 15) bearing four frontal teeth with variably rounded tips, submesial pair shorter than lateral pair. Metagastric area with length approximately equal to posterior width, anterior width about 2 times length. Anterolateral margins moderately

arched, anterolateral teeth exclusive of outer orbital and lateral spine varying from acute with serrate margins to increasingly acuminate and forward curving with nearly smooth margins at lateral end of row. Lateral spine relatively stout. Surface of carapace coarsely granulate, but granules more widely spaced or absent near margins, on epibranchial surfaces, and along regional sulci; most closely crowded granules on mesogastric, cardiac, and mesobranchial areas. Epibranchial line prominent and nearly uninterrupted.

Chelipeds with propodus and carpus moderately ridged, granules on dorsal and lateral ridges becoming smooth with age; chelae of large specimens very strong, major one often very broad with fingers heavily toothed (if not worn), lower margin of propodal finger often decurved near base opposite enlarged basal tooth of dactylus.

Male abdomen and telson reaching beyond midlength of thoracic sternite IV; telson lanceolate, much longer than broad; sixth segment of abdomen broadened distally. Mature female abdomen and telson reaching about midlength of thoracic sternite IV; telson elongate triangular with inflated sides, sixth segment longer than fifth. First gonopods of male (Figures 19c, 20p) very long, usually exceeding telson and crossed near tips; sinuously curved and overlapping proximally, diverging distally, twisting mesioventrally on axis lateral to abdominal locking tubercle and recurving to termination near midline; armed distally with dorsolateral band of large and small retrogressive spinules. Gonopores of female (Figure 23a) ovate in outline with apex on long axis directed anteromesad; aperture of each sloping from surface on mesial side under rounded, sinuous anterolateral border superior to a rounded eminence on posterior border.

*Size of carapace in mm.*—Largest male: length 71, width at base of lateral spines 125, including lateral spines 151. Largest female: length 59, width at base of lateral spines 105, including lateral spines 127. Summary of selected measurements is given in Tables 1 and 2. The species is characteristically large at adult size, Irvine (1947) reporting carapace widths of 8-12 inches (20-30 cm).

*Color.*—Uniform greenish brown with articulations and internal face of chela and dactyl bluish; ventral aspect yellowish white (Rossignol, 1957). Khaki colored with bluish tinge and bluish legs

(Irvine, 1932, 1947); predominantly brown, perhaps where waters are often turbid with silt (Longhurst, 1958). A mottled olive coloration persists at least as long as 20 yr in some preserved specimens.

*Variation.*—Aptly named for one of their most distinctive features, adults of *C. latimanus* have broad major chelae. Chelae with worn tooth rows and gaping fingers seem disproportionately large in old males, and in their smooth surfaces these may resemble the hands of *C. bocourti* (excellent example, AMNH 3111), but the entire cheliped is shorter and thicker than in that species. There is usually a strongly developed proximal tooth on the dactyl of the major hand and opposite it a strongly decurved propodal finger. The minor chela (normally left) is much slimmer than the major, its two fingers toothed with meshing sectorial triads or variants of this pattern.

Especially in juveniles, the submesial pair of frontal teeth often overhangs and obscures the epistomial tooth, though not so completely as in *C. toxotes*. Adult females have coarse granulations over the whole carapace though not so closely crowded at the edges as in central elevated parts behind the epibranchial line. There are smooth areas between more scattered granules in front of the epibranchial line in both sexes.

First gonopods of males may extend beyond the telson.

*Distribution.*—Baie de Saint-Jean [19°27'N, 16°22'W], Mauritania, to Cabinda, Angola (Figure 27). (Perhaps farther south in Angola on basis of published accounts such as Gruvel [1912] and Monod [1956], and specimens of uncertain origin [AMNH 5895].)

*Habitat.*—In a category Longhurst (1958) called "mobile invertebrates," the most important estuarine species in the Sierra Leone River (site studied) appeared to be *C. latimanus* and *Parapenaeopsis atlantica* Balss. Neither of these was completely restricted to the estuary but occurred only sporadically outside it. *Callinectes latimanus* was most abundant in the mid-estuarine region in many of the otter-trawl hauls, and extended far up creeks to low-salinity water. Sourie (1954b) found *C. latimanus* widely distributed in estuaries of Senegal ranging from fresh water to salt concentrations near saturation, and Gruvel (1912) reported brackish water habitats in

Ghana where the species abounds on muddy bottoms. Crosnier (1964, and pers. data) and a number of others listed the depth range as 0-35 m in warm water.

*Callinectes latimanus* is preyed upon by *Galeoides decadactylus* Bloch and *Pomadasys jubelini* Cuvier (Longhurst, 1957), and *Callinectes* sp. [probably *latimanus*] by *Dasyatus margarita* Gunther and *Caranx alexandrinus* Cuvier and Valenciennes (Monod, 1927).

*Spawning*.—In all museum material available to me only four collections that are dated contain ovigerous females: January-February, Ivory Coast; May, Senegal, Nigeria; October, Togo. In the warm West African region it is likely that spawning occurs the year round, but may be concentrated at seasonal peaks.

*Economic importance*.—There is no literature on strictly commercial aspects of a fishery for this species, but it is important as food in coastal communities. Rathbun (1900a) recounted an early report that the crab was found only in fresh water of rivers, and much sought after for the exceptionally good meat. Monod (1927) listed *C. latimanus* as common in the Cameroons and customarily eaten there. Gruvel (1912) wrote that it is extremely abundant along the coast from Senegal to Angola, and so much so in certain areas such as the Ivory Coast, Dahomey, etc., that the people there brought large basketfuls alive to the markets to be either boiled in water or fried in palm oil. He regarded the crabs as extremely tasty and therefore subjects for a fishery, at least from Senegal to the Cameroons, where they were captured around lagoons and among mangroves in brackish water, generally on mud bottom, by means of small seines, baited traps, or fishing lines. Irvine (1947) listed similar fishing methods and considered the crabs quite edible, while Rosignol (1957, 1962) considered this crab the most abundant in the genus, subject to a regular fishery by native peoples in estuaries and lagoons, and although acceptable, not always so savory as *Portunus validus* Herklots.

*Remarks*.—The syntype male in the USNM (19877) is a mature specimen with first gonopods extending beyond the telson, a quite sharply granulate carapace with acute anterolateral teeth (especially from the fourth tooth laterad), and a left chela with strong proximal tooth on the dactyl

heavier than the right, but it is a poor specimen because both chelipeds are detached from the body and parts of other legs are detached or missing. The series of syntypes in the BMNH (91.4.1.63/69) is in much better condition, consisting of two mature and two immature males, and one mature and two immature females. The largest male is the most perfect specimen, and the first gonopods on it exceed the tip of the telson.

The early confusion of this species with the American *C. bocourti* is easy to understand because each is described comparatively in terms of the other, the relationships being obviously close.

*Material*.—Total: 39 lots, 116 specimens.

USNM. 9 lots, 16 specimens.

#### SENEGAL

18735, no date, 1 ♂ juv, from Mus. Nat. Hist., Paris.

#### LIBERIA

123087, Robertsport, Grand Cape Mount Co., 28 Dec. 1947, 1 ♀, J. T. Baldwin, Jr.

#### NIGERIA

120943, Lagos, 06°28'N, 03°23'E, 10 May 1965, 1 ♀, Pillsbury. Lagos, Guinea [= Nigeria], nodate, 1 ♂, A. Molony, (Type).

#### ANNOBÓN ISLAND

120944, 01°24'S, 05°37'E, 20 May 1965, 2 ♂, 2 juv, Pillsbury, Stn. 281.

#### ZAIRE

54253, 54254, 54310, Banana, mouth of Congo River, July-Aug. 1915, 5 ♂, 2 ♀, H. Lang.

AMNH. 6 lots, 15 specimens.

#### ZAIRE

3326, no date, 1 ♂, Congo Exped. 3110, 3111, 3112, 3417, Banana, July-Aug. 1915, 7 ♂ (1 dry), 4 ♀ (1 juv), H. Lang and J. Chapin.

#### ANGOLA [?]

5895, 1925, 2 ♀, Vernay Angola Exped.

BMNH. 6 lots, 17 specimens.

#### SIERRA LEONE

1916.6.23.1/2, Gbanbama, 1 ♂, 1 ♀, N. W. Thomas. 1922.9.13.6/7, Sherbo I., 2 ♀, C. H. Allan.

## GHANA

Accra, no date, 1 ♂, 1 ♀, F. R. Irvine.

## NIGERIA

91.4.1.63/69, Lagos, Bight of Benin, 4 ♂, 3 ♀ (2 juv), A. Moloney, (Types). 1948.4.30.1/2, Lekki Lagoon, 16.2.1947, 2 ♂, Trewavas.

## ANGOLA

1912.4.2.4/5, Chiloango River, Cabinda, July 1911, 2 ♂, Ansorge.

MNHNP. 5 lots, 7 specimens.

## GAMBIA

Basse, Côte de Troire, 1907, 1 ♂, Bouet.

## SENEGAL

No number, 1 ♂, 1 ♀ juv, date and col. unknown. Bignona, May 1946, 2 ♂, P. L. De Keyser and A. Villiers.

## GUINEA

Conakry, Guinée, 1 ♀, Inst. Fr. d'Afrique Noire.

## CONGO

1892-94, 1 ♂ juv, Dybowski.

RMNH. 6 lots, 20 specimens.

## LIBERIA

Grand Cape Mount, 1881, 1 ♂, J. Büttikofer and J. A. Sala. 1864, Fishermans Lake, [35 mi NW Monrovia], among stones, Jan. 1881, juv 2 ♂, 2 ♀, J. Büttikofer and J. A. Sala.

## GHANA

376, St. George d'Elmina, 1 ♂, H. S. Pel.

## NIGERIA

20614, Lagos harbor, 23 May 1964, 1 ♀ (ov), Pillsbury. 15533, Niger Delta, May-Aug. 1960, 3 ♂, 3 ♀, H. J. G. Beets.

## CONGO

No number, 1880, (juv) 2 ♂, 5 ♀, T. Kameron.

UNC-IMS. 7 lots, 41 specimens, from A. Crosnier.

## TOGO

2733, Lagune D'Anecho, 5 ♂, 3 ♀, A. Stauch. 2734, Côtes du Togo, 06°06'30"N, 01°37'30"E, 16 Oct. 1963, 1 ♀ (ov), A. Crosnier.

## CAMEROON

2735, Cotes du Cameroun, 03°34'N, 09°35'E, 23 Aug. 1963, 1 ♀, A. Crosnier.

## CONGO

2736, Lagune de Zambi [03°58'S, 11°17'E], 13 May, 1964, 2 ♀, A. Stauch. 2737, Lagune de Conkouati [03°58'S, 11°19'E], 14 May 1964, 1 ♀, 17 juv, A. Stauch. 2738, Plage de Pointe-Noire, no date, 2 ♂, 2 ♀. A. Crosnier. 2739, Plage de Pointe-Noire, July 1963, 4 ♂, 4 ♀, A. Crosnier.

*Supplementary literature records.*—Baie de Saint-Jean [19°27'N, 16°22'W], Mauritania; St. Louis, Yof, Sobané [= Sobène?], Bignona, Sédhiou + 3 nearby localities, Ziguinchor, Senegal; Tamara, Ile Poulet, Guinea; Abidjan, Lagune Ébrié, Baie de Cocody, Ivory Coast; near Densu, Gold Coast [= Ghana] (Monod, 1956); Bissau, porto de Biombo, Ilhéu de Âncora, Portuguese Guinea (Vilela, 1949); Sierra Leone River (Longhurst, 1958); Gold Coast (Irvine, 1947); Fernando Póo (Crosnier, 1964); Príncipe I. (Forest and Guinot, 1966); Senaga, Cameroon (Odhner, 1923); Songolo [= Songololo], Loya, Longo, Djeno, Congo (Rossignol, 1957).

## CALLINECTES SAPIDUS RATHBUN Blue Crab

Figures 1, 16, 17, 19d, 21, 23b-c, 26

*Portunus hastatus*.- Bosc, 1802, p. 212-214, 219.- 1830, p. 234.

*Lupa hastata*.- Say, 1817, p. 65 (not *L. hastata* Desmarest, 1832 = *Cancer hastatus* Linnaeus, 1767).

*Portunus diacantha* Latreille, 1825, p. 190 (variety) (type localities: North America, Antilles, Brazil, etc.; types not extant; restricted to Philadelphia, Pa., by Holthuis, 1962, p. 232; name suppressed by International Commission of Zoological Nomenclature, Opinion 712 [1964, p. 336]).

?*Lupea dicantha*.- H. Milne Edwards, 1834, p. 451 (part).

*Lupa dicantha*.- Gould, 1841, p. 324.- de Kay, 1844, p. 10, pl. 3, fig. 3.- Holmes, 1858, p. 9 (fossil).

*Callinectes diacanthus*.- Stimpson, 1860, p. 220.- Young, 1900, p. 186 (part).

*Callinectes hastatus*.- Ordway, 1863, p. 568 [3].- A. Milne Edwards, 1879, p. 224 (var. of *C.*

- diacanthus*.- R. Rathbun, 1884, 1893, p. 775, pl. 267.- Young, 1900, p. 187 (var. of *C. diacanthus*).
- ?*Neptunus hastatus*.- Brocchi, 1875, p. 55, pl. 16, fig. 81.
- Neptunus (Callinectes) diacanthus*.- Ortmann, 1894, p. 77 (part: specimens g, Florida; l, Brazil; n, Haiti).
- Callinectes sapidus* Rathbun, 1896, p. 352, pl. 12; pl. 24, fig. 1; pl. 25, fig. 1; pl. 26, fig. 1; pl. 27, fig. 1 (type locality restricted to "east coast of United States" by Williams, 1965).- 1929, p. 31, fig. 41.- 1930, p. 99, text-figs. 15a, 16c, 17c, 18a, 19, pl. 47.- Bouvier, 1901, p. 16.- Clark, 1906, p. 172, pl. 41, figs. 1-3 (fossil).- Verrill, 1908a, p. 370, text-figs. 22a, 23a, 24, pl. 17, fig. 2.- Hay and Shore, 1918, p. 432, pl. 35, fig. 1.- Chace, 1940, p. 33.- Chace and Hobbs, 1969, p. 133, figs. 36, 37f.- Balss, 1957, p. 1641.- Holthuis, 1961, p. 50, pl. 1, fig. 2, pl. 2, fig. 2.- 1969, p. 34, pl. 1.- Holthuis and Gottlieb, 1955, p. 91, pl. 3, fig. 11.- Pounds, 1961, p. 42, unnumbered col. frontis., unnumbered text-fig. p. 9, text-figs. 1-2, pl. 7, figs. 1, 2a.- Futch, 1965, p. 2, figs. 1, 2, 3, 4, 5c.- Williams, 1965, p. 168, fig. 151.- Christiansen, 1969, p. 72, fig. 29.- Taissoun, 1969, p. 37, photos 3-6, figs. 11A-D.- 1973, p. 34, figs. 4E, 5F, photo 5.
- Callinectes sapidus acutidens* Rathbun, 1896, p. 354, pl. 13; pl. 24, fig. 2 (type: ♂, MCZ 4696, Santa Cruz [Estado de Bahia] Brazil, Thayer Exped.).-1901, p. 47.- 1930, p. 111, text-fig. 15 c, pl. 48.- 1933, p. 48.- Young, 1900, p. 191.- Contreras, 1930, p. 228, fig. 1.- Pretzmann, 1966, p. 305, 2 pls.- Bulgurkov, 1968, fig. 1.
- Callinectes africanus*.- A. Milne Edwards and Bouvier, 1900, pl. 4, fig. 5 (not p. 71, var. of *C. diacanthus* = *C. marginatus*).

*Description*.—Carapace (Figures 16, 17) bearing two broad either obtuse or acuminate, triangular frontal teeth with mesial slopes (incorporating a pair of rudimentary submesial teeth) longer than lateral slopes. Metagastric area with posterior width approximately 1.2 times length, anterior width about 2 times length. Anterolateral margins slightly arched; anterolateral teeth exclusive of outer orbital and lateral spine obtuse to acuminate and directed outward more than forward. Much of surface smooth, with scattered granules, but granules concentrated locally on

mesobranchial, posterior slope of cardiac, and anterior portion of mesogastric area; a tendency to crowding of granules into transverse ridge at summit of cardiac and mesobranchial area in some individuals. Sculpturing of surface varying individually from low to raised relief. Lateral spines varying from rather stout, blunt, and forward trending to slender, elongate, and slightly backward trending. Epibranchial line nearly straight over branchial region, otherwise sinusously curved.

Propodus and carpus of chelipeds with moderate finely granulate ridges, width of chelae similar, propodal finger of major hand occasionally with lower margin decurved proximally.

Male abdomen and telson reaching about midlength of thoracic sternite IV; telson lanceolate, much longer than broad; sixth segment of abdomen broadened distally. Mature female abdomen and telson reaching about midlength of thoracic sternite IV; telson with inflated sides almost equilaterally triangular, fifth and sixth abdominal segments equal in length. First gonopods of male (Figures 19d, 21) very long, reaching beyond suture between thoracic sternites IV and V but not exceeding telson; sinusously curved and overlapping proximally, diverging distally, twisting mesioventrally on axis lateral to abdominal locking tubercle and recurving to termination near midline; armed distally with row of large and small retrogressive spinules following ventral and lateral borders with twist of axis; tip membranous, flared portion suggesting an elongate quadrilateral in outline. Gonopores of female (Figure 23b, c) paraboloid in outline with apex on long axis directed anteromesad, aperture of each sloping from surface on mesial side under irregularly rounded and linearly wrinkled anterior border superior to bulbous posterolateral border.

*Size of carapace in mm*.—Largest male: length 91, width at base of lateral spines 168, including lateral spines 209. Largest female: length 75, width at base of lateral spines 143, including lateral spines 204. Mature size of females varies considerably, the smallest examined having a carapace length of 21, width at base of lateral spines 41, including lateral spines 55. Summary of selected measurements is given in Tables 1 and 2.

Pretzmann (1966) discussed a large immature female with acute spines: length 65, width 132.5. The largest immature female I have seen, also with fairly acute spines, reached a carapace

length of 60, width at base of lateral spines 109, including lateral spines 135. Some others in material studied approached this size. All such specimens seen by me are from the Gulf of Mexico and may represent parasitized individuals in which the maturation process has been altered.

*Color.*—Grayish, bluish, or brownish green of varying shades and tints dorsally on carapace and chelipeds; spines may have reddish tints, tubercles at articulations of legs orange, and legs varying blue and white with traces of red or brownish green. Males with propodi of chelae blue on inner and outer surfaces, fingers blue on inner and white on outer surfaces and tipped with red. Mature females with orange fingers on chelae tipped with purple. Underparts off-white with tints of yellow and pink. Futch (1965) and Taisoun (1969) gave a good description of color; De Kay (1844), Milne Edwards and Bouvier (1900; plate IV, Figure 5), Churchill (1919), and Pounds (1961) published colored illustrations of the species, and still others are scattered in popular literature.

Color variations other than those associated with sexual dimorphism and molt cycle are known. Albinos or partial albinos are in museum collections and have been reported both in systematic literature and elsewhere (Gowanloch, 1952; Sims and Joyce, 1966). Haefner (1961) reported an adult male lacking dorsal green coloration and bright blue and scarlet markings on the legs. Instead, the upper surface of the carapace was "robins egg blue" and the appendages were paler than usual, but the abdomen and underparts had normal color. A similar blue specimen was reported elsewhere (Maryland Tidewater News, 1950). Haefner also pictured a bilateral gray and brown colored specimen from the collection of L. Eugene Cronin. Hopkins (1962, 1963) discussed biochemistry of the sexual color dimorphism.

*Variation.*—There are morphological variations in this species having far greater systematic interest than size and color. Study of many specimens from throughout the range of the species bears out the conclusion of Chace and Hobbs (1969) that extreme variants "are so different from each other that they could easily be interpreted as distinct species," but there is "no point of demarcation"—morphological, geographic, bathymetric—between the "typical" rather blunt-spined form predominating along the east

coast of the United States and the acute-spined form named *C. sapidus acutidens* by Rathbun predominating from Florida southward.

Rathbun (1896) characterized the "acutidens" form (paraphrasing) as being wider than the "typical" with all prominences more strongly marked, areolations separated by deeper depressions, granules more raised, gastric ridges stronger and more sinuous, a transverse granulate ridge on each cardiac lobe, frontal teeth narrower and more acute and bearing two small intervening teeth, anterolateral teeth broad at base and narrowing abruptly to long acuminate tips with margins granulate, lateral spines longer than in "typical" specimens of equal size, and ridges of chelipeds quite prominent and strongly granulate. Figures 16 and 17 show two extremes, the first a mature young male of typical form, and the second a mature male of "acutidens" form.

I thought for a time that a species distributed through approximately 85° of latitude from North Temperate through Tropic to South Temperate Zones might reflect responses to temperature in spination or other characters, "typical" structure being prevalent in the temperate zones and sharp spination in the tropics, the differences thereby justifying nomenclatural recognition. There is weak but inconsistent evidence for this pattern. Though "acutidens" individuals are uncommon outside the tropics, intermediates occur everywhere to some degree, and some "typical" individuals occur in the tropics. Genetic pooling or environmental response reflected in morphology seems poorly structured.

For example: Occasional specimens found as far north as Woods Hole, Mass., (USNM 4946, 40723, 43178) are nearly as sharp spined as some Caribbean material. Churchill (1919, plates 53-54) pictured individuals from Chesapeake Bay that approach the "acutidens" form. In the collection of the USNM is a huge male from Wye River, Md., (92452) that has acuminate anterolateral and suborbital teeth, though not so attenuated as in Florida material; two carapaces from Virginia (76184) have such acute spines that Rathbun identified them as the "acutidens" form; and a huge lot (60601) from Hatteras, N.C., composed of mainly "typical" blunt-spined individuals characteristic of eastern United States shows variation in frontal teeth from no submesial frontals to rudimentary evidence for their presence. In Maryland, few specimens examined show easily identifiable submesial teeth on the inner



slopes of the prominent frontal teeth, but in material from Louisiana there is a tendency to development of the submesial frontals, and the anterolateral teeth are generally more acute than in Chesapeake Bay material. Specimens from Veracruz, Mexico, in the AHF collection show rather blunt frontal but acuminate anterolateral teeth and rather prominent regions on the carapace. Most specimens from southern Florida to southern Brazil approach the "acutidens" form, but throughout this vast region there is much variation.

The sharpest- and longest-spined forms with most prominent development of rudimentary submesial frontal teeth occur in the western Caribbean Sea along the Guatemala-Panama coast. These individuals also have regions on the carapace more deeply and sharply sculptured than in the "typical" form, sharp granulation on both carapace and chelipeds, and cardiac and to some extent mesobranchial regions exhibiting a crowding of granules at the apex leading to formation of slight transverse ridges, but with the anterior slopes of these regions lacking granules. While some specimens from Puerto Rico approach those from the western Caribbean in ornamentation, there is a mixture of "typical" features in many individuals, as elsewhere in the Antilles. Perhaps the best illustration of mingling features is illustrated by three lots of specimens in the RMNH. In 23404 from Trinidad are two males. Both have crowding of granules into a transverse ridge on the cardiac lobes with largest granules behind and fewer on the anterior slope, and a faint tendency to ridging of granules on the mesobranchial regions. The smaller specimen has the more deeply sculptured carapace, but rather blunt frontal, outer orbital, and suborbital teeth, and rather short, acute anterolateral teeth except for the last two which are acuminate. The larger specimen has a rather smooth carapace, but acuminate, long, and outwardly turned outer orbital and suborbital teeth, rather acute frontals with rudimentary submesial teeth, and quite acuminate anterolateral teeth throughout the length of the row. Another male from Trinidad (17738) has a transverse row of crowded granules on each cardiac lobe with the anterior slope relatively smooth, and mesobranchial regions with crowded granules but no ridging. The frontal teeth are neither especially sharp nor sinuous mesially, and the anterolateral, outer orbital, and suborbital teeth, like many "typical" specimens, are acuminate

but not markedly so. Two females from Curacao (11881) seem to be nearly "typical" in all respects. One of them has granules crowded into a poorly defined transverse ridge on each cardiac lobe; however, there are granules on the anterior slopes of these lobes. In sum, each of these specimens shows different combinations of the "sapidus"- "sapidus acutidens" complex.

The paratype male "acutidens" from Rio de Janeiro (USNM 19083) is not as acute spined as Panamanian material and the outer orbitals are rather blunt by "acutidens" standards.

In rather scanty material available from southern Brazil and Uruguay, though the "acutidens" form predominates, teeth are not so sharp as in Panama and the ridging of granules on the carapace is suppressed to give a smoothed effect reminiscent of that in North American specimens.

The first gonopods of males, one of the most reliable characters for separating species of *Callinectes*, offer no help in separating "typical" and "acutidens" forms of *sapidus*. This pair of appendages shows individual variation on a basic structural theme (Figure 21) having more correlation with age than with general body facies or geographic region. It is apparent that movable retrogressive spinules in the main row of spinules increase in length with age, and that there is no set arrangement except a tendency to an irregular grouping of slender subterminal spinules more erect than the proximal ones. The flared membranous tip has an irregular quadrilateral or elliptical shape.

Abdominal segments of mature females vary in shape, some (such as USNM 126789, Dominica) having the distal edge of the sixth segment broadened at its distal corners to an almost rectilinear form, whereas in most this segment tapers toward the telson.

Gonopores of the females vary in width of aperture and ornamentation of margins. The variations shown in Figure 23b, c represent some extremes, but there is no association of pattern with geography, the only constant being the elongate opening characteristic of species in which gonopods of males are long.

*Distribution.*—Occasionally Nova Scotia, Maine, and northern Massachusetts to northern Argentina, including Bermuda and the Antilles; Øresund, Denmark; the Netherlands and adjacent North Sea; southwest France (found twice); Golfo di Genova; northern Adriatic; Aegean, western

Black, and eastern Mediterranean Sea (Figure 26).

The extreme southern record by Ringuélet (1963) is substantiated by the figure in his paper. Records north of Cape Cod occur only during favorable warm periods (Scattergood, 1960).

Holthuis and Gottlieb (1955, 1958), Holthuis (1961, 1969), and Christiansen (1969) summarized the introduction of *C. sapidus* into Europe, and Bulgurkov (1968) extended the known range, recording an adult female taken in the western part of Varna Bay in October 1967. From these accounts it is clear that introduction in the Mediterranean and adjacent waters is an active one involving a breeding population, whereas the others seem to be temporary occurrences, but all are judged to have come from transport of small specimens in the ballast tanks of ships (op. cit., and Wolff, 1954a, 1954b). Banoub (1963) published one of the most complete accounts, noting that presence in Egypt does not seem to have been recorded before 1940. When *C. sapidus* was first noticed in Lake Manzilah, Egypt, it was confused with *Portunus pelagicus* (Linnaeus), itself an immigrant to the area from the Indian Ocean via the Suez Canal, and this confusion has persisted in literature on both species. Banoub thought that *C. sapidus* may have migrated from Greece around the eastern Mediterranean to flourish in the brackish lakes of Egypt, reproducing the life pattern it exhibits in the Western Hemisphere.

*Habitat.*—The blue crab is a coastal creature occurring on a variety of bottoms in fresh, estuarine, and shallow ocean from the water's edge to approximately 90 m (Franks et al., 1972), but mainly in the shallows to depths of 35 m. Biology of the species is better known than that of any other in the genus. Hatching in mouths of estuaries and shallow ocean, development of larvae progresses in the ocean (development studied both in nature and the laboratory), followed by migration of megalopae and young crabs back into estuaries to mature into adults (summarized in Williams, 1965, 1971; Tagatz, 1968; Taissoun, 1969; and literature compilation, Tagatz and Hall, 1971). It is probable that all species in the genus carry out their life histories on this model.

Tolerant of extremes, the species has been found from fresh water to hypersaline lagoons such as Laguna Madre de Tamaulipas, Mexico, where collections have been made in salinities ranging

from 44 to 48‰ and unproductive portions of the lagoon range up to 117‰ (Hildebrand, 1957), in temperatures ranging from 3° to 35°C, and in tertiary sewage treatment ponds in which mean daily O<sub>2</sub> tension dropped as low as 0.08 mg/liter in summer (Smith, 1971). In Lebanon it has been collected in winter in 39‰ salinity water at 17.5°C where there is no good place for estuarine development because streams are small, seasonal, and exceedingly foul in dry weather (George and Athanassiou, 1965). In Marion Co., Fla., large males have been taken from salt springs in the St. Johns River over 180 miles from the sea.

Often considered a scavenger, which it certainly is, the normal diet includes a variety of materials including fishes, benthic invertebrates, and plant material (Darnell, 1959; Tagatz, 1968). Odum and Heald (1972) confirmed this assessment, finding mainly an abundance of small mussels in stomach contents of individuals in a marsh in SW Florida.

*Spawning.*—Most spawning occurs in spring and early summer, warm months helping to assure survival of larvae. Females with egg masses have been found in North Carolina from mid-March to late November. Northward the season is somewhat shorter and to the south (United States) it is longer (Williams, 1965). Early spring spawners may cast a second batch of eggs in late summer contributing to a lengthened spawning season or a secondary late summer peak. The number of eggs per spawning has been estimated at 700,000 to more than 2 million (Williams, 1965). Ovigerous females in museum collections are rare, but suggest that at least some eggs are spawned almost the year round in tropical waters. Taissoun (1969) showed this to be true in the Golfo de Venezuela where ovigerous females are most abundant between April and September, reaching a sample maximum of 75% in July and August. Also, in the northern part of Bahía del Tablazo, Venezuela, ovigerous females occur during all of the year except between August and November, reaching a sample maximum of 95% in May. Absence of ovigerous females there in late summer and fall occurs because heavy rainfall and increasing river flow freshen the area, driving females downstream to areas of higher salinity; consequent increases of ovigerous females occur in the Golfo de Venezuela during August and September.

*Economic importance.*—Though all species of *Callinectes* are consumed as human food, there is

no doubt that *C. sapidus* is the most valuable in commercial fisheries, providing a highly acceptable, nutritious product worth several million dollars annually in the United States alone. Traditionally, the seat of this fishery in the United States has been Chesapeake Bay where records on the fishery have been kept for about a century. Pearson (1948), summarizing annual catch for this area from 1880 to 1942, showed the annual catch to have increased from 9.5 million pounds in 1890 to a peak of 68.7 million pounds in 1930. Catch, however, fluctuated before and after 1930, declining to 35.8 million by 1942 during World War II. Van Engel (1962) provided a history of the types of gear used in this fishery, an evolution from hand-dip trotline to the baited crab pot (trap) and dredge. Adoption of the baited pot and its spread to the Carolinas and elsewhere during the late 1950's, along with other methods of capture including incidental harvest of crabs from shrimp trawls, greatly expanded the catch. By 1967 (latest available annual summary) the U.S. fishery landed nearly 150 million pounds of hard and soft crabs worth 10 million dollars (Lyles, 1969).

The species is harvested throughout its range either as an object of commercial enterprise or for home use. Taissoun (1969, and pers. commun.) reported a growing industry in Venezuela. Banoub (1963) reported growth of an Egyptian fishery in lakes (poor flavor) and sea (good flavor), but remarked on losses from damage to nets and on the myriads of crabs having no local commercial value because the Egyptians consider the meat unpalatable (Fishing News International, 1965). A developing fishery in Northern Greece (Kinzelbach, 1965) declined because of overfishing (Boschma, 1972).

*Fossil record.*—I have reviewed the fossil material treated by Rathbun (1919a, b, 1935) and more recent acquisitions in collections of the USNM and U.S. Geological Survey (USGS) and concluded that only two specimens can be positively identified as *C. sapidus*. Eighteen lots of specimens are probably *Callinectes*, and some of these are possibly *C. sapidus*, but most of the remains are too fragmentary for positive identification. The entire record ranges from lower Miocene of Florida to Pleistocene of Maryland and New Jersey, material identifiable to species probably being limited exclusively to the Pleistocene.

Published records of Pleistocene occurrence include *Lupa dicantha* (= *C. sapidus*) from sandy beds in Wadmalaw Sound, S.C. (Holmes, 1858), a two-thirds grown specimen of *C. hastatus* (= *sapidus*) in a concretion from excavation for a Hudson River Tunnel on the New Jersey side (Whitfield, 1891), a male *C. sapidus* from near the mouth of Choptank River at Cook Point, Dorchester Co., Md., and fragmentary remains from Wailes Bluff near Cornfield Harbor, and Federalsburg, Md., as well as Heislerville, N.J. (Clark, 1906), all cited by Rathbun (1935).

USGS 25272. (= Locality of Tulane University Department of Geology, Field No. 546). Eight-foot (+) vertical exposure 0.52 mi (0.84 km) due E Florida hwy. 84 (30°29'55"N, 85°11'32"W) along N bank of prominent sharp bend in Ten Mile Creek, Calhoun Co., Fla. Material collected "in situ" from the lower 3 ft (0.9 m) of section. Chipola Formation; late Lower Miocene. Paul E. Drez, summer, 1972, on loan from Warren C. Blow, Paleontology and Stratigraphy Branch, USGS. (A) A well-preserved right palm and one-third of propodal finger, facets bearing resemblance to *C. declivis* on external face, but hand broad and flat dorsally as in females of modern *Callinectes*, molar complex absent. (B) One disarticulated right dactyl with broken tip having moderate-sized, worn, proximal tooth. (C) One rather large, straight, right propodal finger with sectorial teeth.

USGS 25273. Fifteen foot (4.6m) vertical exposure along S bank Mattiponi River, just below White Oak Lodge at White Oak Landing (about 2.5 mi [4 km] E King William Courthouse) King William Co., Va. Material collected "in situ" between 1 and 2.5 ft (30-76 cm) above beach level in a blue gray, highly burrowed, sparsely fossiliferous, silty sand (devoid of mollusks) which overlies a highly fossiliferous shell bed consisting of abundant *Turritella*. "Virginia" St. Marys Formation; Middle Miocene. Lauck W. Ward, 1961, on loan from Warren C. Blow, Paleontology and Stratigraphy Branch, USGS. An immature female *Callinectes* with triangular abdomen (length about 23 mm from posterior edge of exposed segment 3 to tip of telson) and broad sternites, few remnants of carapace not coarsely granulate.

USGS 25274. White Oak Landing, about 2.5 mi (4 km) E King William Courthouse, along S bank Mattiponi River, King William Co., Va. Material collected as "float" along 400 ft (120 m) (+) beach between tributary just below landing proper and

next tributary upstream. The material, though "float," apparently washed out of the lower bed of the "Virginia" St. Marys Formation, which outcrops along this beach. Lauck W. Ward, 1961, on loan from Warren C. Blow, Paleontology and Stratigraphy Branch, USGS. Three immature specimens of *Callinectes*. Two females with broad sternites and triangular abdomen exposed; (A) a half-grown individual with fragmented abdomen distorted (abdomen length about 29 mm from posterior edge of exposed segment 3 to estimated tip of telson); (B) a much smaller individual with incomplete abdomen (abdomen length about 12 mm from posterior edge of exposed segment 3 to estimated tip of telson); (C) cephalothorax of an immature individual about 45 mm wide, with broad sternal plates as well as areolations of carapace suggesting *C. sapidus*, frontal and anterolateral teeth missing, abdomen unexposed, shape of telson suggesting a female.

USGS 25275. "Road fill" NW side of Virginia hwy. 360, along both sides of Manquin Creek, King William Co., Va. Material is "spoil" thought to be derived from nearby road cut(s) during construction of addition to hwy. 360. Age unknown, probably Yorktown Formation; Late Miocene. Lauck W. Ward, 1961, on loan from Warren C. Blow, Paleontology and Stratigraphy Branch, USGS. Large, complete right palm (dorsal length about 30 mm), propodal finger, and mold of dactyl broken out of a concretion; palm heavily ridged, facets between ridges reticulated as in *C. reticulatus* (internal mold of hand), but remnants of exoskeleton externally smooth except for granules on ridges; portion of finger remaining resembling *Callinectes* with proximal enlarged tooth on dactyl and molar apparatus on propodal finger. The palm is compressed in preservation, but appears as broad in restoration as a modern *Callinectes*.

USGS 3859. Pleistocene (Miocene?), "tongued up in the Rappahannock River near the Chesapeake Bay by an oysterman" and sent to the Smithsonian Institution in 1902 by W. McD. Lee. Flattened partially crushed central portion of an adult male *C. sapidus*, including part of carapace with regions exposed and sternum with abdomen missing. The dark color of the specimen only suggests similarity to other Pleistocene (Miocene?) material from the area of origin, for exact horizon is unknown.

USNM 371729, Pleistocene, Broadwater, Va., R. Phillips. A large adult male fragment consist-

ing of a deformed carapace (length 67, width at base of lateral spines 127 mm) along with a right cheliped lacking fingers. The chela is disarticulated. Shape of abdomen, carapace, and carpus of cheliped with no internal spine indicate *C. sapidus*.

Seven lots from the Pleistocene, Wailes Bluff, St. Marys Co., Md., treated in part by Rathbun (1935) and Blake (1953), are similar to Modern *C. sapidus* but lack definitive characters.

USNM 145356. Talbot Formation, Bd. 1 (of Mansfield), 1937, S. F. Blake. Immature male with carapace and sternum exposed.

USNM 146701. Frank Burns, 1886, Stn. No. 2032. Portion of left minor dactyl and right propodal finger.

USNM 371726. Talbot Formation, L. W. Stephenson, W. C. Mansfield, and W. P. Popenoe, 26 June 1925, (10902). Portion of left propodal finger and hand, and nearly intact right propodal finger.

USNM 371727. Talbot Formation, W. C. Mansfield, 8-12 June 1920 (8932). Fragments of a left chela (propodus), tips of two fingers, and fragments of a minor chela.

Uncatalogued lot. (Bd. 1), R. J. Taylor, 15 June 1941. Mostly fragments of four right propodal fingers, six left propodal fingers, and one complete right dactyl.

Uncatalogued lot. (Bd. 1), R. J. Taylor, 15 June 1941. Three immature female and one immature male fragmentary sterna.

Uncatalogued lot. Pamlico Formation, W. E. Salter. Two dactyls from right and left chelae.

Five lots from Pleistocene, Cape May and Atlantic Counties, N.J., similar to modern *C. sapidus*.

USNM 371930. Cape May Formation, Stone Harbor, H. G. Richards. A short section of finger.

USNM 371933, Cape May Formation, Two Mile Beach, H. G. Richards. A short, stocky propodal finger with well developed molar complex.

USNM 371934. Cape May Formation, Two Mile Beach, H. G. Richards. Five central portions of right propodal fingers of half- to full-grown individuals, three central portions of left propodal fingers of comparable size, two proximal portions of probable left dactyls of large crabs, and three other pieces possibly broken from above.

USNM 371936. Cape May Formation, Two Mile Beach, H. G. Richards. Tooth row and tooth sockets on finger, probably a dactyl.

Uncatalogued lot. Brigantine I., Atlantic Co., H. B. Roberts, May 1953. A large, somewhat crushed right chela with proximal half of fingers.

*Remarks.*—Resolution of the taxonomic confusion surrounding the correct name for *C. sapidus* by Holthuis (1962) greatly simplifies both discussion of the species' systematic history and variability over its range. From Latreille's (1825) description, it is apparent that the original material from Philadelphia (possibly not the actual site of collection) indeed represented the "typical" form from eastern North America. Holthuis' selection of a lectotype from this material and Williams' (1965) restriction of the type locality to "east coast of the United States" support the facts as well as they can be known today. Search of the collection at ANSP revealed no specimens of *C. sapidus* that date from the time of Latreille, and it is almost certain that specimens on which he based his description are lost. There is no need now to designate a new type specimen, indeed selection of a neotype would not be in keeping with the spirit of the International Code (Art. 75), for no complex zoological problem now depends upon a specimen for its solution in this case.

The earliest "scientific" treatment of the species (Bosc, 1802) was more a natural history account than a description, the name *Portunus hastatus* being taken from a description paraphrased from J. C. Fabricius (1798) that applied to the European species originally described as *Cancer hastatus* by Linnaeus (1767).

I consider the whole *C. sapidus* complex to be a single species which has diverged into ill defined populations in certain portions of its range. The "acutidens" form predominates over most of the latitudinal range, but there are variations. Among these are "typical" features that reach their most pronounced expression in the population along the east coast of the United States. Taxonomic thinking of biologists has been clouded by the fact that the form originally described was the North American variant which became the standard against which all comparisons were made.

*Callinectes sapidus* is the member of the genus which has most successfully invaded the Temperate Zone, and in this respect it may be that speciation into forms associated with temperature regimes is progressing, but the process is not yet complete enough that morphological separation is distinct.

*Material.*—Total: 460 lots, 1,500+ specimens.

Specimens listed in Rathbun (1930) from USNM (45656 and 26092 not found), MCZ, and BMNH.

USNM. 284 lots, 1,060+ specimens, including the following not cited above plus 7 lots and 13 specimens from undetermined localities and 2 lots of fingers from Indian mounds.

#### UNITED STATES

Massachusetts: 122952, Deadneck, Cotuit, Barnstable Co., 1 July 1949, 1 ♂, 3 ♀ (juv), H. E. Winn.

New York: 63260, Sing Sing [Ossing], no date, 1 ♂, 1 ♀, A. K. Fisher.

New Jersey: 63177, 63178, 63181, off New England Creek, 19 Oct. 1929, 2 ♂, 1 ♀ (juv), H. G. Richards. 63179, 1 mi off Dennis Creek, 13 Aug. 1929, 3 juv, H. G. Richards. 77006, 77041, Dennis Cove, 13 and 25 Aug. 1929, 61 juv, H. G. Richards. 77007, 77040, Barnegat Bay, Lavalette, 15 Aug. 1931, 2 ♂, 3 ♀, 4 juv, H. G. Richards.

Delaware: 77037, Delaware Bay near Woodland Beach, no date, 1 ♂ (juv), Coltam and Saylor. 63180, Mispillion River, 10 July 1929, 1 ♂ (juv), H. G. Richards. 77039, Mispillion Cove, 26 Aug. 1931, 3 ♂ (juv), H. G. Richards.

Maryland: 92452, Wye River, 16 Aug. 1951, 1 ♂, M. Sandoz. 113230, Sullivan Cove, Severn River, 31 Aug. 1966, 1 ♂, deformed chela, B. Truett. 77036, Lake Ovington, near Bay Ridge, 19 July 1936, 3 ♂, 2 ♀ (juv), C. R. Aschemeir. 76996, mouth Patuxent River, Solomons I., 16 July 1934, 2 ♀ (juv), P. Bartsch. 77033, Coster, about 3 mi N Solomons I., no date, 1 ♂, deformed chela, B. Coster. 67646, Coster, no date, 1 ♀, albino, W. Everett. 76148, Point Lookout, 9 Sept. 1932, 1 ♀ (juv), E. Bowles. 77004, Ridge, St. Marys Co., 26 Apr. 1930, 1 ♂ (juv), W. H. Ball. 76129, Blakistone I., 9 Sept. 1932, 1 ♀ (juv), E. Bowles. 66326, Herring Creek (Lower Potomac), 31 July 1929, 5 ♀ (juv), B. A. Bean. 66328, 77000, Riverside, 21 Nov. 1912, 2 ♂, 3 juv, U.S. Bur. Fish. 66614, Cobb I., Rock Point, Potomac River opposite Colonial Beach, 14 Aug. 1931, 1 ♂, E. D. Reid, W. L. Brown, and W. Pike. 75448, Analostan I., Potomac River at Georgetown, D.C., 11 Sept. 1930, 2 ♂, W. Reynold. 81473, 81474, Crisfield, 7 Oct. 1941, 41 juv, W. L. Schmitt. 95733, off Smiths I., 20 Aug. 1953, 1 ♂, partial albino, J. M. Ingley.

Virginia: 61146, Tangier, Dec. 1927, 1 deformed chela, J. Parks. 76998, Smiths I., 5 July 1935, 4 juv, W. H. Ball. 77034, Smiths I., Northampton

Co., 6 July 1935, 1 ♂, Lombino. 63320, Cape Charles, no date, 1 ♂, 1 ♀ (juv), H. G. Richards. 112857, Chesapeake Bay (believed to be in southwest middle grounds area), 15 Oct. 1964, 1 ♂, H. A. Martin. 67739, Elizabeth River, Portsmouth, 16 June 1933, 1 ♂, deformed chela, W. L. Hughes. 81483, Craney Island Lab., Norfolk, no date, 1 ♀ (juv), F. F. Ferguson. 81485, U.S. Public Health Serv., Craney I., Norfolk, Aug. 1940, 1 ♀, F. F. Ferguson. 76184, Virginia Beach, 4 July 1932, 2 carapaces (dry), G. E. Brandt.

North Carolina: 107137, Currituck Sound, 15 Nov. 1960, 1 ♂ (juv), J. A. Kerwin. 122964, Currituck Sound, no date, 1 ♂ (juv), J. R. Davis. 60601, Hatteras, May 1927, 67 ♂, 23 ♀, A. J. Poole and R. Kellogg. 107477, approx. ½ mi S Silver Lake Inlet and Ocracoke Village, 6 Aug. 1958, 2 ♀, col. unknown. 62462, Gallant Point, Beaufort Harbor, 13 Sept. 1928, 3 ♀ (juv), Schmitt and Shoemaker. 76999, Beaufort, no date, 1 ♂, col. unknown. 77002, Newport R. above "narrows," Beaufort, 3 Apr. 1931, 1 ♂ (juv), S. F. Hildebrand. 77003, Beaufort, 29 Sept. 1929, 1 ♂ (juv), Hobbs and Maloney.

South Carolina: 17191, South or North Carolina, no date, 1 ♀, *Fish Hawk* Stn. 6850.

Florida: 99892, Sewall Point, Martin Co., 27 Feb. 1955, 1 ♂ (juv), D. K. Caldwell, et al. 122944, Deep Lake, Miami, 5 Apr. 1952, 2 ♂, H. Field and Y. Lazor. 122949, Little Duck Key on S side of Rt. 1, Dade Co., 21 Dec. 1962, 1 juv, E. Kotkas and R. Chandler. 122950, Beach area and tidal flats on S ridge of Bahia Honda Key, Monroe Co., 3 Aug. 1965, 1 juv, N. R. Foster and D. G. Smith. 71606, S side of County Road, Key West, 13 Nov. 1922, 1 juv, Stephenson. 77038, Marquesas Keys, 11 Aug. 1931, 7 juv, A. S. Pearse. 77031, between Long and Bush Key, Tortugas, 26 July 1931, 1 ♀, A. S. Pearse. 77030, Tortugas, 25 June 1931, 1 ♂, W. L. Schmitt. 122958, Charlotte Harbor, 13 Sept. 1939, 1 ♀ (juv), USFWS Launch 58, hauls 1, 2, 3. 122953, Sarasota near Cape Haze Marine Lab., 26 Jan. 1966, 1 ♀, 4 juv, R. F. Cressey and R. H. Brown. 122954, Sarasota, near Cape Haze Marine Lab., 27 Jan. 1966, 2 juv, R. F. Cressey and R. Brown. 71654, Sarasota Bay, summer 1930, 4 juv, W. W. Wallis. 122943, Homasassa Springs, 30 Mar. 1946, 1 ♂, Herald and Strickland. 122929, Hernando Co., Gulf of Mexico, Gulf Beach and March outlet to Gulf at Pine I., 8 mi NW Weekiwachee Springs, 7 Apr. 1955, 2 ♂, 3 ♀ (juv), R. D. Suttkus and Sylvia A. Earle. 77566, Cedar Key, 25 Jan. 1938, 1 ♂, 15 juv, C. R. Aschmeier. 98085, Choctawatchee Bay,

no date, 1 deformed chela, col. unknown. 122951, Florosa, Okaloosa Co., 3 Dec. 1941, 4 ♂ (juv), W. F. Blair. 66753, Florida, no date, 1 ♂, 1 ♀, Ross Allen.

Alabama: 81480, Big Lake, Gulf State Park, 14 Oct. 1939, 1 ♂, col. unknown.

Mississippi: 85543, Mississippi Sound, east end, 1 Sept. 1947, 1 ♂, J. W. Ward, et al. 122947, inside Petit Bois I., Mississippi Sound, 20 Apr. 1967, 1 ♂, 2 ♀, *George M. Bowers* Stn. 4, 5.5 m. 122938, Simmons Bayou trib. to Davis Bay, 2 mi SE Ocean Springs, 2 Aug. 1957, 1 ♂ (juv), R. D. Suttkus. 90299, S side of Cat I., Mississippi Sound, 9 Aug. 1949, 1 ♀ (juv), col. unknown. 2028, Washington [Adams Co.], no date, 1 ♂, Wailes. 77035, coast, May 1937, 1 ♀, J. S. Dolley.

Louisiana: 69676, Ycloskey [Bernard Parish], 10 June 1934, 2 ♀, J. N. Gowanloch. The following from Point aux Herbes, Lake Pontchartrain, 122940, 15 July 1955, 4 ♂, 18 ♀ (juv), R. R. Lubritz. 122939, 22 June 1955, 83 juv, R. R. Lubritz. 122927, 4 June 1955, 80+ juv, R. D. Suttkus. 122926, 4 June 1955, 1 ♂, 1 ♀ (soft), R. D. Suttkus. 122928, W Pearl River immediately above, N of Mill Bayou, St. Tammany Parish, 11 Aug. 1955, 1 ♀, M V *Lyman* Stn. 136. 122934, ¼ mi up West Pearl River from mouth, St. Tammany Parish, 11 Aug. 1955, 1 ♀, M V *Lyman* Stn. 138. 122933, Lake Pontchartrain, Salt Bayou, 9 June 1955, 10 juv, R. D. Suttkus. 122935, 2.5 mi NW Salt Bayou on Pearl River, St. Tammany Parish, 11 Aug. 1955, 1 ♀, M V *Lyman* Stn. 143. 122936, ¼ mi SE West Pearl River Bridge, Lake Pontchartrain, St. Tammany Parish, 11 Aug. 1955, 1 ♂, M V *Lyman* Stn. 144. 122930, Lake Pontchartrain, first point W Liberty Bayou, 9 June 1955, 2 juv, M V *Lyman* Stn. 18. 122931, St. Joe Channel [Lake Pontchartrain], 21 June 1954, 2 parasitized, Patursan and Peterson. 97992, Lake Pontchartrain just S mouth of Tanipahoa River, 17 Oct. 1953, 11 ♂, 2 ♀, R. M. Carnell. 96990, Lake Pontchartrain, no date, 1 ♀ parasitized, col. unknown. 96322, Rigolets, Lake Pontchartrain, 29 Oct. 1953, 1 ♀ deformed carapace, L. Eddy. 122932, Rigolets at Lake Borgne, 7 June 1955, 1 ♀ (juv), R. D. Suttkus. 122960, Lake Pontchartrain at mouth of Tchefuncta River, St. Tammany Parish, 1 Apr. 1948, 2 ♀, R. M. and M. K. Bailey. 122945, Lake Pontchartrain, Aug. 1962, 1 ♂, J. Q. Burch. 64145, off Breton I., Nov. 1930, 1 ♂, S. Springer. 122963, 3-6 mi ESE of SW Pass, 16 Feb. 1934, 1 ♂, T. C. D., M. J. L., and W. W. A. 122959, [S of Plaquemines Parish] 29°01'N, 89°33'W, 8 July 1938, 1 ♀, *Pelican* Stn. 77-2. 105317, Barataria Bay, Jefferson

Parish, 27 Feb. 1960, 1 ♂, 4 ♀ (parasitized), E. H. Behre. 122937, Grand Isle, 3 Feb. 1957, 1 ♂, 1 ♀, R. D. Suttikus. 122961, [off Caillou Bay] 28°39.5'N, 91°04.5'W, 11 July 1938, 1 ♀, *Pelican* Stn. 81-2. 122962, on 9-fathom line between Ship to Trinity Shoal Buoy, 28°39.5'N, 91°04.5'W, 11 July 1938, 3 ♀, *Pelican* Stn. 81-2. 122956, 28°51.5'N, 91°33'W to 28°56.5'N, 91°50'W, 11 July 1938, 2 ♂, 2 ♀, *Pelican* Stn. 82-1 to 82-5. 5509, Louisiana, 1883, 2 ♂, 1 ♀, R. W. Shufeldt.

Texas: 78397, Galveston Bay, Galveston Co., 16 Apr. 1939, 3 ♀, C. E. Burt. 122957, Galveston, 4 May 1941, 1 ♂, 3 ♀ (2 juv), J. L. Baughman. 122955, Galveston south of ferry landing, 27 Aug. 1965, 1 ♀ (juv), J. McCain. 122948, south end, west side new Galveston-Houston causeway, Galveston, 24 Aug. 1965, 1 juv, J. C. McCain. 122946, 17 mi S, 7 mi E Alvin, Brazoria Co., 28 July 1952, 1 ♂, S. Alvin. 122942, Freeport, 12 May 1940, 1 ♀ (ov), J. L. Baughman. 122941, Alligator Head, Matagorda Bay, no date, 13 juv of ♀ form parasitized (dry), J. D. Mitchell. 81479, Aransas Pass, 8 July 1941, 1 ♂, 2 ♀ (soft and 2 parasitized), J. L. Baughman. 99243, Laguna Madre, 15 mi N of Port Isabel, 24 Jan. 1956, 2 juv, col. unknown. 71663, Texas, no date, 1 ♂, C. T. Reed. 81475, Texas, no date, 1 ♂ (juv), col. unknown.

#### JAMAICA

120626, Fresh River headwaters, N end of Caymanas Plantation, St. Catherine Parish, 7 Apr. 1959, 1 ♂, Hart, G. Thomas, R. Bengry, Thornton.

#### PUERTO RICO

80667, no date, 1 ♀ (recently ov, bearing jar label "nov. var?"), S. T. Danforth. 77044, Río Canovanillas, Canovanas [18°23'N, 65°55'W], 16 Feb. 1934, 2 ♂, S. F. Hildebrand.

#### VIRGIN ISLANDS

The following from St. Croix: 71524, Fairplain, no date, 1 ♂, 1 ♀ (juv), H. A. Beatty. 71794, Fairplain Stream, Dec. 1934, 1 ♀ (juv), H. A. Beatty. 72337, Fairplain Stream, 1935-36, 1 juv (soft), H. A. Beatty. 72356, Fairplain stream below bridge, 1935-36, 2 ♂, H. A. Beatty. 77032, on sea coast, Rust-op-Twist, no date, 1 ♀, H. A. Beatty.

#### GUATEMALA

123096, Atlantic at Punta Marrabique, N of Puerto Barrios, 1 May 1947, 1 ♂, R. R. Miller. 123097, Lago de Izabal, 26 Apr. 1947, 1 ♂, Miller et al.

#### COSTA RICA

113278, Tortuguero, May 1964, 1 ♂, 1 ♀, D. P. Kelso.

#### PANAMA

77043, Gatun Locks, C.Z., 21 Feb. 1935, 12 juv, S. F. Hildebrand.

#### VENEZUELA

The following from Golfo de Venezuela: 123099, 11°46'N, 71°16'W, 6 Oct. 1965, 1 ♀, *Oregon* Stn. 5670. 123095, 11°33'N, 71°31'W, 6 Oct. 1965, 1 ♀ *Oregon* Stn. 5672. 123100, 11°27'N, 71°39'W, 6 Oct. 1965, 4 ♀, *Oregon* Stn. 5673. 80649, Lago de Los Pájaros, 1 km above Lago de Maracaibo, 30 Apr. 1942, 2 ♂, L. P. Schultz. 80650, Lago de Maracaibo, 20 Feb. 1942, 2 ♀ (juv), L. P. Schultz. 80651, Lago de Maracaibo, 7-9 Apr. 1942, 2 ♂, L. P. Schultz. 80652, Cãno de Sagua, 25 km N Sinamaica, 12 Mar. 1942, 3 ♀, L. P. Schultz.

#### BRAZIL

Rio de Janeiro: 77042, Recreio dos Bandeirantes, 9-16 Feb. 1935, 1 chela, D. M. Cochran. Santa Catarina: 123098, Nov. 1965, 1 ♀ (juv), Jones-Lowe.

#### URUGUAY

99848, Roca Arroya de Balizas [= Valizes?], Jan.-Feb. 1953, 2 ♀, R. Vaz-Ferreira.

AHF. 6 lots, 10 specimens.

#### UNITED STATES

Florida: Pompano Beach, Sept. 1943, 1 ♀, E. R. T. Marco I., Collier Co., 10 Mar. 1946, 1 ♀ (juv), *Velero* A87-46. Santa Rosa Sound at Camp Navarre, 12 May 1949, 2 ♂, Stn. LM4-49.

Louisiana: Lake Borgne, 27 Aug. 1954, 1 ♀, R. Darnell.

#### MEXICO

Veracruz: Drainage ditch 5 mi W Veracruz, 19 Aug. 1949, 1 ♀ (juv), B. W. Halstead. Boca del Río, 9 Aug. 1949, 1 ♂, 3 ♀, B. W. Halstead.

AMNH. 19 lots, 26 specimens, including 4 lots with no data.

#### UNITED STATES

Massachusetts: 1002, Chappaquiddick I., Martha's Vineyard, 28 July 1909, 1 ♂ (dry), R. W. Miner.

New York: 221, New York Harbor, no date, 1 ♂, 1 ♀, L. P. Gratacap. 6267, Mastic, Long Island, Aug. 1930, 1 ♂, J. T. Nichols. 9856, Hudson River opposite Spuyten Duyvil, Sept. 1945, 1 deformed chela, J. Dvorak. 9778, Sheepshead Bay, N.Y. City, 1944, 1 ♂, H. Savalli. 6316, Freeport, Long Island, 5 Oct. 1930, 1 ♀, F. Limekiller. 6258, Inner Harbor, Cold Spring, Long Island, 26 July 1930, 1 ♂, C. H. Curran. 983, Fort Schuyler, N.Y. City, no date, 1 ♂, and extra chelae, E. Forshan.

New Jersey: 6491, Newark Bay, foot 27 St., Bayonne, 28 Aug. 1931, 1 ♂ (deformed chela), K. Wangler. 6653, Barnegat Bay, no date, deformed right chela (dry), col. unknown.

Florida: Lake Worth, July-Aug. 1945, 1 ♀, W. G. Van Name and A. H. Verrill. 10249, Destin, 29 July 1948, 6 juv, L. A. Burry.

#### BAHAMAS

Nassau and Andros I., Mar.-Apr. 1930, 1 ♀, Bacon-Miner Exped. and International Exped. to Andros.

#### CUBA

1024, 1913, 1 juv, J. T. Nichols.

#### PUERTO RICO

2787, Tallaboa [18°00'N, 66°43'W], 29 July 1914, 1 ♂ (juv), R. W. Miner.

ANSP. 26 lots, 41 specimens.

#### UNITED STATES

North America: 35, [Delaware Bay], no date, 1 ♀ (dry) Blanding.

New Jersey: 2798, along coast, no date, 2 ♀ (dry), W. M. Wood. 2933, Ventnor, Aug. 1928, 1 deformed chela (dry), R. D. Benson, Jr. 3659, Great Egg Harbor, no date, 1 ♂ (dry), S. Ashmead. 3604, Point Breeze, Delaware River, no date, carapace, F. L. LeCompte. Delaware River, 30 July 1951, 2 ♂, 1 ♀, J. Bates.

Maryland: Potomac River at Popes Creek, Charles Co., Aug. 1966, 3 ♂, 1 ♀ (juv), S. L. H. Fuller. Potomac River ¼ mi above Lower Cedar Pt., WNW Morgantown, Charles Co., Aug. 1966, 3 ♀ (juv), S. L. H. Fuller. 3492, Chesapeake Bay, no date, 1 ♂ (dry), from U.S. Explor. Exped.

Virginia: York River, 31 May 1956, 1 ♀, F. A. Aldrich. York River, 2 June 1956, 3 ♀ (1 ov), F. A. Aldrich. York River, 21 Sept. 1956, 1 ♂, 1 ♀, F. A. Aldrich. James River, 17 June 1957, 1 ♂, F. A. Aldrich.

North Carolina: 4873, Fort Macon, 2 ♀, Yarrow. Florida: 3481, Key West, no date, 1 ♀ (juv), S. Ashmead. 3569, Manatee River, no date, 1 ♂ (dry), S. Ashmead.

Texas: Houston-Galveston Ship Canal, July 1954, 1 ♂, 1 ♀ (juv), F. A. Aldrich. Cow Bayou, trib. of Sabine River, Orange Co., 11 Aug. 1962, 1 ♂, C. W. Hart, Jr. Sabine River, Orange Co., 9 Aug. 1962, 2 ♂, C. W. Hart, Jr. Sabine River, N of Sabine I., Orange Co., 13 Aug. 1962, 2 ♂, C. W. Hart, Jr.

#### CUBA

4697, Cojimar near La Habana, 10 July 1940, 2 ♀, R. A. McLean.

#### DOMINICAN REPUBLIC

3519, no date, 1 ♂ (dry), W. M. Gabb. 2957, no date, 1 ♀ (dry), W. M. Gabb.

#### PUERTO RICO

3179, off Guánica Harbor, no date, 1 ♂ (dry), Fowler.

#### PANAMA

1305, no date, 1 ♀ (juv), McNeil Exped.

#### BRAZIL

3514, no date, 3 ♂ (dry), T. B. Wilson.

BMNH. 15 lots, 28 specimens.

#### UNITED STATES

Connecticut: 98.5.7.312, Long Island Sound, 1 ♂, 1 ♀, Norman. 80.26, New Haven, 1 ♀, Norman.

New Jersey: 98.5.7.317/18, 3 ♂, 1 ♀ (juv) Verrill and Smith. Unreg., Cape May, 1 ♂ (dry) vi/9, J. K. Townsend. Unreg., 1 ♀ (juv, dry) vi/6.

Maryland: 1964.9.7.13, Chesapeake Biological Lab. Pier, Solomons, 1 ♂ (juv), F. J. Schwartz and A. C. Edwards. 1964.9.7.14/16, Patuxent River at Evans pier, Solomons, 1 ♂, 1 ♀ (juv), A. C. Edwards and F. J. Schwartz.

Florida: 1966.12.5.555/557, coast of Everglades Park, 3 juv, U. Miami, Inst. Mar. Sci. 1966.12.5.667, 1 ♂, Univ. Miami, Inst. Mar. Sci. 1966.12.5.666, 1 ♂, Univ. Miami, Inst. Mar. Sci. 1966.12.5.668/671, 4 juv, Univ. Miami, Inst. Mar. Sci.

#### TOBAGO

1925.1.28.11/12, 1 ♂, 1 ♀, P. L. Guppy.

#### TRINIDAD

1940.7.8.15, 1 ♂, A. K. Totton.



## BRAZIL

Unreg. 1 ♀ (juv, dry) vi/6, col. unknown.

MCZ. 42 lots, 159 specimens.

## BERMUDA

5122, no date, 1 ♀ (juv), Bickmore.

## UNITED STATES

Massachusetts: 322, Cohasset, 1922, 1 ♀, J. A. Murphy. 5110, Naushon I., Buzzards Bay, 1873, 2 ♀, W. Faxon. 333, Pocasset, 1919, 1 ♀, J. A. Cushman.

Connecticut: 5563, New London, no date, 2 ♂, 3 ♀, G. G. Hammond, Aug. 1876. 8510, New London, no date, 3 ♂, 10 ♀, G. G. Hammond, 1876.

New York: 332, Fishers I., 1874, 1 ♀ (ov), Hyatt and Rathbun. 5471, 1 ♂, 2 ♀, L. Agassiz, 1859.

New Jersey: 5112, Somers Point [N shore across from Ocean City], no date, 3 ♂, 3 ♀, W. Stimpson, recd. Oct. 1864. 5212, Somers Point, no date, 50 juv, W. Stimpson, recd. Dec. 1864.

Maryland: 5117, Baltimore, 1860, 2 ♂, A. Hyatt.

North Carolina: 11351, 2 mi SE Roanoke I., 19 Dec. 1940, 1 ♂, R. Foster. 11353, 5 mi SW Nags Head, near Roanoke I., Dec. 1940, 1 ♂ (juv), R. Foster. 5113, Beaufort, no date, 3 ♂, 3 ♀ (juv), A. S. Bickmore.

South Carolina: 5116, Waccamaw, no date, 1 ♀, L. Agassiz. The following from Charleston: 5114, no date, 2 ♂, 2 ♀, L. Agassiz (part of Ordway's material). 5202, no date, 2 ♂, 12 ♀, col. unknown. 8751, no date, 1 ♂, 1 ♀, T. Lyman.

Georgia: 5201, May 1859, 1 ♂, T. S. Allanson.

Florida: 5205, June 1859, 1 ♀, G. Wurdemann. 8752, no date, 6 ♂, col. unknown. 11936, Key West, May 1940, 2 juv, J. R. Miller. 5118, Tortugas, 2 ♂, Jacques, from Peabody Acad. Sci. Nov. 1885. 5203, Fort Jefferson, Tortugas Is., no date, 2 ♂, col. unknown. 10163, Sanibel I., Mar. 1938, 3 ♂, 3 ♀, F. A. Chace, Jr. 5119, Charlotte Harbor, 1 ♂, L. Gibbes, recd. 13 Feb. 1861. 8334, Lemon Bay and Gulf, Englewood, Sarasota Co., Jan.-Apr. 1935, 2 ♂, 2 ♀, 3 juv, D. J. Zinn.

Alabama: 5204, Mobile, no date, 1 ♂, 1 ♀, 2 juv, L. Agassiz.

Mississippi: 11942, Ship I. off Biloxi, June 1941, 1 juv, J. R. Miller.

Louisiana: 12046, Bayou La Fourche near Shriever, June 1941, 1 ♂, J. R. Miller.

Texas: 5120, no date, 1 ♂, G. Wurdemann. 5121, Galveston, 1871, 1 ♀, Boll.

## CUBA

5123, La Habana, no date, 1 ♂, S. Garman. 10887, Cienfuegos [22°09'N, 80°27'W], 19 Feb. 1938, 1 ♀, Harvard-Havana Exped.

## HAITI

5213, Jérémie. Apr. 1865, 1 ♂, 1 ♀, D. F. Weinland.

## MEXICO

Yucatán: 8623, Progreso, 1904, 1 ♂, L. J. Cole.

## BRAZIL

The following from Rio de Janeiro: 5126, no date, 1 ♂, Thayer Exped., recd. 1865. 5127, no date, 1 ♂, Thayer Exped. Estado de Rio Grande do Sul: 4699, Rio Grande, June 1861, 1 ♂, Harrington.

MNB. 1 lot, 1 specimen.

## BRAZIL

Santa Catarina: 57, Ponta do Farol, São Francisco do Sul, 1 ♀, recd. July 1901.

MNHNP. 1 lot, 1 specimen, plus 3 specimens in old dry collection.

## FRANCE

Rochefort, 1900, 1 ♂, from M. Vieuille.

RMNH. 49 lots, 109+ specimens.

## UNITED STATES

East coast of N America, Sept. 1836, 1 ♂, 1 ♀, G. Troost.

Connecticut: 401, New Haven, no date, from Smithsonian Inst.

New York: 13790, Shinnecock Bay, Long Island, Oct. 1955, 4 juv, A. Perlmutter.

New Jersey: 15253, Creek at Stone Harbor, Cape May Co., 8 May 1960, 2 ♀, juv, J. L. Scheltema.

Delaware: 11407, 11408, Delaware Bay, juv, date and col. unknown. 11344, Delaware Bay about 1 mi off Lewes, Sussex Co., 27 Apr. 1957, 1 ♀, L. B. Holthuis.

Maryland: 14616, Mouth of Potomac River, Point Lookout, St. Marys Co., 20 Mar. 1960, 2 ♀, J. L. Scheltema. 9827-9832, Chesapeake Bay, series of juv from 6 localities, date and col. unknown. 9833, mouth of harbor at Snowhill Landing, Snowhill, Worcester Co., 30 Sept. 1952, 1 ♂, juv, L. B. Holthuis. 9836, northern portion of Chincoteague

Bay, N of Snowhill, Worcester Co., 29 Sept. 1952, 1 ♂, 1 ♀, L. B. Holthuis. 9837, Johns Creek at mouth of St. Leonards Creek in cove of Patuxent River, W of Lusby, Calvert Co., 16 May 1953, 1 ♀, L. B. Holthuis.

Virginia: 9838, Harborton, Accomack Co., 28 Sept. 1952, 1 ♀, L. B. Holthuis.

Florida: The following from Biscayne Bay—21351, off Rickenbacker Causeway, 1 Feb. 1965, 1 ♀, J. A. Cabrera and L. B. Holthuis. 23432, near Mathesan Hammock S of Miami, 3 Jan. 1965, 1 ♂, juv, L. B. Holthuis. 21346, S of Rickenbacker Causeway, Miami, 4 Feb. 1965, 1 ♀ (ov), L. B. Holthuis. The following from Bear Cut near Marine Lab., Virginia Key—24258, 1 Sept. 1965, 1 juv, J. A. Cabrera and L. B. Holthuis. 24259, 22 Dec. 1964, 1 juv, L. B. Holthuis. 18710, 2-9 Sept. 1963, 1 ♀, L. B. Holthuis. 15635, Marco Beach S of Marco, washed ashore by hurricane Donna, 12 Sept. 1960, 1 ♀, L. B. Holthuis. 15634, mangroves near Marco Beach S of Marco, 12 Sept. 1960, 1 ♀ (juv), L. B. Holthuis.

#### PUERTO RICO

23465, Rio Guánica, 15 Sept. 1963, 1 ♂, 1 ♀, P. W. Hummelinck.

#### TRINIDAD

23404, mouth of Diego Martin River [5 mi NNW Port of Spain], 1965-66, 2 ♂, H. O. von Hagen. 17738, Matura, NE coast of island, 19 June 1961, 1 ♂, I. Kristensen.

#### CURAÇAO

11881, Waaigat, Willemstad, 30 Jan. 1957, 2 ♀, L. B. Holthuis.

#### NETHERLANDS

23434, Friesland, washed ashore, 7 May 1967, 2 ♂, 1 ♀, T. P. Broerse. 24754, southern North Sea 25 mi NW Ijmuiden [14 mi WNW Amsterdam], 19 Jan. 1968, 1 ♀, Rijks. Inst. Visserij Onderzoek. Beach at Dishoek between Flissingen and Zoutelande, Zeeland, 20 Jan. 1967, a large right swimming leg (dry), G. R. Heerebout. Washed ashore at Vlissingen in cooked condition, Aug. 1950, carapace of adult ♀ (dry), A. C. Visser.

#### GREECE

Delta area of Axiós and Gallikós near Pírgos, Thessaloníki, 15 June 1964, part of ♀ carapace and abdomen, from shallow water in *Salicornia* fields, from fisherman, W. J. Wolff and M. Loosjes. 18689,

fishmarket in Thessaloníki, from Gulf of Thessaloníki, 14 Mar. 1963, 1 ♀, R. Kinzelbach. Beach at Strimonikós Kólpos (= Gulf of Orfani) near Aspróvalta, about 15 km W Tsgezi (= Iraklitsa), 10 Mar. 1963, 2 rather worn carapaces (dry), R. Kinzelbach. 13082, Aegean Sea near harbor of Pórtó Lágo, 29 June 1959, 2 ♀, C. Swennen.

#### TURKEY

21148, on S coast near Silifke (Seleucia), 19 Aug. 1964, 1 ♀, Turkey Excursion, 1964 from Hamburg Mus. 13137, E coast of Akyatan Lagoon 45 km S Adana, 18 May 1959, 4 ♂, 2 ♀.

#### ISRAEL

The following from Naaman River S of Acre: 18829, mouth of River, 2 Feb. 1955, 1 ♂ (juv), A. Perlmutter. 13795, near Acre, 13 Oct. 1955, 2 juv, A. Perlmutter. 13794, same, 17 Aug. 1955, 1 ♀, E. Gottlieb. 17840, between railroad bridge and mouth, 30 Apr. 1962, 2 ♂, 3 ♀, L. B. Holthuis. Mouth of river, 30 April 1962, carapace and chelae of 2 or more individuals (dry), L. B. Holthuis. 18832, Lagoon on Kishon River, N of Haifa, 31 Jan. 1955, 1 ♀, Sea Fish Res. Stn., Haifa. 10722, Mouth of Tiphlis River near Tantura, about half-way between Cesarea and Atlit, 26 Oct. 1955, 1 ♂ encrusted with *Chelonibia patula* (Ranzani), A. Perlmutter. 13793, Mouth of Hefzibah [Hadera?] River near Hadera, 21 Nov. 1951, 1 ♀ (juv), E. Gottlieb. 13792, Hefzibah, 21 Nov. 1951, 1 ♀ (juv), E. Gottlieb. 13791, Alexander River near mouth [S Hadera], 20 Dec. 1955, 1 ♀ (juv), E. Gottlieb.

SADZ-B. 7 lots, 27 specimens.

#### BRAZIL

Rio de Janeiro: 3240, Atafona, 12 July 1963, 10 ♂, 8 ♀, N. Meneses. 1721, Atafona, 1964, 1 ♂, N. Meneses. 950, S. João da Barra, Nov. 1911, 1 ♀, E. Garbe.

São Paulo: 1814, Santos, 11 Sept. 1962, 1 ♀, G. Melo. 1727, Guarujá, Jan. 1920, 1 ♀, Hempel.

Santa Catarina: 664, Itajaí, Dec. 1914, Luederwaldt.

Rio Grande do Sul: 3234, Praia de Torres, 5 Oct. 1964, 1 ♂, 2 ♀ (1 ov), J. Bertoletti.

UNC-IMS. 8 lots, 34+ specimens.

#### UNITED STATES

Delaware: 1853, Near Port Mahon, 1 July 1954, 2 ♀, H. J. Porter.

North Carolina: 2246, West Bay near Cedar I., Pamlico Sound, Carteret Co., 21 July 1969, 2 ♀ (ov), includes smallest mature ♀ on record, from fisherman. 821, Neuse River near New Bern, Craven Co., 24 July 1957, 1 ♂ (juv), Tagatz and Dudley. 738, Neuse River at Smith Farm, near North Harlowe, Craven Co., 1 Oct. 1957, 3 ♂, 1 ♀, juv, Judy and Dudley. 739, Neuse River at North Harlowe, 26 July 1957, 3 ♀ (juv), Tagatz and Dudley. 820, Pivers Island near Beaufort, Carteret Co., 27 May 1957, 1 ♂, 4 ♀ (juv), Talbot and Fischler. 913, off Beaufort Inlet, 26 Nov. 1959, 4 ♀ (3 ov), covered with *Chelonibia*, H. J. Porter.

#### PUERTO RICO

2136, Fresh water canal, 5 km S Lajas, 10 Feb. 1967, 3 ♂, 1 ♀ juv.

YPM. 1 lot, 1 specimen.

#### BRAZIL

6399, Rio Grande, 7 June 1860, 1 ♂ bearing *Chelonibia*, G. Harrington.

*Supplementary literature records.*—Nova Scotia (Piers, 1923); Maine and Nova Scotia (Scattergood, 1960); Bermuda (Verrill, 1908a, b); Laguna Madre de Tamaulipas, Mexico (Hildebrand, 1957); Alvarado, Veracruz, Mexico (Contreras, 1930); Dominica (Chace and Hobbs, 1969); Lago de Maracaibo and Golfo de Venezuela (Taissoun, 1969); Quenquén, Buenos Aires, Argentina [?] (Boschi, 1964); Elbe estuary, Germany (Kühl, 1965); Netherlands and North Sea localities (Holthuis, 1969); mouth of Gironde, France (Amanieu and Dantec, 1961); Gulf of Spezia and Genoa Harbor, Italy (Tortonese, 1965); northern Adriatic lagoons, Italy (Holthuis, 1961 [review]); Greece and parts of eastern Mediterranean (Serbetis, 1959); Beirut, Lebanon (George and Athanassiou, 1965); Buḥayrat Idkū and Buḥayrat Manzilah, Egypt (Banoub, 1963).

### QUESTIONABLE SPECIES

Rathbun (1907) described *Callinectes alexandri* from Papeete, Tahiti, and Suva, Fiji Islands, on basis of two juveniles, and later (1911) noted a small mature male from Cragados, Carajos [Shoals, Mascarene Islands, Indian Ocean]. Stephenson and Campbell (1959) synonymized this confusing form with *Portunus pelagicus* (Linn.), commenting on its close similarity to

members of *Callinectes* and temporarily questioning the validity of *Callinectes*. Later Stephenson et al. (1968) accepted the generic status quo. Stephenson (1968) confirmed his recognition of *Callinectes* and, after examination of Rathbun's specimens of *C. alexandri*, reidentified the Tahiti and Fiji material as *P. sanguinolentus* (Herbst) and the Indian Ocean specimen as *P. pelagicus*. The history of these bleached specimens emphasizes the difficulty in identifying some juvenile portunid material.

Chen (1933) described *Callinectes platei* on basis of a small male (length 14, width 29 mm), and *C. alcocki* on basis of a small ovigerous female (length 10.5, width including lateral spines 16 mm) from Tuticorin [Madras, India]. There is no sure way to identify these forms because specimens from the Plate collection are apparently no longer in existence. From the descriptions and figures, the two species possibly represent male and female of the same form, a small portunid with internal carpal spine. This alone is enough to remove them from *Callinectes*. Moreover, no known *Callinectes* is ovigerous at the tiny size of this female.

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