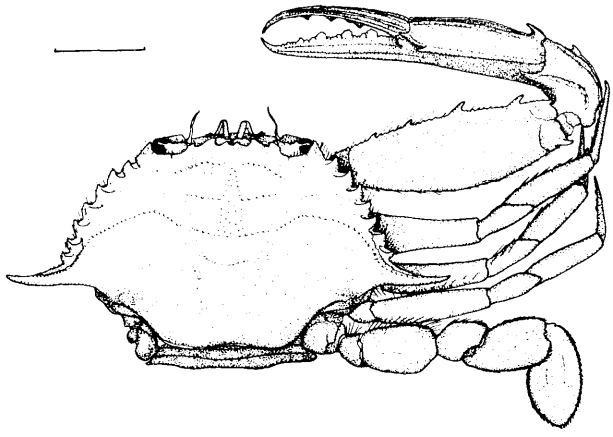

FIGURE 145.—*Portunus anceps* (Saussure). Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Color.—Mottled gray and yellowish white so as to imitate sand; first pair of legs red or yellow; chelipeds and other legs same color in part (Verrill, 1908). Hairs on legs colorless (Abramowitz, 1935).

Habitat.—This form lives on or near sandy shores in tropical waters, but is sometimes carried northward in the Gulf Stream to the North Carolina capes; surface to 40 fathoms.

Type locality.—Cuba.

Known range.—Cape Hatteras, N.C., to Brazil; Bermuda.

Remarks.—Rathbun (1930a) recorded ovigerous females from June in Cuba to October in North Carolina.

Portunus gibbesii (Stimpson)

Figure 146

Lupa gibbesii Stimpson, 1859, p. 57.
Portunus gibbesii: Hay and Shore, 1918, p. 428, pl. 33, fig. 1.—Rathbun, 1930a, p. 49, pls. 16–17 (rev.).

Recognition characters.—Carapace approximately twice as wide as long, not tumid, thickly covered with small spherical granules, pubescent, and with three or four naked, transverse ridges, two of which arise from lateral spines and run toward gastric region. Eight frontal teeth including two points of each inner orbital, median pair of frontal teeth narrower and slightly more advanced than next pair. External orbital tooth not much larger than teeth of anterolateral border, these latter stout, acute, directed forward; last tooth, or lateral spine, slender, sharp, curved forward and about as long as space occupied by three preceding teeth. One or more small, naked, iridescent areas near anterolateral margin at base of teeth.

Chelipeds long, slender; merus with five to seven spines in front, and one behind at distal end; carpus with a large internal and a smaller external spine; hand slender, ribbed on all surfaces; ribs continued on fingers and roughened by sharp-pointed, appressed tubercles; hand with two spines, one at articulation with carpus, another near distal end of superior rib; fingers nearly straight with incurved tips.

Measurements.—Carapace: male, length, 29 mm.; width, 61 mm.

Color.—Brownish red, transverse ridges on carapace, spines, and margins of chelipeds carmine red; front side of legs brilliantly iridescent by lantern light, iridescence evident to some extent in preserved material.

Habitat.—The species is fairly common about the Beaufort, N.C., region and is often taken in deeper channels of the harbor. Along with *P. spinimanus*, Hildebrand (1955) reported this species as common on the shrimping grounds on Campeche Bank in the Gulf of Mexico, but rare on the Texas coast. Surface to 48 fathoms, rarely deeper.

Type locality.—South Carolina and St. Augustine, Fla.

Known range.—Southern Massachusetts to Texas; Venezuela; Surinam.

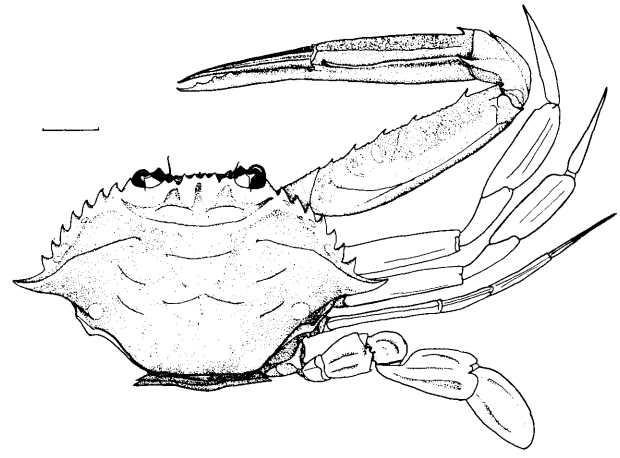

FIGURE 146.—*Portunus gibbesii* (Stimpson). Male in dorsal view, legs of left side not shown, 10 mm. indicated.

Remarks.—Ovigerous females have been reported and are otherwise known to occur in the months February to June from North Carolina to Surinam (Holthuis, 1959; Rathbun, 1930a).

Gray (1957) computed gill area per unit weight for *P. gibbesii* as intermediate among a number of swimming crabs studied.

Portunus spinimanus Latreille

Figure 147

Portunus spinimanus Latreille, 1819, p. 47.—Hay and Shore, 1918, p. 429, pl. 33, fig. 4.—Rathbun, 1930a, p. 62, text-fig. 10, pls. 26–28 (rev.).

Recognition characters.—Carapace considerably less than twice as wide as long, finely granulate and pubescent, with a number of prominent, curved, coarsely granulate, transverse ridges. Eight frontal teeth, including inner orbitals, each notched at summit and presenting two points; median pair of teeth slightly narrower and more advanced than next pair, all considerably more advanced than inner orbitals. Outer orbital teeth obtuse, not much larger than teeth of anterolateral borders, these latter strong, acute, or acuminate, about equal in size except last; this tooth about twice as large as others and usually curved forward.

Chelipeds long, pubescent, serratogranulate all over; merus with four, occasionally five, strong, curved spines in front and one at distal end; carpus with two spines, inner one much stronger, and with four conspicuous ridges on upper surface; hand slender, all surfaces with ridges which extend on fingers; a strong spine at carpal articulation and another near base of dactyl; fingers nearly straight, tips incurved.

Measurements.—Carapace: female, length, 55 mm.; width, 88 mm.

Variations.—Large males have relatively longer, thinner chelipeds and longer walking legs than large females.

Color.—Pubescence yellowish or reddish brown, ridges of carapace, spines of chelipeds, fingers and tips of legs reddish brown; anterolateral teeth reddish at base, white at tips; merus, carpus, and hand of chelipeds with white blotches.

Habitat.—This species is common in the waters off Beaufort Inlet, N.C., and is sometimes found in deeper channels of the harbor. *P. gibbesii* is often found in company with *P. spinimanus.* A similar association of these two species was reported by Hildebrand (1955) for the Campeche Banks in the Gulf of Mexico where they are common. On beach under *Sargassum;* surface to 50 fathoms.

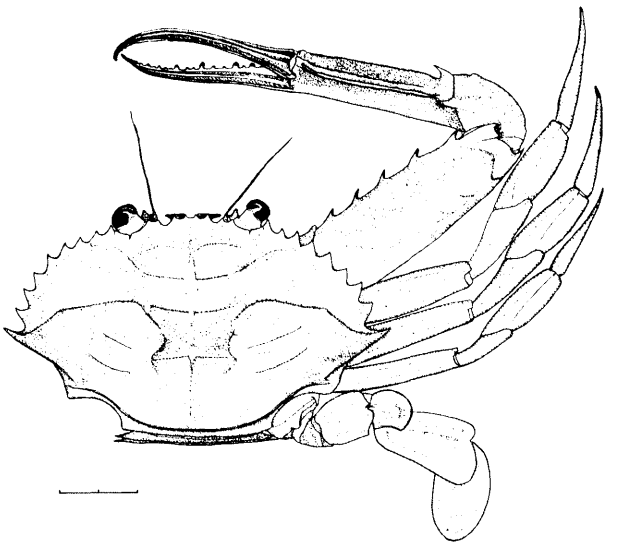

FIGURE 147.—*Portunus spinimanus* Latreille. Male in dorsal view, legs of left side not shown, 20 mm. indicated.

Type locality.—American waters, common in Brazil.

Known range.—New Jersey through Gulf of Mexico and West Indies to southern Brazil; Bermuda.

Remarks.—This species, which somewhat resembles *P. gibbesii*, can be readily distinguished from the latter by its narrower, rounder form, and by the entire lack of iridescent patches on the carapace mentioned for *P. gibbesii.*

Ovigerous females are known from January to July in Florida (Wass, 1955, in part); March in Campeche; April in Isle of Pines; May, August, and September in Surinam (Holthuis, 1959); and July in St. Thomas, V.I. (Rathbun, 1930a). Lebour (1950) found an ovigerous female among *Sargassum* in Bermuda in May, and from the eggs reared larvae which she illustrated.

Gray (1957) computed gill area per unit weight for *P. spinimanus* as intermediate among a number of swimming crabs studied.

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Portunus ordwayi (Stimpson)

Figure 148

Achelous ordwayi Stimpson, 1860a, p. 224.
Portunus ordwayi: Hay and Shore, 1918, p. 431, pl. 33, fig. 6.—Rathbun, 1930a, p. 71, pl. 33 (rev.).

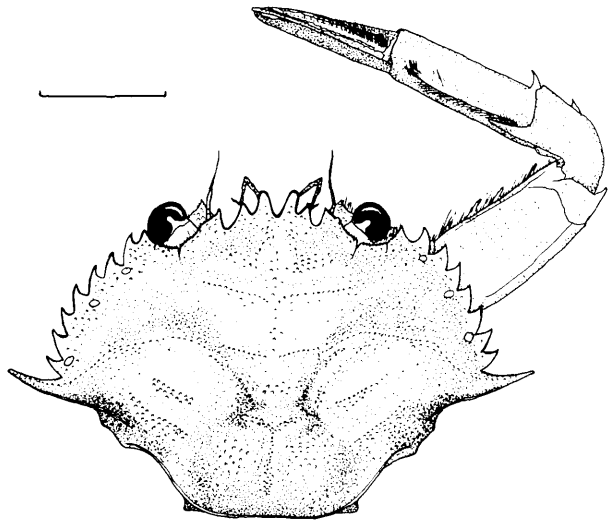

FIGURE 148.—*Portunus ordwayi* (Stimpson). Male in dorsal view, legs not shown except for right cheliped, 10 mm. indicated.

Recognition characters.—Carapace approximately 1.5 times as wide as long, uneven, elevations granulate and depressions pubescent, with a number of conspicuous, curving, transverse ridges. Six frontal teeth including acuminate inner orbitals; true frontal teeth about equal in size, triangular, acute, middle pair advanced beyond others. Outer orbital tooth large; anterolateral teeth diminishing slightly in size from first to seventh, inclusive, eighth about as long as space occupied by two preceding teeth, tips of all acute and turned forward.

Chelipeds of moderate length; merus with four or five strong spines in front, a single distal one behind; carpus ribbed and with strong internal and much smaller external spine; hand ribbed on all surfaces except flat, highly iridescent, superior surface; superointernal ridge raised into a crest terminating distally in a sharp spine. Margins of carapace and chelipeds more or less fringed with silky hairs.

Measurements.—Carapace: male, length, 26 mm.; width, 42 mm.

Color.—Carapace and legs reddish brown due to fine mottling with red, yellowish brown, and gray; pale orange beneath, deeper orange on chelipeds and legs; chelae deep red brown above, fingers with two cross bands of light orange red. Blue coloration also apparent near red and dark pigments; hairs on appendages deep red (Abramowitz, 1935).

Habitat.—This is another of the tropical swimming crabs which move northward with warm water currents; surface to 58 fathoms, rarely deeper.

Type localities.—Key Biscayne and Tortugas, Fla.; St. Thomas, [V.I.].

Known range.—Vineyard Sound, Mass.; North Carolina through Gulf of Mexico, Caribbean Sea, and West Indies to State of Bahia, Brazil; Bermuda.

Remarks.—Rathbun (1930a) listed an ovigerous female in March from Florida.

Portunus depressifrons (Stimpson)

Figure 149

Amphitrite depressifrons Stimpson, 1859, p. 58.
Portunus depressifrons: Hay and Shore, 1918, p. 430, pl. 33, fig. 7.—Rathbun, 1930a, p. 84, pl. 41 (rev.).

Recognition characters.—Carapace approximately 1.6 times as wide as long, uneven, pubescent, and with indistinct transverse ridges. Six frontal teeth, including inner orbitals much larger than others, tips of all teeth about on a line. External orbital tooth strong, tip rounded; anterolateral teeth acute, turned forward, lateral tooth scarcely longer than one in front, teeth and intervals between them fringed with hairs.

Chelipeds trigonal, serratogranulate and pubescent; merus with five spines in front and a distal one behind; carpus with two spines, outer much smaller than inner one; hand short and compressed, upper margin raised into a crest terminating distally in a stout spine, a smaller spine at carpal articulation; fingers flattened, dactyl with border of hairs on superior margin. Walking legs unusually long and slender, first pair with articles fringed with hairs. Swimming legs shorter than in most species of genus.

Measurements.—Carapace: male, length, 26 mm.; width, 41 mm.

Color.—Carapace in life irregularly mottled with light and dark gray, closely imitating colors of sand; chelipeds and posterior legs similar, though paler; first pair of walking legs bright

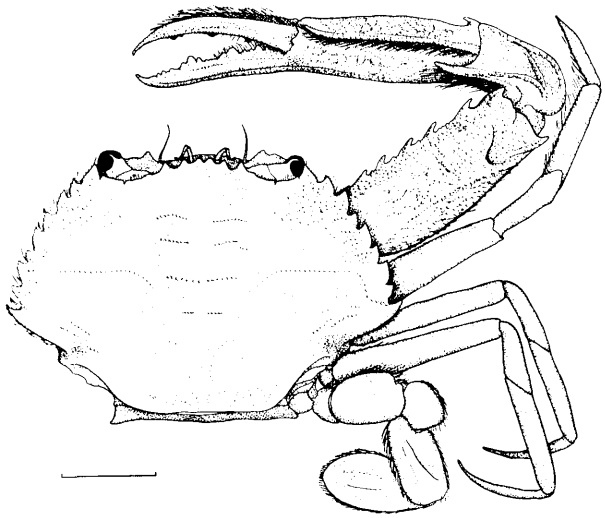

FIGURE 149.—*Portunus depressifrons* Stimpson. Male in dorsal view, legs of left side not shown. 10 mm. indicated.

purple, or deep blue in larger specimens, while some portion of same color usually apparent on next two pairs, but color of first pair in striking contrast with rest of crab. Very young specimens do not show this distinction in color of legs, so far as observed (Verrill, 1908).

Habitat.—Abundant in shallow water on sandy bottoms of coves and inlets at Bermuda (Verrill, 1908); surface to 16 fathoms.

Type localities.—South Carolina and Florida Keys.

Known range.—Fort Macon, N.C. (Coues and Yarrow, 1878; Kingsley, 1880) to Gulf of Campeche and Caribbean Sea; Bermuda.

Remarks.—This crab has not been collected in the Carolinas for many years, so far as recorded. Records in the U.S. National Museum show no specimens from farther north than Key West, Fla., and the Bahamas near the southeast coast of the United States. A number of specimens in the U.S. National Museum collection were taken from the stomachs of the gray snapper, *Lutjanus* (=*Neomaenus*) *griseus*, the yellow goatfish, *Mulloidichthyes* (=*Upeneus*) *martinicus*, and other predaceous fish. Rathbun (1930a) reported ovigerous females in June from Florida, and in August from Florida and the Caribbean. More recently, egg-bearing females have been taken on Campeche Banks in late August.

Portunus spinicarpus (Stimpson)

Figure 150

Achelous spinicarpus Stimpson, 1871a, p. 148.
Portunus spinicarpus: Hay and Shore, 1918, p. 429, pl. 33, fig. 3.—Rathbun, 1930a, p. 92, pl. 45.

Recognition characters.—Carapace slightly more than twice as wide as long, sculptured, with a number of naked, rather coarsely granulate, arching, transverse ridges separated by finely granulate and pubescent surfaces. Six frontal teeth, including inner orbitals, with sinuate but unnotched outer margins; true frontal teeth narrow, acute, separated by broad notches, median pair considerably advanced beyond others. External orbital tooth acute, larger than neighboring teeth of anterolateral margin; latter varying somewhat in size, concave sided, acute; lateral tooth with form of slender curving spine more than half as long as anterolateral border; posterolateral angle sharp, margin slightly recurved.

Chelipeds long, slender; merus with four or five stout, curved spines in front, and a single, similar, distal spine behind. Carpus with two spines, outer one small and weak, inner one long, extending along side of hand to near base of dactyl. Hand with serratotuberculate ridges, prolonged on fingers, and two spines, one at carpal articulation, another near base of movable finger. Fingers nearly straight, incurved at tips.

Measurements.—Carapace: male, length, 18 mm.; width, 38 mm.

Variations.—Rathbun (1930a) stated that ovigerous females are smaller than males, and their chelipeds are shorter, with the carpal spine not reaching beyond the superior spine of the hand. The lateral spine is relatively longer in young than in old individuals and changes in angle of projection with age, extending straight laterally or slightly backward in the young, but curving slightly forward in mature individuals.

Color.—Carapace buff pink, mottled, highest ridges touched with cinnamon red; fingers bordered with crimson and maroon; two basal teeth of dactyl and margin of palm white; rest of chela maroon purple and purplish red, same color on fringe of hair on carpal spine; walking legs purple. (Schmitt *in* Rathbun, 1930a, where great detail on younger individuals is given.)

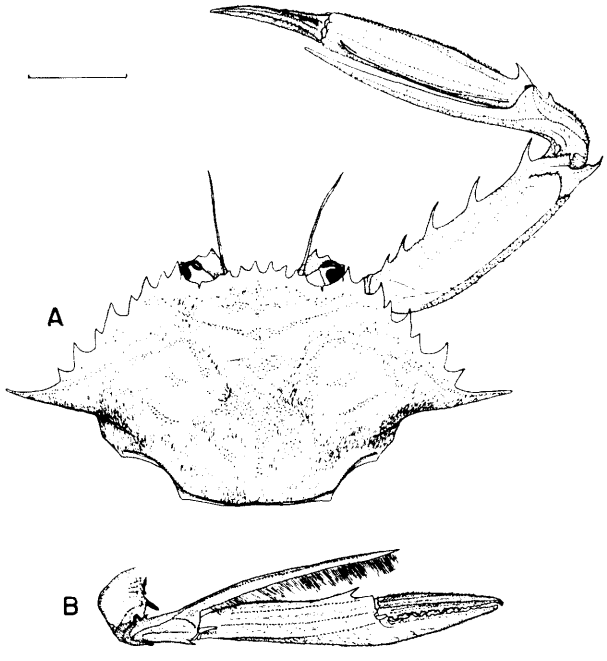

FIGURE 150.—*Portunus spinicarpus* (Stimpson). A, male in dorsal view, legs not shown except for right cheliped; B, right chela of male in frontal view; 5 mm. indicated.

Habitat.—This appears to be a species living in deeper waters of the region. On shrimping grounds in the western Gulf of Mexico, Hildebrand (1954) reported it as found only along the seaward side in depths of 15 to 37 fathoms. Five to 300 fathoms.

Type localities.—Off Tortugas, Carysfort Reef, Conch Reef, Alligator Reef, Pacific Reef, and American Shoal, Fla.; lat. 31°31′ N. long. 79° 41′ W. off Georgia; in depths ranging from 13 to 150 fathoms.

Known range.—Off Cape Hatteras, N.C., to State of São Paulo, Brazil.

Remarks.—Ovigerous females have been taken from January to September from Florida to Surinam, and in November in Texas. Pearse (1932b) found the barnacle, *Dichelastis sinvata* Aurivillius, on a number of individuals.

Genus ***Callinectes*** Stimpson, 1860

Rathbun, 1930a, p. 98.

KEY TO SPECIES IN THE CAROLINAS

a. Frontal teeth, including inner orbitals, four *sapidus* (p. 168).

aa. Frontal teeth, including inner orbitals, six *ornatus* (p. 172).

Callinectes sapidus Rathbun. Blue Crab

Figure 151

Lupa hastata Say, 1817, p. 65.

Callinectes sapidus Rathbun, 1896a, p. 352, pls. 12; 24, fig. 1; 25, fig. 1; 26, fig. 1; 27, fig. 1 (rev.).—Hay and Shore, 1918, p. 432, pl. 35, fig. 1.—Rathbun, 1930a, p. 99, pl. 47 (rev.).

Recognition characters.—Carapace, including lateral spines, 2.5 times as wide as long, moderately convex, nearly smooth, except lightly tuberculate on inner branchial and cardiac regions; a tuberculate transverse line from side to side between lateral spines, and a shorter transverse line about halfway between this and frontal margin. Four frontal teeth, including inner orbitals, triangular, acute, both pairs more or less distinctly bilobed. Anterior eight anterolateral spines of subequal length, concave on both margins and acuminate; lateral spines nearly straight, usually longer than space occupied by three preceding teeth; inner suborbital tooth prominent and acute.

Chelipeds of male large and powerful, smaller in female; merus with three spines in front and one small spine at distal end behind; carpus with one spine and one spiniform tubercle on external surface; hand strong, prominently ribbed, and with a strong proximal spine; fingers nearly straight and strongly toothed. Abdomen of male in form of inverted T; basal segments broad, distal segments narrow; penultimate segment constricted in proximal half, wider at both ends, terminal segment approximately oblong-lanceolate; first pleopods reaching nearly to, or beyond, extremity of abdomen, approximated through basal half, distal portions widely divergent except at tips. Immature female with abdomen triangular; mature female with abdomen broad, rounded, and lying loosely on ventral side of thoracic sterna.

Measurements.—Width of carapace (including spines): males, 200 mm.; females, 198 mm.; smallest mature females (excluding dwarfs), 86 mm. Exceptional males in water of low salinity may measure 230 mm., or more, in width.

Color.—Grayish, or bluish green of varying shades and tints, relieved by more or less red on spines of carapace; males with blue fingers on hands, mature females with red fingers on hands; underparts off white with tints of yellow and pink. Churchill (1919) gave a colored frontispiece showing ventral and other views.

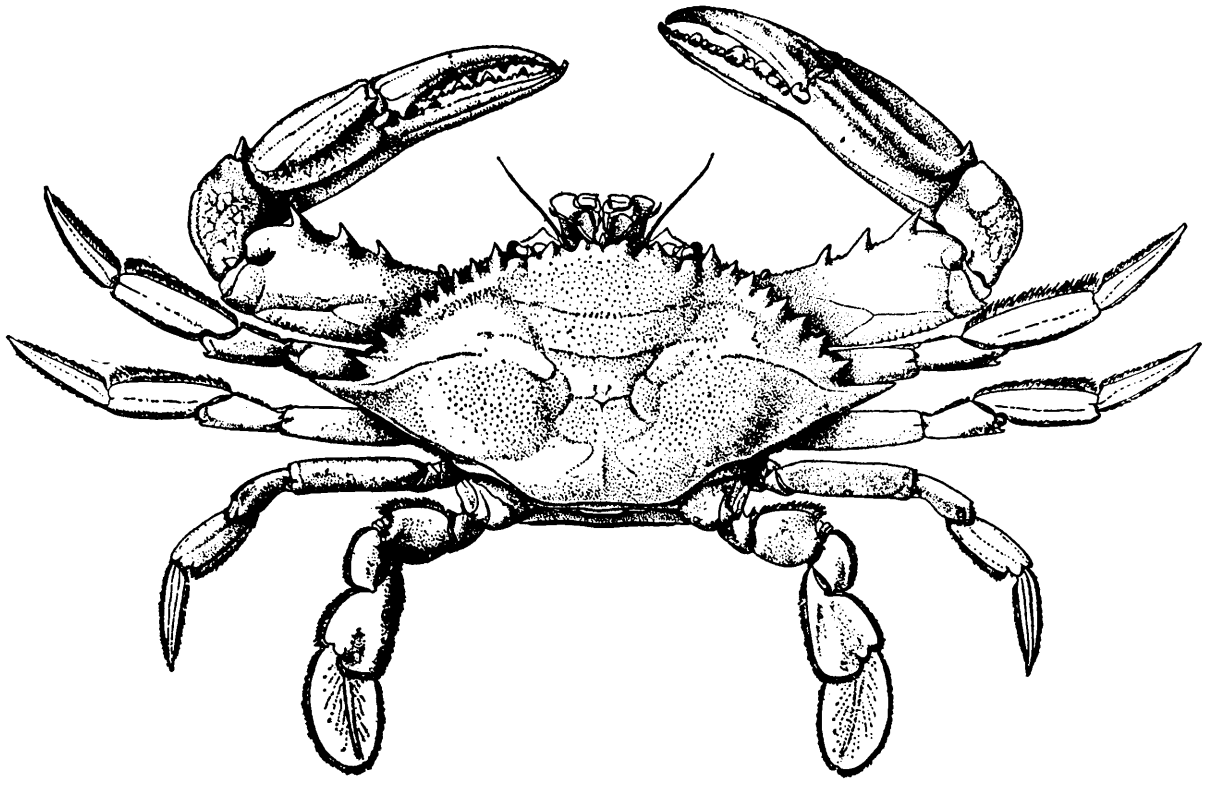

FIGURE 151.—*Callinectes sapidus* Rathbun. Animal in dorsal view (after Rathbun, 1884).

Habitat.—Found on a variety of bottom types in estuaries and shallow oceanic water; water's edge to 20 fathoms.

Type locality.—[East coast of United States].

Known range.—Native recent range, Nova Scotia (no longer endemic, Bousfield, personal communication) to Uruguay; Bermuda. The species has been introduced in Europe, and was reported from southwest France in 1901; from Holland in 1932, 1934, and 1951; near Copenhagen, Denmark, in 1951; in and near Venice, Italy, in 1949 and 1950; and in Israel in 1955. Holthuis (1961) reviewed these occurrences in addition to recently found well-established colonies in Turkey and Greece and remarked that the species must now be regarded as indigenous to Europe.

Remarks.—There is a tremendous literature concerning the blue crab, largely because of its great economic value. Since it is not possible to summarize this literature in a brief account such as this, the interested student is referred to the comprehensive bibliography compiled by Cronin, Van Engel, Cargo, and Wojcik (1957) for a list of the literature to that date, to excellent life history and ecological summaries by Churchill (1919), Truitt (1939), and Van Engel (1958) for the crab in Chesapeake Bay; and to Darnell (1959) for occurrence in Louisiana. Though these papers are current and available, for the sake of convenience certain essentials are reviewed here.

The fossil record for *Callinectes sapidus* reaches back to the lower Miocene of Florida, and the species has been found at later levels in Virginia, Massachusetts, New Jersey, and the Carolinas (Rathbun, 1935; Blake, 1953).

The spawning season on the east coast of the United States is quite long. Females with yellow egg masses attached have been found in North Carolina from as early as March 21 to as late as October 26. In that area, the greatest number of females with eggs occur in spring, the time of peak occurrence varying somewhat with season. In Chesapeake Bay, the spawning season, with rare exceptions, extends from late April to early September with the peak occurring in June. Farther south, on the coast of Texas the spawning season extends from December to October and may include November as well, but the peak oc-

curs in June and early July (Daugherty, 1952). Five stages in the reproductive cycle of mature females have been described (Hard, 1942), and a number of authors have shown that the number of eggs in an egg mass (sponge) may range from 700,000 to more than 2 million.

The eggs hatch into zoeae, undergoing development through seven stages. These stages have been described from laboratory cultures (Costlow, Rees, and Bookhout, 1959; Costlow and Bookhout, 1959). Atypically, an eighth stage may occur. The last zoeal stage molts into a megalops stage and this into the first crab stage.

Churchill found that eggs hatch in about 15 days at 26.1° C. and slightly faster at higher temperatures. Development from hatching to megalops lasts from 31 to a maximum of 49 days in various salinities, but development time in the different stages is quite variable even in a single salinity-temperature combination. The megalops stage lasts from 6 to 20 days. It was found that development progresses at a comparable rate in salinities between 20.1 and 31.1 °/₀₀ at 25° C. Salinity above 31.1 °/₀₀ slowed development, and below 20.1 °/₀₀ larvae rarely completed the first molt. Larvae never went beyond the first zoeal stage when reared at 20° C. and did not progress beyond the third zoeal stage when reared at 30° C. Once the first crab stage is reached, the animals continue to molt as they grow and are estimated to undergo some 18 to 20 or more molts before reaching maturity (Van Engel, 1958).

In Chesapeake Bay, where the crab is perhaps more abundant than in other areas, it has been demonstrated that crabs spawned in June of one year are mature about 14 months later and at that time mate. Most mating pairs are found in July, August, or September, though the mating season extends from May to October. At this time, females ready to molt into the mature stage (terminal molt) are carried about, cradled upright, under the males' bodies. Such pairs are called doublers. The male frees the female during the time she is actually casting the old exoskeleton, but when this is shed he grasps her again, this time with the ventral surfaces together, and completes the breeding act by introducing sperm via the copulatory stylets into the spermathecae. Copulation may last for several hours. When sperm transfer is complete, the female is allowed to resume an upright posture and is again carried under the male for a time until her shell is hardened. Males may mate more than once and at any time during their last three intermolts (Van Engel, 1958); females only do so once, but the sperm supply may serve to fertilize more than one mass of eggs. Usually, a female mated in late summer casts the first batch of eggs the following spring at an age of approximately 2 years, but egg laying may be at any time from 2 to 9 months after mating. A second spawning has been observed to occur later in summer among some individuals, and it is possible that a third may occur, possibly as late as the succeeding spring or at an age of 3 years. Three years is judged to be about the normal maximum age for this species.

The life history of the blue crab is complicated by the fact that it leads a migratory existence. The migratory patterns have been studied in greatest detail in Chesapeake Bay but the same pattern appears to be true of other areas as well. Mating usually takes place in water of reduced salinity well up in estuaries. After this, the females migrate downstream to areas of higher salinity near the mouths of estuaries where the eggs are laid and hatched, whereas the males tend to remain in the low-salinity areas for the remainder of their lives. For this reason, samples of adult crabs (or commercial catches) near the sea contain greater numbers of females, whereas those from the middle or upper reaches of bays contain larger percentages of males except at the breeding season. Once in the spawning areas, the females tend to remain there for the remainder of their lives or move a short way out to sea. Once hatched, the zoeae lead a planktonic existence until they transform to the megalops stage. As soon as the crabs transform to the first crab stage, they begin a migration up the estuary toward the mating grounds. Some early recruits may reach these areas in their first summer of life, the remainder early in the second year of life. In areas smaller than Chesapeake Bay, there may be a certain amount of overlap in mating and spawning grounds but the two areas tend to be distinct. In Chesapeake Bay, the spawning grounds are near the mouth of the Bay; in North Carolina and Louisiana, near the inlets and passes. In Texas,

most females with eggs are found in the Gulf proper (Daugherty, 1952).

Aside from size variation associated with the annual growth cycle, there is an apparent variation in size correlated with location in which the animals are found (Van Engel, 1958). Though never conclusively proved by experiments, it is thought that there is a negative correlation of size with the salinity in which a crab matures. Very large males are probably large because they have remained in water of low salinity. Fischler (1959) reviewed the occurrence of "dwarf" ovigerous females ranging in width from 52.3 to 80 mm. All these specimens were taken near the sea, and, as the author pointed out, may be small because of environmental influences of high salinities throughout life.

That the blue crab can tolerate fresh water is well established. The subject is reviewed in some detail by Odum (1953). On the basis of experiment and observation he reached the conclusion that oligohaline (100–1,000 p.p.m. Cl) and nearly oligohaline waters (25–100 p.p.m. Cl) can be invaded to a considerable extent if the crabs are able to adjust slowly to the reduced chlorinity, which, of course, is the case in natural invasions. Many of the Florida streams and lakes are oligohaline and contain blue crabs, but in other areas this is not true and blue crabs in such areas are seldom found far from salt water.

Because the blue crab supports the largest crab fishery in the United States, fluctuations in abundance (especially in the Chesapeake area) have been the subject of many conjectures and a number of investigations. Pearson (1948) dealt with this subject at length. The fluctuations appear to be associated with variable rates of survival in the first year of life. No correlation was found between relative abundance of female crabs and their progeny. On the basis of examination of 13 generations, size of spawning stock did not determine size of population surviving to commercial age at the rate of fishing prevailing during the years studied. Pearson found evidence that excessively cold weather may reduce availability of immature and adult crabs either by direct mortality or by making crabs less available to the fishery immediately after the periods of cold weather. Heavy runoff in some wet years may lower salinity in the spawning areas enough to have an adverse effect on survival of young, but such limits are poorly understood.

Piers (1923) reported a population of blue crabs in Nova Scotia, the recorded northern limit for the species, and considered that it was a natural rather than an introduced population. Bousfield (personal communication) reports that the species is certainly no longer endemic there. Scattergood (1960) commented that fluctuations in the population in Maine seemingly were correlated with temperature when a series of warm years accompanied an increase in number of blue crabs.

The blue crab is often summarily dismissed as a scavenger. Though it may be a scavenger, and, indeed, is lured to crab pots or wire traps by means of dead fish used for bait, students of the feeding habits of the species agree that it is an omnivore and prefers fresh to putrid flesh (Churchill, 1919; Truitt, 1939; Van Engel, 1958). Darnell (1961) showed that blue crabs in Lake Pontchartrain, La., eat a variety of materials including fishes, large and small bottom animals, some vascular plant material, and organic detritus. Of these materials, the category including small bottom animals (*e.g.*, those that are intimately associated with the bottom) made up about half of the diet. There are numerous notes on feeding and predation in the literature recording such habits as feeding on oysters, clams, and tunicates.

In a study of gill area correlated with degree of activity and habit of several species of crabs, Gray (1957) found that the blue crab has a larger gill area per gram of body weight than the other portunids studied (*Ovalipes*, *Arenaeus*, and *Portunus* spp.) and, in fact, exceeded that of any crab studied among aquatic, intertidal, and land crabs in the Beaufort, N.C., area. The blue crab is noted for its vigorous and pugnacious nature, and this anatomical feature gives one reason for such temperament.

Callinectes sapidus is fairly long-lived following its last molt, and thus affords a lodging place for barnacles and bryozoans. Its gills and gill chambers become clogged with clusters of a small stalked barnacle, *Octolasmus lowei* (Causey, 1961). The barnacles *Balanus amphitrite* and *Chelonibia patula* attach to the carapace. The sacculinid parasite, *Loxothylacus texanus*, lives

beneath the abdomen (Wass, 1955). Hopkins (1947) discussed infestations of the parasitic nemertean *Carcinonemertes carcinophila* on female blue crabs showing that only light-colored worms are found in the gills of mature females which have never spawned. Large red worms are found only on the gills of mature female crabs which have spawned at least once, or in the gills and egg masses of ovigerous females. Presence of large red nemerteans in the gills is a sure sign that the crab has spawned some time in the past. Pearse (1932b) reported trematode metacercariae on the gills.

Pigment in the melanophores of *C. sapidus* displays an endogenous rhythm with a frequency of 24 hours in the Gulf of Mexico where there is one high and one low tide per day (Fingerman, 1955). The pigment is in a dispersed state during the day and in a contracted state at night. This cycle is maintained under constant laboratory conditions. Superimposed on the diurnal rhythm is a tidal rhythm with a frequency of 12.4 hours. This rhythm is manifested by a supplementary dispersion of melanin which occurs about 50 minutes later each day and is most evident when the low or high tide is either in the morning or late afternoon. Under constant conditions, the phases bear a definite relationship to times of low and high tides in the native habitat. Also, there is evidence for a semilunar rhythm. Only once every 14.8 days are the diurnal and tidal rhythms in the same phases relative to each other.

Callinectes ornatus Ordway

Figure 152

Callinectes ornatus Ordway, 1863, p. 571.—Hay and Shore, 1918, p. 433, pl. 34, fig. 2.—Rathbun, 1930a, p. 114, pl. 50 (rev.).

Recognition characters.—Carapace, including lateral spines, slightly more than twice as wide as long, somewhat tumid, finely granulate throughout, transverse lines distinct, metagastric area less than half as long as its anterior width. Six frontal teeth including inner orbitals, submedial teeth short, variable in length. Anterolateral teeth shallow and broad, tips of first five or six acute, others acuminate; lateral spines curved forward, scarcely as long as space occupied by three preceding teeth; inner suborbital angle prominent.

Chelipeds shaped as in *C. sapidus*, but smaller, with spines possibly more acute; ridges of hand more developed, and teeth on fingers relatively larger and sharper. Abdomen of male with first segment produced laterally into an acute, upturned spine.

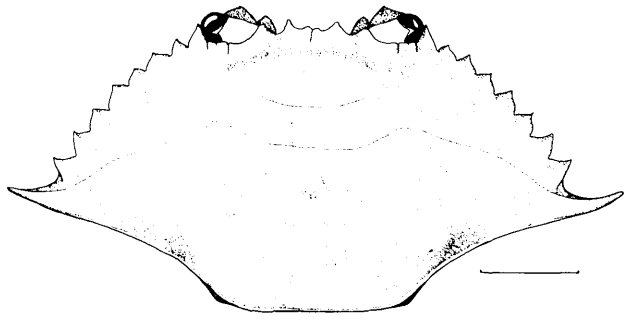

FIGURE 152.—*Callinectes ornatus* Ordway. Animal in dorsal view, legs not shown, 10 mm. indicated.

Measurements.—Carapace: male, length, 33 mm.; width, 74 mm.

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. Under parts white and blue.

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.

Habitat.—This crab, like its near relative, *C. sapidus*, is a coastal species often found in estuaries, sometimes in fresh water. Brues (1927) observed a large, active male that had been trapped at the head of a Cuban tidal river in fresh water during a dry period of about 3 months' duration. Lunz (1958), writing of a form from the South Carolina crab fishery,

doubtfully referred to *C. ornatus*, said that it tends to occupy oceanic waters and high- to medium-salinity areas of estuaries chiefly in a temperature range of 15° to 31° C., but has been found in temperatures as low as 9° C. From over 500 trawl hauls in South Carolina, a depth maximum of 9 fathoms was found for the species. However, specimens have been taken under a light at night swimming at the surface in 925-fathom water off the Mississippi River Delta (U.S. National Museum notes).

Reported from surface to 40 fathoms, with above exception.

Type localities.—Charleston Harbor [S.C.]; Tortugas [Fla.]; Bahama Islands; Gonaives [Haiti]; Cumana [Venezuela].

Known range.—New Jersey to State of São Paulo, Brazil; Bermuda.

Remarks.—Blake (1953) reported a fossil record for this species dating from the Pleistocene of Maryland. Lunz (1958), in addition to habitat data, reported ovigerous females from South Carolina in May, August, and September, and added that spawning probably takes place offshore. He found a sex ratio of approximately two males to one female. Ovigerous females occur as late as November in North Carolina.

Genus *Arenaeus* Dana, 1851

Rathbun, 1930a, p. 134.—Hemming, 1958b, p. 13.

Arenaeus cribrarius (Lamarck). Speckled crab

Figure 153

Portunus cribrarius Lamarck, 1818, p. 259.
Arenaeus cribrarius: Hay and Shore, 1918, p. 434, pl. 34, fig. 3.—Rathbun, 1930a, p. 134, pl. 58, figs. 2–3; pls. 59–60 (rev.).

Recognition characters.—Carapace more than twice as wide as long, finely granulate, produced on each side into a strong spine. Front not so far advanced as outer orbital angles, with six teeth including inner orbitals; central tooth of each side partly coalesced with adjacent submedian tooth. Anterolateral teeth strong, somewhat acuminate, heavily ciliate beneath. Superior wall of orbit with two deep fissures dividing it into three lobes; inferior wall of orbit with wide external fissure and inner angle much advanced; lower surface of carapace hairy.

Chelipeds of moderate size; merus with three spines on anterior border, and a short tuberculiform one near distal end of posterior border; carpus with two spines; hand short, with five longitudinal granulose ridges and two spines, one at articulation with carpus, another above base of dactyl. Walking legs rather short and broad, densely ciliate. Swiming legs stout. Basal segment of abdomen produced on each side into strong, sharp, slightly upcurved spine.

Measurements.—Carapace: male, length, 48 mm,; width, 116 mm.

Color.—Light vinaceous brown or olive brown thickly covered over dorsal surface with small, rounded, white spots; spots on dorsal surface of chelipeds somewhat larger; tips of walking legs yellow. Color pattern persisting in alcohol.

Habitat.—As far as known, this crab seldom enters estuaries and is rarely washed ashore along the outer beaches. It lives in rather shallow water close to the shore, and is well adapted to life in the waves and shifting sand. Hildebrand (1954) reported it as preferring the relatively shallow water of the white shrimp grounds in Texas. Siebenaler (1952) reported it as a "trash" form on the Florida east coast shrimp grounds. Waterline along beaches to 37 fathoms.

Type locality.—Brazil.

Known range.—Vineyard Sound, Mass., to State of Santa Catarina, Brazil.

Remarks.—Ovigerous females are known in August from Florida, and in September from Venezuela and Brazil.

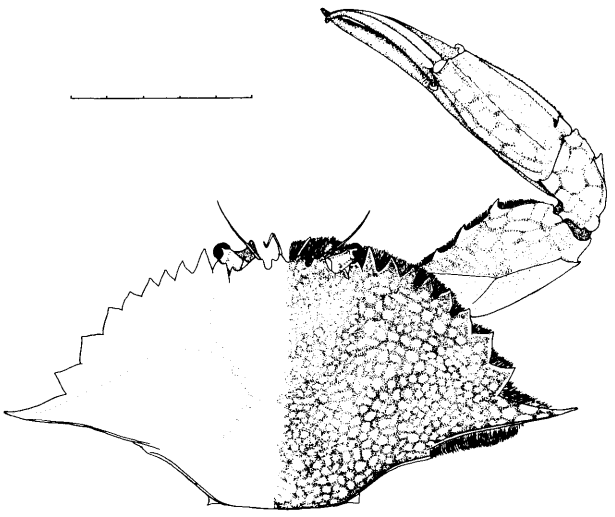

FIGURE 153.—*Arenaeus cribrarius* (Lamarck). Male in dorsal view, legs not shown except for right cheliped, color pattern of right side indicated, 50 mm. indicated.

Pearse, Humm, and Wharton (1942) stated that where waves roll at the low-tide mark *A. cribrarius* may scurry across sand and burrow backward. In doing this, the crab flirts sand forward away from the body with the chelipeds, waves legs two to four rapidly from the median line laterally, and moves the fifth legs posteriorly and dorsally, thus sinking vertically into the sand. Often the crabs bury themselves completely. The heavy coat of hairlike setae on each side of the mouth parts keeps out sand, and with the chelipeds held close to the body a clear channel is left for currents from the branchial chamber. Ability to maintain strenuous activity in the breaker zone near shore may be partially explained also by the relatively large respiratory surface in this species (Gray, 1957).

Genus ***Cronius*** Stimpson, 1860

Rathbun, 1930a, p. 138.

Cronius ruber (Lamarck)

Figure 154

Portunus ruber Lamarck, 1818, p. 260.
Cronius ruber: Rathbun, 1930a, p. 139, pls. 62–63 (rev.).

Recognition characters.—Carapace hexagonal, smooth, pubescent; a sinuous transverse ridge extending between lateral spines, and another shorter, transverse, biarcuate ridge about halfway between this ridge and front. Front proper with four teeth, not including inner orbitals; submedian pair of teeth most advanced; second pair more pointed, and directed slightly laterad, separated from notched inner orbitals by a deep cut. Orbit nearly circular. Basal article of antenna with spine below insertion of movable portion. Anterolateral teeth unequal, alternating large and small; lateral spine not strikingly enlarged.

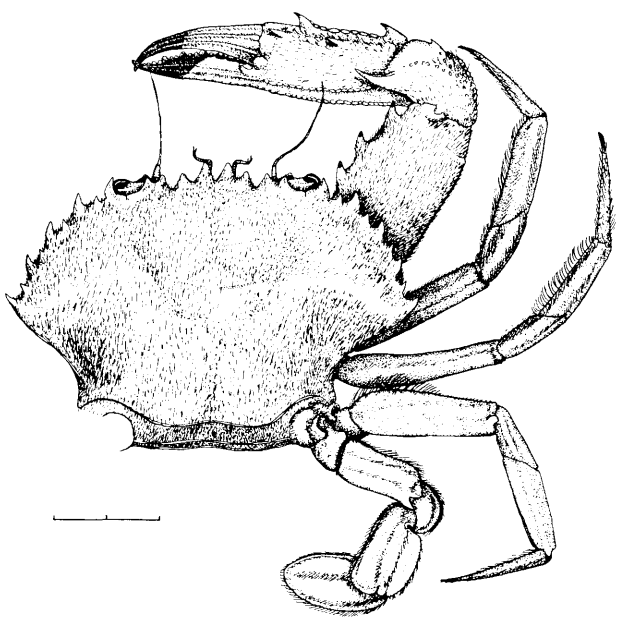

FIGURE 154.—*Cronius ruber* (Lamarck). Animal in dorsal view, legs of left side not shown; (redrawn from Monod, 1956).

Chelipeds heavy; merus with four to six spines in front, and with small distal spine behind; carpus with granulate ridges, one large internal spine, and three small spines on outer surface; hand with granulate ridges on all surfaces, armed with four spines on superior surface, two on inner and two on outer border.

Measurements.—Carapace: male, length, 50 mm.; width, 75 mm.

Color.—"Violet red or deep purple red more or less marbled with a lighter shade or white. Extremity of all spines black." (Rathbun, 1930a.)

Habitat.—Siebenaler (1952) reported *C. ruber* as a "trash" form on the Tortugas shrimping grounds; below low tide mark to 40 fathoms.

Type locality.—Brazil.

Known range.—South Carolina to State of Santa Catarina, Brazil; Lower California, Mexico, to Peru and Galapagos Islands; west Africa from Senegal to Angola.

Remarks.—Rathbun (1930a) reported ovigerous females from May through September in Curaçao, in June from Cuba, and in July from Jamaica.

Family **Cancridae**

Carapace broadly oval or hexagonal. Last pair of legs not adapted for swimming. Antennules folding lengthwise. Antennae with flagella more or less hairy.

Genus ***Cancer*** Linnaeus, 1758

Rathbun, 1930a, p. 176.—Hemming, 1958b, p. 51.

MacKay (1943) gave a review of the modern world distribution of members of the genus *Cancer*, as well as the geologic record which dates from the Eocene Period. The modern distribution of the genus is limited, apparently by temperature, to the temperate zones except along the northwestern coast of South America in the cold Humboldt Current.

KEY TO SPECIES IN THE CAROLINAS

a. Anterolateral teeth of carapace with margins granulate; chelipeds granulate, not denticulate
irroratus (p. 175).

aa. Anterolateral teeth of carapace with denticulate margins; upper margin of palm denticulate
borealis (p. 175).

Cancer irroratus Say. Rock crab

Figure 155

Cancer irroratus Say (in part), 1817, p. 59, pl. 4, fig. 2.—Hay and Shore, 1918, p. 435, pl. 35, fig. 1.—Rathbun, 1930a, p. 180, text-fig. 29, pl. 85, fig. 1 (rev.).

Recognition characters.—Carapace approximately two-thirds as long as wide, convex, granulated. Anterolateral border divided into nine teeth with margins granulate, not denticulate as in *C. borealis*, and with notches between teeth continued on carapace as short, closed fissures giving teeth a pentagonal character. Posterolateral border a granulated ridge with one tooth at outer end similar to those of anterolateral border but smaller. Front with three teeth, middle one exceeding others and depressed.

Chelipeds of moderate size, not so long as second pair of legs; carpus with granulated ridges and a sharp spine at inner distal angle; hand nearly smooth on inner face, outer face with four or five granulated lines, two lower ones continued on slightly deflexed immovable finger, superior one cristate. Walking legs rather long and slender; merus of first and second pairs extending far beyond carapace. Abdomen of male broad, first, second, and third segments with transverse granulated ridge.

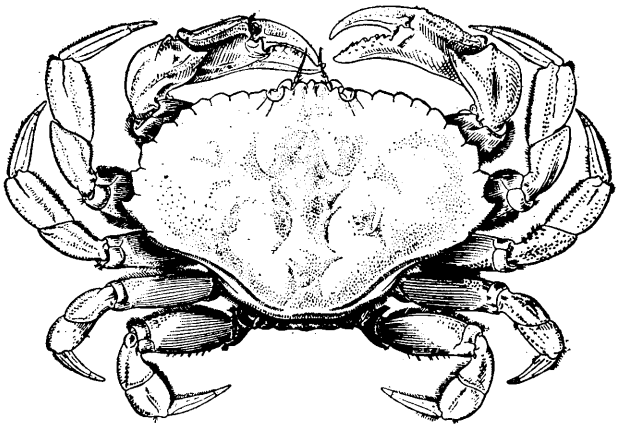

FIGURE 155.—*Cancer irroratus* Say. Male in dorsal view, reduced (after Rathbun, 1884).

Measurements.—Carapace: length, 65 mm.; width, 95 mm.

Color.—Yellowish closely dotted with dark purplish brown, becoming reddish brown after death.

Habitat.—Most individuals taken near Beaufort, N.C., are immature, but larger specimens have been taken farther from the coast. This species, and the following one, are members of a northern fauna with ranges extending south of the Carolinas only in deep water. Low water mark to 314 fathoms.

Type locality.—"Inhabits the ocean." [Atlantic coast of United States.]

Known range.—Labrador to South Carolina; shallow water in the North, deeper water in the South.

Remarks.—This species has a fossil record extending from the Miocene to the present in North America (MacKay, 1943). Ovigerous females are known to occur in March in Florida, and have been reported in August from Massachusetts (Rathbun, 1930a).

Cancer borealis Stimpson. Jonah crab; northern crab

Figure 156

Cancer borealis Stimpson, 1859, p. 50.—Hay and Shore, 1918, p. 434, pl. 35, fig. 2.—Rathbun, 1930a, p. 182, text-fig. 30 (rev.).

Recognition characters.—Carapace transversely oblong, approximately two-thirds as long as wide, angular at sides, surface granulate. Anterolateral margins divided into nine quadrangular, crenate lobes or teeth, with margins minutely denticulate and with notches between teeth continued on carapace as short closed fissures. Front produced beyond internal orbital teeth and provided with three teeth, center one longest and depressed. Orbits circular, with two narrow fissures above and two below; suborbital lobe strongly produced.

Chelipeds nearly as long as second pair of legs, stout; carpus and hand with strong, granulose rugae; carpus with sharp spine at inner angle; hand smooth on inner face, heavily rugose on outer face, two rugae continued from hand on slightly deflexed immovable finger; dactyl with rough upper surface, both fingers slaty black at tip. Walking legs short, fringed beneath, dactyls dark tipped.

Measurements.—Carapace: length, 62 mm.; width, 91 mm.

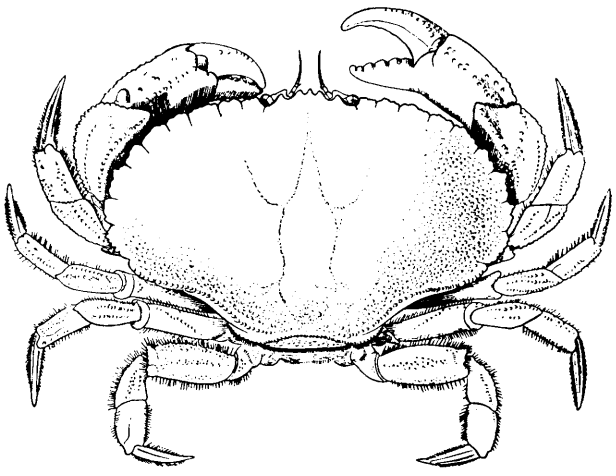

FIGURE 156.—*Cancer borealis* Stimpson. Male in dorsal view, reduced (after Smith, 1879).

Color.—Yellowish beneath, red above; back with two curved lines of yellowish spots and, behind middle, a figure somewhat resembling letter H; legs mottled and reticulated with yellow and red, more or less purplish.

Habitat.—Small and immature individuals are found in the Beaufort, N.C., harbor region; larger individuals occur in deep water off the coast; between tides among rocks to 435 fathoms.

Type localities.—Nova Scotia to Cape Cod.

Known range.—Nova Scotia to south of Tortugas, Fla.; Bermuda.

Remarks.—This species has a fossil record dating from the Miocene of North America (MacKay, 1943). Ovigerous females are recorded in June from southern Florida.

Family **Xanthidae**

Crabs with body transversely oval or transversely hexagonal. Front broad, never produced in form of a rostrum. Last pair of legs normal. Antennules folding obliquely or transversely. Male openings rarely sternal (Rathbun, 1930a).

In the key to the genera of Xanthidae in the Carolinas it has been impossible to use characters which show the general relationships unless pleopods of the males are employed. Differences between genera are often subtle and the general worker is, therefore, compelled to use a combination of trivial characters for identification. Because most of the genera occurring in the Carolinas contain a single species, the generic key is in large part also a key to species. Parts of the key have been adapted from Rathbun (1930a) and Ryan (1956).

Arrangement of the genera differs in some respects from that of Rathbun and is based on similarities and differences in the first pair of male pleopods. In such arrangement I follow broadly the arrangements of Stephensen (1945) and Monod (1956). As in Rathbun (1930a) and Monod (1956), no attempt is made to divide the family Xanthidae into subfamilies, though at least three well-marked groups appear in the Carolinas, and perhaps the third of these groups (fig. 183) could be split into additional groups.

KEY TO GENERA IN THE CAROLINAS

a. Entire body and legs with surface deeply and intricately eroded, resembling piece of stony coral_*Glyptoxanthus* (p. 185).
aa. Entire body and legs with surface not deeply and intricately eroded.
  b. Antennae widely separated from orbits_____*Eriphia* (p. 182).
  bb. Antennae not separated from orbits.
    c. Chelipeds with a large notch clearly forming an open hole between carpus and hand when viewed frontally with chelipeds fully pressed against body_____*Carpoporus* (p. 186).
    cc. Chelipeds without a large notch clearly forming an open hole between carpus and hand when viewed frontally with chelipeds fully pressed against body.
      d. Extreme edge of frontal margin with shallow transverse groove, each half appearing double (under magnification).
        e. Carapace more or less nodose in front, upper edge of frontal groove formed by line of nodules_*Leptodius* (p. 192).
        ee. Carapace not nodose in front but with transverse ridges on dorsum_____*Rhithropanopeus* (p. 187).
      dd. Extreme edge of frontal margin not transversely grooved, each half presenting but a single edge (under magnification).
        e. Teeth of anterolateral border subtriangular or with edges flattened and rounded; carapace never nodose.
          f. Carapace with regions on dorsum defined; carapace not smooth to unaided eye.
            g. Major cheliped with a more or less conspicuous tooth at base of dactyl, tooth larger than adjacent teeth and often of contrasting color.

h. Third and fourth teeth of anterolateral border definitely pointed forward with outer borders curved.
i. Tooth at base of major dactyl large and conspicuous; body definitely arched above—*Panopeus* (p. 196).
ii. Tooth at base of major dactyl present but often not large and conspicuous; posterior two-thirds of carapace flattened above—*Eurypanopeus* (p. 194).
hh. Third and fourth teeth of anterolateral border triangular and pointing outward or slightly forward, outer borders not conspicuously curved—*Hexapanopeus* (p. 188).
gg. Major cheliped with no tooth at base of dactyl, or with obsolescent tooth little if any larger than adjacent teeth.
h. A red spot on internal face of ischium of third maxillipeds—*Eurypanopeus* (p. 194).
hh. No red spot on internal face of ischium of third maxillipeds—*Neopanope* (p. 190).
ff. Carapace with regions on dorsum obsolete; carapace smooth to unaided eye.
g. Fingers white; anterolateral teeth pointed or rounded—*Eurytium* (p. 199).
gg. Fingers black; anterolateral teeth broad, not pointed, with occasional exception of most lateral tooth; often attains large size—*Menippe* (p. 183).
ee. Teeth of anterolateral border usually distinctly spiny or spiniform; sometimes subtriangular, serrated or with spiny tips, and with carapace more or less nodose (nodes occasionally small).
f. Carapace nearly devoid of hairs and with nodose areas on front and anterolateral portions usually clearly evident, though sometimes poorly developed; adult size small—*Micropanope* (p. 192).
ff. Carapace with either long, plumose hairs, numerous short hairs, or both.
g. Carapace and chelipeds variably spiny; not nodose; with long plumose (clubbed) hairs, short hairs, or both—*Pilumnus* (p. 177).
gg. Carapace with patches of nodules on anterolateral margins extending back from front; with close pile of short hair only; body massive, thick—*Lobopilumnus* (p. 181).

Genus *Pilumnus* Leach, 1815

Rathbun, 1930a, p. 481.—Hemming, 1958b, p. 35.

KEY TO SPECIES IN THE CAROLINAS

a. Hair not covering whole carapace or not forming so thick a coat as to conceal surface beneath.
b. Two or more superhepatic spines—*sayi* (p. 177).
bb. No superhepatic spines—*dasypodus* (p. 178).
aa. Hair covering whole carapace and forming a thick coat concealing surface beneath (hair sometimes worn off).
b. Chelipeds spinose above; a transverse row of long hairs across front—*floridanus* (p. 179).
bb. Chelipeds not spinose above; carapace tuberculate, but tubercles often sparse and low.
c. Tubercles of carapace not numerous nor prominent, upper margin of orbit not spinose—*lacteus* (p. 180).
cc. Tubercles on anterior half of carapace and upper surface of chelipeds numerous, upper margin of orbit with truncate spines (but occasionally these poorly developed)—*pannosus* (p. 181).

Pilumnus sayi Rathbun. Hairy crab

Figures 157 A, B; 158

Cancer aculeatus Say, 1818, p. 449.
Pilumnus sayi Rathbun: 1897b, p. 15.—Hay and Shore, 1918, p. 440, pl. 35, fig. 4.—Rathbun, 1930a, p. 484, pl. 200, figs. 1–2; pl. 201, figs. 4–7 (rev.).

Recognition characters.—Carapace about three-fourths as long as wide, anterior half semicircular, strongly deflexed, sparsely covered with long filiform and plumose hairs. Anterolateral border with four marginal spines including outer orbital; two curved spines on hepatic region with sometimes one, two, or three supplementary spines; one long spine and sometimes spiniform tubercles between first and second marginal spines below margin. Orbit armed with three long spines above, and four long and two to four short spines below. Front advanced, deeply notched in center, less so on each side, armed with about four spines on each side.

Superior surfaces of chelipeds and walking legs with many filiform and plumose hairs; carpal and propodal articles most thickly covered and with several strong spines as well. Chelipeds large, unequal; carpus with 15 or 20 erect dark spines; spines of hand strong and acute above but becoming smaller on external surface, spines tending to arrangement in rows on large hand; fingers ribbed, dark, and with obtuse teeth; dactyl spiny above at base.

Measurements.—Carapace: male, length, 23 mm.; width, 32 mm.

Variations.—The specimen taken on Frying Pan Shoal off North Carolina (Charleston Museum No. 38.228) reported by Lunz (1939) appears to be an aberrant specimen of *Pilumnus sayi* rather than *P. marshi.* The specimen lacks superhepatic spines on the carapace but otherwise more nearly resembles *P. sayi* than any other Western Atlantic species of *Pilumnus.*

Color.—Grayish brown irregularly suffused with red or purple on body and legs; spines black, horn color, or purple; fingers of chelae black or brownish purple.

Habitat.—This species is fairly common in the Carolinas, and is often taken on shelly bottom. It has been taken from wharf piles, buoys (Lunz, 1937a), the sponge *Stematumenia strobilina* (Lamarck) (Pearse, 1934), and from offshore reefs (Pearse and Williams, 1951). From low-water mark to 49 fathoms.

Type locality.—Georgia and east Florida.

Known range.—North Carolina through Gulf of Mexico and West Indies to Curaçao.

Remarks.—Ovigerous females occur in the Carolinas from May to August, and as early as March in Florida (Wass, 1955). Chamberlain (1961) reported four zoeal stages and one megalops stage in the larval development of the species,

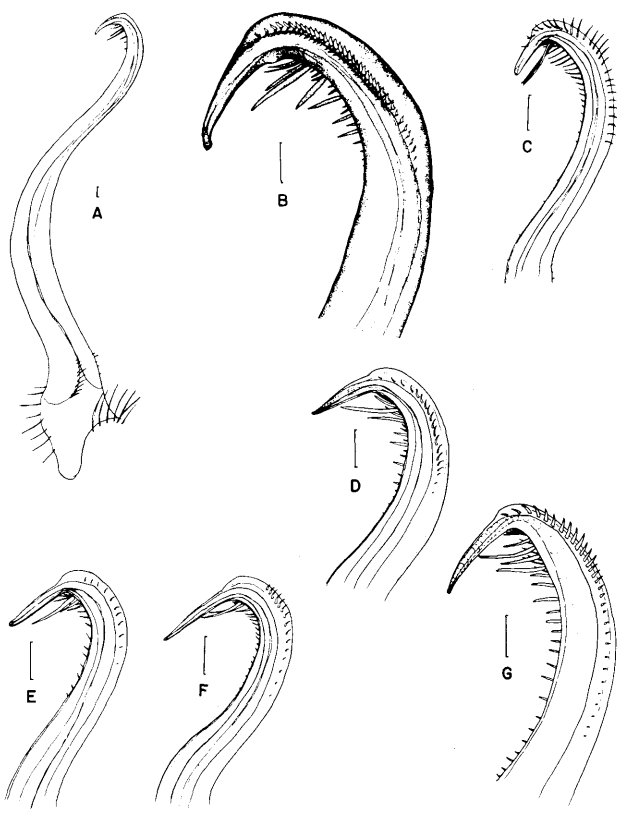

FIGURE 157.—Male first pleopods in medial view; A, *Pilumnus sayi* Rathbun, entire pleopod; B, *Pilumnus sayi* Rathbun, tip in detail; C, *Pilumnus dasypodus* Kingsley, tip; D, *Pilumnus floridanus* Stimpson, tip; E, *Pilumnus lacteus* Stimpson, tip; F, *Pilumnus pannosus* Rathbun, tip; G, *Lobopilumnus agassizii* (Stimpson), tip; 0.125 mm. indicated.

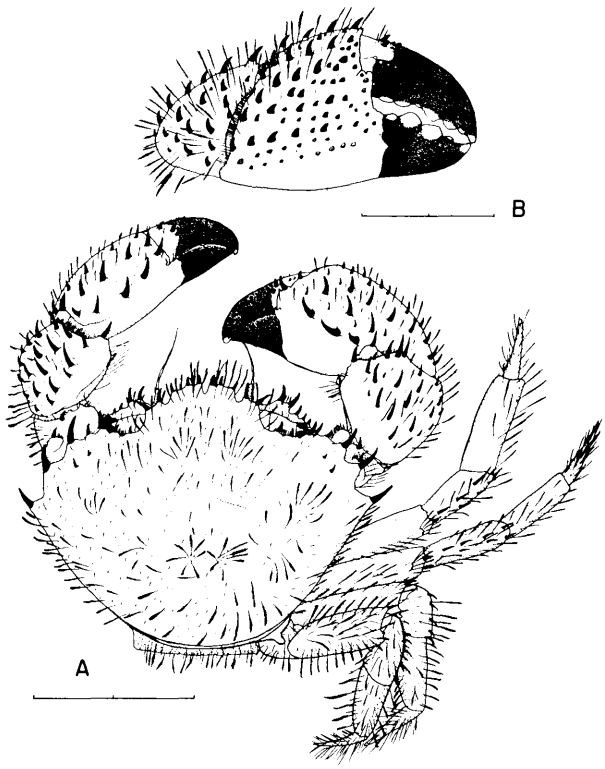

FIGURE 158.—*Pilumnus sayi* Rathbun. A, male in dorsal view, walking legs of left side not shown, 10 mm. indicated; B, large chela in frontal view, 10 mm. indicated.

but did not describe the stages in detail. He found that larval development time varied with temperature (18 days at 30° C., 28 at 21° C.) and with food. Larvae matured most rapidly when fed *Artemia salina* nauplii, did moderately well on *Artemia* and algae, but did not transform at all when fed algae alone.

Pilumnus dasypodus Kingsley

Figures 157C, 159

Pilumnus dasypodus Kingsley, 1879, p. 155.—Rathbun, 1930a, p. 493, pl. 200, figs. 5–6 (rev.).

Recognition characters.—Carapace thinly covered on anterior two-thirds with long, fine hair and occasional stouter setae; upper surface of chelipeds and walking legs similarly clothed; small sharp granules on anterolateral region. Anterolateral border with four spines including small outer orbital; spines with bases conical, extremities long, slender, incurved. Orbital border with three or four spines above and about seven below. Frontal lobes separated by a

median V- or U-shaped notch; margins furnished with short spines or sharp granules, with an outer tooth separated from remainder of margin by a U-shaped notch.

Chelipeds unequal, spinose, and granulate except for smooth and naked lower distal two-thirds of outer surface of major palm, spines and granules not arranged in rows on upper part of major palm; fingers of minor chela grooved on outside, dactyls with rows of sharp granules and hairs at base. Walking legs spinose above.

Measurements.—Carapace: male, length, 11 mm.; width, 15 mm.

Color.—Body and claws brownish-red color, legs much lighter; fingers and extremities of spines brown (Milne Edwards *in* Rathbun, 1930a).

Habitat.—This species has been taken from pilings, jetties, and buoys (Lunz, 1937a), and from offshore reefs (Pearse and Williams, 1951) in the Carolinas; and from similar situations elsewhere (Rathbun, 1930a) including loggerhead sponge *Speciospongia vespara* (Lamarck) (Pearse, 1934). One-half to 16 fathoms.

Type locality.—Key West, Fla.

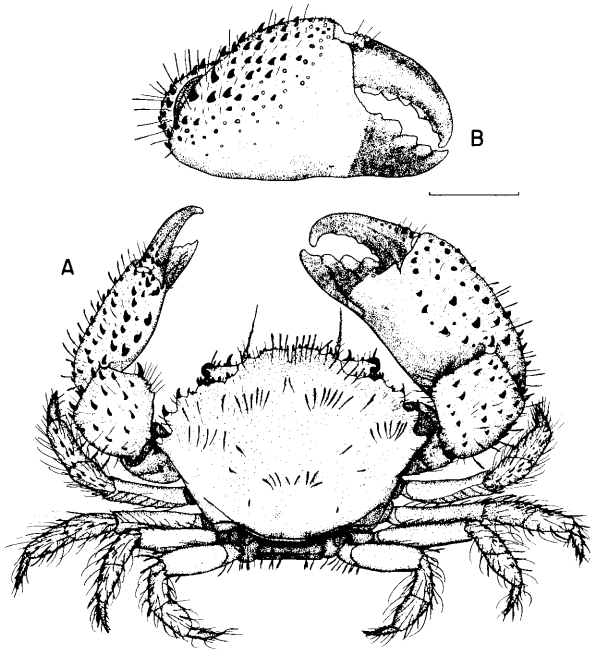

FIGURE 159.—*Pilumnus dasypodus* Kingsley. A, male in dorsal view; B, large chela in frontal view; 5 mm. indicated.

Known range.—Off Cape Hatteras, N.C., through Gulf of Mexico and West Indies to State of Santa Catarina, Brazil.

Remarks.—This species is not so common in the Carolinas as *P. sayi*, and small specimens of *dasypodus* are not always easily distinguished from *sayi*. Rathbun (1930a) stated that, "*dasypodus* is less heavily clothed with hair than *sayi* and less ragged looking. The front is more deflexed and less advanced, therefore appears wider. The spines and tubercles of the major palm in *sayi* are arranged more or less in rows and these rows have a tendency to encroach on the lower distal half; in *dasypodus* there are seldom any definite rows and the lower distal two-thirds or one-half in both sexes is smooth and bare. The immovable finger of the major chela in *dasypodus* is a little longer than in *sayi*."

Lunz (1937a) reported ovigerous females from April through August in the Carolinas, and they have been found in North Carolina in September. In the West Indies they occur at all seasons of the year (U.S. National Museum records).

Pilumnus floridanus Stimpson

Figures 157D, 160

Pilumnus floridanus Stimpson, 1871a, p. 141.—Rathbun, 1930a, p. 507, pl. 205, figs. 3–4 (rev.).

Recognition characters.—Carapace covered with dense, short pubescence thinning behind, and with a few longer clavate hairs, a conspicuous transverse series of these crossing frontal region. Anterolateral margin with four somewhat conical spines; a small subhepatic spine between outer orbital and second spine; hepatic region slightly roughened but with no spines. Frontal lobes almost bare, edge slightly oblique, entire, with median triangular notch and rounded lateral notches; tooth at outer angle minute, deflexed. Orbital margin unarmed above, with 8 to 10 spinules below.

Chelipeds spinose above; merus with two spines near distal end on upper surface; carpus armed over entire exposed surface; spines on hand becoming pointed tubercles on outer surface. Male with large hand smooth and bare on outer lower half or less of surface, smooth portion more restricted in female. Walking legs spined above.

Measurements.—A small species. Carapace: male, length, 7 mm.; width, 10 mm.

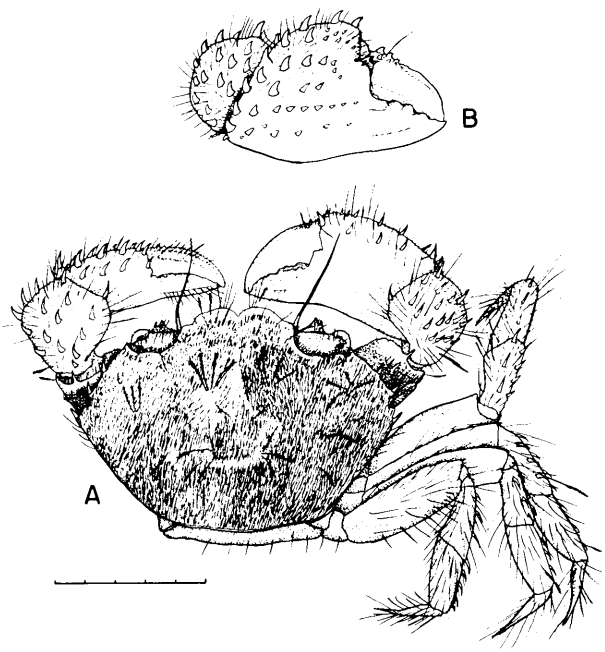

FIGURE 160.—*Pilumnus floridanus* Stimpson. A, animal in dorsal view, walking legs of left side not shown; B, large chela in frontal view; 5 mm. indicated.

Habitat.—In North Carolina this species has been taken from an offshore reef (Pearse and Williams, 1951) and has been found in sponges. Rathbun (1930a) listed it as taken from rocks, grass, and a variety of bottoms. Low-tide mark to about 80 fathoms.

Type locality.—Tortugas, [Fla.].

Known range.—Off Cape Lookout, N.C., through eastern Gulf of Mexico, and Yucatan Channel, to Honduras; through West Indies to Venezuela.

Remarks.—This species is not common north of Florida. Ovigerous females are known from March to August in Florida (Rathbun, 1930a, in part) and they have been taken in February in North Carolina.

Pilumnus lacteus Stimpson. Small hairy crab

Figures 157E, 161

Pilumnus lacteus Stimpson, 1871a, p. 142.—Hay and Shore, 1918, p. 440, pl. 35, fig. 3.—Rathbun, 1930a, p. 511, pl. 205, figs. 1–2 (rev.).

Recognition characters.—Carapace about three-fourths as long as wide, covered with short velvet-like pubescence easily rubbed off (and often is), nearly smooth, sparse tubercles almost invisible through hairy coating; a row of five tubercles paralleling anterolateral and orbital margins, others scattered. Anterolateral margins with four anteriorly directed teeth, first or outer orbital small. Front depressed, deeply notched in middle, and with a smaller notch near eye. Orbital margin occasionally a bit uneven but not tuberculate.

Chelipeds dissimilar in size but otherwise nearly alike, stout, setose, and plumose-hairy, somewhat tuberculate above, but naked and polished below and on ventral half or two-thirds of both inner and outer surfaces of chelae; merus with two similar curved spines on upper margin distally; carpus with a stout spine on inner angle.

Measurements.—Carapace: male, length, 12 mm.; width, 15 mm.

Color.—Gray or pinkish, with plumose hairs whitish or cream colored; hands and tips of legs light red.

Habitat.—This crab may be found by a careful search of wharf pilings about the Beaufort, N.C., harbor area, but is rarely taken in dredge hauls. It has been taken from buoys both in sounds and at sea in South Carolina (Lunz, 1937a). Rathbun (1930a) reported it from a variety of situations farther south. Near low-tide mark to about 8 fathoms.

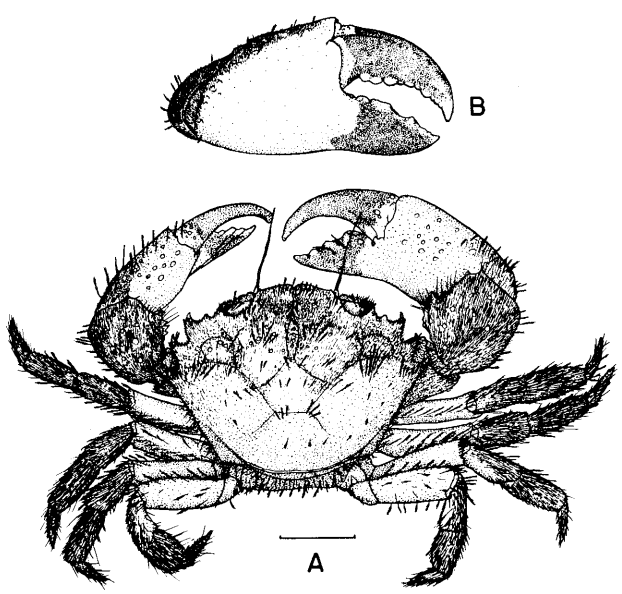

FIGURE 161.—*Pilumnus lacteus* Stimpson. A, animal in dorsal view; B, large chela in frontal view; 5 mm. indicated.

Type locality.—Cruz del Padre, Cuba, and Key West, Fla.

Known range.—Near Beaufort, N.C., to Florida; Cuba.

Remarks.—Ovigerous females have been reported in December from Florida, and in May from Cuba (Rathbun, 1930a) and South Carolina (Lunz, 1937a).

Pilumnus pannosus Rathbun

Figures 157F, 162

Pilumnus pannosus Rathbun, 1896b, p. 142.—Rathbun, 1930a, p. 514, figs. 4–5 (rev.).

Recognition characters.—Carapace about three-fourths as long as wide, almost entirely covered with unevenly distributed, soft, thick, velvety pubescence, with scattered longer club-shaped setae giving ragged appearance; lobulations of anterior portion of carapace and tubercles of chelipeds showing through pubescence. Anterior half of carapace and upper surface of chelipeds and legs dotted with beadlike tubercles. Anterolateral margin with four triangular spines (outer orbital small) having slender forward-projecting tips; subhepatic spine between first and second tooth well developed. Frontal lobes (when well formed) broadly subtriangular, granulate on margin, separated by a V-shaped notch; outer tooth of front almost triangular, acute (blunt at tip in some specimens). Upper margin of orbit with three truncate teeth covered by pubescence, lower margin with a row of short, stout, truncate teeth or tubercles.

Chelipeds with upper surface tuberculate but usually with large part of outer surface smooth and naked; small hand with outer surface often rough with rows of spines; dactyls with a few tubercles near articulation. Male with shallow grooves on fingers, female with well-defined grooves on minor fingers and fixed major finger. Walking legs pubescent, fringed with club-shaped setae mixed with long fine hair.

Measurements.—Carapace: male, length, 9 mm.; width, 12 mm.

Color.—Carapace under pubescence and bare part of palms bright red (Milne Edwards *in* Rathbun, 1930a).

Habitat.—Pearse and Williams (1951) listed this species as taken from a submerged rocky reef, and Rathbun (1930a) listed it from similar situations, as well as from sponges and corals. A few feet to 9 fathoms.

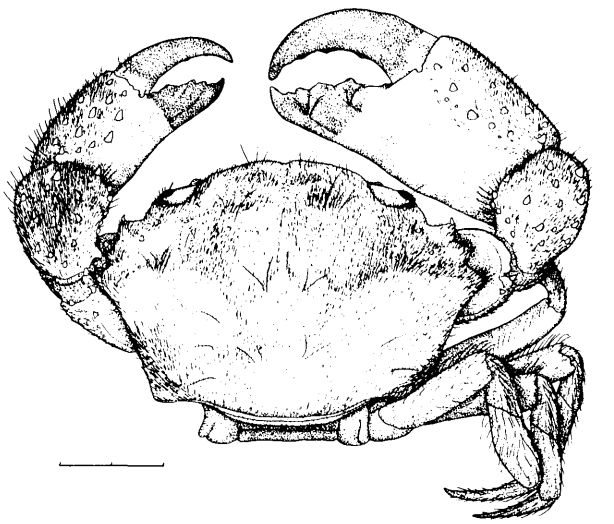

FIGURE 162.—*Pilumnus pannosus* Rathbun. Male in dorsal view, walking legs of left side not shown, 2 mm. indicated.

Type locality.—Key West, Fla.

Known range.—Bogue Sound off Beaufort, N.C., to Port Aransas, Tex.; West Indies to Virgin Islands.

Remarks.—The species has rarely been taken north of Florida. Rathbun (1930a) listed ovigerous females in December and January from Florida, and they are known from April to August between South Carolina and Cuba.

Genus ***Lobopilumnus*** Milne Edwards, 1880

Rathbun, 1930a, p. 525.

Lobopilumnus agassizii (Stimpson)

Figures 157G, 163

Pilumnus agassizii Stimpson, 1871a, p. 142.
Lobopilumnus agassizii: Hay and Shore, 1918, p. 441, pl. 34, fig. 5.—Rathbun, 1930a, p. 526, pl. 211 (rev.).

Recognition characters.—Regions of carapace protuberant, surface pubescent, except naked and thickly granulated on anterior and anterolateral regions; depressions between regions broad, occupying as much area as regions themselves. Front consisting of two large lobate masses deeply separated from each other and from orbits. Orbital region protuberant and granulate, margin crenulated with granules, with two fissures above and two very narrow ones below. Anterolateral margin with three triangular, spine-tipped teeth of moderate, equal size; subhepatic tooth distinct.

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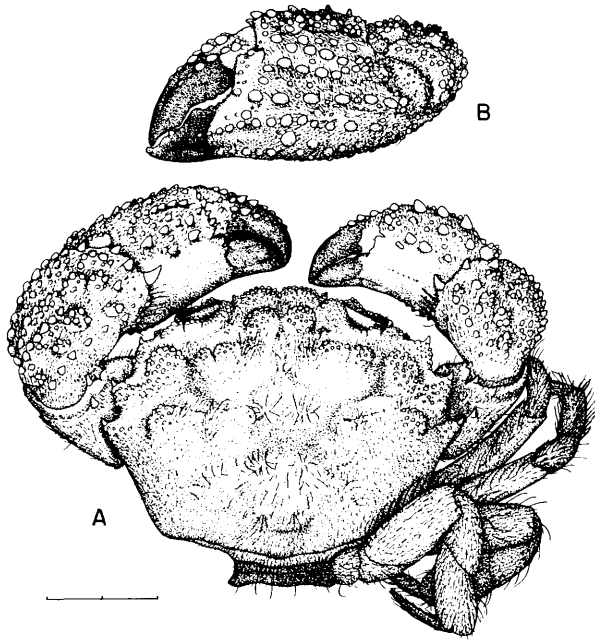

FIGURE 163.—*Lobopilumnus agassizii* (Stimpson). A, male in dorsal view, walking legs of left side not shown; B, large chela in frontal view, 10 mm. indicated.

Chelipeds short, stout; carpus with forwardly directed granules, confluent exteriorly; hands with superior and outer surfaces covered with small prominent mammillary tubercles, arranged largely in rows on outer surfaces and having apices directed forward. Walking legs pubescent and hairy, carpal and propodal articles with minute spines above.

Measurements.—Carapace: female from North Carolina, length, 16 mm.; width, 21 mm.

Variations.—Rathbun (1930a) stated that this species is variable as to the number and prominence of regions on the carapace, and she recognized four environmental forms within the species. Because only one specimen has ever been reported from North Carolina, and this is no longer extant, it is not possible to assign a form or forms to this area.

Color.—Gray above with granules and knobs yellowish red and reddish brown; legs white or with whitish spots (Schmitt *in* Rathbun, 1930a).

Habitat.—In Bermuda, Verrill (1908) found the carapace and legs of this species often thickly covered, sometimes almost concealed, by a coating of calcareous mud and sand adhering to hairs on the back. He found it most frequently under stones and dead corals at low tide. Pearse (1934) reported this crab from loggerhead sponge *Speciospongia vespara* (Lamarck). Low-tide mark to 28 fathoms.

Type locality.—Typical form: East and Middle Keys, Tortugas, Fla.

Known range.—North Carolina; southern and west Florida; Yucatan; Cuba; Trinidad; Bermuda.

Remarks.—Ovigerous females are known from February to July in Florida and Cuba (Rathbun, 1930a, in part).

Genus ***Eriphia*** Latreille, 1817

Rathbun, 1930a, p. 545.

Eriphia gonagra (Fabricius)

Figures 164 A, B, C; 165

Cancer gonagra Fabricius, 1781, p. 505.
Eriphia gonagra: Hay and Shore, 1918, p. 439, pl. 35, fig. 6.-Rathbun, 1930a, p. 545, text-fig. 83, pl. 222 (rev.).

Recognition characters.—Carapace approximately quadrate, about one-fourth wider than long, flattened, with regions clearly marked off on anterior two-thirds; surface nearly smooth posteriorly but granulate anteriorly, and with two transverse lines of subspinous granules, one in front of epigastric lobes and another across protogastric and hepatic lobes. Front wide, strongly deflexed, and divided into four lobes, both median lobes broader and more advanced than lateral ones, and with a finely granulate border. Lateral lobes forming front of raised margin of orbits and in contact beneath with a prolongation of infraorbital plate, thus completely excluding antenna from orbit. Anterolateral margins each with a row of five spines including outer orbital, behind and inside these a few squamiform tubercles.

Chelipeds unequal, strong, swollen; hands covered with large, round, flattened, squamiform tubercles, more elevated on small than on large hand; carpus with less prominent tubercles; dactyls with squamiform tubercles above at base; major dactyl with large rounded tooth at base. Walking legs rather slender, their distal three articles with fine stiff hairs.

Measurements.—Carapace: male, length, 31 mm.; width, 44 mm.

Color.—Gaily colored. Anterior half of carapace and a broad median stripe extending to posterior margin, dark purplish brown, legs a lighter tint of same color; front margined with brownish orange. Sides of carapace, upper surface of chelipeds, dactyls, bases of legs, and a narrow band on distal margin of other articles, light yellow. Tubercles on upper half of chelipeds, dark blue; on lower half, yellow. Underparts of body and chelipeds, white, fingers brown. Rathbun (1930a) gives another detailed color description.

Habitat.—The species has been found in a variety of situations: under flat rocks above the watermark, in seaweed, sponges, brackish ponds, tide pools, and on coral reefs. Shoreline to shallow water of uncertain limits.

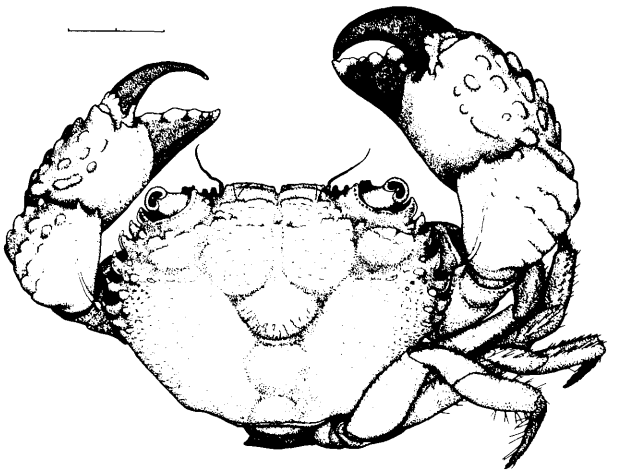

FIGURE 165.—*Eriphia gonagra* (Fabricius). Male in dorsal view, walking legs of left side not shown, 10 mm. indicated.

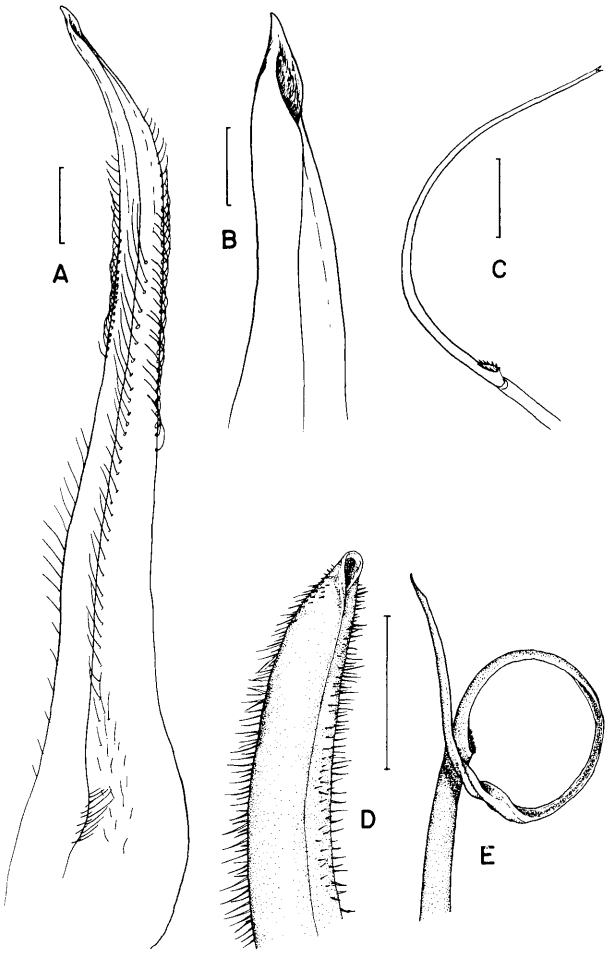

FIGURE 164.—*Eriphia gonagra* (Fabricius); A, entire first pleopod, 0.75 mm. indicated; B, tip of first pleopod, 0.25 mm. indicated; C, tip of second pleopod, 0.75 mm. indicated; *Menippe mercenaria* (Say); D, tip of first pleopod; E, tip of second pleopod; 5 mm. indicated.

Type locality.—Jamaica.

Known range.—North Carolina to Argentine Patagonia.

Remarks.—Ovigerous females are known from March to September in various parts of the West Indies and southern Florida; in October from Santa Catarina, and February from Bahia, Brazil (Rathbun, 1930a, in part).

Genus ***Menippe*** de Haan, 1833

Rathbun, 1930a, p. 472.

Menippe mercenaria (Say). Stone crab

Figures 164 D, E; 166

Cancer mercenaria Say, 1818, p. 448.

Menippe mercenaria: Hay and Shore, 1918, p. 439, pl. 35, fig. 8.—Rathbun, 1930a, p. 472, text-fig. 78, pls. 191–193 (rev.).

Recognition characters.—Carapace transversely oval, approximately two-thirds as long as wide, convex, nearly smooth to unaided eye, minutely granulate and punctate. Anterolateral border divided into four lobes: first two wide, third wide but dentiform, fourth much narrower and dentiform. Front with a median notch and a broad trilobulate lobe on each side. Orbital border thick, fissures indistinct.

Chelipeds large and heavy, unequal, nearly smooth; inside surface of hands with a patch of fine, oblique, parallel striae serving as a stridulating organ and adapted for playing against thick edge of second and third anterolateral teeth and

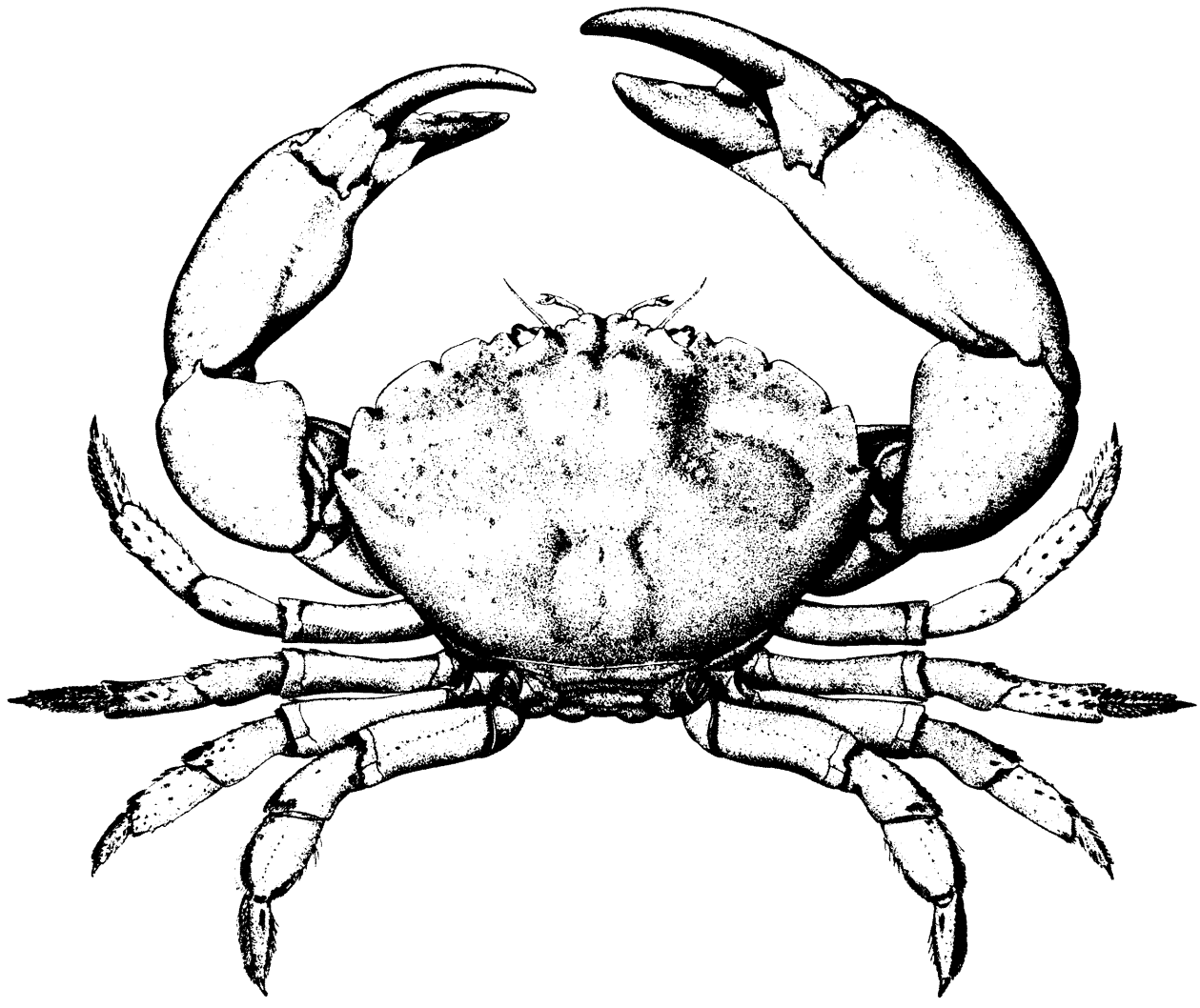

FIGURE 166.—*Menippe mercenaria* (Say). Male in dorsal view, approximately × 0.6 (after Rathbun, 1884).

outer suborbital tooth; dactyl of major chela with a large basal tooth, and immovable finger with a large subbasal tooth; fingers of minor chela with numerous small teeth. Walking legs stout, hairy distally.

Measurements.—Female: length of carapace, 79 mm., width, 116 mm.; length of cheliped, 155 mm. This is the largest xanthid species in the area.

Color.—Young individuals dark purplish blue, very young always with a white spot on carpus. Older individuals become a dark brownish red more or less mottled and spotted with dusky gray; fingers dark.

Habitat.—The young resort to deeper channels of saltier estuaries where they live under shell fragments. Young have also been taken from buoys in South Carolina (Lunz, 1937a). On attaining a width of about one-half inch, they apparently move to shallower water and may be found among oyster shells, on rocks, pilings, and about jetties. (In northwest Florida, *M. mercenaria* apparently prefers turtle grass (*Thalassia testudinum*) flats (Wass, 1955).) Here they live until they have attained nearly full size when they may move to some shoal and make burrows just below low-tide mark. Such burrows are about 6 inches in diameter and extend for 12 to 20 inches. The crabs can be taken from burrows by hand if the collector keeps his hand against the upper wall of the hole, and a number of specimens for

the Institute of Fisheries Research Laboratory have been taken in this manner. Specimens have also been taken from baited plots set for capture of blue crabs, and in trawls from the oceanic littoral. Surface to 28 fathoms.

Type locality.—"The Southern States."

Known range.—Cape Lookout, N.C., to Yucatan, Mexico; Bahamas; Cuba; Jamaica.

Remarks.—The genus *Menippe* has a fossil record in North America dating from the Cretaceous, the thick, hard exoskeleton no doubt enhancing its chances of fossilization. The record for *M. mercenaria* dates from the Pleistocene (Rathbun, 1935).

Ovigerous females have been taken from May to July (perhaps August) in North Carolina. Binford (1912) discussed spermatogenesis and fertilization in the species and gave notes on spawning habits. Porter (1960) reviewed literature on fecundity and larval development of *M. mercenaria* and described zoeal stages reared in the laboratory. Females have been observed to molt, then mate immediately after spawning in the laboratory, and produce a new sponge a week after the previous egg mass has hatched. Subsequent to such mating, more than one mass of eggs may be produced before another molt or mating occurs. Females have been known to produce six egg masses in 69 days, each mass containing between 500,000 and 1 million viable eggs.

Porter described one prezoeal and six zoeal stages for larvae reared in culture on *Artemia* nauplii, but the prezoeal and sixth stages were considered as probably atypical. Length of larval life was approximately 27 days under the conditions imposed, and from experimental data it was concluded that warm water of high salinity is needed for optimum survival.

Manning (1961) gave data on relative growth, showing that the juveniles have a relatively broader front than adults. Both he and Wass (1955) pointed out the superficial resemblance of young *M. mercenaria* to *Panopeus herbstii* and *Eurytium limosum*, and Manning gave distinguishing characters for each species at comparable sizes. Further, the stridulating mechanism was shown not to be visible in small specimens and, indeed, stridulation itself has not been observed in the adults (Guinot-Dumortier and Dumortier, 1960).

In studies on the relationship of number and volume of gills to oxygen consumption, Pearse (1929) and Ayers (1938) found this form, along with other mud crabs, intermediate between the sluggish common spider crab and the more active, partially terrestrial, fiddler and ghost crabs. Pearse also found that *M. mercenaria* could withstand considerable dilution of the environment with fresh water. Gray (1957) found gill area per gram of weight to be intermediate in an array of species ranging from land to shallow-water habitats.

Menzel and Hopkins (1956) found the stone crab in Louisiana to be an active predator on oysters. The powerful crabs killed small and large oysters alike. Though predation was found to be lowest in winter and highest in fall, the average rate of consumption in the area studied was 219 oysters per crab per year (=1,000 bushels of oysters per acre if this number were available).

Genus ***Glyptoxanthus*** Milne Edwards, 1879

Rathbun, 1930a, p. 263.

Glyptoxanthus erosus (Stimpson)

Figures 167, 183A

Actaea erosa Stimpson, 1859, p. 51.
Glyptoxanthus erosus: Rathbun, 1930a, p. 263, pl. 107 (rev.).

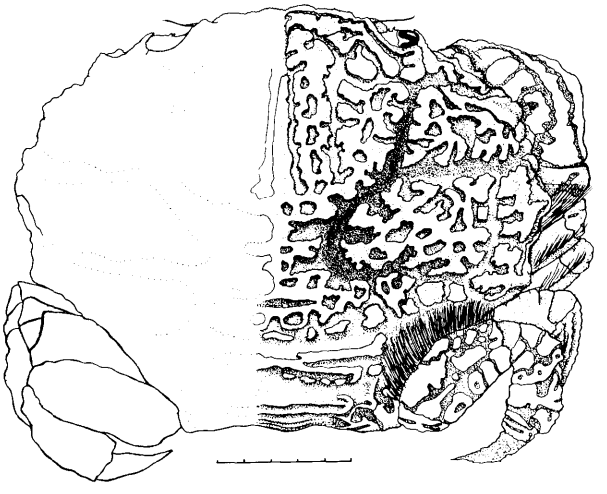

FIGURE 167.—*Glyptoxanthus erosus* (Stimpson). Animal in dorsal view, detail shown on right side, 5 mm. indicated.

Recognition characters.—Surface of body and legs covered with rough vermiculations, with furrows or cavities between them narrow, making a regular pattern and giving body an eroded appearance; elevated portions between furrows or cavities formed by masses of small granules crowded together producing rough surface in young and half-grown individuals, but variably worn smooth in old ones; margins of cavities with short pubescence. Carapace areolated, but divisions obscured to large extent by character of surface; lateral boundaries of gastric region and median suture from front to middle of gastric region deep. Front steeply inclined, median lobes evenly rounded, margins granulate. Ischium of third maxilliped with deep, longitudinal, central groove.

Chelae short and broad, upper surface divided by furrows into transverse tuberculate ridges, outer surface divided into longitudinal tuberculate ridges; fingers short, deeply grooved, even toothed; dactyls tuberculate at base on upper side. Walking legs with hairy edges, dactyls pubescent.

Measurements.—Carapace: male, length, 39 mm.; width, 54 mm.

Color.—Rathbun (1930a) described a specimen in formalin as cream white with blotches and small spots of bright red, color especially persistent on walking legs, with dactyls red at base and yellowish distally.

Habitat.—The species has been taken from rocks and the alga *Halimeda* in shallow water, from coarse sand, and from sponges and coral reefs in deeper water. Low-tide mark to 37 fathoms.

Type locality.—Florida.

Known range.—Cape Lookout, N.C., to Yucatan; through West Indies to Guadeloupe.

Remarks.—Ovigerous females have been taken off northeast Florida in January.

Genus ***Carpoporus*** Stimpson, 1871

Rathbun, 1930a, p. 269.—Hemming, 1958b, p. 14.

Carpoporus papulosus Stimpson

Figure 168, 183B

Carpoporus papulosus Stimpson, 1871a, p. 139.—Rathbun, 1930a, p. 269, pl. 110, figs. 3–6, pl. 111 (rev.).

Recognition characters.—Carapace subhexagonal, nearly as long as broad, naked above; regions

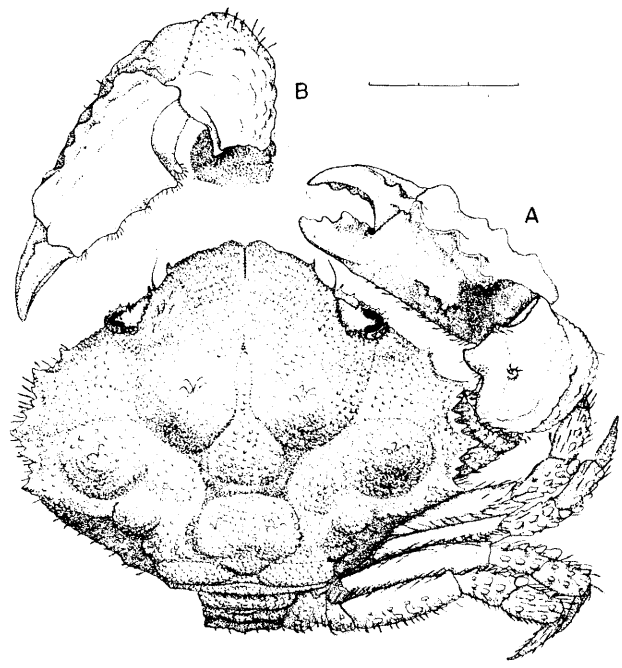

FIGURE 168.—*Carpoporus papulosus* Stimpson. A, animal in dorsal view, legs of left side not shown; B, cheliped in frontal view partially extended; 3 mm. indicated.

protuberant, somewhat wartlike and granulated, gastric and epibranchial regions prominent. Two or three small, spiniform lateral teeth, interspaces armed with denticles. Front strongly projecting at middle, bilobed, margin concave, inner end rectangular, outer end spiniform. Peduncle of eye granulated; orbit with margin granulate above. Exposed surface of third maxilliped with beadlike granules.

Chelipeds when retracted having a large hole between carpus and hand for passage of water to afferent branchial apertures; inner surface of hand with two unequal peglike spines near middle forming a kind of filter in front of branchial opening; carpus and hand sculptured externally with granulated protuberances, arranged in four or five serial rows on hand; hand serrate above with four teeth partially joined; fingers stout, short. Walking legs hairy below.

Measurements.—Carapace: male, length, 13 mm.; width, 16 mm.

Habitat.—Eighteen to 62 fathoms.

Type localities.—Southwest of Tortugas, and off Carysfort Reef, [Fla.].

Known range.—Between Capes Hatteras and Lookout, N.C.; Cape Catoche, Yucatan, Mexico.

Genus *Rhithropanopeus* Rathbun, 1898

Rathbun, 1930a, p. 455.—Hemming, 1958b, p. 37.

Rhithropanopeus harrisii (Gould)

Figures 169, 183C

Pilumnus harrisii Gould, 1841, p. 326.
Rhithropanopeus harrisii: Hay and Shore, 1918, p. 441, pl. 35, fig. 5.—Rathbun, 1930a, p. 456, pl. 183, figs. 7–8 (rev.).

Recognition characters.—Carapace subquadrate, approximately three-fourths as long as wide, much less convex from side to side than from front to back, sparsely pubescent toward anterolateral angles; protogastric regions with two transverse lines of granules; a similar line from one posterior lateral tooth to opposite one across mesogastric region. Front almost straight, slightly notched, and with margin transversely grooved, appearing double when viewed from in front. Postorbital angle and first anterolateral tooth completely coalesced; first and second developed anterolateral teeth of about same size and perhaps larger than last one.

Chelipeds unequal and dissimilar; carpus not grooved above and with a moderately developed internal tooth; chelae indistinctly costate above. Major chela with short immovable finger and strongly curved dactyl. Minor chela with proportionately longer immovable finger and long straight dactyl. Walking legs long, slender, compressed, and somewhat hairy.

Measurements.—Carapace: male, length, 15 mm.; width, 19 mm.

Variations.—The chelipeds are nearly smooth in old individuals, but in small specimens the carpus is rough with lines and bunches of granules, the distal groove deep, the upper margin of palm with two granulate ridges, and the upper edge of the fingers granulate.

Color.—Brownish above, paler below; fingers light.

Habitat.—In Chesapeake Bay, Ryan (1956) found this species distributed primarily in the upper bay and in tributaries of the lower bay in depths of 0 to 5 fathoms. A similar distribution has been found for upper Delaware Bay (McDermott and Flower, 1953) and the tributaries of the Neuse River estuary in North Carolina. Ryan collected specimens in waters ranging from fresh to 18.6‰. The places from which the form was taken always afforded some kind of shelter—oyster bars, living and decaying vegetation, old cans, and other debris. Bousfield (1955) found larvae of the species in water from 4 to no higher than 28.5 ‰ salinity. Surface to 20 fathoms.

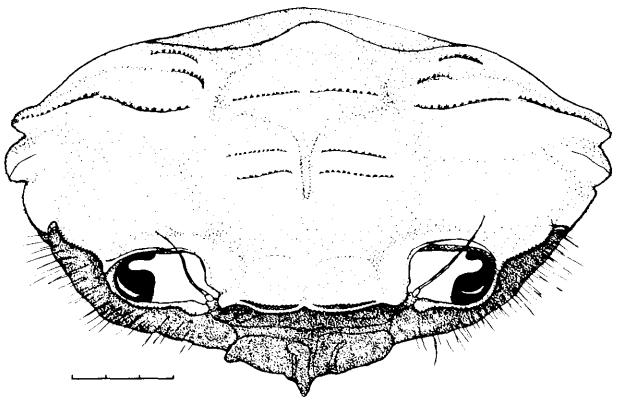

FIGURE 169.—*Rhithropanopeus harrisii* (Gould). Frontal aspect of body viewed from above, 3 mm. indicated.

Type locality.—Cambridge Marshes and Charles River, Mass.

Known range.—The original range of this species was in fresh to estuarine waters from New Brunswick, Canada, to Veracruz, Mexico; northeast Brazil. The species has been introduced on the west coast of the United States and in parts of Europe.

Remarks.—Connolly (1925) stated that four zoeal stages and one megalops stage comprise the larval and postlarval development of this species. These conclusions were based on study of plankton taken from the Miramichi River estuary, New Brunswick, Canada, in August. Chamberlain (1962) confirmed and supplemented Connolly's account with eggs taken from Chesapeake Bay and cultured in the laboratory. Duration of larval stages was twice as long when zoeae were fed copepod nauplii and algae as when fed nauplii alone. In an array of salinities and temperatures, development was found to proceed best at 6 to 10 ‰ salinity. Developmental time increased with decreasing temperature. Developmental times of larvae in nature were found to be in agreement with results of laboratory culturing at similar salinities and temperatures. Mortality rates for larvae in nature were found to be lower than expected. A relatively high rate was postulated for the megalops or early crab stages. Presence of adult crabs in fresh water was deemed a result of migration after larval stages are complete. Hood

(1962) also described a series of larval and postlarval stages from eggs hatched and reared under laboratory conditions in Mississippi.

Ryan (1956) summarized life history data for *R. harrisii* in the Chesapeake Bay area. Ovigerous females were collected from June to September (also in April in Louisiana and Brazil). Though juveniles were found in all months of the year, they occurred most frequently in samples taken from July to October. Immature forms of undetermined sex ranged from 2.2 to 2.6 mm. in width. Immature males ranged from 3.2 to 5.0 mm. and similar females from 3.3 to 5.7 mm. in width. Ryan considered maturity to be reached the following summer at a carapace width of 4.5 mm. for males and 4.4 to 5.5 mm. in females.

Adults continue to grow and molt after maturity is reached, and males finally attain a larger size than females (up to 14.6 and 12.6 mm. wide respectively). No concrete data on number of instars throughout life are available but it is estimated that there may be four instars between attainment of the 5 and 10 mm. carapace widths.

This species has been transported from its original range to two widely separated areas of the earth. One of these is the west coast of the United States where it was reported in the San Francisco Bay area by Jones (1940) and Filice (1958), and at Coos Bay, Oreg., by Ricketts and Calvin (1952). An older and wider introduction in Europe was reviewed by Buitendijk and Holthuis (1949) who considered the European form a separate subspecies (*R. h. tridentatus* (Maitland)). Originally confined to the old Dutch Zuider Zee, the species gradually diminished in abundance there with the closing of that inland sea in 1936. In that same year it was first reported outside Netherlands waters. In 1939 it was first reported in large numbers from southern Russia in the Dnjetr and Bug River estuaries, and according to fisherman there was first observed in 1936 but certainly not present before 1932. The latest extension of range was reported by Wolff (1954) in South Harbor of Copenhagen, Denmark.

Because this form is easily collected and can tolerate a low but broad range of salinities, it has been the subject of study in investigations on the mechanism of osmoregulation (Jones, 1941; Verwey, 1957).

Genus ***Hexapanopeus*** Rathbun, 1898

Rathbun, 1930a, p. 383.

KEY TO SPECIES IN THE CAROLINAS

a. Carpus slightly tuberculate_____*angustifrons* (p. 188).
aa. Carpus tuberculate_____*paulensis* (p. 189).

Hexapanopeus angustifrons (Benedict and Rathbun). Narrow mud crab

Figures 170, 183D

Panopeus angustifrons Benedict and Rathbun, 1891, p. 373, pl. 22, fig. 3; pl. 24, fig. 18.
Hexapanopeus angustifrons: Hay and Shore, 1918, p. 436, pl. 34, fig. 7.—Rathbun, 1930a, p. 384, pl. 169, figs. 1–2 (rev.).

Recognition characters.—Carapace hexagonal, about two-thirds to three-fourths as long as wide, convex from front to back, regions fairly well marked, surface finely granulate. Anterolateral edge thin, upturned, and divided into five teeth, first two separated by a well-defined sinus, third and fourth successively broader, fifth shorter, narrower, more distinctly directed outward; each of last two teeth with a ridge extending obliquely inward and backward for distance twice length of teeth. Front narrow, produced, divided in half by a prominent V-shaped notch; each half bilobate, with markedly sinuate anterior border forming a broad inner and small, inconspicuous outer lobe.

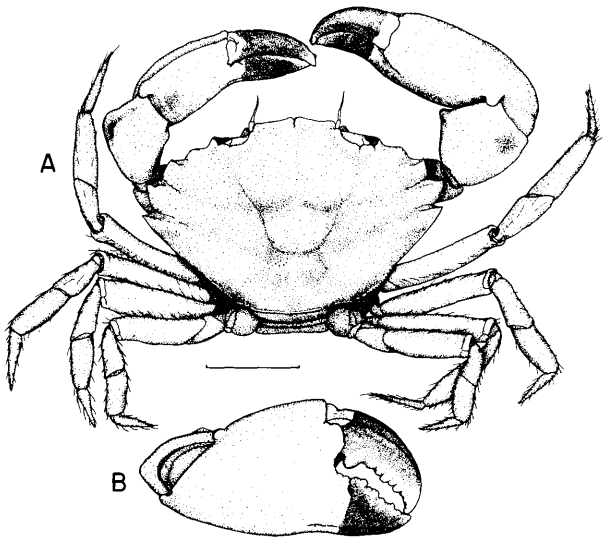

FIGURE 170.—*Hexapanopeus angustifrons* (Benedict and Rathbun). A, animal in dorsal view; B, large chela in frontal view; 5 mm. indicated.

Chelipeds strong, granulate, and finely rugose; merus with a well-developed tooth on upper margin; carpus with a moderately deep groove parallel to distal margin, an obtuse tooth at inner angle, and with superior surface rough and more or less tuberculate. Hands unequal and dissimilar; palm usually with a fairly strong ridge above and indications of one on outer surface, both ridges continued on fingers; fingers strong, slightly hooked at tips; dactyl of larger hand with strong tooth at base.

Measurements.—Carapace: length, 20 mm.; width, 28 mm.

Color.—Usually dark reddish brown or dark gray, sometimes a uniform brownish yellow or light buff; females usually darker than males and often more or less spotted; fingers black or dark brown at base, lighter at tips, color not continued on palm. Often a light yellow band along anterior border of carapace (Wass, 1955, in part).

Habitat.—Ryan (1956) found this species infrequently in the lower portion of Chespeake Bay in from 6- to 25-fathom water (Cowles, 1930, in part) and in salinities ranging from 18 to 32‰. McDermott and Flower (1953) found the species only in the lower portion of Delaware Bay. Rathbun (1930a) recorded the species from oyster bars along the New England coast, and it is found in shelly situations in the Carolinas (Lunz, 1937a). Though it occurs in places such as Beaufort Harbor, N.C., the species is apparently not found primarily in shallow water near shore (see also Wass, 1955). Near shore to 76 fathoms.

Type locality.—Long Island Sound.

Known range.—Vineyard Sound, Mass., to Port Aransas, Tex.; Bahamas; Jamaica.

Remarks.—Ovigerous females are known from February to August in Florida, in July from North Carolina and Virginia, and in October from Texas. Ryan (1956) gave the range in carapace width of mature males as 9.7 to 28.9 mm. and of mature females as 8.4 to 20.2 mm. in Chesapeake Bay. Rathbun (1930a) considered specimens from Chesapeake Bay southward to average smaller than those from farther north.

Chamberlain (1961) reported four zoeal stages and one megalops stage in larval development of the species but did not describe the stages in detail. He found that larval development time varied with temperature (17 days at 30° C., 28 at 21° C.) and with food. Larvae matured most rapidly when fed *Artemia salina* nauplii, matured moderately well on *Artemia* and algae, but did not transform at all when fed algae alone.

Hexapanopeus paulensis Rathbun

Figures 171, 183E

Hexapanopeus paulensis Rathbun, 1930a, p. 395, pl. 170, figs. 5–6.

Recognition characters.—Carapace hexagonal, approximately two-thirds to three-fourths as long as wide, convex, regions fairly well marked, surface with approximately 12 transverse granulated lines on gastric, cardiac, and branchial regions. First tooth of anterolateral border small; second larger, broad, and shallow, with arcuate outer margin; third with nearly straight margin directed forward and inward; fourth and fifth acute and prominent; sometimes with small denticle between first, second, or third pairs of teeth. Front with edge thin, arcuate, with small, median, V-shaped notch, and each half with small lobule at outer end. Inner suborbital angle large; a raised line of granules on subhepatic region.

Chelipeds with carpus and upper part of palm roughened; carpus with approximately 15 tubercles above, an internal tooth, and below it a small tooth or denticle, distal groove deep. Hand with a superior groove and another on outer surface below upper edge, ridges bordering groove with low tubercles; fingers deeply grooved, dark or horn colored, color continued somewhat on palm, ending in an oblique line; tips light.

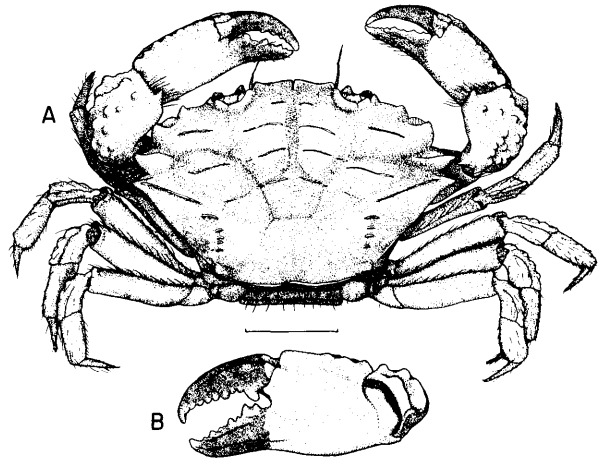

FIGURE 171.—*Hexapanopeus paulensis* Rathbun. A, animal in dorsal view; B, large chela in frontal view; 5 mm. indicated.

Measurements.—Carapace: male, length, 7 mm., width, 10 mm.; female, length, 10 mm., width, 14 mm.

Habitat.—Three fathoms (Lunz, 1937a).

Type locality.—Santos, São Paulo, Brazil.

Known range.—South Carolina, through Gulf of Mexico to State of São Paulo, Brazil.

Remarks.—This species has been reported from only a few widely separated areas. Rathbun (1930a) reported ovigerous females in September from Brazil.

Genus ***Neopanope*** Milne Edwards, 1880

Rathbun, 1930a, p. 366.

KEY TO SUBSPECIES IN THE CAROLINAS

a. Fingers white or light horn colored
texana texana (p. 190).

aa. Fingers dark colored.....*texana sayi* (p. 190).

Neopanope texana texana (Stimpson)

Figures 172, 183F

Panopeus texanus Stimpson, 1859, p. 55.

Neopanope texana texana: Rathbun, 1930a, p. 367, text-fig. 57, pl. 168, figs. 1–2 (rev.).

Recognition characters.—Carapace quite convex in both directions, high in middle, length contained in width about 1.3 times, greatest width at fifth pair of anterolateral teeth. Carapace minutely pubescent, especially in female; regions defined. First two anterolateral teeth coalesced, separated by a shallow sinus; first tooth triangular, second arcuate; third and fourth teeth sharp, with tips pointing forward; fifth tooth short, sharp, directed outward and upward; each of last two teeth with a short ridge extending inward. Front slightly produced, rounded, with small median notch.

Chelipeds smooth, unequal, and dissimilar; carpus with subdistal groove, fingers white or horn colored in males, somewhat darker in females, color extending somewhat on palm and terminating in a distinct line; no large tooth at base of major dactyl. Walking legs long and slender.

Measurements.—Carapace: male, length, 21 mm.; width, 27 mm.

Variations.—In individuals 14 mm. wide and smaller, the carpus is much rougher than that described above, has a sharper internal spine, and a longitudinal groove on the upper surface of the palm. In individuals with a carapace width less than 5 mm., the first and second anterolateral teeth are completely coalesced. Where the ranges of *N. t. texana* and *N. t. sayi* overlap, specimens are often found which share characters of both subspecies (Rathbun, 1930a, p. 370, in part).

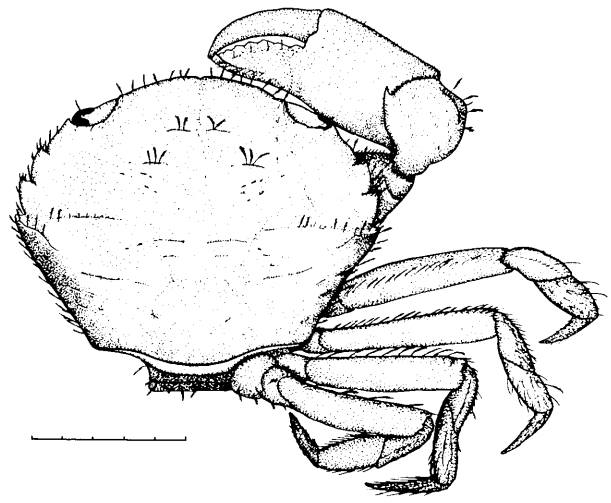

FIGURE 172.—*Neopanope texana texana* (Stimpson). Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Color.—Body mottled gray; a roughly W-shaped grayish configuration on anterior half of carapace with its anterior points located in midline and behind orbits, and a less definite continuation of this figure extending toward anterolateral borders; hands of chelipeds mottled gray, fingers with light tips; walking legs with narrow gray cross bands alternating with lighter ground color.

Habitat.—Most abundant in shallow water where bottom is soft and there is vegetation (Wass, 1955). Low tide to 28 fathoms.

Type locality.—St. Josephs Island, Tex.

Known range.—York River, Va., via Florida Keys and Gulf coast to Laguna Madre, Tamaulipas, Mexico.

Remarks.—Ovigerous females have been reported in March from Florida (Rathbun, 1930a), and they are known from North Carolina in July and August.

Neopanope texana sayi (Smith)

Figures 173, 183G

Panopeus sayi Smith, 1869a, p. 284.

Neopanope texana sayi: Hay and Shore, 1918, p. 438, pl. 34, fig. 8.—Rathbun, 1930a, p. 369, text-fig. 58, pl. 168, figs. 3–4 (rev.).

Neopanope texana nigrodigita Rathbun, 1934, pp. 3–4, illus.

Recognition characters.—Carapace subhexagonal, length contained in width about 1.3 to 1.4 times, greatest width at fifth pair of anterolateral teeth, quite convex; carapace minutely granulate, and lightly pubescent especially near anterior and lateral regions. Five anterolateral teeth, first two coalesced and separated by a shallow sinus, third and fourth larger and directed forward, fifth smaller and directed somewhat outward; each of last two teeth with an oblique ridge extending inward and backward. Front with small median notch, each half only slightly sinuate, with whole forming a much flattened curve extending from eye to eye.

Chelae barely unequal, smooth, dissimilar; carpus and merus with a shallow groove parallel to distal margin, and usually a blunt internal spine; major dactyl without large basal tooth, fingers of minor chelae not spoon shaped.

Resembles *Eurypanopeus depressus.*

Measurements.—Carapace: length, 17 mm.; width, 23 mm.

Variations.—Where the ranges of *N. t. texana* and *N. t. sayi* overlap, specimens are often found which share characters of both subspecies (Rathbun, 1930a, p. 370, in part).

Color.—Carapace a dark, slaty bluish green, brown or buff, with dark reddish-brown speckles on yellowish background, or bluish purple on gray background, especially on anterior portion of carapace and upper portion of chelae; outer face of chelae yellowish gray; fingers dark or black, color extending extensively on palm, tips light.

Habitat.—Most studies indicate greatest abundance on mud bottoms, though the form occurs in other situations as well, and in the Chesapeake area in a salinity range of 14.66 to 31.62 °/₀₀ in a dry year. Low-tide mark to 15 fathoms.

Type localities.—New Haven, Conn., and Cape Cod, Mass.

Known range.—Miramichi Bay, Prince Edward Island and Cape Breton Island, New Brunswick, Canada (Bousfield, 1956), to eastern Florida. Introduced, Swansea, Wales (Naylor, 1960).

Remarks.—Rathbun's subspecies *N. t. nigrodigita* is here regarded as conspecific with *N. t. texana* on the basis of examination of a series of specimens in the Charleston Museum. Rathbun (1930a) reported the largest male on record as 27.2 mm. wide.

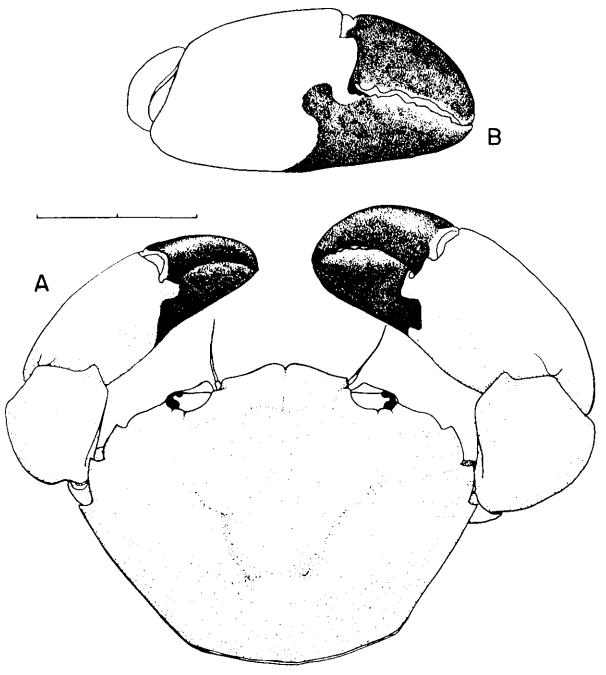

FIGURE 173.—*Neopanope texana sayi* (Smith). A, male in dorsal view, walking legs not shown; B, large chela in frontal view; 10 mm. indicated.

Ovigerous females have been taken from April in South Carolina (Lunz, 1937a) to October in Chesapeake Bay. Cowles (1930) found young individuals during fall, winter, and spring in Chesapeake Bay, and concluded that juveniles reach maturity the first summer after hatching. Ryan (1956) summarized the work of Hyman (1925) on zoeal and megalops stages, and gave some data on size at maturity. He concluded that mature females ranged in width from 6.1 to 18.7 mm.

Chamberlain (1957, 1961) discussed development time and stages in detail. He found development limited to four zoeal stages (sometimes preceded by a brief prezoeal stage) and one megalops stage. Developmental time varied with temperature (14 days at 30° C., 27 at 21° C.) and with food. Larvae matured most rapidly when fed *Artemia salina* nauplii, did moderately well on *Artemia* and algae, but did not transform at all when fed pure algae.

McDermott and Flower (1953) considered this form to be the most abundant mud crab in Delaware Bay, but within the area studied it was more common on oyster beds than in littoral or low-

salinity areas. They found (also McDermott, 1960) that *N. t. sayi* readily preys on *Balanus improvisus*. Farther north, Landers (1954) reported the crab abundant in Narragansett Bay where it is a serious predator on young *Mercenaria mercenaria*. Ryan (1956) found the form widely distributed in Chesapeake Bay, but apparently not so abundant as in the more northern bays. Here it ranged in depth from 2 to 25 fathoms (Rathbun, 1930a, in part), depths similar to those reported by Sumner, Osburn, and Cole (1913a, b) for the Woods Hole region.

Genus ***Leptodius*** Milne Edwards, 1863

Rathbun, 1930a, p. 296.—Hemming, 1958b, p. 33.

Leptodius agassizii Milne Edwards

Figures 174, 183H

Leptodius agassizii Milne Edwards, 1880, p. 270, pl. 49, fig. 3.—Hay and Shore, 1918, p. 441, pl. 34, fig. 6.—Rathbun, 1930a, p. 307, pl. 141, figs. 4–5 (rev.).

Recognition characters.—Carapace broad, suboval, flattened, and finely granulate posteriorly, conspicuously sculptured anteriorly; regions lobulate, with coarse granules and fine scattered hairs along front margin of lobules. Frontal margin transversely grooved, appearing double; upper margin less pronounced than lower, with groove extending across from orbit to orbit, both edges of groove and orbital margin granulate. Of five anterolateral teeth only last two or three well developed, sharp, and turned forward; second tooth, and sometimes third, triangular and obtuse, first (outer orbital angle) represented by an elevated mass of granules.

Chelipeds unequal; larger one with strong, blunt-tipped fingers; smaller one with more slender, more acute, and more conspicuously grooved fingers showing tendency to be spoon shaped at tips; fingers dark, both hands with upper and outer surfaces granulate and tuberculate and with tubercles arranged in rows; carpus strong, with a sharp internal spine, sometimes a double spine, and with many irregular, granulate rugae above. Walking legs granulate and hairy.

Measurements.—Carapace: male, length, 8 mm., width, 12 mm.; ovigerous female, length, 20 mm., width, 31 mm.

Variations.—Small specimens from near Beaufort, N.C., have the last three anterolateral teeth well developed, but a series in the U.S. National

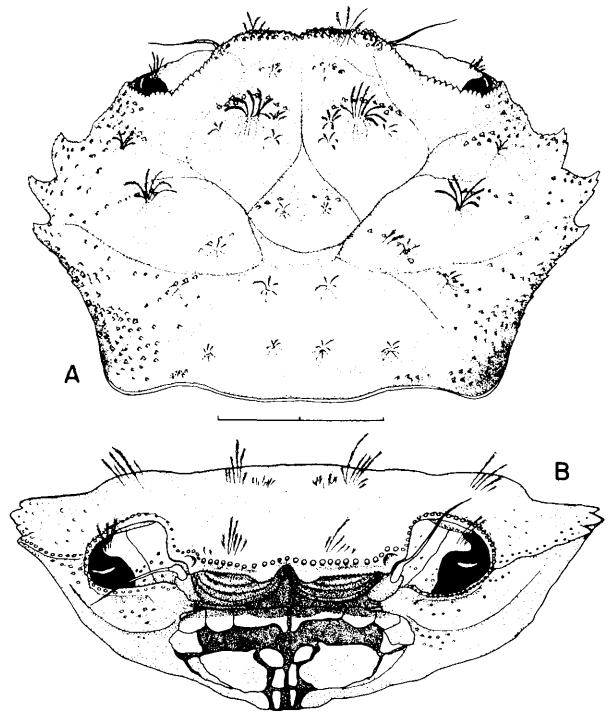

FIGURE 174.—*Leptodius agassizii* Milne Edwards. A. carapace in dorsal view; B, carapace in frontal view; 2 mm. indicated.

Museum from Pensacola, Fla., shows that the number of these spines may be reduced to two in larger individuals.

Color.—After a short preservation in alcohol, light red, fingers black.

Habitat.—This species has been taken from coral rock, sponges, and on sandy bottom. Approximately 6 to 45 fathoms.

Type locality.—Florida Reefs, 12 to 18 fathoms.

Known range.—Cape Hatteras, N.C., to Pensacola, Fla.; Virgin Islands.

Remarks.—Ovigerous females are known from April to November in various parts of the range.

Genus ***Micropanope*** Stimpson, 1871

Rathbun, 1930a, p. 426.—Hemming, 1958b, p. 34.

KEY TO SPECIES IN THE CAROLINAS

a. Last lateral tooth of carapace obsolescent, carapace rough, legs spinulose_____*sculptipes* (p. 193).
aa. Last lateral tooth of carapace small but easily discernible.
b. Second lateral tooth present, last lateral tooth dentiform, not spinose; outer surface of hand somewhat rugose_____*xanthiformis* (p. 193).

bb. Second lateral tooth absent or fused with first; outer surface of hand rough with large beadlike granules ..... *nuttingi* (p. 194).

Micropanope sculptipes Stimpson

Figure 175

Micropanope sculptipes Stimpson, 1871a, p. 140.—Rathbun, 1930a, p. 428, pl. 178, figs. 1–3 (rev.).

Recognition characters.—Carapace naked, distinctly areolated; anterior and anterolateral regions somewhat roughened in front with small, sharp, toothlike tubercles partially disposed in lines. Anterolateral teeth sharp, denticulate, fifth (last) obsolescent, first and second almost entirely fused. Frontal lobes abruptly deflexed, with convex outline; margin thin, minutely crenulate, with slight furrow above it. A small tubercle on subhepatic region below second anterolateral tooth.

Chelipeds granulate above; carpus with granules arranged more or less in raised reticulated rugae, inner margin denticulate and with a sharp spine; hand with double denticulate crest above and with minute granules on outer surface showing tendency to arrangement in rows, becoming obsolete in distal lower half of major chela, upper part of inner surface granulate; fingers grooved, with a thin superior crest on dactyls. Walking legs with minute spines above forming two rows on carpus.

Measurements.—Carapace: male, length, 4 mm.; width, 6 mm.

Habitat.—Fifteen to 101 fathoms.

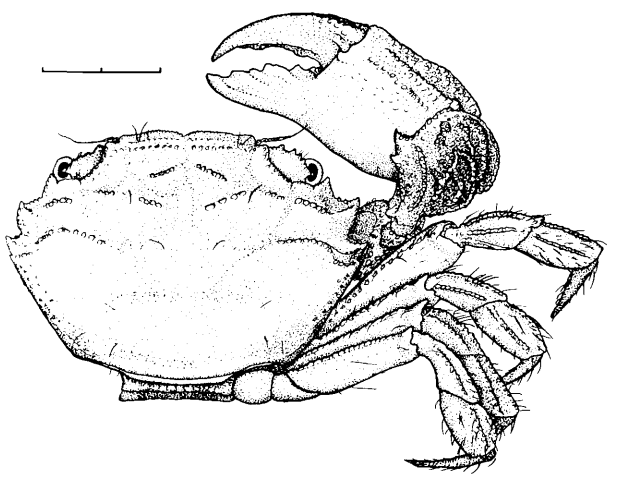

FIGURE 175.—*Micropanope sculptipes* Stimpson. Animal in dorsal view, legs of left side not shown, 2 mm. indicated.

Type locality.—Florida Keys.

Known range.—South Carolina to Port Aransas, Tex.; West Indies to Barbados.

Micropanope xanthiformis (Milne Edwards)

Figures 176, 183I

Panopeus xanthiformis Milne Edwards, 1880, p. 353, pl. 53, figs. 4–4b.—Rathbun, 1930a, p. 442, pl. 180, figs. 7–8 (rev.).

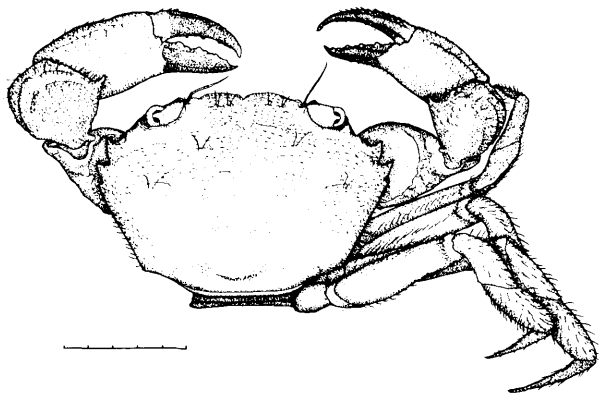

FIGURE 176.—*Micropanope xanthiformis* (Milne Edwards). Animal in dorsal view, walking legs of left side not shown, 5 mm. indicated.

Recognition characters.—Carapace depressed, regions well defined, with depressed coarse granulations on anterior and anterolateral portions, an oblique ridge on hepatic region. Five anterolateral teeth with granulate margins; second tooth small, blunt, obsolescent in young but considerably larger than first in adults; third and fourth teeth large, acute; fifth tooth small and pointed. Front slightly deflexed, shallow, lobes separated by a narrow fissure; margin sinuous, outer corner rectangular. A slight subhepatic elevation formed by a number of granules.

Chelipeds rugose with coarser granules than on carapace; merus with a row of spines above; carpus with a deep distal groove and two inner spines, one above other, upper one largest. Chelae roughened proximally and on upper portion, roughness more extensive on minor chela; fingers deeply grooved, major dactyl with large basal tooth. Walking legs long, slender; merus with row of spines above, other articles spinulose.

Measurements.—Carapace: male, length, 7 mm.; width, 10 mm.

Color.—"Anterior portion of carapace light yellowish orange. Fingers of major chela brownish black, of minor chela black. Spines and tu-

bercles of both chelipeds light salmon." (Rathbun, 1930a.)

Habitat.—Various types of bottom in deeper water; 7.5 to 182 fathoms.

Type locality.—Off Grenada.

Known range.—Cape Hatteras, N.C.; Florida through Gulf of Mexico and West Indies to Cabo Frio, Rio de Janeiro, Brazil; Yucatan.

Remarks.—Ovigerous females are known in June and August from Florida, and in October from North Carolina (Rathbun, 1930a, in part).

Micropanope nuttingi (Rathbun)

Figures 177, 183J

Xanthias nuttingi Rathbun, 1898, p. 271, pl. 4, fig. 1.
Micropanope nuttingi: Rathbun, 1930a, p. 450, fig. 74 (rev.).

Recognition characters.—Carapace suboval, convex from front to back, nearly flat transversely; regions distinct, anterior half rough with squamose tubercles. Second normal anterolateral tooth completely united with small first tooth; three remaining teeth sharp pointed, posterior one smallest. Front convex, bilobulate, with granulate margins separated by a V-shaped sinus, outer angle of each lobe subrectangular.

Chelipeds heavy, quite unequal; merus spinulose on upper edge; carpus covered with beadlike tubercles, with a deep distal groove, and an inner angular eminence tipped with a spinule and a second spinule below. Females with whole outer surface of both chelae tuberculate. Major chela of males with upper and approximately two-thirds of outer surface beaded, tuberculate; lower third and distal extremity smooth and shining; fingers broad, not gaping, brown with light tips, color of immovable finger not continued on palm and ending in a line with articulation of dactyl; dactyl with large basal tooth. Minor chela almost entirely tuberculate, growing less so toward distal and lower margins; upper margin with longitudinal groove, fingers deeply grooved. Upper margin of walking legs tuberculate or granulate.

Measurements.—Carapace: male, length, 4 mm.; width, 6 mm.

Color.—"In alcohol, speckled with blue; larger patches of blue on anterior gastric and cardiac region." (Rathbun, 1930a.)

Habitat.—Has been taken from boulder-covered beach, from *Porites* clumps and *Halimede* (U.S. National Museum records); shallow water to 100 fathoms.

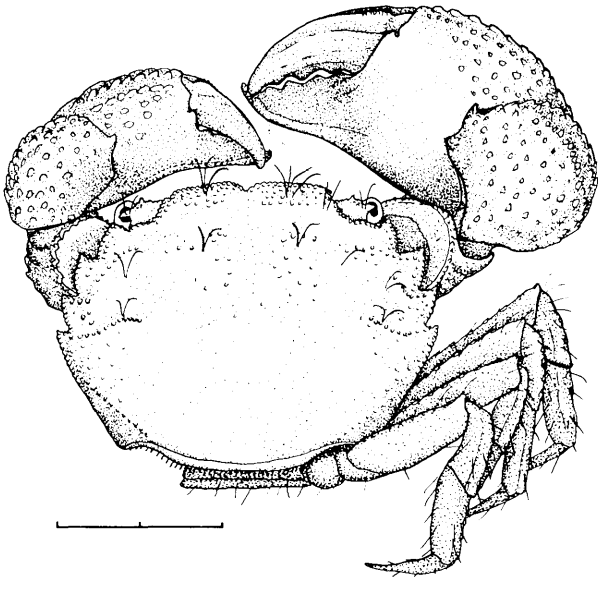

FIGURE 177.—*Micropanope nuttingi* (Rathbun). Animal in dorsal view, walking legs of left side not shown, 2 mm. indicated.

Type locality.—Bahama Banks.

Known range.—Cape Hatteras, N.C., through Gulf of Mexico and West Indies to Cape São Roque, Rio Grande do Norte, Brazil.

Remarks.—Ovigerous females have been taken in July in Florida.

Genus ***Eurypanopeus*** Milne Edwards, 1880

Rathbun, 1930a, p. 403.

KEY TO SPECIES IN THE CAROLINAS

a. Fingers of both chelae with acute tips, not spooned *abbreviatus* (p. 194).
aa. Fingers of minor chela spoon-shaped at tip *depressus* (p. 195).

Eurypanopeus abbreviatus (Stimpson)

Figures 178, 183K

Panopeus abbreviatus Stimpson, 1860a, p. 211.
Eurypanopeus abbreviatus: Rathbun, 1930a, p. 404, text-fig. 63, pl. 172, figs. 1–2 (rev.).

Recognition characters.—Carapace approximately two-thirds broader than long, moderately convex in two directions, naked above, granulate and uneven on front and along anterolateral border, smooth and polished elsewhere; areolations slightly but distinctly indicated, a number of well-marked rugae among granules. Front strongly deflexed, four-lobed, median lobes prominent, separated by a V-shaped notch. Antero-

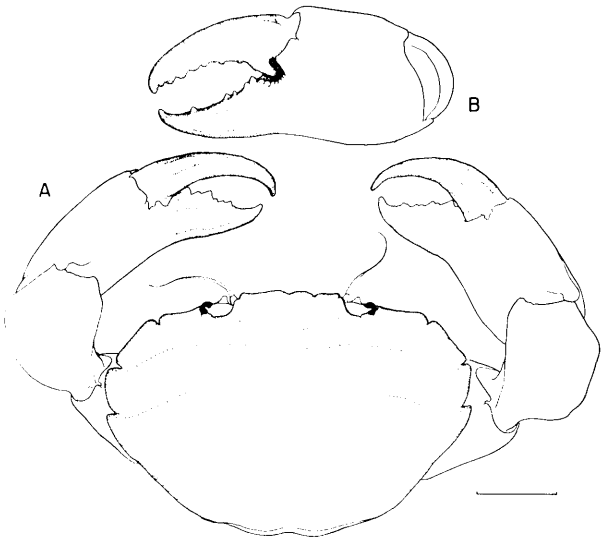

FIGURE 178.—*Eurypanopeus abbreviatus* (Stimpson). A, male in dorsal view, walking legs not shown; B, right chela in frontal view; front with anomalous notch to right of midline; 5 mm. indicated.

lateral margin thin, divided into four lobes, first and second teeth coalesced, separated by a slight concavity; third tooth obtuse; fourth with outer margin longitudinal or nearly so; fifth subtriangular, directed outward. A low granulated swelling below interval between first two teeth.

Chelipeds quite unequal in males; carpus with blunt internal tooth; fingers slender, pointed, widely gaping in major chela; fitting closely in minor, tips crossing in both; major dactyl with a large basal tooth, color of fingers not extending on palm.

Measurements.—Carapace: male, length, 14 mm.; width, 22 mm.

Color.—Yellowish or brownish above, front margin of carapace and chelipeds roseate or tinged with bluish purple; fingers black with paler tips. Brazilian specimens with a number of large dark spots on upper half of chelipeds.

Habitat.—Specimens have been found near shore on oysterbeds, under rocks, and among sponges and bryozoan growth; shore and shallow water to unknown depth.

Type locality.—Barbados, British West Indies.

Known range.—South Carolina, through West Indies and Gulf of Mexico to State of Santa Catarina, Brazil.

Remarks.—Ovigerous females are known from April to November in the West Indies, and August to November in southern Brazil (Rathbun, 1930a, in part).

Eurypanopeus depressus (Smith). Flat mud crab

Figures 179, 183L

Panopeus depressus Smith, 1869a, p. 283.

Eurypanopeus depressus: Hay and Shore, 1918, p. 437, pl. 34, fig. 4.—Rathbun, 1930a, p. 410, text-fig. 65, pl. 173, figs. 3–4 (rev.).

Recognition characters.—Carapace transversely oval, approximately three-fourths as long as wide, flattened posteriorly, convex in anterior half; areolations well defined, finely granulate, with several pairs of transverse rows of granulations. Anterolateral teeth four, outer margins granulate; first two teeth coalesced to form broad lobe with slightly sinuate margin; third tooth blunt; fourth and fifth spines tipped, pointing obliquely upward and forward. Front nearly straight, median notch small or absent.

Chelipeds dissimilar and quite unequal. Smaller one more rugose than larger and with margins of fingers nearly straight and opposable for a considerable distance, with opposed margins of tips thin edged and hollowed out—"spoon shaped." Larger cheliped with nearly smooth articles, hand heavy and inflated; dactyl strongly curved, obscurely toothed at base, and meeting immovable finger only at tip; internal tooth of carpus tipped with small spinule; in unworn condition both fingers show indication of spoonlike flattening.

Measurements.—Carapace: length, 14 mm.; width, 20 mm.

Variations.—Ryan (1956) described a persistent, central, oval, blood-red spot or structure on the inner surface of the ischium of the third maxillipeds of both sexes. The spot is often two-thirds the length of the article, with its surface raised slightly above the surface of the ischium. When pressure is applied, the hard spot cracks and is easily dissected out. A similar spot has been noted on *P. herbstii.*

The normal male abdomen is narrow with the third, fourth, and fifth segments fused. A few variant males have wide abdomens with seven segments, resembling females.

Color.—Mottled grayish olive or dark olive brown, especially on upper surfaces of chelipeds and anterior portions of carapace; fingers dark brown with dark color of immovable finger extended on palm; body and legs light colored underneath.

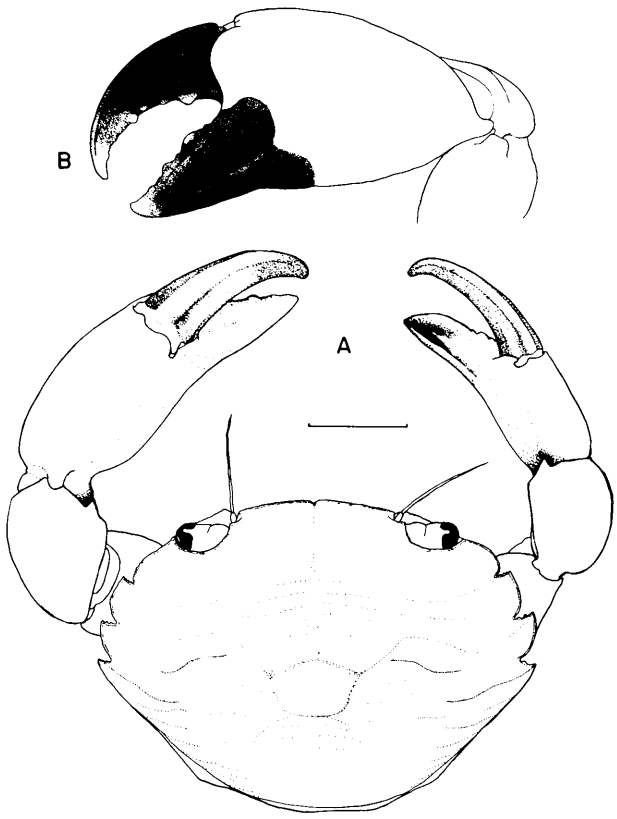

FIGURE 179.—*Eurypanopeus depressus* (Smith). A, animal in dorsal view, walking legs not shown; B, large chela in frontal view; 5 mm. indicated.

Habitat.—In Chesapeake Bay, Ryan (1956) found this species in greater abundance on oyster bars than any other species of mud crab, and evidence was presented showing a positive relationship between presence of oyster shells and this species. Others have noted a similar habitat preference (Lunz, 1937a). In the bay, the depth range was 1 to 15 fathoms (Cowles, 1930, in part), and the salinity range occupied was 4.5 to 20.4 °/₀₀. Elsewhere the species occurs from shore to 26 fathoms.

Type locality.—New Haven, Conn.

Known range.—Massachusetts Bay through Florida (east and west coasts) to Texas; Bermuda; West Indies.

Remarks.—Ryan (1956) gave much detail on the life history of this species in Chesapeake Bay. Ovigerous females were collected from June to September. Elsewhere, Rathbun (1930a) and Lunz (1937a) reported such females in April from Virginia and South Carolina, September from Mississippi and the Leeward Islands, November and February from Florida. Zoeal stages have been studied by Hyman (1925) from plankton tows made in the Beaufort, N.C., area. Costlow and Bookhout (1961b) worked out the entire larval and postlarval history in captivity and illustrated four zoeal stages and a single megalops stage. Immature males from Chesapeake Bay ranged in width from 3.2 to 6 mm. and females from 3.6 to 6.4 mm.

Maturity was considered to be attained at widths of 5.1 to 6 mm. in males, and 5.5 to 6.4 mm. in females. The mature individuals range widely in size, up to a width of 21 mm. for females, and ovigerous females show a range of 6 to 17 mm. Such a broad range of sizes among mature individuals suggested to Ryan that growth and molting continue after maturity is reached. Maturity may be reached in the first summer after eggs have hatched.

McDermott (1960) found that *E. depressus* is a predator on oyster spat in southern New Jersey but not so serious a pest as *P. herbstii.*

Genus ***Panopeus*** H. Milne Edwards, 1834

Rathbun, 1930a, p. 333.

KEY TO SPECIES IN THE CAROLINAS

a. Dark color of immovable finger continued more or less on outer surface of palm, especially in males; no distal groove on carpus of chelipeds_____*herbstii* (p. 196).

aa. Dark color of immovable finger not continued on outer surface of palm; carpus of chelipeds with shallow groove parallel to distal margin__*occidentalis* (p. 198).

Panopeus herbstii H. Milne Edwards. Common mud crab

Figures 180, 183M

Panopeus herbstii H. Milne Edwards, 1834, p. 403.—Hay and Shore, 1918, p. 437, pl. 34, fig. 9.—Rathbun, 1930a, p. 335, text-figs. 52–53, pl. 156, figs. 1–3; pl. 157, figs. 1–3 (rev.).

Recognition characters.—Carapace approximately two-thirds as long as wide, regions well marked, surface sparingly granulate. Anterolateral margins with five teeth; first two teeth coalescent; third and fourth larger, prominent, and with arcuate outer margins and acute tips; fifth smaller, acute at tip and with outer margin straight. A transverse ridge extending inward from fifth tooth, and a shallow groove from fourth tooth. Front wide, not produced, with narrow median fissure; anterior margin of each half sinuous. Male abdomen with sides of

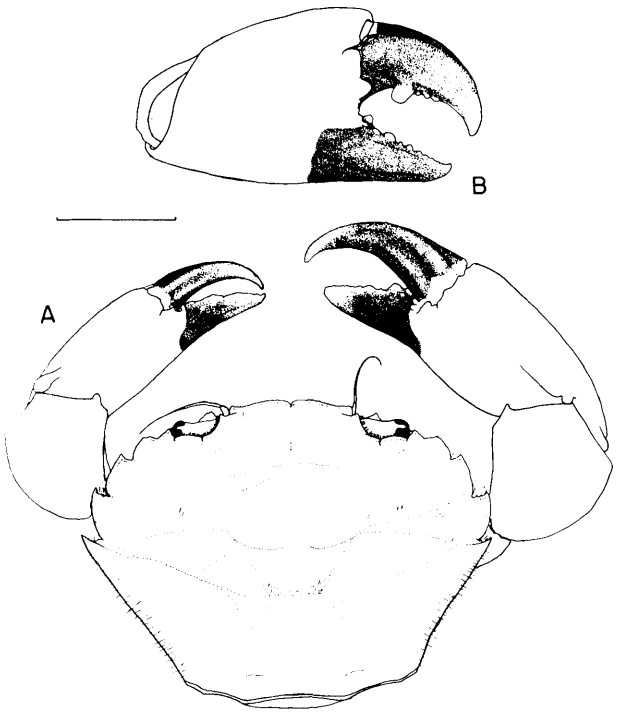

FIGURE 180.—*Panopeus herbstii* H. Milne Edwards. A, animal in dorsal view, walking legs not shown; B, right chela in frontal view; 5 mm. indicated.

penultimate segment nearly parallel; terminal segment broader than long, rounded at tip.

Chelipeds heavy, finely granulate; carpus without groove on superior surface and with a blunt internal spine; hands unequal and dissimilar, large one with dactyl curved and strongly toothed at base, dactyl of smaller more nearly straight; fingers dark, with color extending somewhat on palm.

Measurements.—Carapace: male, length, 26 mm.; width, 38 mm.

Variations.—Rathbun (1930a) separated this species into a number of forms on the basis of structural characteristics but considered these the result of response to environment rather than genetic differences. Intermediates may occur in any locality; thus, the forms are not always easily separated.

Ryan (1956) described a persistent, central, oval, red spot or structure on the inner surface of the ischium of the third maxillipeds of both sexes. Mrs. Peggy Keney of the U. S. Fish and Wildlife Service Bureau of Commercial Fisheries, Biological Laboratory, Beaufort, N.C., found this spot to occur on 100 percent of males and 55 percent of females in the Beaufort area. A sample of 596 specimens was examined.

Habitat.—Depth distribution for the species ranges from the intertidal zone to 12 fathoms. Ryan (1956) found the species to be rare in Chesapeake Bay in a salinity range of 13.95 to 19.04 $^{o}/_{oo}$. The depth distribution there was 2 to 6 fathoms and at each collection spot the bottom was composed of soft mud with few oyster shells. McDermott and Flower (1953) found the species common on oyster beds in Delaware Bay, where it commonly cracks and eats small oysters and the barnacle *Balanus eburneus*. The toadfish was considered a common predator.

In North Carolina and South Carolina, this is one of the most common crabs of estuarine regions, found wherever the bottom is muddy or covered with shells or stones. In some localities along edges of the higher marshes, it is found in burrows and is frequently associated with *Sesarma reticulata* and *Uca minax*.

In the West Indies, collections have been made from mangrove roots, sponges, and coral reefs.

Type locality.—North America.

Known range.—Boston, Mass., to State of Santa Catarina, Brazil; Bermuda.

Remarks.—This common xanthid crab has a fossil record dating from the Miocene in North America, and the genus *Panopeus* has a record extending from the Eocene to the present (Rathbun, 1935).

Ovigerous females are known virtually the year around in Florida. They are known through late spring and summer in the Carolinas, in July in Maryland, February to September in various parts of the West Indies, and August to October in southern Brazil.

Ryan (1956) gave carapace widths of mature males as 8.3 to 37.3 mm., and of mature females as 21.6 to 27.8 mm. A specimen 45 mm. wide was found at Beaufort, N.C., in 1960 (Mrs. Keney, personal communication), and Wass (1955) reported a male 55 mm. wide.

Costlow and Bookhout (1961a) reviewed early descriptions of larvae and described and illustrated four zoeal and one megalops stage reared in the laboratory.

Costlow, Bookhout, and Monroe (1962) reared the larval stages under 12 different conditions of

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salinity and temperature. Eggs were maintained in salinities of 12.5, 20.1, 26.5, and 31.1 °/₀₀ and all larvae hatched as first stage zoeae. Succeeding stages showed higher percentages of survival under different conditions, with shortest development time in the highest salinity. The lowest salinity tested did not permit development to be completed. In addition, low temperature affected duration of all larval stages and mortality of some stages. Larval development was completed to first crab in 48–52 days at 20° C., in 18–28 days at 30° C. From data, the effects of salinity and temperature on mortality of larval stages were projected by statistical methods over a wide range of combinations. The hypothesis is presented that the effect of temperature on successive larval stages limits the productive spawning period. Low temperatures favor the spring brood of larvae [in these latitudes], prolonging larval development until warmer water produces favorable conditions for the megalops stage. Larvae hatched in fall are not so favored and mortality in late zoeal and megalops stages would be high.

In a study of the relationship of habitat to oxygen consumption by estuarine crabs, Ayers (1938) found *P. herbstii* to be intermediate in a scale of partial adaptation of the respiratory mechanisms to life in air. Teal (1959) found this species active on Georgia marshes when the tide was high or the sky cloudy. When the marsh was exposed, it was found in burrows, usually near the top, in air or water. Among various marsh crabs studied (see remarks, *Uca minax*) only *P. herbstii* was active at temperatures below 12° C. Respiration in this crab was most affected by reduced oxygen pressure among species tested, showing a rate reduction of 90 percent at 4 mm. Hg.

Menzel and Nichy (1958) found that *P. herbstii* and *Menippe mercenaria* are the only xanthids large enough to kill significant numbers of adult oysters. McDermott (1960), studying predatory activities of xanthid crabs on oyster beds in New Jersey, found that *P. herbstii* destroyed 1- and 2-year-old oysters at a rate of 0.15 oysters per crab per day. The crab also preyed actively on oyster spat as well as barnacles (*Balanus improvisus*). He concluded that *P. herbstii* is potentially the most destructive of the five species of mud crabs occurring on New Jersey oyster beds.

Panopeus occidentalis Saussure

Figures 181, 183N

Panopeus occidentalis Saussure, 1857, p. 502.—Rathbun, 1930a, p. 348, text-fig. 55; pl. 161, figs. 1–3 (rev.).

Recognition characters.—Similar to *Panopeus herbstii*, but differing in having more convex carapace, especially in gastric region; front narrow, advanced; second anterolateral tooth usually narrower and separated by deeper sinus from first tooth, third to fifth teeth thicker, more prominent and widely separated, third one blunt, forming almost a right angle at tip; abdomen of male wider, sides of penultimate segment not parallel, narrowed toward proximal end.

Carpus of chelipeds with groove parallel to distal margin, sometimes rugose; dark color of immovable finger not continued on palm. Walking legs somewhat longer and more slender.

Measurements.—Carapace: male, length, 23 mm.; width, 33 mm. Smaller than *P. herbstii*.

Variations.—There is considerable variation even in a single lot of specimens. The carapace may be smooth and shining, or with light, granulate, transverse lines; the second anterolateral tooth may be small, subacute, and similar to the first rather than broadly rounded and large; the female abdomen may have sides of the sixth segment parallel instead of converging slightly toward the proximal end. Variations in teeth of the anterolateral border were noted in 12 percent of females studied by de Oliveira (1940). In these the first, second, and third teeth of one side were depressed, giving the impression of but one sinuous tooth while those of the other side were normal.

This species, like *P. herbstii*, has been divided into two environmental forms (typical and serrate), and both occur in the Carolinas (Rathbun, 1930a).

Color.—Carapace dull yellow spotted with brown and red; legs yellow with brown maculations and speckles on chelipeds; walking legs with brown or rose streaks. De Oliveira (1940) gave color of the species in Brazil as: carapace dark yellow with red blotches or chocolate varying in tone; legs same color but spotted with reticulated points, points of fingers chocolate to almost black; body yellow ventrally, legs yellow to grayish; some rare specimens completely yellow.

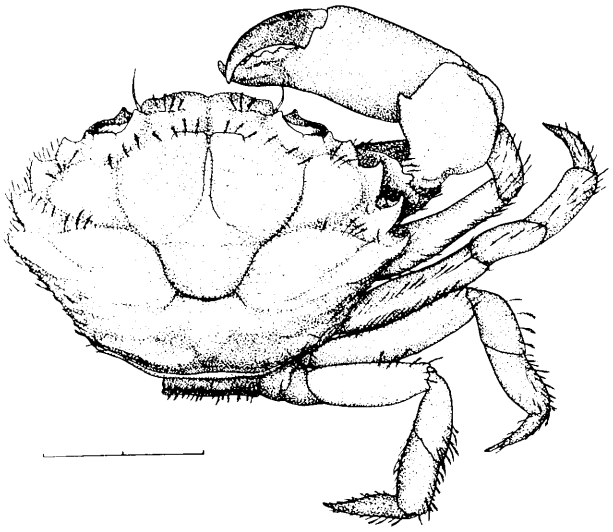

FIGURE 181.—*Panopeus occidentalis* Saussure. Animal in dorsal view, legs of left side not shown, 10 mm. indicated.

Habitat.—This species has been found among rocks, mangrove roots, sponges, ascidians, and seaweed, and on pilings of piers along shore; shore to 10 fathoms.

Type locality.—Guadeloupe.

Known range.—North Carolina to State of Santa Catarina, Brazil; West Indies and Bermuda.

Remarks.—De Oliveira (1940) reported in some detail on the natural history of this species where it occurs in the vicinity of the Ilha Pinheiro, near Rio de Janeiro, Brazil. The species is primarily crepuscular or nocturnal and is found living chiefly in ditches, between and beneath stones, and among mangrove roots, often burrowing to a depth of 30 cm. Both sexes were found together except when the eggs were deposited, and then females were not so often seen. Molting individuals and copulating pairs were rarely found.

Mating pairs were found from November to December, and on one occasion in water of 22 °/₀₀ at 22° C. Periods of egg deposition extended from January to May, and again from July to August (September, Rathbun, 1930a). (In the Caribbean area ovigerous females are known from January to July, U.S. National Museum records.) The seldom-seen ovigerous females bore dark, chocolate colored eggs. Such females showed a range in carapace width from 13.3 mm. to 35.2 mm., and bore 3,000 to 70,000 eggs, depending on size. Females were observed to aerate and clean the eggs in water at low tide in the evening. Eggs in the laboratory hatched in about 15 days. Molting of females followed hatching of eggs.

Young of the species were found throughout the year, as others have noted. One large male measured 48.2 mm. [width], though the average dimension for the typical form was 27.7 mm. long by 40.5 mm. wide; for the serrate form, 19.9 mm. long by 27.5 mm. wide.

The species was believed to have few natural enemies. Material from the gut was found to consist of a variety of plant and animal matter. In addition to the ecological discussion, de Oliveira gave a number of observations on autotomy and its effect on movement and behavior.

Genus ***Eurytium*** Stimpson, 1859

Rathbun, 1930a, p. 422.—Hemming, 1958b, p. 32.

Eurytium limosum (Say)

Figures 182, 183 O

Cancer limosa Say, 1818, p. 446.

Eurytium limosum: Hay and Shore, 1918, p. 438, pl. 35, fig. 7.—Rathbun, 1930a, p. 423, pl. 176, figs. 1–2 (rev.).

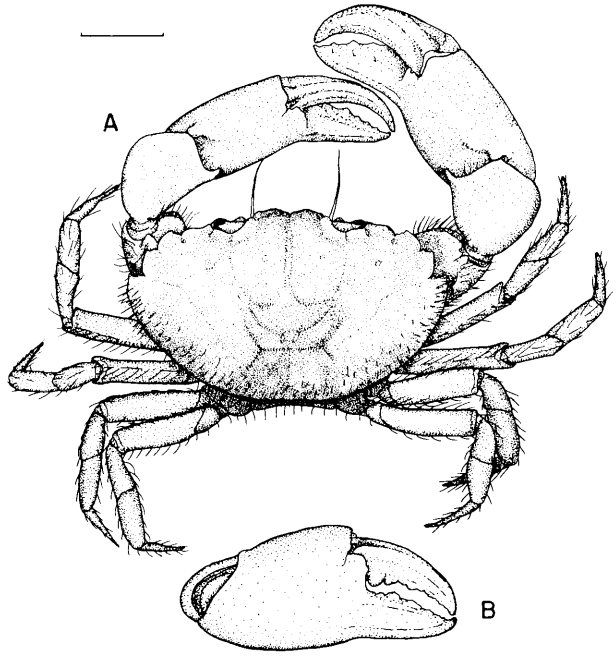

FIGURE 182.—*Eurytium limosum* (Say). A, animal in dorsal view; B, large chela in frontal view; 10 mm. indicated.

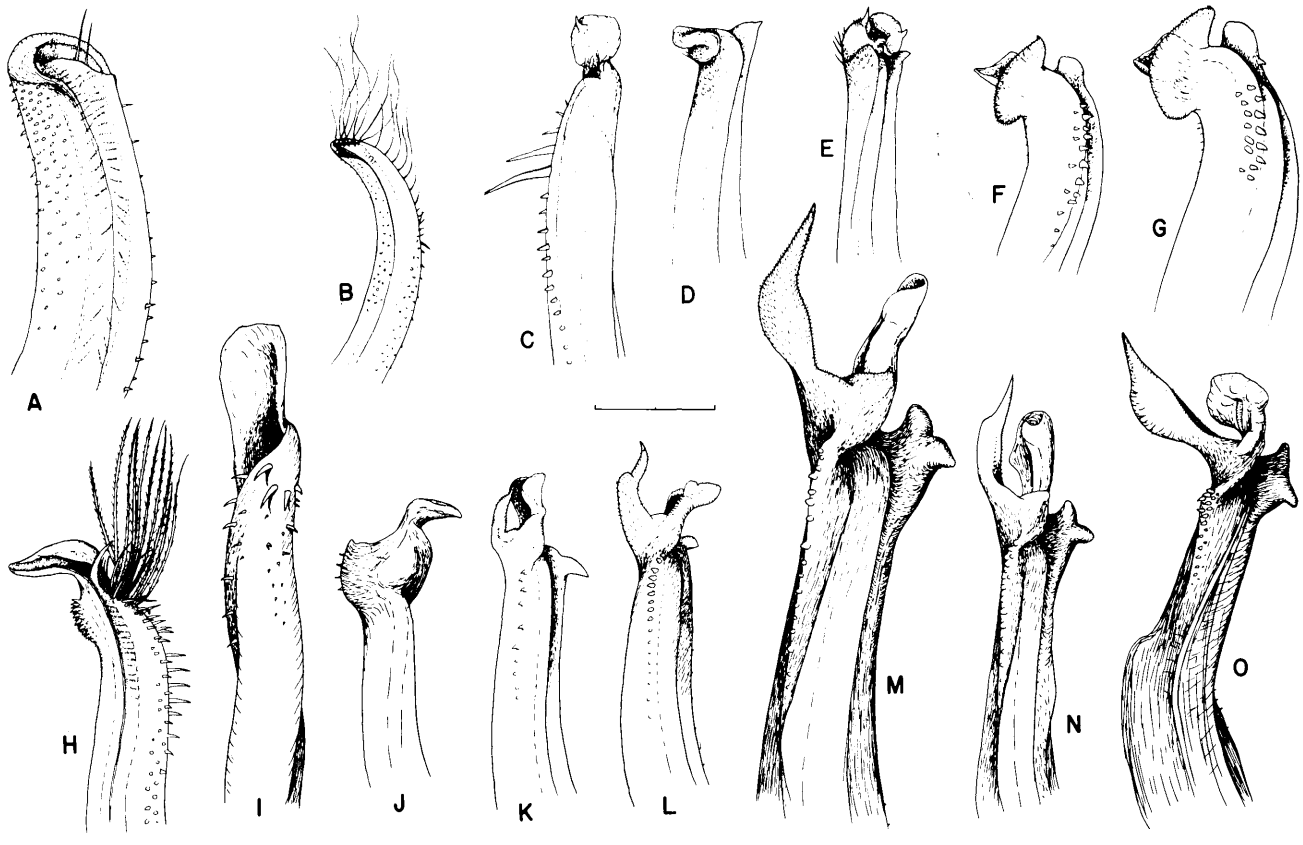

FIGURE 183.—Tips of right first pleopods of male xanthids; A, *Glyptoxanthus erosus* (Stimpson), medial view; B, *Carpoporus papulosus* Stimpson, medial view; C, *Rhithropanopeus harrisii* (Gould), medial view; D, *Hexapanopeus angustifrons* (Benedict and Rathbun), medial view; E, *Hexapanopeus paulensis* Rathbun, medial view; F, *Neopanope texana texana* (Stimpson), medial view; G, *Neopanope texana sayi* (Smith), medial view; H, *Leptodius agassizii* Milne Edwards, medial view; I, *Micropanope exanthiformis* (Milne Edwards), abdominal view; J, *Micropanope nuttingi* (Rathbun), medial view; K, *Eurypanopeus abbreviatus* (Stimpson), medial view; L, *Eurypanopeus depressus* (Smith), medial view; M, *Panopeus herbstii* H. Milne Edwards, medial view; N, *Panopeus occidentalis* Saussure, medial view; O, *Eurytium limosum* (Say), medial view; 0.5 mm. indicated for all figures, except I and J twice this magnification, and O one-half this magnification.

Recognition characters.—Carapace broad, approximately 1.5 times as wide as long, quite convex from front to back, nearly plane from side to side; surface smooth to eye but under a lens finely granulate, granulations coarser near frontal and anterolateral margins. Front approximately one-fourth width of carapace, divided into two lobes by a median notch giving rise to a shallow groove disappearing over gastric region. Orbital margins somewhat elevated; external orbital tooth coalesced with first tooth of anterolateral border, division between these teeth indicated by a shallow notch. Anterolateral teeth with raised margins, second and third teeth rounded at tip, fourth more prominent and subacute.

Chelipeds massive, unequal, and dissimilar, more so in male than in female; merus with coarsely tuberculate superior border and a distal spiniform tooth; carpus with a narrow internal spine, not grooved; fingers pointed, deflexed, with large basal tooth on major dactyl.

Measurements.—Carapace: length, male, 24 mm.; width, 36 mm.

Color.—Carapace brilliant purplish blue, dark gray, or black; carpus and hand bluish; proximal upper half of dactyl pink or purple; remainder of fingers porcelain white; lower portion of chelipeds, and also carpal teeth, yellow or orange; color of fingers not continued on palm.

Habitat.—This primarily tropical species lives in muddy or marshy banks a bit below the high-

tide mark in burrows partially filled with water, among stones at the high-tide mark, in burrows in sand, under stones between tides, and on coral reefs (Rathbun, 1930a). High-tide mark to shallow depths near shore.

Type locality.—"Inhabits shores of the Northern States."

Known range.—Modern records, South Carolina to State of São Paulo, Brazil; Bermuda. Formerly reported from New Jersey (Ryan, 1956).

Remarks.—This species has a fossil record in North America dating from the Miocene of North Carolina and Florida (Rathbun, 1935).

Teal (1959) found this species active on Georgia marshes when the tide was high or the sky cloudy. When the marsh was exposed, it was found in burrows, usually near the top, either in air or water. Respiration rates in water were higher than in air. The species showed internal regulation of metabolism in that it was independent of oxygen tension but not of acclimation to temperature.

Ovigerous females have been reported from Florida in August (Wass, 1955).

Family **Goneplacidae**

Palp of external maxillipeds articulating at or near anterointernal angle of merus; exognath normal in size, not concealed. Antennular septum a thin plate. Division of orbit into two fossae usually not indicated. Genital ducts of male usually perforating base of last pair of legs, often passing through a groove in sternum.

This group has a general resemblance to the Xanthidae in body shape. Members of the group are all bottom dwellers.

KEY TO GENERA AND SPECIES IN THE CAROLINAS

a. Base of third segment of male abdomen covering whole space between last pair of legs; carapace subquadrate, widest between postorbital angles; anterior border entirely occupied by square-cut front, and orbits formed into long, narrow trenches..*Goneplax hirsuta* (p. 201).

aa. Base of third segment of male abdomen not covering whole space between last pair of legs.

b. Frontoorbital width almost as great as total width of carapace; eyestalks long; carapace subquadrate, posterolateral margins converging *Euryplax nitida* (p. 202).

bb. Frontoorbital width from one-half to three-fourths total width of carapace; eyestalks short; anterolateral margins arcuate *Speocarcinus carolinensis* (p. 202).

Genus ***Goneplax*** [Leach, 1814]

Rathbun, 1918b, p. 25.—Hemming, 1958a, p. 32.

Goneplax hirsuta Borradaile

Figure 184

Goneplax hirsuta Borradaile, 1916, p. 99, fig. 11.—Rathbun, 1918b, p. 28, text-fig. 7 (rev.).

Recognition characters.—Carapace approximately two-thirds as long as broad, greatest width between tips of postorbital spines; regions faintly marked except for H-shaped depression in middle. Sides converging backward from prominent, sharp, postorbital spines; armed with sharp spine near postorbital spine. Front almost straight, with low rostral prominence in broad, shallow median notch. Orbital margin sinuous, sloping backward, width of orbit and front nearly equal.

Chelipeds almost equal; merus about two-thirds length of carapace, deep, with a spine a little beyond middle of upper edge; carpus broader than long, with a stout internal spine. Hand longer than remainder of limb; fingers about equal to palm, irregularly toothed, not gaping; external base of hand and distal half of carpus with a long dense tuft of hair, fringe of similar hairs along inner side of merus. Walking legs slender, meri smooth or fringed with light pubescence, distal articles fringed with hairs.

Measurements.—Carapace: male, length, 19 mm.; width, 29 mm.

Habitat.—Forty to eighty fathoms.

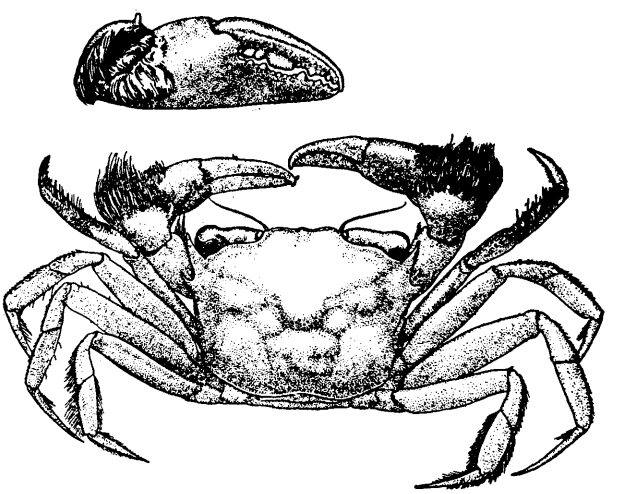

FIGURE 184.—*Goneplax hirsuta* Borradaile. A, animal in dorsal view; B, right chela and carpus in outer view; approximately × 1.75 (after Borradaile, 1916).

Known range.—North Carolina to Rio de Janeiro, Brazil.

Remarks.—Ovigerous females have been taken in the Gulf of Mexico off Florida in June (U.S. National Museum records).

Genus ***Euryplax*** Stimpson, 1859

Rathbun, 1918b, p. 34.—Hemming, 1958b, p. 32.

Euryplax nitida Stimpson

Figure 185

Euryplax nitida Stimpson, 1859, p. 60.—Rathbun, 1918b, p. 34, text-fig. 11, pl. 7 (rev.).

Recognition characters.—Carapace smooth and shining, convex. Front deeply notched on each side at insertion of antennae; interantennal margin nearly straight. Anterolateral margins converging anteriorly, less than half as long as posterolateral margins and armed with three strong teeth including outer orbital. Carapace widest at level of third tooth.

Merus of chelipeds in male with a deep round pit at anterior distal corner of lower surface, pit surrounded by a fringe of long hair, and with a sharp curved spine near distal end of upper surface; carpus with a sharp inner spine and inner surface pilose. Walking legs slender.

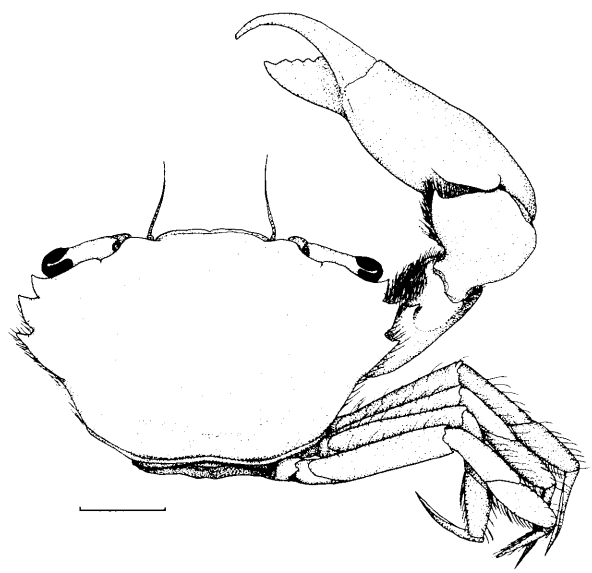

FIGURE 185.—*Euryplax nitida* Stimpson. Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Female with narrower carapace; chelipeds more nearly equal, and merus lacking pit with surrounding hair.

Measurements.—Carapace: male, length, 15 mm.; width, 25 mm.

Color.—Distal half of fingers white (Rathbun, 1918b).

Habitat.—Shallow water to 49 fathoms.

Type locality.—Florida Keys.

Known range.—Off Beaufort, N.C., to Texas; West Indies to St. Thomas; Bermuda.

Remarks.—Ovigerous females have been taken in June from southern Florida.

Genus ***Speocarcinus*** Stimpson, 1850

Rathbun, 1918b, p. 38.—Hemming, 1958b, p. 37.

Speocarcinus carolinensis Stimpson

Figure 186

Speocarcinus carolinensis Stimpson, 1859, p. 59, pl. 1, figs. 1–3.—Rathbun, 1918b, p. 39, pl. 8, pl. 159, fig. 6 (rev.).

Recognition characters.—Carapace subcylindrical, nearly smooth, punctate, obscurely granulate near margins, pubescent; gastric region and subdivisions well defined. Anterolateral margin with five teeth including outer orbital; second tooth rounded and not always separated from first; last three teeth sharp, well defined. Posterolateral margins parallel. Front approximately one-fourth width of carapace, sinuous, nearly straight, with median emargination. Eyestalks constricted near cornea.

Chelipeds strong, nearly smooth, margins hairy; merus with a strong spine on upper border; carpus granulate internally and with a blunt internal tooth; hand with outer surface smooth, microscopically granulate; dactyl with stout tooth at base. Walking legs with hairy margins.

Measurements.—Carapace: male, length, 23 mm., width, 29 mm.; female, length, 17 mm., width, 27 mm.

Habitat.—"This crab lives in the subterranean galleries excavated in the mud at low-water mark by the *Squilla*, *Callianassa*, and other Crustacea, or by large worms," (Stimpson *in* Rathbun, 1918b); near low-tide mark to 76 fathoms.

Type locality.—Charleston Harbor, S.C.

Known range.—South Carolina through Gulf of Mexico and West Indies to Surinam.

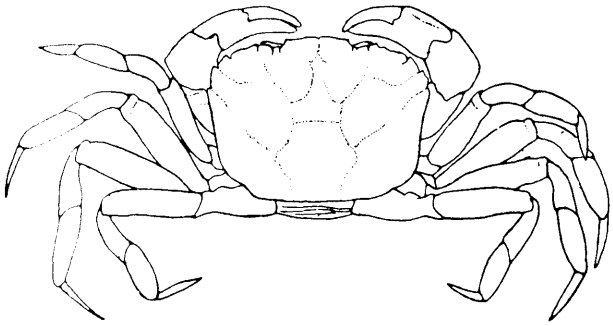

FIGURE 186.—*Speocarcinus carolinensis* Stimpson. Type female in dorsal view (after Rathbun, 1933).

Family **Pinnotheridae**

Carapace often somewhat membranous. Anterolateral margins entire or very slightly dentate. Front, orbits, and eyestalks very small, cornea often rudimentary. Buccal cavity usually wide, often semicircular in outline. Merus of third maxilliped never quadrate, and never with palp distinctly at anterointernal angle; ischium small, absent, or fused with merus and directed obliquely inward (Rathbun, 1918b).

Small crabs living as commensals or parasites in bivalve mollusks, ascidians, worm tubes, and on or in echinoderms. Free living or migratory stages are occasionally taken in open water.

KEY TO GENERA IN THE CAROLINAS

a. Dactyls of walking legs simple, acute.
  b. Third walking leg little, if any, longer than other legs.
    c. Carapace suborbicular and somewhat membranous in mature female, flattened and firm in hard stage male and female buccal mass subquadrate *Pinnotheres* (p. 203).
    cc. Carapace oval, flattened, and rather firm; buccal mass subtriangular *Parapinnixa* (p. 208).
  bb. Third walking leg longer and stronger than others, often considerably so *Pinnixa* (p. 210).
aa. Dactyls of first, second, and third walking legs bifurcate *Dissodactylus* (p. 209).

Subfamily **Pinnotherinae**

Carapace usually not markedly transverse. Ischium of external maxillipeds either rudimentary or indistinguishably fused with merus to form single piece, usually oblique, occasionally nearly transverse; palp not so large as merus-ischium (Rathbun, 1918b).

Genus ***Pinnotheres*** Bosc [1801 or 1802]

Rathbun, 1918b, p. 62.—Hemming, 1958b, p. 36.

KEY TO SPECIES IN THE CAROLINAS

Hard-stage males and females

a. Carapace with a striking pattern of light spots on dark background of pubescence *maculatus* (p. 206).
aa. No striking color pattern *ostreum* (p. 203).

Posthard females (and male *maculatus*)

a. Carapace nearly naked *ostreum* (p. 203).
aa. Carapace covered with a short deciduous pubescence *maculatus* (p. 206).

Pinnotheres ostreum Say. Oyster crab

Figures 187, 188, 189

Pinnotheres ostreum Say, 1817, p. 67, pl. 4, fig. 5.—Rathbun, 1918b, p. 66, text-fig. 30; pl. 15, figs. 3–6 (rev.).—Hay and Shore, 1918, p. 443, pl. 35, fig. 9.

Pinnotheres depressum Say, 1817, p. 68.

Pinnotheres depressus: Rathbun, 1918b, p. 79, pl. 17, figs. 1–2 (rev.).

Recognition characters.—Mature female: Carapace subcircular in outline; surface glabrous for most part, smooth, shining, membranous, yielding to touch, convex from front to back and with a broad, shallow, longitudinal depression at each side of cardiac and gastric areas. Lateral margins thick and bluntly rounded; posterior margin broad. Front rounded, slightly produced, covering and concealing eyes. Orbits small, subcircular, anteriorly placed. Antennule large; antenna small, flagellum not so long as diameter of orbit. Buccal mass roughly quadrangular in outline but bent into broad crescentic arch, short anteroposteri-

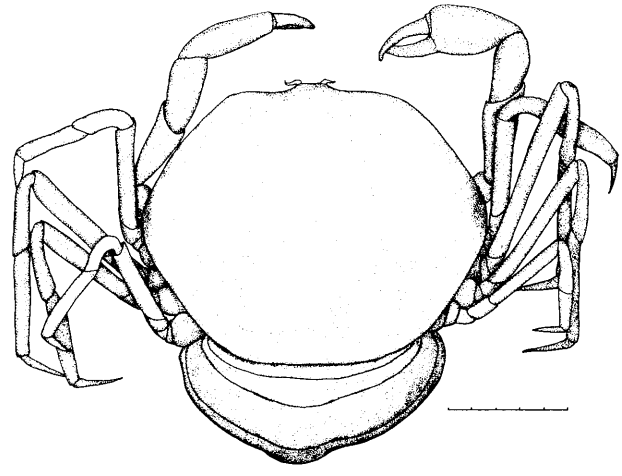

FIGURE 187.—*Pinnotheres ostreum* Say. Mature female in dorsal view, 5 mm. indicated.

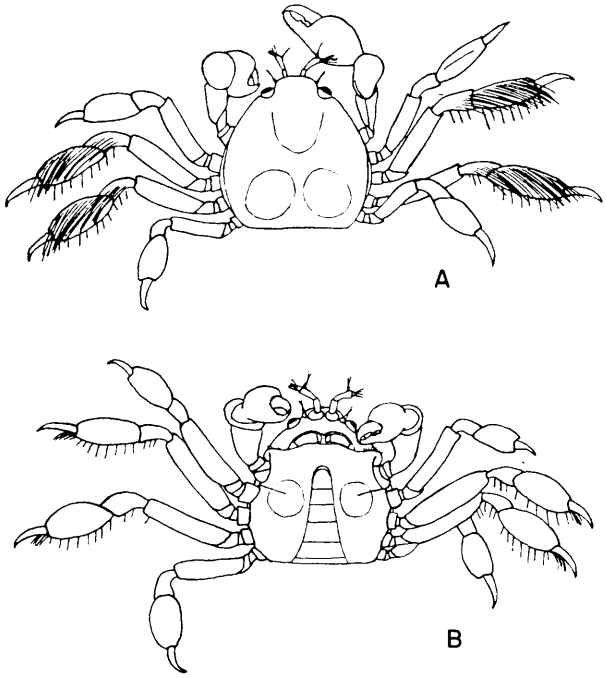

FIGURE 188.—*Pinnotheres ostreum* Say. A, stage I female in dorsal view; B, stage I female in ventral view; approximately × 9 (after Stauber, 1945).

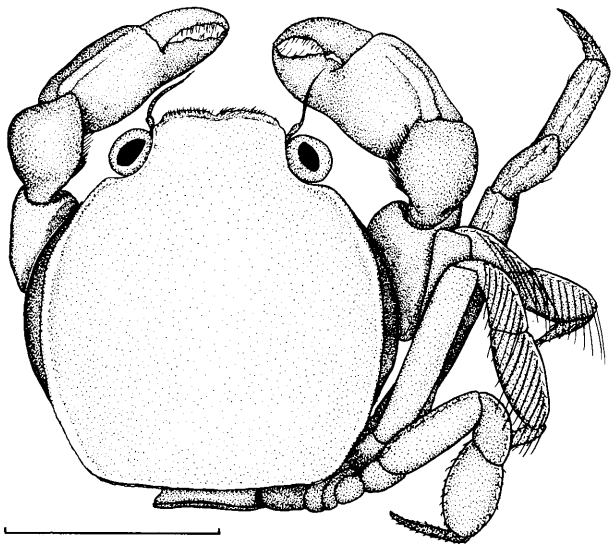

FIGURE 189.—*Pinnotheres ostreum* Say. Male in dorsal view, walking legs of left side not shown, 1 mm. indicated.

orly. Outer maxilliped with ischium and merus fused; carpus, or first article, of palp short, oblong; propodus elongate, end rounded; dactyl inserted behind middle of propodus, minute, slender.

Chelipeds small; merus and carpus rather slender. Palm somewhat flattened inside, swollen outside, strongly widened from proximal toward distal end, then narrowed; width across base of fingers less than greatest width of palm; fingers, especially immovable one, stout, not gaping, tips hooked past each other, minute teeth on opposed edges, a larger tooth near base of each, immovable finger horizontal. Walking legs slender, subcylindrical; last two articles with thin fringe of hair; second and third legs about equal in length, first legs slightly stouter, last pair turned backward and upward.

Abdomen large, extending beyond carapace in all directions.

Measurements.—Carapace: width, ranging from 4 to 15 mm. (Christensen and McDermott, 1958).

Color.—Whitish or salmon pink.

Recognition characters.—Mature male and hard-stage female: Carapace well calcified, flat dorsally, subcircular in outline, with truncate front more advanced than in mature female. Posterior margin straight; lateral margin thin, rather sharply bent from dorsal side, margin marked by a raised band of short dense hair. Eyes well developed. Buccal mass crescentic, arched, broad from side to side but short anteroposteriorly; cavity completely closed by external maxillipeds formed as in mature female.

Chelipeds stout; merus and carpus not slender as in mature female. Palm slightly flattened inside, swollen outside, and shaped as in mature female, both margins convex. Hand with bands of pubescence on upper and outer surface of palm, and outer surface of immovable finger. Fingers stout, especially immovable finger, with tips hooked past each other when closed; dactyl with small tooth proximally, tooth fitting between two protuberances on immovable finger when closed; both fingers with stiff hairs on gripping edges. Walking legs flattened, with posterior margins thickened, and with plumose swimming hairs on second and third pairs.

Abdomen narrow, confined to sternal depression; copulatory stylets of male well developed, first pair bladelike and hairy, second pair rodlike and almost hairless (Stauber, 1945).

Measurements.—Carapace: male, width, 1.4 to 4.6 mm.; female, width, 1.3 to 2.7 mm. (Christensen and McDermott, 1958).

Color.—Dark or medium-dark brown with two large, distinct, almost circular, pale white spots on both carapace and sternum; dorsal spots on branchial regions, ventral spots flanking abdomen and medial to first pair of legs; color and spots persistent in alcohol (various authors).

Habitat.—Parasitic [or commensal] chiefly in the oyster, *Crassostrea virginica*, also in *Pecten* spp. and *Anomia simplex* (Christensen and McDermott, 1958), and in *Mytilus edulis* (McDermott, 1961). Also occasionally found in *Chaetopterus* tubes (Gray, 1961).

Type locality.—Given as—"inhabiting the common oyster."

Known range.—Salem, Mass., to State of Santa Catarina, Brazil.

Remarks.—Say's *P. depressus* appears almost certainly to be the hard-stage male as described above and discussed below.

The works of Hyman (1924a), Stauber (1945), Sandoz and Hopkins (1947), and Christensen and McDermott (1958) together have made knowledge of the biology and life history of *P. ostreum* the most complete for any species of *Pinnotheres* in the world. The serious student should refer to these thorough works, for they can be summarized only in barest outline here. The complex life cycle of this species encompasses many developmental stages, as well as a striking sexual dimorphism in the mature animals, which, together with the structural specializations and mode of existence, demonstrate a beautiful accommodation to an unusual habitat.

The larval stages include four zoeae followed by one megalops. The first two zoeal stages were described by Hyman (1924a), and a description of all these stages (partial for fourth zoeal stage) was given by Sandoz and Hopkins (1947). In general, the zoeae and megalops have no dorsal or lateral spines on the carapace. Time of development from hatching to molting of the megalops to first crab stage is 25 days.

From the first crab stage on, development is summarized by Christensen and McDermott (1958, p. 154). The first crab stage, actually the stage which invades oysters, is called the invasive stage by these authors. It was described by Sandoz and Hopkins (1947) and in many respects is similar to the later hard stage in its flattened shape, legs adapted for swimming, and characteristic color markings (carapace width, 0.59–0.73 mm.).

In Delaware Bay, few invasions take place before August 1. The peak of oyster setting there is in July; spat will have grown to size sufficient to harbor one or more crabs by the peak of the crab invasions in September. Though invasive stages in oysters are found all winter, growth and development stop about the first of November when water temperatures begin to drop below 15° C. Surprisingly small spat may be invaded. Two crabs were found in an oyster 4.2 mm. long, and in larger spat up to seven crabs were found in a single specimen. The crabs prefer to invade spat or yearling oysters rather than older ones (76.7, 54.6, and 21.5, being respective infestation percentages for a given year class of crabs), but survival rate of crabs is better in yearlings and older oysters.

Following the invasive stage are two ill-defined stages designated as prehard. These stages, described by Christensen and McDermott (1958), are soft and resemble later posthard stages of the females (carapace width: male, 1.4–4.6; female, 0.75–2.7 mm.). The legs are rounded and not adapted for swimming. These stages are found in all parts of the water-conducting system of infested oysters. In the region of Delaware Bay, most young crabs reach the prehard stages before growth ceases in fall and they overwinter in these stages. Development resumes when temperatures rise above 15° C.

The hard stage, formerly regarded as the invasive stage, is characterized above. On the average, males are larger than females, as they are in the preceding stages. The form of this stage resembles that of the invasive stage, and males of this stage swim freely. This is the copulatory stage, and the males normally die in this stage.

The succeeding female stages, described by Stauber (1945), resemble the adult female, and are found only in the host on the gills. Stage II (the hard stage was designated as stage I by Stauber) has a thin flexible carapace but a narrow abdomen contained wholly in the sternal groove (carapace width, 1.3–3.1 mm.). Stage III has an abdomen extending beyond the depression in the sternum (carapace width, 2.6–4.4 mm.). Stage IV

has a relatively wide abdomen reaching the coxae of the legs in most cases (carapace width, 3.6–8.9 mm.). Stage V is the adult female described above.

The posthard stages are passed through rapidly. In Delaware Bay by mid-July, 62 percent of females have developed from the overwintering stage to maturity. By mid-August, 95 percent are mature and more than half are ovigerous; thus, *P. ostreum* reaches maturity within its first year. Males live 1 year or less, but females continue to grow after they have hatched their first batch of eggs and may live to an age of 2 or 3 years, though many probably die after they have hatched their eggs in the second summer. In the second or third year, females may become ovigerous as early as mid-June, and ovigerous yearlings may occur as late as mid-October. Farther south the breeding season is more extended, and ovigerous females have been collected near Ocracoke, N.C., as early as mid-April.

Ovigerous females measuring 9.4 and 10.8 mm. in width carried 7,957 and 9,456 eggs respectively. It is not known how long a female carries eggs, but it is believed to be 3 to 5 weeks. The females produce only one batch of eggs the first year but in a second or third year may produce twice.

Except for the brief free-swimming periods in the invasive hard stages, the crabs lead a parasitic existence. Stauber (1945) and Christensen and McDermott (1958) both found that the crab feeds on food filtered from water by the host by picking food strings from the margins of the gills with its chelipeds. The crab also will catch newly formed mucus-food masses with its walking legs and then reach beneath the abdomen with its chelipeds, comb the legs, and pass the food on to the mouth. The method of feeding for young crabs not on the gills is unknown, but they may filter food with the mouth parts. Posthard stages are found only on the gills, indicating that feeding on the food-laden mucus alone can insure adequate food for rapid growth and egg production. Growth of females is positively correlated with size of host and is probably related to food supply and amount of water pumping by the host.

The ordinary feeding activities are harmful to the host (Stauber, 1945), particularly causing gill erosion of two types, local erosion of one or more demibranchs, and an extensive shortening of demibranchs from the anterior end of gills to a point ventral to the adductor muscle. Christensen and McDermott (1958) noted that this erosion is a progressive process and nearly all infested oysters show some gill damage, some few older oysters having hardly any gill tissue left. Usually, however, only presence of a mature crab over a long time will noticeably affect growth of an oyster in normal environmental circumstances.

Pinnotheres maculatus Say. Mussel crab

Figure 190

Pinnotheres maculatum Say, 1818, p. 450.
Pinnotheres maculatus: Rathbun, 1918b, p. 74, text-figs. 35–36, pl. 17, figs. 3–6 (rev.).—Hay and Shore, 1918, p. 443, pl. 35, fig. 10.

Recognition characters.—Mature female: carapace suborbicular, somewhat broader than long, thick and firm but not hard, convex, smooth; surface uneven, covered with a short, dense, deciduous tomentum. Gastrocardiac area higher than, and separated by depressions from, branchiohepatic area. Front slightly advanced, approximately one-fifth width of carapace, subtruncate in dorsal view, slightly bilobed. Orbits small, subcircular, eyes spherical. Antenna longer than width of orbit; antennule large, obliquely transverse. Buccal mass roughly quadrangular, crescentic, much broader than long; ischium and merus of external maxilliped united; propodus larger than carpus; dactyl narrow, curved, spatulate, attached near middle of propodus, and reaching to near extremity of propodus.

Chelipeds moderately stout, articles subcylindrical and more or less pubescent; carpus elongate; palm thick, blunt edged, increasing in size distally; fingers stout, fitting closely together with tips hooking past each other; immovable finger nearly horizontal; dactyl with tooth near base fitting into sinus with tooth at either side on immovable finger. Walking legs slender, hairy above and below; second pair longest, shorter than chelipeds; first three dactyls falcate, shorter than propodi; last leg shortest, turned forward and upward, with long dactyl equaling propodus.

Abdomen large, extending to bases of legs.

Measurements.—Carapace: length, 13.7 mm.; width, 14.3 mm.

Color.—Obscure brown.

Recognition characters.—Mature male: Carapace flat, subcircular, diameter about half as great

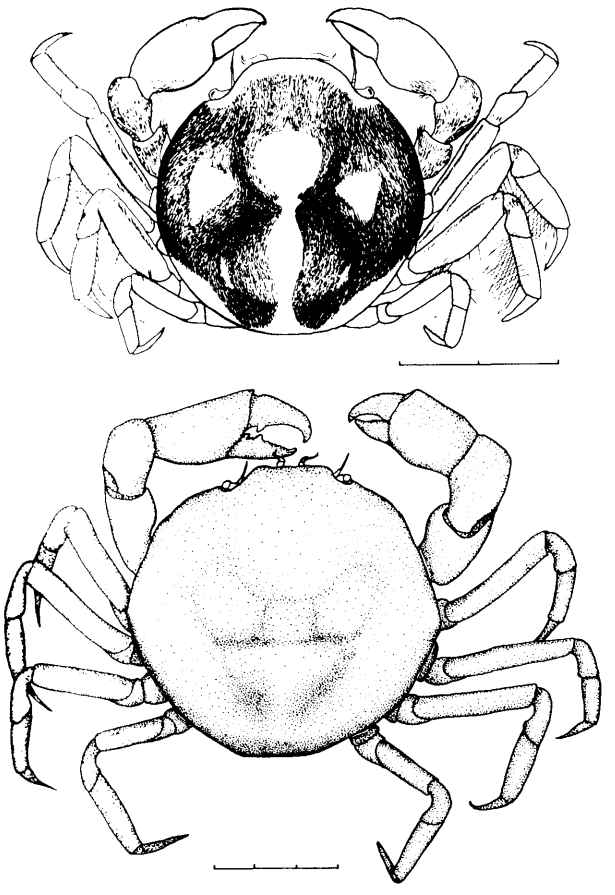

FIGURE 190.—*Pinnotheres maculatus* Say. Upper drawing: male in dorsal view, 2 mm. indicated; Lower drawing: female in dorsal view, 3 mm. indicated.

as female, somewhat longer than wide, harder than female. Regions superficially defined more by color than by structural prominence, light areas mostly elevated, usually allowing pubescence to wear; gastric, cardiac, and branchial regions separated by broad, shallow, confluent indentations. Front broad, prominent, depressed, slightly bilobed, approximately one-third width of carapace. Orbits subcircular, eyes large. Antennae somewhat longer than width of orbit.

Chelipeds shorter than in female, hands stouter. Walking legs wider, especially propodal articles of first three legs; posterior surface overlaid with thin fringe of hairs attached near upper margin; last leg relatively shorter than in female, not reaching propodus of third, dactyl more nearly like third than in female.

Abdomen at middle approximately one-third width of sternum, gradually narrowing from third to seventh segment, sides of third convex, of seventh obtusely rounded; sutures between segments of abdomen and sternum with narrow lines of dark pubescence.

Measurements.—Carapace: length, 9.1 mm.; width, 8.7 mm.

Color.—Striking light dorsal color pattern of bare spots on a background of dark pubescence consisting of a median stripe constricted in middle and behind, a subtriangular spot on each side in front of middle, and a linear spot on each side behind. Chelipeds with dark pubescence on inner and upper surface of carpus, a bit on upper surface of merus and inner side of palm proximally, otherwise scattered flecks on hands and walking legs.

Variations.—Young females resemble dark-colored males except in shape of the abdomen and the character of its appendages. Such females are free swimming and range upward in length to 5.2 mm. More mature females, light colored and commensal or parasitic in habit, range from 3.3 mm. in length upward. In such small and medium sized females the long hair on the legs persists.

Some males resemble mature females in coloration and structure of legs, ranging in length from about 4 mm. upward. Such males are commensal or parasitic in habit.

Individuals vary in stoutness of chelae, and in length and curvature of dactyls on the second legs. Normally this dactyl is like the dactyls on the first and third legs, but may be straightened and longer, and may occur on one or both sides of an individual and in different individuals in the same lot.

Habitat.—Mature males and females are commensal or parasitic in *Mytilus edulis*, *Modiolus modiolus*, *M. americanus*, *Mya arenaria*, *Aequipecten gibbus*, *A. irradians*, *Placopecten magellanicus*, oyster (?), *Atrina serrata*, and in tubes of *Chaetopterus variopedatus*, from *Molgula robusta*, the pharynx of *Bostrichobranchus pilularis*, and on *Asterias vulgaris*. The free-swimming stages have been found in bays and sounds. Surface to 25 fathoms.

Type locality.—Given as—"inhabits the muricated *Pinna* of our coast."

Known range.—Off Marthas Vineyard, Mass., to Mar del Plata, Argentina.

Remarks.—Though no detailed life-history studies have been made on this species comparable

to those on *P. ostreum*, more incidental data are available on mature individuals of both sexes from casual collecting. Ovigerous females have been found through most of the range of distribution. They have been reported in January from St. Thomas, March from Jamaica, May to November from Florida, June to January from North Carolina, July to September from Massachusetts and Rhode Island, and in June in Brazil (Rathbun, 1918b, and U.S. National Museum records). Hyman (1924a) described the first stage zoea which, unlike the zoeae of *P. ostreum*, has well-developed spines on the carapace. These zoeae are common near Beaufort, N.C., throughout the summer.

As in *P. ostreum*, the hard stage is found in both males and females and, though both swim actively, the males predominate in open water. An invasive stage may precede the relatively large hard stage as in *P. ostreum*. Unlike *P. ostreum* males, at least some *P. maculatus* males apparently live beyond the hard stage, for larger, somewhat globose males, resembling females in adaptation to parasitic or commensal life, occur in some hosts (see variations above).

Welsh (1932) found the swimming velocity of *P. maculatus* larvae to be greatly influenced by temperature and light intensity. The larvae are sensitive to only a small range of light intensity. At temperatures between 20° and 25° C. the maximum velocity of swimming is attained at intensities between 10 and 25 meter-candles. When series of measurements are made to determine the effective light at different constant temperatures, it is found that, besides a marked effect on general activity, there is a change in the relationship of velocity to intensity; slopes of curves showing these relationships change, and the maximum possible velocity of swimming for each temperature is reached earlier at the higher temperatures.

Genus ***Parapinnixa*** Holmes, 1894

Rathbun, 1918b, p. 107.

Parapinnixa bouvieri Rathbun

Figure 191

Parapinnixa bouvieri Rathbun, 1918b, p. 111, text-fig. 60, pl. 25, figs. 4–10.

Recognition characters. — Minute. Carapace smooth, shining, not more than twice as wide as long, longitudinally very convex, slightly convex

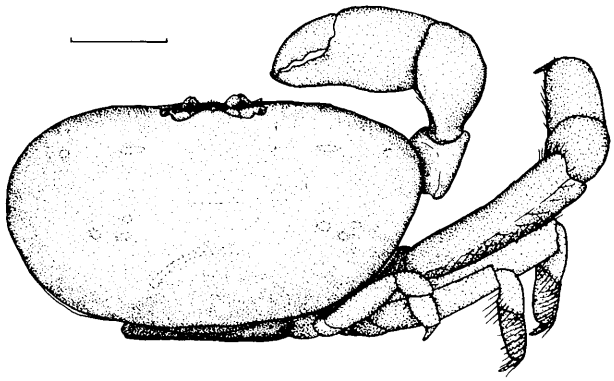

FIGURE 191.—*Parapinnixa bouvieri* Rathbun. Ovigerous female in dorsal view, legs of left side not shown, 1 mm. indicated.

transversely, sides arcuate; widest part with a thin pubescent margin on lower edge; anterior margin nearly straight, a row of four distant pits behind margin. Frontoorbital width about one-third carapace width. Front broadly triangular, deflexed, tip invisible in dorsal view, edge emarginate and pubescent; a pubescent groove running parallel to and immediately behind front terminating in orbital margins. Orbits circular, filled by eyes, cornea black, visible from above. Antennular cavities large, not wholly separated from each other or from orbits, and extending laterally beyond minute antennae. Outer maxilliped triangular when folded in place, two free corners rounded, longitudinal side approximately two-thirds as long as posterior side; ischium and merus fused, obliquely truncate distally leaving first joint of palp exposed; propodus elongate, distally tapering; dactyl small, suboval, both articles folding under merus.

Chelipeds short, stout, merus especially, partly hairy inside; palms thick, hairy outside; lower margin convex; immovable finger subtriangular, broad at base, a small tooth on gripping edge near tip; dactyl with small basal tooth, remainder of edge finely and irregularly denticulate. Walking legs with edges more or less pubescent, second and third pairs with line of long hairs applied to posterior surface of carpus and propodus; first leg thick, merus not reaching laterally beyond carpus of cheliped; second and third leg about equal; fourth small, not exceeding merus of third; dactyls of second and third legs longer and more slender than of first and fourth.

Male abdomen with sides gradually convergent, seventh segment not more than 1.5 times as long as wide; female abdomen with sides of triangular portion straight.

Measurements.—Carapace: female, length, 1.6 mm., width, 3.1 mm.; male, length, 2 mm., width, 3.5 mm.

Habitat.—Approximately 3 or 4 to 40 fathoms.

Type locality.—Off Cape Catoche, Yucatan, [Mexico]; *Albatross* station 2362.

Known range.—Off Charleston, S.C.; south of Tortugas, Fla.; Puerto Rico; and type locality.

Remarks.—Ovigerous females have been taken in Florida in August. The ovigerous specimen taken in Puerto Rico (no date) was found among ventral spines of a rose sea urchin (J. A. Rivero, U.S. National Museum).

Genus ***Dissodactylus*** Smith, 1870

Rathbun, 1918b, p. 114.—Hemming, 1958b, p. 31.

Dissodactylus mellitae Rathbun

Figure 192

Echinophilis mellitae Rathbun, 1900a, p. 590.

Dissodactylus mellitae: Rathbun, 1918b, p. 117, text-fig. 66, pl. 28, figs. 7–8 (rev.).—Hay and Shore, 1918, p. 444, pl. 36, fig. 1.

Recognition characters.—Minute. Carapace about one-fourth wider than long, slightly wider at lateral angles than posteriorly, dorsal surface convex, smooth, and polished except anterior portions slightly pubescent. Edge of front concave, fringed with short hairs. Anterolateral borders arcuate, with a fine raised rim curving inward on carapace at lateral angles and continuing mediposteriorly for some distance; posterior margin sinuous. Orbits opening medially, eyes small.

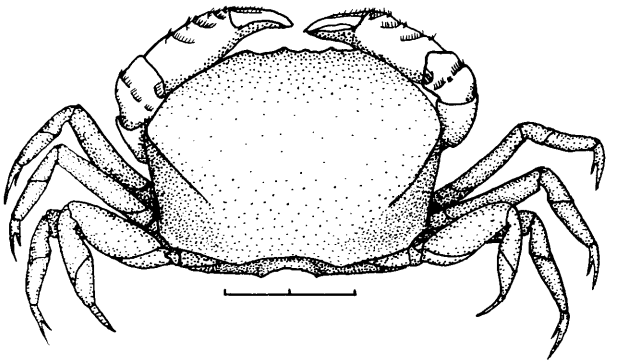

FIGURE 192.—*Dissodactylus mellitae* Rathbun. Animal in dorsal view, 2 mm. indicated.

Outer maxilliped with fused, spatulate merus and ischium; outer edge of carpus arcuate; propodus quadrate.

Chelipeds short and stout; hand longer than other articles combined, cylindrical, upper and outer faces bearing a few impressed, short, oblique lines with short appressed hairs extending distally; fingers considerably shorter than palm, bent inward and curved, opposable margins with tufts of short bristles; carpus with a distal fringe of short hairs and an impressed line similar to those on chelae; merus short and stout, lower surface with oblique lines. First, second, and third walking legs stout, margins fringed with short hairs, dactyls deeply bifid; fourth walking legs with styliform dactyls, fringed with long hairs on margins.

Abdomen of male with first and second, and third to fifth segments partially fused, margins convex; telson subtriangular with convex sides. Abdomen of female with first segment linear, second to fourth fused; telson broadly triangular, half as wide as sixth segment, sides sinuous.

Measurements.—Carapace: male, length, 2.9 mm., width, 3.5 mm.; ovigerous female, length, 3.3 mm., width, 4.5 mm.

Color.—Light, with scanty dark mottlings which persist in alcohol and are then of purplish color (Rathbun, 1918b).

Habitat.—This species clings to the outside of the keyhole urchin *Mellita quinquesperforata* and the sand dollars *Echinarachnius parma* and *Encope michelini.* The crabs are easily overlooked because as the sand dollars are lifted from the water, the small crabs may move about and drop off. Shallow water to 11.5 fathoms.

Type locality.—Pensacola, Fla., on *Mellita quinquesperforata.*

Known range.—Western part of Vineyard Sound, Mass., to Charleston, S.C.; western Florida.

Remarks.—Hyman (1924a) described the first zoeal stage of this crab, comparing it to the zoea of *Pinnotheres maculatus*, and reported it as common in plankton tows in the Beaufort, N.C., area in summer. Ovigerous females occur there during the same period, and are reported from Narragansett Bay in August (Rathbun, 1918b), and in Florida from July to October (Wass, 1955, in part).

Subfamily **Pinnothereliinae**

Carapace transverse, usually broadly so. Ischium of external maxilliped usually distinct from merus, though smaller and sometimes imperfectly united with it. Merus longitudinal or somewhat oblique; palp of good size, sometimes as large as merus-ischium (Rathbun, 1918b).

Genus ***Pinnixa*** White, 1846

Rathbun, 1918b, p. 128.—Hemming, 1958b, p. 35.

KEY TO SPECIES IN THE CAROLINAS

a. Posterior part of carapace with conspicuous, sharp, transverse ridge extending uninterruptedly from side to side_____*cristata* (p. 210).
aa. Posterior part of carapace without ridge, or with ridge on cardiac region only.
  b. Chela with immovable finger bent downward.
    c. Propodus of third walking leg less than twice as long as wide_____*chaetopterana* (p. 210).
    cc. Propodus of third walking leg slender, twice or more than twice as long as wide___*sayana* (p. 212).
  bb. Chela with immovable finger straight or nearly so, not bent downward.
    c. No cardiac ridge present_____*retinens* (p. 212).
    cc. With cardiac ridge present.
      d. Merus of third walking leg with posterior surface not deeply cupped out____*cylindrica* (p. 213).
      dd. Merus of third walking leg with posterior surface deeply cupped out_____*lunzi* (p. 214).

Pinnixa cristata Rathbun

Figure 193

Pinnixa cristata Rathbun, 1900a, p. 589.—1918b, p. 134, text-fig. 78, pl. 29, figs. 8–9 (rev.).—Hay and Shore, 1918, p. 446, pl. 36, fig. 5.

Recognition characters.—Carapace short, surface punctate, wrinkled, and microscopically granulate, slightly pubescent at extreme outer corners; a high, sharp, almost straight ridge extending without a break entirely across carapace somewhat in front of posterior border; a deep furrow behind gastric region. Anterolateral margin with a raised crest stopping short of hepatic region; posterior margin wide, concave. Front deflexed, not advanced. Orbit no wider than half of front.

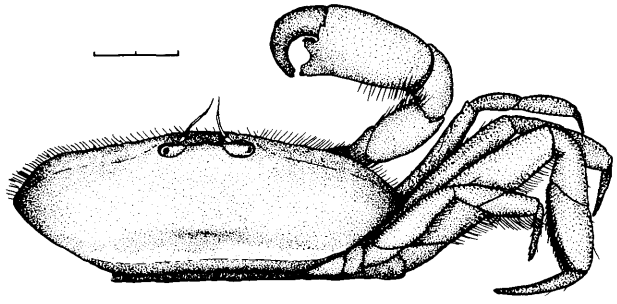

FIGURE 193.—*Pinnixa cristata* Rathbun. Male in dorsal view, legs of left side not shown, 2 mm. indicated.

Chelipeds rather stout; palm oblong with upper and lower margins convex, surface covered with reticulate pattern of fine granulations; immovable finger short, deflexed, gripping edge with a truncate subbasal tooth, another small tooth distally forming a truncate tip; dactyl long, gaping, with inner margin bent in a curved right angle. Walking legs somewhat longer than in related species, sparsely hairy along margins only, third walking leg strongest; dactyls slender, slightly curved on first three, straight on last walking leg.

Measurements.—Carapace: female, length, 4 mm.; width, 11 mm.

Type locality.—Beaufort, N.C.

Known range.—Beaufort, N.C., to Edisto Island, S.C.; Grand Isle, La., to Long Lake, Blackjack Peninsula, Aransas County, Tex. (Hedgpeth, 1950, and U.S. National Museum records).

Remarks.—The species has been taken from sandy beaches by digging or sifting in North Carolina and South Carolina, and Louisiana, and from the mouth of *Galeichthys felis* in Louisiana.

Pinnixa chaetopterana Stimpson

Figure 194

Pinnixa chaetopterana Stimpson, 1860a, p. 235.—Rathbun, 1918b, p. 151, text-figs. 93–94, pl. 33, figs. 3–6 (rev.).—Hay and Shore, 1918, p. 445, pl. 36, fig. 4.

Recognition characters.—Carapace transversely oval, somewhat more than twice as wide as long, more swollen in female than in male, surface uneven, sides densely pubescent. Regions well defined by pubescent grooves; cardiac region with an acute transverse crest broadly interrupted in middle forming two dentiform prominences, more conspicuous in male than in female; subbranchial region advanced, forming a prominent shoulder with granulated edge. Posterior margin concave. Front narrow, with a deep median groove.

Chelipeds stout, smooth, pubescent. Hand in male with distal palmar edge perpendicular; immovable finger short, deflected, truncate at tip, with a prominent rounded tooth on cutting edge; dactyl strongly curved, almost vertical, forming

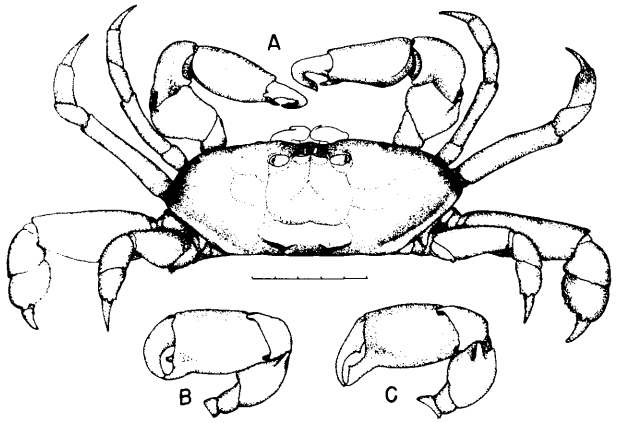

FIGURE 194.—*Pinnixa chaetopterana* Stimpson. A, male in dorsal view; B, chela of male in frontal view; C, chela of female in frontal view; 5 mm. indicated.

oval gape when closed with tips of fingers meeting. Hand of female relatively smaller; immovable finger with tooth somewhat beyond middle followed by an irregularly dentate, raised, cutting edge terminating in a blunt tip; dactyl with a small basal tooth, longer than in male, fingers agape proximal to cutting portion when closed with tips crossing each other. First and second pairs of walking legs slender, propodi with distal V-shaped row of spinules on lower border; dactyls with one or more short rows of spinules. Third pair longer and much stouter, conspicuously pubescent, and with inferoposterior margins of ischium, merus, and propodus dentate; fourth pair like third but smaller, with minute spinules on dactyls.

Male abdomen with sixth segment slightly constricted laterally at middle; telson semicircular.

Measurements.—Carapace: male, length, 6 mm., width, 14 mm.; female, length, 6 mm., width, 11 mm.

Variations.—Wass (1955) pointed out that two forms of this species occur on the northern Gulf of Mexico coast, a larger and smaller form.

Color.—Nearly white, but usually much obscured by brown or blackish hairs and by dirt collected in them; eggs bluish (various authors).

Habitat.—The large form of this crab lives commensally with the worms *Chaetopterus variopedatus* and *Amphitrite ornata*, and is seldom found outside their tubes. The small form lives in the upper portion of *Callianassa* burrows on the northern Gulf coast (Wass, 1955). Intertidal to 8.5 fathoms.

Type locality.—Charleston Harbor, S.C., on muddy or clayey shores in tubes of *Chaetopterus variopedatus* [=*pergamentaceus*].

Known range.—Wellfleet, Mass., to South Carolina; Punta Rassa, Fla., to Galveston, Tex.; Rio de Janeiro, and Villa Bella, São Sebastião, Brazil.

Remarks.—Ovigerous females have been reported from Beaufort, N.C., between April (Gray, 1961) and late October (Enders, 1905), from Florida in October (Wass, 1955) and February (Gray, 1961), and from southern Massachusetts in July and August (Pearse, 1913; Rathbun, 1918b). Otherwise they are known from South Carolina in February. Faxon (1879) and Hyman (1924a) described the first zoeal stage.

Some habits of this crab were observed by Pearse (1913) at Woods Hole, Mass. The species is strongly thigmotactic. Crabs placed on sand in an aquarium usually buried themselves, but soon explored the surface and entered and remained in glass tubes left lying on the sand. In experiments, crabs found a buried, artificial "*Chaetopterus* tube" by accident. Adult crabs could enter or leave this tube. The crabs moved either forward or sideways on sand. The third walking leg was the chief locomotor organ, but in tubes the crabs braced themselves with all the legs.

Crabs placed in standing water in an artificial worm tube were able to exist for 8 days before leaving the tube for better aerated water. The crabs' respiratory currents were feeble and inconstant in direction and force. Crabs were usually fouled with encrusting organisms and they took no trouble to clean their bodies except for mouth parts, eyes, and antennae. They fed by extending the fringed external maxillipeds and sweeping them toward the mouth, filtering small particles from the water, then cleaning the fringe with other mouth parts.

Gray (1961, see also account for *Polyonyx gibbesi*) described *Pinnixa chaetopterana* as primarily a mud crab and a facultative commensal of *Chaetopterus*. He found that the crabs readily enter and leave the tubes of the host, and if diameter of the parchment chimney of the worm tube is too small, the crab bites a hole at the base of the chimney to make an entrance or exit.

Pinnixa sayana Stimpson

Figure 195

Pinnixa sayana Stimpson, 1860a, p. 236; Rathbun, 1918b, p. 156, text-fig. 98, pl. 34, figs. 2–4 (rev.).—Hay and Shore, 1918, p. 446, pl. 36, fig. 3.

Recognition characters.—Carapace smooth, polished, lightly pubescent on sides, depressed at middle, a low, ill-defined, transverse ridge parallel with and close to posterior margin extending about one-third width of carapace. Anterolateral slope with similar ridge, lateral two-thirds of crest beaded. Front deeply grooved above.

Chelipeds with hands stout, compressed, hardly twice as long as broad; immovable finger very short, with truncate basal tooth; dactyl strongly curved. Walking legs long and slender, smooth; first walking leg reaching to propodus of second; second and third leg same length; fourth reaching beyond middle of carpus of third; merus of third leg approximately 3.5 times as long as wide, lower margin, and that of propodus, minutely denticulate; dactyls of first two legs slightly curved, of third straight, posterior edge of last dactyl slightly convex.

Measurements.—Carapace: male, length, 5 mm., width, 10 mm.; female, length, 4 mm., width, 7 mm.

Variations.—Females differ from males in that the cardiac ridge is lower and less sharp, the fingers do not gape, the immovable finger is longer and less bent, and the dactyl on the chela is more oblique.

Color.—Almost white, but lightly stained with brown.

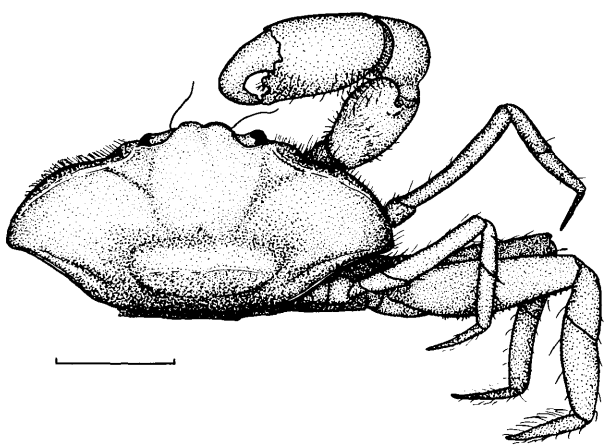

FIGURE 195.—*Pinnixa sayana* Stimpson. Male in dorsal view, legs of left side not shown, 1 mm. indicated.

Habitat.—The species has been found free in the water, has been dug out of mud, and is said to be found in the tubes of *Arenicola cristata;* shore to 26 fathoms.

Type locality.—Mouth of Beaufort Harbor, N.C., 6 fathoms, sandy mud.

Known range.—Vineyard Sound, Mass., to Beaufort, N.C.; Sarasota Bay, Fla., to Grand Isle, La.

Remarks.—Ovigerous females have been reported in August from Narragansett Bay, R.I. (Rathbun, 1918b), and are known in September from Louisiana. The last zoeal stage of a *Pinnixa*, commonly found off the New England coast and described by Faxon (1879), was tentatively referred to this species by Smith (1880a). Both Faxon and Smith found the first crab stage to follow immediately the last zoeal stage. These stages in development of *P. sayana* were summarized and illustrated by Hyman (1924a).

Pinnixa retinens Rathbun

Figure 196

Pinnixa retinens Rathbun, 1918b, p. 139, text-figs. 83–84, pl. 41, figs. 1–2.

Recognition characters.—Carapace nearly twice as wide as long, almost flat, except sloping downward toward margins; regions indicated. Lateral margin marked by sharp, granulate ridge reaching to subhepatic sulcus, no cardiac ridge; posterior margin preceded by a subparallel groove. Outer maxilliped with obliquely spatuliform dactyl attached to middle of inner margin of propodus.

Chelipeds small, approximately as long as first leg; hand with lower margin straight, suboblong, marginate below; fingers slender, subequal, not gaping; dactyl with tooth at proximal third of gripping edge. First and second walking legs similar; second a little longer, dactyls slightly curved, long, pointed. Third walking leg stout, exceeding second by length of dactyl and half of propodus; lower edge of ischium, merus, and propodus armed with stout spinules; posterodistal end of ischium prolonged in a stout, curved spine with point directed upward and backward; dactyl more curved than in first and second legs, pointed. Last leg extending to distal end of third merus; dactyl stout, nearly straight, tip curved slightly upward.

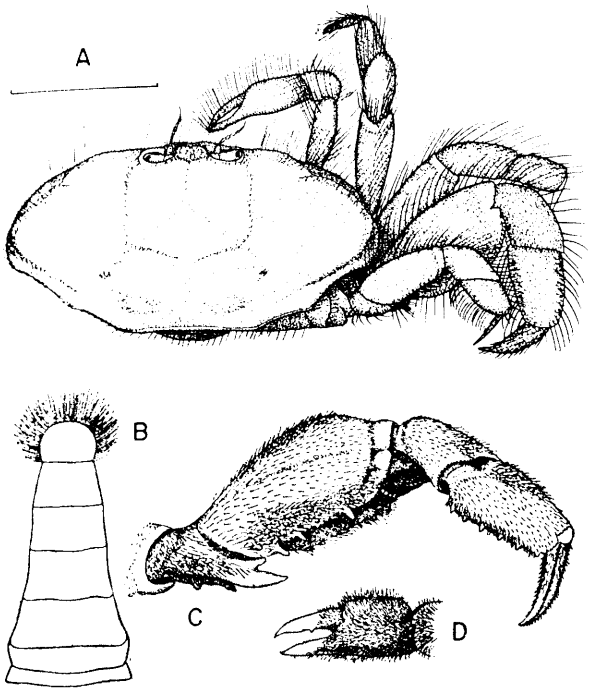

FIGURE 196.—*Pinnixa retinens* Rathbun. A, female in dorsal view, legs of left side not shown, 5 mm. indicated; B, male abdomen; C, male third walking leg, lower side; D, male left chela; B–D, holotype approximately × 9 (after Rathbun, 1918b).

Abdomen constricted at base of second segment, widest between second and third, and tapering to base of telson; telson wider than long; anterior and posterior margins of sternal segments granulate.

Measurements.—Carapace: male, length, 4 mm., width, 7 mm.; ovigerous female, length, 6 mm., width, 12 mm.

Habitat.—An ovigerous female was taken from the burrow of *Upogebia affinis* at Alligator Harbor, Fla., in June (Wass, 1955). Small specimens have recently been taken from mud bottom in Chesapeake Bay (Wass, personal communication). Near low-tide mark to 20 fathoms.

Type locality.—Chesapeake Bay, off Poplar Island, Md., 20 fathoms, soft bottom.

Known range.—Chesapeake Bay; Alligator Harbor, Fla.; Aransas area of Texas coast (U.S. National Museum records).

Remarks.—Though this species has never been reported in the Carolinas, its occurrence in the above localities would indicate that it probably ranges at least between them.

Pinnixa cylindrica (Say)

Figure 197

Pinnotheres cylindricum Say, 1818, p. 452.
Pinnixa cylindrica: Rathbun, 1918b, p. 159, text-fig. 99, pl. 35, figs. 5, 8 (rev.).—Hay and Shore, 1918, p. 446, pl. 36, fig. 2.

Recognition characters.—Carapace smooth, polished, punctate, punctations small and scarce in middle third, large and more numerous elsewhere; pubescent at extreme outer corners; depressed in middle; anterior cardiac region separated from gastric and branchial regions by a groove. Anterolateral portions with a sharp granulate crest not reaching cervical suture; middle of cardiac region crossed by a transverse (sometimes inconspicuous) ridge; posterior border short, somewhat concave. Front not prominent, bilobed, with submarginal groove.

Chelipeds moderately stout, smooth, punctate; hands suboval, approximately 1.5 times as long as wide; fingers horizontal, subequal in length, tips strongly hooked, overlapping when closed, leaving a gape; immovable finger with tooth near tip; dactyl with a tooth near middle; a finely milled crest running from tip of immovable finger backward and upward approximately two-fifths length of palm on outer surface. First walking leg slender, reaching to propodus of second; second stouter, reaching to middle of dactyl of third; third leg stoutest, merus 1.6 times as long as wide, distally narrowed, upper and lower margins finely granulate; fourth short; dactyls nearly straight, that of fourth leg convex posteriorly, slightly concave anteriorly.

Abdomen of male with sixth segment constricted laterally, constriction narrower than telson.

Measurements.—Carapace: male, length, 7 mm., width, 14 mm.; female, length, 10 mm., width, 20 mm. (McDermott, 1962).

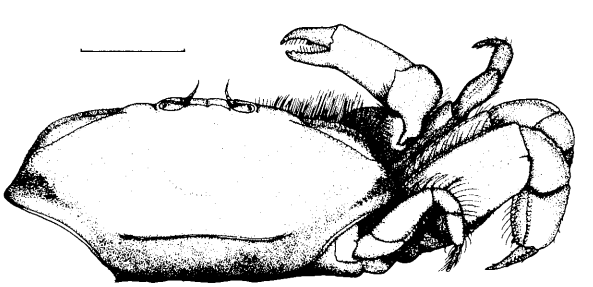

FIGURE 197.—*Pinnixa cylindrica* (Say). Female in dorsal view, legs of left side not shown, 5 mm. indicated.

763-049 O—65——15

Color.—Yellowish gray, light to dark brown, or sometimes grayish, and mottled with dark gray and/or white. Rhythmic chromatophore changes as well as genetic differences may control observed variations (McDermott, 1962).

Habitat.—The species lives in burrows of *Arenicola cristata* Stimpson (Wass, 1955; McDermott, 1962), and possibly with other large annelids; shallow water to 20 fathoms.

Type locality.—Jekyll Island, Ga.

Known range.—North Falmouth, Mass., to Alligator Harbor, Fla.

Remarks.—McDermott (1962) summarized existing knowledge of the habits of this species and added numerous ecological observations. He reported the crab for the first time from New Jersey, finding it associated with 76 percent of the lugworms collected during summer. Crabs and worms were collected by manual digging. With one exception, single crabs were found on worms.

Of 18 female crabs found in July, 16 were ovigerous. One captive female produced eggs on July 7 and liberated zoeae "around" August 5. Crabs which liberated zoeae when collected produced new sponges of eggs which were in late stages of development approximately 30 days later. McDermott judged that this species produces at least two egg masses in a breeding season. Molting between broods did not occur in the laboratory.

Associates of *P. cylindrica* were found to be *Zoothamnium sp.*, attached *Crepidula convexa* Say, and colonies of *Triticella elongata* (Osburn).

Pinnixa lunzi Glassell

Figures 198–199

Pinnixa lunzi Glassell, 1937, p. 3, figs. 1–8.

Recognition characters.—Carapace slightly more than twice as wide as long, punctate, regions indicated, borders flanged, with a shoulder formed near wide lateral angle. Gastric and cardiac regions separated by a depression connecting with a deeper depression on each side of these regions; a prominent cardiac ridge extending transversely almost across carapace with an abrupt slope from crest of ridge to posterior border. Front prominent, bilobed, truncate, upturned over antennules.

Chelipeds stout; hands of male shorter and stouter than in female, appearing disproportionately small in female; palm with margins subparallel in female, widest at base of dactyl in male; in both sexes fingers gaping; immovable finger horizontal, armed with row of small teeth, distal tooth largest; dactyl stout, curved, armed with median lobe. Walking legs stout. First two lightly crested with setae on merus; carpus crested with a sharp beaded rim; propodus armed with a row of fine, sharp, brown spinules; dactyls contorted, sharp pointed, fluted, with rows of small,

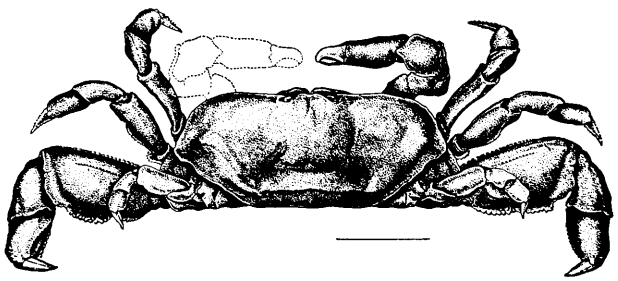

FIGURE 198.—*Pinnixa lunzi* Glassell. Male holotype in dorsal view, 7 mm. indicated (after Glassell, 1937).

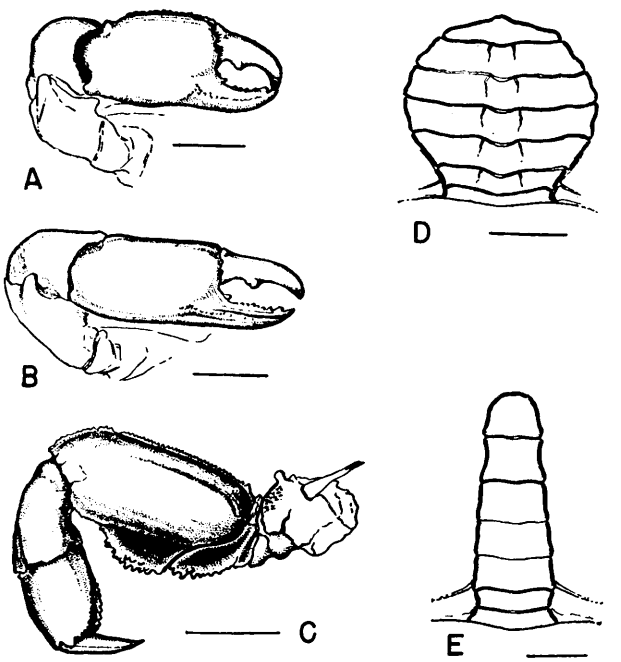

FIGURE 199.—*Pinnixa lunzi* Glassell. A, right chela of male; B, right chela of female, 3 mm. indicated; C, left third walking leg of female, 4 mm. indicated; D, abdomen of female, 6 mm. indicated; E, abdomen of male, 3 mm. indicated (after Glassell, 1937).

sharp, forward pointing spinules on crests. Third leg large; merus with two separated, upper, crenulated margins, lower border tuberculate, posterior surface with a deep, pubescent concavity, smooth within; ischium at lower distal end extending well past base of merus and with meral concavity continued on posterior face, lower border tuberculate; carpus and propodus together equal in length to upper length of merus; dactyl stout, nearly straight, without minute spinules. Fourth leg similar to third but smaller, merus with lower border tuberculate, dactyl slightly upturned at tip.

Male abdomen with telson semioval, sides not wider than concave sided sixth segment; third, fourth, and fifth segments partially fused.

Measurements.—Carapace: male, length, 9 mm., width, 21 mm.; female, length, 9 mm., width, 21 mm.

Color.—In alcohol, a muddy bluish brown; legs, abdomen, and chelipeds ivory.

Type locality.—Isle of Palms (about 15 miles northeast of Charleston, S.C.), washed on beach, under drift material.

Remarks.—The above account is taken chiefly from Glassell (1937). The types are the only known specimens and the host and habitat are unknown.

Family **Palicidae**

Carapace broadly transverse, subquadrilateral. Anterolateral margins dentate. Frontoorbital width great, front dentate. Orbits and eyes large. Buccal cavity quadrate, outer maxillipeds not covering it; ischium of third maxillipeds strongly produced forward on inner side; merus small, subtriangular, with a notch on inner distal side for articulation of palp. Afferent channels to branchiae opening at bases of chelipeds; efferent channels at anteroexternal angles of buccal cavity.

Chelipeds of moderate size, often unequal in male, usually tuberculate or granulate. Next three pairs of legs long, slender, and rough; last pair either very short and slender, subdorsal, smooth, or similar in position and ornamentation to other legs, and near size of first walking leg. Abdomen of male much narrower than sternum (Rathbun, 1918b).

Genus ***Palicus*** Phillipi, 1838

Rathbun, 1918b, p. 183; Holthuis and Gottlieb, 1958, p. 104.

KEY TO SPECIES IN THE CAROLINAS

a. Merus of second and third walking legs with an obtuse lobe at superodistal angle; frontal notch shallow, forming nearly a right angle at base_____*alternatus* (p. 215).

aa. Merus of second and third walking legs with a prominent, sharp pointed lobe at superodistal angle; frontal notch deeper than wide_____*faxoni* (p. 216).

Palicus alternatus Rathbun

Figure 200

Palicus alternatus Rathbun, 1897a, p. 95.
Cymopolia alternata: Rathbun, 1918b, p. 188, text-fig. 117, pls. 42–43 (rev.).

Recognition characters.—Carapace broader than long, somewhat depressed, elevations covered with small tubercles composed of single or a few granules. Front broadly triangular, notched at middle, with four lobes or teeth, outer teeth less advanced than inner and broadly rounded. Eyes large; orbits deep, with upper border cut into teeth; middle tooth broad, obliquely truncate, bounded on each side by a V-shaped fissure; next tooth separated from outer tooth by a shallow sinus; outer tooth directed forward or a little outward, tip curved inward. First two anterolateral teeth dentiform with rounded tips, separated

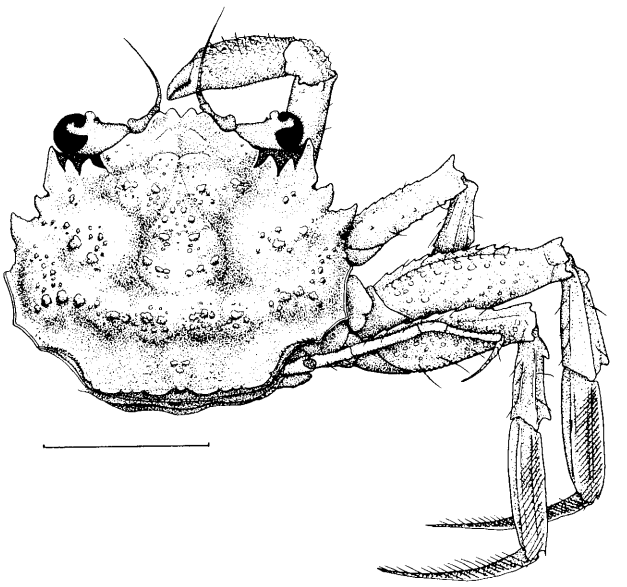

FIGURE 200.—*Palicus alternatus* Rathbun. Animal in dorsal view, legs of left side not shown, 5 mm. indicated.

by small V-shaped sinuses; third tooth rudimentary or in form of a small tubercle. Suborbital margin oblique, with two clefts; outer lobe nearly straight; inner lobe divided into two parts with inner angle produced in an acute tooth beyond triangular, pterygostomian lobe. Posterior margin bordered above by a thin, sinuous, elevated ridge broken into a variable number of unequal transverse tubercles with usually some granules interspersed.

Chelipeds of male occurring in two forms. In one form, chelipeds very unequal; on right side large and heavy, on left, slender and weak, both tuberculate and pubescent; carpus with an outer, laminated, lobed crest; hand surmounted by a similar double crest. Right hand very thick, width at distal end often equaling one-half length of carapace; immovable finger short, wide; dactyl strongly bent down, overlapping opposed finger and leaving a narrow gape. Left hand somewhat over one-third width of right, fingers long and narrow. In second, weaker form males, right hand about twice depth of left; fingers long and slender. Females with chelipeds more nearly equal.

Second pair of walking legs longer than others. First walking legs reaching middle of propodus of second, with posterior margin of propodus and proximal half of dactyl hairy in male; third walking leg reaching middle of dactyl of second, fourth leg slender, much shorter than third. Meri rough with squamous tubercles; with a single longitudinal groove on anterior surface, two on upper surface; first three meri with a superodistal lobe, subtriangular on first, subrectangular in second and third, lobe exceeding article in first, equal to article in second, not reaching end of article in third. Carpus with a rounded, anterior proximal lobe; anterior subdistal lobe low and rounded on first leg, triangular on second and third legs. Propodus with anterior margin convex, posterior margin straight.

Abdominal appendages of first form of male stout and twisted, tip bilobed, inner lobe thinner and longer than outer; second form of male with appendages weaker, not twisted, and tip less spreading.

Measurements.—Carapace: male, 7 mm., width, 8 mm.; female, length, 8 mm., width, 9 mm.

Variations.—This species shows great variation in structure. In some individuals the carapace is wider behind in proportion to its length than in typical individuals, and the sides are less parallel. There is no consistency in relative size of the anterolateral teeth, for in some the first are largest and all teeth point forward, but in others the second teeth are largest and point slightly outward. In some individuals the anterodistal tooth on the merus of the second and third legs is more produced than in typical specimens, and there is variation in the length-width proportions of the propodus of the second leg. Details of lobulation on the front and lower margin of the eye are also subject to variation.

Habitat.—The species has been taken from a variety of fine and coarse bottoms (Rathbun, 1918b); 4 to 60 fathoms.

Type locality.—Lat. 29°11′30″ N., long. 85°29′ 00″ W., 26 fathoms (south of Cape San Blas, Fla.).

Known range.—Cape Hatteras, N.C.; Gulf of Mexico along west coast of Florida from Cape San Blas to Key West.

Remarks.—Ovigerous females have been reported in Florida from January to August, and from North Carolina in October (Rathbun, 1918b, and U.S. National Museum records).

Palicus faxoni Rathbun

Figure 201

Palicus faxoni Rathbun, 1897a, p. 96.
Cymopolia faxoni: Rathbun, 1918b, p. 194, text-fig. 120, pl. 45, figs. 2–3 (rev.).

Recognition characters.—Carapace broader than long, sides converging anteriorly; adult female quite convex, surface hairy, and with numerous tubercles and granules. Front broadly triangular; four frontal lobes well marked, outer pair not much wider than inner, median emargination deeper than wide with end often rounded, lateral emarginations shallow. Eyes large; orbits deep, with upper border cut into teeth by V-shaped sinuses, middle and outer teeth triangular, subacute, middle one equilateral, outer one narrow and separated from outer orbital tooth by a shallower sinus; outer tooth directed forward, tip oblique, its lateral margin nearly straight. Lateral border with two similar, sharp-pointed teeth, second one smaller, outer borders convex, inner concave. Lower margin of orbit oblique, bilobed; inner lobe in advance of outer, divided in two, outer portion rounded, inner portion a small acute

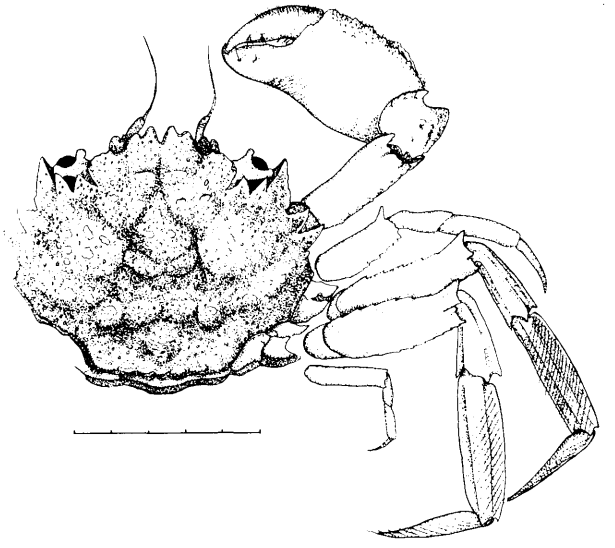

FIGURE 201.—*Palicus faxoni* (Rathbun). Male in dorsal view, legs of left side not shown; cheliped, second and third walking legs detached; first and fourth walking lags from female in Rathbun (1918b); 5 mm. indicated.

tooth somewhat obscured by ventrally bent pterygostomian lobe, sharp pointed at tip; outer lobe slightly convex. Posterior margin preceded by a tuberculate ridge.

Chelipeds in both sexes somewhat unequal, right hand approximately twice as wide as left. Walking legs short and broad; first three meral articles with a large, flat, acute distal spine, posterior distal tooth of merus sharp; carpal lobes prominent, distal one of second and third legs acute; propodus of second and third legs widening distally, dactyls wide, posterior margin sinuous.

Measurements.—Carapace: male, length, 10 mm., width, 10 mm.; female, length, 10 mm., width, 11 mm.

Habitat.—Thirty-two to 51 fathoms.

Type locality.—Off Cape Hatteras, N.C., 49 fathoms.

Known range.—Type locality; off Jacksonville, Fla.; off Yucatan, Mexico; off Cabo Frio, Rio de Janeiro, Brazil(?).

Family **Grapsidae**

Front quite wide; carapace usually quadrilateral, with lateral borders either straight or slightly arched, and orbits at or near anterolateral angles. Buccal cavern square; generally a gap, often large and rhomboidal, between external maxillipeds. Male openings sternal. Palp of external maxillipeds articulating either at anteroexternal angle or at middle of anterior border of merus, exognath either slender or broad. Interantennular septum broad. Division of orbit into two fossae accented (Rathbun, 1918b).

KEY TO SUBFAMILIES, GENERA, AND SOME SPECIES IN THE CAROLINAS

a. Antennules folding beneath front of carapace in usual way.
  b. Third maxillipeds without a pubescent oblique ridge.
    c. Lower border of orbit running downward toward buccal cavern (Subfamily Grapsinae).
      d. Carapace decidedly broader than long. *Pachygrapsus transversus* (p. 217).
      dd. Carapace about as long as broad; legs strongly fringed with hairs——*Planes minutus* (p. 218).
    cc. Lower border of orbit not running downward toward buccal cavern, but supplemented by remote suborbital crest in line with anterior border of epistome (Subfamily Varuninae) *Euchirograpsus americanus* (p. 220).
  bb. Third maxillipeds with an oblique pubescent ridge crossing ischium and merus (Subfamily Sesarminae) *Sesarma* (p. 221).
aa. Antennules visible dorsally in deep clefts in front of carapace (Subfamily Plagusiinae).
  b. Carapace broader than long *Plagusia depressa* (p. 223).
  bb. Carapace longer than broad *Percnon gibbesi* (p. 224).

Subfamily **Grapsinae**

Front usually strongly deflexed. Lower border of orbit running downward toward buccal cavern. Antennal flagellum very short. External maxillipeds usually separated by a wide rhomboidal gap, not traversed by an oblique hairy crest; palp articulating at or near anteroexternal angle of merus; exognath narrow and exposed throughout. Male abdomen filling all space between last pair of legs (Rathbun, 1918b).

Genus ***Pachygrapsus*** Randall, 1840

Rathbun, 1918b, p. 240.

Pachygrapsus transversus (Gibbes). Mottled shore crab

Figure 202.

Grapsus transversus Gibbes, 1850, p. 181.
Pachygrapsus transversus: Rathbun, 1918b, p. 244, pl. 61, figs. 2–3 (rev.).—Hay and Shore, 1918, p. 447, pl. 36, fig. 9.

Recognition characters.—Small species. Carapace rectangular, about one-fourth broader than

FIGURE 202.—*Pachygrapsus transversus* (Gibbes). Animal in dorsal view, legs of left side not shown, 5 mm. indicated.

long, depressed, polished, with fine transverse plications, except oblique ones on branchial regions. Sides slightly arched, strongly converging posteriorly, and armed with a well-marked tooth behind orbital angle. Front slightly more than half as wide as carapace, edge sinuous and granulate, upper surface with four low elevations. Orbits oblique, approximately two-fifths width of front, lower border denticulate.

Chelipeds equal, much stouter than legs, 1.6 times longer than carapace in male, finely granulate; inner edge of merus produced in a laminate, toothed expansion; meri of all legs and carpus of cheliped transversely striated; carpus with blunt internal tooth; upper surface of palm with a marginal line, oblique striae on inner and lower side, an oblique line on outer surface near lower edge; fingers narrowly gaping except for large triangular tooth near middle of immovable finger. Merus of walking legs with posterodistal angle dentate; first and fourth walking legs subequal, second and third pairs longer and subequal, last three articles bristly and thorny. Female with conspicuous feathery hairs on carpus and propodus of first walking legs.

Male abdomen with telson broadly triangular.

Measurements.—Carapace: male, length, 11 mm.; width, 14 mm.

Color.—Variable; ground color almost black, olive green, yellowish, yellowish brown or dull gray, covered by irregular mottlings of dark brown, reddish or dark olive; usually darkest anteriorly with transverse ridges edged with greenish gray, reddish or dark brown; chelae often plain or reddish brown, tips light; walking legs brown or blackish with gray spots (various authors).

Habitat.—This species is found among rocks, on pilings, on roots of mangroves, and on sandy shores.

Type locality.—Key West, [Fla.].

Known range.—Cape Lookout, N.C., to Montevideo, Uruguay; Bermuda. Beyond this region the species has a wide distribution in tropical and subtropical seas and has been carried to higher latitudes than it normally inhabits by transport on ships' bottoms.

Remarks.—At Bermuda, where this crab is abundant, ovigerous females have been observed from April to July (Verrill, 1908). Ovigerous females have been reported from February to August in various parts of the Caribbean area (Rathbun, 1918b, in part), and are known from North Carolina in August and September. Lebour (1944) illustrated some of the larval stages of this species from their occurrence at Bermuda.

Pearse (1932b) reported the protozoan *Epistylis*, and Verrill (1908) the isopod *Leidya distorta* in the gill cavities of this crab.

In the past, occurrence of this crab in the Beaufort, N.C., area has been irregular and these intrusions from more southerly waters may reflect annual variations in temperature or occasional transport on vessels. As Verrill (1908) suggested, the range of this species may have been greatly extended by commerce in modern times.

Genus ***Planes*** Bowdich, 1825

Rathbun, 1918b, p. 253.—Chace, 1951.—Hemming, 1958b, p. 36.

Planes minutus (Linnaeus). Gulf weed crab; turtle crab; Columbus crab

Figure 203

Cancer minutus Linnaeus, 1758, p. 625.
Planes minutus: Hay and Shore, 1918, p. 448, pl. 36, fig. 6.—Chace, 1951, p. 81, figs. 1a, 2 a, d, g, j, k, l, 3 a–h (rev.).—Holthuis, 1959, p. 240.

Recognition characters.—Carapace approximately as wide as long, subquadrate in young, trapezoidal in medium sized, laterally convex in old individuals, convex dorsally, smooth, but with faint oblique lines on outer part of branchial region. Front approximately half as wide as cara-

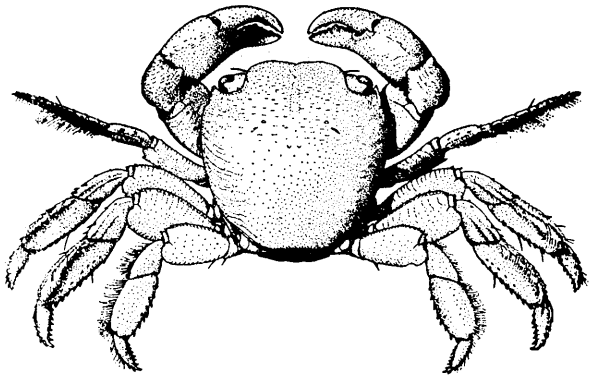

FIGURE 203.—*Planes minutus* (Linnaeus). Male in dorsal view, approximately × 2 (after Chace, 1951).

pace, decurved, usually slightly emarginate in middle, edges minutely denticulate or smooth. Eyes large; orbits large, lower margin granulate, tooth at inner angle equilateral, subacute, outer angle spiniform, behind it a small sinus.

Chelipeds large and heavy; merus and ischium with a thin serrate crest along inner margin terminating in two or three spines at distal end of merus; carpus with a strong blunt spine on inner face; hands inflated and smooth except for small sharp granules near lower margin; immovable finger bent downward, especially in males, dactyl curved, both with blunt teeth throughout length. Walking legs long, slender, and flattened; second and third legs subequal, fourth legs shortest; meri occasionally with an inconspicuous anterior subterminal tooth and a few posterior denticles; last three articles thorny and with a dense fringe of hair on anterior edge.

Abdomen of male rather broadly triangular; telson rather narrowly triangular, approximately as long as basal width.

Measurements.—Carapace: male, length, 19 mm., width, 19 mm. Length of a large series reported by Chace (1951), 3.7 to 19 mm.

Color.—Extremely variable; irregularly mottled or blotched with light greenish yellow or pale yellow on a darker olive-green ground color; or reddish-fawn color, more or less blotched with dark brown, and usually with a small white spot on each side or one large white spot on front of carapace (various authors).

Crozier (1918) observed no color change in a mahogany-colored *P. minutus* placed for a day on a lighter background. Hitchcock (1941) found three types of chromatophores in *P. minutus:* white, black, and yellow. The most prominent chromatophore is white. Color adaptation to different backgrounds is slow and though the chromatophores are responsive to change in background, extracellular pigment in the hypodermis and exoskeleton prevents the animal from effecting an immediate change in appearance. Hitchcock concluded that the pattern of the individual crab is probably genetic. Chace (1951) remarked that in view of these findings, the apparent color of any individual can be changed only at the time of molting.

Habitat.—These crabs are more abundant on *Sargassum* in the Sargasso Sea than elsewhere, but throughout their range they depend on flotsam, or on floating or swimming organisms to which they cling (Chace, 1951).

Type locality.—On sargasso and other submarine sea plants on the north side of Jamaica (Sloane *in* Holthuis, 1959).

Known range.—Atlantic Ocean south of Newfoundland, west of 50° W. latitude, and exclusive of the Gulf of Mexico (Chace, 1951); Netherlands coast, North Sea (van den Oord and Holthuis, 1959).

Remarks.—The genus *Planes* has been thoroughly reviewed by Chace (1951), and the serious student should consult this paper. Chace included remarks on relative growth, stating that . . .

> The carapace length-width relationship remains fairly constant with a slight tendency toward narrowing, from the smallest immature specimens examined to a carapace length of about 11 mm. At this stage the carapace seems to become somewhat narrower rather abruptly and continues to become narrower at a slightly more rapid rate than during the younger stages. A similar, but even more striking, trend is noticed in the relative shortening of the walking legs.

Chace conjectured that the specimens larger than about 11 mm. are found on flotsam and turtles rather than on sargassum, and that the shorter legs may be more adapted to this existence than to life on floating weed. It is also possible that these sizes represent different forms of *Planes* with somewhat different habits, but Chace deferred such a designation until a time when more material is available for study.

Both Hyman (1924b) and Lebour (1944) illustrated some larval stages of *Planes minutus*. In the region of the Carolinas, ovigerous females have been taken virtually throughout the year.

Subfamily **Varuninae**

Front moderately or little deflexed, sometimes sublaminar. Branchial region with downward sloping posterolateral portion set off from rest of region by a more or less distinctly marked line. Suborbital crest, supplementing defective lower border of orbit, rather distant from orbit and usually running in a line with anterior border of epistome. Antennal flagellum usually of good length. External maxillipeds moderately or slightly gaping, without oblique hairy crest; palp articulating with middle of anterior border or near anteroexternal angle of merus; exognath in American genera rather narrow, sometimes partly concealed. Male abdomen rarely covering all space between last pair of legs (Rathbun, 1918b).

Genus ***Euchirograpsus*** Milne Edwards, 1853

Rathbun, 1918b, p. 281—Hemming, 1958b, p. 31.

Euchirograpsus americanus Milne Edwards

Figure 204

Euchirograpsus americanus Milne Edwards, 1880, p. 18.—Rathbun, 1918b, p. 282, text-fig. 144, pl. 74.—Hay and Shore, 1918, p. 448, pl. 36, fig. 7.—Garth, 1946, p. 511, pl. 85, figs. 5–6.

Recognition characters.—Carapace slightly broader than long; sides nearly straight and parallel, flattened posteriorly, sloping gently down toward sides and front; surface covered with granules and short, soft hair. Front somewhat produced, lamellate, with a narrow median notch. Eyes large; orbits large, a small tooth at inner angle; upper margin oblique, sinuous; outer angle spiniform, behind it three smaller spines on lateral margin, middle spine largest; lower margin of orbit denticulate. Third article of antennae hollowed out on inner side.

Chelipeds stout, 1.5 times as long as carapace; merus with surface crossed by fine granulated lines, margins spinulose, a superior subdistal spine; carpus with inner distal margin spinulose; hand with three spinulose ridges above, a ridge near lower edge, and another less distinct through middle; fingers slender, grooved, pointed, gripping edges with low, irregular teeth fitting together. Walking legs slender, compressed, hairy; second pair over twice length of carapace; all meri crossed by fine granulated lines and with three subdistal spines, one above, one inner, and one outer below, first merus spinulose below; dactyls armed with long spines.

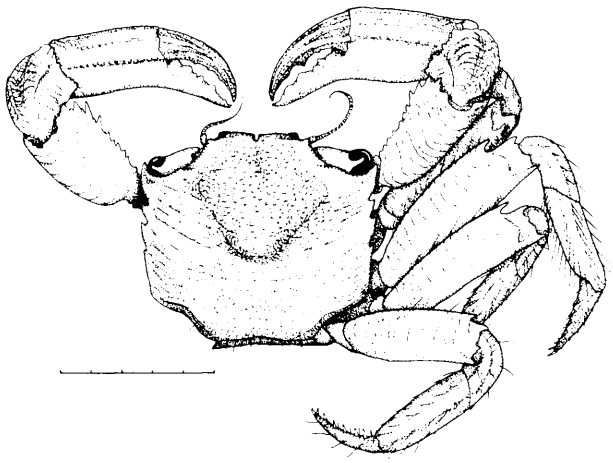

FIGURE 204.—*Euchirograpsus americanus* Milne Edwards. Animal in dorsal view, walking legs of left side not shown, 5 mm. indicated.

Measurements.—Carapace: female, length, 14 mm.; width, 16 mm.

Color.—Yellowish gray, arranged in marblings on carapace and in alternately light and dark bands on legs, or light brown with five or six bands of red on legs (various authors). More detail given by Garth (1946).

Habitat.—Seventeen to 278 fathoms.

Type locality.—Barbados, 69 fathoms, *Blake* station 278.

Known range.—Off Oregon Inlet, N.C., through West Indies to Barbados, and through Caribbean Sea to Monosquillo [Morrosquillo], Colombia; Galapagos Islands.

Remarks.—This species had rarely been taken off the Carolinas until recently. Offshore collecting has shown it to be not uncommon, and a northern, as well as upper bathymetric record, was established when an ovigerous female was taken off Oregon Inlet, N.C., at 17 fathoms in February (Cerame-Vivas, Williams, and Gray, 1963). Ovigerous females are otherwise known in Florida from March to September.

Subfamily **Sesarminae**

Front strongly deflexed. Lower border of orbit commonly running downward toward angle of buccal cavern. Side walls of carapace finely reticulated with granules and hairs or hairs only. External maxillipeds separated by a wide rhomboidal gap, an oblique hairy crest traversing them from a point near anteroexternal angle of ischium to a point near anterointernal angle of merus; palp articulating either at summit or near anteroexternal angle of merus; exognath slender and either partly or almost entirely concealed. Male abdomen either filling or not quite filling all space between last pair of legs (Rathbun, 1918b).

Genus ***Sesarma*** Say, 1817

Rathbun, 1918b, p. 284.

KEY TO SPECIES IN THE CAROLINAS

a. Lateral margin of carapace sinuous; last three articles of first three walking legs tomentose; body strongly convex above ..... *reticulatum* (p. 221).

aa. Lateral margin of carapace straight; walking legs not tomentose; body nearly flat above ..... *cinereum* (p. 222).

Sesarma (*Sesarma*) *reticulatum* (Say)

Figure 205

Ocypode reticulatus Say, 1817, p. 73, pl. 4, fig. 6.
Sesarma reticulatum: Rathbun, 1918b, p. 290, pl. 77 (rev.).
Sesarma reticulata: Hay and Shore, 1918, p. 448, pl. 36, fig. 12 (rev.).

Recognition characters.—Carapace about four-fifths as long as broad, convex, regions distinct, surface punctate and with scattered clumps of setae above and in front; sides concave behind widest point, convergent at orbital angles. Posterolateral regions obliquely striated and setose; inferolateral and frontal regions with irregular rows of tubercles bearing short, curved hairs. Dorsal portion of carapace overhanging sides; beneath projecting shelf a line of cilia. Lower surface of carapace covered with fine net of geniculate hairs. Front broad, slightly sinuate above basal articles of antennae. Eyestalks short and stout, set in deep oval orbits; a deep gap below outer orbital angle leading into system of grooves opening into a notch at anterolateral angle of buccal cavern. External maxillipeds separated by a wide rhomboidal gap largely filled by a hairy fringe, and obliquely traversed by a conspicuous line of hairs from point behind anteroexternal angle of ischium to anterointernal angle of merus.

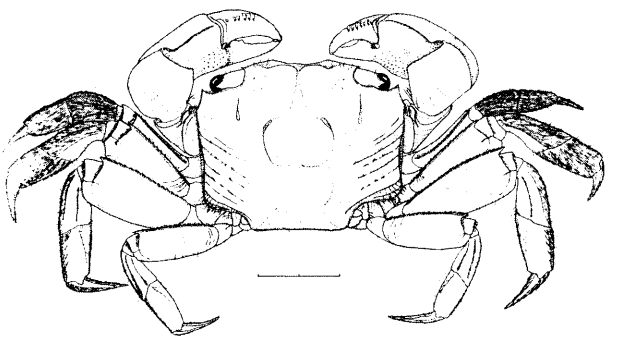

FIGURE 205.—*Sesarma* (*Sesarma*) *reticulatum* (Say). Animal in dorsal view, 10 mm. indicated.

Chelipeds stout, subequal in male; merus and carpus lightly rugose; merus with an obtuse subterminal tooth above, both lower margins denticulate; carpus with inner angle rounded. Palm almost smooth, in male a little higher than midlength, upper edge with a single granulate line, inner surface with a short irregular ridge of tubercles near distal end; dactyl with seven to nine depressed spinules above on basal two-thirds; fingers agape, an enlarged tooth near each end. Palm of female half again as high as midlength, fingers slightly agape. Third pair of walking legs approximately twice as long as carapace, last three articles densely tomentose.

Measurements.—Carapace: male, length, 23 mm.; width, 28 mm.

Color.—Carapace dark olive, nearly black or purple; dark plum colored or bluish-black speckles crowded on grayish background, grayish color showing little except on posterior part; upper part of chelipeds similarly colored but brighter, greater part of palm yellowish, tips of fingers white or yellowish; upper part of legs as carapace; under parts grayish (various authors).

Habitat.—Burrows in muddy salt marshes.

Type locality.—Muddy salt marshes [east coast of United States].

Known range.—Woods Hole, Mass., to Calhoun County, Tex.

Remarks.—Ovigerous females have been reported from Massachusetts in July, and in summer months farther south on the coast. Crichton (1960) found 8,000 to 10,000 eggs per egg mass.

Hyman (1924b) described the first zoeal stage and compared it with *S. cinereum*. Recently, Costlow and Bookhout (1962a) described the complete

larval development listing three zoeal stages and one megalops stage, and compared these to similar stages they had previously described for *S. cinereum*. The authors also concluded that photoperiod has no observable effect on development.

Crichton (1960) studied a colony of *S. reticulatum* in Delaware. With the aid of rubber casts, he found that the species digs burrows which may have several openings leading at a gentle slope to a depth of 3 or 4 inches where a series of more or less level corridors curve, twist, and often interconnect. Each corridor usually leads to a vertical shaft as much as 30 inches deep and usually filled with water. Burrows are communal, containing a male or two and several females. Crichton found that this species will eat fiddler crabs (the burrows occasionally intersect) when it can capture them; however, the usual diet is *Spartina*, and swaths often are cut through this marsh grass. Burrowing action of the crab tills the land, increases erosion, and turns over the cord grass more rapidly than the annual decay cycle could do it unaided.

Teal (1959) found this species active on Georgia marshes when the tide was high or the sky cloudy. When the marsh was exposed, the crabs were found in burrows, usually near the top, in air or water. Respiration rates were higher in water than in air. Gray (1957) found the gill area of *S. reticulatum* to be relatively low as compared with other species living in a similar habitat (*Uca pugnax* and *minax*). He found *S. reticulatum* to be more robust but less active than the close relative, *S. cinereum*.

Humes (1941) described a harpacticoid copepod (*Cancrincola plumipes*) from the gill chambers of this crab.

Sesarma (Holometopus) cinereum (Bosc). Wharf crab; wood crab; friendly crab; square-backed fiddler

Figure 206

Grapsus cinereus Bosc [1801 or 1802], p. 204, pl. 5, fig. 1.
Sesarma cinereum: Rathbun, 1918b, p. 300, text-fig. 149, pl. 83 (rev.).
Sesarma cinerea: Hay and Shore, 1918, p. 449, pl. 36, fig. 11.

Recognition characters.—Carapace rectangular, nearly uniform in width throughout; regions well marked; surface nearly smooth, punctate, rough with squamiform tubercles toward front; suprafrontal lobes well marked, inner pair widest. Front 4 times as wide as high, widening below,

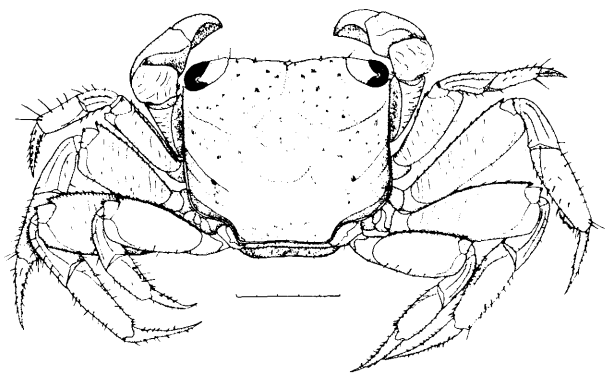

FIGURE 206.—*Sesarma (Holometopus) cinereum* (Bosc). Animal in dorsal view, 5 mm. indicated.

somewhat four-lobed in dorsal view, lower edge sinuous. Outer orbital angle acute. Lower surface of carapace covered with fine net of geniculate hairs.

Chelipeds heavy; merus and carpus covered with short transverse lines of scabrous granules; merus with upper edge sharp, inner edge irregularly dentate with a triangular laminar expansion on distal half; carpus with inner angle rounded. Palm nearly twice as high as upper length; outer surface covered with scabrous granules arranged in parallel lines near upper margin; inner face coarsely granulate, with short prominent ridge near distal end; fingers gaping narrowly, largest tooth at middle of immovable finger. Walking legs rather narrow, meri with a superior subdistal spine; third pair of legs over twice as long as carapace.

Abdomen of male broadly triangular; telson much narrower than sixth segment.

Measurements.—Carapace: male, length, 18 mm., width, 20 mm.; female, length, 20 mm., width, 23 mm.

Color.—Brown varying toward olive.

Habitat.—Found actively crawling about on wharves and stone jetties or resting in shallow burrows above tidemark along the shores. The crabs have often been found on vessels along the coast hiding anywhere out of sight or reach and coming forth at night to feed.

Type locality.—"*La Caroline.*"

Known range.—Magothy River, Chesapeake Bay, Md., to British Honduras; West Indies to Venezuela.

Remarks.—This species is abundant where it occurs in the Carolinas. Ovigerous females occur

from May to November in North Carolina, and have been found along the Potomac River in January (U.S. National Museum records). Hyman (1924b) briefly described the first zoeal stage. Costlow and Bookhout (1960) described 4 zoeal stages and 1 megalops stage from 1,200 zoeae reared on *Artemia* nauplii and *Arbacia* eggs under constant conditions of temperature, salinity, and light. Costlow, Bookhout, and Monroe (1960) found that optimum salinities exist for each larval stage, but that development proceeds best in the 20–26.7 ‰ range (among those tested). Temperature was found to have more effect on length of larval development than on mortality, with higher temperature speeding development. No "extra stages" were observed. The authors concluded that salinity is the chief physical factor confining *S. cinereum* to estuaries.

Pearse (1929) found that this species can survive for a considerable period of time in dilutions of sea water and also that it shows considerable resistance to desiccation. Oler (1941) maintained captive specimens from a Maryland tidal river in a house basement for about a year. The animals burrowed in mud in an aquarium where the only moisture provided was tap water. Vegetable matter was fed at irregular intervals. After several months, the larger animals ate the smaller ones, presumably at the time of ecdysis. Duncker (1934), in Germany, secured three live female *S. cinereum* which had been transported by chance in a cargo of logs from the West Indies. The animals were kept alive in a glass jar with damp peat and a container for a source of fresh water. One lived 4 years and 72 days from date of captivity. The crabs were fed shredded beef or fish and commercial fish food plus Collembola that appeared in the jar. All eating was done on land. Some regeneration of lost appendages occurred, and the longest lived specimen molted four times, molting always taking place in water. To the author's surprise, eggs were released six times, always in water, the longest lived female producing five of these batches. Larvae hatched from all but one of the egg masses, but survived only a short time. Duncker concluded that one mating was effective for 3 years or more. The incubation period was approximately 30 days. The female ate eggs that protruded over the edge of the abdomen. The number of eggs ranged from about 4,700 to 13,400 per sponge. Duncker considered that *S. cinereum* acted more like a land animal than a water-inhabiting animal, each individual having its own burrow.

Teal (1959) implied the same conclusion, for in experiments under water this species was relatively inactive, thus holding its oxygen consumption down. There was some experimental evidence for thermal acclimation of metabolism, but more evidence for acclimation by selection of microclimate. Gray (1957) also emphasized the terrestrial habits of the species, but showed that its relative gill area is nearly double that of the similar species *Ocypode quadrata.*

Subfamily **Plagusiinae**

Front cut into lobes or teeth by antennular clefts visible in dorsal view. Lower border of orbit curving down into line with prominent anterior border of buccal cavity. External maxillipeds neither completely closing buccal cavity nor leaving wide rhomboidal gap, not crossed by an oblique hairy crest; palp articulating near anteroexternal angle of merus, often no flagellum on exposed exognath. Antennal flagella short. Male abdomen filling all space between last pair of legs (Rathbun, 1918b.).

Genus ***Plagusia*** Latreille, 1804

Rathbun, 1918b, p. 331.—Monod, 1956, p. 455.

Plagusia depressa (Fabricius)

Figure 207

Cancer depressus Fabricius, 1775, p. 406.
Plagusia depressa: Rathbun, 1918b, p. 332, text-fig. 154, pl. 101 (rev.).—Monod, 1956, p. 455, figs. 614–617 (rev.).

Recognition characters.—Carapace subhexagonal, wider than long, depressed, covered with flattened tubercles margined with short setae. Regions distinct; front of gastric region with a series of approximately six, prominent, acute tubercles arranged in an arc. Indefinite front broad, with a deep median furrow and deep notches for antennules; a spiniform tubercle on each side between median furrow and antennulary notch. Orbits deep; outer orbital angle produced into a strong, curved spine followed on anterolateral margin by three similar spines of diminishing size. Epistome prominent beyond anterior border of carapace and usually cut into five lobes.

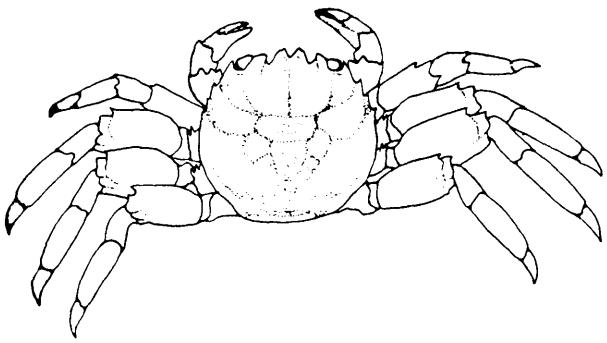

FIGURE 207.—*Plagusia depressa* (Fabricius). Animal in dorsal view (after Rathbun, 1933).

Chelipeds of adult male massive, approximately as long as carapace, in female slender, three-fourths as long as carapace; chelipeds and legs rugose dorsally; merus with three small spines above at distal end; carpus with inner angle densely dentiform; palm and dactyl with tubercles arranged in longitudinal ribs, outer surface smooth. Walking legs strong, increasing in size from first to third, fourth shorter than second; second and third legs with a dentate crest above on coxae; meri with subterminal spine on anterior border; distal three articles with a dense strip of long hair; dactyls with two rows of strong spines on concave side.

Measurements.—Carapace: large female, length, 45 mm.; width, 49 mm.

Color.—Light reddish, dotted with blood red, tubercles bordered with blackish cilia with extremity gray; blood-red spots on legs; underside of body yellowish (Latreille *in* Rathbun, 1918b).

Habitat.—This species is found among rocks, on jetties, in tide pools, and is thought to be transported on ships' hulls.

Type locality.—"*In mari mediterraneo.*"

Known range.—Beaufort, N.C. through West Indies to Pernambuco, Brazil; Bermuda; Azores; Madeira; West Africa, from Senegal to Gold Coast.

Genus ***Percnon*** Gistl, 1848

Rathbun, 1918b, p. 337.—Hemming, 1958b, p. 35.

Percnon gibbesi (Milne Edwards). Spray crab

Acanthocarpus gibbesi Milne Edwards, 1853, pp. 146 and 180.
Percnon gibbesi: Rathbun, 1918b, p. 337.—Schmitt, 1939, p. 24.

Recognition characters.—Carapace thin, disc-like, longer than wide, covered with small short bristles except for bare raised patches; dorsal surface with a few low tubercles. Front deeply cut by antennular furrows; portion between antennules narrow and extended in form of a rostrum, armed with two erect spines on each side distally and a row of inconspicuous spinules just within and parallel to each margin proximally. Eyes large, reniform. Inner margin of orbit bearing three spines, two distal spines prominent; middle of upper orbital border more or less serrate. Anterolateral border of carapace with four acute spines counting large spine on outer orbital angle; second spine in series with its lateral margin shorter than that of third spine.

Chelipeds varying in size with age and sex, small in females but large and unequal in adult males; merus and carpus armed with spines; palm nearly smooth, oval, and somewhat compressed, proximal upper surface with an ill-defined groove extending one-third length of upper margin, groove filled with pubescence; fingers short, blunt, with tips concave on opposed surfaces. Meral article of each walking leg with large uniform spines on anterior margin, upper surface covered with short bristles similar to carapace; posterior margin ending in a distal spine; merus of first two legs with a second row of spinules parallel with anterior border, row indistinct on third merus and absent on fourth.

Measurements.—Carapace: male, length, 30 mm., width, 28 mm.; female, length, 33 mm., width, 34 mm. (Garth, 1946).

Color.—Carapace and meral articles of walking legs brown or mottled above; usually a median longitudinal stripe of white or pale blue; legs banded with reddish, brown, and light pink distally; eyestalks and chelae orange; ventral side of body pale blue with legs pale pink (Garth, 1946; Verrill, 1908).

Habitat.—The usual habitat for this species is the underside of rocks at the low-tide level (Verrill, 1908), or in the surf at knee to hip depth, where it is extremely difficult to capture because of its propensity for rapidly keeping to the underside of turned objects (Garth, 1946).

Type locality.—Antilles.

Known range.—Fort Macon, N.C.; southern

Florida and Bahamas to Brazil; Bermuda; Azores to Cape of Good Hope; Cape San Lucas, Lower California, to Chile; Galapagos Islands.

Remarks.—Two immature females found on the Fort Macon, N.C., jetty in August 1963, by R. A. Heard, are referred to this species on the basis of characters given by Schmitt (1939) in his key to species of the genus *Percnon*. It is impossible to refer the descriptions of Rathbun (1918b) and Verrill (1908) to this species or *planissimum* with certainty, and the figures given by them also are not adequate for this purpose; but on the basis of a Bermuda specimen collected in 1962, Verrill's material was probably *P. gibbesi*.

Failure to record this species from North Carolina prior to this time is probably because there are few suitable habitats along this coast. There are few natural rocks on the North Carolina coast.

Family **Ocypodidae**

Palp of external maxillipeds coarse, articulating at or near anteroexternal angle of merus; exognath generally slender and often somewhat concealed. Front usually of moderate width, and often a somewhat deflexed narrow lobe. Orbits occupying entire anterior border of carapace outside front, and with their outer wall often defective. Buccal cavity usually large and somewhat narrower in front than behind, external maxillipeds often, but not always, completely closing it. Abdomen of male narrow. Male openings sternal (Rathbun, 1918b).

Genus ***Ocypode*** Weber, 1795

Rathbun, 1918b, p. 366 (described).—Monod, 1956, p. 390 (synonomy).

Ocypode quadrata (Fabricius). Ghost crab; sand crab

Figure 208

Cancer quadratus Fabricius, 1787, p. 315.
Ocypode albicans: Rathbun, 1918b, p. 367, pls. 127–128 (rev.).—Hay and Shore, 1918, p. 450, pl. 37, fig. 1.
Ocypode quadrata: Holthuis, 1959, p. 259.

Recognition characters.—Carapace quadrilateral, convex above from front to back, sides nearly vertical; dorsal region finely granulate on middle and posterior portions, coarsely granulate toward sides, center of carapace with a well-marked H-shaped depression. Front and side margins raised, beaded, or serrulate, lateral margin continued into

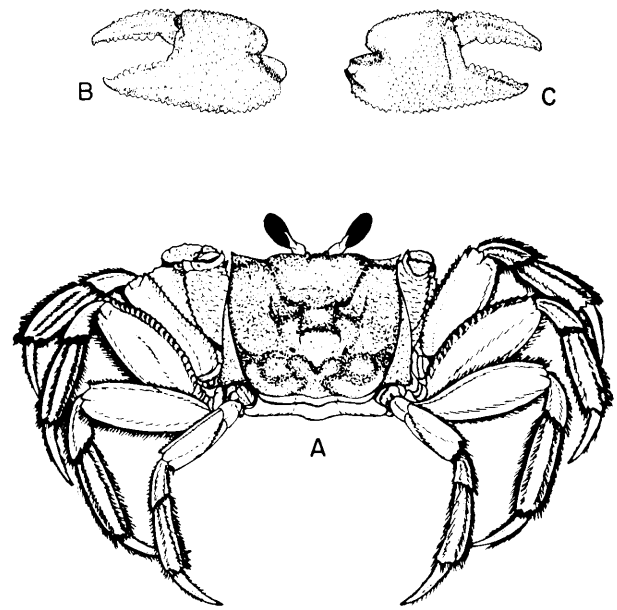

FIGURE 208.—*Ocypode quadrata* (Fabricius). A, female in dorsal view, reduced (after Gmitter and Wotton, 1953); major chela of male, B, outer view, C, inner view, reduced (after Crane, 1941).

a prominent, acute angle at outer corner of orbit; a similar but lower ridge extending upward and forward from base of third walking leg. Orbits large and open, extending all along anterior margin on either side of narrow front, both upper and lower margins crested and dentate. Eyestalks large, club-shaped, cornea covering over half of distal article. Front deflexed; antennules and antennae much reduced, flagellum of antennules hidden beneath front.

Chelipeds in both sexes, and in young, unequal, well developed, rough; merus serrulate above, toothed on lower margins; carpus with sharp spines at inner angle; hands coarsely scabrotuberculate, margins of palm and fingers dentate, fingers pointed. Large hand with a vertical stridulating ridge of tubercles on inner surface near base of movable finger that plays against smooth, distal, anteroventral ridge of ischium. Walking legs almost smooth, fringed with long, stiff, yellow hair, third pair longest, fourth shortest; meri of first three pairs broadened; propodi of these legs with longitudinal brushes of hair on anterior surface; dactyls of all legs fluted, depressions hairy.

A hair-fringed breathing slit on ventral surface between basal articles of third and fourth walking legs.

Measurements.—Carapace: male, length, 44 mm.; width, 50 mm.

Color.—Gray, pepper-and-salt, grayish white, pale yellow, straw color, or yellowish white imitating color of beaches; sometimes light amber and often iridescent; yellow markings below and and on legs; young mottled gray and brown (various authors).

Habitat.—This species, the most terrestrial of the decapod crustaceans in the Carolinas, lives in abundance along the ocean beaches and sometimes on harbor beaches. The crabs construct burrows 2 to 4 feet in depth from near the high-tide line to distances up to a quarter of a mile from the ocean.

Type locality.—Jamaica.

Known range.—Block Island, R.I., to State of Santa Catarina, Brazil (megalops have been taken at Woods Hole).

Remarks.—The ghost crabs are so large, accessible, and widely distributed that they have been extensively investigated in various parts of their range.

Perhaps because of its mode of life, this animal has left a fragmentary fossil record. Rathbun (1935) recorded *O. quadrata* questionably from the Pleistocene of Florida. Hayasaka (1935) compared the "sandstone pipes" commonly found in certain Tertiary sandstones of Formosa to plaster casts of burrows made by the Formosan crab, *O. ceratophthalma*, and found them to be much alike. Burrows of the modern Formosan and eastern North American species are similar.

The egg-laying season in the Carolinas appears to extend from April (Coues, 1871) to July. Apparently the egg-bearing period is approximately the same farther south at Tortugas, Fla. (Cowles, 1908), and farther north in New Jersey (Milne and Milne, 1946). The latter authors pointed out that ovigerous females differ in behavior from other individuals in that they wade in water more freely, run along on the bottom, and at intervals when the water is quiet open the abdomen out, flip upside down, extend the mouthparts, rotate the legs, and, thus, force water through the egg mass. Such females will run quickly to water when disturbed. The free-swimming zoea of this species has not been described, but the megalops was first described by Say (1817) as *Monolepis inermis*. Smith (1873a, 1873b, 1880b) recognized the true status of the form, and pointed out that though this megalops is carried as far north as Vineyard Sound by the Gulf Stream, that area is apparently too cold to support an adult population.

Habits of *O. quadrata* have been treated in a number of scholarly and popular works, but the serious student is referred especially to Cowles (1908) and Milne and Milne (1946). A popular account of some value, except for the concluding conjectures, was given by Phillips (1940). Only a brief summary from these authors can be given here.

The young crabs are found close to shore. Burrows of the young are near the water and extend to water level or are covered by high tides for a time, whereas older crabs burrow farther from water; such burrows seldom are deep enough to reach water level. Burrows are of three general types: (1) a short vertical burrow made by young crabs, (2) a burrow sloped downward at about 45 degrees away from the shoreline, often with a vertical branch extending upward almost to the surface, and (3) burrows higher on the beach, much like the second type but without the vertical side branch. In fall in New Jersey, the burrows were found to be farther from water and far deeper than any studied earlier in the year, and it is presumed that a variety of sizes of crabs hibernate in these deep burrows.

Burrow making is primarily an occupation of daylight hours. The crabs cease feeding on the wet beach toward dawn. Those feeding on a fish carcass often burrow within an inch or two of the carcass. Young crabs near water make new burrows, older ones range inland and build burrows or occupy old holes. Sand is brought to the mouth of the burrow and dropped or spread near the opening in a fan-shaped area. Toward noon, openings to burrows are plugged with damp sand, thus concealing the burrow. Toward evening the crabs begin to emerge again, and by 10 p.m. the whole population is usually on the beach.

These crabs are scavengers (and cannibals) and tend to feed most actively along the drift line, looking for beached fish or refuse and small bits of food buried in the top layer of sand. The crabs

do not enter the water to search for or capture food.

The crabs have to go into the water at intervals to moisten the gills, and the young do this more frequently than adults. When undisturbed, the individuals do not actually enter water but will stop a few inches from the waterline with one side presented to the water, the legs of the other side anchored in sand, and wait for a wave to wash over them after which they return to the higher parts of the beach. If disturbed, the crabs will run into the water, then leave it as soon as possible. These crabs do not swim but walk on the bottom or are rolled about by waves. The crabs can survive for a limited time if forced to remain submerged.

Locomotion is accomplished by all eight walking legs. Usually the crabs walk sideways or obliquely. If hotly pursued, the crabs will run in another manner, holding the last pair of legs clear of the ground. Usually the crabs walk or run toward the side with the small chela. This crab can also walk forward, or sometimes approach food by walking slowly backward.

The eyes of *O. quadrata* are so large and prominent that it seems as if the crab can see exceptionally well. Experiment has shown that the eyes are primarily sensitive to large changes in intensity of light. The crabs do not tend to avoid strong light, but try to hide if lights are suddenly shut off or if an object on the beach is suddenly moved. The eyes apparently aid in the search for food, but actual detection of food is by taste or smell.

There is no evidence that *O. quadrata* can hear, though a well-developed stridulating ridge is borne on the large chela. No one has reported observing this crab in the act of stridulating.

Cowles (1908) noticed that the ghost crab exhibits color changes. The crabs are generally dark in subdued light and in direct sunlight if temperature is not above 35° C. Above 35° C., the crabs are light colored regardless of light intensity. In absence of light, the crabs are light colored regardless of temperature.

The general relationship of habitat to oxygen consumption and general activity among certain decapods has been a subject of study by Ayers (1938), Pearse (1929), Vernberg (1956), and Gray (1957) in the Beaufort, N.C., area. In all these studies, *O. quadrata* was of prime interest because of its terrestrial adaptation combined with great activity. Of all the crabs studied in this geographic area, the ghost crab possesses the highest rate of oxygen consumption both for the whole animal and for gill tissue alone. This is more striking when it is emphasized that *O. quadrata* has a reduced number of gills (though it does have accessory respiratory tissues in the gill cavity) and the gill area per gram of weight in this species is by far the lowest among 16 species studied in near-shore, intertidal, and above-tide zones.

Flemister and Flemister (1951) and Flemister (1958) have shown that when *O. quadrata* is confined in water, oxygen consumption is elevated, but elevated least when chloride ion concentration of the water equals that of the blood. Lower or higher ion concentration of the water raises the respiration rate. They demonstrated that the animals normally have blood hypotonic to sea water. In sea water containing less than 120 or more than 160 millimoles of chloride per liter, the internal concentration is not maintained but tends to rise or fall depending on which end of this range the animal experiences. The antennal gland, aided by the gill membranes, functions in regulation of internal chloride ion concentration.

Genus *Uca* Leach, 1814

Rathbun, 1918b, p. 374.—Monod, 1956, p. 399.

KEY TO SPECIES IN THE CAROLINAS

a. Large cheliped of male with oblique tuberculate ridge on inner surface of palm extending upward from lower margin.
  b. A prominent transverse depression behind orbit; leg joints red on large cheliped; color dark, usually grayish toward front margin ..... *minax* (p. 227).
  bb. Without prominent transverse depression behind orbit; leg joints not red; color dark, often with blue on front ..... *pugnax* (p. 229).
aa. Large cheliped of male without oblique tuberculate ridge on inner surface of palm extending upward from lower margin ..... *pugilator* (p. 232).

Uca minax (Le Conte). Red-jointed fiddler; brackish water fiddler

Figures 209A, 210B

Gelasimus minax Le Conte, 1855, p. 403.
Uca minax: Rathbun, 1918b, p. 389, pl. 137 (rev.).—Hay and Shore, 1918, p. 451, pl. 37, fig. 3.

Recognition characters.—Carapace subquadrilateral, approximately 1.3 times as wide as long, widest behind outer orbital angles, convex in both

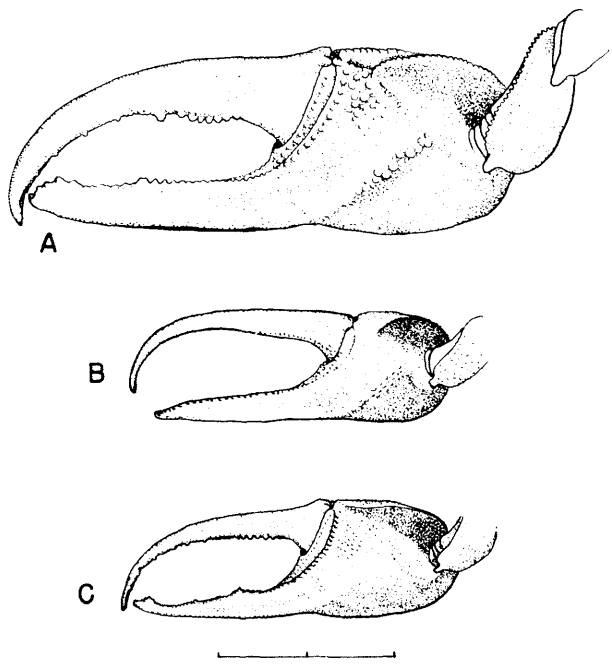

FIGURE 209.—Large chela of male, view of inner side; A, *Uca minax* (Le Conte); B, *Uca pugnax* (Smith); C, *Uca pugilator* (Bosc); 20 mm. indicated.

directions, finely granulate, except somewhat coarsely so near anterolateral angles; a shallow H-shaped depression near center of carapace, and a horizontal depression behind orbit. Lateral margins nearly vertical; anterolateral angles slightly produced, continued backward and inward as a low, well-defined ridge, and above orbits as a low revolute ridge. Front greater than one-third frontoorbital width, broadly convex. Orbits large, open, eyebrow 5 times as wide as deep, lower margin dentate; eyestalks long, slender. Antennules and antennae small, flagellum of antennules hardly visible. Merus of second maxilliped with never more than 10 exceedingly slender spoon-shaped hairs.

Chelipeds in male very unequal, in female equal and of small size. Large chela with upper surface of merus sparingly granulate, inner edge denticulate, outer edge granulate; carpus tuberculate. Upper and outer face of large hand in male with tubercules diminishing to granules on lower face, ridged above; inner surface with an oblique row of granules from lower margin to carpal cavity, a short curved row leading down from ridge on upper margin, area between ridges tuberculate and with a tuberculate ridge running along immovable finger from tip to internal distal border of palm. Fingers strong, with wide gape, cutting edges tuberculate; immovable finger with a few larger teeth at irregular intervals, truncate at tip; dactyl longer and curving downward past tip of opposed finger. Walking legs strong, sparsely hairy, meri slightly wrinkled.

Measurements.—Carapace: male, length, 25 mm.; width, 38 mm.

Color.—Chestnut brown, becoming gray in front; chelipeds with red spots at articulations; hands ivory white; legs olive or grayish brown.

Habitat.—This species occurs in marshes at some distance from water of high salinity. It is usually found on muddy substrates where flooding with fresh water occurs (Teal, 1958), or on a mud and sand substrate (Gray, 1942). In North Carolina, the species is found in *Spartina* marsh, often far from banks of ditches, and in the area immediately preceding the *Salicornia-Distichlis* zone (Vernberg, 1959). It has also been observed at the edge of low woodlands (Teal, 1959). The crabs live in burrows which they dig to various depths, but the maximum is about 2 feet. The openings are often considerably above high-tide level, and the bottoms reach to ground-water level. The burrows are only wide enough to accommodate the occupant. Usually only one crab lives in a burrow, though at times two females may occupy a single burrow, and burrows of females sometimes communicate with burrows of males, the connection being made by the female (Gray, 1942). Young crabs are sometimes found in the burrows of females, never in those of males.

Type locality.—Beesleys Point, N.J.

Known range.—Buzzards Bay (Wareham), Mass., to Matagorda Bay, Tex.; Colombia; Dominican Republic.

Remarks.—This species has been the subject of a number of ecological and physiological studies, undoubtedly because of its wide distribution and accessibility. It is the largest of the three species of fiddler crabs occurring on the east coast of the United States, though it is not so abundant as the other two species and its habitat is somewhat more restricted.

Spawning occurs in the Carolinas and as far north as mid-Chesapeake Bay in summer. In Chesapeake Bay, ovigerous females are most

abundant in July; none are known to occur before July or after the first week in September, and about the same length of breeding season is found in the Beaufort, N.C., area. Gray (1942) presented evidence for two spawnings per season. The act of egg laying has not been studied in minute detail, but Gray (1942) observed egg deposition among captive females held in aquaria. Completion of spawning was usually accomplished in a day but sometimes took as long as 3 days, depending on temperature. (Hyman (1920) and others have dug ovigerous females from burrows.) Freshly laid eggs were yellow or pale orange in color, but the color changed with development through a purplish-black to an ashy gray color, at which stage the larvae emerged (see also Hyman, 1920). Estimated egg counts on a number of ovigerous females ranged from 10,000 to 300,000, depending on size of the individual. Newly laid eggs measured about 0.09 mm. in diameter but increased to about 0.27 mm. at the time of hatching. Both Hyman (1920) and Gray (1942) observed that the females entered water in order to let the eggs hatch. Time of hatching extended from about 7:00 to 10:00 p.m., and the hatching of an egg mass required slightly less than an hour.

The first zoeal stage of *U. minax* is the smallest among our three species of *Uca*. The larval stages are discussed in the remarks on *U. pugilator*.

Uca minax is an omnivorous feeder but avoids highly putrified debris (Gray, 1942). Teal (1958) showed that fiddler crabs can subsist on a mixture of sand, clay, bacteria, and fermented marsh grass (natural staples in their diet), and he observed *U. minax* kill and eat *U. pugnax* and *U. pugilator* on several occasions. Contrary to the findings of others, he observed (1959) that *U. minax* can and does feed underwater. Miller (1961) compared the mouthparts of *U. minax* to those of the more specialized Carolinian *Ucas*. He found that it prefers to feed in low areas of the *Spartina* marshes well up in estuaries where mud is fluid.

In a search for factors that might limit *U. minax* to its particular habitat, Teal (1958) found that the temperatures experienced in nature had no effect on survival but that the species could live in fresh water for more than 3 weeks and, when offered fresh and salt water, *U. minax* chose to live in fresh water. When offered a choice of mud or sand substrates, this species chose mud either above or under water, but when competitive species of *Uca* were present fewer burrows were dug. Teal (1959) found that *U. minax* had the lowest rate of oxygen consumption among a number of marsh crabs investigated (*U. pugnax* and *pugilator*, *Sesarma cinereum* and *reticulatum*, *Eurytium limosum*, and *Panopeus herbstii*) which is contrary to the argument of Ayers (1938) that the more terrestrial species have relatively higher rates of metabolism than do aquatic forms. Teal (1959) and Vernberg (1959) further observed that *U. minax* in all probability does not acclimate respiratory rate to changes in temperature. Gray (1957) found gill area per gram of body weight in *U. minax* lowest among East Coast *Ucas*, Below 20° C., this species is inactive (Gray, 1942; Teal, 1959). Gray found that *U. minax* overwinters in burrows just below the frost line.

Sexual display of the males among fiddler crabs has been a subject of much study and is too complex for complete review here. Crane (1943, 1944) dealt with this subject briefly for *U. minax*. In display, the males rear back on the last two or three walking legs so that the carapace is vertical. The major cheliped is extended diagonally up to about half of maximum extension. This position may be held for minutes, then the cheliped may be fully extended swiftly and smoothly, and finally brought back to the half-extended position in a series of jerks. This movement may be repeated about four times rather slowly. The small cheliped is moved asynchronously in similar motions.

Uca pugnax (Smith). Mud fiddler

Figures 209B, 210A

Gelasimus pugnax Smith, 1870, p. 131, pl. 2, fig. 1, pl. 4, figs. 2–2d.

Uca pugnax: Rathbun, 1918b, p. 395, pl. 139.—Hay and Shore, 1918, p. 451, pl. 37, fig. 4.—Tashian and Vernberg, 1958, p. 89 (rev.).

Recognition characters.—Carapace subquadrilateral, approximately 1.5 to 1.75 times as wide as long, widest behind outer orbital angles, very convex anteroposteriorly, lower edge of front and upper margin of orbit invisible in dorsal view, smooth. A shallow H-shaped depression near center of carapace, a pit on branchial region in line with gastro-cardiac sulcus, and a pit behind mid-

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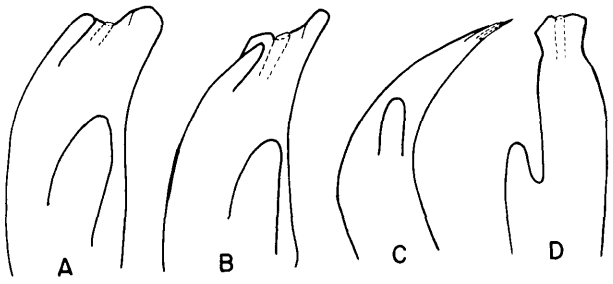

FIGURE 210.—Tips of right abdominal appendages of adult males, hairs omitted; A, *Uca pugnax*, anterior view; B, *Uca minax*, anterior view; C, *Uca pugilator*, anterior view; D, same, lateral view (after Crane, 1943).

dle of orbit. Anterolateral angles slightly produced, continued backward and inward as a low, well-defined ridge, and across entire frontoorbital width. Front about two-sevenths of frontoorbital width, margin regularly arched. Orbits large, open, upper margin sinuous and oblique, lower margin dentate. Eyestalks long, slender. Antennule and antenna small. Merus of second maxilliped with between 10 and 20, rarely 25, spoon-tipped hairs.

Chelipeds in male very unequal, in female equal and of small size. Large cheliped of male rough; merus with granulated rugose lines outside, lower margins granulate. Carpus and palm tuberculate outside; inner surface of palm with oblique row of granules leading from lower margin to carpal cavity; a short row leading down from ridge of proximal half of upper margin; area between crests coarsely granulate or tuberculate and with tuberculate ridge running along finger from tip to internal distal border of palm. Fingers long, slender, widely gaping; immovable finger usually with one large tooth near middle, inferior border nearly straight, tip sometimes depressed, truncate; dactyl evenly denticulate and with irregularly placed large tubercles, strongly curving downward past tip of opposed finger. Walking legs with carpal and propodal articles hairy.

Measurements.—Carapace: male, length, 15 mm.; width, 23 mm.

Variations.—There is a tendency toward decrease in size in the southern extremity of the range (Tashian and Vernberg, 1958).

Color.—Carapace of male dark greenish olive, middle and anterior portion mottled with grayish white; front variably light blue between and above bases of ocular peduncles, margin tinged with brown; large cheliped lighter than carapace, pale brownish yellow at articulations and along upper edge of dactyl, fingers nearly white along opposed edges; ocular peduncles and eyes much like dorsal surface of carapace; smaller cheliped and legs somewhat translucent and thickly mottled with dark grayish olive; sternum and abdomen mottled ashy gray. Females less mottled with white dorsally, and without blue on front (various authors).

Habitat.—Pearse (1914) recorded this species as living primarily on intertidal flats of mud or clay among the roots of *Spartina*, but overlapping to some extent the sandier habitat frequented by *U. pugilator*. He found the maximum number of burrows about 2 feet below high-tide mark, and often the burrows had mud towers at the mouths when the beach was littered with debris. Crane (1943) observed "shelter building" in this species to be in its most rudimentary form among the *Ucas*. She found that in a mixed population of *U. pugnax* and *U. pugilator*, *U. pugnax* always chose the side of any surface irregularity for a hole entrance in preference to flat ground. Pearse (1914) found burrows extending to 2 feet in depth and terminating at the water level. Teal (1958) reported burrows on Georgia Sea Islands to be in situations similar to those observed by Pearse, on low levees bordering tidal creeks or farther from creeks in firm, marshy ground sometimes covered only at spring tides. Schwartz and Safir (1915) found *U. pugnax* burrows on a muddy substrate well shaded by marsh vegetation; hence, continually moist. *U. pugnax* digs most actively when the tide is falling, and often hastens to plug burrows when the tide is rising to cover the burrow mouths (Pearse, 1914).

Type locality.—New Haven, [Conn.].

Known range.—Cape Cod, Mass., to near St. Augustine, Fla. (Tashian and Vernberg, 1958); northwest Florida to Texas (Hedgpeth, 1950).

Remarks.—Like the preceding species, *U. pugnax* is an abundant and easily accessible, relatively large decapod which has received the attention of numerous students. Only information of greatest general interest can be mentioned here.

The fossil record for this species extends only into the Pleistocene of New Jersey and Delaware (Rathbun, 1935).

Ovigerous females have been observed near Woods Hole, Mass., from July 4 to July 15 (Pearse, 1914), wandering about over the ground. Farther south the spawning season is more extended, from early July to mid-August in New Jersey (Crane, 1943), and as early as May 21 at Long Lake, Tex. (Hedgpeth, 1950), and in April in northeastern Florida (U.S. National Museum records). On Long Island, N.Y., the peak of spawning occurs in August (Schwartz and Safir, 1915). Crane (1943) thought it likely that in the region near New York two breeding times occur, one in July and the other in August.

The larval and postlarval stages are discussed in the remarks on *U. pugilator*. Hyman (1920) secured ovigerous females for hatching of eggs by digging them from burrows. He found the first zoea of *U. pugnax* to resemble closely that of *U. pugilator* except for smaller size of the former.

Schwartz and Safir (1915) found the food of *Ucas* to consist largely of minute algae left on sand by the outgoing tide. Such algae were picked up by means of the small cheliped in males; females, using both small chelae, secured more food in a given time than males. The small chelipeds seemed sensitive to such food, for they were dragged along on the sand while the animals searched for food. Much sand was taken up with the food. Rapidity of movement of the small chelipeds to the mouth was timed and found to be from 24 to 26 times a minute in males, and from 74 to 92 times per minute in females. Teal (1958) found that *U. pugnax* frequently feeds underwater, and that it often remains outside burrows and feeds as the tide rises. This species can subsist on bacteria and organic debris. Miller (1961) in his well-illustrated study considered *U. pugnax* to be intermediate in development of spoon-shaped hairs on the mouth parts and, therefore, more ubiquitous in choice of feeding substrates than its congeners in the Carolinas. Great detail is given in this study.

In experiments on salinity tolerance, Teal (1958) found that 50 percent of *U. pugnax* placed in fresh water died within 1.5 days. In water of 7 °/₀₀, 50 percent mortality occurred after 3 days. Given a choice of fresh or 30 °/₀₀, *U. pugnax* chose salt water. Teal concluded that these data are consistent with the general distribution of the species, which is restricted to tidal marsh.

Given a choice of sand or mud substrate above or under water, *U. pugnax* burrowed only in mud without any reference to water level, and competitive species of *Uca* had no significant effect on numbers of burrows dug. When restricted to the relatively high *Salicornia-Distichlis* marsh, *U. pugnax* survived less well than *U. pugilator*.

Respiration rates for *U. pugnax* are higher underwater than in air (Teal, 1959), probably because of increased activity necessary to ventilate the gills.

At normal habitat temperatures, *U. pugnax* (=*rapax*) from Trinidad showed a higher metabolic rate than from localities in the United States (Tashian, 1956). Tashian found that there is a decrease in sensitivity to temperature change from southern to northern populations, along with an increase in tolerance to low temperature. Teal (1958) found that temperatures experienced in nature are not limiting factors in distribution of *U. pugnax* in Georgia, though high temperatures near a lethal level occur at times in summer. He (1959) concluded that among marsh crabs studied (see "remarks *U. minax*"), *U. pugnax* exhibits the most highly developed thermal acclimation, and its abundance on the marshes may be explained in part by its ability to regulate its metabolism over a wide range of temperature. Vernberg (1959) and Vernberg and Tashian (1959) reinforced this conclusion, showing that *U. pugnax* exhibits a marked tendency to demonstrate seasonal thermal acclimation. Brett (1960) showed that the daily oxygen-consumption cycle is considerably modified by locomotion of the crabs. Gray (1957) found gill area per gram of weight in *U. pugnax* to be lowest among the East Coast *Ucas*.

Crane (1943) observed hibernating *U. pugnax* in New Jersey, where the burrows were weathered open along the muddy banks of small creeks and could only have been submerged at spring tides. In March at air temperatures of 1.7° to 5.5° C., the immobile crabs were found from the burrow mouths to about 4 inches below the surface. Slight warming in the hand or in the sun elicited fairly rapid movement.

In another vein, Passano (1960) found an inverse correlation between temperature and pro-

ecdysis duration in *U. pugnax*. Surprisingly, at some temperature between 15° and 22° C. proecdysis fails to proceed normally, though these animals experience much lower temperatures throughout their range. It was suggested that the northern limits of the species are influenced by the inability of larvae to molt in cold water; hence, adults cannot appear there.

Crane (1943) gave a detailed description of the display and breeding relationships for this species. Display of males starts with the body elevated moderately high and both chelae held well off the ground and flexed in front of the mouth. Both chelipeds are extended obliquely upward, then the major claw is returned downward in a jerk or a series of jerks with no pause between extension and flexion. The fingers usually remain nearly closed, and a complete cycle of movement usually requires about 2 seconds. (Movement of the small chela is not described.) At times males will exhibit a series of bobbings or "curtseys," especially when displaying to females. Pearse (1914) and others considered these activities to be courtship display.

Other activities which have received much attention in experiments are rhythmic cycles. Brown and his coworkers (Brown and Sandeen, 1948; Brown and Webb, 1948, 1949; Brown, Webb, Bennett, and Sandeen, 1954) showed that fiddler crabs (among them *U. pugnax*) exhibit temperature-independent, diurnal, rhythmical color changes. These rhythms may be altered, or delayed, by lowering temperature for a time, or by altering the period or time of illumination. They further demonstrated that possibly two centers of rhythmicity exist in these crabs, each capable of having its rhythm altered independently of the other, and with one center influencing the other. Brown, Fingerman, Sandeen, and Webb (1953) demonstrated that amplitude of diurnal cycles under constant conditions increased to a maximum in 2 weeks. Superimposed on diurnal cycles are tidal rhythms which persist in phase with native local conditions under constant laboratory conditions. Oxygen consumption reflects these cycles as well as a lunar cycle (Brown, Bennett, and Webb, 1954; Brown, Fingerman, and Hines, 1954; Brown, Webb, Bennett, and Sandeen, 1955). Bennett, Shriner, and Brown (1957) found that degree of spontaneous locomotor activity is also related to tidal cycles although the rhythm persists only about a week under constant conditions.

Primarily because of the tremendous asymmetry in chelipeds of male fiddler crabs, *Uca* became an object of studies on relative growth. (In some of these papers no clear species designation was made.) In fiddler crabs [*Uca pugnax*] the percentage weight of the chela alters throughout life from 2 percent (the value retained by the female) to 65 percent (Huxley, 1927). In the related larger species, *U. minax*, since allometric growth continues longer, the chela may weigh over three-fourths of the remainder of the body (77 percent). Increasing relative size of the chela is associated with an increasing asymmetry of the central nervous system. Thus, such animals have no fixed form, for the proportions of parts are changing throughout postlarval life. On this basis, Huxley challenged Morgan's (1923) statement that females with intermediate width abdomens (subject also to allometric growth, Huxley, 1924) were actually intersexual female types. Tazelaar (1933) explored the subtleties of relative growth in *U. pugnax* in detail, finding that walking legs near the great chela and near the wide abdomen of females also reflect relative growth influences.

Uca pugilator (Bosc, [1801 or 1802]). Sand fiddler

Figures 209C; 210 C, D; 211

Ocypoda pugilator Bosc, [1801 or 1802], p. 197.
Uca pugilator: Rathbun, 1918b, p. 400, pl. 141; pl. 160, fig. 2 (rev.).—Hay and Shore, 1918, p. 452, pl. 37, fig. 2.

Recognition characters.—Carapace subquadrilateral, up to 1.5 times as wide as long, widest behind outer orbital angles, very convex, smooth; a shallow H-shaped depression near center of carapace and a narrow, flattened shelf behind orbit. Lateral margin strongly curved outward behind orbit, continued backward and inward as a low, well-defined ridge across entire frontoorbital width. Front more than one-third of frontoorbital width, broadly rounded below. Orbits large, open, upper margin slightly sinuous, lower margin dentate. Eyestalks long, slender. Antennule and antenna small. Merus of second maxilliped with 150 to 200 spoon-tipped hairs arranged in about 10 rows on inner side.

Chelipeds in male very unequal, in females equal and small. Merus of large chela with short,

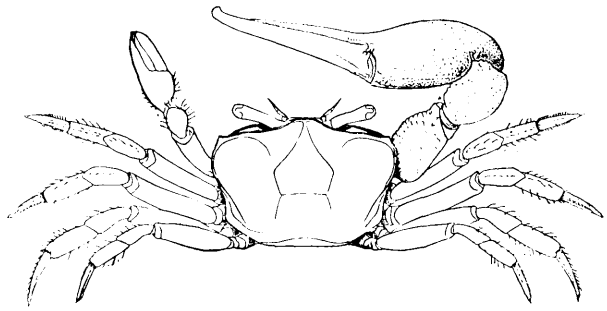

FIGURE 211.—*Uca pugilator* (Bosc). Male in dorsal view, about natural size (after Rathbun, 1884).

granulated, rugose lines above and with isolated dark hairs proximally, nearly smooth outside, lower margins granulate; merus of small chelipeds with scattered hairs. Carpus and outer surface of large hand with tubercles diminishing to granules on lower face of hand. Inner surface of palm without oblique tuberculate ridge as in *U. minax* and *U. pugnax*, but with a tuberculate ridge running along immovable finger from tip backward on internal distal border; surface granulate, granules coarser on thickest part of palm. Fingers strong, gaping; immovable finger with largest tubercles just behind middle and near truncate tip, inferior surface convex; dactyl evenly denticulate and with irregularly placed large tubercles, strongly curving downward past tip of opposed finger. Walking legs narrow.

Measurements.—Carapace: male, length, 17 mm.; width, 26 mm.

Color.—Carapace of male a dull light purplish or grayish blue of varying shades, or with irregular markings of brown or dark gray, a large patch of deep purplish blue on anterior half; large cheliped dull light blue at base with white tubercles, articulations yellowish; fingers mostly white; small chelipeds and legs buff with blue or brown speckles (various authors). Specimens from Massachusetts, bluish gray; those from Florida, reddish yellow (Démeusy, 1957).

Habitat.—This species occurs in countless numbers on sandy and muddy beaches bordering marshes, and along banks of tidal creeks. The crabs also occur farther from water in sandy situations of the *Salicornia-Distichlis* marsh and at times in *Juncus* marsh where the soil is sandy (Teal, 1958). The species burrows much as does *U. pugnax*, and populations of the two species are often intermingled (Pearse, 1914), though *U. pugilator* prefers sandier situations (Hyman, 1922). Dembowski (1926) found that choice of a place to burrow depends upon many factors, among them phototaxis and thigmotaxis. Burrows may have any shape but are unbranched and usually dug at an angle to the surface of the ground, the length of the burrow depending in part on the amount of moisture in the ground. Digging by males is done with legs on the side opposite the large claw. The crabs plug the opening as soon as they feel the water level rising in the burrow with the tide, and do this by pulling in the edges of the burrow and by ramming sand up from below. The end chamber, thus, functions as an air chamber during high tide.

Type locality.—"Caroline."

Known range.—Boston Harbor, Mass., to Texas; Old Providence Island (Coventry, 1944); Haiti.

Remarks.—Uca pugilator, like its east American congeners, has been the subject of much study, and one of the most readable accounts of its natural history is that of Hyman (1922).

In the vicinity of Beaufort, N.C., ovigerous females are found in spring and early summer. In Virginia, they are known from March to July (U.S. National Museum records). Schwartz and Safir (1915) found ovigerous females at Long Island, New York, from the first week in July until mid-August; in Massachusetts, Pearse (1914) found no ovigerous specimens until the first part of August. In Texas, Hedgpeth (1950) reported zoeae taken in a plankton net on May 20 at Long Lake. The breeding season, thus, is similar to those of the species discussed above in being seasonally related to latitude. Schwartz and Safir (1915) and Hyman (1920, 1922) stated that ovigerous females were rarely seen at the surface, but Hyman found that they left their burrows to aerate the eggs in water for a time at dusk. When the eggs were ready to hatch, the zoeae were released at such time in the water.

The larval and postlarval stages of the East Coast species of *Uca* were described and illustrated by Hyman (1920) based largely on study of *U. pugilator*. Hyman could find no consistent morphological differences among each stage of the three species. Five zoeal stages and a megalops stage were described. Gray (1942) described a

transitory prezoeal stage. Hyman found the first two zoeal stages most abundant at the surface, the third probably at intermediate depths, and the fourth and fifth zoeae usually on the bottom. He found the zoeal stages to last collectively about a month.

The megalops, a single stage lasting nearly a month, is a powerful swimmer. At the end of this stage the animal retires to cover of some sort, molts through two relatively weak crab stages and at last emerges as an active small crab measuring about 2 mm. across the carapace.

Feeding movements in *U. pugilator* are essentially the same as in the other two species of *Uca* and are discussed in the account for *U. pugnax*. Schwartz and Safir (1915) found the males moved the small cheliped to the mouth 28 to 46 times per minute, and females 61 to 92 times, when actively feeding on small particles in sand. Teal (1958) found that this species may wander into tide pools and shallow creeks to feed underwater at low tide. Miller (1961) considered *U. pugilator* to be the most specialized in mouth parts among Carolinian *Ucas* and well adapted to feeding on coarse substrate such as protected sandy beaches.

In experiments on salinity tolerance, Teal (1958) found that in fresh water 50 percent of *U. pugilator* died after 3.5 days. In water of 7 °/₀₀ more than 50 percent of the animals survived a 10-day test. Given a choice of fresh or 30 °/₀₀ sea water, *U. pugilator* chose salt water, but preferences shown by females were less strong than those shown by males, as was true also of *U. pugnax*. Teal concluded that this species lies between *U. minax* and *U. pugnax* in its tolerance of fresh water and can survive soakings of the *Salicornia* marsh with rain between spring tides.

Given a choice of sand or mud substrate above or underwater, *U. pugilator* burrowed almost exclusively in sand above water level. When either of the other species of *Uca* was present as a competitor for space, there was a reduction of 50 percent in the number of burrows that *U. pugilator* dug in sand above water. In tanks where there was no favorable substratum of sand above water, its behavior was not changed by presence of another species. When restricted to an unfavorable, low, muddy marsh, *U. pugilator* did not survive. Teal conjectured that this species cannot feed properly where sand is absent.

Respiration rates for this species are higher underwater than in air (Teal, 1959), probably due to increased activity necessary to ventilate the gills.

Teal (1958) found that temperatures of 45° C. on open sand flats of the *Salicornia-Distichlis* marsh in Georgia prevent *U. pugilator* from permanently occupying these areas, though they do feed there in cooler parts of the year. In general, temperatures experienced in nature were not considered a limiting factor. Orr (1955) found that *U. pugilator* died in 81 minutes at 40° C., in 18 minutes at 41° C., in 9 minutes at 43° C.. and in a little less than 9 minutes at 46° C. Démeusy (1957), investigating respiratory rates in populations of this species from Florida and Massachusetts, found that the northern population had a higher rate of metabolism at low temperatures (1.4° C.) than the Florida population, but that at 15° C. the difference was not significant. Démeusy found the northern population less sensitive to temperature change and more resistant to low temperature than the Florida population. On the other hand, Edwards (1950) found metabolic differences in these populations at 20° C. Teal (1959) found that above 25° C. specimens from Georgia showed no adjustment of respiration for temperature acclimation, but that below 20° C. there was some evidence of acclimation though not so well developed as in *U. pugnax*. Vernberg (1959) pointed out that metabolic activity in *Uca* of the temperate zone exhibits a seasonal cycle and that this cyclic change must be taken into account in comparing physiologic activity of relatives at different latitudes. Moreover, he stated that metabolic response of fiddler crabs has real significance in their distribution.

Crane (1943) gave a detailed description of the display and breeding relationships for this species. Display of males starts with the body elevated, cheliped tips lowered, and the meral-carpal joint of the major cheliped elevated. The cheliped is then extended up and out, the crab at the same time raising to tiptoe. The cheliped is held out for an instant, then smoothly returned to the original position. The minor chela makes weak corresponding gestures and fingers of both chelae are nearly closed throughout. Waves are made at a rate of about one per second. At moments of

extreme excitement, the major cheliped may be rapped against the ground in a flexed position.

Burkenroad (1947b) observed a drumming sound produced by males vibrating their large cheliped just outside the burrow at night, or in daytime just after waving and retreating into the burrow. Pearse (1914) was never able to observe copulation in the field following display, but did observe five matings of captive pairs in the laboratory. Females mated in the "hard shell" condition.

Color changes in *U. pugilator* have been investigated extensively in recent years. Carlson (1937) contended that the chromatophores respond to humoral control by the sinus gland in the eyestalks. Brown and Sandeen (1948) and Brown and Webb (1948) showed that there is a rhythmic secretion of hormone which operates to disperse the black and white pigments in the day and concentrate these at night. Superimposed on these responses are responses to background color, to total illumination, and to temperature, such that both pigments tend to disperse as intensity of illumination increases; but black pigment tends to concentrate as temperature increases above or decreases below about 15° C., and white pigment tends to disperse as temperature is increased above or decreased below about 20° C. Such lightening or darkening has been recorded in the field by a number of observers. Brown (1950) extended Carlson's work on red chromatophores, giving evidence for the activating principles and their daily rhythmicity. Further experiments with black chromatophores (Webb, Bennett, and Brown, 1954) showed that the diurnal rhythmic darkening and lightening are independent of structures in the eyestalks and that a substance which concentrates black pigment participates in regulation of the chromatophore system. Guyselman (1953) described a series of five color changes or stages which occur during the premolt period of normal animals. He found (as suggested earlier by Abramowitz and Abramowitz, 1940) that the sinus gland-X organ complex plays a role in regulation of metabolism of water and inorganic constituents. Evidence of a diurnal rhythm of water uptake was presented. Fingerman (1956) showed that even in the Gulf of Mexico, where tides are daily, the persistent rhythmic color changes remain scheduled as they are in crabs living where tides are semidiurnal, but (1957) that for a given local area the phase may be slightly altered according to the time that the burrows are uncovered by a receding tide.

Extending their investigations on rhythmicity, Brown, Webb, Bennett, and Sandeen (1955) showed that oxygen consumption in both *U. pugilator* and *U. pugnax* shows apparent persistent trends related to solar and lunar cycles.

As a sidelight to work with eyestalkless *U. pugilator*, Brown and Jones (1949) found that removal of eyestalks from adult females resulted in a period of rapid ovarian growth, with accompanying increase in oocyte diameter and a color change of the ovary from light pink to deep purple. Eggs produced by such animals failed to become attached to the pleopods.

The subject of intersexuality and relative growth was reopened by Darby (1935) as a result of examination of some 9,000 specimens of *U. pugilator* collected at Beaufort, N.C. Among these, 12 females were obtained with 2 fiddles, but no female was found in 1 large chela. These 12 specimens had fully widened, typically female abdomens and were always found feeding with the males in contrast to the other small-clawed females which stayed close to their holes. Darby termed these female-to-male intersexes. A male-to-female intersex; that is, a crab with a typical male abdomen and normal reproductive appendages, yet with small claws, was found only once, at Charleston, S.C. Because feeding is accomplished with the small claw, even partially symmetrical males must be handicapped in obtaining food, and it is not surprising that perfectly symmetrical adults do not, or rarely, occur. Darby, thus, refuted the arguments of Huxley and Rathbun that females with narrow abdomens were merely extremes in the normal variation curve for female abdomen growth, and supported the contention of Morgan that these were truly intersexes.

Superfamily **Oxyrhyncha**

Carapace more or less narrowed in front, and usually produced to form a rostrum; branchial regions considerably developed, hepatic regions small. Epistome usually large; buccal cavity quadrate, with anterior margin usually straight.

Gills almost always nine in number on each side; efferent channels opening at sides of endostome or palate. Antennules longitudinally folded (Rathbun, 1925).

Family **Majidae**

Chelipeds specially mobile, usually about same size as other legs with fingers straight. Second article of antenna well developed, generally fused with epistome and often with front. Orbits generally more or less incomplete. Hooked hairs almost always present. Male openings coxal (Borradaile, 1907). Palp of external maxilliped articulated either at summit or at anterointernal angle of merus (Alcock, 1895). First pleopod greatly exceeding second pleopod in length (Garth, 1958).

KEY TO SUBFAMILIES OF MAJIDAE IN THE CAROLINAS

Modified after Garth (1958)

a. Eyes either without orbits, or with commencing orbits.
  b. Eyes without orbits; eyestalks generally long, either nonretractile, or retractile against sides of carapace, or against acute postocular spine affording no concealment; basal (fused) antennal article extremely slender and usually long_____*Inachinae* (p. 236).
  bb. Eyes with commencing orbits; basal (fused) antennal article not extremely slender.
    c. Eyes lacking a postocular cup, but with tubelike housing.
      d. Eyestalks long; orbit partially protected by a hornlike supraocular spine or eave, a strong postocular tooth, or both; body truncate in front *Ophthalmiinae* (p. 246).
      dd. Eyestalks short, relatively immobile, and either concealed by a supraocular spine, or sunk in sides of rostrum; basal antennal article truncate-triangular_____*Acanthonychinae* (p. 248).
    cc. Eyes with cupped postocular process into which eye retracts, and with a supraocular eave or spine *Pisinae* (p. 250).
aa. Eyes with complete or nearly complete orbits; basal antennal article broad, expanded to form floor to orbit *Mithracinae* (p. 254).

Subfamily **Inachinae**

Eyes without orbits; eyestalks generally long, either nonretractile, or retractile against sides of carapace, or against an acute postocular spine. Basal article of antenna extremely slender throughout its extent, and unusually long (Alcock, 1895). First pleopod not very stout, straight or curved, apically tapering, but apex most varying (hairy, spinose, naked, etc.; acute, blunt, bifid, etc.); second pleopod short (Stephensen, 1945).

KEY TO GENERA OF INACHINAE IN THE CAROLINAS

Modified after Garth (1958)

a. Seven free abdominal segments in both sexes; rostrum double_____*Anomalothir* (p. 236).
aa. Six free abdominal segments in male, five in female.
  b. Rostrum double.
    c. Interantennular spine present and conspicuous.
      d. Spine of basal antennal article equally advanced with front_____*Euprognatha* (p. 237).
      dd. Spine of basal antennal article not equally advanced with front_____*Batrachonotus* (p. 238).
    cc. Interantennular spine absent or inconspicuous. *Collodes* (p. 239).
  bb. Rostrum single.
    c. Merus of outer maxilliped as broad as ischium; palp of moderate size.
      d. Postorbital tooth large, curving around side of eye_____*Pyromaia* (p. 240).
      dd. Postorbital tooth small, or if large not curving around side of eye_____*Anasimus* (p. 240).
    cc. Merus of outer maxilliped often narrower than ischium; palp large and coarse.
      d. Rostrum considerably less than postrostral length; basal antennal article often longitudinally sulcate_____*Podochela* (p. 241).
      dd. Rostrum approaching or surpassing postrostral length; basal antennal article not longitudinally sulcate.
        e. Carapace nodulose; a long spine at end of merus of walking legs; rostrum sparsely spined *Metoporhaphis* (p. 243).
        ee. Carapace smooth; spine at end of merus of walking legs no longer than others; rostrum multispinose_____*Stenorynchus* (p. 244).

Genus ***Anomalothir*** Miers, 1879

Rathbun, 1925, p. 23.

Anomalothir furcillatus (Stimpson)

Figures 212, 223A

Anomalopus furcillatus Stimpson, 1871a, p. 125.
Anomalothir furcillatus: Rathbun, 1925, p. 24, text-fig. 6, pl. 8, fig. 2; pl. 9, fig. 2; pl. 206 (rev.).

Recognition characters.—Carapace much elongated, almost subcylindrical, pubescent, with regularly placed tubercles. Rostrum long, from two-thirds to 1.25 times as long as remainder of carapace, bifurcate, horns contiguous for half or more of length, slightly divergent. Eyes without orbits; pre- and post-orbital spines small, acute. Antenna visible in dorsal view, basal article narrow. Merus of maxilliped without notch at inner angle where palp inserts.

Chelipeds in adults longer than carapace; merus subcylindrical, with row of small spines below

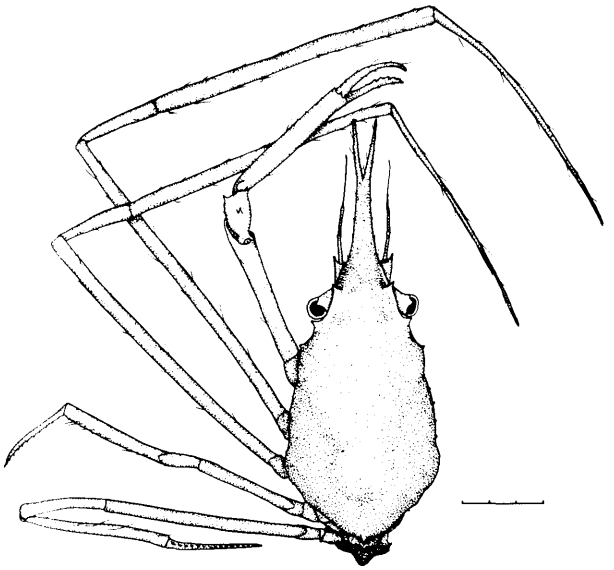

FIGURE 212.—*Anomalothir furcillatus* (Stimpson). Female in dorsal view, legs of right side not shown, 3 mm. indicated.

and less distinct row above; carpus with three spines on outer surface; palm unarmed, elongate; fingers short, stout, less gaping in male than in female. Walking legs pubescent; first two pairs long, slender; third and fourth pairs shorter, prehensile, with dactyls spinose on inner border; third pair shortest, merus with three strong hooked spines beneath, propodus and curved dactyl of about equal length; fourth pair intermediate in length, nearly straight, with propodus longer than dactyl.

Abdomen of both sexes with seven free segments.

Measurements.—Carapace: male, length including rostrum, 17 mm.; width, 6 mm. Length of rostrum, 7.5 mm. Carapace: female, length including rostrum, 20 mm.; width, 5 mm. Length of rostrum, 6 mm.

Color.—Light orange yellow; palms much deeper color (Henderson *in* Rathbun, 1925).

Habitat.—Rathbun (1925) listed this form from sandy, broken shell, pebbled, and rocky bottoms; 30 to 262 fathoms.

Type locality.—Off "The Samboes" [Southern Florida], 123 fathoms.

Known range.—Off Cape Lookout, N.C., through Gulf of Mexico and West Indies to Grenada.

Remarks.—Though the depth range of this species is usually beyond the 100-fathom mark, it may occur in shallower water in the Carolinas. Ovigerous females are known from the northeastern Gulf of Mexico in March.

Genus ***Euprognatha*** Stimpson, 1871

Rathbun, 1925, p. 95.

Euprognatha rastellifera marthae Rathbun

Figures 213, 223B

Euprognatha rastellifera Stimpson, 1871a, p. 123.—Hay and Shore, 1918, p. 454, pl. 37, fig. 7.

Euprognatha rastellifera marthae Rathbun, 1925, p. 96, text-fig. 30, pl. 33; pl. 34, figs. 1–2; pl. 35, figs. 3–4; pl. 216 (rev.).

Recognition characters.—Carapace pyriform, granulate, a tubercle or short truncate spine on gastric and cardiac regions, each branchial region, and supraorbital margin. Rostrum short, with two small teeth on horns. Ocular peduncles short, with tubercle at emargination of cornea. Frontal teeth short, spiniform, or triangular. Postorbital projection dentiform, triangular, tapering to a slender point. Obtuse antennal spines directed obliquely forward, approximately as advanced as front; interantennular spine inclined downward, equaling or surpassing front. Sides of hepatic and pterygostomian region with a few

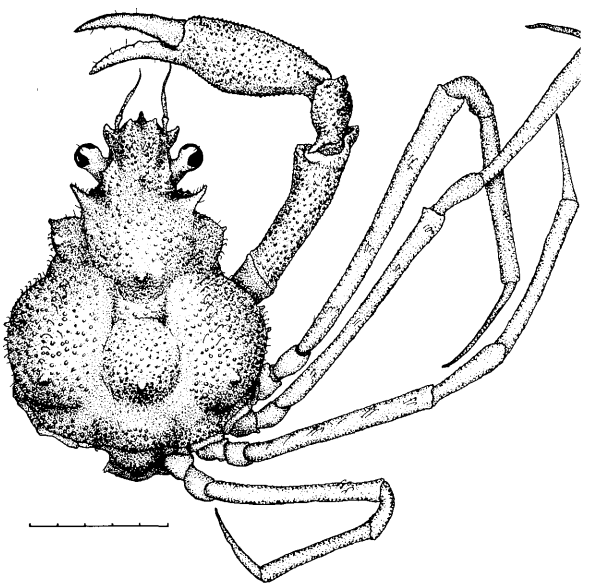

FIGURE 213.—*Euprognatha rastellifera marthae* Rathbun. Male in dorsal view, legs of left side not shown, 5 mm. indicated.

small spines. Sternum granulate except for concave portion between chelipeds.

Chelipeds approximately twice as long as carapace, granulate, margins spinous; hand swollen; fingers more than half length of palm, slightly gaping. Walking legs granulate, with tufts of curled setae and often small spines; first pair longest, others successively shorter.

Abdomen of males with six, females with five, free segments.

Measurements.—Carapace: male, length, 14 mm.; width, 12 mm.

Variations.—Rathbun (1925) divided the species *E. rastellifera* into a northern subspecies, *marthae* (ranging from Nantucket to southern Florida), and a southern or Caribbean subspecies, *acuta* (ranging from Cuba to Grenada and Barbados), with a region of intergradation in the Florida Keys from which *rastellifera* was originally described. The southern subspecies (*acuta*) has longer, sharper, and more slender spines than *marthae*, and a narrower, higher, and more closely and finely roughened carapace with regions more deeply separated than in the more northern forms. Likewise, the chelipeds have spines on the border of the merus well developed and legs more spinulose than in the northern forms.

Rathbun pointed out that there is considerable overlap in distribution of these subspecies, listing *acuta* from as far north as Marthas Vineyard. Such subspecific treatment seems untenable today, for such overlap of geographic range can hardly exist. No typical form was designated. I have retained the subspecific name *marthae* for the Carolinian form simply because this region lies well within the range mentioned by Rathbun, but I have not studied all of the material comparatively.

Habitat.—The species has been reported from a variety of sandy and muddy bottoms; 44 to 217 fathoms.

Type locality.—Southwest of Marthas Vineyard, Mass., lat. 40° N. long. 70°57′ W., 85 fathoms.

Known range.—Off Georges Bank (lat. 40°35′ N. long. 67°37′ W.) to Carysfort, Fla.

Remarks.—Rathbun (1925) reported an ovigerous female off Marthas Vineyard in July, and they are known off Georges Bank in November (U.S. National Museum records).

Genus ***Batrachonotus*** Stimpson, 1871

Rathbun, 1925, p. 122.

Batrachonotus fragosus Stimpson

Figures 214, 223C

Batrachonotus fragosus Stimpson, 1871a, p. 122.—Rathbun, 1925, p. 123, text-fig. 48, pl. 39, figs. 1–4 (rev.).

Recognition characters.—Male. Carapace triangular, broadly expanded behind; gastric, cardiac, and branchial regions strongly protuberant, each surmounted by a stout spine or large tubercle; intestinal region with two small tubercles just above posterior margin; hepatic region angular, approximating postorbital tooth. Cervical depressions deep and broad giving carapace superior outline much like frog's back. Rostrum short, formed of rounded lobes separated by a shallow notch, scarcely projecting beyond antennulary fossae, margin and supraorbital margin denticulate. Basal articles of antenna with dentate margins and a small tooth at anterior extremity. Merus of outer maxilliped broad with prominent outer and inner anterior angles. Abdomen and sternum granulate except for smooth area be-

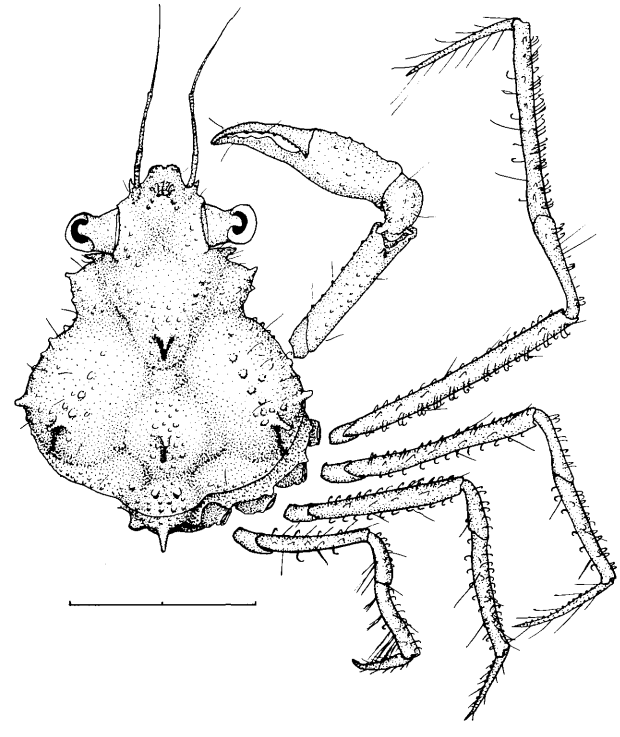

FIGURE 214.—*Batrachonotus fragosus* Stimpson. Animal in dorsal view, legs of right side shown in approximate position, legs of left side not shown, 2 mm. indicated.

tween chelipeds; abdomen with six free segments, last two fused, proximal fixed segment with a prominent median spine.

Chelipeds somewhat longer than carapace, spinulose; ischium with distal spine; hand slightly compressed; fingers nearly as long as palm, gaping nearly whole length, a large tooth in middle of immovable finger. First pair of walking legs more than twice length of second pair, posterior pairs short.

Female. Carapace narrower behind and wider in front than male, tuberculation more uniform, spines less frequent. First walking leg little longer than second, approximately 1.5 times length of carapace. Abdomen tuberculate or granulate, with five free segments, last three fused.

Measurements.—Carapace: male and female, length, 7 mm.; width, 6 mm.

Variations.—Rathbun (1925) stated that this species exhibits wide variations from the type. Some specimens have the elevated regions surmounted by a spine, some have an abdominal spine, others even lack tubercles on the elevated regions.

Habitat.—The species has been reported from mud, sand of various grades, and broken-coral and shell bottoms; shore to 75 fathoms.

Type locality.—South of Tortugas, [Fla.], lat. 24°36′40″ N. long. 80°02′20″ W., 16 fathoms.

Known range.—Cape Hatteras, N.C., to southern and western Florida; West Indies to Rio de Janeiro, Brazil. Ovigerous females are known from Tortugas in June (U.S. National Museum records).

Genus ***Collodes*** Stimpson, 1860

Rathbun, 1925, p. 105.

Collodes trispinosus Stimpson

Figures 215, 223D

Collodes trispinosus Stimpson, 1871a, p. 120.—Rathbun, 1925, p. 107, text-figs. 32a, b; pl. 36, figs. 5–6 (rev.).

Recognition characters.—Carapace ovate-triangular, covered with coarse granules except on front, anterior portion of gastric region, and about bases of spines; a single, slender, erect, capitate spine on gastric and cardiac regions, and on first abdominal segment. Rostrum short, with two minute and usually well-separated horns. Eyes of moderate length, partially retractile; postorbital tooth slender, a granule on upper orbital border. Antenna with first movable article approximately as long as rostral horns; basal article of antenna twisted, with four or five spinules on outer border and with a laminate crest on inner margin ending in a large tooth; interantennular spine short. Merus of outer maxilliped obcordate, deeply cut on distal margin, strongly produced at inner and outer angles.

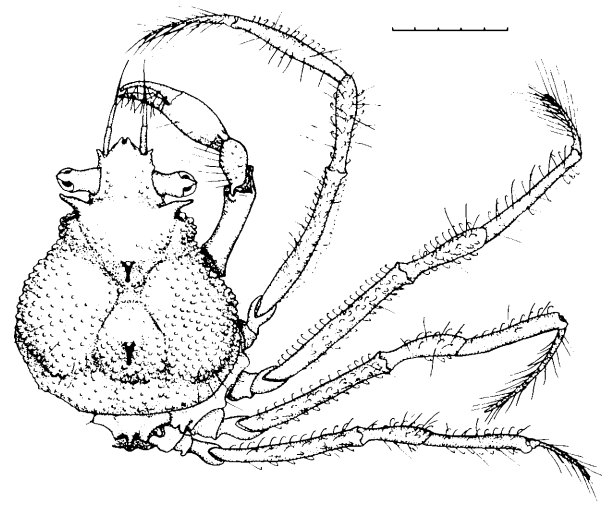

FIGURE 215.—*Collodes trispinosus* Stimpson. Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Chelipeds of male moderately stout, palm thick, smooth outside; surface of carpus and margins of merus and palm spinulose; fingers widely gaping, with a triangular tooth near middle of immovable finger and a low molariform tooth near base of dactyl. Walking legs long; first two pairs variably subequal; third and fourth pairs successively shorter; dactyls as long as propodi.

Measurements.—Carapace: male, length, 14 mm., width, 12 mm.; female, length, 12 mm., width, 10 mm.

Habitat.—Rathbun (1925) reported this species from gray sands of varying coarseness, broken shell, and gravel bottoms; 4 to 82 fathoms.

Type localities.—Off the Quicksands, Carysfort Reef, and French Reef, [Fla.], 34 to 50 fathoms.

Known range.—Near Cape Hatteras, N.C., to south and west Florida near Apalachicola.

Remarks.—Rathbun (1925) reported ovigerous females from North Carolina in October, and they are known from Florida in July (U.S. National Museum records).

Genus *Pyromaia* Stimpson, 1871

Rathbun, 1925, p. 127.

Pyromaia cuspidata Stimpson

Figures 216, 223E

Pyromaia cuspidata Stimpson, 1871a, p. 110.—Hay and Shore, 1918, p. 455, pl. 38, fig. 4.—Rathbun, 1925, p. 129, text-fig. 49; pl. 41 (rev.).

Recognition characters.—Adult male. Carapace pyriform, approximately two-thirds as wide as long; regions well marked, tumid, rough, with scattered granules, sharp tubercles and spines; often six large median spines (two mesogastric, one urogastric, two cardiac, one intestinal), elsewhere one protogastric, two or three hepatic, remainder branchial. Depressions separating branchial regions from other regions somewhat pitted. Rostrum tapering to a point, trigonal; upper and lateral margins spinulose. Interantennular spine acute, triangular, pointing downward and forward. Orbits large, open; supraorbital spine almost erect, directed slightly outward and forward; postorbital tooth large, curved around end of eye; anterior margin fringed with hair. Basal article of antenna long, with terminal spine, a larger spine at middle of inner margin and a small one at middle of outer margin followed by row of tubercles or spinules. A tubercle at angle of buccal cavity. Outer maxilliped spinulose, a longitudinal depression on ischium, merus cordate.

Limbs covered with short fur, surface underneath roughened with sharp granules or spines; merus of cheliped armed on margins, terminal spine of upper margin longest; upper margin of carpus spinulose with a few spines on outer surface; hand inflated, fingers bare, grooved, slightly agape at base. Walking legs spinulose; meri with distal spine; first legs longest, remainder successively shorter.

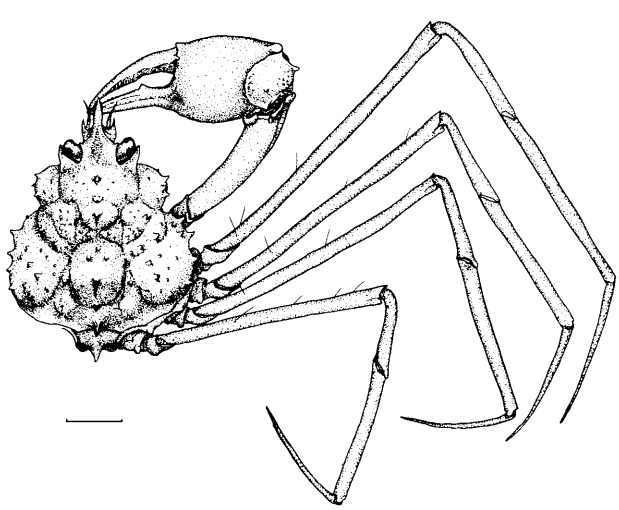

FIGURE 216.—*Pyromaia cuspidata* Stimpson. Male in dorsal view, legs of left side not shown, 10 mm. indicated.

First abdominal segment long, with an acute backward-pointing spine; six free segments, last two fused.

Adult female. Limbs almost bare; chelipeds not much stronger than walking legs, dactyl longer than palm; legs shorter than in male. Five free abdominal segments, last three fused.

Measurements.—Carapace: male, length, 41 mm.; width, 32 mm.

Variations.—The young have pubescence resembling that in females, the postorbital tooth smaller than in adults, slender and directed outward in small specimens (7.5 mm. long), directed outward and forward in somewhat larger forms.

Color.—Immature individuals brown, legs with lighter crossbands.

Habitat.—This species has been taken on gray mud, sand, pebble, and broken-coral bottoms; 15 to 300 fathoms.

Type localities.—Off Sand Key, 82 fathoms; Alligator Reef, 88 fathoms; the Samboes, 93 and 121 fathoms; southwest of Sand Key, 125 fathoms [Florida].

Known range.—Off Cape Lookout, N.C., to west Florida; Yucatan Channel; Cuba.

Remarks.—U.S. National Museum records show ovigerous females off Florida in February and July.

Genus *Anasimus* Milne Edwards, 1880

Rathbun, 1925, p. 64.

Anasimus latus Rathbun

Figures 217, 223F

Anasimus latus Rathbun, 1894, p. 58.—1925, p. 65, pl. 214 (rev.).

Recognition characters.—Carapace broadly ovate, elevated on median line, posterior half semicircular, anterior half broadly triangular, surface covered with unequal granules. Carapace with median row of spines, two gastric (posterior one larger), one large cardiac, one small backward-pointing intestinal, and a long acuminate backward-projecting spine at distal end of first

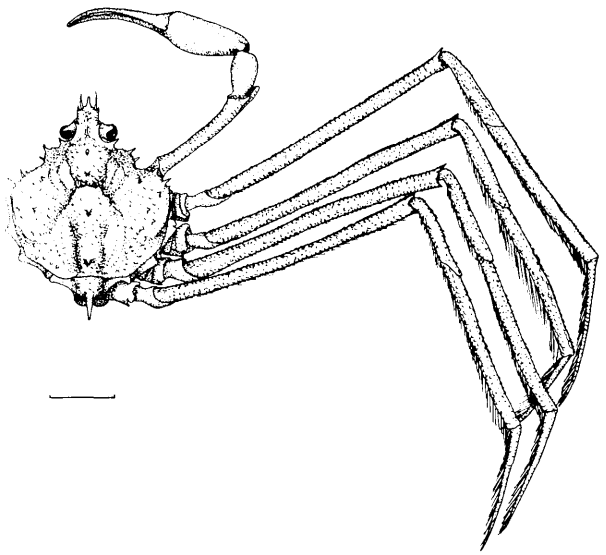

FIGURE 217.—*Anasimus latus* Rathbun. Male in dorsal view, legs of left side not shown, 10 mm. indicated.

abdominal segment; anterior gastric spine one of transverse row of about five; branchial region with three small spines or tubercles in triangular arrangement. Three anterolateral spines, one hepatic and two branchial above base of cheliped. Rostrum short, medially carinate, broadly triangular at base, ending in short, sharp, upturned spine. Eyes large; prominent supraorbital spines separated by depression, postorbital spines long, exceeding eye in large specimens. Antenna short, slightly exceeding rostrum, basal article with terminal spine and a stout spine pointing downward and forward in front of eye. Pterygostomian region with row of spines and spinules continued to antennal segment including long spine at angle of buccal cavity. Sternum of male coarsely granulate.

Chelipeds of male more than twice length of carapace, granulate; merus cylindrical; palm swollen, shorter than fingers; fingers slender, curved inward, gaping at base only, finely and evenly toothed except for larger basal tooth on dactyl. Female with chelipeds a little longer than carapace but smaller than in male, fingers not gaping. Walking legs long, slender, cylindrical, roughened, except on dactyl, with numerous short, stout, appressed spinules; propodi and dactyls with double fringe of hair.

Abdomen of male with six, female with five, free segments; female with median tubercle on third and fourth segments.

Measurements.—Carapace: male, length, 26 mm., width, 24 mm. Length of cheliped, 58 mm., of first walking leg, 106 mm.

Variations.—The adults are relatively broader than the young whose rostrum and dorsal spines are longer. The postorbital spines are very small, pointing directly outward, and with little more than a tubercle in specimens 9 mm. long or less.

Color.—Recently preserved specimens show dark reddish or brown rings on the legs (Holthuis, 1959).

Habitat.—This form has been taken from coarse sand, coral, coral sand, and mud and shell bottom; 26 to 88 fathoms.

Type locality.—Gulf of Mexico, east of Delta of Mississippi River, lat. 29°14′30″ N. long 88° 09′30″ W., 68 fathoms.

Known range.—Off Cape Lookout, N.C., to off Tabasco, Mexico (Hildebrand, 1954); west of Trinidad, and off Surinam (Holthuis, 1959).

Remarks.—Ovigerous females have been reported from southern Florida and the northern Gulf of Mexico in all seasons of the year, from North Carolina in June (Rathbun, 1925, and U.S. National Museum records), and Surinam from April to August (Holthuis, 1959).

Genus ***Podochela*** Stimpson, 1860

Rathbun, 1925, p. 31.

KEY TO SPECIES IN THE CAROLINAS

a. Rostrum broad, rounded in front.
  b. Dactyls of last three pairs of legs less than one-half length of propodus; pterygostomian region bearing a broad, spinelike projection ..... *riisei* (p. 241).
  bb. Dactyls of last three pairs of legs one-half or more length of propodus; pterygostomian region bearing a long thin lamina ..... *sidneyi* (p. 242).
aa. Rostrum long, spiniform ..... *gracilipes* (p. 243).

Podochela riisei Stimpson

Figures 218, 223G

Podochela riisei Stimpson, 1860a, p. 196, pl. 2, fig. 6.—Hay and Shore, 1918, p. 453, pl. 37, fig. 9.—Rathbun, 1925, p. 33, text-figs. 9a–b; pl. 11, figs. 1–2; pl. 208, fig. 2 (rev.).

Recognition characters.—Carapace pyriform, depressed, widest near posterior margin, greatest width about two-thirds length, dorsal region uneven and with tufts of hairs. Rostrum broad,

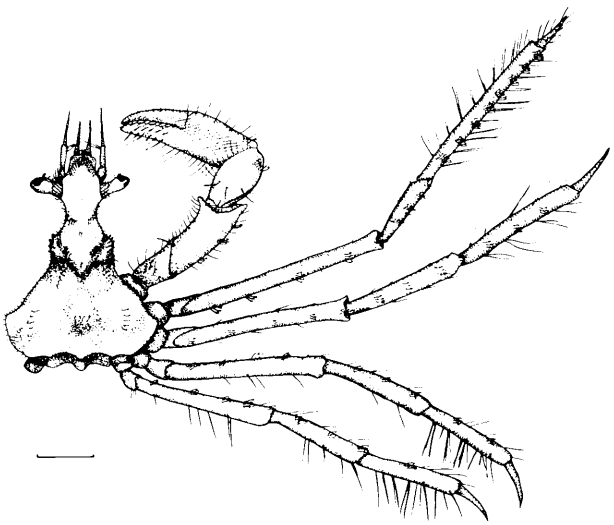

FIGURE 218.—*Podochela riisei* Stimpson. Animal in dorsal view, legs of left side not shown, 5 mm. indicated.

rounded in front, deeply excavated below for antennules, carinate above and with a tuft of curled hairs. Orbits rounded, margins thickened and with a row of hairs. Eyestalks short and stout, cornea oblique, dorsal emargination with distal tubercle tufted. Basal article of antenna with a high crest on each margin. Sternum of male thrown into ridges radiating to bases of legs.

Chelipeds slender in both sexes, fingers in contact throughout their length (stouter and slightly agape proximally in adult males). First pair of walking legs stouter than others, about three times as long as carapace; upper surface of all legs with regularly spaced tufts of stiff curled hairs.

Abdomen of male with six, female with five, free segments.

Measurements.—Carapace: male, length, 21 mm., width, 16 mm.; female, length, 23 mm., width, 20 mm.

Variations.—The rostrum is variable in shape and length. Margins of the basal antennal articles are thick in old individuals but may be thin in younger ones. Sternal segments of males usually have rounded surfaces but are sometimes flattened.

Color.—Overall color light brown; legs lighter, grading to almost off white or pale yellow; chelae and chelipeds nearly white to almost transparent; carapace darker on lateral aspects of urogastric and cardiac regions, as well as at posterolateral portions of metabranchial regions. Wass (1955) reported brick red specimens.

Habitat.—Has been taken from among hydroids on pilings at Beaufort, N.C., and in rocky areas in northwestern Florida (Wass, 1955); shallow water to 30 fathoms.

Type locality.—Island of St. Thomas, [West Indies].

Known range.—North Carolina to Campeche, Mexico; through West Indies to St. Thomas; Rio de Janeiro and south of Pernambuco, Brazil; Bermuda.

Remarks.—Ovigerous females have been taken in North Carolina in September. They have been taken in Florida from June to August and from November to February (U.S. National Museum records).

Podochela sidneyi Rathbun

Figures 219, 223H

Podochela sidneyi Rathbun, 1924, p. 1.—Rathbun, 1925, p. 39, text-fig. 9c, pls. 12–13 (rev.).

Recognition characters.—Closely resembling *Podochela riisei.* Rostrum narrower at base. Pterygostomian region bearing a long thin lamina either subtriangular or produced downward in a lobe. Sternal segments flat with sharp cristate margins.

Chelipeds of adult male less inflated than in *P. riisei*, proximal gape narrower, teeth on cutting edges more numerous and uniform in size. Walk-

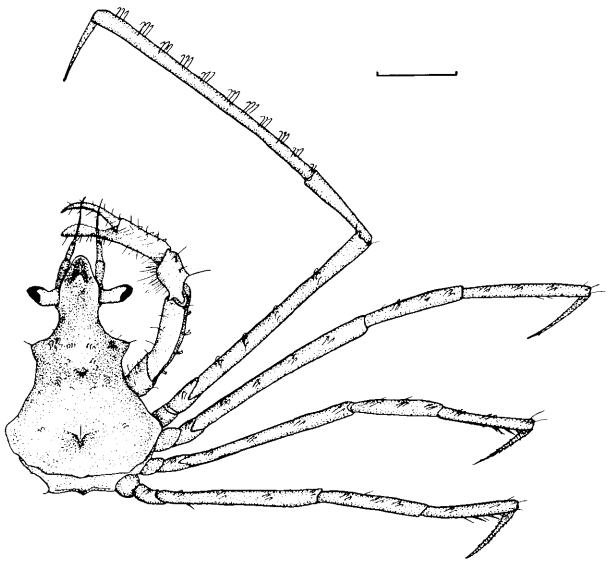

FIGURE 219.—*Podochela sidneyi* Rathbun. Animal in dorsal view, legs of left side not shown, 5 mm. indicated.

ing legs longer than in *P. riisei;* first pair of walking legs 3 or more times as long as carapace; dactyls of last three pairs less curved, longer and relatively more slender than in *P. riisei;* dactyl of second leg up to one-half length of propodus, of third leg to two-thirds, and of fourth leg to three-fourths length of propodus.

Abdomen of male with six, female with five, free segments.

Measurements.—Carapace: male holotype, length, 14 mm., width, 11 mm.

Habitat.—Shallow water to 102 fathoms.

Type locality.—Off Cape Hatteras, N.C., 49 fathoms.

Known range.—Off Cape Hatteras, N.C., to Port Aransas, Tex.; northwestern Cuba; Yucatan Channel.

Remarks.—Hildebrand (1954) reported the carapace of this species as decorated with hydroids and ascidians.

Podochela gracilipes Stimpson

Figures 220, 223I

Podochela gracilipes Stimpson, 1871a, p. 126.—Hay and Shore, 1918, p. 454, pl. 37, fig. 6.—Rathbun, 1925, p. 47, text-fig. 12, pl. 17 (rev.).

Recognition characters.—Carapace narrow, pyriform, depressed; constricted behind orbits; with rounded protuberance on cardiac region and two smaller median protuberances on gastric regions. Rostrum long, spiniform, hairy, unarmed. Sternum of males with thick blunt spine at base of cheliped. Crests on basal article of antenna less pronounced than in *P. riisei*, article long, narrow posteriorly, with a diagonal ventral ridge merging with terminal spine distally.

Chelipeds in male stout, inflated, fingers widely agape to near tip, large tooth near base of dactyl. Chelipeds slender in female. Walking legs slender, first pair three times length of carapace; dactyls long, nearly straight, one-third length of propodus; propodi of last three pairs thickened distally; dactyls slightly scythe-shaped, two-fifths length of propodus on second pair, one-half length on third, and two-thirds length of propodus on fourth pair.

Abdomen of male with six, female with five, free segments.

Measurements.—Carapace: male, length, 13 mm., width, 9 mm.; ovigerous females, length, 9 mm., width, 6 mm.

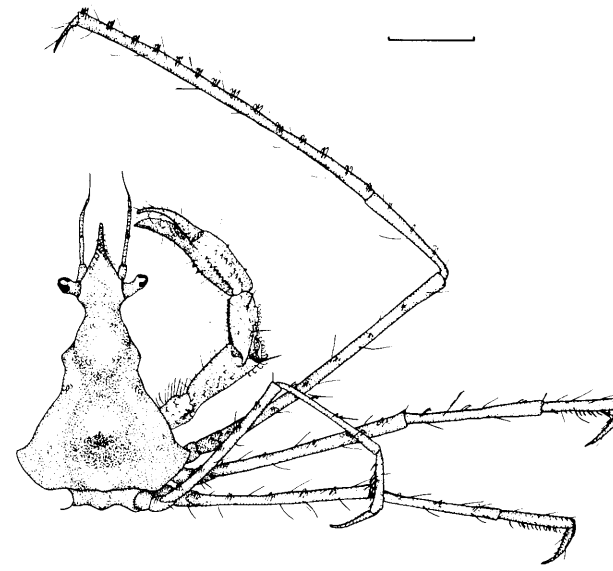

FIGURE 220.—*Podochela gracilipes* Stimpson. Animal in dorsal view, legs of left side not shown, 5 mm. indicated.

Habitat.—Eighteen to 120 fathoms.

Type localities.—West of Tortugas, off Pacific and Carysfort Reefs, [Fla.], 36 to 60 fathoms.

Known range.—Off Cape Lookout, N.C., to Gulf of Mexico; Caribbean Sea to Columbia and Barbados; Cabo Frio, Brazil.

Remarks.—Ovigerous females are known in December from North Carolina.

Genus ***Metoporhaphis*** Stimpson, 1860

Rathbun, 1925, p. 19.

Metoporhaphis calcarata (Say)

Figures 221, 223J

Leptopodia calcarata Say, 1818, p. 455.

Metoporhaphis calcaratus: Hay and Shore, 1918, p. 454, pl. 37, fig. 5.

Metoporhaphis calcarata: Rathbun, 1925, p. 21, text-fig. 5, pls. 6–7 (rev.).

Recognition characters.—Carapace triangular, longer than broad, uneven, nodulose with each nodule surmounted by a tubercle and this in turn usually with a pencil of soft, hooked hairs. Rostrum as long as or longer than carapace, subcylindrical, tapering to a point, often armed with four or five slender spines projecting outward alternately from opposite sides of lower surface, and with distal pair so close to tip as to give tip bi- or tri-spinose appearance. Eyes protuberant, peduncles terminating in superior spinule project-

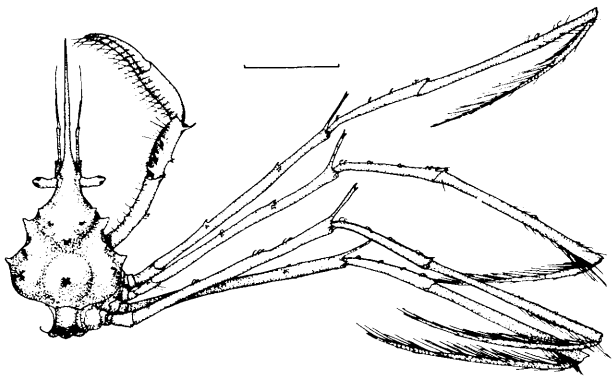

FIGURE 221.—*Metoporhaphis calcarata* (Say). Animal in dorsal view, legs of left side not shown, 10 mm. indicated.

ing beyond cornea. Basal antennal article with spine below at midpoint of length, another at outer distal angle, and a spinule at end of next two articles.

Chelipeds of moderate length, twisted, stout in male and less than half as long as first walking legs, margin of lower (really inner) surface armed with sharp spines; merus with sharp terminal spine; carpus with two sharp dorsal spines, one near each extremity of upper surface; hand broad, inflated; fingers about as long as palm, bent medially. Female with chelipeds feebler, palm shorter, fingers longer and more gaping. Walking legs slender, articles cylindrical but somewhat crooked; meri with one conspicuous spine and two smaller spines at extremity; dactyls longer than propodi, fringed with hair.

Male with six, female with five, free abdominal segments.

Measurements.—Carapace: female, length (including rostrum), 21 mm., width, 10 mm. Length of rostrum, 11 mm.

Color.—Dirty gray to lemon yellow.

Habitat.—Often found among hydroids near Morehead City, N.C., and also taken in dredges in Bogue Sound nearby; shallow water to 49 fathoms.

Type locality.—Bay of Charleston, S.C.

Known range.—Off Cape Hatteras, N.C., to Rio de Janeiro, Brazil.

Remarks.—Ovigerous females have been taken off South Carolina in August, and in Florida in March and August (Wass, 1955). Wass also noted that this species can remain suspended in water by "rhythmic waving of its long, setae-lined legs."

Genus ***Stenorynchus*** Lamarck, 1818

Rathbun, 1925, p. 13.

Stenorynchus seticornis (Herbst). Arrow crab

Figures 222, 223K

Cancer seticornis Herbst, 1788, p. 229, pl. 16, fig. 91 (see Rathbun, 1925).

Stenorynchus sagittarius: Hay and Shore, 1918, p. 455, pl. 37, fig. 8.

Stenorynchus seticornis: Rathbun, 1925, p. 13, text-fig. 3, pls. 2–3 (rev.).—Monod, 1956, p. 567, figs. 838–839.

Recognition characters.—Carapace smooth, triangular, longer than broad, diminishing in width to level of eyes and thence produced into a slender, horizontal, flattened, laterally spiniliferous rostrum varying from slightly longer to 2.5 times as long as carapace; rostral tip acuminate. Orbits not defined; postorbital spine small, occasionally bifid. Eyes short, not retractile. Basal article of antenna slender, with strong spine at middle directed downward and forward.

Legs extremely long and slender, composed of cylindrical articles, finely spinulose and bearing in addition two rows of spines on merus, two or three spines on carpus, and several terminal spines on these articles. Chelipeds slender, cylindrical; hand weak; palm of male cheliped from 2.5 to

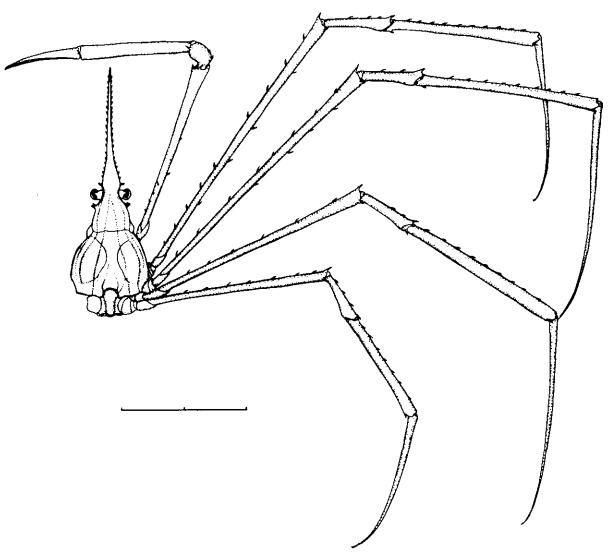

FIGURE 222.—*Stenorynchus seticornis* (Herbst). Animal in dorsal view, legs of left side not shown, 30 mm. indicated.

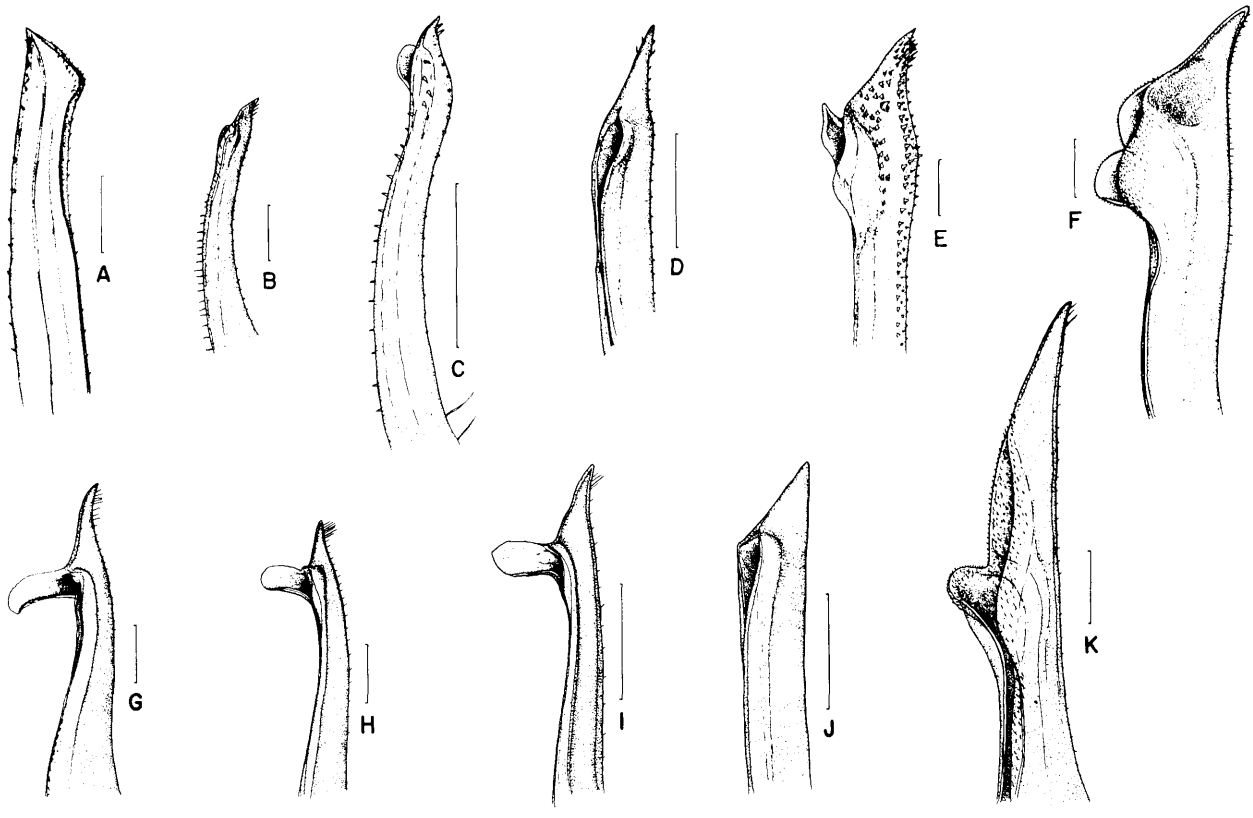

FIGURE 223.—Subfamily Inachinae, tips of right first pleopods of males; A, *Anomalothir furcillatus* (Stimpson), abdominal view; B, *Euprognatha rastellifera marthae* Rathbun, sternal view; C, *Batrachonotus fragosus* Stimpson, sternal view; D, *Collodes trispinosus* Stimpson, sternal view; E, *Pyromaia cuspidata* Stimpson, sternal view; F, *Anasimus latus* Rathbun, sternal view; G, *Podochela riisei* Stimpson, sternal view; H, *Podochela sidneyi* Rathbun, sternal view; I, *Podochela gracilipes* Stimpson, sternal view; J, *Metoporhaphis calcarata* (Say), sternal view; K, *Stenorynchus seticornis* (Herbst), sternal view; 0.33 mm. indicated.

4 times as long as dactyl. First pair of walking legs from 8 to 9 times as long as postrostral portion of carapace; second, third, and fourth legs successively shorter; dactyls on each pair longer than propodi.

Abdomen in male with six, female with five, free segments.

Measurements.—Carapace: male, length including rostrum, 57 mm.; width, 13 mm. Length of rostrum, 41 mm.

Variations.—There is great variation in length of rostrum, relative length of palm and fingers, and length of legs. In old individuals the rostrum, chelipeds, and legs are pubescent.

Color.—Body ground color gray, banded dorsally with stripes of light and dark brown or black converging anteriorly as a nested series of inverted V's; one dark pair of stripes continuing united on dorsal side and another more lateral pair of like color on ventral side of rostrum. Legs reddish brown, joints darker; fingers of chelipeds bluish purple.

Rathbun (1925) summarized other color observations. The general pattern is as above, with ground color creamy white, buff, or light orange vermilion; stripes white, chestnut, brown, or black; legs reddish with bright red spots at joints; chelae purple or mauve; spines on legs and rostrum orange or red; eyes maroon.

Habitat.—This form has been dredged or trawled from a variety of bottoms—rock, coral rock, pebbles, sand, or sand mixed with broken shell; also, it has been taken from wharf pilings and rock jetties. Near surface to 814 fathoms.

Type locality.—Guadeloupe (Holthuis, 1959).

Known range.—North Carolina to Rio de Janeiro, Brazil; Bermuda; eastern Atlantic from Madeira and Canary Islands to Angola.

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Remarks.—Though this species has a tremendous recorded range in depth, it is usually found well inside the 100-fathom mark. On September 6, 1953, an ovigerous female was collected from wharf pilings in Bogue Sound near Bogue Inlet, N.C.

Otherwise, ovigerous females are known or have been reported in the western Atlantic from February in the Gulf of Darien, throughout spring and summer in North and Middle America, and northern South America, to November off the Amazon River (U.S. National Museum records; Hildebrand, 1954; Holthuis, 1959; Rathbun, 1925).

Subfamily **Ophthalmiinae**

Orbit consisting, if complete, of a supraocular eave and a postocular spine; intercalated spine lacking . . . [but] . . . longer spinous outgrowths on supraocular eave and on postocular spine for most part present. Shape of body elongate, somewhat truncate in front, often provided behind with a median spine or outgrowth (Balss, 1929).

KEY TO GENERA OF OPHTHALMIINAE IN THE CAROLINAS

Modified after Garth (1958)

a. Eyes furnished with projecting and tubular commencing orbits ..... *Pitho* (p. 246).

aa. Orbit completely unprotected below; eyes protected above by a lamellate projection consisting of supraocular eave and an outgrowth of hepatic region ..... *Tyche* (p. 247).

Genus ***Pitho*** Bell, 1835

Garth, 1958, p. 162.

Pitho lherminieri (Schramm)

Figures 224, 233A

Othonia lherminieri Schramm, *in* Desbonne and Schramm, 1867, p. 20.

Pitho lherminieri: Hay and Shore, 1918, p. 459, pl. 38, fig. 8.—Rathbun, 1925, p. 362, text-fig. 117b, pl. 128, figs. 1–2; pl. 129, figs. 1–2; pl. 252, fig. 2 (rev.).

Recognition characters.—Carapace as broad as long in adult males, longer than broad in other individuals, narrow behind in males, broader in females, roughened with tubercles of different sizes, and adorned with scattered hooked hairs. Frontal teeth forming rostrum more advanced than orbital angles. Anterolateral margins armed with five strong teeth, exclusive of postorbital tooth; first tooth largest, second and third subequal, fourth and fifth much smaller, second occasionally bilobed. Orbits small, tubular, deep. Antenna short, with stiff hairs on borders; basal article lamellate, forming floor of orbit; second article flat, short, and broad; third article smaller, flattened.

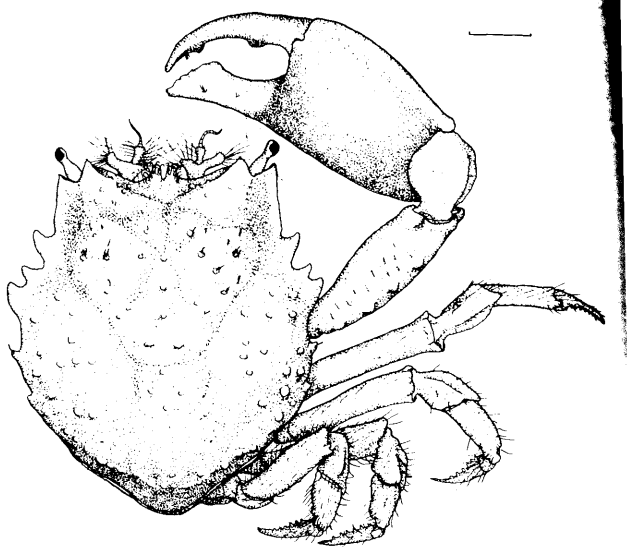

FIGURE 224.—*Pitho lherminieri* (Schramm). Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Chelipeds of adult male from 1.5 times to nearly twice length of body; merus subcylindrical; carpus and hand more or less compressed and distinctly angled along margins; fingers of adult male hollowed into spoon shape, touching only at extremity. In female and young male, fingers short and weak, evenly dentate, with margins in contact.

Abdomen of both sexes with seven free segments.

Measurements.—Carapace: male, length, 26 mm., width, 24 mm.; female, length, 18 mm., width, 17 mm.

Variations.—In females and young males the carapace is more tuberculate than in old males, the lateral teeth are sharper, and the last two teeth are more prominent than in mature males.

Color.—Dirty brownish yellow (Desbonne *in* Rathbun, 1925).

Habitat.—This species has been found on a variety of bottoms including mud, sand, shell-sand, shell, rock and coral, and grass (Rathbun,

1925). One-half to 28 fathoms, rarely to 120 fathoms.

Type locality.—Guadeloupe, in cavities of the keys.

Known range.—Off Beaufort Inlet, N.C., to west Florida; Vera Cruz, Mexico; West Indies to Islet of São Sebastião, São Paulo, Brazil.

Remarks.—Ovigerous females are known from May to November in the Bahamas and Florida, and in December from Brazil (Rathbun, 1925, and U.S. National Museum records).

Genus ***Tyche*** Bell, 1835

Garth, 1958, p. 172.

Tyche emarginata White

Figures 225, 226, 233B

Tyche emarginata White, 1847a, p. 206.—Hay and Shore, 1918, p. 461, pl. 39, fig. 4.—Rathbun, 1925, p. 508, pl. 272; pl. 273, figs. 7–12 (rev.).—Garth, 1946, pp. 406–408, text-fig. 1.

Recognition characters.—Carapace oblong-oval, flattened, with lamellate expansions in front covering ocular peduncles, and another prolonged and bilobed behind, stout hooked hairs on rostrum and prominent elevations. Front wide, with four long horns, lateral horns forming anterior angles of orbit, divergent, longer and more elevated than median rostral horns. Ocular peduncles entirely uncovered below. Gastric region swollen, with three low tubercles, two anterior, and a third posterior and median; cardiac region depressed, with three small tubercles. Lateral borders straight and nearly parallel at hepatic regions, rounded at branchial regions. Dorsal surface of hepatic region concave; branchial region with large tubercle on anterior lobe, and a prominent tuberculate crest above lateral margin. Exopodite of third maxilliped with basal protuberance recurving to cover base of ischium, merus inserting deeply into outer distal portion of ischium by similar but less developed process, inner margin of ischium strongly dentate.

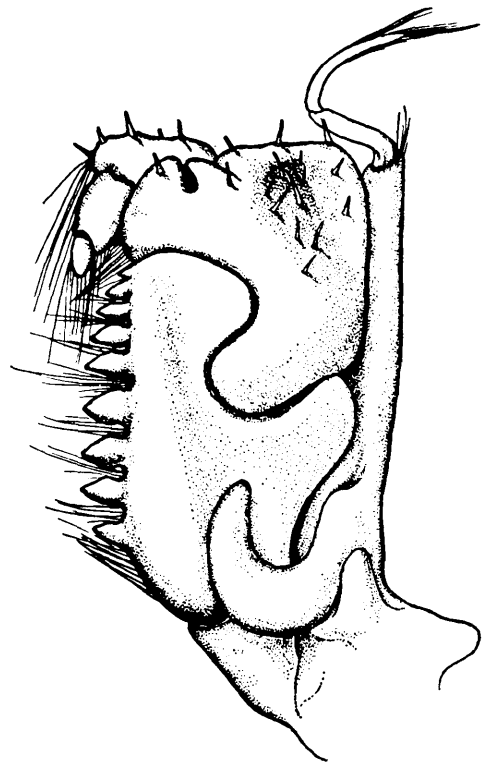

FIGURE 226.—*Tyche emarginata* White. Left outer maxilliped (after Garth, 1946).

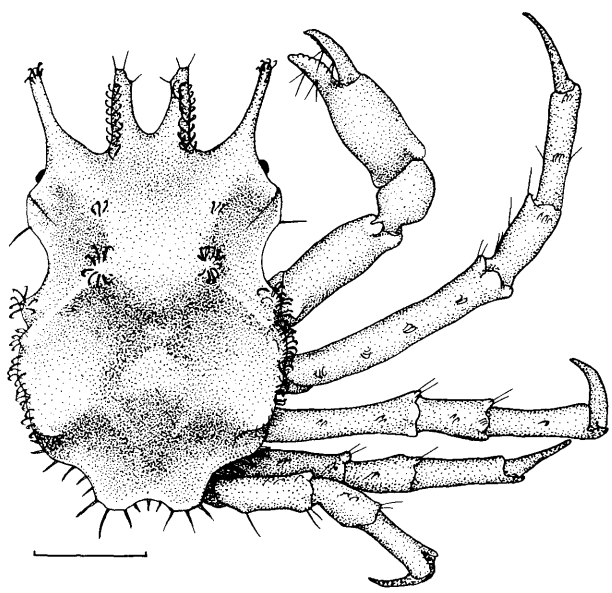

FIGURE 225.—*Tyche emarginata* White. Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Chelipeds of male more than twice length of postorbital part of carapace; palms somewhat dilated and compressed; fingers gaping at base, dentate throughout length. Walking legs ornamented with stout hooked hairs; dactyls spinulous on middle third, spinules increasing in size distally.

Abdomen of both sexes with seven free segments.

Measurements.—Carapace: female, length, 35 mm.; width, 21 mm.

Color.—Generally yellowish gray; carapace greenish above, with two triangular white spots; blackish above base of legs (various authors).

Habitat.—The species has been reported from rocky or coarse shell bottoms (Rathbun, 1925); a few feet to 20 fathoms.

Type locality.—West Indies.

Known range.—Off Beaufort Inlet, N.C.; through Bahamas to west coast of Florida; Cape São Roque, Rio Grande do Norte, Brazil.

Remarks.—Garth (1946) gave a detailed comparison of this species with its Pacific counterpart, *T. lamellifrons.*

Subfamily **Acanthonychinae**

Eyes without true orbits; eyestalks very short or sometimes obsolescent, either concealed beneath an anteriorly produced supraocular spine, or sunk in sides of a huge beaklike rostrum; a postocular spine or process sometimes present, but not excavated for reception of retracted eye. Basal antennal article elongate but truncate-triangular. External maxillipeds with merus as broad as ischium. Dactyls of walking legs prehensile or subchelate; last three pairs of legs often disproportionately short compared with [first] pair (Alcock, 1895). Postocular spine not cupped (except in *Sphenocarcinus*); rostrum either simple or two-spined; palp on third maxilliped arising from anterointernal angle of merus (Rathbun, 1925). First pleopod medium stout, apex most varying (hammer-shaped; divided into three or four lobes; etc.); second pleopod short (Stephensen, 1945).

KEY TO GENERA OF ACANTHONYCHINAE IN THE CAROLINAS

a. Rostrum double; seven free abdominal segments in both sexes ..... *Sphenocarcinus* (p. 248).

aa. Rostrum single or secondarily bifurcate; six free abdominal segments in male, five in female ..... *Epialtus* (p. 249).

Genus ***Sphenocarcinus*** Milne Edwards, 1878

Garth, 1958, p. 217.

Sphenocarcinus corrosus Milne Edwards

Figures 227, 233C

Sphenocarcinus corrosus Milne Edwards, 1875, pl. 17, figs. 5–5c.—Hay and Shore, 1918, p. 460, pl. 39, fig. 1.—Rathbun, 1925, p. 187, text-fig. 73, pl. 62; pl. 223, figs. 3–5 (rev.).

Recognition characters.—Carapace subpentagonal, broad behind, anterolateral margin concave, posterolateral margin convex. Dorsal surface deeply channeled, leaving symmetrical, coarsely punctuate, or eroded elevations in regular pattern as follows: a longitudinally placed, trefoil-shaped gastric, a transversely placed cardiac with two deep posterior indentations, a transversely elongate intestinal, paired laterals extending from near lateral angles to near eyes, and paired small postocular and larger supraocular elevations; margins of all elevations sharply defined with surface finely eroded. Rostrum usually longer than carapace, formed of two pointed horns contiguous to near tips, slightly divergent in old individuals. Eye deeply sunk between two low smooth excrescences. Basal antennal article truncate, antennal flagellum hidden beneath rostrum. Epistome long, narrow.

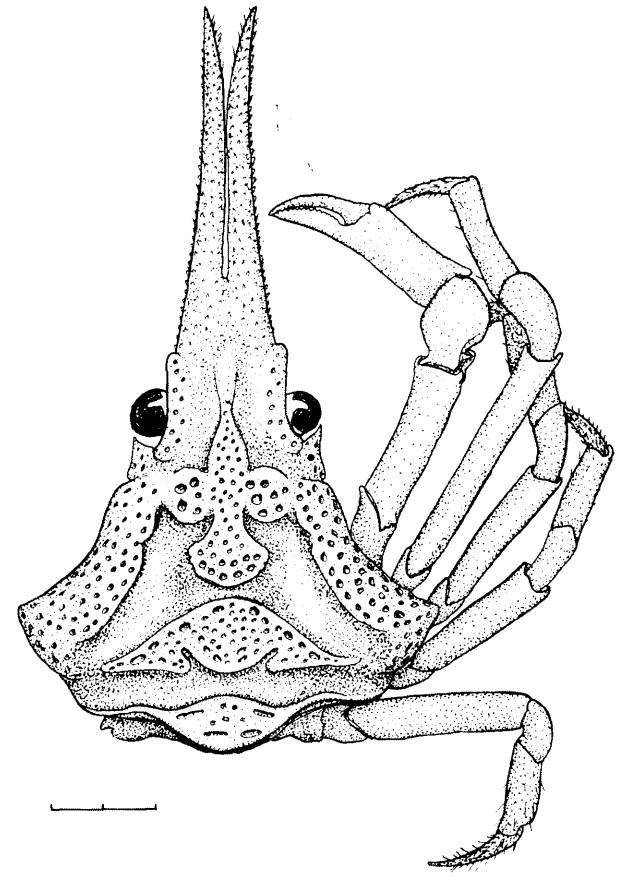

FIGURE 227.—*Sphenocarcinus corrosus* Milne Edwards. Male in dorsal view, legs of left side not shown, 2 mm. indicated.

Chelipeds weak; first pair of walking legs longer than others and exceeding length of chelipeds by more than length of dactyl.

Abdomen in both sexes with seven distinct segments.

Measurements.—Carapace: male, length, 13 mm., width, 7 mm.; ovigerous female, length, 23 mm., width, 11 mm.

Variations.—Divergence of the rostral horns varies individually. In some specimens the horns are contiguous nearly to the tip, in others the horns may be divergent for half their length, and in still others there is no evidence at all of bifurcation.

Color.—Orange-red.

Habitat.—Ninety to 148 fathoms.

Type locality.—Off Barbados, 100 fathoms.

Known range.—Off Cape Lookout, N.C., to Barbados.

Remarks.—Ovigerous females have been reported from North Carolina in April (Rathbun, 1925).

Genus ***Epialtus*** H. Milne Edwards, 1834

Garth, 1958, p. 227.

Epialtus dilatatus Milne Edwards

Figures 228, 233D

Epialtus dilatatus Milne Edwards, 1878, p. 140, pl. 27, figs. 4–4b.—Rathbun, 1925, p. 153, text-fig. 53j, pl. 45, fig. 2 (rev.).

Recognition characters.—Small species. Carapace broad, subpentagonal, almost smooth, with hepatic and branchial projections more or less laminate. Rostrum broad, somewhat triangular, short, bilobed at tip, slightly depressed on median line dorsally with depression continued ventrally and limited by two crests uniting posteriorly in an acute angle. Eyes small; preorbital angles scarcely marked; postorbital teeth minute. Basal article of antenna triangular, movable part concealed beneath rostrum.

Chelipeds moderate in size; carpus with four longitudinal crests; hand slightly enlarged distally, upper margin blunt, defined by depression on either side; fingers short and stout. Walking legs with slight tuft of hair on lower margin of propodi.

Abdomen of male with six, female with five, free segments.

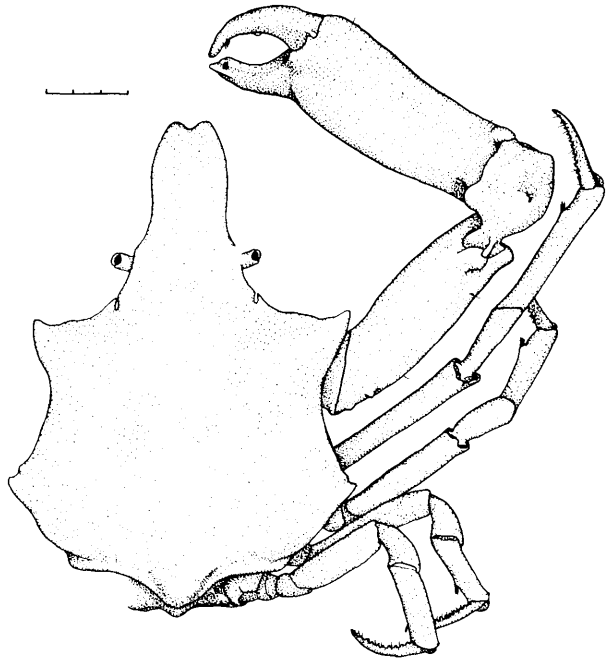

FIGURE 228.—*Epialtus dilatatus* Milne Edwards. Male in dorsal view, legs of left side not shown, 3 mm. indicated.

Measurements.—Carapace: male, length, 17 mm., width, 13 mm.; female, length, 10 mm., width, 8 mm.

Variations.—Members of the genus *Epialtus* are variable in a number of respects. The hepatic expansion may vary in shape and the rostrum may vary from triangular to suboblong in shape.

Rathbun (1925) recognized from southwestern Florida an elongate form which has a longer rostrum and slightly different lateral expansions than the typical form.

Habitat.—The species has been reported from shell reefs and coarse coral sand, and the elongate form has been found on sandy-grassy bottoms as well. Two and one-half to 12 fathoms.

Type locality.—St. Thomas.

Known range.—Off Beaufort Inlet and New River, N.C.; southwest Florida; Yucatan; Bahamas to St. Thomas.

Remarks.—Rathbun (1925) reported ovigerous females from Florida in April. They are known from North Carolina in June, and in Florida through the summer. Other records are Brazil in September, and Puerto Rico in November (U.S. National Museum records).

Subfamily **Pisinae**

Eyes with commencing orbits, eye retractile into sometimes large, blunt, usually isolated, cupped postocular tooth or lobe, but never to such extent as to conceal completely cornea from dorsal view; usually a prominent supraocular eave with anterior angle sometimes produced forward as a spine; eyestalks short. Basal antennal article broad, at least at base, anterior angle generally produced to form a tooth or spine. Merus of external maxilliped broader than ischium owing to expansion of anteroexternal angle, and carrying palp at anterointernal angle. Rostrum [except in *Neodoclea* among New World forms] two-spined; legs often very long (Alcock, 1895). First pleopod medium stout to slender, usually apically somewhat tapering, but apex extremely varying (blunt, acute, filiform, straight, geniculate, etc.); second pleopod short (Stephensen, 1945).

KEY TO GENERA OF PISINAE IN THE CAROLINAS

Modified after Garth (1958)

a. Intercalated orbital spine present----*Nibilia* (p. 251).
aa. Intercalated orbital spine absent.
  b. Supraocular eave and postocular process not closely approximated----*Pelia* (p. 250).
  bb. Supraocular eave and postocular process closely approximated----*Libinia* (p. 251).

Genus ***Pelia*** Bell, 1835

Garth, 1958, p. 268.

Pelia mutica (Gibbes)

Figures 229, 233E

Pisa mutica Gibbes, 1850, p. 171.
Pelia mutica: Hay and Shore, 1918, p. 455, pl. 38, fig. 7.—Rathbun, 1925, p. 278, text-fig. 94, pl. 98, figs. 2–3 (rev.).

Recognition characters.—Small species. Carapace pyriform, greatest width approximately two-thirds greatest length, swollen, devoid of tubercles, covered with sparse pubescence, gastric and cardiac regions elevated. Rostrum well developed, two-fifths as long as remainder of carapace, formed of two more or less distally divergent horns with outer margins often parallel, a furrow on basal portion. Eyes retractile. Basal antennal article long, slender, forming incomplete floor to orbit and jutting out beyond orbital margin, usually with small tooth or spine at anteroexternal angle; antennal flagellum greatly developed.

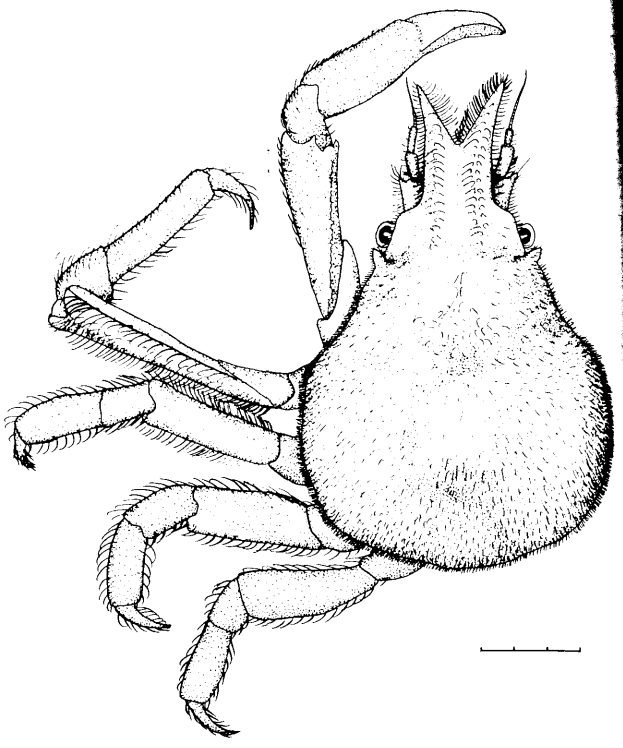

FIGURE 229.—*Pelia mutica* (Gibbes). Animal in dorsal view, legs of right side not shown, 3 mm. indicated.

Chelipeds of mature male as long as first walking legs but stouter and almost bare, weaker in females and young males; upper and inner margin of merus dentate; carpus with a longitudinal denticulate ridge; upper and lower margins of hand slightly arcuate; basal half of fingers widely agape, with denticulate margins on occludent portions and broad basal tooth of dactyl; fingers weaker and not agape in females and young males. Walking legs with marginal rows of stiff setae, meri much compressed, dactyls strongly curved.

Abdomen of both sexes with seven free segments.

Measurements.—Carapace: male, length, 13 mm., width, 9 mm.; ovigerous females, length, 5–10 mm. (Wass, 1955).

Color.—Bright red in patches on carapace and in bands on legs, spots of light red on chelipeds (Rathbun, 1925).

Habitat.—This species has been found on gravelly and shelly bottoms of bays and sounds, among hydroids, ascidians, and sponges on wharf piles, and also on shelly reefs off Beaufort Inlet,

N.C. (Pearse and Williams, 1951). Individuals are often so covered with sponge that they are difficult to recognize. Gray (1961) reported the species from *Chaetopterus* tubes. Low water to 28 fathoms.

Type locality.—Charleston Harbor, off White Point Battery, S.C.

Known range.—Buzzards Bay and Vineyard Sound, Mass., to west coast of Florida; Cuba, Puerto Rico, and St. Thomas, West Indies.

Remarks.—Ovigerous females are known from February to July in Florida, through the summer in the Carolinas, and in Massachusetts in July (Rathbun, 1925; U.S. National Museum records).

Genus ***Nibilia*** Milne Edwards, 1878

Rathbun, 1925, p. 289.

Nibilia antilocapra (Stimpson)

Figures 230, 233F

Pisa antilocapra Stimpson, 1871a, p. 110.
Nibilia antilocapra: Rathbun, 1925, p. 290, text-fig. 97, pls. 102, 103, and 239 (rev.).

Recognition characters.—Carapace pyriform, conspicuously spinose, much swollen, longer than wide; gastric and cardiac regions with about 18 spines of moderate size and smaller ones interspersed, largest spines surmounting summit of regions and somewhat surrounded by circle of smaller spines; other regions also well spined.

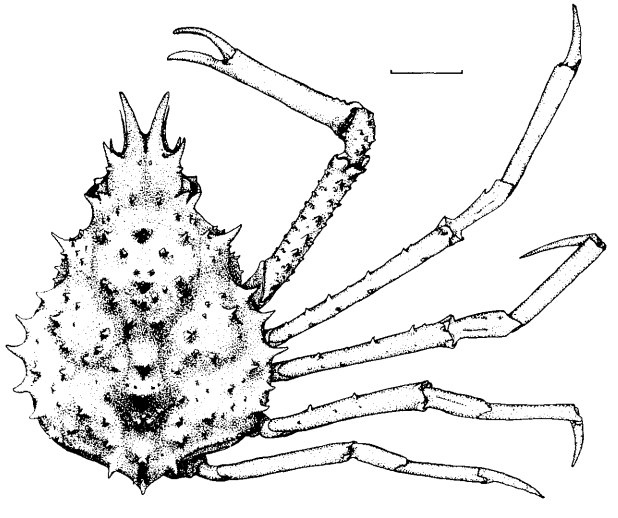

FIGURE 230.—*Nibilia antilocapra* (Stimpson). Male in dorsal view, legs of left side not shown, 10 mm. indicated.

Rostrum horizontal, undivided at base but moderately bifurcate for greater part of length, horns varying from three-fifths to four-fifths total length of rostrum. Preorbital spine ascending, slightly curved, not so advanced as base of horns; behind this a small spine on supraocular eave and a triangular (intercalated) spine or tooth on supraocular border; postocular cup terminating in a spine. Basal antennal article with a short spine just outside posterior end, behind this a tubercle in line with prominent spine at angle of buccal cavity. Maxilliped and sternum smooth.

Chelipeds of adult male longer and stouter than walking legs; merus and carpus rough with spines above and below; chelae almost cylindrical; hand nearly as long as merus, nearly smooth, a few spines near articulation with carpus; fingers agape for half of length in old males, with a well-developed tooth on dactyl in gaping part. Walking legs long, slender; merus and carpus with a few spines longitudinally arranged; dactyls long, stout, unarmed.

Measurements.—Carapace: large male, length, 120 mm., width, 82 mm.; female, approximate length, 60 mm., width, 43 mm.

Variations.—The young and half-grown are covered with short hair, but the old are nearly bare except for hairy dactyls on the walking legs.

Habitat.—The species has been reported from gray and coarse sand, broken-shell, and coral bottoms (Rathbun, 1925); 39 to 140 fathoms.

Type localities.—Florida, off Carysfort Reef, 52 and 60 fathoms; and off Alligator Reef, 118 fathoms.

Known range.—Off Cape Hatteras, N.C., to Gulf of Mexico just east of Mississippi River Delta and Gulf of Campeche; Windward Islands, West Indies.

Remarks.—Ovigerous females have been reported from St. Vincent in February and from Barbados in March (Rathbun, 1925).

Genus ***Libinia*** Leach, 1815

Garth, 1958, p. 322.

KEY TO SPECIES IN THE CAROLINAS

a. Median line of carapace with about nine spines *emarginata* (p. 252).
aa. Median line of carapace with about six spines *dubia* (p. 252).

Libinia emarginata Leach. Spider crab

Figures 231, 233H

Libinia emarginata Leach, 1815, p. 130, pl. 108.—Hay and Shore, 1918, p. 456, pl. 38, fig. 6.—Rathbun, 1925, p. 311, text-figs. 103–104; pls. 110–113 (rev.).

Recognition characters.—Carapace orbicular, about one-sixth longer than wide, spinose and tuberculate, with dense covering of short hairs. Larger spines arranged as follows: median row of about nine extending from near base of rostrum to posterior border consisting of four gastric, one genital, two cardiac, and two intestinal; lateral marginal spines five on each side; two subhepatic spines; two or four spines above posterior margin, aside from median spine, and about four dorsal branchial spines; spiniform tubercles scattered about among larger spines. Gastric region marked off by a deep groove. Rostrum slightly depressed, emarginate or bifid at tip; a median groove between eyes. Orbits with prominent preorbital spine, two spines beneath on basal article of antenna; one fissure above and one beneath.

Chelipeds equal, larger in male; hands granulate; fingers smooth, evenly denticulate, and about half as long as hand. Walking legs long, hairy, unarmed, often unequal and asymmetrical (result, perhaps, of injury and subsequent regeneration).

Measurements.—Carapace: male, length, 103 mm., width including spine, 94 mm.; female, length, 62 mm., width, 58 mm.

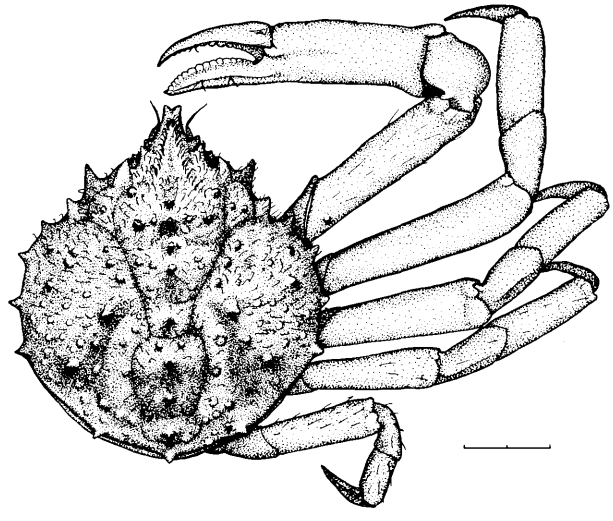

FIGURE 231.—*Libinia emarginata* Leach. Male in dorsal view, legs of left side not shown, 20 mm. indicated.

Variations.—The number of median spines in the gastric region is subject to some variation in size and number.

Color.—A brownish or dirty yellow.

Habitat.—Found on almost any kind of bottom; shore to 27, occasionally 68, fathoms.

Type locality.—Unknown.

Known range.—Windsor, Nova Scotia, to western Gulf of Mexico.

Remarks.—Hildebrand (1954) reported this species as the most common large spider crab in the western Gulf of Mexico. It was most common in July, at which time ovigerous females were observed. Another ovigerous female was taken in February. (Elsewhere ovigerous females are known from New Jersey in August (U.S. National Museum records).) Hildebrand also observed juveniles riding in the bell of scyphozoan *Stomolophus meleagris*, a habit noted by others for the young of *L. dubia*.

The young of *L. emarginata* and *L. dubia* are difficult to distinguish. Wass (1955) pointed out useful distinguishing marks. "The rostrum of *L. dubia* is much longer, forming a V; the carapace is not so wide, and there is but one spine on the intestinal region . . . whereas *L. emarginata* has two."

Gray (1957) compared gill area in this sluggish species with that of other common littoral crabs in the Carolinas and found that it had the smallest gill area per gram body weight of any studied.

Libinia dubia H. Milne Edwards. Spider crab

Figures 232, 233G

Libinia dubia H. Milne Edwards, 1834, p. 300, pl. 14*bis*, fig. 2.—Hay and Shore, 1918, p. 456, pl. 38, fig. 5.—Rathbun, 1925, p. 313, text-figs. 105–106; pls. 114–115; pl. 122, fig. 1 (rev.).

Recognition characters.—Similar in general characters to *L. emarginata* but with more pyriform carapace and fewer spines; median row with but six spines, two gastric, one genital, two cardiac, and one intestinal; preorbital, subhepatic, and lateral spines stronger than in *L. emarginata*, but spiniform tubercles few or wanting altogether. Rostrum slightly longer and more definitely bifid than in *L. emarginata*. Anterolateral angle of buccal frame armed with a spine.

Measurements.—Carapace: male, length, 102 mm.; width including spines, 82 mm. Most individuals smaller.

Variations.—Dorsal spines and tubercles variable in length.

Habitat.—Found on almost all types of bottom in the ocean and the saltier sounds. Occasionally, large individuals are found on Bird Shoal near Beaufort, N.C., in pools left by falling tide; frequently specimens are brought up in otter trawls. Immature individuals are often completely overgrown with sponges, hydroids, or ascidians, but the larger ones are usually almost clean. Near shore to 25 fathoms.

Type locality.—*Côtes des Etats-Unis.*

Known range.—Cape Cod, Mass., to southern Texas; Bahamas and Cuba.

Remarks.—This species has a geologic record extending from the upper Miocene of Virginia (Rathbun, 1935) through the Pleistocene of New

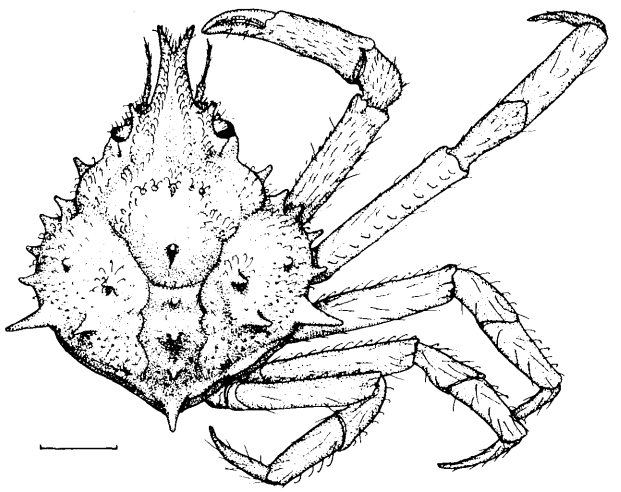

FIGURE 232.—*Libinia dubia* H. Milne Edwards. Male in dorsal view, legs of left side not shown, 10 mm. indicated.

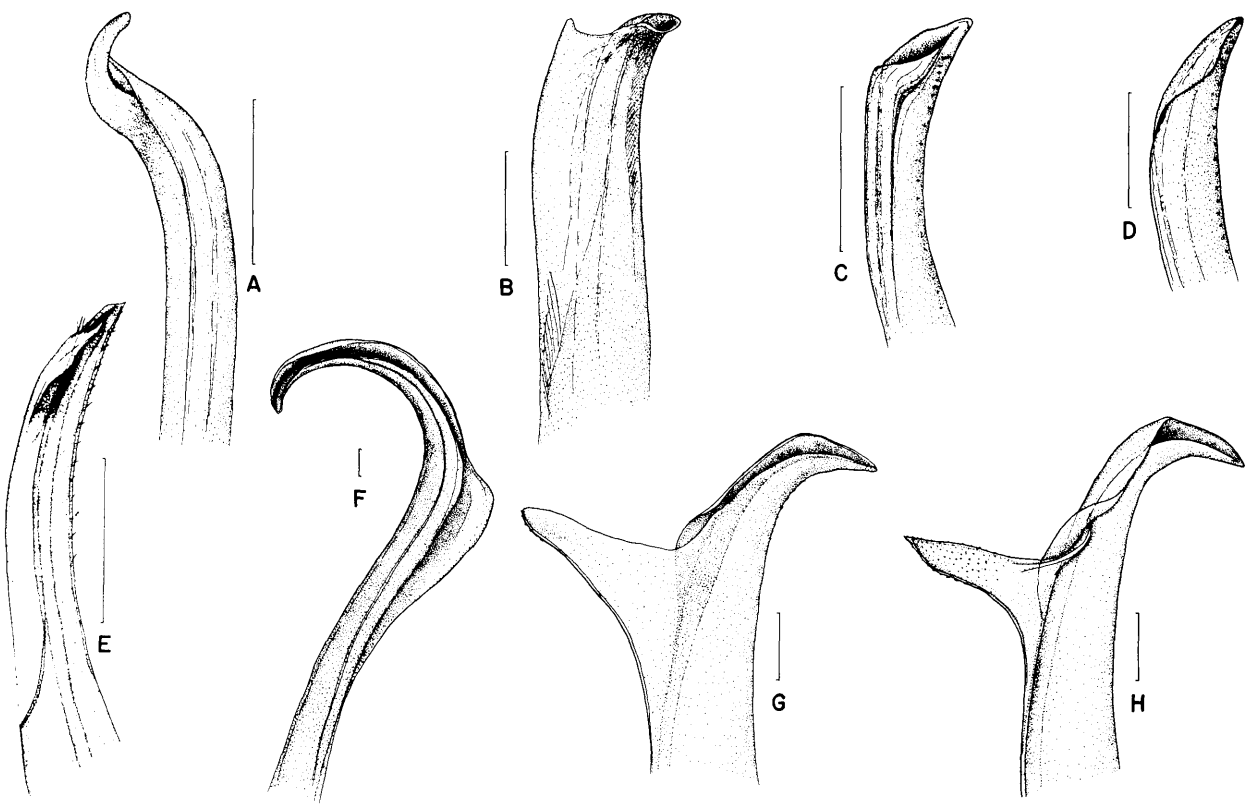

FIGURE 233.—Subfamilies Ophthalmiinae, Acanthonychinae, and Pisinae, tips of right first pleopods of males; A, *Pitho lherminieri* (Schramm), abdominal view; B, *Tyche emarginata* White, lateral view; C, *Sphenocarcinus corrosus* Milne Edwards, sternal view; D, *Epialtus dilatatus* Milne Edwards, sternal view; E, *Pelia mutica* (Gibbes), sternal view; F, *Nibilia antilocapra* (Stimpson), abdominal view; G, *Libinia dubia* H. Milne Edwards, lateral view; H, *Libinia emarginata* Leach, lateral view; 0.33 mm. indicated.

Jersey (Rathbun, 1935) and Maryland (Easton, 1940).

Ovigerous females are known to occur in spring in North Carolina.

Pearse (1929), studying the survival rates of various estuarine crabs in dilutions of sea water and in air, found *L. dubia* least able to survive desiccation and dilutions of sea water. Ayers (1938), in a study of the relationship of habitat to oxygen consumption among certain estuarine crabs, found that *L. dubia* lives much of the year in relatively deep [estuarine] water where there is low oxygen content, sometimes very little. The species is correspondingly sluggish and slow. Gray (1957) showed that gill area per gram of weight in this species is small.

A peculiar association of this species with the jellyfish *Stomolophus meleagris* has been reported. The crabs have been found in the subumbrellar space and on occasion small specimens have been taken from the genital pits. Corrington (1927) found medusae with crabs between Sullivans Island and Isle of Palms, S.C., in May, and Gutsell (1928) found the association in the vicinity of Cape Lookout, N.C., in summer and fall. The crabs were found in adult jellyfish and varied in length from 3 to 37 mm.

Pearse (1952b) reported *Octolasmis lowei* (=*mulleri*) on the gills and mouth parts, and *Chelonibia patula* on the carapace of *L. dubia* in Texas.

Subfamily **Mithracinae**

Carapace broadened anteriorly by outstanding, often tubular, orbits; orbits formed (1) by an arched supraocular hood, or semitubular horn, (2) by a hollowed postocular process, and (3) by a remarkable broadening, or by a prolongation, of anterior part of basal antennal article, affording complete concealment to retracted eye. Rostrum often more or less deflexed (Alcock, 1895). First pleopod like that in Pisinae; second pleopod short (Stephensen, 1945).

KEY TO GENERA OF MITHRACINAE IN THE CAROLINAS

Modified after Garth (1958)

a. Intercalated orbital spine present (between supraorbital and postorbital spine); orbits projecting somewhat beyond general outline of carapace, but not tubular.
  b. Rostrum small; carapace ovate, usually broader than long ..... *Mithrax* (p. 254).
  bb. Rostrum large, usually with two strong horns; carapace broadly pyriform; basal antennal article armed with a prominent spine at anteroexternal angle ..... *Microphrys* (p. 259).
aa. Intercalated orbital spine absent; orbits tubular.
  b. Lateral margin of carapace armed with series of strong spines; basal antennal article very broad ..... *Stenocionops* (p. 260).
  bb. Lateral margin of carapace not armed with series of strong spines, but with a spine, usually strong, at lateral angle of carapace ..... *Macrocoeloma* (p. 263).

Genus ***Mithrax*** Desmarest, 1823

Garth, 1958, p. 352.

KEY TO SPECIES IN THE CAROLINAS

(Modified from Garth, 1958, and Rathbun, 1925)

a. Carapace roughened to greater or lesser extent by tubercles or spinules, branchial grooves wanting; intermediate orbital teeth conspicuous, pointed, or subtruncate ..... (Subgenus *Mithrax*).
  b. Hand armed above with spines or spinules.
    c. Two spines only on basal (fused) article of antenna ..... *spinosissimus* (p. 254).
    cc. Three spines on basal (fused) article of antenna; carapace paved with flattened granules, concealed by short hair ..... *verrucosus* (young) (p. 255).
  bb. Hand not armed above with spines or spinules.
    c. Carapace paved with close-set, tessellated granules ..... *verrucosus* (p. 255).
    cc. Carapace not paved with close-set, tessellated granules.
      d. Gastric region without definite transverse row of five tubercles ..... *hispidus* (p. 256).
      dd. A transverse row of five tubercles across gastric region ..... *pleuracanthus* (p. 257).
aa. Carapace smooth and bearing oblique branchial grooves, either strongly or weakly indicated; intermediate orbital teeth inconspicuous, tuberculiform (Subgenus *Mithraculus*).
  Carapace broader than long; anterolateral margins cut into spines, or angular lobes, or spines and lobes; four anterolateral protuberances behind orbit ..... *forceps* (p. 258).

Mithrax (Mithrax) spinosissimus (Lamarck)

Figures 234, 245A

Maia spinosissima Lamarck, 1818, p. 241.
Mithrax spinosissimus: Rathbun, 1925, p. 383, pl. 135 (rev.).

Recognition characters.—Large. Carapace nearly naked, subcircular, approximately as broad as long; surface rough with short spines, those in center blunt, elsewhere sharp; cervical suture deep; hepatic and cardiac regions distinctly delimited. Rostral horns narrow, obliquely truncate and granulate at extremity, separated by a U-

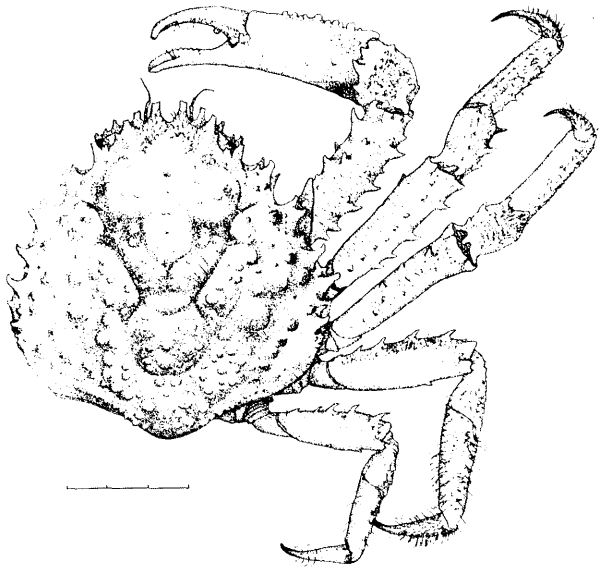

FIGURE 234.—*Mithrax* (*Mithrax*) *spinosissimus* (Lamarck). Male in dorsal view, legs of left side not shown, 30 mm. indicated.

shaped notch of equal length and breadth; two stout spines at base of horns and two more behind these but farther apart; preorbital spine stouter, truncate, and less advanced than rostrum. Orbital border with three small teeth exclusive of postorbital spine; suborbital margin with one acute spine outside antennal segment and lateral to this a larger truncate spine. Antennal segment with an outer small acute spine and an inner spine more advanced than rostrum bearing a small secondary lateral spine near end. Lateral margin with six spines, first two double, last and smallest one on posterolateral margin. Other spines present on suborbital, subhepatic, subbranchial, pterygostomian regions, and at angle of buccal cavity.

Chelipeds of adult male massive, longer than walking legs; merus armed with eight or nine stout spines on outer margin, others irregularly placed; carpus armed with unequal spines, about five on inner margin; hand deep, compressed, armed above with a more or less double row of spines and on inner surface with two to four spines proximally; fingers curved leaving wide gape, strong tooth near middle of dactyl, tips spooned with edges crenate preceded by a few low tubercles. Adult female with chelipeds no longer and not much stouter than first pair of walking legs; hand tapering somewhat distally; fingers narrowly gaping with numerous denticles on cutting edges. Walking legs of both sexes spinose and coarsely hairy; propodi elongate and compressed.

Abdomen of male with seven free segments, female with six.

Measurements.—This is the largest species of *Mithrax*. Carapace: male, length, 170 mm., width, 184 mm.; female, length, 77 mm., width, 80 mm.

Variations.—In old males, spines on the chelipeds tend to become blunt and tuberculiform. In medium-sized individuals, the carapace is relatively longer than in the old, spines are sharper, rostral horns curve inward at the sharp tips, the carapace is covered with short hair, chelipeds of both sexes are small, and the gape extends only half the length of the fingers. In young individuals, the spines are even more accentuated, rostral horns are one-fifth as long as the carapace, there are two spines on the suborbital margin outside the antennal segment, chelipeds are no longer or stouter than the first walking legs, and gape of the fingers is less than in older individuals.

Color.—Bright carmine; vinous red with yellowish tints; or thorax dark red; walking legs brick red and chelipeds rose red with yellow fingers (various authors including Rathbun, 1925).

Habitat.—The species is often found among rocks. The carapace is often covered with encrusting organisms; shallow water to 98 fathoms.

Type locality.—Ile-de-France. Locality erroneous.

Known range.—Either North Carolina or South Carolina (?) through Florida Keys and West Indies to Guadeloupe.

Remarks.—Ovigerous females have been reported in May and June from Cuba (Rathbun, 1925).

Mithrax (Mithrax) verrucosus H. Milne Edwards

Figures 235, 245B

Mithrax verrucosus H. Milne Edwards, 1832, cl. 7, pl. 4 (col.) [+ unpaginated description].—Rathbun, 1925, p. 400, pl. 144 (rev.).

Recognition characters.—Mature males, large- to medium-sized. Carapace covered with flattened, closely crowded granules, nearly naked, granules covered with small pits, cervical suture deep; branchial region with a few dorsal spines on outer part, front and orbit with truncate spines. Rostral

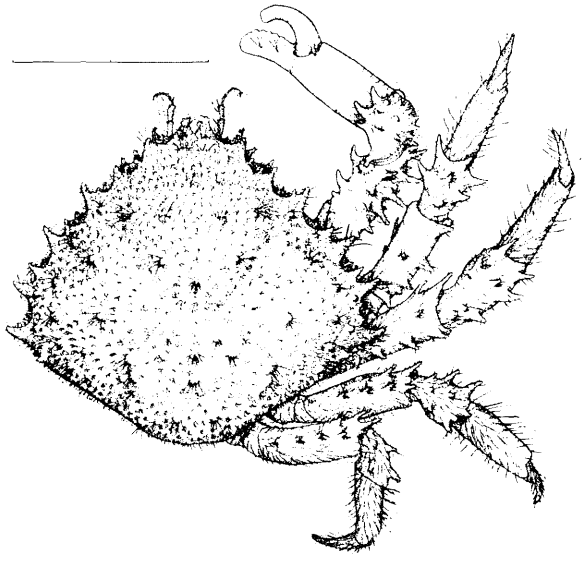

FIGURE 235.—*Mithrax* (*Mithrax*) *verrucosus* H. Milne Edwards. Male in dorsal view, legs of left side not shown, 20 mm. indicated.

horns short, separated by a deep notch. Preorbital spine directed somewhat outward, four other spines on orbital margin aside from three occurring on broad basal antennal article. Anterolateral margin with eight spines, first six in pairs, anterior spines of each pair smaller, spines in first two pairs more or less united at base; a single posterolateral spine, and below lateral margin a row of about nine spines.

Chelipeds stout; outer margin of merus with six sharp spines, approximately six spines on upper surface; inner margin of whole cheliped armed with blunt spines or lobes, one on ischium, four on merus, two or three on carpus; carpus with dorsal surface smooth or slightly tuberculate proximally; palm unarmed, elongate, somewhat swollen, fingers gaping with a large tooth near middle of dactyl, edges of spoon-shaped tips slightly crenulate, two bunches of hair inside spoon. Walking legs covered with coarse hair, meri and carpi spiny.

Measurements.—Carapace: male, length, 51 mm.; width, 65 mm.

Variations.—Females, young, and most immature males differ from mature males in that the carapace is covered densely with hair. Rostral horns of females and immature males are shorter and farther apart, but horns of the young are sharper. Spines on the inner margin of the chelipeds are sharper, the carpus is more or less spiny dorsally, and the palm is spinulous and hairy above proximally. The degree of spination on the chelipeds also varies individually.

Color.—Dark red; color largely concealed by hairiness, carapace dark dull red, pincers olive above and lighter olive below, tips claret, teeth white, underparts maroon flecked with white and yellow (various authors and Rathbun, 1925).

Habitat.—This species lives near shore among rocks, where it hides in holes. It is nocturnal, and has been caught with the aid of a light while feeding. Shallow water near shore.

Type locality.—Robert Bay, Martinique.

Known range.—Charleston, S.C., through West Indies to Fernando Noronha Island (225 miles northeast Cape São Roque), Brazil.

Remarks.—Pearse (1932a) determined freezing point of blood in this species at Tortugas (range −1.99° to −2.24° C.).

Mithrax (Mithrax) hispidus (Herbst). Coral crab

Figures 236, 245C

Cancer hispidus Herbst, 1790, p. 245 (247 by error), pl. 18, fig. 100.

Mithrax hispidus: Rathbun, 1925, p. 406, text-fig. 124, pls. 145–146; pl. 147, fig. 3 (rev.).

Recognition characters.—Carapace swollen, considerably wider than long, smooth except for some low, rounded prominences chiefly toward outer margin of branchial region, gastric tubercles

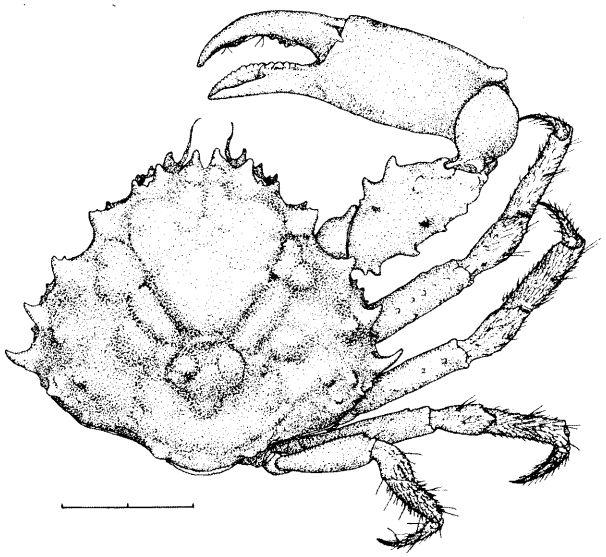

FIGURE 236.—*Mithrax* (*Mithrax*) *hispidus* (Herbst). Male in dorsal view, legs of left side not shown, 20 mm. indicated.

faint; front wide. Rostral horns short, obtuse, separated by a U-shaped notch. Preorbital angle blunt, slightly produced. Basal article of antenna with two teeth, inner one nearly as advanced as rostrum, outer smaller one on orbital border. Orbit with four tubercles on margin, two superior much smaller than external or inferior ones. Anterolateral margin with four spiniform teeth, first one obtuse, often bifid at tip; second longer, sharp, double, and curving forward; third and fourth slender. Posterolateral border with a smaller tooth situated higher on carapace in line with two obliquely located tubercles, or a low spine and a tubercle. Subhepatic region with two tubercles; a few other tubercles on subbranchial and pterygostomian regions.

Chelipeds large, unequal in males, equal in females: merus with four or five spines and a few tubercles on upper surface and two spines on inner margin; carpus smooth; hand smooth; fingers spooned at tips, gaping, with a broad low crenulated tooth near base of dactyl.

Measurements.—Carapace: large male, length, 102 mm.; width, 146 mm.

Variations.—Young individuals have tubercles on the carapace more protuberant than in the old.

Color.—Nearly uniform deep brownish-red or terra cotta color above, brighter on chelipeds and darker on legs (due to brown hairs); legs often with brighter red bands at joints; underparts of body mostly white or bluish white; legs red, speckled with pale yellow (Verrill, 1908).

Habitat.—Commonly lives on rough bottom; shallow water to 30 fathoms.

Type locality.—Unknown.

Known range.—Recorded in literature from as far north as Delaware Bay (Say, 1818), off Charleston Harbor, S.C., and Georgia (Gibbes, 1850). Bahamas and Florida Keys through West Indies to São Paulo, Brazil; Bermuda.

Mithrax (Mithrax) pleuracanthus Stimpson

Figures 237, 245D

Mithrax pleuracanthus Stimpson, 1871a, p. 116.—Milne Edwards, 1875, p. 95, pl. 20, figs. 3–3f.—Rathbun, 1901, p. 68.—Hay and Shore, 1918, p. 458, pl. 38, fig. 3.—Rathbun, 1925, p. 411, pl. 150 (rev.).

Mithrax depressus Milne Edwards, 1875 (in part), p. 96, pl. 20, figs. 4–4c.—Rathbun, 1901, p. 68.—Verrill, 1908, p. 407, pl. 23, fig. 1.—Hay and Shore, 1918, p. 458, pl. 38, fig. 2.

Mithrax hispidus Rathbun, 1892 (in part), p. 265.

Recognition characters.—Carapace not much wider than long, conspicuously tuberculate; front wide. Rostral horns shorter and wider than in *M. hispidus*, notch between horns narrower and nearly triangular, always triangular in young individuals. Preorbital angle blunt, slightly produced; orbit with two superior tubercles; a small postorbital angle and a suborbital tubercle. Basal article of antenna with two teeth, inner one nearly as advanced as rostrum, outer smaller one on orbital border. Spines of anterolateral border well developed, anterior one or two inclined to be double, posterior two more acute and pointed forward, small tubercles about base of spines. Gastric region with transverse row of five tubercles, in front of these, two pairs of tubercles, anterior pair at base of rostral horns. Mesogastric region with two tubercles on each side in a transverse line. Cardiac region with three poorly defined tubercles. Branchial area with four rather strong tubercles and several smaller ones arranged more or less in three oblique rows radiating from cardiac region to anterolateral border.

Chelipeds large; merus with scattered low spines on upper margin, with a simple spine, spine and tubercle, or rounded eminence on inner margin, and five small spines on posterior border; carpus smooth or with a few low tubercles on upper surface; hands smooth; fingers slightly gaping, dentate for nearly entire length, spoon-shaped at tips. Walking legs dentate and hairy.

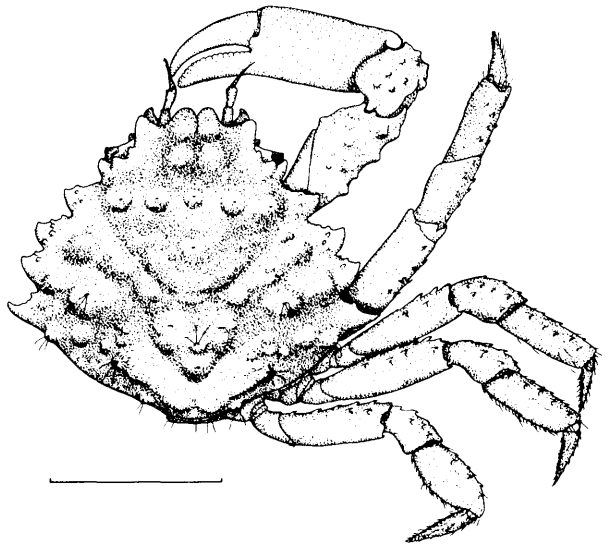

FIGURE 237.—*Mithrax (Mithrax) pleuracanthus* Stimpson. Animal in dorsal view, legs of left side not shown, 10 mm. indicated.

Measurements.—Carapace: large male, length, 36 mm., width, 43 mm.; ovigerous female, length, 16 mm., width, 19 mm.

Variations.—In young individuals the rostral horns are wider behind and flatter than in adults; the notch between the rostral horns in extremely large individuals may be U-shaped; the large tubercle above the posterolateral margin may be spiniform but is located higher on the carapace than the similarly formed tubercle in *M. hispidus*.

Color.—Carapace yellowish white, with blotches of bright red; two largest red spots over branchial areas, a median spot on cardiac area, a pair situated farther back, a small pair behind orbits, and another beneath orbits; legs yellowish white, blotched or barred with red; chelae light red with pale tips (Verrill, 1908, for *M. depressus*).

Habitat.—This species, which is often encrusted with bryozoans and other organisms, is found predominantly on coarse or rocky substrates but occasionally on muddy or sandy bottom. In North Carolina it is a common species on the offshore banks and is associated with *Mithrax forceps*. Pearse (1934) found the species in canals of the sponge *Stematumenia strobilinia* (Lamarck) at Tortugas, Fla. Shallow water to 28 fathoms.

Type localities.—Key West, 2–5 fathoms, Tortugas, 5–6 fathoms [Fla.]; St. Thomas.

Known range.—Beaufort, N.C., to Pensacola, Fla.; Yucatan Channel off Cape Catoche, Mexico, and Gulf of Campeche; West Indies to Venezuela; Bermuda.

Remarks.—Ovigerous females are known in Florida from December to February, and in August. They are known from North Carolina in April, St. Thomas in July, and Venezuela in September (Rathbun, 1925; U.S. National Museum records).

Mithrax (Mithraculus) forceps (Milne Edwards)

Figures 238, 245E

Mithraculus forceps Milne Edwards, 1875, p. 109, pl. 23, fig. 1.
Mithrax forceps: Hay and Shore, 1918, p. 457, pl. 38, fig. 1.—Rathbun, 1925, p. 431, pl. 156 (rev.).

Recognition characters.—Carapace about one-fifth wider than long, deeply sculptured in young individuals but smoother with age. Anterolateral margin with four tubercles or teeth exclusive of postorbital angle, separated by broad rounded sinuses, first tooth usually shortest, remainder usually acute and turned forward at tip. Three

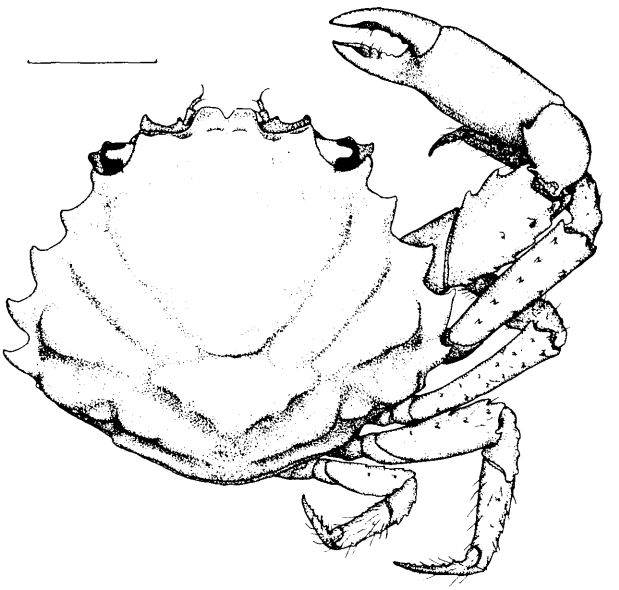

FIGURE 238.—*Mithrax (Mithraculus) forceps* (Milne Edwards). Male in dorsal view, legs of left side not shown, 5 mm. indicated.

grooves running diagonally backward over branchial area from near first, second, and fourth sinuses of anterolateral margin, between these grooves two well-defined, unbroken ridges and a broken ridge behind third groove. Cardiac and gastric regions crossed by less sharply defined ridges somewhat broken up into low rounded tubercles. Notch between rounded rostral horns broadly V-shaped, two pairs of tubercles on frontal region behind lobes of rostrum. Preorbital angle prominent, not exceeding rostrum. Orbital margin with a dorsal and ventral tubercle near postorbital angle. Outer spine of fused antennal article nearly equaling rostrum.

Chelipeds strong. Merus with two strong spines or tubercles in front, five much smaller ones on posterior margin, and usually two on upper surface near posterior margin. Carpus smooth or with a small spine or tubercle on inner margin near inner distal angle. Hand smooth, polished, somewhat tumid. Fingers widely gaping in male, with expanded hollowed-out tips; dactyl with single large tooth one-third distance from proximal end, or with a few minute teeth; immovable finger with from one to three small teeth or tubercles in middle. Walking legs spiny or denticulate with many fine hairs.

Measurements.—Carapace: male, length, 21 mm.; width, 25 mm.

Color.—Red, approaching vermilion, with occasional trace of purple. Terra cotta, or uniform yellowish brown, varying to greenish brown; often with a wide, pale yellow, median dorsal stripe, and legs often banded, especially in young individuals (various authors).

Habitat.—The species lives on rocky shores and reefs in crevices, under stones and dead coral; also exposed between tides and in shallow water in certain areas (Verrill, 1908). In North Carolina this form is found on offshore reefs and has been found in the sponge *Stematumenia strobilinia* (Lamarck) at Dry Tortugas, Fla. (Pearse, 1934). Intertidal to 30 fathoms.

Type locality.—Guiana.

Known range.—From Cape Hatteras, N.C., through Gulf of Mexico to Rio de Janeiro, Brazil; Bermuda.

Remarks.—Ovigerous females have been taken in Florida from November to February and from June to August; they are known from the Gulf of Mexico in February, Curaçao in April, Barbados and Aruba in midsummer, and from Venezuela in September and November (Rathbun, 1925; U.S. National Museum records). Some of the larval stages have been described by Lebour (1944).

Genus ***Microphrys*** H. Milne Edwards, 1851

Garth, 1958, p. 385.

KEY TO SPECIES IN THE CAROLINAS

a. Carapace without lateral laminiform processes; one strong branchial spine_____*bicornutus* (p. 259).

aa. Carapace with two lateral laminiform processes; two strong branchial spines_____*antillensis* (p. 260).

Microphrys bicornutus (Latreille)

Figures 239, 245F

Pisa bicornuta Latreille, 1825, p. 141.

Microphys bicornutus: Hay and Shore, 1918, p. 459, pl. 38, fig. 10.—Rathbun, 1925, p. 489, text-fig. 139, pl. 175 (rev.).

Recognition characters.—Carapace subtriangular, moderately hairy, all raised parts covered with rounded tubercles; a line of four tubercles arching upward on intestinal region, branchial region with two or three short spines and another spine at lateral angle. Rostrum composed of two stout horns, divergent throughout or divergent at base with extremities curving inward, one-half to one-third length of remainder of carapace. Basal article of antenna with a conspicuous, flat, obtuse spine at anterior angle and behind this a marginal tubercle or a short stout spine in old individuals. Orbits small, circular, with closed fissures, eyes small, preorbital angle rectangular.

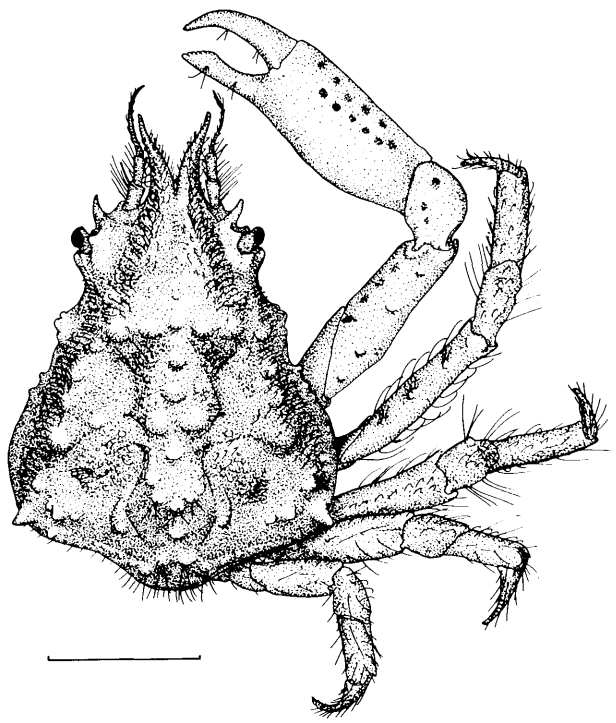

FIGURE 239.—*Microphrys bicornutus* (Latreille). Male in dorsal view, legs of left side not shown, 10 mm. indicated.

Chelipeds spotted, spots persisting for many years in alcohol; merus with three or four tubercles or short, blunt spines above; carpus somewhat nodose; hand smooth; fingers gaping, hollowed out at tips. Walking legs diminishing noticeably in length from first to fourth pair, hairy, margins somewhat rough.

Abdomen of both sexes with seven separate segments.

Measurements.—Carapace: male, length, 36 mm., width, 26 mm.; female, length, 24 mm., width, 20 mm.

Color.—Variable; carapace often dull yellowish brown or bright purplish rose; chelipeds grayish white, covered with small, round, purplish spots.

Habitat.—The species is common on coral reefs. It is often disguised by foreign objects such as sponges, anemones, hydroids, algae, etc., which

became attached to it. Shallow water to 16.5 fathoms.

Type locality.—Nouvelle Hollande.

Known range.—Near Beaufort, N.C., to Cedar Keys, Fla.; Bahamas to Florianopolis, Santa Catarina, Brazil; Bermuda.

Remarks.—Ovigerous females have been reported from March to August in the Caribbean area, and from November to January in the West Indies, Venezuela, and Brazil (Rathbun, 1925; U.S. National Museum records).

Pearse (1932b), working at Dry Tortugas, listed the copepod *Anthiacus intermedius* from the gill lamellae (accidental guest) and a tapeworm plerocercoid, *Rhynchobothrus*, from the viscera, and (*in* Wilson, 1935) reported a few specimens of *Cancrincola jamaicensis* Wilson from the branchial cavity of this crab.

Microphrys antillensis Rathbun

Figures 240, 245G

Microphrys antillensis Rathbun, 1920, p. 20.—1925, p. 498, text-fig. 141, pl. 176, figs. 3–4 (rev.).

Microphrys platysoma: Hay and Shore, 1918, p. 459, pl. 38, fig. 9.

Recognition characters.—Carapace depressed, tuberculate, and granulate, area at inner angle of branchial region finely granulate; intestinal region with four large, equal tubercles. Anterolateral wall with two laminiform processes, one on hepatic, one on branchial region; hepatic process with anterior end acute, projecting outward and occasionally forward in large individuals, sometimes with outward-projecting tubercle at middle of upper edge; a spine between and below level of hepatic and branchial processes; branchial process not rimmed nor sharply defined. Branchial region with three spines, one forming posterolateral angle occasionally doubled. Posterior margin with row of tubercles increasing in size medially. Rostral horns slender, directed forward, about one-sixth length of remainder of carapace. Basal article of antenna with spine at outer angle about half length of rostral spines. Orbits small, circular, with closed fissures; eyes small; preocular spines acute, about half as long as antennal spines.

Merus of chelipeds with dentate and laminate dorsal crest; carpus tuberculate; palm less than twice as long as broad; fingers widely gaping, immovable finger strongly curved downward. Walking legs sparsely hairy and with a few spines and tubercles; propodi with prominent distal laminiform process for articulation of dactyls.

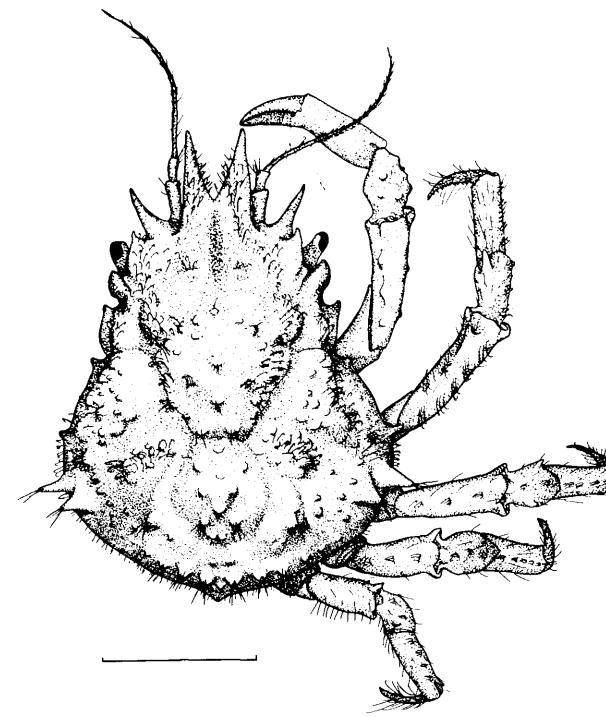

FIGURE 240.—*Microphrys antillensis* Rathbun. Male in dorsal view, legs of left side not shown, 5 mm. indicated.

Abdomen of both sexes with seven free segments.

Measurements.—Carapace: male, length, 18 mm.; width, 16 mm. Length of rostral horns, 3 mm.

Habitat.—Two to 15 fathoms.

Type locality.—Off Montego Bay Point, Jamaica.

Known range.—Beaufort Harbor, N.C., to Cape Fear, N.C.; Cuba; Jamaica; Puerto Rico.

Remarks.—Ovigerous females have been reported in September from North Carolina (Rathbun, 1925), in June from Florida, and November from Bimini (U.S. National Museum records).

Genus ***Stenocionops*** Desmarest, 1823

Garth, 1958, p. 401.

KEY TO SPECIES IN THE CAROLINAS

a. Hepatic region not enlarged nor produced beyond general outline of carapace, armed with not more than one large spine.

b. Marginal spines behind orbit four, carapace with about four median spiniform tubercles
furcata coelata (p. 261).

bb. Marginal spines behind orbit three, carapace with about eight median spines
spinimana (young) (p. 262).

aa. Hepatic region enlarged and produced separately from curve of branchial region, marginal hepatic spines 3; carapace with 12 or 13 median spines
spinimana (adult) (p. 262).

Stenocionops furcata coelata (Milne Edwards)

Figures 241, 245H

Pericera coelata Milne Edwards, 1878, p. 224.
Stenocionops furcata coelata: Hay and Shore, 1918, p. 460, pl. 39, fig. 3.—Rathbun, 1925, p. 540, pl. 164 (rev.).

Recognition characters.—Carapace oblong-ovate, approximately three-fourths as wide as long, uneven, with strong spines and a dense covering of short setae and many scattered, longer, hooked hairs. Rostrum consisting of two nearly straight diverging horns with rows of hooked setae. Orbital region broad, eyes small, retractile within tubular orbits; preorbital spine strong, suborbital and postorbital spines much smaller.

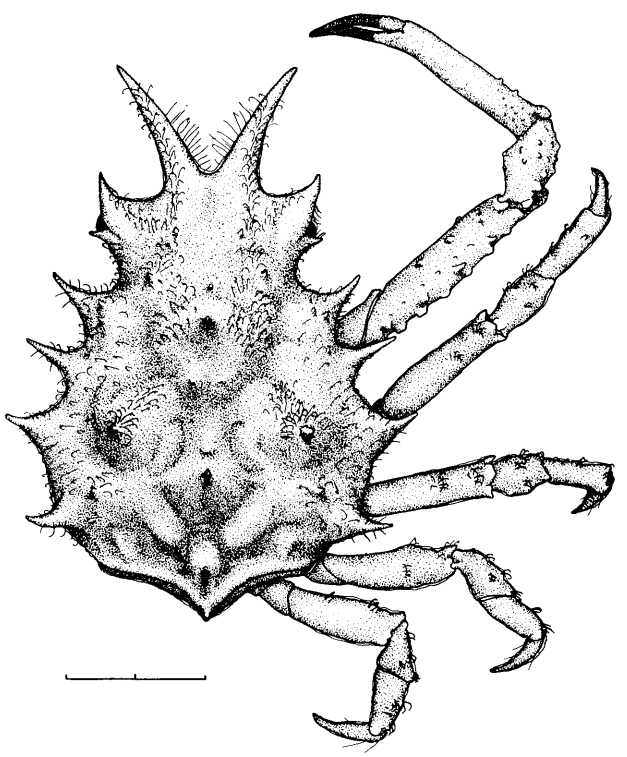

FIGURE 241.—*Stenocionops furcata coelata* (Milne Edwards). Male in dorsal view, legs of right side in part after Rathbun (1925), legs of left side not shown, 20 mm. indicated.

Basal antennal article enlarged, armed with one or two small distal spines or tubercles not visible dorsally. Middorsal line with four strong spiniform tubercles, one on gastric region, remainder on cardiac and intestinal regions, fourth spine with tip curved forward. Lateral border with four stout spines, one on hepatic, remainder on branchial region; in addition, two other stout spines on branchial region and various smaller ones toward front. Ventral surface of body, except distal articles of chelipeds, closely covered with bulbous setae hiding carapace.

Chelipeds in adult males fairly large and nodose; hand long, cylindrical, and granulate; fingers approximately half as long as palm, gaping in basal half, a tooth on dactyl near base. In other individuals chelae weak; fingers less than half as long as palm; merus with strong spines above near distal end preceded by several smaller spines. Walking legs moderately elongate, more or less rough with clusters of hooked hairs, articles subcylindrical.

Abdomen in male and female with seven distinct segments.

Measurements.—Carapace: large male, length, 137 mm.; width, 111 mm. Length rostral horn, 26 mm. Carapace: smaller male, length, 91 mm.; width, 64 mm. Length rostral horn, 25 mm.

Variations.—Large specimens have relatively shorter rostral horns than smaller individuals; young specimens are smoother than old ones.

Color.—Dark red.

Habitat.—This species is found on a variety of bottoms, including fine white sand, yellow sand, coarse gray sand, sand with algae, sandy shell, broken shell, and coral. It has been reported most often from coarse bottom (Rathbun, 1925), and occurs on shelly reefs off Beaufort Inlet, N.C. Shallow water near shore to 60 fathoms, rarely to 278 fathoms.

Type localities.—Ten miles from Jolbos Islands [Yucatan], and near Havana [Cuba], 175 fathoms.

Known range.—Off Beaufort, N.C., to northwest Florida and Alabama; Yucatan Channel; West Indies to Barbados.

Remarks.—This species is similar to the typical subspecies *S. f. furcata* which ranges from Georgia to Bahia, Brazil, in shallow water near shore to 35 fathoms depth. The typical subspecies has the carapace more evenly sculptured and is

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less spinous than *S. f. coelata* (Rathbun, 1925, p. 449).

Ovigerous females are known in Florida from March to August (U.S. National Museum records).

Stenocionops spinimana (Rathbun)

Figures 242, 245I

Libinia spinimana Rathbun, 1892, p. 240, pl. 30.
Stenocionops spinosissima: Hay and Shore, 1918, p. 460, pl. 39, fig. 2.
Stenocionops spinimana: Rathbun, 1925, p. 457, pl. 267 (rev.).

Recognition characters.—Carapace subpyriform, convex, covered with sparse growth of short, fine, curled hairs; 8 to 13 median dorsal spines, and numerous other spines on gastric and branchial regions; anterior marginal hepatic spines 3, anterior-most spine small and occasionally absent in old individuals. Rostral horns widely divergent, straight, tapering gradually to slender tip. Orbits tubular, not strongly projecting, eyes small, retractile within orbits; preorbital spine acute, curving forward slightly at tip; postorbital spine similar in size to spine near anterolateral angle of basal article of antenna.

Merus and carpus of chelipeds with numerous spines, hand rough throughout length with two rows of spines above, one below, spines becoming progressively smaller distally. Walking legs with a few spines. Meral articles with a terminal spine above, and on first leg a longitudinal inner-upper row of five or six, and a ring of about four spines near distal end; on second leg a ring of three or four; on third and fourth only one or two spines besides terminal one. Carpus of first leg with three or four spines, second with three spinules or tubercles, third and fourth with one.

Abdomen in male and female with seven segments, six free in females.

Measurements in millimeters	Large male	Holotype of *spinimana* (male)	Half-grown male	Young female
Length of carapace, including horns	130	89	53	18
Width of carapace, including spines	118	76	42	13
Width of carapace, excluding spines	110	69	36	10
Length of rostral horns	11	10	10	3

Variations.—This species exhibits great change in shape and spination with increasing age, as has

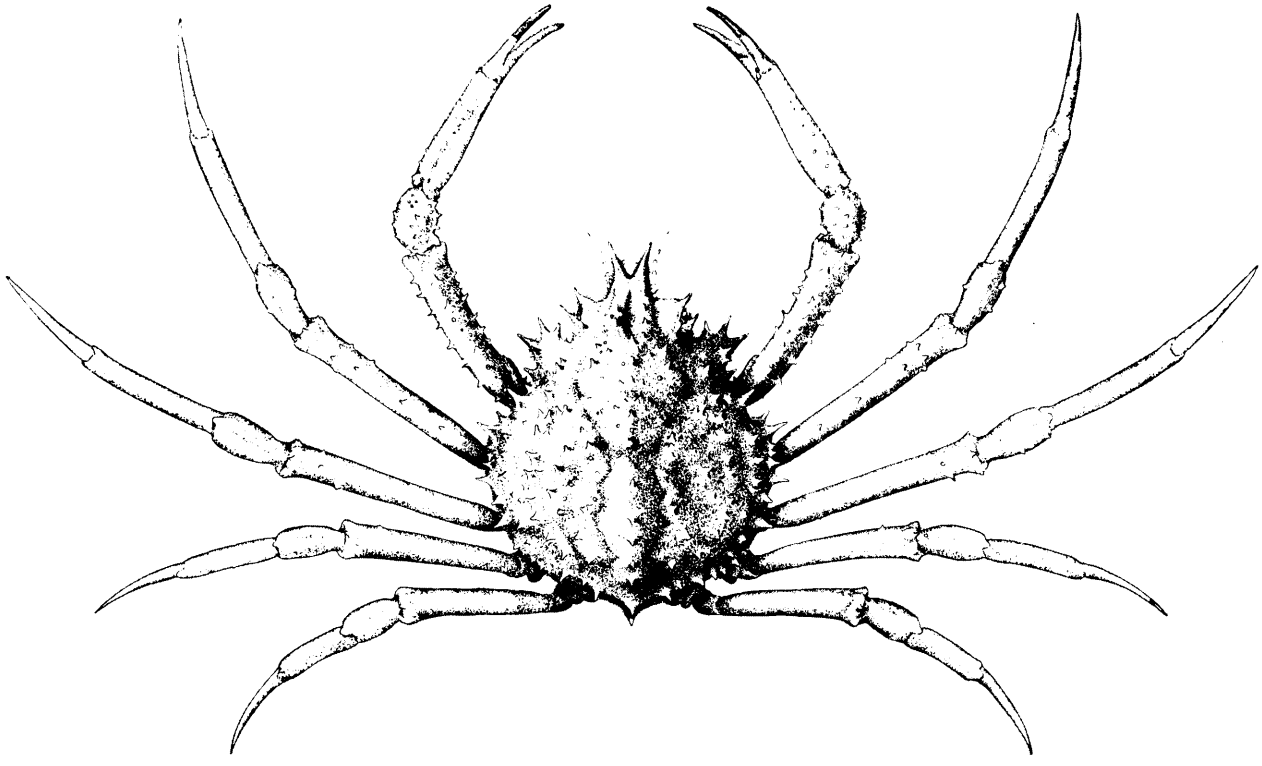

FIGURE 242.—*Stenocionops spinimana* (Rathbun). Holotypic male in dorsal view (after Rathbun, 1892).

been pointed out by Rathbun (1925), and Garth (1958) for related forms. Young individuals are much different in shape from adults, having a width considerably less than length (width about 70 percent of length including spines and rostrum), whereas the mature animals are more rounded in contour (large adult male, with about 90 percent of length). Old individuals have a thicker coating of hair than immature ones, especially on the chelipeds. Chelipeds in old individuals become quite large and stout with the palm compressed (length more than twice that of carapace). The young have fewer spines than adults, the hepatic region is not expanded and bears only one marginal spine as opposed to three spines in adults.

Habitat.—The species has been found on a variety of bottoms, from gray mud, through various grades of sand, to sand-shell, coral, and rock (Rathbun, 1925). Twenty to 124 fathoms.

Type locality.—Off Cape Lookout, N.C., 124 fathoms.

Known range.—Off Cape Hatteras, N.C., to Florida Straits and Gulf of Mexico off Mobile Bay, Ala.

Remarks.—Ovigerous females have been reported from South Carolina in December (Rathbun, 1925).

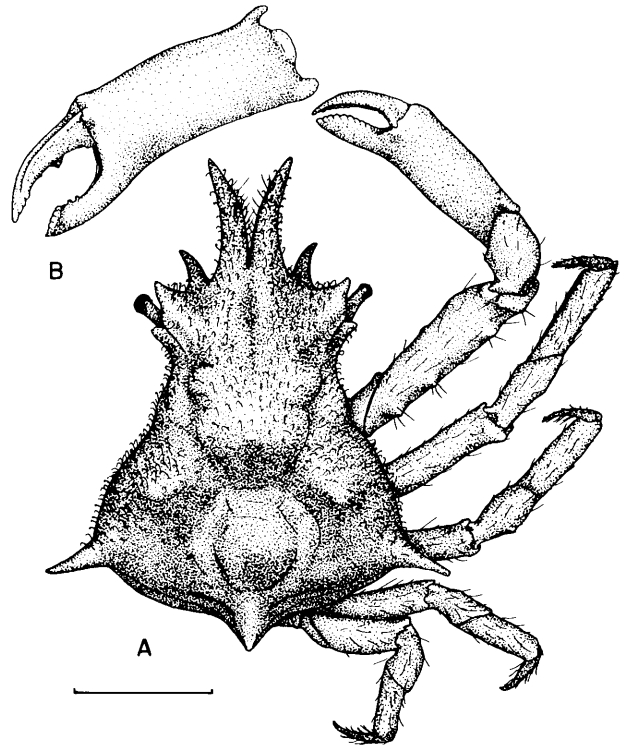

FIGURE 243.—*Macrocoeloma trispinosum* (Latreille). A, small male in dorsal view, legs of left side not shown, 10 mm. indicated; B, right chela of adult male in frontal view.

Genus ***Macrocoeloma*** Miers, 1879

Garth, 1958, p. 412.

KEY TO SPECIES IN THE CAROLINAS

a. Carapace without dorsal spines in addition to epibranchial and posterior spines____*trispinosum* (p. 263).
aa. Carapace with dorsal spines in addition to epibranchial and posterior spines_____*camptocerum* (p. 264).

Macrocoeloma trispinosum (Latreille). Grass crab, sponge crab, decorator crab

Figures 243, 245J

Pisa trispinosa Latreille, 1825, p. 142.
Macrocoeloma trispinosum: Hay and Shore, 1918, p. 457, pl. 38, fig. 11.—Rathbun, 1925, p. 466, text-fig. 132, pl. 166, fig. 1; pl. 167 (rev.).

Recognition characters.—Carapace irregularly triangular, body and legs with velvety covering of short brown hairs, thick and swollen, wide at level of orbits, narrowing distinctly in hepatic portion, widening again posteriorly. Middorsal region much elevated and bearing four low, rounded tubercles or bosses, one on gastric, one on cardiac, and one on each epibranchial region. Posterolateral angle prolonged into a long flattened spine directed obliquely outward and backward, sometimes curved upward; posterior margin with broad, median, triangular projection with tip sometimes slightly recurved. Rostrum formed of two somewhat flattened horns adjacent and subparallel at base, divergent distally. Eyes retractile within roomy, projecting, tubular orbits, upper margin of orbit deeply emarginate, pre- and post-ocular teeth prominent, preocular teeth curved forward. Basal article of antenna with inner angle produced, exceeding frontal margin, and forming a broad spine directed obliquely outward at each side of rostrum.

Chelipeds of male narrow, approximately as long as carapace; merus nodose; palm with subparallel sides; dactyl approximately half as long as upper margin of palm and lightly furrowed above. Walking legs rather slender, slightly nodose.

Abdomen with seven separate segments in both sexes.

Measurements.—Carapace: male, length, 34 mm.; width, 29 mm.

Variations.—Rathbun (1925) discussed variation in this species throughout its known range. Body shapes falling into three general series are distinguishable. In the first, the typical form, the posterolateral prominences are narrow, with regularly tapering spines, projecting beyond the general outline of the carapace and directed more or less backward, and sometimes strongly curved from base to tip with the concavity forward. The carapace is considerably constricted behind the orbits. The orbits are prominent owing to this constriction, and the pre- and post-ocular teeth are strong, the former directed forward and curved. The upper edge of the orbit is deeply emarginate. The four large tubercles or bosses are prominent, some or all with an acute tip, that on the gastric region sometimes nearly a spine.

In the second series, treated by Rathbun as an unnamed variety, the posterolateral prominences are wider than in the first series, less spinelike and more laminate, their hind margins nearly transverse. The carapace is less narrowed behind the orbits, the orbital teeth less marked, though the preocular tooth is directed forward and a little curved, and the superior emargination less deep. The four large dorsal bosses are lower than in series one, but the gastric boss tends to be surmounted by a sharp tubercle or granule.

In series three, called *M. t. nodipes*, the posterolateral prominences are broader and more obtuse than in series two with their margins almost continuing the margin of the carapace. The carapace is constricted little or not at all behind the orbits; the preocular tooth is acute but not prominent, and the postocular tooth blunt or subacute with both teeth somewhat more prominent in young individuals than in old ones. The orbit has a slight emargination in the upper border. The dorsal bosses are lower than in the other series, smoothly rounded and blunt.

In the three series the posterior median spine varies in a manner similar to the lateral spines. Within the three series, the rostrum shows great variability in length, direction, and curvature of the horns.

Color.—Hairs yellowish or reddish brown (various authors).

Habitat.—In North Carolina, this species has been found in seaweed in Beaufort Harbor, in the ocean on floating masses of *Sargassum*, and dredged from offshore reefs. Elsewhere it has been found in a variety of situations, from pilings and mangrove roots to weedy rocks, coarse-coral sand, sand-shell, and broken-shell bottoms. The species is often concealed by a covering of sponge. Shallow water to 45 fathoms.

Type locality.—Nouvelle Holland (?) [error].

Known range.—Beaufort, N.C., to Alligator Harbor, Fla.; Yucatan; through West Indies to off Cape São Roque, Brazil.

Remarks.—Ovigerous females have been reported from southern Florida in December, Cuba in April, and Jamaica and St. Thomas in July (Rathbun, 1925; U.S. National Museum records).

Macrocoeloma camptocerum (Stimpson)

Figures 244, 245K

Pericera camptocera Stimpson, 1871a, p. 112.
Macrocoeloma campterocerum: Hay and Shore, 1918, p. 457, pl. 38, fig. 12.—Rathbun, 1925, p. 469, pl. 174, fig. 4; pl. 270, fig. 2 (rev.).

Recognition characters.—Carapace irregularly triangular; surface covered with short, close

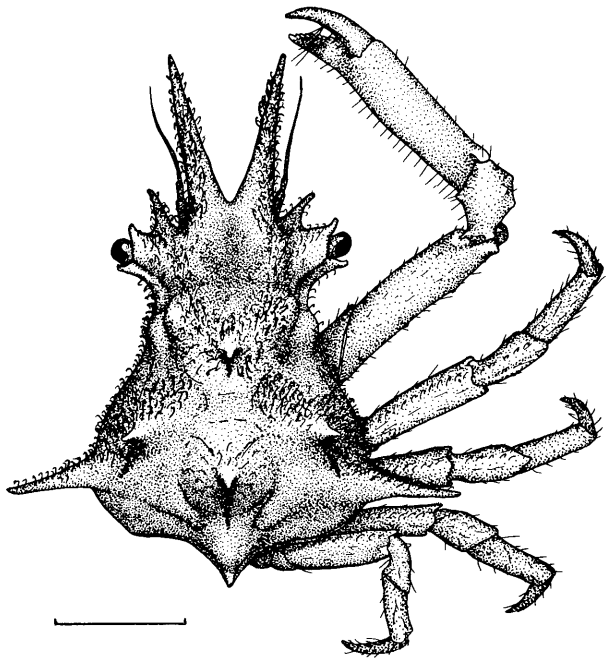

FIGURE 244.—*Macrocoeloma camptocerum* (Stimpson). Male in dorsal view, legs of left side not shown, 10 mm. indicated.

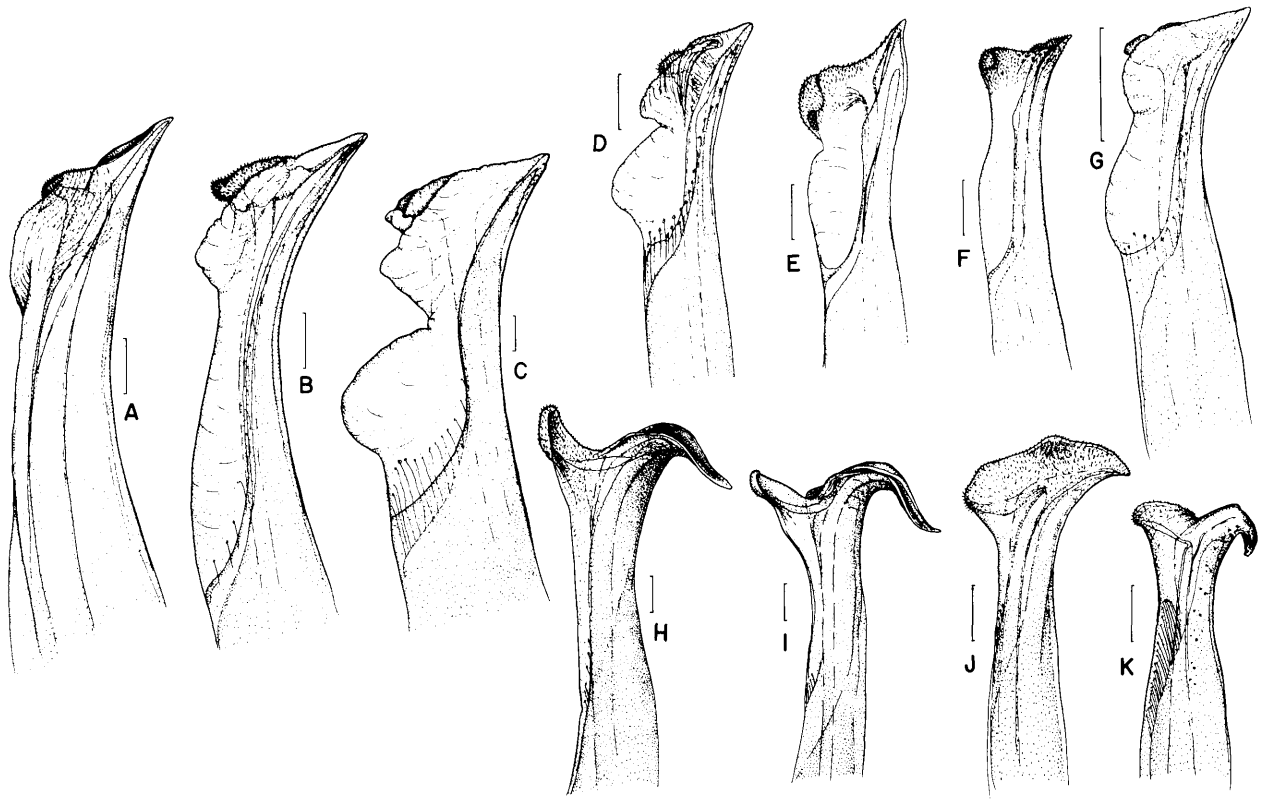

FIGURE 245.—Subfamily Mithracinae, tips of right first pleopods of males; A, *Mithrax spinosissimus* (Lamarck), sternal view; B, *Mithrax verrucosus* H. Milne Edwards, sternal view; C, *Mithrax hispidus* (Herbst), sternal view; D, *Mithrax pleuracanthus* Stimpson, sternal view; E, *Mithrax forceps* (Milne Edwards), sternal view; F, *Microphrys bicornutus* (Latreille), sternal view; G, *Microphrys antillensis* Rathbun, sternal view; H, *Stenocionops furcata coelata* (Milne Edwards), sternal view; I, *Stenocionops spinimana* (Rathbun), sternal view; J, *Macrocoeloma trispinosum* (Latreille), lateral view; K, *Macrocoeloma camptocerum* (Stimpson), lateral view; 0.33 mm. indicated.

pubescence, and, in addition, long, stiff, curled hairs on front, gastric region, and lateral portions of branchial regions; wide at level of orbits, narrowing distinctly in hepatic portion, widening again posteriorly; with four strong spines on dorsal region, one on gastric, one on cardiac, and one on each epibranchial region. Posterolateral spines subconical, regularly tapering, acute, and directed slightly backward; posterior median spine shorter, acute, obliquely erect. Rostral horns acute, rather regularly divergent from base. Spines on basal article of antennae rather slender, divergent. Orbital tubes, pre- and post-orbital spines protuberant laterally, preorbital spine curving a little forward.

Chelipeds of male strong, longer than carapace; merus with a few short spinules above; carpus somewhat nodose with a tubercle at inner angle; palm widest near articulation; fingers tipped with black or dark brown. Walking legs nearly smooth.

Abdomen with seven separate segments in both sexes.

Measurements.—Carapace: male, length, 40 mm., width, 36 mm.; female, length, 24 mm., width, 20 mm.

Variations.—The rostral horns may be straight or slightly curved outward at tips, and range in length from one-sixth to one-third the total length of the carapace. The interspace between horns may vary from a narrow V-shape to almost a right angle. The posterolateral spine may be straight in frontal section or curved upward and nearly transverse or directed strongly backward.

Color.—A dirty brown.

Habitat.—The species has been taken on a variety of bottoms ranging from sand with grass, or a hard smooth substrate, to rocky or coral bottoms. Rathbun (1925) reported the form from predominantly coarse bottoms. About 2 to 13 fathoms.

Type locality.—Near Key West [Fla.], in from 2 to 5 fathoms.

Known range.—Beaufort Harbor, N.C., via southern Florida to Alligator Harbor, Fla.

Remarks.—Ovigerous females are known in Florida from January to March (U.S. National Museum records).

Family **Parthenopidae**

Eyes usually retractile within small, circular, well-defined orbits, floor of orbit nearly continued to front, leaving a hiatus usually filled by second [article] of antennary peduncle. Basal antennal [article] small, deeply imbedded between inner angle of orbit and antennulary fossae. Antennules folding somewhat obliquely (Alcock, 1895).

Subfamily **Parthenopinae**

Carapace commonly equilaterally triangular, sometimes subpentagonal or ovate-pentagonal, and sometimes almost semicircular or semielliptical in outline. Cardiac and gastric regions usually deeply marked off from branchial regions on either side, making dorsal surface of carapace trilobed. Rostrum simple or obscurely trilobed. Chelipeds vastly longer and more massive than walking legs (Alcock, 1895). First pleopod varying, more or less stout, apically tapering or not tapering; second pleopod usually short and of usual shape (Stephensen, 1945).

KEY TO GENERA IN THE CAROLINAS

(Modified after Rathbun, 1925)

a. Carapace not laterally expanded over walking legs.
  b. Carapace tuberculate or eroded—*Parthenope* (p. 266).
  bb. Carapace smooth, except for a few strong spines *Solenolambrus* (p. 270).
aa. Carapace more or less expanded forming a vault beneath which walking legs are concealed *Heterocrypta* (p. 270).

Genus ***Parthenope*** Weber, 1795

Garth, 1958, p. 434.

KEY TO SPECIES IN THE CAROLINAS

a. Carapace ovate-pentagonal, surface scarcely carinate in adult (Subgenus *Parthenope*) ——— *agona* (p. 266).
aa. Carapace broadly triangular, carinate or tuberculate, with more or less rounded sides (Subgenus *Platylambrus*).
  b. Carapace and chelipeds very flat; spine at end of main dorsal branchial ridge small——*serrata* (p. 267).
  bb. Carapace convex, chelipeds not flat; spine at end of main dorsal branchial ridge large.
    c. Carapace much broader than long; hand with 8-12 teeth on inner, 10-12 on outer margin *pourtalesii* (p. 268).
    cc. Carapace not much, if any, broader than long; hand with few good sized marginal teeth, six to eight on inner, three to five on outer margin *fraterculus* (p. 269).

Parthenope (Parthenope) agona (Stimpson)

Figures 246, 252A

Lambrus agonus Stimpson, 1871a, p. 131.
Parthenope agona: Hay and Shore, 1918, p. 462, pl. 39, fig. 5.
Parthenope agonus: Rathbun, 1925, p. 513, text-fig. 146, pls. 178–179; pl. 275, figs. 1–3 (rev.).

Recognition characters.—Carapace ovate-pentagonal or subcircular, somewhat broader than long, with rounded sides, without angles. Postorbital constriction slight, not involving pterygostomian ridge continuing from lower side of orbit to point above cheliped. Depressions be-

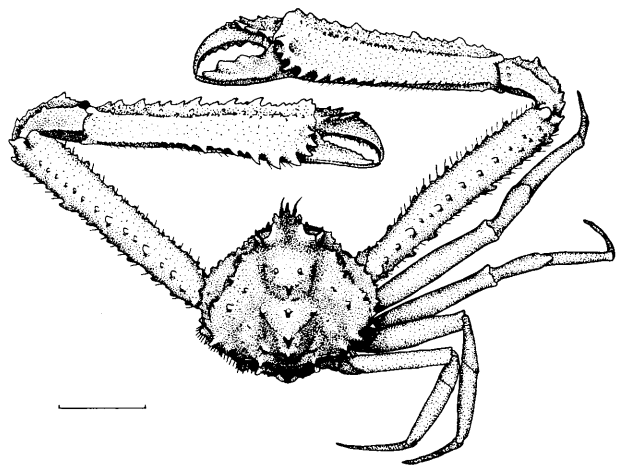

FIGURE 246.—*Parthenope (Parthenope) agona* (Stimpson). Male in dorsal view, position of legs reconstructed, walking legs of left side not shown, 10 mm. indicated.

tween regions of carapace not markedly deep; surface coarsely punctate or eroded, and with numerous granules and tubercles, larger tubercles more or less spiniform and arranged as follows: five on gastric region, three on cardiac, one on each side of urocardiac lobe, five on branchial, and one on each hepatic region. Anterolateral margin of branchial region with six small teeth, below and behind last tooth a broad triangular tooth, and still lower on ventral surface a spine visible between ischia of cheliped and first leg. Median rostral tooth narrow, produced, denticulate at base, an acute forward-pointing tooth over each antennular cavity. Orbit with several spines on outer margin, a suture above, open below; eye with small spine on upper surface. A conical spine or tubercle on each side of sternum near base of chelipeds.

Chelipeds long, slender (length of merus approximately 1.3 times width of carapace), prismatic, upper surface finely rugose. Merus and carpus with an irregular row of dentiform tubercles near middle of upper surface, on inner and outer margins, and near outer margin of hand. Upper margin of hand with row of 18–20 irregular teeth, largest near base of fingers but decreasing in size both proximally and distally; outer margin with 4 to 6 larger teeth and many intermediate smaller ones. Walking legs long, slender, bare, and almost smooth.

Second segment of abdomen with sharp transverse crest.

Measurements.—Carapace: male, length, 20 mm.; width, 21 mm. Length of merus, 30 mm.

Variations.—The rostrum may be broadly triangular, subentire, instead of tridentate with denticulate margins. In young individuals the pterygostomian ridge is less developed anteriorly, and the postorbital constriction is more evident.

Color.—Light buff, somewhat marbled with purple, chelipeds and legs with broad bands of purple.

Habitat.—The species has been reported from predominantly sandy or broken-shell bottom (Rathbun, 1925); 25 to 115 fathoms.

Type localities.—Off the Marquesas, Carysfort Reef, and Conch Reef, 40 and 49 fathoms [southern Florida].

Known range.—Off Capes Hatteras and Lookout, N.C.; Gulf of Mexico near Pensacola, Fla., through Florida Straits; Puerto Rico; Trinidad; between British and Dutch Guiana.

Remarks.—Ovigerous females have been taken from southwestern Florida in March (Rathbun, 1925), and off the Guianas in September (U.S. National Museum records).

Parthenope (Platylambrus) serrata (H. Milne Edwards)

Figures 247, 252B

Lambrus serratus H. Milne Edwards, 1834, p. 357.
Platylambrus serratus: Hay and Shore, 1918, p. 463, pl. 39, fig. 7.
Parthenope serrata: Rathbun, 1925, p. 516, pls. 180–181; pl. 275, figs. 7–10 (rev.).

Recognition characters.—Carapace depressed, width approximately 1.5 times length; convex anterolateral margin of branchial region with seven to nine triangular teeth in front of long, flat, lateral spine. Posterolateral margin concave; posterior margin convex, wide, both margins together with seven tubercles noticeably larger than others, each terminating an indefinite longitudinal or oblique line of tubercles. Elevations of carapace ornamented with numerous unequal granulated tubercles; depression between gastric and branchial regions deep. Rostrum short, tridentate, narrow at tip, and with raised margin continuous with superior wall of orbits. Pterygostomian and subhepatic regions with an excavation reaching margin of orbit and, with chelipeds retracted, forming covered efferent passages.

Chelipeds, when extended, approximately 2 to 2.5 times as long as carapace, trigonal, smooth beneath, more or less tuberculate on upper sur-

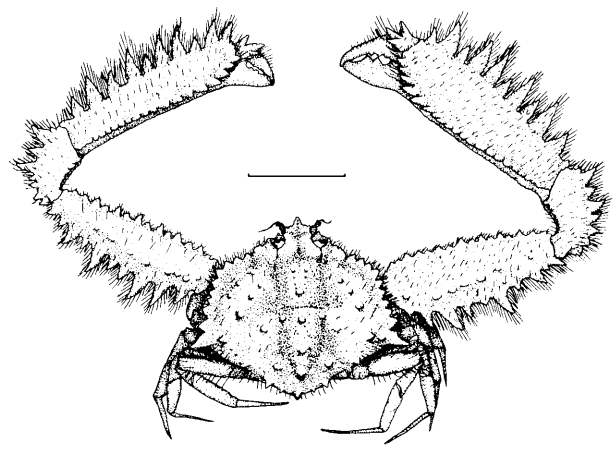

FIGURE 247.—*Parthenope (Platylambrus) serrrata* (H. Milne Edwards). Male in dorsal view, 10 mm. indicated.

face, and with margins cut into lanceolate or triangular teeth fringed with fine hairs, much stronger on outer than on inner side of articles; hand with about nine teeth alternately large and small; fingers stout, oblique. Walking legs of moderate size, longest not exceeding merus of cheliped.

Abdomen of male with segments three to five fused, sixth segment with a median spine.

Measurements.—Carapace: male, length, 19 mm.; width, 28 mm. Length of cheliped, 60 mm.

Color.—Red somewhat mottled with gray; fingers carmine, shading to black.

Habitat.—The species has been reported from a variety of bottoms ranging from coral to fine sand and mud, but it has been taken most often from muddy or sandy bottoms (Rathbun, 1925; Holthuis, 1959). Shallow water to 60 fathoms.

Type locality.—l'Ocean indien [erroneous locality].

Known range.—Off the three North Carolina capes, Gulf of Mexico from Pensacola to southern Florida, and off Campeche, Mexico; West Indies to Bahia, Brazil.

Remarks.—Hildebrand (1955) and Holthuis (1959) added distributional extensions to Campeche and Surinam. Ovigerous females have been reported in May and June from Surinam (Holthuis, 1959). They are known from North Carolina in June, Florida in summer, and Cuba in October (U.S. National Museum records).

Parthenope (Platylambrus) pourtalesii (Stimpson)

Figures 248, 252C

Lambrus pourtalesii Stimpson, 1871a, p. 129.
Parthenope pourtalesii: Hay and Shore, 1918, p. 462, pl. 39, fig. 6.—Rathbun, 1925, p. 521, pls. 182, 183, and 276 (rev.).

Recognition characters.—Carapace broadly ovate-triangular, convex; branchial regions rather deeply separated from gastric, cardiac, and hepatic regions. Posterolateral angle marked by conspicuous laciniated spine located behind bulging curve of anterolateral margin; hepatic margin armed with a small but prominent spine. Anterolateral margin behind cervical suture armed with eight or nine teeth and spines, first three or four shorter than remainder. Posterolateral margin with three or four unequal spines in addition to large one on ridge; posterior margin with three large and several small spines. General surface of carapace pitted and eroded,

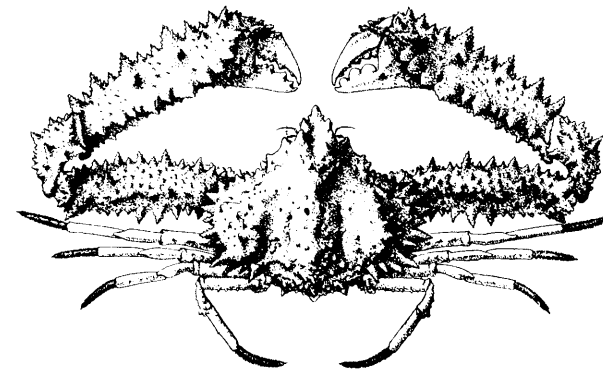

FIGURE 248.—*Parthenope (Platylambrus) pourtalesii* (Stimpson). Female in dorsal view, approximately × 0.80 (after Smith, 1887).

with granulated tubercles disposed as follows: one gastric, one genital, two cardiac, two on branchial ridge in line with lateral spine, and a tendency to rows of tubercles on branchial regions. Rostrum with a long, narrow, obtuse tooth with a denticle on each side, a subacute basal tooth, and below and outside this a short spine. Supraorbital spine blunt, postorbital spine smaller but somewhat sharper; upper side of emargination on eye spined.

Chelipeds long, rough, armed with laciniated teeth and spines on both margins; merus with an additional median row of spiniform tubercles on upper surface; carpus with largest spine at inner angle; hand with an obsolete median row beneath. Meri of walking legs spinulose, also carpus and propodus of last pair; dactyls furred; a tubercle on sternum at base of cheliped and each of legs one to three.

Abdomen with a large tubercle in middle of second to sixth abdominal segments and a conical tubercle at extremity of segments two and three; segments three to five fused in male. Lower surface of body granulate and tuberculate.

Measurements.—Carapace: male, length, 36 mm.; width, 47 mm. Length of cheliped, 122 mm. Carapace: ovigerous female, length, 11 mm.; width, 13 mm.

Variations.—The species varies greatly in the number and prominence of tubercles and teeth, and in constriction and ornamentation of the rostrum. The elevations of the carapace may bear spines or tubercles.

Color.—Purplish red with cross bands of buff on chelipeds and walking legs; palms pinkish brown (various authors).

Habitat.—The species is found predominantly on sand or sandy mud bottoms (Rathbun, 1925); 10 to 134 fathoms.

Type localities.—Off Conch Reef, French Reef, and American Shoal [southern Florida].

Known range.—Off Marthas Vineyard, Mass.; latitude of New Jersey through West Indies to Grenada.

Remarks.—Ovigerous females are known from North Carolina in December.

Parthenope (Platylambrus) fraterculus (Stimpson)

Figures 249, 252D

Lambrus fraterculus Stimpson, 1871a, p. 130.
Parthenope fraterculus: Rathbun, 1925, p. 525, pls. 186–187; pl. 190, fig. 2 (rev.).

Recognition characters.—Carapace subtriangular, approximately four sided, posterolateral margins continuous with sides of posterior margin, and long anterolateral margins in line with rostral borders. Depressions separating branchial from cardiac and hepatic regions deep; cardiac and gastric regions connected by a narrow ridge, hepatic and branchial regions by a wider ridge bounded below by a deep hollow visible in side view; hepatic region with a large submarginal tubercle visible in dorsal view. Margin of branchial region cut into 11 to 13 small teeth; posterior margin with 3 equal teeth. Prominences of carapace ornamented with a few large tubercles and spines as follows: three gastric in a triangle, one genital, two cardiac, and three on branchial ridge. Front inclined about 45 degrees, ending in a narrow, blunt tooth, a blunt tooth on each side above antennules, and outside, below these, a small slender spine. A tubercle on preorbital lobe; orbit with a small blunt tooth on inner lower angle and a large tubercle between this and angle of buccal cavity. Endognath with row of five tubercles near outer margin.

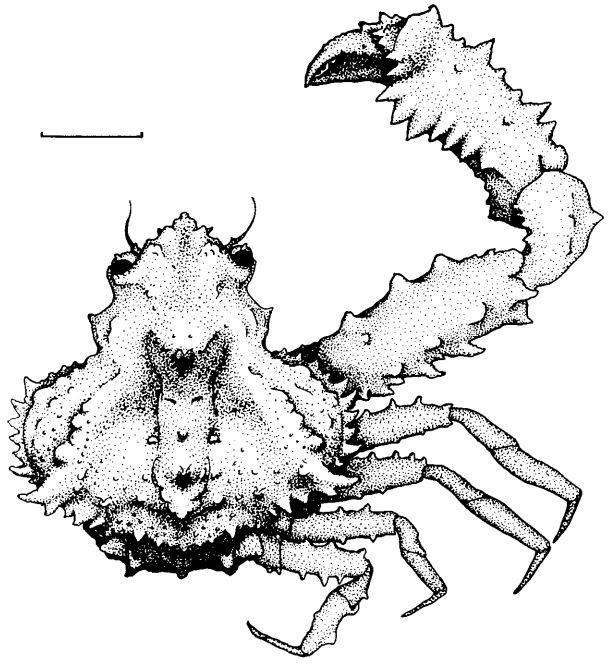

FIGURE 249.—*Parthenope (Platylambrus) fraterculus* (Stimpson). Male in dorsal view, position of legs reconstructed, legs of left side not shown, 5 mm. indicated.

Chelipeds of male approximately 2.5 times as long as carapace; inner, outer, and upper margins of merus with a few unequal stout spines; inner and outer margin of hand armed with triangular, denticulate, unequal teeth, six or seven larger ones on inner, three or four on outer margin; largest tubercle on upper surface at proximal third conical. Walking legs with meri denticulate; dactyls furred except at tip; carpus and propodus of last pair with two or three lobes above and five denticles below.

Sternum and abdomen tuberculate, second to sixth abdominal segment with a large transverse tubercle.

Measurements.—Carapace: male, length, 16 mm., width, 17 mm.; female, length, 16 mm., width, 18 mm.

Variations.—There is great individual variation in the nature of tubercles and spines. In some individuals the prominences are low and blunt, in others high and sharp. The front may vary in degree of inclination, and margins of the frontal lobes and orbits may be denticulate, entire or subentire.

Color.—Uniform red, eggs bright red (various authors).

Habitat.—The species has been taken predominantly on rocky or shelly bottoms (Rathbun, 1925; Holthuis, 1959); 4 to 110 fathoms.

Type localities.—Off Sand Key, Carysfort and Conch Reefs, West of Tortugas, 26 to 68 fathoms [southern Florida].

Known range.—Off Cape Fear, N.C.; Gulf of Mexico, off Cape San Blas, Fla., to Florida Straits; off Cape Catoche, Yucatan, Mexico; through West Indies to mouth of Amazon River (U.S. National Museum records).

Remarks.—Ovigerous females have been reported in May from southern Florida (Rathbun, 1925), and August from northeastern Florida (U.S. National Museum records).

Genus ***Solenolambrus*** Stimpson, 1871

Garth, 1958, p. 458.

Solenolambrus tenellus Stimpson

Figure 250

Solenolambrus tenellus Stimpson, 1871a, p. 134.—Hay and Shore, 1918, p. 463, pl. 39, fig. 8.—Rathbun, 1925, p. 541, pl. 194, figs. 3–4; pl. 279, figs. 5–9 (rev.).

Recognition characters.—Small delicate species. Carapace but little broader than long and about equally produced in front of and behind line of lateral angles; surface punctate; protuberances of gastric and cardiac regions fairly well marked near posterolateral margin but almost obsolete anteriorly. Anterolateral margins of carapace crenulated, five or six teeth on expanded and broadly rounded lateral angle being most prominent and defined chiefly by impressed lines on marginal shelf; hepatic region with two or three denticulate teeth. Posterolateral margin concave; posterior margin convex, its lateral angles obtuse.

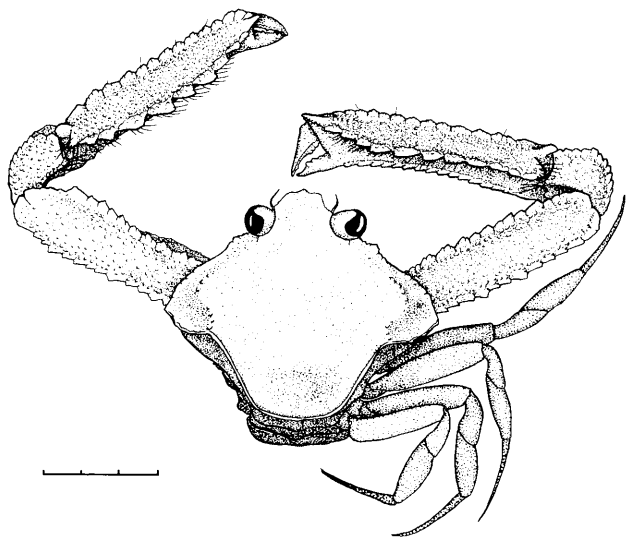

FIGURE 250.—*Solenolambrus tenellus* Stimpson. Female in dorsal view, walking legs of left side not shown, 3 mm. indicated.

Rostrum rather prominent, faintly tridentate at extremity, median tooth smallest and most prominent. External angle of orbit not prominent; eyes large with extremely minute tubercle at summit. Basal article of antenna approximately as long as next article. External maxilliped with ischium somewhat tuberculate near outer margin and extremity.

Chelipeds long, slender, general surface smooth, polished; edges denticulate. Merus with about 13 teeth on either edge, third tooth from distal end larger than others. Hand with 12 sharp forward-curving teeth on superior edge, terminal tooth above finger spiniform and considerably longer than others; outer margin with about 11 small teeth, inner with 19 or 20 minute teeth. Walking legs naked, compressed, without laminiform crests; merus of last pair slightly expanded below near base.

Abdomen and sternum of male coarsely pitted, otherwise smooth and glabrous.

Measurements.—Carapace: male, length, 6 mm.; width, 6 mm. Length of cheliped, 16 mm. Carapace: ovigerous female, length, 5 mm.; width, 6 mm.

Habitat.—Thirty to 115 fathoms.

Type localities.—Off Carysfort, Conch, and French Reefs, 35 to 49 fathoms [southern Florida].

Known range.—Off Cape Lookout, N.C.; Gulf of Mexico, near Cape St. George, Fla., to Florida Keys; Bahamas; Barbados.

Remarks.—Ovigerous females have been reported in May from Barbados, May and June from Florida (Rathbun, 1925), and questionably in August from North Carolina (an incompletely labeled specimen from Hay and Shore's material in Institute of Fisheries Research collection, and *Fish Hawk* records for 1902).

Genus ***Heterocrypta*** Stimpson, 1871

Garth, 1958, p. 473.

Heterocrypta granulata (Gibbes). Pentagon crab

Figures 251, 252E

Cryptopodia granulata Gibbes, 1850, p. 173.
Heterocrypta granulata: Hay and Shore, 1918, p. 464, pl. 39, fig. 9.—Rathbun, 1925, p. 555, text-fig. 152, pl. 203, figs. 1–2; pl. 282, figs. 1–3 (rev.).

Recognition characters.—Carapace subtriangular, with wide clypeiform vaulted expansions, length two-thirds width; general surface smooth,

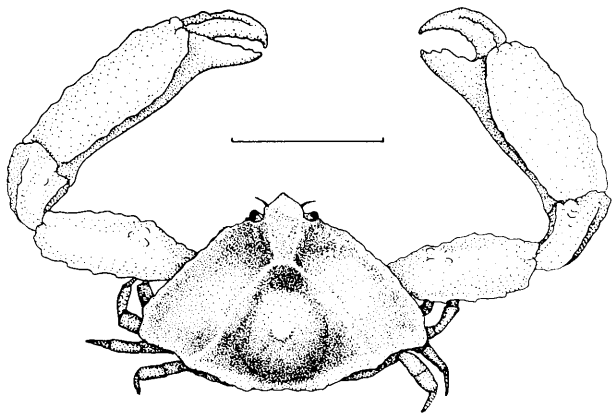

FIGURE 251.—*Heterocrypta granulata* (Gibbes). Male in dorsal view, 10 mm. indicated.

punctate; margins crenulate. Anterolateral margin nearly straight, with dorsal surface sloping upward from margin to prominent, granulate branchial ridge running parallel with each side, these connected by a short transverse ridge on gastric region and joined behind to posterior marginal ridge. Rostrum broad, blunt, deflexed, with rounded margins connected to gastric ridge by a pair of granulate crests. Orbits small, nearly circular; eyes small, retractile. Cardiac region with a large domelike elevation granulated at summit.

Chelipeds unequal, rather heavy, longer than width of carapace; outer and inner margins of upper surface of merus, carpus, and hand expanded into irregular granulate or dentate crests; fingers short, agape in larger cheliped. Walking legs short, almost completely hidden beneath carapace.

Sternum and lower surface of abdomen coarsely granulate; male abdomen with third, fourth, and fifth segments fused, sixth segment with a sharp proximal appressed spine with tip lying between two tubercles on fifth segment.

Measurements.—Carapace: male, length, 12 mm., width, 18 mm.; female, length, 15 mm., width, 21 mm.

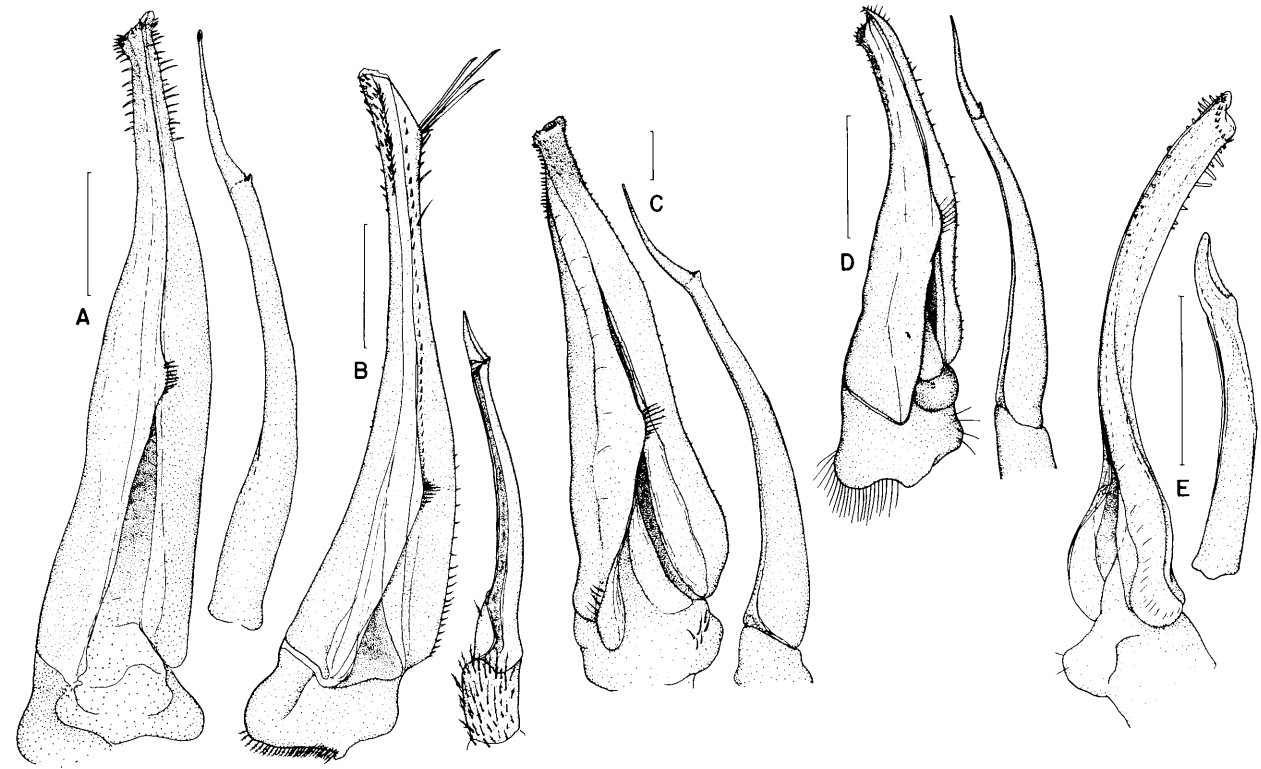

FIGURE 252.—Family Parthenopidae, first and second right pleopods of males; A, *Parthenope agona* (Stimpson), medial view; B, *Parthenope serrata* (H. Milne Edwards), medial view; C, *Parthenope pourtalesii* (Stimpson), medial view; D, *Parthenope fraterculus* (Stimpson), medial view; E, *Heterocrypta granulata* (Gibbes), mediosternal view; 1 mm. indicated.

Color.—Varying from light gray to nearly black, usually commingled so as to produce an irregular mottling or marbling (various authors).

Habitat.—This species is found on shingly bottoms, and not infrequently on shelly bottoms in Morehead City, N.C., harbor. Its angular form and coloration bear so close a resemblance to fragments of shells among which it lives that it is extremely difficult to detect. Two to 75 fathoms.

Type localities.—Near Kiawah Island, Sullivans Island, and White Point Shoal, Charleston Harbor, S.C.

Known range.—Nantucket Sound, Mass., to Georgia; Florida Straits to Sabine, Tex.; through West Indies to St. Thomas.

Remarks.—Ovigerous females are found in the Beaufort, N.C., area throughout the summer.

ACKNOWLEDGMENTS

Considerable aid was provided for completing this revision. The Society of the Sigma Xi gave a grant-in-aid to help with curatorial duties in the Institute of Fisheries Research Collection. National Science Foundation gave two grants (G–5638 and G–18545) for study, travel, curatorial expenses, and illustration. Without these grants, the work would not have been possible.

Fenner A. Chace, Jr., Senior Scientist, Department of Zoology, U.S. National Museum, gave encouragement and counsel, and aided greatly by providing space for study at the USNM, and by loaning specimens. G. Robert Lunz, Director, Bears Bluff Laboratories, Wadmalaw Island, S.C., extended similar help; and E. Milby Burton, Curator, The Charleston Museum, provided study space and made loans of specimens. L. B. Holthuis, Rijksmuseum van Natuurlijke Historie, Leiden, gave counsel and many kindnesses. My associates, A. F. Chestnut, E. E. Deubler, W. E. Fahy, W. A. Lund, H. J. Porter, G. S. Posner, and W. J. Woods, helped with many details; and my colleagues in nearby laboratories of the U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries and Duke University, Beaufort, N.C., provided both field data and other help.

Special thanks are due my assistant, George W. Bryce, Jr., who did much of the curatorial and photographic work, and the able artist, Doris H. King, who drew all original figures except the map.

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