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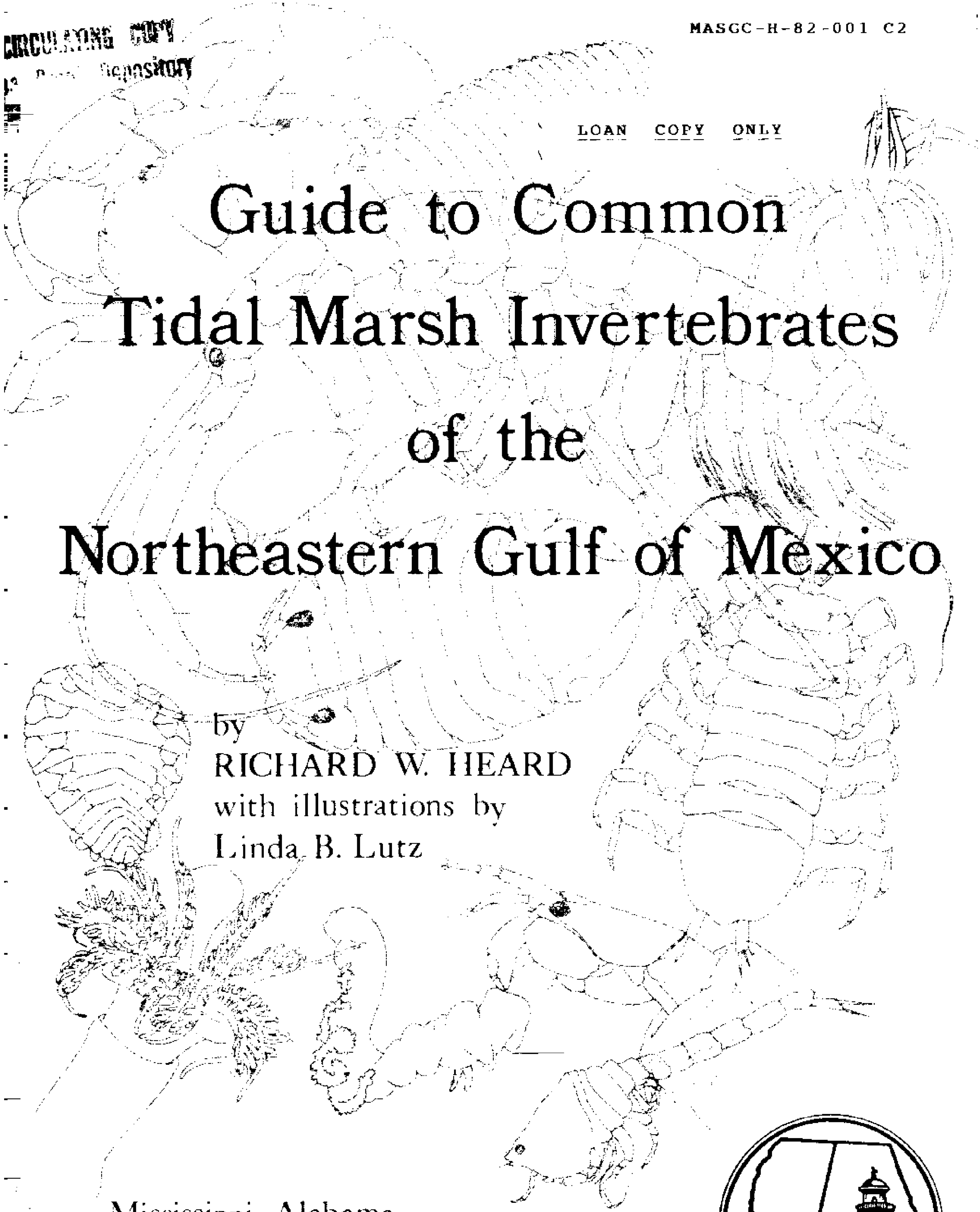

Guide to Common Tidal Marsh Invertebrates of the Northeastern Gulf of Mexico

by
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with illustrations by
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Mississippi Alabama
Sea Grant Consortium

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Guide to Common Tidal Marsh Invertebrates of the Northeastern Gulf of Mexico

by

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*Present address.

This Handbook is dedicated to
WILL HOLMES
friend and gentleman

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PREFACE

Since the realization of the ecological and economic importance of salt marshes, millions of dollars in research funds have been allocated for the study of these valuable and productive wetlands. Very little information, however, has been compiled for the identification of marine and estuarine salt marsh invertebrates. Ursin (1972) and Olmstead and Fell (1974) have published handbooks or guides to salt marsh organisms, but both these guides are designed for the temperate tidal marshes of the Atlantic coast. The only popular account of salt marsh invertebrates for our region is a guide by Fotheringham and Brunenmeister (1975)* to the common invertebrates of the northwestern Gulf Coast. Although their treatment is interesting, it is general and therefore limited in its treatment of tidal marsh invertebrates. Teal (1962), in his paper on Georgia salt marshes, was the first to give an extensive list of salt marsh invertebrates. The most comprehensive faunal study of the salt marshes of the northern Gulf was that of Subrahmanyam *et al* (1976). They listed over 50 species of marine macroinvertebrates from *Juncus-Spartina* tidal marshes and adjacent tidal marsh creeks at St. Marks, Florida.

I feel that the necessity for this handbook is supported by the many requests for identification of salt marsh species that I have received during the past several years. The taxonomic literature of many of the salt marsh species of invertebrates is often obscure, inaccessible, or difficult to interpret by the layman, student, or ecologist or other specialist untrained in taxonomy. Well-illustrated, up-to-date identification guides for the marine invertebrates of the northern Gulf are urgently needed. This guide attempts to fill part of this need by treating the common brackish water macroinvertebrates that live or occur in the salt marshes along the Mississippi–Alabama coast and immediately adjacent areas of Florida and Louisiana.

*Revised by Fotheringham (1979).

INTRODUCTION

The macroinvertebrates found in the salt marshes of the northern Gulf coast are members of a unique ecosystem. Some spend their entire lives in the salt marsh, others forage there, and still others are found there only as juveniles, since the salt marsh is part of the estuarine "nursery grounds" for many fishes and invertebrates.

Salt marshes are formed along the shores of coastal plains in the temperate and tropical zones of the world wherever wave action is slowed enough to allow grasses to become established. They are found in the intertidal zone in shallow water, in the lee of sea islands, along borders of bays and inlets, and along tidal streams, bayous, and the mouths of rivers. In the United States, an almost continuous band of salt marshes fringes the Atlantic and Gulf coasts. The predominant grass in Atlantic coastal marshes is smooth cordgrass, *Spartina alterniflora*. Tides along the Atlantic coast occur regularly twice a day and have amplitudes of 4 to 8 feet (1.3 to 2.6 meters). Conditions are different in the northern Gulf of Mexico where tides in most regions occur at irregular intervals and are much lower in amplitude than along the Atlantic coast. Tides in the Gulf are usually no higher than 1.5 feet (0.5 meters). Strong southerly winds can "blow in the tide" during a normal low tide, and strong northerly winds can "blow out the tide" during a normal high tide. The weak tidal amplitudes restrict the intertidal zone and may be a factor limiting the population of smooth cordgrass. The dominant grass in Gulf coastal marshes is needlegrass or black rush, *Juncus roemerianus*. The area covered by the Gulf tidal marshes is reported to equal 60% of the total area of U.S. coastal marshes.

Salt marsh organisms are often exposed to harsh conditions, which restrict the number of plant and animal species. Unlike the open ocean, where conditions are relatively stable, waters in the marshes can undergo daily rapid changes in salinity, temperature, oxygen concentration, and pH. Salinity varies from one area to the other depending on temperature, wind, inflow of fresh water from streams and rivers, rainfall, and evaporation during low tides.

In spite of these harsh conditions, tidal marshes are extremely fertile areas in terms of the production of organic matter. The few plants that have adapted to this variable, but nutrient rich, habitat are able to grow in dense concentrations. Because of their high productivity, tidal marshes have often been compared to wheat fields.

The marsh grass is one of the key primary producers that form the basis of the complex food-web of the estuary. The other key primary producers are phytoplankton (small, planktonic algae) and mud-algae (diatoms of many kinds).

Although the food web of the estuary is apparently largely based on plants, less than 10% of the vascular plant matter produced in the marsh is consumed directly by plant-eaters. Researchers estimate that over 90% of the marsh grass dies, falls into the water, and is broken down by microbial decomposition and other biological agents into particulate organic matter known as detritus. Although organic detritus comes from a variety of sources, salt marshes probably are one of its major sources in estuaries.

Animals fit into the marsh food web in several categories according to what they consume as food. Animals that feed directly on plant tissues are called herbivores. Only a few marsh species are strict herbivores. The meat-eaters, or carnivores, are at the top of the food-chain. A third category is the detritivore, an animal which consumes detritus. Actually, many of these animals do not utilize the basic detrital particles as food but digest the diatoms, bacteria, fungi, protozoans, nematodes, and other small organisms that occur in or on the surfaces of the particles. The detrital particles are expelled in the feces of the detritivore and can be eaten again by other detritivores. The degree of importance of salt marsh detritus as a direct or indirect food source for salt marsh and estuarine animals is still being debated by ecologists. Some specialists believe that phytoplankton is more important than salt marsh grasses in the food chain.

The classification of marsh animals in the food web according to food preference, whether plant, animal, or detritus, is complicated by two factors. First, the feeding habits of many salt marsh and estuarine invertebrates are difficult to categorize. Many species eat detritus, algae, and animal matter. Animals with these diverse and unspecific feeding habits are called omnivores. Detritivores could be classified as a specialized type of omnivore since they ingest algae and animal matter associated with detritus. Second, the feeding habits for many salt marsh species vary greatly with the seasons or other environmental factors. In some cases, a species may be classified as carnivorous during the winter, herbivorous during the spring, and omnivorous during the summer and fall.

Another complication in understanding life in the salt marshes is the fact that the animals are of two types — transitory and permanent. Many carnivores and omnivores, such as raccoons, mice, estuarine fishes, blue crabs, penaeid shrimps, and herons, are in the marshes only when feeding. The permanent residents include some mammals such as muskrats, birds such as the clapper rail, and many invertebrates both small and large. The small or microinvertebrates (meiofauna) are the tiny, interstitial or surface-dwelling, adult forms and the larvae and juveniles of larger species. They include protozoans, flatworms (Turbellaria), roundworms (Nematoda), gastrotrichs, copepods, ostracods, and polychaete larvae. The larger invertebrates, or macroinvertebrates, are the subject of this guide.

The three major groups of marine and estuarine macroinvertebrates of the tidal marshes of the northern Gulf are (1) polychaete worms, (2) mollusks and (3) crustaceans. This guide covers most of the known salt marsh species of these three groups from this region. One member of the Phylum Coelenterata, an anemone, occurs in salt marshes and is included. Oligochaetes, insects, and arachnids are excluded. Information on the recognition characters, distribution, habitat, and biology of each species is given. The taxonomy of some species is clarified. Most of the species discussed are also illustrated.

Binomial Latinized scientific names, which are made up of capitalized generic names followed by uncapitalized species names, are used for all the species in this guide. Common names are also given when feasible. The name and/or names and the date following a scientific name refer to the authority or authorities who originally named and described the species and to the year in which it was described. The describer's name is not separated from the scientific name by any punctuation marks. When the describer's name and the date are enclosed in parentheses, it means that the first or generic name of the binomial scientific name has been changed or replaced. When synonyms are given for a species, they are limited to the other names that the species has been called previously.

General References: Bagur and Rienstra (1977); Brown *et al* (1978), Cammen (1979); Daiber (1976); de la Cruz (1973); Eleuterius (1972); Eleuterius and McDaniel (1978); Gosselink (1980); Gosselink, Odum, and Pope (1974); Kraeuter and Wolf (1974); Kruczynski *et al* (1978); Odum (1961); Shuster (19-66); Subrahmanyam *et al* (1976); Teal (1962); Teal and Teal (1969); Turner (1976); Wass and Wright (19-69).

SALT MARSH MACROINVERTEBRATES OF THE NORTHERN GULF OF MEXICO

PHYLUM CNIDARIA (=COELENTERATA)

This phylum contains three classes – Hydrozoa; Scyphozoa (jellyfishes); and Anthozoa (anemones, corals). No published records exist of cnidarians from Gulf coast tidal marshes, probably because of the unfavorable habitat and the lack of intensive study by biologists. Several times I have seen in tidal marsh ponds of northwestern Florida and Georgia hydrozoans that resembled *Hydra,* although in each specimen several individual polyps were connected by a stolon. These specimens were not collected, and I have been unable to get additional material. Careful studies of marsh pools and the wetter areas of tidal marshes should reveal this form and possibly other cnidarians. I have found one species of anthozoan, an anemone, in tidal marshes of the northeastern Gulf of Mexico.

Class Anthozoa

Family Edwardsiidae

Nematostella cf. *vectensis* Stephenson, 1935

Figure 1

Common Name: Dwarf Mud Anemone
Synonym: *Nematostella pellucida* Crowell, 1946
Recognition Characters. Small, elongate, nearly transparent body up to 25 mm in length; usually with 16 oral tentacles in 2 rows of 8 each.
Distribution: Europe, North America – California, Massachusetts, Florida, Mississippi.
Habitat: Euryhaline; on mud bottoms of marsh tidal pools and ponds rich in detritus and decaying vegetation.
Remarks: The specimens that I have collected from tidal marshes in Florida (St. Marks) and in Mississippi (Ocean Springs) appear to be *N. vectensis. Nematostella* from Massachusetts was originally described as a distinct species, *N. pellucida*; however, later studies by C. Hand, who compared specimens from Europe with those from Massachusetts and California, indicated that *N. vectensis* and *N. pellucida* are the same species. *Nematostella* has been observed feeding on the polychaete worm *Hobsonia florida* (Hartman, 1951) in New England.
References: Crowell (1946); Hand (1957); Pettibone (1977).

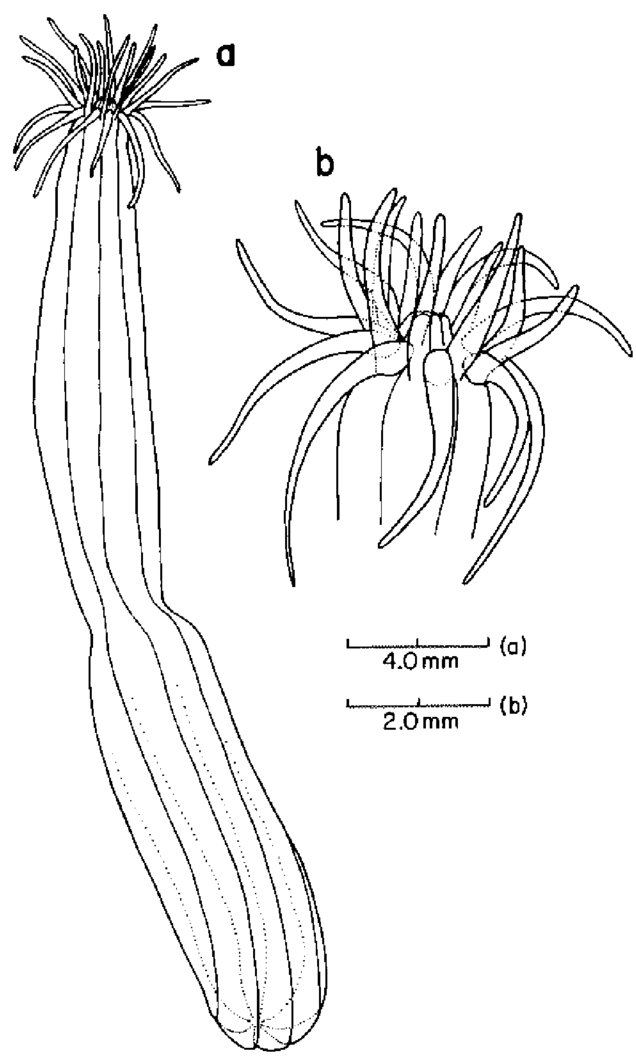


Figure 1. *Nematostella* cf. *vectensis* from a tidal marsh pool at St. Marks, Florida: a- entire animal; b- oral end showing tentacles and mouth (tentacles partially contracted).

PHYLUM ANNELIDA (ANNELIDS)

This phylum contains three classes – Oligochaeta (earthworms); Hirudinea (leeches); and Polychaeta. Only the polychaetes will be covered in detail by this guide, since they are much better represented in the marshes than the other two classes.

Class Oligochaeta (Oligochaetes)

The tidal marsh oligochaetes of the northern Gulf are not well known, although several freshwater species occur in the low salinity tidal marshes. A large species, *Pontodrilus bermudensis* Beddard, 1891, which resembles a common earthworm, occurs in sandy, upper intertidal areas along the offshore islands (i.e. Dauphin Island and Horn Island). There are no simple guides to the identification of oligochaetes; however, the serious reader may wish to refer to the works of Brinkhurst and Jamieson (1971) and Cook and Brinkhurst (1973) for aid in identifying specimens of the coastal marshes and estuaries of the northeastern Gulf of Mexico.

Class Hirudinea (Leeches)

In Gulf salt marshes there is only one common species of the Class Hirudinea – the "crab leech," *Myzobdella lugubris* Leidy, 1851, which is often found attached to blue crabs and to grass shrimps (Daniels and Sawyer, 1975; Overstreet, 1978).

In low salinity tidal marshes several species of freshwater leeches may also be found. For an identification guide to marine and brackish leeches, the reader is referred to the work of Sawyer, Lawler, and Overstreet (1975).

Class Polychaeta (Polychaetes)

Polychaetes can be distinguished from oligochaetes and leeches by the presence of appendages (parapodia) on the body segments and "tentacles" on the head regions; however, several of the families (Capitellidae, Serpulidae, Sabellidae), highly modified for burrowing or for living in tubes, have lost superficially one or both of these characteristics. Though generally found in marine and estuarine environments, some polychaete species are also known from freshwater habitats.

Of the three annelid classes, only polychaetes have a planktonic larval stage or trochophore. Some polychaete species, especially tube-dwelling forms, brood their young, thus bypassing a planktonic larval stage. Most authorities believe that the Class Polychaeta is more ancient than either the oligochaetes or the leeches. The oligochaetes are thought to have evolved from polychaete ancestors and the leeches from freshwater oligochaete ancestors.

Thirteen species of polychaetes representing 12 genera and eight families are now known from tidal marshes in the northern Gulf of Mexico. Additional species will probably be added to this list.

Family Nereidae (Nereids)

Four species of this family are known to occur in northeastern Gulf tidal marshes. Nereids can be distinguished from other marsh polychaetes by a well-developed head and parapodial appendages and by the presence of a pair of simple serrate jaws. The latter is visible only when the worm has extended its proboscis (feeding apparatus) or upon dissection.

Neanthes succinea (Frey and Leuckart, 1847)

Figures 2 k, j; 5 b

Synonym: *Nereis succinea* (Frey and Leuckart, 1847)
Recognition Characters: Relatively large worms up to 80 mm long; paragnaths present on proboscis; dorsal ligules of posterior segments relatively narrow and elongate; usually with light to dark brown pigment on head region.
Distribution: Cosmopolitan in temperate and subtropical regions of the world.
Habitat: Various estuarine habitats (marshes, pilings, under debris, oyster reefs, mud bottoms) in salinities ranging from less than 5‰ to over 30‰.
Remarks: *Neanthes succinea* is one of the most commonly encountered nereids in estuaries along the eastern United States. In salt marshes it makes shallow burrows in the substratum around plant roots or under rafts of dead marsh grasses and other debris. *Neanthes succinea* is also a common associate of oysters.

The sexes of *N. succinea* are distinct during breeding. In preparation for breeding, the bodies of both males and females become highly modified for swimming and are called "epitokes." They leave the bottom to form breeding aggregations or swarms near the surface. Hundreds of these worms can be seen at a time swimming on the surface. During breeding the males release millions of sperm cells. The bodies of the females rupture, releasing thousands of eggs, which are then fertilized externally in the water by the sperm cells. The timing of this swarming has been suggested to be related to the phases of the moon.

Neanthes succinea is an omnivorous feeder, eating detritus, algae, and small crustaceans. In turn it is eaten by marsh birds (rails, seaside sparrows, and sandpipers) and by fishes (killifishes, sciaenids).
References: Bishop (1974); Cammen (1976 a, b, 1979, 1980); Cammen, Rublee, and Hobbie (1978); Pettibone (1963).

Laeonereis culveri (Webster, 1880)

Figures 2 h, i; 5 c

Recognition Characters. Relatively large worm up to 70 mm long with small head; proboscis with fleshy, finger-like papillae; prominent, light blotches (glands) on parapodia.
Distribution: Atlantic and Gulf coasts from North Carolina to Texas; West Indies; Brazil.
Habitat: Euryhaline (0‰ to over 35‰); intertidal to shallow subtidal in substrata with at least some sand.
Remarks: This species often occurs in the sand or

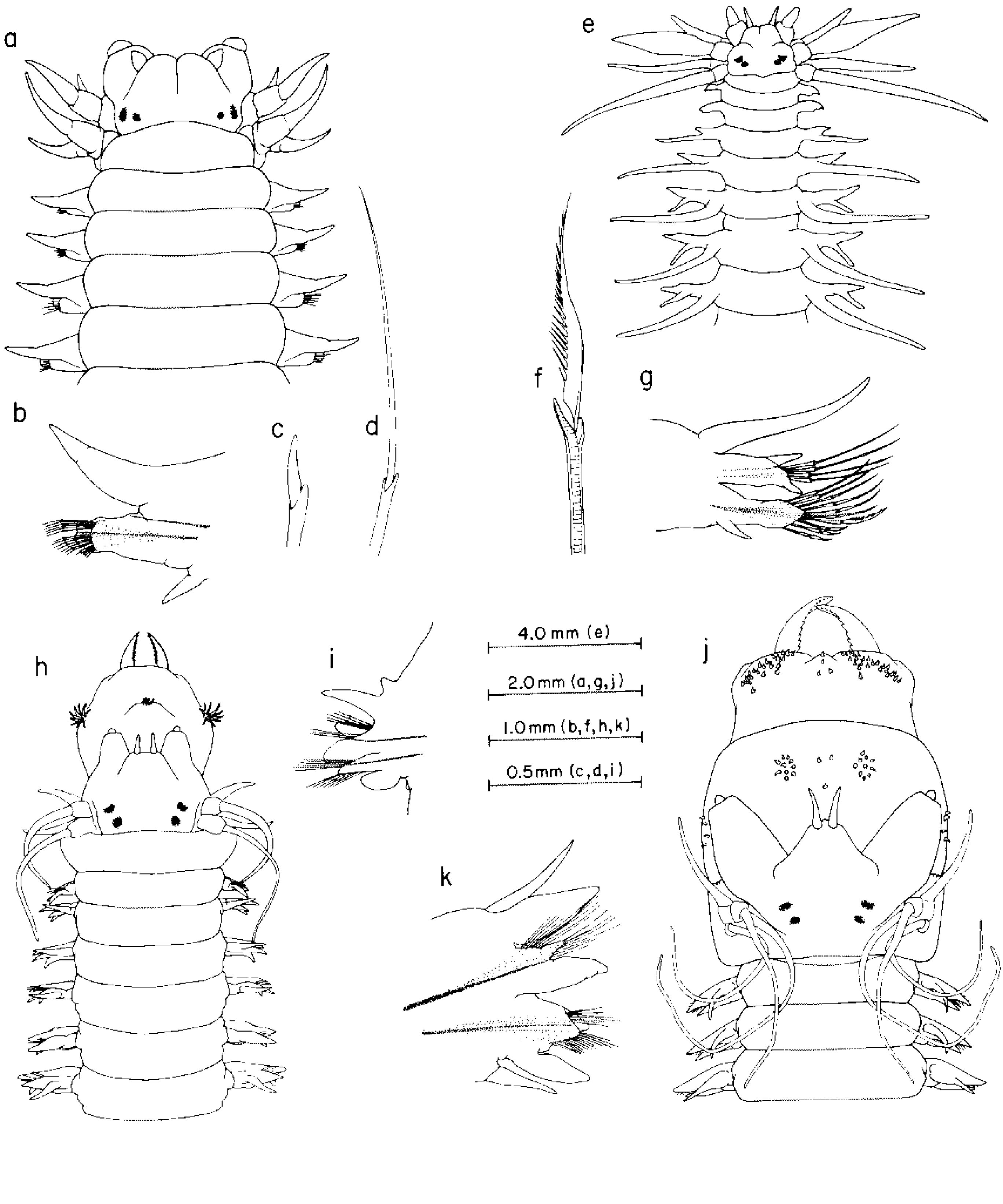


Figure 2. Tidal marsh nereid polychaetes and structures: a- *Namalycastis abiuma*, anterior end; b- *Namalycastis abiuma*, parapodia; c- heterogomph falciger; d- heterogomph spiniger; e- *Stenoninereis martini*, anterior end; f- *Stenoninereis martini*, specialized heterogomph seta; g- *Stenoninereis martini*, parapodium; h- *Laeonereis culveri*, anterior end; i- *Laeonereis culveri*, parapodium; j- *Neanthes succinea*, anterior end (proboscis everted); k- *Neanthes succinea*, parapodium.

sand-mud substrata of tidal marshes. The linings of its burrows are a distinctive rust color. The intestines of *L. culveri* specimens are usually full of sand grains, a condition that often readily distinguishes it from other nereids that occur in tidal marshes.
References: Cammen (1976 a, b, 1979); Gardiner (1975); Hartman (1945, 1951); Pettibone (1971).

Namalycastis abiuma (Müller, in Grube, 1871)

Figures 2 a, b; 5 a

Synonyms: *Lycastopsis tecolutlensis* Rioja, 1946
Lycastoides pontica Jakubova, 1930
Lycastopsis hummelincki Augener, 1933
Recognition Characters: Relatively large worm up to 100 mm long; parapodia appearing uniramous; notopodium reduced; proboscis not ornamented (paragnaths and papillae absent).
Distribution: North Carolina, Georgia, Florida (west coast) to Louisiana.
Habitat: Upper intertidal in low to medium salinity tidal marshes (0‰ to 20‰); burrowing in mud and silt substrata or under dead marsh vegetation and driftwood.
Remarks: Little is known about the biology of this rare and unique nereid. In Mississippi (Gulf Park), I have found it living in nearly semi-terrestrial conditions under the bark of dead pine trees that have fallen into the edges of brackish marshes. Females have large eggs indicating the possibility of an abbreviated life cycle. This species thrives in aquaria with wet mud and dead marsh grass. On the coast of Georgia, *Namalycastis abiuma* has been reported from low salinity tidal marshes and as a food organism for the white catfish.
References: Foster (1972); Gardiner (1975); Hartman (1959); Heard (1975); Heard and Sikora (1972); Subrahmanyam *et al.* (1976).

Stenoninereis martini Wesenberg-Lund, 1958

Figures 2 e, f, g; 5 k

Recognition Characters: Small worms up to 8 mm long with 34 body segments; proboscis not ornamented (no papillae or paragnaths present).
Distribution: North Carolina; Gulf of Mexico from western Florida to Texas; West Indies (St. Martin Island).
Habitat: Brackish (0‰ to 30‰); warm mineral springs (Florida), tidal ponds (St. Martin Island), salt marsh ponds, tidal creeks and rivers; on silt and mud bottoms.
Remarks: I have collected this species from marsh tide pools and bayous in Mississippi. It has not been reported in Alabama waters but undoubtedly occurs there. This little nereid lives and reproduces well in aquaria. Information on its biology indicates that it can live in water with little or no oxygen content.
References: Gardiner (1977); Pettibone (1971); Williams *et al.* (1976).

Family Pilargiidae (Pilargiids)

Parandalia americana (Hartman, 1947)

Figures 3 a; 5 e

Synonym: *Loandalia americana* Hartman, 1947.
Recognition Characters: Earthworm-like; body usually coiled (cork-screw shaped); head region whitish with remainder of body reddish-orange; reaching lengths of 115 mm, up to 300 body segments; palps present; tentacular cirri absent; parapodia weakly developed; notopodia minute.
Habitat: Oligohaline and mesohaline bays and tidal marshes; in fine sand or sand-mud substrata.
Distribution: Northern Gulf of Mexico from western Florida to Texas.
Remarks: This is a fairly common estuarine species often present in tidal marsh habitats. *Parandalia americana* can burrow deep into the substratum and can apparently exist in areas with little or no free oxygen. No studies on the biology or life history of this polychaete have been published.
References: Emerson and Fauchald (1971); Hartman (1951).

Family Orbiniidae (Orbiniids)

Scoloplos fragilis (Verrill, 1873)

Figures 3 b; 5 d

Synonym: *Haploscoloplos fragilis* (Verrill, 1873)
Recognition Characters: Prostomium ending in acute point; branchiae dorsally arranged beginning between setigers 11 and 23; body widest between segments 7 and 14.
Distribution: Atlantic and Gulf Coasts from southern Canada to northern Gulf of Mexico.
Habitat: Infaunal; burrowing in sand, mud-sand, and mud substrata; estuarine; lower intertidal to shallow subtidal.
Remarks: This species often occurs in damp, poorly drained parts of mesohaline tidal marshes along the eastern and Gulf coasts. It is not usually found in salinities below 10‰.
References: Hartman (1951); Pettibone (1963); Subrahmanyam *et al.* (1976).

Family Capitellidae (Capitellids)

Many members of this polychaete family super-

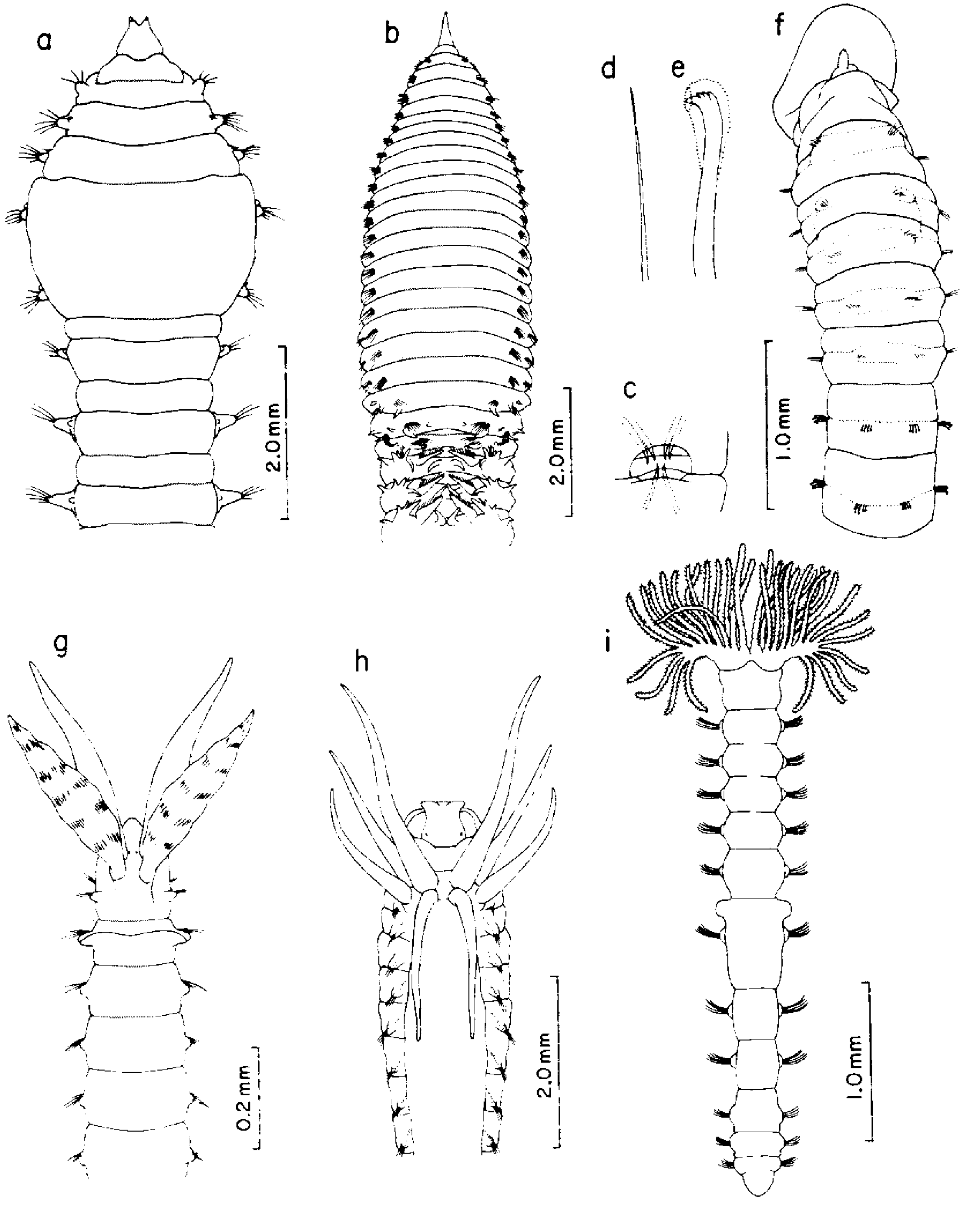


Figure 3. Tidal marsh polychaetes. a- *Parandalia americana*, anterior end; b- *Scoloplos fragilis*, anterior end; c- *Capitella* cf. *capitata*, genital setae; d- capillary detae; e- hooded hook seta; f- *Heteromastus filiformis*, anterior end; g- *Streblospio benedicti*, anterior end; h- *Hobsonia florida*, anterior end; i- *Manayunkia speciosa*, entire animal (after Leidy, 1883).

ficially resemble oligochaetes. The thorax of capitellid polychaetes usually consists of the first 9 to 14 body segments. The taxonomy of many genera of species is based on the number of thoracic segments present and on the distribution of different types of setae on these segments. In separating estuarine capitellid species of the Gulf coast from each other, one must determine on which thoracic body segment occur the modified setae called "hooded hooks." The other common type of setae that are found on the thorax are simple pointed setae or capillary setae. A compound microscope is usually required to examine the setae. Some species such as *Capitella capitata* (Fabricius, 1780) have genital setae on the thoraces, and the segment on which these setae occur is an important taxonomic character. Those who wish to understand more about the taxonomy of the family Capitellidae are referred to a monograph by Hartman (1947).

At least three capitellids – *Capitella capitata, Heteromastus filiformis* (Claparède, 1864), and *Notomastus* sp. – have been found or reported in tidal marshes along the Gulf. Another species, *Mediomastus californiensis* Hartman, 1944, common in shallow bottoms, may occur in Gulf tidal marshes. *Mediomastus californiensis* and *Notomastus* sp. are not presented in the text but are included in the taxonomic key with *Capitella* and *Heteromastus.*

Capitella cf. *capitata* (Fabricius, 1780)

Figures 3 c; 5 i

Recognition Characters: Small, thin, reddish worms with 9 thoracic segments; first segment having setae; parapodia reduced, without lobes; genital setae present on segments 8–9.
Distribution: Temperate marine and estuarine waters of the world.
Habitat: Subtidal and intertidal in mud and silt bottoms.
Remarks: *Capitella capitata* lives in vertical burrows in muddy substrata and feeds primarily on organic detritus. There are numerous records of its occurence in tidal marshes, but there are only a few reports of its presence in marshes along the northern Gulf of Mexico. *C. capitata* has been used as an indicator organism in several environmental and pollution studies; however, recent studies indicate that it may actually represent a complex of different forms or "species" with varying life histories and larval development.
References: Grassle and Grassle (1974, 1976).

Heteromastus filiformis (Claparède, 1864)

Figures 3 f; 5 h

Recognition Characters: Body 20 to 40 mm long; first body segment without setae; following 5 body segments with only simple capillary setae; next 6 body segments having hooded hooks.
Distribution: East and west coasts of North America; Europe; scattered localities throughout temperate parts of the world.
Habitat: Estuarine in sand-silt substrata rich in organic matter; lower intertidal and shallow subtidal; mesohaline from less than 15‰ to over 30‰.
Remarks: This species is the only capitellid known from estuaries of the northern Gulf that has the "hooded-hook" type of setae beginning on the sixth setigerous segment. Like *Capitella capitata,* it constructs vertical burrows. The presence of *H. filiformis* is often indicated by a small cone or mound of sediment around the mouth of its burrow.
Reference: Hartman (1951).

Family Ampharetidae (Ampharetids)

Hobsonia florida (Hartman, 1951)

Figures 3 h; 5 f

Synonyms: *Amphicteis gunneri floridus* Hartman, 1951
Amphicteis floridus Hartman, 1951
Hypaniola florida (Hartman, 1951)
Hypaniola grayi Pettibone, 1953
Recognition Characters: Tube-dwelling; body up to 30 mm long; inflated anteriorly; tapering to narrow posterior end; 4 pairs of dorsal "finger-like" branchiae clustered together on first few body segments; prostomium with pair of small, lateral eye spots.
Distribution: Atlantic and Gulf coasts from New Hampshire to Texas.
Habitat: Estuarine; in bays, tidal marsh creeks, and tidal marsh pools; in variable substrata of fine sand, sand-mud, and silt; common in oligohaline and mesohaline areas rich in detritus, or in grass beds *(Ruppia).*
Remarks: This little polychaete is abundant in marsh tide pools where it constructs mucous tubes using varying combinations of sand, mud, detritus, and other debris. During the warmer months it reproduces. Large eggs are released, fertilized, and brooded within the tubes of the females. When the young develop to the 2 to 3 setiger stage, they crawl out of their parents' tubes and begin feeding and constructing their own tubes. *Hobsonia florida* has been reported to serve as the primary host for a trematode parasite. Mollusks are almost always the primary host for trematode parasites, and only in a few rare cases have polychaetes been reported to serve this role.
References: Banse (1979); Hartman (1951); Oglesby (1961); Pettibone (1953, 1977); Zottoli (1974).

Family Spionidae (Spionids)

Streblospio benedicti Webster, 1879

Figures 3 g; 5 g

Recognition Characters: Tube-dwelling; body relatively small, about 8 mm; palpi long and well developed; single pair of prominent branchiae on anterior end next to palpi, which are nearly equal in size; second body segment with broad collar.
Distribution: East and west coasts of North America; South America; Europe.
Habitat: Estuarine in muddy substrata; intertidal and subtidal; in a wide range of salinities from less than 5‰ to over 25‰.
Remarks: *Streblospio benedicti* is a common estuarine species often occuring in wetter parts of tidal marshes along the northern Gulf of Mexico. This little polychaete lives in soft, mucoid tubes on muddy substrata. The young are brooded from the egg to the early juvenile stage within a specialized "brood pouch" on the parent worm. The small juveniles leave the parent's brood pouch and tube when they have developed between 9 and 13 setigerous segments or setigers.
References: Cammen (1980); Collier and Jones (1967); Foster (1971); Hartman (1945).

Family Sabellidae (Sabellids)

Manayunkia spp.

Figures 3 i; 5 l

Recognition Characters: Tube-dwelling; minute, 3 to 5 mm long; prominent crown of tentacles; does not have hard, white, calcareous tubes or an operculum as does the serpulid, *Ficopomatus miamiensis* (Treadwell, 1934).
Distribution: Undetermined pending clarification of taxonomy; two or possibly three species occuring in Mississippi - Alabama estuarine waters and tidal marshes.
Habitat: Oligohaline waters in mud or silt; lower intertidal to subtidal.
Remarks: Several specimens of *Manayunkia speciosa* Leidy, 1858, were recently reported from a low salinity tidal marsh bayou near Ocean Springs, Mississippi. Researchers in Alabama are currently investigating the taxonomy of what appear to be two additional species of *Manayunkia* from tidal marshes and from Mobile Bay. The specimens from Alabama tidal marshes have a close affinity to a European form, *M. aestuarius* Bourne, 1893, which has been reported as a dominant salt marsh species in Georgia. A figure of *Manayunkia speciosa* is given to illustrate the general body form for the genus.

References: Brehm (1978); Hartman (1951); Teal (1962).

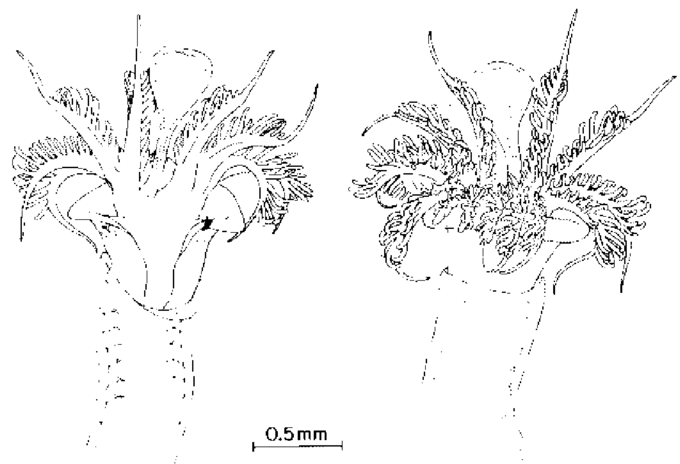


Figure 4. *Ficopomatus miamiensis* removed from its calcareous tube, anterior end showing ventral (at left) and dorsal (at right) aspects.

Family Serpulidae (Serpulids)

Ficopomatus miamiensis (Treadwell, 1934)

Figures 4; 5 j

Synonyms: *Sphaeropomatus miamiensis* Treadwell, 1934
Mercierellopsis prietoi Rioja, 1945
Recognition Characters: Small, living in smooth, white, calcareous tubes; 12 to 19 branchiae forming

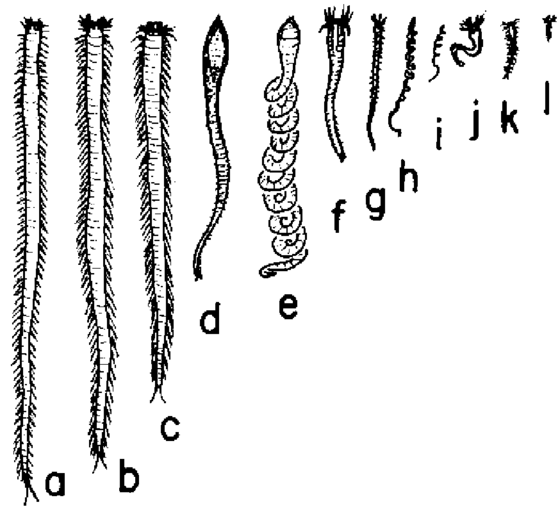


Figure 5. Representations of adult polychaetes showing their actual sizes (representative of each species): a- *Namalycastis abiuma*; b- *Neanthes succinea*; c- *Laeonereis culveri*; d- *Scoloplos fragilis*; e- *Parandalia americana*; f- *Hypaniola florida*; g- *Streblospio benedicti*; h- *Heteromastus filiformis*; i- *Capitella* cf. *capitata*; j- *Ficopomatus miamiensis*; k- *Stenoninereis martini*; l- *Manayunkia* sp.

head "plume" or "fan"; operculum spherical or fig-shaped.
Distribution: Florida, Louisiana; east coast of Central America; Caribbean.
Habitat: Epifaunal on submerged roots, shells of mollusks and crustaceans, and other hard substrata; protected estuarine waters (i.e. marsh tide pools) in salinities from less than 2‰ to over 25‰.
Remarks: This little serpulid was described from tubes attached to the carapace of a freshwater shrimp, *Macrobrachium americanum* Bate, 1868, collected at Miami, Florida. I have seen thousands of its tubes clustered on the submerged roots of *Spartina* marsh grass in the vicinity of St. Marks, Florida. It also occurs in the low salinity waters of Lake Pontchartrain, Louisiana. It has not yet been reported from the coasts of Mississippi or Alabama. No other serpulids are known from tidal marshes along the northern coast of the Gulf of Mexico.
References: Ten Hove and Weerdenburg (1978).

PHYLUM MOLLUSCA (MOLLUSKS)

Members of two classes of this phylum, the Gastropoda (snails and conchs) and the Bivalvia (clams and mussels), are important parts of the tidal marsh fauna. One member of the Class Cephalopoda - the common, estuarine squid, *Lolliguncula brevis* (Blainville, 1823) - during warmer months enters tidal marsh bayous and creeks where salinities are above 20‰. *Lolliguncula* is primarily a pelagic form that occurs intermittently along the edges of tidal marshes, where it feeds on shrimps and small fishes.

I have collected or there are reports of at least 16 species of gastropods and 9 species of bivalves in the tidal marshes of the northern Gulf of Mexico. Authorities disagree on the classifications above the family level (subclasses, superorders, orders, etc.) for the Classes Gastropoda and Bivalvia. For detailed listings of these various taxonomic categories, the works of Abbott (1974) and Andrews (1977) should be consulted.

Class Gastropoda (Gastropods)

Family Neritidae (Nerites)

The family Neritidae, along with several other families, has been placed in a group called the Archiogastropoda - (=Diotocardia). The gastropods belonging to this group are characterized by a pair of unipectinate gills, or as in Neritidae, a single bipectinate gill.

Neritina usnea (Röding, 1798)

Figure 6

Common Name: Olive Nerite
Synonym: *Neritina reclivata* (Say, 1822)
Recognition Characters: Size 10 to 14 mm; shell globular, greenish-brown or light brown with surface having many transverse, often wavy, dark lines; body whorl large, expanded; spire low, often eroded; animal with single bipectinate gill.
Distribution: Atlantic coast from North Carolina to Florida; entire Gulf coast; east coast of Mexico to Central America.
Habitat: Estuarine in shallow bays, ponds, bayous and tidal marshes; euryhaline in salinities from less than 1‰ to over 40‰; lower intertidal and silt substrata rich in organic matter, submerged vegetation *(Ruppia, Valasinaria).*
Remarks: This snail was long known by the name *Neritina reclivata*; however, recent reports (Porter, 1974; Clarke, 1978) list this name as a synonym under the obscure and older name *N. usnea.* Since the name *"usnea"* has been used so rarely in the past, it may eventually be surpassed by taxonomists in favor of the familiar and well-used name *"reclivata."*

This globular, euryhaline snail, one of the most common invertebrates found in the protected shallow bays and bayous of the Gulf coast, is often numerous in damp, lower, intertidal areas of tidal marshes. I have observed specimens climbing up the lower parts of *Spartina* stalks to graze on encrusted algae and other microflora that often occur there. On Horn Island, Mississippi, *Neritina* occurs in tide pools that sometimes have salinities exceeding 40‰, whereas large numbers of specimens have been collected in the St. Marks River in Florida from water that is fresh except during very high tides.

One of the most frequent requests that I receive from laymen, students, and colleagues is to identify the egg cases of *Neritina.* During the breeding season in the warmer months, females may lay over 50 small, white, oval, egg capsules measuring about 1 mm in diameter. The female snail deposits the conspicuous, white capsules on marsh grass stems, submerged vegetation, living and dead mollusk shells, dead wood, and any other hard surfaces available. When laid, each egg capsule usually contains from 60 to 80 eggs. The capsule ruptures several days after being laid, releasing planktonic veliger larvae with small, embryonic shells. The veliger larvae remain in the plankton and grow until they settle to the bottom as small juveniles to begin a bottom-dwelling existence.

Populations of *Neritina* in the bays and marshes are thought to be an important food for wild ducks. I have observed blue crabs and Gulf toadfish eating adult snails and seaside sparrows eating juvenile snails. The shells of *N. usnea* from marsh tide pools often are encrusted with barnacles *(Balanus* spp.), and bryozoans *(Membranopora).* In marsh pools at St.

Marks, Florida, shells were found fouled with tubes of serpulid polychaetes *(Ficopomatus miamiensis)*.
References: Andrews (1935); Andrews (1977); Clarke (1978); Porter (1974).

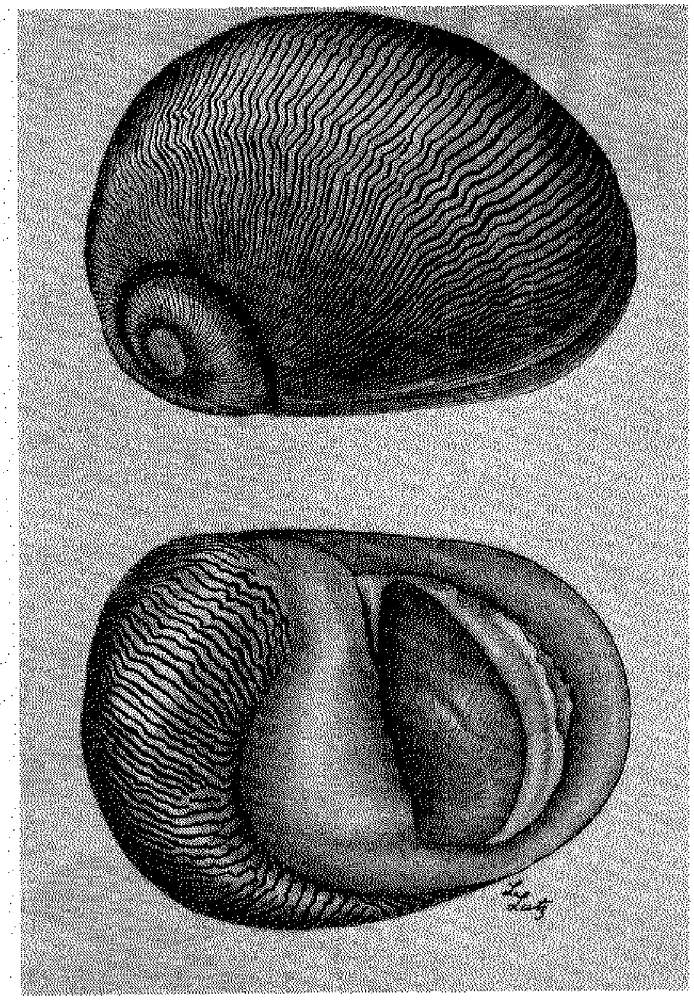


Figure 6. *Neritina usnea (=N. reclivata)*: dorsal and ventral aspects of shell.

Family Hydrobiidae (Hydrobiids)

Members of this family can be found in large numbers in marsh pools and other wet areas of Gulf tidal marshes; however, they often are overlooked by the casual observer because of their very small size. Eight or more species occur in the estuarine areas of the northern Gulf of Mexico, and of these, at least six can be found in tidal marsh habitats. Hydrobiids feed on detritus and its associated microflora. Since their populations are often large, in some cases exceeding 10,000 snails per square meter, and since they have a rapid feeding rate, these small snails may be ecologically important in some tidal marsh systems.

The taxonomy of the Gulf species is still unsettled, and several new species may be present. The shells of some species are almost identical; however, the males of these forms can often be separated by the number and kind of papillae on their copulatory organs (verges). Other characters used to separate closely related hydrobiid species include the number of gills and morphology of the female reproductive system. This requires refined dissecting and histological techniques, which are beyond the scope of this guide. Help from an expert will often be required to identify many hydrobiid snails because of their small sizes and similar appearance.

Littoridinops palustris Thompson, 1968

Figure 7 e; 8 d

Recognition Characters: Small, reaching 4.5 mm in length; shells similar to *Littoridinops monroensis* (Frauenfeld, 1863); verge of male usually with single row of 8 to 15 papillae on convex margin and 2 to 3 subterminal papillae on concave margin.
Distribution: Coast of the Gulf of Mexico from western Florida (Yankeetown) to eastern Louisiana (Lake Borgne).
Habitat: On muddy or silty substrata rich in organic matter; intertidal in marshes and shallow bays immediately adjacent to land; or subtidal, associated with widgeon grass *(Ruppia)* in shallow bayous and bays; wide range of salinities from nearly fresh to over 25‰.
Remarks: In the wetter parts of tidal marshes this hydrobiid is often one of the most common and important invertebrates. These little snails apparently feed on microflora (diatoms, filamentous algae, bacteria) and other organic matter occurring on the marsh floor or on the surfaces of living or decaying vegetation. I have found these snails in the stomachs of blue crabs, killifishes *(Fundulus)*, and seaside sparrows, and undoubtedly they are eaten by other animals such as mud crabs, rails, and ducks.

Littoridinops palustris is similar to *L. monroensis* and to *L. tenuipes* (Couper, 1844), an east coast species. On the Gulf coast, *L. palustris* occasionally occurs with *L. monroensis* in brackish water tidal ponds; however, *L. palustris* usually does not occur in the more open pond habitats preferred by *L. monroensis*, and *L. monroensis* is not commonly found in the intertidal marsh habitats where *L. palustris* is common. Often the shells of *L. palustris* from subtidal areas in shallow bayous and bays have a thickened or swollen area on the last body whorl near the aperture. The reason for the occurrence of this phenomenon in subtidal populations is unknown.

On the southeast Atlantic coast, *L. tenuipes* occurs in the same habitat types occupied by *L. palustris* on the Gulf coast. Although the two species are very similar, the verge of *L. tenuipes* has an extra

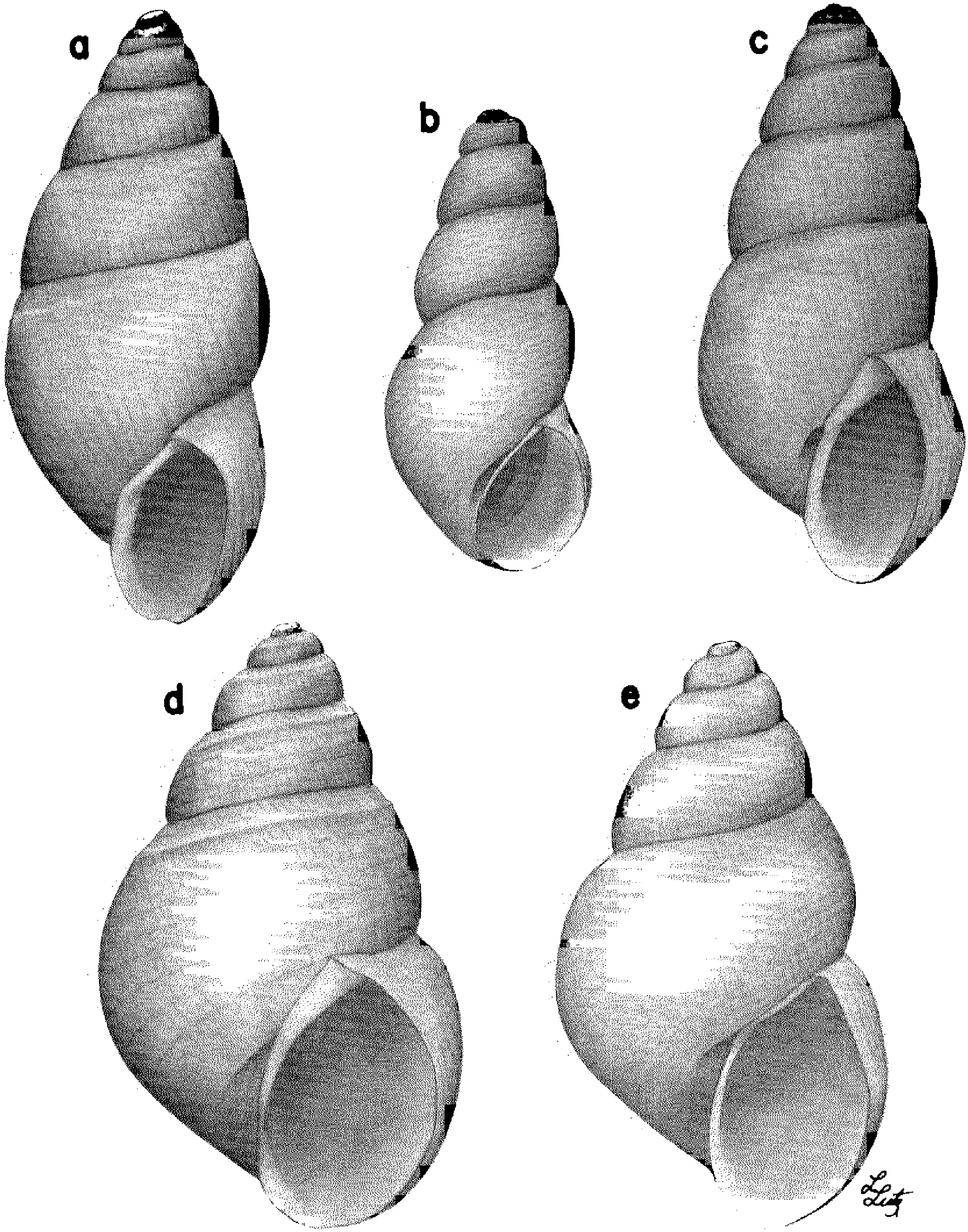


Figure 7. Hydrobiid shells: a – *Texadina sphinctostoma;* b – *Onobops* cf. *jacksoni;* c – *Heleobops* sp. (form B); d – *Pyrgophorus* sp.; e – *Littoridinops palustris.*

cluster of 3 to 10 papillae at its base (Figure 8 c).
Reference: Thompson (1968).

Littoridinops monroensis (Frauenfeld, 1863)
Figure 8 b

Synonyms: *Littoridina monroensis* (Frauenfeld,1863)
Littoridinops sp. A: Taylor *in* Andrews (1977)
Recognition Characters: Shell smooth, similar to *Littoridinops palustris*; verge with 2 or 3 rows of papillae on convex margin, 2 to 3 individual glands on concave margin.
Distribution: Atlantic and Gulf coasts from South Carolina (Georgetown) to Texas (Galveston).
Habitat: On mud-silt bottoms or submerged vegetation; in fresh and brackish water coastal lakes, ponds, and tide pools.
Remarks: This snail was common in several oligohaline ponds on Galveston Island in 1975, and large populations exist in several fresh and oligohaline ponds on Horn Island, Mississippi. I have also examined specimens from tidally influenced, freshwater ponds near Georgetown, South Carolina. Specimens have been collected from tide pools in *Juncus* and *Spartina* marshes at St. Marks, Florida, and Dauphin Island, Alabama. The development of its young is similar to that of *Heleobops* with young snails hatching directly from relatively large egg capsules attached to mollusk shells and other hard substrata.
References: Andrews (1977); Thompson (1968).

Heleobops spp.
Figures 7 c; 8 f, g

Recognition Characters: Shells relatively narrow with fine striations on whorls; verge with 6 to 8 suction-cup-like glands on outer (convex) margin, with 2 subterminal glands smaller and distinctly separated from proximal glands; subterminal process on inner margin adjacent to opening of sperm duct.
Distribution: Gulf coast from northwest Florida to Mississippi.
Habitat: Near or adjacent to open Gulf; mesohaline; intertidal to shallow subtidal; in tidal marshes, shallow bays and inlets; on mud, mud-silt, and sand-silt bottoms.
Remarks: There appear to be two, or possibly three, new species of *Heleobops* in the northeastern Gulf tidal marshes. All of the specimens of *Heleobops* that I have collected came from areas of moderate salinities near the open Gulf. Three distinct verge types and at least two shell types can be recognized. The verge of one form (Form A), known only from habitats at or near St. Marks, Florida, has a wide, low, keel-like process directly adjacent to the opening of the sperm duct (Figure 8 f). The verge of another form (Form B), which occurs sporadically along the northeastern Gulf, has finger-like processes instead of the wide, keel-like structure (Figure 8 g). Another type (Form C), which has a verge similar to Form B, has a shell with distinct striations on the whorls that are similar, but not as strongly pronounced as those on *Onobops* spp. *Heleobops docima* Thompson,1968, known from marshes and mangroves in the southern half of Florida, is related to Form B but lacks the subterminal sac-like glands on its verge. Fred Thompson and I are attempting to clarify the taxonomy of this group and to publish taxonomic papers on the species from the northeastern Gulf. Until then I suggest that they be classified as *Heleobops* sp. (Forms A, B, and C). All three forms lay relatively large, individual, egg capsules. There is no pelagic veliger stage. A single snail emerges from each capsule after a week or more, depending on the temperature during incubation.
Reference: Thompson (1968).

Onobops cf. *jacksoni* (Bartsch, 1953)
Figures 7 b; 8 e

Common Name: Jackson's Hydrobiid
Synonym: *Hydrobia jacksoni* Bartsch, 1953
Recognition Characters: Shell elongate, whorls impressed, striations; verge simple without glands; gill with 20-24 lamellae; operculum with about 3 whorls.
Distribution: Atlantic and Gulf coasts from Maryland to Mississippi.
Habitat: Mesohaline; in tide pools or wet areas of *Juncus* and *Spartina* marshes; mud or mud-silt bottoms with organic matter.
Remarks: As in the case of *Heleobops*, a complex of two or three species may be present in the northeastern Gulf tidal marshes. On Horn Island, Mississippi, a large form almost twice as large as the normal size reported for *O. jacksoni* is present in marsh pools with mud bottoms and large amounts of organic matter. Also on Horn Island I found populations of a minute form about half the size of typical *O. jacksoni*. The egg capsules of all three size groups appear similar. A second species of *Onobops*, *O. crassa* Thompson, 1968, was described from southern Florida. Though similar to *O. jacksoni*, the snail has more gill lamellae (26-28) and usually four opercular whorls.

As in the case of *Texadina sphinctostoma* Abbott and Ladd, 1951, after several days of incubation, a well-developed, shelled veliger larva emerges from each capsule. Further taxonomic, ecological, and life history studies are needed to determine whether one or more species are involved in the northern Gulf marshes.
Reference: Thompson (1968).

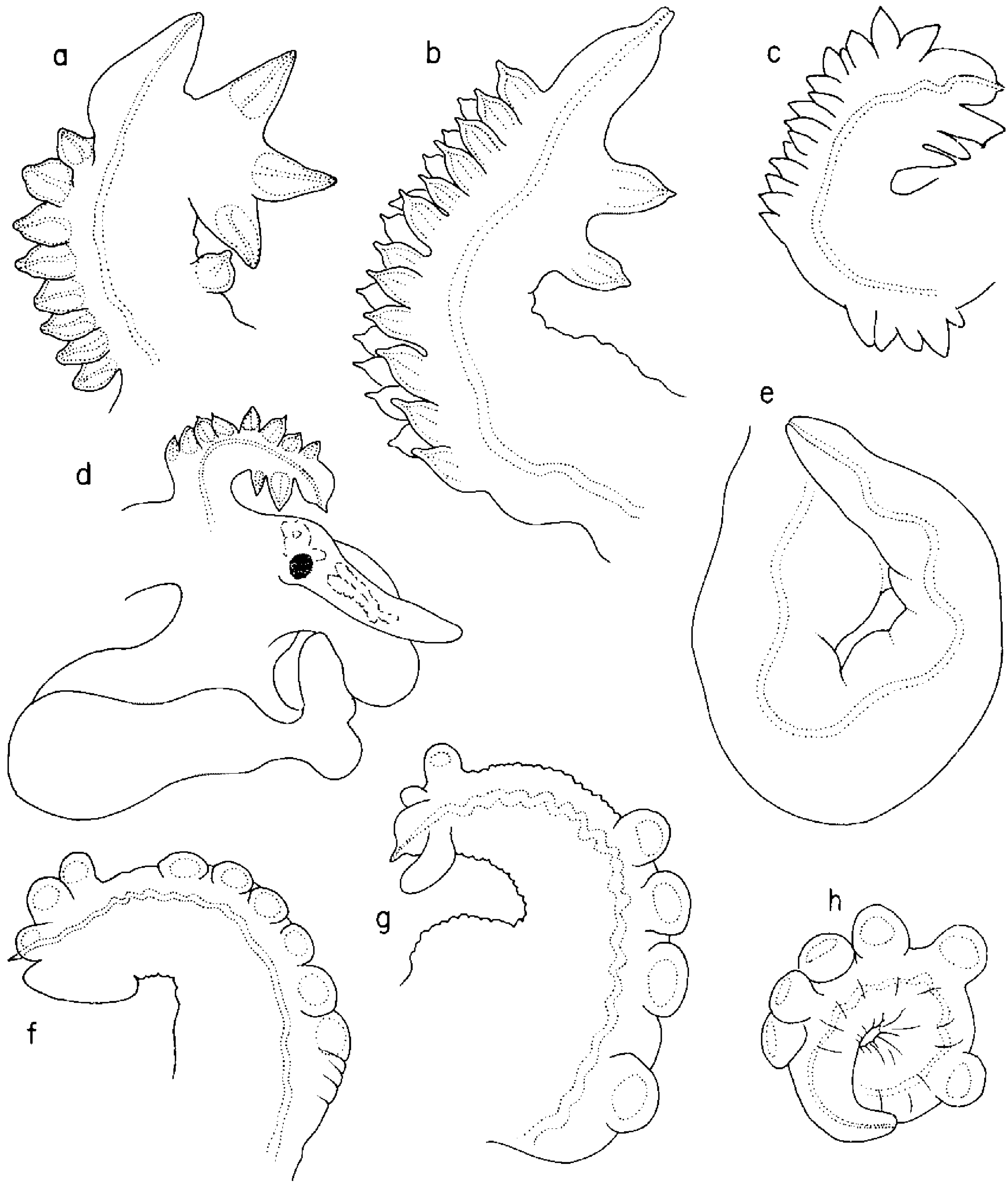


Figure 8. Hydrobiid verges (male copulatory organs): a — *Pyrgophorus* sp.; b — *Littoridinops monroensis;* c — *Littoridinops tenuipes*; d — *Littoridinops palustris* (anterior part of body with verge); e — *Onobops* cf. *jacksoni*; f — *Heleobops* sp. (form A); g — *Heleobops* sp. (form B); h — *Texadina sphinctostoma.*

Pyrgophorus sp.

Figures 7 d; 8 a

Recognition Characters: Shells similar in size and shape to *Littoridinops* but with distinct keel or ridge near anterior margin of whorls; ovoviviparous (young snails often visible through semi-transparent shell of female); verge similar to *Littoridinops palustris,* but usually with a single papilla on concave side near base.
Distribution: Mississippi (Horn Island).
Habitat: Mesohaline marsh pools on muddy or silty bottoms rich in detritus.
Remarks: This species or form of *Pyrgophorus* lacks the spines on the whorls that are so often characteristic of this genus. It is similar to the unspined form of *P. platyrachis* Thompson, 1968, which was described from southern Florida and was recently reported from Louisiana.

Spined and unspined forms of *P. platyrachis* occur in both fresh and brackish waters. The spined and unspined forms of another species, *P. (=Lyrodes) parvulus* (Guilding, 1828) also have been reported from brackish waters in Louisiana. The species from Horn Island, Mississippi, may represent an ecotype (ecological form) of *P. platyrachis, P. parvulus,* or *P. cornatus* (Pfeiffer, 1840) or may be a new species. Additional research will be needed to determine the taxonomic status of this species.

Females of the genus *Pyrgophorus* are the only hydrobiids from the northeastern Gulf of Mexico that do not deposit their eggs. Instead, the eggs are brooded within the female until the young snails are fully formed. This type of reproductive development is termed "ovoviviparity." In fact, females of the genus *Pyrgophorus* can be easily identified while they are brooding their young, since the young snails can be seen through the semi-transparent shells of the females' bodies. When the young are released, they are each contained within a thin, membranous, egg capsule. The juvenile snails immediately rupture the egg capsules and crawl out on to the sediment to begin feeding and growing. As in the genera *Littoridinops* and *Heleobops, Pyrgophorus* bypasses a planktonic larval stage.
References: Bridgeman (1969); Garrett and Dundee (1979); Thompson (1968).

Texadina sphinctostoma Abbott and Ladd, 1951

Figures 7 a; 8 h

Common Name: Small-mouthed Hydrobiid
Synonym: *Littoridina (Texadina) sphinctostoma* Abbott and Ladd, 1951.
Recognition Characters: Aperture constricted in adult specimens; male verge with 5 to 6 glands along outer margin.
Distribution: Coast of the Gulf of Mexico from Alabama (Mobile Bay) to the Yucatan Peninsula.
Habitat: Estuarine, oligohaline to lower mesohaline; in shallow bays and bayous on silt and fine sand-silt bottoms.
Remarks: I have collected *T. sphinctostoma* from oligohaline tidal marsh pools in Mississippi, but in general it is rare in tidal marsh habitats. It usually occurs, often in large numbers, in subtidal areas on the bottom of shallow oligohaline bays, where it is commonly associated with the clam, *Rangia cuneata* (Gray, 1831), and with another hydrobiid, *Probythinella (=Vioscalba) louisianae* (Morrison, 1965). *Texadina sphinctostoma* lays egg capsules containing a single egg, which ruptures after several days and releases a veliger larva with a well-developed shell.

Another species of *Texadina, T. barretti* (Morrison, 1965), occasionally occurs with *T. sphinctostoma* on silt-mud bottoms. *Texadina barretti* was originally placed in the genus *Odostomia* (Family Pyramidellidae) and was later listed under the name *Hydrobia boonae* Morrison, 1973. It appears to be a subtidal species and is not currently known from tidal marsh habitats.
References: Abbott and Ladd (1951); Heard (1979); Taylor *in* Andrews (1977).

Family Assimineidae

Assiminea succinea (Pfeiffer, 1840)

Figure 9

Common Name: Atlantic Assiminea
Synonym: *Syncera succinea* (Pfeiffer, 1840)
Recognition Characters: Small, hydrobiid-like snails; length under 3 mm; shell smooth; fine, thread-like ridge often around anterior margin of body whorls; narrow, slightly raised callus on margin of inner lip; eyes on tips of reduced, stubby tentacles.
Distribution: U.S. Atlantic and Gulf coasts from Massachussetts to Texas; Brazil; Bermuda.
Habitat: Upper intertidal zone of salt marshes and mangrove swamps, moderate to high salinities; often among debris or on bases of plants.
Remarks: This little snail superficially resembles a hydrobiid, but it can be distinguished from those aquatic forms by its short, stubby tentacles with the eyes on the tips and by its ability to tolerate desiccation. The hydrobiids, which have well-developed tentacles with the eyes at their bases, are unable to withstand desiccation even for a few minutes. Development of *A. succinea,* as in many hydrobiids, is direct. Females deposit egg capsules, each containing a single egg, on damp leaves or other debris in upper intertidal

zones. After several weeks of development, juvenile snails emerge from the capsules and begin crawling and feeding among the damp debris.

References: Abbott (1974); Andrews (1977); Marcus and Marcus (1964).

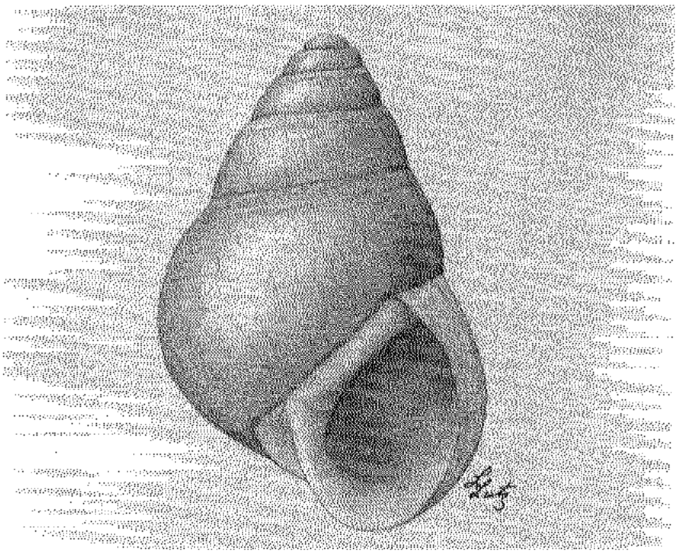


Figure 9. Shell of *Assiminea succinea.*

Family Potamidae (Horn Shells)

Genus *Cerithidea* Swainson, 1840

Three species of this genus occur in salt marshes of the northern Gulf. The genus is characterized by an elongate shell with axial ribs, 10-15 convex body whorls, and a flared, thickened, outer lip in adults.

Cerithidea pliculosa (Menke, 1829)

Figure 10 c

Common Name: Plicate Horn Shell

Recognition Characters: Several old varices present; adults reaching over 26 mm in length.

Distribution: Gulf coast from Alabama to Texas; east coast of Central America to northern South America (Venezuela); West Indies.

Habitat: Muddy substrata in coastal marshes and mangrove swamps; moderate to high salinities.

Remarks: The plicate horn shell is the only species of its genus known to occur in the northwestern Gulf of Mexico. Its shell is distinguished from the other two northwestern Atlantic species, *C. costata* (de Costa, 1778) and *C. scalariformis* (Say, 1825), by irregular, swollen, vertical ridges (old varices). *Cerithidea pliculosa* appears to be more similar and closely related to a west coast species, *C. californica* Haldeman, 1840, than to the two northwestern Atlantic species. Like *C. pliculosa, C. californica* has old varices markings on its shell; these structures do not occur on the shells of *C. costata* and *C. scalariformis.*

Plicate horn shells are known to be an important food of shore birds and to serve as host for a variety of larval flatworm (trematode) parasites. These snails feed on algae and detritus occurring on the muddy marsh floor and at the bases of marsh plants.

References: Abbott (1974); Andrews (1977), Bequaert (1942); Fotheringham and Brunenmeister (1975).

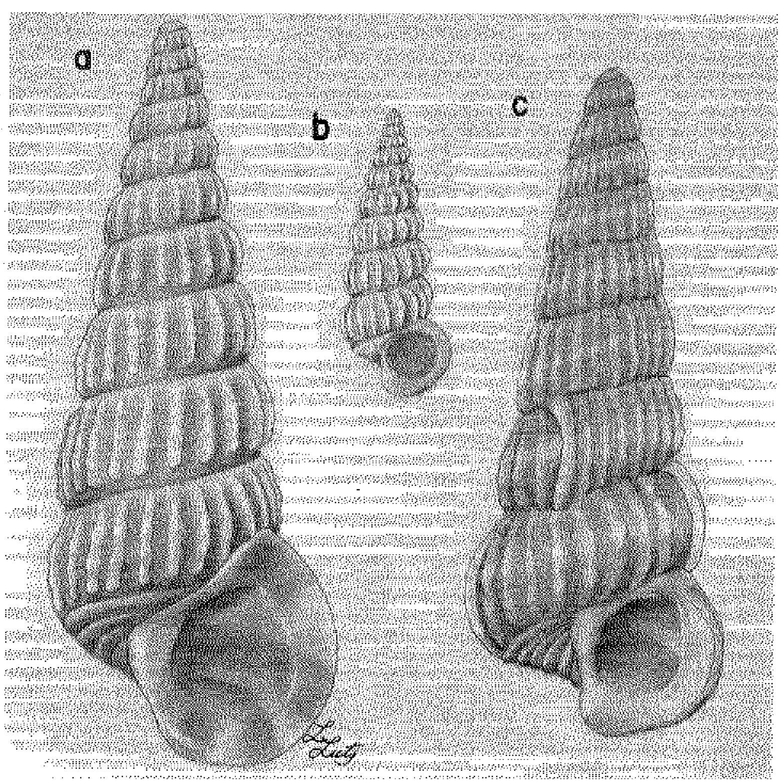


Figure 10. Shells of *Cerithidea* spp.; a – *C. scalariformis*; b – *C. costata*; c – *C. pliculosa.*

Cerithidea scalariformis (Say, 1825)

Figure 10 a

Common Name: Ladder Horn Shell
Recognition Characters: Body without old varices; approximately same size as *C. pliculosa;* last two body whorls with strongly developed axial ribs; base of shell with several distinct spiral ridges; outer lip of aperture strongly flared.
Distribution: Atlantic and Gulf coasts from South Carolina to northwestern Florida; West Indies; Bermuda.
Habitat: Upper intertidal zone in mangrove swamps and salt marshes; on mud to sand-mud substrata; moderate to high salinities.
Remarks: This species is often associated with *Melampus bidentatus* Say, 1822, *Melampus coffeus* (L., 1758), and *C. costata* (de Costa, 1778). It can live higher in the intertidal zone than can *C. costata* and *C. pliculosa* and can withstand longer periods of desiccation (up to three weeks). *Cerithidea scalariformis* is part of the diet of many salt marsh predators, including mud and blue crabs, rice rats, rails, and large shore birds. The larvae of over 10 different species of trematode parasites are known to develop in the tissues of this marsh snail.
References: Abbott (1974); Bequaert (1942); Holliman (1961).

Cerithidea costata (de Costa, 1778)

Figure 10 b

Common Name: Costate Horn Shell
Recognition Characters: Small; one-half length of *C. pliculosa* and *C. scalariformis;* no old varices present; axial ribs indistinct on last two body whorls.
Distribution: Atlantic and Gulf coasts from South Carolina to northwestern Florida; West Indies.
Habitat: Intertidal zone in mangrove swamps and salt marshes; on mud, sand-mud substrata; moderate to high salinities.
Remarks: This species usually occurs with its larger relative *C. scalariformis.* In northern Florida I found populations of *C. costata* occurring in *Spartina-Juncus* marshes as far west as Cape San Blas. Like the other two Gulf species of *Cerithidea,* it is eaten by mud and blue crabs and by a variety of shore birds. It is also a host for the larvae of many trematode parasites.
References: Abbott (1974); Bequaert (1942).

Family Littorinidae (Periwinkles)

Littorina irrorata (Say, 1822)

Figures 11, 12

Common Name: Marsh Periwinkle
Recognition Characters: Adults up to 23 mm in length, slightly longer than broad; shell thick, stout, having 8 to 10 body whorls with many evenly spaced, spiral grooves; last body whorl about half length of whole shell; color of shell light gray or grayish white with reddish-brown flecks on the spiral ridges; inner margin of outer lip with reddish-brown flecks corresponding to spiral grooves; smooth margin of inner lip pale brownish-orange.
Distribution: Atlantic and Gulf coasts from New York to Texas excluding southern Florida.
Habitat: Mesohaline *Spartina-Juncus* marshes.
Remarks: This species is probably the best known salt marsh invertebrate of southeastern North America. It is absent from southern Florida where salt marshes are replaced by mangroves and where its tropical relative *Littorina angulifera* (Lamarck, 1822) is common.

Female marsh periwinkles shed their fertilized eggs directly into the water during high tides. After a short period of development, the eggs hatch and develop into planktonic veliger larvae. The veliger stages

Figure 11. Marsh periwinkles on *Spartina* marsh grass stalks.

gradually change into small juvenile snails which settle on the marsh floor and immediately begin feeding and growing. Marsh periwinkles can live for several years. During low tide they feed on detritus and algae from the marsh floor and the bases of marsh grass stalks.

Littorina irrorata has been the subject of several ecological and behavioral studies, some of which are cited in the references. Although they have gills, these snails rarely enter the water and then only for short periods of time. Usually, as the tide rises, they retreat up marsh grass stalks. This apparent avoidance of water is thought to be due, in part, to a behavioral response to avoid predation by blue crabs. Gliding over the marsh floor, these snails leave mucous trails, which can be detected and followed by other marsh periwinkles.

References: Abbott (1974); Alexander (1979); Andrews (1977); Bandel (1974); Bequaert (1943); Bingham (1972); Fotheringham and Brunenmeister (1975); Hall (1973); Hamilton (1976, 1977, 1978a, 1978b), Odum and Smalley (1959).

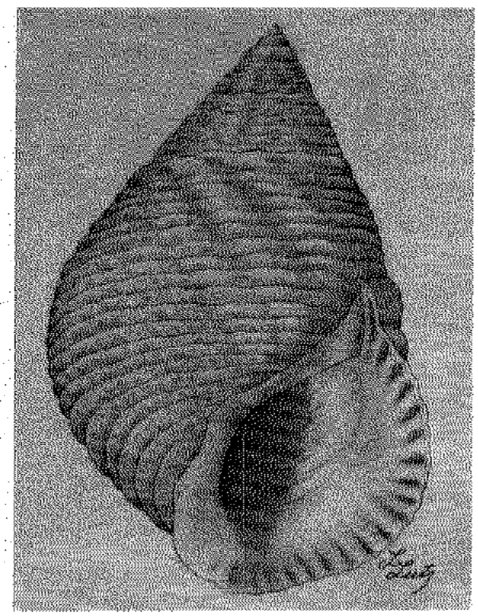


Figure 12. Shell of *Littorina irrorata* (marsh periwinkle).

Family Melongenidae (Whelks)

Melongena corona (Gmelin, 1791)

Figure 13

Common Name: Common Crown Conch

Recognition Characters: Relatively large shell (50 to 100 mm); prominent crown of spines on shoulder and base of shell; well-developed siphonal notch present.

Distribution: Southern Florida and Florida Gulf coast.

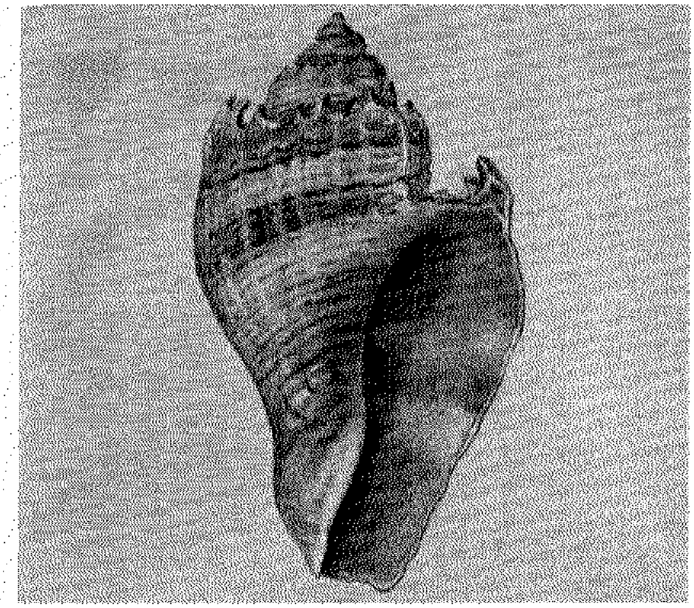


Figure 13. Shell of common crown conch *(Melongena corona).*

Habitat: Subtidal and intertidal, in or along the edges of mesohaline (12‰ to over 30‰) bays, usually associated with oysters, *Crassostrea virginica* (Gmelin, 1791).

Remarks: This species has long been considered an important predator of oysters and other mollusks; however, studies have demonstrated that it also commonly feeds on detritus and dead animal matter and thus may serve an important role as scavenger.

The females deposit strings of disc-shaped egg capsules, often attaching them to oyster shells. Each capsule usually contains from 100 to over 300 eggs. The larvae "hatch" from the egg capsule after approximately 20 days of incubation. They have well-formed shells and apparently do not go through a planktonic (pelagic) stage.

I have often observed crown conchs associated with oysters on the edges of *Spartina* marshes of northwestern Florida. Their occurrence in Alabama is sporadic and apparently does not occur in the United States west of Mobile Bay.

References: Abbott (1974); Hathaway and Woodburn (1961).

Family Pyramidellidae (Pyram Shells)

Sayella spp.

Figure 14

Recognition Characters: Tentacles flat, triangular, not extending beyond front of large flat foot; front of foot "squared-off," posterior to bases of tentacles; shell elongate with end of spire blunt, often eroded; aperture with oblique fold on inner margin.

Distribution: Gulf Coast from Florida (St. Marks) to Mississippi (Horn Island).
Habitat: Mesohaline *Spartina* tidal marsh pools and ponds on muddy or silty bottoms; collected with the anthozoans *(Nematostella)* and the hydrobiid snails *(Heleobops* and *Littoridinops).*
Remarks: The taxonomy of *Sayella, Odostomia,* and other genera belonging to the family Pyramidellidae is still unsettled and as a result often very confusing. Based on Abbott's 1974 treatment of the family, I consider the specimens collected from tidal marshes at St. Marks and Horn Island to belong to the genus *Sayella* Dall, 1885. Other authorities consider forms that are closely related to this species to be members of the genus *Odostomia*, such as *O. producta* (C. B. Adams, 1840) and *O. livida* Rehder, 1935.

Members of the genus *Sayella* are usually considered ectoparasites of other invertebrates, especially polychaete worms and bivalve mollusks. As a modification for a parasitic existence, the radula of *Sayella* and other pyramidellids has been replaced by a tubular proboscis, used when feeding on the host (which is unknown for *Sayella* from the northern Gulf).

Sayella superficially resembles hydrobiid snails, with which it is often collected. It is distinguished from the hydrobiids by the "squared-off" foot, flat, triangular tentacles, and a fold on the inner margin of the shell's aperture.
References: Abbott (1974); Andrews (1977); Morrison (1939).

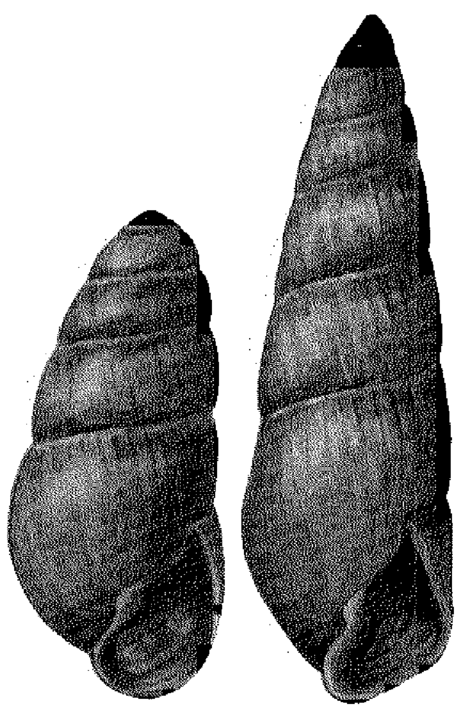


Figure 14. Shells of two different *Sayella* spp.: a – specimen from Cedar Key, Florida; b – specimen from St. Marks, Florida.

Family Melampidae (Melampid Snails)

Snails belonging to the family Melampidae, or Elliobiidae, lack gills. They breathe or respire with a "lung" that is formed by a modification of the mantle cavity. They are considered one of the most primitive members of the "air-breathing" gastropods, the Pulmonata. Two species of melampid snails occur in northern Gulf tidal marshes.

Melampus bidentatus Say, 1822

Figure 15, left

Common Name: Eastern Melampus
Recognition Characters: Moderately small (10-15 mm); shell ovateconical; broadest anteriorly with last body whorl approximately three-fourths body length; spire low and blunt with fine, spiral, incised lines or striations on whorls; aperture elongate with two folds on posterior margin of inner lip (folds on inner lip look like teeth, or denticles, hence the specific name *"bidentatus");* other lip of aperature with 1 to 4 small, thin, elevated, spiral ridges (lirae); operculum absent; color brownish, often with several dark bands, especially on younger, smaller specimens.
Distribution: Atlantic and Gulf coasts of North America, southern Canada to Texas; Bermuda; West Indies.
Habitat: Salt marshes and mangrove swamps; upper intertidal; exposed to wide range of salinities (0 to 50‰; occurring on marsh grass stems, under intertidal debris (wood, dead grass).
Remarks: This little bean-shaped snail is one of the more characteristic snails in tidal marshes of the northern Gulf. It is amphibious but usually avoids water. It also avoids bright light and during sunny, hot days usually retreats to shaded areas (under logs, dead marsh grass, and other intertidal debris). *Melampus bidentatus* is most active at night and feeds then or during periods of reduced sunlight. It feeds on algae and detritus, which it obtains from the bases of marsh stems and from the marsh floor, and on decaying animal matter. *Melampus bidentatus,* in turn, serves as food for other animals, including mud crabs, blue crabs, fishes, wild ducks, rails, seaside sparrows and rice rats.

During the warmer months, adult snails usually deposit gelatinous egg masses, which generally contain 500 to 1000 eggs, on damp or wet areas under debris on the marsh floor. Unlike other pulmonate snails, *M. bidentatus* and its relatives have a planktonic veliger stage. The hatching of larvae and the settling of the post-larvae in the upper intertidal region of the salt marsh corresponds to the phases of the moon and the resultant tidal effects. Young snails become sexually mature at about 5 mm in length. *Melampus bidentatus* lives for 3 to 4 years with adults attaining lengths of up to 15 mm.

Another closely related species, *Melampus coffeus* (L., 1758), overlaps with *M. bidentatus* in the coastal mangrove regions of southern Florida and the West Indies. Although the shells of the two species are very similar, *M. coffeus,* which is usually larger, lacks spiral, incised lines on its spire (see Figure 15, right).

References: Abbott (1974); Apley (1970); Fotheringham and Brunenmeister (1975); Hausman (1936a, b); Holle and Dineen (1957, 1959); Morrison (1958a, b); Russell-Hunter *et al.* (1972).

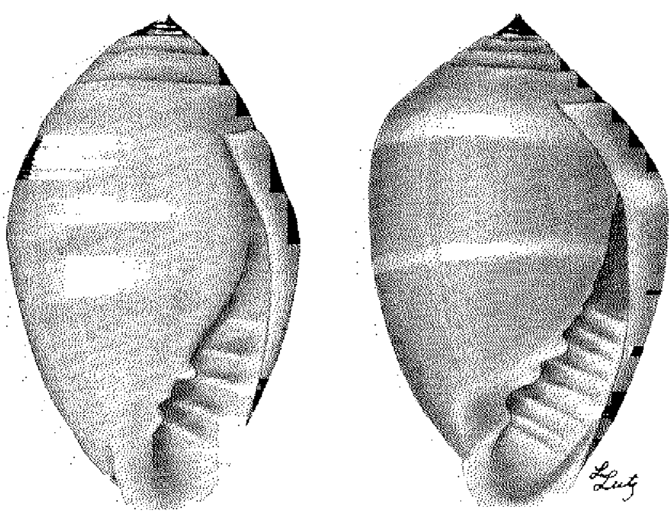


Figure 15. Shells of melampid snails: left – *Melampus bidentatus;* right – *Melampus coffeus.*

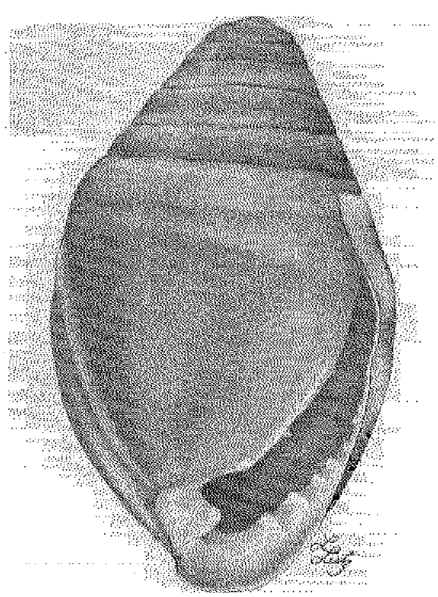


Figure 16. Shell of *Detracia floridana.*

Detracia floridana (Pfeiffer, 1856)
Figure 16

Common Name: Florida Melampus
Synonym: *Melampus floridana* Pfeiffer, 1856
Recognition Characters: Shell small (6 to 8 mm), glossy, biconical, spires higher than *M. bidentatus,* often eroded, lacking spiral striations; aperture with posterior inner margin having large denticle (fold), smaller denticle located anteriorly, outer lip of aperture with approximately 10 small, thin, elevated, spiral ridges (lirae); color dark brown, often with a few light bands.
Distribution: Atlantic and Gulf coasts from New Jersey to Louisiana.
Habitat: Upper intertidal zone in brackish marshes, on marsh grass stalks, or on or under debris on marsh floor.
Remarks: In the northern Gulf this species often occurs with its larger relative *M. bidentatus* in brackish *Juncus* marshes. Unlike *M. bidentatus,* which can also occur in high salinity marshes near the open Gulf, *D. floridana* appears to be restricted to the low salinity marshes of tidal rivers, bayous and bays. The life cycle is apparently similar to that of *M. bidentatus,* but *D. floridana* deposits larger and far fewer (20-50) eggs per egg mass. The eggs hatch into planktonic veliger larvae. Like *M. bidentatus,* it feeds on algae and detritus and is itself a common food of crabs, fishes, ducks, rails, seaside sparrows, and rice rats. In some east coast tidal marshes it often occurs in large numbers; one authority estimated 4 billion snails per square mile in the Virginia tidal marsh.
References: Abbott (1974); Morrison (1951, 1953, 1964); Holle and Dineen (1959).

Class Bivalvia (=Pelecypoda) (Bivalves)

Clams, mussels, and oysters belong to this highly modified class of mollusks. The class is characterized by the absence of a head and radula and by the presence of a hatchet-shaped foot and a shell made up of two valves. The valves of the shell are attached by a hinge with an associated ligament and by one or two adductor muscles. In addition to the shape and external morphology of the valves of the shell, other characteristics (e.g., the type and number of teeth on the hinge, the location of the ligament, the shape and location of the anterior and posterior adductor muscles, the shape of the pellial sinus, and the location of the pellial line) are important taxonomic characters used to identify bivalves.

Many bivalves are adapted for digging with a modified foot, and they usually live completely or partially buried in the sediment (infaunal). Other bivalves, such as many species of mussels, are epifaunal, often attaching externally to the shells of other bivalves, roots, pilings, or other substrata.

Five species of bivalves occur commonly in tidal marshes along the northern Gulf of Mexico and another four species have been listed from Gulf marshes.

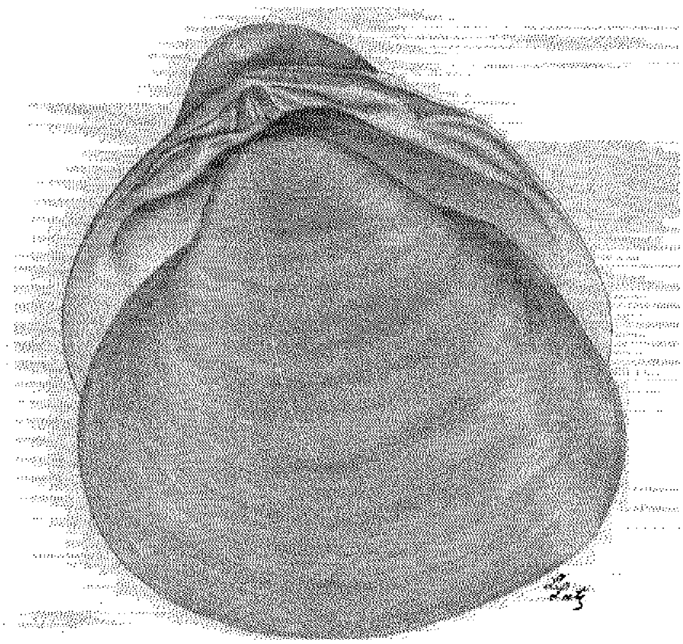


Figure 17. Shell of *Polymesoda caroliniana.*

Family Corbiculidae (Marsh Clams)
Polymesoda caroliniana (Bosc, 1802)
Figure 17

Common Name: Carolina Marsh Clam
Recognition Characters: Moderate-sized (25 to 40 mm), deep-bodied, suboval-shaped clams; beaks (umbones) close together; ligament narrow, external; three subequal cardinal teeth; one anterior lateral tooth; one posterior lateral tooth, not extending to posterior adductor scar; inner surface of living or recently dead shells often pale blue; periostracum prominent, dark, often eroded away on and adjacent to beaks.
Distribution: Virginia to Texas (excluding southern Florida).
Habitat: Intertidal, occasionally subtidal, oligohaline and mesohaline tidal marshes; in mud, mud-fine sand, or fine sand-silt substrata.
Remarks: The Carolina marsh clam is one of the most characteristic species found in tidal marshes of the southeastern United States. In protected *Juncus* marshes where salinity is low, this species often occurs in large numbers. The adults are often eaten by raccoons and blue crabs.

Though quite different, *P. caroliniana* is often confused with *Rangia cuneata* (Family Mactridae) (Figure 18). These two species are both infaunal and are superficially similar in shape and size, but the resemblance stops there. *Rangia* nearly always is found in the subtidal zone in bays of low salinity; very rarely does it occur in the intertidal areas of tidal

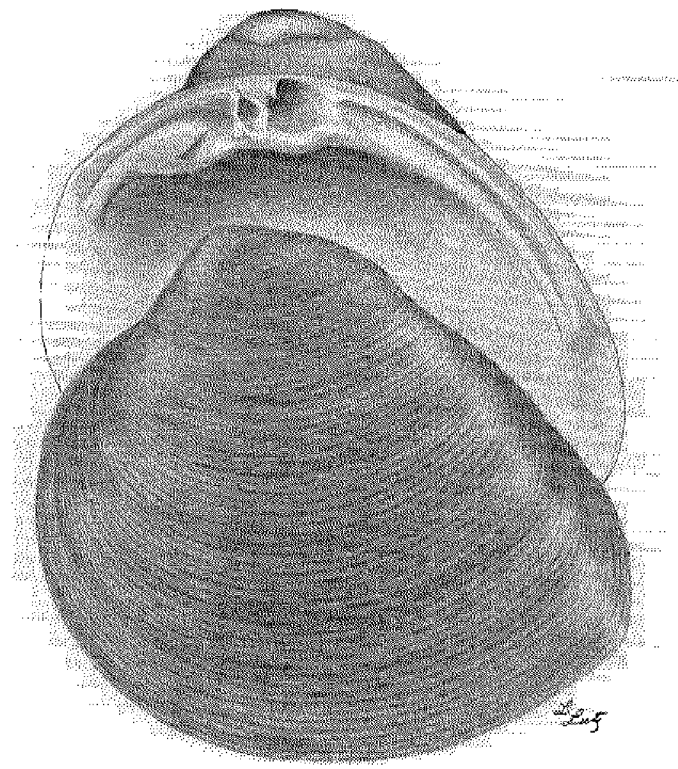


Figure 18. Shell of *Rangia cuneata.*

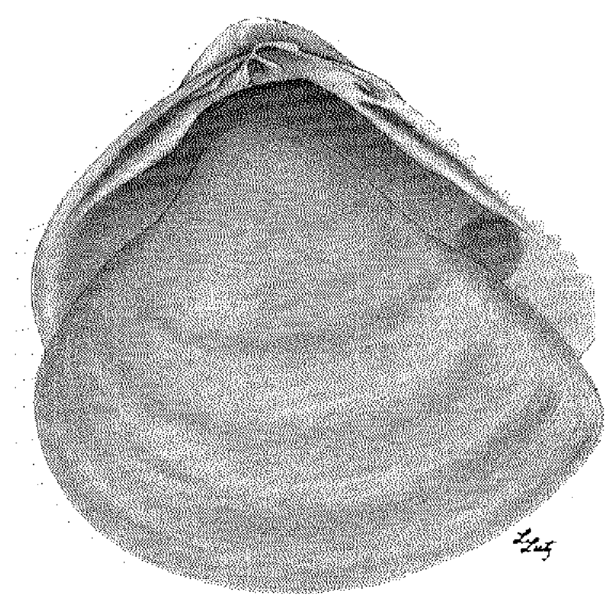


Figure 19. Shell of *Polymesoda maritima.*

marshes. The shell of *Rangia* is much thicker, and the beaks are noticeably more separated than those of *P. caroliniana.* The most striking difference between the two clams is the hinge area. In *R. cuneata* there is a deep pit, or chondrophore, between the cardinal teeth and posterior lateral tooth. This pit contains a tough pad or ligament-like structure, the resilium, which causes the valves of the shell to gape open when the adductor muscles relax. The posterior lateral tooth is very long, reaching nearly past the posterior adductor muscle, and its margin is finely serrate. Another species of *Rangia, R. (=Rangianella) flexuosa* (Conrad, 1839) can be distinguished from *R. cuneata* by its more wedge-shaped shell and shorter, non-serrate, posterior, lateral tooth.
References: Abbott (1974); Andrews (1977); Andrews and Cook (1951); Van der Schalie (1933).

Polymesoda maritima (Orbigny, 1842)

Figure 19

Common Name: Florida Marsh Clam; Orbigny's Marsh Clam.
Synonyms: *Pseudocyrena maritima* (Orbigny, 1842)
Pseudocyrena floridana (Conrad, 1846)
Recognition Characters: Shell smaller, more variable; less robust and more elongate than that of *P. caroliniana;* lacks thick, dark, periostracum; inner surface of living or recently dead shells partially or completely purple; outer surface of shell tinged with pink or light purple.
Distribution: Gulf coast of North America from Key West, Florida, to the Yucatan Peninsula.
Habitat: Salt marshes and mangrove swamps; near surface, usually in sand and sand-mud substrata; in areas of moderate to high salinities near or adjacent to open Gulf water.
Remarks: This species is much more colorful than its drab cousin, *P. caroliniana,* which usually occurs in muddier areas and in lower salinities. In the northern Gulf there are well-established populations of *P. maritima* in several coastal marsh systems of northwest Florida. As yet, this clam is not known from Alabama-Mississippi tidal marshes, which may be due to the lower salinities or the lack of collections in this region.
References: Abbott (1974); Andrews (1977).

Family Mytilidae (Mussels)

Geukensia demissa (Dillwyn, 1817)

Figure 20

Common Name: Ribbed Mussel
Synonyms: *Arcuatula demissa* (Dillwyn, 1817)
Modiolus demissus (Dillwyn, 1817)

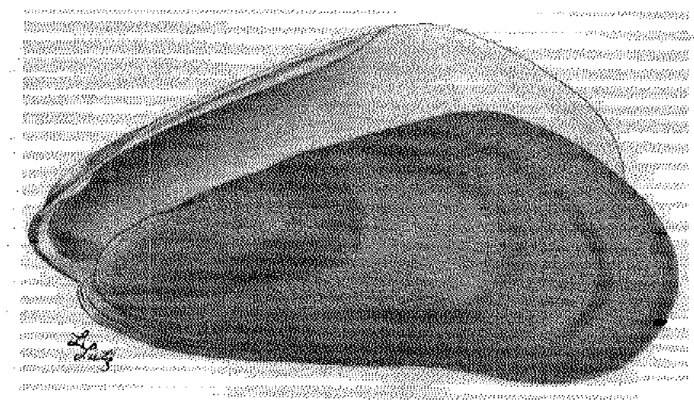


Figure 20. Shell of *Geukensia demissa.*

Recognition Characters: Moderate size (to over 100 mm); elongate with rounded posterior margin; over 25 strong, radial, beaded ribs; no teeth on long hinge; with byssus; epifaunal or infaunal.
Distribution: Atlantic and Gulf coasts from Maine to Texas; California (introduced).
Habitat: Intertidal or rarely subtidal (juveniles); mesohaline tidal marshes in mud among marsh grass roots (infaunal) or attached to exposed marsh grass roots (epifaunal).
Remarks: Many authorities consider the populations of *G. demissa* in southeastern Florida and the Gulf to be a distinct subspecies, *G. d. granosissima* (Sowerby, 1914). This subspecies is characterized by more and smoother ribs than the typical Atlantic form.

The ribbed mussel often occurs in large colonies on the tidal marsh floor. Often juveniles and subadults are present on the exposed roots of marsh grass *(Juncus* and *Spartina).* In a tidal pond at St. Marks Refuge in Florida, I have found large numbers of ribbed mussels attached to the submerged roots of *Spartina.* With these mussels, often attached to them, were equally large numbers of Conrad's false mussel, *Mytilopsis (=Congeria) leucophaeta* (Conrad, 1831). As the common name implies, *Mytilopsis* is not a true mussel, although it is often confused with mussels because of its elongate shell and byssal threads (see Figure 21). It belongs to the family Dressenidae,

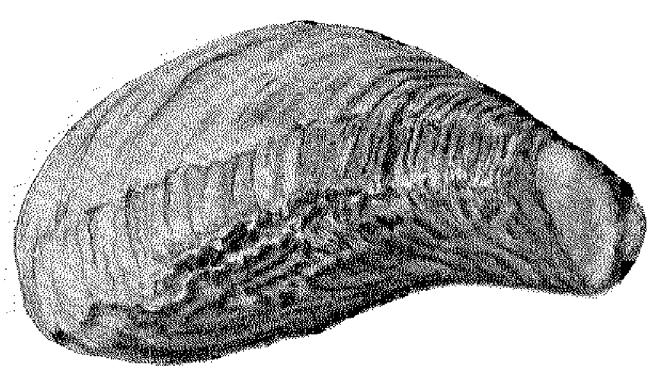


Figure 21. Shell of *Mytilopsis leucophaeta.*

which is only remotely related to the family Mytilidae.

Two other species of true mussels, the hooked mussel *Ischadium recurvum* (Rafinesque, 1820) and the paper mussel *Amygdalum papyrium* (Conrad, 1846), occasionally occur in tidal marshes. The hooked mussel is epifaunal, often attached to oysters or even to the exposed shells of the ribbed mussel. It differs from the ribbed mussel by having fewer and relatively larger ribs, not beaded, and a hooked anterior end (see Figure 22). The paper mussel, usually occurring subtidally in soft bottoms, is generally infaunal. Its shell resembles that of the ribbed mussel but is smaller, glossy, and lacks ribs (see Figure 23). The paper mussel is also quite colorful, often with fine greenish and reddish markings.

The ribbed mussel is the only mussel well-adapted for living in tidal marshes along the northern Gulf of Mexico. The false, hooked, and paper mussels should not be considered typical marsh species, since they occur only marginally in tidal marshes and are better adapted to other estuarine habitats.

References: Andrews (1977); Fotheringham and Brunenmeister (1975); Kuenzler (1961); Stiven and Kuenzler (1979); Teal (1962).

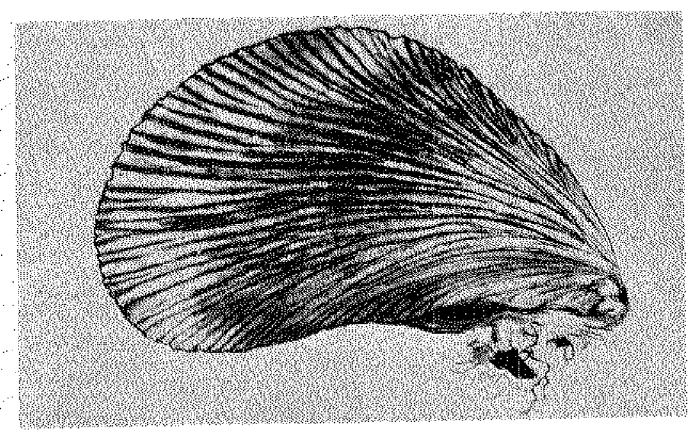


Figure 22. Shell of *Ischadium recurvum.*

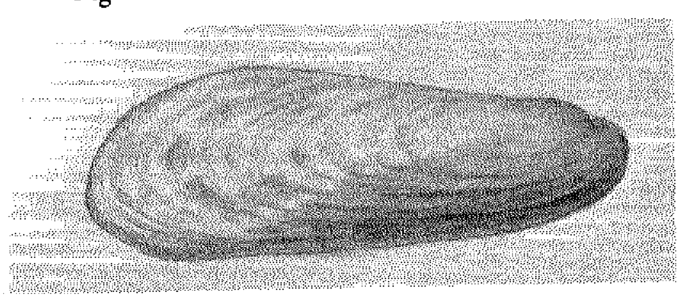


Figure 23. Shell of *Amygdalum papyrium.*

Family Cyrenoididae

Cyrenoida floridana Dall, 1896

Figure 24

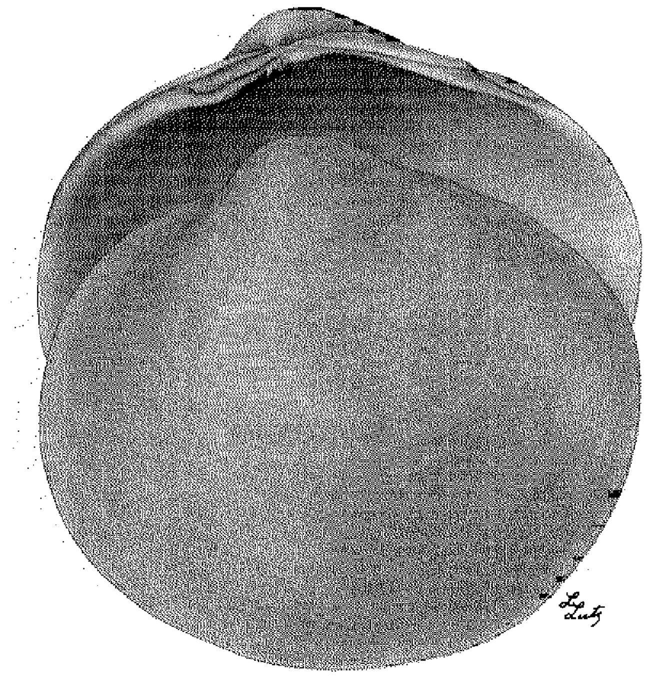


Figure 24. Shell of *Cyrenoida floridana.*

Common Name: Florida Marsh Clam; Dall's Marsh Clam.

Recognition Characters: Shell small (up to 10 mm), oval, thin, fragile, moderately deep; periostracum thin, inconspicuous; left valve with delicate, bidentate, cardinal tooth and a prominent, narrow, blade-like, anterior, lateral tooth; posterior, lateral teeth appearing absent; foot, when extended; extremely narrow and long.

Distribution: Atlantic and Gulf coasts from Delaware to Louisiana.

Habitat: Brackish (from less than 1‰ to over 25‰) in marshes and mangroves; in damp intertidal areas under decaying vegetation or mats of filamentous algae or in mud-sand, fine sand, or sand-silt substrata.

Remarks: Dall's marsh clams, often very abundant in brackish marshes, are often overlooked because of their small size. As a result, little is known about their biology. Externally they resemble the equally small freshwater "pill clams" of the family Sphaeriidae. In fact, like the "pill clams," *C. floridana* broods its young, releasing them as young juveniles. Dall's marsh clams have also been confused with juveniles of the Carolina marsh clam *P. caroliniana.* Juvenile Carolina marsh clams have thicker shells, a thick, well-developed periostracum, and distinctly different hinge teeth (three cardinals and a well-developed posterior lateral).

Dall's marsh clam has been reported previously from brackish waters in Delaware, Georgia, southern Florida, and Mississippi. I have collected *C. floridana* from tidal marshes near Tuckahoe, New Jersey; Beaufort, North Carolina; and Lake Pontchartrain, Louisiana. My New Jersey and Louisiana collections are northern and western range extensions for *C. floridana*.

Often the interior of the shells of *Cyrenoida* are covered with igloo-like bumps. These bumps, which can be seen in a photograph of *C. floridana* in Abbott (1974), are caused by the larvae of trematode (flatworm) parasites. The trematodes, after settling on the inner surface of the shell, become partially surrounded with mother-of-pearl, produced by the clam. The infected clams are then eaten by marsh birds and raccoons, and the adult trematodes develop in the intestinal tracts of these animals. The life histories of this trematode and several other parasites of *Cyrenoida* are currently being studied by the author and R. M. Overstreet.
References: Abbott (1974); Leathem *et al.* (1976).

Family Solecurtidae

Tagelus plebius (Solander, 1786)

Figure 25

Common Name: Stout Tagelus; Stout Razor Clam
Synonym: *Tagelus gibbus*
Recognition Characters: Valves elongate, equal, rectangular, with ends gaping when closed; hinges with cardinal teeth present, laterals absent; living specimens with well-developed, elongate siphons; shells reaching lengths of over 10 cm.
Distribution: Atlantic and Gulf coasts of North America from Cape Cod to Texas.
Habitat: Mesohaline bays in fine sand and mud substrata; subtidal to lower intertidal.

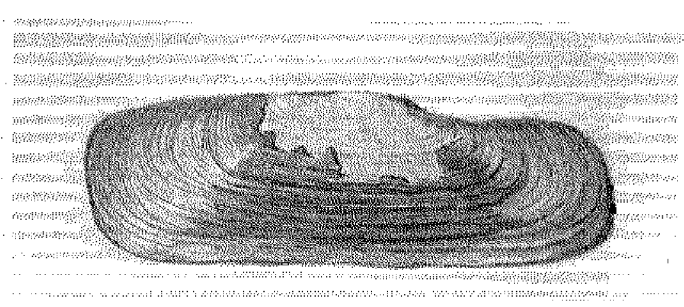


Figure 25. Shell of *Tagelus plebius.*

Remarks: Stout razor clams are often common in mud banks along the edges of Gulf salt marshes. I have collected them buried among the roots of *Spartina alterniflora* in the lower intertidal zone. These distinctive bivalves are deep burrowers; however, they are preyed upon by blue crabs and occasionally by large fishes such as rays and drum.
References: Abbott (1974); Andrews (1977).

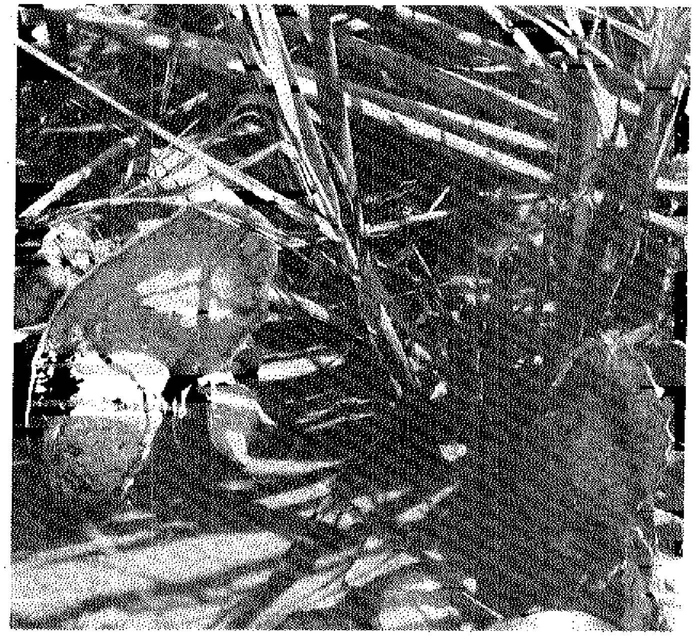


Figure 26. Common oyster *Crassostrea virginica.*

Family Ostreidae

Crassostrea virginica (Gmelin, 1791)

Figures 26,27

Common Name: Eastern Oyster; American Oyster
Recognition Characters: Shell reaching over 150 mm in length, irregularly shaped depending on growth conditions; attached to hard objects at umbo; often occurring in clumps of several individuals; outer edges of valves thin, fragile, sharp; single, large, adductor muscle, scar conspicuous, dark purple.

Figure 27. Common oysters in the edge of a *Spartina* marsh.

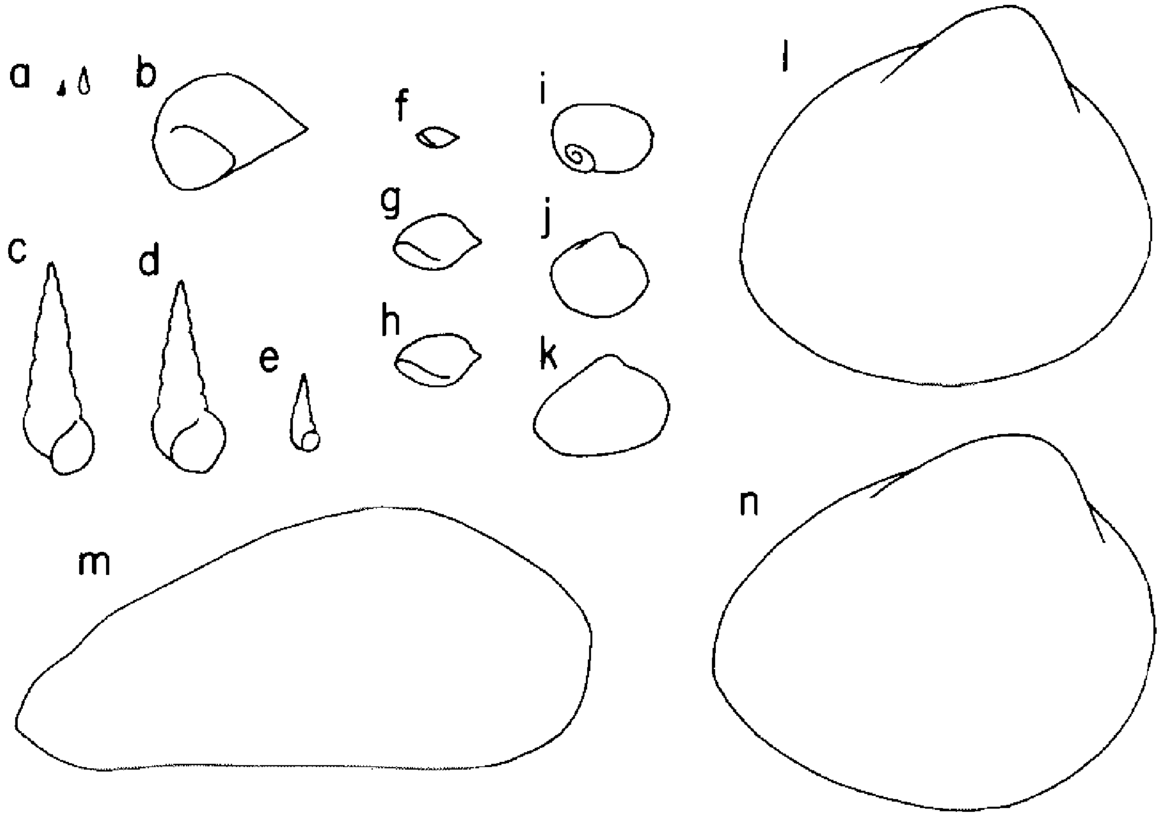


Figure 28. Representations of actual sizes for some tidal marsh mollusks: a – hydrobiid snails, *Sayella* sp., *Assiminea succinea*; b – *Littorina irrorata*; c – *Cerithidea pliculosa*; d – *C. scalariformis*; e – *C. costata*; f – *Detracia floridana*; g – *Melampus bidentatus*; h – *M. coffeus*; i – *Neritina usnea*; j – *Cyrenoidea floridana*; k – *Polymesoda maritima*; l – *P. caroliniana*; m – *Geukensia demissa*; n – *Rangia cuneata*.

Distribution: Atlantic and Gulf coasts of North America from Gulf of St. Lawrence to Mexico (introduced into west coast of United States).
Habitat: Mesohaline; subtidal to lower intertidal; attached (cemented) to hard substrata (i.e., other oysters, wood, rocks).
Remarks: In the northern Gulf of Mexico the eastern oyster usually occurs in subtidal areas or on the lower intertidal banks of mesohaline bays and bayous. Occasionally populations extend into the edges of *Spartina* marshes. Oysters have a large number of associated epifaunal invertebrates, including oyster drills, barnacles, mussels, polychaetes, and xanthid crabs. Some of the species associated with oysters are included in this guide; however, a discussion of all the associated invertebrates of tidal marsh oyster populations would be far too lengthy to include here.

Because of its economic importance as a sea food, the eastern oyster has been one of the most intensively studied mollusks in the world. In addition to its food value, the commercial use of the dead shells of oysters is also a multi-million dollar industry. For further information and references, the reader is referred to works by Galtsoff and Joyce.
References: Galtsoff (1964); Joyce (1972); Wells (1961).

PHYLUM ARTHROPODA

The members of this phylum are characterized by a jointed, chitinous exoskeleton. The arthropods are a highly adaptive group, and, of the million or more animal species described, over ¾ belong to this phylum. The phylum Arthropoda is divided into four distinct subphyla: Trilobitomorpha, Chelicerata, Uniramia and Crustacea. The subphylum Trilobitomorpha, which is generally considered the most primitive arthropod group, contains the fossil trilobites. The subphylum Chelicerata, which is characterized by claw-like feeding structures (chelicerae) and no antennae, contains the classes Merostomata (horseshoe crabs), Pycnogonida (sea spiders) and Arachnida (scorpions, spiders, mites, ticks). The subphylum Uniramia has five classes, including the Insecta (=Hexapoda), Chilopoda (centipedes) and Diplopoda (millipedes), and is characterized by having uniramus appendages and a single pair of antennae. The subphylum Crustacea contains eight classes and far more marine species than any other arthropod group; it is characterized by the presence of biramus appendages and two pairs of antennae.

The class Insecta (=Hexapoda) is by far the largest group of arthropods. Several hundred species of insects have been reported from tidal marshes in the southeastern United States. Insects are not treated in this guide since they are considered more or less terrestrial forms. It should be noted that the larvae of several groups of insects, such as the chironomid midges, tabanid flies, and dragonflies are often common in tidal marsh pools or sediment and are therefore often collected with other marsh invertebrates.

Along the Atlantic and Gulf coasts, the class Merostomata is represented by a single species, the horseshoe crab, *Limulus polyphemus* (L., 1758). Horseshoe crabs usually inhabit shallow, open coastal waters, but they occasionally feed on mollusks and polychaete worms along or on the edges of tidal marshes near the open Gulf. The sea spiders (Class Pycnogonida) are generally a high salinity, epifaunal group that are not known from the northern Gulf marshes. Aquatic mites occur in salt marsh pools and ponds, but because of their small size they usually are included with meiofauna. As in the case of the insects, spiders occurring in tidal marshes are not treated in this guide.

Subphylum Crustacea

In Gulf tidal marshes, crustaceans are the dominant aquatic and semiaquatic arthropods. Several groups, the copepods, ostracods, and cladocerans are small and usually considered members of the meiofauna or plankton; their inclusion would be beyond the scope of this guide. With the exception of the barnacles, the groups treated here belong to the subclass Malacostraca, which includes the larger and more highly advanced crustaceans.

In general, the presence of two pairs of antenna or "feelers" on crustaceans separates them from other arthropod groups that have only a single pair. In addition to an extra pair of antennae, they have more than six legs, which distinguishes them from the insects. Many aquatic and semiaquatic crustaceans also have planktonic larval stages. The primitive nauplius larva is unique to the Crustacea. The other crustacean larval types will be discussed under the groups in which they occur. It should be mentioned that some authorities believe that several groups of arthropods, including the Crustacea, should be split into different phyla. Moore (1969) considered the Crustacea to be a subphylum composed of eight distinct classes, including the barnacles (Class Cirripedia) and the higher crustaceans (Class Malacostraca). This classification is followed here.

Class Cirrepedia

Commonly called barnacles, the members of this class are free-living sessile forms or parasites. There are over 800 described species contained within five orders (two free-living and three parasitic). Many species are hermaphroditic while the others are diecious (sexes separate). Barnacles have two types of planktonic larvae, the feeding nauplius type and the non-feeding cypris type. There are six naupli stages or instars followed by the cypris or settling stage. The cypris leaves the plankton and attaches to a suitable substratum or host where it metamorphoses into a young barnacle.

Order Thoracica
Suborder Balanomorpha

The members of this suborder are sessile. They have a volcano-shaped shell composed of interlocking side plates. The opening of the shell is guarded by four movable opercular plates (a pair of turgal plates and a pair of scutal plates). This group of barnacles is notorious for being one of the most common fouling organisms on ship bottoms, and much research has been done on their control. They feed with their thoracic appendages, which are highly modified for filtering food from the water. One species, *Chthamalus fragilis* Darwin, 1854, is often common within high salinity tidal marshes.

Chthamalus fragilis Darwin, 1854
Figure 29

Recognition Characters: Shell low, relatively small, fragile; shell wall with end plates (rostrum and carina) overlapped by adjacent plates.
Distribution: Atlantic and Gulf coasts of North America from Massachusetts to Texas.
Habitat: Upper intertidal on *Spartina alterniflora* stalks, pilings, and rock jetties on or near to the open Gulf in salinities greater than 15‰.
Remarks: This species is common on the stalks of marsh grass (*S. alterniflora*) in the high salinity areas of northwestern Florida. It appears to be less common in Alabama, Mississippi, and Louisiana marshes where salinities are generally much lower.

Two other species of balanomorph barnacles, *Balanus eburneus* Gould, 1841, and *B. subalbidus* Henry, 1973, occasionally occur attached to oyster shells, tree stumps, bridge pilings, and other hard substrata along or on the edges of tidal marshes. The genus *Balanus* differs from *Chthamalus* by having larger, thicker, and higher shells with only one end plate (carina) overlapped by adjacent plates (Fig. A).

When *Balanus eburneus*, a mesohaline species, occurs in tidal marshes, it is usually found attached to the shell of the eastern oyster, *C. virginica*. *Balanus subalbidus*, which was long confused with *B. improvisus*, tolerates low salinities and appears to be the only barnacle in the northern Gulf that can live in oligohaline waters. It often occurs on exposed tree roots, dead wood, pilings and other hard substrata adjacent to low salinity tidal marshes.
References: Dando and Southward (1980); Henry and McLaughlin(1976); Poirrier and Partridge(1979).

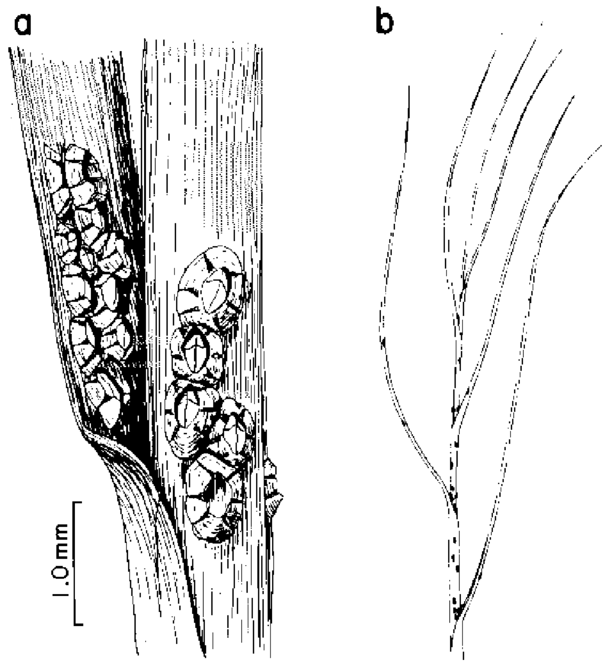


Figure 29. *Chthamalus fragilis*. a — close up view of barnacles on stem and leaf of *Spartina alterniflora*; b — stalk of *S. alterniflora* with barnacles.

Class Malacostraca

Class Malacostraca contains the most evolutionarily advanced crustaceans and the largest number of described species (over 20,000). Its members include the mysid shrimps, cumaceans, tanaids, isopods, amphipods, decapods, and a number of other smaller and lesser-known groups. The malacostracans are divided into two subclasses — the Phyllocarida (a small, exclusively marine group containing a single order, the Leptostraca) and Eumalacostraca. The eumalacostracans have eight pairs of thoracic appendages; however, in most members of this group one to three pairs of these thoracic limbs are modified into mouth parts called maxillipeds. Members of this subclass make up an important part of the tidal marsh fauna. Members of the subclass Phyllocarida are characterized by having eight abdominal segments, bivalved carapace and hinged rostrum. The subclass has approximately 25 extant species belonging to three genera, none of which are associated with northern Gulf tidal marshes.

Superorder Peracarida

Peracaridans brood their young in pouches formed by outgrowths from the bases of the thoracic legs. The pouch is called a marsupium, and the plate-like outgrowths of which it is composed are called oösteg-ites or brood plates. Over 20 species of peracaridans have been found associated with tidal marshes in the northern Gulf.

Several orders are included within the Superorder Peracarida, five of which (Mysidacea, Cumacea, Tanaidacea, Isopoda and Amphipoda) are represented in estuarine and tidal marsh habitats of the northern Gulf.

There is considerable variation in the body form and shape among the orders, as well as within each order. With the exception of cumaceans, peracaridans characteristically have a single pair of maxillipeds.

Order Mysidacea

Mysids are small, shrimp-like peracaridans. Most members of the order are marine forms; however, a number of species are known from brackish and fresh waters. The shallow water species belong to the family Mysidae. The presence of seven pairs of biramus legs, a brood pouch, and a statocyst on the inner ramus of the uropod distinguish the Family Mysidae from the "true shrimps" of the Order Decapoda. The shrimp-like body and stalked eyes separate mysids from the other common peracaridans (tanaids, cumaceans, isopods, and amphipods). Six mysid species occur in waters adjacent to tidal marsh habitats in the northern Gulf of Mexico.

Family Mysidae

Taphromysis louisianae Banner, 1953

Figure 30 f

Recognition Characters: Anterior margin of carapace bearing spine—like projection just below level of eyestalk; distal end of telson cleft or notched, bearing 40 or more small spines; lateral margins with 10 or more spines.
Distribution: Northern Gulf of Mexico from Appalachicola, Florida, to Galveston, Texas.
Habitat: In freshwater and oligohaline (low salinity) habitats: drainage ditches (lower coastal plains of Louisiana and Texas), mouths or rivers, upper parts of bays and estuaries, low salinity tidal marsh pools.

Remarks: This form is most common in freshwater and low salinity areas of Louisiana and eastern Texas. It is not a common species in marsh habitats but is occasionally taken from marsh tidal pools adjacent to low salinity waters.

References: Banner (1953); Stuck, Perry, and Heard (1979 a, b).

Taphromysis bowmani Bacescu, 1961

Figure 30 e

Recognition Characters: Anterior margin of carapace lacking spine-like projection below level of eye-stalk; distal end of telson broadly cleft or notched, bearing 35 or less spines; lateral margins bearing 10 or less spines.

Distribution: Southern Florida (Everglades) to Texas.

Habitat: Most common in lower salinities but can occur over a wide range (0‰ to 30‰); occurring sporadically in tidal creeks, bayous and tidal marsh ponds.

Remarks: During 1975 and 1976, I collected large numbers of this species from a shallow tidal pond adjacent to the southwest end of the Destin bridge (U.S. Highway 98). At this locality, specimens were collected among the submerged stalks and roots of *Spartina* marsh grass surrounding the pond.

No information on the diet of this species in the northern Gulf is available; however, in the Florida Everglades the species has been reported to feed on detritus and, to a lesser extent, on diatoms and copepods.

Recent studies indicate that *T. bowmani* may intergrade with *T. louisianae* in Mississippi and Louisiana. Specimens from these areas often had a mixture of characters of both species.

References: Băcescu (1961); Brattegard (1969); Compton and Price (1979); Stuck, Perry and Heard (1979 a, b).

Mysidopsis almyra Bowman, 1964

Figure 30 a, c

Recognition Characters: Telson entire (without notch), bearing four to eight pairs of terminal spines gradually increasing in length to the mid-line; inner ramus of uropod with one spine near statocyst.

Distribution: U.S.A. - northeastern Florida to Texas; northeastern Mexico.

Habitat: Low to medium salinities (0‰ to 25‰; oligohaline to lower mesohaline); estuaries, tidal rivers, and tidal marsh creeks.

Remarks: *M. almyra* is an important food organism for estuarine fishes and has been reported as a possible food for commercial shrimp. Like *Taphromysis bowmani,* it has been reported to feed on detritus, diatoms, and copepods in southern Florida waters. It occurs in tidal water adjacent to marshes and may forage among the stalks of marsh plants during high tides.

References: Brattegard (1970); Ogle and Price(1976); Odum and Heald (1972); Price (1978); Price and Vodopich (1979); Stuck, Perry and Heard (1979 a, b).

Mysidopsis bahia Molenock, 1969

Figure 30 b

Recognition Characters: Telson entire with four to five pairs of terminal setae abruptly increasing in length to the mid-line; inner ramus of uropod with two to three spines near statocyst.

Distribution: Gulf Coast from southern Florida (Everglades) to Mexico (San Geronimo).

Habitat: Bays and estuaries; usually medium range salinities (8 to 25‰).

Remarks: This species is similar to *M. almyra* in size and overall morphology, but apparently occurs in higher salinities. Like *M. almyra,* it occurs adjacent to tidal marshes and may be collected among marsh plants (*Juncus* or *Spartina*) during high tides.

References: Price (1978); Stuck, Perry and Heard (1979 a, b)

Bowmaniella spp.

Figure 30 d

Recognition Characters: Distal end of telson cleft or notched, bearing two large spines laterally and many small spine-like processes medially; inner ramus of uropod with 6 to 8 spines along inner edge.

Habitat: Bays, estuaries, and shallow waters adjacent to beaches; usually associated with sandy substrata; found over a wide range of salinities (5‰ to 30‰).

Remarks: Two species of *Bowmaniella* are found in estuarine waters of this area, *B. floridana* Holmquest, 1975 and *B. brasilinsis* Băcescu, 1968. Immature males and females and adult females cannot, however, be reliably separated. Mature males can only be separated by the detailed structure of the male third pleopod. Stuck, Perry and Heard (1979a) have discussed their separation in detail and have illustrated the male third pleopod of both species.

References: Stuck, Perry and Heard (1979 a, b)

Order Tanaidacea (Tanaids)

The order Tanaidacea contains approximately 400 described species. At one time, because of a number of similar morphological characteristics, the tanaids were listed under the name "Chelifera" as a subgroup of the Order Isopoda. The bodies of both tan-

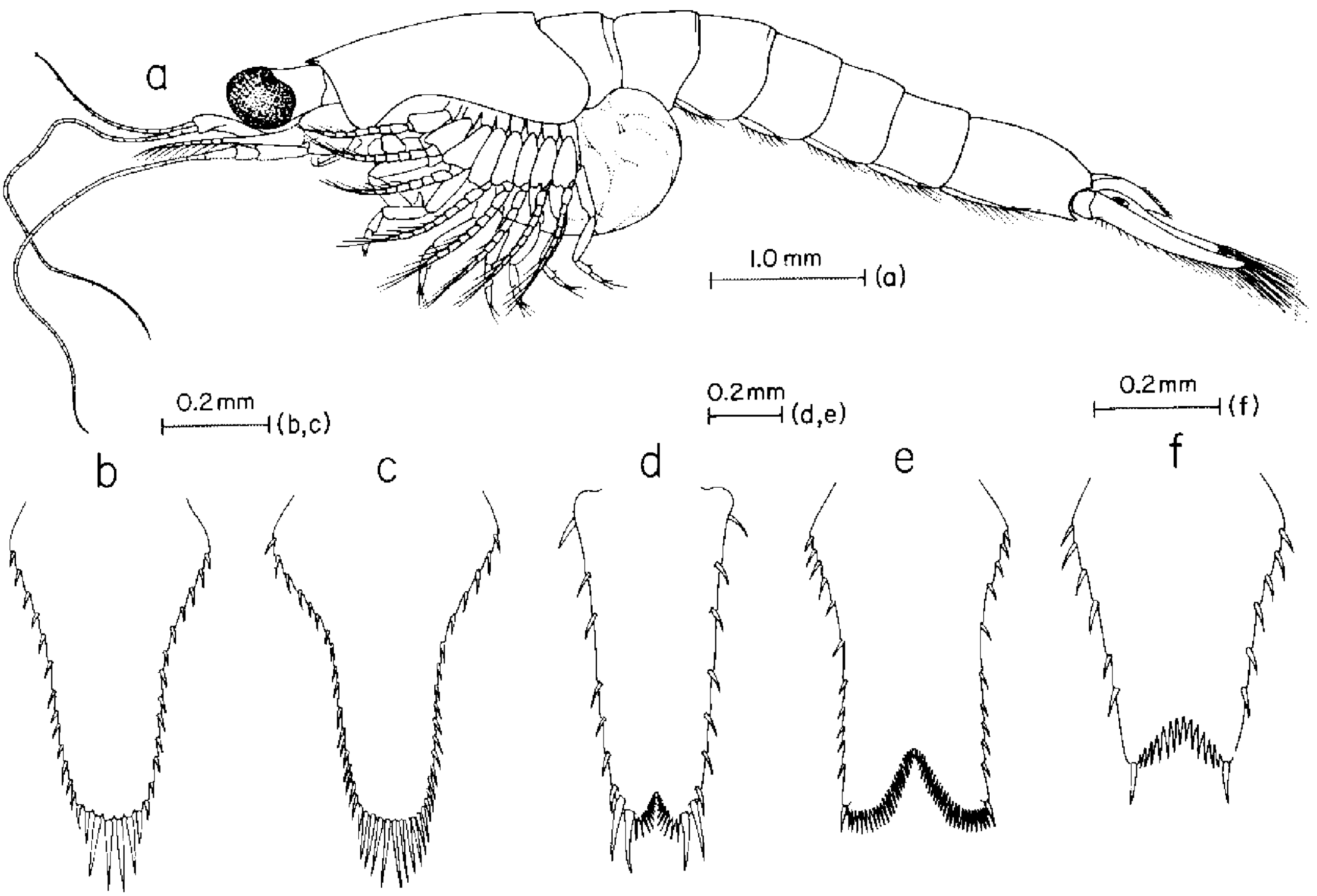


Figure 30. Mysidacea. a – *Mysidopsis almyra*, lateral aspect of gravid female; b-f telsons; b – *Mysidopsis bahia*; c – *M. almyra*; d – *Bowmaniella* sp.; e – *Taphromysis bowmani*; f – *T. louisianae*.

aids and isopods generally have flattened dorsal and ventral body surfaces, seven pairs of legs, and one pair of uropods.

Technically, tanaids are distinguished from isopods by the fusion of the first two body segments (thoracic somites), forming a small carapace to which the first pair of legs is attached. Thus, tanaids have six free thoracic segments having a pair of legs, whereas isopods have seven free body segments bearing legs. Another striking difference between the two orders is that in tanaids the first legs are chelate, whereas in isopods they are nearly always simple or subchelate. The tanaids were formerly called "Chelifera" because they possessed chelate first legs. Another difference between the isopods and tanaids is the site of respiration (carapace in tanaids; pleopods in isopods).

Tanaids are most common in the high salinity waters of the ocean; however, two species are known from tidal marshes of the northern Gulf of Mexico. One of these species lives in tubes, and the other burrows into the substratum.

Family Paratanaidae

Hargeria rapax (Harger, 1879)

Figure 31

Synonyms: *Leptochelia rapax* Harger, 1879
Leptochelia sp. of Odum and Heald 1972
Leptochelia dubia (in Gulf of Mexico)

Recognition Characters: Small (up to 7mm) with glossy, cream-white body; second leg not highly modified for digging; males have very large elongate claws (chelae); lacking multi-articulate accessory flagella on first and second antenna.

Distribution: Atlantic and Gulf coasts of North America from Massachusetts to Texas; Bermuda.

Habitat: Muddy or silty bottoms of estuarine systems rich in organic matter; wide range of salinity from nearly fresh water at the mouths of rivers to hypersaline conditions (40‰) in marsh tide pools during dry periods in the summer.

Remarks: *Hargeria rapax*, which in U.S. waters has been often confused with *Leptochelia dubia* Kroyer, is often very abundant in the wetter parts of tidal marshes on the Gulf Coast. Using its own mucous; it constructs small tubes of silt and organic detritus. The tubes are attached to the roots of marsh plants, to decaying plant matter, or even to tubes built by other salt marsh invertebrates such as *Corophium louisianum* and *Hobsonia florida*.

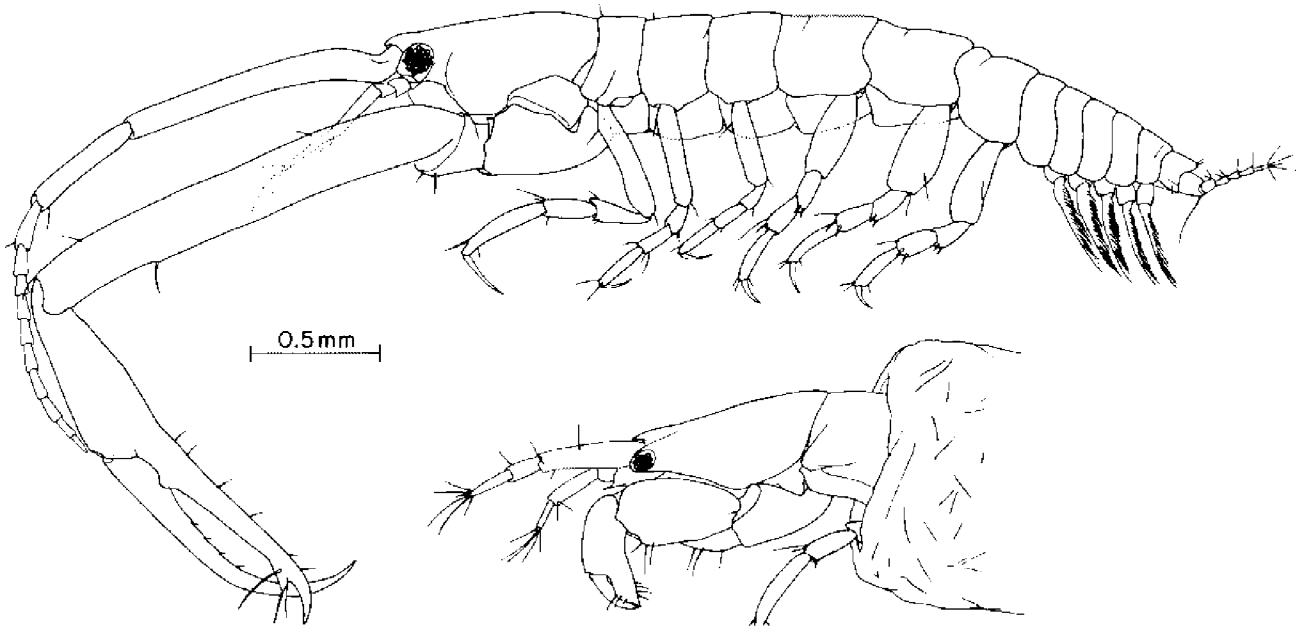


Figure 31. *Hargeria rapax.* a – lateral view of adult male; b – anterior part of female protruding from her tube.

The presence of *Hargeria* in a marsh tide pool can often be determined by disturbing the bottom of the pool. If small, white, elongate crustaceans appear on the pool's surface, they are probably *Hargeria.* These creatures are "non-wettable;" that is, they have a waxy coating over their bodies. When dislodged from their tubes, they often swim to the water surface and become stuck on the surface film.

Very little is known about *H. rapax*, but it is apparently an important part of the food web in wet marsh and estuarine environments. It feeds on diatoms, detritus, and fine organic particles. *Hargeria rapax* is commonly eaten by tidal marsh killifishes (*Fundulus* spp.) and many other adult and juvenile estuarine fishes.

The adult males of *H. rapax* may not feed or molt at all and may die soon after breeding. Males after molting into the large-clawed, adult stage have greatly reduced mouth parts which appear to be nonfunctional. Adult males also have better developed pleopods (swimmerets) than females. The better developed pleopods are thought to aid males during prolonged swimming excursions when they actively seek out females with which to mate. More research and study on the natural history of *H. rapax* is necessary to fully understand its apparently complex life cycle and ecology.

References: Boesch and Diaz (1974); Lang (1973); Odum and Heald (1972); Richardson (1905).

Family Apseudidae

Halmyrapseudes bahamensis Băcescu and Guțu, 1974

Figure 32

Synonym: *Apseudes* sp. Subrahmanyam, Kruczynski, and Drake (1976).

Recognition Characters: Body grayish and very setose; first antennae with distinct accessory flagellum; second leg broadened and modified for digging and burrowing.

Distribution: West coast of Florida (St. Marks and Cedar Key); Bahama Islands (Andros Island).

Habitat: Brackish water in muddy tidal flats (Bahama Islands) and among the roots of *Juncus* in tidal marshes (Florida), usually where salinities are higher than 10‰.

Remarks: This species has not yet been reported from the coasts of Alabama, Mississippi, or Louisiana, but its distribution probably extends into this region where suitable habitats occur. Based on my observations of this species in Florida tidal marshes, the most likely places to look for it on the northern Gulf would be the *Juncus* marshes on the mainland side of the offshore islands. *Halmyrapseudes* is usually collected by careful sieving of the substrata around the roots of the salt marsh vegetation. Information on the biology of this species from northwestern Florida will be presented by J. Sieg *et al*, in a forthcoming publication.

References: Băcescu and Gutu (1974); Subrahmanyam *et al.* (1976).

Order Cumacea

Members of this order of peracaridans, which contains approximately 800 described species, are usually oceanic; however, many species are known from estuarine habitats. Cumaceans have a very distinctive

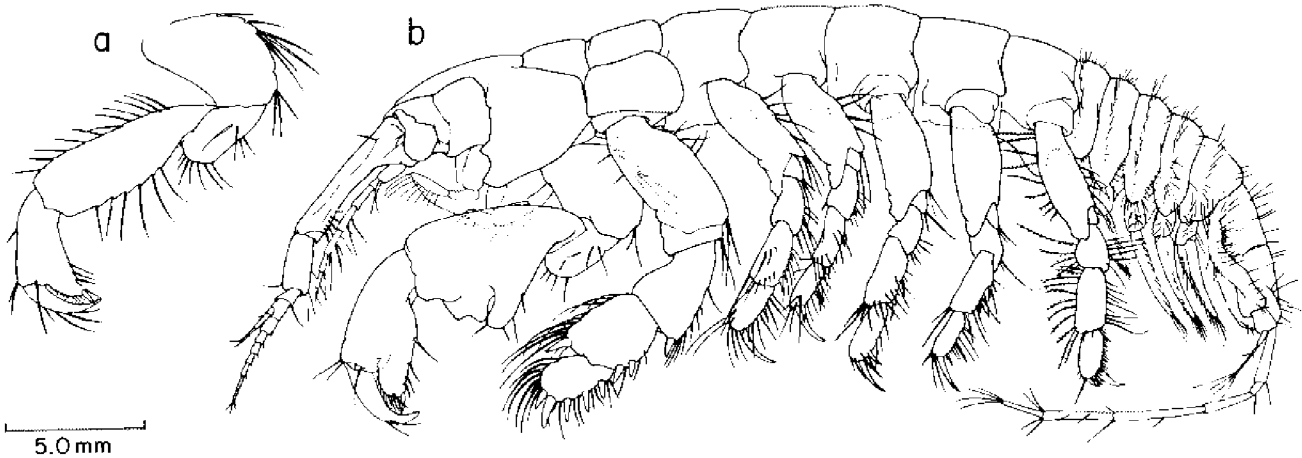


Figure 32. *Halmyrapseudes bahamensis*. a – first leg of female; b – lateral view of male.

body form. The carapace appears inflated, and the abdomen is elongate and narrow. Cumaceans have a single pair of uropods and, in some families, a telson. The eyes, if present, are small and located medially near the front of the carapace.

Cumacea differ from other peracaridans by having only five pairs of legs instead of the usual seven pairs that are characteristic of tanaids, mysids, isopods, and amphipods. In the Cumacea the first three pairs of thoracic legs have become modified into mouth parts (maxillipeds). This condition is also characteristic of the higher crustaceans of the Order Decapoda (crabs and shrimps), but this is only a single superficial resemblance, and the two orders are very different morphologically and not related to each other. One species, an undescribed species of *Almyracuma*, occurs in tidal marsh areas of the northern Gulf.

Family Nannasticidae

Almyracuma sp.

Figure 33

Recognition Characters: Without telson; pair of lateral expansions, or keels, on carapace of males, absent on females; inner ramus of uropod uniarticulate (with one joint); both males and females with pair of exopodites on third maxilliped, and first and second legs.

Distribution: Gulf of Mexico from Florida (St. Marks) to Louisiana.

Habitat: Fresh to brackish water tidal rivers, creeks, and marsh pools; most commonly on silty bottoms with organic detritus; at night often leaving bottom and becoming part of plankton.

Remarks: *Almyracuma* sp. from the Gulf Coast is very similar to *Almyracuma proximoculi* Jones and Burbanck, 1959, the only other species belonging to the genus. *Almyracuma proximoculi* was described from a low salinity tidal marsh in New England and is currently known from Massachusetts to Virginia. *Almyracuma* sp. is smaller than *A. proximoculi*. The males of *A.* sp. have well-developed lateral expansions on their carapaces; in the males of *A. proximoculi* these structures are reduced and not well developed. Very little is known about the biology of the new species from the northern Gulf. *Almyracuma* sp. is currently being described and named.

A second cumacean species, *Oxyurostylis smithi* Calman, 1912, possibly could be collected in large tidal pools or creeks in or near salt marshes in high salinity areas on the offshore islands. *Oxyurostylis smithi* has a pointed telson, distinguishing it from *Almyracuma*, which lacks a telson.

References: Calman (1912); Jones and Burbanck (1959).

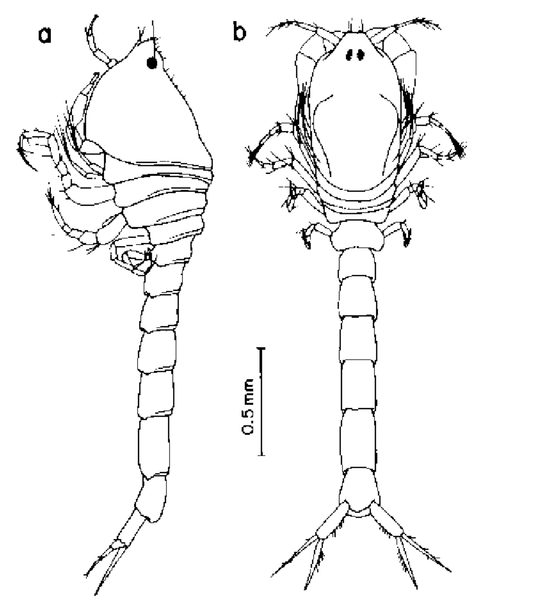


Figure 33. *Alymyracuma* sp. a – female, lateral aspect; b – male, dorsal aspect.

Order Isopoda (Isopods)

The Isopoda, which now numbers over 4,000 described species, is considered by some carcinologists to be the most phylogenetically advanced order of peracaridans. Isopods resemble tanaids and, in some respects, amphipods. They differ from tanaids by usually lacking chelate first legs and having seven rather than six free thoracic segments. A single pair of uropods and five pairs of pleopods distinguish isopods from amphipods, which have three pairs of pleopods and usually three pairs of uropods. In general, isopods have dorso-ventrally flattened bodies whereas, amphipods have laterally compressed bodies; however, exceptions exist (e.g. *Cyathura*).

Although the majority of isopod species are marine and estuarine, the group is well represented in freshwater and terrestrial habitats. The freshwater species are largely represented by a single family, the Asellidae, two members of which occur in brackish marshes along the northern Gulf. Some terrestrial forms, belonging to the suborder Oniscoidea and often referred to as "sowbugs", "pillbugs", "sea roaches", and "roly-polies", occur along the edges of tidal marshes in the supratidal zone. These terrestrial forms, beyond the scope of this guide, are not treated here. I have collected or found reports of only eight species of isopods in tidal marshes along the northeastern Gulf coast. *Edotea* cf. *montosa* (Stimpson, 1853), an estuarine species common in shallow mesohaline waters adjacent to the tidal marshes, is included in the Key since it might occasionally occur in tidal marsh pools.

Family Anthuridae (Anthurids)

Cyathura polita Stimpson, 1855

Figure 34

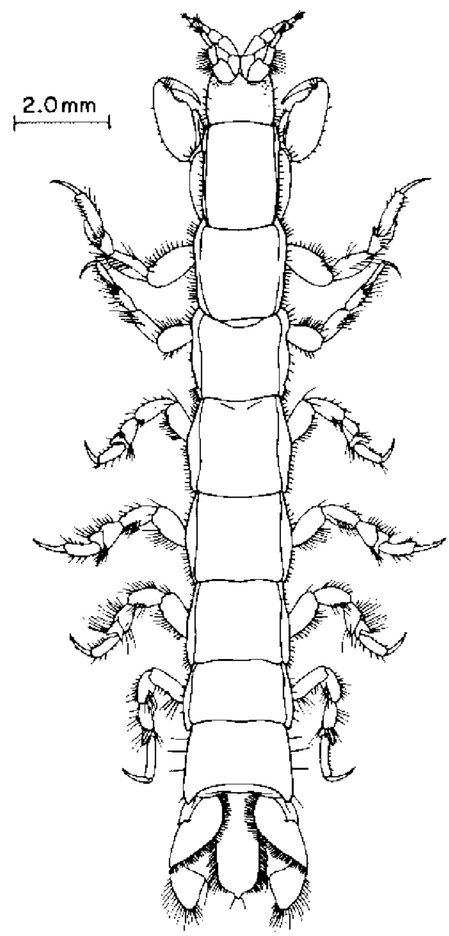


Figure 34. *Cyathura polita*, dorsal aspect.

Recognition Characters: Body vermiform (worm-like), elongate (over 7 times longer than wide), cylindrical, reaching 25mm in length (usually smaller on Gulf coast than on Atlantic coast); first pair of legs strongly subchelate; dorsal surface of head and thorax smooth with light blotches of dark gray pigment; antennae short; antenna 2 longer than antenna 1; antenna 1 approximately equal in length to cephalon (head); first 5 abdominal segments completely fused; sixth abdominal segment reduced, fused with telson.

Distribution: Atlantic and Gulf coasts of North America from Maine to Louisiana.

Habitat: Oligohaline to mesohaline (less than 1‰ to 20‰); burrows in mud to mud-sand substrata in estuaries and damp areas of tidal marshes.

Remarks: The biology of this common but secretive marine isopod is well known because of the extensive work of W. D. Burbank and his students. Recent studies by other scientists on *C. polita* populations occurring in *Juncus* tidal marshes on northwestern Florida indicated a two-year life cycle. Juveniles mature during the spring after approximately one year of development. Often, mature females transform into males, a condition technically described as "protogynic." *Cyathura polita* often occurs in large numbers and forms an important part of the food web in many estuaries.

References: Burbanck (1967); Frankenburg and Burbanck (1963); Kruczynski and Subrahmanyam (1978); Miller and Burbanck (1961).

Family Sphaeromidae (Sphaeromids)

Cassidinidea ovalis (Say, 1818)

Figure 35

Synonym: *Cassidinidea lunifrons* (Richardson, 1900)

Recognition Characters: Body small, reaching 3 to 4 mm, rounded, flattened; cephalon distinctly narrower than and recessed into first free thoracic segment; lateral margins of first free thoracic segment extending to posterior margin of pleotelson; inner branch of uropod well developed, extending to pos-

terior margin of pleotelson; outer branch of uropod greatly reduced, inserted into margin of inner branch.
Distribution: Atlantic coast of North America from New England to Georgia; Gulf coast of North America from northwestern Florida to Louisiana.
Habitat: Oligohaline to lower mesohaline (less than 1‰ to 20‰); shallow bay bottoms on oysters and submerged vegetation; intertidally in marsh pools on fallen leaves and other plant debris.
Remarks: In wet, intertidal areas of low salinity marshes, this little sphaeromid is often found flattened against the surface of leaves, wood, shells, and marsh grass stems. Because it usually matches the color of the surface to which it is attached, *Cassidinidea ovalis* can be easily overlooked.

For many years *Cassidinidea ovalis* and *C. lunifrons* were listed as separate species. The original, brief description of *C.* (=*Naesa*) *ovalis* by Thomas Say in 1818 was based on specimens from the coast of South Carolina. Harriet Richardson's 1900 description of *C.* (=*Cassidinia, Cassidisca*) *lunifrons* was based on specimens from New Jersey. Richardson (1905) indicated that the two species might be the same, but because Say's original specimens were in very poor condition and no additional specimens from South Carolina were available, she tentatively recognized a second species. Other authorities, including Menzies and Frankenberg (1965) and Schultz (1969), have also suggested that *C. ovalis* and *C. lunifrons* might be the same species. Based on the many collections I have made along the coasts of North Carolina, South Carolina, and Georgia, I believe that only one species of *Cassidinidea* is present on the eastern coast of North America. Since *C. ovalis* (Say, 1818) is the oldest available name, *C. lunifrons* Richardson, 1900, becomes its synonym. In a recent publication, Livingston *et al.* (1977) used the name *C. ovalis* for specimens collected in northwestern Florida.
References: Livingston *et al.* (1977); Menzies and Frankenberg (1966); Richardson (1900, 1905); Say (1818); Schultz (1969).

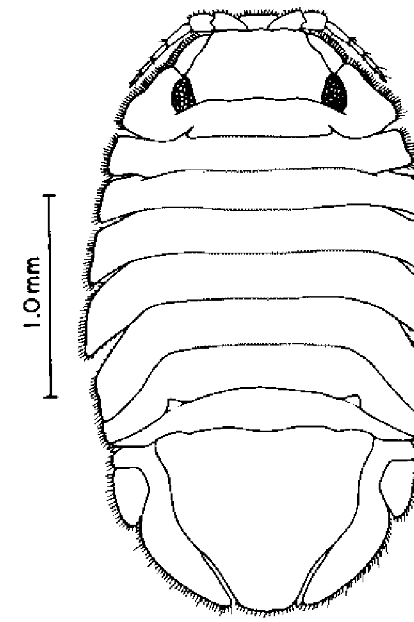


Figure 35. *Cassidinidea ovalis*, dorsal aspect.

Sphaeroma terebrans Bate, 1866

Figure 36

Synonym: *Sphaeroma destructor* Richardson, 1897
Recognition Characters: Body up to 8 mm long with rounded extremities, slightly over twice as long as wide; cephalon nearly as broad as first free thoracic segment; first free thoracic segment not extending beyond anterior of eyes; last thoracic segment with four dorsal tubercles; abdominal segments and pleotelson with several low but distinct tubercles; uropods extending past pleotelson, outer longer with four teeth on outer edge.
Distribution: Widely spread throughout subtropical and tropical seas of the world; east and Gulf coasts of North America from South Carolina to Texas.
Habitat: Occurring over a wide range of salinities in shallow subtidal to intertidal areas; usually found burrowing in dead wood, or occasionally hard-packed sand substrates.
Remarks: *Sphaeroma terebrans* is not a true tidal marsh species but is included here because I have found it in decaying wood along the edges of low salinity tidal marshes of the northern Gulf. In other coastal areas of southern North America and various

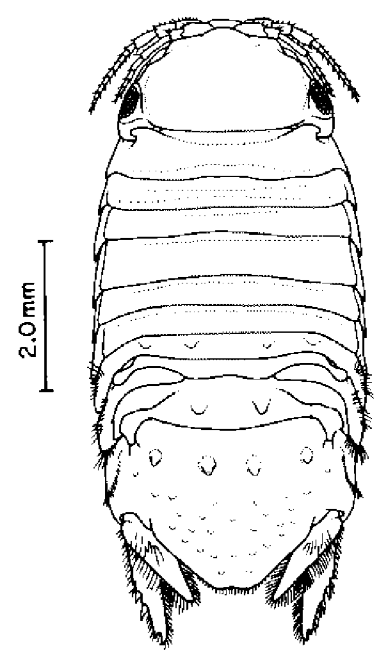


Figure 36. *Sphaeroma terebrans*, dorsal aspect.

subtropical- tropical regions, this wood-burrowing species has been reported to cause considerable damage to wooden bridges and pier pilings. A study in southern Florida indicated that *S. terebrans* commonly bores into the roots of red mangroves and might have an important ecological impact on the mangrove swamps of that area. *Sphaeroma destructor,* described from infested dock pilings in northeast Florida, was recently considered a junior synonym of *S. terebrans* by Estevez and Simon (1975).

Another species of *Sphaeroma, S. quadridentatum* Say, 1818, was reported from tidal marshes in northwestern Florida. This species is common in Gulf estuaries and along open beaches where it often causes decay in old tree stumps and pilings. Thus, like *S. terebrans,* it is not a true marsh species; its occurrence in salt marshes is not common. The body of *Sphaeroma quadridentatum* lacks tubercles, easily distinguishing it from *S. terebrans.*

References: Estevez and Simon (1975); Behm and Humm (1973); Richardson (1905); Simberloff *et al.* (1978).

Family Munnidae

Munna reynoldsi Frankenberg and Menzies, 1966

Figure 37

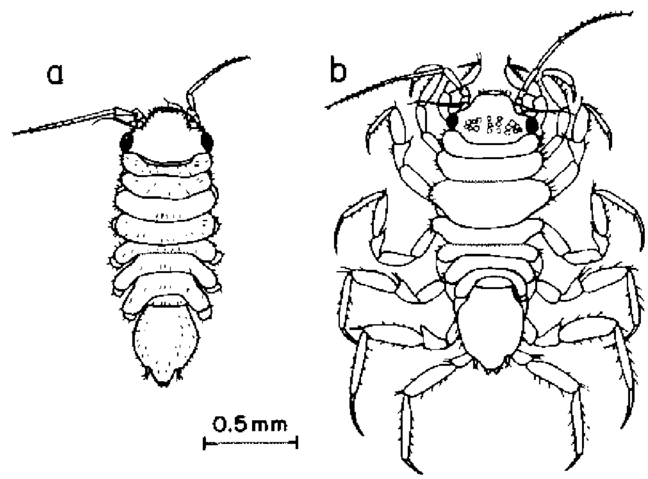


Figure 37. *Munna reynoldsi.* a – male, dorsal aspect (legs omitted); b – Female, dorsal aspect. (a -- after Menzies and Frankenburg, 1966).

Recognition Characters: Body minute, less than 2 mm long; eyes on lateral protuberances; first antenna small, less than half the length of second antenna; second antenna about one-half length of body; legs long, extending laterally from body; pleotelson longer than wide; uropods small, inserted in lateral indentations near end of pleotelson, not extending beyond pleotelson.

Distribution: Atlantic coast of North America from North Carolina to Georgia, Gulf coast from Florida to Texas.

Habitat: In low salinity (less than 1‰ to 15‰) areas of shallow bays, bayous, and tidal marsh pools; usually associated with decaying leaves, marsh grass, and wood.

Remarks: The males and females of this little isopod are quite distinct. Females, usually larger than males, have a much larger third free thoracic segment and a cephalon ornamented with a cluster of white dots surrounded by dark pigment. On males, the third free thoracic segment is similar in size and shape to adjacent thoracic segments, and the cephalon lacks the cluster of white dots and associated pigment.

This species has only recently been reported from the northern Gulf of Mexico (Clark and Robertson, 1977; Livingston *et al.*, 1977). *Munna reynoldsi* occurs commonly in low salinity salt marshes and bays along the coast of the northern Gulf but is usually overlooked because of its minute size. I have also collected *M. reynoldsi* from a brackish water ditch on the South Newport River in Carterette County, North Carolina, a record which extends its range northward up the Atlantic from Georgia. The isopod, often preyed upon by salt marsh killifishes and other small cyprinodont fishes, feeds on detritus and benthic algae.

References: Callahan, Clark, and Robertson (1977); Frankenberg and Menzies (1966); Livingston *et al.* (1977); Schultz (1969).

Family Asellidae

Asellid isopods, the largest family of freshwater isopods, seldom invade estuarine areas. They are mentioned here because I have collected specimens of *Asellus obtusus* Williams, 1970, and *Lirceus* sp. from brackish tidal marsh pools in Mississippi (Davis Bayou and Gulf Park) and Louisiana (Lake Pontchartrain). *Asellus obtusus* and *Lirceus* can be distinguished from each other by their cephalons. The cephalon of *A. obtesus* is small, narrow and unnotched with eyes located on the lateral margins (Figure 38), whereas the cephalon of *Lirceus* sp. is broad with a pair of lateral notches and eyes not located on the lateral margins (Figure 39).

The tidal marsh localities from which I collected these isopods were near areas of freshwater run-off, and the isopods probably originated from these freshwater habitats. It would be interesting to study how well *A. obtusus* and *Lirceus* sp. can adapt to estuarine conditions. Once, I collected both species from a

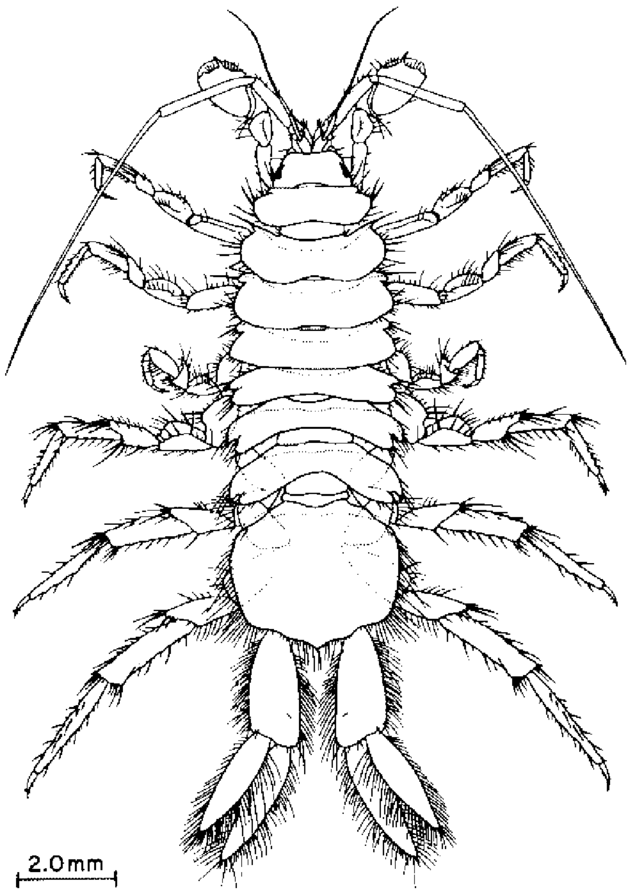


Figure 38. *Asellus obtusus*, dorsal aspect.

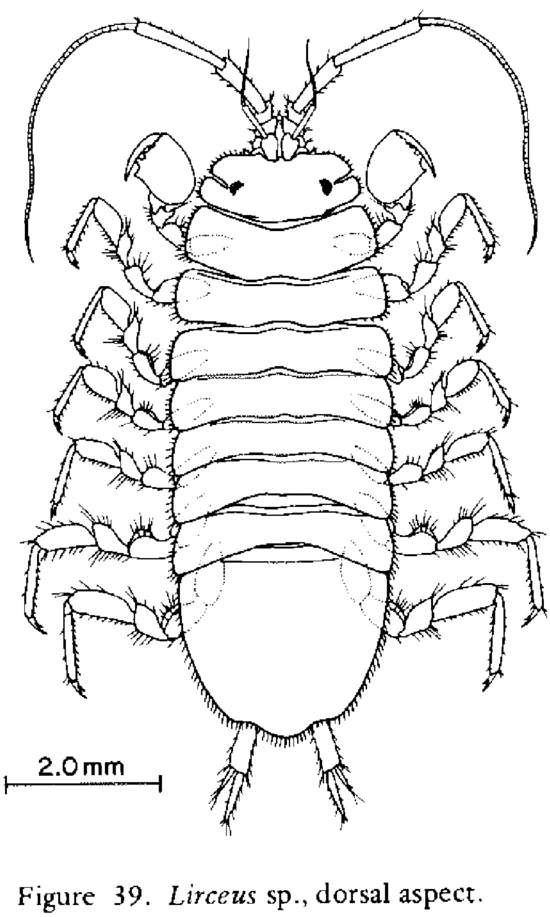


Figure 39. *Lirceus* sp., dorsal aspect.

tidal pool with a salinity of over 10‰.
References: Williams (1970).

Family Bopyridae

Probopyrus pandalicola Packard, 1880

Figure 40

Recognition Characters: Occurring in pairs, with small dwarf male usually attached to pleopods of female; body of female highly modified for parasitism; parasitic on *Palaemonetes pugio*.
Distribution: Eastern and Gulf coasts of North America from New England to Mexico.
Habitat: Estuarine, parasitic in gill chamber of estuarine grass shrimps, *Palaemonetes pugio*.
Remarks: In some instances I have observed over 25% of adult grass shrimp from tidal marsh ponds infected with *Probopyrus pandalicola*. Usually, however, the isopod infects less than 1% of the shrimp population. *Probopyrus pandalicola* has a complex life cycle involving two hosts. A female can produce 3 or more broods, each with hundreds of eggs that hatch into small, free-swimming larvae (epicaridean stage). The epicaridean larva attaches to a planktonic copepod (*Arcatia tonsa*) and transforms into a microniscus stage. After a period of feeding and development on the copepod, the microniscus stage metamorphoses into a larger larval stage, the crytoniscus. The crytoniscus leaves the copepod, seeks out and attaches to a young grass shrimp. After attaching to the grass

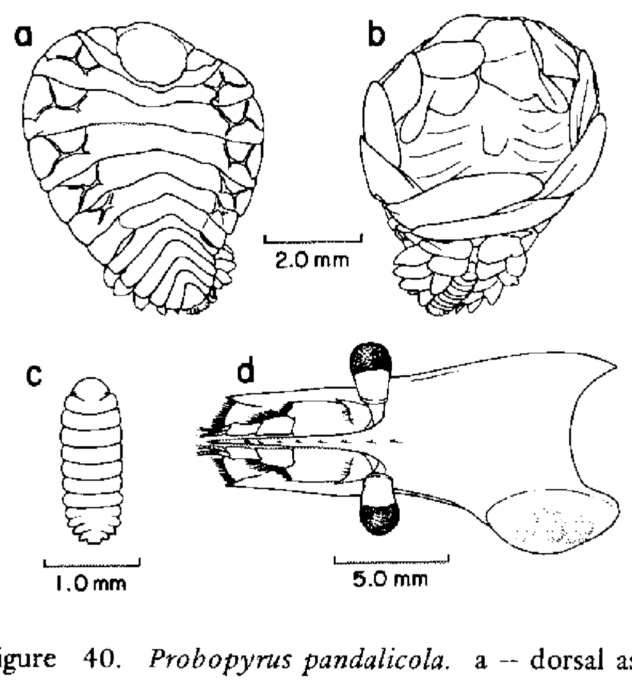


Figure 40. *Probopyrus pandalicola*. a – dorsal aspect of female, b – ventral aspect of female with attached male; c – dorsal aspect of male; d – carapace of host shrimp showing swollen area caused by *P. pandalicola*.

shrimp, the crytoniscus moves into the gill chamber of its host and metamorphoses into the adult parasite. The first crytoniscus larva to reach the gill chamber of the shrimp becomes a female, and the next to arrive becomes a "dwarf" male, only a fraction of the size of the female. Such development and behavior indicate that the sex of this parasitic isopod is not predetermined. The biochemical or hormonal mechanisms involved in the determination of the sex of *P. pandalicola* and other members of the family Bopyridae is still not understood.

Two other palaemonid shrimps from Gulf estuaries are infected with two species of *Probopyrus*. The freshwater grass shrimp *Palaemonetes paludosus* Gibbes, 1850, and the river shrimp *Macrobrachium ohione* (Smith, 1874) are parasitized by *Probopyrus floridensis* Richardson, 1904, and by *P. bithynis* Richardson, 1904, respectively.

References: Anderson (1975 a; 1975 b); Beck (1980 a, b); Overstreet (1978); Richardson (1905).

Order Amphipoda

Amphipods comprise the largest and one of the most advanced groups of peracaridans. Since they occur so commonly in marine environments and in such diverse habitats, amphipods are called the "insects of the sea." Many species also occur in fresh and ground water habitats, especially in Europe. Though primarily aquatic, the members of one family, the Talitridae, have become adapted to living on land.

Like the isopods, amphipods lack a carapace and usually have seven distinct (unfused) thoracic segments. Amphipods generally differ structurally from isopods and other peracaridans by having three pairs of uropods, three pairs of pleopods, and a laterally compressed body; however, some groups of amphipods have secondarily evolved cylindrical or dorso-ventrally flattened body forms. In other groups, one or more of the uropods are vestigial or absent.

Of the four currently accepted suborders (Gammaridea, Caprellidea, Hyperidea, Ingolfiellidea), only the gammarideans occur in tidal marshes of the northern Gulf of Mexico. The amphipod fauna associated with Mississippi-Alabama tidal marshes is represented by at least five different families.

Parhyale hawaiensis (Dana, 1853) (Family Hyalidae), which I collected from tidal marshes in Georgia and which has been recently reported in association with the root systems of marsh grasses in Louisiana by Thomas (1976), is included in the key (Appendix), since in the future it may be found in similar marsh habitats of Mississippi and Alabama.

Family Gammaridae

Gammarus mucronatus Say, 1818

Figure 41 a

Recognition Characters: Eyes reniform (kidney-shaped); first 3 segments of the abdomen (pleon) with sharp, posteriorly directed dorsal processes (mucronations); third uropods biramus, subequal.

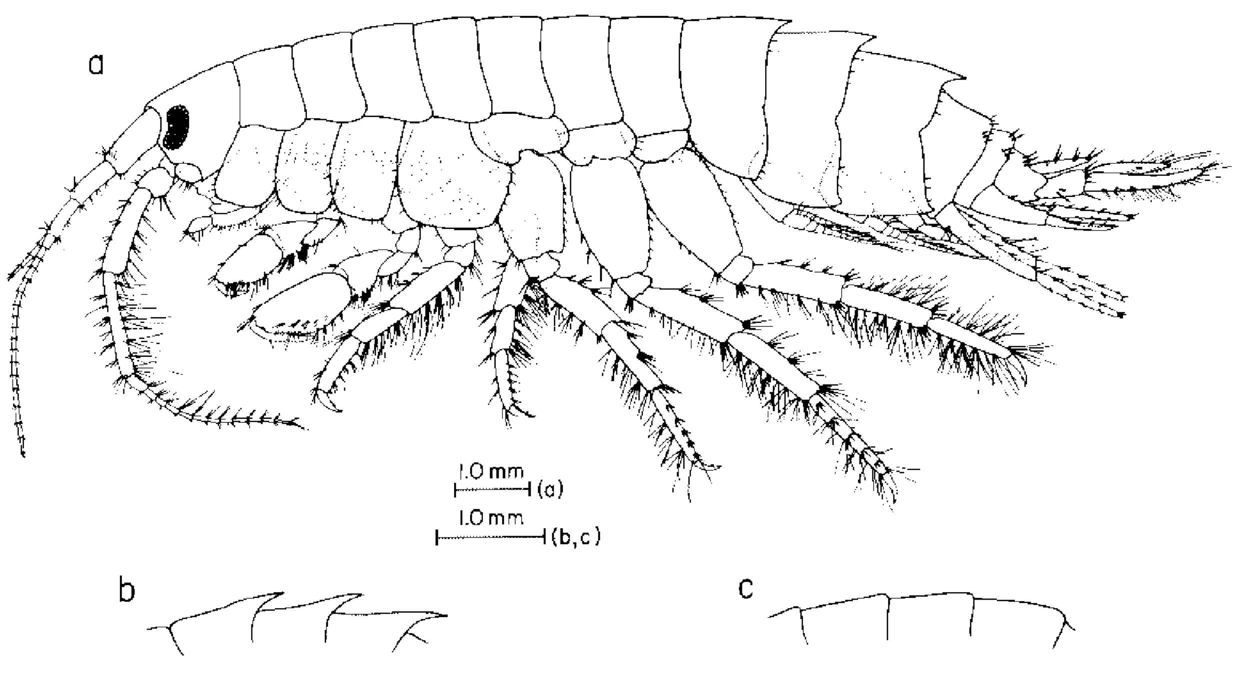


Figure 41. *Gammarus* spp. a — *G. mucronatus*, adult male (after Bousfield, 1973); b — "macromucronate" species; c — *Gammarus* sp. (near *tigrinus*).

Distribution: North America from southeastern Canada to southern Florida; Gulf coast states; California (introduced).
Habitat: Euryhaline; in shallow bays and tidal marsh pools, often associated with submerged vegetation, widgeon grass, turtle grass, submerged marsh grass, roots, and hydroids.
Remarks: Along the northern Gulf coast *Gammarus mucronatus* is commonly found in marsh tide pools during the cooler months; populations reach their highest concentrations during early spring. *Gammarus mucronatus* is an important part of the diet of many estuarine fishes. In areas where it is abundant, *G. mucronatus* may be an important biological agent in the production of detritus. It masticates and ingests parts of decaying marsh grasses in order to feed on the associated microflora and microfauna. Consequently a large population of *G. mucronatus* can reduce considerable quantities of dead marsh grass into fine particulate matter.

In the oligohaline regions of the upper bays and river mouths, *G. mucronatus* is replaced by a closely related and as yet undescribed species of *Gammarus*. This species can be distinguished from *G. mucronatus* by the much more strongly developed mucronations (macromucronations) on the posterior dorsal margins of the first three abdominal segments (Fig. 41 b).

A third species closely related to *Gammarus tigrinus* (Sexton, 1939) which lacks mucronations (Fig. 41 c) often occurs with *G. mucronatus* and *Gammarus* sp. (macromucronate form) in oligohaline areas. Like the "macromucronate" form, *Gammarus* (nr. *tigrinus*) is also an undescribed species. Tolerating even lower salinities than the form, it can live in tidally influenced freshwater regions.
References: Bousfield (1973); Farrell (1970), Thomas (1976).

Family Melitidae

Melita spp. (*nitida* complex)

Figure 42

Recognition Characters: First antenna larger than second, accessory flagellum present; eyes irregularly rounded; second pair of gnathopods larger than first; third uropod with inner ramus minute and outer ramus strongly developed, extending well beyond first and second uropods.
Distribution: East and Gulf coasts of North America from southern Canada to Louisiana.
Habitat: Shallow bays and estuaries; euryhaline; found on algae and dead wood and among oyster shells and submerged marsh grass roots.
Remarks: Recent studies indicate that *M. nitida* Smith, 1873, and three closely related species (*M. elongata* Sheridan, 1980, *M. intermedia* Sheridan, 1980, and *M. longisetosa* Sheridan, 1980) occur in the estuaries of the northern Gulf of Mexico. In

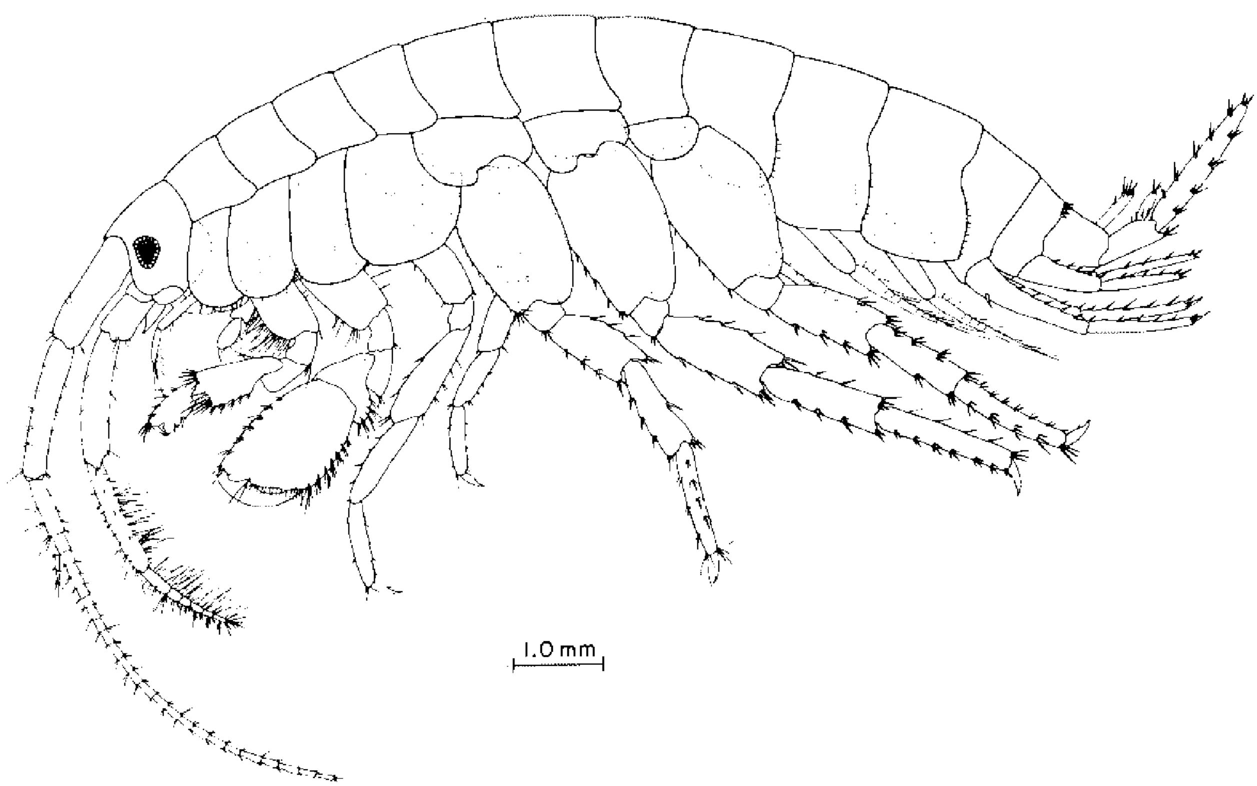


Figure 42. *Melita nitida*, adult male (after Bousfield, 1973).

light of the recent descriptions of *M. elongata, M. longisetosa* and *M. intermidia,* all previous records of *M. nitida* from the Gulf region should be suspect. Until the distribution of these four species is further understood, the number of species associated with tidal marsh habitats will remain uncertain. My preliminary observations indicate that at least two species, *M. intermedia* and *M. longisetosa*, occur in tidal marsh pools along the northern Gulf. On several occasions I found specimens of *M. intermedia* in water-filled burrows of fiddler crabs *(Uca minax).* All four species from northern Gulf estuaries are included in the key in the appendix.

References: Bousfield (1973); Odum and Heald (1972); Sheridan (1980); Thomas (1976).

Family Aoridae

Grandidierella bonnieroides Stephensen, 1948

Figure 43

Recognition Characters: Body reaching over 8mm in length, gray with patches of dark pigment; eyes irregularly rounded; first pair of gnathopods larger than second; first antenna longer than second; peduncle of second antenna well developed, over 3 times longer than flagellum; accessory flagellum on first antenna vestigial, minute, represented by a microscopic scale (visible only with compound microscope); third uropod uniramus, with ramus narrower and longer than peduncle; tube-dweller.

Distribution: Widely distributed in tropical-subtropical coastal areas of U.S.A.; eastern and Gulf coasts from North Carolina to Texas.

Habitat: Euryhaline, less than 1‰ to over 40‰; in shallow bays, lagoons, tidal rivers, bayous, tide pools in marshes and mangrove swamps.

Remarks: *Grandidierella bonnieroides* commonly occurs in marsh tide pools where it constructs delicate tubes using its own mucus, plus silt and organic detritus from surrounding sediment. These tubes usually

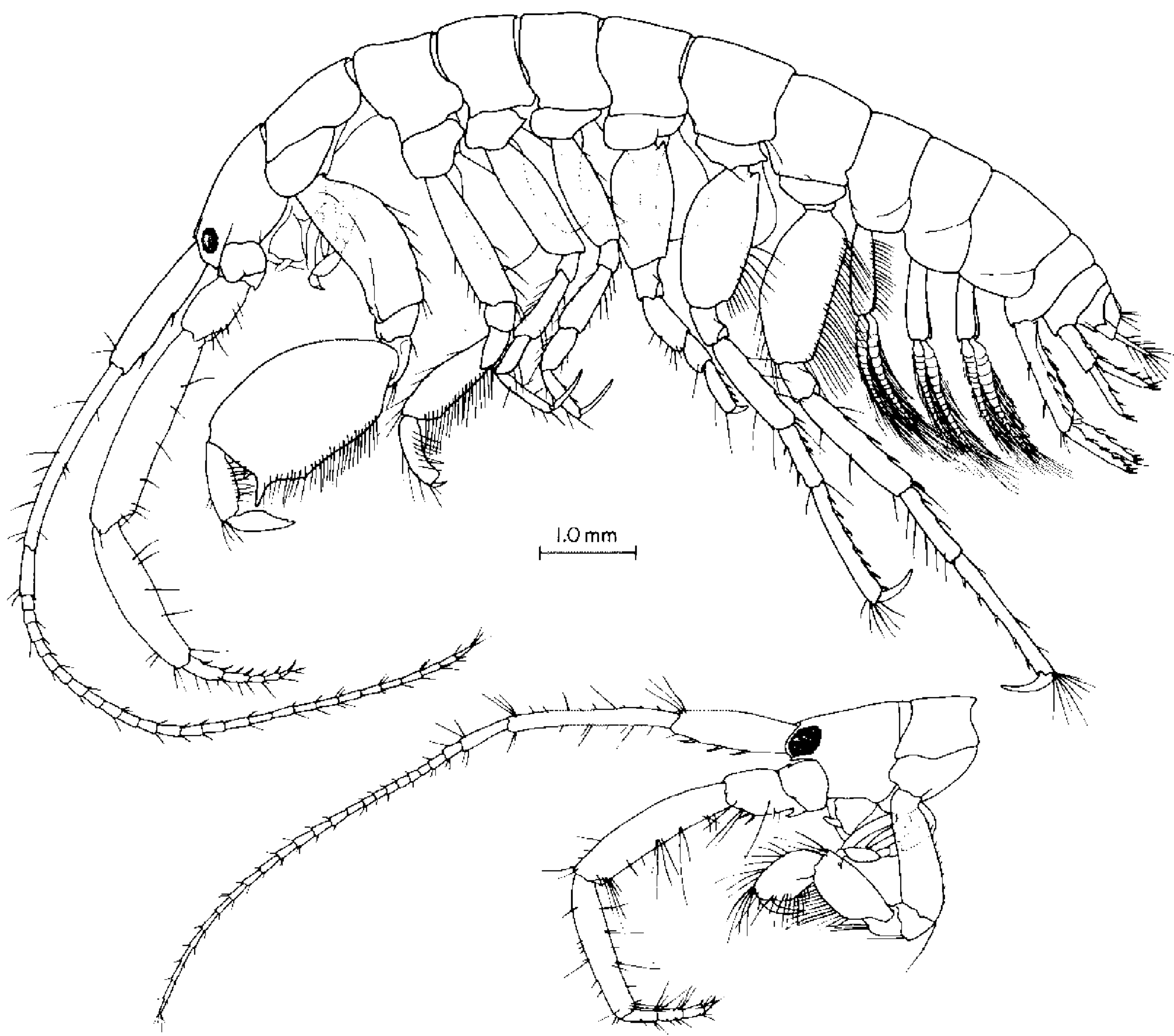


Figure 43. *Grandidierella bonnieroides*, male (above) and anterior end of female (below).

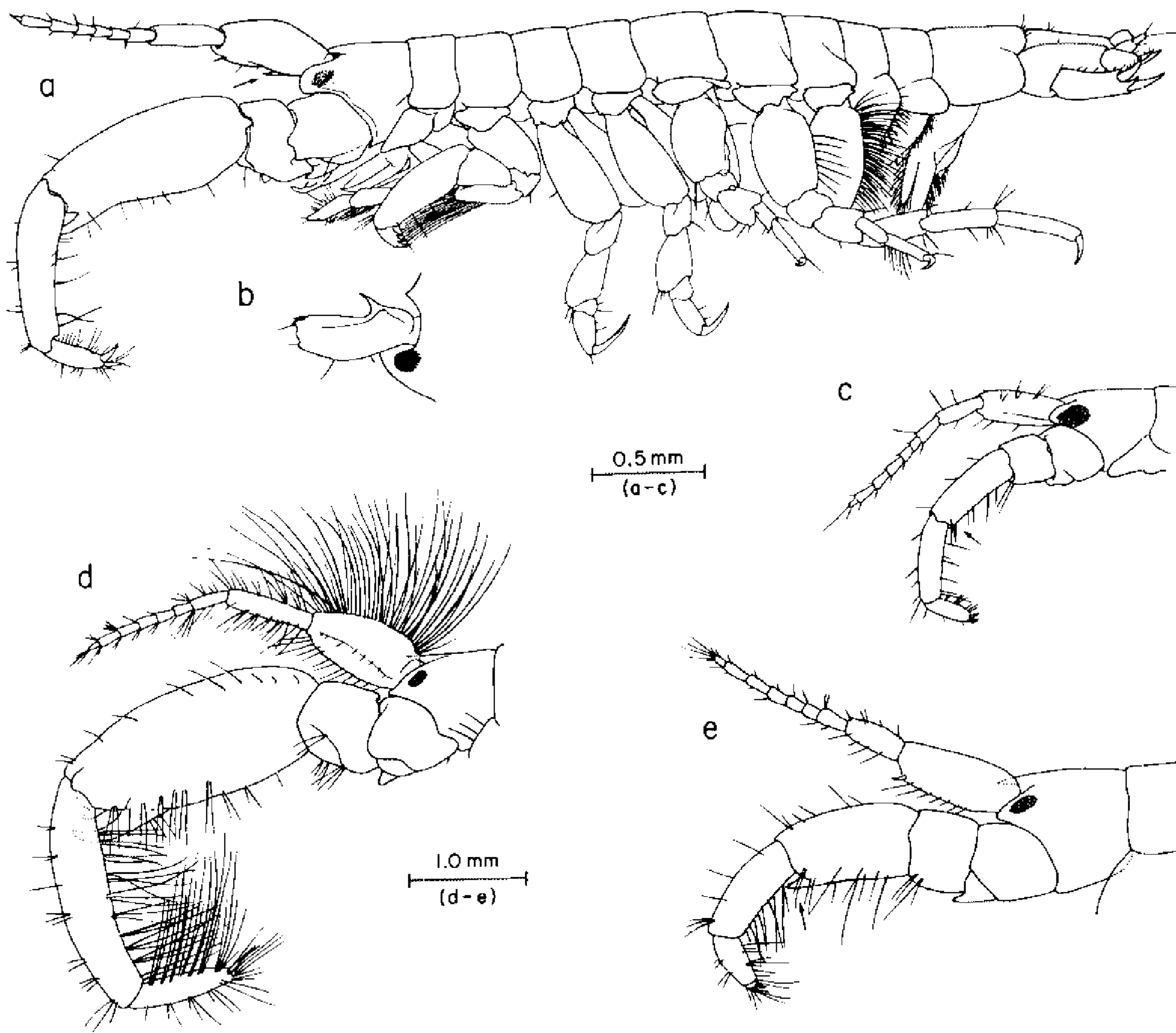


Figure 44. *Corophium* spp. a-c – *C. louisianum*; d, e – *C. lacustre*. (d, e – after Bousfield, 1973).

lie horizontally on the surface of shells, wood, and other hard substrata. *G. bonnieroides* is common in the diet of many estuarine fishes and serves as an intermediate host for an acanthocephalan parasite *(Dollfusentis chandleri)* whose adult stage develops in the Atlantic croaker, spot, and other estuarine fishes.

The genus *Grandidierella* was once considered a member of the family Corophiidae; however, based in part on the presence of a minute vestigial accessory flagellum on the first antenna, many authorities now consider it an aberrent member of the family Aoridae.

References: Buchner *et al.* (1978); Myer (1970); Thomas (1976).

Family Corophiidae

Corophium louisianum Shoemaker, 1934

Figure 44 a, b, c

Recognition Characters: Body dorsally flattened, reaching 7mm in length, gray with blotches of dark pigments; second antenna stout (massive in male), longer than first; flagellar segments greatly reduced, fused; first segment of first antenna of male with anteriorly acute process or tooth on inner margin (absent in female); in female, fourth segment of second antenna armed with distoventral spine (not a tooth); last three abdominal segments of urosome fused, lateral margins upturned; tube-dweller.

Distribution: Gulf coast of United States from south Florida to Texas.

Habitat: Euryhaline (less than 1‰ to over 25‰) in tidal marsh pools and along edges of marshes, rarely in open bays; within self-constructed tubes attached to shells, wood, leaves, exposed or partially exposed root systems of marsh grasses, and other firm substrata.

Remarks: *Corophium louisianum* is a common Gulf marsh species. Hundreds of individuals can be found in tubes attached to the roots of a single stalk of marsh grass. The tubes of *C. louisianum* are composed of mucus mixed with sand, silt or detritus. A closely related species, *Corophium lacustre* Vanhoffen, 1911, replaces *C. louisianum* in the non-tidal marsh areas of Gulf estuaries (e.g. dock pilings, open bay bottoms). Although they appear similar, the two species can be distinguished easily by comparing their antennae. Segment one of the first antenna of male *C. louisianum* has a prominent, forward-projecting, acute process (Fig. 44 b) that is absent on the males of *C. lacustre* (Fig. 44 d). A small spine is present on the distoventral margin of the fourth, or largest, segment of the second antenna on the female *C. louisianum* (Fig. 44 c); whereas, in the same location on *C. lacustre*, a distinct tooth is present (Fig. 44 e). Both *C. louisianum* and *C. lacustre* are important in the diets of estuarine fishes.

References: Shoemaker (1947); Thomas (1976).

Family Hyalellidae

Hyalella azteca Saussure, 1857

Figure 45

Recognition Characters: Body reaching 8mm in length, often green in living specimens; eyes irregularly oval; first antenna shorter than second, without accessory flagellum; dorsal-posterior margin of first two segments of abdomen with a sharp process (mucronation); third pair of uropods with single ramus (unirumas); apex of telson rounded, entire.

Distribution: North and Central America; Caribbean Islands.

Habitat: Freshwater in lakes, rivers, ponds.

Remarks: In the northern Gulf this widely distributed freshwater species often occurs with *Gammarus* sp. (macromucronate form) and *Gammarus* sp. (near *tigrinus*) on algae and other aquatic vegetation in tidal marsh pools where fresh water or oligohaline conditions prevail. Although it is superficially similar to *Gammarus* sp. (macromucronate form), *Hyalella azteca* differs in having irregularly oval eyes, only two mucronations on the abdomen, uniramus third uropods, and a rounded (uncleft) telson.

References: Bousfield (1973); Thomas (1976).

Family Talitridae

Members of this group of terrestrial and semiterrestrial species are often called "beach fleas," "beach hoppers," "marsh hoppers," or simply "hoppers" because they jump about erratically when disturbed. Species of this family have: (1) a reduced first antenna lacking accessory flagellum and distinctly shorter than the peduncle of the second antenna, (2) reduced uniramus third uropods, and (3) large eyes adapted for nocturnal activity. Males are usually larger than females and they have large, well-developed second gnathopods. Four species of talitrids are known to occur in tidal marshes of the northern Gulf of Mexico.

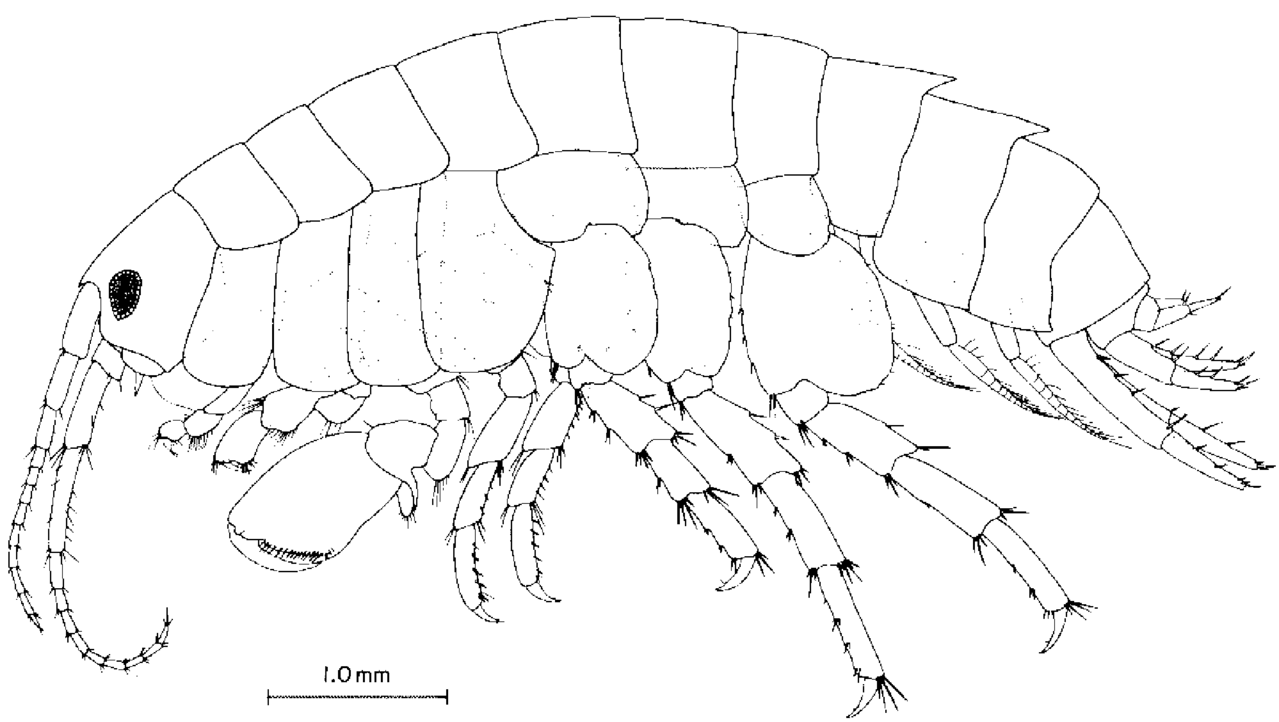


Figure 45. *Hyalella azteca*, adult male (after Bousfield, 1973).

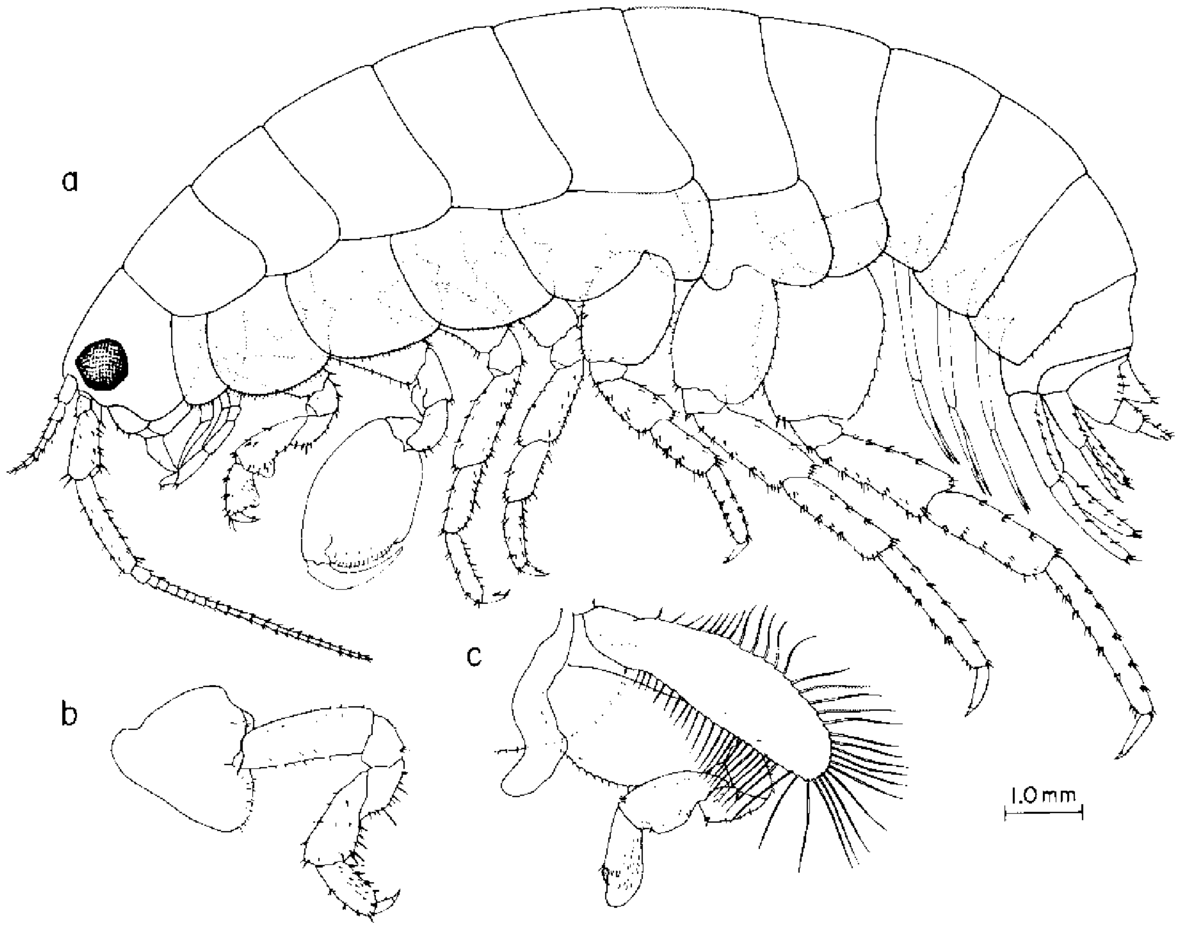


Figure 46. *Orchestia grillus.* a – adult male; b – first leg (gnathopod) of female; c – secong leg (gnathopod) of female (after Bousfield, 1973).

It should be noted that a true terrestrial species, *Talitroides topotum,* known originally from India, has been introduced into the coastal regions of Louisiana and Mississippi, presumably from the port of New Orleans. In this colorful species, the males do not have well-developed second gnathopods and are smaller than the females. *Talitroides topotum* is most common on hardwood forest floors underneath leaf mold; however, it occasionally may intrude into supratidal zones adjacent to tidal marshes.

Orchestia grillus Bosc, 1802
Figure 46

Common Name: Common Marsh Hopper
Synonym: *Orchestia palustris* Smith, 1873
Recognition Characters: Body relatively large, to 18mm in length, color usually light gray or brown; second antenna approximately 3 times longer than first; second gnathopod of mature adults with dactyl reaching back less than one half length of palm (propodus); first uropods lacking a strongly developed spine on peduncle at base of rami; outer ramus with lateral spines on margin.
Distribution: Atlantic coast of North America from southern Canada to Florida, Gulf coast from western Florida to Texas.
Habitat: Euryhaline; intertidal and supraintertidal zones of tidal marshes; under dead marsh grasses or other debris.
Remarks: *Orchestia grillus* is the largest amphipod found in Gulf tidal marshes. This secretive creature can often be found under rafts or dead marsh grasses occurring along the upper intertidal zone of marshes. The common marsh hopper is a scavenger, feeding on detritus and decaying plant and animal matter. It is eaten by shore and marsh birds, including rails, plovers, willets, and seaside sparrows. Because of its diet, *O. grillus,* as well as the other tidal marsh species of *Orchestia,* may be important biological agents in the mechanical breakdown of vascular plant matter to detritus in the intertidal zone.
References: Bousfield (1973); Thomas (1976).

Orchestia uhleri Shoemaker, 1936
Figure 47

Common Name: Uhler's Marsh Hopper
Recognition Characters: Body reaching 13 mm in length; second gnathopod of adult male with dactyl reaching back past propodus; first uropod with well-developed spine on peduncle at base of rami.
Distribution: East and Gulf coasts of North America from North Carolina to Louisiana.
Habitat: Under dead and living vegetation; intertidal zone of oligohaline and mesohaline tidal marshes.
Remarks: This species often occurs with *O. grillus*; however, *O. uhleri* is more common in lower salinity habitats, and it generally occupies damper areas of the tidal marsh.
Reference: Bousfield (1973).

Orchestia sp. (near *O. costaricana* Stebbing, 1906)
Figure 48

Common Name: Chelate Marsh Hopper
Recognition Characters: Body reaching 10 mm in length; second antenna over 4 times longer than first; second gnathopod of male chelate; first uropod with well-developed spine on peduncle at base of rami; outer ramus lacking lateral spines.
Distribution: Gulf coast of United States from southern Florida to Texas.
Habitat: Intertidal zones of marshes; euryhaline, under marsh vegetation.
Remarks: This form apparently represents a new species, which will be placed along with the closely related *O. costaricana* in a new genus in a forthcoming publication by E. L. Bousfield. *Orchestia costaricana* was described from Costa Rica. Like *Orchestia grillus* and *O. uhleri*, chelate marsh hoppers are eaten by a variety of marsh and shore birds. Like *O. uhleri*, it is more common in damper parts of the marsh than its larger and more terrestrial relative *O. grillus*. The females of *Orchestia* sp. (near *costaricana*) can be distinguished from those of *O. grillus* and *O. uhleri* by the absence of lateral spines on the outer ramus of their first uropod.
References: Stebbing (1906); Thomas (1976).

Orchestia platensis Krøyer, 1845
Figure 49

Common Name: Krøyer's Beach Hopper

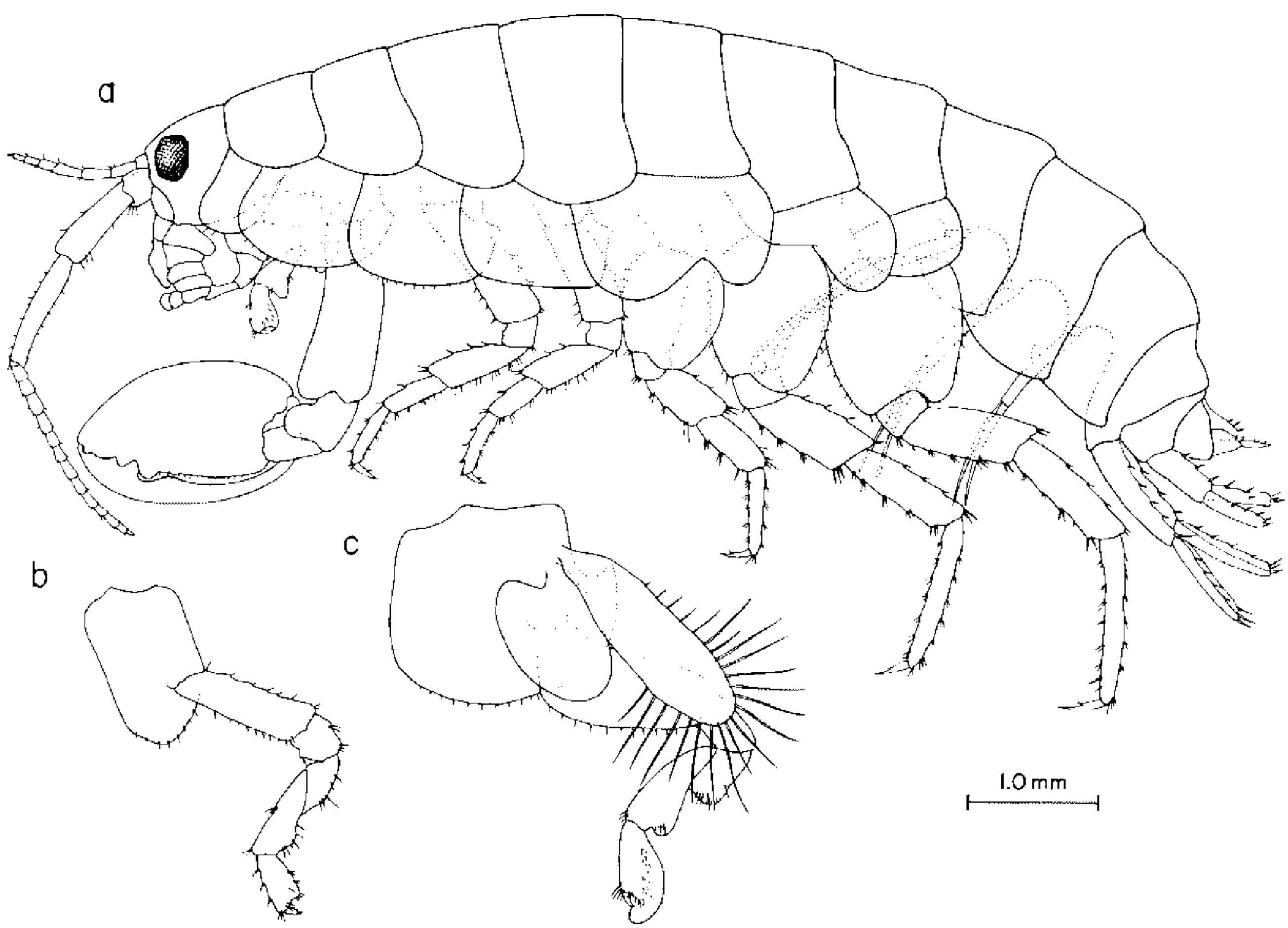


Figure 47. *Orchestia uhleri*. a – adult male; b – first leg of female; c – second leg of female (after Bousfield, 1973).

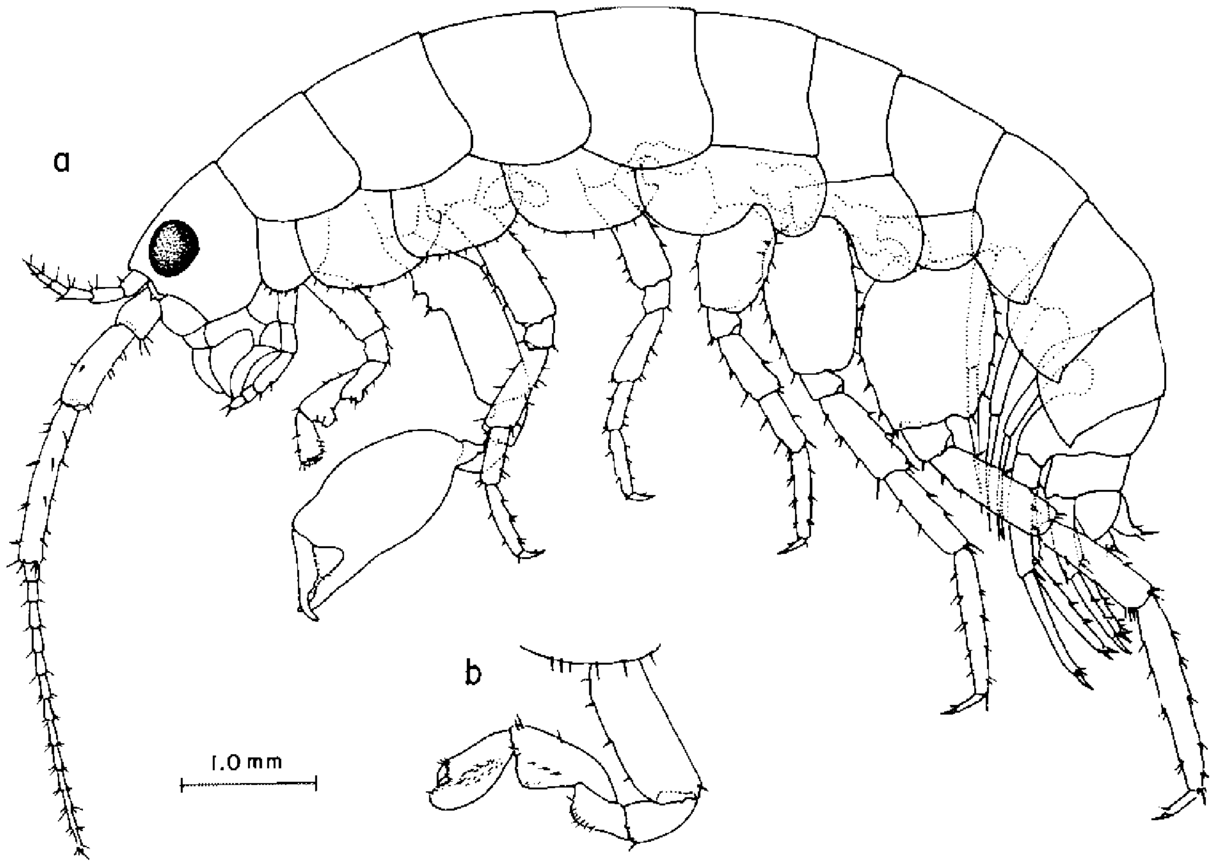


Figure 48. *"Orchestia"* nr. *costaricana.* a – adult male; b – second leg of female (after Bousfield, unpublished).

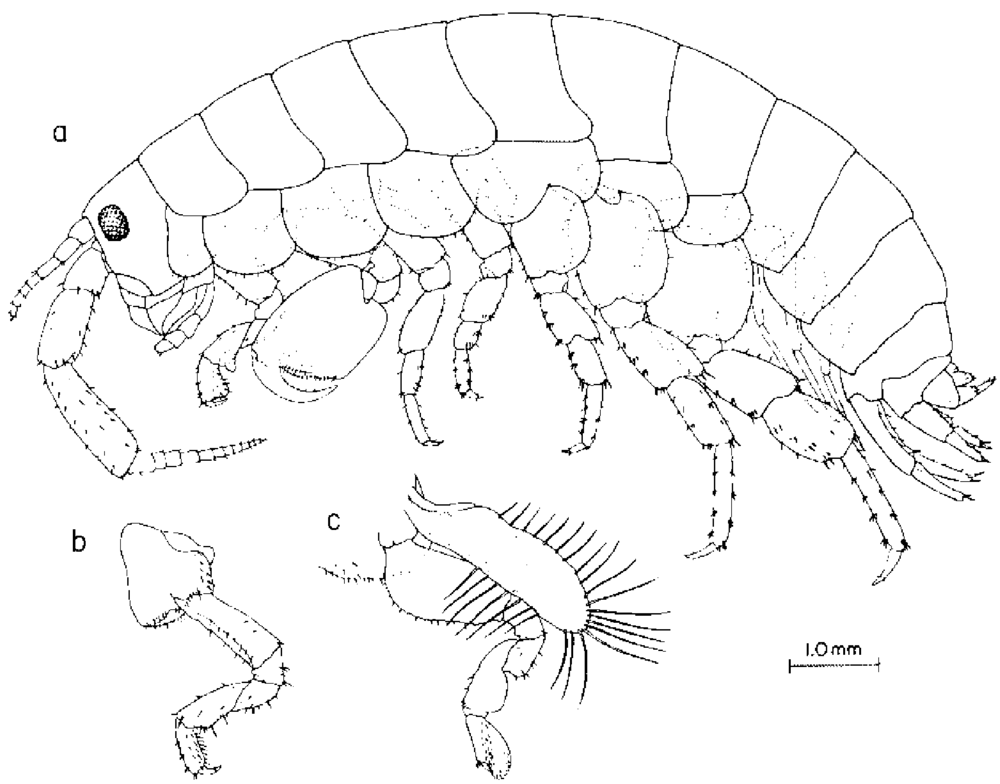


Figure 49. *Orchestia platensis.* a -- adult male; b – first leg of female; c – second leg of female (after Bousfield, 1973).

Synonym: *Orchestia agilis* Smith, 1873
Recognition Characters: Body reaching 12 mm in length; second antenna approximately 3 times longer than first with peduncle segments thickened in adult males; second gnathopod of male with dactyl reaching back less than one half length of palm (propodus); first uropod with outer ramus lacking lateral spines.
Distribution: Widely distributed throughout temperate, subtropical, and tropical coastal areas of the world, nearly cosmopolitan.
Habitat: Euryhaline in upper intertidal and supratidal zones; under dead vegetation and other debris; on sandy shores, usually receiving some wave action.
Remarks: *Orchestia platensis* is a well-known beach species; however, it is also occasionally common along the exposed edges of tidal marshes adjacent to open water. This amphipod comprises a major component of open shore and beach communities and serves as an important food for many species of shore birds.
Reference: Bousfield (1973).

Superorder Eucarida
Order Decapoda

The Decapoda are considered the most advanced group of crustaceans. Approximately 9,000 species are presently known. The order contains the larger and better known crustaceans, such as lobsters, crayfishes, hermit crabs, shrimps, and crabs. The decapod body plan is generally shrimp-like (Caridoid) or crab-like (cancroid). The order is characterized by the following: (1) modification of the first three pairs of thoracic appendages into mouth parts (maxillipeds); (2) five pairs of legs (hence the term "decapods"); (3) a shell or carapace formed from the fusion of the head and thoracic segments covering the head, thorax, and associated coxial gills; and (4) usually planktonic larval stages.
larval stages.

Over 20 different species of decapods occur in or along the edges of tidal marshes of the northern Gulf. In most instances, I follow the taxonomic categories presented in Moore (1969).

Suborder Dendrobranchiata
Infraorder Penaeidea

This group of shrimps is characterized by: (1) the first three pairs of legs being chelate; and (2) the edges of the lower part of the second abdominal segment not overlapping those of the first. The life cycle of the Dendrobranchiata differs from all other groups of decapods. Instead of the female incubating the eggs on her pleopods, the fertilized eggs are released directly into the water. A free-swimming nauplius larva hatches from the egg and, after several molts, metamorphoses into a shrimp-like larval stage called a zoea. The zoea molts several more times before becoming a postlarva. The Penaeidea are the only group of decapod crustaceans known to have a free-swimming nauplius stage, which is usually associated with more "primitive" crustacean groups such as cephalocaridians, copepods, and barnacles.

Family Penaeidae

The family Penaeidae contains several important commercial species. Along the northern Gulf during the warmer months, juveniles of two commerical species of the genus *Penaeus* forage in tidal marshes during high tides and occasionally occur temporarily in the larger marsh pools and ponds.

Members of the genus *Penaeus* breed in offshore waters over the continental shelf. Here the pelagic nauplius and zoeal stages occur. The post-larvae migrate into brackish water bays where they develop into juveniles. Nurtured by the rich food supplies available in the estuarine and adjacent tidal-marshes, the young shrimp grow rapidly. After only three or four months in these estuarine "nursery-grounds," they become subadults, large enough to be caught commercially. The subadults migrate to offshore waters, where they mature into adults that form the breeding stock for the next year's "crop." The Gulf species of *Penaeus* rarely live over one-and-a-half to two years.

Penaeus aztecus Ives, 1891

Figure 50 b, d

Common Name: Brown Shrimp
Recognition Characters: Top of carapace with pair of well-developed grooves extending on either side of rostral keel to near posterior margin.
Distribution: East and Gulf coasts of United States from North Carolina to Texas; Central America; northern South America.
Habitat: Planktonic larvae and adults in shallow offshore waters; post-larvae and juveniles in estuaries.
Remarks: From April through the summer months the postlarvae and juveniles of brown shrimp often forage in or around the tidal marshes. Edible-size juveniles are present in late May and June. They grow rapidly, and as subadults they begin migrating to offshore waters in late June and early July.
References: Farfante (1969); Williams (1965).

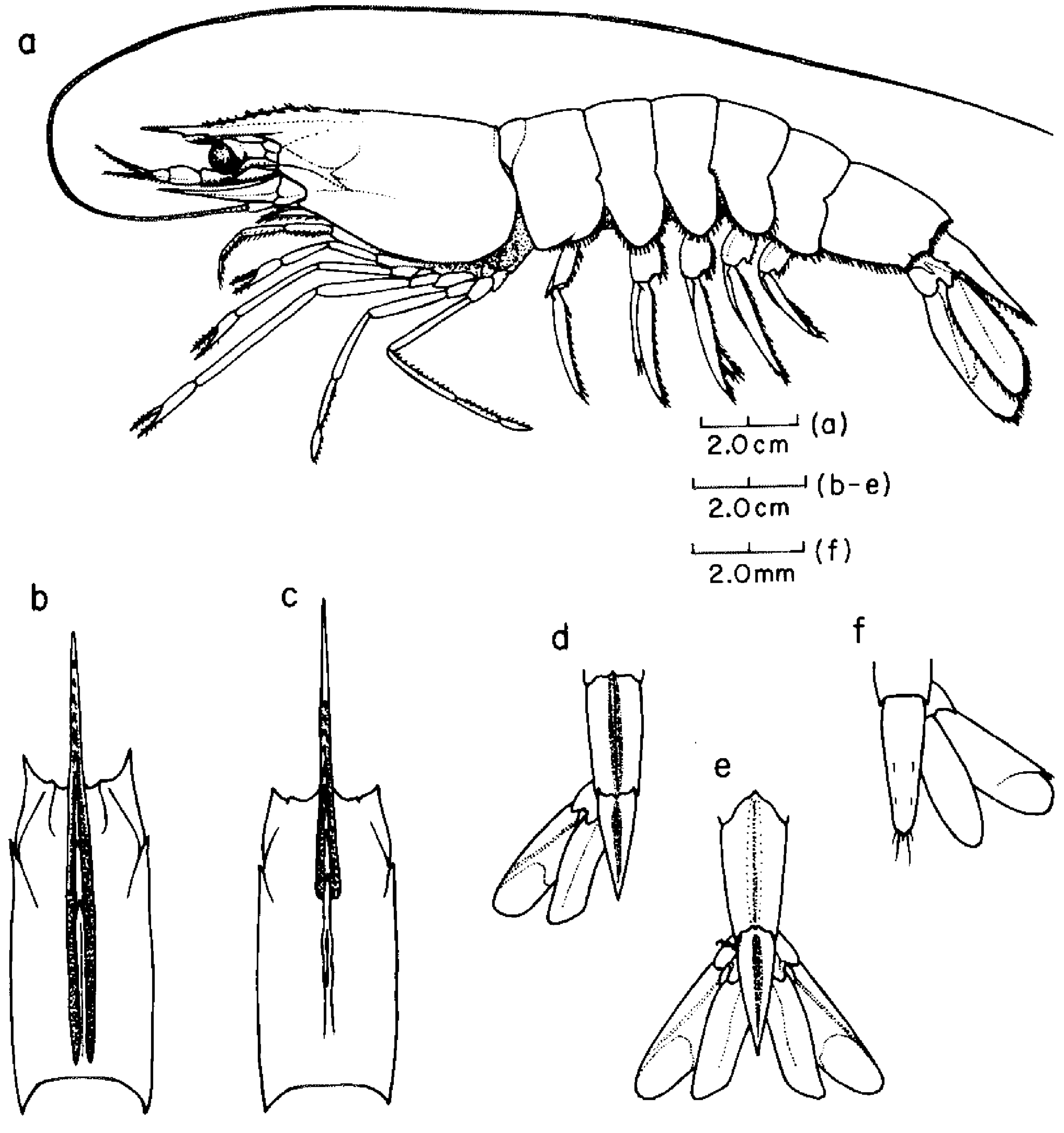


Figure 50. a – *Penaeus setiferus*; b, c – dorsal aspects of the carapaces of *Penaeus aztecus* and *P. setiferus*, respectively; d, e – *P. aztecus* and *P. setiferus*, respectively, dorsal aspects of last (sixth) abdominal segments, uropods, and telsons; f – *Palaemonetes pugio*, dorsal aspect of the telson and uropod (a – after Williams, 1965; b, c – after Farfante, 1969).

Penaeus setiferus (L., 1767)

Figure 50 a, c, e

Common Name: White Shrimp
Synonym: *Penaeus fluviatilis* Say, 1818
Recognition Characters: Pair of grooves on either side of rostral keel not extending into posterior part of carapace.
Distribution: East and Gulf coasts of North America from New York to Texas; Mexico; Cuba; Jamaica.
Habitat: Like that of *Penaeus aztecus.*
Remarks: Like the post-larvae and juveniles of the brown shrimp, white shrimp are seasonally common in northern Gulf estuaries and often feed in tidal marshes during high tides. White shrimp breed one or two months later than brown shrimp and thus the postlarvae of white shrimp arrive in the estuaries later. Juvenile white shrimp usually become numerous in July and August and remain in the bays and estuaries until fall and the advent of cold weather; then as subadults, most leave the estuaries for offshore waters.
References: Farfante (1969); Williams (1965).

Suborder Pleocyemata

Infraorder Caridea

Caridean shrimps differ from penaeids in two ways: (1) carideans have non-chelate third legs; and (2) the pleura of the second abdominal segment of carideans overlaps the first and third segments. Female carideans carry their fertilized eggs on their pleopods. A planktonic nauplius stage is absent, and zoea hatch directly from the eggs.

Family Palaemonidae (Palaemonid Shrimps)

Palaemonetes pugio Holthuis, 1949

Figure 51 a

Common Name: Marsh Grass Shrimp
Recognition characters: .Tip of rostrum blade-like, lacking spines; second legs larger than first with chela lacking teeth; palm (propodus) shorter than carpus in female; branchiostegal spine present; hepatic spine absent.
Distribution: Atlantic and Gulf coasts from Massachusetts to Texas.
Habitat: Euryhaline (less than 1‰ to over 30‰) in bays and tidal creeks; common in shallow water in or around tidal marshes, submerged vegetation, and oyster reefs.
Remarks: *Palaemonetes pugio* is a year-round resident in Gulf coast estuaries. It is eaten by many animals including estuarine fishes, blue crabs, herons, ducks and rails. Marsh grass shrimps are opportunistic feeders and eat a variety of animal and plant matter, including detritus, meiofauna, algae, and dead animal matter.

In addition to the bopyrid isopod *Probopyrus pandalicola* (previously discussed), *Palaemonetes pugio* is parasitized by several other organisms. One of these parasites, a larval trematode, *Carneophallus turgidus* Leigh, 1958, commonly encysts in the abdominal muscles of the grass shrimp. In many instances *C. turgidus* is itself parasitized (hyperparasitized) with a protozoan. The protozoan parasite causes the encysted trematode to swell and turn dark. The hyperparasitized trematodes, which resemble "buck-shot," can be seen with the naked eye through the transparent bodies of infected marsh grass shrimp.

Three other species of grass shrimps, *P. vulgaris* (Say, 1818), *P. paludosus* (Gibbes, 1850), and *P. kadiakensis* (Rathbun, 1902), may also occur in the vicinity of tidal marshes. *Palaemonetes vulgaris* (Fig. 51 c, d) is distinguished from *P. pugio* by the following: (1) *P. vulgaris* has a rostrum with teeth nearly reaching the tip; (2) the palm of the second leg of the female *P. vulgaris* is distinctly longer than the carpus; and (3) *P. vulgaris* has small teeth on the chela of its second legs (two on the movable finger and one on the fixed finger). Although *P. pugio* and *P. vulgaris* occasionally occur together around oyster reefs adjacent to the salt marshes, *P. vulgaris* usually is more commonly associated with fouling organisms (barnacles, hydroids) on dock pilings and shell bottoms. *Palaeomonetes vulgaris* is also more sensitive to low salinities and usually does not occur in waters below 10‰.

Palaemonetes paludosus and *P. kadiakensis* replace *P. pugio* in the freshwater tidal marshes adjacent to the mouths of rivers. All three species, however, may occasionally occur together in oligohaline conditions. Distinguishing characters for separating these three species are presented in the key and illustrated in Fig. 51 a, e, f.

Another palaemonid shrimp, *Macrobrachium ohione* (Smith, 1874), may also be found with *P. pugio* in oligohaline tidal marshes, especially those adjacent to the mouth of the Mississippi River. The juveniles of *M. ohione* are similar to adult *P. pugio,* but the presence of a hepatic spine and the lack of a branchiostegal spine on *M. ohione* (Figure 51 g) readily separates the two forms.
References: Holthuis (1952); Overstreet (1978); Welsh (1975); Williams (1965).

Infraorder Anomura

The anomurans comprise a morphologically diverse group of crustaceans which include the hermit crabs, mud shrimps, mole crabs, and porcellanid crabs. One species of hermit crab commonly occurs in salt marshes bordering open bays and large bayous. Also, three species of mud shrimps, *Upogebia affinis* (Say, 1818), *Callianassa jamaicense* Schmitt, 1935, and *Callianassa trilobata* Biffar, 1971, which live in deep burrows, occur in the substrata along the edges of tidal marshes of the northern Gulf. These three mud shrimps are not discussed below, but are included within the taxonomic key.

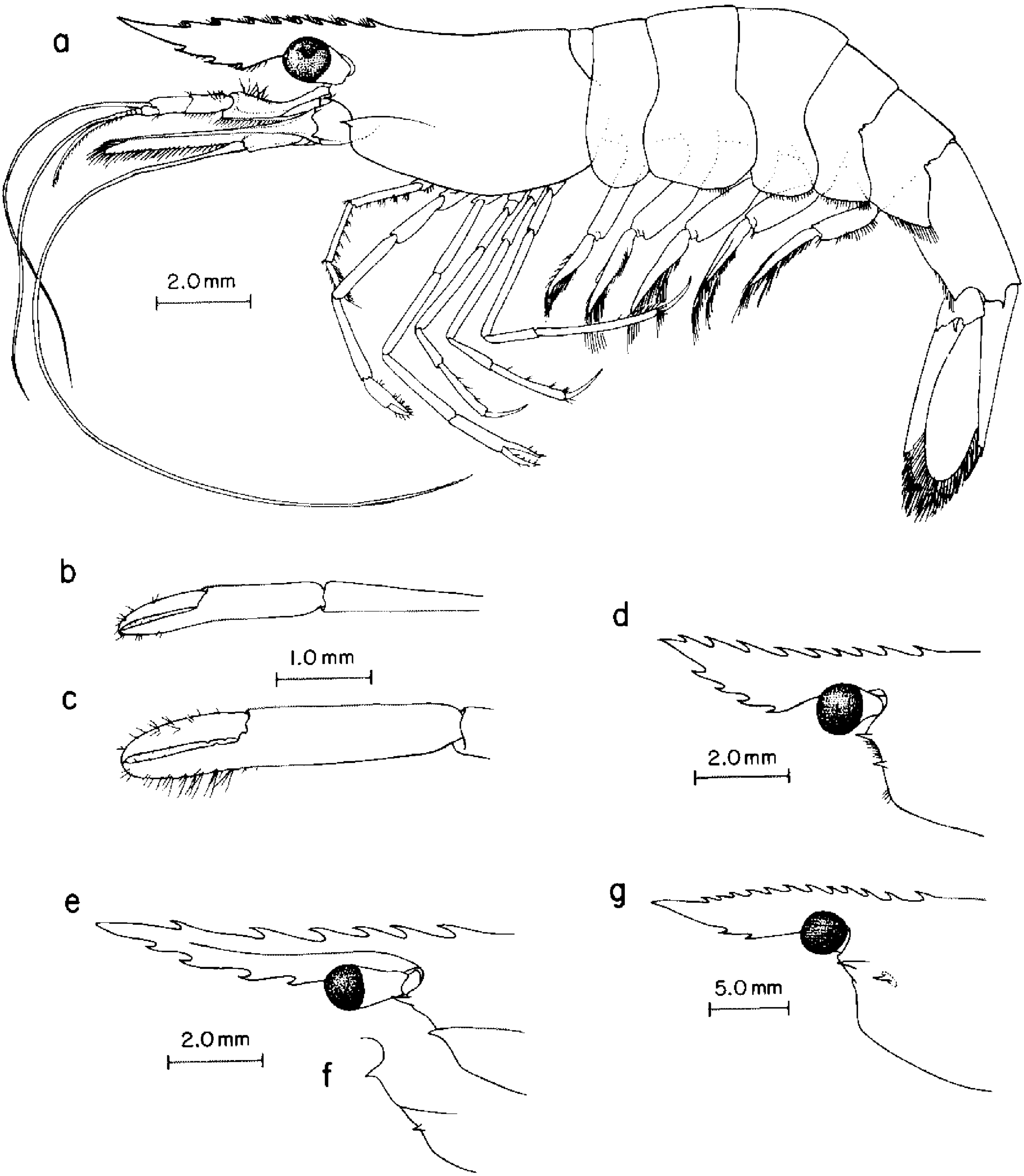
a


Figure 51. a – *Palaemonetes pugio*; b, c – *P. pugio* and *P. vulgaris*, respectively, chelae of second legs; d-g – lateral aspects of the rostra and anterior parts of the carapace; d – *P. vulgaris*; e – *P. paludosus*; f – *P. kadiakensis*; and g – *Macrobrachium obione*. (e, f – after Holthuis, 1952).

Family Diogenidae (Diogenid Hermit Crabs)

Clibanarius vittatus (Bosc, 1801 or 1802)

Figure 52

Common Name: Striped Hermit Crab
Recognition Characters: Abdomen asymmetrical, modified for occupying gastropod shells; chelipeds nearly equal in size; walking legs with 4 pairs of light, longitudinal stripes.
Distribution: Atlantic and Gulf coasts of North America; Central America, and South America from Virginia to Brazil (Rio de Janeiro).
Habitat: Shallow subtidal to intertidal zone; mesohaline to polyhaline (10‰ to over 35‰); common on rock jetties, protected beaches, and in salt marshes near the open Gulf.
Remarks: The adults and especially the juveniles of this common hermit crab are often present in tidal marshes near the Gulf. In salt marshes, juveniles usually occupy the shells of Marsh Periwinkles and Olive Nerites, whereas the adults most often utilize the shells of Oyster Drills, Crown Conchs, and Moon Snails. The Striped Hermit Crab is an omnivorous scavenger.
References: Williams (1965).

Infraorder Brachyura (Crabs)

The Brachyura, or true crabs, have reduced abdomens that lack uropods and are tightly flexed underneath their cephalothoraces. These features distinguish brachyurans from the superficially similar porcellanid "crabs" of the infraorder Anomura, which have "free-flapping" abdomens with uropods. Four families of crabs, represented by at least 15 different species, occur on or along the edges of northern Gulf tidal marshes.

Family Portunidae (Swimming Crabs)

Callinectes sapidus Rathbun 1896

Figures 53,54

Common Name: Common Blue Crab
Recognition Characters: Last pair of legs with terminal segment oval and flattened, modified for swimming; carapace with posterior-most, lateral spine sharp, strongly developed; four notches on frontal margin between eyes; chelipeds of females and subadult males with red area on palm.
Distribution: East and Gulf coasts of North America, Central America, and South America from Massachu-

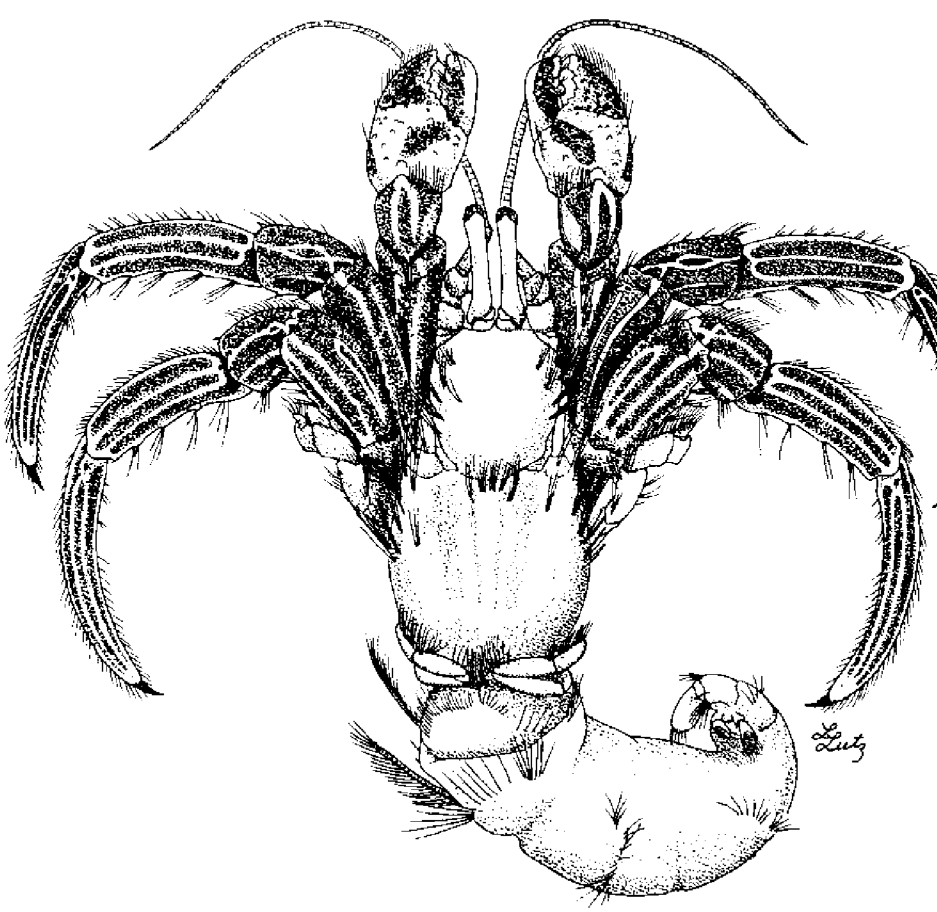


Figure 52. *Clibanarius vittatus* removed from a gastropod shell, large adult life size.

setts to southern Brazil; Bermuda; West Indies.
Habitat: Euryhaline (less than 1‰ to more than 35‰); throughout all estuarine intertidal and subtidal habitats.
Remarks: The blue crab is the most common large estuarine crab in the northern Gulf and supports an important commercial fishery. After mating and a period of feeding in the estuary, the adult females form an egg mass which is attached to the pleopods under the abdomen. Ovigerous females are often called "sponge" crabs because their large egg masses resemble sponges. A single "sponge" crab may carry

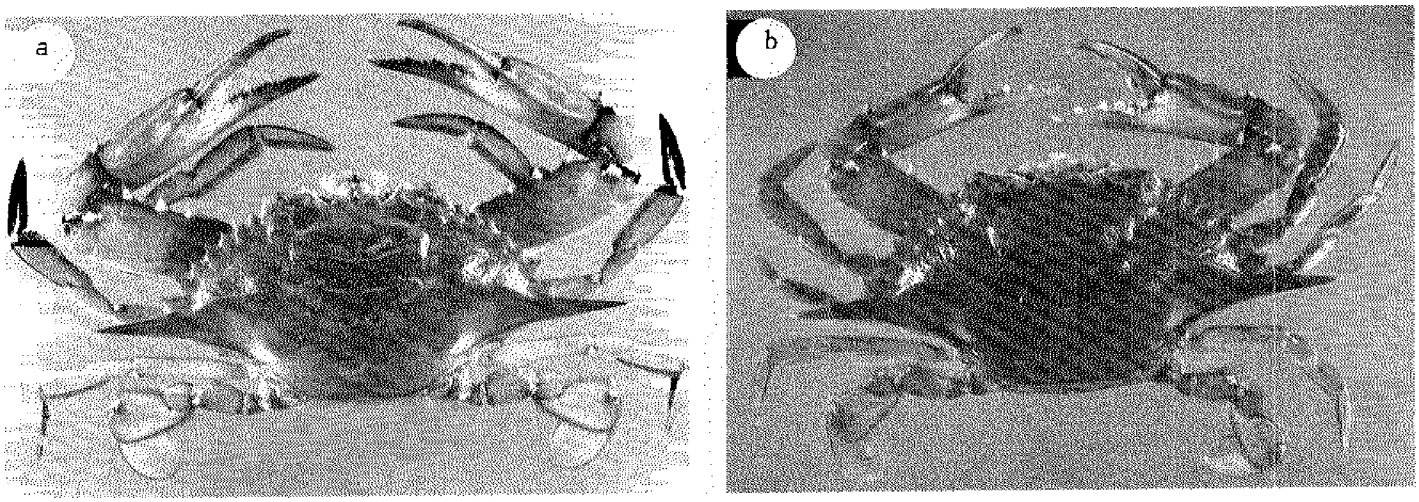


Figure 53. *Callinectes sapidus*, dorsal aspects. a – adult male; b – adult female.

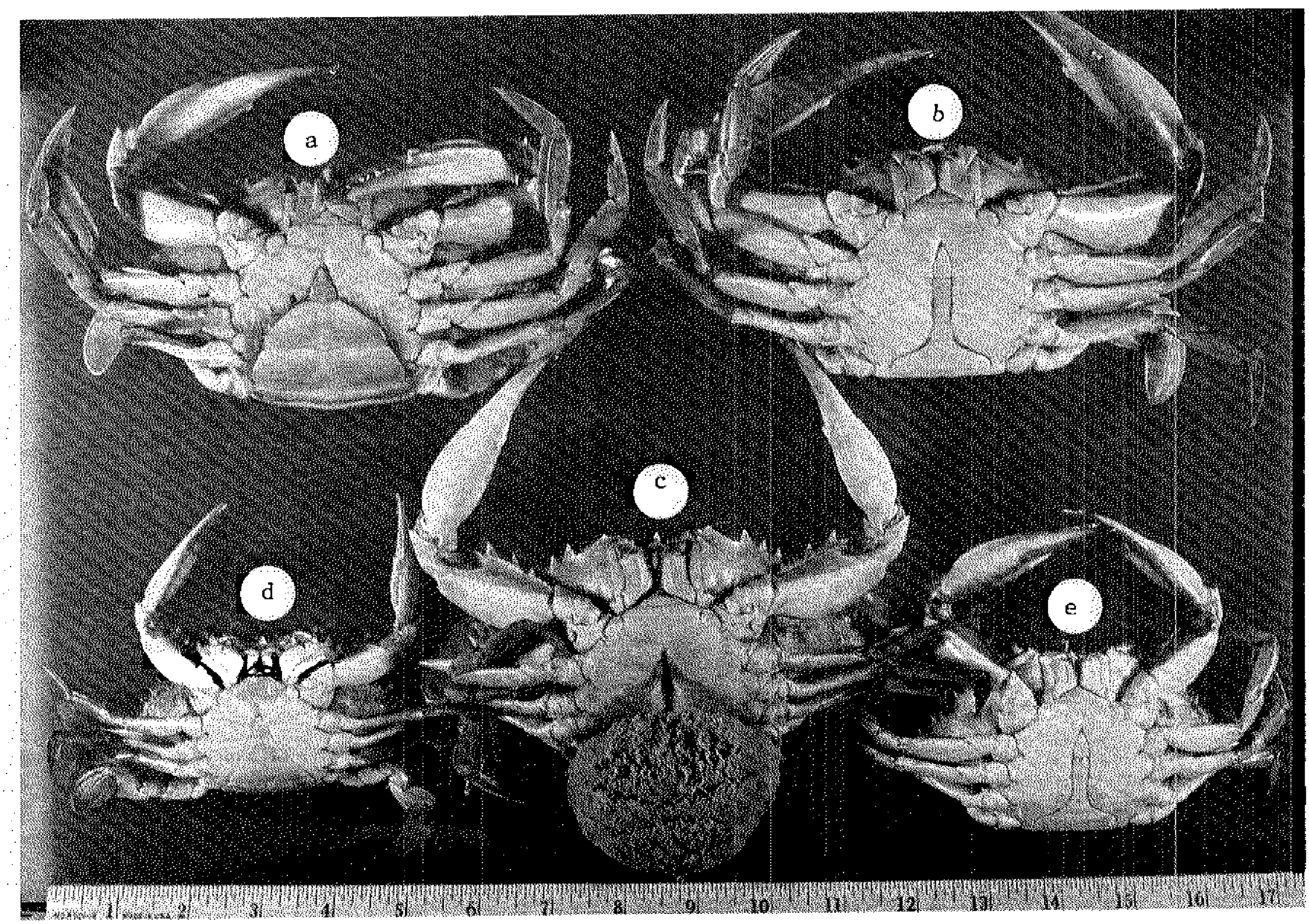


Figure 54. *Callinectes sapidus*, ventral aspects. a – adult, non-ovigerous female; b – adult male; c – adult ovigerous female; d – immature female; e – immature male.

from 700,000 to over 2,000,000 fertilized eggs. During the warmer months egg-bearing females migrate into the higher salinity waters around the mouths of bays or just offshore where salinities are optimal for hatching of their eggs and survival of the larvae. Seven zoeal larval stages and one megalopal stage (an intermediate stage between the shrimp-like zoea and the first juvenile crab stage) usually occur in the life cycle of *C. sapidus.*

Blue crabs are omnivores and voracious feeders, eating a variety of foods including detritus, snails, oysters, clams, other crabs (including their own species), and decaying animal matter. In tidal marshes, fiddler crabs and marsh periwinkles are important parts of their diets. On several occasions I have observed blue crabs concealed in the marsh mud in areas where fiddler crabs (*Uca* spp.) were feeding. When a fiddler crab, unaware of a blue crab's presence, came too close, the blue crab quickly lifted its claws out of the mud and grabbed the unsuspecting prey. Once I saw a blue crab quickly scuttle out of the water, grab a fiddler from a marsh bank, and immediately scuttle back into the water with its meal. Studies on the behavior of *L. irrorata* indicate that their movements up marsh grass stalks as the tide rises may be due at least in part to an "escape" reaction to avoid predation by blue crabs.

In addition to the blue crab, a smaller species of *Callinectes*, the lesser blue crab *C. similis* Williams, 1966, occurs around the mouths of estuaries where salinities are generally higher than 20‰.

Occasionally juveniles of this species occur in sandy areas along edges of *Spartina* marshes of the outer islands. The lesser blue crab lacks red pigment on the palms of its bright blue claws and has six frontal notches between the eye orbits, features which distinguish it from similar sized immature *C. sapidus.*

References: Costlow and Bookhout (1959); Hamilton (1976); Overstreet (1978); Perry (1975); Tagatz (1968); Tagatz and Hall (1971); Williams(1965, 1966, 1974).

Family Xanthidae (Mud Crabs)

The tidal marsh members of this large family are generally characterized by having transversely oval bodies, no distinct rostrums, the last pair of legs unmodified, and from three to five anterolateral teeth on their carapaces. Mud crabs usually have 4 zoeal larval stages.

Panopeus herbstii H. Milne Edwards, 1834

Figures 55, 56

Common Name: Common Mud Crab

Recognition Characters: Major claw with well-developed tooth (or tubercle) on movable finger (dactyl); fingers of claw dark; bright red spot on inner surface of third maxilliped of all males.

Distribution: Eastern Atlantic and Gulf of Mexico from Massachusetts to Brazil; Bermuda.

Habitat: Bays and estuaries; mesohaline and polyhaline (less than 10‰ to over 35‰) on a variety of subtidal and intertidal substrata.

Remarks: Two distinct forms of this species are present in or adjacent to northern Gulf tidal marshes. Simpson's mud crab, *Panopeus herbstii* forma simpsoni Rathbun, 1930, is predominantly an oyster associate that occurs subtidally and intertidally along the edges of salt marshes where oysters are present. It is usually found with another xanthid oyster associate, *Eurypanopeus depressus* (Smith, 1869). Although superficially similar to Simpson's mud crab, *E. depressus* is smaller, lacks large tubercles on the movable finger of its major claw, has a spoon-shaped tip on the fixed finger of the minor claw and has a red spot on the inner face of the third maxilliped of both males and females. Only the males of Simpson's mud crab have this red spot (Fig. 55 c).

Simpson's mud crabs often excavate shallow burrows under clumps of oysters. This mud crab preys on oyster spat, young oysters, and a variety of other organisms. Estuarine fishes, including the Gulf toadfish, red drum, and sheepshead often feed on Simpson's mud crabs.

The second form, the Obese Mud Crab, *P. herbstii* forma obessa (Smith, 1869), which is larger and more darkly colored than Simpson's mud crab, often builds extensive burrows and galleries under the banks along the edges of salt marshes. Although it can occur with Simpson's mud crab in oyster habitats, in the northern Gulf the obese mud crab is primarily an intertidal form associated with tidal marshes.

The obese mud crab occurs in association with three other marsh crabs, *Eurytium limosum, Sesarma reticulatum* and *Uca longisignalis.* Like Simpson's mud crab, the obese mud crab is an opportunistic feeder. It is a major predator on marsh periwinkles and preys on other marsh crabs, especially fiddler crabs. In turn it is eaten by raccoons, red drum and toadfish. Studies being conducted by Robert Reames in Alabama indicate that the obese mud crab is a distinct species, which can be distinguished from Simpson's mud crab by a deeper body, larger eyes, blunter anterolateral teeth, a darker and more convex carapace, and like *Eurypanopeus depressus* a red spot on the third maxilliped of the female (Fig. 56 c). It dif-

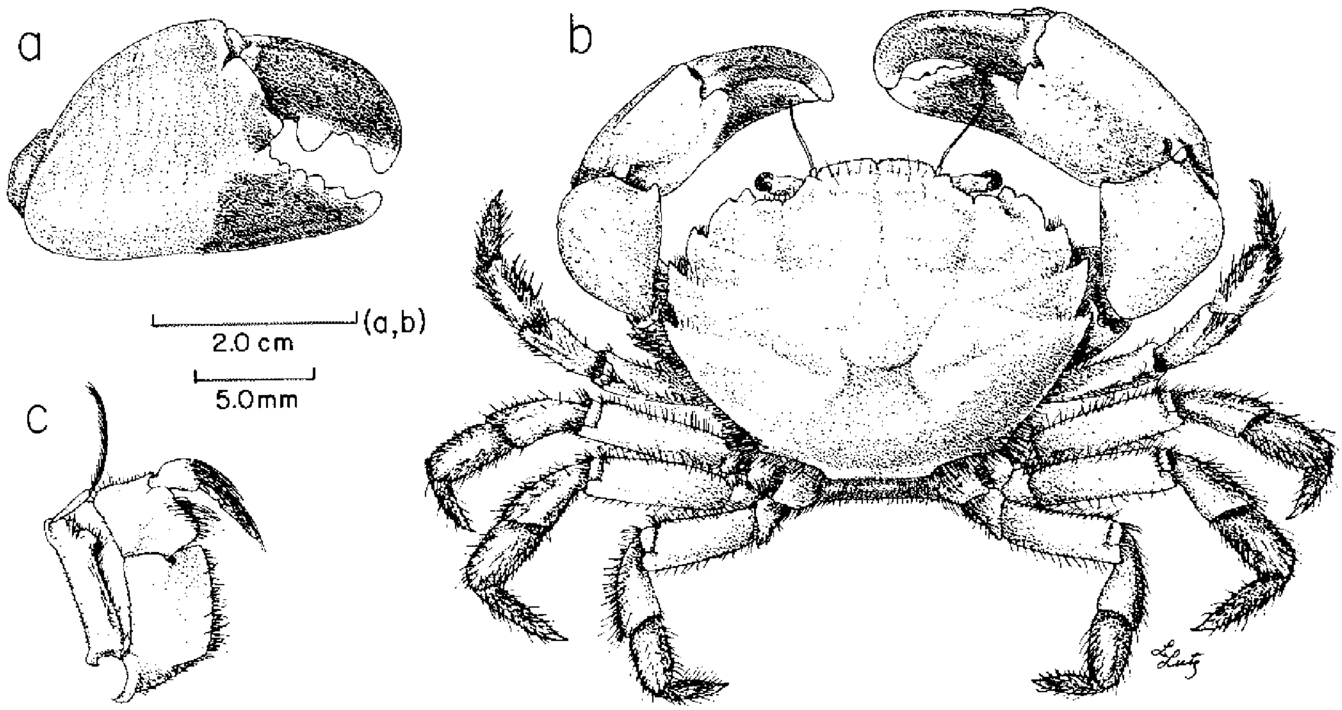


Figure 55. *Panopeus herbstii* forma *simpsoni*. a – male major chela, lateral aspect; b – adult male, dorsal aspect; c – inner face of female third maxilliped lacking red spot.

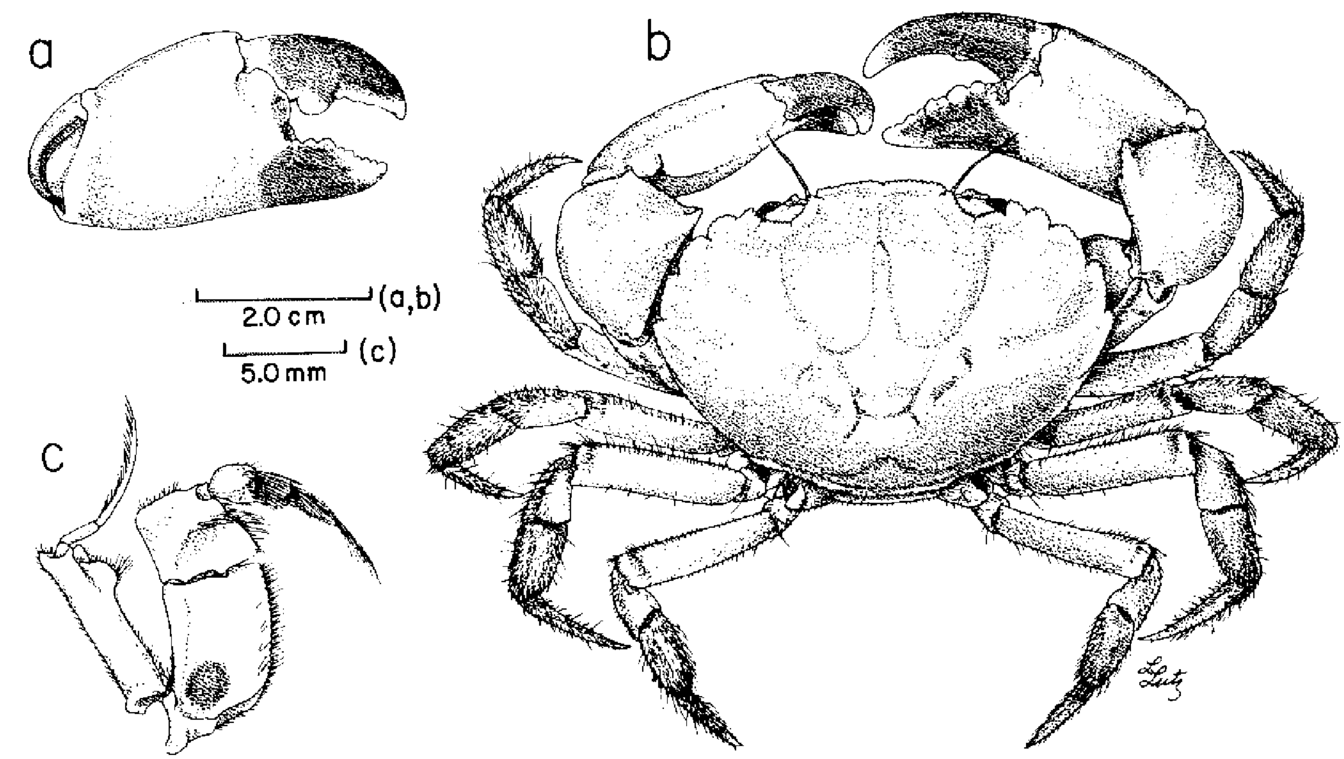


Figure 56. *Panopeus herbstii* forma *obessa*. a – male major chela, lateral aspect; b – adult male, dorsal aspect; c – inner face of female third maxilliped with red spot on first segment of exopod.

fers from *E. depressus* by its much larger size, the presence of a large pronounced tooth on the movable finger of the large claw, and the lack of a "spoon-shaped tip" on the fixed finger of the small claw.

Eurytium limosum (Say, 1818)
Figure 57

Common Name: White-Clawed Mud Crab
Recognition Characters: Carapace purplish blue, smooth, reaching over 36 mm in width; chela with fingers white, except for pink or purple coloration on proximal upper part of moveable finger; lower part of palm yellow or orange; first anterolateral tooth of carapace weakly developed, flattened, coalescing with external, orbital tooth; moderate-sized tooth at base of moveable finger.
Distribution: Western Atlantic and Gulf of Mexico from South Carolina to Brazil (Sao Paulo); Bermuda.
Habitat: Mesohaline to polyhaline; intertidal in muddy substrata of salt marshes and mangrove swamps.
Remarks: This colorful and secretive mud crab constructs deep vertical burrows in tidal mud and is often found associated with the obese mud crab, purple marsh crab, and Gulf mud fiddler crab. It leaves its burrow to search for food during darkness or at high tide when its burrow is covered with water. White-clawed mud crabs are thought to be carnivorous, but little information on their feeding habits and biology is available.
References: Teal (1959); Williams (1965).

Rhithropanopeus harrisii (Gould, 1841)
Figure 58

Common Name: Harris's Mud Crab
Recognition Characters: Claws with fingers light, nearly white; carapace up to 20 mm in width, surface with several transverse rows of granules, frontal margin with a shallow groove (Fig. 58 c).
Distribution: Western Atlantic and Gulf coasts from Canada to northeast Brazil; introduced on West coast of North America and in Europe.
Habitat: Tidal fresh water to 20‰; intertidal and subtidal in mud banks and grass beds, on pilings, among shells, under debris.
Remarks: This little mud crab is the only xanthid in the northwestern Atlantic region that can tolerate freshwater and oligohaline conditions.

Harris's mud crab eats a variety of foods, including detritus, small crustaceans, mollusks, and decaying animal matter. *Rhithropanopeus* is eaten by several predators, especially blue crabs, sparid and sciaenid fishes, rails, and raccoons.

The larvae of *R. harrisii* have been the subject of a number of experiments testing the effects of varying temperatures, salinities, conditions, and toxic substances on crab larval development.
References: Costlow *et al.* (1966); Odum and Heald (1972); Williams (1965).

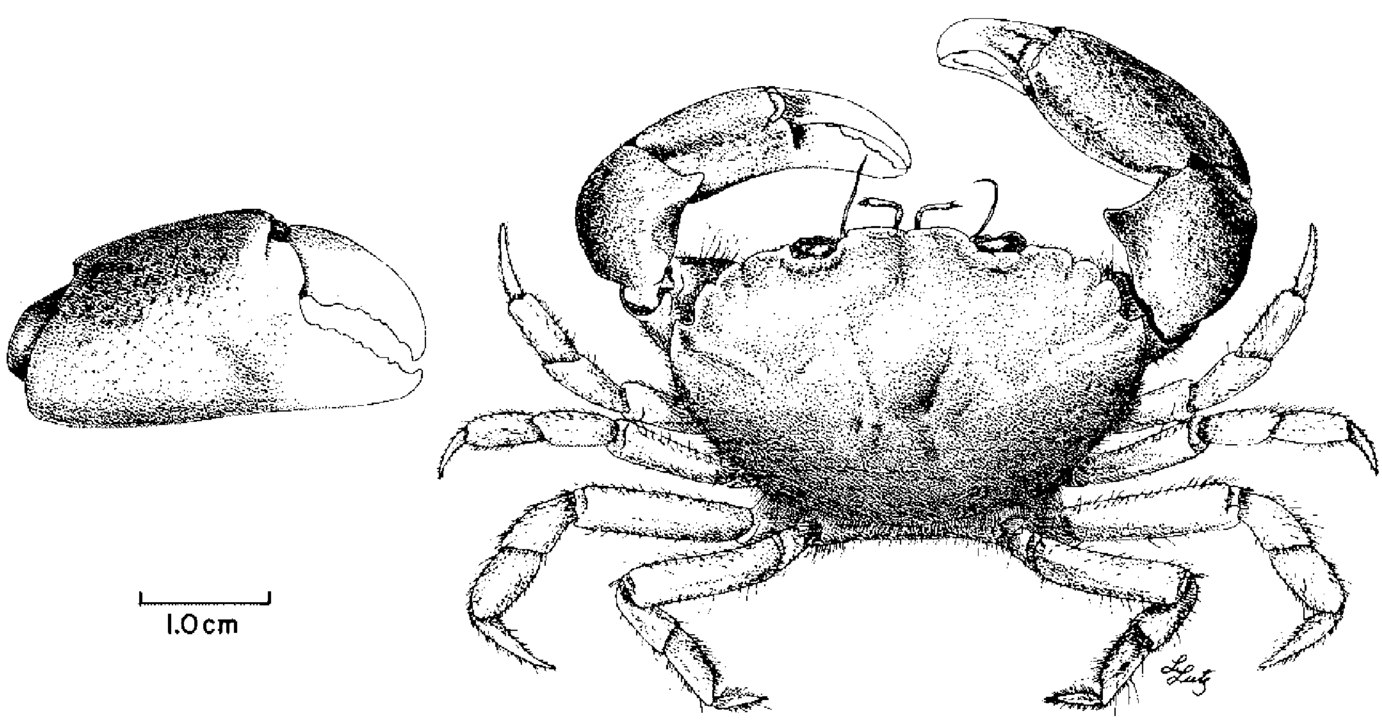


Figure 57. *Eurytium limosum* a – male major chela, lateral aspect; b – adult male, dorsal aspect.

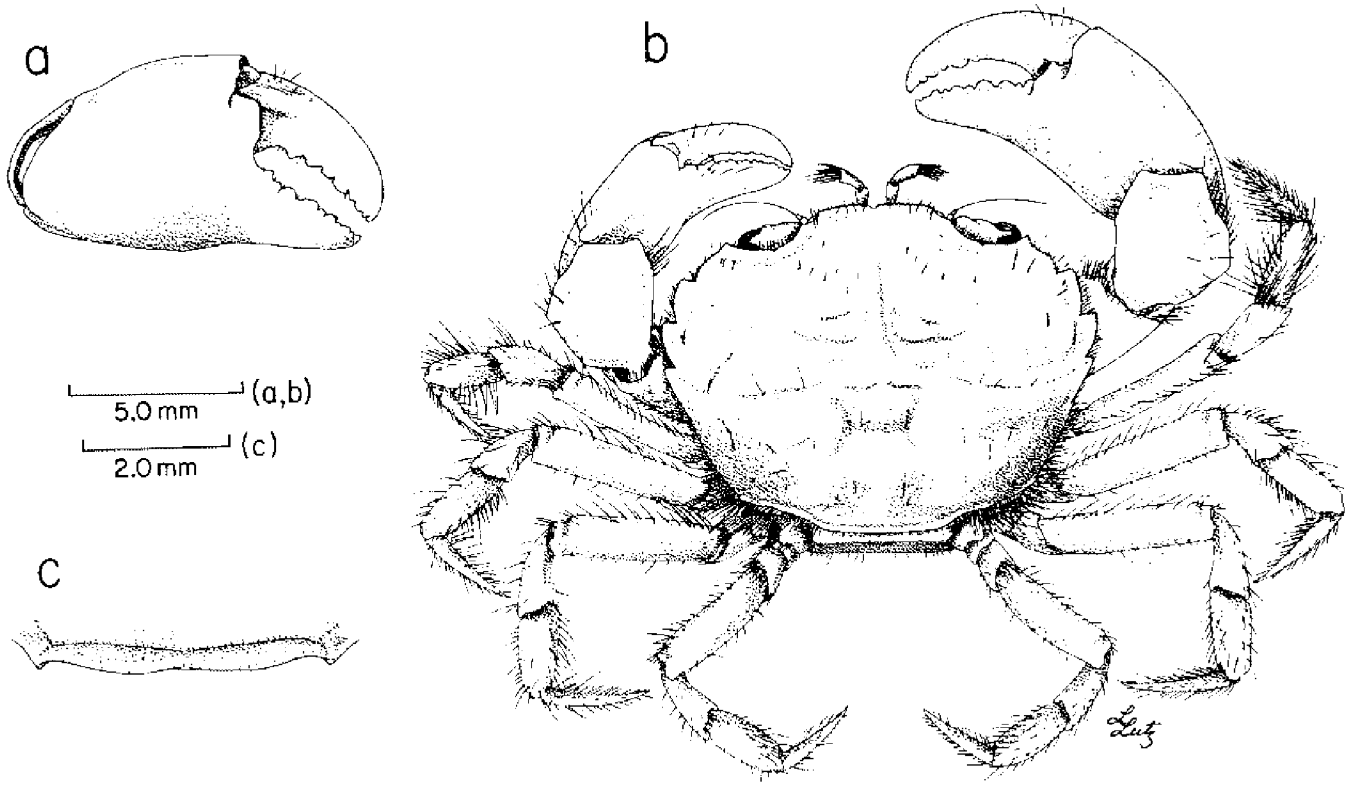


Figure 58. *Rhithropanopeus harrisii.* a – male major chela, lateral aspect; b – adult male, dorsal aspect; c – frontal margin of carapace.

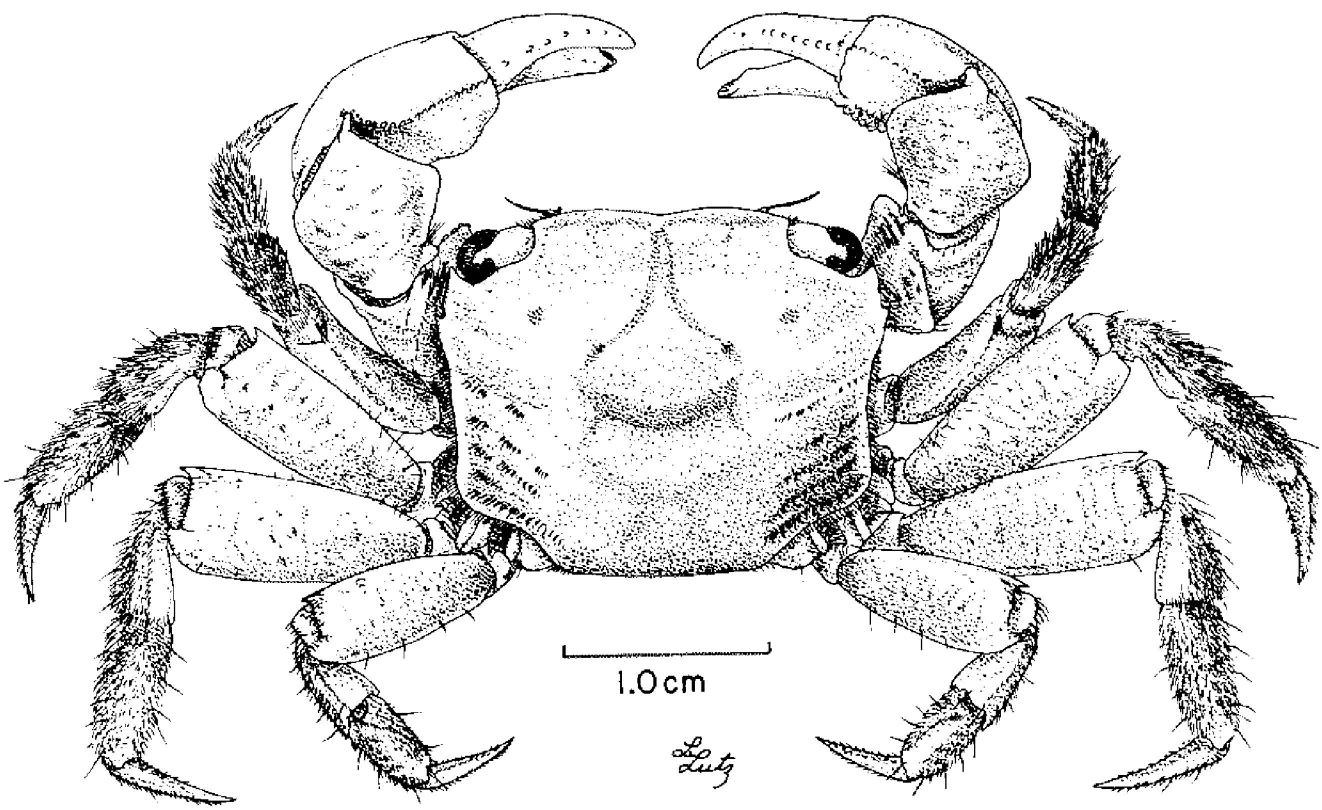


Figure 59. *Sesarma reticulatum,* adult male.

Family Grapsidae

Sesarma reticulatum (Say, 1818)

Figure 59

Common Name: Purple Marsh Crab

Recognition Characters: Carapace convex, reaching 28 mm in width, with a blunt spine or tubercule on anterior lateral margins, each chelae with upper inner edge of carpus having well-defined ridges of tubercles running its length; upper surface of fingers on male claws with row of several tubercles (such tubercles indistinct or lacking in females); last 3 articles of walking legs with thick clusters of fine, hair-like setae or pubescent.

Distribution: Atlantic and Gulf coasts (excluding southern Florida) from Massaachusetts to Texas.

Habitat: Intertidal mud of marshes and marsh banks; euryhaline.

Remarks: The common name for this grapsid crab is misleading, since only large adults, especially males, are purplish in color. It is a common tidal marsh species which constructs networks of burrows, some with corridors reaching over two feet in length. *Sesarma reticulatum* feeds directly on living marsh plants *(Spartina alterniflora)* and also eats fiddler crabs, detritus, and algae. Purple marsh crabs are consumed by some of the larger marsh predators, including blue crabs, rails, and raccoons. Ovigerous females occur during the warmer months (April through September). The larval development of *S. reticulatum* involves three zoeal stages and one megalopal stage.

References: Abele (1973); Costlow and Bookhout (1962); Crichton (1960, 1967); Williams (1965).

Sesarma cinereum (Bosc, 1801 or 1802)

Figure 60

Common Name: Wharf Crab, Friendly Crab, Square-Backed Crab.

Recognition Characters: Carapace flattened, reaching 23 mm in width with antero-lateral margins straight; chela with upper, inner edge of carpus lacking ridge of tubercules; last three articles of walking legs not pubescent.

Distribution: Atlantic and Gulf coasts of North and Central America, from Maryland to Mexico (Vera Cruz).

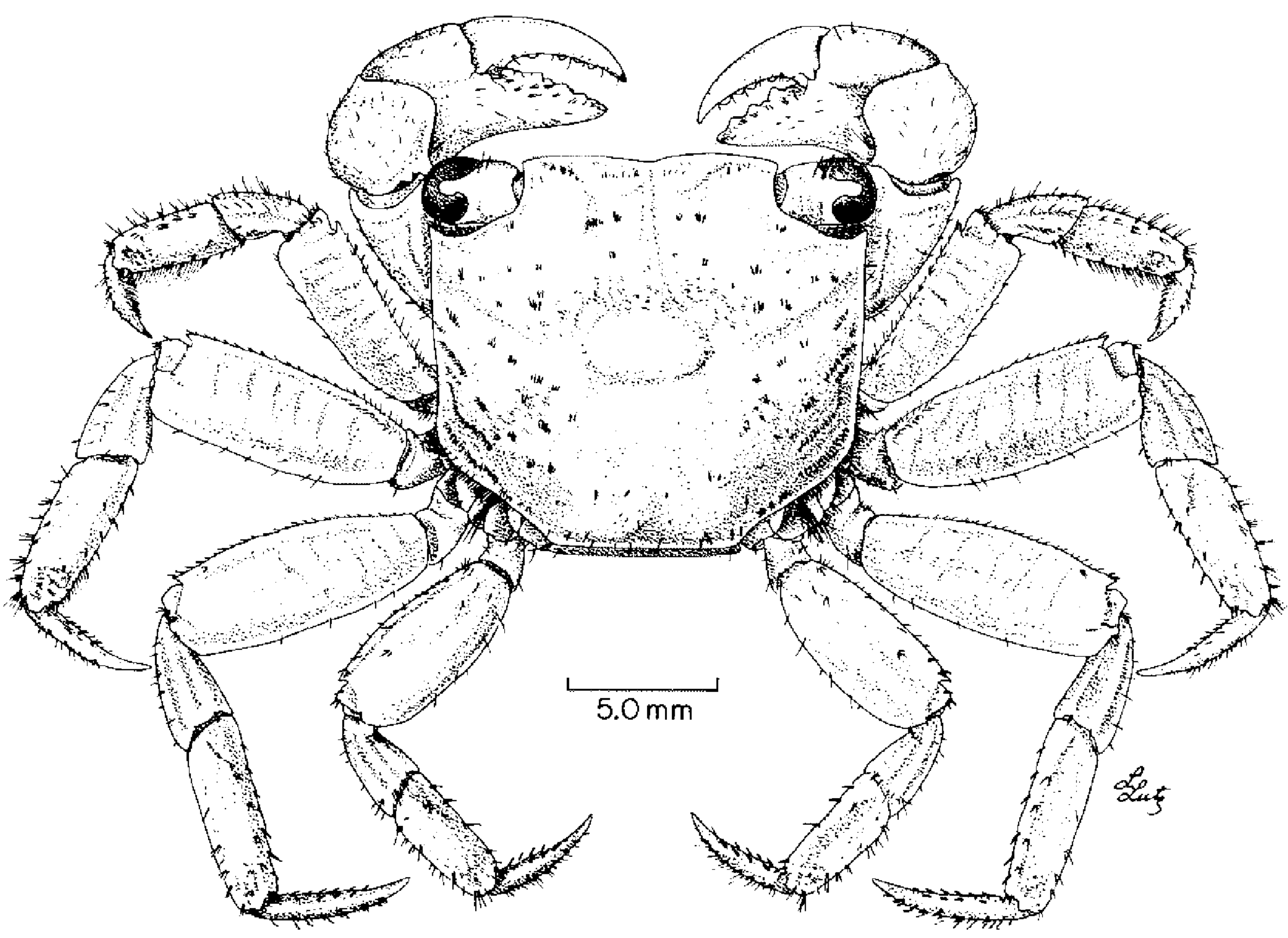


Figure 60. *Sesarma cinereum*, adult.

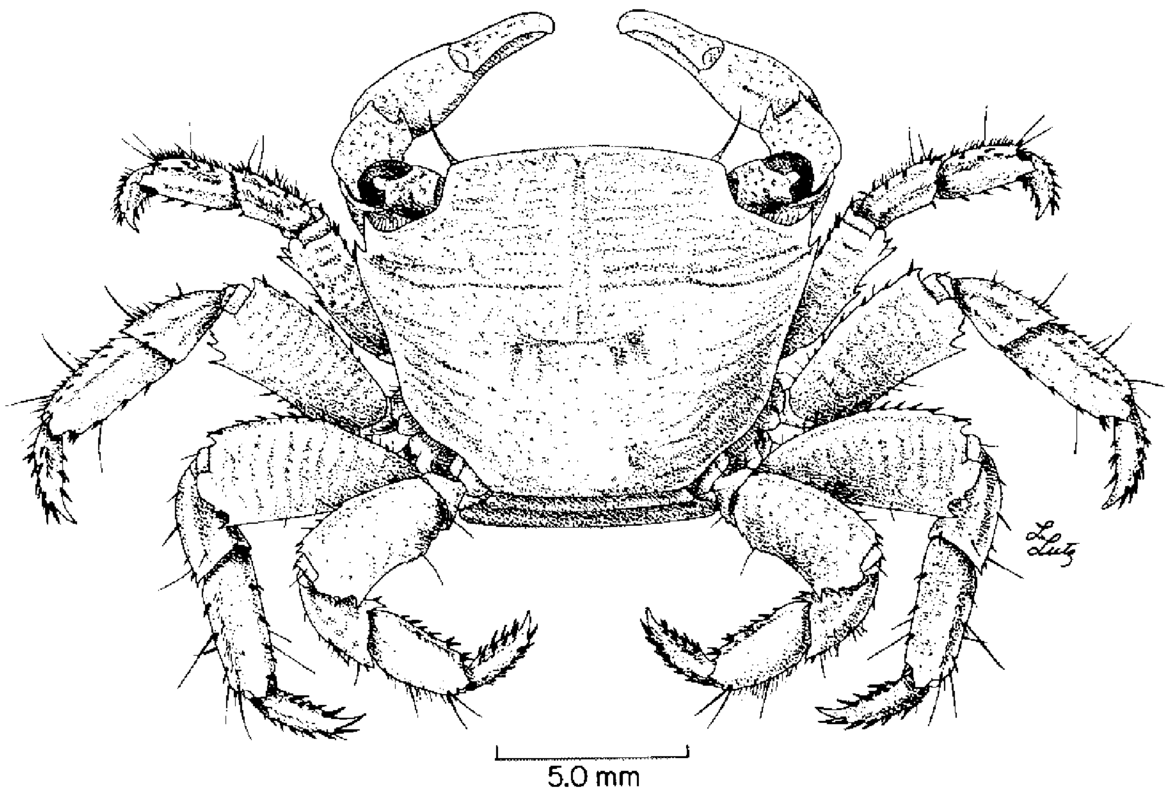


Figure 61. *Pachygrapsus transversus*, adult.

Habitat: Intertidal and supratidal; euryhaline; edges of tidal marshes and on rock jetties and docks.
Remarks: Square-backed fiddler crabs are common along the northern Gulf coast. They will forage in terrestrial areas more than 100 yards inland from the intertidal zone. In areas near the shore they are often seen on roads, around houses, and sometimes, in houses, which is the reason they are called "friendly crabs." The only other crab commonly occurring with *Sesarma cinereum* in similar terrestrial areas along the northeastern Gulf is the fiddler crab *Uca minax*.

Each crab has its own shallow burrow or den, usually under plant debris or drift wood in the upper intertidal or supratidal zones.

Square-backed crabs are scavengers, feeding largely on decaying animal and plant matter. Predators of *S. cinereum* include seaside sparrows, raccoons, and clapper rails.

Like *S. reticulatum*, ovigerous females of *S. cinereum* occur during the warmer months; however, there are four zoeal stages and one megalopal stage in the larval development of *S. cinereum*.
References: Abele (1973); Costlow and Bookhout (1960).

Pachygrapsus transversus (Gibbes, 1850)
Figure 61

Common Name: Mottled Shore Crab
Recognition Characters: Carapace reaching 14 mm in width; distinctly tapering posteriorly, antero-lateral margin with strong spine; distal segments of walking legs not pubescent; carapace with numerous transverse lines.
Distribution: Throughout tropics, North America from North Carolina to Mexico.
Habitat: Intertidal on or under rocks, debris, pilings; among exposed mangrove and salt marsh roots; mesohaline to polyhaline (15‰ to 36‰).
Remarks: The mottled shore crab is not common in the northern Gulf of Mexico; however, it and the closely related *Pachygrapsus gracilis* (Saussure, 1858) are often found associated with pilings and rock jetties on or near the open Gulf. Twice I have collected single subadult specimens of *P. transversus* among the exposed roots of *Spartina alterniflora* on the west shore of Mobile Bay (Dauphin Island Causeway). I consider its occurrence in salt marshes of the northern Gulf to be sporadic and rare.
References: Felder (1973); Williams (1965).

Family Ocypodidae

Ocypodid crabs, which are considered one of the more highly evolved and advanced groups of decapods, make up an important part of the intertidal fauna of tropical and subtropical areas of the world. Along the northern Gulf two genera of this Family are present. One of these genera, *Ocypode,* is only represented by a single species, the ghost crab *O. quadrata.* Ghost crabs are found on open beaches and are not associated with tidal marshes. Members of the second genus *Uca,* represented by at least seven species in the northern Gulf, are common in or adjacent to tidal marshes. The males of this genus have one claw greatly enlarged. The male crab uses his large claw in courtship and in combat against other males during terrestrial disputes. Courting males wave their large claws in rhythmic patterns which are unique to each species of *Uca.* The movements involved during waving or courtship display often resemble fiddling movements, hence the common name "fiddler crab" or "fiddler" for members of the genus.

Fiddlers are deposit feeders and scavengers, ingesting a variety of food including detritus, nematodes, bacteria, fungi, algae, and decaying animal matter. The females have both their small claws adapted for feeding. The male cannot use his large claw for feeding, therefore, he must use the small claw much more rapidly in order to eat the same amount as a female during the same period of time.

Fiddler crabs make up an important part of the diet of many coastal animals, including blue crabs, mud crabs, purple marsh crabs, red drum, diamondback terrapins, willets, gulls, rails, herons, rice rats, and raccoons.

The taxonomy of fiddler crabs occuring in the northern Gulf of Mexico is confusing. In recent years, three new species *(Uca panacea, U. longisignalis,* and *U. virens)* have been described from this region, and the taxonomic validity of these is still unsettled (see Heard, 1977; Hagen, 1976, 1980). Pending additional taxonomic and ecological studies, I tentatively recognize seven species of *Uca* occuring in tidal marsh areas of the northern Gulf of Mexico.

Uca pugilator (Bosc, 1802)

Figure 63 b

Common Names: Sand Fiddler Crab; Calico Fiddler
Recognition Characters: Large claw of male with inner face of palm (propodus) smooth (lacking ridge of tubercles); inner margin of carpus with some red pigment (but not bright red); cardiac depression of carapace grayish brown.
Distribution: Atlantic and eastern Gulf coasts of North America from Massachusetts to western Florida.
Habitat: Intertidal on sand or sandy-mud substrata in salt marshes or open sand flats.
Remarks: *Uca pugilator* is one of the most colorful and well known of the fiddler crabs, and there have been numerous studies on its ecology, behavior, and physiology. It often builds burrows in open areas along the edges of marshes. While foraging at low tide, sand fiddlers aggregate into large groups or "herds" containing thousands of crabs. Easily collected, the sand fiddler has become a popular fishing bait, especially for sheepshead and for red and black drum.

In addition to waving its large claw during courtship display, the male uses it to produce a rapid, drumming sound. The sound apparently is caused by the claw striking either the edge of the carapace or the ground. During feeding, the sand fiddler takes sandy material into its mouth (buccal cavity) and specialized spoon-shaped setae on its maxillipeds scour the algae and other organic matter off the sand grains. After the sand grains have been cleaned by the setae, the mouth parts form the grains into "feeding balls" or "pseudo-feces" which are redeposited onto the substratum. Often large concentrations of pseudo-feces occur around the openings of the burrows of *U. pugilator.*

For many years *U. pugilator* was considered to be present along the entire northern Gulf; however, in 1974, Salmon and Novak recognized a closely related and morphologically similar species, *U. panacea,* from northwestern Florida. The works of Novak and Salmon (1974), Thurman (1973), and my own observations indicate that previous records of *P. pugilator* west of Pensacola, Florida, are probably referable to *U. panacea.*
References: Aspey (1978); Crane (1975); Hagen (1980); Heard (1977); Miller (1961); Montague (1980); Novak and Salmon (1974); Salmon (1965); Salmon and Atsaides (1968 a, b); Salmon *et al.* (1978); Teal (1958); Thurman (1973); Vernberg and Costlow (1966); Williams (1965 a).

Uca panacea Novak and Salmon, 1974

Figures 62 g, h; 63 a

Synonym: *Uca pugilator* (for records west of Pensacola, Florida)
Common Name: Panacea Sand Fiddler
Recognition Characters: Large claw with inner face of propodus smooth, (lacking ridge of tubercles) and inner margin of carpus bright orange to purplish-red;

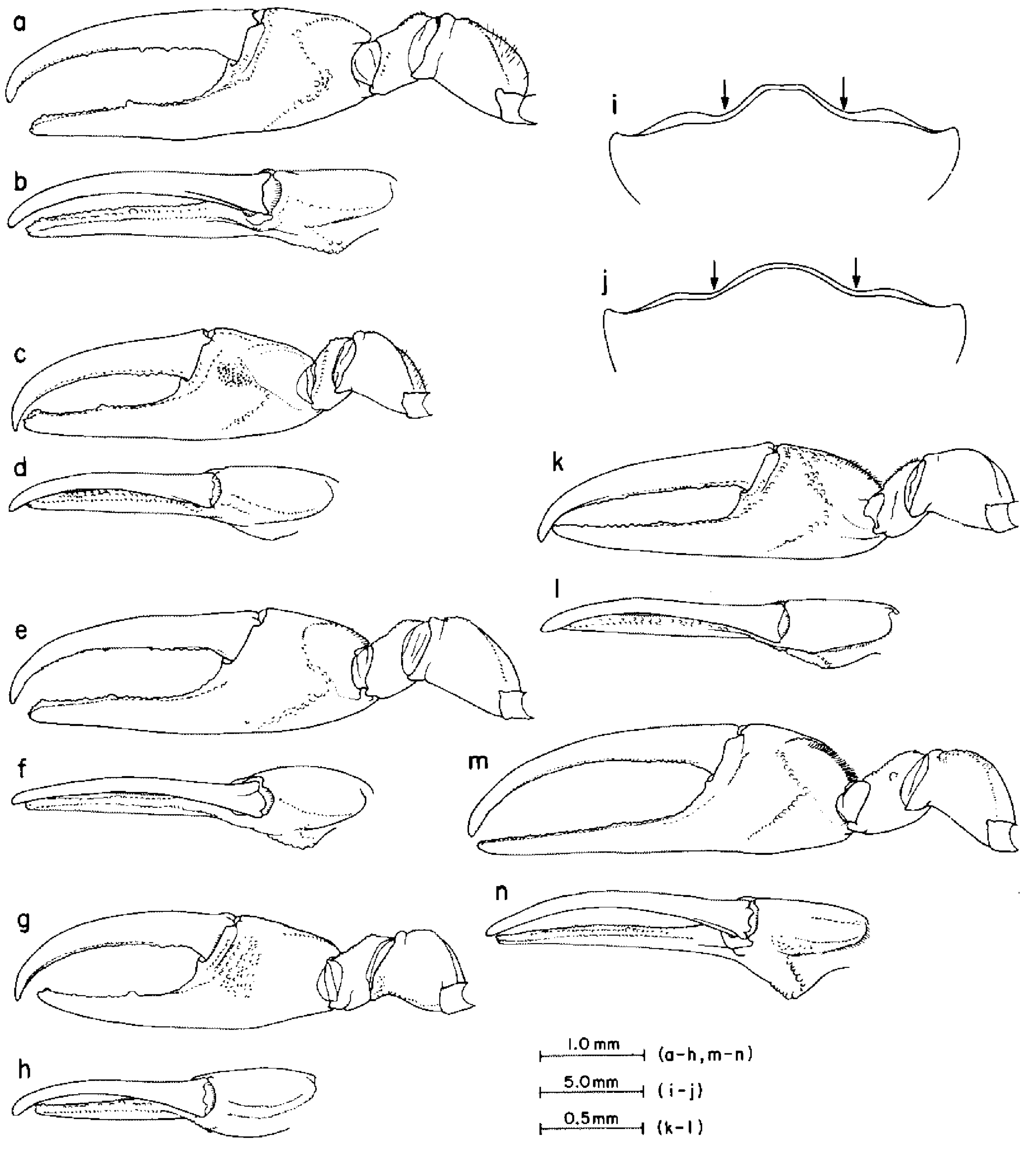


Figure 62. Chelae (a-h, k-n) and frontal margins (i, j) of *Uca* spp. a, b - *Uca rapax;* c, d - *U. longisignalis*; e, f – *U. minax*; g, h – *U. panacea*; i – *U. rapax*; j – *U. longisignalis*; k, l – *U. speciosa*; m, n – *U. spinicarpa.*

cardiac depression of carapace rust-red.

Distribution: Northern Gulf of Mexico from Florida panhandle to Texas.

Habitat: Similar to that of *U. pugilator.*

Remarks: *Uca panacea* is very similar to *U. pugilator* and even experts are hard-pressed to separate preserved, faded specimens of the two species. Like *U. pugilator, U. panacea* forms "feeding balls" as a by-product of feeding in sandy areas. Although there are differences the "waving" and "drumming" courtship behavior of both species is basically similar. In addition to differences in behavior, the two species have different biochemical, color, and minor morphological characteristics. Some authorities question whether or not *U. panacea* should be considered a distinct species, and one study indicated that *U. panacea* and *U. pugilator* do hybridize where their ranges overlap in northwest Florida. Pending additional research and analysis of this taxonomic problem, I recognize *Uca panacea* as a distinct species.

References: Hagen (1980); Heard (1977); Novak and Salmon (1974); Powers (1975); Powers and Cole (19-76); Salmon *et al.* (1978); Thurman (1973).

Uca spinicarpa Rathbun, 1900

Figures 62 m, n; 63 c

Synonym: *Uca speciosa spinicarpa*

Recognition Characters: Carapace width up to 23mm; large male claw with inner face of propodus strongly developed, raised ridges of tubercles forming large process, carpus usually with distinct large tubercle or tooth near middle of inner surface; frontal area of carapace of both sexes often with bright green patch of pigment.

Distribution: Northern Gulf of Mexico from Alabama to Texas.

Habitat: Fresh to brackish water, intertidal banks and marshes with firm clay, clay-sand, or clay-mud substratum.

Remarks: *Uca spinicarpa* was recently designated as a subspecies of *U. speciosa* in Crane's (1975) extensive monograph on the world species of *Uca.* The large male claw of *U. speciosa* lacks the strongly raised tuberculate ridges on the palm and the large tubercle on the carpus which characterize *U. spinicarpa.* Also, *U. spinicarpa* is distinctly larger than northern Gulf specimens of *U. speciosa.* Because of these and other differences, I prefer to consider both *U. spinicarpa* and *U. speciosa* as distinct species. Comparative studies on these two fiddler crabs are needed to further clarify their taxonomy.

References: Crane (1975), Felder (1973), Heard (1977).

Uca speciosa (Ives, 1891)

Figures 62 k, l; 63 d

Recognition Characters: Carapace width up to 15mm; large male claw delicate, elongate, and whitish in color with carpus lacking distinct large tubercle on ridge of inner margin; ridge of tubercles on inner face of propodus not distinctly raised into processes.

Distribution: Southern Florida to Mississippi; eastern Mexico; Cuba.

Habitat: Mesohaline to polyhaline areas on silt or silty sand substrata in intertidal marshes or mangrove thickets.

Remarks: Individuals from the northern Gulf populations of *Uca speciosa* are generally much smaller than those from populations of the Florida Keys. *Uca speciosa* occurs sporadically in tidal marshes on the offshore islands of Mississippi and Alabama, with well-established populations occuring from Cape San Blas southward along the western Florida coast. In the northern Gulf, it rarely if ever occurs with the similar and apparently closely related *U. spinicarpa,* which is usually confined to lower salinity habitats.

References: Crane (1975); Heard (1977); Salmon (1967); Thurman (1973).

Uca minax (LeConte, 1855)

Figures 62 e, f; 63 h

Common Name: Red-jointed Fiddler Crab; Freshwater Fiddler

Recognition Characters: Carapace width up to 33mm; front of carapace cream-white in adult; large male claw with tubercles lining inner face of palm; carpal joints with red patch of pigment; mergus of second walking leg lacking patch of dense pubescence on ventral margin.

Distribution: Massachusetts to central eastern Florida; western central Florida to Louisiana.

Habitat: On muddy substrata in low salinity and freshwater tidal marshes; usually occuring adjacent to mouths of rivers.

Remarks: *Uca minax* is the largest species of *Uca* that occurs in North America and the only species from this region that migrates into and lives in freshwater habitats. It withstands dessication better than other local species of *Uca,* and, like the friendly crab, *Sesarma cinereum,* red-jointed fiddlers often forage in terrestrial areas a hundred or more feet inland from the intertidal zone. Juvenile and subadult *U. minax* are usually brownish to brownish-gray in color and usually lack the cream-white coloration on the front

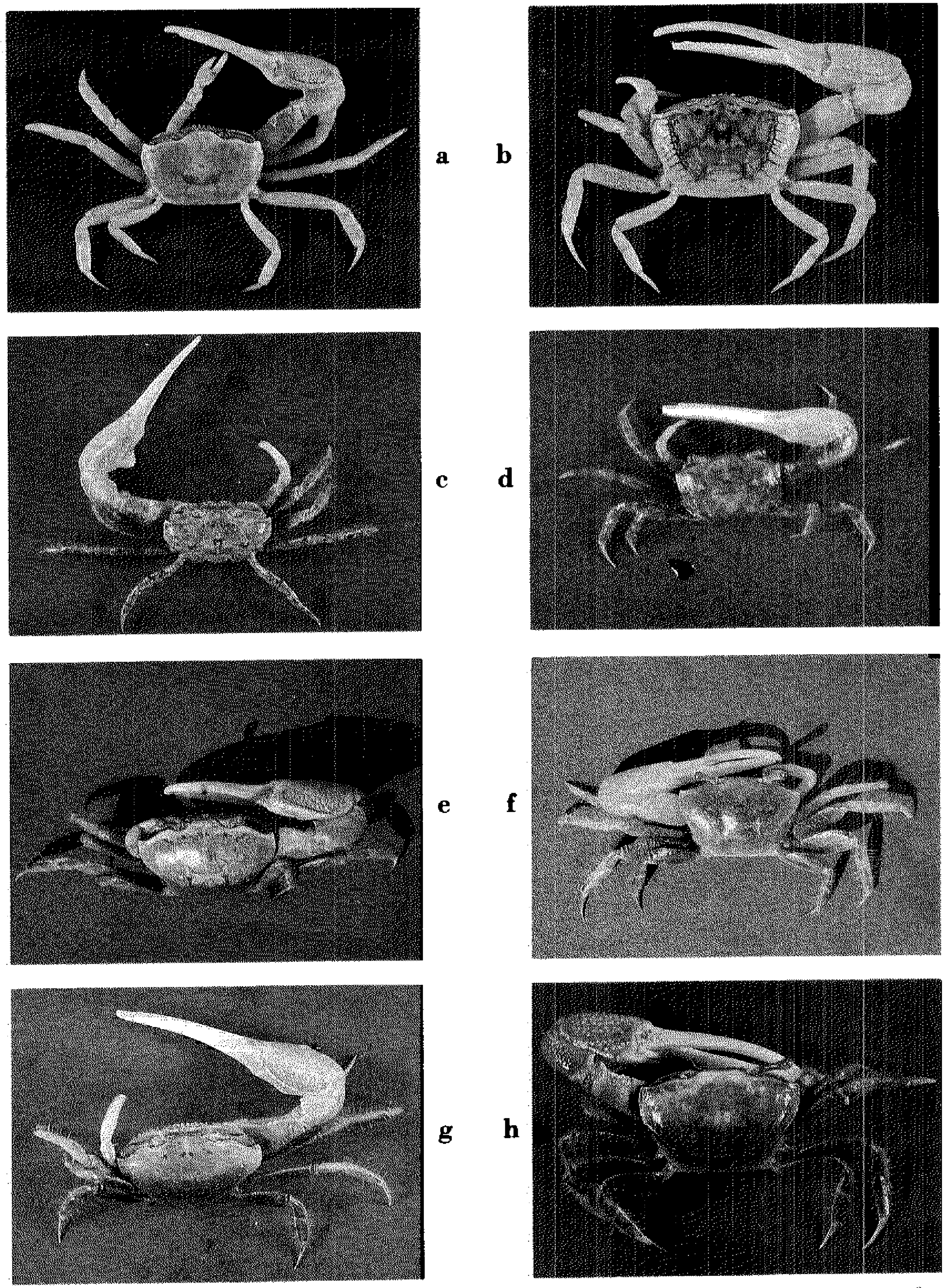


Figure 63. a – *Uca panacea*; b – *U. pugilator*; c – *Uca spinicarpa*; d – *Uca speciosa*; e – *Uca rapax*; f – *Uca pugnax* (from Atlantic East Coast); g – *Uca longisignalis*; h – *Uca minax*.

of the carapace, which characterizes the adult.

References: Crane (1975); Heard (1977); Miller (1961); Montague (1980); Teal (1958); Thurman (1973); Whiting and Meshri (1974).

Uca longisignalis Salmon and Atsaides, 1968

Figures 62 a, b, j; 63 g

Common Name: Gulf Mud Fiddler

Synonyms: *Uca pugnax*
Uca minax
Uca rapax longisignalis

Recognition Characters: Carapace width up to 26mm; front of carapace bright greenish-blue; large male claw with low tuberculate ridge on inner face of palm; merus of second walking leg with patches of dense pubescence.

Distribution: Gulf coast from central western Florida to Texas.

Habitat: Mesohaline, on mud to mud-sand substrata in tidal marshes.

Remarks: The taxonomic status of *Uca longisignalis* is currently muddled. Crane (1975) considered this crab a subspecies of *U. rapax*, and, more recently, Hagen (1980) synonymized it with *U. minax*. *Uca minax* and *U. longisignalis*, however, have distinctly different color patterns and salinity preferences, and there are morphological differences in the setae of the mouth parts and walking legs. Because of these and other more subtle differences, I consider *U. longisgnalis* to be a distinct species. Many of the previous records of *Uca pugnax* from the Gulf Coast are referable to *U. longisignalis*. *Uca pugnax* (see Fig. 63 f) occurs only along the Atlantic eastern coast of North America from New England to central Florida. The Gulf mud fiddler is the most common species of fiddler in Mississippi and Alabama salt marshes. In low salinity areas, it occurs sympatrically with *U. minax* and *U. spinicarpa*, and, in higher salinity habitats, it occurs with *U. rapax* and *U. panacea*.

References: Atsaides and Salmon (1968); Crane (1975); Hagen (1980); Heard (1977); Powers (1975); Thurman (1974).

Uca rapax (Smith, 1870)

Figures 62 c, d; 63 e

Synonyms: *Uca virens*
Uca pugnax virens

Recognition Characters: Carapace width up to 23mm in northern Gulf populations; front of carapace with bright blue pigment; large male claw with tuberculate ridge on inner face of palm; merus of second walking leg lacking dense patch of pubesence on ventral margin.

Distribution: Southern Florida; Alabama to Texas; Caribbean and Atlantic coasts of Central America and northern South America.

Habitat: Sandy-silt substrata in mesohaline and polyhaline salt marsh and mangrove areas.

Remarks: The northern Gulf populations of *Uca rapax* were described as a separate species, *Uca virens*, by Salmon and Atsaides (1968); however, studies by Thurman (1973) and Hagen (1976, 1980) indicate that the two species, though their color varies greatly within the range, are synonymous. I tentatively accept the synonymy of *U. virens* with *U. rapax*. To further clarify the taxonomy of *U. rapax*, living specimens from northern Gulf and Caribbean populations should be carefully compared morphologically and with regard to behavior.

References: Crane (1975); Felder (1973); Hagen (1980); Heard (1977); Powers (1975); Powers and Cole (1976); Salmon and Atsaides (1969); Tashian and Vernberg (1958).

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TAXONOMIC KEYS TO SOME POLYCHAETE WORMS, MOLLUSKS, AND CRUSTACEANS FOUND ASSOCIATED WITH TIDAL MARSHES OF THE NORTHERN GULF OF MEXICO

POLYCHAETA

1 Anterior end with crown of radially arranged tentacles (Figs. 3i, 4). 2

Anterior end lacking radial crown of tentacles. 3

2 Living in white calcareous tube; stalked opercular plug present (Fig. 4) . . . . *Ficopomatus miamiensis*

Not living in calcareous tube; operculum absent; minute forms, less than 5 mm long (Fig. 3i). . . . . *Manayunkia* spp.

3 Head and first 3 body segments lacking antennae, tentacles, palps, and gills (Fig. 3b,f) .4

Head and first 3 body segments with at least 1 of these structures (Fig. 64a). 8

4 Hooded hook setae present (Fig. 3c: look on setigers 10–20); gills (branchae) present or absent; body width variable; head region not sharply tapering to an acute point. 5

Hooded hook setae absent; gills dorsal, beginning between setigers 11 and 23; body widest between setigers 8 and 15; head region tapering to an acute point (Fig. 3b) . . . . *Scoloplos fragilis*

5 At least first 7 setigers with capillary setae (Fig. 3d) only 6

Hooded hook setae on some of the first 7 setigers 7

6 Genital setae (Fig. 3e) and/or hooded hook setae on setigers 8 and 9. . . . . *Capitella* spp.

First 11 setigers lacking genital setae and hooded hook setae, only capillary setae present . . . . *Notomastus* spp.

7 Hooded hook setae beginning on 5th setiger. . . . . *Mediomastus* cf. *californiensis*

Hooded hook setae beginning on 6th setiger (Fig. 3f). . . . . *Heteromastus filiformis*

8 Gills, peristomial cirri, and antennae absent; small pair of palps present; anterior end of worm whitish-yellow, swollen (Fig. 3a); stout notopodial spines present in posterior segments . . . . *Parandalia americana*

Gills, antennae, and/or peristomial cirri present; stout notopodial spines absent. 9

9 One pair of long peristomial cirri and 1 pair of equally long gills (both often broken off) on 1st and 2nd setigers, respectively; raised collar on dorsal surface of 2nd setiger (Fig. 3g) . . . . *Streblospio benedicti*

Four pairs of gills or 4 pairs of peristomial cirri present; raised collar on dorsal surface of 3rd setiger absent 10

10 Four dorsal, transversely arranged pairs of finger-like gills just posterior to head (Fig. 3h); mouth with retractable oral tentacles; uncini present; eyes and parapodia weakly developed; antennae and jaws absent . . . *Hypaniola florida*

Finger-like gills and uncini absent; four pairs of peristomial cirri, pair of well-developed palps, pair of antennae present, proboscis with pair of serrate jaws; eyes and parapodia well developed . . . . (Nereidae) 11

11 Parapodia appearing uniramous, notopodia greatly reduced, notosetae absent (Fig. 2b). . . . . . *Namalycastis abiuma*

Parapodia distinctly biramous, notopodia well developed with notosetae present (Fig. 2i, k) 12

12 Small worms, less than 10 mm long; body with 34 segments; proboscis without paragnaths or papillae; dorsal cirri well developed, filiform (Fig. 2e) . . . . *Stenoneries martini*

Adult worms reaching lengths of 50 mm with over 70 body segments; proboscis armed with paragnaths or papillae . . 13

13 Proboscis with dark paragnaths (Fig. 2j). . . . . *Neanthes succinea*

Proboscis with tufts of finger-like papillae (Fig. 2h) . . . . *Leonereis culveri*

MOLLUSCA

1 Pelagic; free swimming; torpedo shaped; head with large pair of eyes and 10 oral arms (tentacles) armed with suckers; shell reduced, internal . . . . . *Lolliguncula brevis*

Epibenthic or benthic; not torpedo shaped; tentacles with suckers absent; external calcareous shell present 2

2 Shell consists of two valves (Figs. 17–24) . . . . . (Bivalvia) 22

Shell a single-coiled valve (Fig. 65) . . . . . (Gastropoda) 3

3 Aperture an elongate slit; operculum and gills absent; shell conic or biconic (Figs. 15, 16) 20

Aperture usually oval, not an elongate slit; operculum and gills present 4

4 Animal with single bipectinate gill; shell globular with many transverse, often wavy, dark lines (Fig. 6) . . *Neritina usnea*

Animal with unipectinate gill or gills; shell lacking transverse dark lines 5

5 Shell with siphonal canal (Fig. 13) 6

Shell without siphonal canal (Fig. 7) 7

6 Prominent crown of spines on shoulder and base of shell (Fig. 13) . . . . . *Melongena corona*

Crown of spines absent; shoulder and spire with fine spiral cords and nodules . . . . . *Thais haemastoma*

7 Shell elongate, about 3 times longer than wide; strong axial ribs on body whorls 8

Shell usually less than 2.5 times longer than wide; lacking strong axial ribs 10

8 Spire with old varices (Fig. 10, right; Fig. 65) . . . . . *Cerithidea pliculosa*

Spire lacking varices (Fig. 10, left) 9

9 Shell reaching only about 15 mm in length; axial ribs indistinct on last 2 body whorls . . . . . *Cerithidea costata*

Shell reaching over 25 mm in length; axial ribs well developed on last 2 body whorls . . . . . *Cerithidea scalariformis*

10 Adult shells over 20 mm, grayish white, whorls with spiral ridges flecked with reddish brown; inner margin of outer lip with spiral grooves (Fig. 12) . . . . . *Littorina irrorata*

Adult shells small, less than 4 mm; inner margin of outer lip lacking spiral grooves 11

11 Aperture with oblique fold on margin of inner lip (Fig. 14) . . . . . *Sayella* spp.

Aperture without oblique fold on inner lip (Fig. 7) 12

12 Eyes on tips of stubby tentacles; amphibious . . . . . *Assiminea succinea*

Eyes at base of elongate tentacles; aquatic . . . . . (Hydrobiidae) 13

13 Verge unornamented (lacking papillae) (Fig. 8e); shell elongate with striated whorls (Fig. 7b) . . . *Onobops* cf. *jacksoni*

Verge armed with papillae (Fig. 8a-d, f-h) 14

14 Verge with convex margin having 1 or more rows of nipple-like papillae (Fig. 8a-d) 15

Verge with convex margin with sucker-like papillae (Fig. 8f, g, h) 17

15 Verge with 2 to 3 rows of papillae on convex margin (Fig. 8b) . . . . . *Litterodinops monroensis*

Verge with single row of papillae on convex margin 16

16 Concave margin of verge bearing a subapical lobe with 2 to 3 papillae and a single more proximal papilla (Fig. 8a); ovoviviparous (developing snails can often be seen through semitransparent shell of female); low ridge or teeth on distal margin of whorls (Fig. 7d) . . . . . *Pyrgophorus* spp.

Concave margin of verge with 2 to 3 subapical papillae not borne on lobe, proximal papilla absent (Fig. 8d). . . . . . . *Littoridinops palustris*

17 Concave margin of verge with subterminal finger-like or keel-like process; 2 subterminal papillae on convex margin of verge distinctly separated from more proximal papillae (Fig. 8f, g) 18

Concave margin of verge lacking finger- or keel-like process; isolated subterminal papillae not present on convex margin of verge (Fig. 8h). 19

18 Subterminal keel-like process on concave margin of verge (Fig. 8f) . . . . . *Heleobops* sp. (form A)

Subterminal finger-like process on concave margin of verge (Fig. 8g) . . . . . *Heleobops* sp. (forms B and C)

19 Verge with 5 to 6 stalked papillae; aperture of shell constricted in adult specimens . . . . . . *Texadina sphinctostoma*

Verge with 3 to 4 stalked papillae; shell glossy, translucent with aperture not constricted in adult specimens . . . . . . *Texadina barretti*

20 Shell biconic, length of spire nearly one third of total shell length, tip of spire often eroded (Fig. 16) . . . . . *Detracia floridana*

Shell conic, length of spire only one fourth or less of total shell length 21

21 Whorls of spire with fine spiral striations (Fig. 15, right). . . . . *Melampus coffeus*

Whorls of spire lacking spiral striations (Fig. 15, left) . . . . . *Melampus bidentatus*

22 Shell with irregular margins and surface; edges of valves thin, fragile, and sharp (Fig. 26); attaching to substrate on surface of left valve; single large adductor muscle present (on empty valves attachment of adductor muscle marked by dark purple scar). . . . . *Crassostrea virginica*

Shell not as described above; two adductor muscles present (on empty valves adductor muscle scars distinctly separated) 23

23 Beak (umbo) terminal or subterminal (at or near anterior end of shell); byssal threads (for attachment to substratum) present on living specimens 24

Beak central or subcentral; byssal threads absent on living specimens. 27

24 Beak terminal (at anterior end of shell) 25

Beak subterminal. 26

25 Outer surface of valves purplish-gray with strong radiating ribs (Fig. 22); 3 to 4 small teeth on edge of shell under beak; interior glossy usually with brownish-purple pigment . . . . . *Ischadium recurvum*

Outer surface of valves light grayish-brown to tannish (sometimes with zigzag markings), lacking radiating ribs (Fig. 21); platform or plate in interior of shell under beak; interior dull white, not glossy . . . . . *Mytilopsis leucophaeata*

26 Outer surface of valves smooth (Fig. 23), glossy with yellowish-brown and greenish pigment. . . . *Amygdalum papyrium*

Outer surface of valves usually dark brown with strong radiating ribs (Fig. 20), beak often eroded . . *Geukensia demissa*

27 Shell elongate (more than 3 times longer than high), subrectangular with ends gaping when valves closed (Fig. 25) . . . . . *Tagelus plebius*

Shell oval or suboval (less than 1.5 times longer than high) 28

28 Hinge with chondrophore; margins of lateral teeth serrate; shell thick, heavy; beaks widely separated from each other in adults (Fig. 18) . . . . . *Rangia cuneata*

Hinge without chondrophore; margins of lateral teeth lacking serrations; beaks not widely separated from each other. 29

29 Hinge with 2 cardinal teeth (posterior tooth large, blade-like; anterior tooth small, bifed on right valve), lateral teeth indistinct; shell thin, fragile, small (usually less than 10 mm long) (Fig. 25). . . . . *Cyrenoida floridana*

Hinge with 3 cardinal teeth (posterior tooth weakly bifed on both valves), lateral teeth well developed; shell not fragile, more than 10 mm in length 30

30 Shell nearly oval; periostricum dark forming wavy, scale-like ridges (Fig. 17); beaks usually eroded in adults; interior of shell usually white, occasionally lightly stained bluish-purple . . . . *Polymesoda caroliniana*

Shell suboval, often wedge shaped, angular posteriorly; periostricum translucent, not forming scale-like ridges (Fig. 19); beaks not eroded; interior of shell nearly always stained purple in varying degrees . . . . *Polymesoda maritima*

HIGHER CRUSTACEA (MALACOSTRACA)

1 Females with brood plates (oöstegites) (for incubating eggs) arising from the bases of some thoracic legs; usually 7 pairs of legs and 1 maxilliped (except cumaceans which have 5 pairs of legs and 3 maxillipeds) present; carapace, when present, not covering all thoracic segments . . . . . (Peracaridea) 2

Females without specialized brood plates; 5 pairs of thoracic legs and 3 pairs of maxillipeds present; carapace completely covering cephalothorax. . . . . . (Decapoda) 36

2 Abdomen nearly as long or longer than combined length of head and thorax 3

Abdomen distinctly less than half length of combined head and thorax 4

3 Shrimp-like; carapace nearly covering thorax; eyes stalked, thoracic limbs all biramus; inner ramus of uropod with statocyst (Figs. 30a, 67) . . . . . (Mysidacea) 6

Cephalothorax swollen; eyes sessile; abdomen and uropods narrow (Fig. 33). . . . . . (Cumacea) 11

4 First pair of legs chelate; thorax with 6 free segments (Figs. 31, 32) . . . . . (Tanaidacea) 10

First pair of legs not chelate; thorax with 7 free segments (Figs. 39, 41). 5

5 Abdomen with 5 pairs of pleopods and 1 pair of uropods; body usually dorsoventrally flattened (Figs. 34, 39). . . . . (Isopoda) 14

Abdomen with 3 pairs of uropods and 3 pairs of pleopods (Fig. 68); body usually laterally compressed . . . . . (Amphipoda) 21

6 End of telson cleft (Fig. 30d,e) 7

End of telson entire, convex (Fig. 30b,c) 9

7 Antennal scale with lateral tooth; posterior margin of fifth abdominal segment with dorsal process (Fig. 6--) . . . . . *Bowmaniella* spp. (*floridana-brasiliensis* complex)

Antennal scale lacking lateral tooth; posterior margin of fifth abdominal segment without dorsal process. 8

8 Anterior margin of carapace with small lateral spine just below base of eye stalk; inner ramus of uropod with single spine on posterior margin of statocyst . . . . . *Taphromysis louisianae*

Anterior margin of carapace lacking lateral spine just below base of eye stalk; inner ramus of uropod with single spine distinctly posterior to statocyst near lateral margin of uropod . . . . . *Taphromysis bowmani*

9 Apex of telson with 12 to 16 long spines gradually increasing in length medially; inner ramus of uropod with 1 spine near statocyst . . . . . *Mysidopsis almyra*

Apex of telson with 8 to 12 spines abruptly increasing in length medially; inner ramus of uropod with 2 or more spines near statocyst . . . . . *Mysidopsis bahia*

10 First antenna lacking distinct accessory flagellum; second leg not distinctly different from legs 3–7; appendages not densely setose (Fig. 31) . . . . . *Hargaria rapax*

First antenna with well-developed, segmented, accessory flagellum; second leg armed with strong spines, modified for burrowing, distinctly different from legs 3–7; appendages densely setose (Fig. 32) . . . . *Halmyrapseudes bahamensis*

11 Narrow pointed telson present . . . . . *Oxyurostylis smithi*

Telson lacking. 12

12 Inner ramus of uropod a single segment; male with pair of lateral keels on upper part of carapace (Fig. 36b). . . . . . *Almyracuma* sp.

Inner ramus of uropod two segmented; male lacking lateral keels on carapace 13

13 Male lacking pleopods; female with dorsal keel on third thoracic segment. . . . . *Spilocuma watlingi*

Male with 5 pairs of pleopods; female without dorsal keel on third thoracic segment . . . . *Cyclaspis* cf. *varians*

14 Uropods terminal or subterminal, originating in posterior third of pleotelson 19

Uropods originating in anterior half of pleotelson 15

15 Uropods folded under pleotelson, not visible dorsally, forming ventral operculum over pleopods . . *Edotea* cf. *montosa*

Uropods lateral, visible dorsally 16

16 Body ovate, less than 3 times longer than wide; uropods flattened, not extending above pleotelson. 17

Body elongate, approximately 7 times longer than wide; uropods partially folded and extended laterally above pleotelson (Fig. 34) . . . . *Cyathura polita*

17 Eyes located sublaterally (not on lateral margin of cephalon) on post cephalic lobes; outer ramus of uropod greatly reduced, inserted into margin of outer ramus (Fig. 35) . . . . *Cassidinidia ovalis*

Eyes located on lateral margins of head; both branches of uropods well developed. 18

18 Dorsal surface of pleotelson smooth . . . . *Sphaeroma quadridentata*

Dorsal surface of pleotelson tuberculate (Fig. 36) . . . . *Sphaeroma terrebrans*

19 Body minute, less than 3 mm; uropods small, not extending beyond distal end of pleotelson; eyes on lateral protuberances (Fig. 37) . . . . *Munna reynoldsi*

Body over 10 mm in adults; uropods extending well beyond pleotelson; eyes not on lateral protuberances 20

20 Head small, narrow, unnotched; eyes on lateral margins (Fig. 38) . . . . *Asellus acutus*

Head relatively large and broad with a pair of deep lateral notches; eyes not on lateral margins, located at proximal ends of cephalic notches (Fig. 39). . . . . *Lirceus* sp.

21 Third uropod uniramus (Figs. 43, 45, 46). 29

Third uropod biramus (inner ramus may be minute) (Figs. 41a, 42). 22

22 Eyes nearly round, or irregularly shaped; inner ramus of third uropod minute (Fig. 42) 23

Eyes kidney-shaped; rami of uropod 3 subequal (nearly same size) (Fig. 41a) . . . .(Genus *Gammarus*) 27

23 First antenna shorter than second antenna and lacking accessory flagellum; third uropod short, stout, not extending past second uropod, larger outer ramus composed of 1 segment, subequal in length to peduncle segment . . . . *Parhyale hawaiensis*

First antenna longer than second antenna with small (2 to 3 segmented) accessory flagellum; third uropod long, slender, extending well past second uropod (over 1.5 times longer than peduncle), larger outer ramus composed of 2 segments (distal segment very small). 24

24 Outer ramus of uropod 3 (male and female) with numerous long setae. . . . . *Melita longisetosa*

Outer ramus of uropod 3 lacking numerous long setae 25

25 Male, antenna 2, flagellum with "bottle brush" setation, peduncle segment 5 approximately equal in length to segment 4 26

Male, antenna 2, flagellum lacking "bottle brush" setation, peduncle segment 5 distinctly longer than segment 4. . . . *Melita elongata*

26 Male, antenna 2, peduncle segment 5 with bottle brush sëtae . . . . *Melita nitida*

Male, antenna 2, peduncle segment 5 lacking bottle brush setae . . . . *Melita intermedia*

27 Dorsal mucronations (spine) on posterior margin of each pleonal segment (Fig. 41a,b) 28

No dorsal mucronations on pleonal segments (oligohaline to fresh water) (Fig. 41c). . . . . *Gammarus* nr. *tigrinus*

28 Dorsal mucronations of moderate size (mesohaline) (Fig. 41a) . . . . *Gammarus mucronatus*

Dorsal mucronations large, strongly developed (oligohaline) (Fig. 41b) . . . . *Gammarus* sp. "macromucronate form"

29 Ramus of third uropod narrow, longer than peduncle (basal segment) (Fig. 43). . . . . . . *Grandidierella bonneiroides*

Ramus of third uropod either equal in length or shorter than peduncle (Fig. 45) or broad and flattened. 30

30 Ramus of uropod 3 broad, body flattened dorsoventrally; urosomal segments fused together; second antenna of male massive (Fig. 44); living in tubes . . . . (Genus *Corophium*) 31

Ramus of uropod 3 reduced, shorter than peduncle, body laterally compressed; urosomal segments distinctly separate; second antenna of male not massive; not living in tubes 32

31 Male with tooth on inner margin of first peduncle segment of first antenna (Fig. 44b); female with spine on disto-ventral end of peduncle segment 4 of second antenna (Fig. 44c). *Corophium louisianum*

Male without tooth on inner margin of peduncle segment of first antenna (Fig. 44d); female with tooth on disto-ventral end of peduncle segment 4 of second antenna (Fig. 44e). . . . . *Corophium lacustre*

32 Antenna 1 extending well past peduncle of second antenna; dorsal posterior margin of first two pleonal segments mucronate (Fig. 45); aquatic, epibenthic, in fresh and oligohaline waters . . . . *Hyalella azteca*

First antenna not extending past peduncle of second antenna; dorsal posterior margin of pleonal segments smooth (not mucronate); intertidal, semiterrestrial . . . . (Talitridae) 33

33 First uropod, outer ramus lacking lateral spines (Figs. 48, 49) 34

First uropod, outer ramus with lateral spines (Figs. 46, 47) 35

34 First uropod with well-developed spine between rami; gnathopod of male chelate; second antenna approximately 4 times longer than first antenna (Fig. 48) . . . . *Orchestia* sp. (near *Orchestia costaricana*)

First uropod lacking well-developed spine between rami; gnathopod of male typically subchelate; second antenna approximately 3 times longer than first antenna (Fig. 49) . . . . *Orchestia platensis*

35 First gnathopod of adult male with dactyl reaching back past palm; first uropod of both sexes with well-developed spine between rami (Fig. 47) . . . . *Orchestia uhleri*

First gnathopod of adult male with dactyl reaching back only one-half the length of palm; first uropod of both sexes lacking well-developed spine between rami (Fig. 46). . . . . *Orchestia grillus*

36 Abdomen asymmetrical or twisted, modified for living in gastropod shells; walking legs with 4 pairs of longitudinal stripes (Fig. 52). . . . . *Clabanarius vittatus*

Abdomen not asymmetrical or modified for living in gastropod shells 37

37 Abdomen well developed, not tightly flexed beneath cephalothorax; uropods present (Figs. 50, 51) 38

Abdomen reduced, tightly flexed beneath cephalothorax; uropods absent (Fig. 54a,b,d,e). . . . .(Crabs) 47

38 Lobster-like body form with broad telsons and uropods (living in deep burrows); rostrum reduced, not blade-like . . . (Mud Shrimps) 39

Shrimp-like body form with telsons narrow, distinctly longer than wide; rostrum well developed, blade-like (Figs. 50, 51) . . . . (Shrimps) 41

39 First legs chelate with movable finger (dactyl) distinctly longer than fixed finger; second legs simple; rostrum and anterio-dorsal region of carapace with many course stout spines; second pair of pleopods similar to following 3 pairs; body gray to grayish-brown . . . . *Upogebia affinis*

First 2 pairs of legs chelate, dactyl (movable finger) of first pair not distinctly extending beyond fixed finger; rostrum and anterio-dorsal region of carapace smooth; second pair of pleopods reduced, not similar to following 3 pairs; body whitish or cream-colored . . . . (*Callianassa*) 40

40 Lateral margin of telson trilobed; ischium of major chela with midventral projection . . . . *Callianassa trilobata*

Lateral margin of telson entire, ischium of major chela lacking midventral projection . . . . *Callianassa jamaicense*

41 Third pair of legs chelate; pleura of first abdominal segment overlapping that of second segment; telson ending in sharp point without terminal setae (Fig. 50a,d,e). . . . .(Penaeidae) 42

Third pair of legs simple; pleura of second abdominal segment overlapping that of first and third segments; telson with terminal spines not ending in sharp point (Figs. 50f, 51a). 43

42 Groove on either side of rostrum extending posteriorly to near posterior border of carapace (Fig. 50b) . . . . *Penaeus azteca*

Groove on either side of rostrum not extending into posterior half of carapace (Fig. 50c) . . . . *Penaeus setiferus*

43 Hepatic spine present (Fig. 50g); mandible with palp (Fig. 73) . . . . *Macrobrachium ohione*

Hepatic spine absent (Fig. 50d); mandible without palp 44

44 Fused part of 2 rami of upper antennular flagellum distinctly longer than unfused part; rostrum narrow with teeth irregularly spaced 45

Fused part of 2 rami of upper antennular flagellum distinctly shorter than unfused part 46

45 Branchiostegal spine (see Fig. 70) located on anterior margin of carapace just below branchiostegal groove (Fig. 51e). . . *Palaemonetes paludosus*

Branchiostegal spine distinctly removed from anterior margin of carapace and located some distance below branchiostegal groove (Fig. 51f). . . . . *Palaemonetes kadiakensis*

46 Carpus of second leg in adult female shorter than palm; movable and fixed fingers of chela with 2 and 1 small teeth, respectively, on cutting edge; rostral teeth nearly reaching to tip of rostrum . . . . *Palaemonetes vulgaris*

Carpus of second leg in adult female longer than palm; cutting edges of movable and fixed fingers of chela lacking small teeth; tip of rostrum dagger-like without teeth . . . . *Palaemonetes pugio*

47 Carapace with 8 lateral teeth, posterior-most lateral tooth greatly enlarged, with sharp point extending well beyond other anterio-lateral teeth; posterior pair of legs with terminal segment flattened or paddle-like (modified for swimming) (Fig. 53) . . . . (Portunidae) 48

Carapace with less than 6 lateral teeth, posterior-most anterio-lateral tooth not greatly enlarged; posterior pair of legs with terminal segment not flattened or paddle-like. 49

48 Frontal margin of carapace (between eyes) with 4 teeth . . . . *Callinectes sapidus*

Frontal margin of carapace with 6 teeth. . . . . *Callinectes similis*

49 Carapace with 2 or less lateral teeth (including anterio-lateral angle) 54

Carapace with 3 or more lateral teeth 50

50 Frontal margin of carapace double, forming a shallow groove (Fig. 58c) (carapace with distinct pubescent, transverse ridges of raised granules; fingers of chelae whitish). . . . . *Rhithropanopeus harrisii*

Frontal margin of carapace single, lacking shallow groove 51

51 Fingers of chelae whitish, movable finger with persistent pink or purple color confined to upper surface of proximal half. . . . . *Eurytium limosum*

Fingers of chelae dark (except for whitish tips) 52

52 Movable finger of major chela lacking prominent enlarged tooth on lower margin (Fig. 58a); minor chela with spoon-shaped fingers (inner face of third maxilliped with raised, oval red spot in both sexes) . . . . *Eurypanopeus depressus*

Movable finger of major chela with prominent large tooth on lower margin (Fig. 55a, 56a) 53

53 Inner face of third maxilliped with oval red spot in male only; carapace dorsally flattened, usually brownish with whitish-yellow markings . . . . *Panopeus herbstii* forma simpsoni

Inner face of third maxilliped with oval red spot in both sexes (Fig. 55c); carapace dorsally convex, usually uniform bluish-gray to dark blue . . . . *Panopeus herbstii* forma obesa

54 Eye stalks elongate, over 4 times longer than wide, both originating in middle third of frontal region of carapace; males with one chela greatly enlarged . . . . (*Uca*) 57

Eye stalks only moderately elongate, less than 3 times longer than wide; originating in outer third of frontal region of carapace; chelae of male not greatly dissimilar in size 55

55 Carapace nearly square, margin immediately behind post-orbital tooth unarmed or with blunt weak tooth or low process; outer face of third maxilliped with oblique ridge of dense setae (Figs. 59, 60) . . . . (*Sesarma*) 56

Carapace distinctly narrowing posteriorly, lateral margin immediately behind post-orbital tooth armed with a well-developed sharp tooth (Fig. 61): outer face of third maxilliped lacking ridge of dense setae. . . . . *Pachygrapsus transversus*

56 Lateral margin of carapace immediately behind outer-orbital tooth armed with blunt tooth or process; distal segments of first three walking legs densely pubescent (Fig. 59) . . . . *Sesarma reticulatum*

Lateral margin of carapace behind outer-orbital tooth unarmed, straight; walking legs without dense pubescence (Fig. 60) . . . . *Sesarma cinereum*

57 Inner face of palm of male large chela with oblique ridge of tubercles (Fig. 62a-f, k-n) 59

Inner face of palm of male large chela lacking ridge of tubercles (Fig. 62g,h). 58

58 Cardiac depression of carapace rust-red; large chela of male with inner face of carpus bright reddish-orange to purplish-red (Fig. 63a) . . . . *Uca panacea*

Cardiac depression of carapace grayish-brown to diffuse-black; large chela of male with inner face of carpus having reddish pigment, but not bright reddish-orange or purplish-red (Fig. 63b). *Uca pugilator*

59 Large male chela with carpus usually having distinct enlarged, spine-like tubercle on inner face (Fig 62m); ridge of tubercles strongly elevated forming acute triangular process at junction with carpal cavity (Fig. 62n) . *Uca spinicarpa*

Large male chela with carpus not having enlarged spine-like tubercle on inner face; oblique ridge on palm not forming strongly elevated triangular process. 60

60 Carapace with anterior third of both lateral margins straight; male large chela whitish, elongate, delicate; small species (Figs. 62k,i; 63d). . . . . *Uca speciosa*

Carapace with anterior third of one or both lateral margins slightly convex, continued posteriorly in gradual curve; male large chela not all whitish (with some distinct pigment). 61

61 Front (of carapace) less than one-third of carapace width (Fig. 62i); frontal region of carapace with reddish brown-maroon reticle pattern (may overlap blue) (Figs. 62i, 63e). . . . . *Uca rapax*

Front greater than one-third of carapace width (Fig. 62j) 62

62 Second and third walking legs with ventral pubescence; joints of chelae not red (usually pale orange); frontal region of carapace usually bright green or greenish-blue in adults (Fig. 63g) . . . . *Uca longisignalis*

Second and third walking legs lacking ventral pubescence; joints of chelae red; frontal region usually cream colored in adults (Fig. 63h) . . . . *Uca minax*

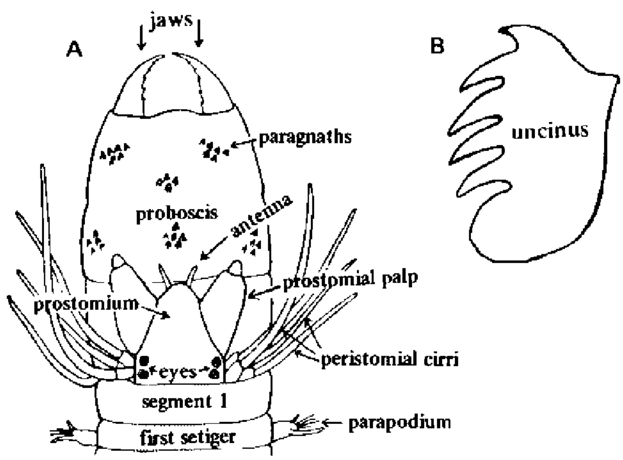


Figure 64. Polychaete morphology: (A) anterior end of nereid polychaete (modfied from Hartman, 1951); (B) uncinus (modified seta) of *Hobsonia florida* (greatly magnified).

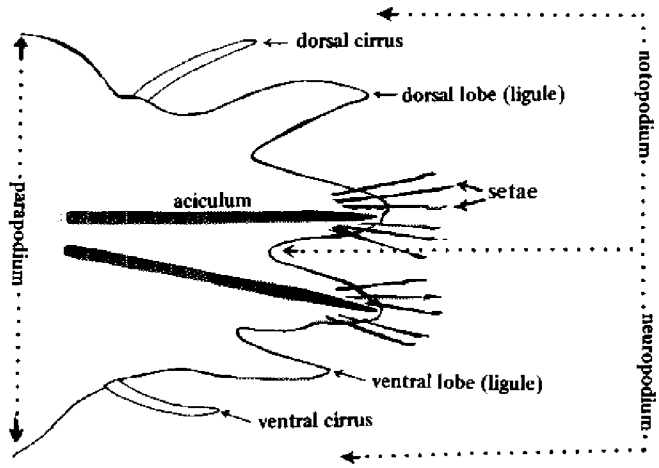


Figure 65. Polychaete morphology: generalized parapodium of nereid polychaete.

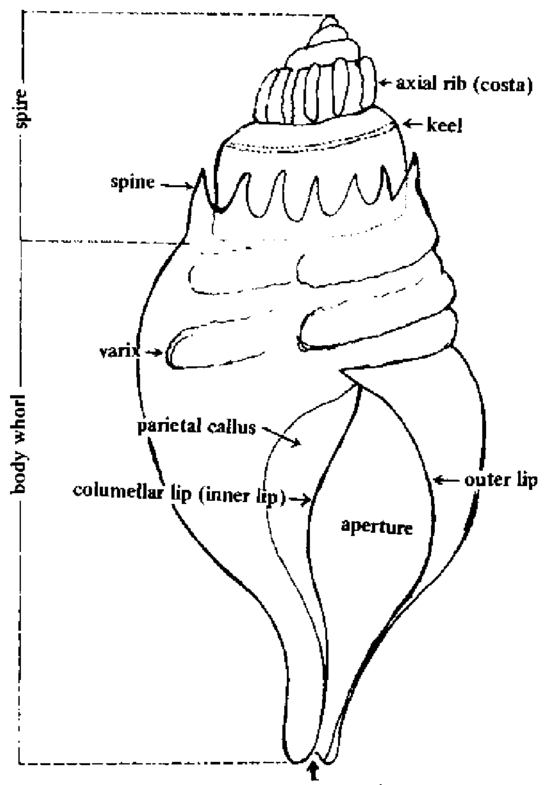


Figure 66. Schematic drawing of a gastropod mollusk shell.

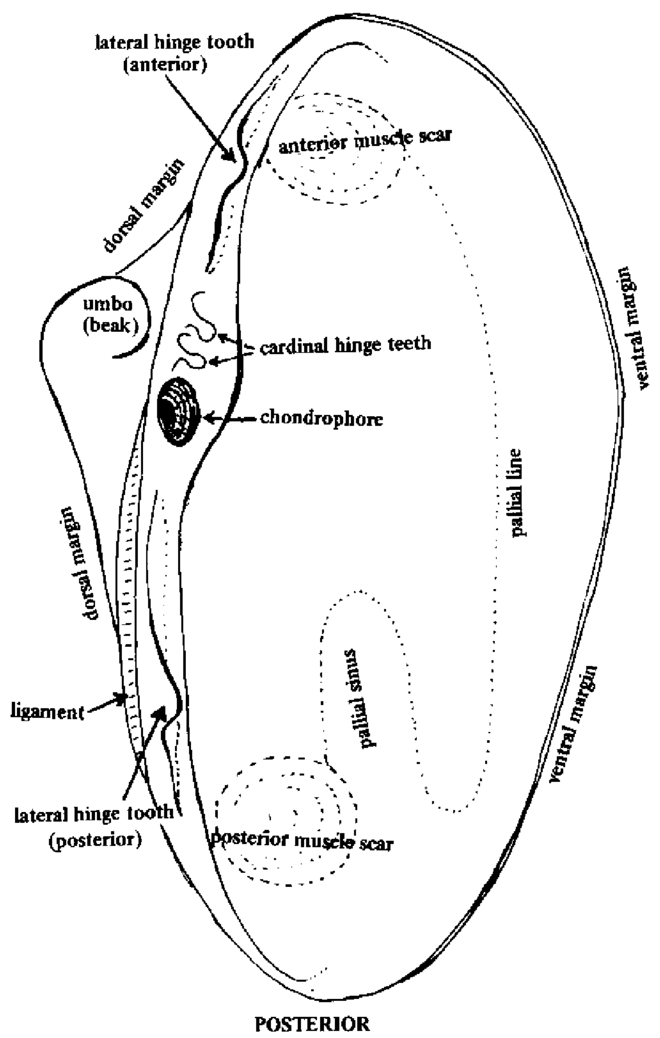


Figure 67. Schematic drawing of the left (sinistral) valve of a bivalve mollusk shell.

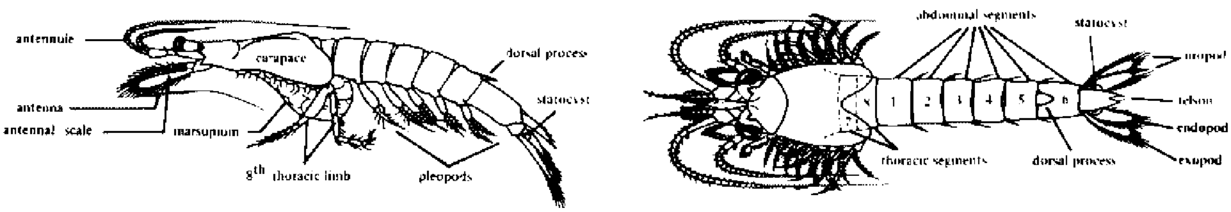


Figure 68. Schematic drawing of a mysid (family Mysidae) showing lateral and doral views (from Stuck, Perry and Heard, 1978a).

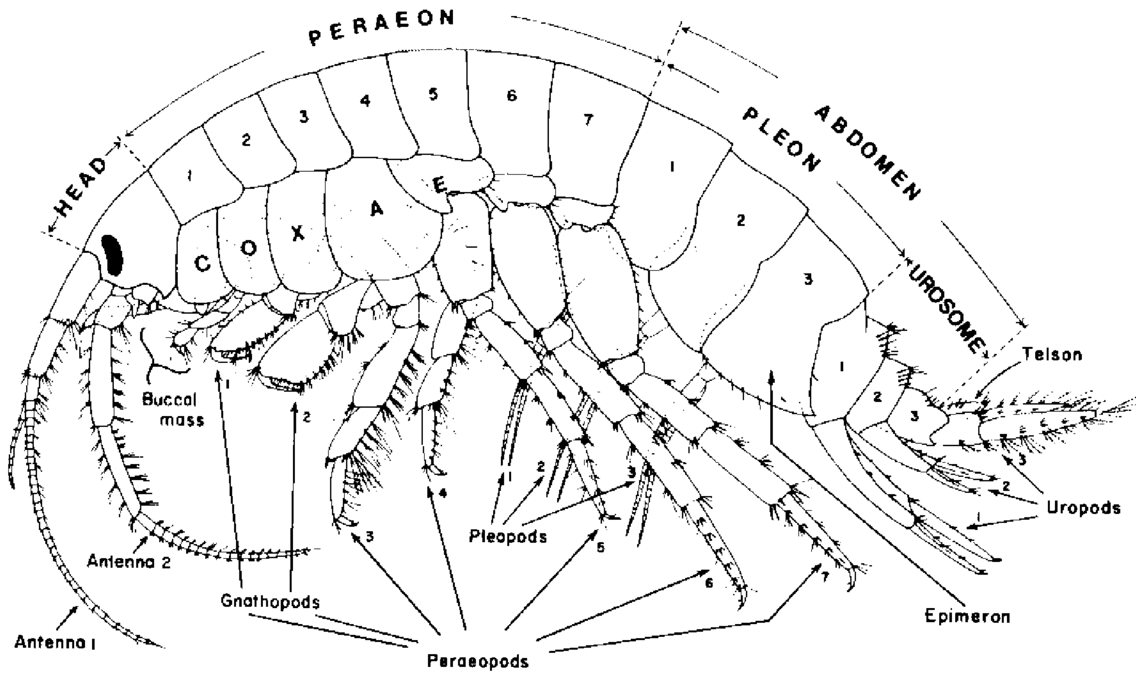
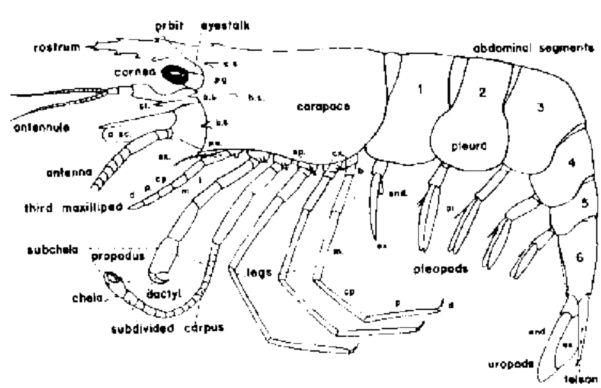


Figure 69. External morphology of a gammaridean amphipod (from Bousfield, 1973).

Figure 70. Schematic drawing of shrimp in lateral view; ai., appendix interna; a.s., antennal spine; a. sc., antennal scale; b., basis; b.s., branchiostegal spine; cp., carpus; ex., coxa; d., dactyl; end., endopod; ep., epipod; ex., exopod; h.s., hepatic spine; i., ischium; m., merus; p., propodus; p.g., postorbital groove; p.s., pterygostomian spine; s.s., supraorbital spine; st., stylocerite (from Williams, 1965).



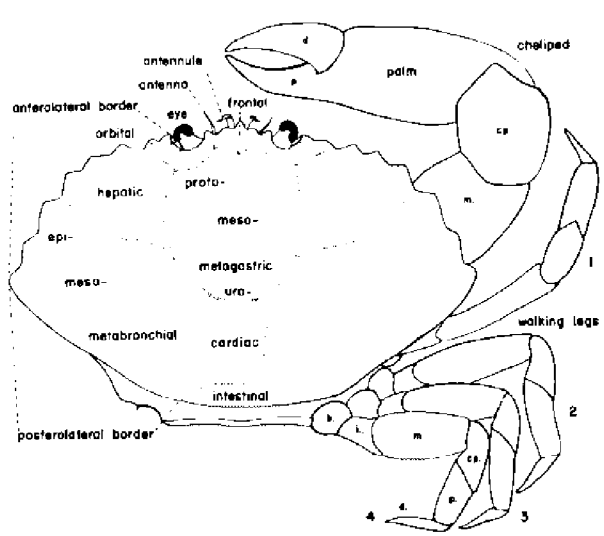


Figure 71. Schematic drawing of brachyuran crab in dorsal view; areas of carapace indicated; legs of right side only shown; b., basis; cp., carpus; d., dactyl; i., ischium; m., merus; p., propodus (from Williams, 1965).

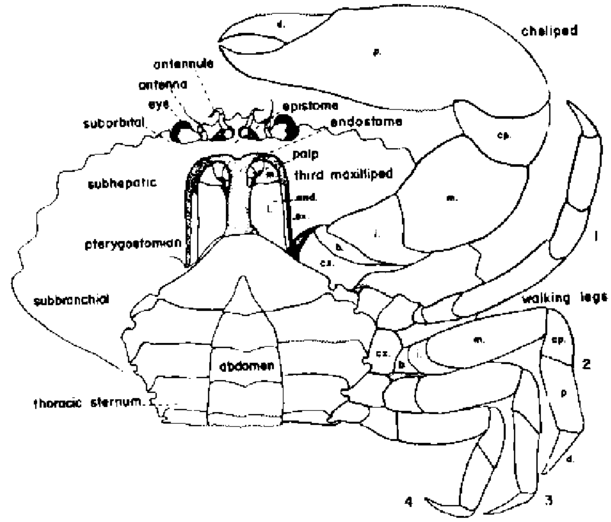


Figure 72. Schematic drawing of brachyuran crab in ventral view; areas of carapace indicated; legs of left side only shown; b., basis; cp. carpus; cx., coxa; d., dactyl; end., endognath; ex., exognath; i., ischium; m., merus; p., propodus (from Williams, 1965).

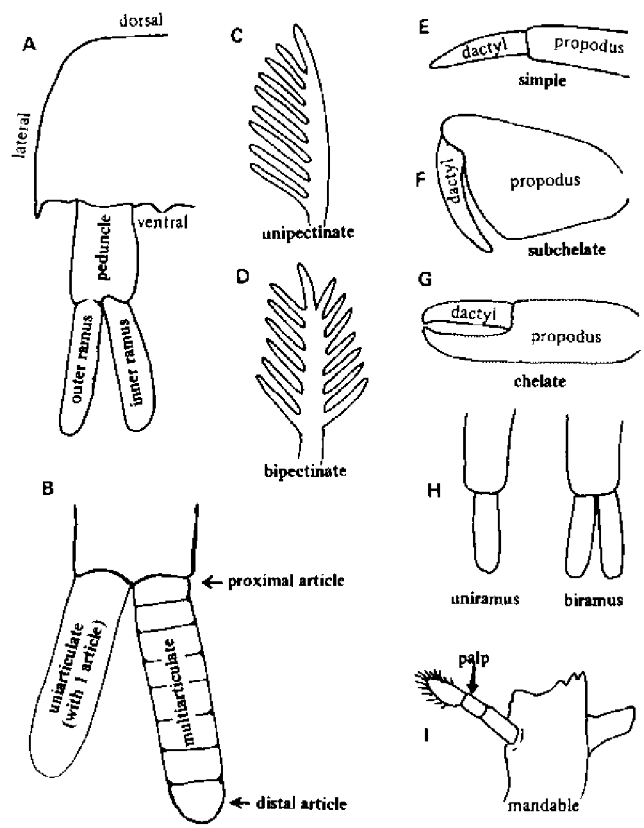


Figure 73. Some morphological features referred to in this guide.

GLOSSARY

adductor muscle: a muscle that holds the valves of a bivalve mollusk together.

adductor muscle scar: scar or feature on inner surface of bivalve shell that indicates the place of attachment of an adductor muscle (Fig. 66).

anterior: in bivalve mollusks, forward end of a bivalve shell (Fig. 67); in polychaetes and crustaceans, toward the head or front end.

aperture: an opening; the cavity or opening of a gastropod shell (Fig. 66).

axial: in the same direction as the axis; from apex to the base of a gastropod shell; axial rib (see Fig. 66).

beak: the earliest formed part of a bivalve shell; the tip near the hinge; the umbo (Fig. 67).

biconate: biconic; similar in form to a double cone; the spire about the same shape and size as the body whorl.

bidentate: with two teeth.

biramus: with two branches or rami (Fig. 73).

bipectinate: in reference to gastropod gill, having both margins of gill with a series of comb-like projections or lamellae (Fig. 73).

body whorl: the last and usually the largest turn in a snail's shell (Fig. 66).

brackish: referring to sea water that has been diluted with fresh water. Most estuaries are brackish due to mixing of river water with sea water.

branchia (pl. ***branchiae***): a gill; a specialized process, lamella, or appendage through which respiratory gases (oxygen, carbon dioxide) are exchanged.

brood plates: oöstegites; plate-like processes originating from the bases of some legs of peracaridan crustaceans. Collectively the brood plates form a marsupium (Fig. 68) or brood chamber for incubating the young of peracaridans.

byssal threads: a series or clump of thread-like fibers that serve to anchor certain bivalves, such as mussels, to some support (Fig. 22).

calcareous: of hard calcium carbonate.

capillary seta: in polychaetes, a long, slender, simple, tapering setae (Fig. 3d).

carapace: hard outer protective covering of some animals. In crustaceans, it covers the head and gill region.

cardinal teeth: the main and usually largest teeth in a bivalve hinge located just below the beaks or umbones (Fig. 67).

carina: keel or ridge.

carnivore: an animal that eats other animals; meat eater.

carpus: third segment or article from the distal end of a crustacean leg.

cephalon: head.

cephalothorax: body division in many higher crustaceans representing the fusion of the head and one or more thoracic segments. In crabs, the fusion of the head and all thoracic segments is complete.

chela (pl. ***chelae,*** adj. ***chelate***): claw; pincer-like or scissor-like distal part of crustacean appendage in which a distal prolongation of the propodus (fixed finger) opposes the dactyl (movable finger) (Fig. 73).

chelicerae: claw-like mouth parts of horseshoe crabs and arachnids.

chondrophore: a pit, or spoon-like shelf, in the hinge of a bivalve, such as *Rangia*, into which fits a chitinous cushion, or resilium (Fig. 67).

cirrus (pl. ***cirri***): in polychaetes, refers to a sensory projection, usually slender and cylindrical, from the upper part of the notopodium (dorsal cirrus) or from the under part of the neuropodium (ventral cirrus). Tentacle-like appendages of anterior segments near head (peristomial cirri) (see Figs. 64, 65).

cypris stage: larval settling stage of a barnacle.

dactyl: last or distal segment of a crustacean leg (Fig. 70).

denticles: small projections, resembling teeth, around the margin of the gastropod aperture or the pelecypod valve.

detritivore: an animal that eats detritus.

detritus: particulate organic and inorganic matter.

diatom: microscopic plant; a kind of unicellular or single-celled alga.

diecious: individuals of a species having distinct sexes (either male or female).

distal: away from the body; toward the extremity of an appendage, ramus, or article (Fig. 73); opposite of proximal.

dorsal: back (for dorsal orientation in bivalve mollusks, see Fig. 67).

ecdysis: molting or shedding of "old shell" (exoskeleton) in crustaceans as part of growth phase in which the new soft shell expands in size before hardening takes place.

ecosystem: taken as a whole, all the organisms in a community plus all the associated chemical and physical environmental factors.

ectoparasite: a parasitic animal which infests or infects the external surface of its host.

endopodite: inner ramus or limb of crustacean biramus appendage (Fig. 73).

epifaunal: living exposed, above or on the substratum surface; may be with or without attachment.

epitoke: modified polychaete reproductive stage, often swarming.

estuary (adj. ***estuarine***): the brackish water regions of and near river mouths influenced by tides.

euryhaline: having or living in a wide spectrum of salinities ranging from nearly fresh water to full strength sea water.

exopodite: outer ramus or limb of crustacean biramus appendage (Fig. 73).

exoskeleton: the external chitinous "shell" covering crustaceans and many other arthropods.

falciger: a distally blunt and curved seta (Fig. 2c) found in many polychaetes.

gnathopod(s): term applied to the first two pairs of legs (usually specialized for grasping) of amphipods (Fig. 69).

hermaphroditic: having male and female sex organs in the same individual.

heterogomph: referring to a compound polychaete seta in which the articulation is clearly oblique to the long axis of the shaft (Fig. 2c, d, f).

hooded hook seta: a relatively short, blunt, often distally curved and dentate seta which is distally covered by a delicate chitinous envelop or guard (Fig. 3e).

host: an organism to which a parasite or other symbiont is attached or otherwise associated.

indicator organism: an organism typical or representative of a certain habitat or certain environmental conditions.

infaunal animal: spending all or part of its life buried within the substratum.

intertidal: occurring between the high and low tide zones.

keel: a longitudinal ridge, carina, or prominent spiral ridge usually marking a change of slope in the outline of a shell or exoskeleton.

lamellae: thin plates or ridges.

larva: a young stage of an animal that differs morphologically from the adult stage.

lateral: to the side of midline of the body.

ligule: parapodial lobe; finger-shaped major process on a polychaete parapodium (Fig. 65).

marsupium: see brood plates.

maxilliped(s): mouth parts originally derived from the modification of the first 1–3 pairs of thoracic appendages; originating directly posterior to the maxillae (see Figs. 70, 72).

meiofauna: small infaunal or surface-dwelling animals (e.g., harpacticoid copepods, nematodes, invertebrate larvae) that will pass through a 0.5 mm sieve, and are retained by a 0.1 mm sieve.

mesohaline: brackish water with intermediate salinities (greater than 2 ppt and less than 36 ppt) ranging between oligohaline and full strength sea water.

mucronation: acute process or tooth.

multiarticulate: having two or more segments or articles (Fig. 73).

notopodium: dorsal branch of a polychaete parapodium (Fig. 65).

oligohaline: low salinity conditions (more than 0.5 ppt and less than 2 ppt) between fresh water and mesohaline conditions.

omnivore: an animal that eats a variety of animal and plant substances; lacks specialized diet.

oöstegites: see brood plates.

operculum: a cover or lid; in gastropod mollusks, a shell-like or horny plate attached to the foot and used to close the aperture of the shell; in polychaetes, a "stopper" for the tubes of some tubicolous worms when the occupant is retracted (Fig. 4).

oral: referring to the mouth.

ovoviviparous: retention of developing eggs within the oviduct of female until young are fully formed before being released.

palp: in polychates, fleshy projection from prostomium (Fig. 64); mandibular palp of crustaceans, distal articulated part of mandible that functions as an aid in feeding or cleaning (Fig. 73).

papillae: small, ripple-like projections.

paragnath(s): chitinous denticle in the pharyngeal cavity of nereid polychaetes (everted pharynx forms the "proboscis") (Figs. 2j, 64).

parapodium (pl. ***parapodia***): in polychaetes, the segmentally arranged lateral projections carrying setae; "foot."

parts per thousand (ppt, $^0/_{00}$): used in describing the concentration of salt in brackish and marine waters; refers to the number of grams of salt per thousand grams of water. Full strength sea water has approximately 36 grams of salt per thousand grams of water.

peduncle: the basal segment or segments of biramus or unimous appendanges (antennae, pleopods, uropods) (Fig. 73).

pelagic: pertaining to or inhabiting the open sea far from land.

pellial line: a groove or channel near the inner margin of a bivalve shell, where the mantle is made fast to the lower part of the shell. When this line is continuous and not marked with a pellial sinus it is said to be simple (Fig. 67).

pellial sinus: a U-shaped indentation in the pellial line produced by the siphon (Fig. 67).

periostracum: outer layer of a shell, composed of a form of sclerotized protein, or conchiolin.

phytoplankton: plant plankton.

plankton (adj. ***planktonic***): floating and drifting aquatic organisms whose primary movements result from water movement rather than their swimming efforts.

pleon: abdominal segments having pleopods (Fig. 69).

pleopod(s): swimmeret; ventral appendages (excluding uropods) in amphipods of any of the first five abdominal segments in peracaridan and decapod crustaceans (Figs. 68, 69, 70).

pleotelson: posterior body part of isopods and some other crustaceans resulting from the fusion of the telson with one or more pleonal segments.

posterior: situated away from the anterior part of a shell or body; toward the "tail."

proboscis: a long, flexible snout; when everted, the pharynx of polychaetes is often called a proboscis.

propodus: second segment or article from the distal end of a crustacean leg (Figs. 70–73).

prostomium (pl. ***prostomia***): in polychaetes, the anterior pre-segmental part of the body anterior to the mouth, enclosing at least the anterior part of the brain, often with antennae and eyes; part of polychaete "head" (Fig. 64).

protogynic (n. ***protogyny***): type of hermaphroditic development in which the female reproductive system becomes functional before the male reproductive system. Opposite of protandrous.

proximal: toward body; closest to body (Fig. 73); opposite of distal.

pubescent: covered with dense mat of fine hair-like setae.

radula: in gastropod mollusks, a rasp-like organ, or lingual ribbon armed with tooth-like processors; used in feeding.

ramus (pl. ***rami***): branch of an appendage.

reniform: kidney-shaped.

resilium: a triangular ligament sturcture; a tough chitinous pad, residing in a chondrophore or pit, along the inner hinge margin of a bivalve which causes the shell to spring open when the muscles relax.

rostrum: a medial anterior extension of the cephalon or carapace between the eyes; can be long and well developed, reduced, or absent (Fig. 70).

serrate: a formation resembling the toothed edge of a saw.

sessile: attached to substratum.

seta (pl. ***setae,*** adj. ***setose***): a needle or hair-like extension of integument, cuticle, or exoskeleton.

setiger: in polychaetes, a segment having setae (Fig. 64).

siphonal canal: a posterior prolongation of a gastropod shell forming a narrow groove or canal to accommodate the siphon; this structure is characteristic of Neogastropoda (Fig. 66); siphonal notch formed by the sinus at the distal tip of siphonal canal.

somite: body segment.

spiniger: in polychaetes, a seta that tapers to a fine point (Fig. 2d).

spire: upper whorls, from the apex to the body whorl, but not including the body whorl (Fig. 66).

statocyst: balancing organ in many crustaceans used in body orientation.

stolon: stem-like attachment structure of hydroids.

subequal: nearly equal.

suboval: irregularly oval.

subterminal: occurring very near the end, but not at the end, of an appendage or segment.

subtidal: below low-tide zone.

swimmeret: see pleopod(s).

synonym: two or more scientific names referring to the same species or taxonomic category.

telson: terminal segment following the sixth abdominal segment of higher crustaceans; absent in some groups (Figs. 68, 70).

tentacular: tentacle-like.

thorax (adj. ***thoracic***): in crustaceans, the central part of the body between the head and abdomen; completely covered dorsally in decapod crustaceans. Chela and legs are thoracic appendages.

trochophore: ciliated larval stage of polychaetes and some mollusks.

umbo (pl. ***umbones***): see beak.

uniarticulate: having one segment or article (Fig. 73).

unipectinate: in reference to gastropod gill, having a single row of comb-like processes or lamellae (Fig. 73).

uniramus: with one branch or ramus (Fig. 73).

uropod: appendages arising from the sixth abdominal segment of many higher crustaceans; in amphipods, the 4–5 abdominal segments also have uropods; in adult brachyuran crabs, uropods are absent (Figs. 68–70).

urosome: abdominal segment or segments having uropods (Fig. 69).

varix (pl. ***varices***): prominent, raised rib on the surface of a snail shell, caused by a periodic thickening of the lip during rest periods in the shell's growth (Fig. 66).

veliger: a larval stage of mollusks, which has a ciliated band or bands and often an embryonic shell.

ventral: the lower side, opposite the dorsal area (Figs. 67, 73).

verge: penis, male copulatory organ of a gastropod mollusk.

whorl: a complete turn, or volution, of a snail shell (Fig. 66).

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