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Bulletin No. 20: Tidal Marsh Invertebrates of Connecticut

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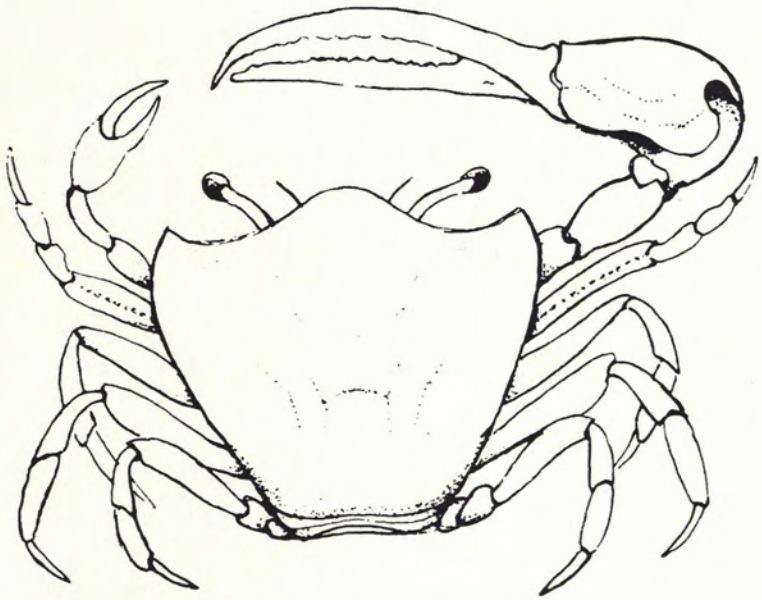

THE CONNECTICUT ARBORETUM
CONNECTICUT COLLEGE

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TIDAL MARSH INVERTEBRATES OF CONNECTICUT

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and

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Drawings by **Sibyl A. Hausman**

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CONNECTICUT ARBORETUM
BULLETIN NO. 20 OCTOBER 1974

FOREWORD

In our efforts to preserve the tidal marshes of Connecticut the Arboretum has spearheaded the movement to highlight the roles of tidal marshes in marine productivity through a series of Bulletins originating as early as 1961. Although protective tidal marsh legislation has been enacted, there is still a great need to create a further awareness of the ecological value of the tidal marsh-estuarine ecosystem. Many organisms at this land-water interface play a role in this productivity. Among them are the invertebrates, including the insects, arachnids, crustaceans, and molluscs, about which this Bulletin is concerned. Although lacking backbones common to higher animals, they are of great importance as intermediate transformers of much of the energy tied up in the tidal marsh plants. They are also important in the recycling of mineral nutrients which in turn stimulate the phytoplankton, the base of the marine food chain. Thus these organisms are a vital part of the complex self-perpetuating system that supports the great productivity of the estuary. No nutrients in the form of commercial fertilizers are needed to produce the shellfish and finfish so prized and taken in such great quantities by man from the mud flats and offshore waters.

In the preparation of this publication, we are most grateful to Mrs. Nancy C. Olmstead, Dr. Paul E. Fell, and Miss Sibyl A. Hausman for their professional talents and dedicated efforts. Their first-hand field observations and insights lend a unique quality to this volume.

It is hoped that this publication will be useful to laymen, teachers and students who are interested in learning the diversity of life forms and in understanding the role these organisms play in the tidal wetlands.

William A. Niering

Director

TIDAL MARSH INVERTEBRATES

THE TIDAL MARSHES which fringe the coastline are recognized as being among the most biologically productive areas in the world. Not only do they provide food, shelter, and nesting sites for many bird species, but the bays and tidal creeks which border them serve as nurseries and spawning grounds for many varieties of fish and shellfish. In addition, dead and decaying marsh grasses are exported to the estuaries as detritus (all the particulate organic matter involved in the decomposition of dead organisms). This detritus, along with algae and phytoplankton, becomes food, either directly or indirectly, for the fish and shellfish of the shallow coastal waters. Since the great majority of the fish caught for market throughout the world come from these coastal waters (1), the importance of this nutrient input can be appreciated.

It is estimated that Connecticut's 15,500 acres of tidal marsh produce 42,000 tons of plant material yearly (2), much of which is eventually carried away by the tides to the offshore waters. Tall saltwater cordgrass (*Spartina alterniflora*) forms a belt along the seaward edges of the marsh and along the banks of the tidal creeks and mosquito ditches, and covers between ten and twenty percent of the surface of the tidal marshes in Connecticut (2). This area, which is inundated by every tidal cycle, is defined as low marsh. In the high marsh meadows, which are not submerged by all high tides, the principal vegetation consists of saltmeadow grass *(Spartina patens)*, spikegrass *(Distichlis spicata)*, and blackgrass *(Juncus gerardi)*, a rush. A stunted form of saltwater cordgrass appears in high marsh areas in depressions known as pannes. Other areas (forb pannes) are covered with colorful flowering herbs such as sea lavender *(Limonium carolinianum)*, gerardia *(Gerardia maritima)*, and aster *(Aster tenuifolius)*. Along the upland border of the marsh, in areas which are submerged by only the highest spring or storm tides, the marsh elder shrub *(Iva frutescens)* is common. All of these plants are described in *Tidal Marshes of Connecticut* (3).

The Ecological Role of Invertebrates

The invertebrate animals (such as crabs, snails, mussels, spiders, and insects) which are found among the grasses and in the tidal creeks and mosquito ditches of the marsh play many important roles in this highly productive system. They are a major part of both the marine and terrestrial food chains. When the marsh is covered by high tides, the blue crabs, eels, and minnows of the creeks and ditches are able to invade the marsh and feed upon the small invertebrates found there. In turn, these animals are fed upon by the larger fish of the offshore waters. The invertebrates also make up the largest percentage of the diet of many species of birds found on the marshes (4). A simplified food chain including tidal marsh invertebrates is shown on page 5.

Less obvious but equally important is the role which the marsh invertebrates play in raising the nutritional value of the detritus which is exported to the estuaries. Dead marsh grasses are broken into progressively smaller pieces by the feeding activities of these animals, first by the animals which feed directly upon the grasses, and then by those which feed upon the partially decomposed grasses in the mud and peat. This progressive fragmentation of the grasses makes them more accessible to the bacteria which are essential for their ultimate breakdown. Grass which has been broken down into detritus contains more protein than either living or dead grass (5), and it is therefore of greater

biological value for fish and shellfish. The invertebrates also enrich the mud with their feces and dead bodies.

The invertebrates which inhabit the tidal marshes encounter many stresses. They must be able to tolerate alternating periods of submergence and exposure and with them considerable changes in temperature. In addition, there may be variation in the salinity of their surroundings, depending upon the amount of rainfall and the degree of evaporation. Because of these stresses there is not a great diversity of animal species, but those species which have been able to adapt to marsh life are often present in very large numbers. Few of these species eat the grasses directly. Most feed on mud algae, bacteria, and decaying vegetable and animal material. It is the availability of an abundant supply of detritus and the lack of interspecific competition which permits the presence of such large populations. In spite of their numbers, most of the animals which inhabit the marsh are inconspicuous. Few of the invertebrates are large or highly colored, and the marsh plants usually provide a dense cover for them. In order to study these animals, one must look carefully for them.

Some of the invertebrates inhabit only the low marsh, while others inhabit the high marsh. Their distribution is related mainly to the frequency of tidal inundation (hydroperiod), which is also an important factor in the distribution of the marsh grasses. Some invertebrates are found in both the low and high marsh areas. In general, these are the insects, which are able to escape submergence by flying or crawling away, and whose distribution is determined more by their food preferences than by hydroperiod. Specific quantative data presented here were obtained from studies of the invertebrate populations of the Cottrell Marsh, Stonington, Conn., an area owned by the Nature Conservancy (6). Other distributional data utilized were obtained from studies of the invertebrates found on ten salt marshes in eastern, central, and western Connecticut (7).

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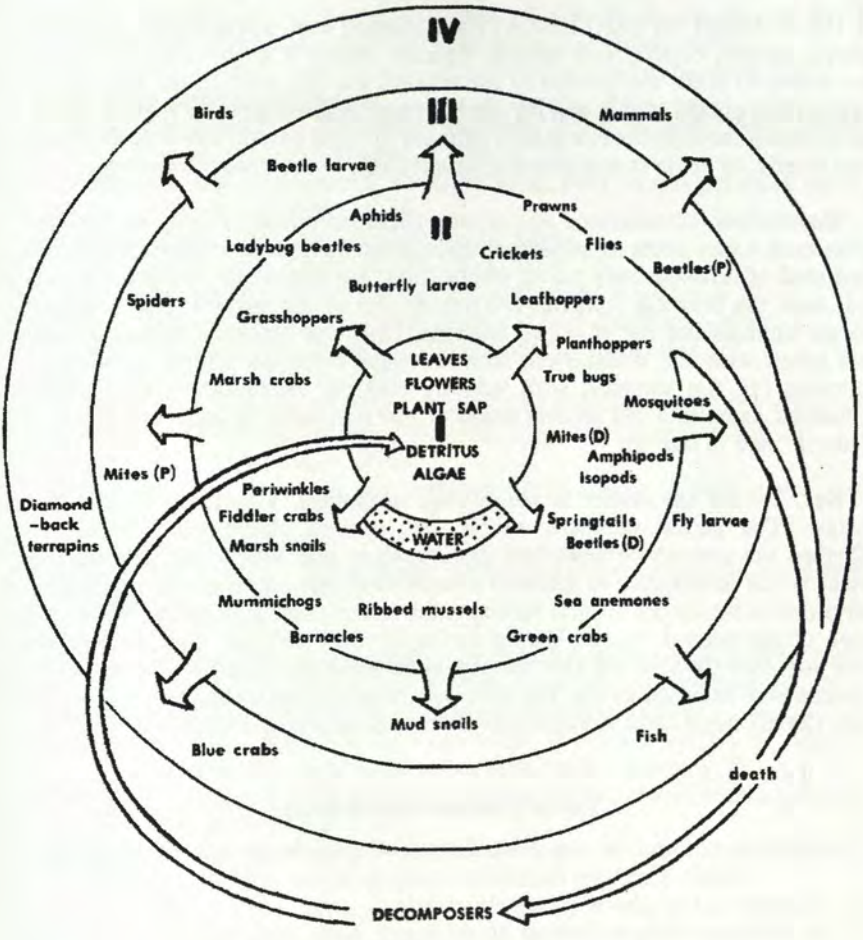
(7) Pellegrino, P.E. and A.T. Carroll. 1974. The Distribution of Invertebrates in Connecticut Salt Marshes. *In* Tidal Wetlands of Connecticut: Vegetation and Associated Animal Populations, Vol. 1. (W.A. Niering and R.S. Warren, eds.) Dept. of Environmental Protection, State of Connecticut, in cooperation with the Bureau of Sports Fisheries and Wildlife, U.S. Dept. Int.

FOOD CHAIN



Simplified food chain of tidal marsh animals. The different trophic (feeding) levels are represented by Roman numerals. Level I, the base of the food chain, is made up of the detritus which results from the breakdown of dead animal and vegetable material, and of the living green plants and algae (the primary producers) which trap energy from the sun. Subsequent trophic levels are increasingly removed from the primary source of energy. Level II consists of the herbivores, which feed directly on the plants and algae, and the detritus-feeders. The small predators, or carnivores, which prey upon the herbivores and detritus-feeders make up Level III. The marsh food chain culminates with Level IV, the larger predators, which feed upon the animals in Level III.

The names of those animals which are both herbivorous and carnivorous straddle the line between Level II and Level III. Within a few of the groups some species are predators (P), while others are detritus-feeders (D). (Drawing by Allen T. Carroll)

IDENTIFICATION OF THE INVERTEBRATES

THE MARSH INVERTEBRATES discussed here are grouped according to phyla, classes, orders, and species. Species within a given class are arranged according to their distribution in the marsh, starting with those animals found in the tidal creeks and mosquito ditches (and including some vertebrates), and progressing through the low marsh animals to those of the high marsh meadows, and finally, to those invertebrates characteristic of the upland borders.

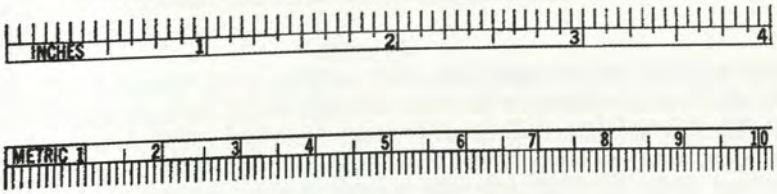
Illustrations. Illustrations accompany the description of most of the animals discussed. Lines point to important distinguishing characteristics. Drawings are included of isolated body parts, where these are important in identification. A bar near the drawing indicates the actual size of the animal. For a few of the larger animals the bar is in two sections. Only the common names of animals are given with the illustrations except where common names refer to entire families (as, for instance, with ladybug beetles). In these instances both the common name and the generic name of the particular animal are given, if the latter is used in the text.

Key. To aid the reader in identifying specimens, a simple key is presented below. The paired numbers on the left present alternative characteristics. Choose the one which describes the specimen and follow the numbers at the right which lead either to the next choice or to the name of the phylum, class, or order to which the animal belongs and to the page number on which discussion of the animal begins. Larval forms of some beetles, flies, and butterflies are not described in the key but are illustrated on page 32. Three vertebrate species not included in the key (the common mummichog, the American eel, and the diamond-back terrapin) are discussed on pages 33 and 34.

Key to Common Invertebrates

1. Animals non-motile, no jointed appendages, body not enclosed in a shell—Cnidaria (sea anemones), p. 8.
1. Animals not as above, generally motile 2
   2. Animals without jointed appendages; body enclosed in a hard, calcareous shell consisting of one or two valves—Mollusca 3
   2. Animals with jointed appendages, body not enclosed in a one- or two-valved shell—Arthropoda 4
3. Shell consisting of one valve—Snails, p. 8.
3. Shell consisting of two valves—Bivalves, p. 12.
   4. Body typically with a horny shell, appendages often with pincer-like terminal segments—Crustacea 5
   4. Body without a shell, appendages generally without pincer-like terminal segments 10
5. Animals with 2 pairs of appendages for grasping, 5 pairs of walking legs, 6 pairs of legs for swimming or leaping; body laterally compressed—Amphipoda (sand fleas, beach hoppers), p. 16.
5. Legs fewer in number 6

6. Animals with 7 pairs of walking legs, body dorsoventrally flattened—Isopoda (sow bugs, wood lice), p. 18.
6. Legs fewer in number 7
7. Animal with 6 pairs of legs, used only in feeding; non-motile; body enclosed in 6 calcareous plates—Cirripedia (barnacles), p. 20.
7. Legs fewer in number, body not enclosed in calcareous plates 8
8. Animals with 5 pairs of legs for walking or swimming—Decapoda .. 9
8. Legs fewer in number 10
9. Body dorsoventrally flattened, abdomen much reduced, body length generally over 20 mm—Crabs, p. 13.
9. Body laterally compressed, abdomen long, body length generally under 20 mm—Shrimp, p. 16.
10. Animals with 4 pairs of legs—Arachnida 11
10. Animals with 3 pairs of legs—Insecta, p. 22 12
11. Body divided into cephalothorax and abdomen—Spiders, p. 21.
11. Body oval, not divided into cephalothorax and abdomen—Mites, p. 22.
12. Minute wingless insects—Collembola (springtails), p. 27.
12. Insects generally with wings 13
13. Insects with one pair of wings, second pair represented only by a pair of knob-like structures—Diptera (flies and mosquitoes), p. 27.
13. Insects with two pairs of wings 14
14. Hind legs enlarged for jumping—Orthoptera (grasshoppers and crickets), p. 30.
14. Hind legs otherwise 15
15. Forewings leathery throughout, hindwings membranous—Coleoptera (beetles), p. 24.
15. Forewings otherwise 16
16. Forewings leathery at base, membranous at tip, beak arising from front of ventral surface of head—Hemiptera (true bugs), p. 28.
16. Forewings membranous throughout or wings lacking 17
17. Wings present, beak arising from back of ventral surface of head—Homoptera (aphids, planthoppers, leafhoppers), p. 30.
17. Wings present, covered with overlapping scales—Lepidoptera (butterflies and moths), p. 32.
17. Wings present or absent, ovipositor present and often modified as a sting—Hymenoptera (ants), p. 30.



CNIDARIANS

THE PHYLUM CNIDARIA includes the jellyfishes, hydroids, corals, and sea anemones. Only the sea anemones are represented in appreciable numbers on the Connecticut tidal marshes. They belong to the Class Anthozoa.

SEA ANEMONES

Sea anemones are relatively stationary animals. One end of the body is attached to the substrate (generally to rocks, shells, wharf pilings, or mud) and consists of a flattened pedal disc. At the opposite end of the animal is the oral disc, which bears many tentacles surrounding a slit-like mouth. The cylindrical body column between the two discs is highly contractile. When the sea anemone contracts, it becomes very much smaller and the upper part of the column is pulled tightly over the oral disc. Since the body surface area is reduced, and since moisture is enclosed within the column, the animal can withstand periods of exposure in this contracted state. Both fully expanded and partially contracted sea anemones are shown in the accompanying illustration.

Although sea anemones are generally attached to a surface, they can change location by expanding the pedal disc in one direction, contracting it, and pulling the body into the new position.

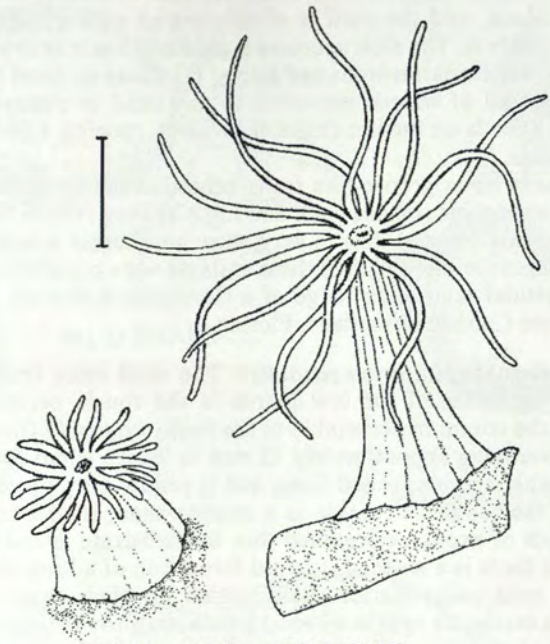
Striped Sea Anemone *(Haliplannella luciae)*: The column of the striped sea anemone is olive-brown or green and has thin vertical stripes which are orange or yellow. This is a small anemone, not exceeding 20 mm in length when expanded. Since feeding and gas exchange take place under water, striped sea anemones are only found in areas where they are submerged for at least a part of each day. In eastern Connecticut they are very abundant on the mud of the mosquito ditch banks, sometimes averaging 100 anemones per square meter. They may also be found on the stalks of the tall saltwater cordgrass of the low marsh, and on the mud underneath this grass. Their food consists of small animals such as amphipods, fish fry, small worms, and other bits of animal tissue which are suspended in the water. Food is captured as it comes in contact with the body, or it is actively seized by the tentacles. In turn, these sea anemones are preyed upon by larger marine worms, various crabs, and fish.

MOLLUSCS

THE PHYLUM MOLLUSCA includes the snails, bivalves, squid and octopuses, chitons, and tooth shells. In the Connecticut tidal marshes one finds only the snails (Class Gastropoda) and bivalves (Class Pelecypoda). In both the snails and the bivalves the body is enclosed in a hard, calcareous shell.

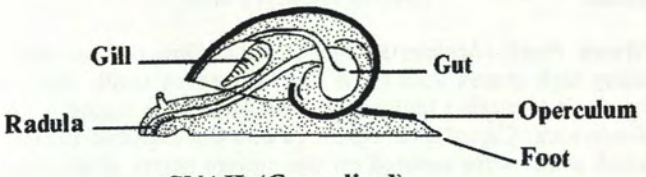
SNAILS

The snails possess a single valve shell, which is in the shape of a conical spire. This shell has an opening at the base through which the head and the muscular creeping foot are extended. In most snails there is a calcareous or horny plate (the operculum) on the posterior dorsal aspect of the foot which closes the shell aperture when the head and foot are withdrawn. The head of snails is well developed, with eyes and tentacles. Within the mouth cavity is the radula, a ribbon- or belt-like structure covered with rows of sharp teeth. The radula can be extended and retracted, and the teeth serve as a scraper. Some snails are herbi-



STRIPED SEA ANEMONE

vorous and scrape algae and detritus off rocks and vegetation. Others are carnivorous and can drill holes through the shells of other molluscs and barnacles with the radula and accessory boring organ. Many snails are also scavengers.



SNAIL (Generalized)

There are three species of snails which are abundant on the Connecticut tidal marshes or at their immediate edges, and each occupies a different habitat. These are the mud snail *(Nassarius obsoletus)*, which is found on the tidal mud flats; the rough periwinkle *(Littorina saxatilis)*, found in the intertidal tall salt-water cordgrass; and the salt marsh snail *(Melampus bidentatus)*, which inhabits the high marsh.

Mud Snail *(Nassarius obsoletus)*: On the tidal mud flats of the estuaries bordering the marshes and in muddy tidal creeks and mosquito ditches, the mud snail

is often very abundant. This snail has a conical shell up to 25 mm in length, with an elevated spire which is often badly eroded. The shell color is dark gray or brown or black, and the shell is often covered with a slippery layer of algal growth and debris. The shell aperture is oval and has a heavy, broad lip.

The mud snail is carnivorous and active. It locates its food by chemoreception, following a trail of waterborne odors to any dead or decaying organisms. Occasionally it feeds on the live tissue of bivalves, rasping a hole through the shell with its radula.

Mud snails leave groove-like trails behind them as they travel through the mud, and wave their siphons back and forth as they search for food odors. They may congregate on mud flats in very large numbers if a suitable food supply is present. Approximately 4000 of these animals were counted on one square meter of the intertidal mud at the edge of a Connecticut marsh. The range of these snails is from Canada to southern Florida.

Rough Periwinkle *(Littorina saxatilis)*: The snail most frequently found in the saltwater cordgrass of the low marsh is the rough periwinkle. This snail is related to the common periwinkle of the rocky coasts,*(Littorina littorea)*, but is smaller, averaging approximately 12 mm in length when fully grown. The shell is rough, with irregular raised lines, and is yellow-gray or yellow-green in color. Although the rough periwinkle is a marine snail, it can remain active during long periods of exposure provided that the substrate is moist. It has been suggested that there is a tendency toward formation of a lung in this snail.

Unlike most other marine snails, which lay their eggs in water, the rough periwinkle carries its eggs in a brood pouch until the young are fully formed and able to meet the demanding conditions of marsh life. As many as 3500 small *L. saxatilis*, ranging in size from 1 mm to 5 mm, have been found on one square meter of an eastern Connecticut marsh in midsummer. It is not known whether numbers of this magnitude are found each summer. If so, the mortality of these young snails must be high, since the average number of adult *L. saxatilis* found in the low marsh area of this same marsh was 14 per square meter.

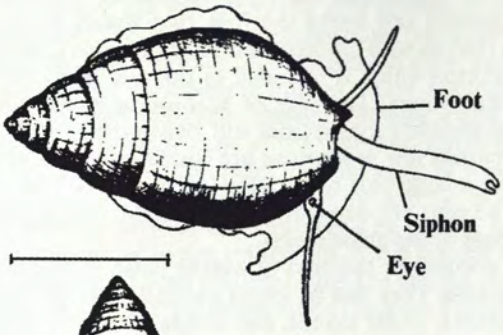
L. saxatilis feeds on algae and detritus, which it scrapes off the surface of the peat and grass stalks with its radula. The diet may include a small component of plant tissue.

Salt Marsh Snail *(Melampus bidentatus)*: One of the most abundant and interesting high marsh animals is the salt marsh snail, *Melampus bidentatus*. This small air-breathing (pulmonate) snail has been found in salt marshes from New Brunswick, Canada, to Texas. In one Connecticut marsh as many as 600 salt marsh snails were counted on one square meter of marsh, and densities of 200 or more per square meter were not uncommon.

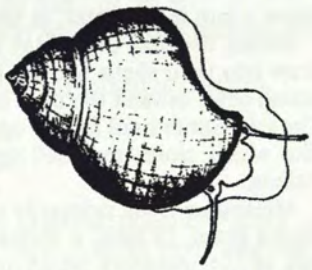
The shells of young *Melampus* are always shiny and vary in color from light to dark brown. There are from one to six transverse bands. The shells of older snails are corroded and rough and usually lack the transverse bands. The shell is ovoid, with a short conical spire. The aperture of the shell is narrow, and two ridges which resemble teeth are present on the inner wall.

The life span of *Melampus* is from three to four years. The usual maximum shell length for fully grown snails is approximately 12 mm, but snails as large as 14 mm have been found on Connecticut marshes. Snails with shell length from 6 mm to 8 mm form the largest size class.

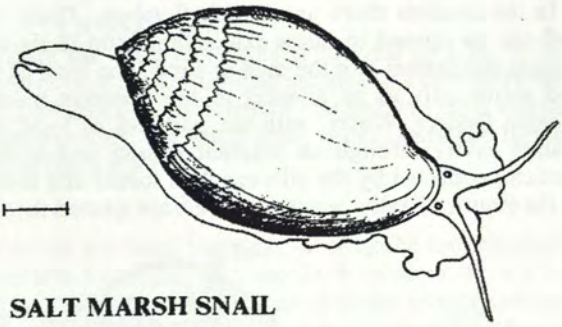
Melampus is seldom found in the low marsh. Its usual habitat is the salt-meadow grass or spikegrass of the high marsh, between the mean high water level of neap tides and the mean high water level of spring tides. Adult snails are not aquatic since they possess an air sac and must breathe air in order to



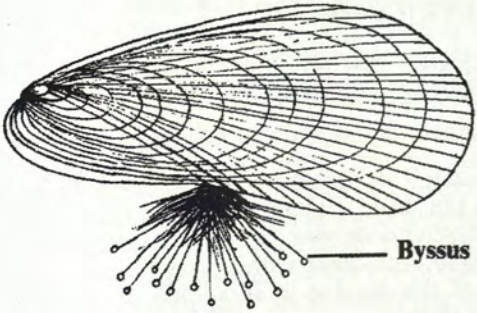
MUD SNAIL



ROUGH PERIWINKLE



SALT MARSH SNAIL



RIBBED MUSSEL

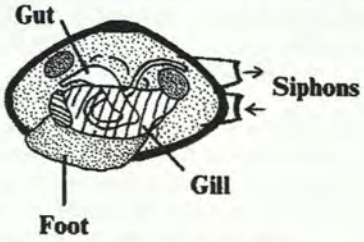
survive. Therefore, they cannot be submerged for long periods of time. The larvae, on the other hand, are aquatic and spend the first two weeks or so of their lives as planktonic veligers (larvae with ciliated swimming organs). In this stage they are part of the zooplankton which is included in the diet of many of the fish and shellfish of the coastal waters. The eggs of *Melampus* must therefore be laid in an area where semi-monthly spring tides will sweep the larvae out to sea as they hatch. For these reasons few *Melampus* are found either in areas of the marsh which are flooded for a large part of each day or in areas above the levels reached by spring tides. The eggs are deposited in hemispherical masses, about 1 mm in diameter, at the base of the grass stems.

During the heat of the day in summer or the cold of winter these snails withdraw into their shells and are inactive. They can be found partially buried in the marsh peat, around the base of plants, under stones, and inside of empty shells. The salt marsh snail has no operculum but apparently can secrete an impervious film which closes the shell opening and affords protection from adverse conditions.

Melampus feeds primarily on the algae of the peat surface and on bits of decaying grass. In turn, it forms an important part of the diet of the marsh birds and of the minnows which penetrate the high marsh during periods of tidal flooding.

BIVALVES

In the bivalves there are two shell valves. These valves are hinged dorsally and can be opened to allow extension of the blade-like foot which is used for digging the animal into the mud or sand. The head of bivalves is greatly reduced and serves only as an opening to the digestive tract. These animals are suspension feeders. Water, with the particles of food it bears, is taken into the mantle cavity through an inhalant siphon and is filtered by the gills. Food particles collected by the gills are then sorted and some of them are transported to the mouth. Finally, waste materials are ejected through an exhalant siphon.



BIVALVE (Generalized)

Although several species of bivalves can be found in the estuaries which border the marshes, only the ribbed mussel *(Modiolus demissus)* has invaded the marsh itself.

Ribbed Mussel *(Modiolus demissus)*: The ribbed mussel, which gets its name from the many radiating ribs on the shell, is abundant in the mud of the low marsh and along the banks of mosquito ditches. Several mussels are usually found clumped together, attached to each other with byssal threads which are secreted by the foot. The shell of this bivalve is dark blue or greenish-blue in color and may reach a length of 10 cm.

The ribbed mussel can only feed when submerged and therefore is found only

in areas which are covered by water for a part of each day. Particles suspended in the water are sorted by the gills according to size, with the smaller particles being passed on to the esophagus and the larger particles being ejected onto the mud. In this manner the mussel actually concentrates organic and mineral particles and enriches the mud in which it is found.

The ribbed mussel is the only bivalve which has been able to penetrate into the high intertidal zone of the marshes, where it is exposed to air as much as or more than it is submerged. This invasion of a terrestrial habitat is made possible by the behavioral adaptation of air-gaping, in which the mussel leaves its shells ajar during periods of exposure. The mussel buries itself in the mud in such a way that water is not spilled out of the mantle cavity when the tide recedes, and gas exchange takes place through the gaping shells.

The range of the ribbed mussel is from Prince Edward Island to Georgia.

ARTHROPODS

ANIMALS with jointed appendages and hard external skeletons make up the phylum Arthropoda. This phylum contains more species than any other phylum, and these species have adapted to a wide diversity of ecological niches. The classes within the Arthropoda which are found in the Connecticut tidal marshes include the Crustacea, the Arachnida, and the Insecta.

CRUSTACEANS

The body of animals within the class Crustacea is covered by a horny shell and the appendages often have pincer-like terminal segments. There are several orders within this class. Those that can be found on Connecticut tidal marshes are the Decapoda (crabs and shrimp), the Amphipoda (sand fleas), the Isopoda (sow bugs) and the Cirripedia (barnacles).

CRABS

The head and thorax of crabs are fused together, forming the cephalothorax, and the body is dorsoventrally flattened. The thorax is covered by a dorsal carapace (hard plate of exoskeleton), the front edges of which often have teeth. These teeth vary in number and shape and can be used as distinguishing features in identifying the crabs. The sides of the carapace overhang and enclose the gills which are in lateral branchial chambers. There are five pairs of thoracic legs (pereiopods), the first of which are chelate (have pincer-like terminal segments) and are usually larger and heavier than the rest. The abdomen is greatly reduced and is bent under the cephalothorax, where it fits into a shallow depression. The abdominal legs (pleopods) have been reduced and modified for copulation in the male and for egg-carrying in the female. The exoskeleton of crabs is relatively impervious to water and there is evidence that in many of the estuarine and semi-terrestrial crabs the permeability varies with the salinity of the water.

There are five species of crabs on the Connecticut marshes. Two of these, the blue crab *(Callinectes sapidus)* and the green crab *(Carcinus maenas)* are swimming crabs. The marsh crab *(Sesarma reticulatum)* and the fiddler crabs *(Uca pugnax* and *Uca minax)* are semi-terrestrial crabs. The blue crab is found only in areas which are submerged. The other species are usually found in the tall saltwater cordgrass areas of the low marsh and along the creeks and ditches, but the fiddler crabs may occasionally dig their burrows in the mud of other vegetation types.

Blue Crab *(Callinectes sapidus)*: The blue crab is found only in the tidal creeks and mosquito ditches except during periods of high tides when it invades the areas of the high marsh which are submerged. This crab apparently prefers to spend a large part of the time in brackish waters, but after breeding the females move to waters of higher salinity before the larvae hatch, and both sexes spend the winter in offshore waters.

The carapace of this large crab is broad, measuring approximately 15 cm in width. There are nine teeth, or spines, along each side of the front edge of the carapace between the eye socket and the lateral angle. The first eight teeth are short, but the ninth is long and sharp and is a distinguishing feature of the blue crab. The segments of the last legs are broad and flattened and the terminal segment is paddle-shaped. The upper surface of the body of this crab is dark green and the lower surface is whitish. The crab gets its name from the blue color of the claws.

Blue crabs are active and pugnacious predators. Their diet includes small living bivalves and crabs, live plants, and dead animal material. These crabs can be found along the entire eastern coast from Cape Cod to Florida. In parts of this range the blue crab fishery is of considerable economic importance. Blue crabs are eaten not only when the shell is hard, but also, as "soft-shelled crabs", immediately after moulting before the new shell has hardened. Blue crab fishing is also an important recreational asset associated with the estuarine environment.

In addition to man, the blue crab's predators include shore birds and some of the larger fish.

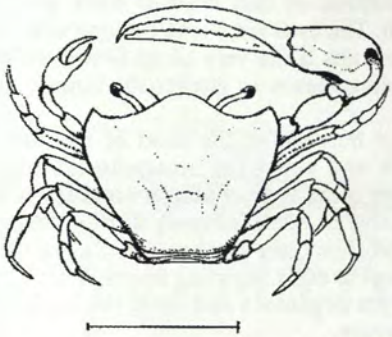
Green Crab *(Carcinus maenas)*: Although the green crab is often found in the tall saltwater cordgrass areas of the low marsh, it is even more common in the tide pools or hidden in the seaweed of the intertidal areas along rocky shores. The carapace of this crab is almost square. It is smaller than that of the blue crab, usually measuring from 5 cm to 7.5 cm in width and only a little less in length. There are five very sharp teeth on each side of the anterior edge of the carapace between the eye socket and the lateral angle, and three low teeth between the eyes. The color varies from dark green or blue-green to greenish orange. Although this crab is a swimming crab, the terminal segment of the last pair of legs is pointed rather than paddle-shaped as in the blue crab.

The range of the green crab is from Cape Cod to New Jersey. It is chiefly a scavenger and feeds on any dead animal material. It will also prey on living animals such as worms if these are readily available.

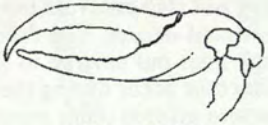
Marsh Crab *(Sesarma reticulatum)*: The marsh crab is common on southern tidal marshes but is not found in large numbers on Connecticut marshes. These crabs are brownish-purple in color, with yellow claws. The eyes are borne on short eye stalks. The carapace is very square and the crab is sometimes known as the "square-backed fiddler".

Marsh crabs excavate burrows in the mud, often among the smaller fiddler crab burrows. Each burrow is inhabited by several crabs. The burrows are always in or near the tall saltwater cordgrass, since the outer leaves of this grass make up a major part of the marsh crab's diet. In areas where this crab is abundant, bare patches of mud may result from the grazing and from the undermining of the grass roots by burrow excavation. Marsh crabs also occasionally feed on fiddler crabs.

Fiddler Crabs *(Uca pugnax* and *Uca minax)*: The fiddler crab, *Uca pugnax*, (also known as the marsh fiddler crab or the black fiddler crab) is very abundant

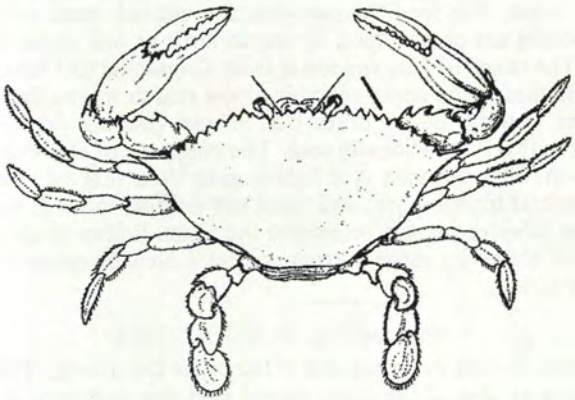


Female

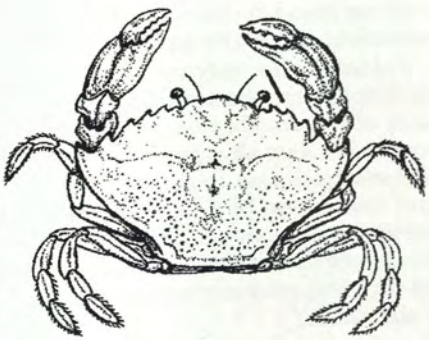


Claw of Male

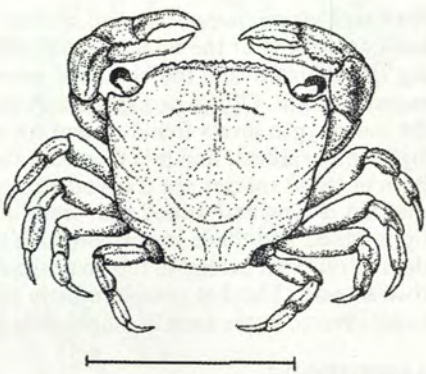
FIDDLER CRAB



BLUE CRAB



GREEN CRAB



MARSH CRAB

Bars indicate carapace width.

on Connecticut tidal marshes. The carapace of this crab is dark gray and generally does not exceed 22 mm in width. The eyes are borne on long eye stalks. The truly distinguishing feature of these crabs is the very large first claw of the males. This claw is used during the breeding season to attract the female and to threaten and fight other males.

These fiddler crabs generally dig their burrows in the mud of the tall saltwater cordgrass areas of the low marsh and along the mosquito ditches, but they will also excavate burrows among any other type of marsh vegetation where soft mud occurs. The crabs remain inactive in these burrows during periods of high tides but emerge to feed at low tides. They are most active during the low tides that occur during the night or during the early morning hours. This activity pattern affords them some protection from predators and from the higher daytime temperatures which they cannot tolerate.

The black fiddler crabs feed on the algae, bacteria, partly decomposed marsh grass, animal remains, and worms in the mud of the marsh. Mud is scooped up with the claws and placed in the mouth, where edible particles are separated from inedible ones. The inedible particles are ejected back onto the marsh. These fiddler crabs are preyed upon by marsh birds as well as by blue crabs and marsh crabs. The range of *Uca pugnax* is from Cape Cod to Florida.

Along the ditches in the upper sections of the marsh where the salinity of the water is lowest, another fiddler crab, *Uca minax*. (the big fiddler crab or red-jointed fiddler crab), is occasionally seen. The carapace of this crab may reach a width of 36 mm. The carapace is a lighter gray than that of the black fiddler crab, with a central brown mark, and there are reddish spots at the joints of the front claws. In other respects it resembles the black fiddler crab. It is an herbivore, feeding on algae. Its range is from southern New England (where it is not abundant) to Florida.

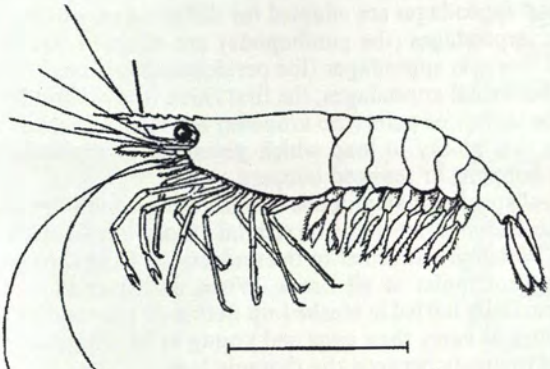
SHRIMP

Like the crabs, shrimp are members of the order Decapoda. The general body plan is the same as that of the crabs except that the abdomen is much longer, the body is laterally compressed, and the carapace is not as hard. The last pair of appendages is fused with the last abdominal segment, forming a caudal fin which is used for swimming backward. There is a rostrum (beak-like process) above the mouth.

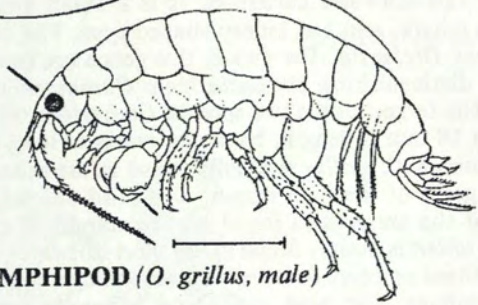
Prawns *(Palaemonetes)*: the two species of shrimp found in the mosquito ditches and tidal creeks of the tidal marshes of Connecticut and in the estuaries bordering the marshes are the common prawn, *Palaemonetes vulgaris*, and *Palaemonetes pugio*. Of the two species, *P. pugio* is apparently better able to tolerate the low oxygen levels found in shallow waters of the marshes during periods of high temperatures, and it is therefore the more abundant shrimp in these areas. Both of these species are translucent in color and have very long antennae. The rostrum is long and armed with teeth in both species, but in *P. pugio* the rostral tip is naked and there are two or three ventral rostral teeth, while in *P. vulgaris* the rostral teeth extend to the tip of the rostrum and there are four or five ventral rostral teeth. The diet consists mostly of seaweed and saltwater cordgrass. Some small invertebrates such as amphipods are also eaten.

AMPHIPODS

Amphipods are extremely abundant on the tidal marshes. They are an important part of the diet of birds and of the fish and crabs which move into the marsh when the tide is high. These small crustaceans have laterally compressed bodies and arched backs. The semi-terrestrial species found on the marshes

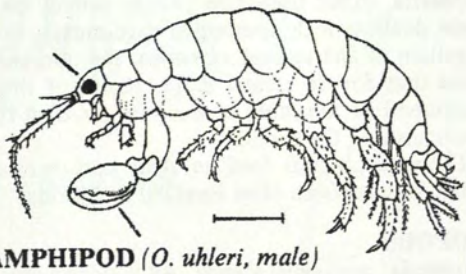


COMMON PRAWN

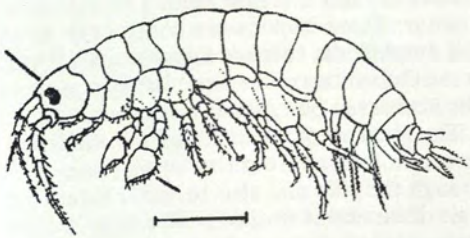


AMPHIPOD *(O. grillus, male)*

Gnathopod of Female Orchestia



AMPHIPOD *(O. uhleri, male)*



AMPHIPOD *(Gammarus, male)*

may be brownish green, olive green, or orange. Some are mottled with red or brown. The head has two pairs of antennae and there are thirteen pairs of legs or appendages. These appendages are adapted for differing purposes. The first two pairs of thoracic appendages (the gnathopods) are adapted for grasping. The next five pairs of thoracic appendages (the pereiopods) are used for walking. Of the six pairs of abdominal appendages, the first three (the pleopods) are used for swimming and the last three pairs (the uropods) are stiff and short and are used for leaping. It is this ability to leap which gives the amphipods the name of sand fleas, beach hoppers, or seaweed hoppers.

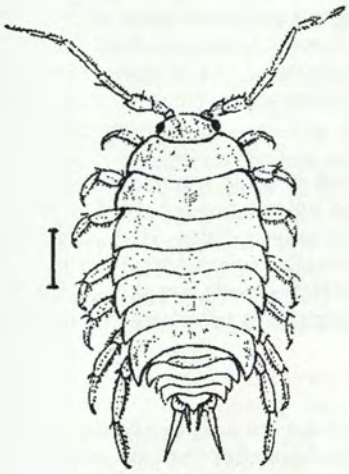
Although several species of amphipods inhabit areas which are exposed much of the time, none has become fully terrestrial. Since respiration takes place through the gills, which are attached to the underside of the thoracic legs, these animals must be kept moist at all times. When undisturbed, amphipods are generally found partially buried in washed-up debris or seaweed or in the peat of the marsh. Amphipods carry their eggs and young in brood pouches located on the ventral side of the body between the thoracic legs.

Three species of amphipods are abundant on Connecticut marshes, each inhabiting a different part of the marsh, although there is some overlap of their distribution. One, *Gammarus palustris,* is found most abundantly in the low marsh, in tall saltwater cordgrass. It is a small amphipod, measuring up to 13 mm in length, and has kidney-shaped eyes. The other two species are both of the genus *Orchestia.* The eyes in this genus are round, (eye shape provides a means of distinguishing *Orchestia* from *Gammarus*), and the first antenna is reduced. The largest of the two species, *Orchestia grillus,* generally measures no more than 18 mm in length, but some males as long as 22 mm have been seen in late summer. *O. grillus* is usually found in the saltmeadow grass, spikegrass, and blackgrass of the high marsh. The third species, *Orchestia uhleri,* is the smallest of the amphipods found on the marsh. It measures up to 10 mm in length. *O. uhleri* is mainly found in the short saltwater cordgrass (where as many as 400 of these amphipods have been seen in one square meter of grass) and in the forb pannes. The most noticeable difference between the two species of *Orchestia,* other than size (which cannot be used as a distinguishing feature when dealing with immature specimens), is the number of segments in the flagellum of the second antennae; the number for *O. grillus* being 20 or more, while that for *O. uhleri* is 12. In all of these amphipod species the second gnathopod of the male is much larger than that of the female and is a way of distinguishing the sexes.

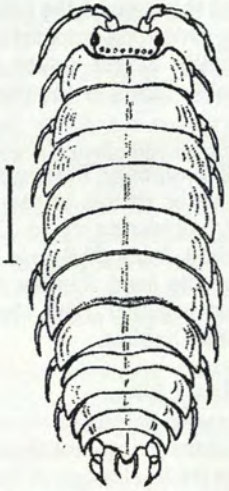
These amphipods feed on algae and detritus. Their range extends along the Atlantic coast from New England to Florida.

ISOPODS

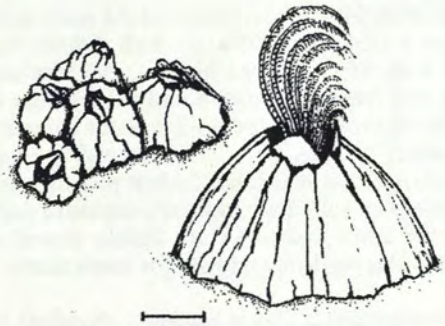
Isopods are crustaceans with dorsoventrally flattened bodies. There is variation in anatomy among species, but the terrestrial or semi-terrestrial isopods found on Connecticut tidal marshes belong to the same suborder (the Oniscoidea) and are similar. These isopods are commonly known as sow bugs or wood lice. As in the amphipods, there are two pairs of antennae (the first of which is vestigial in the Oniscoidea). The first thoracic appendages are modified for feeding, and the next seven pair, which are of more or less equal length, are used for walking. The abdominal appendages are modified as gills, which are covered by an operculum formed from the outer plate of the legs. Gas exchange takes place through the gills and also to some extent through the operculum. There is one pair of biramous uropods. The eggs are carried in a brood pouch, called a marsupium, which is located on the ventral surface of the body between the thoracic legs.



ISOPOD *(Philoscia)*



ISOPOD *(Porcellio)*



ROCK BARNACLE

Because of the shape of their bodies and legs the isopods are more stable and better suited for locomotion on land than are the amphipods. However, since gas exchange takes place through the gills and through the integument, they are not truly adapted for terrestrial existence and, like the amphipods, must be kept moist at all times. They seek out damp and dark shelters and are usually found under debris or partially buried in the peat. Most species are detritus and algae feeders, but some also feed on bark.

Philoscia vittata: The most abundant isopod found on the Connecticut tidal marshes is the semi-terrestrial *Philoscia vittata.* This is a small isopod, seldom measuring more than 8 mm in length, although larger specimens are occasion-

ally seen. The color is mottled brown, with yellow lateral margins. This isopod is found throughout the saltmeadow grass, spikegrass and blackgrass of the high marsh, averaging approximately 20 per square meter. Although these animals are usually hidden under debris or among the roots of the grasses, they occasionally climb to the tips of the grass stalks to escape submergence at high tide.

Porcellio rathkei: This isopod is sometimes found in large numbers under the marsh elder shrubs of the high marsh along the upland border. It is a larger isopod, measuring up to 13 mm in length, and is gray in color. It may be distinguished from *Philoscia* by the lateral lobes which project forward on both sides of the head. Unlike *Philoscia,* these terrestrial isopods are usually found clumped together. This clumping may aid the animals in retaining moisture in their drier habitat.

BARNACLES

Barnacles belong to the subclass Cirripedia and are the only sessile (attached) crustaceans. Metamorphosis into the adult takes place after the free-swimming larva in its final stage of development has settled on a substrate and become attached by means of cement which is secreted by a gland at the base of the first antenna. In all of the common barnacles a calcareous shell consisting of six plates is then secreted by the mantle (or carapace). These six overlapping plates ring the body of the animal. Four more plates (the paired scuta and terga) cover the top of the animal. The scuta and terga are moveable and can be opened or closed. There is much reduction of body parts so that the adult barnacle consists only of a head region and a thoracic region to which the six pairs of legs, or cirri, are attached. The body is positioned so that the legs extend upward. During feeding the scuta and terga are opened and the legs are extruded. The legs sweep back and forth rhythmically, creating a water current and trapping food particles in their feathery bristles. Phytoplankton and zooplankton of suitable size are then transported to the mouth by the first pair of legs.

Many species of barnacles can tolerate temporary exposure during periods of low tide. At such times the scuta and terga are tightly closed and the water trapped inside the shell provides sufficient oxygen for respiration.

Rock Barnacle *(Balanus balanoides)*: This is the most abundant barnacle in the intertidal zone along the northern Atlantic coast from the Arctic Ocean to Delaware Bay. It is found in very large numbers on the rocks and seaweed of rocky coasts and in the lower part of the estuaries which border the tidal marshes. It can be identified by the basis, or attached undersurface, which is membranous in the rock barnacles but calcareous in all other species of this area. This barnacle does not tolerate waters of low salinity, and the barnacle most commonly found in the higher part of the estuaries, where the water is fresher, is the ivory barnacle, *Balanus eburneus.* Identification of the different species of barnacles having calcareous bases is based on various features of the scuta and terga.

ARACHNIDS

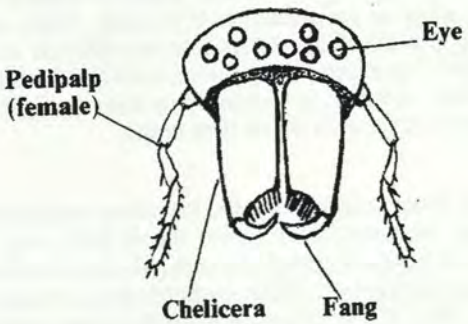
The class Arachnida includes spiders, scorpions, harvestmen (Daddy-long-legs), ticks, and mites. Of these, only the spiders and mites are common on the tidal marshes of Connecticut.

SPIDERS

Spiders belong to the order Aranaea. In members of this group the head is fused to the thorax, forming the cephalothorax, which is covered by a carapace. There is one pair of appendages in the front of the head, the jaws or chelicerae. These are tipped with fangs. There are no antennae. Behind the head there are five pairs of appendages. The first are the pedipalps, which are sensory and prehensile. In females the last segment of the pedipalps is simple but in males it is enlarged and modified as a copulatory organ. The next four pairs of appendages are the legs. There are never any abdominal legs. In spiders the abdomen is attached to the cephalothorax by a thin stalk. At or near the end of the abdomen there are from two to four (generally three) pairs of spinnerets, through the openings of which silk is emitted. The exoskeleton of spiders, like that of the insects, contains a waxlike layer in the epicuticle and is very impermeable to water.

Most spiders have eight eyes, but some have six. The arrangement of the eyes is one of the distinguishing features of the various species. Other such features include the orientation of the chelicerae, the number of claws on the tarsi (the terminal segment of the legs), and the structure of the male pedipalp.

All spiders feed on living prey. On the tidal marshes they are probably the chief predators on small invertebrates. In turn, they are eaten by birds, some kinds of insects, and by other spiders.



HEAD OF SPIDER

Dwarf Spiders *(Grammonota trivittata* and *Ceraticelus* sp.*)*: Several species of dwarf spiders (family Micryphantidae) are found on the Connecticut tidal marshes. The largest of these, *Grammonota trivittata,* is an abundant spider in the tall saltwater cordgrass of the low marsh. It is also found throughout the high marsh, but generally not in large numbers. Although *Grammonota* is a small spider, not exceeding 3 mm in length, it is often seen with larger insects in its jaws. The cephalothorax of this spider is yellow-brown, the abdomen gray with a yellow pattern on the dorsal surface, and the legs yellow. There are eight eyes, arranged in two rows, with the anterior row being strongly recurved. The median posterior eyes are larger than the other six.

Other species of dwarf spiders which are also abundant in some areas of the Connecticut marshes are members of the genus *Ceraticelus*. These are the smallest marsh spiders, usually measuring no more than 1.5 mm in length. They are all of a yellow-orange color, usually black in the eye region, and many of them have a scutum (sclerotized plate) on the dorsal abdomen.

Wolf Spiders *(Pardosa* sp.*)*: Probably the most abundant spiders on the Connecticut marshes are two species of the wolf spider family (Lycosidae), both members of the genus *Pardosa.* One is a dark brown spider with yellow submarginal lines on the carapace. The other is lighter in color, having light brown markings on a yellowish background. There are eight eyes. The four posterior eyes are larger than the four anterior eyes and appear to form two rows of two eyes each.

These spiders are found in very large numbers throughout the summer, running through the saltmeadow grass and spikegrass meadows of the high marsh. They are also occasionally found in drifted eelgrass or in the tall saltwater cordgrass of the low marsh. These are medium sized spiders, measuring up to 6.5 mm in length. Like all members of the wolf spider family, their bodies and legs are covered with hairs. *Pardosa* can often be seen running on the surface of the water of the mosquito ditches. Because of their impermeable exoskeletons, and because the body hairs trap bubbles of air which can be used for respiration, these spiders are able to withstand short periods of submergence.

During most of the summer female wolf spiders can be seen with egg sacs attached to the spinnerets, and after emergence the young are carried about on the mother's back.

Sac Spider *(Clubiona* sp.*)*: Another common spider, found in all areas of the marsh, is a species of the genus *Clubiona* (family Clubionidae). There is much variation in size in this genus, but the average length is approximately 8 mm. These sac spiders are tawny or greenish-yellow in color. There are seldom any markings on the body and the different species are difficult to identify. The chelicerae are very stout. Compared with *Grammonota* and *Pardosa,* sac spiders seem quite inactive. This, however, is because they hunt at night and generally remain hidden by day in silk retreats which they make.

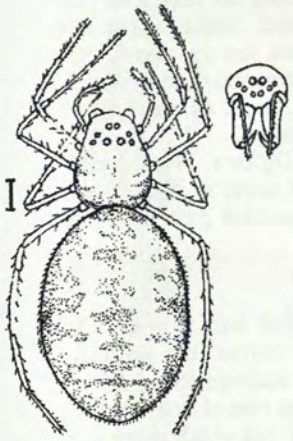
MITES

Mites belong to the order Acari. As with the other arachnids, adult mites have four pairs of legs. However, most larval stages have only three pairs of legs. Mites differ from the spiders in that the cephalothorax is broadly joined to the abdomen and there is generally little segmentation apparent, so that the body is oval in shape. Most of the mites are minute in size, many being microscopic. Both predaceous and detritus-feeding mites are found on the Connecticut salt marshes, the former apparently feeding on Collembolans and on smaller mites. All of the larger salt marsh mites are bright red in color. This color is generally thought to serve as a warning to predators that the animal bearing it is distasteful or poisonous. However, these mites appear to make up a major part of the diet of the salt marsh spiders.

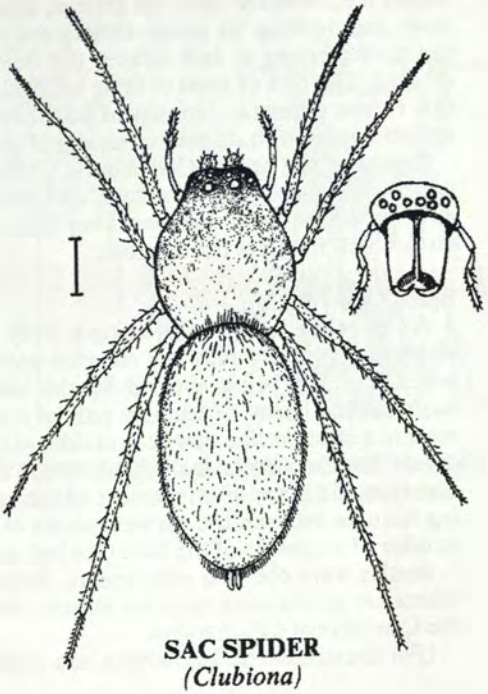
INSECTS

Insects differ from other arthropods in having three pairs of legs and, usually, two pairs of wings which are attached to the thorax. There is generally one pair of antennae. Insect mouthparts may be of the chewing, piercing and sucking, or lapping varieties.

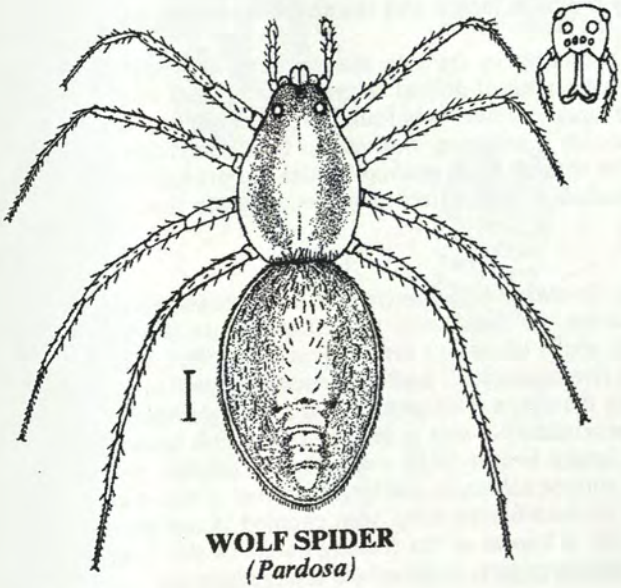
Insects are able to escape submergence during periods of high tides by flying away or by crawling to the top of grass stalks. In addition, their exoskeletons contain a waxlike layer in the epicuticle which is very impermeable to water. For these reasons, insects are not much affected by the tidal cycles. Their distribution on the marsh is influenced more by their food requirements. Some



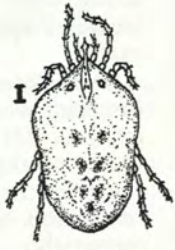
DWARF SPIDER
(Grammonota)



SAC SPIDER
(Clubiona)



WOLF SPIDER
(Pardosa)



MITE

insects feed directly upon the grasses, either chewing the leaves or piercing the plant and sucking its juices. Others are predaceous, either biting into animal tissue or piercing it and sucking the fluids. A few lap up plant secretions or detritus. The diet of most of these insects is quite restricted and specialized. For this reason a greater diversity of insect species is found as one approaches the upland border with its greater variety of plant types.

Insects of the orders Collembola, Coleoptera, Diptera, Hemiptera, Homoptera, Lepidoptera, Hymenoptera, and Orthoptera occur in significant numbers on Connecticut tidal marshes. They form an important part of the diet of the birds which frequent the marshes.

BEETLES *(Coleoptera)*

As in other insects, the beetle's body is divided into a head, thorax, and abdomen. Dorsally only the anterior part of the thorax (the pronotum) is exposed, the rest being covered by the wings. A distinguishing feature of the beetles is the horny or leathery pair of front wings (the elytra) which generally meet in a straight line down the middle of the back and which serve as protective covers for the membranous hind wings. These hind wings are used for flying. The type and place of attachment of the antennae are often used as distinguishing features between the various species of beetles, as are the body form and the number of segments of the tarsi (the last segments of the legs).

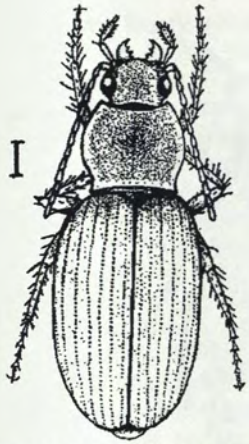
Beetles have chewing mouthparts. Some are plant or detritus feeders, while others are predaceous on other insects. Several species of beetles are found on the Connecticut salt marshes.

(For illustration of beetle larva, see page 32).

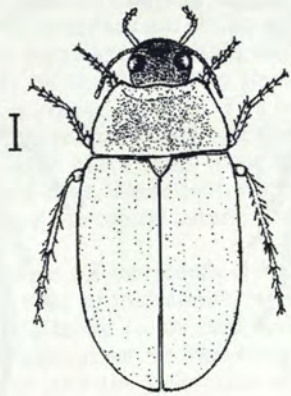
Ground Beetle *(Bembidion* sp.*)*: Members of the family Carabidae are known as ground beetles. In this family the antennae are threadlike and have eleven segments. The tarsi have five segments. The abundant ground beetle of the Connecticut salt marshes is a species of the genus ***Bembidion***. This is a small, dark brown, shiny beetle with striae (longitudinal depressed lines) on the elytra. It measures approximately 5 mm in length and the shape is that of an elongated oval.

Bembidion is found primarily in the low marsh areas and is particularly abundant wherever there are piles of drifted eelgrass, sometimes numbering as many as 100 beetles per square meter. It is found even among the marsh elder shrubs of the upland border if eelgrass, washed up by storm tides, has been caught in the stalks of the shrubs. Most ground beetles are predaceous, and the correlation between *Bembidion* and drifted eelgrass suggests that it feeds on springtails.

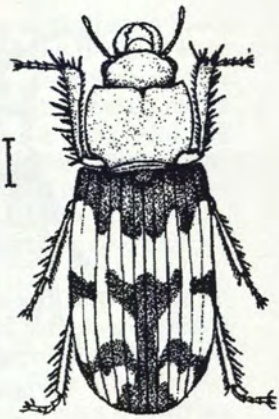
Water Scavenger Beetle *(Enochrus hamiltoni)*: Water scavenger beetles belong to the family Hydrophilidae. In this family the antennae are short while the labial palps (appendages of the lower lip) are long and are often mistaken for antennae. The tarsi are five-segmented, and in ***Enochrus hamiltoni*** there are rows of impressed dots on the elytra. This small water scavenger beetle is oval in shape and measures approximately 5 mm in length. It is a dull brown in color. Most members of this family live in fresh water; a few inhabit moist earth. *E. hamiltoni* prefers the stunted saltwater cordgrass pannes of the marsh where drainage is poor. Eighty of these beetles have been counted in one square meter of stunted cordgrass. Little is known of the feeding habits of this beetle. Some members of the family are scavengers, while others are predaceous.



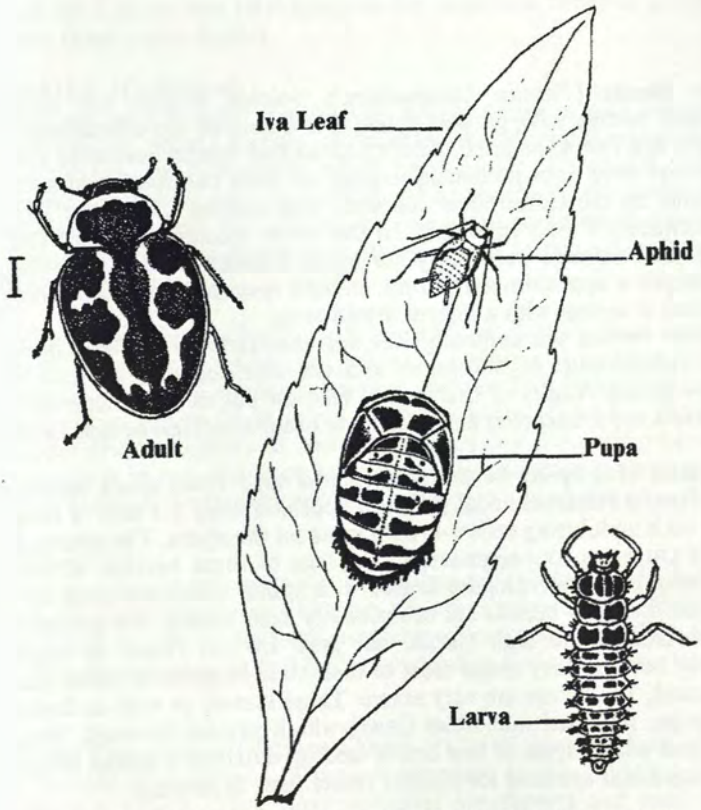
GROUND BEETLE
(Bembidion)



WATER SCAVENGER BEETLE
(Enochrus)

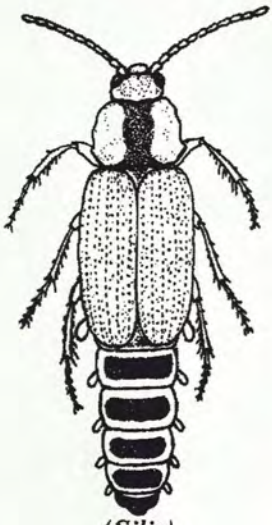


MUD-LOVING BEETLE
(Heterocerus)



LIFE HISTORY OF LADYBUG BEETLE *(Naemia)*

(Cantharis)



(Silis)

SOLDIER BEETLES

Soldier Beetle *(Family Cantharidae)*: Soldier beetles are medium-sized, elongated beetles with parallel sides. The antennae are eleven-segmented and the tarsi are five-segmented. These soft-bodied beetles resemble lightningbugs but do not have light-producing organs. At least two species of soldier beetles are found on the Connecticut marshes. One species (*Cantharis* sp.) measures approximately 7 mm in length. In the other species (*Silis* sp.) the abdomen is large and extends posteriorly for some distance beyond the wings and the body length is approximately 9 mm. In both species the elytra are black and the pronotum is orange with a central brown area.

Soldier beetles are common, but not abundant, in the marsh elder shrubs at the upland edge of the marsh and are also occasionally seen in the salt-meadow grass. Adults of this family feed on pollen and nectar or on foliage. The larvae are predaceous and prey upon other small larvae and insects.

Variegated Mud-loving Beetle *(Heterocerus* sp.*)*: These small beetles (members of the family Heteroceridae) measure approximately 5.5 mm in length and are brown with undulating yellow-brown spots on the elytra. The antennae are short and the tarsi are four-segmented. The legs of these beetles, which are a distinguishing characteristic, are armed with spines which are used for burrowing in the mud. These beetles are occasionally seen among the grasses and marsh elder shrubs of the high marsh, but they are not found in large numbers, probably because they spend most of their time in galleries which they excavate in the mud. The larvae are very active. These larvae, as well as the adult males, have large, flattened mandibles (jaws) which project forward. Since both the larval and adult forms of this beetle feed on detritus, it seems likely that these large mandibles are used for defense rather than in feeding.

Ladybug Beetle *(Naemia seriata)*: Ladybug beetles belong to the family Coccinellidae. In this group the antennae are eleven-segmented and the tarsi have three segments. There are many species within this family, each with its own distinctive pattern of spots on the elytra. The abundant ladybug beetle of the Connecticut salt marshes is *Naemia seriata.* This beetle has a black head and black pronotum with orange-yellow lateral and frontal margins. The orange-yellow elytra have three large black spots along each lateral edge and three black spots along the central edge. These central spots coalesce to form a common row of large spots along the central suture. The lateral spots also coalesce to varying degrees.

Naemia seriata is abundant on the marsh elder shrubs of the Connecticut high marshes during the period of midsummer when these shrubs are infested with aphids. Both adult and larval forms feed upon the aphids. Later in the summer the beetles are abundant on the flowering heads of the tall saltwater cordgrass of the low marsh and the spikegrass of the high marsh. Ladybug beetles must eat aphids in order to lay eggs, with the number of eggs laid depending upon the number of aphids available, but it is the pollen eaten in late summer which provides the beetles with the fat which they need for overwintering.

Other species of ladybug beetles are seen on the tidal marshes and some, such as *Hippodamia convergens*, may be abundant in certain summers. It would appear that the Connecticut tidal marshes are important breeding grounds and nurseries for these useful beetles.

SPRINGTAILS *(Collembola)*

The members of this order are minute, wingless insects with elongated or oval bodies. On the ventral surface of the anterior abdominal segment there is a tubular structure, the collophore, which bears a pair of eversible sacs which help the insect to cling to smooth surfaces. Most species of this order have an abdominal jumping organ, the furcula, on one of the posterior abdominal segments. Collembolans have chewing or piercing and sucking mouthparts and feed on decaying matter.

Seashore Springtail (family Poduridae: *Anurida maritima*): This springtail is slate-colored and lacks the jumping organ. The body is elongated and about 3 mm in length. The body segments are very distinct. This insect is found in extremely large numbers in damp areas along the edges of the low marsh, particularly under drifted eelgrass. It feeds on the decaying grass and other detritus in the mud, and is in turn fed upon by many of the predaceous invertebrates of the marsh. It forms a very important part of the marsh food chain.

FLIES *(Diptera)*

Flies have membranous front wings which are used for flying. The hind wings are reduced, knoblike structures which are known as halteres. The venation pattern of the wings is used in distinguishing the various species of flies. The eyes are large. Mouthparts are adapted for either piercing and sucking or for lapping or sponging.

Picture-winged Flies (family Otitidae): These are small, blackish flies with wings which are banded or patterned. They are abundant in the tall saltwater cordgrass of the low marsh. They have sponging mouthparts and feed on plant secretions.

Horseflies, Deerflies (family Tabanidae: *Tabanus* sp.): The large horseflies found in abundance on the tidal marshes have green eyes and are known as greenheads. Deerflies are smaller, being approximately the size of houseflies. They are black or brownish and generally have dark spots on the wings. *Tabanus* larvae are found in the mud or peat of all sections of the marsh, even in the wet mud at the low marsh edges. They are apparently protected from the effects of submergence by their leathery outer covering. These larvae are very active and are voracious predators. (See illustration of *Tabanus* larva on page 32).

MOSQUITOS *(Diptera)*

Mosquitoes, like flies, have one pair of forewings and one pair of halteres. The wings are long and narrow and are fringed with scale-like bristles. These bristles also occur along the wing veins. There is a long proboscis. The antennae of the males are feathery, while those of the females bear only a few short hairs.

The proboscis of the female mosquito is adapted for piercing and sucking, and it is only the female which feeds upon blood. The food of male mosquitoes consists of liquids such as plant juices.

The larvae of all mosquitoes are aquatic. They have chewing mouthparts and feed upon animal and vegetable matter in the water.

Salt Marsh Mosquito *(Aedes sollicitans)*: This is the abundant mosquito of the Connecticut marshes. It is found in brackish waters all along the Atlantic coast from Canada to Florida and along the coast of the Gulf of Mexico. There may be as many as seven broods of these mosquitoes each summer. During periods between rainfall or tidal inundation eggs may remain viable for several weeks as long as the mud upon which they are laid is damp, and the young will hatch as soon as the eggs are submerged. For these reasons, larvae may be found in any standing water on the marshes throughout the summer.

The salt marsh mosquito is the intermediate host for the species of round worm which causes heartworm in dogs, a disease which is becoming increasingly common.

TRUE BUGS *(Hemiptera)*

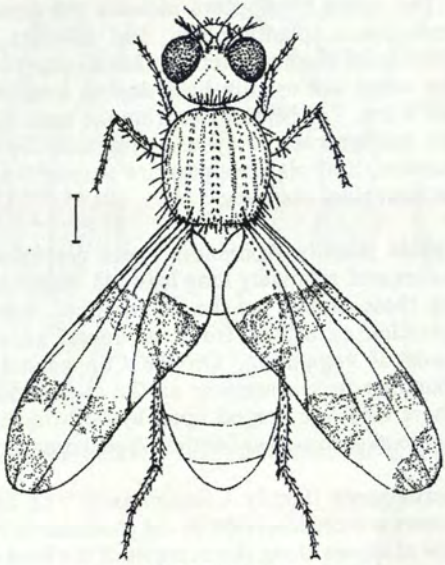
The forewings of the true bugs are thickened and leathery at the base and membranous at the tip. The wings are held flat over the body when not in use. There is a beak which arises from the front of the head and extends backward along the ventral surface. This beak is used for piercing plant tissues and sucking plant juices.

Plant Bug *(Trigonotylus* sp.*)*: This member of the plant bug family (family Miridae) is a small, slender, bright green bug, measuring approximately 5 mm in length, with long legs and long antennae. It is very abundant in the tall saltwater cordgrass of the low marsh all summer long. It is also occasionally found in the saltmeadow grass. It feeds on the juices of these marsh grasses and is considered to be a major grazer on salt marsh grasses from Georgia to New England.

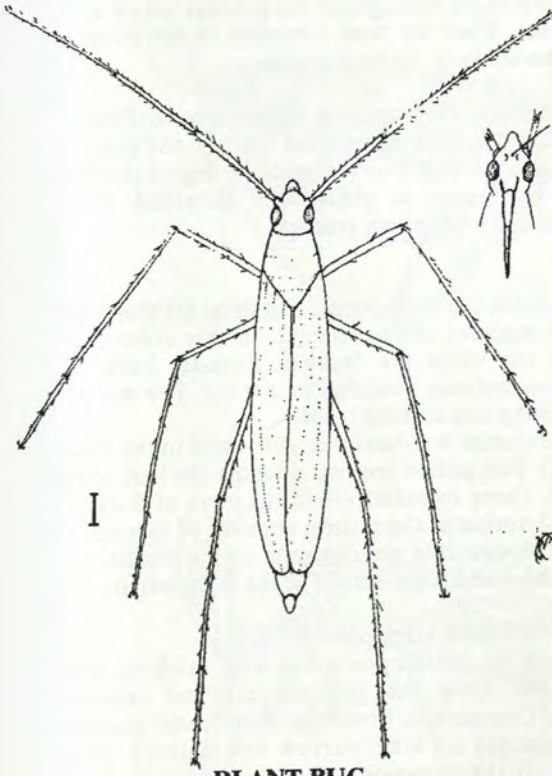
Stink Bug *(Rhytidolomia saucia)*: These members of the stink bug family (family Pentatomidae) are a dark olive-green in color and measure approximately 10 mm in length. Their bodies are broad and short and the head and prothorax form a triangle. In Connecticut tidal marshes they feed on the high marsh grasses and the shrubs of the upland border, but are not found in large numbers.

SPRINGTAIL

Collophore

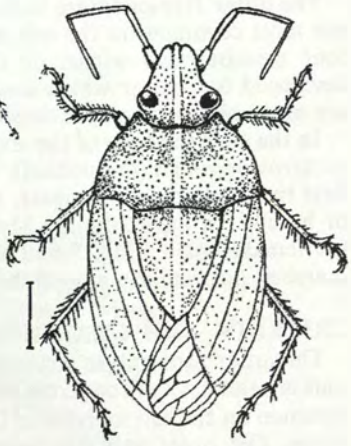


PICTURE-WINGED FLY



PLANT BUG
(Trigonotylus)

Ventral View of Head of Plant Bug Showing Beak



STINK BUG
(Rhytidolomia)

LEAFHOPPERS, PLANTHOPPERS, APHIDS *(Homoptera)*

The order Homoptera includes the cicadas, whiteflies, aphids, scale insects, treehoppers, planthoppers, leaf hoppers, and froghoppers. The homoptera differ from the hemiptera in that all parts of the forewings are membranous and the wings are usually held sloping over the back in a roof-like manner when not is use. The beak arises from the back of the ventral surface of the head. Like the hemipterans, they use this beak for sucking plant juices. Aphids, leafhoppers, and planthoppers are among the most abundant insects on the Connecticut tidal marshes.

Aphids (family Aphidae): These are minute, green insects with pear-shaped bodies and relatively long legs and antennae. In many species of aphids, including those found on the Connecticut marshes, there is a pair of tubes, the cornicles, extending from the dorsal abdomen. Aphids infest many different kinds of vegetation. On the Connecticut tidal marshes they are extremely abundant in midsummer on the marsh elder shrubs along the upland border, where they are preyed upon by both larval and adult ladybug beetles and the larvae of some other beetles. (See illustration of an aphid on page 25).

Leafhoppers (family Cicadellidae): The distinguishing features of these small insects are the insertion of the antennae in front of and between the eyes, and the row of spines along the margins of the hind legs. The insects get their name from the manner in which they leap from leaf to leaf when disturbed. Several different species of leafhoppers are found throughout the summer on all different vegetation types on the marshes. They are most abundant in the saltmeadow grass/spikegrass/blackgrass meadows of the high marsh.

Planthoppers (family Delphacidae): Planthoppers differ from leafhoppers in having the antennae situated on the sides of the head beneath the eyes. In the family Delphacidae there is a moveable spur on the posterior legs. Like the leafhoppers, these insects jump from plant to plant when disturbed. They are common in both the low marsh and high marsh grasses.

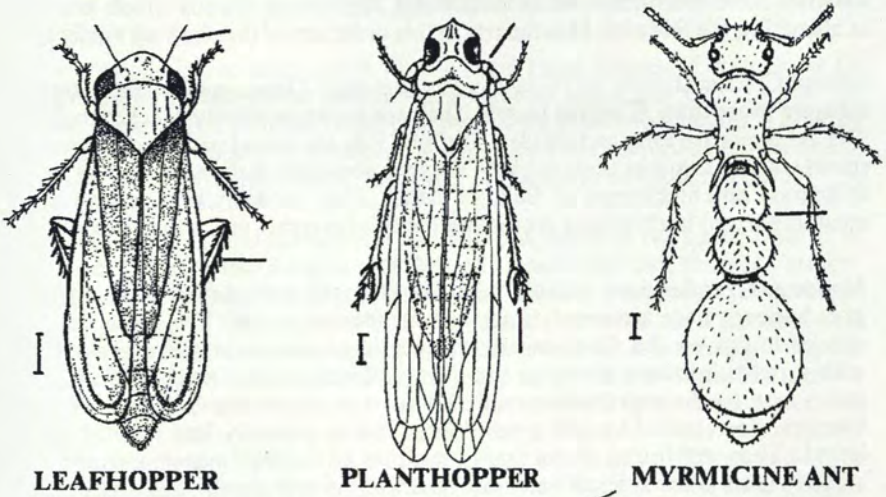
ANTS *(Hymenoptera)*

The order Hymenoptera includes the ants, wasps, and bees. Of these the ants are most common on the salt marshes of Connecticut. In this order there are four membranous wings, or the wings are lacking. Females have a well-developed ovipositor which is sometimes modified as a sting. The mouthparts are of the chewing or both chewing and sucking types.

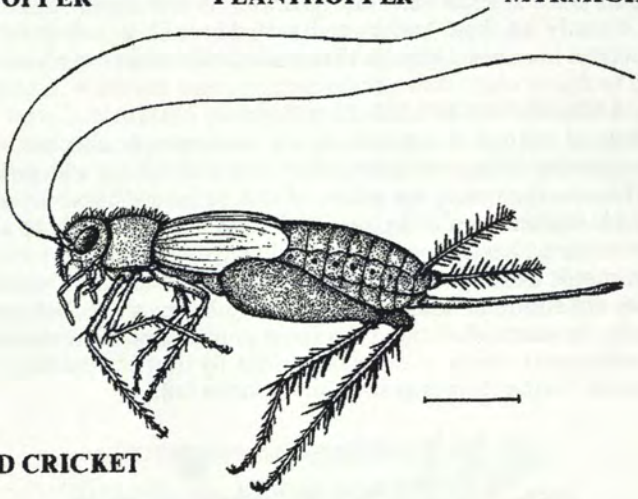
In the ants the base of the abdomen is constricted and joined to the thorax by a narrow segment (the pedicel). This pedicel consists of either the first one or the first two abdominal segments. These segments are in the form of dorsal nodes or humps. In the subfamily Myrmicinae the pedicel consists of two nodes and the female has a sting. Small myrmicinae are common on Connecticut's tidal marshes, particularly among the marsh elder shrubs of the high marsh.

CRICKETS AND GRASSHOPPERS *(Orthoptera)*

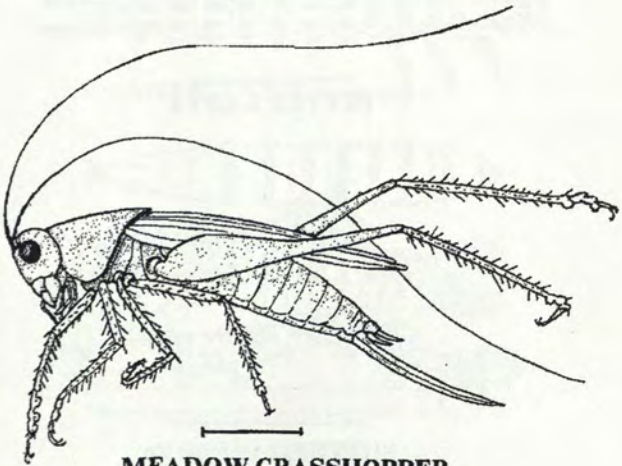
The order Orthoptera includes the grasshoppers, katydids, crickets, mantids, walkingsticks, and cockroaches. Only the grasshoppers and crickets are common on the salt marshes of Connecticut. Members of this order possess four wings. The outer pair (the tegmina) are long, narrow and leathery and serve as covers for the underwings. At the posterior end of the abdomen there is a pair of appendages, the cerci. The males of the grasshoppers, crickets, and



LEAFHOPPER PLANTHOPPER MYRMICINE ANT



GROUND CRICKET



MEADOW GRASSHOPPER

katydids have modifications on their wings for making sounds which are used in attracting the females. Mouthparts in this order are of the chewing variety.

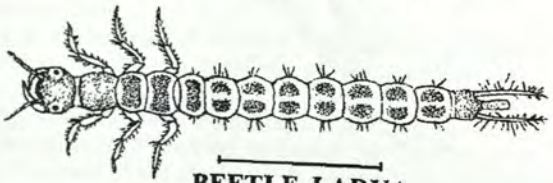
Ground Cricket (family Gryllidae: *Nemobius* sp.): These small crickets seldom measure more than 12 mm in length. They are brown to velvety-black in color. The antennae are long and slender. The hind legs are armed with long, moveable spines. In late summer these crickets are very abundant in the saltmeadow grass, spikegrass and blackgrass of the high marsh. They probably rank as one of the most important herbivorous grazers on the tidal marshes in Connecticut.

Meadow Grasshoppers (family Tettigonidae: *Conocephalus* sp.): Meadow grasshoppers have extremely long and slender antennae. The most common species found on the Connecticut marshes is an attractive green grasshopper with a reddish-brown stripe on the head and pronotum. Other species of this genus seen on the marshes are reddish-brown or yellow brown. Meadow grasshoppers are relatively small grasshoppers, being generally less than 17 mm in length. They are found in the grass meadows of the high marsh and are occasionally seen in the tall saltwater cordgrass of the low marsh. Like the crickets, they feed directly on these grasses and probably rank as important grazers on the Connecticut marshes, although their abundance varies from year to year.

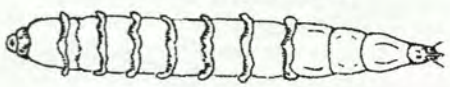
MOTHS AND BUTTERFLIES *(Lepidoptera)*

The wings of butterflies and moths are membranous and are covered with overlapping scales. It is these scales which come off on one's fingers as a sort of "dust". The mouthparts of the adults of this order are fitted for sucking. The larvae, or caterpillars, are cylindrical and have from five to eight pairs of legs. These larvae have chewing mouthparts and feed on foliage.

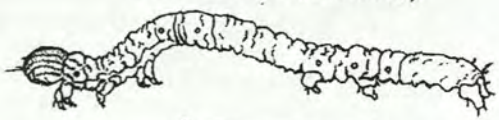
Various moths and butterflies can occasionally be seen on the tidal marshes. The larvae are common among the flowering herbs in the forb pannes of the high marsh. In years when there are large populations of monarch butterflies *(Danaus plexippus)*, many of these butterflies fly over the marsh or rest on the marsh grasses during their migration south in the fall.



BEETLE LARVA



FLY LARVA *(Tabanus)*



BUTTERFLY LARVA

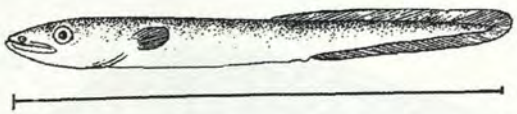
VERTEBRATES

IN any discussion of tidal marsh invertebrates three species of vertebrates (in addition to birds) should be mentioned, since they are major predators on the smaller animals and form an important part of the marsh food chain. These are the common mummichog *(Fundulus heteroclītus)*, the American eel *(Anguilla rostrata)*, and the diamond-back terrapin. *(Malaclemys terrapin terrapin)*.

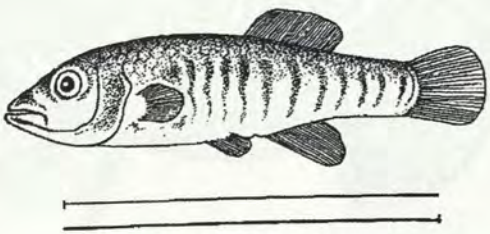
American Eel *(Anguilla rostrata)*: The small eels found in the upper reaches of tidal creeks and in the mosquito ditches of Connecticut salt marshes are immature American eels. When fully grown and sexually mature these eels make the long journey to the Sargasso Sea off Bermuda to breed. It is assumed that the adult eels then die, since mature eels are never seen returning from the Sargasso Sea. The young migrate back to the coastal waters which their parents have left and find their way into the tidal creeks leading to fresh water. Although a few immature eels can be found in intertidal salt waters, the majority work their way up the brackish tidal creeks and mosquito ditches and on to fresh water streams and ponds. Here they spend six to eight years before beginning the breeding migration themselves in the fall of the year.

Full-grown female eels are longer than the males, sometimes being one meter or more in length, while the males seldom reach a maximum length of more than 45 cm. The body is elongated, rounded in the front but compressed posteriorly. The head has a somewhat pointed snout, with the lower jaw projecting. The dorsal and anal fins are low and continuous with the caudal fin; the ventral fins are lacking. The color is greenish-brown on top and pale gray below. The young eels found in the salt marshes may be as small as 6.5 cm in length. The smallest eels are transparent, with pigmentation increasing as the eels grow.

American eels are found all along the Atlantic coast from Newfoundland to Panama, and in the West Indies. They generally remain buried in the mud or sand by day and feed by night on any type of living or dead animal matter.



AMERICAN EEL *(immature)*



MUMMICHOG

Common Mummichog *(Fundulus heteroclitus)*: The mummichog is abundant in the tidal creeks and mosquito ditches of Connecticut salt marshes. This minnow has a stout body which is compressed posteriorly. The head is short and blunt, with the lower jaw projecting. Both males and females are olive-green above, lighter on the sides, and yellowish below. During the breeding season males are darker on the back and brighter yellow below. Males have silver or black vertical stripes on the sides, while in the females the stripes are indistinct. Mummichogs may reach a length of 15 cm but are generally not more than 10 cm long.

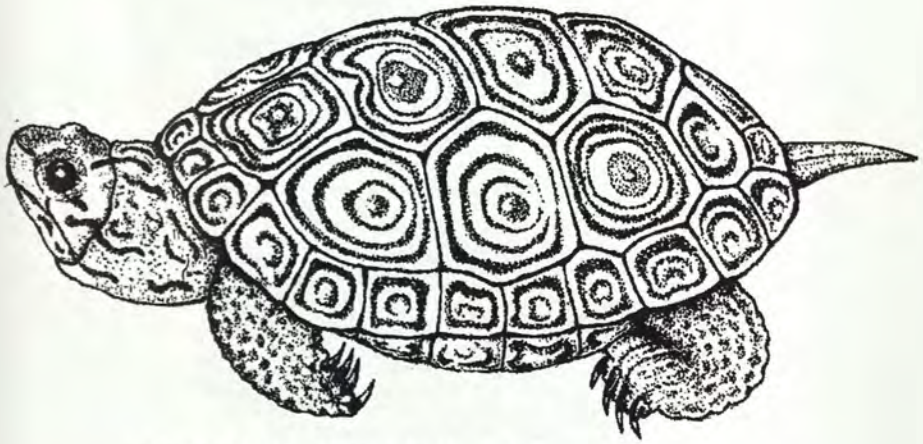
The range of these minnows is from the Gulf of St. Lawrence south to Florida. They prefer brackish water, but appear to tolerate both the high salinities and low oxygen levels found in some shallow tidal pools left behind by outgoing tides.

Mummichogs feed on a variety of animal and vegetable matter.

Northern Diamond-Back Terrapin *(Malaclemys terrapin terrapin)*: The northern diamond-back terrapin is an interesting and occasionally abundant vertebrate of the Connecticut tidal marshes. It is a relatively small turtle. The average carapace (dorsal shell) length of an adult female is approximately 23 cm. Males are smaller. The head, neck, and legs of this terrapin are gray with black spots, while the color of the carapace varies from light brown to black. There are concentric ridges on each plate of the carapace.

This terrapin was once found in large numbers on the Connecticut marshes and was prized as an article of food. It was hunted commercially to such an extent that its numbers were greatly reduced and it became rare in this area. It is now protected, and although it is still absent from many marshes, it is abundant on others, chiefly those in the central part of the state. The diamond-back terrapin can apparently tolerate waters of varying salinities and is often found quite far up rivers.

The range of the northern diamond-back terrapin is from Massachusetts to North Carolina. It feeds on snails, crabs, worms, insects, and some plant material.



NORTHERN DIAMOND - BACK TERRAPIN (X½)

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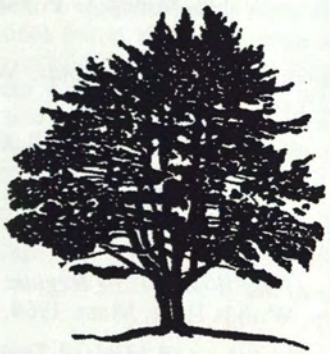

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Membership is open to organizations and individuals interested in supporting the Arboretum and its program. Members receive Arboretum publications and enjoy other privileges, including notices of special field trips and lectures, and the use of the Arboretum facilities.

Connecticut Arboretum Bulletins

No. 6. Check List of Woody Plants growing in the Connecticut Arboretum and Guide to the Arboretum. Richard H. Goodwin, Katherine H. Heinig and Kaleb P. Jansson. pp. 32. 1950.

No. 7. The Connecticut Arboretum: Its History and the Establishment of the Natural Area. pp. 16. 1952

No. 8. The Connecticut Arboretum: The Mamacoke Acquisition and Our Research Program. pp. 20. 1955 (out of print)

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