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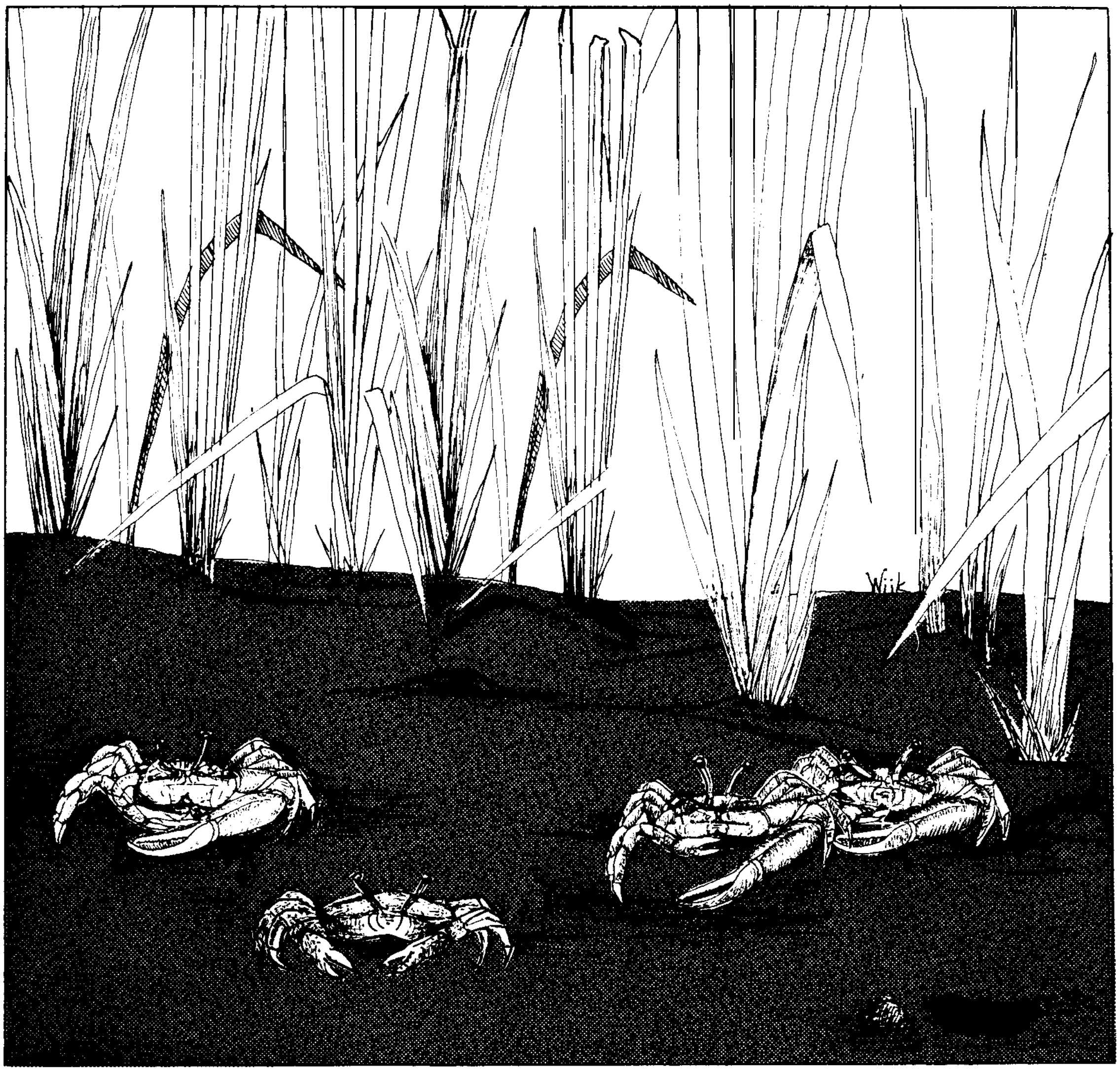
Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates -(Mid-Atlantic)

ATLANTIC MARSH FIDDLER



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Fish and Wildlife Service

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Coastal Ecology Group
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U.S. Army Corps of Engineers

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Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes ana Invertebrates (Mid-Atlantic)

ATLANTIC MARSH FIDDLER

by

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PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

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CONVERSION TABLE

Metric to U.S. Customary

Multiply	By	To Obtain
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters (m)	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers (km)	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (1)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters (m^3)	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons (t)	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (°C)	1.8(°C) + 32	Fahrenheit degrees

U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces (oz)	28.35	grams
pounds (lb)	0.4536	kilograms
pounds (lb)	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (°F)	0.5556 (°F 32)	Celsius degrees

CONTENTS

ACKNOWLEDGMENTS

We would like to express our sincere thanks to F. H. Earnwell, University of Minnesota; Austin 8. Williams, U.S. National Museum of Natural History; and Richard Forward, Duke University, for their helpful comments and criticisms of the manuscript. Additionally, we would like to extend our appreciation to Dorothy Wright for typing and arranging the manuscript.

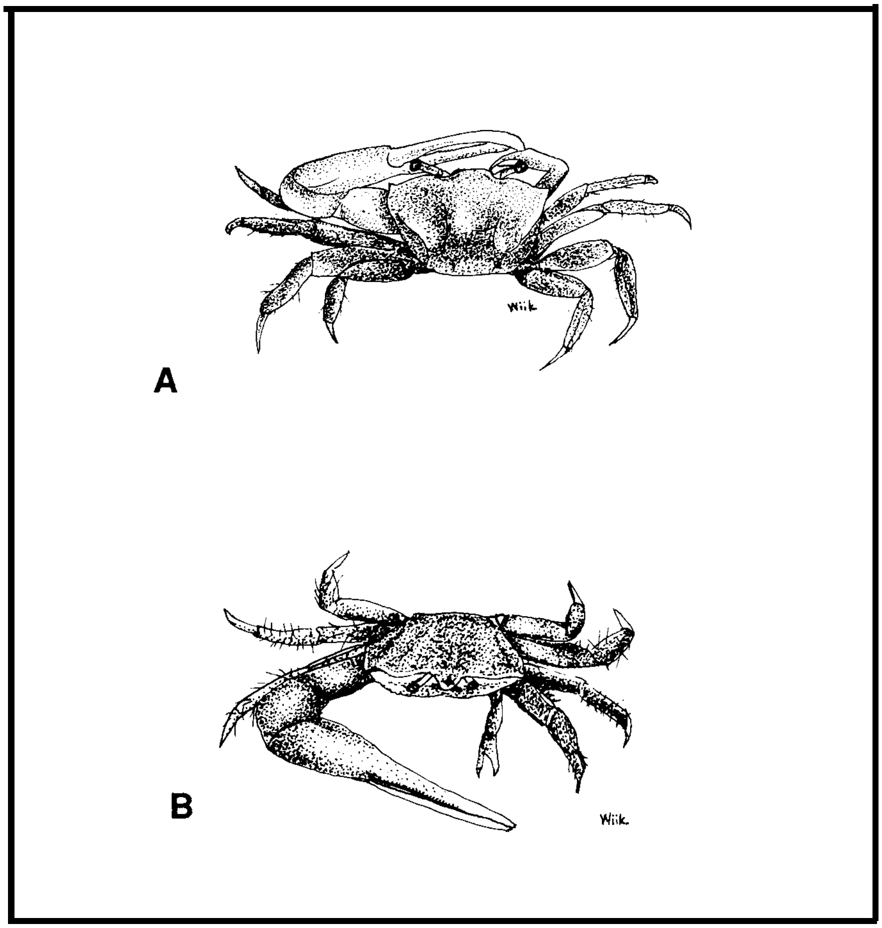

Figure I. Male Atlantic marsh fiddler (carapace length 12 mm) (Crane 1975). A. Dorsal view. B. Frontal view.

ATLANTIC MARSH FIDDLER

NOMENCLATURE/TAXONOMY/RANGE

Scientific name . . . . *Uca pugnax* (Smith)
Preferred common name . . . . Atlantic marsh fiddler (Figure 1)
Other common names . . . . Calling crab, fiddler crab, fiddler, mud fiadler (Williams 1984), mud fiddler crab (Wheeler 1978), marsh fiddler crab (Ward et al. 1976).
Class . . . . Crustacea
Order . . . . Decapoda
Family . . . . Ocypodidae
Geographic range and habitat: Estuarine intertidal marshes from Provincetown, MA, to Daytona Beach, FL. (Figure 2) (Crane 1975; Williams 1984).

MORPHOLOGY/IDENTIFICATION AIDS

Crabs belonging to the genus Uca are moderate to large in size. The three species common to the Mid-

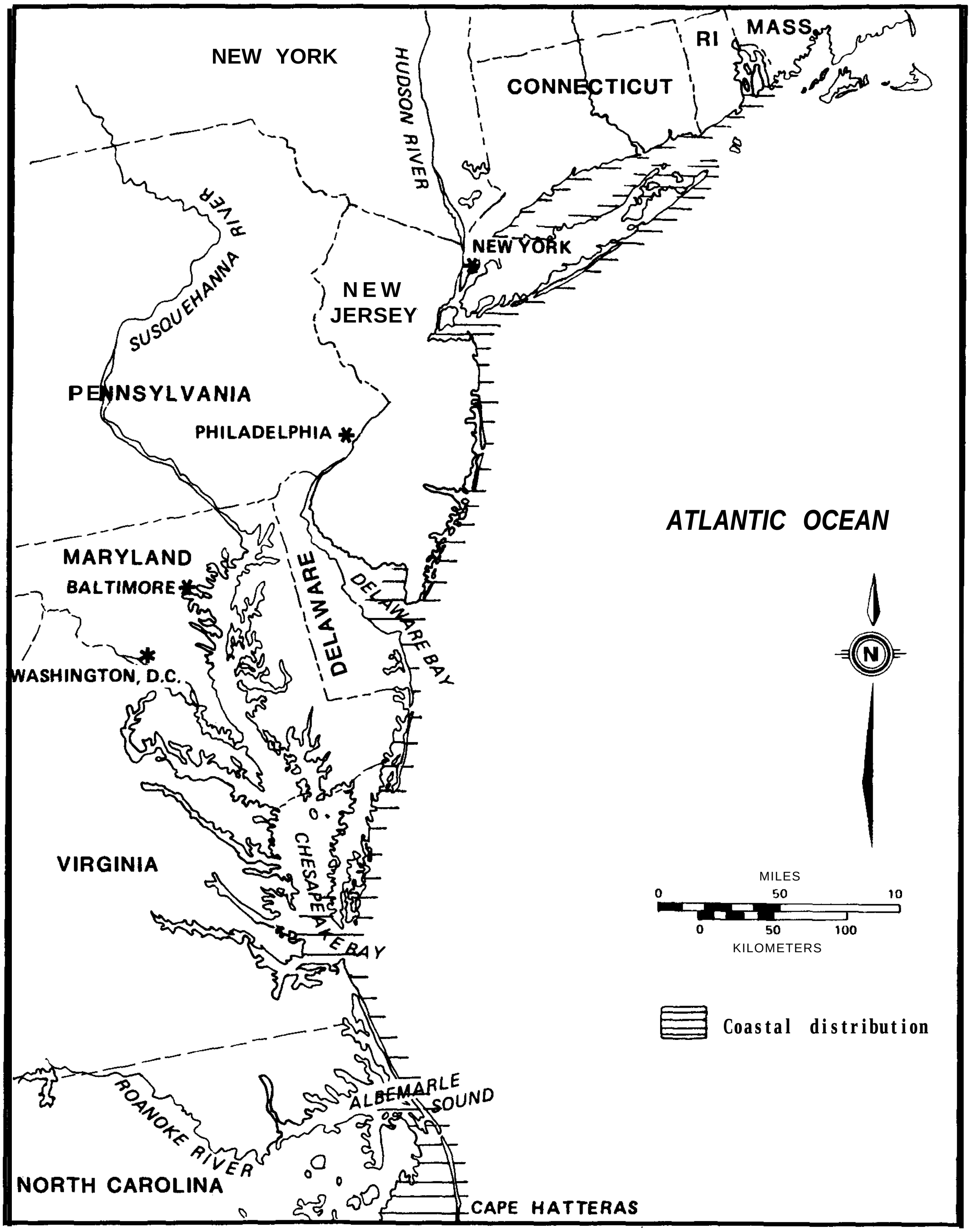

Figure 2. Distribution of the Atlantic marsh fiddler along the Mid-Atlantic coast.

Atlantic reqion are Uca puqnax (Atlantic marsh fiadler), U. minax (rea-jointea fiadler), and U. pugilator (sand fiddler). The car-a-pace of the Atlantic marsh fidaler male averages 15 mm long X 23 mm wiae; that of the female averages 13 mm long X 18 mm wiae (Williams 1984) (Figure I).

In life, the Atlantic marsh fiadler is mostly brown (with some pale gray in the gill regions). The anterior part of the carapace dnd eyestalks range from blue to blue-green (Crane 1975; Williams 1984). There are no purple or rea spots as are found on other fiddlers. The frontal region is about two-sevenths of the boay width, with slender eyestalks (Figure 1) (Williams 1984). The dorsal carapace is flattened rather than convex as in other crabs (Barnwell and Thurman 1984). At the intersection of the front and lateral edges of the dorsal carapace, there is a sharp angle (Figure i).

Specific identification charac-teristics are usually aescriptive of the male and often refer to the major chelipea (large claw) (Figure 3). In the Atlantic marsh fiddler, the major chelipea rdnges from a dull yellowish orange to yellow-white. In males, joints of the major cheliped have a yellow or yellow-orown boraer (Williams 1965). In the northern part of the range, fingers of the major cheliped are nearly always white (Crane 1975). These structures in females are colored less strongly than males (Crane 1975).

The minor (smaller) chela is white. The other appendages--the walking legs--are usually dark and may be banded (Crane 1975; Williams 1984). A patch of rows or paired rows of dense velvety pubescence, as well as sparse rows of stiff hairs, are on the ventral surface of the merus (the long section of the appendage closest to the body) of the secona and thira walking legs (Crane 1975). The meral

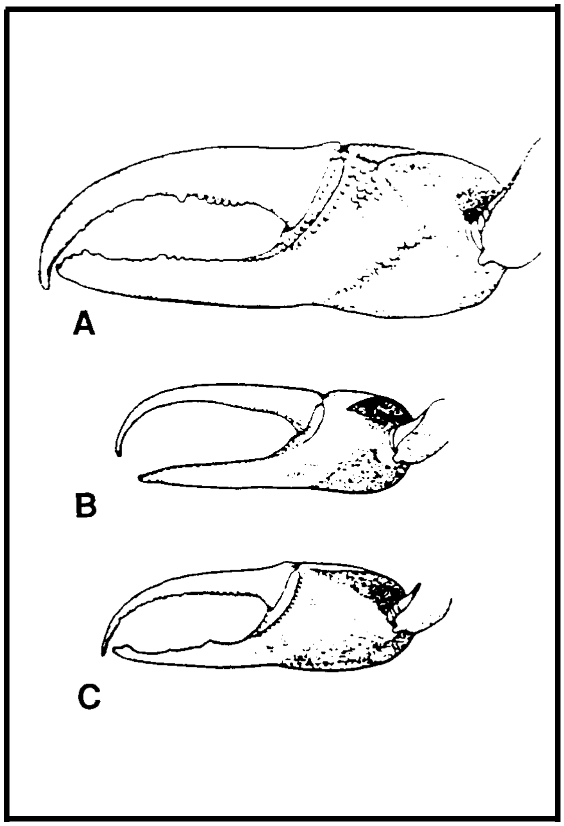

Figure 3. Inner side of the larqer chelipea of the males of three species of fiddler craos common on the Mid-Atlantic coast: A. Uca minax; B. U. pugnax; c. U. pugilator (20 mm) (Williams 1965).

surface of the second maxilliped usually has u-75 spoon-tipped hairs (Williams 1984).

The large claw of the males occurs about equally on the right or on the left of the Atlantic marsh fiddler (Crane 1975). The weight relationship of the large chelipea ranges from 2% to 65% of the body weight (Huxley 1927). Females have two small cnela that are equal in size ana are colored similarly to males, but the color is less viviu (Williams 1984).

REASON FOR INCLUSIOK IN SERIES

Fiddler crabs are the most abundant and conspicuous invertebrates in many salt marshes (Montague 1980). They are probably the most thoroughly studied of the shore crabs in North America (Barnwell and Thurman 1984). Although there are 15 species along the North American coast, the Atlantic marsh fiddler is the only one endemic to the temperate Mid-Atlantic coast of the United States (Miller and Vernberg 1968; Barnwell and Thurman 1984). The Atlantic marsh fiddler, red-jointed fiddler, and the sand fiddler are the three major species on this coast and make up the greatest animal invertebrate biomass in the salt marsh intertidal zone (Teal 1962; Bason and Frey 1977). The Atlantic marsh fiddler is the most abundant of these (Crane 1975).

The ecological influence of fiddler crabs in the,salt marsh is large. Their activities and byproducts can significantly influence the transfer of energy and nutrients within the marsh ecosystem (Montague 1980; Daiber 1982). The sensitivity of these crabs to pollutants and their role in the balance of the salt marsh ecosystem, are major reasons for the inclusion of the Atlantic marsh fiddler in this series.

For further information on the Atlantic marsh fiddler as well as other species of Uca in the Mid-Atlantic region, thereader is referred to selected lengthy review articles and books by Crane (1975), Powers (1977), Montague (1980), Daiber (1982), Barnwell and Thurman (1984), and Williams (1984).

LIFE HISTORY

Mating

Courtship of the Atlantic marsh fiddler consists of a series of visual and acoustical displays and were extensively studied and characterized by Crane (1943, 1975). Visual and acoustical signals replace the standard chemical communications of most aquatic crustaceans (Bliss 1968; Salmon and Atsaides 1968b).

Usually in precopulatory behavior, male fiddler crabs display a high intensity waving of the major cheliped and produce acoustical signals (Pearse 1912, 1914; Crane 1943); however, male Atlantic marsh fiddlers often have lethargic displays. Acoustical displays by males are produced by vibrating and stamping of the walking legs on the substrate (Salmon 1967; Salmon and Atsaides 1968 a, b). The waving of the large claw can be seen at considerable distances and is weakly circular and very jerky (Crane 1975). Displaying males are not bleached in color during mating to the extent shown by males of other species of fiddlers, but the major cheliped lightens to light brown or yellow (Crane 1975). Nocturnal reproductive behavior, including acoustical displays, of the Atlantic marsh fiddler in the southern part of its geographic range, has been reported in Salmon (1965).

After these courtship displays, the female usually follows the male to his burrow to mate (Crane 1975). Although herding (the male physically maneuvering the female to his burrow) is found in other species of fiddler crabs, it is seldom seen in the Atlantic marsh fiddler (Salmon 1967). Copulation usually takes place in the burrow, but has been observed on the surface of the marsh in nature; in captivity, mating has been observed underwater (Herrnkind 1968a). Unlike mating in some other crabs, fiddlers mate while the exoskeleton of the female is in a hardened state (Hartnoll 1969; Crane 1975).

Eggs

The fertilized eggs are carried on the abdomen of female intermolt Atlantic marsh fiddlers until they hatch and are released. DeCoursey (1979) found clutches (eggs per crab) of 1,500 to 94,000 eggs. Other reports of the Atlantic marsh fiddler clutches range from 4,500 to 23,700 (Shanholtzer 1973). The size of the clutch, commonly known as the sponge, is probably related to the size of the female (Gray 1942).

Ovigerous females have been observed along the eastern U. S. coastline beginning in April in Florida and in July and August at Woods Hole, Massachusetts (Pearse 1914), and New Jersey (Crane 1943). Crane (1943) suggested that there are two breeding seasons in New York--one in July and one in August. Spawning periods are extended--May to September--in the lower latitudes (Crane 1975).

DeCoursey (1979) found that eggs hatched, over a period of 2 hours. The larvae were released (with the aid of abdominal contractions) in phase with the nocturnal high tide. In laboratory experiments, isolated females released their larvae in synchrony with those females in the wild (DeCoursey 1979). Wheeler (1978) found that larval release coincided with the lunar cycle in the Delaware Bay, and that the Atlantic marsh fiddler released larvae during the spring and neap tides. It is hypothesized that the synchrony with the noctural high tide maximum allows minimal exposure of the ovigerous females to predation and provides the zoeae with a favorable tidal current upon which to be swept from the marsh into the coastal waters (Crane 1975; DeCoursey 1979; Christy 1982; Salmon et al. 1986). Christy (1982) concluded that the timing of the release of zoeae probably is a response to selective pressures that cause larval mortality such as lethal high temperature, low salinity, and predation by planktivores.

Larvae

After hatching, the planktonic larvae of the Atlantic marsh fiddler pass through five zoeal stages (each lasting from 7 days to a month) and one megalops stage of 4 days to a month (Hyman 1920, 1922; Herrnkind 1968a). Most published information on larval and postlarval stages of fiddler crabs is on sand fiddlers (Herrnkind 1968a); however, the Atlantic marsh fiddler larvae are similar in most respects to those of sand fiddler larvae though they are smaller (Hyman 1920). The zoeae of all three Atlantic species of fiddler crabs are carnivorous.

The zoeae of the three common Mid-Atlantic fiddlers make up a significant portion of the estuarine plankton; for example, Sandifer (1973) found zoeae of fiddler crabs to be the most abundant larval decapods in the Chesapeake Bay, reaching numbers greater than 100 per cubic meter plankton tow. Larvae in this bay were present from June to October, with peak abundance in July. In Delaware estuaries, the zoeal stages lasted 15 days at 25 °C and 25 ppt salinity, and the megalops stage lasted 12.5 days (Wheeler 1978).

The distribution of zoeae appeared to be stratified in the water column, and surface waters were preferred by first and second stage zoeae. Third stage zoeae were found in intermediate depths, and fourth and fifth stages were in greater depths (Hyman 1920, 1922).

Metamorphosis and Juveniles

Megalops larvae of the Atlantic marsh fiddler metamorphose into the first crab stage (lasting from 3 to 4 days) and settle to the substratum (Hyman 1920, 1922). The second crab stage lasts 4 to 5 days and the third stage lasts 7 days (Hyman 1920, 1922; Herrnkind 1972). While in these stages the crabs are weak, cling to objects, and are not capable of burrowing (Herrnkind 1972).

Adults

The Atlantic marsh fiddler matures in one year's time and growth rates in males and females are similar if not identical (Shanholtzer 1973). The average life span of the Atlantic marsh fiddler is estimated to be 1-1.5 years (Shanholtzer 1973).

GROWTH AND MOLTING CHARACTERISTICS

Little is known about the molting habits of the Atlantic marsh fiddler except that molting in adult crabs occurs 1-2 times per year (Guyselman 1953). Montague (1980) hypothesized that the burrow is the likely place for routine molting because it offers protection from desiccation and predators; available water; and lack of disturbance. During an. extensive two year study in North Carolina, Grimes (1976) observed no molts on the marsh surface.

Molting in adult Atlantic marsh fiddlers is temperature dependent and is completely inhibited at 20 °C and below (Passano 1960; Miller 1965; Miller and Vernberg 1968; keis 1976). keis (1976) determined that other factors that negatively influence molting are light, extremes in salinity, and mechanical disturbances. Many physiological changes occur during the molting cycle of fiddler crabs (Guyselman 1953; Kleinholtz and Bourquin 1941; Snyder and Green 1970).

ECOLOGICAL ROLE

General Considerations

Montague (1980) reviewed the ecological role of fiddler crabs in the salt marsh and found that the crabs affect the nutrient cycles and energy flow of the marsh ecosystem. He identified three categories of influence: burrow excavation, feeding bioturbation, and production of fecal pellets (Figure 4).

Burrow excavation differentially affects biomass of Spartina alterniflora at different tidal heights. This grass grows in three different zones, two with tall growth forms (one found at the seaward edge and one at intermediate tidal height) and one with a short growth form found higher up in the marsh. The effect of burrow excavation is most pronounced in the intermediate zone, where burrows significantly increase grass biomass, possibly because of the burrows' effects on the sediment. Crab burrows increase soil drainage and soil oxidation-reduction potential, which may facilitate root function. Burrows also increase litter decomposition in the soil, which may increase nutrient availability. Finally, crab burrows may facilitate the penetration of belowground plant production to greater soil depths (Bertness 1985).

Feeding bioturbation is extensive according to Montague (1980), and probably stimulates algal growth by reducing crowding. As a result of feeding bioturbation, the first 5 mm of the marsh surface can be turned over once per year (Krauter 1976; Edwards and Frey 1977). Fecal pellets (100-200/crab/day) sometimes can literally cover the marsh, and Krauter (1976) reported that the Atlantic marsh fiddler can contribute 9 $mg/m^2/day$ of organic nitrogen in fecal pellets--more than any other invertebrate present in the marsh (Krauter 1976).

Abundance

Standing stock of the Atlantic marsh fiddler was estimated at 29 dry weight g/m^2 (Krebs et al. 1974). The density of crab populations ranges from 27 $crabs/m^2$ in Georgia (Teal 1958) to 152 $crabs/m^2$ in New Jersey (Ward et al. 1976). In both studies only crabs greater than 0.5 cm in carapace length

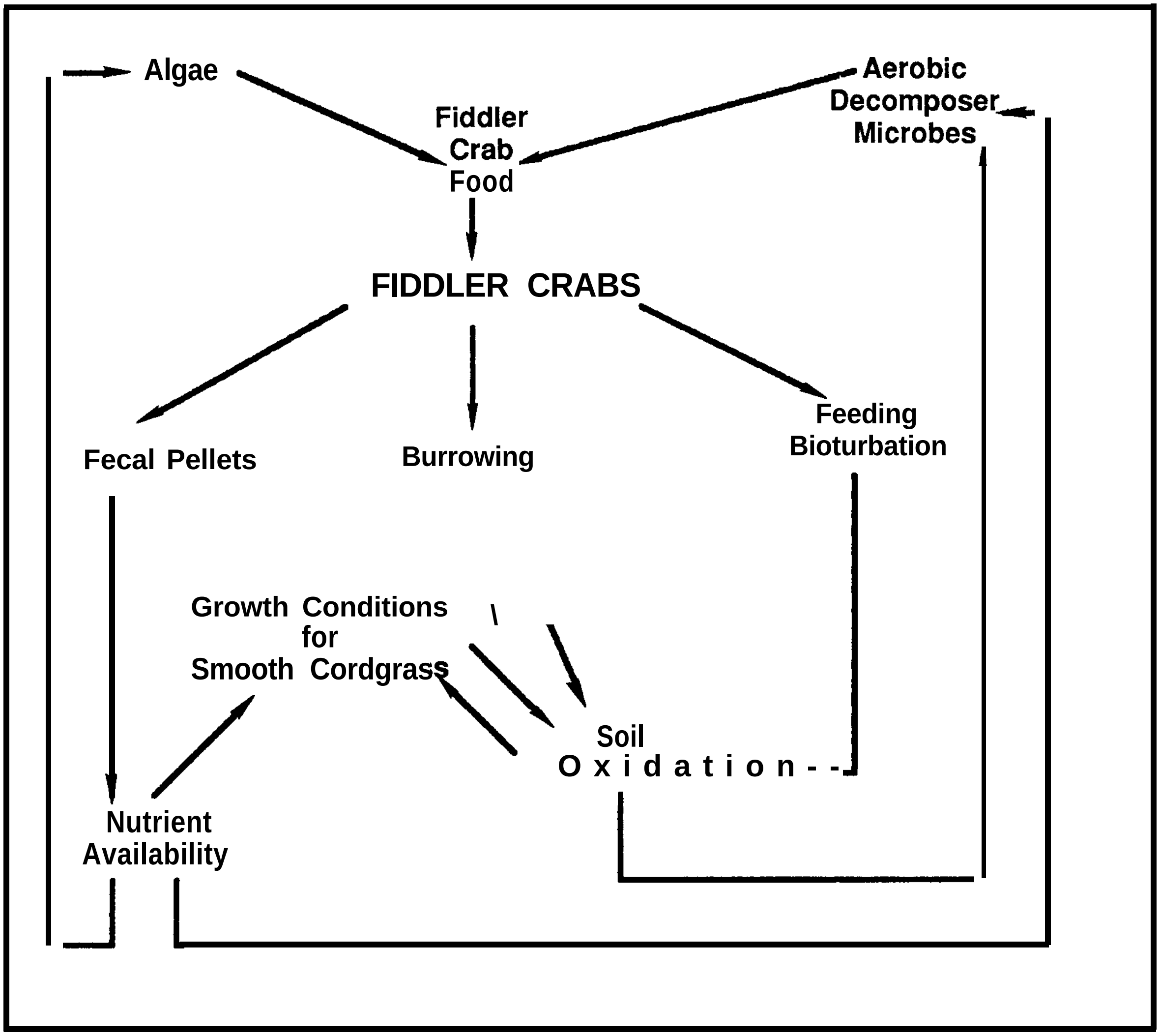

Figure 4. Positive influence of fiddler crabs on the ecology of salt marshes (after Montague 1980).

were included. Montague (1980) attributed the wide variety of densities to sampling variability as well as spatial and temporal considerations. Abundance generally increases with tidal height. Preliminary results of O'Connor (1987) suggest that settlement occurs throughout the marsh and post-settlement events determine the adult distribution.

Feeaing Habits

Fiddler crabs emerge in great numbers from their burrows at low tides ana feed. The Atlantic marsh fiddler feeds by scrubbing muady particles of substratum (Crane 1975). Its mouthparts are structured to manipulate and feed on particulate organic matter in muddy substrates (Miller 1961, 1965). Male fiddlers are reported to spend more time feeding than females (Valiela et al. 1974), probably compensating for the fact that males have only one chela (the smaller claw) that is functional in feeding. Some Atlantic marsh fiddlers forage far from their burrows. Montague (1980) observed feeding up to 20 m from burrows. Some adults have been seen to feed underwater (Teal 1958).

According to Shanholtzer (1973), the diet of the Atlantic marsh fiddler consists of 33% diatoms, 25% fungi, 20% vascular plants. and 20% unknown substance. The Atlantic marsh fiddler ingested 0.4 g (dry weight) of material over six hours of feeding in one laboratory study (Valiela et al. 1974). Crane (1975) noted that although diatoms were ingested with other food items, many were egested live, presumably unharmed. The crabs significantly reduce the abundance of meiofauna (crustaceans, nematodes, and segmented worms), probably by feeding on them (Hoffman et al. 1984).

The feeding efficiency of the three common species of fiddlers of the Mid-Atlantic Region was as follows: sand fiddler > Atlantic marsh fiddler > red-jointed fiddler. These efficiencies correlate well with the number of spoon-tipped hairs on the second maxillipeds (mouthparts) which may be most efficient at scouring bound material from sand grains. The relatively low ability for feeding on sandy material may restrict the Atlantic marsh fiddler to muddy habitats (Coward et al. 1970; Robertson and Newell 1982; Williams 1984). Habitats of Atlantic marsh fiddler and purple marsh crab (Sesarma reticulata) overlap. The purple marsh crab feeds differently, however, utilizing vascular plants and occasionally animal matter; this crab also feeds at high tide. Behavioral patterns may prevent competitive exclusion of one of the species (Bursey 1982).

In foraging, fiddlers actively sort out indigestible from digestible items and place indigestible material aside in the form of balls which break up and return to the ecosystem beginning on the next tide. Undigested material passing through the gut of the fiddler is deposited as fecal pellets. These pellets often blanket the marsh, and can persist through successive tidal cycles (Basan and Frey 1977; Edwards and Frey 1977).

Behavior

Aggressive encounters occur among adults, usually adult males. Hyatt and Salmon (1978) have observed and characterized these encounters between males of the Atlantic marsh and sand fiddlers. The challenge and defense behavior centers around crabs that own burrows and those that are wanderers attempting to usurp a burrow (Hyatt and Salmon 1978). Unlike other fiddlers, the Atlantic marsh fiddlers do not select smaller crabs for aggressive encounters. Aggressive displays are not related to temperature or obviously related to time (Hyatt and Salmon 1978). The Atlantic marsh fiddler is markedly more passive than the sand fiddler (Hyatt and Salmon 1978).

Predators

Fiddler crabs, including the Atlantic marsh fiddler, are a food source for many other animals. Fiddler crab parts have been found in stomach contents of adult pigfish (Orthopristis chrysoptera) (Adams 1976), channel bass (Sciaenops ocellata) (Shanholtzer 1973; Montague 1980), and bighead searobin (Prionotus tribulus) (Linton 1904). Fiddler crabs are an integral part of the diet of the white catfish (Ictalurus catus) (Heard 1975).

Some wading shorebirds and marsh birds take fiddlers as part of their aiet, including the white ibis (Eudocimus albus) and clapper rail (Rallus longirostris) (Peterson and Peterson 1979). Shanholtzer (1973) reported fiddler crabs in the diet of egrets, ibis, and herons. Cattle egrets (Bubulcus ibis) and snowy egrets (Egretta thula) also prey upon fiddlers (Pfeiffer 1974; Ward et al. 1976; Montague 1980).

Some species of crustaceans, e.g., red-jointed fiddlers (Teal 1958) and the blue crab, Callinectes sapidus (Shanholtzer 1973; Montaque 1980) prey upon fiddlers. According to Montague (1980), raccoons (Procyon lotor) in Georgia salt marshes and elsewhere take fiddler crabs as a normal part of their diet.

Parasites and Commensals

The Atlantic marsh fiddler has not been extensively studiea for its parasites and commensal organisms. Heard (1970) reported on trematodes and cestodes that parasitize fiddler crabs. Trager (1957) noted apostome cysts on the gills and in the molts of the crabs from Woods Hole, MA. Grimes (1976) extensively examined the ciliate commensals on the gills of North Carolina crustaceans and described a new species of apostome ciliate found as a small oval resting stage in the bases of gills of the Atlantic marsh fiddler. These commensals can reach great numbers (greater than 100) on the gills and may clog the gills to some extent, reducing the oxygen absorbing capabilities of the crab.

ENVIRONMENTAL REQUIREMENTS

Temperature

The range of the Atlantic marsh fiddler is limitea by temperature extremes. Passano (1960) found that molting in adults is blocked by temperatures less than 20 °C. This temperature is the same as the summer Water temperature at Cape Cod (the upper limit of the geographic range of the Atlantic marsh fiddler). He hypothesized that the air temperature may be more influential than water temperature in semiterrestrial crabs, and that the northern geographical limit of the Atlantic marsh fiddler may be determined by the effect of water temperature on the planktonic larvae.

Temperate species of fiddler crabs can cope with some temperature extremes better than tropical species (Vernberg and Tashian 1959; Vernberg 1959 a, b). Of the several species tested, the Atlantic marsh fiddler was the most adaptable to temperature variation (Teal 1959). Tashian (1956) founa an increase in tolerance to low temperatures and a decrease in sensitivity to temperature change in populations proceeding from south to north.

The Atlantic marsh fiddler, in particular, can eventually acclimate to lower temperatures (Vernberg 1959 a, b), but it dies at 2-3 °C (Vernberg and Tashian 1959). Hibernating crabs dug from New Jersey marshes when air temperatures were from 1.7 to 5.5 °C were revived (Crane 1943). To raise their body temperatures a few degrees, some fiddler species orient themselves to the sun during low-temperature periods (Smith and Miller 1973).

Death from thermal exposure occurs at 40 °C in humid air and at 45 °C in dry air (Teal 1959; Vernberg and Tashian 1959; Wilkins and Fingerman 1965). Lethal temperatures can occur in nature. For example, in Georgia marshes Teal (1959) reported that lethal air temperatures of 40 °C are reached in the summer. To avoid lethal temperatures and subsequent desiccation, fiddler crabs move to their burrows or shady parts of the marsh during periods of high temperatures (Smith and Miller 1973). Altevogt (1968) describes a European species of fiddler that produces foam to avoid desiccation.

Salinity

In laboratory experiments with the Atlantic marsh fiddler, Teal (1958) found that given a choice between freshwater and 30 ppt seawater, all crabs chose the seawater. Additionally, he demonstrated a lack of tolerance of freshwater. Fifty percent of the crabs died within 1.5 days after being placed in freshwater; after being placed in 7 ppt salinity water, 50% died within 3 days. In experiments with higher salinities, Green et al. (1959) found that when crabs were kept in 175% seawater, their blood serum remained hypotonic to the external medium.

Oxygen

Respiration rates have been measured for the Atlantic marsh fiddler (Teal 1959). The maximum respiratory rates for this species are from 550-600 ul O_2/g/hr at 40 ^{o}C (g is dry weight) (Edwards 1950; Shanholtzer 1973). The amount of oxygen uptake has been correlated with activity in fiddlers (Brett et al. 1959), the highest occurring when the low tide is early in the day (Fingerman 1957a; Barnwell 1966). The lowest oxygen consumption occurs in the burrows, where crabs probably go into oxygen debt (Teal 1959).

Habitat and Substrate

Teal (1958) found many Atlantic marsh fiddlers (in various combinations with other species) in short cordgrass (Spartina alterniflora) in both low and high salt marsh habitats. It is generally found in areas where there are nearly monospecific stands of smooth cordgrass (Basan and Frey 1977). The density of the burrows of these crabs decreases from the low to the high salt marsh (Teal 1558; Krebs and Valiela 1978). This decline results from a heavy root mat accumulation in the high marsh that limits burrowing. Burrow longevity in the lowest parts of the marsh is limited because the substratum is generally soft and unsupportive. Burrowing in the lowest parts of the marsh can be successful if the burrows are supported by structure (stems of S. alterniflora or mussels) (Bertness and Miller 1984). The crabs prefer to burrow into optimal substratum of intermediate root mat density. High root density in the upper marsh impedes burrowing. Females and small males have far greater burrowing ability than large males, probably because of the large claw in the big males (Bertness and Miller 1984).

Burrowing is a major activity of Atlantic marsh fiddler adults. The burrows average 1 to 2 cm in diameter and from 15 to 25 cm in depth (Basan and Frey 1977), although Pearse (1914) found burrows to 30 cm. The burrow shapes vary from a simple "U"-shape to a more complex maze, connecting with other burrows of their own species as well as those of other species of crabs (Basan and Frey 1977). In one laboratory experiment, the Atlantic marsh fiddler did not burrow as frequently as the sand fiddler (Coward et al. 1970) but, in the field, their burrow density is 8 to 10 times greater (Aspey 1978). Pearse (1914) found that Atlantic marsh fiddlers tended to plug their burrows as the tide rose, and dug actively as the tide fell. The number of burrows was largest at about 30 cm below the high tide line. Areas of dense root growth of salt marsh plants and of sediments that are saturated with too much water are not suitable for burrowing by the Atlantic marsh fiddler (Krauter and Wolf 1974). Ringold (1979) determined that with higher root density, burrow density is lower.

The preferred burrowing site of these crabs is in a muady location with irregularities in the surface, rather than in an area where the muddy marsh is perfectly smooth (Crane 1943, 1975). The Atlantic marsh fiddlers do not build mud towers outside their burrows as some tropical species of fiddler crabs do (Crane 1943, 1975).

The Effects of Contaminants

Different response patterns to the effects of radiation (using a cobalt source) were found for the Atlantic marsh, red-jointed, and sand fiddler crabs along the Mid-Atlantic coast (Engle 1973). In the experiments with male fiddler crabs, natural conditions (e.g., temperature salinity) were kept constant. The Atlantic marsh fiddler had a slightly higher projected LD-50 (16,500 rad) than the other two common sympatric species (Engle 1973). Adaitionally, the mortality response pattern of the Atlantic marsh fiddler aiffered from patterns of other species of fiddler crabs. In other species, mortality was proportional to dose; however, in the Atlantic marsh fiddler at dosages from 4,000 to 16,000 rad, mortality was independent of dose (Engle 1973). Engle was unable to explain this difference because physiological evidence was lacking.

In experiments in a New Jersey marsh, Ward and Howes (1974) found that the application of Temefos (Abate), an organophosphate insecticide, at normal-use levels significantly reduced the population of the Atlantic marsh fiddler. Temefos is commonly applied as a granular larvicide for control of salt-marsh mosquitoes. In other experiments with caged populations of the Atlantic marsh fiddler, Ward et al. (1976) determined lethal and sublethal effects of Temefos. Further, they found that sublethal' doses reduced populations of crabs in open test plots, but not in closed cages, and hypothesized that the insecticide probably impairs the fiddler's escape response, leading to increased predation.

In an Ii-day laboratory experiment, Odum et al. (1569) fed Atlantic marsh fiddlers natural detritus, contaminated with DDT resiaues (10 ppm) from Long Island Souna, New York. After 5 days all crabs showed a loss of coordinated avoidance reaction, which was hypothesized to negatively affect predator avoidance in natural populations. At the end of the experiment, crab muscle from the large claw showed a three-fold increase in concentration of DDT over background level. Other workers have found a three-fold concentration of DDE (a degradation product of DDT) in natural populations of fiddlers (Krebs et al. 1974).

Krebs et al. (1974) found other contaminants which affect fiddler crabs (including the Atlantic marsh fiddler) are PCB's, and the insecticides in fertilizers, Aldrin and Dieldrin, which are found in agricultural runoff. Though they found no PCB's in marsh sediments, Krebs et al. did find measurable levels in crabs and hypothesized that fiddler crabs concentrate these chlorinated hydrocarbons from seawater or from food. Dieldrin was concentrated in crab tissues and impaired locomotion, killing crabs at the higher concentrations (Krebs et al. 1974). Chemical contaminants were responsible for the drastically reduced populations of fiddler crabs in the marsh (Krebs et al. 1974).

Other species of fiddler crabs have been found to be sensitive to pollutants and contaminants. This sensitivity has been shown for mercury (DeCoursey and Vernberg 1972; Vernberg and Vernberg 1972), PCB's (Nimmo et al. 1971), and cadmium (O'Hara 1973).

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5. Supplementary Notes

U.S. Army Corps of Engineers Report No. TR EL-88-025

6. Abstract (Limit: 200 words)

The Atlantic marsh fiddler is the only endemic species of Uca in the Mid-Atlantic region. Males display a series of visual and acoustical displays during mating, with a weak waving and bleaching of the larger claw. Egg clutch size in female varies. Larvae are released in phase with the nocturnal high tides. The 5 zoeal and 1 megalops stages compose much of the estuarine plankton. First and second crab stages are weak and unable to burrow. Adult lifespan is 1 - 1.5 years with 1 - 2 molts per year. Molting is temperature dependent and ceases below 20 "C. Crabs feed by scrubbing the preferred muddy substratum for diatoms, fungi, vascular plants, and debris, bioturbating and recycling the marsh surface. This crab is eaten regularly by estuarine birds, fish, crabs, and some mammals. This fiddler can acclimate to lower temperatures, but dies below 2-3 °C or above 40 "C. It prefers seawater, lacking freshwater tolerance. Oxygen uptake correlates with activity Preferred habitats are muddy substrata and short smooth cordgrass. Burrow density decreases from low to high marsh. The Atlantic marsh fiddler has the highest radiation LD-50 of sympatric species of fiddler crabs. Insecticides Temefos, DDT, DDE, Aldrin, and Dieldrin, and contaminant PCB's, mercury, and cadmium reduce populations of fiddlers, some being concentrated in their tissues.

17. Document Analysis a. Descriptors

Uca pugnax	smooth cord grass	salt marsh
Atlantic marsh fiddler	insecticides	predation
endemic species	contaminants	ecology
life history	freshwater	

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

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