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WHITE SHRIMP including P. setiferus

LIFE HISTORY

PHYSICAL DESCRIPTION:

Freshly caught white shrimp often have widely spaced body chromatophores; consequently they are lighter colored than pink or brown shrimp. The white shrimp is sometimes called the non-grooved shrimp (Whitacker 1981) because its adrostral carina does not extend behind the middle of carapace in adults nor to the posterior margin of carapace in juveniles. In contrast, the brown shrimp (P. aztecus) and pink shrimp (P. duorarum), co-existing along the southeast and gulf coasts of the United States, each has a deep groove (adrostral sulcus) extending almost to the posterior margin of the carapace. In the white shrimp, the adrostral sulcus is short, extending to the epigastric back tooth of the rostrum. Gastrofrontal carina is absent. Thelycum is open, with anterolateral ridges; mesially turned pair of fleshy protuberances on sternite XIV. Antennal flagella 2.5 to 3 times the body length in Penaeus setiferus as in P. schmitt, a species found in Cuba, the Virgin Islands, and along eastern Central and South American Atlantic coast south to Laguna, Brazil. Zamora and Trent (1986) noted that the keel was smooth on the sixth abdominal somite of postlarvae white shrimp but bore spines on brown shrimp and pink shrimp.

Sexes are easily distinguishable by the modified endopod of the first pair of pleopods on the males and the open-type thelycum between third, fourth, and fifth pereopods on the females. At lengths of 28 mm, males can be distinguished from females by the shorter and narrower endopods of the first pleopods and by two protuberances on sternite XIV.

REPRODUCTION:

Along the south Atlantic coast of the United States, white shrimp spawn from March to November, but mostly from April (May in South Carolina) to October. According to McKenzie (1981) spawning conditions extended into September in

South Carolina, Georgia, and northeast Florida, and into October in central Florida. Shrimp spawn as late as November in Georgia, activity decreasing from south to north. Spawning peaks in May and June along the offshore water of northeast Florida. In general, the increase of bottom water temperatures in spring triggers spawning, and rapid decreases in water temperature in the fall coincide with the end of spawning. As judged by the low percentages of spent females in June to August, white shrimp may spawn as many as four times during their life span; however, there is some evidence that they spawn only once in Carolina waters.

White shrimp spawn along the South Atlantic coast of the United States in water more than 9 m deep, and within 9 km from the shore. Spawning shrimp seemingly prefer salinities of 27 ppt or more. In the Gulf of Mexico most white shrimp spawn at depths of 8 to 31 m. Sexually mature and spent female white shrimp were captured along the northeast Florida coast only in offshore water depths over 11 m. Little is known about the spawning location offshore from North and South Carolina, but adult shrimp tagged in North Edisto River estuary in South Carolina in May 1983 were recaptured within 9 km from the coast.

White shrimp were first spawned in captivity in 1980. The general requirements for maturation and reproduction usually fall in the range of 20% to 60% light intensity, 10 to 14 h photoperiod, 20 degrees to 28 degrees C water temperature, and 26 to 34 ppt salinities. In some laboratory experiments, white shrimp spawned only at night but in others some spawned during daylight. The food source required was fresh marine invertebrates and fish supplied at 3% to 5% dry weight of the weight of the shrimp.

In copulation (limited to hard-shelled individuals), the male attaches a spermatophore onto the thelycum of the female. Spermatozoa are believed to be released from the spermatophore simultaneously with expulsion of the ova. About 0.5 to 1 million eggs are discharged per spawn from each female.

The eggs of white shrimp are discharged directly into the water and sink to the bottom. The spherical and opaque ripe eggs, which are 0.192 to 0.3 mm in diameter, have a purplish-blue chorion.

BEHAVIOR:

Migration. White shrimp along the southeast Atlantic coast migrate southward during autumn and early winter and then northward in late winter and early spring. More specific migrations reported by Joyce (1965) showed a major southerly migration from North Carolina to Cape Canaveral, Florida, in fall and a northerly migration from the Cape in spring. In Georgia, a mark and recapture

study revealed that 96% of the shrimp recovered in the winter came from more southerly waters. A white shrimp tagged in October off North Carolina was recaptured 576 km southward off Florida's east coast and one white shrimp tagged January off central Florida was recaptured 416 km to the north off South Carolina. Whitaker suggested a correlation between shrimp migration and latitude with activity being greatest in the more southern areas. In northeast Florida, white shrimp 120 to 140 mm TL moved offshore from August through April. Detailed analysis of white shrimp sampling from June 1962 - June 1963 by Joyce (1965) revealed that white shrimp caught off Cape Canaveral, Florida had migrated from more northern nursery areas in December and January, suggesting that Cape Canaveral is the southern limit of commercial white shrimping along Florida's east coast. Southward movements of 10 to 20 km per day during fall were suggested by Joyce for schooling white shrimp along the northeast Florida coast. Movements of individual shrimp tagged in Georgia waters and recaptured of Florida ranged from 1.8 to 6.9 nautical miles per day. Offshore migrants make up the valuable spring fishery for adult families in Georgia, South Carolina, and North Carolina in years following relatively mild winters.

White shrimp emigration from estuaries is governed largely by body size, age, and environmental conditions. Low water temperatures (<18 degrees C) and spring tides at full moon stimulated mass movements from South Carolina estuaries. During ebb tides, white shrimp tend to school and migrate near the surface at night. Williams (1958) suggested that muddy substrate is not strongly preferred during emigration from estuaries to the sea. Emigration was delayed in South Carolina and Georgia when unusually low freshwater inflow caused high salinities. In South Carolina, shrimp congregated in the deeper channels (staging areas) as water temperatures declined to about 9 degrees C. Recent studies showed that white shrimp movements offshore in fall and winter are triggered by water temperature declines in estuaries in the south Atlantic, and Louisiana. Precipitation, spring tides, and strong tidal exchanges associated with northeasterly storms also influence the timing and magnitude of emigraton from inshore waters.

LIMITING FACTORS:

Diseases and parasites.
The effect of diseases and parasites on white shrimp mortality is not well known. A 99% loss of egg production was attributed to a microsporidian parasite infection of white shrimp gonads, yet the next year's production was as high as that of the preceeding year. Vibrio infection of male white shrimp prevented egg fertilization under laboratory conditions. Literature reviews of diseases and parasites of penaeid shrimp show that viruses, bacteria, fungi, protozoa, helminths, and nematodes often infect shrimp. Diseases and parasites ranked after predation and periodic physical catastrophes as limiting factors in nature

and after nutrition and reproduction requirements in mariculture. Symbionts may be related to shrimp kills during low oxygen conditions. A parasitic cestode, Prochritanella penaei, infecting the hepattopancreas of adult shrimp is of some concern in the Mississippi Sound; however, from an economic standpoint, microsporidian protozoans that cause a "cotton" appearance in the musculature of shrimp are the most threatening. In Georgia in 1978-81, microsporidian parasites were observed in 3.9% of 33,350 white shrimp captured for tagging. Lower recovery rates of tags from infected than from uninfected shrimp suggested higher mortality among the infected shrimp. Hutton et al. (1959) suggested that infected shrimp may be more susceptible to predation and disease.

Environment. The loss of nursery grounds has been considered the major threat to the white shrimp fishery in the Gulf of Mexico because that is where shrimp are most vulnerable to habitat disturbance. Studies in Florida, Louisiana, and Texas identified landfill, dredging, and impoundments as major detriments to shrimp production. Because of the loss of rich organic material along bulkheads, shrimp abundance there was reduced to about 1/8 that of nearby unaltered shorelines. About 18,171 ha of wetlands, 3.5% of the total, were lost from the Sourth Atlantic coast between 1954 and 1968. Manmade canals in Louisiana estuaries have increased salinity and adversely affected white shrimp survival and growth. Trawl catches of white shrimp dropped below seasonal averages when dissolved oxygen was below 3.0 mg/l in altered, eutrophic canals associated with housing developments in West Bay, Texas.

Temperature. Water temperatures below 20 degrees C inhibit growth of juvenile shrimp and growth is virtually nil at 16 degrees C. White shrimp are more tolerant of high temperatures and less tolerant of low temperatures than either brown or pink shrimp. Among postlarvae, brown shrimp were more resistant than white shrimp to higher temperatures.

White shrimp mortality was reported at water temperatures of 8 degrees C and lower. Mortality of white shrimp is total at 3 degrees C or lower, regardless of salinity. White shrimp survival at low temperatures depends on ambient temperature, the rate of temperature decline, the duration of low temperatures and salinity. Adult white shrimp (> 90 mm long) may be more susceptible than juveniles to cold temperatures. It was found that the 24-hLC (subscript 50) (temperature causing 50% mortality in 24 h) to be 36 degrees and 37 degrees C for white shrimp acclimated at 29 degrees and 34 degrees C, respectively. Postlarvae and 30-mm long juveniles have similar but higher resistance times than 50-mm juveniles.

Salinity. The lowest salinity in which white shrimp were recorded in the northern Gulf of Mexico was 0.42 ppt. Although field studes indicate that juvenile white shrimp prefer low salinities, laboratory studies have revealed that white shrimp

appear to tolerate a wide range of salinities; they have been successfully reared at salinities of 18 to 34 ppt.

Other Environmental Considerations. The loss of nursery grounds has been considered the major threat to the white shrimp fishery in the Gulf of Mexico because that is where shrimp are most vulnerable to habitat disturbance. Studies in Florida, Louisiana, and Texas indentified landfill, dredging, and impoundments as major detriments to shrimp production. Manmade canals in Louisiana estuaries have increased salinity and adversely affected white shrimp survival and growth. Increased salinities have favored brown shrimp over white shrimp in the central-northern Gulf of Mexico. Trawl catches of white shrimp dropped below seasonal averages when dissolved oxygen was below 3.0 mg/l in altered, eutrophic canals associated with housing developments in West Bay, Texas.

POPULATION ATTRIBUTES:

Growth. Juvenile white shrimp grow during summer and fall, grow slowly over winter, and then resume growth as water temperatures rise in the estuaries during April and May. Spring growth is about equal to the summer growth of 18 to 30 mm per month. Similar growth rates were calculated from mark-recapture studies in Georgia from 1978 to 1981. The rate of increase in weight is relatively low among the small white shrimp, highest in mid-sizes, and decreasing among the larger ones.

Following two mysis stages and two postlarval stages, young white shrimp 7 mm long enter the estuaries where their growth rate is about 1.2 mm per day. Juvenile shrimp in the south Atlantic grow 1.0 to 2.3 mm per day or 28 to 64 mm per month.

Female shrimp grow faster and reach larger sizes than males. In northeast Florida the largest female sampled was 192 mm long and the largest male was 175 mm long; most shrimp longer than 115 mm were females.

Mortality. Few white shrimp live as long as one year; however, mark and recapture studies showed that a few lived as long as 27 months in Mississippi, more than 17 months in Georgia, and as long as 4 years (average 18 months) in Texas. Because of the usually short life span, the abundance of white shrimp would be expected to fluctuate widely from year to year but apparently compensating factors are at work; e.g., in 1977 after a massive winter kill in Georgia coastal waters, when the numbers of spawning white, shrimp were reduced to 7% of normal, subsequent recruitment into the fishery was only 40% below normal. For white shrimp in the south Atlantic fishery, instantaneous mortality rates were 0.02 to 0.25 (fishing), 0.21 to 0.56 (natural), and 0.24 to 0.80 (total). Weekly mortalities ranged from 13 to 51%; the lower rates were nearer to reality for both juveniles and adults.

Hurricanes cause major losses of white shrimp in the Gulf of Mexico. A hurricane striking the Louisiana coast in summer 1957 destroyed large numbers of white shrimp when salinities increased, cover and food supplies were destroyed, dispersal and stranding were excessive, and turbulence in estuaries was high. Hurricane Carla caused a 61% drop in the 1961 Louisiana catch of white shrimp and Hurricane Camille caused an 88% drop in production in Mississippi in August 1969. Sudden cold fronts and subsequent declines in water temperatures have caused mortality and reduced recruitment of white shrimp in south Atlantic shallow inshore waters; two consecutive mild winters may be required to support spring harvests in South Carolina.

The Fishery. White shrimp enter the commercial fishery when the gravid shrimp congregate off the central and southward coast of South Carolina in April or May and remain in the South Carolina fishery through June or early July. In Georgia, the white shrimp fishery season opens in June in territorial offshore waters. Juveniles enter the coastal fishery in August in South Carolina, Georgia, and northeast Florida. In North Carolina, they are caught mainly in the fall in the area from Southport to Cape Fear. The fishery continues through mid-December in South Carolina and to the end of December in Georgia and northern Florida. Catches in nearshore waters of Georgia are lowest in June and peak in August and September. Catch per unit of effort was highest in northern Georgia's offshore waters in late summer and fall and landings peaked in September and October. As water temperatures drop, white shrimp move southward and are caught in coastal waters of extreme southern Georgia in January; however, some may be caught as late as February depending on the date of closure of territorial waters. Studies reported that abundance peaked in December and January in northern Florida from St. Augustine to Cape Canaveral.

Most commercial shrimp catch is made within 9 km of the coast on trawlable bottoms within the 11-m depth contour. The breadth of the Continental Shelf within the 11-m (6-fathom) contour is greatest along the northern and central Georgia shelf, but is narrower along the coast of northeast Florida, South Carolina, and North Carolina. About 99% of North Carolina's white shrimp catch was taken in its territorial waters. For the other states, the percentages were 90% for South Carolina, 85% for Florida, and 59% for Georgia.

Freshwater inflow is the dominant factor influencing abundance, distribution, and growth of white shrimp. During the drought and low freshwater inflow in 1980, the shrimp moved further up estuaries, which lengthened their residency there and increased mortality. The lower landings in 1980-81 were caused by low freshwater inflow and low winter water temperatures.

MANAGEMENT PRACTICES

Adverse	Dredging
Adverse	Shoreline modification/development
Adverse	Salinity alteration
Adverse	Construction of navigational improvements [dams, locks, etc.]
Adverse	Applying pesticides
Adverse	Applying other toxicants
Beneficial	Controlling pollution [thermal, chemical, physical]
Beneficial	Controlling refuse disposal [landfills]
Existing	Regulating commercial harvest gear types

COMMENTS ON MANAGEMENT PRACTICES -
The loss of nursery grounds has been considered the major threat to the white shrimp fishery in the Gulf of Mexico because that is where shrimp are most vulnerable to habitat disturbance. Studies in Florida, Louisiana, and Texas identified landfill, dredging, and impoundments as major detriments to shrimp production. Because of the loss of rich organic material along bulkheads, shrimp abundance there was reduced to about 1/8 that of nearby unaltered shorelines. About 18,171 ha of wetlands, 3.5% of the total, were lost from the South Atlantic coast between 1954 and 1968. Manmade canals in Louisiana estuaries have increased salinity and adversely affected white shrimp survival and growth. Increased salinities have favored brown shrimp over white shrimp in the central-northern Gulf of Mexico. The effects of pesticides and pollution on shrimp habitat along the gulf coast are also of concern. Trawl catches of white shrimp dropped below seasonal averages when dissolved oxygen was below 3.0 mg/l in altered, eutrophic canals associated with housing developments in West Bay, Texas. Maintaining suitable nursery grounds ultimately may decide the future of the shrimp resources of the gulf coast and south Atlantic.

North Carolina, South Carolina, Georgia, and Florida do not permit commercial trawling in designated nursery areas.