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Courtney T. Hackney
University of North Carolina at Wilmington

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A NOTE ON THE REPRODUCTIVE SEASON OF THE CAROLINA MARSH CLAM *POLYMESODA CAROLINIANA* (BOSC) IN AN IRREGULARLY FLOODED MISSISSIPPI MARSH

COURTNEY T. HACKNEY
Department of Biological Sciences, University of North Carolina at Wilmington, Wilmington, North Carolina 28406

ABSTRACT The gonadal development of *Polymesoda caroliniana* in an irregularly flooded, brackish marsh was followed for 13 months. Ripe individuals (condition prior to spawning) were found in May, July, August, and October, suggesting either an extended period of spawning or three discrete spawning periods. This pattern is different from another study of *P. caroliniana* in a more flooded habitat.

The observed gonadal condition correlates with the presence of newly recruited clams in the marsh during most of the year, but failed to explain a pulse of juveniles found in February. The different reproductive pattern observed in this brackish marsh may be either a genetic or physiological adaptation to life in an unpredictably flooded marsh.

INTRODUCTION

The Carolina marsh clam *Polymesoda caroliniana* (Bosc 1802) is a moderate-sized clam, 25–40 mm, and occurs from Virginia to Texas. Present systematics place *P. caroliniana* in the family Corbiculidae which primarily includes fresh and brackish water bivalves. The clam is found in shallow water or intertidal habitats (Van der Schalie 1933, Tabb and Manning 1961, Hoese 1973, Swingle and Bland 1974, Olsen 1976, Subrahmanyam et al. 1976, Duobinis 1978, Duobinis-Gray and Hackney 1982).

Only Olsen (1976) provided information on the reproduction of *P. caroliniana*. He examined the reproductive cycle of a population on the northwest Florida Gulf coast and found that it spawned from July through September. Little is known about the physical conditions necessary to induce spawning. Olsen (1976) suggested that a 5-ppt change of salinity would induce spawning. Tabb and Moore (1971), however, suggested that reproduction occurs at salinities under 5 ppt and is most successful in fresh water. Conversely, Cain (1973) believed that the larvae were killed in salinities below 2 ppt and needed at least 6 ppt to remain viable.

Two studies of the fauna of a high intertidal, low-salinity marsh in Mississippi found newly recruited specimens of *P. caroliniana* present during much of the year (Bishop 1981, Duobinis-Gray and Hackney 1982). These recruitment patterns did not fit the spawning patterns found by Olsen (1976) in a northwest Florida population. Two hypotheses might explain this discrepancy: 1) the Mississippi population had a different spawning season, or 2) the larvae of *P. caroliniana* were capable of long-term residence as meroplankton, i.e., they delayed metamorphosis. The following study of the reproductive condition of *P. caroliniana* in an irregularly flooded Mississippi marsh over a 13-month period: 1) examines whether clams in this stressed habitat produce gametes, and 2) determines whether reproduction by clams in the intertidal population could explain the recruitment patterns previously noted.

MATERIALS AND METHODS

Study Area

The tidal marshes on the western side of St. Louis Bay, Mississippi (30°22′N,89°15′W), are well studied (Hackney and de la Cruz 1982). They are irregularly flooded and dominated by the black needlerush *Juncus roemerianus* (Schlee). The sediment in the top 10 cm of the marsh is approximately 36% sand, 18% silt, and 46% clay (Bishop 1981) and the salinity of the flooding water has only occasionally exceeded 8 ppt (Hackney and de la Cruz 1982).

Gonadal Study

Clams were collected monthly from March 1979 through March 1980. Approximately 20 individuals were collected each month, but some were later determined to be unsuitable or regarded as subadult (< 20 mm) and not used. Each clam was fixed, embedded in paraffin and sectioned (8 μm). Sections were taken from portions of the entire gonadal area, stained with hematoxylin and counterstained with eosin. The designation of gonadal condition followed Olsen (1976) who graciously loaned photographs of each reproductive stage to insure consistency between the two studies. Those interested in detailed aspects of gametogenesis in *P. caroliniana* should refer to Olsen (1976).

RESULTS AND DISCUSSION

Ripe individuals (male and female) were found in May, July, August, and October (Figure 1) in the Mississippi marsh. This extends the potential spawning season two months earlier and one month later than Olsen's (1976) study in Florida (Figure 1A). Curiously, there were no ripe individuals in June or September. All clams collected in November, December, January, and February showed no gonadal

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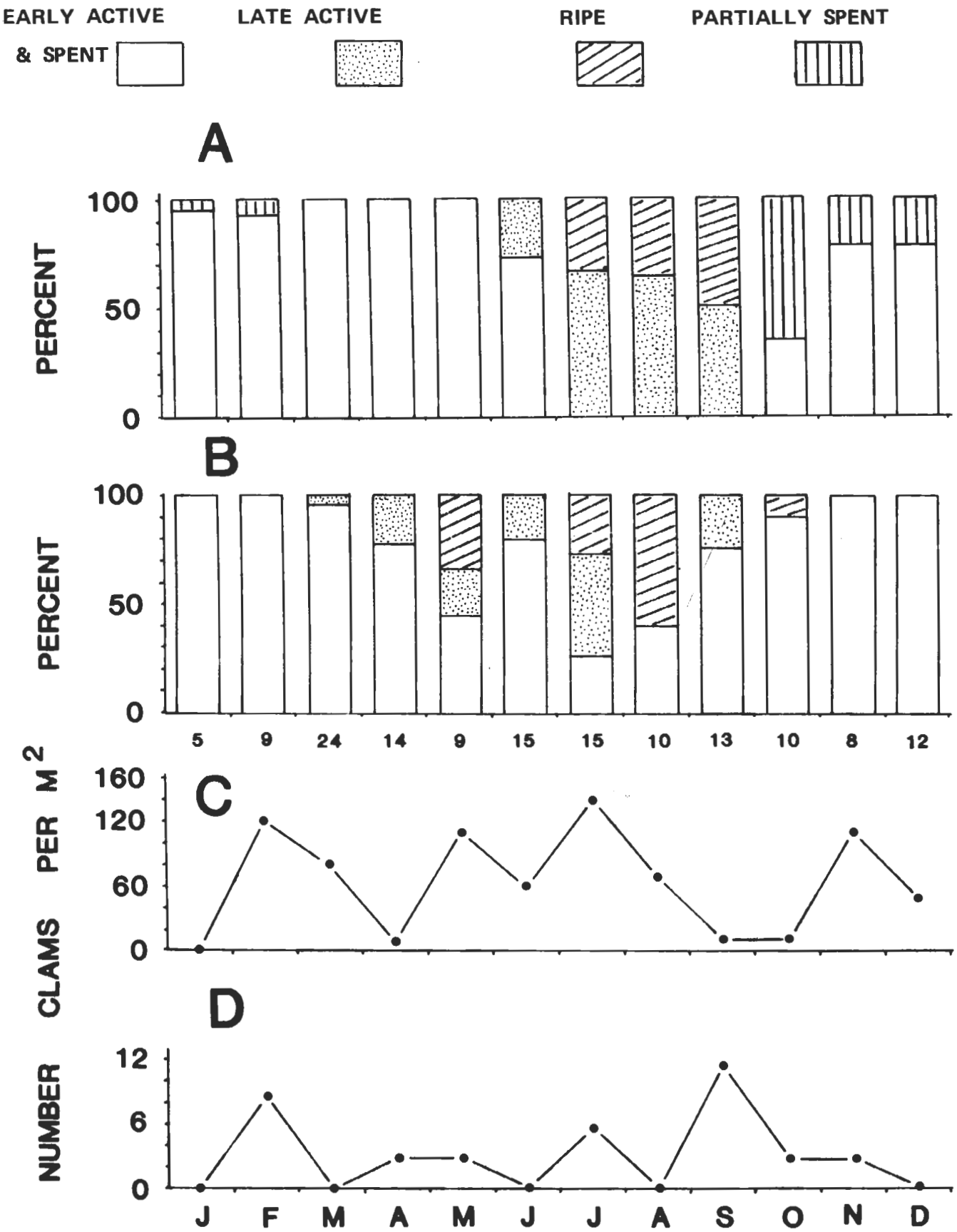
EARLY ACTIVE & SPENT
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PARTIALLY SPENT
A
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NUMBER CLAMS PER M2
160
120
60
12
6
J F M A M J J A S O N D

development (Figure 1B). This contrasts with Olsen's (1976) study in which a significant proportion of clams from October through February were partially spent (condition following spawning), a condition that was never noted in this study. Furthermore, from July through September all individuals in the Florida population were either in the late active stage of development or ripe. This was never the case in the Mississippi population (Figure 1B). While these data suggest that the Mississippi population has three spawning periods; May, July-August, and October, a more thorough study with shorter intervals between collections and more individual clams would be needed to substantiate such a claim.

The reproductive pattern found in the Mississippi population explains the occurrence of very small specimens of *P. caroliniana* in late spring and early summer (Figure 1C), the pulse of juveniles in September (Figure 1D), and the pulse in November (Figure 1C). The February pulse that was reported by Bishop (1981) and Duobinis-Gray and Hackney (1982) cannot be explained without either assuming a lengthy planktonic period or the spawning of another nearby population at a different time. The data used in Figure 1C and 1D were collected during different years, but the gonadal data (Figure 1B) and the recruitment data (Figure 1D) overlapped except for April and May.

Survival in a high, intertidal marsh is difficult for animals that depend on the flooding tide for food and reproduction. Even though *P. caroliniana* can survive for weeks without water (Duobinis-Gray and Hackney 1982) it is undoubtedly stressed by long periods without inundation. Such conditions frequently occur in this marsh (Hackney and de la Cruz 1982). In addition to testing the physiological tolerance of these clams, the lack of inundation prevents the release of eggs and sperm and the settlement of larval clams. It is not surprising that different degrees of recruitment would be noted for the same area from year to year, both in timing and abundance (Figures 1C & 1D).

The extension of the reproductive season in the Mississippi intertidal population is a response that would aid successful reproduction. If reproductive effort was restricted to a single spawning period, the entire year's effort would be wasted if the marsh did not flood. By extending the reproductive period, some degree of success is insured each year. Furthermore, these data suggest that at least a portion of the population is spawning twice because the sum of clams spawning over a year equals 129% of the population.

Variations in timing of gonadal maturity between Florida and Mississippi populations may be genetically based or the result of external forces acting upon a population which is physiologically plastic. For instance, both populations may be responding to the same external stimulus, e.g., temperature. If temperature was the primary factor controlling gonadal development, then variations between populations could be explained without the presumption of genetic differences. The intertidal population would reach the critical spawning temperature earlier than a more flooded population because it lacks the protective insulation of the water. Thus, the difference in timing of gonadal activity does not necessarily mean that Florida and Mississippi populations are different physiological races.

CONCLUSIONS

Carolina marsh clams inhabiting a relatively high intertidal marsh produced mature gametes indicating that poorly flooded populations are reproductively viable. Variations in gonadal development were found between well flooded and irregularly flooded intertidal populations of *P. caroliniana* living at the same latitude. Whether the populations differ genetically or are exhibiting physiological plasticity is unknown. Recruitment of juveniles during the year cannot be explained entirely by the reproductive pattern of adults or by the intertidal habitat prior to the recruitment period.

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Figure 1A. Reproductive state of adult clams (> 20 mm) from a subtidal area in the Ochlockonee River estuary on the northwest Florida coast (modified from Olsen 1976). Each collection datum represents 20 clams collected from November 1974 through October 1975. B. Reproductive state of adult clams (> 20 mm) from a high intertidal marsh in Mississippi. The number below the month indicates the number of clams examined. Collections were made from March 1979 through March 1980. March on the figure includes clams collected in March 1979 and March 1980. C. Recruitment of juvenile clams (2.5–4.0 mm) into a high intertidal marsh in Mississippi (adapted from Duobinis 1978). Data were collected from February 1977 through January 1978. D. Recruitment of juvenile clams (< 4.9 mm) into a high intertidal marsh in Mississippi (data provided by T. D. Bishop, Dept. Ecology, Univ. Georgia, Athens, GA). Data were collected from June 1979 through May 1980.

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