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RELATIONSHIP BETWEEN PEA CRAB (*PINNOTHERES MACULATUS*) PARASITISM AND GONAD MASS OF THE BAY SCALLOP (*ARGOPECTEN IRRADIANS*)

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ABSTRACT We investigated the prevalence of pea crabs (*Pinnotheres maculatus*) in bay scallops (*Argopecten irradians*) from 1994 through 1996 in a scallop population from St. Joseph Bay, Florida. We also assessed their impacts on scallop reproductive potential. Our results showed that prevalence in bay scallops varied between 0 and 20% and were extremely low during 1996 (<2%). Comparing Gonadal-Somatic Indices (GSI) between infested and non-infested bay scallops in samples assessed the impact of pinnotherid parasitism. Results showed that GSI was significantly reduced in infested individuals compared to non-infested individuals of the same size range ($t_{12} = 2.3$, $P < 0.04$). These results suggest that *P. maculatus* infestation may lower the reproductive potential of individual scallops, but the low rates of parasitism may only minimally impact the host population.

INTRODUCTION

Species of crabs in the family Pinnotheridae are either parasitic or commensal, and live within bivalves (Palmer 1995), gastropods (Geiger and Martin 1999), ascidians (Williams 1984) and holothurians (Takeda et al. 1997) or associated with burrows of worms (Grove and Woodin 1996) and decapods (Alves and Pezzuto 1998). They also may live on the surface of some echinoderms (Williams 1984). Members of the genus *Pinnotheres* are typically associated with bivalves and may cause substantial damage to their hosts. For example, *P. ostreum* occurs parasitically in oysters where its activities may damage the gills of its host (Christensen and McDermott 1958). However, only the presence of mature female crabs negatively affects oyster growth (Williams 1984) and reproductive potential (O'Brien and Walker 1999). *Pinnotheres maculatus* commonly occurs in scallops, mussels and a variety of other bivalves (Williams 1984, Bierbaum and Shumway 1988). Because this species actively feeds within the mantle, it is associated with stunting in scallops (Kruczynski 1975) and reductions of filtration rates in infested mussels (Bierbaum and Shumway 1988). However, little else is known about the effects of *P. maculatus* on either the growth or reproductive output of host scallops.

Bay scallops, *Argopecten irradians*, are common bivalves in many coastal seagrass communities in the Gulf of Mexico and Atlantic Coasts of the United States (Clarke 1965). Their short life span (10–24 months) and high rates of post-spawn mortality (Capuzzo and Hampton 1984) suggest that they are semelparous or a short lived iteroparous species with reproductive effort domi-

nated by a single spawning event (Barber and Blake 1983). They are an important commercial and recreational fishery in many of these communities (Arnold et al. 1998), but have declined in abundance in some regions (Ford 1997). Consequently, impact of parasitic pinnotherid crabs may negatively affect scallop reproductive output. Here we report the prevalence of pinnotherid parasitism in an exploited population of bay scallops in St. Joseph Bay, Florida. Previous research has indicated that scallops from St. Joseph Bay show at least 2 annual peaks in reproductive output, but spawning may occur throughout the year (Bologna 1998). We also compared the effects of infestation on the Gonadal-Somatic Index (GSI) of infested bay scallops.

MATERIALS AND METHODS

St. Joseph Bay, Florida, USA (29°N, 85.5°W) is a shallow semi-enclosed lagoon with little fresh water input. Salinities in St. Joseph Bay range from 22‰ to 35‰ and temperatures from 8.5° C to 32° C (Bologna 1998). Extensive seagrass meadows occupy the shallows (<2 m) and cover about 2,300–2,400 hectares (Savastano et al. 1984, Iverson and Bittaker 1986). Seven hundred thirty-seven (737) *A. irradians* were collected between April 1994 and October 1996, frozen and returned to the laboratory. Shell height and breadth of each scallop were measured to the nearest 0.05 mm and presence of pinnotherid crabs was noted for each scallop to determine prevalence. Scallops were then dissected to assess infestation and reproductive condition. Somatic and reproductive tissues were dissected and removed from the shell. Each tissue was dried at

TABLE 1

Monthly prevalence, expressed as percent infestation, of *Pinnotheres maculatus* in *Argopecten irradians* collected from 1994 through 1996 in St. Joseph Bay, Florida. Values in parentheses indicate total number of scallops collected and dissected for analysis. † Indicates scallops were not collected during these months. NA indicates the termination of scallop collection.

Month	1994	1995	1996
January		8.00 (25)	0.00 (13)
February		0.00 (28)	10.00 (20)
March		7.14 (28)	0.00 (28)
April	10.34 (29)	13.51 (37)	0.00 (24)
May	2.22 (45)	2.38 (42)	0.00 (21)
June	20.45 (44)	5.88 (33)	0.00 (21)
July	0.00 (23)	3.22 (31)	†
August	1.11 (90)	4.17 (48)	0.00 (16)
September	†	0.00 (37)	†
October	†	18.18 (22)	0.00 (19)
November	†	†	NA
December	0.00 (6)	0.00 (6)	

80° C for 72–96 hours and weighed. Based on the weight ratio of gonadal and somatic tissue, a Gonadal-Somatic Index (GSI) was calculated for each scallop ((Gonad weight/Total weight) × 100). To assess the impact that pinnotherid crabs had on gonadal mass, comparisons were made between infested and non-infested individuals in samples. Comparisons were made

using similar-sized individuals (within 5 mm shell height) from the non-infested population. Scallop GSI was then compared between non-infested and infested individuals using a paired t-test on date-averaged means. Specifically, each scallop pair in the analysis represents an independent field collection sample (e.g., June 1994). The mean GSI for each collection date was calculated for infested and non-infested scallops in the given size range. These values were then inserted as a date-averaged pair into the paired t-test analysis (e.g., June 1994, non-infested vs. infested). This process allowed meaningful comparison to be made between infested and non-infested individuals, eliminated size bias, as well as differences among dates, which might relate to seasonal spawning events and resultant changes in GSI.

RESULTS

The prevalence of *P. maculatus* in bay scallops ranged from 0 to 20% (Table 1). Prevalence was higher in 1994 and in 1995 compared to 1996. Pinnotherid parasitism occurred during 13 of 25 monthly sample collections. Results showed that infested individuals had significantly lower GSI values compared to non-infested individuals ($t_{12} = 2.3$, $P < 0.04$, Figure 1) and significantly lower gonad weights as well ($t_{12} = 2.9$, $P < 0.01$).

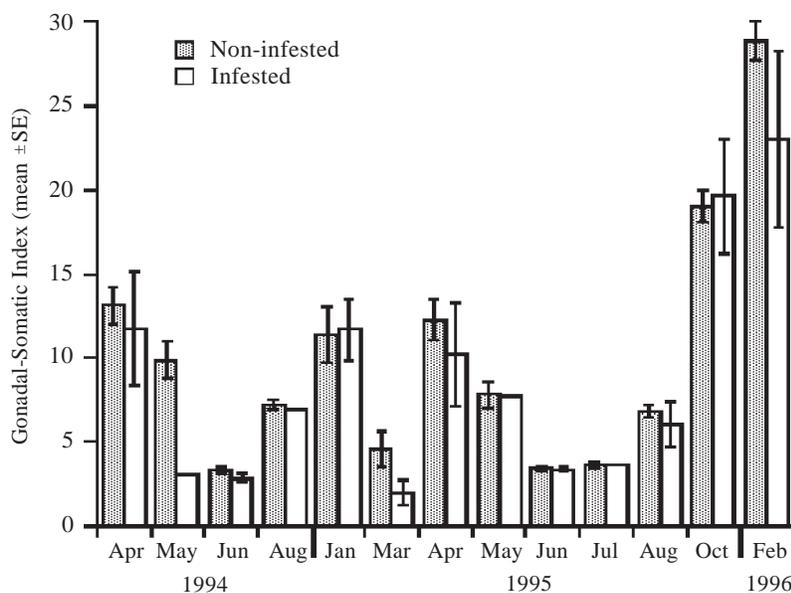


Figure 1. Comparisons of reproductive potential expressed as Gonadal-Somatic Index between infested and non-infested bay scallops, *Argopecten irradians*, collected during 1994 through 1996 from St. Joseph Bay, FL. Values represent date averaged means ± 1 Standard Error. For values with no error bars, only one infested individual was available for analysis.

DISCUSSION

Pinnotherid crabs show both parasitism and amensalism in marine communities (Williams 1984, Haines et al. 1994). Previous work has shown that the presence of mature female pinnotherid crabs associated with *Mytilus edulis* can significantly reduce tissue weight, but that male and juvenile-stage crabs did not appear to significantly impact *M. edulis* (Tablado and Lopez-Gappa 1995). However, O'Brien and Walker (1999) showed that non-infested oysters (*Crassostrea virginica*) had significantly greater gonad area compared to infested individuals. Our results concur with these studies, as scallops infested by *P. maculatus* showed significantly reduced GSI (Figure 1) and gonad weight. Based on these observations, we conclude that presence of *P. maculatus* in bay scallops is detrimental to individuals and this relationship should be classified as parasitic.

One of the most striking features of this research is the relatively low percentage of infested scallops (Table 1). With maximum values of 20% parasitism, this value is well below that seen for *Sanguinolaria acuta* (90% infestation, Soong 1997) and *M. edulis* (54–72%, Tablado and Lopez-Gappa 1995), but similar to infestation rates seen by O'Brien and Walker (1999) for *C. virginica* and Kruczynski (1973) for *A. irradians*. Perhaps this relates to the short life span of *A. irradians*, limiting potential infestation, or the numerical dominance of tulip mussels (*Modiolus americanus*) that are present in this system (Valentine and Heck 1993), which could provide *P. maculatus* with an alternate host (B. Peterson, pers. comm.). Another possibility is that the relative mobility of bay scallops may impede pinnotherids from successfully infesting scallops when switching hosts in the field (*sensu* Grove and Woodin 1996). Although Sastry and Menzel (1963) showed that adult *P. maculatus* were able to identify and infest *A. irradians* in experimental trials, *P. maculatus* showed no preference for *A. irradians* over pen shells (*Atrina rigida*). Consequently, they suggested that host proximity might be most important in determining host infestation in the natural environment (Sastry and Menzel 1963). Regardless, these relatively low infestation rates (Table 1) suggest that pinnotherid parasitism may play only a minimal role in affecting the bay scallop population in St. Joseph Bay, Florida.

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