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Pea Crab, *Pinnotheres ostreum* Say, 1817, in the Eastern Oyster, *Crassostrea virginica* (Gmelin, 1791): Prevalence and Apparent Adverse Effects on Oyster Gonad Development

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Abstract. Incidence of pea crab, *Pinnotheres ostreum* Say 1817, infestation in the eastern oyster, *Crassostrea virginica* (Gmelin, 1791), was recorded and related to oyster gametogenic activity over 18 months. Sampling occurred at two tidal heights (high intertidal HI and low intertidal LI) at two sites (House Creek, HC and Skidaway River, SR) in Wassaw Sound, Georgia. Overall, incidence rates were 3% HC LI, 1% HC HI, 8% SR LI, and 4% SR HI. At both tidal heights at HC, no differences were observed in gonad area between those oysters with and without pea crabs. At SR (where overall incidences were higher), oysters without pea crabs had significantly higher gonad area values than those oysters with pea crabs present. These results suggest that at higher incidences of pea crab infestation, oyster reproductive capabilities could be impacted, and support the claim that the pea crab/oyster relationship is a parasitic one.

INTRODUCTION

The brachyuran pea crab, *Pinnotheres ostreum* Say, 1817, has been observed in a number of bivalve species, e.g., *Mytilus edulis* Linnaeus, 1758, *Geukensia demissa* (Dillwyn, 1817), *Anomia simplex* d'Orbigny, 1842, and *Pecten* sp. (Williams, 1984). However, it is primarily a parasite (formerly considered a commensal) of the eastern oyster, *Crassostrea virginica* (Gmelin, 1791). This pea crab is found predominantly in the western Atlantic from Massachusetts, United States, to Santa Catarina in Brazil (Williams, 1984). The prevalence of the pea crab in oysters along the eastern seaboard of the United States has generally been high, with prevalences of up to 100% in some subtidal oyster populations in the Chesapeake Bay (Galtsoff, 1964). However, records of pea crab occurrence in the southeastern United States and especially coastal Georgia are scant. Linton (1968) stated that the occurrence of pea crabs in subtidal oysters in coastal Georgia was 100%. However, the vast majority of Georgia oysters occur intertidally (Harris, 1980). Parks (1968) reported that there were substantially higher proportions of pea crabs in oysters found subtidally than in those found intertidally. In the present study, oysters were sampled over a period of 1½ years, and the gonads were examined histologically. Pea crab presence and absence was recorded in the oysters and these data were then related to the gonad condition of the oysters throughout the sampling period.

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SITE DESCRIPTION AND METHODS

The two sites chosen for this investigation are shown in Figure 1. House Creek (HC), a shallow sheltered creek, is located on the northern end of Wassaw Sound, Georgia. This site is characterized by relatively high salinities (> 25 ‰) and is sheltered from wave action. The Skidaway River (SR) site, under the Skidaway Institute of Oceanography dock on the north end of Skidaway Island, has more variable salinities and is exposed to higher wave action from passing boats than the House Creek site.

Two tidal heights were chosen for this study. The low-intertidal (LI) area was that area in and around the mean low water mark. The high-intertidal (HI) area was designated as the area above the region designated by the tidal level at approximately 3 hours after mean low water. In coastal Georgia, the majority of oysters occur between these two intertidal boundaries.

Sampling commenced in June 1993 and continued on a biweekly basis until the end of September 1993, when monthly sampling took place. Monthly sampling continued until January 1994. Biweekly sampling recommenced in April 1994 through September 1994.

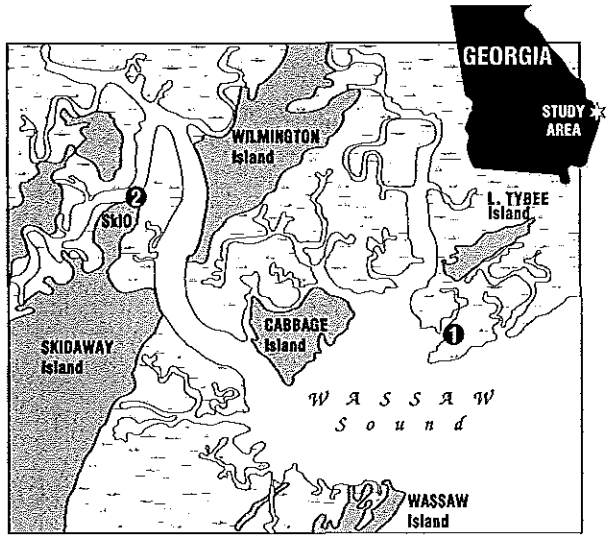

Figure 1

Wassaw Sound, Georgia with the two sampling sites indicated: (1) House Creek and (2) Skidaway River near the Skidaway Institute of Oceanography (SkIO).

At each sampling period, 20 (n = 20) adult oysters were taken from each tidal height at each site. Upon shucking, the tissue was examined and the presence or absence of pea crabs were recorded. A transverse tissue section (5 mm) was dissected from each shucked oyster and was processed for histological examination and qualitative and quantitative analysis of the gonad tissue according to the methods outlined in O'Beirn et al. (1996). The quantitative parameter used in this study was gonad area which accounted for that proportion, in a standard viewing area of a histological section of the oyster's tissue, occupied by gonad.

Statistical Analysis

Single factor repeated measures analysis was carried out on the data whereby all of the independent variables (oyster height, gonad area) were grouped into two categories—pea crabs present or pea crabs absent. Two dependent variables were examined in the analysis-of-variance (ANOVA): pea crab presence/absence and sampling periods. No interaction term was determined. The variations from the grand mean due to pea crabs and sampling periods will have been accounted for with remaining deviations being the source of error. All proportional data was arcsine square-root transformed prior to analysis. An arbitrary value of (α = 0.05) was chosen as the significance level for each ANOVA.

RESULTS

The highest recorded proportion of pea crabs in oysters was at the Skidaway River low intertidal site, where 8% of oysters sampled throughout the study contained pea crabs (Table 1). The lowest proportion of pea crabs was at the House Creek high intertidal site where 1% of the oysters contained pea crabs (Table 1). Within the sampling periods, the highest incidence of pea crabs in oysters was found in the Skidaway Low Intertidal oysters in April, 1995 where 21% (4 of 19) of the oysters contained pea crabs. No oysters were found containing more than one pea crab.

There were no significant differences in gonad area between those oysters with pea crabs and those without, at both tidal heights at House Creek (HI P = 0.4152 and LI P = 0.8366; Table 2).

The high intertidal oysters at Skidaway River had significantly higher (P = 0.0085) gonad area in oysters without pea crabs, than those with pea crabs (Table 2). The low intertidal oysters also had significantly higher gonad area values (P = 0.0117) in oysters where pea crabs were absent than those with pea crabs present (Table 2).

Table 1

Percent of oysters, *Crassostrea virginica,* according to presence or absence of pea crabs, *Pinnotheres ostreum.* Also given (in parentheses) is the absolute number of oysters in each category.

	PEA CRAB	
	Present	Absent
HOUSE CREEK		
HIGH INTERTIDAL	1% (4)	99% (394)
LOW INTERTIDAL	3% (13)	97% (380)
SKIDAWAY RIVER		
HIGH INTERTIDAL	4% (16)	96% (380)
LOW INTERTIDAL	8% (33)	92% (364)

Table 2

Percent gonad area of oysters, *Crassostrea virginica,* according to presence or absence of pea crabs, *Pinnotheres ostreum.* Also given are the p-values of repeated measures analysis using ANOVA.

	PEA CRAB		
	Present	Absent	p-value
HOUSE CREEK			
HIGH INTERTIDAL	38.4%	55.4%	0.4152
LOW INTERTIDAL	54.5%	56.8%	0.8366
SKIDAWAY RIVER			
HIGH INTERTIDAL	38.4%	56.9%	0.0085
LOW INTERTIDAL	42.0%	52.5%	0.0117

DISCUSSION

The number of pea crabs found in oysters in our study is substantially lower that those reported previously for oysters in coastal Georgia. Not surprisingly, in our study, oysters located near the low-tide mark had higher numbers of pea crabs than those located higher in the intertidal zone. A similar phenomenon was reported by Beach (1969) in North Carolina. However, the maximum proportions at any one intertidal height and site of 8% was substantially lower than that of 100% in subtidal oysters as reported previously by Linton (1968). Parks (1968) did record higher instances of pea crabs in subtidal oysters than intertidal oysters. However, the values in Park's (1968) study were in terms of number of pea crabs obtained from a specific number of oysters necessary to give one pint of oyster meat. The number of oysters differed considerably between the sites (tidal heights). Therefore, comparison of Park's (1968) data to those obtained in this study can only be cursory. The disparity between the results of Linton (1968) and this study can be accounted for by the differences in sampling location (subtidal versus intertidal, respectively). However, given that the majority of oysters in coastal Georgia are located intertidally (Harris, 1980), the proportions reported herein are perhaps more reflective of pea crab incidence in oysters in the region.

In Delaware Bay, Flower & McDermott (1952) noted that the proportion of oysters containing pea crabs was higher as they sampled from the upper reaches of the bay toward the ocean, which was concomitant with an increase in salinity. Such a pattern was not observed in this study. In fact, it appears that the higher incidences of pea crabs were found at the Skidaway River site, which traditionally has lower salinities (O'Beirn et al., 1995, 1996; Spruck et al., 1995). The reason for this apparent reversal in prevalence is unclear, but it might be related to the exact location of the House Creek sampling site. All oysters were removed from a small sheltered tidal creek, which is subject to high temperature fluctuations on a daily basis. O'Beirn et al. (1995) reported an 8°C water temperature change at this site in the space of 8 hours in 1991. Also, because of the shallow nature of the creek, it is subject to higher salinity fluctuations caused by freshwater runoff from the marsh, originating from storms which are frequent in the summer months in coastal Georgia. Pea crab development is inhibited by salinities less than 15‰ (Beach, 1969). Assuming the salinities will drop below 15‰, such factors might inhibit free-swimming invasive stages from surviving and hence infesting oysters, at this particular site. A more comprehensive investigation of pea crab incidences along a salinity gradient in the Wassaw Sound, Georgia area would need to be carried out to confirm that our findings were not anomalous. It must be noted that Kruczynski (1974) found no relationship between presence or absence of pea crabs in *Mytilus edulis* and salinity.

The presence of pea crabs within the mantle cavity of bivalves has been determined to have an adverse effect on the host mollusk. Physical damage to the gills, palps, and gonads of the bivalves has been recorded by a variety of authors (Stauber, 1945; McDermott, 1962; Dix, 1973; Jones, 1977). The presence of pea crabs, *Pinnotheres maculatus* Say, 1818, was deemed responsible for adversely impacting filtration and oxygen consumption rates in *Mytilus edulis* (Bierbaum & Shumway, 1988), as well as having an apparent negative impact on growth rates in nutrient-poor environments (Bierbaum & Ferson, 1986). Tablado & Lopez-Gappa (1995) demonstrated that *Mytilus edulis* individuals harboring mature female pea crabs, *Tumidotheres* (*Pinnotheres*) *maculatus* (Say), were significantly smaller and had lower dry weights than those mussels without pea crabs. Bay scallops, *Argopecten irradians concentricus* (Say, 1822), containing adult female pea crabs tended to weigh less and were smaller than those scallops without pea crabs in Bogue Sound, North Carolina (Kruczynski, 1972). Havert (1958) determined that oysters, *Crassostrea virginica,* containing pea crabs, *Pinnotheres ostreum,* had significantly lower dry meat weight and condition indices than oysters without pea crabs. Kruczynski (1972) noted that in the presence of large female pea crabs, the host bivalves tended to have reduced gametogenic output, which was attributed to physical pressure on the gonads.

At both sites in our study, oysters with pea crabs present had lower gonad area values overall than oysters without the pea crabs (Table 2). At the House Creek site, no significant difference in gonad area was determined between those oysters with or without pea crabs. We attribute this to insufficient numbers of infested oysters obtained from this site. The differences at the Skidaway River site were statistically significant, at both tidal heights. In a parallel study (O'Beirn, unpublished studies), oysters in the high intertidal zone tended to have higher quantitative gametogenic parameters than oysters lower down, suggesting that the high intertidal zone was less stressful to the oyster than previously hypothesized (O'Beirn, unpublished studies). In this study, this apparent negative impact of pea crabs on oyster gonad quantity was not confined to these supposedly more stressful environments as was the case with *Mytilus edulis* infested with *Pinnotheres maculatus* (Bierbaum & Ferson, 1986).

The observation in this study that the presence of pea crabs corresponded with lower gonad area measurements in oysters would question the classification of pea crabs as a commensal of oysters. Haines et al. (1994) proposed that the relationship between female pea crabs and their molluscan hosts be classified as true parasitism, as the female is rarely found free-living outside of the host. The results of the findings herein go further to suggest that the pea crabs negatively impact the fitness of oysters. The

significance of these results in terms of pea crab influence on oyster reproduction, must be tempered by the fact that the infestation rates observed were low. Consequently, the impact on the oyster populations in Georgia would appear to be minimal. However, given the high rates of pea crab infestation in oysters reported elsewhere, the apparent negative impact may be extensive and could have more far-reaching implications.

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LITERATURE CITED

BEACH, N. W. 1969. The oyster crab, *Pinnotheres ostreum* Say, in the vicinity of Beaufort North Carolina. Crustaceana 17: 87–199.

BIERBAUM, R. M. & S. FERSON. 1986. Do symbiotic pea crabs decrease growth rates in mussels? Biological Bulletin 170: 51–61.

BIERBAUM, R. M. & S. E. SHUMWAY. 1988. Filtration and oxygen consumption in mussels, *Mytilus edulis*, with and without pea crabs, *Pinnotheres maculatus*. Estuaries 11:264–271.

DIX, T. G. 1973. Mantle changes in the pearl oyster *Pinctada maxima* induced by the pea crab *Pinnotheres villosulus*. The Veliger 15:330–331.

FLOWER, F. B. & J. J. MCDERMOTT. 1952. Observations on the occurrence of the oyster crab, *Pinnotheres ostreum*, as related to oyster damage in Delaware Bay. Proceedings of the National Shellfisheries Association 43:44–50.

GALTSOFF, P. S. 1964. The American oyster, *Crassostrea virginica*, Gmelin. United States Fish and Wildlife Service, Fishery Bulletin 64:1–480.

HAINES, C. M. C., M. EDMUNDS & A. R. PEWSEY. 1994. The pea crab, *Pinnotheres pisum* (Linnaeus, 1767), and its association with the common mussel, *Mytilus edulis* (Linnaeus, 1758), in the Solent (UK). Journal of Shellfish Research 13: 5–10.

HARRIS, D. C. 1980. Survey of the Intertidal and Subtidal Oyster Resources of the Georgia Coast. Georgia Department of Natural Resources, Coastal Resources Division (Project No. 2-234-R), Brunswick, Georgia. 44 pp.

HAVEN, D. S. 1958. Effects of pea crabs, *Pinnotheres ostreum*, on oysters, *Crassostrea virginica*. Proceedings of the National Shellfisheries Association 49:77–86.

JONES, J. B. 1977. Natural history of the pea crab in Wellington Harbour, New Zealand. New Zealand Journal of Marine and Freshwater Research 11:667–676.

KRUCZYNSKI, W. L. 1972. The effect of the pea crab, *Pinnotheres maculatus* Say, on growth of the bay scallop, *Argopecten irradians concentricus* (Say). Chesapeake Science 13:218–220.

KRUCZYNSKI, W. L. 1974. Relationship between depth and occurrence of pea crabs, *Pinnotheres maculatus*, in blue mussels, *Mytilus edulis*, in the vicinity of Woods Hole Massachusetts. Chesapeake Science 15:167–169.

LINTON, T. L. 1968. Feasibility of raft culturing oysters in Georgia. Pp. 69–73 in T. L. Linton (ed.), Proceedings of the Oyster Culture Workshop, July 11–13, 1967. University of Georgia and Georgia Game and Fisheries Commission, Marine Fisheries Division, Contribution Series Number 6.

MCDERMOTT, J. J. 1962. The incidence and host-parasite relations of pinnotherid crabs (Decapoda, Pinnotheridae). Proceedings of the First National Coastal Shallow Water Research Conference. 1961:162–164.

O'BEIRN, F. X., P. B. HEFFERNAN & R. L. WALKER. 1995. Preliminary recruitment studies of the eastern oyster, *Crassostrea virginica*, and their potential applications in coastal Georgia. Aquaculture 136:231–342.

O'BEIRN, F. X., P. B. HEFFERNAN, R. L. WALKER & M. L. JANSEN. 1996. 'Young of the year' oyster, *Crassostrea virginica*, reproduction in coastal Georgia. Estuaries 19:651–658.

PARKS, P. 1968. A comparison of chemical composition of oysters (*Crassostrea virginica*) from different ecological habitats. Pp. 147–173 in T. L. Linton (ed.), Proceedings of the Oyster Culture Workshop, July 11–13, 1967. University of Georgia and Georgia Game and Fisheries Commission, Marine Fisheries Division, Contribution Series Number 6.

SPRUCK, C. R., R. L. WALKER, M. L. SWEENEY & D. H. HURLEY. 1995. Gametogenic cycle in the non-native Atlantic surfclam, *Spisula solidissima* (Dillwyn, 1817) cultured in the coastal water of Georgia. Gulf Research Reports 9:131–137.

STAUBER, L. A. 1945. *Pinnotheres ostreum* parasitic on the American oyster, *Ostrea* (*Gryphea*) *virginica*. Biological Bulletin 88:269–291.

TABLADO, A. & J. LOPEZ-GAPPA. 1995. Host-parasite relationships between the mussel, *Mytilus edulis* L., and the pea crab, *Tumidotheres maculatus* (Say), in the southwestern Atlantic. Journal of Shellfish Research. 14:417–423.

WILLIAMS, A. B. 1984. Shrimps, Lobsters and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Smithsonian Institution Press: Washington D.C. 550 pp.