THE FOOD HABITS OF FIVE CRAB SPECIES AT PETTAQUAMSCUTT RIVER, RHODE ISLAND

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ABSTRACT

The stomach contents of five crab species—green crab, *Carcinus maenas*; blue crab, *Callinectes sapidus*; lady crab, *Ovalipes ocellatus*; mud crab, *Neopanope texana*; and spider crab, *Libinia emarginata*—were examined from collections made in the Pettaquamscutt River, Rhode Island, during 1955–57. A carnivorous food habit characterized all species, although spider crabs contained plant foods more often than animal foods. Mollusks (especially pelecypods) and arthropods were frequent dietary components of the green, blue, and lady crabs. Intense predation on small, recently set pelecypods was indicated. The three species of portunid crabs (green, blue, and lady) appeared to have similar food habits, suggestive of potential interspecific competition for food. Crab remains were most frequently encountered in blue crab stomachs; lady crabs contained this food more often than green crabs. Small crustacea and plant foods occurred more often than hard-shelled foods and with equal frequency in the stomachs of small green crabs (<20 mm carapace width).

Predation by crabs has been identified as a serious threat to successful management of commercial bivalve resources (Carriker 1967; R. N. Hanks 1963; R. E. Hanks 1969). Many studies have concentrated on the green crab, *Carcinus maenas*, because of its abundance, its extensive distribution in the coastal zone of northeastern United States and Canada and Europe, and its predation on bivalves, especially the soft-shelled clam, *Mya arenaria*. Ropes (1968) and Welch (1968) have provided extensive reviews of the U.S. literature on this species; Davies (1966) and Kitching et al. (1959) have reported on its effects on European or blue mussel, *Mytilus edulis*, culture. Blue crabs, *Callinectes sapidus*; lady crabs, *Ovalipes ocellatus*; and mud crabs, *Neopanopeus texana*, have also been found to be predators of bivalves (Ryder 1884; Hay 1905; Fowler 1911; Belding 1930; Anon. 1941; Lunz 1947; Turner 1948; Bulter 1954; Landers 1954; Dunnington 1956; Darnell 1958, 1959; McDermott 1960; Galtsoff 1964; Loosanoff 1965). Many of these studies described the relationship between a particular predator and prey.

After completing collection and examination of green crab stomachs from Plum Island Sound, MA, I found that four of the species mentioned above and the spider crab, *Libinia emarginata*, could be collected from a fairly restricted area at the mouth of the Pettaquamscutt River, RI. This was an opportunity to examine possible inter- and intraspecific feeding habits by sympatric decapod crustaceans. The taxonomic relationship and morphological differences of the three portunid crabs (blue, green, and lady crabs) suggested making comparisons of stomach contents with each other and the two other crab species to determine the potential for predation on bivalves and to observe possible similarities and differences in their diets. The impact of such predation on bivalves of commercial importance has practical implications for resource management.

METHODS

From 1955 through 1957, crabs were collected during daylight hours from three subtidal areas of Pettaquamscutt River, RI, (Fig. 1) by towing a scallop dredge from a 12 ft aluminum boat powered by an 18 hp outboard motor (see Ropes [1968] for a description of the dredge). Intertidal areas were limited by the sharply sloping marsh banks which could not be sampled by the dredge. Thus, tows were made subtidally over shoal bars, along the edges of bars in the channel, and near the banks of the river. All samples were taken during ebb tide and before low water because experience at Plum Island Sound had shown that green crabs were actively moving about at that time. In 1955, five collection trips were made in July, September, and October; in 1956, six trips were made from May through August; and in 1957, nine trips were made in August through October (Table 1). At the laboratory, the species and

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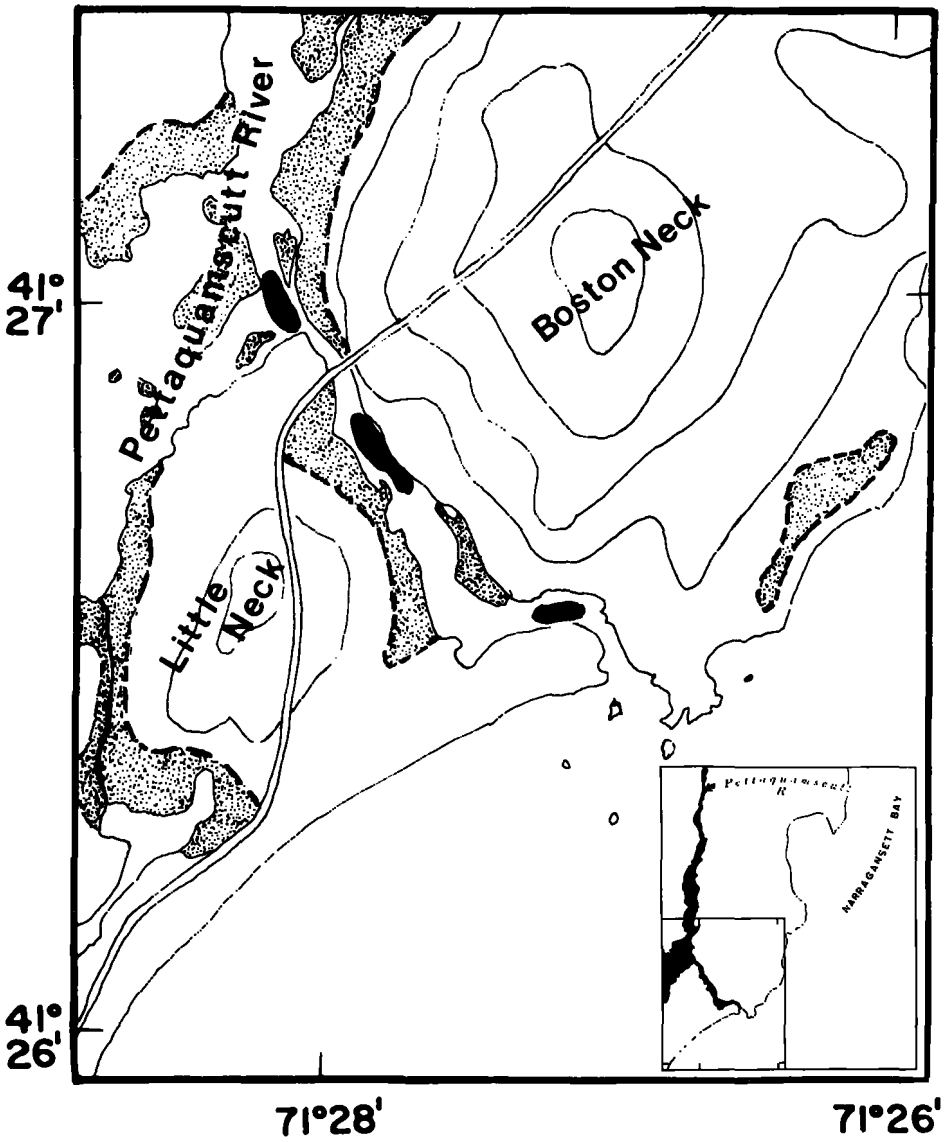

FIGURE 1.—Areas dredged (black areas) for crabs in Pettaquamscutt River, RI, 1955–57. Shoal bars were extensive near dredging areas. The islands were marshy (stippled areas) and were contiguous with mainland areas (dashed lines). An insert (bottom, right corner) shows Pettaquamscutt River in relation to the West Passage to Narragansett Bay.

sex of each crab were determined, and the carapace width (in mm) of each crab was measured with vernier calipers. Stomachs were then removed and preserved in 10% formalin. Food items were identified using a stereoscopic microscope, and the frequency of occurrence of each item was recorded. For some stomachs it was possible to count individual bivalves.

Descriptions of the amount of food in the stomachs were as follows: 1) full stomachs, containing tissues and hard parts of foods, 2) nearly empty stomachs, containing only a few fragments of hard parts of foods, and 3) empty stomachs. The stomachs in the first category were tabulated as the percentage of all crabs in a sample, and those in the second category as a percentage of the stomachs containing

TABLE 1.—Numbers of crabs caught in dredge tows at Pettaquamscutt River, RI, 1955–57.

Date	Number of tows	*Callinectes sapidus*	*Carcinus maenas*	*Ovalipes ocellatus*	*Neopanopeus texana*	*Libinia emarginata*
1955						
3 July	11	12	33	6	0	[1]1
6 Sept.	5	0	97	0	27	0
8 Sept.	9	14	26	14	8	0
3 Oct.	4	6	12	0	17	0
4 Oct.	4	0	18	0	0	0
1956						
2 May	4	0	16	0	0	0
4 June	7	0	25	2	0	[1]5
5 June	6	0	22	1	0	1
3 July	7	0	5	1	0	7
30 July	8	0	37	0	3	[1]6
29 Aug.	7	0	58	0	0	0
1957						
5 Aug.	3	14	[1]1	0	0	0
6 Aug.	3	30	[1]1	0	0	0
8 Aug.	3	19	0	0	0	0
15 Aug.	6	10	2	0	0	0
23 Aug.	5	62	24	1	0	3
4 Sept.	2	[1]2	20	0	[1]1	0
25 Sept.	4	19	27	5	0	7
14 Oct.	3	[1]2	29	0	0	0
31 Oct.	3	0	65	0	0	0

[1]Stomachs not examined.

food. Empty stomachs were omitted from all calculations.

Since most food consisted of crushed or fragmented remains, hard structures were relied upon for food identification. To assign a food to a definite species category was not always possible, but it could usually be included in a general taxonomic group. Thus, not all major taxonomic groups are the sum of specific items. Mollusk shells, and especially the hinge structure of pelecypods, could be most readily recognized. Annelids were identified by their jaws (whole worms were rarely found). Arthropods could rarely be identified to species, but were separated into three general groups: 1) crabs, which consisted of heavy pigmented exoskeletal remains, 2) small crustaceans, which consisted of translucent exoskeletal remains of amphipods, isopods, and small shrimp, and 3) barnacles (shells and bodies). Many stomachs contained food remains that were too fragmented or digested for identification. These were classified as unidentified remains.

Analysis of food habits by sex, molting condition, egg bearing, and mating were not possible due to the small numbers of each species collected. In a study of nearly 4,000 green crabs, Ropes (1968) found that feeding habits by sex were inconsistent and that feeding habits by premolt and very soft-shelled crabs (not included in the present study) were arrested. Similarly, ovigerous green crabs examined by Ropes (1968) tended to feed less than nonovigerous crabs, and the stomachs of mated pairs were nearly empty. Thus, analyses in the present study focused only on general food habits of the five species.

RESULTS

Although a few blue crabs were caught in 1955, none were taken in 1956 (Table 1). They were most numerous in the 1957 samples. The mean number per tow varied from 0 to 12.4. Green crabs were caught during every collection trip, except 8 August 1957, and were usually more numerous than the other crab species. The 6 September 1955 collection was unusual: 90 green crabs <10 mm CW (carapace width), 6 crabs <20 mm, and 1 crab 58 mm were caught entangled in decaying algae. It was the only collection containing such a large number of small-sized crabs. The mean number of green crabs caught per tow varied widely (0 to 21.7). Other crab species were caught infrequently and then in relatively low numbers.

Blue crabs ranged from 20 to 160 mm CW (Fig. 2). Although none exceeded 105 mm in 1955, 35% were larger in 1957. No size group was dominant; most ranged from 40 to 109 mm. Green crabs ranged from 4 to 70 mm, with most between 20

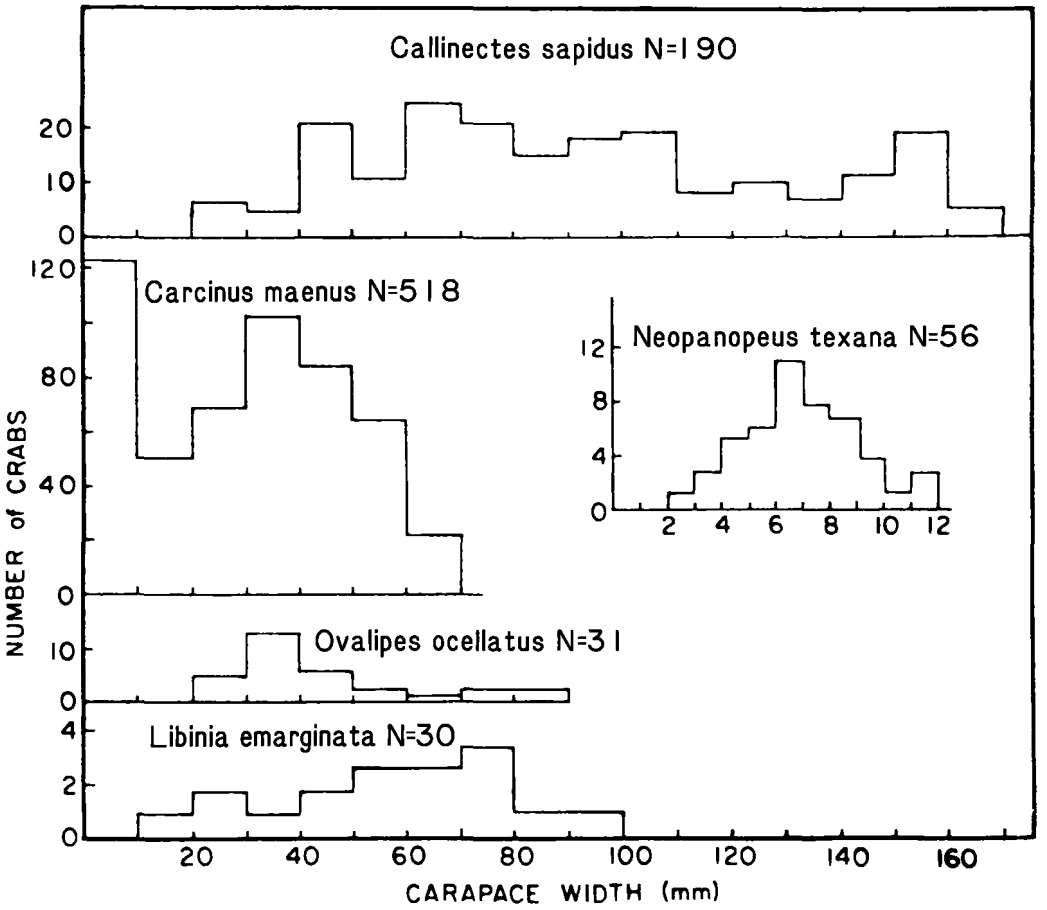

FIGURE 2.—Frequency distribution of carapace widths of five crab species collected from Pettaquamscutt River, RI, 1955–57.

and 59 mm. Lady crabs ranged from 27 to 83 mm CW, with most <50 mm. Spider crabs ranged from 13 to 93 mm and mud crabs from 3 to 12 mm.

Blue Crab

Animal foods were found in 91% of the blue crab stomachs and plant foods in 19% (Table 2). This indicated a predominantly carnivorous food habit. Of the animal foods, arthropods were more frequently (68%) encountered than mollusks (55%) or annelids (17%). Crabs (40%) and small crustaceans (33%) eaten by blue crabs were examined. Pelecypods (49%) were found more often than gastropods (12%), while the gem clam, *Gemma gemma*, (28%) and blue mussel (16%) occurred most often. The number of gem clams in 43 stomachs ranged from 2 to 821 (with an average of 66.8 per stomach). Few whole mussels had been eaten (≤4 per stomach), but most of them occurred as shell fragments. Other pelecypods found infrequently were soft-shelled and hard-shelled clams, and glossy shell (possibly *Tellina* sp.) and ribbed shell (possibly *Argopecten* sp.) fragments. Gastropods were found infrequently and, except for *Hydrobia* sp., were incomplete, broken shells or operculi. The jaws of *Nereis* sp. found in 13% of the stomachs indicated that it was the most frequently eaten annelid. Fish remains were found in 18% of the stomachs. Of the plant foods, *Spartina* occurred in 12% of the stomachs and algae in 8%. Unidentified tissues were in 67% of the stomachs. Although 75% of the blue crab stomachs contained food, 24% of these were nearly empty.

TABLE 2.—Occurrence and (percent frequency of occurrence) of foods eaten by five species of crabs collected in Pettaquamscutt River, RI, 1955–57.

Food items	*Callinectes sapidus*	*Carcinus maenas*	*Ovalipes ocellatus*	*Neopanopeus texana*	*Libinia emarginata*
Animal	126 (91)	240 (80)	17 (94)	16 (42)	5 (42)
Annelids	24 (17)	48 (16)	2 (11)	1 (3)	
Nereis sp.	18 (13)	37 (12)	2 (11)		
Other	1 (1)	3 (1)			
Mollusks	77 (55)	130 (43)	14 (78)	1 (3)	3 (25)
Pelecypods	68 (49)	92 (31)	13 (72)	1 (3)	3 (25)
Mytilus edulis	22 (16)	72 (24)	10 (56)	1 (3)	2 (17)
Gemma gemma	39 (28)	4 (1)	3 (17)		
Mercenaria mercenaria	3 (2)				
Mya arenaria	1 (1)				
Other		12 (4)	4 (22)		1 (8)
Gastropods	16 (12)	48 (16)	1 (6)		1 (8)
Hydrobia sp.	6 (4)	1 (1)			
Other	9 (7)	34 (11)	1 (6)		1 (8)
Arthropods	94 (68)	106 (35)	9 (50)	13 (34)	1 (8)
Crabs	55 (40)	11 (4)	5 (28)	1 (3)	1 (8)
Small crustaceans	46 (33)	75 (25)	3 (17)	12 (32)	1 (8)
Barnacles	1 (1)				
Foraminifera	2 (1)	20 (7)			
Fish	25 (18)	1 (1)		1 (3)	
Other					1 (8)
Plant	26 (19)	118 (39)		8 (21)	9 (75)
Algae	11 (8)	92 (31)		6 (16)	8 (67)
Spartina sp.	17 (12)	55 (18)		3 (8)	3 (25)
Unidentified	93 (67)	250 (83)	4 (22)	38 (100)	7 (58)
Stomachs with food	139 (75)	301 (71)	18 (58)	38 (69)	12 (67)
Stomachs nearly empty	33 (24)	50 (17)	1 (6)	3 (8)	3 (25)
Total number of crab stomachs examined	186	426	31	55	18

Green Crab

Animal foods were found in 80% of the green crab stomachs; plant foods occurred in 39% (Table 2). This indicated a predominantly carnivorous food habit with herbivorous tendencies. Of the animal foods, mollusks were found more frequently (43%) than arthropods (35%) or annelids (16%). Pelecypods (31%) occurred more often than gastropods (16%). Of the pelecypods, blue mussels were found most often (24%); gem clams and other pelecypods were infrequent food items. Other gastropods occurred most often (11%) as unidentifiable broken shells or operculi. The jaws of *Nereis* were found in 12% of the stomachs. Of the plant foods, *Spartina* was found in 31% of the stomachs, and algae in 18%. Unidentified tissues occurred in 83% of the stomachs. Although 71% of the green crab stomachs contained food, 17% of these were nearly empty.

Stomach analyses of small green crabs (<20 mm CW) caught on 6 September 1955 were sufficiently different to warrant separate representation (Table 3). Animal and plant foods occurred with equal frequency (69%) in the stomachs. Of the animal foods,

TABLE 3.—Occurrence and (percent frequency of occurrence) of foods eaten by small (<20 mm CW) green crabs caught on 6 September 1955.

Food item	Carapace width (mm) <10	Carapace width (mm) 10–19	Combined (Percent)
Animals	47 (70)	3 (60)	70 (69)
Annelids	1 (2)		1 (2)
Nereis sp.			
Other	1 (2)		1 (2)
Mollusks	1 (2)		1 (2)
Pelecypods	1 (2)		1 (2)
Mytilus edulis	1 (2)		1 (2)
Arthropods	43 (64)	3 (60)	46 (64)
Crabs	1 (2)		1 (2)
Small crustaceans	41 (61)	3 (60)	44 (61)
Foraminifera	1 (2)		(2)
Plants	46 (69)	4 (80)	50 (69)
Algae	44 (66)	4 (80)	48 (67)
Spartina sp.	2 (3)	1 (20)	3 (4)
Unidentified	25 (37)	3 (60)	28 (39)
Stomachs with food	67 (74)	5 (83)	72 (75)
Stomachs nearly empty	6 (8)		6 (6)
Total number of crab stomachs examined	90	6	96

arthropods were found most frequently (64%) and were predominantly (61%) small crustacean remains. The occurrence of the blue mussels, crab remains, and foraminifera in 2% of the stomachs indicated that these were minor dietary components. Algae was the dominant (69%) plant food; *Spartina* occurred in only 4% of the stomachs. Unidentified remains were found in 39% of the stomachs. Most stomachs (75%) contained food, although 6% of these were nearly empty.

Lady Crab

Animal foods were found in 94% of the lady crab stomachs; none contained plant foods (Table 2). This indicated a strictly carnivorous food habit. Of the animal foods, mollusks were encountered more often (78%) than arthropods (50%) or annelids (11%). Pelecypods occurred much more often (72%) than gastropods (6%). Blue mussels found in 56% of the stomachs were usually shell fragments; gem clams were found in 17% of the stomachs, and one stomach contained as many as 17. Other pelecypods found in 22% of the stomachs were glossy-white fragments (possibly *Tellina* sp.). Arthropod foods encountered were crab (28%) and small crustacean (17%) remains. The jaws of *Nereis* were found in 11% of the stomachs. Unidentified tissues occurred in 22% of the stomachs. Although 58% of the lady crab stomachs contained food, 6% of these were nearly empty.

Mud Crab

Animal foods were found in 42% of the mud crab stomachs; plant foods were in 21% (Table 2). This indicated a predominantly carnivorous food habit with herbivorous tendencies. Of the animal foods, arthropods were more frequently (34%) encountered than mollusks (3%) or annelids (3%). Small crustaceans were found in 32% of the stomachs, and crabs in 3%. Blue mussels were found in only 3% of the stomachs and none contained gastropods. Fish remains were found in only 3% of the stomachs. Of the plant foods, algae was found in 16% of the stomachs and *Spartina* in 8%. All of the stomachs with food contained unidentified tissues. Although 69% of the mud crab stomachs contained food, only 8% of these were nearly empty.

Spider Crab

Animal foods were found in 42% of the spider crab stomachs and plant foods in 75% (Table 2). This indicated a predominantly herbivorous food habit with carnivorous tendencies. Of the animal foods, mollusks occurred more often (25%) than arthropods (8%). Pelecypods were found more often (25%) than gastropods (8%). Blue mussels occurred in 17% of the stomachs. None of the stomachs contained annelids. Of the plant foods, algae was found in 67%, and *Spartina* was found in 25% of the stomachs. Unidentified tissues were found in 58% of the stomachs. Although 67% of the spider crab stomachs contained food, 25% of these were nearly empty.

DISCUSSION

Food habits of the five crab species were generally similar, a probable reflection of prey availability. Blue, green, and mud crabs tended to be carnivorous and spider crabs tended to be herbivorous, while lady crabs were observed to be exclusively carnivorous. However, neither of the latter two species was well represented (Table 2). Mollusks and arthropods were frequent dietary components of the blue and lady crab specimens (50% to 78%); such foods were in 43% and 35% of the green crab stomachs (Table 2). Many of the lady crabs (72%) and blue crabs (49%) contained pelecypods, but only 31% of the green crabs had eaten this food.

Green crabs are the sole portunid in the decapod fauna of Plum Island Sound, and Ropes (1968) found mollusks in 75% of the stomachs examined, with pelecypods (68%) the most frequent type of mollusk eaten. At Pettaquamscutt River, the low occurrence of pelecypods in green crab stomachs suggested that interaction between portunid species may have been affecting their feeding habits. Blue and lady crabs are adept at swimming and may use this ability in obtaining food and avoiding conflicts over food items; green crabs may be at a disadvantage in competing for food by their relatively poor swimming abilities. Many blue crabs were larger than the green or lady crabs taken, and their powerful claws may have been of positive advantage in encounters with other crabs. The high occurrence (40%) of crab remains in blue crab stomachs suggests inter- or intraspecific predation occurred, although the fragmented remains did not allow identification to species. Lady crabs may also have exerted predator pressure because 28% of their stomachs contained crab remains. Crab predation by green crabs was the lowest (4%) for the portunids examined and was lower than reported by Ropes (1968) at Plum Island Sound (13%).

Small green crabs caught on 6 September 1955

were almost equally carnivorous and herbivorous (Table 3). Relatively soft-shelled, small crustaceans (61%) and algae (67%) were found in the stomachs of green crabs; while only 2% of hard-shelled foods, such as pelecypods and crabs, were found. The mat of algae that entangled the crabs probably provided the foods seen in the stomachs and shelter from large predatory crabs and fishes. Ropes (1968) observed finger-sized holes, mats of algae, and *Spartina* high on the marsh banks of Plum Island Sound that were a refuge for small green crabs. This may be a means of circumventing cannibalism, because large green crabs typically occurred on the lower level clam flats during high tide and migrated to the subtidal zone during low tide. Ropes (1968) also found that soft foods, such as *Spartina* and algae, were important dietary components of small crabs. The omnivorous food habit and existence of small crabs in ecological niches apart from large predators has probable survival value.

Stomach analyses of the five crab species indicate that their food habits have probable important impact on the macrobenthic fauna of Pettaquamscutt River; these results support similar findings of other investigators of the food habits of crabs. The omnivorous food habit of the crabs has survival value, minimizing their dependency on particular food items. The carnivorous habit of blue, green, and lady crabs, which have a tendency to include many small pelecypods in their diet, suggests that recently settled pelecypods may be rapidly eliminated or severely reduced in numbers by predation. Clearly, a management scheme that minimizes the effects of crab predation on a bivalve fishery has a better potential for success.

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