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THE INTERACTION BETWEEN ADULTS AND RECRUITMENTS IN THE *BRACHIDONTES VARIABILIS* L. (LAMELLIBRANCHIATA) BED IN THE BITTER GREAT LAKE, SUEZ CANAL

By

S. Z. Mohammed
Marine Science Department, Faculty of Science, University of Qatar, Doha, Qatar
Permanent Address: Zoology Department, Faculty of Science, Suez Canal University, Ismailia, Egypt.

التفاعل بين الحيوانات البالغة والامداد في مقر بلح البحر من نوع يراكيدونتس فاريباليس (ذات مصراعين) في البحيرات المرة الكبرى بقناة السويس

سعد زكريا محمد

يهدف هذا البحث إلى اختبار نظريتين تتعلق بالتفاعل بين الحيوانات البالغة والمستقدمين في مجتمع مكدس من مرشح العوالق بلح البحر (براكيدنتس فاريباليس) في البحيرات المرة الكبرى بقناة السويس . النظرية التي تفترض أن وجود الحيوانات البالغة يعوق استقرار الصغار لهذه الحيوانات لم يثبت صحتها حيث وجد أن الحيوانات الكبيرة في الحجم لا تكون سائدة سيادة كاملة في المجتمع وهذا يدل على أن وجود الاجيال القديمة لا تستطيع ان تمنع استقدام الصغار . ولم يثبت ايضاً صحة النظريات التي تفترض التأثير السلبي لبلح البحر على الامداد من الغونا الاخرى حيث وجد ان كثافة الغونا داخل مقر بلح البحر كانت أعلى منها في خارج المقر . ومعظم هذه الغونا كانت من الرخويات الاخرى ومن الديدان الشوكية (دودة النيرس) .

Key Words: Adult, Assemblage, Bivalves, Fauna, Interactions, Larvae, Recruitment, Settlement.

ABSTRACT

The purpose of the present study was to test two hypotheses concerning the interactions between adults and recruitments in the densly-packed assemblages of a population of suspension feeder (*Brachidontes variabilis* L.) in the Great Bitter Lake, Suez Canal.

The hypothesis that the adults of *B. variabilis* inhibit the settlement of their own recruits was not supported. The size-class structure of *B. variabilis* population revealed no dominance of large individuals, indicating that older cohorts were not able to prevent subsequent mussel recruitment. The hypothesis that *B. variabilis* has a negative effect on the recruitment of other infaunal species also was not supported. The density of infauna inside the mussel bed was significantly higher than outside. Other molluscs and polychaets (*Nereis sp.*) were the most common and had higher abundances inside the mussel bed.

INTRODUCTION

The interactions between adults and larvae (or recruitments) in dense infaunal assemblages have been studied and predicted for deposit and suspension feeders (Woodin, 1976; Peterson, 1982; Peterson & Andre, 1980; Williams, 1980; Maurer, 1983). The interpretations of these predictions for deposit feeders have been a major thrust of recent soft bottom community research (Brenchley, 1981; 1982).

With regard to suspension feeders, however little data has been collected to test the two hypotheses formulated by Woodin; (1976) for these interactions based upon adult-larval relationships in dense infaunal assemblages. These state that:

1. Suspension feeding bivalves and polychaets inhibit successful larval settlement by larvae including their own and consequently reduce the appearance of new recruitments. Therefore, their assemblages should persist but be strongly age-class dominated.
2. No infaunal forms should consistently attain their highest densities among densely packed suspension-feeding bivalves. The mechanisms for such interactions are ingestion of larvae by filtering bivalves and burial of larvae in faeces and pseudofaeces (Thorson, 1950; Mileikovsky, 1974; Woodin, 1976).

Few experiments have been conducted with suspension-feeding bivalves to test these hypotheses. Williams, (1980) studied the abundance of *Tapes japonico* and found that their recruitment differed with different densities. Peterson, (1982) showed that the pressure of *Prototheca stomina* individuals affected the clam's recruitment and that of another bivalve in mud, but in sand it had no significant effect. Best, (1978) demonstrated that *Mercenaria mercenaria* adults reduce the recruitment of some species with planktonic larvae, but had positive or no effect on most species that brood. Other density manipulations with *M. mercenaria* showed no effect on recruitment and abundance (Young & Young, 1978; Beal, 1983; Maurer, 1983; Hunt *et al*, 1987). Thus it appears that interaction tests between adults and larvae (or recruitments) with suspension-feeding bivalves have produced equivocal results.

The purpose of the present investigation was to test Woodin's, (1976) hypotheses using a simple approach. Benthic communities were sampled outside and inside a dense population of the mussel *Brachidontes variabilis* on a soft bottom intertidal flat in the Great Bitter Lake (Suez Canal). Mussles filter large volumes of water in order to capture food particles, and they produce abundant faeces and pseudofaeces (Seed, 1976; Bayne *et al*, 1976; Jasim, 1986; Mohammed, 1987). They form long-lived beds with discrete boundaries in soft bottom system (Verwey, 1952; Seed, 1976; Bayne *et al*, 1976; Griffiths, 1981). *Brachidontes variabilis* appears to satisfy all the requirements formulated by Woodin, (1976) in her description of a densly packed suspension-feeding bivalve assemblage. If her hypotheses are correct, then:

(i) The *B. variabilis* population at the study site should be strongly age-class dominated, with a large proportion of old individuals and few young ones; and

(ii) The density of other infauna should be lower inside the *B. variabilis* bed than outside.

Such investigations are important in studying the influences of infaunal filter (or suspension) feeding adults on settling larvae and recruitments (Williams, 1980). It can give an indication and allow prediction of the changes in marine infaunal assemblages in relation to their boundaries (Connell, 1955, Trevallion *et al*, 1970, Woodin, 1974) or in relation to physical changes in the population bed (Johnson, 1970 & Day *et al*, 1971).

MATERIALS AND METHODS

The study was conducted in the Fayed area of intertidal and subtidal flats of sandy mud in the Great Bitter Lake, Suez Canal (29° 30'N, 33° 70'E). The *B. variabilis* bed is located in the subtidal zone and covered an area of about 3 km. Water temperature at the site varies from a winter low of approximately 14°C to a summer high of about 29°C. Salinity is usually around 35% but is somewhat lower in the winter (34%) and a higher during summer (37%).

On 13 August, 1989, nine 20-cm deep, 0.025 m^2 cores were taken one metre apart along each of two transects parallel to the boundary of the mussel bed. The inner transect was located within the mussel bed, 15 m. from the boundary. The other transect was 15 m. outside the mussel bed. Core contents were seived in the field using a 5.0 mm mesh screen. The residue was placed in 3% buffered formalin and sorted for infauna. The mean number of each infaunal species was estimated and calculated as mean ± S.D./m^2. The length of all live *B. variabilis* and empty, disarticulated valves were measured to the nearest 0.1 mm with Vernier caliper.

Additional cores were taken within the bed, to obtain more live mussels and empty valves for construction of size-class histograms. Two transects were established parallel to the others one inside the bed (5.0-m from the boundary, and one outside the bed (also 5.0-m from the boundary). These transects were sampled in exactly the same way as the others, except that only live mussels and empty valves were analyzed. Size-class histograms (using data from all transects) were constructed for live mussels and for the dead shells.

Stadent's t-test was employed to make density comparisons inside and outside the mussel bed and Spearman's rank correlation coefficient was used for all correlations (Zar, 1984).

RESULTS

***Brachidontes variabilis* population:**

Very few *B. variabilis* were recorded in the samples taken outside the mussel bed (0.02±0.01 animal/m^2). However, density within the bed was high (1182.1±75.2/m^2) (Fig. 1).

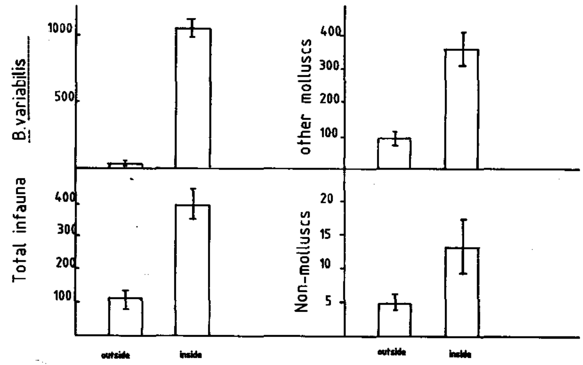

Fig. 1: Densities (mean ± S.D./m^2) of organisms outside and inside the *B. variabilis* bed in the Great Bitter Lake.

Densities varied between 900 on the hard substrate and about 2200 on the soft substrate. The size-class histogram for the disarticulated valves of dead mussels (Fig. 2) shows that most *B. variabilis* died at a length of about 26-30 mm. The size-class histogram for the mussels is polymodal (Fig. 2) indicating that the population contains mussels from many age classes.

Although many large mussels up to 36 mm long were recorded in the Great Bitter Lake, the greatest peak in abundance occur at small and medium sizes (Fig. 2a), indicating that older age classes were notable to prevent subsequent mussel recruitment. Examination of individual core samples also failed to show a negative correlation between the abundance of large and young mussels. These results do not support the hypothesis that recruitment of *B. variabilis* is inhibited by the presence of densly packed adults in the Great Bitter Lake.

Other infauna:

A total of 18 infaunal species (in addition to *B. variabilis*) were found in the study area with 10 species outside the mussel bed and 17 species inside. There was a significant difference

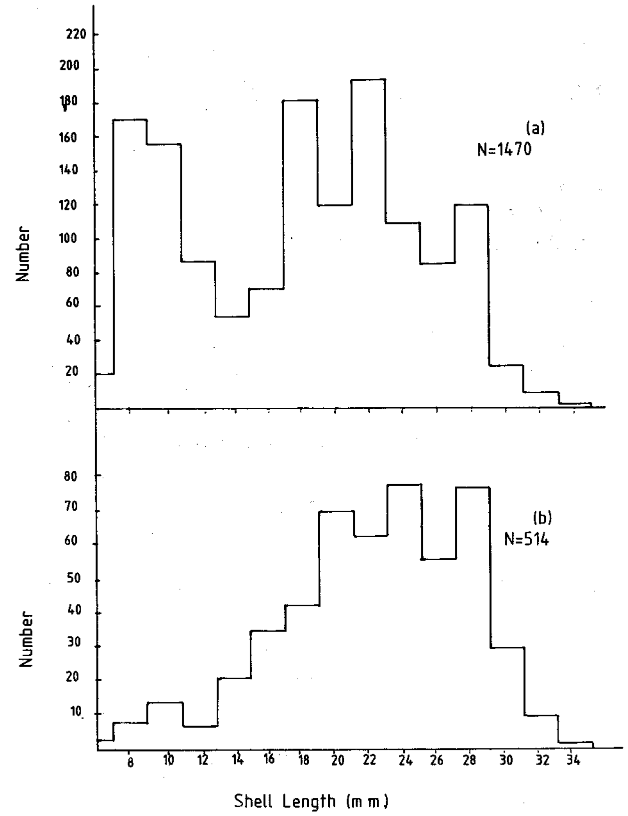

Fig. 2: Size-class histograms for (a) live *B. variabilis*, and (b) disarticulated *B. variabilis* valves in the Great Bitter Lake, Suez Canal.

($P<0.025$) between the number of species per m^2 outside (17.2 ± 1.7) and inside (13.9 ± 2.8) the mussel bed. Also, species composition and rank order differ between the two habitats (Table 1). The density of infaunal organisms (exclusive of *B. variabilis*) was significantly higher ($P<0.001$) inside the mussel bed (Fig. 1). Also, there was a positive correlation between *B. variabilis* and infaunal densities (Spearman $r_s=0.71$, $P<0.05$).

The most abundant taxa recorded outside and inside the mussel bed were the gastropoda and bivalvia (exclusive of *B. variabilis*) (Table 1). Their density was significantly higher inside the mussel bed ($P<0.01$) and there was a positive correlation between their density and the density of *B. variabilis* (Spearman $r_s=0.65$, $P<0.05$).

Molluscs accounted for 80.9% and 91.2% of the individuals outside and inside the mussel bed respectively. They were therefore more abundant in both absolute and relative numbers in the presence of *B. variabilis.*

The density of non-molluscan infauna (Table 1 & Fig. 1) was significantly higher inside the mussel bed than outside ($P<0.001$). Most of the specimens were polychaets (*Nereis sp.*) which showed also positive correlation with *B. variabilis* density (Spearman $r_s=0.67$, $P<0.05$).

Exponential equations which estimated between the rank order and the density of molluscs outside ($\ln Y=\ln 60.01 - 0.496\ X$, $r=0.9549$) and inside ($\ln Y=\ln 106.36 - 0.362\ X$, $r=0.9104$) the *B. variabilis* bed were significant ($P<0.001$) with significantly higher negative slope values for the external as opposed to the internal population ($P<0.025$) indicating a greater decline in density with increase in rank order in the outersample than in the inner one. These results, again, do not, support the hypothesis that *B. variabilis* has a negative effect on the recruitment of other infaunal species in the Great Bitter Lake.

Table 1

Densities (Mean + S.D. M^{-2}) of infauna outside and inside a soft bottom, intertidal (*B. variabilis*) bed in the Great Bitter Lake, Suez canal.

	Outside	
Rank	Species	Density
A	Molluscs	
1	*Pirenella conica*	50.6 + 17.9
2	*Timoclea sp.*	25.8 + 7.5
3	*Trochus erythnaeaus*	11.2 + 3.3
4	*Gafrarium pectinatum*	5.3 + 2.5
5	*Attachtidea sp.*	3.7 + 1.5
6	*Ancilla sp.*	3.1 + 1.6
7	*Arca sp.*	2.9 + 1.4
B	Non-Molluscs	
	Nereis sp. (Polychaets)	8.1 + 2.3
	Gammarus sp. (Crustaceans)	3.4 + 2.1
	Tripneustes sp. (Echinoderms)	1.2 + 0.6
	Total =	107.5 + 32.3
	Inside	
Rank	Species	Density
A	Molluscs	
1	*Pirenella conica*	273.9 + 31.7
2	*Gafrarium pectinatum*	46.7 + 14.8
3	*Trochus erythnaeus*	25.2 + 6.5
4	*Attachtidea sp.*	15. 9 + 4.2
5	*Timoclea sp.*	9.6 + 2.7
6	*Ancilla eburnea*	8.1 + 2.4
7	*Cerastoderma glaucum*	6.6 + 2.5
8	*Haminoea sp.*	5.6 + 3.2
9	*Nassarius pauperns*	4.9 + 2.3
10	*Cylichna alba*	3.7 + 2.2
11	*Clanculus bicinctus*	3.2 + 2.2
B	Non-Molluscs	
	Nereis sp. (Polychaets)	21.3 + 8.5
	Gammarus sp. (Crustaceans)	5.1 + 3.6
	Lucosia sp. (Crustaceans)	3.4 + 1.3
	Tripneustes sp. (Echinoderms)	1.3 + 0.5
	Holothuria sp. (Echinoderms)	4.9 + 2.1
	Porites sp. (Tunicates)	3.0 + 2.1
	Total =	396.4 + 40.7

DISCUSSION

The analysis of the size-class structure for *B. variabilis* in the Great Bitter Lake fails to support the hypothesis that adults have a major negative effect on the mussel recruitment. The size-class structure for the blue mussel (*Mytilus edulis*) bed on soft substrate in New England (Nixon *et al*, 1971) also revealed no evidence of age-class dominance by older mussels. Similar patterns were observed for hard substrate *M. edulis* populations (Seed, 1969; Commito, 1987) and *Chloromytilus meridionalis* (Griffiths, 1981) at different tidal levels.

Although, there is much literature on mussel recruitment, there is no conclusive evidence that adults reduce the recruitment of their larvae (Seed, 1969; Hancock, 1973; Bayne, 1976). It is known that mussel adults can ingest larvae (Mackenzie, 1981; Cowden *et al*, 1984), but the presence of shells and byssal threads probably stimulates larval settlement into mussel beds (Verwey, 1952; Seed 1969; Bayne, 1976) and reduces the rate of ingestion of incoming larvae. Post-Settlement mussels can also migrate into a bed at a size too large to be ingested by the mussels already there (Kuenen, 1942; Seed, 1969). Some bivalves however can have a deleterious impact on their own recruitment (Williams, 1980). This author found that clam spat settled more heavily in areas with no or only moderate adult clam densities than in area with high adult clam densities. In addition Peterson, (1982) found that there is intra and interspecific competition in populations of suspension feeding bivalves which have a deleterious effect on their young. For other bivalves, there is little evidence of a negative relationship between adult densities and recruitment (Hancock, 1973).

As the infaunal density data outside the *B. variabilis* bed in the Great Bitter Lake was lower than that inside the bed, results do not support the hypothesis that mussels have a negative effect on recruitment of other species. Total density of infauna inside the mussel bed was approximately four times that of outside. Other molluscs (especially *Pirenella conica*) were the most common organisms at the study site and had higher absolute and relative abundances inside the mussel bed than outside. Also, non-molluscs (as a group) were significantly higher in density inside the mussel bed, especially the polychaets (*Nereis sp.*). This provides further evidence against the hypothesis formulated by Woodin's, (1976) that suspension feeders have a negative effect on the recruitment of other infaunal species in the Great Bitter Lake. Other molluscs and polychaets were more abundant inside the *B. variabilis* bed than ouside (Table 1, Fig. 1). Also, the exponential regressions between the rank order and the density of molluscs outside and inside the *B. variabilis* bed showed a greater decline in density externally than internally. Best, (1978) found that most infaunal species were not adversely affected by densly packed *Mercenaria mercenaria* and pointed out that dispersal of recently hatched larvae can be achieved by changes in the water currents in the presence of suspension feeders (Eckman, 1983) or by grouping inside empty mussel valves (Peterson & Andre, 1980) or (in case of polychaets) by crawling through sediment (Hunter & Arthur, 1978). These results could explain the occurrence of other infaunal species in high densities in the presence of suspension feeders such as *B. variabilis.*

Thus, present results agree with Best, (1978) rather than with Woodin, (1976) in that adults of the densly packed *B. variabilis* may not inhibit the settlement of its own recruits, or those of other infaunal species whose dispersal stages can avoid ingestion by these suspension feeders or suffocation by their faeces or pseudofaeces.

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