

FEEDING EFFICIENCY OF *PENAEUS INDICUS* AND *METAPENAEUS DOBSONI* IN DIFFERENT EXPERIMENTAL SUBSTRATA

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ABSTRACT

Preying efficiency in the substrata of different concentrations of mud sand, silt and clay and also in mud from natural habitat was examined with respect to *Penaeus indicus* and *Metapenaeus dobsoni* in order to understand the factors in their natural substrata which affect the preying efficiency and the differences in the degree of adaptation of the two species. The study indicates that silt and clay adversely affect the preying efficiency of both the species, especially in higher concentrations. The data also suggest that *P. indicus* gets more easily adapted to a muddy substratum than *M. dobsoni*.

INTRODUCTION

Penaeus indicus, *Metapenaeus dobsoni*, *Metapenaeus monoceros* and *Metapenaeus affinis* are the most common penaeid prawns that are frequently caught in the Cochin backwater. They are often found growing together as juveniles and subadults and therefore, it is likely that the four species may have many similar environmental requirements which are met by the backwater, their main nursery ground. These species often forms part of the biological environment, subtle differences in their ecological preferences and optima may also exist in order to minimise competition especially if the ecosystem is comparatively simple and uniform. Since their natural substratum is predominantly muddy and the prawns mostly feed on benthic organisms and detritus, the degree of adaptation to a muddy substratum with reference to their feeding efficiency may be an important factor governing their growth and survival. Experiments conducted by Balasubramanian, Lalithambika Devi and Krishnankutty (1979) on *M. dobsoni* have shown that its preying efficiency decreased with increasing quantities of mud. Williams (1958) found that nature of substratum is a factor in shrimp distribution, *Penaeus duorarum* being often found on shell-sand while softer muddier substrates were preferred by *P. aztecus* and *P. setiferus*. In the present paper, the preying efficiency of *P. indicus* in relation to different concentrations of mud in the substratum is studied and compared with that of *M. dobsoni*.

MATERIALS AND METHODS

Juveniles of *P. indicus* were collected during November 1976 to July 1977 and during March-April 1979 from the highly productive tidal ponds of Raman-

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thuruth Island located near the entrance of the Cochin harbour. The preying efficiency in different concentrations of the bottom mud from these ponds was studied, after removing the macrobenthos by passing the mud through a 0.5 mm mesh sieve and using the tanaidacean, *Apseudes chilensis* as the prey species. Further details of the method employed were described by Balasubramanian, Lalithambika Devi and Krishnankutty (1979).

Experiments on the preying efficiency of *P. indicus* using the natural substratum were repeated many times to get conclusive evidence since different results were obtained when compared to that of the earlier studies on *M. dobsoni* (Balasubramanian, Lalithambika Devi and Krishnankutty, 1979). In few trials all the prey species in certain experimental containers were eaten by the prawn and therefore statistical analysis was confined only to those trials where some prey species were always left at the end of the experiment in the beakers.

In order to identify the factors in the substratum that affect the preying efficiency and the degree of adaptability of the two species, *P. indicus* and *M. dobsoni*, the number of prey eaten in substrata of different combination of sand, silt and clay were tested and compared. This is done by studying the preying efficiency in clean fine sand, in clayey mud, in natural substratum (sieved mud) and in sand and clay dominated mud obtained by mixing clean fine sand and clayey mud respectively in equal proportions with the natural substratum (sieved mud). All the tests were done in replicates. The data obtained for the two species were subjected to analysis of variance involving four-way classification after log transformation in order to test the Null hypothesis and to help the interpretations of the data. When clayey mud was used alone or with sieved mud as substratum some experimental prawns died in higher concentrations. Since the death is due to treatment effect, preying efficiencies in these cases were treated as zero for doing the analysis of variance.

Percentage of sand, silt and clay in the substrata provided were also studied by the combined sieving and pipette methods given by Krumbien and Pettijohn (1966). Ten grams of oven dried sediments were dispersed overnight in 0.025 N solution of sodium hexametaphosphate. The silt-clay fraction was separated by washing the dispersed sediments through a 0.062 mm mesh sieve. The coarse fraction retained in the sieve was oven-dried and weighed. The finer fractions were analysed by the pipette methods in an airconditioned room with temperature ranging between 20°–22°C

Table I. Percentage composition of sand, silt and clay in the different experimental substrata.

Experimental substratum	Sand (%)	Silt (%)	Clay (%)
Natural substratum	46.21	12.79	41.00
Sieved mud	36.52	20.14	43.34
Sieved mud and sand	86.72	1.06	12.22
Sieved mud and clayey mud	37.66	10.14	52.20
Clayey mud	27.53	14.82	57.65

in order to avoid temperature correction. From the sieve and pipette analysis data the weight percentages of sand, silt and clay in the different experimental substrata were calculated.

RESULTS AND DISCUSSION

The percentages of sand, silt and clay in the different experimental substrata are given in Table I. The number of *A. chilensis* eaten by *P. indicus* under different concentrations of mud and sand are given in Table II. Depth of mud in different beakers ranged from 0 to 1.4 cm. When clean fine sand was used as the substratum preying efficiency was almost unaffected by the different concentration of sand. However, a higher feeding activity was noticed in all the beakers even after adjusting for the different number of prey used for different trials. With mud the results were less clear, yet no definite trend was noticed with preying efficiency with increase in the concentration of mud. Prawns of 0.29 to 1.6 gm weight were used for the trials and those belonging to the smallest size showed almost the same result as those belonging to the largest size group although the latter had eaten more in the beakers without any mud. The results of the analysis of variance of the data showed that there was no significant difference in the preying efficiency with different concentrations of mud or sand although in the two trials with large prawns the number of prey eaten in the beakers containing no mud was significantly higher than in the rest of the beakers. Since the same results were obtained in all the trials with mud irrespective of the size of the experimental prawn, *P. indicus* appear to be better adapted to a muddy substratum. Balasubramanian, Lalithambika Devi and Krishnankutty (1979) found that the adverse effect of increasing quantities of mud on the preying efficiency compared to that of sand was more conspicuous in the case of *M. dobsoni*.

Analysis of variance on the effect of different concentrations of sand, silt and clay (Table III) on the preying efficiency of *P. indicus* and *M. dobsoni* given in Table IV further confirms the above conclusion. Highly significant variance

Table II. Effect of mud and fine sand on the preying efficiency of *P. indicus*.

Mud or sand (ml)	SIEVED MUD					SAND								
	(a) Trial 1	(b) Trial 2	(c) Trial 3	(d) Trial 4	(e) Trial 5	(f) Trial 1	(g) Trial 2							
	<i>Number eaten at the end of 1 hr</i>													
0	9	9	10	9½	8½	9	11	6	19½	16½	17	16	19	12
5	8	10	10½	7	12	7	11	8	5	5	16	16	12½	13½
15	10	9	11	5	9	10	0	6	8	3	15	20	13	11½
30	2	10	0	8	7½	8½	5	3	5	5	18	19	11½	15½
40	7	5	0	9	7	5	5½	5	2	4	16	17½	15	13

Weight range (g) of the prawns and number of prey (in parenthesis), given during the different trials: (a) 0.39-0.64 (10); (b) 0.37-0.48 (11); (c) 0.32-0.45 (15); (d) 0.35-0.45 (15); (e) 1.0-1.5 (20); (f) 0.29-0.33 (20); (g) 0.30-0.38 (20).

ratio between species, between treatments and between concentrations indicate that there is species effect, rather species difference in the preying efficiency besides treatment and concentration effects, *P. indicus* on the whole having a higher preying efficiency. The treatment and concentration effect, *i. e.*, the effects of the different percent of sand, silt and clay in the substratum and its thickness both significantly affect the preying efficiency. Further, all the three first order interactions being significant, preying efficiency is also affected (a) by the joint or interaction effects of concentration and treatment and also (b) by the adaptability of the species both to concentration and to treatment separately and perhaps also together although second order interaction is nonsignificant. To help further interpretation of the data analysis of variance was performed separately for each species. It was found that in the case of *M. dobsoni* the treatment and concentration effects on the preying efficiency were higher when compared to *P. indicus*. Besides these, the effect of their interaction-concentration \times treatment was significant only for *M. dobsoni*. Since the second order interaction in Table IV is nonsignificant, most of the sources of variation seem to have been explained by those already considered.

In clean fine sand the prawns are very restive but, a predominantly sand substratum does not usually support a rich benthic fauna. A muddy sand substratum may be more essential for benthos to be abundant but need not be so essential for the prawn. Higher feeding activity was also noticed in both the trials when clean fine sand was used (Table II). Although the present study clearly indicates that silt and clay affect the preying efficiency, further studies are needed to confirm whether their presence in the substratum affect the feeding activity to any extent and whether clean fine sand stimulates it. Balasubramanian, Lalithambika Devi and Krishnankutty (1979) based on their studies have also pointed out that in the natural habitat of prawns, prey species may not all

Table III. Effect of substratum on the preying efficiency of *P. indicus* and *M. dobsoni*.

Volume of substratum provided (ml)	<i>Penaeus indicus</i>								<i>Metapenaeus dobsoni</i>							
	Substratum								Substratum							
	Sieved mud I	Sieved mud & sand II	Sieved mud & clayey mud III	Clayey mud IV	Sieved mud I	Sieved mud & sand II	Sieved mud & clayey mud III	Clayey mud IV	Sieved mud I	Sieved mud & sand II	Sieved mud & clayey mud III	Clayey mud IV				
	<i>Number eaten at the end of 1 hr</i>															
0	8½	9	6	7	7	10	7	6	6	6½	9	10	9	12½	8½	11½
5	12	7	8	8	7	6	1	3	4	6	6	13½	4	2	7	6
15	9	10	7	6	5½	0	0	0	4	1½	5	3	3¾	2¾	2	1
30	7½	8½	3	8	2	0	0	0	0	0	2	4	0	0	0	0
40	7	5	3	7	3	3	0	0	0	0	5¾	2	0	0	0	0

Weight range (g), length range (mm) of the prawns and number of prey (in parenthesis) given during the different trials.

Penaeus indicus : I, 0.32-0.45, — (15); II, 0.30-0.38, 30-35 (15);
III, 0.30-0.38, 30-35 (15); IV, 0.30-0.38, 30-35 (15).

Metapenaeus dobsoni : I, 0.41-0.57, — (15); II, 0.56-0.83, 35-40 (15);
III, 0.56-0.83, 35-40 (15); IV, 0.30-0.38, 30-35 (15).

Table IV. Analysis of variance on the number of prey eaten by *P. indicus* and *M. dobsoni* in different concentrations of sand, silt and clay (Table III).

Source	ss	df	ms	F
Total	12.2656	79		
Bet. Species	0.3623	1	0.3623	15.417 ^c
Bet. Treatments	2.3755	3	0.7918	33.694 ^c
Bet. Concentrations	4.9922	4	1.2481	53.111 ^c
Bet. Duplicates	0.0082	1	0.0082	0.349
Species × Concentrations	0.7336	4	0.1834	7.804 ^b
Species × Treatments	1.3427	3	0.4476	19.047 ^c
Concentrations × Treatments	1.0524	12	0.0877	3.732 ^b
Species × Concentrations × Treatments	0.4813	12	0.0401	1.706 NS
Error	0.9174	39	0.0235	

b = significant at 1% level

c = significant at 0.1% level

become available for predation especially in higher concentrations of silt and clay. Since both the species are closely related and are often found together in the backwater this difference in the degree of adaptation to a muddy substratum may be of ecological significance with reference to the growth and survival of the two species.

It can also be seen from Table II that even the juvenile prawns in the size range, 0.29 to 0.33 g can consume as many as twenty *A. chilensis* in one hour equivalent to 0.049 g in weight which is a high feeding rate considering the weight of the prawn. In the light of their experimental studies on *M. dobsoni*, Balasubramanian, Lalithambika Devi and Krishnankutty (1979) found that it is a voracious feeder showing preference for live and freshly killed organisms when compared to dead decaying animal matter. The high feeding rate of *P. indicus* observed in the present study also supports their findings.

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