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Some Aspects of Biology of the Pea-Crab *Pinnotheres placunae* Hornell and Southwell*

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Pinnotheres placunae feeds on the food particles that are drawn in by the oyster *Placenta placenta* in a thin film of mucous strings. The crab feeds on diatoms consisting of *Coscinodiscus* sp. and *Nitzschia* sp. Ovigerous females occur throughout the year and in abundance during January–April and August–October. Females outnumbered the males in all months. The chi-square test showed significant difference at 5% level, the sex ratio deviated from the expected 1 : 1 ratio within the year and between the years. The predominance of females may be due to short life span of the males or free living habit of the males. Copulation takes place in the hard-stage female, and occurs more than once in the life span of the female. After copulation the female lays eggs in several batches. The smallest ovigerous crab measures 4 mm in carapace length. The relation of fecundity to carapace length has been calculated as:

Log number of eggs = 3.5981 + 1.6153 log carapace length in cm.

Key Words: *Pinnotheres placunae*, **Food and feeding habits, Sexual dimorphism, Sex ratio, Fecundity**

Introduction

Observations on the feeding behaviour of the species of *Pinnotheres* within mantle cavity of the host bivalves are available (Coupin 1894, Orton 1921, White 1937, Wells 1940, Strauber 1945, Mac Ginitie & Mac Ginitie 1949). Sexual dimorphism in crabs with reference to size and shape of abdomen is well known. Males resembling females in consistency and lack of colour have been reported (Rathbun 1917, Strauber 1945). Sex ratio of *P. margaritifera* (Southwell 1910), *P. latissimus* (Ohshima 1927), *P. villossimus* (Chopra 1931), *P. placunae* (Chhapgar 1957), *P. maculatus* (Pearse 1964), *Pinnotheres* sp. (Silas & Algarswami 1967), and *P. vicaji* (Krishna Kumar & Rao 1974) are known. Spawning season in a few species of *Pinnotheres* is known (Christensen & Dermott 1958, Krishna Kumar & Rao 1974). Fecundity of *P. ostreum* (Christensen & Dermott 1958), *Pinnotheres* sp. (Silas & Alagarswami 1967) and *P. vicaji* (Krishna Kumar & Rao 1974) have been reported.

As there is no published information on the food and feeding habits, reproduction, sex ratio and fecundity in *P. placunae*, studies on these aspects were made and the results are presented here.

Material and Methods

Monthly samples of the host *Placenta placenta* Linn were obtained over a period of two years (1974–75) from the Kakinada Bay. Samples were brought to the laboratory and were examined in live condition in order to collect the live crabs for

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various studies of biology and ecology; 10 minute plankton hauls with plankton net of 50 cm ring diameter and 0.3 mm mesh size were made once in a month, subsamples by volume were made, number of zoea larvae of *Pinnotheres placunae* counted and estimates were made for the whole sample.

As it was not possible to observe the feeding behaviour of *P. placunae* in the host directly, the gut contents of 113 crabs (73 females and 40 males) and 90 hosts were studied. The feeding habits of the crabs were also studied by maintaining 158 females, consisting of 58 juveniles in the carapace length range of 1.5–3.5 mm, 50 adult non-ovigerous crabs of carapace length 4–7, 50 ovigerous crabs of carapace length 4–10 mm and 102 males of the carapace length 2.5–7 mm. Ninety females (20 juveniles, 20 adult non-ovigerous and 50 ovigerous crabs) and 50 males were maintained separately under starvation.

Chi-square test of variance for homogeneity and theoretical binomial proportion 1 : 1 in monthly samples, and between the years were calculated following Snedecor and Cochran (1967).

Egg counts were made by following the method of Rajyalakshmi (1962) in the case of large crabs (length 7–10 mm) and in small sized crabs (length 4–6 mm), all the eggs were counted. The relationship between number of eggs and carapace length was calculated (only the data collected in the field was considered) by the least squares method $(y = a + bx)$ after logarithmic transformation. Twenty eggs from each crab were measured with an ocular micrometer in the fresh condition, to determine the relation between the length of the carapace and the diameter of the egg.

Observations

Food and Feeding Habits

Gut contents of oyster consisted of detritus, diatoms and small larvae of crustaceans. Gut contents of *Pinnotheres placunae* constituted partly digested diatoms and the larval forms, showing the relation between the food of the host and the crab. This statement is further strengthened as the crab lodges near the inhalent siphon and gills. The crab shares and feeds on the food that is brought in by the oyster. The crabs were fed with mixed plankton samples containing copepods, nauplius, zoea, mysis and post larvae of prawns and other crustaceans, diatoms and dinoflagellates. The crabs were dissected immediately after feeding and the gut contents constituted mostly of diatoms and dinoflagellates, the diatoms and dinoflagellates were separately fed to the crabs and it was found that *P. placunae* mostly feeds on *Coscinodiscus* sp, *Nitzschia* sp, *Biddulphia* sp. and *Stephanopyxis* sp. *Nitzschia* sp. and *Coscinodiscus* sp. were found in large numbers. When fresh mucous strings from the oysters were added, 20 adult females including 4 ovigerous crabs have preferred.

Ovigerous females and hard-shelled stage males when starved for 10 days exhibited cannibalism. Ovigerous females were observed to feed on their own eggs. Crabs starved between 10–15 days when supplied with small bits of prawn meat readily fed on them. From these observations it is clear that the crabs seem to prefer diatoms and sometimes resort to filter feeding. When the natural food is not available they become cannibalistic.

Sexual Dimorphism and Spawning Season

Sexual dimorphism in adult crabs, with reference to size, shape of abdomen and colour was evident in *P. placunae*. The males were smaller in size, with 'V'-shaped abdomen, dark brownish grey in colour, testis seen as white specks on either side of the alimentary canal. Females larger in size with 'U'-shaped abdomen, paler in colour, with orange-yellow reproductive system visible through the translucent carapace.

The ovigerous females were found throughout the year (figure 1) but in abundance during January to April and August to October. The zoea larvae were available in the waters throughout the year in abundance during April, May and October, November.

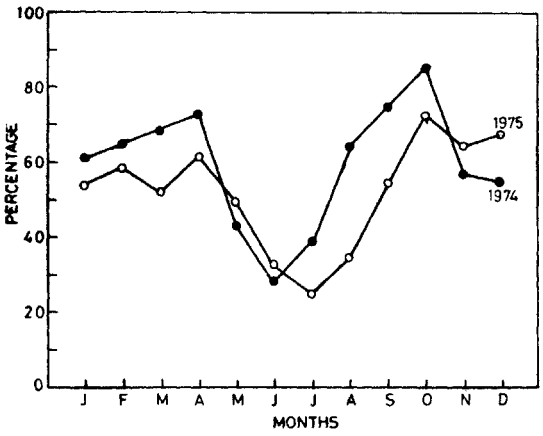

Figure 1 Occurrence of ovigerous females of *P. placunae* during 1974 and 1975

Sex Ratio

Sex ratio of *P. placunae* for the years 1974 and 1975 was analysed in order to determine their binomial distribution. Out of 1,642 oysters examined, 270 male crabs and 1,078 female crabs were recorded. Chi-square tests showed (tables 1 and 2) that the same sex ratio were not maintained throughout the year and χ^2 values obtained were highly significant at 5% level within the year and between the years. Predominance of females over males was observed throughout the year, except in May and July (1974, 1975) when the χ^2 values were not significant at 5% level.

Table 1 *Sex ratio of* Pinnotheres placunae *Hornell and Southwell during 1974-75 (The test of variance of homogeneity)*

Months	1974			1975		
	Sample size	Males (a)	Ratio (P)	Sample size	Males	Ratio
January	75	16	0.213	87	18	0.206
February	49	3	0.061	39	3	0.076
March	53	12	0.226	41	9	0.219
April	63	19	0.301	62	18	0.290
May	34	14	0.411	58	24	0.413
June	81	21	0.259	59	16	0.301
July	40	12	0.300	30	9	0.300
August	53	10	0.188	62	12	0.193
September	77	9	0.116	72	9	0.125
October	42	3	0.071	52	4	0.076
November	58	4	0.068	57	3	0.052
December	58	13	0.224	46	9	0.1951

1974: χ^2 . df 11, 36.520. Highly significant at 5% level
1975: χ^2 . df 11, 45.308. Highly significant at 5% level

Table 2 *Sex ratio of* Pinnotheres placunae χ^2 *Test of theoretical binomial distribution 1 : 1 ratio*

Months	1974				1975			
	Male	Female	Total	χ^2 Value	Male	Female	Total	χ^2 Value
January	16	59	75	24.653*	18	69	87	43.49*
February	3	46	49	37.734*	3	36	39	27.92*
March	12	41	53	15.867*	9	32	41	12.90*
April	19	44	63	9.920*	18	44	62	10.90*
May	14	20	34	1.058†	24	34	58	1.72†
June	21	60	81	18.777*	16	43	59	12.33*
July	12	28	40	5.41†	9	21	30	4.8†
August	10	43	53	20.541*	12	50	62	23.29*
September	9	68	77	45.20*	9	63	72	40.50*
October	3	39	42	30.85*	4	48	52	37.23*
November	4	54	58	43.10*	3	54	57	45.63*
December	13	45	58	17.655*	9	37	46	17.04*
Total	136	547	683	247.32*	134	531	665	237.00*

* Highly significant at 5% level
† Not significant at 5% level

Copulation and Egg-Bearing Period

From the field collections of 50 hard-stage females in the carapace length range of 2.4 to 3.6 mm, the spermathecae of 29 crabs were observed to be filled with sperms. Out of 230 adult females observed (carapace length 4–10 mm), 40 crabs were found with empty spermathecae. From these observations, it may be stated, that copulation takes place very early at the hard-stage itself, and more than once in the life span of a female.

Observations made in the laboratory on the ovigerous crabs concerning the duration of egg-bearing period showed that out of 50 ovigerous crabs, 30 bore eggs for the second time after the liberation of eggs in a period of 10 to 15 days. Though the number of eggs was less, they were viable and hatched out to zoea stage. Thus sperms released from a single copulation were sufficient and viable to fertilise several batches of eggs in the successive extrusions. The smallest and largest ovigerous females observed were at 4 mm and 10 mm in carapace length respectively. Mating in *P. placunae* may take place both in the ambient environment of the host as hard-stage female lead the free swimming life, and within the hosts mantle cavity as the male crabs were found with the females in oysters. The incidence of multiple infestations adds weight to this explanation.

Fecundity

A total of 38 ovigerous crabs having 4–10 mm carapace length were studied. In general, fecundity increased with increase in carapace length (figure 2). There was a wide range in the number of eggs carried by crabs of any given carapace length, and the range increased with increase in carapace length, the greatest of range was in the crabs of 7–9 mm length. Females in this size group had 1,700–4,100 eggs. The equation describing the carapace length and fecundity in *P. placunae* is written as:

$$\log Y = 3.5981 + 1.6153 \log X$$

Where Y is the number of eggs and X the carapace length in cm. The correlation co-efficient *(r)* for the regression was found to be 0.96.

The mean egg diameter varied among the crabs, but could not be related to carapace length. The diameter of the eggs in the initial stage of development (orange in colour) varied from 0.256 mm to 0.391 mm and in the advanced stage of development (grey in colour) ranged from 0.400 to 0.650 mm. The number of eggs varied from 250 to 900 in the small crabs (4 mm carapace length); and from 4,100 to 6,031 in the large crabs (10 mm carapace length).

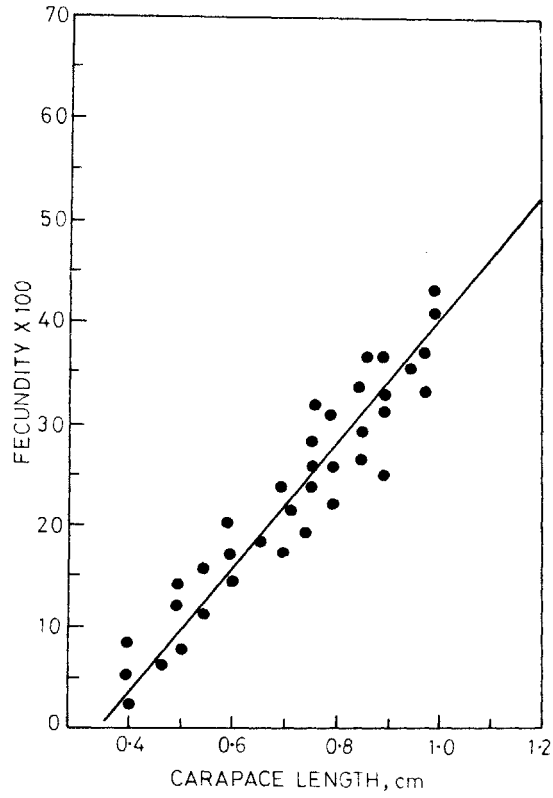

Figure 2 Relaiton between carapace length and fecundity in *P. placunae*

Our observations on copulation are in agreement with those made by Atkins (1926), Orton (1921), Berner (1952) Christensen and McDermott (1958), Silas and Alagarswami (1967), and Krishna Kumar and Rao (1974). Occurrence of male crabs in May and July coincides with the pre-spawning period, the male crabs might have entered the host in search of females for copulation. The differential sex ratio may be due to the death of the males after copulation or due to free living habit of the males.

Fecundity in *Pinnotheres placunae* differs from the fecundity of the known species of *Pinnotheres*. In the case of *P. ostreum*, Christensen and Mc Dermott (1958) found, ovigerous females measuring 9.4 mm and 10.8 mm in carapace width carrying 7,957 and 9,456 eggs respectively. They also

observed that, in *P. pisum* measuring 10.4 mm in width carried 5,800 eggs. In *Pinnotheres* Silas and Alagarswami (1967) observed that the number of eggs varied from 1,700 to 2,800 (average 3,250) where the width of the carapace ranged from 6.2 to 7.0 mm. The fecundity in *P. vicaji* as observed by Krishna Kumar and Rao (1974) varied from 3,800 in a crab of 7.8 mm carapace length to 611 in a crab of 5 mm length.

The wide range in fecundity observed in the present study may be due to successive egg laying habit without mating as observed in the laboratory; and the number of eggs at the beginning of the spawning is more, and the number declines towards the close of spawning phase.

Discussion

Our observations on the food and feeding habits of *P. placunae* agree with those of Coupin (1894), Orton (1921), White (1937), Wells (1940), Strauber (1945), Mac-Ginitie and Mac-Ginitie (1949) and Christensen and Mc Dermott (1958). The crabs feed on the food particles that are drawn and enmeshed in a thin film of mucous strings by the host and sometimes resort to filter feeding.

The observations on the spawning period of *P. placunae* to some extent agree with those on *P. ostreum*, *P. pisum* and *P. ostreum* Say by Strauber (1945), Berner (1952) and Christensen and Mc Dermott (1958). It is known that the crabs of tropical waters have extended breeding period, and the onset of the season varies from place to place. Krishna Kumar and Rao (1974) observed the ovigerous females of *P. vicaji* throughout the year, but in abundance from January to April.

Sexual dimorphism is evident in *P. placunae* as is the case with all the species of *Pinnotheridae* studied (Atkins 1945, Strauber 1945, Berner 1952, Christensen & Mc Dermott 1958, Silas & Alagarswami 1967, Krishna Kumar & Rao 1974). Predominance of females over males was observed by Christensen and Mc Dermott (1958), Southwell (1910), Chopra (1931), and Chhapgar (1957).

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References

Atkins D 1926 The moulting stages of the pea-crab *(Pinnotheres veterum); J. mar. biol. Assoc. UK* **14** 475–493

Berner L 1952 Biologie de *Pinnotheres pisum* Penn. (Decapode: Brachyoure); *Bull. Soc. Zool. France* **77** 344–349

Chhapgar B F 1957 On the marine crabs (Decapoda: Brachyura) of Bombay state; *J. Bombay nat. Hist. Soc.* **54** 503

Chopra B 1931 Further notes on crustacea Decapoda in the Indian Museum. II. On some Decapod Crustacea found in the cloaca of Holothurians; *Rec. Indian Mus.* **33** 303–323

Christensen A M and Mc Dermott J J 1958 Life history and biology of the Oyster crab *Pinnotheres ostreum* Say; *Biol. Bull.* **114** 114–179

Coupin H 1894 Sur L'alimentation de deux commensaux (Nereilepas et Pinnotheres); *C. R. Acad. Sci. Paris.* **119** 540–543

Krishna Kumar L and Virabhadra Rao K 1974 Life-cyle of the pea crab, *Pinnotheres vicajii* Chhapgar, infesting the clam, *Paphia malabarica; Indian J. mar. Sci.* **3** 165–172

Mac Ginitie G E and Mac Ginitie N 1949 *Natural History of Marine Animals* (New York: McGraw-Hill Book Co) 473 pp

Ohshima H 1927 A pycnogon living parasitic in a bivalve; *Bull. Sci. Fakult. Terkultura Kjusu Imp. Univ.* **2** 366–379 *(Pinnotheres latissimus*—showing multiple infestation in *Paphia)*

Orton J H 1921 The mode of feeding and sex phenomena in the pea-crab *(Pinnotheres pisum); Nature* **106** 533–534

Pearse J B 1964 On reproduction in *Pinnotheres maculatus* (Dedapoda: Pinnotheridae); *Biol. Bull.* **127** 384

Rajyalakshmi T 1962 Studies on maturation and breeding in some estuarine palaemonid prawns; *Proc. natn. Inst. Sci. India* **27** 179–188

Rathbun M J 1917 Grapsoid crabs of America; *Bull. U.S. Nat. Mus.* pp 1–461

Silas E G and Alagarswami K 1967 On an instance of parasitisation by the pea-carb *(Pinnotheres* sp) on the backwater clam *(Meretrix casta)* (Chemnitz) from India with a review of the work on the systematics, ecology, biology and ethology of the pea-crabs of the genus *Pinnotheres* Latreille; *Proc. Symp. Crust* Part 3 pp 1161–1227 (Marine Biological Association of India)

Snedecor G W and Oochran W G 1967 *Statistical Methods* 6th edn (Calcutta: Oxford & I B H Publishing Co) 593 pp.

Southwell T 1910 Description of a new species of *Pinnotheres* and of the female of *P. margaritiferae* Laurie; *Ceylon mar. Biol. Rep.* **19** Pt V, pp 226–227

Strauber L A 1945 *Pinnotheres ostreum* parasite on the American oyster, *Ostrea* (Gryphaea) *Virginica; Biol. Bull.* **88** 269–291

Wells W W 1940 Ecological studies on the Pinnotherid crabs of Puget sound; *Bull. Univ. Washington. Publ. Oceanogr.* **2** 19–50

White K M 1937 *LMBC Mem.* **31** pp 1–177 Mytilus (The University of Liverpool Press)