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FECUNDITY IN THE SPINYLOBSTER *PANULIRUS POLYPHAGUS* (HERBST)

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ABSTRACT

Ovigerous females of *P. polyphagus* were encountered in the landings throughout the year at Bombay forming about 25 to 30% of the females in the catch. The rate of production of eggs was very high and there appeared linear relationships between the size of a female and the number of eggs in a batch and also with the number of batches of eggs to be spawned in a year. The number of eggs spawned in a year at different ages and the number of batches involved in it were discussed. Annual egg productions of 1,43,000 and 47,23,000 were estimated for specimens of 180 mm and 353 mm in total length respectively.

INTRODUCTION

THE LOBSTER *Panulirus polyphagus* supports an important commercial single species spiny lobster fishery meant for the main purpose of export market in Bombay since 1976. Ovigerous females are encountered all round the year contributing as high as 25 to 30% to the catch. This high level of exploiting the breeding population may have an adverse effect on the recruitment of the juveniles, thus affecting the future of entire population. But for the work of Hussain and Amjad (1980) on the breeding and fecundity of the same species *P. polyphagus* from Pakistan Coast, no work on this aspect is available for any of the lobsters in the Indian waters. Informations on the fecundity of spiny lobsters from other parts are available in the works of Berry (1971) on *P. homarus* and Morgan (1972) and Chittleborough (1976) on *P. longipes cygnus*.

This investigation on the fecundity of *P. polyphagus* at Bombay was taken up with a view to assess the danger if any, to its population due to the indiscriminate capture of ovigerous females which are the potential resource for building up its fishery.

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MATERIAL AND METHODS

Pleopods bearing eggs were removed from 30 females ranging from 193 mm to 334 mm in total length at the landing centres New Ferry Wharf, Bombay during October 1983 to March 1984, a period which included major and minor spawning months (Kagwade, 1986 b) and preserved in 5% formalin for some days. All the pleopods from an individual were carefully washed in fresh water to remove the formalin. The moisture was mopped up by keeping the pleopods with eggs in between the blotting paper and then all the eggs were separated from the pleopods. These eggs were weighed in grams. A small subsample of it weighing about a gram was

weighed and the number of eggs in it was counted. By simple proportion, the total number of eggs on the pleopods was computed for an individual.

RESULTS

A scatter diagram showing the number of eggs attached to the pleopods in thousands against the length did not show exponential relationship between these 2 parameters. Spread of the scatter was rectangular for which the correlation coefficient in the normal course should be zero. However, in this particular instance, the correlation coefficient worked out to 0.5572 which when subjected to test, revealed that it was significant at 5% level. Since a single regression line could not be fitted for this set of observed values, a preliminary test was made by their frequency distribution. Table 1 showed the frequency of number of eggs in thousands against the lengths at 10 mm class interval. The frequency distribution showed that the number of eggs were less spread in lower and higher lengths and that the scatter was concentrated between the lengths 211 and 280 mm. This had resulted in the frequencies to be diagonally spread. It was noticed that the observations were distributed in 5 groups. The number of eggs in thousands against lengths for each group was carefully chosen from Table 1 and treated as a set of readings to work out linear regression by the method of least squares. The number of eggs were plotted against lengths

TABLE 1. *Frequencies of number of eggs in thousands at 10 mm class intervals of total length (mm) in* P. polyphagus

Length	Eggs								
	100-200	201-300	301-400	401-500	501-600	601-700	701-800	801-900	901000
181—190									
191—200		1							
201—210	1								
211—220	2	2	1						
221—230	1								
231—240	2	3							
241—250	1		1	1	1				
251—260			1						
261—270	1	1							
271—280				3			1		1
281—290	1	1							
291—300									
301—310				1					
311—320									
321—300				1					
331—340							1		

(Fig. 1) and 5 straight lines a - e were fitted for the 5 sets. The linear regression gave the following 5 formulae and the correlation coefficient ' r ' where ' x ' stood for the total length and ' y ' for the number of eggs in thousands on the pleopods—

$y = -1172.1107 + 7.2521 \times (r = 0.9495)$
$y = -896.6058 + 5.0382 \times (r = 0.8743)$
$y = -1496.2876 + 7.0875 \times (r = 0.9579)$
$y = -1608.1452 + 7.0265 \times (r = 0.9760)$
$y = -1263.3926 + 5.2076 \times (r = 0.9805)$

Using these formulae, the number of eggs in different batches at various lengths could be estimated. Often in the field, the pleopods of the ovigerous females were founded to be fully laden with the eggs. Apart from this there were also instances where a major portion of the eggs were shed and a part of it left behind attached to the pleopods. It was inferred from this that the earlier batches released greater number of eggs than the later ones. Table 2 showed that the number of broods were nil at 146 mm, 2 at 180 to 200 mm,

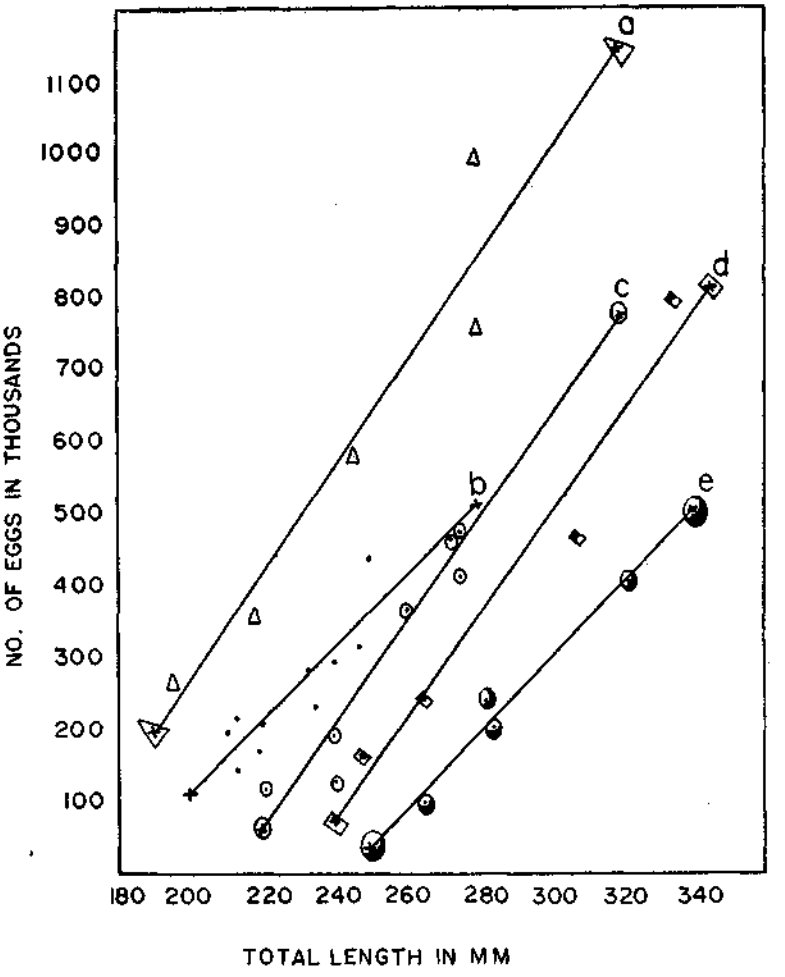

FIG. 1. Linear regressions 'a' to 'e' between the total length and the number of eggs carried on the pleopods of *P. polyphagus*.

3 at 210 to 220 mm, 4 at 230 to 240 mm and 5 beyond 250 mm. The smallest ovigerous female encountered was 146 mm in length but it did not appear to bear any brood when these formulae were applied. This might be because the size at maturity was found to be 175 mm (Kagwade, 1986 b) and the specimen bearing eggs at comparatively such a small length might have been a freak case, not worth taking into account. The number of eggs increased from 133 to 1388 thousands in the first and from 10 to 882 thousands in the second batches in the sizes ranging from 180 to 353 mm. The egg counts ranged from 8 to 1006 thousands in the third and from 8 to 872 thousands in the fourth batches in the sizes ranging from 210 mm in the former and 230 mm in the latter to 353 mm. Eggs numbered 38 to 575 thousands in the fifth batch in the sizes between 250 and 353 mm. It could be inferred from this that the number of eggs in each of the batches increased with the length and the same was true with the number of batches of eggs. Kagwade (1986 a) observed the recruitment of 6-7 broods per year to the fishery and also noted an individual to spawn 4 times in a year in batches (Kagwade, 1986 b). The absolute fecundity of *P. polyphagus* would be the sum total of all the eggs in each of the batches for a particular size.

Table 2 also indicated that the number of eggs was the maximum in the first batch and it either decreased gradually or showed marginal fluctuations in the subsequent batches. The average number of eggs per batch varied from 72,000 for the length at 180 mm to 945,000 for the length at 353 mm while the absolute number of eggs corresponding to these lengths varied between 1,43,000 and 47,23,000.

Making use of the knowledge on the length at age (Kagwade, 1986 a), Table 3 was prepared by applying the 5 formulae mentioned above. From Tables 2 and 3, there appeared 2 batches of eggs in the III year, 3 to 5 batches during the IV year and 5 batches in the ages above 4 years. Table 3 showed that the total number of eggs produced at the age of 3 years was 4,51,000. In the successive 4 years till the age of VIII years, on an average 10,00,000 eggs were added each year to the previous one. Thus at VII year, 44,70,000 eggs were produced.

Discussion

Fecundity is generally estimated from the ova of mature ovaries. Initially an attempt was made here to estimate the number of ova from the mature ovaries of females in different conditions, such as, those which were neither impregnated nor ovigerous and those which were impregnated, ovigerous impregnated and ovigerous. The results were not encouraging because of the practical difficulty faced in the isolation of ova from the tissue for counting even with the help of gilson's fluid. In spite of maximum amount of teasing the tissue to separate the ova, there was every chance for an error in counting. The number of ova estimated from the ovaries was much lesser than the eggs carried by the females on their pleopods. Hence, this attempt was abandoned and the eggs attached to the pleopods alone were considered for this study.

In this connection, it may be pointed out that Abello' and Sarda' (1982) mentioned that some authors estimated the fecundity of the lobster *Nephrops norvegicus* from the eggs carried on the abdomen while others from the oocytes of the mature ovaries and there were also some who used both the methods. In all these cases he reported that the number of eggs and oocytes were directly proportional to the size of female. He further mentioned that in the investigations when both the methods were used, the number of eggs carried on the abdomen was lesser than the oocytes

TABLE 2. *Number of eggs in thousands in different batches at various lengths (mm) in* P. polyphagus

Length	Eggs						
	I	II	III	IV	V	Total	Average per batch
146 ..	—	—	—	—	—	—	—
180 ..	133	10	—	—	—	143	72
190 ..	206	61	—	—	—	267	134
200 ..	278	111	—	—	—	389	195
210 ..	351	161	8	—	—	520	173
220 ..	423	212	63	—	—	698	233
230 ..	496	262	134	8	—	900	225
240 ..	568	312	205	78	—	1163	291
250 ..	641	363	275	148	38	1465	293
260 ..	713	413	346	219	90	1781	356
280 ..	858	514	488	359	195	2414	483
300 ..	1003	615	630	500	299	3047	609
320 ..	1148	716	772	640	403	3679	736
340 ..	1294	816	913	781	507	4311	862
353 ..	1388	882	1006	872	575	4723	945

TABLE 3. *Number of eggs in thousands in different batches at different ages and length (mm) in* P. polyphagus

Age in years	Total length	No. of batches of eggs spawned	Batches					Total No. of eggs	Average No. of eggs per batch
			I	II	III	IV	V		
III ..	205	2	315	136				451	225
IV ..	255	3-5	677	388	311	184	64	1624	325
V ..	290	5	931	564	559	429	247	2730	546
VI ..	320	5	1148	716	772	640	403	3679	736
VII ..	345	5	1330	842	949	816	533	4470	894

in the ovaries. However, it was not the case in the present investigation of *P. polyphagus*. In almost every case it was reverse, the number of eggs attached to the pleopods were higher than the oocytus in the ovaries.

Herrick (1909) and Saila *et al.* (1969) found a logarithmic relationship between fecundity and the total length and carapace length respectively for the American lobster *Homarus americanus*. Hepper and Gough (1978) suggested a linear relationship rather than a logarithmic one for the European lobster *Homarus gammarus* and so also Abello' and Sarda' (1982) for the Norway lobster *N. norvegieus*. Berry (1971), Moigao (1972) and Hussain and Amjad (1980) observed linear relationship between fecundity and size in spiny lobsters.

Egg production per spawning in 3 different species of spiny lobsters each measuring 100 mm in carapace length was 1,00,000 to 9,00,000 for *P. homarus* (Berry 1971), 1,80,000 for *J. lalandii* (Heydorn, 1964) and 4,60,000 for *P. cygnus* (Morgan, 1972). Hussain and Amjad (1980) from Pakistan estimated as many as 7,90,880 eggs in a *P. polyphagus* measuring 211 mm in tail length. Chittleborough (1976) noted that small *P. cygnus* carried lesser eggs per brood and also lesser number of broods per year. He further observed that large females of *Panulirus* could produce even 4 broods per year as was evidenced by Berry (1971) in the case of *P. homarus*.

In the light of above information, the present findings towards the progressive increase in the number of eggs per batch and in the number of batches of eggs for spawning in a year, with the size of *P. polyphagus* are justified. The highest count of eggs in the present investigation was 9,91,000 for a female of 280 mm in total legtth. This value is close to 9,00,000 recorded by Berry (1971) in *P. homarus*.

Females contributing maximum to the fishery belonged to the size between 200 and 300 mm and they could produce eggs between 3,89,000 and 30,47,000 per year in 2-5 batches. Sizes beyond this upto 345 mm representing moderately in the catch could produce eggs upto 44,70,000 per year. This showed a very high rate of production of offsprings which will only reflect on the high rate of mortality to which this species is subjected. Nearly 25 to 30% of the females fished out were ovigerous every month throughout the year. This itself is a very heavy toll on a population so small as that of *P. polyphagus* whose annual landing is about 200 to 300 tonnes at Bombay. Added to this is the high fecund of this species which necessitates to take some protective measure such as banning the capture of ovigerous females.

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