OBSERVATIONS ON THE POSTLARVAL PRAWNS (PENAEIDAE) IN THE PULICAT LAKE WITH NOTES ON THEIR UTILIZATION IN CAPTURE AND CULTURE FISHERIES

by

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ABSTRACT

The seasonal recruitment of the postlarvae of *Penaeus indicus*, *P. monodon* and *P. semisulcatus* in the Pulicat Lake during the years 1966-67 is outlined. The postlarvae of *Penaeus indicus* were the dominant group in the plankton. The incursion was generally highest between the third and fifth hours of the incoming tide at night. The postlarvae of the species showed two maxima in a year, one during the period January to April and the other during the period June to September, which showed a correlation with the catch during the following periods, May to August and October to December, respectively. Predictions on the basis of the above correlations gave interesting results during the years 1966-67. Some observations on the growth rate of *Penaeus indicus* have also been included.

INTRODUCTION

The study of the availability and abundance of penaeid postlarvae, coupled with the knowledge of their growth rate, is a useful instrument to predict the nature of the forthcoming prawn crop and a measure to suggest the prospects of cultivating specific varieties of prawns. On the basis of postlarval counts made during a specific period, the nature of the future prawn crop could be predicted in *Penaeus indicus* and *P. monodon* from the Chilka Lake (Subrahmanyam, 1967, P. No. 204). The prospects of prawn harvest in brackishwater culture ponds, however, depend upon the environmental parameters and the availability of abundant fast growing prawn fry. The lack of sound knowledge about the latter prompted the present investigation.

The Pulicat Lake is a marine dominated brackishwater system on the east coast of India and is rich in prawn fisheries (for a detailed description of Pulicat Lake see Chacko *et al.*, 1953, P. No. 1) comprising about 40-50% in the total landings from the lake. The total prawn landings from the lake are about 476 m. tons (Chacko, 1955, P. No. 3). Although several varieties of prawns are recorded from the lake (Subrahmanyam, unpublished) a single species, *Penaeus indicus* contributes the bulk of the prawn catch (300-400 m. tons per year) comprising about 1/3 of the total fish landings and about 60% of the total prawn landings from the lake. Two other species, *Penaeus monodon* and *P. semisulcatus*, do not contribute much to the commercial catch but the size of the prawns landed makes them desirable for the prawn freezing plants. All the three species grow fast and reach marketable size in 4-6 months.

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The present study was undertaken to delineate the recruitment pattern of the postlarvae of *Penaeus indicus*, *P. monodon* and *P. semisulcatus* into the Pulicat Lake during the years 1966 and 1967. On the basis of the growth rate determined for *Penaeus indicus* from the Ennur and Adyar estuaries (Subrahmanyam, in Press) it is possible to suggest the number of crops that can be harvested by cultivation in brackishwater ponds. The junior author attempted a further detailed investigation of the recruitment pattern during the period January to June 1968.

MATERIAL AND METHODS

The material for the present study was collected by operating an ordinary half-meter organdie tow-net and a shooting net at the mouth region of the lake during the years 1966-67. (Fig. 1).

Fortnightly collections were made at all the four stages of the tide during a 24-hour cycle (2 high tide and 2 low tide collections) coinciding with the full moon and new moon periods. The tow-net operations were of 15 minutes duration while the shooting net collections were of one-hour duration at each stage of the tide. The shooting net collections were made from April 1966. To determine the period when the postlarval recruitment is maximum during each incoming tide and whether the postlarvae run out the ebb tide, 12-hour cycles were studied from January to June 1968. The collections were of 15 minutes duration by the shooting net as this gear was found efficient to catch the postlarval populations. The methods of analysis were similar to those followed in the Chilka Lake (Subrahmanyam, 1967, P. No. 203).

A small brackishwater pond (about 1/20 acre) formed during the post-flood period in January 1968 at the lake-mouth was found suitable to study the growth rate in *Penaeus indicus*. This pond was cut off from the lake early in January 1968. The pond is shallow with rich algae and other vegetation, amphipods, and organic matter on which prawns are found to feed in confined waters. The salinity and temperature were high during the period of study (32-34 ‰ 30-31°C). Sampling was done once in a month by employing a drag net (Kondavalai). All measurements are in total length (from the tip of the rostrum to the tip of the telson).

SYSTEMATICS

The postlarvae of the three Penaeus species, *Penaeus monodon*, *P. indicus* and *P. semisulcatus*, can be separated on the basis of the chromatophore distribution and other characters (Table I, Fig. 2). Detailed description of the body parts of the postlarvae will be published separately. The postlarvae of *Penaeus monodon* are larger than those of the other two species which are almost identical in length but differ in colouration. When the chromatophores expand a prominent bluish or reddish-brown streak appears on the ventral side of the body in case of the postlarvae of *P. monodon*. The chromatophores are prominent on the sixth abdominal segment in case of the postlarvae of *P. semisulcatus* while the postlarvae of *P. indicus* appear

transparent to the naked eye due to poor pigmentation. It is, therefore, possible to separate the postlarvae of the three species by the pigmentation on the body. (Table II).

DISTRIBUTION AND ABUNDANCE

The postlarvae of all the three species were recorded almost throughout the year, those of *P. indicus* being the dominant group and very plentiful during two periods in the year, January to April and June to September. Rich incursion of the postlarvae was also noted in May and October 1966. The postlarvae of *P. monodon* were usually rich during the periods January to April and August to November. The postlarvae of *P. semisulcatus* were plentiful in the collections during the periods, March to June and September to October.

RECRUITMENT IN RELATION TO LUNAR, DIEL AND TIDAL PERIODICITY

It was generally observed that the postlarval incursion was maximum during the highest tides (Spring tides) of the full moon and new moon quarters. To compare the relative efficiency of capture of fry by the tow-net and shooting net, the unit of measurement for the tow-net was raised to one hour. Collections made during the two quarters, generally coinciding with the full moon and new moon days, did not show any consistent trend. The day and night variations in the ingress of the postlarvae of all the three species was, however, well pronounced (Table IV). More postlarvae were entering the lake at night than during the day except in one instance. The postlarvae of *P. indicus* entered the lake in unusually large numbers in the day collection on the full moon day in March 1967 (12,186/hour) while the incursion at night on the same day was relatively low (5,284/hour). In all the other months distinct diel periodicity was evident. The most important problem to be solved is whether all the recruits remain in the lake or return to the sea at the turn of the tide. Present studies showed that a negligible number moved out at ebb tide and hence emigration did not appear to be a serious problem. (Fig. 3).

It is also pertinent to know at what stages of the tide the postlarval incursion is maximum. It is obvious from the above observations that the postlarval incursion is relatively rich at night. It was, therefore, felt that hourly collections made at night during a 12-hour period would solve the problem. This study was made at fortnightly intervals during the period January to June 1968, the time of collection coinciding with the full moon and new moon days. The postlarval incursion was maximum during the third, fourth and fifth hours after the setting of the tide in case of all the three species. In case of *P. indicus*, however, the incursion of postlarvae was considerable even during the second hour. No data on current velocity could be collected although it was observed that the strength of the current was maximum during the period of the peak postlarval recruitment.

GROWTH STUDIES IN *PENAEUS INDICUS*

The growth rate in *Penaeus indicus* was determined by studying the population in the Ennur estuary when it was closed (Subrahmanyam, in press). When the study was repeated in a small pond near the lake-mouth the growth rate was found slightlyless. (Table V).

This difference could be the result of seasonal changes and the high temperature of the pond water. The study in the Ennur estuary was made during the period May to October 1967. It was assumed that the juveniles caught in the pond in March 1968 were about two months old. These juveniles attained an average size of 92.7 mm in two months, and 100.44 mm in three months. The prawns in the pond were feeding exclusively on decaying plant matter, while the food of prawns from the Ennur estuary included some animal matter also.

The pond-harvested prawns consisted of 80 count whole prawns per pound while those from the Ennur estuary were 60 count whole prawns per pound five months from the time of the postlarval entry. In six months 43 count whole prawns per pound could be harvested from the Ennur estuary. The number of prawns surviving in this natural environment for more than six months is generally small. Hence it may be concluded that a double crop of 40-60 count whole prawn per pound in a year is a possibility in brackishwater prawn culture provided the natural supply of fry and the environment are favourable.

PREDICTION OF PRAWN CROP BASED ON POSTLARVAL INDICES

The occurrence of two peaks of postlarvae provided the basis for the two peaks in prawn abundance. The density of postlarvae entering the lake during the periods January to April and June to September was reflected in the magnitude of the prawn catch during the ensuing periods May to August (primary peak) and October to December (secondary peak) respectively. (Table VI).

In the Chilka Lake, the period June to September coincides with the South-west monsoon and hence there is no indication of a secondary peak (October to December) during the same year due to poor postlarval recruitment. On the contrary, the South-west monsoon has negligible influence over the Pulicat Lake while the North-east monsoon plays a vital role. In the year 1966, the postlarval incursion was rich during the period January to April, but was poor during the period June to September. Accordingly, the prawn catch was good during the May to August period. 1967 showed a reverse picture; the postlarval recruitment was poor during the period January to April but a rich incursion was noted during the period June to September. The prawn catch also showed a corresponding pattern. In the year 1968, the postlarval incursion was very poor. Thus the number of postlarvae recruited during the periods January to April and June to September may be treated as indicators of future prawn abundance in the Pulicat Lake. (Table VI).

DISCUSSION

The diagnostic features mentioned for the three prawns, *Penaeus monodon*, *P. indicus* and *P. semisulcatus* are useful to separate the postlarvae. The mouth of the Pulicat Lake is very shallow and hence is suitable for collecting

the postlarvae with shooting nets. Observations made in the Pulicat Lake and the neighbouring estuaries showed that *Penaeus indicus* is the dominant element in the prawn catches from these areas and this is related to the abundance of the postlarvae of the species in the plankton population. It is, therefore, possible that the fishery of *P. indicus* can be developed in nature by conservation and by nurture in brackishwater farms.

The postlarvae of *P. indicus* showed abundance during two periods, January to April and June to September. In the Cochin backwaters also two peaks of incursion were noted, one during February to April and the other in November to December (George, 1962, p. 113). The former period is closely similar to the first peak period in the Pulicat Lake and also in the Chilka Lake (Subrahmanyam, 1967, p. 204). The period of occurrence of the second peak is different in the Cochin backwaters, as the period coincides with the north-east monsoon in the Pulicat Lake.

The availability of the fry at the mouth region alone does not appear to be peculiar to the Pulicat Lake. In the Chilka Lake also the availability and abundance are often confined to the lowermost regions of the outer channel (Subrahmanyam, unpublished). Bearden (1961, p. 7) also noticed that the postlarvae of prawns were more abundant in the collections made near the mouths of the tidal sounds and rivers than offshore or well up in tidal streams in South Carolina. The incursion of the fry in the Pulicat Lake is relatively rich during the night, as in the other tidal systems (Ganapati and Subrahmanyam, 1964, p. 15; Bearden, 1961, p. 7; Williams, 1959, p. 284). The present observations also indicate that the incursion of postlarvae is maximum during the flood tide and conform to similar observations made by Amant *et al.* (1965, p. 5) and Hall (1962, p. 101). Preliminary observations made on the incursion pattern also show that the maximum incursion is between the third and fifth hours of the incoming tide and shows striking similarity with the observations made on the postlarvae of *Penaeus aztecus* in Barataria Bay, Louisiana (Amant *et al.*, 1965, p. 5).

The growth rate of *Penaeus indicus* was low in a small brackishwater pond near the lake-mouth when compared with the growth rate in the Ennur estuary. Apart from the environmental differences and seasons, the food factor is suspected to be one of the reasons for the reduced growth rate in the pond. The prawns in the pond fed on vegetable matter only while the prawns in the Ennur estuary fed on a mixed diet of vegetable and animal matter. Hudinaga and Pearson have observed that captive postlarvae feed on algal matter but grow faster if animal supplement is given. (Quoted by Williams, 1959, p. 284). Perhaps the grown-up individuals also behave the same way.

The postlarval growth of *Penaeus indicus* is maximum for about three months and decreases gradually thereafter. The rate of growth is very low after the fifth month by which time the prawn attains an average size of 114.87 mm (Subrahmanyam, in press). Our knowledge on prawn mortality rates is negligible and if it can be proved that the mortality is low during the period of growth in confined waters it is possible that the poundage of the crop can be increased by delaying the harvest by a month more, when the prawns would attain an average size of 122.45 mm (40 count whole prawn per pound). Theoretically, it is thus possible to raise two crops of 40-60 count whole

prawn per year (5-6 months old). Lunz (1957) suggested that even three crops can be raised in one year. If the prawns are harvested at an average size of 100 mm as in the Adyar fish farm (Subrahmanyam, unpublished) it is possible to raise three harvests per year as suggested by Lunz (1957, p. 47). He also noted that shorter duration of time of cultivation yielded higher poundage of prawns (Lunz, 1957, p. 45). The magnitude of the postlarval incursion from season to season and from year to year varies considerably, and it is felt that such variations would be reflected in the catch from the ponds which are stocked by the inflowing tides (Hall, 1962, p. 94). It is, therefore, necessary that indices of abundance are maintained in the waters outside the ponds so that measures for artificial stocking may be taken at times of poor recruitment.

The postlarval studies are very useful to predict the nature of the future prawn catch (Kutkuhn, 1962, p. 72; Baxter, 1962, p. 79; Bearden, 1961, p. 3, Subrahmanyam, 1967, p. 204). The present studies on the prediction of prawn catch in *Penaeus indicus* confirm the previous findings (Subrahmanyam, 1967). These predictions are, however, limited to indicate only good or bad seasons (Amant *et al.*, 1962, p. 17). Unlike the Chilka Lake, two periods of postlarval maxima are observed in Pulicat Lake, one from January to April and the other from June to September, and these may be useful to predict the nature of the harvest during the ensuing periods May to August and October to December respectively. Hence the number of postlarvae recruited during the above periods are considered as indicators of future prawn abundance. The only difference between the Chilka Lake and Pulicat Lake appeared to be the poor postlarval incursions during the period June to September as a result of which the secondary prawn production peak (October to December) is not significant in the Chilka Lake.

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Table 1

Comparison of the Postlarval Penaeids (*Penaeus* species)

	Penaeus monodon	*Penaeus semisulcatus*	*Penaeus indicus*
Total length (mm) Range	9.84 - 13.41	6.92 - 10.29	8.12 - 11.60
Mean	11.67	8.71	8.64
Carapace length (mm) Range	2.22 - 2.65	1.45 - 1.95	1.79 - 2.22
Mean	2.32	1.76	1.70
Rostrum length (mm) Range	0.87 - 1.16	0.63 - 1.40	0.70 - 1.74
Mean	0.93	0.91	0.71
Sixth pleonic somite (mm) Range	2.73 - 3.00	1.62 - 2.05	1.87 - 2.26
Mean	2.71	1.90	1.99
Telson ..... (mm) Range	1.71 - 1.91	1.16 - 1.62	1.11 - 1.45
Mean	1.70	1.36	1.21
Rostral formula (including epigastric) Range	4 - 6/0	1 - 7/0-3	2-6 / 0-5
Mode	5/0	4 - 5/0	4/0
Rostrum	Reaching almost the tip of the first segment of antennular peduncle	Reaching the tip of the first segment of the antennular peduncle	Slightly falling short of the first segment of the antennular peduncle
Third pereiopod	Slightly exceed the eye	Reaches the anterior end of the eye	Reaches almost the anterior edge of the eye
CHROMATOPHORES:			
Number of chromatophores on the ventral side of the body (base of the antennules to the tip of sixth pleonic somite)	28 - 35	24 - 27	10 - 16
Number of chromatophores on the ventral side of the sixth pleonic somite	14 - 19	8 - 11	5 - 7
Number of chromatophores on the antennular peduncle	12 - 14 (Usually 5 chromatophores on the second segment of the peduncle)	7 - 8 (Usually 2 chromatophores on the second segment of the peduncle)	0 - 2 (Usually absent)
Dorsal and dorsolateral chromatophores on the abdomen	-	8	-
Antero-lateral chromatophores on the sixth pleonic somite	Absent	Present	Present

Table II

Provisional Key for the Identification of Postlarval Penaeids (*Penaeus* species)

1. 5-7 reddish brown (or yellowish) chromatophores on the ventral side of the sixth abdominal somite. One reddish brown chromatophore at the anterior end of the sixth abdominal segment laterally .....
..... *Penaeus indicus*

   More than eight chromatophores on the ventral side of the sixth abdominal somite. One reddish brown chromatophore at the anterior end of the sixth abdominal segment present or absent 2

2. 8-11 reddish brown (sometimes bluish) chromatophores on the ventral side of the sixth abdominal somite. One reddish brown chromatophore at the anterior end of the sixth abdominal segment laterally. One or two reddish brown chromatophores are also present on the dorsal side of each abdominal segment .....
..... *Penaeus semisulcatus*

   14-19 reddish brown (sometimes bluish) chromatophores on the ventral side of the sixth abdominal segment. No lateral chromatophore on the sixth abdominal segment anteriorly. The ventral chromatophores on the sixth abdominal segment appear as a bluish or reddish brown streak in expanded condition .....
..... *Penaeus monodon*

Table III

Seasonal Distribution of Postlarval Prawns in the Pulicat Lake

Species	Jan.	Feb.	Mar.	Apr.	May	June	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Aver-age No. per month	%
1966	Tow-net (Average number per 15 minutes)													
Penaeus indicus	32	466	3	1	9	-	13	89	3.5	17	7.5	2	53.58	95.20
Penaeus monodon	12	11	1	-	1	-	0.2	0.8	0.2	0.8	2.0	2.0	2.58	4.58
P. semisulcatus	-	-	-	-	-	-	-	-	-	1.0	0.5	-	0.13	0.22
1967														
Penaeus indicus	5.5	-	75.5	30	-	257	109	71.8	979	2.5	1.0	14.5	128.82	98.03
Penaeus monodon	3.2	-	0.5	5.3	-	3	0.5	7.5	-	-	-	1.25	1.77	1.34
P. semisulcatus	0.3	-	0.25	-	-	4	0.5	-	-	-	-	4.75	0.82	0.63
	Shooting net (Average number/hour)													
1966														
Penaeus indicus	-	-	-	103	859	424	245	732	906	665	92	4	335.83	85.56
Penaeus monodon	-	-	-	2.0	3	3	0.3	4	48	84.5	99	29	22.73	5.79
P. semisulcatus	-	-	-	-	-	-	1	-	252	145	7.5	2.0	33.96	8.65
1967														
Penaeus indicus	9	25.5	4702	2780	111	5019	1279	718	13275	75	38	70.5	2341.83	97.63
Penaeus monodon	10	13.5	32.8	187	14	19	21	190	5	6	23	8.8	44.17	1.84
P. semisulcatus	-	5.0	67.8	14.3	4.5	12.5	4	8.5	7	5	2	22.8	12.78	0.53

Table IV

Lunar, Diel and Tidal Periodicity in Relation to Postlarval Immigration and Emigration in the Pulicat Lake

Species	Full moon				New moon			
	Day		Night		Day		Night	
	High tide	Low tide	High tide	Low tide	High tide	Low tide	High tide	Low tide
	Tow-net (Average number per hour)							
1966								
Penaeus monodon	14.8	0.4	25.6	-	3.5	0.5	5.0	1.0
Penaeus indicus	35.6	8.8	80.8	1.2	21.5	1.0	1126.5	20.3
P. semisulcatus	-	-	0.4	-	-	-	2.5	-
1967								
Penaeus monodon	10.0	-	10.7	-	-	-	8.0	-
Penaeus indicus	175.3	0.3	256.3	3.0	222.9	2.5	1551.2	175.5
P. semisulcatus	0.3	-	0.7	-	-	-	13.1	0.7
	Shooting net (Average number/hour)							
1966								
Penaeus monodon	0.5	-	29.6	0.3	-	0.9	86.5	5.6
Penaeus indicus	27.0	0.1	159.3	4.4	472.3	34.8	1532.0	411.0
P. semisulcatus	-	-	5.5	0.5	1.1	-	285.9	10.5
1967								
Penaeus monodon	49.4	-	96.5	0.8	5.0	0.9	61.4	1.3
Penaeus indicus	1205.6	46.5	1100.3	1.6	869.5	34.3	6925.6	281.6
P. semisulcatus	2.8	0.2	19.7	-	3.3	-	31.1	3.2

Table V

Size Distribution and Growth Rate in *Penaeus indicus* from a Brackishwater Pond at Pulicat Lake-mouth

Month	No. examined	Size-range (mm)	Mode (mm)	Mean (mm)	Growth rate/ day (mm)	Growth rate/ 30 days (mm)
1968						
March	67	48-92	60	60.49		
April	68	53-103	85	81.12	0.645	19.35
May	20	74-118	95	92.7	0.414	12.42
June	39	87-140	95-100	100.44	0.267	8.01

Table VI

Prediction of Prawn Abundance Based on Postlarval Forms

Year	Post-larvae No./haul (Jan-April) Tow-net	Post-larvae No./haul (Jan-April) Shooting net	Catch in M. tons (May-Aug.)	Postlarvae (No./haul) (June-Sep) Tow-net	Postlarvae (No./haul) (June-Sep.) Shooting net	Catch in M.tons (Oct.-Dec.)
1966	502	No data	128.834	105.5	2307	64.312
1967	84	7516.5	94.182	1417	20291	171.238

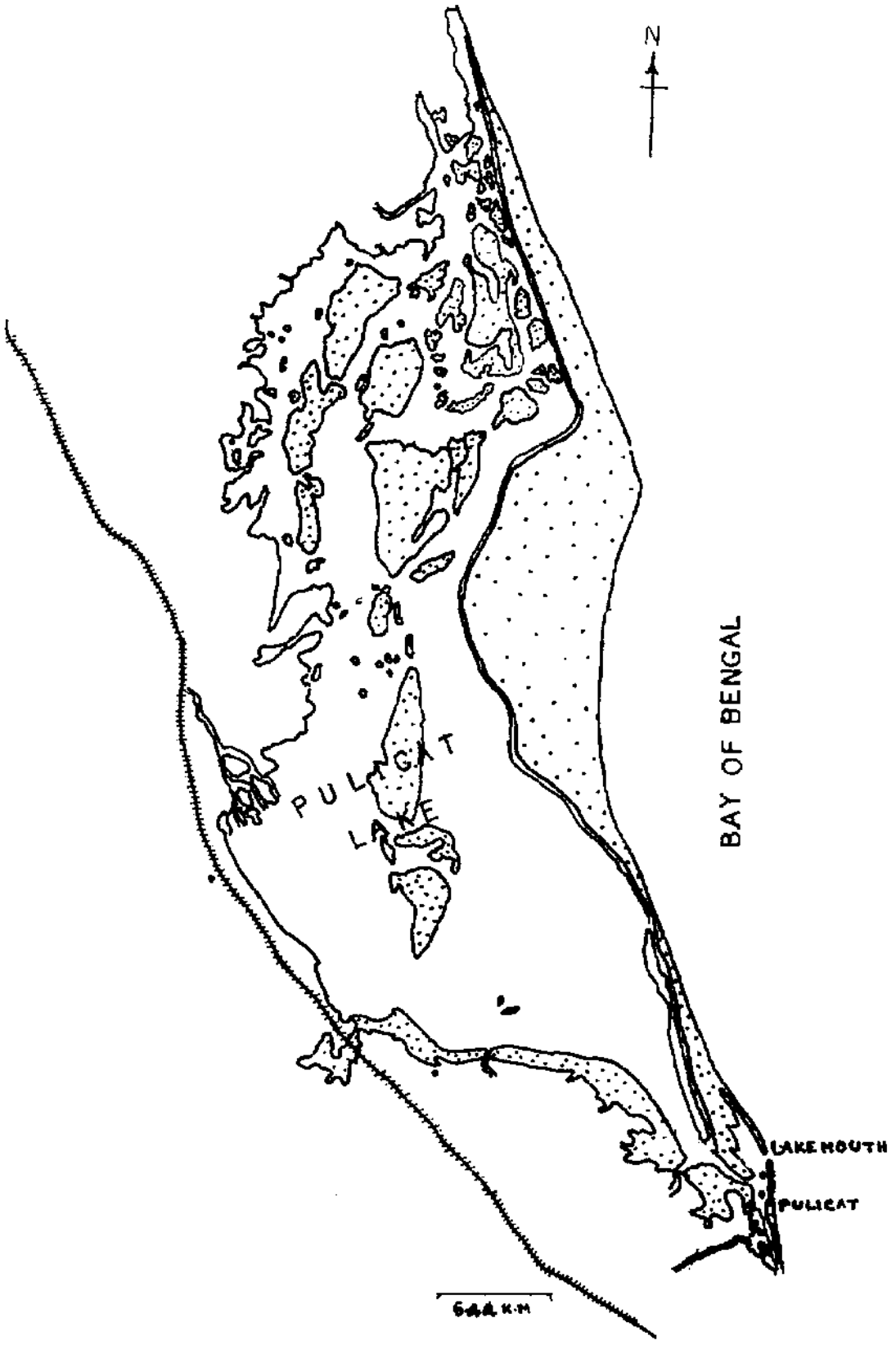

FIG. 1

Map of the Pulicat Lake.

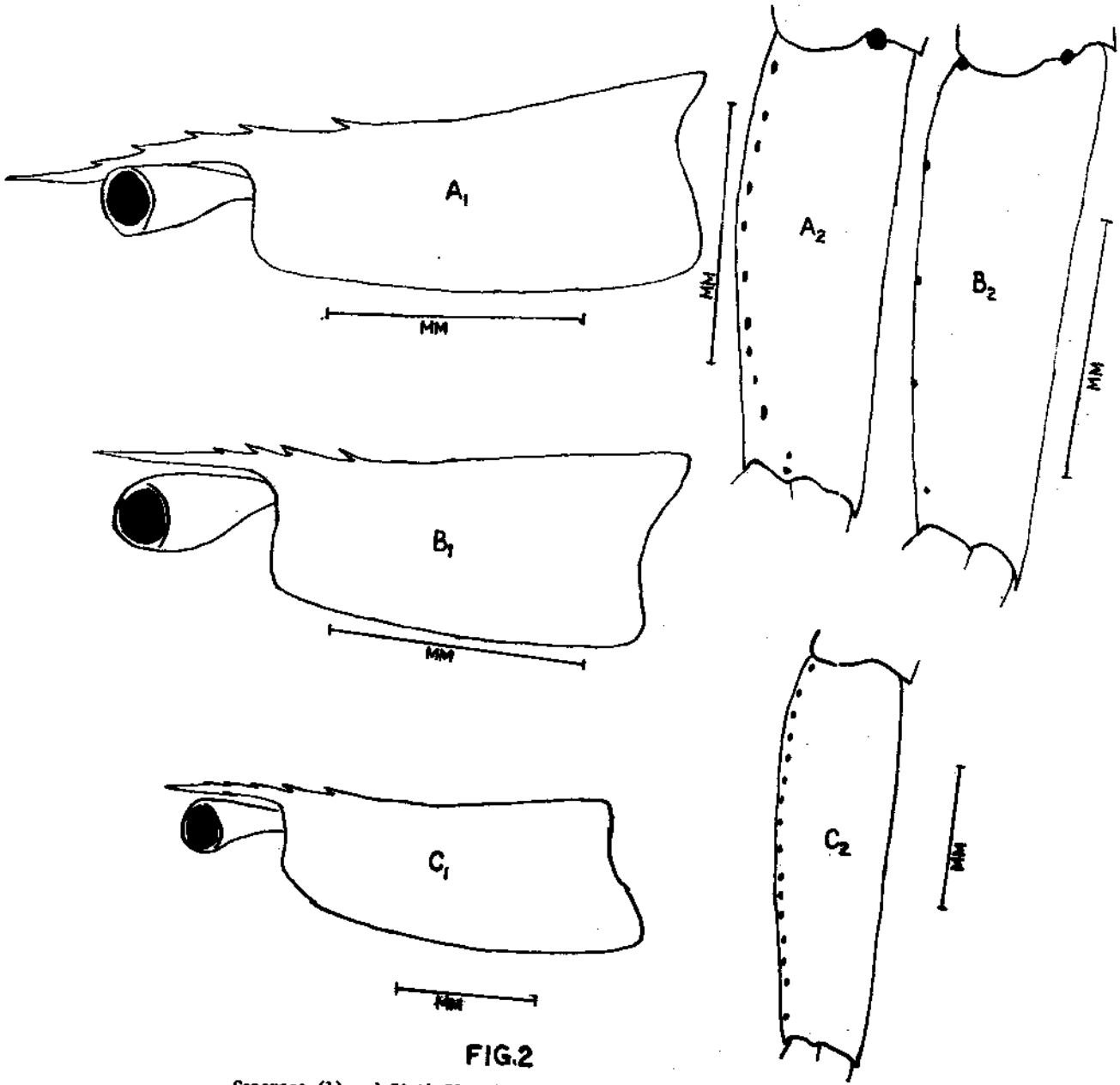

FIG.2

Caparace (1) and Sixth Pleonic Somite (2) of the Postlarvae.
A = *P. semisulcatus* B = *P. indicus* C = *P. monodon*

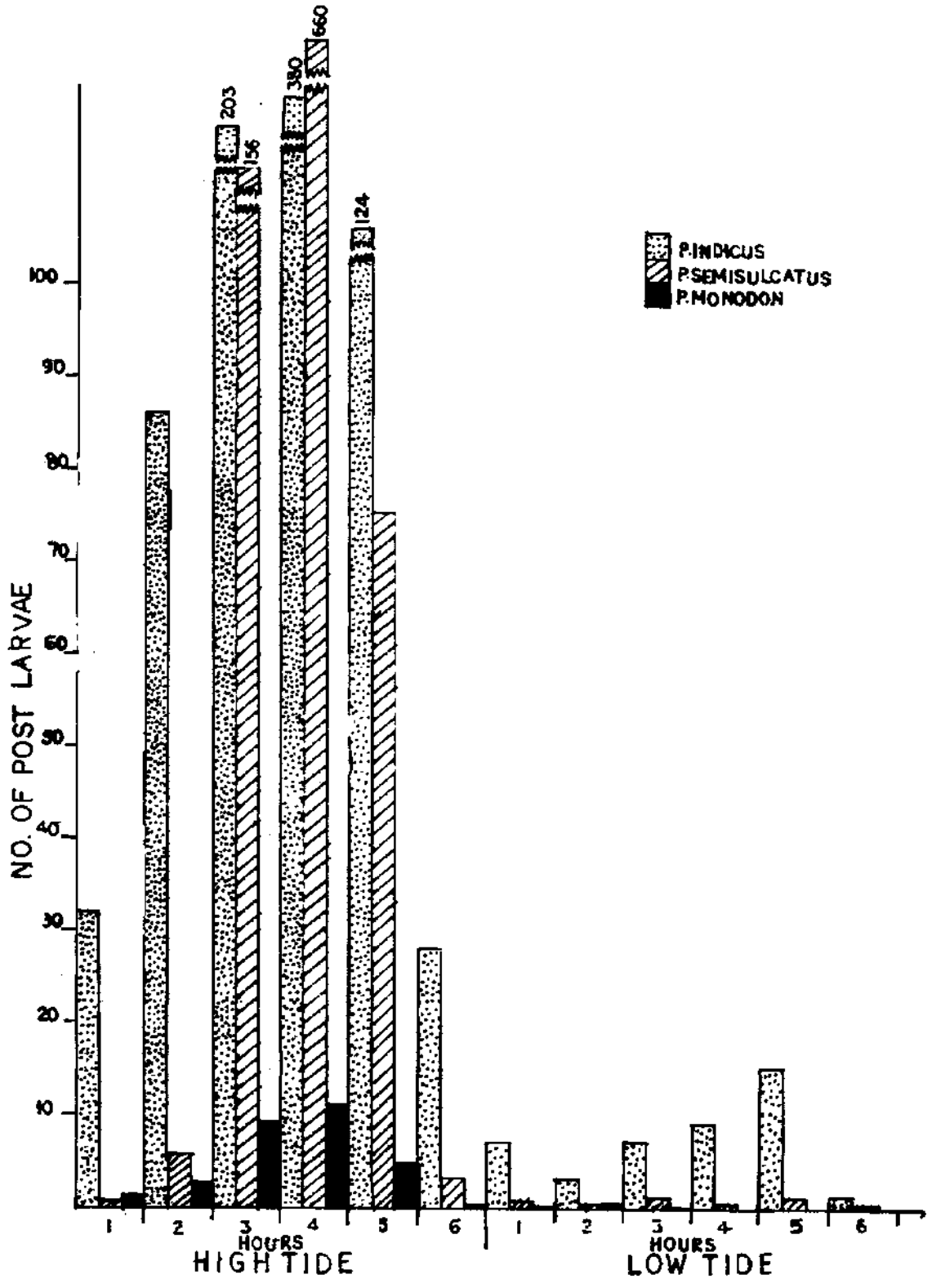

FIG.3. 12-HOUR CYCLE

Immigration and Emigration of Postlarvae: Shooting Net Collections at One Hour Intervals: Average No. of Postlarvae/15-minute Haul for the Period January to June 1968.