

REPRODUCTION, FECUNDITY AND SEX RATIO  
OF THE GREEN TIGER PRAWN,  
*PENAEUS SEMISULCATUS* DE HAAN

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ABSTRACT

Investigations on the reproduction, gonado-somatic index, fecundity and sex ratio of *Penaeus semisulcatus* were carried out at Mandapam Camp, from April, 1967 to March, 1969. Five stages of maturity could be differentiated depending on the colour of the ovarian lobes, the thickness of the ovary and the size of the ova. Female prawns with mature ovaries occurred throughout the year showing that they spawn continuously, the peak season being June to September and January to February. The gonado-somatic index exhibited a variation from 2.2 to 13.2. The minimum size at maturity in females was found to be 23 mm carapace length. The fecundity of the species was found to range between 51,605 and 6,60,904. There was no relation between the fecundity and the length of prawn, weight of prawn or weight of ovary. The samples examined contained more or less same number of males and females, although, during certain months the males were more in number while in other months the females were dominating.

INTRODUCTION

The reproduction, gonado-somatic index, fecundity and other aspects of the biology of a number of species of penaeid prawns have been studied in varying details by earlier workers such as King (1948); Menon (1951; 1953); Panikkar and Menon (1956); Shaikmahmud and Tembe (1958); Cummings (1961); George (1961; 1962); Oka and Sirahata (1965); Subrahmanyam (1963); Tuma (1967); Rao (1968) and George *et al* (1968). But no work has so far been done on these aspects of *Penaeus semisulcatus*. Therefore, detailed investigations on these aspects of the species were taken up during the period April, 1967 to March, 1969 and the results are presented here.

MATERIAL AND METHOD

During the present studies about 100 specimens of *Penaeus semisulcatus* were examined every month from the trawl catches landed at Mandapam, both from Palk Bay and Gulf of Mannar. In each sample the total length, carapace length, weight, sex and state of maturity of gonad were recorded. Specimens

with broken rostrum or telson were discarded. The entire ovaries were dissected out for fecundity studies while in other cases the anterior portion of the ovaries including the anterior and lateral lobes and a portion of the extension into the abdomen were preserved. It was observed that there was no appreciable shrinkage or swelling of the preserved ova in comparison with the fresh material.

The structure of the gonads of female *P. semisulcatus* agrees with that of other penaeid prawns, *Penaeus setiferus* (King, 1948), *Parapenaeopsis styliifera* (Shaikmahmud and Tembe, 1958), *Penaeus duorarum* (Cummings, 1961), *P. indicus* (Subrahmanyam, 1963), *P. orientalis* (Oka and Sirahata, 1965), *P. merguensis* (Tuma, 1967), and *Metapenaeus dobsoni*, *M. affinis*, *P. indicus*, *Parapenaeopsis styliifera* (Rao, 1968).

Ova from the anterior, middle and posterior portions (Fig. 1) did not show marked difference in diameter. Therefore, ova diameter measurements were taken from the middle lobes of one side only, to maintain uniformity.

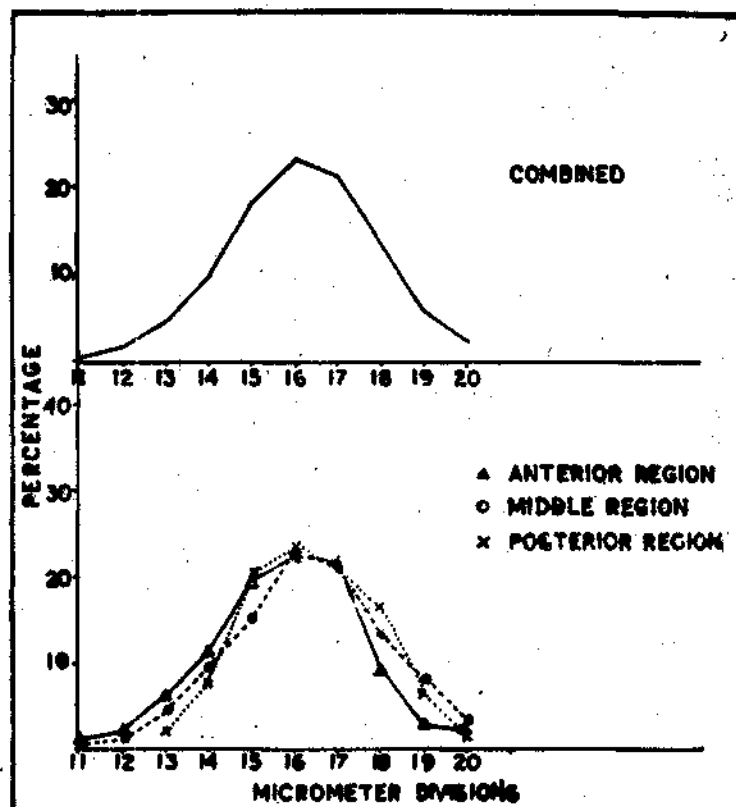


FIG. 1. Oviometer frequency polygons showing the development of ova of mature ovary in *Penaeus semisulcatus* de Haan.

In order to study the maturity and to fix the spawning season, 2491 females and 1266 males were examined. The various stages in females were decided on macroscopic and microscopic examination of the gonads. The terminal ampules of the vas deferens of small males were examined under microscope to know whether they have reached maturity. The white colour of the terminal ampule seen from outside at the bases of the fifth pereopods is also indicative of the presence of spermatophores in them. However, all the males examined were mature.

#### DEVELOPMENT OF OVARY AND SPAWNING

In the development of the ovary in *P. semisulcatus* five stages were detected as in other prawns.

*Stage I:* Diameter of the ovarian lobes smaller than adjacent gut; translucent or white in colour. Ova uniformly small and transparent with clear nuclei. Ova diameter 0.033 — 0.050 mm.

*Stage II:* Diameter of ovarian lobes same as that of the adjacent gut or a little more; translucent or white in colour. 0.167 — 0.184 mm.

*Stage III:* Diameter of ovarian lobes much larger than that of the gut; colour light to olive green. 0.234 — 0.251 mm.

*Stage IV:* Diameter of ovarian lobes very much larger than the diameter of the gut, filling almost the entire space inside the body cavity in the cephalothorax and abdomen. Colour dark green or greenish brown. Majority of ova fully mature with rod-shaped bodies arranged radially in the cytoplasm around the periphery. Only few small-sized ova present. 0.3031 — 0.317 mm.

*Stage V:* Ovarian lobes flaccid and much convoluted. Colour varies from cream to light yellow. Majority of ova small as in stage I while mature ova undergoing resorption present in varying numbers.

#### *Development of ova to maturity*

Ova diameter measurements of 500 ova from a mature ovary were taken at random. The value of each micrometer division is 0.167 mm. The ova diameter frequency polygons (Fig. 1) shows only one mode at 16 microdivisions (0.267 mm) representing mature ova although there were smaller ova of the size found in stage I.

Ova diameter frequency polygons were drawn for other stages of maturity (Fig. 2). In stage I ova of size range 0.033 — 0.100 mm were only present while in stage II the only mode was noticed at 0.167 — 0.184 mm diameter, the range being from 0.117 — 0.217 mm.

#### *Spawning*

The presence of prawns with ovaries in more than one stage of maturity in the same sample indicates that there is no periodicity in spawning.

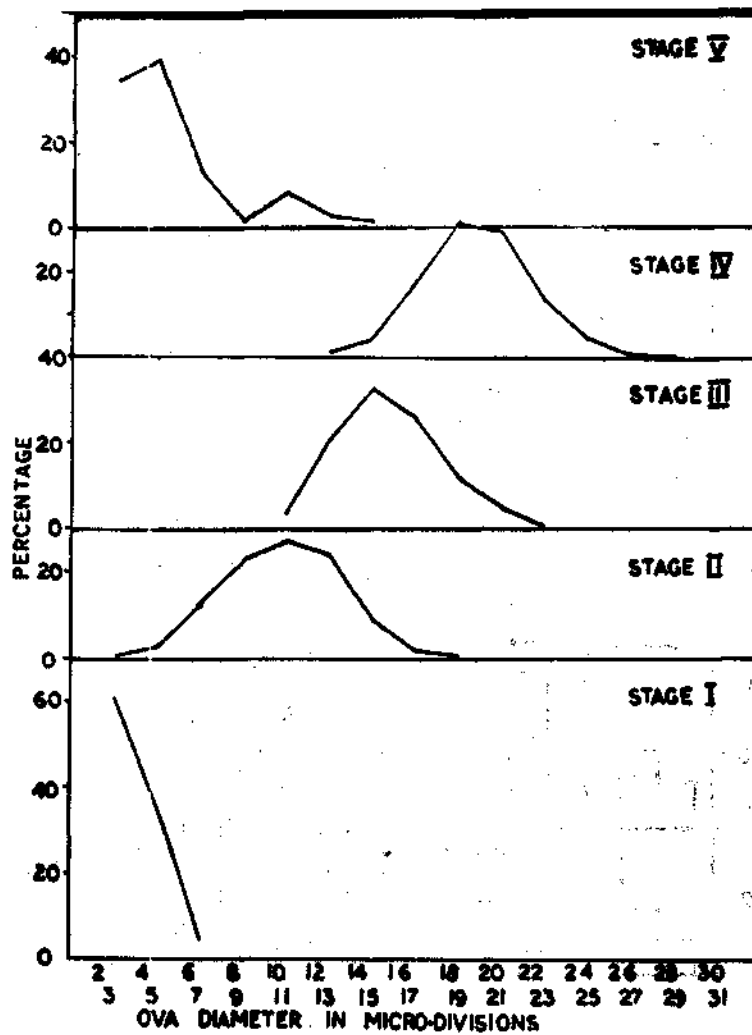


FIG. 2. Ovadiameter frequency polygons showing development of ova in ovaries in stages I to V in *Penaeus semisulcatus* de Haan.

In all, 1648 females during April, 1967 to March, 1968 and 845 females during April, 1968 to March, 1969 were examined to study the percentage occurrence of maturity. During both years of study mature females were encountered in all months, the highest percentages of occurrence being in the months of June to September, October and January to March, indicating the peak spawning season. Immature prawns were found in the samples mostly in December and March, showing probably the recruitment period. (Figs. 3 & 4). The occurrence of prawns with ovaries in late stages of maturity along with spent

ones in most of the months during the period of two years indicates that maturation of the gonad from immature to ripe stages occur always, resulting in a continuous addition of mature prawns to the stock every month. Males were

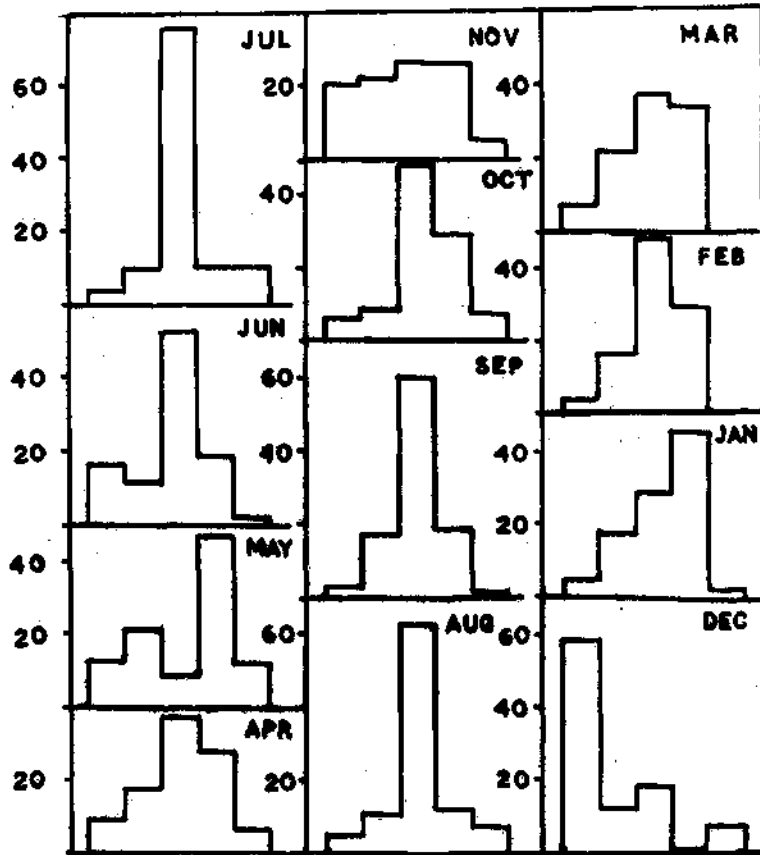


FIG. 3. Percentage occurrence of *Penaeus semisulcatus* de Haan in different stages of maturity during the period April, 1967 to March, 1968.

found to be mature during all the months. Prolonged breeding period with peak occurrence during certain months has been reported in several prawns along the Indian coast. (Menon, 1951; 1953; 1955; Panikkar and Menon, 1956; Kesteven and Job, 1957; George, 1961; 1962; George, *et al.* 1968; Shaikmahmud and Tembe, 1960; Subrahmanyam, 1963 and Rao, 1968).

#### *Gonado-somatic index*

The size of the ovary and the largest common ova diameter of the ovary are the two factors in determining the stage of maturity of a prawn. But, in *P. semisulcatus* there is clear overlapping of the weights of ovaries belonging to

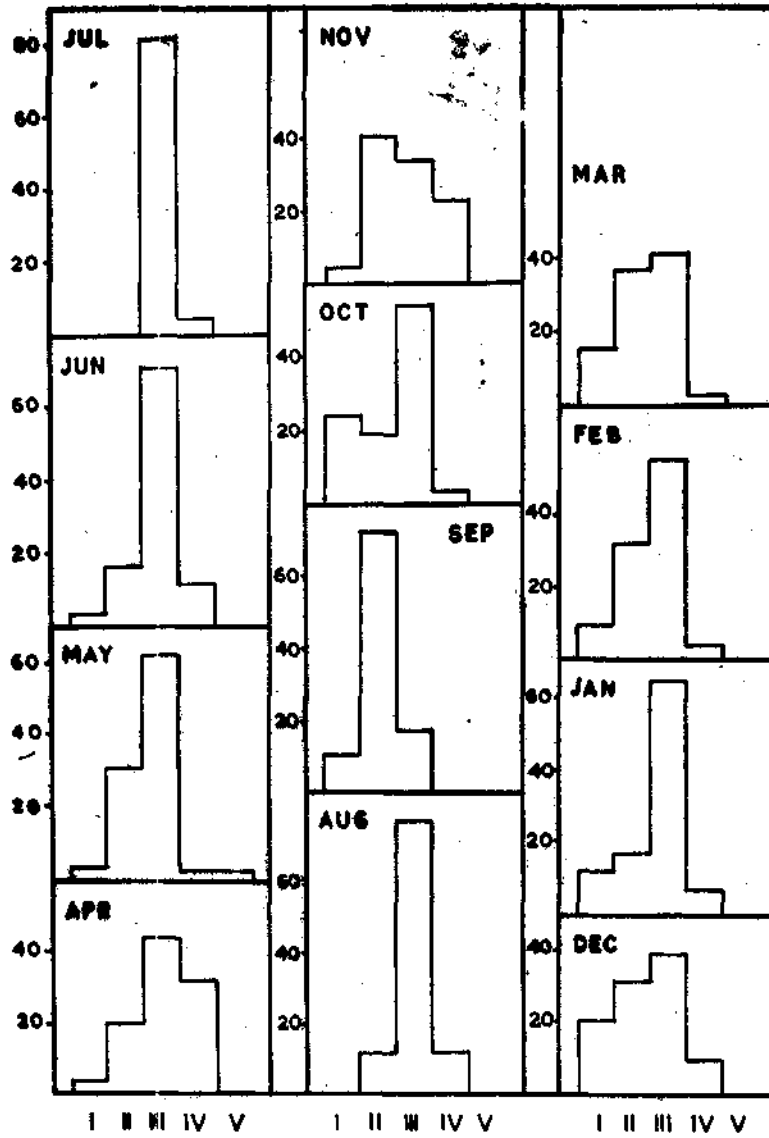


FIG. 4. Percentage occurrence of *Penaeus semisulcatus* de Haan in different stages of maturity during April, 1968 to March, 1969.

the various stages of maturity. It has been pointed out by several authors (June, 1953; Yuen, 1955 and others) that relative ovary weight (ovary weight x 100/weight of prawn) is more suitable to explain the maturity of fishes. This was found to be true in this case also.

The relative ovary weight or the gonado-somatic index was calculated for mature prawns only, as the number of immature ones was very small. The relative ovary weight of prawns with maturing and ripe ovaries (stages III & IV) show a variation from 2.2 to 13.2. The variation in the relative ovary weights in different months may be due to the prolonged spawning over many months.

*Size at first maturity*

Prawns were grouped into 2 mm size classes and the percentage occurrence in various stages of maturity in these groups was calculated. Prawns with ovaries in stages III, IV and V have been grouped under mature prawns while the stages I and II were considered immature for the purpose of calculating the size at first maturity.

From Table 1 it could be seen that all females were with immature ovaries upto a carapace length of 21-22 mm. Mature prawns were found to have carapace length of 23 mm and above. Spent specimens were recorded in the size groups of 27-28 mm and above. In the size groups of 25-26 mm and 27-28 mm the percentage of immature prawns was more than the mature ones. It

TABLE 1. *Percentage occurrence of females in different stages of maturity in the various size groups 1967-1969.*

Size groups	No. of prawns	Stages of maturity				
		I	II	III	IV	V
17-18	2	100.00	—	—	—	—
19-20	1	100.00	—	—	—	—
21-22	19	100.00	—	—	—	—
23-24	47	79.39	13.46	7.15	—	—
25-26	84	48.21	36.23	13.43	2.13	—
27-28	155	31.23	33.23	25.64	8.74	1.16
29-30	239	21.42	29.76	38.26	10.56	—
31-32	271	7.02	23.85	54.75	13.58	0.80
33-34	380	2.94	21.42	59.44	14.54	1.66
35-36	342	1.35	16.61	60.19	16.73	3.12
37-38	343	2.57	13.20	55.30	26.36	2.57
39-40	288	0.26	12.02	58.21	25.39	4.12
41-42	173	0.86	6.57	56.55	33.02	3.00
43-44	78	2.38	7.39	54.89	31.20	4.14
45-46	49	—	10.33	45.25	38.42	6.00
47-48	16	—	4.55	33.63	57.27	4.55
49-50	4	—	50.00	16.66	16.67	16.67
51-52	—	—	—	—	—	—
53-54	2	—	50.00	—	50.00	—

TABLE 2. *Number of mature ova in individuals of P. semisulcatus*  
*Stages of maturity: III & IV.*

Sl. No.	Carapace length mm	Weight of prawn g	Weight of ovaries g	Total No. of mature ova
1.	35	32.4	1.080	1,39,725
2.	36	32.4	2.540	1,34,499
3.	36	32.4	0.810	79,907
4.	37	36.0	1.269	1,11,260
5.	38	46.6	1.994	2,40,875
6.	38	47.9	1.920	2,43,600
7.	39	39.9	0.892	52,605
8.	39	46.3	4.322	4,86,873
9.	39	47.0	3.410	1,72,205
10.	40	43.7	1.905	1,13,030
11.	40	47.2	4.952	4,13,298
12.	40	43.7	2.010	2,18,932
13.	40	48.6	2.822	6,02,400
14.	42	54.4	3.930	3,10,942
15.	42	54.4	4.462	4,26,120
16.	44	58.7	1.890	1,57,127
17.	45	63.8	5.870	4,26,456
18.	45	65.4	7.040	6,60,904
19.	29	18.5	0.871	67,891
20.	31	22.0	2.447	4,65,120
21.	32	22.2	1.570	1,16,596
22.	33	27.6	1.390	91,532
23.	37	37.9	3.992	5,10,781
24.	37	37.9	3.740	2,54,881
25.	37	41.2	3.550	2,14,229
26.	38	44.4	3.694	2,31,359
27.	38	41.2	3.990	1,08,418
28.	39	46.3	4.995	3,05,483
29.	39	45.6	2.787	3,30,674
30.	40	45.7	2.770	1,50,688
31.	41	52.4	4.180	1,96,695
32.	41	51.4	3.064	2,04,062
33.	41	49.1	6.472	3,70,600
34.	42	53.1	4.022	1,96,072
35.	45	65.0	7.290	5,19,270
36.	46	63.8	6.190	3,55,856



is also observed that although some prawns were found to be mature at the size of 23-24 mm, majority attained maturity at about 31-32 mm size. The size at first maturity appears to be near about 23 mm carapace length.

The males were all mature at sizes 17-18 mm which were the smallest size caught in the trawls. Therefore, it is seen that the males attain maturity earlier than females.

#### *Fecundity*

The ovaries of 18 prawns in stage III ranging from 35-44 mm and with a size range of 29-46 mm in stage IV, were examined for fecundity studies. A piece of ovary from one of the lateral lobes was separated and weighed. The entire ova in this piece were teased out into a plankton counting chamber and all the mature ova counted. The total number of ova in the entire ovary was estimated from this.

The details are given in Table 2. The number of ova in each ovary varied from 51,891 to 6,60,904 (mean: 2,68,430). Since an individual prawn may spawn more than once a year, as shown by Rao (1968), the actual number of eggs produced by a single prawn in one year cannot be estimated accurately.

#### *Relation between fecundity and length of prawn*

From Table 2 it can be seen that two prawns with carapace length of 40 mm have produced 1,13,030 and 6,03,400 eggs while two others of 39 mm length have given fecundity values 51,605 and 4,86,873. This shows that there is no correlation between the number of eggs and the length of prawns.

#### *Relation between fecundity and weight of prawn*

No correlation between these two factors could be established as prawns of 58.7 and 32.4 g weight produced 1,57,197 and 1,39,725 eggs respectively (Table 2).

#### *Relation between fecundity and weight of ovary*

From the fact that prawns having ovaries weighing 2.822 and 7.040 g have been able to produce 6,02,400 and 6,60,904 ova respectively it is evident that there is no relation between the weight of ovary and fecundity of these prawns.

#### *Sex ratio*

The percentage occurrence of sexes in different months of the the two years under study are given in Table 3. In general, the ratio between the two sexes did not vary much from 1:1.

It is seen from the table that during April, 1967 to March, 1968 females were more than 50% of the samples in the months of May, June, July, 1967 and February, 1968, while in all the remaining months the males dominated.

TABLE 3. Sex ratio of *P. semisulcatus* in the commercial catches April, 1967 — March, 1969.

Months	1967-1968		1968-1969	
	Total No. of prawns	Percentage of females	Total No. of prawns	Percentage of females
April	559	41.14	581	55.94
May	515	52.82	763	56.62
June	577	52.17	903	41.75
July	382	55.50	624	49.20
August	541	45.84	611	50.57
September	646	48.14	594	55.22
October	593	48.23	616	54.87
November	510	40.00	512	52.54
December	639	48.20	777	56.11
January	454	45.37	753	51.13
February	524	61.83	704	56.53
March	501	36.72	540	44.44

During the month of February, 1968 alone percentage of females was above 60% whereas, males reached this percentage only in the month of November, 1967 and March, 1968.

In the second year of observation, the variation in the proportion between the females and males was within 10%. Thus only in the months of May and December, 1968 and February, 1969 the percentages of females were as high as 56. Similarly, during June, 1968 alone about 58% of males were occurring in the samples examined.

#### DISCUSSION

Panikkar and Menon (1956) reported that the spawning in *Penaeus indicus* on the west coast has peak seasons from October to November and May to June, while Rao (1968) observed that this peak in Cochin waters was between October and April. But, Subrahmanyam (1963) reported the highest breeding activity in Madras waters in March and May to September. The present studies on *P. semisulcatus* from Palk Bay and Gulf of Mannar also revealed similar peaks in June to September and January to February. The resemblance between these peak seasons at these two centres on the east coast of India is probably due to the profound influence of the North East Monsoon while the west coast is more affected by the South West Monsoon.

The fecundity values of the present investigations are quite in conformity with those recorded by Rao (1968). But, there was no correlation between the size of the prawn and fecundity. The sex ratio of *P. semisulcatus* is similar to those of *P. indicus* (Menon, 1957) in that the sexes were more or less equally distributed, although, distinct variation was observed by George and Rao (1967) in respect of *P. indicus*, *Metapenaeus dobsoni*, *M. affinis* and *Parapenaeopsis stylifera* from the trawl catches off Cochin. It is, therefore, likely that there is no marked spawning migration of *P. semisulcatus* in Palk Bay and Gulf of Mannar.

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#### REFERENCES

- CUMMINGS, W. C. 1961. Maturation and spawning of the pink shrimp, *Penaeus duorarum* Burkenroad. *Trans. Am. Fish. Soc.*, 90 (4)
- GEORGE, M. J. 1961. Studies on the prawn fishery of Cochin and Alleppey coasts. *Indian J. Fish.*, 8 (1):75-95.
- GEORGE, M. J. 1962. On the breeding of penaeids and recruitment of post-larvae into the backwaters of Cochin. *Indian J. Fish.*, 9 (1):110-116.
- GEORGE, M. J. AND P. V. RAO. 1967. Distribution of sex ratios of penaeid prawns in the trawl fishery off Cochin. *Proc. symp. Crustacea, mar. biol. Ass. India*, Pt. II; 698-700.
- GEORGE, M. J., K. RAMAN AND P. K. NAIR. 1968. Observations on the off shore prawn fishery of Cochin. *Indian J. Fish.*, 10 (2):460-499 (1963).
- JUNE, F. C. 1953. Spawning of the yellow fin tuna in Hawaiian waters. *Fish. Bull., Fish. Wildl. Serv., U.S.* 56 (77):47-64.
- KESTEVEN, G. L. AND T. J. JOB. 1957. Shrimp culture in Asia and the Far East. A preliminary review. *Proc. Gulf Caribb. Fish. Inst.*, :49-68.
- KING, E. 1948. A study of the reproductive organs of the common marine shrimp, *Penaeus setiferus* (Linn.). *Biol. Bull.*, 94 (3):244-262.
- MENON, M. K. 1951. The life history and bionomics of an Indian penaeid prawn, *Metapenaeus dobsoni* Miers. *Proc. Indo-Pacif. Fish. Council.*, 3 (2-3):80-93.
- MENON, M. K. 1953. Notes on the bionomics and fishery of *Metapenaeus dobsoni* Miers, on the south-west coast of India. *Indian J. Fish.*, 2 (1):41-56.
- MENON, M. K. 1957. Contributions to the biology of penaeid prawns of the south-west coast of India. I. Sex ratio and movements. *Indian J. Fish.*, 4 (1):62-74.

- OKA, M. AND S. SIRAHATA. 1965. Studies on *Penaeus orientalis* Kishinouye: Pt. 2: Morphological classification of the ovarian eggs and the maturity of the ovary. *Bull. Fac. Fish. Kagasaki Univ.*, **18**:30-40.
- PANIKKAR, N. K. AND M. K. MENON. 1956. Prawn fisheries of India. *Indo-Pacif Fish. Council.*, **6** (3): 328-344.
- RAO, P. V. 1968. Maturation and spawning of the penaeid prawns of the South-West Coast of India. *FAO Fish. Rep.*, **57** 2:285-302.
- SHAIKMAHMUD, F. S. AND V. B. TEMBE. 1958. Study of Bombay prawns. The reproductive organs of *Parapenaeopsis stylifera* (M. Edwards). *J. Univ. Bombay*, **27** (3): 99-110.
- SUBRAHMANYAM, C. B. 1963. A note on the annual reproductive cycle of the prawn, *Penaeus indicus* (Milne Edwards) of Madras Coast. *Curr. Sci.*, **32** (4):165-166.
- TUMA, D. J. 1967. A description of the development of the primary and secondary sexual characters in the banana prawn, *Penaeus merguensis* de Man (Crustacea, Decapoda, Penaeidae). *Aust. J. mar. Freshwat. Res.*, **18** (1):73-88.
- YUEN, H. S. H. 1955. Maturity and fecundity of big-eye tuna in the Pacific. *Spec. scient. Rep. U.S. Fish. Wildl. Serv.*, **150**:1-30.