

## REPRODUCTIVE BIOLOGY OF *PARAPENAEOPSIS STYLIFERA*

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### ABSTRACT

Controversy exists regarding the incidence and reproductive habits of *Parapenaeopsis stylifera* along the coast of Kerala. Results are reported of a detailed study on the different aspects of the reproductive biology based on the trawl catches landed at Neendakara coast for a period of one year. This species breeds throughout the year with peak breeding activity in May and November. The monsoon catches consist of juveniles. Life span of the species is 2.5 years and total length at first maturity is 75mm. Measures for the effective management of the species in the area are discussed.

### INTRODUCTION

Among the maritime states of India, the state of Kerala is still the major producer of Indian shrimps. The rich shrimp resources are confined to the coastal belt of Kerala which largely determine the annual production of shrimps in the country. The realisation of the export potential of the marine products especially prawns has resulted in substantial increase in the mechanised fishing crafts mainly the small bottom trawlers aiming primarily for prawns. This purely prawn based growth has ultimately resulted in the strain and stress not only on the resources exploited but also between the various sectors involved in fishing, warranting immediate steps to be taken for rational exploitation and judicious management of the resources.

In recent years Shaktikulangara - Neendakara area in the Quilon district of Kerala has gained considerable importance as a major centre of fishing industry in the state where thousands of trawlers operate and substantial quantities of shrimps are landed. Presently, the peak fishing activities of the trawlers at Shaktikulangara takes place during the monsoon period (June- August) when several hundreds of trawlers from the neighbouring areas also move into this area and carry out hectic fishing activities.

Though a number of species of penaeid

prawns contribute to the shrimp fishery in general, one characteristic feature of the monsoon fishery at Shaktikulangara is that it is predominantly supported by a single species *Parapenaeopsis stylifera*, popularly known as 'Karikkadi chemmeen' in Malayalam, which contributes to nearly 95% of the total shrimp production of the state in the mechanised sector (Suseelan *et al.* 1989). Though *P. stylifera* occurs throughout the Indian coasts, its maximum abundance has been observed along the Kerala coast. Commercial trawling for this resource rapidly increased in the near shore areas within 0 - 50m depth zone. Of late, some concern has been felt on unsteady production and occasional depletion of fishery.

One of the most controversial issues in the fishery sector today is whether there should be reasonable restrictions in the mechanised fishing activities. When the question of imposing restrictions in fishery operations with particular reference to bottom trawling was engaging the attention of authorities, one of the points raised by the mechanised sector was a conspicuous lack of data on the breeding periods of both fin fish and shell fish along the west coast.

Considerable controversy exists regarding the incidence, relative abundance, and reproductive habits of *P. stylifera* along the coast of Kerala. The study is all the more significant in the light of the great controversy on the total ban on trawling during the monsoon period

(June, July & August.). Salient features of population characteristics, magnitude of resource, biological characteristics and rate of exploitation of the species along the coast have been studied by Rao (1970), George, *et al.* (1983) and Alagaraja, *et al.* (1986). However, only scanty information is available regarding several aspects of the biology of *P. stylifera*, more especially on the growth rates, size at first maturity, sex-ratio, total life span, breeding and feeding movements, fecundity, length-frequency distribution, gonadosomatic index, breeding season and range of movements from shore to deep sea along the continental shelf. It is in this context, that a study has been undertaken with a view to examining to the extent possible several of the above mentioned factors so that atleast some of the major controversial factors could be examined in some detail.

## MATERIAL AND METHODS

Fortnightly samples of *P. stylifera* were collected from the trawl catches landed at Needakara coast for a period of one year from May 1989 to April 1990.

A random sample of the required number of specimens (80 nos) were taken out of the total fortnightly collections of specimens for observations on the various aspects of breeding biology such as the determination of the various maturity stages, sex-ratio, fecundity, gonadosomatic index, breeding season, size at first sexual maturity, growth rates and total life span.

From each random sample collected, the total length and weight of each prawn was accurately recorded. Based on the external changes in colour, size, texture and microscopical examination of the ovary, five maturity stages have been recognized during the maturation of the ovary (Shaikahmed and Tembe, 1961; Rao, 1968). The different maturity stages are Stage I - Immature, Stage II - Early maturing stage, Stage III - Late maturing stage, Stage IV - Mature Stage and Stage V - Spent recovering. On the basis of these, the season

of highest spawning activity was determined. To delineate the breeding season, a quantitative assessment of the condition of the gonad employing the method of Gonado-Somatic Index for the different months was determined as follows.

$$\text{G.S.I.} = \frac{\text{Wt of ovary}}{\text{Wt of prawn}} \times 100$$

The fortnightly samples were also utilised for assessing the sex-ratio for each month. The size at first maturity was determined by estimating the percentages of all the maturing and mature female prawns in the monthly samples and plotting the length (in 5mm groups) against the percentage of maturing and mature prawns in each size group. The size at which the curve was intersected at 50% level was considered as the size of first maturity for the population. The growth rate was estimated by tracing the progression of modes in length-frequency distribution, and 50 females of varying length were randomly selected for fecundity studies.

## RESULTS AND DISCUSSION

### Distribution and occurrence :

This species is generally distributed along the coasts of Pakistan, Srilanka, Malaysia and Indonesia. In the Indian waters, it is mainly seen along the west coast where it is commercially exploited. Along the west coast of India, this species is most abundant from Veraval to Trivandrum coast; moderate in the northern and southern most region on the west coast, and sparse along the east coast. Adults of this species occur in coastal waters upto a depth of 30-40 m.

### Sex-ratio

Observations on the monthly sex-ratio of this species (Table I) show that the females predominate during all the months of the year. Shaikahmed and Tembe (1960) who studied the variation in the sex-ratio of this species in

Table I : *Monthly sex - ratio of P. stylifera*

Month	% of Males	% of Females
May	37.3	62.6
June	35.6	64.3
July	44.4	55.5
August	34.1	65.8
September	33.5	66.4
October	28.3	38.3
November	48.4	51.5
December	40.5	59.4
January	43.9	56.0
February	42.0	57.9
March	46.3	53.6
April	36.6	63.1

Bombay waters have pointed out that females invariably dominate during the peak breeding season. In the off-shore catches off Cochin, George *et al.* (1968) have observed a preponderance of females in both larger and smaller size groups. Such an instance has also been reported by George and Rao (1967) in the trawl fishery off Cochin.

#### Sexes and sexual difference

*P. stylifera* is heterosexual. No instance of hermaphroditism has been recorded. The female is usually larger than the male. The male is distinguished from the female by its smaller size and bright colour. In the male, the endopodites of the first pair of pleopods are modified to form a copulatory organ, the petasma or andricum. The second pleopod also shows an accessory structure, the appendix masculina. In the female, the most striking character is the presence of a ventral thoracic structure, the thelycum, situated between the last three pairs of thoracic legs. In addition to the above mentioned difference is the location of the openings of the genital ducts. In the female, they are situated on the bases of the coxae of the third pair of pereopods, while in the male they are on the last pair.

#### Size at first maturity

The estimated minimum size at first maturity was found to be in the size range of 71-75mm length groups (Fig.1). No mature

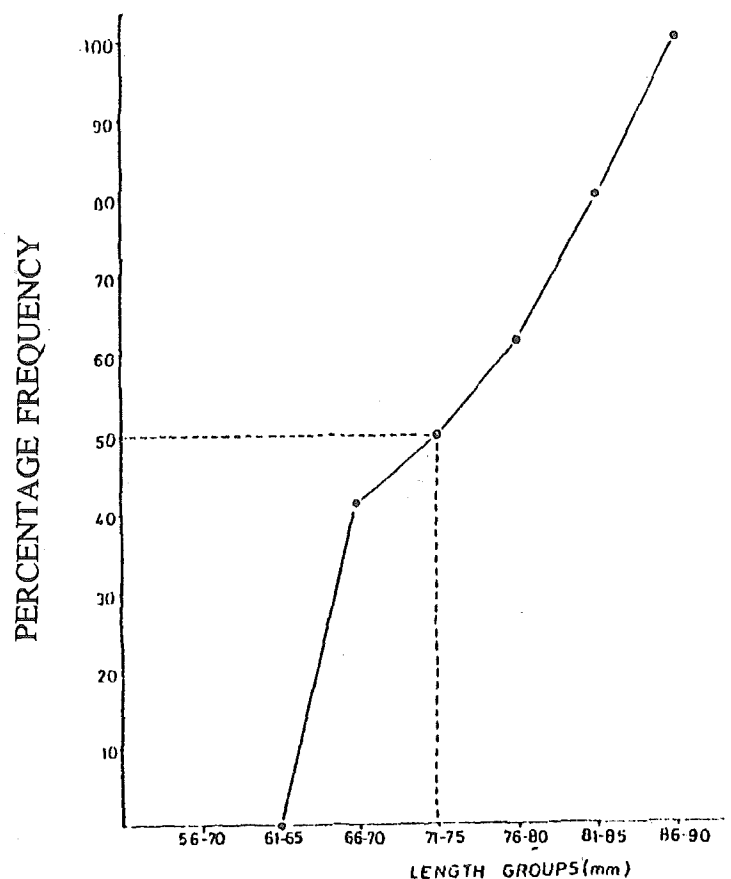
Fig. 1 : *Size at first maturity of P. stylifera.*

Table II : *Percentage composition of various maturity stages of P. styliifera during different months.*

Maturity stages	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April
Immature	3.30	77.50	72.70	64.40	30.0	22.2	3.30	60.50	31.30	6.09	3.58	3.24
Early Maturing	8.26	1.69	10.50	10.80	38.0	48.1	5.70	12.50	38.40	26.70	16.90	16.00
Late Maturing	11.50	2.80	5.64	7.65	13.0	12.5	64.70	11.30	19.00	8.24	49.10	34.20
Mature	77.00	3.12	4.08	6.74	18.0	17.2	26.30	11.30	8.80	8.52	25.38	45.20
Spent	--	14.89	7.09	11.50	--	--	--	10.62	2.80	2.43	5.08	1.43

prawns were found in length groups less than 70mm. The smallest mature prawn that has been observed during the course of the present study measured about 75mm in total length. Therefore, it may be considered that the minimum length at first maturity of female of this species is at about 75mm in total length. According to Menon (1953) males attain maturity at 65 mm and females at 75 mm in total length but Rao (1968) has recorded the minimum size at first maturity of this species at 63.2 mm.

### Spawning Season

Observations on the percentage composi-

tion (Table II) reveal that mature females are seen throughout the year indicating that the prawn is a continuous breeder. But in May and in November over 90% of the females are mature (Fig.2) A close scrutiny also reveals that more spent females are seen shortly after May and November than in other months. Nevertheless, the continuous occurrence of all stages throughout the year indicates that the spawning period is prolonged. The gonado-somatic indices (Table II and Fig 3) also reveal the same picture with a definite peak in May when over 90% of the ovaries are in the ripe condition. The index declines in June, July and August and also in December and January suggesting the spawning periods. Thus there

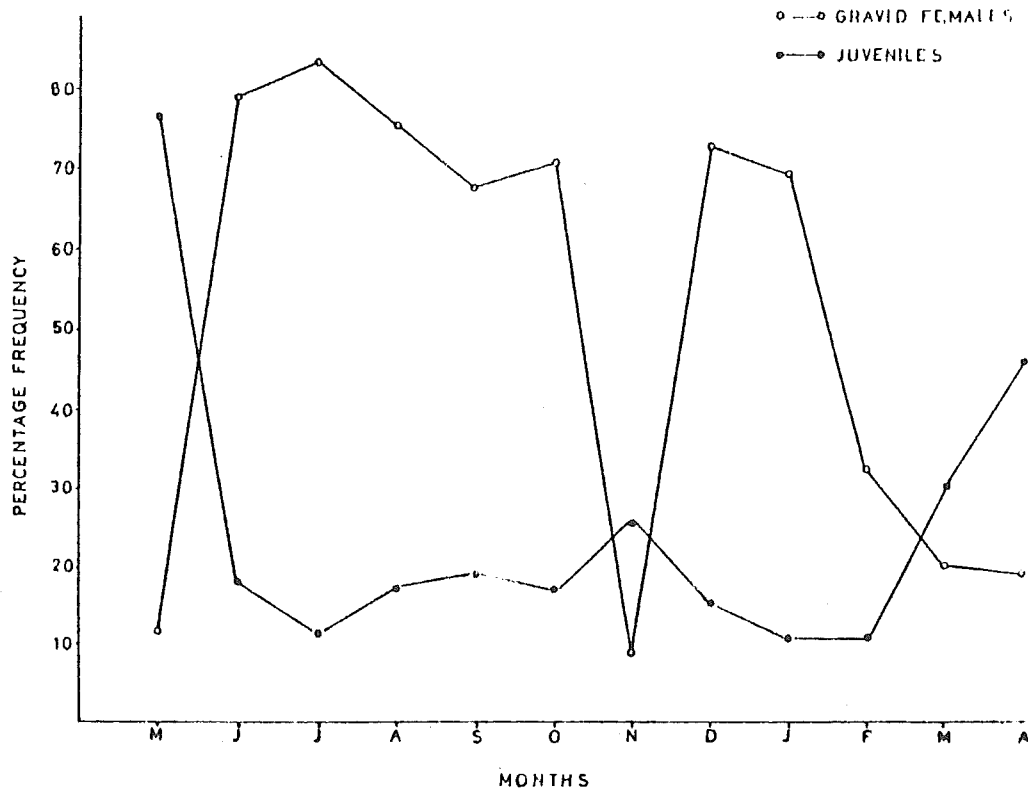


Fig. 2 : *Showing the percentage frequency of the incidence of juveniles and gravid females during different months.*

Table III : *Monthly gonado-somatic index of female P. stylifera during different months.*

Months	Mean G.S.I.
May	4.62
June	2.88
July	2.29
August	1.59
September	1.70
October	1.97
November	3.29
December	2.27
January	1.80
February	1.92
March	2.46
April	3.52

appears to be two peak periods of spawning activities, one in May and the other in November. Those which are spawned in May become ready for the next spawning in November and these juveniles in November/December become sexually mature by April/May.

The size at sexual maturity is approximately 75mm and this they attain in about six months time.

Based on the occurrence of females, breeding of *P. stylifera* in Cochin waters has

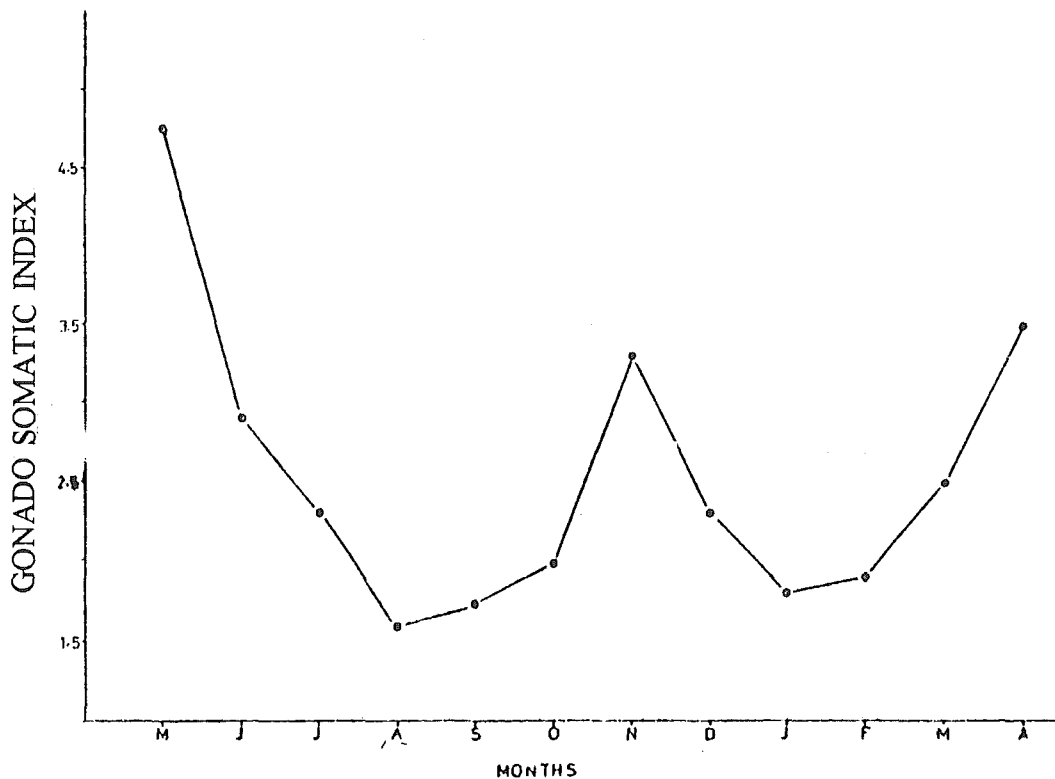
Fig. 3 : *Monthly gonado - somatic index of P. stylifera during different months.*

Table IV : *Peak breeding months for P. stylifera along the coast of India as reported by various authors following different methods*

Locality	Authors	Breeding months	Methods
Cochin	George <i>et al.</i> (1968)	Jan, April, Nov. Dec.	Abundance of mature females
Malabar	Menon (1953)	Oct, Nov, Dec.	Abundance of ripe females
Goa	Achuthankutty <i>et al.</i> (1977)	Jan, Nov, Dec.	Abundance of post larvae
Goa	George Goswami (1977)	February	Abundance of post larvae
Bombay	Mohamed (1967)	Jan, Feb, Sep, Oct, Nov, Dec.	Abundance of gravid females
Bombay	Shaikahmed & Tembe (1960)	Jan, Feb, March, April, May, Dec.	Abundance of gravid females
Maharashtra	Smita (1990)	Feb, May, July, Oct, Nov.	Length - frequency analysis

been recorded to take place throughout the year with peak activity in November, January and April (George *et al.* 1968). In Malabar, incidence of ripe females during October, November and December was 16%, 30% and 20% respectively which decreased progressively to about 8% in May (Menon, 1953). In Bombay waters, breeding was recorded during September-February and possibly in May (Mohammed, 1967) or during December to May (Shaikahmed & Tembe, 1960). In Goa, this species breeds during the post-monsoon months of November-January with peak in November (Achuthankutty, *et al.* 1977) while another study indicated peak spawning in February in Goa (George & Goswami, 1977). Smitha (1990) has reported that the breeding of this species in Bombay waters is protracted with major broods originating in the months of February, May, July, October and November. Thus this species appears to breed throughout the year, but the peak spawning season seems to vary from place to place (Table 4).

#### Fecundity

Penaeid prawns have high fecundity. The number of eggs produced by mature females in *P. stylifera* was determined and it was found

that the number of eggs varied with the size of the prawn in a logarithmic manner. This species produces an average 42,500 eggs at 70mm length and 240,000 eggs at 120 mm length. Similar observations has also been made by Rao (1970).

#### Growth rate and total life span

Monthly length-frequency data have been prepared and are represented in Fig 4. The probable duration of life has been estimated from the length-frequency data for each month by tracing the progression of modes through successive months.

The dominant mode of the species at 30 mm in June 1989 may be traced to the one at 75 mm in November 1989, showing a progress of growth rate of 12.5 mm/month. The same mode could be traced to the one at 90mm/month. Therefore, it has been estimated that at the end of one year, the prawns would attain a size of 90 mm in total length. Taking an average growth rate of 2.5 mm/month based on the above values growth in the second year would be  $90+2.5 \times 12=120$ mm. Since the maximum size of the prawn observed during the course of the present study is 135mm, growth at the end of

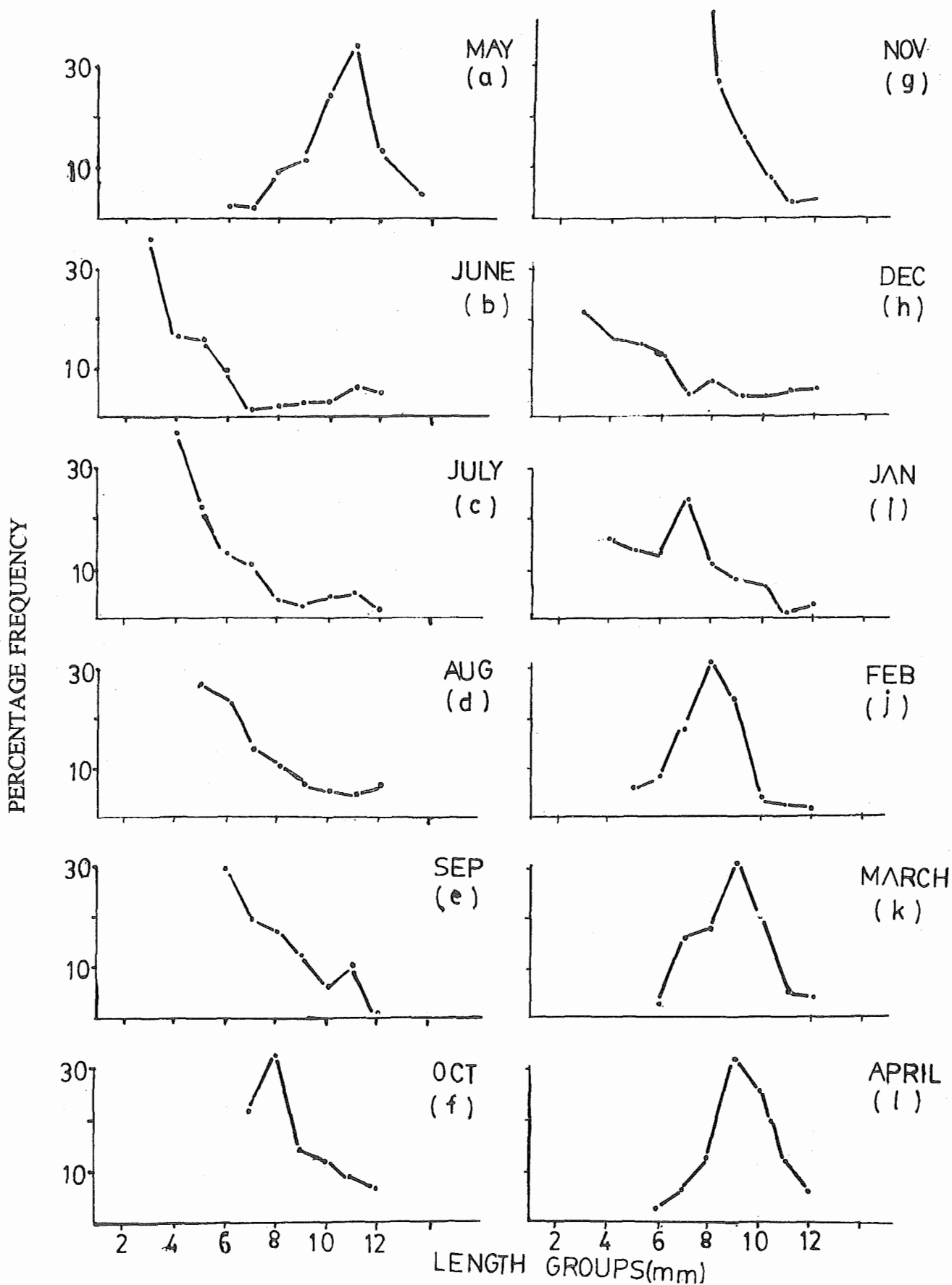


Fig. 4 : Length - frequency distribution of *P. stylifera* during different months.

2.5 years would be  $12+0.25 \times 6 = 135$  mm. Therefore, the probable life span of the species would be 2.5 years. Menon (1953) also stated that this species lives for 2 years but suggested that some may even live longer. Smitha (1990) has observed that one year old females of this species measure about 88.0 mm and life span to be 2.5 years. But the present study reveals that one year old females measure about 90 mm and at the end of 2.5 years, they would attain the maximum length of about 135 mm.

### Movements

Most penaeid shrimps have an amphibiotic life cycle but *P. styliifera* is strictly a marine species. According to Rao (1970) it appears to perform annual movements to and from the coast. George *et al.* (1968) studied the movements of this species along the fishing grounds off Cochin. They have suggested that there is segregated movements of females to deeper waters during the spawning season. They also pointed out that the female ratio is less during the peak spawning season thereby indicating movements of females to deeper waters.

Recent experimental shrimp trawling conducted by the CMFRI (Suseelan *et al.* 1989) off Cochin over a period of two years has shown that during September/October to May, the shrimp stocks occupy the coastal waters within the 20 m depth contour. With the commencement of the south-west monsoon and the consequent changes in the environmental conditions, the 'Karikkadi' is reported to leave the inshore areas in large numbers to deeper waters (Rao, 1970). A small population of the species however is believed to stay very close to the shore within 5-6 m depth during the monsoon period which is predominantly constituted by adult prawns in spawning condition. It is not known whether the migrants return to the coastal waters or not, after the cessation of southwest monsoon. Conclusive evidences are also lacking to confirm that the species performs the same kind of depth-wise migration or any other type of large scale movement at other centres as well of the Kerala coast.

Decrease in the percentage of mature prawns has been observed soon after the commencement of southwest monsoon during the course of the present study indicating egression of these prawns from the inshore trawling grounds to deeper waters. It is not known how much of the population of *P. styliifera* occurring in Neendakara area undertake the offshore movements.

### Observations

- (1) June, July and August seem to be the peak period of breeding activities, when there is a preponderance of juveniles in the fishing grounds. (Fig. 4 b,c & d). It is a fact of observation that during the monsoon period, the catches are chiefly composed of sub-mature form of *P. styliifera*. Indiscriminate catches of these juveniles before they get an opportunity to spawn would adversely affect the stock potential. Therefore a restriction of catches during this period in the form of a ban on trawling will have a salutary effect in saving at least a part of these juveniles and allow them to spawn at least once, thereby assisting the replenishment of the population.
- (2) There is difference in size of 'Karikkadi' caught during the months of June, July and August. Majority of the specimens caught in these months are sub-mature ones below the size of 75 mm. Removing these juveniles in large numbers will adversely affect the stock of this species.
- (3) Life span of 'Karikkadi' is approximately 2.5 years. Therefore, the contention that unless these juveniles are caught at the time of their occurrence during the monsoon, they will be lost to the fishery seems to be far-fetched.

### Recommendations

The Government appointed expert groups to make recommendations for the sustainability



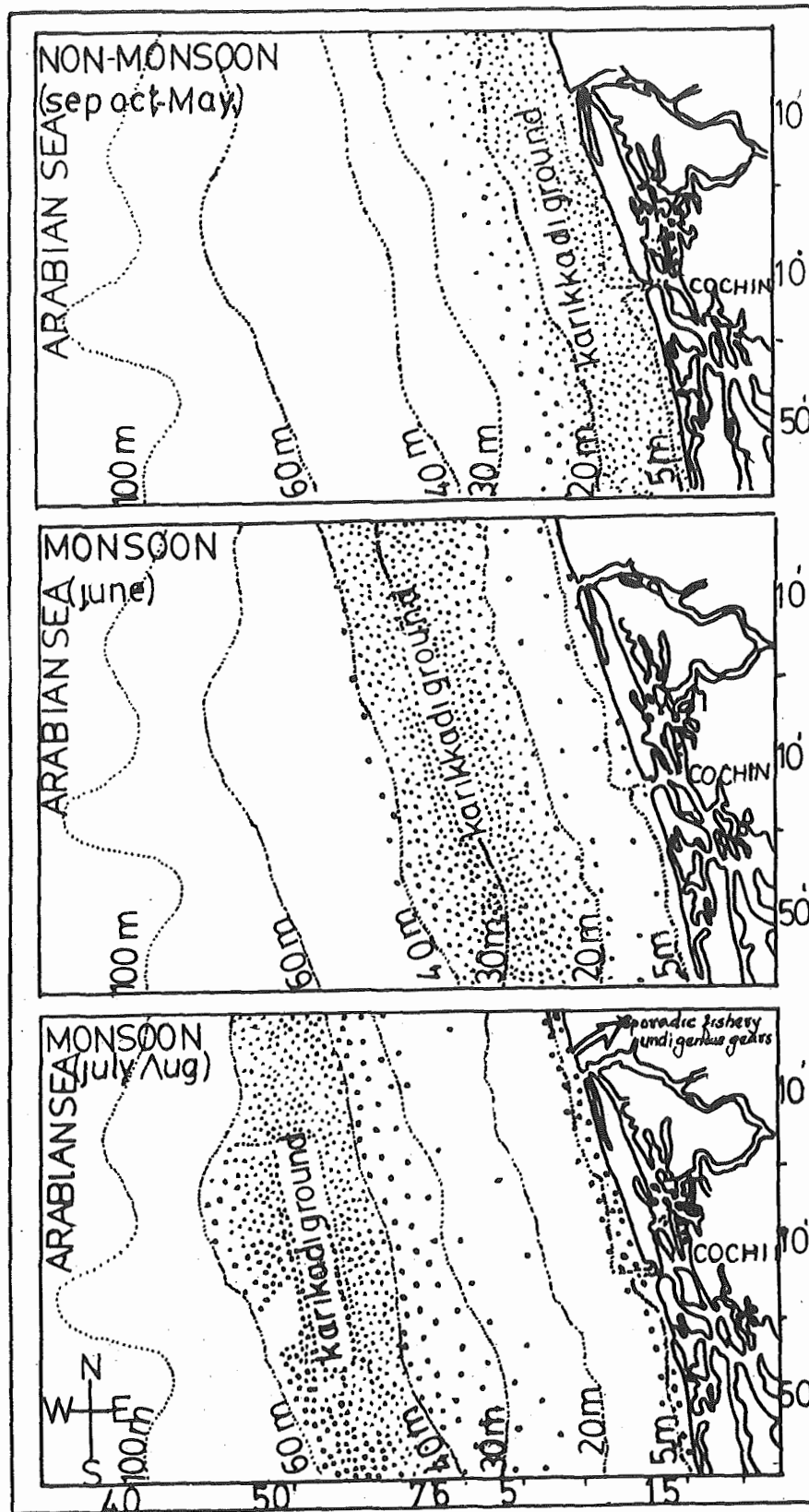


Fig. 5 : Map showing Karikkadi groups off Cochin. Dotted areas indicate distribution and relative abundance. (CMFRI)

of shrimp catches of the country and maintenance of the export trade. The recommendations now in force in the state can be broadly classified as

1. Registration of fishing vessels.
2. Licensing of fishing implements and fishing methods.
3. Mesh size regulations.
4. Prohibition of destructive types of fishing methods.
5. Delimitation of fishing zones and
6. Declaration of closed seasons.

Besides these recommendations, the following suggestions have also been offered.

1. As the spawning of 'Karikkadi' is restricted to the shallow coastal waters, the existing fishing regulations preventing operation of shrimp trawlers within the coastal waters upto 20- 40m depth line should be strictly enforced.
2. In order to prevent the indiscriminate capture of juvenile prawns less than 70mm in total length, a strict ban on the catch and export of undersized prawns is a prerequisite for any purposeful fishery regulation.
3. Operation of mini-trawls in the shallow coastal waters catching mainly the juvenile prawn (25-60mm) should be discouraged.
4. Since 'Karikkadi' is reported to be moving out and concentrating in the offshore waters during the monsoon and post-monsoon period, shrimp trawling in the deeper waters beyond 30m depth may be advantageous to the fishery.

Taking into consideration the reported nature of movements of *P.stlifera* to deeper

waters during monsoon (Fig.5), it has been suggested that this resource would be partly available to the trawlers operating beyond territorial waters during the monsoon (July-August). In addition, this approach will have a favourable effect on the overall conservation of resources as the juveniles now being indiscriminately caught and removed from the population would get an opportunity to reproduce, thus assisting in the replenishment of the stock. This in turn will form a good fishery in the subsequent seasons. Regarding the life span of this particular species, it has been found from the present study that it has a life span of 2.5 years as reported earlier (Suscelan *et al.* 1989) and they grow upto a size of 13.5 cms. Therefore, the argument that these prawns are likely to be totally lost to the fishery seems to be untenable. At any rate, a part of the stock would certainly be available in the offshore waters (in the event of a possible movement of the population as suggested by some workers) where they could be harvested during the post-monsoon by the mechanised groups. Such a procedure would be advantageous since it would facilitate the replenishment of the stock, through a mass spawning by these juveniles when they attain the size of 75mm by November.

The results of the present study would suggest that the ban on monsoon trawling by the Government to ensure resource conservation will serve a useful purpose

#### ACKNOWLEDGEMENTS

The authors are thankful to Prof. P. Natarajan, Head of the Department of Aquatic Biology & Fisheries for the facilities provided. One of the authors (SG) is grateful to the STEC for the award of a research fellowship during the tenure of which this work was carried out.

#### REFERENCES

- Abraham, J.T. 1991. Shrimp production in India - A review. *Sea Food Export Journal*, 23 (4) : 5 - 14.

- Achuthankutty, C.T., George, M.J., and Goswami, S.C. 1977. Larval ingression of penaeid prawns in the estuaries of Goa. *Proc. Symp. Warm water. Spl. Publ.* UNESCO/NIO., 412 - 424.
- Algaraja, K.M., George, M.J., Kurup, N.K. & Suseclan, C. 1986. Yield per recruit analyses on *Parapenaeopsis stylifera* and *Metapenaeus dobsoni* from Kerala State, India. *J. Appl. Ichthyol.*, 2 :1-11.
- Alcock, A. 1906. Prawns of the penaeus group. In. Catalogue of the Indian Decapod Crustacea in the Collection of the Indian Museum. Part III, Macrura, Fasc. I. Calcutta, 55 p.
- George, M.J. 1979. Systematics of the commercially important prawns in Goa. *J. Bombay. Nat. Hist. Soc.*, 76 (2) : 297-304.
- George, M.J. and Goswami, S.C. 1977. Observation on the larvae of penaeid prawns of commercial importance in coastal waters of Goa. *Proc. Symp. Warmwater. Zoopl.*, UNESCO / SCOR / NIO., Goa.
- George, M.J., Raman, K. and Nair, P.K. 1968. Observations of the offshore prawn fishery of Cochin. *Indian. J. Fish.*, 10(2): 460- 99.
- George, M.J. and Rao, P.V. 1967. Distribution of Sex-ratio of penaeid prawn in the trawl fishery off Cochin. *Sym. Ser. Mar. Biol. Assn. India*, 2(2) : 698-700
- George, M.J., Suseclan, C., Thomas, M.M., Kurup, N.S., Rajan, K.N., Kakati, V.S., Gopalakrishnan, K.N., Chellappan, K., Balasubramanyan, K.K. and Nalini, C. 1983. Marine prawn fishery of Neendakara coast, Kerala. A critical study. *Mar. Fish. Infor. Service. T&E. Series*, 53:1-8.
- Hall, D.N.F. 1962. Observations on the taxonomy and biology of some Indo-West Pacific. Penaeidae. (Crustacea, Decapoda). *Fish. Publ. Colonial Off. London*, 17:229p.
- Kalawar, A.G., Devaraj, M. and Parulekar, A.H. 1985. Report of the Export Committee on Marine fisheries in Kerala. Submitted to Govt. of Kerala, CIFE. Bombay. 467. pp.
- Menon, M.K. 1953. Notes on the bionomics and fishery of the prawn *Parapenaeopsis stylifera* (M.Edw) on the Malabar coast. *J. Zool. Soc. India*, 5(1):153-162.
- Mohammed, K.H. 1967. Penaeid prawns in the commercial shrimp fisheries of Bombay with notes on species and size fluctuations. *Symp. Ser. Mar. Biol. Asso. India*, 2(4) : 1408-1418.
- Racek, A.A. and Dall, W. Littoral Penaeidae (Crustacea, Decapoda) from northern Australia, New Guinea and adjacent waters. *Verh. K. ned. Akad. Wet.*, (2), 56 (3) : 119.
- Rao, P.V. 1968. Maturation and spawning of the penaeid prawns of the South-West coast of India. *F.A.O. Fish. Rep.*, 2:285-302.
- Rao, P.V. 1970. Synopsis of biological data on the penaeid prawn *P. stylifera*. *F.A.O. Fish. Rep.*, 4(57) : 1575-1605.
- Shaikahmed, F.S. and Tembe, V.B. 1960. Study of Bombay prawns. The seasonal fluctuation and variation in abundance of the commercially important species of Bombay prawns with a brief note on their size, state of maturity and sex-ratio *Indian. J. Fish.*, 7(1) : 69-81.
- Shaikahmed, F.S. and Tembe, V.B. 1961. A brief account of the changes in the developing ovary of penaeid prawn *Parapenaeopsis stylifera* (M.Edw) in relation to maturation and spawning cycle. *J. Bombay Univ.*, 29 (3&5) : 62-77.

**Smita, H.** 1990. Population dynamics of penaeid prawns of the genera *Metapenaeus* and *Parapenaeopsis* exploited in trawl fishery along the coast of Maharashtra. *Ph.D.thesis*, CIFE, Versova, Bombay.

**Suseelan, C., Rajan, K.N. and Nandakumar, G.** 1989. 'The Karikkadi fishery of Kerala' *Mar. Fish. Infor. Service. T&E. Series*, 102.