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Biology of *Metapenaeus moyebi* (Kishinouye, 1896) and barrier net fishery in Maharashtra waters

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Abstract

Barrier nets down the banks of inshore creeks support localised fisheries along the northern Maharashtra coast. The fishery in Rajpuri creek targeting juveniles of penaeid prawns and fishes is described. Occurrence of penaeid prawn *Metapenaeus moyebi* and its biology is reported for the first time along the northwest coast of India. It occurs seasonally in small quantity in trawl catches also. The size composition, growth, food and feeding and length-weight relationship of the species are described. The reproductive biology in relation to size at maturity, spawning season and spawning area indicate spawning migrations to the sea. The generation time is six months and the species exhibited two generations annually, with summer and winter cohorts.

Key words: *Metapenaeus moyebi,* spawning migrations, generation time, reproductive biology

Introduction

Metapenaeus moyebi is a smaller species of penaeid prawn reported to occur in lesser magnitude in the inshore landings along the southern coast of India. However, the species enjoys wider distribution in Japan, Hong Kong, Malaysia, Philippines (Hall, 1967) and Sri Lanka (De Bruin, 1965). From the Indian waters, it has been mostly reported from the southeast coast (Nair *et al*., 1967; Muthu and Manickam, 1973). Along the southwest coast, the species is reported to form a small fishery in Kali estuary in northern Karnataka (Sukumaran and Nandakumar, 1983). Some biological studies on maturation are reported from Mandovi estuary of Goa (Nair *et al*., 1993) and larval development from the Karnataka coast (Nandakumar *et al*., 1989).

Although detailed account of prawns contributing to the fishery in Maharashtra has been reported (Kunju, 1967), occurrence of adults of *M. moyebi* has not been reported in the coastal waters. However, the postlarvae have been reported by Chaudhary and Jalihal (1998). While analysing samples of prawns from the landing centres in Maharashtra, *M. moyebi* was regularly observed in the Rajpuri creek near Janjeera-Murud in Raigad district and in trawl catches at Harnai landing centre in Ratnagiri District. The present work reports the occurrence of *M. moyebi* from the northwest coast of India for the first time and describes the barrier net operation in the creeks of Maharashtra where it contributes to the prawn fishery. The fishery and biological characteristics such length composition, food and feeding, length weight relationship and reproduction of the species are also reported.

Materials and methods

Samples of M. Moyebi were collected during April 2003 to March 2004 at fortnightly intervals from the barrier nets operated in Rajpuri creek near Janjeera-Murud. During the period, trawl landings were also observed from Harnai, which is about 30 km south of the mouth of Rajpuri creek. In the trawlers, a few specimens of the species were observed during January and February.

The samples were preserved in 10% formalin and brought to the laboratory for biological studies. Total length was measured from the tip of the

rostrum to the tip of the telson to the nearest millimetre and the specimens were weighed up to 0.001 g accuracy in an electronic balance. The length measurements were grouped in 5 mm class interval and monthly length-frequency was obtained separately for the sexes to estimate growth parameters. The von Bertalanffy growth parameters (VBGF) were estimated using FiSAT software (Gayanilo *et al*., 1996).

Maturity stages were classified following Rao (1968); stages I and II were grouped as immature while III and IV as mature. Spent females were noticed only in the samples collected from the trawl catches at Harnai. Males with united petasmal endopodites and spermatophores and females in stages III and IV of maturity were used for determining the size at first maturity by King's (1993) method. Fully mature (stage IV) female specimens were preserved in 10% formalin and fecundity was estimated by gravimetric method. For analysis of food, gut contents were identified up to group level and analysed by 'Index of Preponderance' method suggested by Natarajan and Jhingran (1961). The feeding intensity was visually estimated based on the fullness of gut and quantity of food by assigning points.

Barrier net fishery: Fishing in Rajpuri creek is mainly artisanal and carried out by means of fixed barrier nets locally called '*Dharan Jal*'. These nets are fixed on the bottom by bamboo stakes in very shallow waters and laid as a barrier in about 1.5-2.0 m depth along the shore of the creek. The net consists of about 8 to 10 rectangular pieces (10 m x 2.5 m dimension) of nylon or cotton netting with mesh size of about 8-10 mm having lead weights at the bottom and a simple nylon rope at the top. The pieces of net are joined together to form the barrier. The average length of the net is 80 to 100 m.

During low tide, 2-3 fishermen set the net along the muddy shore of the creek (Plate 1). The lead weights and the bottom rope of the nets are buried in the mud which is sustained by stones and pebbles. When the tide rises to the highest peak of water level, the fishermen from two operating boats erect the upper margin of the net and join the head rope to the bamboo stakes thereby creating a barrier for the fishes and prawns. The boats are non-mechanised dugout canoes, which carry pebbles for setting the net if the gaps open up. During high tide, water spreads along the shore and fishes and prawns which come close to the shore, probably for feeding, get enclosed by the net. As the tide ebbs, the fishes and prawns get entangled in the raised barrier nets by the force of receding water current. The dugout canoes with five crew members

Plate 1. Barrier net at low tide

haul the net to the canoe. On landing, the catch is sorted out from mangrove leaves and prawns. The juveniles of *Penaeus merguiensis* and *Metapenaeus brevicornis*, which command high price are washed to remove the mud and taken immediately for sale. The price varies from Rs 60 to 80 per kg depending on the species and the size. *Mugil*, *Thryssa*, *Escuolosa*, *Therapon*, *Coilia*, catfish, sciaenids, ribbonfish (*Eupleurogrammus muticus*) and crabs which form sizeable portion of the catch are taken for home consumption by the fishermen or sold to women who sell the catch in the nearby villages or barter for grains in the interior places.

Since the force of the tidal current is high during spring tides, the nets are operated only for 4-5 days before and after the new moon and full moon days. Therefore, the fishery is functional for 13-16 days in a month. The barrier net fishery continues almost throughout the year but during festivals, religious functions and death in the village the fishing operation is suspended.

Results

Catch and effort **:** The estimated annual total landing (Table 1) by barrier nets at Khamde landing centre was 31.1 t with the catch per unit of 27.4 kg/unit. The penaeid prawns contributed to 36.8% to the total landings. The prawn landings were maximum in March (2046 kg) and minimum in April (357 kg). Maximum cpue of 22.7 kg was noticed in March. *M. moyebi* with annual catch of 770 kg formed 6.7% of the prawn catch. The catch of the species was maximum in July (173 kg) and there was no catch in November and December.

At Harnai, during January and February, some of the hand operated trawlers fishing in shallow depths (10-20 m) at 5-10 km off the shore caught *M. moyebi* at the rate of 20 kg/boat. However, the contribution of the species to the total prawn catch in trawlers was negligible.

Size composition**:** The size of *M. moyebi* in the barrier nets (in the creek) ranged from 43 to 83 mm for males and 48-108 mm for females. The month-wise mean size of males and females is given in Fig.1. It was noticed that the size was generally smaller in May (mean: 66.8 mm) and larger in February (mean: 87.2 mm). At Harnai, the catch landed from the open sea showed that the mean size of males was 77.0 mm and that of females 98.6 mm.

Table 1. *Estimated monthly catch (kg), effort and CPUE of prawns in barrier nets at Khamde landing centre*

Month	No of units	Total catch (kg)	Catch of prawns (kg)	Total catch (kg/unit)	Prawns (kg/unit)	% of prawns in total catch	Catch of *M. moyebi*
April '03	128	1611	357	12.59	2.79	22.2	46
May	90	1731	766	19.23	8.51	44.3	64
June	90	5408	1188	60.09	13.20	22.0	156
July	105	3961	1185	37.72	11.29	29.9	173
August	83	3282	1279	39.54	15.41	39.0	98
September	98	3338	1556	34.06	15.88	46.6	30
October	90	1750	604	19.44	6.71	34.5	7
November	90	1545	726	17.17	8.07	47.0	0
December	75	2049	823	27.32	10.97	40.2	0
January'04	105	1380	455	13.14	4.33	33.0	10
February	90	1308	480	14.53	5.33	36.7	30
March	90	3750	2046	41.67	22.73	54.6	156
Total	1134	31113	11465	27.44	10.11	36.8	770

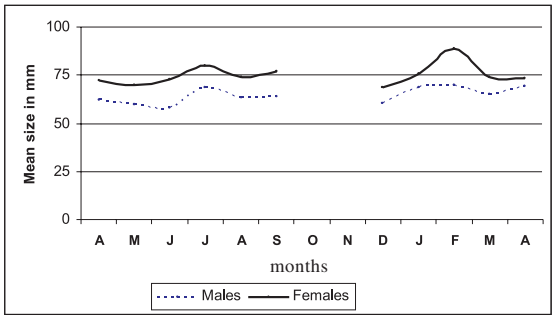

Fig. 1. Monthwise mean size of male and female *M. moyebi*

***Age and growth*:** The maximum predicted sizes by the FiSAT subroutine 'maximum extreme length' were 90.9 mm (95% confidence interval: 82.8-99.0 mm) for the male and 117.8 mm (95% confidence interval: 107.7-128.0 mm) for the female. Considering these values, the asymptotic lengths (L_∞) obtained by the Powell-Weatherall subroutine were 88.7 mm and 117.9 mm for the male and female respectively. Resolving the monthly size frequency by the subroutine 'Bhattacharya analysis' and connecting the modal sizes by Gulland-Holt plot yielded von Bertalanffy growth function parameters (VBGF) L_∞ and K as 87 mm and 3.01 yr^{-1} for males and 119.4 mm and 2.1 yr^{-1} for females respectively. With these VBGF parameters, the male and female are estimated to attain 67.7 mm and 77.6 mm in six months and 82.7 mm and 104.8 mm in one year, respectively (Fig. 2).

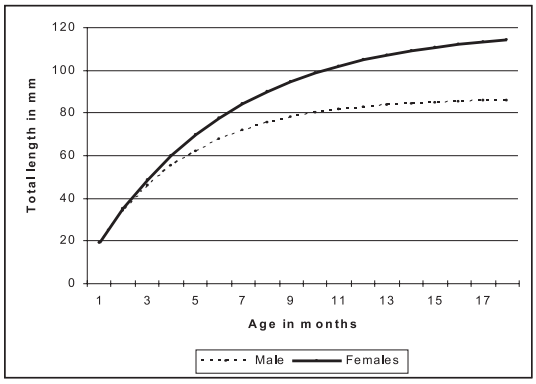

Fig. 2. Growth curves of male and female *M. moyebi*

***Length weight relationship*:** Length weight relationship of 109 males ranging from 47-89 mm in total length and weighing 0.560 to 4.044 g, and 201 females ranging from 49-117 mm in length and from 0.810-10.637 g in weight was estimated. The regression equations of log transformed lengths and weights for the two sexes were:

Male: Log TW= - 4.8524+ 2.8047 Log L, (r^2 = 0.93)

Female: Log TW= - 5.1659+ 2.9925 Log L, (r^2 = 0.98)

Regression coefficients of both the sexes were compared by analysis of covariance, which showed that the slopes of male and female prawns were significantly different ($p<0.05$). Further, slopes of the regression lines of both the sexes, which were tested by't' test, showed that only females followed the cube law at 95% confidence interval. Therefore, length-weight relationships are different between the sexes.

Food composition: As the gut contents were thoroughly macerated, the food items could be identified up to group level only. There was no significant difference between the feeding intensity of sexes (r_s 0.89; $p>0.05$). Index of Preponderance (IP) of various food items from estuarine habitat showed that the major constituents (Table 2) were polychaetes (IP 57.7%) followed by detritus (IP 19.7%) and bivalves (IP 10.0%). Food of prawns in the open sea also showed preference for polychaetes (IP 49.4%), penaeid prawns (IP 36.4%) and detritus (IP 7.8%). Sex-wise analysis of food in male and female prawns showed almost equal dominance of the same food items.

Length at maturity: To estimate the length at maturity, mature females collected from both inshore barrier nets and the trawlers were used. In the case of males, the individuals with fused petasmal endopodites were considered as mature. The smallest mature male was 42 mm and the length at first maturity (L_{50}) was 45.2 mm (Fig. 3a). Similarly, the smallest mature female measured 54 mm and the L_{50} was 69.4 mm (Fig. 3b).

Table 2. *Index of Preponderance (%) of food items of* M. moyebi

Area /Sex	No. of specimens	Prawn remains	Gastropods	Bivalves	Foraminiferans	Polychaetes	Benthic crustaeceans	Fish	Semi-digested matter	Detritus
Inshore waters										
Females	130	8.15	2.35	9.57	0.01	56.08	4.99	0.01	0.00	18.81
Males	84	3.01	1.05	10.65	0.01	59.64	4.32	0.00	0.27	21.05
Total	214	5.93	1.80	10.01	0.01	57.69	4.74	0.01	0.05	19.75
Open sea										
Females	45	36.43	0.10	2.35	3.33	49.36	0.00	0.59	0.00	7.84

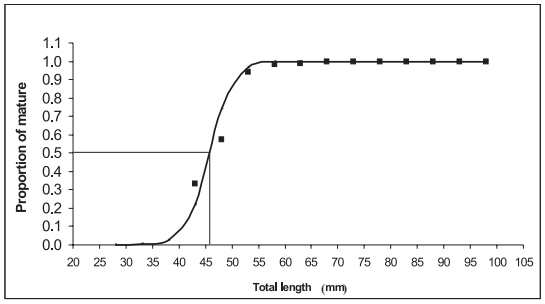

Fig. 3 a. Length at maturity of male, *M. moyebi*

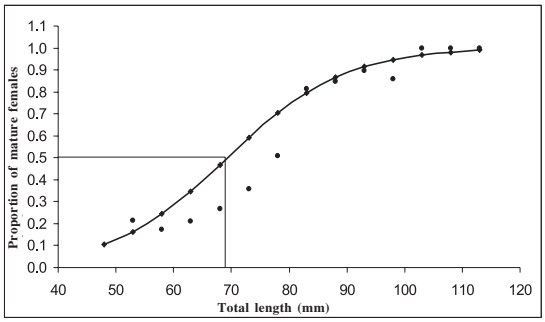

Fig. 3b. Length at maturity of female *M. moyebi*

Maturation: Analysis of gonadal condition showed that the females mature (stages III and IV) during July to September and January to April (Fig. 2) with peak in February (47%) in Rajpuri creek. Samples from open sea off Harnai showed

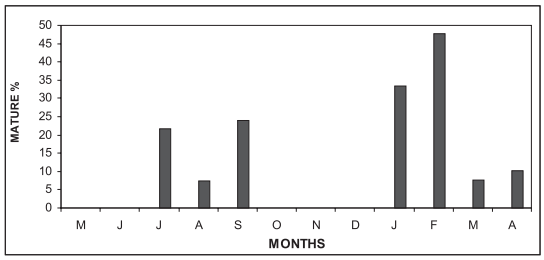

Fig. 4. Monthwise percentage of mature females, *M. moyebi* in inshore waters

that 80% females were in mature state during January-February.

Fecundity: The fecundity of 22 specimens ranging from 68 to 112 mm in total length and weighing between 2.126-10.554 g with ovary weights between 0.385-1.386 g was estimated. The number of ova ranged from 38,984 to 182,028. The log converted relationship between total length and the number of eggs was:

$$\text{Log } F = -1.2632 + 3.1644 \text{ Log } L \quad (r^2 = 0.936)$$

where, F is fecundity (number of eggs) and L is total length (mm).

Discussion

Despite wider distribution of *M. moyebi* in the southeast Asian waters from Japan to Sri Lanka (De Bruin, 1965; Hall, 1967), Nair *et al.* (1967) and

Muthu and Manickam (1973) commented that along the Indian coast the species is restricted to the southern coasts and completes its life cycle in the estuarine waters. However, the present study shows that the species is distributed along the coast of Maharashtra also.

Sukumaran and Nandakumar (1983) noticed a minor fishery for *M. moyebi* in the Mangalore estuary that was supported by juveniles. Adults were not observed in appreciable quantities either in the estuary or the nearby inshore waters and therefore they remarked that the location of the adult population was unknown. They further noted that the fishery, further north at Karwar was constituted by the adults in the inshore waters and juveniles in the Karwar Bay, which prompted them to suggest that the latter originated from the stock in the nearby Mandovi-Zuari estuarine system in Goa. These observations led Sukumaran and Nandakumar (1983) to conclude that the species is essentially estuarine, and completes its entire life cycle in the inshore waters. Subsequently, Nair *et al*. (1993) observed both mature females and juveniles in the Mandovi estuary of Goa but added that females in advanced stages of ovarian maturity may not be able to reach the sea for spawning, in spite of finding a few mature prawns in exploratory trawling operations in the nearshore waters. These observations imply that the species is confined to the estuarine waters and occasionally undertakes seaward movements. In the present study, occurrence of juveniles as well as mature prawns in the inshore landings apparently suggests that the species is confined to the inshore creek waters. But, occurrence of as many as 80% of the females in mature condition in the open sea as observed in the trawl landings at Harnai, substantiates that the species moves out from the estuarine inshore waters to the shallow open sea for spawning. Similarly, mature females in the marine environment of Pulicat bar mouth (Muthu and Manickam, 1973) and in Karwar Bay (Sukumaran and Nandakumar, 1983) must be migrating seaward for spawning. After completing the larval phases in the marine environment, like most of the penaeid prawns, *M. moyebi* enters estuarine creeks where it spends most of its life until the females mature sexually.

The maturity distribution showed two peaks of mature females in January-February and in June (Sukumaran and Nandakumar, 1983) in Karwar Bay and from January-June and in September (Nair *et al*., 1993) in Goa waters. The present study also showed two spawnings, one during January-April and the other from July to September. This bimodal spawning at population level advocates that the generation time of the species is six months. It is possible that the peak spawning in February observed in the present study provides summer cohort that grows through April to July in the creek and spawns in September-October in the sea, which tenders a winter cohort. The offsprings of this winter cohort grow in the creek and spawn in February. Of the two cohorts, the summer cohort appears to be stronger than the winter cohort, as evidenced by the higher abundance and consequent increase in catch rate during June-July. The occurrence of large sized prawns in the sea during January-February indicates that they are the residuals of the summer cohort that are about a year old. A prominent peak of mature females observed in February suggests that *M. moyebi* matures and spawns once again along with the winter cohort to give rise to the summer cohort and thus follows a one year generation cycle which has been generalised for the tropical penaeid prawns by Garcia (1988).

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References

Chaudhari, K. J. and D. R. Jalihal. 1998. Morphometric studies on the seed of penaeid prawns of Ratnagiri coast. *Indian J. Mar. Sciences,* 20: 378-388.

De Bruin, G. H. P. 1965. Penaeid prawns of Ceylon (Crustacean, Decapods: Penaiedae). *Zool. Med. ed.,* 41 (4): 73-104.

Garcia, S. 1988. Tropical Penaeid Prawns. In: (J.A. Gulland, Ed), Fish Population Dynamics. John wieley and Sims, Chichester, P. 219-250.

Gayanilo, F. C. Jr., P. Sparre and D. Pauly. 1996. The FAO-ICLARM Stock Assesment Tools (FISAT): User's Guide *FAO Comput. Info.* Ser. (Fish.) 8: 126 pp.

Hall, D. W. F. 1967. Studies on the penaeid of Japan and its adjacent waters. *J. Tokyo Coll. Fish.,* 36(1): 1-467.

King, M. 1993. *Population dynamics. In*: Fisheries biology, assessment and management. Fishing News Books. p.79-197.

Kunju, M. M. 1967. Observations on the prawn fishery of the Maharashtra Coast. *Proc. Symp.Crustacea. Mar. Biol. Ass. of India*, *Cochin. Part IV.* p.1382-1397.

Muthu, M. S. and P. S. E. Manickam. 1973. On the occurrence of mature specimens of *M. burkenroadi* in the Pulikat Lake. *Indian J. Fish., 20*(1): 214-216.

Nair, P. V. R., G. Luther and C. Adolph. 1967. An ecological study of some pools near Mandapam, formed as a result of the cyclone and tidal wave of 1964. *J. Mar. Biol. Ass. India,* 7(2): 420-439.

Nair, S. R. S., C. T. Achuthankutty and A. H. Parulekar. 1993. Maturation of the penaied prawn *Metapenaeus moyebi* in Mandovi estuary, Goa. *Ind. J. Mar. Sci.* 22:151-152.

Nandakumar, G., N. N. Pillai, K. Y. Telang and K. Balachandran. 1989. Larval development of *M. moyebi* (Kishinouye) reared in the laboratory. *J. Mar. Biol. Ass. India*, 31(1&2): 86-102.

Natarajan, A. V. and A. G. Jhingran. 1961. Index of Preponderance- a method of grading the food elements in the stomach analysis of fishes. *Ind. J. Fish.,* 8(1): 54-49.

Rao, P. V. 1968. Maturation and spawning of the penaeid prawns of the southwest coast of India. *FAO Fish. Rep*., (57) 2: 285-302.

Sukumaran, K. K. and G. Nandakumar. 1983. A potential new resource of prawn from Karnataka coast. *Mar. Fish. Infor. Ser. T & E Ser.,* 54: 16-18.

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