

MANGROVE SWAMPS AS FRY SOURCE FOR SHRIMP CULTURE —A CASE STUDY

C. T. ACHUTHANKUTTY AND S. R. SREEKUMARAN NAIR
National Institute of Oceanography, Dona Paula, Goa-403 004

ABSTRACT

Three species of commercially important penaeid prawns, viz. *Metapenaeus dobsoni* (Miers), *M. monoceros* (Fabricius) and *Panaeus merguensis* de Man occur in the Pilerne mangrove swamp of Goa. *M. dobsoni* was the dominant species contributing 42.66% followed by *M. monoceros* (35.02%) and *P. merguensis* (22.32%). Premonsoon season (February-May) sustained their maximum abundance in this mangrove. Juveniles (10-30 mm) constituted the largest portion of the penaeid population. *M. dobsoni* grows to 50-60 mm length within 5-6 months and *M. monoceros* attains a length of 70-80 mm in 7-8 months. *P. merguensis* stays in this environment for 6-7 months and reaches a length of 80-90 mm. Maximum abundance of juveniles occurs from December to June which would be the most appropriate time for a large scale collection.

INTRODUCTION

Commercial shrimp culture is perhaps one of the ways to meet the increasing demand of prawns for the local and foreign markets. Successful shrimp culture, to a very large extent, depends on the availability of suitable fry. Although the association of the larval and juvenile stages of many marine prawns with the brackish water environment is now known (Panikkar and Aiyar, 1939; George, 1962, 1968 a & b, 1973; Gunter 1967; Kutkuhn, 1966), the exact role of this dynamic ecosystem in the development and growth of these young ones is not yet fully understood.

In Goa, studies have been initiated to locate the spawning grounds and seasons of the commercial penaeid prawns (George and Goswami, 1977; Goswami and George, 1978) and their subsequent migration into the estuaries (Achuthankutty, George and Goswami, 1977; Selvakumar, George, Achuthankutty and Goswami, 1977). The Mandovi-Zuari estuarine system of Goa has about 2,000 hectares of mangrove swamps which form the nursery ground for the juvenile penaeid prawns. Hence, detailed investigation was carried out in a mangrove swamp in Pilerne for one year to estimate the penaeid prawn population and to assess the juvenile resource suitable for commercial culture. The importance of mangroves in the marine fish production especially to the penaeid prawns have been reported earlier (Martosubroto and Naamin, 1977; Snedaker, 1978).

Study area: Pilerne mangrove swamp is situated about 4 km from the region of confluence of the Mandovi estuary and is connected to the mouth of the estuary by the Shinkeri river (Fig. 1). The swamp gets flooded during the high tide and water drains off during the low tide. A low lying area of about 1 hectare was selected for the

present study where the bottom was not exposed even during the ebb tide. The substratum of this swamp is fine silty mud. The physico-chemical features and the vegetation of the mangroves of this area have been studied by Untawale, Dwivedi and Singbal (1973) and Dwivedi, Parulekar, Goswami and Untawale (1974).

MATERIAL AND METHODS

The study was carried out from June 1978 to May 1979. Penaeid prawns were collected during the low tide by hauling a rectangular net of 5 mm mesh size through the bottom covering an area of 50 m². Prawns were identified and the total length from tip of the rostrum to the tip of the telson was measured.

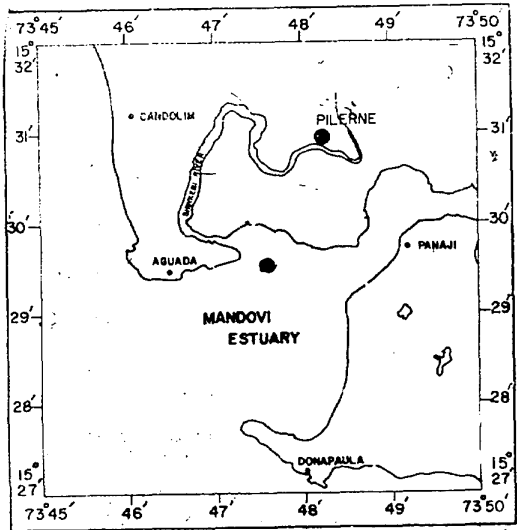


Fig. 1. Location of Pilerne mangrove swamp.

RESULTS AND DISCUSSION

Species composition and abundance

Three species of penaeid prawns, namely, *Metapenaeus dobsoni* (Miers), *M. monoceros* (Fabricius) and *Penaeus merguensis* de Man, which constitute the bulk of the marine prawn landing in Goa, occur in this area. The contribution of these species to the total penaeid population showed that *M. dobsoni* was the dominant species (42.66%) followed by *M. monoceros* (35.02%) and *P. merguensis* (22.32%). Their month-wise abundance showed that *M. dobsoni*, *M. monoceros* and *P. merguensis* varied between 31.26 and 49.69%, 27.66 and 41.67% and 14.89 and 34.37% respectively (Fig. 2).

Seasonal variation was evident in their abundance. Premonsoon season (February–May) recorded the maximum abundance of 59.48%. Monsoon season (June to September) followed with 24.16% and postmonsoon season (October–January) with 16.36% (Table I). In all the three seasons, *M. dobsoni* contributed the major share followed by *M. monoceros* and *P. merguensis* (Table I).

Growth in mangrove swamp

Length frequency distribution of individual species was studied for determining their growth in this ecosystem. In certain months, it was difficult to trace the progress of modes in

Table 1. Relative abundance of penaeid prawns in different seasons.

	Premonsoon	Monsoon	Postmonsoon
<i>M. dobsoni</i>	43.83%	40.20%	42.05%
<i>M. monoceros</i>	35.99%	33.86%	33.18%
<i>P. merguensis</i>	20.18%	25.94%	24.77%
% contribution of penaeids	59.48%	24.61%	16.36%

all the three species. Tracing of the progress of modes would be difficult in a tropical species having slow growth or prolonged breeding or a combination of both (Qasim, 1973). In the present case, the prolonged breeding resulting in continuous recruitment and the size difference of the recruited individuals would have been rendered it difficult in tracing the transformation of modes.

10–20 mm was the smallest size group of the three species occurring in this specialised environment. The growth rate and the maximum size attained were different for different species.

The 10–20 mm size of *M. dobsoni* occurring in March grows to 20–30 mm in April and 50–60 mm in August (Fig. 3). Thus, the progress of modes in this species indicated that the maximum size of 50–60 mm could be attained within 5–6 months. The minimum and maximum size recorded for this species was 11.1 mm and 58.6 mm respectively.

The growth rate of *M. monoceros* closely followed that of *M. dobsoni*, but they live here for a relatively longer time and hence attain a larger size. The 10–20 mm mode in March successively progresses to 60–70 mm mode in September, but further growth could not be traced. Similarly, the 70–80 mm mode in July could be traced back to 10–20 mm mode in January (Fig 3). Thus, this species grows in the mangrove for 7–8 months. The minimum and maximum size of the individuals collected was 11.6 mm and 78.5 mm respectively.

P. merguensis, on the other hand, attains a larger size than the former two species in a relatively short time. Initial growth rate of this species is almost double than the other two species. The 10–20 mm mode in January grows to 30–40 mm mode in February which could further be traced to 70–80 mm in June. Likewise, the 10–20 mm in March progresses to 80–90 mm in September (Fig. 3) thus completing its growth in the mangrove within 6–7 months. The smallest size of the individual collected during the present study was 13 mm and the largest size was 88.3 mm.

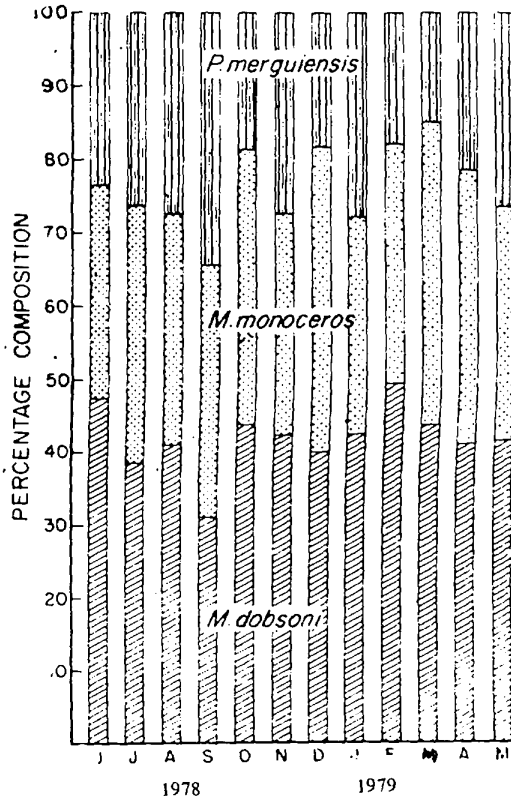


Fig. 2. Percentage composition of the 3 species of penaeid prawns in different months.

Recruitment of juveniles to mangrove swamps

The penaeid larval distribution in Goa waters has indicated that a large number of the larvae of the species under investigation, which are known to breed in the close inshore waters (George, 1962; Rao, 1968; George and Goswami, 1977; Goswami, Achuthankutty and George, 1977) ingress the Mandovi and Zuari estuaries (Achuthankutty, George and Goswami, 1977; Selvakumar, George, Achuthankutty and Goswami, 1977) at the appropriate time. Those which do not enter the estuaries in the right time grow in the inshore waters

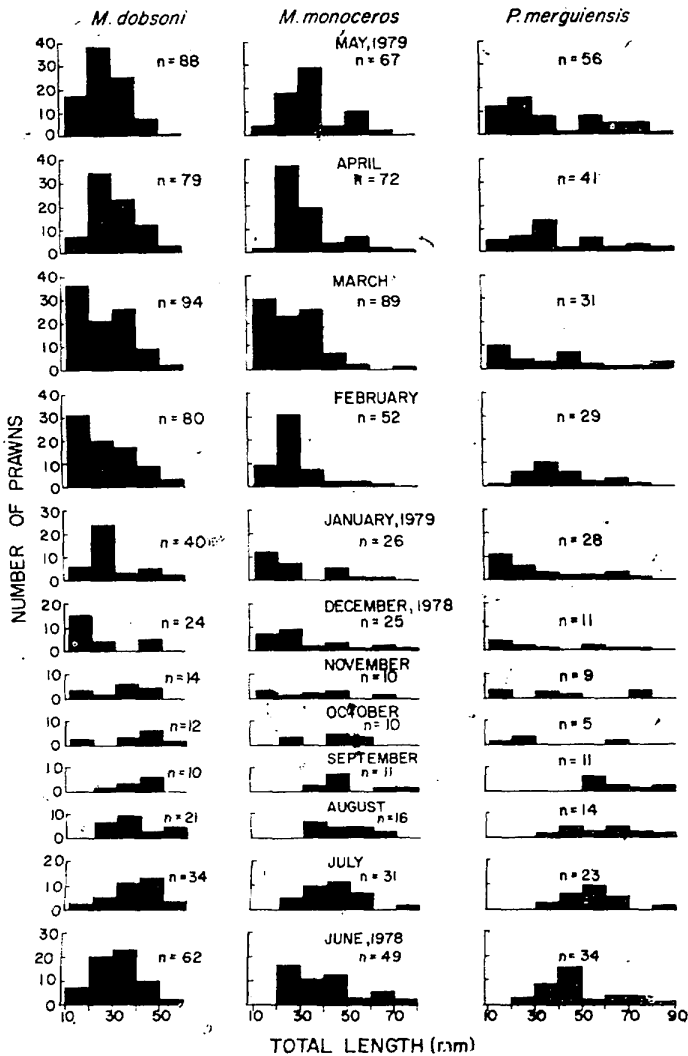


Fig. 3. Length frequency distribution of the 3 species of penaeid prawns in different months.

itself as is evident by the postlarval and juvenile occurrence in this area (George, 1969; Rao, 1972; Goswami, Achuthankutty and George, 1977). 10-20mm being the minimum size of all the three species abundantly occurring in Pilerne, it could be inferred that a good percentage of the larvae which enter the Mandovi estuary, immediately after attaining the juvenile phase find their way into the nearby mangrove swamps. However, individuals of the size range 20-30 mm may also be recruited in some months (Fig. 3). This may be because the exact size of the juveniles being recruited to the mangrove largely depend on the size of the postlarvae taking up the benthic habitat and the time taken to enter the mangrove swamp. The juvenile sizes being recruited to the mangroves of Goa is in conformity with those being recruited to the paddy fields of the southwest coast of India (George, Mohammed and Pillai, 1968).

Juvenile abundance in relation to larval abundance

The relative abundance of the juveniles (10-30 mm) in Pilerne mangrove is shown in Fig. 4. In all the months, invariably the juveniles constituted the major component of the penaeid population. Percentage abundance of juveniles to the total population was 46.56 of which the contribution of *M. dobsoni*, *M. monoceros* and *P. merguensis* was 49.26%, 35.47% and 15.27% respectively.

Seasonal fluctuation was observed in juvenile abundance (Fig 4). Maximum number of juveniles was recorded during the premonsoon season. Their abundance declined during the monsoon season and continued through the early postmonsoon. By late postmonsoon, their number increased to attain the peak in premonsoon months. Although all the species followed the same trend their numbers varied with season.

Larval stages of *M. dobsoni*, *M. monoceros*, *M. affinis*, *P. merguensis* and *Parapenaeopsis stylifera* occur abundantly in the coastal waters of Goa (George and Goswami, 1977; Goswami and George, 1978). But the absence of the larvae of *M. affinis* in the estuaries and their juveniles in the mangrove swamp suggests that they may not be entering the estuarine environment for some reason. In Cochin backwaters, unlike *M. dobsoni* and *M. monoceros* they occur in very small numbers (George, 1969). Although early larval stages of *P. stylifera* have been recorded from the mouth of the estuaries (Achuthankutty, George and Goswami, 1977; Selvakumar, George, Achuthankutty and Goswami, 1977) there is no evidence of their further growth in this habitat. Thus the estuarine environment forms the nursery ground of the three species under investigation in Goa.

Spawning is reported to be continuous for *M. dobsoni* and *M. monoceros* (Menon, 1955; George, 1962, 1970a & b; George, Raman and Nair, 1968; Rao, 1968, 1972) with a primary peak in January-February and subsidiary peaks in March-April and November-December (Achuthankutty, George and Goswami, 1977; George and Goswami, 1977) and discontinuous for *P. merguensis* having peaks in December, February and March to May (Achuthankutty, George and Goswami, 1977; George and Goswami, 1977) in Goa waters. These intensive spawning activities are reflected on the juvenile abundance in the succeeding months in the mangrove swamp. The poor population of juveniles in late monsoon and early postmonsoon months could be traced back to the low intensity or absence of spawning activity in the preceding months.

Mangrove swamp as nursery grounds

Several factors have been attributed to be responsible for the migration of the penaeid larvae into the brackish water habitat. But the functional role of this dynamic

ecosystem in the development and growth of these marine prawns is not yet fully understood. Salinity has been reported to be a single major factor in regulating their growth although many other factors may have a combined influence (Gunter, 1967; George, 1968b).

The water flow to the mangroves is regulated by the prevailing tides. This specialised ecosystem is not subjected to much of disturbances as in the estuaries. The substratum is fine silty mud and the salinity is relatively less than the estuaries (Dwivedi, Parulekar, Goswami and Untawale, 1974). Aggregates of suspended and dissolved organic matter formed by the processes of flocculation and coagulation in this type of environment settle to the bottom in enormous quantities which are the primary food resource for the prawns (Snedaker, 1978). The abundance of mangrove foliage and relatively small number of predators and other harmful organisms provide necessary protection. All other factors being more or less similar to those of estuaries, the mangrove swamps are congenial

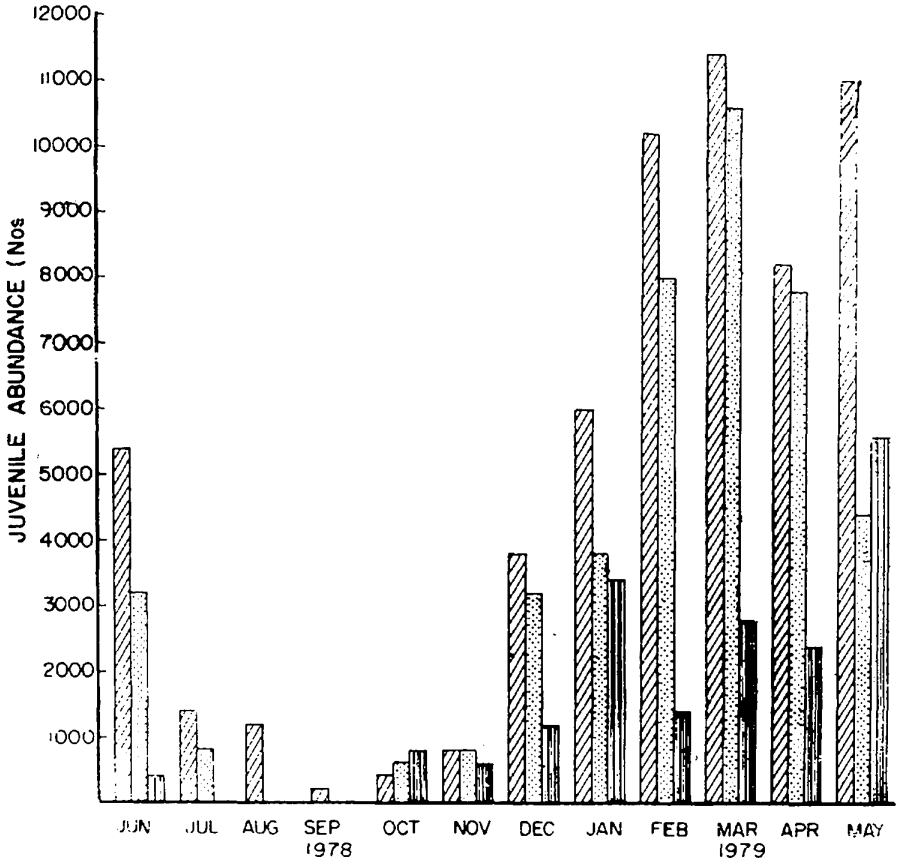


Fig. 4. Juvenile (10-30 mm size) abundance of the 3 species of penaeid prawns in different months.

environment for the growth and perpetuation of penaeid prawns and hence this specialised ecological niche forms ideal nursery ground for the juveniles.

The enormous resource of juvenile prawns in the mangroves of Goa is evident from the present study. Juveniles (10-30 mm) of all the three species which may be the ideal size for commercial culture are available in plenty from December to June (Fig. 4). However, it is likely that the mangroves opening to the lower reaches of the estuaries may sustain a large population of the juveniles as the postlarvae would attain the juvenile phase by the time they enter the estuaries (Selvakumar, George, Achuthankutty and Goswami, 1977), and hence they are poorly distributed in the middle and upper reaches (Achuthankutty, George and Goswami, 1977).

The inevitable need for the management of the brackish water environment for the conservation of prawn fishery resources has been emphasized by George (1968b). So also, the inseparable association of commercial shrimp production to the mangroves has been shown by Martosubroto and Naamin (1977). Mangrove swamps of Goa being the natural nursery ground for the commercially important penaeid prawns, any attempt to alter or disturb this specialised ecosystem may have alarming consequences. Similarly, indiscriminate exploitation of juveniles during their 'mangrove phase' of life history would adversely affect the prawn fishery of this area. Hence it calls for the proper management of this dynamic ecosystem for the conservation of the penaeid prawn population and the judicious exploitation of the juvenile resources for commercial shrimp culture.

ACKNOWLEDGEMENTS

The authors are thankful to Dr. S. Z. Qasim and Dr. T.S.S. Rao for their constant encouragement and constructive criticism.

REFERENCES

- Achuthankutty, C. T., M. J. George and S. C. Goswami, 1977. Larval ingression of penaeid prawns in the estuaries of Goa. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 412-424.
- Dwivedi, S. N., A. H. Parulekar, S. C. Goswami and A. G. Untawale, 1977. Ecology of mangrove swamps of the Mandovi estuary, Goa, India. *Proceedings of the International Symposium on Biology and Management of Mangroves*, Honolulu (Hawaii), 1: 115-125.
- George, M. J., 1962. On the breeding of penaeids and the recruitment of their postlarvae into the backwaters of Cochin. *Indian Journal of Fisheries*, 9 (1): 110-116.
- George, M. J. 1968 a. Postlarval abundance as a possible index of fishing success in prawn *Metapenaeus dobsoni* (Miers). *Indian Journal of Fisheries*, 10A: 135-139.
- George, M. J., 1968 b. The influence of backwaters and estuaries on marine prawn resources. *Proceedings of the Symposium on Living Resources of the seas around India*, ICAR, CMFRI, 563-569.
- George, M. J., 1969. Genus *Metapenaeus* Wood-Mason & Alcock 1891. *Bulletin of the Central Marine Research Institute*, 14: 77-125.
- George, M. J., 1970 a. Synopsis of biological data on the penaeid prawn *Metapenaeus dobsoni* (Miers, 1878). *FAO Fisheries Report*, (57), 4: 1335-1357.
- George, M. J., 1970 b. Synopsis of biological data on the penaeid prawn *Metapenaeus monoceros* (Fabricius, 1798). *FAO Fisheries Report*, (57) 4: 1539-1557.

- George, M. J., 1973. Prawn larvae and assessment of prawn resources. *Mahasagar-Bulletin of the National Institute of Oceanography*, 6: 133-139.
- George, M. J. and S. C. Goswami, 1977. Observations on the larvae of penaeid prawns of commercial importance in the coastal waters of Goa. *Proceedings of the Symposium on Warm Water Zooplankton*, Special Publication, UNESCO/NIO, 146-154.
- George, M. J., K. H. Mohammed and N. N. Pillai, 1968. Observations on the paddy-field prawn filtration of Kerala, India. *FAO Fisheries Report* (57), 2: 427-442.
- George, M. J., K. Raman and P. K. Nair, 1968. Observations on the offshore prawn fishery of Cochin. *Indian Journal of Fisheries*, 10A: 460-499.
- Goswami, S. C. and M. J. George, 1978. Seasonal abundance of penaeid prawn larvae and postlarvae in the coastal waters of Goa upto 50 m depth zone. *Indian Journal of Marine Sciences*, 7: 110-115.
- Goswami, S. C., C. T. Achuthankutty and M. J. George, 1977. Occurrence of larvae of commercially important penaeid prawns along the central west coast of India. *Mahasagar-Bulletin of the National Institute of Oceanography*, 10: 129-137.
- Gunter, G., 1967. Some relationships of estuaries to the fisheries of the Gulf of Mexico. *Estuaries*, American Association for the Advancement of Science, 621-638.
- Kutkuhn, J. H., 1966. The role of estuaries in the development and perpetuation of commercial shrimp resources. *Symposium on Estuarine Fisheries*, American Fisheries Society Special Publication, 3: 16-36.
- Martosubroto, P. and N. Naamin, 1977. Relationship between tidal forests (mangroves) and commercial shrimp production in Indonesia. *Marine Research in Indonesia*, 18: 81-86.
- Menon, M. K., 1955. Notes on the bionomics and fishery of the prawn *Metapenaeus dobsoni* (Miers) on the southwest coast of India. *Indian Journal of Fisheries*, 2: 41-56.
- Panikkar, N. K. and R. G. Aiyar, 1939. Observations on breeding in backwater animals of Madras. *Proceedings of the Indian Academy of Sciences*, 8: 343-364.
- Qasim, S. Z., 1973. Some implications of the problem of age and growth in marine fishes from the Indian waters. *Indian Journal of Fisheries*, 20: 351-371.
- Rao, P. Vedavyasa, 1968. Maturation and spawning of the penaeid prawns of the southwest coast of India. *FAO Fisheries Report*, (57), 2: 285-304.
- Rao, P. Vedavyasa, 1972. Seasonal abundance of larvae of the commercially important penaeid prawns in the inshore waters of Cochin. *Indian Journal of Fisheries*, 19: 86-96.
- Selvakumar, R. A., M. J. George, C. T. Achuthankutty and S. C. Goswami, 1977. Penaeid prawn larval abundance in the Mandovi estuary, Goa. *Indian Journal of Marine Sciences*, 6: 160-162.
- Snedaker, C. Samuel, 1978. Mangrove: their value and perpetuation. *Nature and Resources*, UNESCO, 14(3): 6-13.
- Untawale, A. G., S. N. Dwivedi and S. Y. S. Singbal, 1973. Ecology of mangroves in Mandovi and Zuari estuaries and interconnecting Cumbarjua canal of Goa. *Indian Journal of Marine Sciences*, 2: 47-53.