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V.N. Pillai and N.G. Menon



Central Marine Fisheries Research Institute

(Indian Council of Agricultural Research)

Tatapuram P.O., Cochin-682 014

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32 Prawn fisheries of important brackishwater and estuarine systems in India

Mary K. Manisseri and G. Sudhakara Rao

ABSTRACT

Most of the penaeid prawns spend their juvenile phase in the shallow estuarine and brackishwater regions, supporting rich fisheries in this ecosystem. *Penaeus monodon*, *P. indicus*, *Metapenaeus dobsoni*, *M. monoceros* and *M. brevicornis* are the dominant species contributing to the rich prawn fishery resources of this ecosystem. Both abiotic and biotic factors play a major role in determining the success of the fishery. Small country crafts and different types of bag nets, traps etc. are used for the exploitation of the juvenile prawn resources. Salient features of the prawn fisheries of the major estuarine and backwater systems along both the east and west coasts of our country are presented here.

Introduction

Prawns form an important constituent of the marine fish resources of the country. The average annual landing of penaeid prawns during the years 1993-97 was 1,94,859 t which attained 2,14,741 t in 1998. The postlarvae of most of the penaeid prawns migrate from the sea towards the shallow inshore and estuarine regions and settle down to the bottom, adopting a benthic habitat. After spending the juvenile phase of the life cycle, which lasts generally from 2 to 4 months, the prawns migrate back to the sea where they attain maturity and spawn. It is during their stay in the estuaries and backwaters that they support a rich fishery in this ecosystem. Approximately, 2,14,500 ha of estuaries, backwater lagoons and lakes and 20,20,000 ha of brackishwater area are available in the country for development of estuarine fisheries and coastal aquaculture. The major backwater and estuarine systems in the country are the Hooghly-Matlah in West Bengal,

Mahanadi and Lake Chilka in Orissa, Godavari and Krishna in Andhra Pradesh, Vellar and Killai backwaters and Lake Pulicat in Tamil Nadu, Cochin backwaters and Vembanad Lake in Kerala and Narmada-Tapti and Little Rann of Kutch in Gujarat. In addition to these, there are a number of smaller estuaries which are known to have fishery resources of considerable importance. The salient features of the prawn fisheries of some major estuarine systems are reviewed here.

Backwaters and estuaries of the east coast

The Hooghly-Matlah estuarine system with an extent of 2340 sq km is the biggest of the Indian estuaries. In the main Hooghly estuary the tidal influence is felt up to a distance of 290 km from the mouth (Pantulu and Bhimachar, 1964). Salinity and temperature have been found to be the most significant abiotic factors determining the fishery resources of this system (Gopalakrishnan, 1973). Bag net form the main type of gear and accounts for over 90% of the prawn landings. The fishing activity is observed round the year in different zones of the estuarine system, the winter fishing operations conducted during November-February in the lower Sunderbans accounting for the major portion of the prawn landings. Annual prawn landings varied from 857 t in 1965-66 to 1799 t in 1975-76. Rajyalakshmi (1961, 1966) studied the fishery and biology of *Parapenaeopsis sculptilis* and *Metapenaeus brevicornis*. The unique feature of this estuarine system is that the major penaeid species, *P. sculptilis* and *M. brevicornis* are represented by mature males and females. However, there is no evidence for their spawning in the estuary. Bigger size groups are largely confined to areas of higher salinity. Gopalakrishnan *et al.* (1975) and Basu and Pakrasi (1979) studied the seed availability in this estuarine system giving information on the distribution of penaeids in different zones of the estuary.

The Mahanadi estuary lies in the Cuttack and Puri districts of the State of Orissa and drains into the Bay of Bengal. The tide extends to about 42 km from the mouth of the river. Studies on the hydrology and fisheries of this estuary were made during 1961-64 by Shetty *et al.* (1965). Salinity in the Mahanadi estuary ranged from traces to 35.38 ppt. According to Pantulu and Bhimachar (1964), there exists a vertical salinity stratification in the Mahanadi estuary. Prawns contributed to about 12.4% of the total landings during 1960-64 with their annual landing varying from 114 t in

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1962-63 to 55 t in 1963-64. *Penaeus indicus*, *P. monodon* and *M. brevicornis* were recorded in the catches.

The Chilka lake is a brackish water lagoon situated on the east coast of India in the state of Orissa. The lake has a water spread of 906 sq km in the summer and 1165 sq km in the flood season, with a corresponding depth of 2.5 m in summer and 3.6 m in flood season. The fisheries of the Chilka lake are exploited by means of traps, net fishing and large impoundments constructed with split bamboo in shallow regions (Job and Pantulu, 1953). Jhingran and Natarajan (1969) furnished details of the prawn landings for the years 1957-65. Prawn landings varied from 548 t in 1964 to 1863 t in 1965. Prawns formed about 28% of the total landings from the lake during this period. *P. indicus* (64.2%) and *P. monodon* (23.9%) formed the major components while *M. monoceros* and *M. dobsoni* together formed only 11.9% of the prawns landings. The authors attributed the postlarval abundance during January-March and April-July responsible for the two peaks in the abundance of juveniles in the lake. Studying the daily variations in the recruitment of the postlarvae, Ramakrishnaiah (1979) observed that *Metapenaeus spp.* migrated during night while *Penaeus spp.* did not follow any diurnal trend. A study conducted at Jedpur, a landing centre in the northern sector, during 1988-90 indicated that *P. indicus* and *P. monodon* which dominated the landings in the earlier years relegated to a secondary status in the landings in the latter period.

The Godavari estuarine system is broadly divided into the bigger Goutami-Godavari system and the smaller Vasishta-Godavari system with a total area of 400 sq km. In the Godavari, the tidal influence is felt up to 45 km from the mouth with the salinity fluctuating from traces to 34 ppt (Pantulu and Bhimachar, 1964). Ganapati and Subrahmanyam (1966) listed the penaeid and non-penaeid species contributing to the fishery. Drag net and stake net accounted for over 90% of the prawn landings. Rao (1975) studied the prawn fishery of the Goutami-Godavari estuary during 1968-73. Annual average contribution of prawns in the catches varied from 82% in 1969 to 66% in 1976. Prawn landings fluctuated considerably, from 713 t in 1973 to 241 t in 1976. *M. monoceros*, forming about 56% of the average annual prawn landings showed two peaks, a primary during October-December and a secondary during April-May, corresponding to the peaks observed for the total prawn landings and indicating that the fishery for *M. monoceros* dic-

tated the success or failure of the total prawn fishery of this estuarine system. The monthly length frequency distribution observed for all the species during the ten year period indicated a unimodal distribution indicating that emigration to the sea is continuous and that the spawning of the adults is also a continuous process in the sea. The study indicated that there was a trend of decline in the fishery for *P. monodon* and *P. indicus*. It was estimated that annually about 2,897 t of prawns were harvested from the entire Godavari estuarine system, the penaeid prawns accounting for about 2583t. In addition to this there was a seasonal fishery for non-penaeid prawns at the mouth of the river accounting for over 500 t annually (Rao, 1972). Subrahmanyam (1966) found a correlation between the river discharge during 1959-60 and *P. monodon* landing in the estuarine system in 1960-61

The Krishna estuarine system spreads over an area of 111 sq km and supports a good prawn fishery. The hydrological conditions of the estuary are different from those which prevailed prior to the construction of the barrage at Vijayawada and the reservoir at Nagarjunasagar (Ramanadham and Varadarajulu, 1975; Ravindranath, 1982). The salinity and temperature varied from 5.35 ppt to 34.50 ppt and 25.5°C to 33.0°C respectively, near the mouth of the Nizampatnam canal (Ravindranath, 1982). Dug-out canoe and Plank-built boat are used to operate cast net, stake net and drag net. Five species each of *Penaeus* and *Metapenaeus*, 6 species of *Parapenaeopsis* and one species of *Solenocera* were reported by Ravindranath (1982). The annual landings at a landing centre (Kanuru) where stake net and drag net were operated amounted to 36 t in 1973 (Anon, 1975). *M. monoceros* (59.9%) dominated the prawn landings followed by *M. dobsoni* (21.0%). Prawns were landed throughout the year with a peak during October-December. Based on these data, the landing for the entire estuarine system was estimated as 970 t annually.

The Pulicat lake, the second largest brackishwater lake, is situated between Latitudes 13°24' and 13°47'N and longitudes 80°02' and 80°16'E on the east coast covering an area of 777 sq km. The average depth of the lake is 1.5 m. The tidal influence is limited to a distance of 6-10 km from the mouth of the lake (Jhingran, 1991). Prawn fishing is conducted by stake net, drag net and shore seine. Annual prawn landings from the lake varied from 379 t to 635 t during 1967-71. *P. indicus* formed the dominant component of the landings followed by *P. semisulcatus*, *P. monodon*, *M.*

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monoceros and *M. dobsoni*, in the order of abundance. Sampson Manickam and Srinivasarangan (1973) studied the prawn fishery at Pulicat, Sunnambukkulam and Arambakkam. Annual prawn landings at Pulicat village varied from 262 t to 591 t during 1966-71. Subrahmanyam and Rao (1968) studied the seasonal recruitment of postlarvae of *P. indicus*, *P. monodon* and *P. semisulcatus* in the lake during 1966 and 1967. Gopinath (1978) also studied the abundance and distribution of the penaeid postlarvae. Rao and Gopalakrishnayya (1974) established a relationship between the postlarval recruitment and juvenile landings from the lake.

The Vellar river, with a course of 480 km, drains into the Bay of Bengal at Porto Novo. The total extent of this estuarine system is about 26.7 sq km. The depth varied from 0.32 m to 1.54m at different points depending on the tidal rhythm. Temperature fluctuated between 24°C and 34°C and salinity between 2.7 ppt and 34.1 ppt. Evangeline *et al.* (1975) studied the prawn fishery of this estuarine system during July 1970-June 1971. Stake net (49.5%), cast net (28.9%) and drag net (21.6%) contributed to the prawn landings. The authors estimated the annual prawn landing for the entire estuarine system as 98.6 t. Natarajan *et al.* (1979) gave an account of the prawn fishery during December 1973 to November 1974. Annual prawn landing was estimated at 21.9 t with better catches during January and July-October. Prawns formed about 13% of the total landings from the estuarine system. Subramanian (1987) estimated the prawn landing by stake net at Thonithorai as 41.8t in 1973. *P. indicus* (44.4%), *M. monoceros* (33.7%) and *M. dobsoni* (15.9%) were the dominant components of the fishery.

Backwaters and estuaries of the west coast

A long chain of backwaters extends along the central and southern parts of the Kerala State. Fishing is carried out practically all the year round. From June to August the water, at least the upper layers in the deeper regions, is almost fresh (George, 1958) due to the southwest monsoon rains. Subsequent months witness a steady rise in salinity which is only slightly below that of sea-water in April - May. The Cochin backwaters form the northern extension of the vembanad Lake and support a lucrative fishery for juvenile penaeid prawns. The types of nets used for fishing are mainly stake net, Chinese net, Cast net and drag net (Gopinath, 1953). A substan-

tial part of the total catch is landed by stake net. Menon and Raman (1962) made a detailed study of the fishery at Azhikal and thevara during 1956-58. The highest percentage of prawns in the total catch was recorded in January and the lowest in September, at both the stations. The fishery was supported, practically entirely, by *P. indicus*, *M. monoceros* and *M. dobsoni*. In regard to *M. dobsoni* the modal length frequency varied between 41-45 mm and 56-60 mm. The authors noticed that the modal size groups from month to month did not show any progressive increase in size and this led to the conclusion that a good portion of the postlarvae entering these backwaters reach this size before they return to the sea or get caught in the commercial fishery. The total estimated prawn landing from the Cochin backwaters in 1972 and 1973 were 898 t and 1541 t, respectively (Anon, 1975).

Apuchand (1987) conducted experimental fishing at one of the outlets of the Cochin backwaters into the Arabian Sea in order to study the migratory movements of the penaeid prawns from the backwaters, in relation to the tide and depth. The author reported a marked increase in the catch per haul of prawns in the months of June and July, which could be due to the "spawning run" coinciding with the onset of the southwest monsoon. The mean size of prawns caught in bottom and surface trawls during the same tide did not show much variation. Sexes were almost equally distributed, females showing slight predominance over males. The percentage occurrence at the bottom and surface waters during low tide showed that *P. indicus* was present more at the bottom. *M. dobsoni* occurred relatively at higher percentage in the upper water column suggesting that this species could be moving more through the water column. During high tide bottom trawling, *P. indicus* was found to be predominant. The mean sizes of the male and female *P. indicus* caught during high tide were slightly higher than those caught during low tide. The mean sizes of *M. dobsoni*, however, did not show much variation between low and high tides. Pillai and Muthu (1988) made observations on the prawn landings at Thoppumpadi during 1969 - 1973. The prawn fishery was good during December to March and reached peak values in the premonsoon months of April and May.

Manisseri (MS) studied the juvenile penaeid prawn fishery at Thevara in Cochin backwaters during 1996-99. The total landing of penaeid prawns by stake net during 1996-97 was 292 t, with a catch per unit effort of 3.8 kg. Penaeid prawns formed about 50% of the total landing. Maximum land-

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ing was recorded in the months of June '96 (40.6 t) and March '97 (36.6 t). *M. dobsoni* predominated the fishery contributing to 72.4% of the total landing. *P. indicus* and *M. monoceros* constituted 19.6% and 8.0% respectively. Maximum landing of *P. indicus* was noticed in the months of June and July. *M. dobsoni* ranged in size from 36-40 mm to 71-75 mm in males and 81-85 mm in females. The modal size classes were at 51-55 mm and 41-45 mm in males and females respectively. The total estimated landing of penaeid prawns was 212.7 t in 1997-98. Maximum landing was recorded in the month of June. Penaeid prawns formed about 53% of the total landing. *M. dobsoni* predominated the prawn fishery contributing to 75-92%. *P. indicus* and *M. monoceros* contributed to 16.37% and 7.71% respectively. Maximum landing of *P. indicus* was recorded in the months of June-July as in the previous year. This coincided with the onset of the southwest monsoon. In *M. dobsoni* the modal length classes were at 46-55mm and 46-50mm in males and females, respectively. The total prawn landing during the year 1998-99 was 280.8 t, with a catch per unit effort of 4.29 kg. Penaeid prawn formed about 59.4% of the total landing. *M. dobsoni* predominated the landings constituting on an average 86.17% of the total penaeids. Maximum landing was obtained in the months of February (59 t) and March (59.4 t). The total landing of *P. indicus* was 25.8 t. Maximum landing of this species was obtained in June, August and March. In the case of *M. dobsoni* the modal classes were at 46-55 mm in males and 46-50 mm in females. The modal size classes were comparable over the years and represented the size groups at which the prawns either got caught in the commercial fishery or migrated to the sea for maturation and spawning.

The Korapuzha estuary at Calicut, Kerala, supports a lucrative fishery for penaeid prawns. The landings, composed mainly of juveniles of *M. dobsoni*, were about 32.8 t and 33.3 t in 1972 and 1973 respectively (Anon. 1975). Sarada (MS) studied prawn resources exploited by stake net from Korapuzha estuary during the period 1987-92. The annual average catch was estimated as 262 t with a catch per unit effort of 26 kg. The fishery was constituted by *M. dobsoni*, *M. monoceros*, *P. indicus* and *M. affinis*.

The Karnataka state possesses about 4,000 ha of potential estuaries and brackishwaters, most of this area being distributed in Uttara Kannada District (Silas and Rao, 1996). The major brackishwater bodies of the state are the Kall estuary, Venkatpur estuary, Aghanashini estuary, Gangoli es-

tuary, Sharavati estuary, Udayara estuary, Mulki estuary and Netravathi-Gurupur estuary. The rivers flowing into the Arabian Sea are subjected to tidal influence up to about 15 to 25 km and the salinity fluctuates from 0.5 to 35 ppt (Shastri, 1996). The penaeid prawns available are *M. dobsoni*, *M. monoceros*, *P. indicus*, *P. merguensis* and *P. monodon*. *M. dobsoni* dominates the fishery followed by *P. indicus*. The total estimated landings of prawns from the estuarine waters at Karwar were 3.8 t and 3.1 t in 1972 and 1973 respectively. The landing at Mangalore was 22.1 t in 1973 (Anon. 1975). The extensive method of prawn culture is practised in the coastal districts viz., Dakshina Kannada and Uttara Kannada, involving several hundred acres of low-lying brackishwater areas adjacent to the estuaries. The average annual production of both prawns and fish is about 338 kg per ha, out of which prawns account for 86.58% (Shastri, 1996).

The estuarine and brackishwater resources of Goa is estimated to be about 0.019 million ha. Important penaeid species available in this area are *M. dobsoni*, *M. monoceros*, *P. indicus* and *P. monodon* (Silas and Rao, 1996). Achuthankutty *et al.* (1977) studied the abundance and distribution of larvae of *M. dobsoni*, *M. monoceros*, *P. merguensis* and *P. stylifera* in the Mandovi and Zuari estuaries of Goa. They observed abundance of larvae nearer the mouth than in the upper reaches. *M. dobsoni* was the most abundant species. The estuarine and brackishwater resources of Maharashtra have been estimated to be about 0.081 million ha (Silas and Rao, 1996). The chief cultivable penaeid prawns available in this area are *P. merguensis*, *M. monoceros* and *M. brevicornis*.

Along the coast of Gujarat there are two gulfs and a large number of creeks, low-lying marshes, mangrove swamps and brackishwater areas, the extent of which is estimated as 3,76,000 ha. *P. merguensis*, *M. kutchensis*, *M. brevicornis* and *M. monoceros* are among the penaeid species available in this region (Silas and Rao, 1996). Paulinose *et al.* (1998) reported the availability of larvae of *M. affinis*, *M. dobsoni*, *P. indicus*, *P. stylifera* and *P. hardwickii* from the Gulf of Kutch including the major creek systems of Nakti, Kandla and Hansthal. Larvae of *M. affinis* were dominant in the creek and gulf during monsoon. The Little Rann of Kutch has an area of approximately 3,000 sq km. However, the fishery for prawns exists only in an area of 1,200 sq km on the southern border where the bottom is muddy. Rao (1983) reported a lucrative seasonal prawn fishery, principally consti-

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tuted by juvenile of *M. kutchensis*, during the monsoon months. Juveniles of 71-95 mm length formed the mainstay of the fishery. The gear used was a bag net, locally known as 'Gunja', which could be operated either as a stake net or as a drag net. The total estimated landing during the season in 1980 was 2,312 t.

General remarks

The foregoing analysis of the estuarine fisheries shows that *Penaeus* and *Metapenaeus* spp. spend their juvenile stage in the estuaries. The presence of early juveniles of these species in abundance in the estuaries and their meagre abundance in the inshore waters indicate that estuarine ecosystem is more conducive for their survival and growth. The other advantages in the estuarine habitat are the abundance of food in the form of vegetable matter and animal detritus and protection from predators. Estuarine ecosystem generally provides comparatively soft muddy substratum. Most of the workers have attempted to correlate the fishery resources of penaeids in the estuaries to factors like recruitment of postlarvae, river discharge, rainfall, temperature, salinity and nutrients. It is possible that all these factors jointly determine the nature of environment for penaeids in the estuaries. The most important factor appears to be the seasonal changes in the waterspread area of the estuarine system. Although quantitatively it is difficult to establish a relationship, indirect evidences support this view. It is a common observation that the waterspread area of most of the estuaries along the east coast is maximum during October-December because of increased river discharge and high tidal levels. A reference to the landings from different estuaries shows that prawns landings generally reach a peak during this period. Hence it is necessary to provide as much waterspread area as possible to get better prawn landings. In recent years the estuarine ecosystem is threatened with encroachment by industries, urban development and agriculture resulting in the shrinkage of the waterspread area. Unless this encroachment is arrested the estuarine prawn fishery cannot be maintained at the desired levels. The marine prawn resources of the country are invariably related to the vast brackishwater system along the entire coastline. Constant monitoring and further studies on the various aspects of the fishery are needed to employ effective management measures and to counteract adverse effects, if any, due to the continued fishing pressure and rapid agroindustrial development.

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