Indian J. Fish., 46(1) : 13-23, Jan.-Mar., 1999

Prawn fishery by the sona boats at Visakhapatnam

G. SUDHAKARA RAO

Central Marine Fisheries Research Institute, Cochin – 682 014, India

ABSTRACT

The catch of prawns per hour of trawling along the Visakhapatnam coast (cph) by sona boats (43'OAL) gradually increased from 1.70 kg in 1993-'94 to 2.96 kg in 1996-'97. Prawns were landed throughout the year with the main season during July-December. The peaks in the fishery varied in different years. *Metapenaeus monoceros* dominated forming 23.6-30.3 % of the annual landings in different years followed by *M. dobsoni* (12.2-34.5 %), *M. affinis* (3.0-18.4 %), *P. indicus* (7.9-14.5 %), *P. monodon* (3.0-5.8 %) and *P. semisulcatus* (0.7-1.0 %). *M. affinis* and *P. monodon* indicated overfishing tendencies while all the other commercial species maintained the stocks in a healthy state. Since sona boat is more cost-effective than the small mechanised boats, mini trawlers and large trawlers, it has become a threat to these boats. Hence it is suggested that there should be a restriction on further increase in the number of sona boats not only at Visakhapatnam but also at Paradeep and Kakinada to save the other fleets operating for prawns.

Introduction

The most important technological development in the prawn fishery of Andhra Pradesh in recent years has been the emergence of sona boats. These boats introduced towards the end of 1987 increased gradually in number and started replacing the other types of boats along the northeast coast. With a sea endurance of upto 15 days and being economical in operation the sona boats became popular among the fishermen. As the boats started landing large quantities of prawns resulting in increased earnings, the operators began to call them 'sona boats' (sona = gold).

The sona boats are considerably larger than the existing small mechanised boats and are capable of covering distant areas. They operate one trawl net from the stern. The fishing areas, usually in the depth range of 10-70 m, overlap with those of all the other vessels perhaps with the exception of the 70-100 m depth zone off the sand heads, which has become an exclusive area for the large and mini trawlers. Although most of the sona boats are registered at Kakinada and Visakhapa-tnam, they operate all over the northeast coast. The development of sona boats has been a private undertaking without assistance from the government.

Although the prawn fishery of the northeast coast comprising Andhra Pradesh, Orissa and West Bengal is studied thoroughly (Muthu *et al.*, 1975; Narasimaham *et al.*, 1979; Rao, 1979, 1987, 1988a, 1988b, 1993a, 1993b, 1993c, 1994, Rao *et al.*; 1980, 1995) not much is known about the sona boat fishery at Kakinda and Visakhapatnam except for some information on the details of craft and gear and a rough estimate of the landings. In this paper an attempt is made to describe the prawn fishery of the sona boats operating from Visakhapatnam, based on the data collected during the four year period of 1993-'94 – 1996-'97. The interaction of the different fleets in harvesting the prawn resources of the northeast coast of India is also highlighted.

The boat and the gear

Chittibabu *et al.* (1988) described the boat and the trawl net operated, in detail. The salient features of the sona boat are summarised below:

Overall length (m)	13.1
Gross tonnage	18.0
Net tonnage	5.5
Horsepower of engine	102
Crew strength	6
Fuel capacity (kl)	5
Type of gear	Stern trawl
Design of gear	Four seam
Head rope length (m)	20
Foot rope length (m)	22
Cod end mesh size (mm)	25
Otter boards	60" x 29" (80 kg each)

Sona boats have a fishhold capacity of about 5 t, but do not have cold storage and refrigeration facilities and therefore carry crushed ice to preserve the catch. Although the rated endurance is 8 days most of the boats make voyages varying 8-15 days depending on the weather and abundance of the prawns. A part of the fish by-catch is discarded in the first four days of the voyage. In the remaining period of the voyage, the fish by-catch is dried or salted.

Method of data collection

Data were collected once in three days at the Visakhapatnam Fisheries Harbour on total landings and prawn landings by eye estimation from 10 boats landed on a given observation day. The number of fishing days, fishing hours and the depth of operation of the sampled boats were recorded on enquiry from the crew. A total enumeration of boats was made on the observation days to get the number of boats landed. Data on species composition were collected once in a week from about 10 boats on each observation day by sampling the catches in the boats. From the data obtained on the observation days, the monthly estimates were computed based on the fish landing days of a month by enquiry from the crew and traders as well as from the records maintained at the fisheries harbour.

The prawn fishery

Trend of landings

The details of monthly catch, effort and species composition are given in Tables 1-4. The number of units operated varied from 4,478 to 6,267 in different years of the four year period of 1993-'94 to 1996-'97. The effort expended in fishing hours gradually declined from 7,19,832 in 1993-'94 to 3,92,816 in 1995-'96 and then increased to 4,12,400 in 1996-'97. The prawn landings also gradually declined from 1,223.9 t in 1993-'94 to 979.9 t in 1995-'96 and then increased to 1,219.8 t in 1996-'97 keeping in tune with effort expended in different years. The per-

TABLE 1. *Penaeid prawn landings by 'sona' boats at Visakhapatnam in 1993-'94*

Particulars	Units	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Fishing units	(No.)	473	861	593	634	630	618	575	531	490	268	257	337	6,267
Effort	(hr)	13,161	4,817	33,325	1,10,813	77,610	1,02,702	1,06,003	88,844	8,3851	39,169	31,197	28,340	7,19,832
Total landings	(t)	144.3	117.4	240.4	615.4	475.0	713.4	613.5	536.2	719.2	409.1	450.5	477.6	5,512.0
Prawn landings	(t)	19.5	2.5	84.5	211.0	135.5	173.1	202.7	134.3	146.7	48.5	41.8	23.8	1,223.9
CPH of prawns	(kg)	1.48	0.51	2.54	1.90	1.75	1.68	1.91	1.51	1.75	1.24	1.34	0.84	1.70
Prawns	(%)	13.5	2.1	35.2	34.3	28.5	24.3	33.0	25.1	20.4	11.9	9.3	5.0	22.2
Species composition														
M. monoceros	(t)	10.3	0.5	29.2	61.2	25.7	31.0	26.3	36.7	51.3	22.1	23.8	12.8	330.9
	(%)	52.8	20.0	34.5	29.0	19.0	17.9	13.0	27.3	35.0	45.6	57.0	53.8	27.0
M. dobsoni	(t)	--	0.1	14.9	61.4	22.3	15.0	28.6	6.0	1.5	--	--	--	149.8
	(%)	--	4.0	17.6	29.1	16.5	8.7	14.1	4.5	1.0	--	--	--	12.2
M. affinis	(t)	1.3	--	1.4	12.4	16.3	23.6	39.2	33.8	21.4	2.0	0.8	0.1	152.3
	(%)	6.7	--	1.6	5.9	12.0	13.6	19.4	25.2	14.6	4.1	2.0	0.1	12.4
P. indicus	(t)	0.1	0.2	25.5	31.4	24.0	35.3	48.5	10.0	1.7	0.3	0.2	0.1	177.3
	(%)	0.5	8.0	30.2	14.9	17.7	20.4	23.9	7.4	1.1	0.6	0.4	0.2	14.5
P. monodon	(t)	0.8	0.1	1.7	11.9	8.0	13.5	10.6	12.2	8.5	1.4	1.4	0.5	70.6
	(%)	4.1	4.0	2.0	5.6	5.9	7.8	5.2	9.1	5.8	2.9	3.4	2.1	5.8
P. semisulcatus	(t)	0.2	0.2	0.8	2.3	1.6	1.9	2.4	1.3	1.1	0.5	0.5	0.2	13.0
	(%)	1.0	8.0	0.9	1.1	1.2	1.1	1.2	1.0	0.7	1.0	1.0	1.0	1.0
Other penaeids	(t)	6.8	1.4	11.0	30.4	37.6	52.8	47.1	34.3	61.2	22.2	15.1	10.1	330.0
	(%)	34.9	56.0	13.0	14.4	27.7	30.5	23.2	25.5	41.7	45.8	36.1	42.4	27.0

centage composition of prawns in the total landings varied from 21.1 in 1994-'95 to 27.8 in 1995-'96. Catch per hour of trawling (cph) which is generally considered as an index of abundance of the resource gradually increased from 1.70 kg in 1993-'94 to 2.96 kg in 1996-'97. This was possible because of a reduction in the effort by not only the sona boats but also the large trawlers and mini trawlers which have reduced their fishing effort due to uneconomic conditions.

Seasonal abundance

A reference to Tables 1-4 indicates that prawns were landed throughout the year with the main season lasting for six months during July-December. Not only that 80 % of the annual landings were recorded during this period but also higher proportion of prawns in the total landings and better rate of cph for prawns. The fishery after reaching a peak during July-December gradually declined till May and then abruptly increased in July. The poor landings during April-May may be due to a restriction in the fishing activity to single day fishing as a result of ban on trawling involving voyage fishing apart from the general decline in the abundance of prawns.

There may be slight deviation in the season in some years as was observed in 1993-'94 wherein peaks were observed for cph and percentage of prawns in June while the landings recorded the maximum in July 1993. In 1994-'95 the landings reached a peak in August (321 t) and declined thereafter gradually to 5.5 t in May. Cph for prawns and percentage composition of prawns in the total landings also indicated a similar pattern. The trend in 1995-'96 was slightly different with both cph and percentage composition indicating peaks in June. The lower landings recorded during 1995-'96 were due to a reduction in the effort rather than any decline in the abundance of prawns in the fishing grounds. Most of the boats resorted to single day fishing after the heavy cyclone damage to boats and loss of lives in November 1995 resulting in lower effort during November-January. This has resulted in decline in the overall effort expended in 1995-'96. The fishery in 1996-'97 indicated two peaks. The primary peak of July-September was very prominent with very high values recorded for landings, cph and percentage of prawns while the secondary peak of January recorded the same values only for cph (5.93 kg) with no commensurate effort during the month due to the inclement weather conditions.

Species composition

Although about 37 species of penaeid prawns were observed in the landings only 9 species viz. *Metapenaeus monoceros, M. ensis, M. dobsoni, M. affinis, Penaeus indicus, P. merguiensis, P. penicillatus, P. monodon* and *P. semisulcatus* dictated the economy of the fishery because of abundance and the price realised in the market.

Metapenaeus monoceros was the most dominant component contributing 23.6-30.3 % to the annual prawn landings. The landings of *M. monoceros* declined from 330.9 t in 1993-'94 to 287.5 t in 1996-'97. However, there was a gradual increase in the cph from 0.46 kg in 1993-'94 to 0.76 kg in 1995-'96 and then a slight decline to 0.70 kg in 1996-'97. The species was landed throughout the year with a primary peak in December and a secondary peak in July. However, in some years the peaks may slightly deviate as observed in 1996-'97 wherein

TABLE 2. *Penaeid prawn landings by 'sona' boats at Visakhapatnam in 1994-'95*

Particulars	Units	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Fishing units.	(No)	289	705	264	408	424	381	324	341	377	281	336	348	4,478
Effort	(hr)	9,847	4,069	5,672	75,162	78,647	73,416	62,995	62,064	55,317	24,475	43,404	23,703	5,18,778
Total landings	(t)	185.8	126.9	750.5	551.6	647.4	486.5	485.4	494.4	447.6	404.8	624.3	312.5	5,517.7
Prawn landings	(t)	8.5	5.5	15.5	205.1	321.3	161.3	141.6	100.9	96.5	54.9	39.1	15.1	1,165.4
CPH of prawns	(kg)	0.86	1.36	2.72	2.73	4.09	2.20	2.25	1.63	1.74	2.24	0.90	0.64	2.25
Prawns	(%)	4.6	4.4	2.1	37.2	49.6	33.2	29.2	20.4	21.6	13.6	6.3	4.8	21.1
Species composition														
M. monoceros	(t)	2.2	0.5	2.7	47.1	16.3	20.0	36.4	52.0	55.8	31.5	21.7	8.4	294.6
	(%)	25.8	9.7	17.2	23.0	5.1	12.4	25.7	51.5	57.8	57.3	55.5	55.7	25.3
M. dobsoni	(t)	--	1.7	5.1	82.9	230.6	55.6	23.4	2.9	--	--	--	--	402.2
	(%)	--	30.9	32.7	40.4	71.8	34.4	16.6	2.9	--	--	--	--	34.5
M. affinis	(t)	--	--	--	10.4	24.6	26.7	14.1	6.9	5.6	2.7	1.3	--	92.3
	(%)	--	--	--	5.1	7.7	16.5	9.9	6.8	5.8	5.0	3.3	--	7.9
P. indicus	(t)	0.1	0.2	4.4	26.3	20.9	20.0	19.4	2.5	1.4	0.4	0.3	0.1	96.2
	(%)	0.2	4.5	28.5	12.8	6.5	12.4	13.7	2.5	1.5	0.7	0.8	0.4	8.2
P. monodon	(t)	0.1	0.1	0.2	6.4	5.3	9.5	7.4	13.7	14.3	6.9	2.4	0.7	67.0
	(%)	1.0	2.3	1.2	3.1	1.7	5.9	5.2	13.5	14.8	12.6	6.2	4.4	5.7
P. semisulcatus	(t)	0.2	0.2	0.2	1.8	1.4	1.5	1.8	1.3	1.3	1.0	0.9	0.3	11.9
	(%)	2.1	2.8	1.4	0.9	0.4	0.9	1.3	1.3	1.3	1.7	2.4	1.7	1.0
Other penaeids	(t)	5.9	2.8	2.9	30.2	22.2	28.0	39.1	21.6	18.1	12.4	12.3	5.6	201.1
	(%)	70.9	49.8	19.0	14.7	6.8	17.5	27.6	21.4	18.7	22.7	31.8	37.8	17.3

the December peak shifted to January (Table 4).

Although the landings were recorded as *M. monoceros* it contained some quantity of *M. ensis* also. Since both were treated as one commercial group while segregating the catches they were put together, and iced and stored onboard the vessels. At the time of landing it was difficult to estimate the landings separately as the crew would not permit to be onboard for a longer time to sample the catch.

M. dobsoni formed the second important component with annual landings varying from 149.8 t in 1993-'94 to 402.8 t in 1996-'97 and contributing 12.2 - 34.5 % to the prawn landings. The annual average cph varied from 0.21 kg in 1993-'94 to 1.98 kg in 1996-'97. The fishery of *M. dobsoni* was highly seasonal. It was observed in the landings from May to January that the peak season was during June-October with slight deviation in different years. In 1993-'94 *M. dobsoni* was found during May-December with intensive fishery in July-October. The fishery was limited to July-October in 1994-'95 and formed almost 98 % of the species in the annual landings recorded during this period. Although the species was observed in the landings during June-January in 1995-'96 the abundance was limited to June-August registering around 82 % of the total. In 1996'-97 the species was observed only during May-November with maximum landings in July-September recording almost 89 % of the annual catches.

M. affinis fishery by sona boats indicated a gradual decline during the period of observation. The landings declined from 152.3 t in 1993-'94 to 29.7 t in 1995-'96 with a slight increase in 1996-'97 (37.1t). The percentage composition of *M. affinis* varied from 18.4 in 1993-'94 to 3.0 in 1995-'96. In 1993-'94 the species was observed in almost all the months except May with the active fishery during September-December occuring (77 %). Although *M. affinis* was observed throughout July-February in 1994-'95 the landings were appreciable only during July-October forming almost 82 % of the total. In 1995-'96 *M. affinis* was observed throughout June-March with negligible landings in most of the other months. In 1996-'97 it occurred only during July-February with negligible landings in the rest of the period.

P. indicus formed an important component of the sona boat fishery in view of its demand in the market. The white prawn species have a clear cut pattern of distribution along the northeast coast. *P. indicus* dominates in the area up to Chilka lake while *P. merguiensis* replaces it in the Chilka-Paradeep sector which in turn gets replaced by *P. penicillatus* in the Paradeep-Sunderbans zone. The annual landings of this group sharply declined from 177.3 t in 1993-'94 to 92.3 t in 1994-'95 and then increased to 138.1 t in 1995-'96 and 142.6 t in 1996-'97. The percentage composition of this group varied from 14.5 in 1993-'94 to 7.9 in 1994-'95. The cph varied from 0.19 kg in 1994-'95 to 0.35 kg in 1996-'97 indicating that the stock was in a better condition during the latter half of the period of study. A perusal of Table 1-4 shows that although these species were observed throughout the year in all the four years their abundance was confined to June-October constituting 91-95 % of annual landings.

P. monodon is a very important

TABLE 3. *Penaeid prawn landings by 'sona' boats at Visakhapatnam in 1995-'96*

Particulars	Units	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Fishing units	(No.)	323	586	320	381	341	216	553	638	337	302	515	317	4,829
Effort	(hr)	12,244	3,416	50,688	69,641	60,468	38,169	41,574	19,462	24,488	18,974	31,795	21,897	3,92,816
Total landings	(t)	139.0	179.0	351.0	419.3	374.6	233.0	704.9	99.0	188.5	233.3	409.3	198.3	3,529.2
Prawn landings	(t)	20.5	9.1	169.2	200.5	167.9	88.2	100.2	38.5	60.9	44.8	51.2	28.9	979.9
CPH of prawns	(kg)	1.67	2.60	3.34	2.88	2.78	2.31	2.41	1.98	2.49	2.36	1.61	1.32	2.49
Prawns	(%)	14.8	5.1	48.2	47.8	44.8	37.9	14.2	38.9	32.3	19.2	12.5	14.6	27.8
Species composition														
M. monoceros	(t)	2.7	1.7	49.8	59.7	37.8	24.5	16.1	11.4	30.4	22.0	25.0	15.8	296.9
	(%)	13.2	18.7	29.4	29.8	22.5	27.8	16.1	29.6	49.9	49.1	48.9	54.5	30.3
M. dobsoni	(t)	--	--	38.4	66.5	59.3	17.8	13.1	1.8	2.0	0.7	--	--	199.6
	(%)	--	--	22.7	33.1	35.3	20.2	13.0	4.6	3.3	1.6	--	--	20.4
M. affinis	(t)	--	--	4.7	3.6	4.4	4.4	2.6	2.4	2.8	2.1	1.3	1.4	29.7
	(%)	--	--	2.8	1.8	2.6	5.0	2.6	6.2	4.6	4.7	2.6	4.7	3.0
P. indicus	(t)	0.1	0.1	31.0	23.3	29.3	19.7	23.9	6.5	0.9	1.7	0.7	0.1	138.1
	(%)	0.1	1.1	18.8	11.6	17.4	22.3	23.8	17.0	1.5	3.8	1.5	0.2	14.1
P. monodon	(t)	0.1	0.1	6.2	15.6	8.1	3.6	5.4	2.2	2.7	2.3	2.4	1.0	49.7
	(%)	0.5	1.1	3.7	7.8	4.8	4.1	5.4	5.7	4.5	5.1	4.7	3.5	5.1
P. semisulcatus	(t)	0.1	0.1	3.2	--	--	--	1.4	0.6	0.4	0.7	0.7	0.2	7.4
	(%)	0.7	1.1	1.9	--	--	--	1.4	1.4	0.6	1.5	1.4	0.8	0.7
Other penaeids	(t)	17.5	7.1	35.1	31.8	29.0	18.2	37.7	13.6	21.7	15.3	21.1	10.4	258.5
	(%)	85.4	78.0	20.7	15.9	17.3	20.6	37.6	35.3	35.6	34.2	41.0	36.3	26.3

penaeid prawn resource along the east coast. The landings of *P. monodon* declined gradually from 70.6 t in 1993-'94 to 36.1 t in 1996-'97. The percentage composition of *P. monodon* also declined gradually from 5.8 in 1993-'94 to 3.0 in 1996-'97. In the case of cph, the decline was from 0.129 kg in 1994-'95 to 0.088 kg in 1996-'97. All these factors indicated that *P. monodon* was subjected to heavy fishing pressure and this might have led to overfishing of the species.

P. monodon was observed throughout the year in all the four years. There appears to be no clear cut season for the species in abundance except that the landings are always poor during January-May.

Although the magnitude of landings of *P. semisulcatus* was not much, it has a place in the economics of the sona boats as it commands a good price in the market. The annual landings varied from 13.0 t in 1993-'94 to 7.4 t in 1995-'96. It formed 0.7-1 % of the annual prawn landings during the 4 year period. The species was observed throughout the year with better landings during July-October.

Although a number of species are grouped together as 'other penaeids' it was mainly comprised of *Parapenaeopsis stylifera, P. hardwickii, Metapenaeus lysianassa, Solenocera crassicornis, S. melantho, Metapenaeopsis stridulans* and *M. barbata*. The annual landings of the other penaeids gradually increased from 201.1 t in 1994-'95 to 304.4 t in 1996-'97. They formed 17.3-27 % of the prawn landings in different years of the 4-year period. They were landed throughout the year with better landings during July-December and with variations in different years.

By-catch

Although sona boats conduct aimed trawling for prawns they incidentally catch a lot of finfish, crabs, cephalopods and lobsters. The finfish component was mainly dominated by clupeids, croakers, lizardfish, ribbonfish, bombay duck, silverbellies, carangids and red mullets. The quality fishes like seerfish, pomfrets, eels, tuna and other perches are landed in small quantities. The entire catch of crabs, stomatopods, silver bellies and Bombay duck is generally discarded as they fetch very low price. Even some of the groups like clupeids, croakers, carangids and red mullets are discarded in the first half of the voyage but are retained in the second half. All the quality fishes are retained from the first fishing day onwards as they fetch good price. It is not possible to get precise estimates of the by-catch discarded and landed as most of these boats do not keep any record of their fishing operations. The only possible way of arriving at these estimates is by indirect methods based on the landings of prawns.

In single day fishing at Visakhapatnam by small trawlers it was observed that prawns formed about 12 % of the total catches. Assuming that sona boat catches also had the same composition, the discards by sona boats were estimated as given below.

Year	By-catch (in t)	Landed by-catch (in t)	Discarded by-catch (in t)
1993-'94	4,837	4,288	549
1994-'95	4,847	4,352	495
1995-'96	3,107	2,542	565
1996-'97	4,662	4,080	582

It is apparent from the present analysis that the general contention that sona boats discard large quantities of by-catch at sea is not a reality.

TABLE 4. *Penaeid prawn landings by 'sona' boats at Visakhapatnam in 1996-'97*

Particulars	Units	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
Fishing units	(No.)	483	1670	348	351	507	544	403	364	306	355	382	385	6,098
Effort	(hr)	27,387	10,192	9,636	35,423	79,926	77,550	57,044	25,185	27,606	16,197	22,159	24,095	4,12,400
Total landings	(t)	305.2	185.9	82.4	361.1	711.0	870.9	567.0	464.0	238.0	531.0	591.0	392.0	5,299.5
Prawn landings	(t)	25.0	17.9	42.0	180.8	351.1	226.9	92.1	55.0	54.0	96.0	57.0	22.0	1,219.8
CPH of prawns	(kg)	0.91	1.75	4.35	5.10	4.39	2.93	1.62	2.18	1.96	5.93	2.57	0.91	2.96
Prawns	(%)	8.2	9.6	50.9	50.0	49.4	26.0	16.3	11.9	22.7	18.1	9.6	5.6	23.02
Species composition														
M. monoceros	(t)	16.8	7.2	2.2	41.4	39.3	30.6	10.8	16.4	31.4	53.6	28.3	9.5	287.5
	(%)	67.4	40.1	5.3	22.9	11.2	13.5	11.7	29.8	58.2	55.8	49.8	43.0	23.6
M. dobsoni	(t)	--	5.2	15.8	93.5	182.0	82.9	21.1	2.3	--	--	--	--	402.8
	(%)	--	29.2	37.5	51.7	51.8	36.5	22.9	4.1	--	--	--	--	33.0
M. affinis	(t)	--	--	--	7.9	9.0	4.5	6.5	2.2	2.9	2.8	1.3	--	37.1
	(%)	--	--	--	4.4	2.6	2.0	7.0	4.1	5.3	2.9	2.2	--	3.0
P. indicus	(t)	0.1	1.5	19.7	13.5	38.6	45.8	11.6	4.2	2.9	2.2	2.1	0.4	142.6
	(%)	0.2	8.1	47.0	7.5	11.0	20.2	12.6	7.6	5.4	2.3	3.7	2.0	11.7
P. monodon	(t)	0.4	0.3	0.2	1.9	13.0	7.1	3.5	2.9	1.6	2.3	2.1	0.8	36.1
	(%)	1.6	1.8	0.5	1.0	3.7	3.1	3.8	5.3	3.0	2.4	3.7	3.5	3.0
P. semisulcatus	(t)	0.2	0.1	0.3	0.9	2.2	2.1	1.3	0.6	0.5	0.5	0.3	0.3	9.3
	(%)	0.6	0.3	0.6	0.5	0.6	0.9	1.4	1.2	0.9	0.5	0.5	1.2	0.7
Other penaeids	(t)	7.5	3.6	3.8	21.7	67.0	53.9	37.3	26.4	14.7	34.6	22.9	11.0	304.4
	(%)	30.2	20.4	9.0	11.9	19.1	23.7	40.6	47.8	27.2	36.0	40.1	50.3	25.0

Gordon (1991) assumed that each sona boat on an average discard about one tonne of by-catch daily and the 70 sona boats operating during 1988-'89 period discarded as much as 14,000 t of fish. However, Rao (MS') based on the prawn landings of the sona boats in 1988-'89 estimated it as 1,323-2,101 t. Since there was a gradual decline in the discards over the years in view of the increasing demand for by-catch, the present estimate and the estimate of Rao (MS 1) for 1988-'89 are complimentary to each other.

General remarks

The foregoing analysis of the sona boat prawn fishery indicates that the fishery is on a strong footing with a gradual increase in the cph during the four-year period of 1993-'94 to 1996-'97. Except for *M. affinis* and *P. monodon* which indicated tendencies of overfishing, all the other species indicated a healthy picture of the prawn fishery. However, a comprehensive study of the prawn fishery by the other fleets viz. large trawlers, minitrawlers and small mechanised boats indicated a downward trend in the landings as well as the cph (Rao, 1993 b).

Rao (1987) estimated the maximum sustainable yield (MSY) for prawn stocks of the area between Pentakota and Sunderbans as 9,790 t and suggested a fleet strength of 104 large trawler units (including large trawlers and mini trawlers) keeping the number of other fleets at 1986 level. Disregarding this warning the number of large and mini trawlers was increased to 190 and 100 respectively by 1991-'92 making up to 223 large trawler units. In addition to this the sona boats which were introduced in 1987 increased in number year after year threatening the existence of the other fleets. Rao (1993 b) analysing the prawn fisheries of different fleets operating from Visakhapatnam indicated that the expansion of the sona boat fleet in general and particularly at Paradeep would spell doom for the large and mini trawlers. In spite of these warnings the introduction of sonas continued unabated resulting in the reduction in the margin of profits of all the other fleets and consequent lay off of a number of large and mini trawlers. As a result the number of these trawlers operating in 1996-'97 came down to 60 and 35 respectively. Rao (MS 3) studying the prawn fishery of the small mechanised boats at Visakhapatnam observed that there was a drastic decline in the landings and cph after the introduction of sona boats. Although there is a lull in the introduction of sonas at Kakinada and Visakhapatnam, it is going on at a faster rate at Paradeep because of the ambitious plans of Orissa Government to introduce 350 sona boats in the Orissa coast.

Bioeconomic analysis of the north-east coast demersal fishery (FAO, 1993) suggested a reduction of 40 % from the 1991 level in the number of vessels in each of the five fleets viz. artisanal craft, small machanised boats, sona boats, minitrawlers and large trawlers to make all the fleets economically viable. However, all these suggestions are ignored by the policy makers resulting in the doom of the large and mini trawlers (Rao, MS 2). It may not stop there but may even affect the economics of small mechanised boats operating not only from Visakhapatnam but also from Paradeep, Chandipur and Arafal in Orissa.

References

Chittibabu, K., P. Ramalingam, K. Dhanaraju and T. Nageswara Rao 1988. Introduc-

tion of 43 footer mechanized boats for commercial trawling along the coast of Andhra Pradesh. *Mar. Fish. Inf. Serv.*, T&E. Ser., No. 86, p. 27-29.

FAO 1993. Workshop on bio-economics of the demersal fisheries of the north-east coast of India. GCP/INT/575/ DEN, 120 pp.

Gordon, A. 1991. The by-catch from Indian shrimp trawlers in the Bay of Bengal: The potential for its improved utilization. *Bay of Bengal Programme, Madras, India. BOBP/WP/68* : 25 pp.

Muthu, M.S., K. A. Narasimham, G. Sudhakara Rao, Y. Appanna Sastry and P. Ramalingam 1975. On the commercial trawl fisheries off Kakinada during 1967-'70. *Indian J. Fish.*, **22** : 171-186.

Narasimham, K.A., G. Sudhakara Rao, Y. Appanna Sastry and W. Venugopalam 1979. Evaluation of demersal fisheries resources off Kakinada with a note on the economics of commercial trawling. *Indian J. Fish.*, **26** : 90-100.

Rao, G. Sudhakara 1979. Observations on the marine prawn fishery by shore seines at Kakinada. *Indian J. Fish.*, **26** : 52-65.

Rao, G. Sudhakara 1987. A preliminary study of the prawn fishery of big trawlers along the northeast coast of India. *Indian J. Fish.*, **34** : 312-328.

Rao, G. Sudhakara 1988 a. Exploitation of prawn fishery resources by trawlers off Kakinada with a note on the stock assessment of commercially important species. *Indian J. Fish.*, **35** : 140-155.

Rao, G. Sudhakara 1988 b. Prawn fishery of the big trawlers along the northeast coast of India. *Mar. Fish. Infor. Serv., T&E Ser.*, No. 87, p. 15-30.

Rao, G. Sudhakara 1993 a. An appraisal of the marine fishery resources of Visakhapatnam coast. *Fishing Chimes*, **13**(1) : 81-87.

Rao, G. Sudhakara 1993 b. Shrimp fishery in the coastal and offshore waters of upper east coast. *Proc. National Workshop 'Development of Marine Fisheries for Higher Productivity and Export'* organised by Department of Agricultural and Co-operation at Cochin during 9-10th June 1992, p. 31-61.

Rao, G. Sudhakara 1993 c. An appraisal of the fishery of *Metapenaeus monoceros* along the Kakinada coast. *J. mar. biol. Ass. India*, **35** : 57-73.

Rao, G. Sudhakara 1994. Mortality rates and stock assessment of *Metapenaeus monoceros* along the Kakinada coast. *J. mar. biol. Ass. India*, **36** : 1-18.

Rao, G. Sudhakara, C. Suseelan and S. Lalithadevi 1980. Impact of mesh size reduction of trawl nets on the prawn fishery of Kakinada in Andhra Pradesh. *Mar. Fish. Infor. Serv., T&E. Ser.*, No. 21, p. 1-6.

Rao, G. Sudhakara, V.T. Subramanian, M. Rajamani, P.E.S. Manickam and G. Maheswarudu 1995. Population dynamics of *Penaeus* spp. in the east coast of India. *Indian J. Fish.*, **40** : 1-19.

Rao, G. Sudhakara (MS 1). Discarding Practices by prawn fishing fleets of the northeast coast of India. *Symposium on Advances and Priorities in Fisheries Technology*, organised by Society of Fishereis Technologists and Central Institute of Fisheries Technology, Cochin, 11-13 Feb. 1998.

Rao, G. Sudhakara (MS2). Deep sea prawn fishery along the northeast coast of India – a critical appraisal. *Symposium on Large Marine Ecosystems : Exploration and Exploitation for Sustainable Development and Conservation of Fish Stocks.*

Rao, G. Sudhakara (MS 3). An appraisal of the prawn fishery by small mechanised boats off Visakhapatnam.