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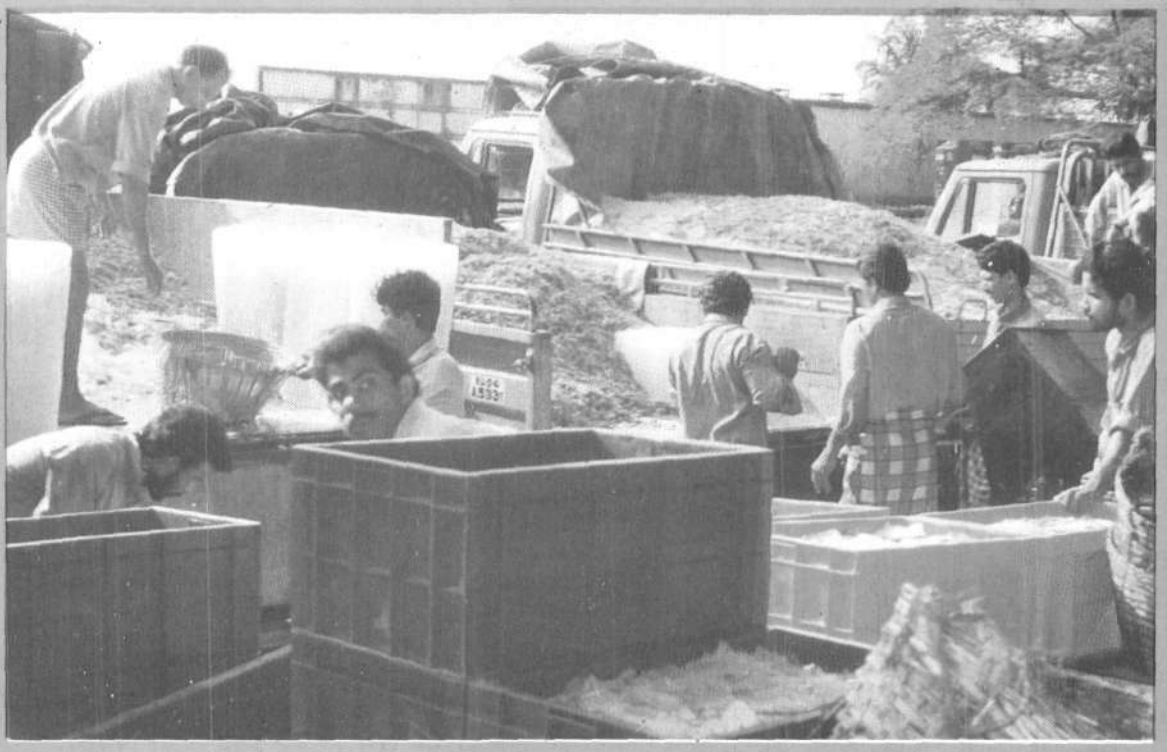

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959 INNOVATIVE EXPLOITATION OF DEEPSEA CRUSTACEANS ALONG THE KERALA COAST

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Introduction

Exploratory surveys carried out since 1965 by fishing vessels belonging to different governmental agencies have revealed the occurrence of commercially important deep sea crustaceans in trawlable concentration along the south-west coast of India. An area of 3300 sq. km lying between Quilon and Alapuzha, popularly known as 'Quilon Bank' was found to be a rich ground for deep sea prawns and lobsters. Lying between Lat. 8°N and 9°N, the bottom slope in the 'Quilon bank' is interrupted by a flat area between 275 and 375 m which is ideally suited for bottom trawling operation for deep sea crustaceans. The three Indo-Norwegian project vessels *'Klaus Sunnana'*, *'Velameen'* and *'Tuna'* carried out exploratory surveys during 1967-69 along the south-west coast and brought out a wealth of information on distribution, abundance, catch composition of deepsea crustacean resources and population characteristics of commercially important species of prawns and deep sea lobster. Using FORV *Sagar Sampada* facilities, Central Marine Fisheries Research Institute carried out exclusive surveys for deep sea crustaceans along the south-west coast in 1988, and 91. These experimental fishing operations further enhanced our knowledge on the distribution of deep sea prawns and lobster in the upper continental slope, as well as their population characteristics.

Some of the important works which throw more light on the deep sea resources along the south-west coast of India and the biological characteristics of constituent species are by Kurian (*Fish. Tech., 2(1), 1965*), Silas (*Bull. CMFRI, 12, 1969*), Suseelan (*J.mar.biol.Ass. India, 16(2), 1974*), Oommen (*I.F.P. Bull. No. 4, 1980*), Kathirvel *et al.* (*Fishing Chimes, 8(11), 1989*) and Suseelan *et al.* (*Proc. First. Workshop Scient. Resul. FORV Sagar Sampada 1989*).

Till recently, deep-sea crustacean resources were considered to be a close preserve of large trawlers. These resources were considered to be beyond the reach of small and medium trawlers operating in the coastal waters. Diminishing catch in coastal waters, spiralling fuel prices and the consequent erosion on income forced a few trawl operators at Sakthikulangara to venture into deep sea fishing operations, for the first time in November 1999. They returned with enormous quantities of deep-sea prawns locally known as *'Pullan konju'*. Others too followed suit, which resulted in the flooding of the fishing harbours at Sakthikulangara, Neendakara, Kochi and Munambam with the red prawns from deep seas. Along with prawns small quantities of deep-sea lobster were also brought in. Availability of deep-sea crustaceans was a boon to the boat owners and prawn starved processing industry had a new lease of life. A new chapter in the fishing history of the country had been opened.

The present communication deals with the fishery and biology of deep sea prawns and lobster exploited by small and medium trawlers from the fishing harbours of Sakthikulangara-Neendakara, Kochi and Munambam between November '99 and March 2000. The fishery data at Kochi consist of landings at Kochi Fisheries Harbour, as well as at private jettys of Kalamukku and Murukkumpadam in Vypeen island.

Craft and gear

Conventional shrimp trawlers of 38 to 65 ft in overall length powered by 100 to 120 HP engines were engaged in deep sea fishing operation. Mostly the existing winches on these vessels were modified by increasing the diameter of the drums and the length of the shaft to accommodate more wire ropes. The thickness of the wire rope was increased to 9-

11 mm in diameter. In some of the boats new winches were installed. Each drum could accommodate 1000 to 1800m of wire rope. Fish hold had a storage capacity of 3 to 6 tonnes. Depending on the length of voyage, trawlers carried 2500 to 5000 litres of fuel.

Shrimp trawls with a cod end mesh size of 25 to 30 mm were in operation. Length of head rope ranged between 100 to 120 ft. By minimising the number of floats on the head rope as well as by reducing the trawling speed, thse boats could operate the net in such greater depths, very successfully, in spite of their limitation in overall length.

Fishing aids

Some of these trawlers were equipped with hi-tech devices such as GPS (Global Positioning Satellites) navigators and echosounders. GPS receivers determine the exact position of the vessel in the sea with high precision in latitude and longitude. Once productive shrimp grounds were located, the vessel could reach the same grounds in subsequent trips with ease with the aid of GPS navigators. Echosounder, helps to know the exact depth of the ground and its terrain which makes the operation of the net an easy task. 'Green seas' a NGO based at Munambam imparts technical knowhow to the crew on the use of these devices.

Area of fishing

Trawling generally extended between Trivandrum and Alapuzha with heavy concentration of fishing vessels at 'Quilon bank' at depths ranging between 175 and 400 m. During March some trawlers even went upto Kanyakumari in the south and Beypore in the north and the depth of operation exceeded 450m.

Generally 6-8 crew members go for fishing in each trip which lasted 2 to 3 days in the beginning of the season. Fishing vessels stayed away from the harbours even upto 5 to 6 days as the season advanced.

Prawn fishery

Details on the deep sea prawn catch, catch rate and species composition are given centrewise.

Munambam: Between November '99 and March 2000, the estimated total deep sea prawn landings amounted to 3393 t with a catch rate of 59 kg / hour of trawling (Table 1). Maximum landings were recorded in December followed by January and February. Catch / hr of trawling ranged between 40 to 77 kg and the maximum catch rate was noticed in December.

Species composition: More than 81% of the prawn catch was contributed by pandalid prawns. Among them, *Heterocarpus woodmasoni* (34.48%) and *Plesionika spinipes* (32.57%) were the major constituents followed by *H. gibbosus* (13.82%). *Plesionika martia* appeared in small quantities in March. Maximum landings of pandalids were obtained in December and January. Among the penaeid prawns *Metapenaeopsis andamanensis* (13.12%) and *Aristeus alcocki* (4.83%) were the major contributors. *Penaeopsis jerryi* and *Solenocera hextii* were represented in the fishery in small numbers in certain months. Maximum landings of *M. andamanensis* occurred in March followed by December. *A. alcocki* was fished in good quantities in February and landings were uniform during the rest of the period between December and March.

Kochi Fisheries Harbour: The total estimated landings of deep sea prawns amounted to 3768 t, with the catch / hr of 59 kg (Table 2). Maximum catch was obtained in December. Catch / hr of trawling was almost uniform (60 kg) in all months except in February when it decreased to 46 kg. Maximum trawling hours were recorded in December with a gradual decline in subsequent months.

Species composition: Pandalid prawns *H. woodmasoni* (33.44%), *P. spinipes* (25.64%) and *H. gibbosus* (16.64%) supported bulk of the prawn fishery. Best landings of *H.woodmasoni* and *P. spinipes* were recorded in December with gradual decline in the following months. Maximum landing of *H. gibbosus* took place in February followed by January. Penaeids contributed to 24.26% of the prawn landings with maximum representation by *A. alcocki* followed by *M. andamanensis*. Maximum catch of *A. alcocki* and *M. andamanensis* was recorded in March and December respectively. *S. hextii*

TABLE 1 Details on catch (t), effort, catch/hr (kg) and catch composition of deep sea crustacean fishery at Munambam during 1999-2000

	Nov.99	Dec.99	Jan.2000	Feb.2000	Mar.2000	Total
No. of boat trips	50	961	797	645	416	2869
Trawling hours	1200	19024	15054	15795	6518	57591
Deep sea prawn catch (t)	48	1464	914	535	432	3393
Catch/hour of trawling (kg)	40	77	61	34	66	59
Deep sea lobster (*Puerulus sewelli*) catch (t)	1	18	17	16	5	57
Catch/hr of trawling (kg)	0.8	0.9	1.1	1.0	0.8	1.0
Species wise prawn catch (t)						
Heterocarpus woodmasoni	21	586	387	96	80	1170 (34.48%)
H. gibbosus	4	125	139	156	45	469 (13.82%)
Plesionika spinipes	15	607	232	168	83	1105 (32.57%)
P. martia	-	-	-	-	14	14 (0.41%)
Aristeus alcocki	1	34	37	56	36	164 (4.83%)
Metapenaeopsis andamanensis	5	112	98	59	171	445 (13.12%)
Penaeopsis jerryi	2	-	21	-	-	23 (0.68%)
Solenocera hextii	-	-	-	-	3	3 (0.09%)

TABLE 2 Details on catch (t), effort, catch/hr (kg) and catch composition of deep sea crustacean fishery at Kochi Fisheries Harbour during 1999-2000

	Dec.99	Jan.2000	Feb.2000	Mar.2000	Total
No. of boat trips	1181	882	725	497	3285
Trawling hours	23541	15556	14367	10665	64129
Deep sea prawn catch (t)	1517	932	666	653	3768
Catch/hour of trawling (kg)	64	60	46	61	59
Deep sea lobster (*Puerulus sewelli*) catch (t)	5	6	7	6	25
Catch/hr of trawling (kg)	0.2	0.4	0.5	0.6	0.4
Species wise prawn catch (t)					
Heterocarpus woodmasoni	656	297	206	101	1260 (33.44%)
H. gibbosus	134	177	194	122	627 (16.64%)
Plesionika spinipes	463	278	134	91	966 (25.64%)
P. martia	-	1	-	-	1 (0.02%)
Aristeus alcocki	64	56	97	327	544 (14.44%)
Metapenaeopsis andamanensis	170	98	20	1	289 (7.67)
Penaeopsis jerryi	13	1	-	-	14 (0.37%)
Solenocera hextii	17	24	15	11	67 (1.78%)

supported a minor fishery with fairly good landings in January. Almost the entire catch of *P. jerryi* was landed in December.

Sakthikulangara-Neendakara: Maximum landings of deep sea prawns were recorded at Sakthikulangara and Neendakara harbours. Estimated catch during the 5 month period amounted to 16265 t at a catch rate of 58 kg/hr of trawling (Table 3). Best landings were observed in December followed by February and March. Catch rate was high during November-December. It declined in January followed by a spurt in February and again a fall in March. Maximum hours were expended for trawling in December followed by March and January. **Species composition:** *H. woodmasoni* (36.78%) and *P. spinipes* (27.79%) contributed to the bulk of the prawn landings. This was followed by *M. andamanensis* (15.68%), *H. gibbosus* (12.24%) and *A. alcocki* (4.96%). Other species namely *P. martia*, *P. jerryi* and *S. hextii* occurred in small numbers in different months. Maximum amount of pandalid prawns and *M. andamanensis* was caught in the month of December '99. Landings of *A. alcocki* was more during February 2000.

General trend on the deep sea prawn fishery along Kerala coast

The total deep sea prawn catch of Kerala coast landed at Munambam, Kochi and Sakthikulangara-Neendakara centres for the period between November 1999 and March 2000 amounted to 23426 t with a catch rate of 58 kg/hr (Table 4). More than 69% of the prawn catch was landed at Sakthikulangara-Neendakara harbours followed by Kochi (16.1%) and Munamban (14.5%). The catch rate was almost similar at these centres. Nearly 70% fishing effort was expended at Sakthikulangara-Neendakara centres followed by Koch (16%) and Munambam (14%).

Pandalid prawns contributed to 78% of the deep sea prawn fishery, the rest being accounted by penaeid prawns (Fig. 1). Among the pandalids, *H. woodmasoni* (37%) and *P. spinipes* (28%) were the dominant constituents followed by *H. gibbosus* (13.0%). *M.*

TABLE 3 Details on catch (t), effort, catch/hr (kg) and catch composition of deep sea crustacean fishery at Sakthikulangara-Neendakara during 1999-2000

	Nov.99	Dec.99	Jan.2000	Feb.2000	Mar.2000	Total
No. of boat trips	2081	7610	5545	3737	5268	24241
Trawling hours	21215	78031	69656	41364	69808	280074
Deep sea prawn catch (t)	1548	6641	2303	2924	2851	16265
Catch/hour of trawling (kg)	73	85	33	71	41	58
Deep sea lobster *(Puerulus sewelli)* catch (t)	76	154	53	89	120	492
Catch/hr of trawling (kg)	3.6	2.0	0.8	2.2	1.7	1.8
Species wise prawn catch (t)						
Heterocarpus woodmasoni	739	2625	878	585	1155	5982 (36.78%)
H. gibbosus	79	698	304	410	499	1990 (12.24%)
Plesionika spinipes	419	2032	483	959	627	4520 (27.79%)
P. martia	-	-	62	-	-	62 (0.38%)
Aristeus alcocki	75	-	178	409	145	807 (4.96%)
Metapenaeopsis andamanensis	236	1286	247	383	399	2551 (15.68%)
Penaeopsis jerryi	-	-	149	102	-	251 (1.54%)
Solenocera hextii	-	-	-	76	26	102 (0.63%)

andamanensis (14%) and *A.alcocki* (6%) were the principal components of the penaeid prawn fishery. The rest of the deep sea prawn fishery (2%) was shared between *P. jerryi, S. hextii* and *P. martia* in order of abundance.

Fishes and crabs caught along with prawns were discarded due to lack of space on board the vessels and non-existence of ready market to purchase them.

Biological studies

Details on size distribution, sex ratio and the breeding season of dominant constituent species had been collected. Since the source of the catch being the same, biological data of all the fishing centres are pooled together for the present study. Specieswise size frequency data of the entire fishing season is pooled together and presented in the Figures 2 to 6. Species-wise, month-wise and sex-wise data on size range, dominant size classes, sex ratio and breeding stock are given in Table 5. The total length of the prawn was measured from tip of the rostrum to the tip of the telson and the sizes are grouped under 5 mm length groups. Species-wise biological informations are given below.

Heterocarpus woodmasoni: This medium sized prawn was the dominant constituent of the deep sea prawn fishery contributing to nearly 37% of catches. In the fishery, 71 to 125 mm sized males and 81 to 125 mm sized females were represented (Fig.2). 96 to 120 mm size classes in both sexes dominated and supported more than 91% of the fishery.

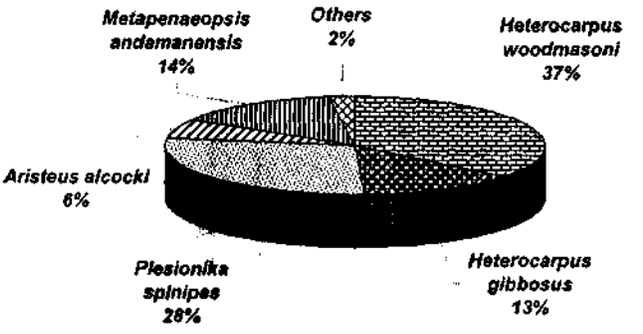


Fig. 1 Species composition of deep sea prawn fishery along Kerala coast

Males outnumbered females in December and March. In the overall fishery males contributed to 54.2% of the landings. Berried females were available throughout the season, with their percentage contribution varying between 74 to 94.4 in different months. This indicates active breeding throughout the season (Table 5). The minimum size of the berried female encountered in the fishery was 93 mm.

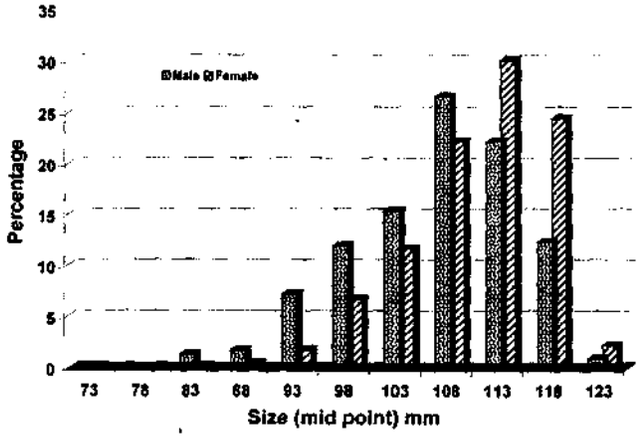


Fig. 2 Size distribution of *Heterocarpus woodmasoni*

TABLE 4 Catch (t), effort and catch/hr (kg) of deep sea crustacean fishery for all centres combined during 1999-2000

	Munambam	Kochi Fisheries Harbour	Sakthikulangara Neendakara	Total
No. of boat trips	2869	3285	24241	30395
Trawling hours	57591	64129	280074	401794
Deep sea prawn catch (t)	3393	3768	16265	23426
Catch/hour of trawling (kg)	59	59	58	58
Deep sea lobster *(Puerulus sewelli)* catch (t)	57	25	492	574
Catch/hr of trawling (kg)	1.0	0.4	1.8	1.4

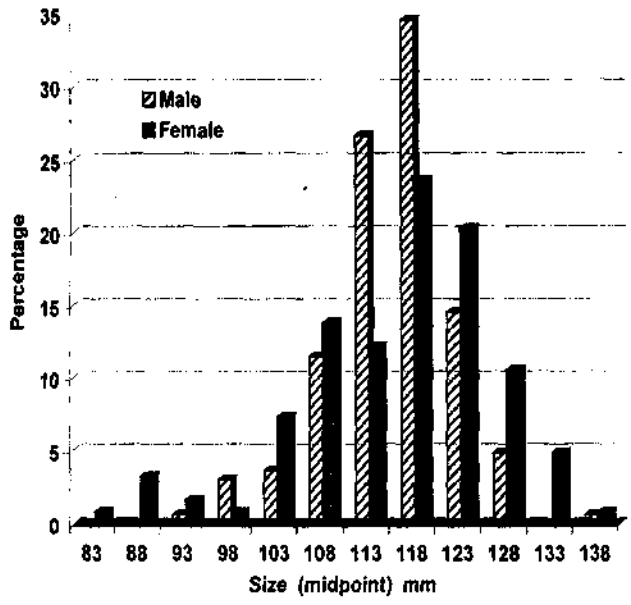


Fig. 3 Size distribution of *Heterocarpus gibbosus*

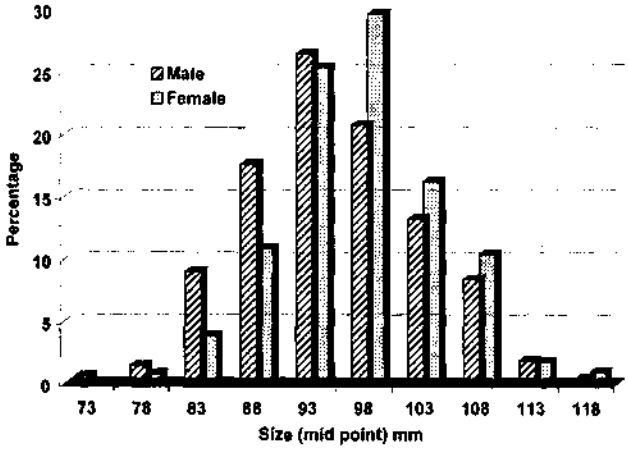


Fig. 4 Size distribution of *Plesiontika spinipes*

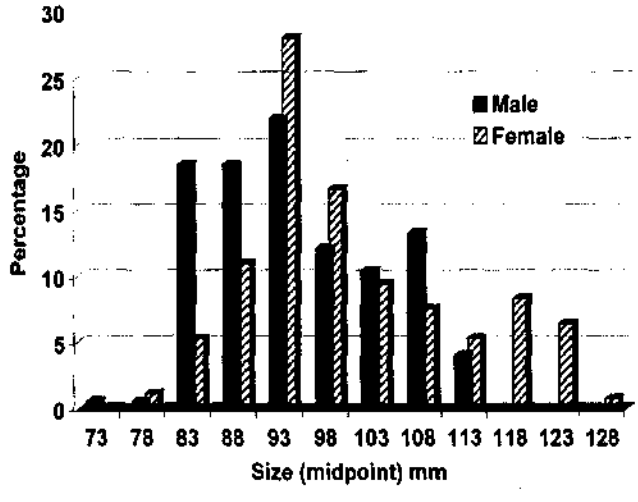


Fig. 5 Size distribution of *Metapenaeopsis andamanensis*

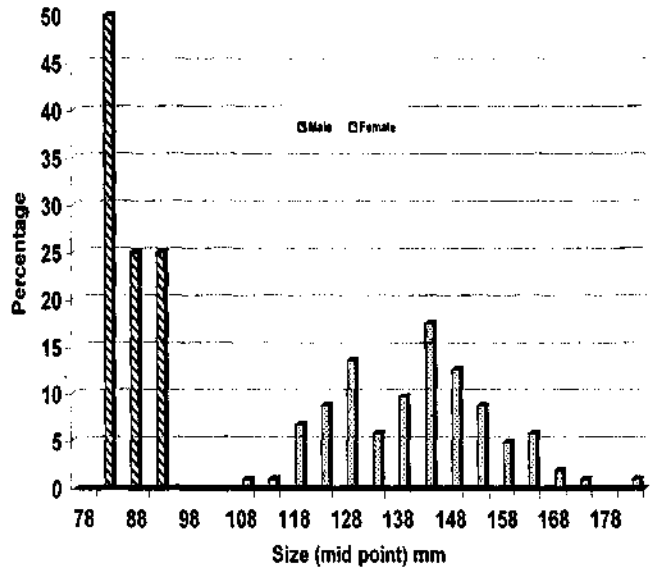


Fig. 6 Size distribution of *Aristeus alcocki*

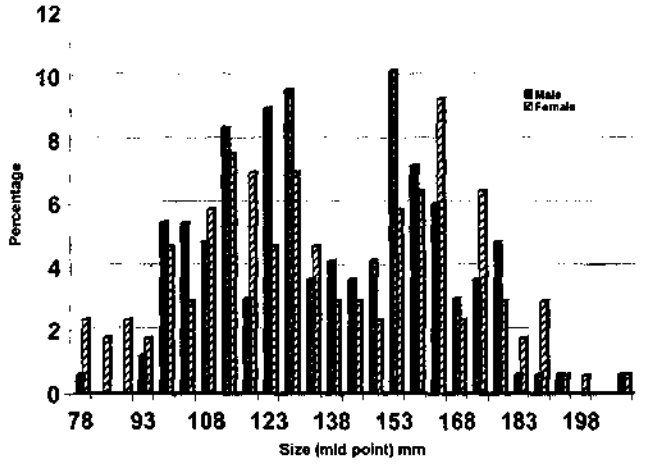


Fig. 7 Size distribution of *Puerulus sewelli*

Number of head-on prawns varied between 111 and 150 in one kg.

Heterocarpus gibbosus: Due to its larger size, this prawn is much sought after by the processing industry. The total length of the prawn in the fishery varied between 91-140 mm in males and 81-140 mm in females (Fig.3). The size classes mainly supporting the fishery were within the range of 111-125 mm in males and 106-125 mm in females. The most dominant modal class for both sexes throughout the season was 116-120 mm and about 73% of the landings was contributed by this size group.

Males dominated the fishery in all months except March. Berried females were recorded

in the fishery between January to March. Most of the berried individuals were recorded in the sizes above 100 mm. However, the smallest berried female measured 88 mm. Berried females in good numbers were fished in February and March suggesting intense breeding during these months (Table 5).

55 to 80 numbers of head-on prawns were available in one kg.

Plesionika spinipes: In the earlier works this species was referred as *Parapandalus spinipes* Chace (1985) placed this prawn under the genus Plesionika. This prawn was the second most dominant component of the deep sea prawn fishery, contributing to 28% of the landings. The fishery was supported by 71-120 mm sized males and 76-120 mm group females (Fig.4). Dominant size classes in the

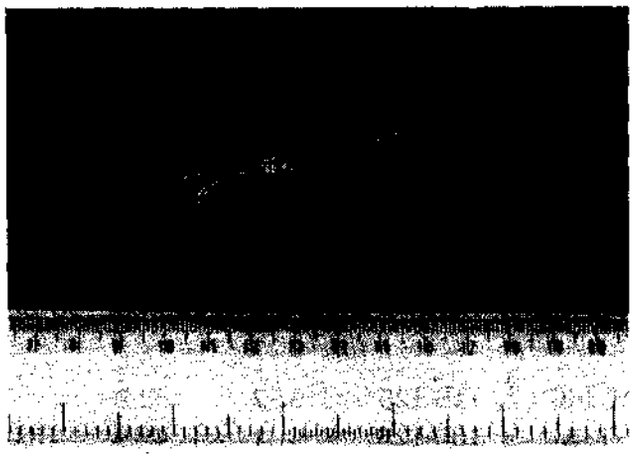
TABLE 5 Biological characteristics of deep sea prawns

	Male		Female		Sex ratio(%)		Berried
	Size range (mm)	Dominant Size (mm)	Size range (mm)	Dominant Size (mm)	Male	Female	Females (%)
	Heterocarpus woodmasoni						
December 1999	71-125	106-120	81-125	106-120	57.8	42.2	74.0
January 2000	81-125	101-120	96-125	106-120	41.5	58.5	77.8
February 2000	81-120	101-115	81-120	106-120	31.0	69.0	94.4
March 2000	81-120	96-110	86-120	96-110	63.5	36.5	90.3
Total	71-125	96-120	81-125	96-120	54.2	45.8	79.3
	Heterocarpus gibbosus						
December 1999	106-140	111-125	101-140	116-125	57.2	42.9	-
January 2000	91-125	111-120	91-135	106-125	51.1	48.9	13.0
February 2000	96-130	111-120	81-135	111-125	61.2	38.3	42.6
March 2000	106-130	116-120	86-125	121-125	37.5	62.5	90.0
Total	91-140	111-125	81-140	106-125	57.3	42.7	28.5
	Plesionika spinipes						
December 1999	71-115	91-105	76-120	91-105	48.2	51.8	71.9
January 2000	76-120	91-105	76-120	96-110	36.7	63.3	75.8
February 2000	71-105	86-95	76-105	86-95	46.7	53.3	69.1
March 2000	81-110	91-100	81-110	91-100	45.5	54.5	72.2
Total	71-120	86-105	76-120	86-110	43.9	56.1	73.0
	Metapenaeopsis andamanensis						% of spawners
December 1999	71-115	81-95	81-130	86-100	46.7	53.3	2.0
January 2000	81-115	91-110	81-130	91-110	36.3	63.7	-
February 2000	86-105	86-90	76-125	91-95	23.1	76.9	-
March 2000	81-115	91-100	76-125	91-100	34.4	65.6	8.5
Total	71-115	81-110	76-130	86-110	39.6	60.4	2.7
	Aristeus alcocki						
February 2000	81-90	81-85	106-185	126-150	3.2	96.8	62.2
March 2000	86-95	86-90	111-155	126-140	7.1	92.9	30.80
Total	81-95	81-90	106-185	126-150	3.9	96.1	58.3

catch were within the range 86-105 mm in males and 86-110 mm in females. These size classes contributed to 86% of the fishery.

Female was dominant in the fishery throughout the period of observation with its monthly percentage contribution ranging between 51.8 and 63.3. Berried females in appreciable numbers were seen throughout the fishing season indicating continuous breeding (Table 5). In the overall fishery they formed 73% of the females. Smallest berried female in the catch measured 83 mm in total length.

In the commercial catch 165 to 300 nos of



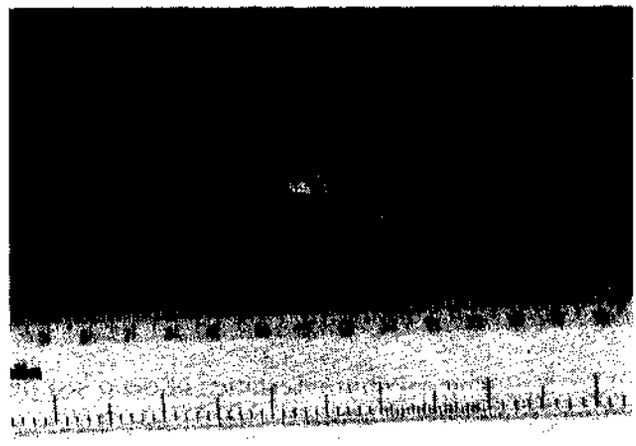
Heterocarpus woodmasoni

head-on prawns constituted one kg.

Metapenaeopsis andamanensis: This was the most dominant penaeid species in the deep sea prawn fishery. 71-115 mm size males and 76-130 mm females contributed to the fishery (Fig.5). Dominant groups in the fishery were within 81-110 mm size range in males and 86-110 mm in females. More than 81% of the catch was contributed by these size classes.

Females outnumbered males in all months, the overall contribution being 60.4% in the landings. Unlike the pandalid prawns, sprawners were rarely represented in the catch (Table 5). While spwners were totally absent in January and February small numbers were encountered in December and March.

Aristeus alcocki : Largest of all deep sea prawns, this prawn is listed as *A. semidentatus* in the earlier works. Suseelan (*J.mar.bio.Ass. India*, 31 1989) established its true identity as



Plesionika spinipes

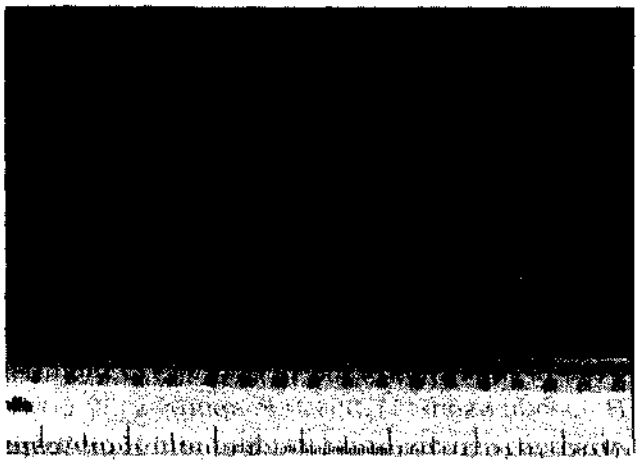
A. alcocki. Popularly known as 'red ring', this is the most sought after deep sea prawn by exporters. Sexes exhibit wide disparity in their size and occurrence. Males in the fishery measured between 81-95 mm in total length where as in females the size ranged between 106-185 mm (Fig. 6). Females of 126-150 mm size range dominated the fishery.

Males were represented very rarely in the catch and the overall contribution was as low as 3.9% (Table 5). Spawners (late maturing and mature stages) were available in good numbers in February and March. Spawners were represented in all size classes above 115 mm. Most of the females in the catch were impregnated.

The count of head-on, average sized females in one kg varied between 60 and 75 numbers and 'tail' contributed to roughly 56% of the total weight.

Deep sea lobster

Deep sea lobster fishery along the south west coast of India is supported by a single species namely *Puerulus sewelli*. This species coexist with deep sea prawns and was harvested in small quantities along with the prawns during the recent commercial fishing by small and medium trawlers. Though distributed along the west coast between latitudes 7°N and 18°N at 150-400 m depth, in the recent commercial operations the deep sea lobster was fished mainly from the 'Quilon Bank'. The catch, effort and catch rate of deep



Metapenaeopsis andamanensis

sea lobster landed at various harbours for the period between November 1999 and March 2000 are given in Tables 1 to 4. Harbour-wise details are furnished below.

Munambam: The total landings for the observations period were estimated at 57 t with a catch rate of 1 kg/hr of trawling. Catch and catch rate were almost uniform between December and February (Table No. 1).

Kochi Fisheries Harbour: When compared with Munambam, catch and catch rates were poor at this centre. The total landings between December to March amounted to 25t, catch rate being 0.4 kg/hr of trawling. Catch and catch rate were evenly distributed in all months (Table 2).

Sakthikulangara-Neendakara: Good landing of *P. sewelli* was recorded at these centres in comparison with Munambam and Kochi. A total landing of 492 t with a catch rate of 1.8 kg/hr of trawling was registered at these centres. Maximum catch was realised in December followed by march. Best catch rate was recorded in November followed by February and December (Table 3).

Total lobster landings of the above three centres were estimated at 574 t, with catch/hr of 1.4 kg. Sakthikulangara-Neendakara contributed to 85.7% of the lobster fishery followed by 9.9% by Munambam and 4.4% by Kochi. Catch rate also followed the same trend (Table 4).

Biological studies: Data on the size structure of the population, sex ratio and breeding stock were collected from all the above landing centres and the pooled data were pesented in Table 6. The length distribution combined for all the observation centres for the period, December 1999-March 2000 is shown in Fig. 7.

The total length of *P. sewelli* ranged between 76-210 mm in both sexes. In the overall fishery, two size groups viz. 106-130 mm and 151-180 mm in males; 96-130 mm and 156-175 mm in females dominated. Large sized lobsters of 151-185 mm were dominant during December - January. In January smaller sizes between 106 and 130 mm were recruited to the fishery which remained dominant in the following months.

Sexes were more or less evenly distributed in the fishery throughout the season. Females contributed to 50.7% of the ovrerall fishery (Table 6). Berried females were available in

Aristeus alcocki

Deepsea Lobster (*Puerulus sewelli*)

good numbers in all months except February. Percentages of berried females ranged between 15.7 to 45.4 in different months indicating a protracted breeding period.

Price structure: In the initial weeks of the fishing season, pandalid prawns *H. woodmasoni* and *P. spinipes* and penaeid prawn *M. andamanensis* fetched a high price of Rs.40 to Rs.50/- per kg respectively. With heavy landings in the following weeks, price first fell to Rs.30 to Rs.40/- per kg and later stabilised between Rs.25 to Rs.35/-. Because of their larger size, *H. gibbosus* and *A. alcocki* were sold at the rate of Rs. 50-60/- and Rs. 80-100/- per kg. Depending upon the size, price of assorted catch of deep sea lobster varied between Rs.100 to 150 per kg.

Discussion

Catch rate of deep sea prawns in the recent commercial operations, species composition of the prawn fishery and biological characteristics of dominant constituent species are well in agreement with the findings of exploratory surveys carried out by Indo Norwegian Project vessels between 1967 and 1969 and the exclusive crustacean cruises conducted by FORV *Sagar Sampada* in 1988 and 1989 off the south west coast of India. Overall catch rate for deep sea prawns in the INP operations was estimated at 89.5 kg/hr. Sagar Sampada operations (Cruise No.40) between 235 and 421 meters realised a catch rate of 75 kg/hr for deep-sea prawns. These catch rates compare favourably with the catch rate of 58 kg/hr registered in the recent operations in the same ground where hundreds of vessels were in operation for a period of 4.5 months. *H. woodmasoni* (41.35%), *P. spinipes* (22.00%), *Aristeus semidentatus* (10.28%) and *H.gibbosus* (6.90%) were the dominant constituents of INP operations. *Plesionika spinipes, H. woodmasoni, H. gibbosus* and *A. alcocki* constituted the bulk of the deep sea prawn catch in *Sagar Sampada* cruises. Species composition of the recent commercial operations were more or less identical to that of the earlier surveys of INP and *Sagar Sampada*. However, the availability of *M. andamanensis* in good quantities in recent operations was the only major departure from earlier observations.

Population characteristics such as size composition, sex ratio and breeding stock of important species collected during recent operations closely agreed with the data generated by INP and *Sagar Sampada* cruises.

TABLE 6 Biological characteristics of deep sea lobster *Puerulus sewelli*

	Male		Female		Sex ratio(%)		Berried
	Size range (mm)	Dominant Size (mm)	Size range (mm)	Dominant Size (mm)	Male	Female	Females (%)
December 1999	121-210	151-180	86-190	156-185	50.7	49.3	45.4
January 2000	91-180	106-130 and 151-165	86-210	106-125 and 156-175	49.6	50.4	42.3
February 2000	76-180	121-130	76-175	116-130	47.4	52.6	15.7
March 2000	91-155	106-115	106-170	106-110	51.5	48.5	43.8
Total	76-210	106-130 and 151-180	76-210	96-130 and 156-175	49.3	50.7	34.9

Pandalid fishery was supported by adult population dominated by spawning stock in INP, *Sagar Sampada* and recent commercial operations. Meagre representation of male population and presence of impregnated females in large proportion in *A. alcocki* landings were the other common features in Sagar Sampada and recent commercial operations.

Excepting one haul, catch rates were poor for deep sea lobsters in *Sagar Sampada* cruises. This trend was reflected in the recent commercial operations too.

The committee appointed by the Govt. of India in 1984 to assess the potential of shrimp resources in the country estimated the exploitable yield of deep sea prawns along the south west coast at 3500 t. The sustainable yield of deep sea prawns along the south west coast of India was estimated at 3123 t. Working group on revalidation of potential marine fisheries resources of EEZ of India in 1991, estimated the potential of deep sea prawns in the entire EEZ as 3000 t. The same working group recommended the deployment of 15 stern trawlers per season to tap the deep sea prawn and lobster resources. All these estimates were arrived at by applying the 'Swept area' method based on exploratory trawling surveys conducted by different government agencies.

In the light of recent commercial operations by small and medium trawlers, all the above estimates were highly under-rated. Within a short span of 4.5 months, the commercial vessels based at Sakthikulangara, Kochi and Munambam harvested more than twenty three thousand tonnes of deep sea prawns with a very high catch rate of 58 kg/ hr. This high catch rate was not a real indicator of regular abundance of prawns in these areas, because the grounds exploited were totally virgin ones. However, good returns of deep sea crustaceans are naturally expected from these grounds.

Reports indicate that more deep sea vessels are under various stages of construction in different boat yards of the state for launching them in the ensuing season. The deep sea prawn stock cannot withstand more fishing pressure in future and yield the same returns as registered in the recent operations and the catch rate is bound to come down in the ensuing fishing season. The deep sea prawn fishery was characterised by absence of juvenile populations and heavy dominance of berried, impregnated or mature females in almost all the species. Unlike coastal species, the deep sea prawns have slow growth rate, long life span and low fecundity. Taking these biological limitations into account, it will be prudent on the part of the industry not to enhance the fishing pressure on this fragile stock. Because of poor catch returns in the north east coast, large shrimp trawlers based at Visakhapatnam shifted their operations to deep sea lobster fishing in south west coast in 1988 and 1989. Overfishing of this resource led to a near total depletion of the stock. Reduction in deep sea lobster catch in recent commercial fishing operations is a pointer to this. The same fate should not befall the fledgling deep sea prawn fishery. The need of the hour is to have a close monitoring of the level of fishing effort in the coming season; study the behaviour of the stock and understand whether it is optimally exploited.

Small and medium shrimp trawlers operating in the coastal waters have proved beyond doubt that they are capable of trawling for deep sea crustacean resources upto a depth of 400 - 450 m with necessary modifications in the winch and installation of advanced technological devices such as GPS navigator and echosounder. In the light of these developments, Government should take a second look at the licensing policy of large trawlers for deep sea fishing operations in future.