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Catch, abundance and some aspects of biology of deep sea fish in the southeastern Arabian Sea

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ABSTRACT

The bottom trawls operated by *FORV Sagar Sampada* in the southeastern Arabian Sea revealed the existence of grounds with potentially rich unexploited deep sea finfish resources. *Chlorophthalmus* sp. formed the most dominant species with catch rates of 4.6 tonne/hr at lat. 8°56′ N long. 73° 35′ E and 4.2 tonne/hr at lat. 8°55′ N, long. 73°35′E. *Cubiceps natalensis* with catch rates of 2.8 t forms the next important species. Maximum catch rate of deep sea fish was observed at depths ranging from 300 to 350 m. The other major exploitable species include *Neopinnula orientalis*, *Pseneopsis cyanea*, *Chascanopsetta lugubris*, *Priacanthus hamrur* and *Chlorophthalmus bicornis*. Information on some aspects of biology of fishes landed in fairly good quantity are also dealt with. Concentrations of deep sea fish resources are found in comparatively shallower depths in the northern latitudes whereas a wider distribution is seen in the southern latitudes.

INTRODUCTION

Deep sea fishes are rapidly gaining importance as a potential fishery resource, as the inshore fishery alone can no longer satisfy the growing demand for fish. In India exploratory fishery surveys conducted in deeper waters of the Exclusive Economic Zone have indicated the presence of unexploited deep sea fish resources in the peripheral shelf area and continental slope which have great scope for commercial exploitation. Joseph & John (1986) have stated that the deep sea resources in the outer shelf and continental slope comprised of a few non-conventional species like "big eye","green eye"," black ruff", *Cubiceps* etc. in contrast to the multiplicity of species in coastal region.

Though the investigations made by Gravely (1929), Silas (1969), Joseph *et al.* (1976), Philip *et al.*(1984), Joseph (1986), Nair & Joseph (1986), Sivaprakasam

(1986), James & Pillai (1990) and Gopalakrishnan *et al.* (1988) have reported on the availability and relative abundance of these deep sea fish resources, there is very little knowledge on the resource characteristics and biology of these deep sea fish resources. The present paper deals with the geographical and the bathymetrical distribution of deep sea fishes in the southeastern Arabian Sea based on data collected during the cruises of *FORV Sagar Sampada* along with information on some aspects of biology of important species. An attempt is also made for estimating the biomass of deep sea fish in this area.

MATERIALS AND METHODS

The material for the present study was collected onboard *FORV Sagar Sampada* during cruise no. 40 and 96 at southeastern Arabian Sea (Fig. 1). During cruise no. 40 (1.1.1988 to 11.1.1988) High Speed Demersal Trawl (HSDT - III) and in cruise no. 96 (18.11.1991 to 18.12.1991). Bottom Lobster trawl (BTR-L) was used. The catch details of stations covered between lat. 8°35'to 12°55' N and long. 73°56' to 76°28'E were analysed. A total of 20 trawling operations were carried out during cruise No.40 between 130 and 777 m depth (Fig. 1 A) High Speed Demersal Trawl (HSDT - III) designed by CIFT, Cochin with a codend mesh size of 22 mm stretched knot to knot was used. In cruise no.96, 30 hauls were taken at an area between lat. 08°38'N to 12°55'N and long. 73°56'E to 76°28'E (Fig.1 B). The depth of operation varied from 185 to 450 m .The catch was grouped into deep sea fish, other fish (which include resources like threadfin breams which are presently under commercial exploitation) and crustaceans and cephalopods. Latitudinal and depth-wise distribution and abundance of deep sea finfish resources were assessed after grouping the stations covered in each cruise into 4 depth zones of 101-200 m (Zone I), 201-300 m (Zone II), 301-400

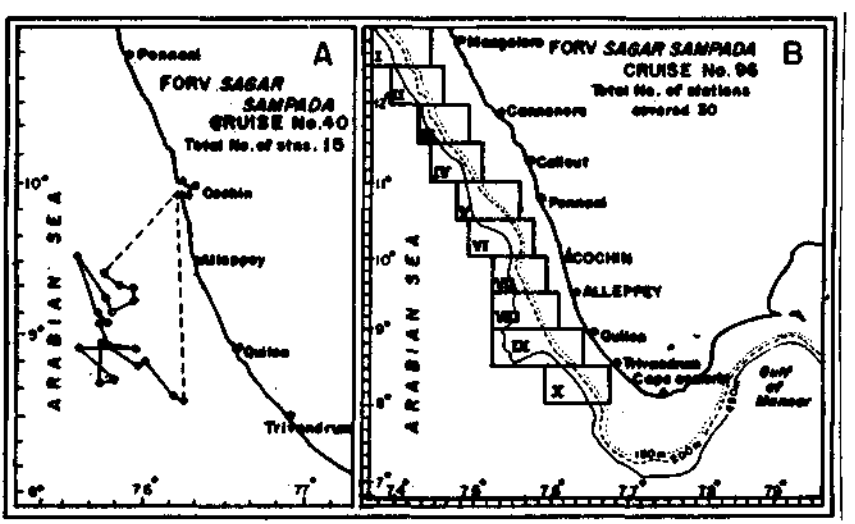

Fig. 1- Map showing the study area: A) cruise no.40, B) cruise no.96

m (Zone-III) and above 401 m to the maximum depth operated (Zone IV). Catch per unit effort was estimated against the total number of hours in each cruise. Samples were collected from each haul for biological investigations on length frequency, length-weight relationship, sex ratio and size at first maturity of important fish resources such as *Chlorophthalmus agassizi, Neopinnula orientalis, Pseneopsis cyanea, Cubiceps natalensis* and *Priacanthus hamrur*. Size frequency and percentage maturity of these species in different depth zones were categorised separately.

Latitudinal and depth-wise biomass of deep sea fish were estimated using "swept area" method (Sparre & Venema, 1992). The average biomass per unit area was estimated using the equation:

$$B = \frac{(Cw/a)*A}{X_1}$$

where Cw = catch in weight of a haul, a = the area swept by the gear during one unit of effort computed from the equation $a = t * v * h * x_2$; where t = time spent for trawling, v = velocity of trawling (3.5 knots), h = average head rope length of HSDT - III and BTR - L (34.6 m), X_2 = the effective net opening which was taken as 0.5 as suggested by Pauly (1983), A = total area swept and X_1 = the portion of biomass actually retained by the gear (taken as 0.5 here).

RESULTS

Details of trawling and fish catch are shown in Table 1 and haul-wise catch data is shown in Table 2. Among the total catch of 16 tonne obtained from all stations together, deep sea fish were most dominant forming 12.89 tonne (79.86%) followed by other fish - 1.59 tonne (9.8%) and crustaceans and cephalopods - 1.7 tonne (10.3%). During cruise no. 40 the maximum catch of 5.6 tonne of deep sea fish was recorded in haul no. 8 with a catch rate of 7.04 tonne/hr of trawling closely followed by 4.95 tonne of catch recorded in haul no. 10 with a catch rate of 4.95/hr of trawling. The total catch in cruise no. 96 was 26.13 tonne of which deep sea fish accounted 20 tonne (76.55%) followed by other fish - 2.2 tonne (8.4 %) and crustaceans and cephalopods 3.9 tonne (14.9%). Maximum catch of 2.97 tonne with the same catch rate was obtained in haul no. 25 closely followed by 2.78 tonne in haul no. 28 with maximum catch rate of 3.6 tonne.

Depth-wise abundance

The area between lat.8°N to 09°N was most productive with average catch rates of 915 kg/hr of deep sea fish closely followed by lat.09° to 10° N with catch rate of 754 kg/hr. Comparatively the least productive area was between lat. 12° to 13°N with a catch rate of 419 kg/hr. The deep sea fish was available at all depth zones (Table 3) between 08° to 09° N whereas this resource was not found above 400 m depth in lat.10° to 11° N. Between 10° to 13° N the bottom trawling did not yield any deep sea fish beyond 300 m depth. In the southeastern Arabian Sea the most productive depth

Table 1 - Haul-wise catch(C) and catch rate(CR) of deep sea fish, other fish, crustaceans and cephalopods in cruise no.40 (C=kg, CR=kg/hr)

Haul no.	Position lat. (N)	Position long. (E)	Depth (m)	Deep sea fishes C	Deep sea fishes CR	Other fishes C	Other fishes CR	Cephalopods & crustaceans C	Cephalopods & crustaceans CR	Total catch C
1	08°35′	76°15′	235-307	106	159	94	141	270	405	470
2	08°38′	76°11′	273-293	21	55	452	1179	39	102	512
3	08°50′	76°00′	130-156	120	240	350	700	-	-	470
4	08°48′	75°45′	322	225	245	-	-	125	137	350
5	08°56′	75°45′	328-334	4948	4948	-	-	52	52	5000
6	08°42′	75°41′	312-314	89	119	18	24	48	64	155
7	08°43′	75°49′	398-421	29	70	12	29	49	118	90
8	08°55′	75°35′	304-307	5634	7043	336	420	30	37	6000
9	08°55′	75°55′	348-350	1200	2057	23	39	27	46	1250
10	08°55′	75°45′	344-358	71	144	-	-	89	180	160
11	09°04′	75°40′	246-260	25	50	13	26	22	44	60
12	09°04′	75°45′	299	55	97	99	175	146	257	300
13	09°08′	75°40′	341	53	106	7	14	50	100	110
14	09°32′	75°33′	731-777	0.6	2	0.4	1	-	-	1
15	09°12′	75°44′	361-382	83	151	6	11	21	39	110

range for deep sea fish was between 301 - 400 m with an average catch rate of 1478 kg/hr. Between 201 - 300 m moderately good catch of deep sea resource was obtained with a catch rate of 594 kg/hr. The average catch rate declined considerably in the deeper waters beyond 400 m depth with an average of 56 kg/hr.

A total of 34 deep sea finfish species were recorded during both cruises, of which 14 were considered important and their depth-wise abundance is shown in Fig. 2. *Chlorophthalmus agassizi* dominated the catch constituting 36.2% of deep sea fish catch followed by *Cubiceps natalensis* (19.2%), *Pseneopsis cyanea* (7.9%), *Neopinnula orientalis* (3.3%), *Peristedion pothumalava* (4.4%), *Chlorophthalmus bicornis* (3%), *Lampadena luminosa* (0.8%) and *Priacanthus hamrur* (0.7%). The depth-wise distribution of catch revealed that about 75% of important deep sea fish was concentrated between depth zone II and III. Only *Gymnoscopelus* sp. showed maximum abundance beyond 400 m depth. *Chlorophthalmus agassizi, Cubiceps natalensis* and *Neopinnula orientalis* were recorded from all depth zones indicating their wide distribution over space and time. *Acropoma* sp. *Priacanthus hamrur,*

Table 2 - Haul-wise catch(C) and catch rate(CR) of deep sea fish, , other fish, crustaceans and cephalopods in cruise no.96 (C=kg, CR=kg/hr)

Haul no.	Position lat. (N)	Position long. (E)	Depth (m)	Deep sea fishes C	Deep sea fishes CR	Other fishes C	Other fishes CR	Cephalopods & crustaceans C	Cephalopods & crustaceans CR	Total catch C
1	09°02′	75°56′	185	283	283	29	29	517	517	829
2	08°54′	75°59′	270	53	71	23	31	374	499	450
3	08°53′	75°44′	340	1482	1482	3	3	15	15	1500
4	08°43′	75°54′	450	745	74	-	-	51	51	125
5	09°10′	75°42′	400	28	42	2	3	25	38	55
6	12°36′	74°12′	185	528	704	161	215	511	681	1200
7	12°55′	73°56′	265	740	740	-	-	60	60	800
8	12°17′	74°20′	265	94	94	24	24	182	182	300
9	12°09′	74°21′	235	106	141	1	1.4	13	41	120
10	11°44′	74°35′	190	36	54	4	6	51	77	91
11	11°50′	74°28′	285	115	173	-	-	10	15	125
12	11°35′	74°58′	170	161	161	110	110	48	48	319
13	10°41′	75°22′	175	-	-	-	-	-	-	-
14	10°31′	75°27′	340	3.2	32	-	-	4.3	43	7.5
15	10°35′	75°15′	375	-	-	-	-	-	-	-
16	09°11′	75°51′	260	915	523	1084	619	51	29	2050
17	09°05′	75°35′	235	1063	1276	108	130	129	155	1300
18	09°00′	75°48′	330	1367	1367	82	82	51	51	1500
19	08°58′	75°58′	190	26	26	55	55	19	19	100
20	08°52′	75°58′	320	210	133	-	-	50	32	260
21	09°00′	75°45′	351	40	96	8	19	2	5	50
22	08°52′	75°55′	315	1691	1691	29	29	80	80	1800
23	09°15′	75°53′	225	27	27	69	69	1104	1104	1200
24	08°56′	75°48′	335	2357	2357	-	-	113	113	2500
25	08°41′	75°37′	335	2969	2969	-	-	31	31	3000
26	08°19′	76°28′	245	1145	1145	-	-	55	55	1200
27	08°38′	76°10′	280	98	90	-	-	52	48	150
28	10°56′	75°08′	260	2778	3623	-	-	22	29	2800
29	09°48′	75°36′	195	223	268	344	413	233	280	800
30	09°36′	75°39′	255	1391	959	25	17	84	58	1500

Table 3 - Depth-wise distribution and abundance [C = catch /(kg), CR = catch rate / (kg/hr), DSFB = deep sea fish biomass (tonnes/nm^2)]

Latitude range	Depth range														
	100 - 200 m			201 - 300 m			301 - 400 m			400 and above			Total		
(°N)	C	CR	DSFB	C	CR	DSFB	C	CR	DSFB	C	CR	DSFB	C	CR	DSFB
8 - 9	754	197	3.01	4916	466	7.13	22559	1581	24.18	131.6	60	0.92	28360.6	915	14.0
10 - 11	197	118	1.80	2893	2018	30.87	3.2	3.2	0.05	-	-	-	3093.2	754	11.5
12 - 13	528	704	10.77	940	342	5.23	-	-	-	-	-	-	1468	419	6.4
Total	1479	237	3.62	8749	594	9.10	22562.2	1478	22.60	131.6	56	0.90	32922.0	853	13.1

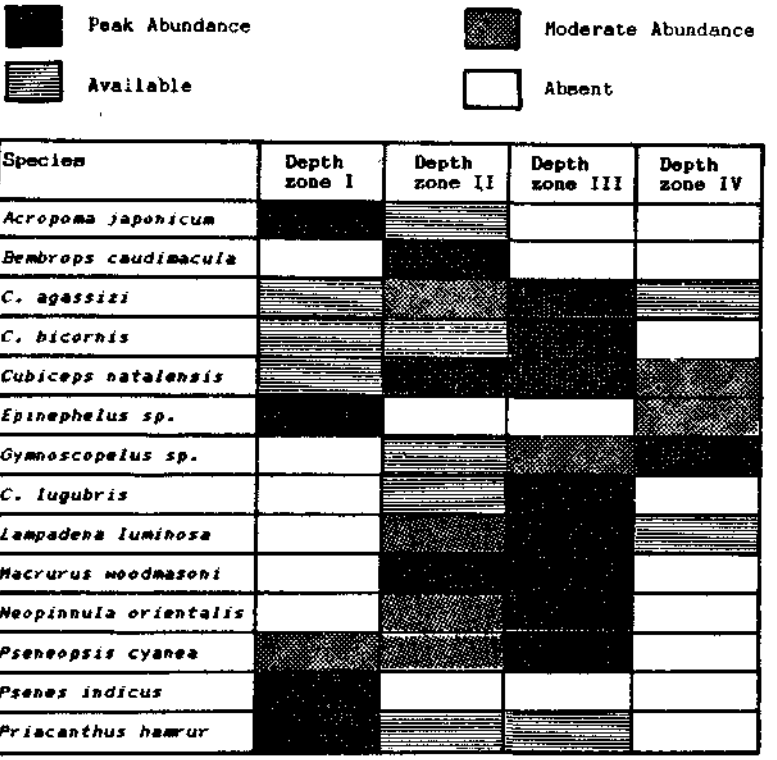

Fig. 2- Depthwise distribution and abundance of deep sea fish in the southeastern Arabian Sea (depth zone I = 100-200 m, depth zone II = 201-300m, depth zone III = 301-400m, depth zone - IV = above 400 m)

Peristedion pothumalava, *Psenes indicus* and *Epinephelus* sp. were found in abundance at relatively shallower areas.

A record catch of 13.3 tonne of *Chlorophthalmus agassizi* with catch rate of 1.7 tonne/hr was obtained at depth zone III. The maximum catch of 4.6 tonne of *Cubiceps natalensis* was recorded at 201 to 300 m depth with a catch rate of 0.4 tonne/hr of trawling.

Biomass

The biomass estimated by 'swept area,' method showed that lat. 08° - 09° was most productive with 14.0 tonne/nm^2 of fish followed by lat. 10°- 11° having 11.5 tonne/nm^2 of deep sea fish. Depth zone III proved to be the most productive area with regard to deep sea fishes in the southeastern Arabian Sea with biomass of 9.1 and 3.6 tonne/nm^2 respectively. The area beyond 400 m depth was least productive with only 0.9 tonne/nm^2. The average biomass of deep sea fishes in all depth zones was 13.1 tonne/nm^2. The most productive area for deep sea fishes during this investigation was located between lat. 10°-11° at depths ranging from 201 - 300 m with a record biomass

of 30.87 tonne/nm^2 closely followed by lat. 08°-09° N at a depth ranging from 301-400 m with 24.18 tonne/nm^2.

Biology

Chlorophthalmus agassizi - Maximum abundance of this species was found in depth zone III (Fig.2). The length range, mean length and mean weight of male and female fishes are furnished in Table 4. Males were dominant in catch. The size at first maturity was estimated as 185 mm for males and females. The length-weight relationship found separately for both the sexes (Table 5) show that the growth in length and weight of this species is allometric. *C. agassizi* was not represented in depth zone I. The length frequency and percentage of mature fishes in different depth zones are depicted in Fig.3. Fish of comparatively smaller size were abundant in depth zone II and bigger sized fish were more abundant in depth zone IV. In zone III the entire catch of *C. agassizi* consisted of males only.

Cubiceps natalensis - This species is highly abundant in depth zones II and III indicating its distribution mainly concentrated between 201 to 400 m depth eventhough this species was found in all the depth zones (Fig.2). The length ranged between 115 to 205 mm for males and 145 to 205 mm for females (Table 4). Males outnumbered females in all depths. The percentage of mature fishes and size frequency in different depths are shown in Fig. 4. Among males 34% of the fish were mature. Depth-wise distribution shows that 52%, 21% and 90% of female fish caught from depth zones I, II and IV were mature. Female fish in depth zone IV were mature

Table 4 - Important biological characteristics of dominant deep sea fish

Species		Length range (mm)	Mean length (mm)	Mean weight (gm)	Sex ratio (%)	Size at first maturity (mm)
Chlorophthalmus agassizi	F	110-299	183.1	45.7	31.9	185
	M	100-299	161.9	31.2	68.1	185
Neopinnula orientalis	F	130-269	203.9	63.8	30.4	185
	M	130-299	181.7	37.2	69.6	185
Cubiceps natalensis	F	140-209	162.9	40.6	38.5	165
	M	110-209	155.8	40.6	61.5	165
Pseneopsis cyanea	F	100-189	147.3	39.5	43.6	165
	M	100-189	147.1	39.3	56.4	155
Lampadena luminosa	F	100-189	154.7	43.4	49	145
	M	50-199	145.8	35.1	51	155
Priacanthus hamrur	F	160-339	212.7	130.3	31.5	205
	M	160-269	206.9	113.0	68.5	195

M = Male F = Female

Table 5 - Length-weight relationships of some important deep sea fish

Species		n	r	a	b
Chlorophthalmus agassizi	F	194	0.76	-3.46817	2.24766
	M	91	0.76	-3.37611	2.19234
Neopinnula orientalis	F	44	0.90	-5.03623	2.94444
	M	78	0.68	-3.44258	2.21046
Pseneopsis cyanea	F	80	0.86	-6.5890	3.76054
	M	108	0.80	-5.74284	3.37546
Cubiceps natalensis	F	94	0.75	-3.58508	2.34119
	M	161	0.50	-1.80714	1.55052
Lampadena luminosa	F	24	0.90	-3.43910	2.31116
	M	21	0.82	-4.89820	2.96750
Priacanthus hamrur	F	47	0.97	-3.99873	2.60965
	M	78	0.61	-3.18588	2.26980

n = No. of observations, r = correlation coefficient
a = Y - axis intercept, b = increment curvature
F = Female, M = Male

and of larger size indicating that the larger sized females concentrate in deeper waters. The size at first maturity estimated from the pooled data was 165 mm for both males and females. Results of length-weight relationship analysis (Table 5) indicate that there is a differential growth pattern in length and weight of females and males, the curvature value (b) being 1.5505 and 2.3411 respectively.

Pseneopsis cyanea - This species shows peak abundance in depth zone III and moderate abundance in zones I and II. The length ranged between 100 to 189 mm for males and 110 to 189 mm for females. The size at first maturity was 155 mm and 165 mm for males and females respectively. The important biological informations are furnished in Table 4. Male fish caught from comparatively shallow depths were all immature whereas in depth zones II and III immature fishes constituted 41% and 53% of males caught (Fig. 5). In case of females 34% of fish caught altogether were mature and 43%, 61% and 23% of female fish caught from depth zones I, II and III respectively were mature. Length-weight relationship shows that females are a little heavier than males with curvature values (b) of 3.76 and 3.37 for females and males respectively (Table 5).

Priacanthus hamrur - This fish was located in heavy concentrations at depth zone I though they were common in depth zone II and III (Fig. 2). *P. hamrur* was not available beyond 400 m. The percentage of maturity and size frequency are plotted in Fig. 6. The size of males ranged between 160 to 269 mm whereas females were much larger sized with sizes ranging from 160 to 339 mm. The males mature when they attain a length of 195 mm, a little earlier than the females (205 mm). Table 4 provides important biological information on *P. hamrur*. The males were dominant at all depth

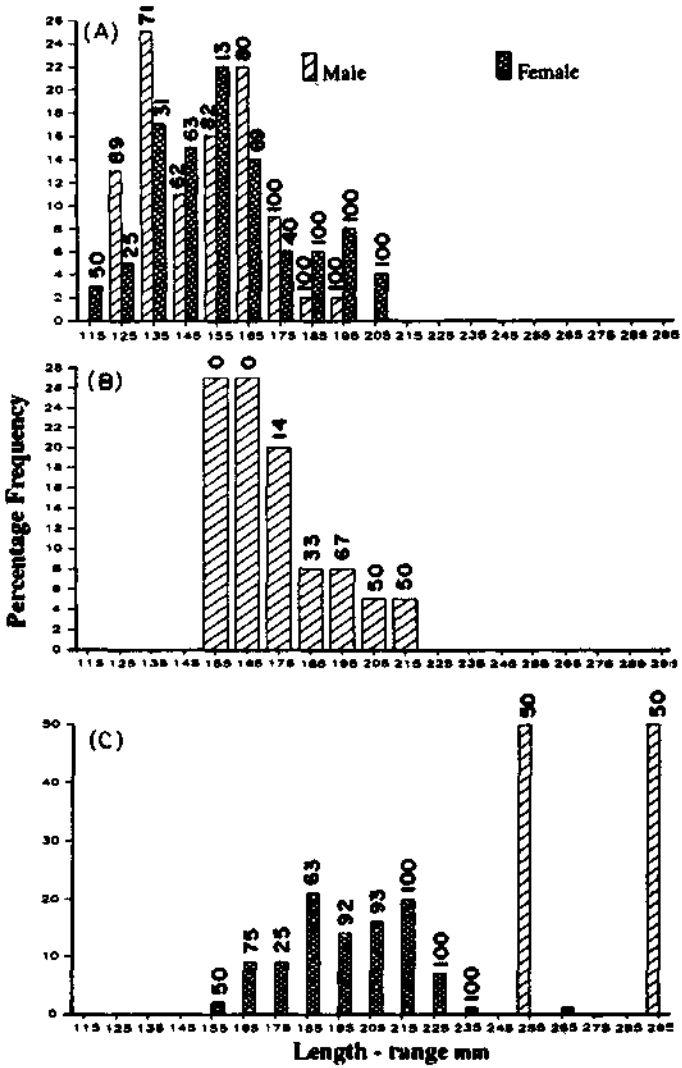

Fig. 3- Length frequency and percentage mature (values) of *Chlorophthalmus agassizi* at depths : A)201-300 m, B) 301-400 m C) >400 m

zones. In the pooled data 71% of male fish caught were mature. Between 101-200 m, 60% of males were mature whereas at 201-300 m 96% of males were in mature state. Only 25% of females caught from the depth zone I were mature while higher concentration of mature female fish (96%) were captured from depth zone II. The length-weight relationship shows allometric growth with curvature value (b) of 2.3 and 2.6 for males and females respectively (Table 5).

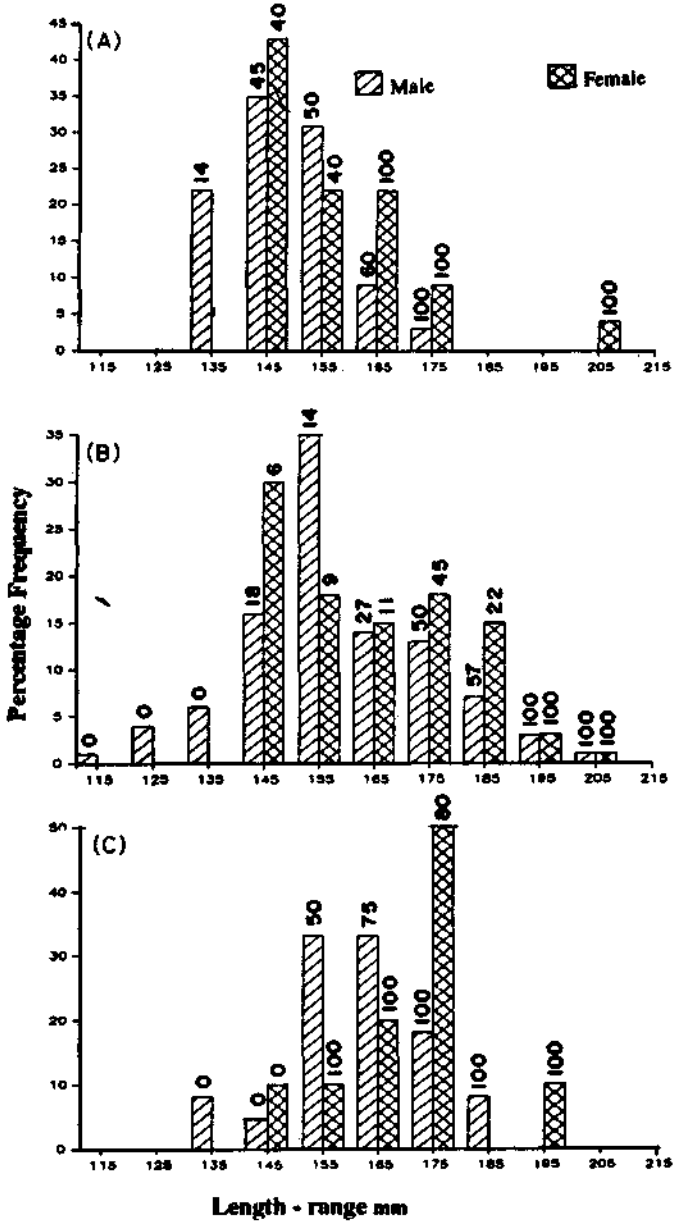

Fig. 4- Length frequency and percentage mature (values) of *Cubiceps natalensis* at depths: A) 100-200 m, B) 201 - 300m, C) > 400 m

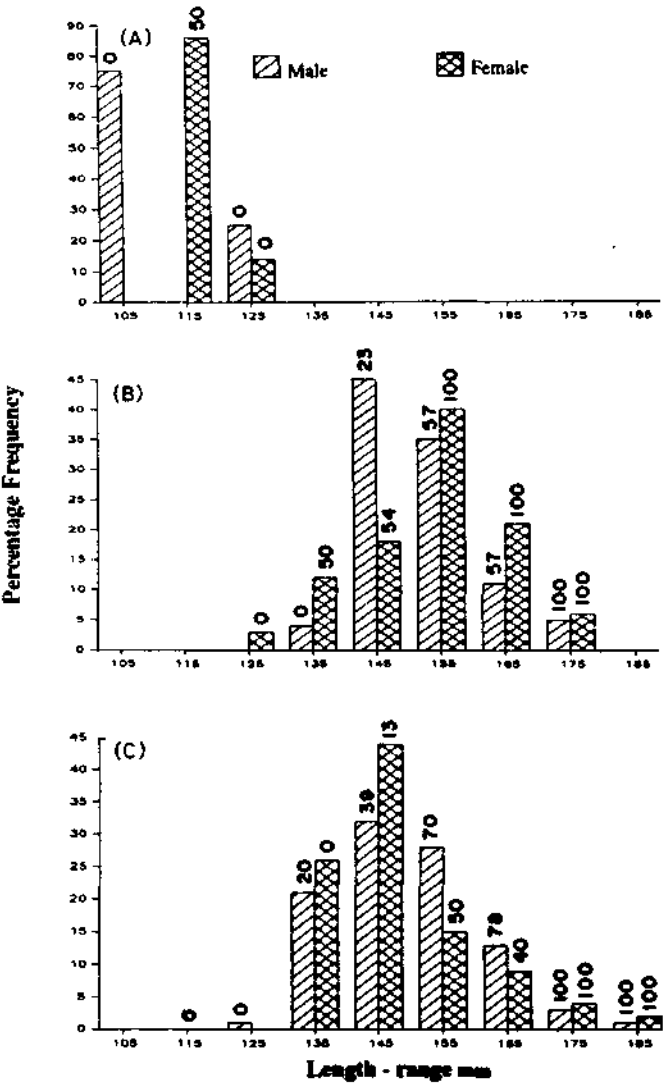

Fig. 5- Length frequency and percentage mature (values) of *Pseneopsis cyanea* at depths: A)100-200 m, B) 201 - 300m, C) 301-400 m

Neopinnula orientalis - This species commonly known as 'sack fish' is highly abundant in depth zone III. The length range varied from 130 to 229 mm for males and 130 to 269 mm for females (Table 4). Males outnumbered females in total catch. 'Sack fish' is confined to depth zones II and III with maximum concentrations at latter depth. Larger sizes of mature females were caught from depth zone III. About 50% of the female fish occurring in depth zones I and II were in mature condition whereas majority (90%) were mature in depth zone III (Fig.7). About 50% of males caught

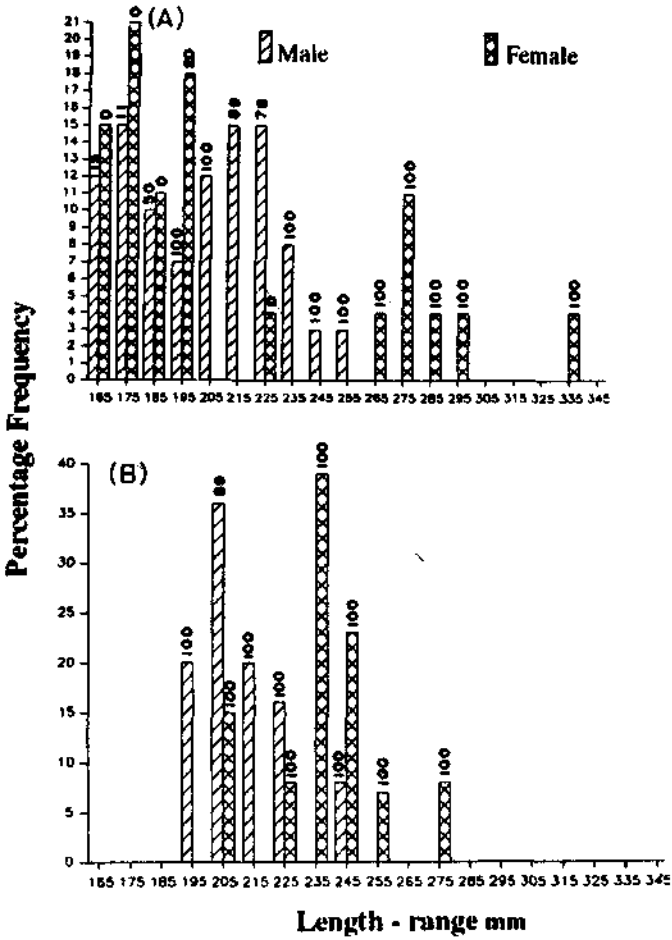

Fig. 6- Length frequency and percentage mature (values) of *Priacanthus hamrur* at depths: A)100-200 m, B) 201 - 300 m

from zone II and III were in mature condition. Both sexes attained maturity at 185 mm length. The length-weight relationship analysis showed an isometric growth for females with curvature value (b) of 2.9 (Table 5).

DISCUSSION

Present study indicates the presence of significant concentrations of exploitable deep sea fish biomass in southeastern Arabian Sea. Studies by Prasad & Nair (1973) have shown high abundance of deep sea species like *Chlorophthalmus agassizi*, *Neopinnula orientalis*, *Pseneopsis cyanea*, *Cubiceps natalensis* etc in the upper continental slope (180-450 m depth zone) of Indian EEZ. According to Sivaprakasam (1986) *Chlorophthalmus agassizi* is available in plenty in the deeper waters between

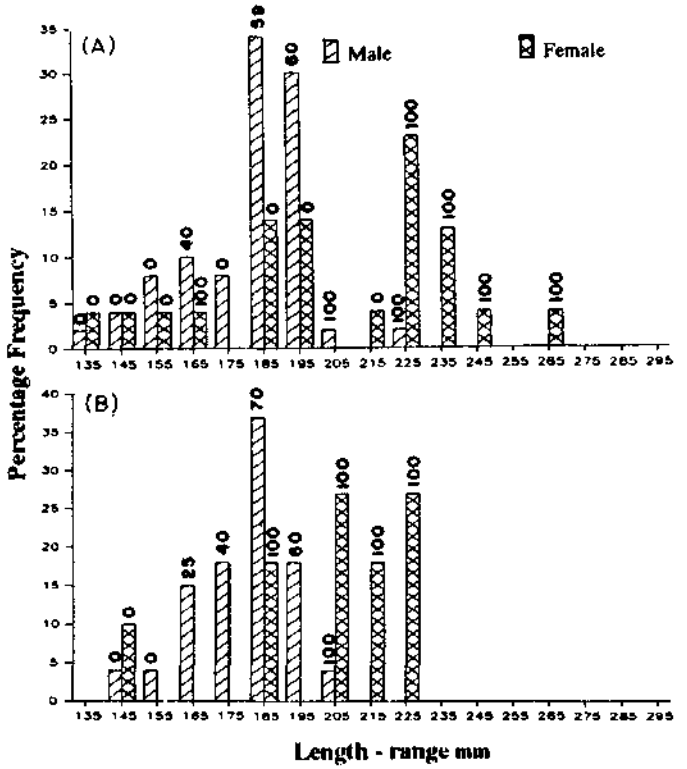

Fig.7- Length frequency and percentage mature (values) of *Neopinnula orientalis* at depths: A) 201-300 m, B) 301 - 400 m

200 to 600 m depth. Bande *et al.* (1990) have reported that *Priacanthus* spp forms a potential deep water resource at lat.07°-15° but beyond 200 m depth the availability decreases. According to Sivakami (1990) the neritic waters in the depth range of 151-398 m have promising potential for deep sea fishes like *Pseneopsis* spp, *Chlorophthalmus* spp, *Priacanthus* spp, *Cubiceps* spp and *Trichiurus auriga*. These fishes formed 43% of the total fish caught from this area. In the present study deep sea fish formed as high as 73% of the total catch.

Studies of Sudarshan *et al.* (1988) have shown that the most productive depth belt in southwest coast for demersal fish is 150-200 m depth with catch rate of 9.36 tonne/nm^2. In the present study comparable biomass was obtained in 101-200 m depth at lat. 12°-13° N. However, maximum biomass of 22.6 tonne/nm^2 was obtained in 301-400 m depth zone. It is significant to note that an average catch rate of 815 kg/hr was recorded in the present study for deep sea fish alone which is very high compared to the catch rate obtained in the exploratory surveys (FSI, 1991). The present investigation shows that deep sea finfish resources are concentrated in comparatively

shallower depths in the northern latitudes whereas wider distribution is seen in the southern latitudes.

Though there are studies on the distribution and abundance of deep sea fishes, investigations on the biology of deep sea fishes are scanty. An analysis of biological data of dominant species mainly *Chlorophthalmus agassizi*, *Neopinnula orientalis*, *Cubiceps natalensis*, *Pseneopsis cyanea* and *Priacanthus hamrur* have provided new information on length-weight relationship, sex ratio, size at first maturity etc of the above species. High concentrations of mature and spawning females of *C. agassizi* at 301 to 400 m depth indicates that this zone may be the spawning grounds for this species. In the case of *Neopinnula orientalis* a clear distinction in the sex ratio in larger groups with mature females dominating in length above 200 mm was observed. It appears that *N. orientalis* spawns beyond 400 m depth as 90% among the females caught from this zone consisted of spawning females. Mature females of *Priacanthus hamrur* dominated above 200 m. Comparison of the length frequency of fishes available at 101 to 200 m depth and 201 to 300 m depths shows that larger sized fishes are available in the latter depths and the fish caught were fully mature indicating that this species may possibly spawn in deeper waters. In the case of *Cubiceps natalensis* the occurrence of mature females in abundance at depth zone III shows that spawners are concentrated in this zone.

Studies of Philip *et al.* (1984) reveals that deep sea fishes are comparable in nutritive values to the commonly available food fishes. The proximate composition indicated that all these species are protein rich, the value ranging from 14.4 to 17.5%. The experiments conducted (CIFT, 1990) have indicated that deep sea finfish resources could be utilised for a variety of fishery products. Therefore exploitation of more or less virgin deep sea finfish resources on larger scale from the Exclusive Economic Zone can significantly change the scenario of Indian fishery sector.

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REFERENCES

Bande, V. N., Menon, N. G & Balachandran, K. 1990. Studies on the distribution and abundance of bull's eye (*Priacanthus* spp) in the EEZ of India, In: *Proc. First Workshop Scient. Resul. FORV Sagar Sampada,* edited by K. J. Mathew, (CMFRI, Cochin) 233-238.

CIFT. 1990. Studies on processing of deep sea fish caught onboard *FORV Sagar Sampada*, In: *Proc. First Workshop Scient. Resul. FORV Sagar Sampada*, edited by K. J. Mathew, (CMFRI, Cochin) 457-465.

FSI. 1991. Annual Report 1990-'91, (Fishery Survey of India, Bombay) pp. 51.

Gopalakrishnan, K., Varghese, B. C., Ali, D. M. & Pandian, P. 1988. Deep sea finfish resources of Indian Exclusive Economic Zone (beyond 150 m depth). In: *Proc. Nat. Workshop Fish. Resour. Data Fish. Indus*(Oct. 1988).

Gravely, F. M. 1992. Report on a systematic survey of deep-sea fishing grounds by S.T."Lady Goshen" for 1927-'28, *Bull. Madras Fish. Dept.* 23 (1) : 153 - 187.

James, P. S. B. R & Pillai, V. N. 1990. Fishable concentration of fishes and crustaceans in the offshore and deep sea areas of Indian Exclusive Economic Zone based on observations made onboard *FORV Sagar Sampada*, In: *Proc. First Workshop Scient. Resul. FORV Sagar Sampada*, edited by K. J. Mathew, (CMFRI, Cochin) 201-213.

Joseph, K. M., Radhakrishnan, N. & Philip, K. P. 1976. Results of demersal fisheries survey along the east coast of India, *Bull. Expl. Fish. Proj. Vol.* 5: pp. 53.

Joseph, K. M. 1986. Some observations on the potential marine fishery resources from the EEZ, *Bull. Fish. Surv. India*, 14: 1- 20.

Nair, K. N. V. & Joseph, K. M. 1984. Important observations on deep sea resources made during 1983-'84, *Bull. Fish. Surv. India*, 13: pp 1-11.

Pauly, D. 1983. Some simple methods for assessment for tropical fish stock, *FAO Fish. Tech. Pap.* 234: pp.52.

Philip, K. M., Premchand, B, Auhad, G. K & Joseph, P. J. 1984. Note on the deep sea demersal resources of Karnataka-north Kerala coast, *Bull. Fish. Surv. India*, 14: pp 84.

Prasad, R. R. & Nair, P. V. R. 1973. India and Indian Ocean Fisheries, *J. Mar. Biol. Ass. India*, 15 (1): 1-19.

Silas, E. G. 1969. Exploratory fishing by *R V Varuna, CMFRI Bull*, 12: pp 86.

Sivakami, S. 1990. Observations on the demersal fishery resources of the coastal and deep sea areas of the Exclusive Economic Zone, In: *Proc. First Workshop Scient. Resul. FORV Sagar Sampada*, edited by K. J. Mathew, (CMFRI,Cochin) 215-231.

Sivaprakasam, T. E. 1986. In: *Occasional papers of FSI* No.4 (Fishery Survey of India, Bombay) p.13.

Sparre, P. & Venema, S.C. 1992. *Introduction to tropical fish stock assessment, FAO Tech. Pap.* 306/1: pp. 655.

Sudarshan, D., Sivaprakasam, T. E., Somavanshi, V. S., John, M. E., Nair, K. N. V. & Joseph, A. 1988. An appraisal of the marine fishery resources of Indian Exclusive Economic Zone, *Bull. Fish. Surv. India*, 18: pp. 81.

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