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KRILL TRAWL BY-CATCH IN INDIAN OCEAN SECTOR OF THE ANTARCTIC REGION DURING AUSTRAL SUMMER 1995-96

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ABSTRACT

Krill trawl by-catch samples were collected at different stations in FAO statistical Fishing Area 58 in the Indian Ocean sector of the Antarctic Ocean during the First Indian Antarctic Krill Expedition (FIKEX) (27 December 1995- 10 March 1996) on board **FORV Sagar Sampada** by operating three types of Gear, 2.5 m Isaccs Kidd Midwater Trawl (IKMT), 42 M Polish Krill Trawl and 49.5 m Krill Midwater Trawl (Cosmos Trawl, Denmark), 18 hauls were made using 2.5 m IKMT in the area 59°00' – 61°08' S lat., 30°04'-40°04' long. Landed total catch of 161.5 kg. This included a by-catch of 148.815 (Salps 148.81 kg and lantern fishes 0.005 kg) and Antarctic krill, *Euphausia superba* 12.69 kg. During 16 aimed trawl operations using krill midwater trawls targeted at Antarctic krill a total catch of 12470 kg was recorded. This included a by-catch of 6833 kg and 5673 kg of Antarctic krill, *Euphausia superba*. The by-catch 6738 kg was constituted by Salps, followed by 35 kg of jelly fish, 12 kg of krill juveniles, 0.11 kg of latern fish, 5.7 kg of squid and 2.7 kg of dagger footh fish.

In commercial exploitation of the Antarctic krill, by-catch plays a major role because sorting of krill from by-catch is more difficult in the presence of Salps, jelly fish, juvenile fish, fish larvae etc. Usually if the by-catch constitutes over 20% of the total catch in a haul either the entire catch will be discarded or opt for change of the fishing ground. Therefore, the entire operation for krill is based on the percentage of the by-catch species. As the information on the by-catch of the Fishing area 58 of Southern Ocean is very limited, an attempt is made in this paper to analyse the by-catch and the species in percentage recorded during the First Indian Antarctic Krill Expedition.

Introduction

Estimates of krill stock vary greatly but generally fall between 100 and 500 million t (Kaleinowski and Witek, 1983). According to FAO 1996, krill biomass is currently estimated at 35.4 lakh t in Area 48 and 39 lakh t in division 58.4.2 based on an assumption, the precautionary harvests of krill should not exceed 11.6% of the biomass. Precautionary catch limits of 41 lakh t for Area 48 while for division 58.4.2., it is 4.5 lakh t have been proposed. In reality catches in 1994-95 have been far below these limits as can be seen from the catch of Japan being 60304 t, Poland 6287 t and Ukraine 51325 t and being total 117916 t. This shows an increase of 32.8% over catches of the 1993-94 season. No catches were reported by Chile and Russia during 1994-95 though they had reported krill catches in the previous season. At present Germany, Japan, Poland, Chile, Ukraine, Russia, Korea etc. are conducting commercial fishing for krill. Commercial fishing is always done after initial sampling of krill swarms for by-catch species in terms of percentage of Salps, jelly fish, juvenile fish, squids etc. If the by-catch constitutes more than 20% of the total catch in a haul change of the fishing ground is resorted to (Budzinski *et.al.* 1985). Thus abundance of by-catches in a sample serves as an indication for selecting fishing ground for krill.

Within the programme of First Indian Antarctic Krill Expedition (FIKEX), a study of Antarctic krill trawl by-catch was also carried out on board **FORV Sagar Sampada** from 26 January to 13 February 1996. In the present study the FIKEX results of by-catch is analysed and their relation to krill catches by aimed trawling in the Indian sector of the surveyed Antarctic region is corroborated.

Materials and methods

The material was caught during the First Indian Antarctic Krill Expedition in the Indian Ocean Sector of the Antarctic region between lat.57° 53' S to 61° 13'S and long.30° 02'E to 40° 05'E. In the survey Isaccs Kidd Mid-water Trawl (IKMT) of head rope length 2.5 m with cod end of 5 mm mesh size was used as gear for sampling in the pre fixed stations. Design details and rigging of the gear are given in Figs.1 and 2. In total 18 stations in the epipelagic zone upto a depth of 50 m from sea surface was operated by expending haul duration ranging from 15 to 45 minutes. Flow metre reading were taken for the volume filtered. Vertical opening of the sampling gear when measured using SIMRAD ITI height sensor showed 3.8 m. In one station, a haul was made by Polish Krill trawl of size 42 m with cod end stretched mesh size of 20 mm with a towing speed of 2 knots.

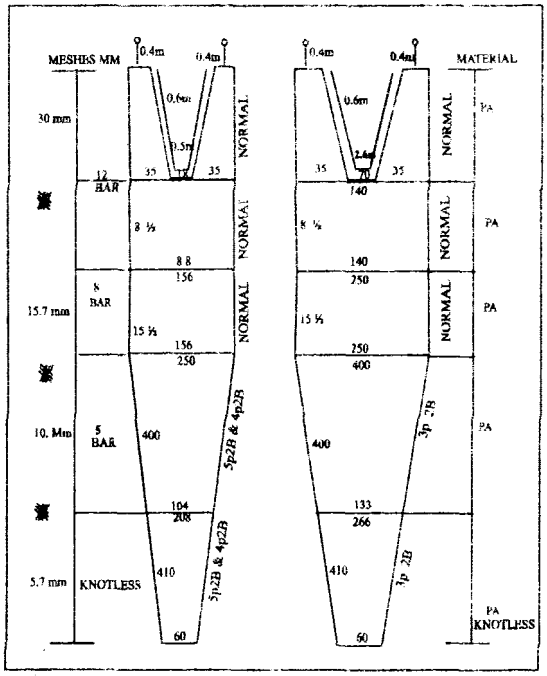

Fig.1 Design of Isaacs-Kidd Midwater Trawl (FORV Sagar Sampada)

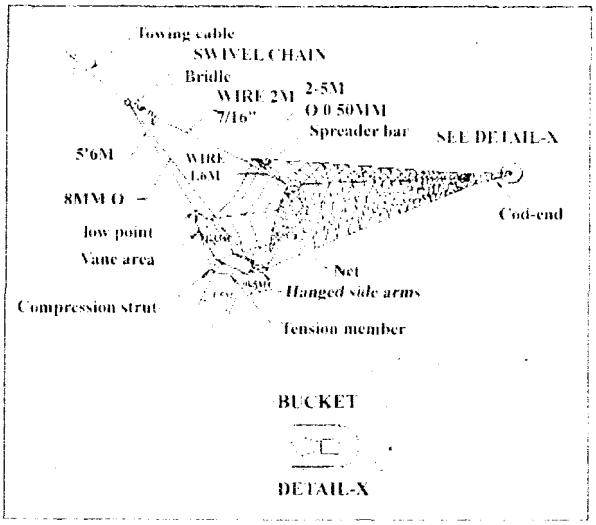

Fig. 2 Rigging of Isaacs - Kidd Mid Water Trawl (for MFV Sagar Sampada)

Krill mid-water trawl of size 49.5 m with cod end stretched mesh size of 10 mm was operated in 15 stations with towing speed of 2 knots. The design details and rigging of the gears are given by Bhoopendranath *et.al.* (1996).

In order to obtain accurate data on by-catch composition each haul of IKMT and krill mid-water trawl samples were taken and then the entire sample was divided into sub samples. Each sub sample was spread over a table and krill were removed one by one from the sub sample. Salps, juvenile fishes etc. remaining after all the krill have been removed were collected in separate containers for each species and labeled. The other fin-fishes, squids, jelly fish etc. from the krill trawl catch were directly collected and kept in separate containers. The collected specimens were identified according to Fisher and Hireau (1985). The percentage of species composition of the total catch was worked out based on the samples taken from each haul of IKMT and 49.5 m krill trawl. The length measurements and weights of the fin-fishes and squids were also taken. These samples were preserved in 4 percent buffered formalin.

Results and discussion

The results of the IKMT operated in 18 stations in the area 59° 00' – 61° 80'S lat. 30° 04'E - 40° 04'E long. from 23rd January to 12th February 1996, the result of which are summarized and presented in Table 1. Out of the total catch of 161.5 kg the Salps constituted 92% (148.81 kg), Antarctic krill, *Euphausia superba*, 8% (12.69 kg) and the latern fish was negligible in quantity (0.005 kg). It is observed that in area (lat.° S' – long.° E) 60-30, 61-30, 60-32, 61-35, 61-38, 60-39, 60-38, 60-34, 59-34, 59-36, the by-catch of Salps was observed in the range of 88 to 100% (at 8 stations 100% Salps and at 3 stations 88 to 99.9%). Only in one haul in area 60° 45' lat., 33 ° 36'E long., 100% krill catch was recorded and in another haul in area 60° 48' lat.33° 20'E long. *Euphausia superba* constituted 97% and by-catch (Salps) 3%. Incidentally this haul gave the highest yield of 7.4 kg for *Euphausia superba* among the IKMT hauls. In area lat.59° 02'S long.30° 57'E krill constituted 80% and the Salps 20% but the krill caught were juveniles. It is observed from the results of IKMT that the by-catch was mainly contributed by Salps which was present in all the areas except the area 60°-30' where no by-catch was observed.

The krill by-catch was recorded in all hauls by 49.5 m krill Mid-water trawl taken from the areas lat. ° S – long ° E / 60-33, 60-34, 60-36, 61-33 and 61-36. The details of area-wise effort and catch details of species composition are given in Table 2. The by-catch accounted for 54.4% of the total catch of

Table 1 : First Indian Antarctic krill expedition survey details of ISSACKID mid-water trawl operations

Haul No.	Station No.	Date & Time (GMT)	Position		Speed (Knots)	Duration of Haul (Hrs.)	Bottom Depth (M)	Fishing Depth (M)	Total Catch (Kgs)	Species-wise Catch Compsition						Volume filtered M^3
			Lat.°S	Long.°E						Krill		Salps		Lantern Fish		
										kg	%	kg	%	kg	%	
1	3369	23/01/96 1035	5902	3057	2	0.58	5312	50	0.296	0.237	80	0.059	20	-	-	22321
2	3370	27/01/96 2210	6000	3002	2	0.5	3999	50	20	-	-	19.998	99.9	0.002	0.1	19133
3	3371	28/01/96 0810	6100	3010	2	0.75	5177	50	25	-	-	25	100	-	-	14874
4	3372	28/01/96 1650	6059	3200	2	0.5	5100	50	8	0.118	2	7.882	98.5	-	-	10725
5	3373	21/01/96 0430	6059	3358	2	0.5	5000	50	3	0.35	12	2.65	88	-	-	18751
6	3374(i)	29/01/96 0900	6043	3336	2	0.71	5310	50	3	1.2	40	1.8	60	-	-	19376
7	3374(ii)	29/01/96 1008	6045	3338	2	0.36	5610	50	3.35	3.35	100	-	-	-	-	10355
8	3376	30/01/96 0510	6102	3558	2	0.33	5400	50	0.2	-	-	0.2	100	-	-	9414
9	3378	30/01/96 2255	6108	3800	2	0.25	5334	50	1.503	-	-	1.5	99.8	0.003	0.2	6962
10	3379	31/01/96 1225	6103	4004	2	0.33	5281	50	30	-	-	30	100	-	-	9281
11	3380	31/01/96 2250	6002	3959	2	0.33	5200	50	2	-	-	2	100	-	-	9719
12	3381	01/02/96 0820	6002	3800	2	0.33	5302	50	2	-	-	2	100	-	-	11693

13	3383	02/02/96 0825	6002	3400	2	0.33	5252	50	0.5	-	-	0.5	100	-	-	9510
14	3386	04/02/96 0415	6048	3405	2	0.25	5348	50	5.25	0.25	5	5	95	-	-	9514
15	3387	04/02/96 1340	6048	3320	2	0.33	5223	50	7.4	7.18	97	0.22	3	-	-	11897
16	3392	06/02/96 1445	6045	3317	2	0.5	5200	50	0	-	-	-	-	-	-	17331
17	3397	11/02/96 1700	5900	3400	2	0.5	5166	50	40	-	-	40	100	-	-	19130
18	3398	12/02/96 0155	5900	3600	2	0.25	5002	50	10	-	-	10	100	-	-	9499
19	3399	12/02/96 1340	5800	3558	HAULING SUSPENDED DUE TO VERY ROUGH WEATHER											
TOTAL						**3.54**			**161.5**	**12.69**	**-**	**148.81**	**-**	**0.005**	**0.3**	

Table 2 : Area-wise effort, catch details and percentage of species composition

Gears used : (1) 42 m Krill Midwater Trawl*
(2) 49.5 m Krill Midwater Trawl

Sl. No.	Area in Lat.° S – Long.° E		59-33*	60-33	60-34	60-36	61-33	61-36	Total	Species Composition (%)
	No. of hauls		1	8	2	1	3	1	16	-
	Fishing Effort in Hrs.	Dragging Effort	2.66	6.47	1.16	1.16	2.58	0.58	14.61	-
		Shooting and Hauling Effort	2.33	12.95	3.74	0.66	3.16	0.90	23.72	-
		Searching Effort	0.50	22.25	13.00	7.00	39.88	3.30	85.93	-
	Total Effort in Fishing Hrs.		5.49	41.67	17.9	8.82	45.62	4.78	124.28	-
	Total catches in Kg.		400.00	5967.785	2500.039	750.05	2651.78	200.00	12469.654	-
	Species Composition (in %)									
1	*Euphausia superba*		-	29.12	55.99	0.01	94.27	23.5	-	45.60
2	Salps		100	70.6	43.99	96.66	5.65	75	-	54.00
3	Jelly fish		-	0.16	-	3.33	-	-	-	0.20
4	*Moroteuthis ingens*		-	0.065	-	-	0.08	0.075	-	0.07
5	*Protomyctophum* sp.		-	-	0.005	-	-	0.075	-	0.13
6	*Gymnoscopelus nicholsi*		-	0.03	-	-	-	-	-	
7	*Anotopterus pharo*		-	-	-	-	-	1.35	-	
8	*Notolepis annulata*		-	0.005	0.015	-	-	-	-	

12.470 t, and 45.6% (5637 kg) was constituted by Antarctic krill, *Euphausia superba*. The by-catch included Salps 6738 kgs which alone constituted 54%, jelly fish 35 kg (0.02%), Antarctic squid 5.69 kg (0.07%) and fin-fishes 0.13% which included lantern fishes *Gymnoscopelus nicholsi* and *Protomyctophum* spp., *Anotopterus pharao* and *Netolepis annulata*.

Systematic position of the fin-fishes and cephalopods which were taken as by-catches is furnished below :

Sl. No.	Species	Family	Size	Weight (Kg)
1	*Moroteuthis ingens* (Greater hooked Squid)	Onchoteuthidae	115 mm (38 g) – 332 mm (724 g)	5.690
2	*Notolepis annulata* (Jonas fish)	Paralopididae	70-260 mm	0.050
3	*Gymnoscopelus nicholsi* (Lantern fish)	Myctophidae	137.5 – 175 mm	2.000
4	*Protomyctophum* spp. Heirops (Lantern fish)	Myctophidae	50-120 mm	0.160
5	*Anotopterus pharao* (Daggertooth)	Anotopteridae	90-1020 mm	2.700

1. *Moroteuthis ingens* Smith 1881

Family : Onchoteuthidae

This family was represented by four species of squids. In this expedition 6 numbers of *Moroteuthis ingens* were caught. Their mantle length was between 11.5 and 33.2 cm. The weight was in the range of 38 to 724 gms. The mode class observed was 13 cm which was weighing average 44 gms. Among the 6 specimens 1 was male and 5 females.

2. *Notolepis annulata* Post, 1978

Family : Paralopididae (Baracudina/Jonas fish)

Only one species of the family *Notolepis annulata* was caught in the survey. The size range was from 7 cm to 26 cm mode. class recorded was 12 cm.

3. (a) *Gymnoscopelus nicholsi* : Gilbert, 1911

Family : Myctophidae / Lantern fishes

There were 6 numbers of specimens of *Gymnoscopelus nicholsi* recorded. The size measured was from 13.75 to 17.5 cm. Model class appeared was 14 cm.

(b) *Protomyctophum* (Hierops) spp.

In this species 11 numbers of specimens caught. The size range was from 5 cm to 12 cm. The modal size class was 6 cm.

4. *Anotopterus pharao* : Zugmayer, 1991

Family : Anotopteridae (Daggertooth)

Only two specimens of *Anotopterus pharao* were caught during this expedition, the size of the specimens were 90 and 120 cm weighting 568 and 2700 gms respectively.

Based on the survey results of krill trawl it is observed that the by-catch of Salp was more than the Antarctic krill catch in almost all areas except 60-32, 61-33 the area 60° 48', 61° 13'S lat. And 31° 19' – 34° 14' long. Better catches of Antarctic krill yielding 1000 kg/haul were obtained between lat.60° 48', 61° 13'S and long. 33° 34'E – 14'E wherein the Salp % was between 5-65% and 44%. Other than the Salp by-catch of 54%, a total of 4 species of fish belonging to three families (*Paralepididae, Myctophidae* and *Anotoperidae*) accounted for only 0.13% and squid of Onchoteuthidae family, *Moroteuthis ingens*, sharing 0.07% and jelly fish 0.2% of the total catch 12.470 t.

Conclusion

The result of krill trawl by-catch in percentage of species composition in the surveyed fishing area 58 in the Indian Ocean sector of Antarctic region between lat.57° 53'S, 61° 13'S long.30° 02'E to 40° 05'E during the Austral summer showed that Salp was the predominant by-catch species which contributed 54% of the total catch of 12.470 t. The IKMT results also showed that the Salp formed 92% of the total catch of 161.5 kg and the krill was only 8%. The Salp present in almost all areas except the area lat.60-33 where the pure krill was harvested. Other than Salp 4 species of fish accounted for 0.13%, squid

0.07%, jelly fish 0.2%. The krill catch percentage was 45.6%. Though this FIKEX expedition indicated the presence of by-catches beyond acceptable limit in the surveyed area it requires further exploration in order to confirm by-catch relationship with Antarctic krill. The reason for high incidence of Salp in the IKMT hauls is due to the fact that these hauls were taken from the pre-determined sampling stations irrespective of sighting a krill shoal or not. The percentage of by-catch might vary to a considerable degree depending on the availability of subject which needs further studies covering all the seasons. Indications during FIKEX that the krill catches to increase towards the continent shows that even during austral summer commercially fishable shoals of krill could be located towards southern latitudes.

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References

Anon, 1996. *FAO Fisheries Circular No.920, 17 Southern Ocean on FAO Statistical Area* 48, 58 and 88.

Budzinski, E., P.Bykowskii and D.Dutkiewics, 1985. FAO Fisheries Technical paper 268 FIPP / T268. Possibilities of processing and marketing of products made from Antarctic krill : 1p.

Bhoopendranath, M.R., M.K.R.Nair, A.Anrose and V.C.George, 1996. Investigation on Mid water Trawling for krill (*Euphausia superba*) in the Southern ocean. DOD proposed workshop on First Antarctic Krill Expedition (MS).

Fischer, W. and J.C.Hureau (Eds.), 1985. *FAO species identification sheets for fishery purpose southern ocean CCAMLR convention area fishing areas* 48, 58 and 88, 1 : 71-87.

Kaleinowski, J. and Z.Witek, 1983. An attempt at estimation of Antarctic krill. *Bull. Sea. Fish.* 1st. *Gdynia*, *14*(5-6) : 34-36.