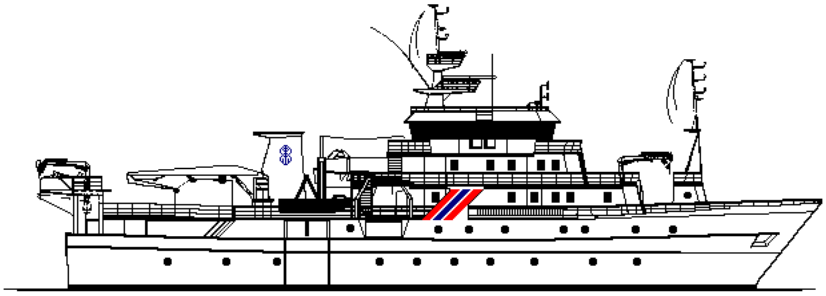
CRUISE REPORTS "DR. FRIDTJOF NANSEN"



BENEFIT SURVEYS

Preliminary Cruise report No 5/2002

ESCAPEMENT OF HAKE UNDER THE FISHING LINE OF A DEMERSAL SAMPLING TRAWL

7 – 16 October 2002

by

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1. INTRODUCTION

Objective

The main objectives of the cruise were to collect information about the hake escapement under the fishing line of a demersal sampling trawl and to record fish behavior in relation to the ground gear using camera.

Swept area surveys conducted in South Africa and Namibia provide input data to the hake stock assessment models used in both countries. The hake abundance and length distribution estimates from the surveys are used in the models, in addition to fishery dependent data, to calculate the age structure and abundance of the hake stocks.

The abundance estimates from the surveys are used as relative indices of the hake biomass, while the length frequencies estimated are assumed to reflect the underlying population characteristic. This assumption is invalid if the efficiency of the trawl differs between length groups. If the efficiency of the trawl is length dependent the estimated length distribution of the stock will be biased and hence also bias the abundance indices if the length structure of the stock changes between years.

This survey with R/V *Dr. Fridtjof Nansen* is the third experiment within the BENEFIT project "Effects of Environmental Factors on Availability and Catching Efficiency of the Demersal Sampling Trawl" where the main objective is to investigate factors that affect the catchability of hake. During the experiments conducted in 2000 and 2001 the herding effects of the bridles were investigated. The results show that large hake seems to be herded into the net.

The objective of this year survey was to establish whether hake escape under the fishing line and to investigate any species and length dependent escapement. By using a collection bag attached to the ground-gear experiments conducted in Europe and North America have shown significant escapement of flatfish and juvenile gadoid fish under the fishing-line of demersal sampling trawls. By using similar techniques we investigated the escapement of hake of different size classes. In addition, a camera were used to take flash photos of the area in front of the ground-gear to look for patterns in the swimming behaviour of hake in relation to the gear.

Participation
The scientific staff consisted of the following:
From Namibia:
Titus Iilende, Espen Johnsen, Peter Schneider, Malakia Shimhanda and Sean Wells

From South Africa:
Pheobius Mullins

From Norway:
Arill Engås, Ingve Fjeldstad, Terje Jørgensen, Tore Mørk and Ingvald Svellingen

Narrative

7 October	Departure Walvis Bay
16 October	Arrival Walvis Bay

2. MATERIAL & METHODS

The bag experiment

The experiment was carried out off the coast of Namibia at five different areas (Fig. 1). The five experimental areas were selected ad hoc based on depth and fish abundance, species and fish size composition. The water depth ranged between 270 and 470 m.

The vessel's standard sampling trawl for hake, the Gisund super (Fig. 2a, b), equipped with 40 m bridles and 7.9 m^2 Thyborøn doors were used. The trawl was fished with door-spread restriction consisting of a 10 m rope between the warps 140 m in front of the doors to ensure stable door and wing spreads and to prevent the trawl from being overspread. A similar technique is used during the standard hake surveys in Namibian waters.

A collection bag was used to catch fish escaping below the fishing line of the trawl (Figure 3). This bag covers the bosom section of the trawl. To collect fish escaping below the remaining of the fishing line of the trawl, wing section were fitted to the collection bag. Fish escaping in the wing sections are "guided" into the collection bag.

The headline of the collection bag and top part of the wings were attached to the fishing line of the trawl, while the front part of the fishing line of the collection bag and/or wings were attached to the ground gear (Figure 3). For bottom protection the bag and the wings were supplied with a rope (44 mm PE and 36 mm PE, respectively). In order to keep proper bottom contact of the main bag, 12 and 16 mm chains were mounted to the rope of the bag, while 13 mm chain was used on the wing part. Scratch marks on the chains showed that both wings and the main bag had proper bottom contact during the experiment.

During the four first hauls (stations number 1162, 1163, 1164 and 1166), only the collection bag was used, while both the bag and the wings were used during the rest of the experiment (Figure 3). The duration of a tow was between 10 and 20 min at a speed of 3 knots (1.5 m/s). All trawl hauls were monitored by Scanmar trawl sensors (door spread, vertical opening and symmetry of the trawl). A total of 23 hauls were carried out.

Camera studies

The camera used was a Nikon Coolpix 990 digital camera with a Nikon wide angle converter (0.63x). Two flashlights were mounted to either side of the camera. The

flashlights used were Nikon SB-26 flashlights. The camera and the flashlights were each enclosed in an underwater housing. The camera and flashlights were used in conjunction with a Harbortronics DigiSnap 2000 electronic shutter release. This allowed for pre-programming of the amount of pictures to be taken at specified intervals starting at a pre-programmed time. The time interval between each picture taken was set at 30 seconds. The trawl speed was around 1.5 m/s which meant that photos were taken at about 45m intervals. The duration of hauls was 1.5 hours which meant that about 180 pictures were taken for every haul.

The camera was mounted on the top panel pointing down towards the ground gear. Best results were achieved when the camera was mounted in the centre of the trawl 2.3 meters behind the headline, with the flashlights mounted 1.9 meters to either side of the camera 1.25 meters in front of the camera (Image 1).

A RS-600 underwater video system was used to determine whether there was any bioluminescence present at the bottom that would make the trawl visible to fish. Altogether 9 hauls were done using the photo camera and three hauls using the video camera.

Hydrography and meteorology
CTD stations were carried out morning, noon and late afternoon. Temperature, salinity, oxygen and light were measured. Wind speed and direction, air and sea surface temperature (5 m depth) were logged automatically throughout the cruise using an Aanderaa meteorological station and light intensity was recorded with a Li-Cor 1000.

3. RESULTS

Bag experiments
Station information and catch composition are given in the Appendix. The catches composed mainly of rattails, hake, monk, catsharks and black slimehead. Catch rates of hake were low, especially of fish below 20 cm and larger than 45 cm (Figs. 5a, 5b, 6a, 6b, 7a, 7b, 8a, 8b, 9a). *M. capensis* dominated in the shallow areas B and C, while *M. paradoxus* dominated in the deeper areas A, D and E.

Escapement of hake below the fishing line was found to vary by species and area (Figs. 5c, 6c, 7c, 8c, 9b). For *M. capensis* escapement was generally below 5%. For the two smallest length classes represented (15-19, 20-24) escapement rate was higher and more variable. For *M. paradoxus* escapement was generally in the range 10-20%. Especially in area D consistent escapement levels of approx. 20% were observed. Data for length classes below 25 cm was only available for the two hauls made in area B and for one haul in area A. Escapement rates differed considerably between the two hauls in area B for these length classes. For fish above 25 cm no trend in escapement with decreasing fish size was seen for either species.

Camera studies
The video camera observations showed that there is considerable bioluminescence present in the water (Image 2). This shows that fish could probably easily detect the approaching trawl.

The photo observations showed clearly that fish do react to the approaching trawl. This can be deducted from the orientation of the fish towards the trawl (Image 3). The majority of fish seen on the pictures show a avoidance reaction pattern towards the trawl. Only in few cases were fish seen close the trawl gear pointing towards the trawl (Image 4). However, no photographs showed collisions of fish with the ground gear. The photos also clearly showed that the fish reacted to the approaching trawl and not to the flashlights. In many cases the sand cloud stirred up by the escaping fish was visible. This sand cloud, however, is often some distance away from the fish on the photo (Image 5). This indicates that the fish was stirred up and started reacting before the photo was taken and it was thus reacting to the trawl and not the flashlight.

It was difficult to distinguish different types of fish on the pictures especially smaller fish but since all fish showed a similar pattern of behaviour this is not of great concern. In some cases the species could be identified clearly (Image 6).

Hydrography , meteorology and light measurement
Temperature, salinity and oxygen levels within 10 m from the seabed are given in Table 1. The environmental factors were stable throughout the cruise. The underwater light profiles taken during daytime showed light level to decrease linearly with increasing depth. At 300 m depth the light level was 10^{-4} Lux. At night the light level decreased exponentially with depth. A level of 10^{-4} Lux was now found at a depth of approximately 100 m.

4. CONCLUDING REMARKS

The experiments have clearly shown that hake escape under the fishing line of the survey trawl used on board the R/V Dr. Fridtjof Nansen. The results indicated clear differences between the two hake species, with 10-20% escapement of *M. paradoxus* but only minor escapement of *M. capensis*. However, fish density of both hake species was low in the study area and the size range of fish narrow. More experiments are required to more confidently determine the level of escapement and its relationship with hake species, fish size and environmental factors like depth, visibility etc.

Table 1. Temperature, salinity and oxygen levels within ten meters from the bottom

Date	Time	Station number	Temperature (°C)	Salinity	Oxygen (ml/l)
08.10.2002	06:06	952	9.02	34.78	1.39
08.10.2002	13:01	953	9.02	34.78	1.40
09.10.2002	06:08	954	8.97	34.78	1.41
09.10.2002	11:27	955	9.64	34.84	1.22
10.10.2002	06:01	956	10.26	34.91	1.20
10.10.2002	11:44	957	10.01	34.89	1.18
11.10.2002	06:00	958	10.06	34.89	1.16
11.10.2002	10:08	959	10.07	34.90	1.14
11.10.2002	17:56	960	10.11	34.90	1.24
12.10.2002	06:06	961	10.95	34.99	1.27
12.10.2002	11:04	962	10.28	34.92	1.25
12.10.2002	13:57	963	10.22	34.91	1.16
13.10.2002	05:20	964	8.94	34.78	1.47
13.10.2002	11:19	965	9.10	34.79	1.14
13.10.2002	17:40	966	9.13	34.80	1.38
14.10.2002	05:08	967	9.21	34.80	1.39
14.10.2002	10:40	968	9.32	34.81	1.33
15.10.2002	02:25	969	8.63	34.76	1.22
15.10.2002	10:35	970	8.57	34.76	1.20

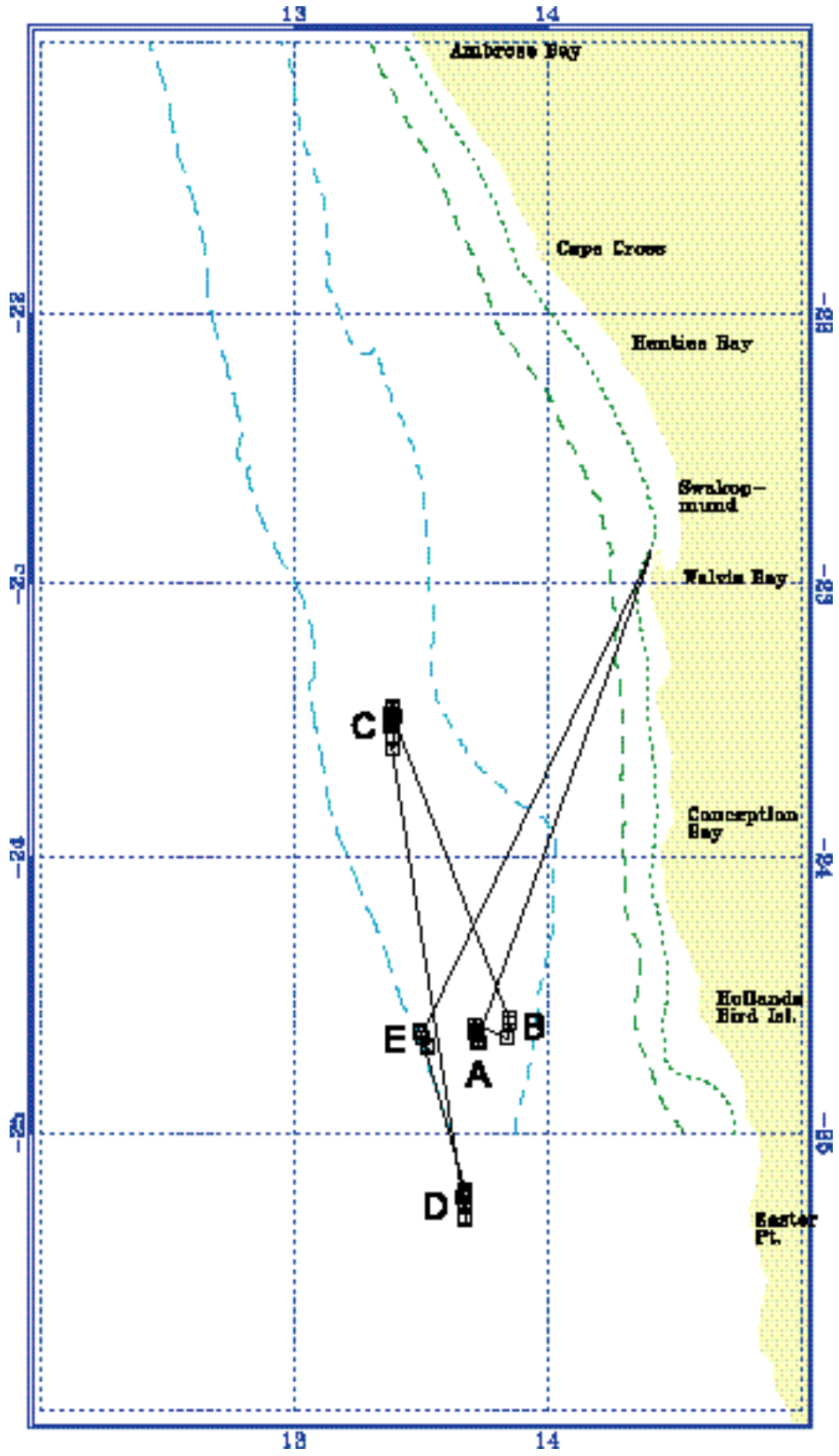

Fig. 1. The fishing area showing the five experimental locations A to E.

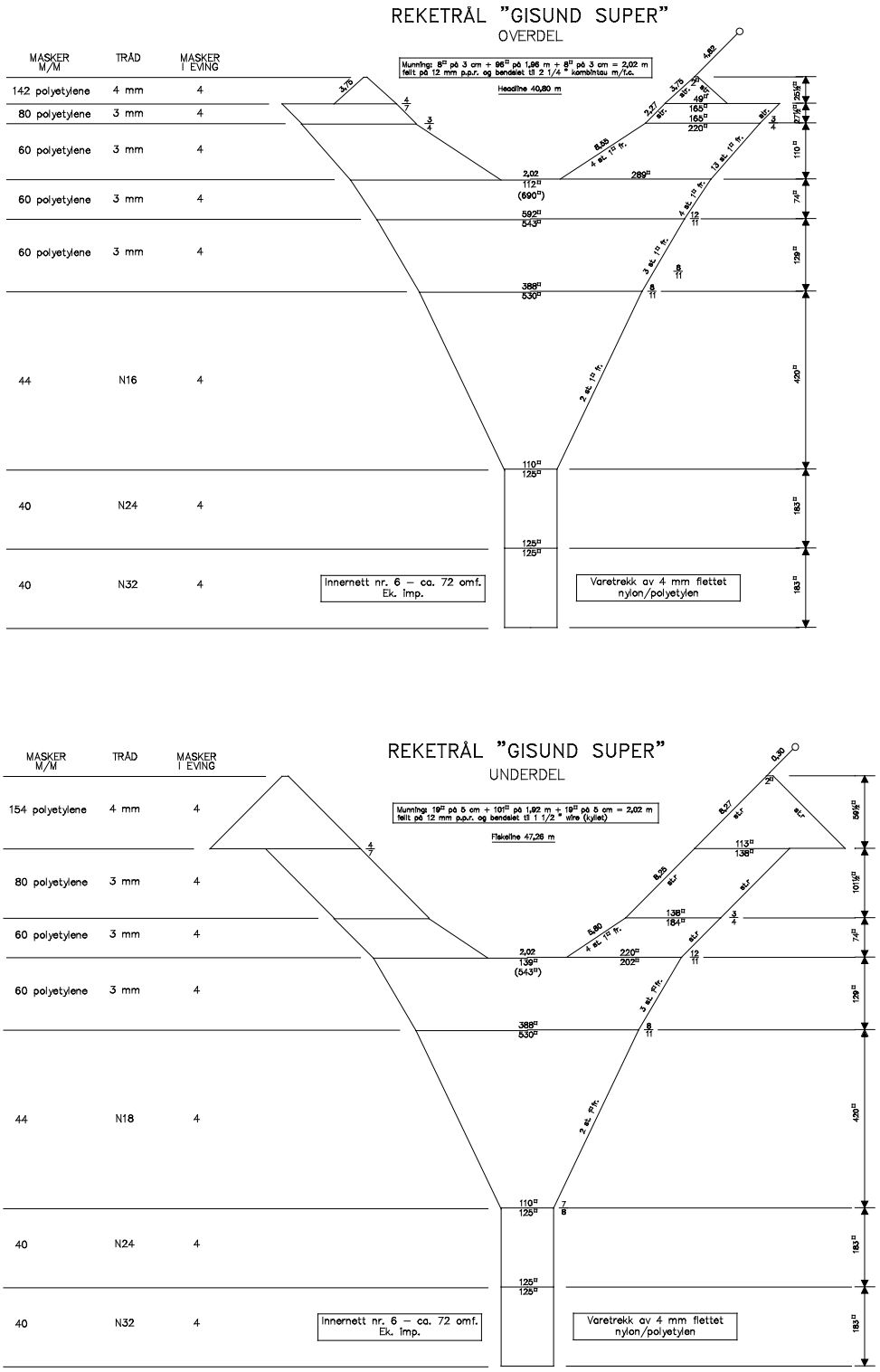

Figure 2a. Design of the trawl used.

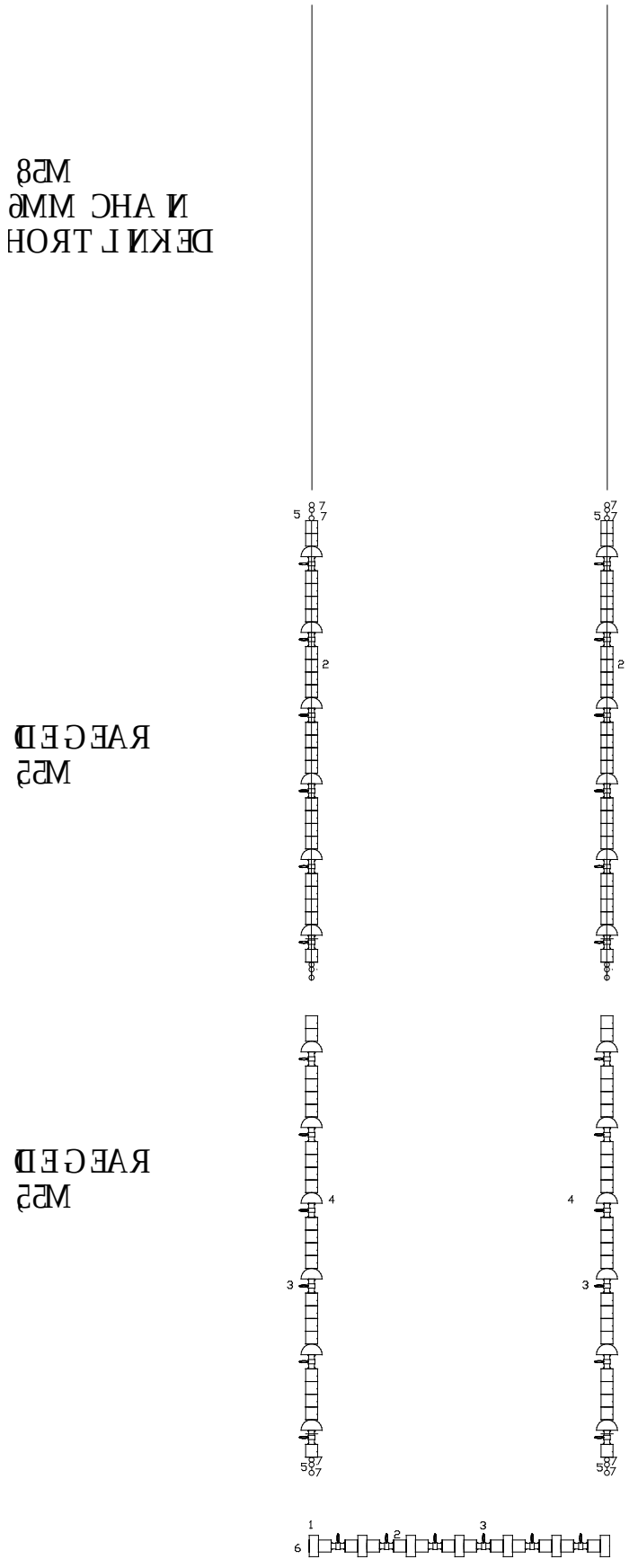

Fig. 2b. Schematic drawing of the ground gear used in the experiments.

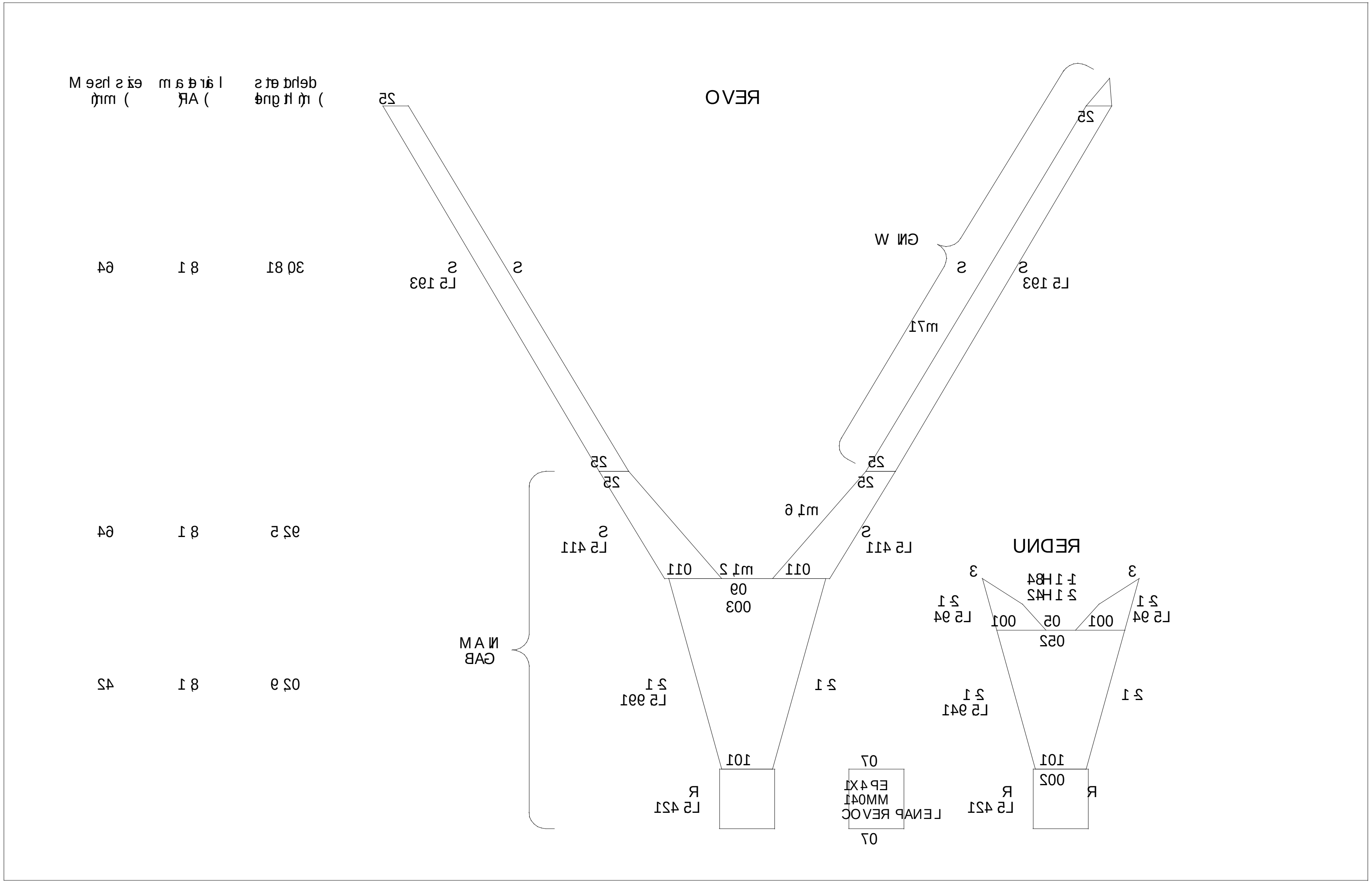

Fig. 3. Design of the collection bag.

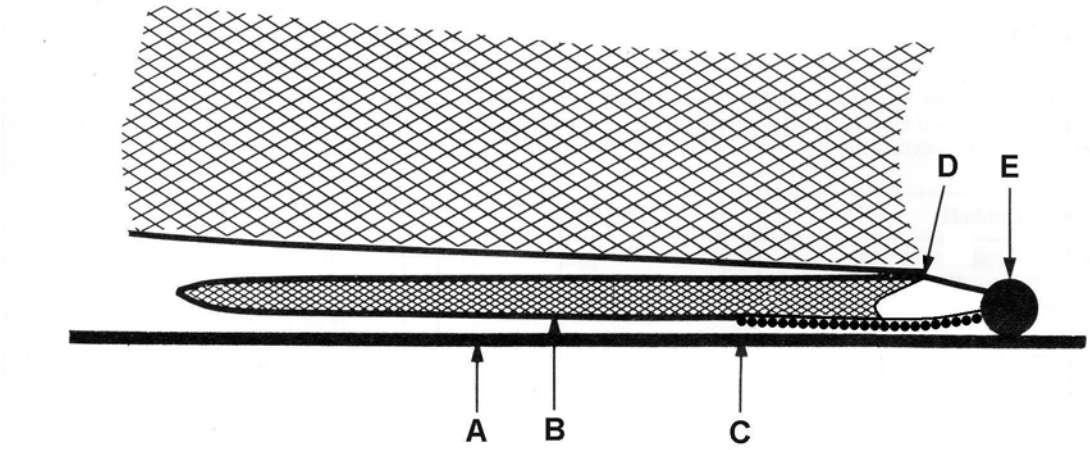

Fig. 4. Schematic presentation of the collection bag under the trawl (seen from the side). A – bottom; B – collection bag; C – footrope with chain; D – headline of the collection bag/ fishing line of the trawl; E – bobbins gear

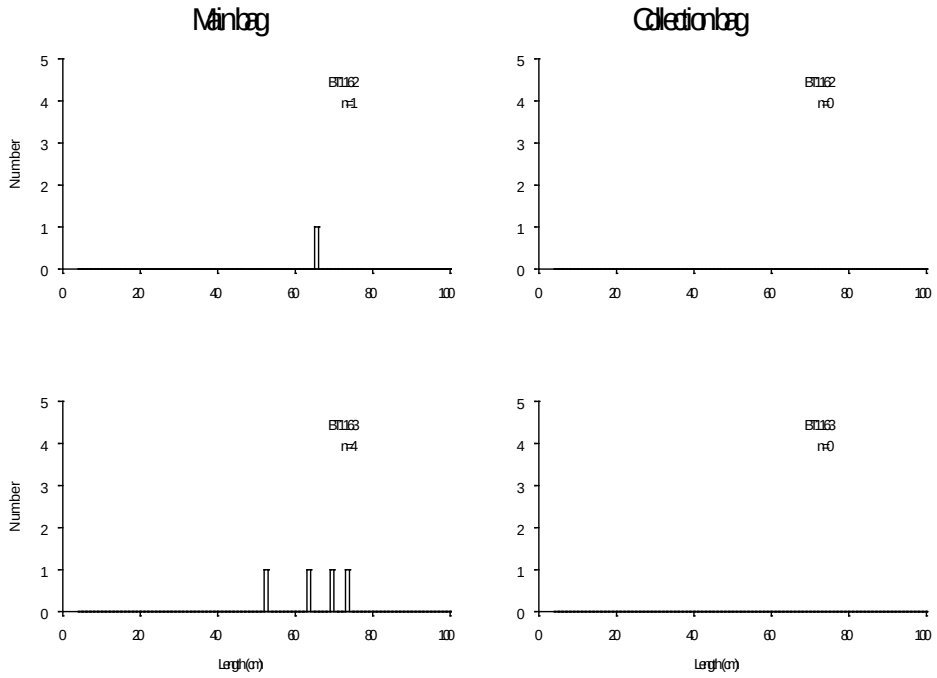

Fig. 5a. Area A. Length distribution of *M. capensis* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

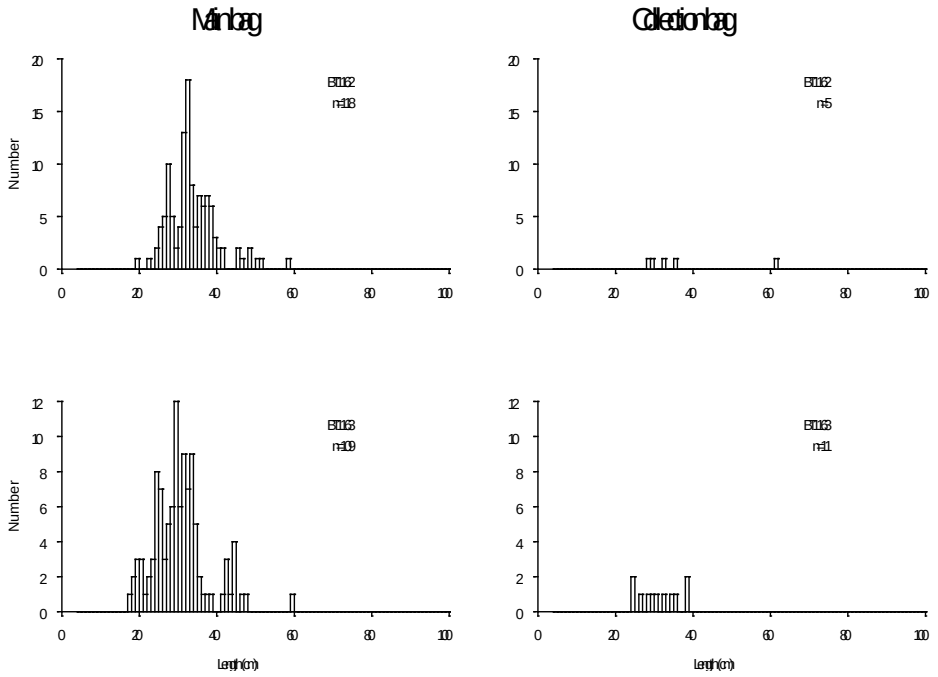

Fig. 5b. Area A. Length distribution of *M. paradoxus* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

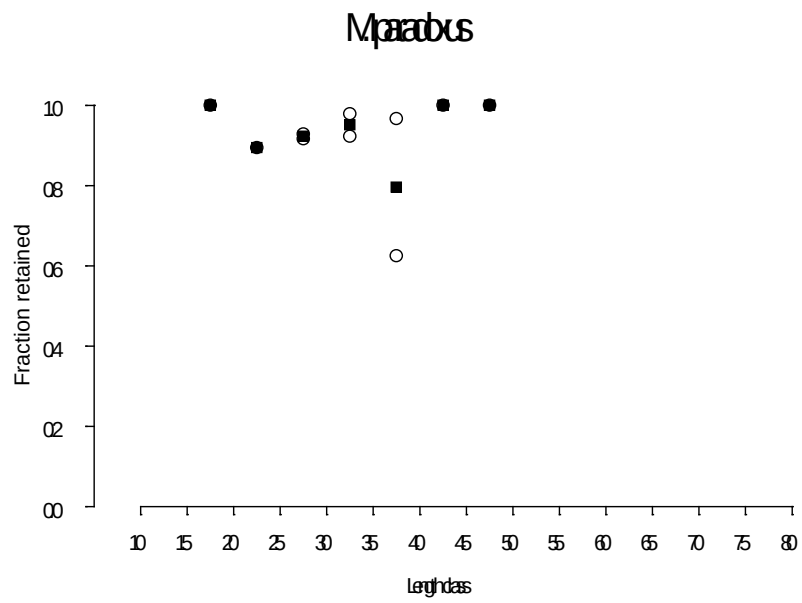

Fig. 5c. Area A. Fraction of the total catch (by number) that was retained in the main bag. Calculations were made for each 5 cm length interval. Only hauls with at least 5 fish in a length class are plotted. Open circles are individual haul observations, filled squares mean values.

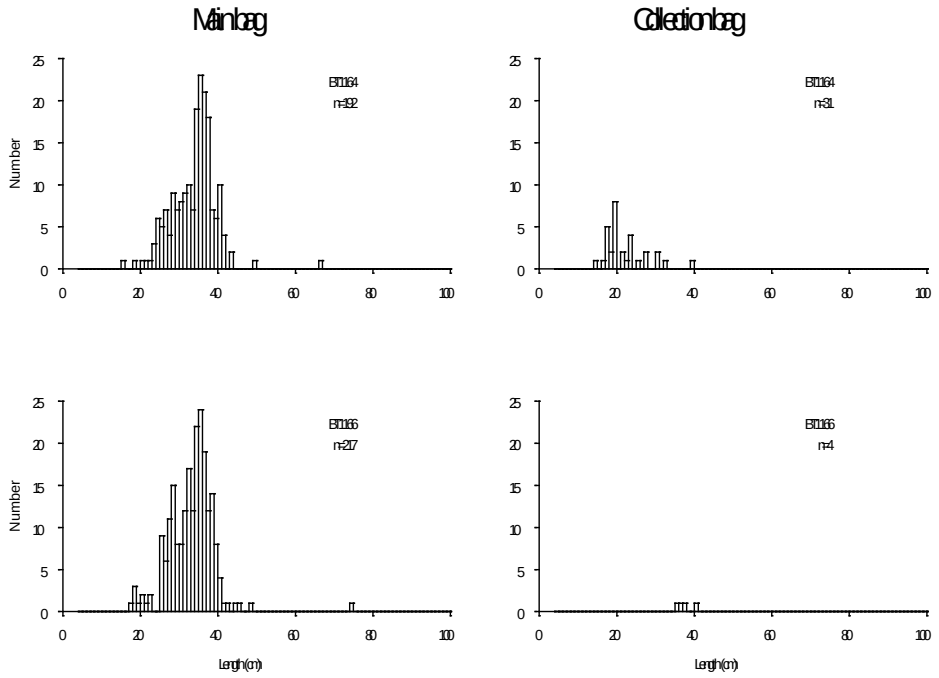

Fig. 6a. Area B. Length distribution of *M. capensis* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

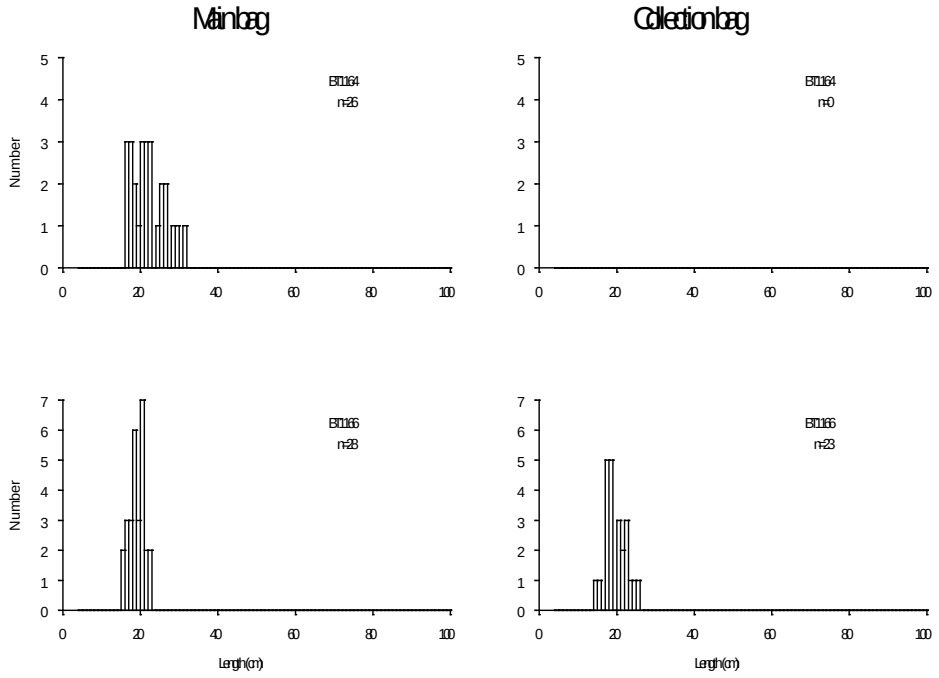

Fig. 6b. Area B. Length distribution of *M. paradoxus* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

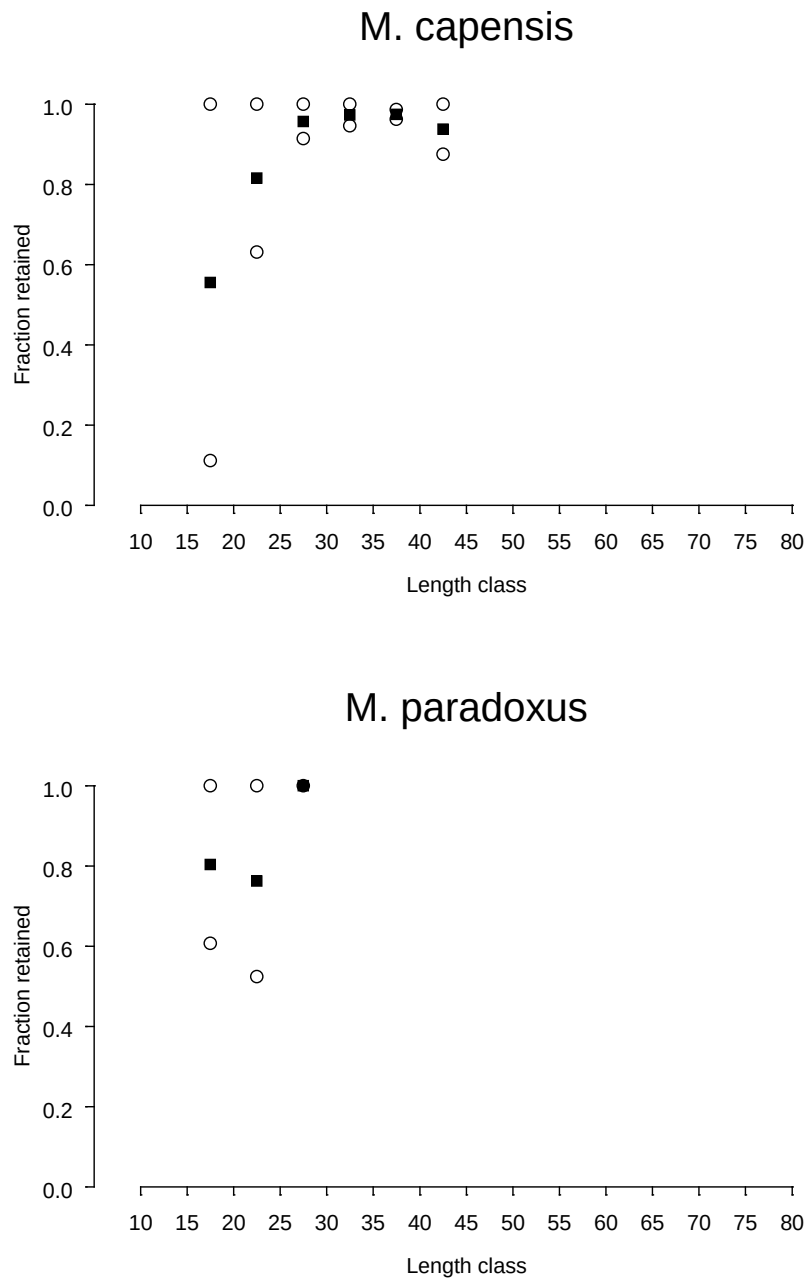

Fig. 6c. Area B. Fraction of the total catch (by number) that was retained in the main bag. Calculations were made for each 5 cm length interval. Only hauls with at least 5 fish in a length class are plotted. Open circles are individual haul observations, filled squares mean values.

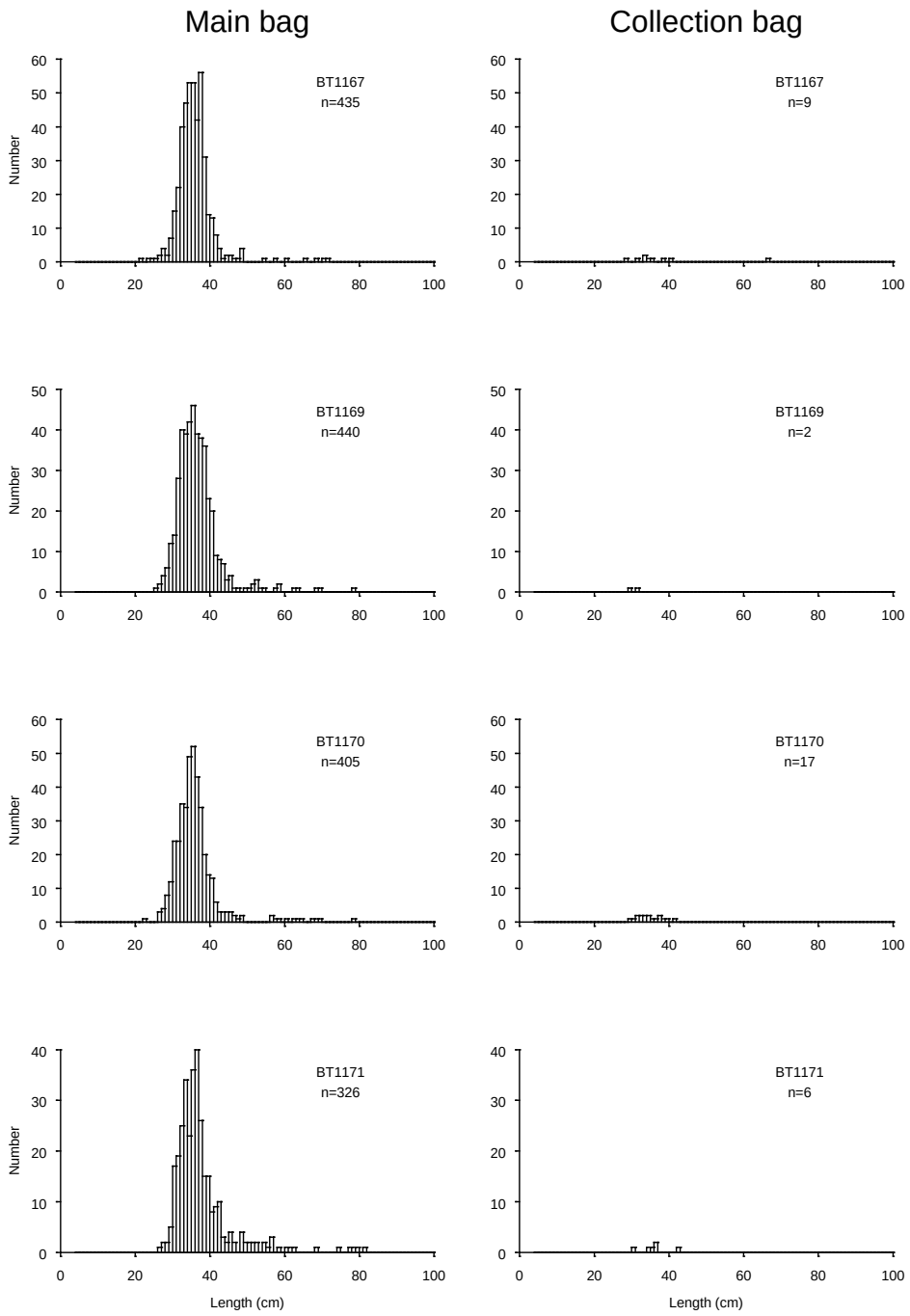

Fig. 7a. Area C. Length distribution of *M. capensis* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

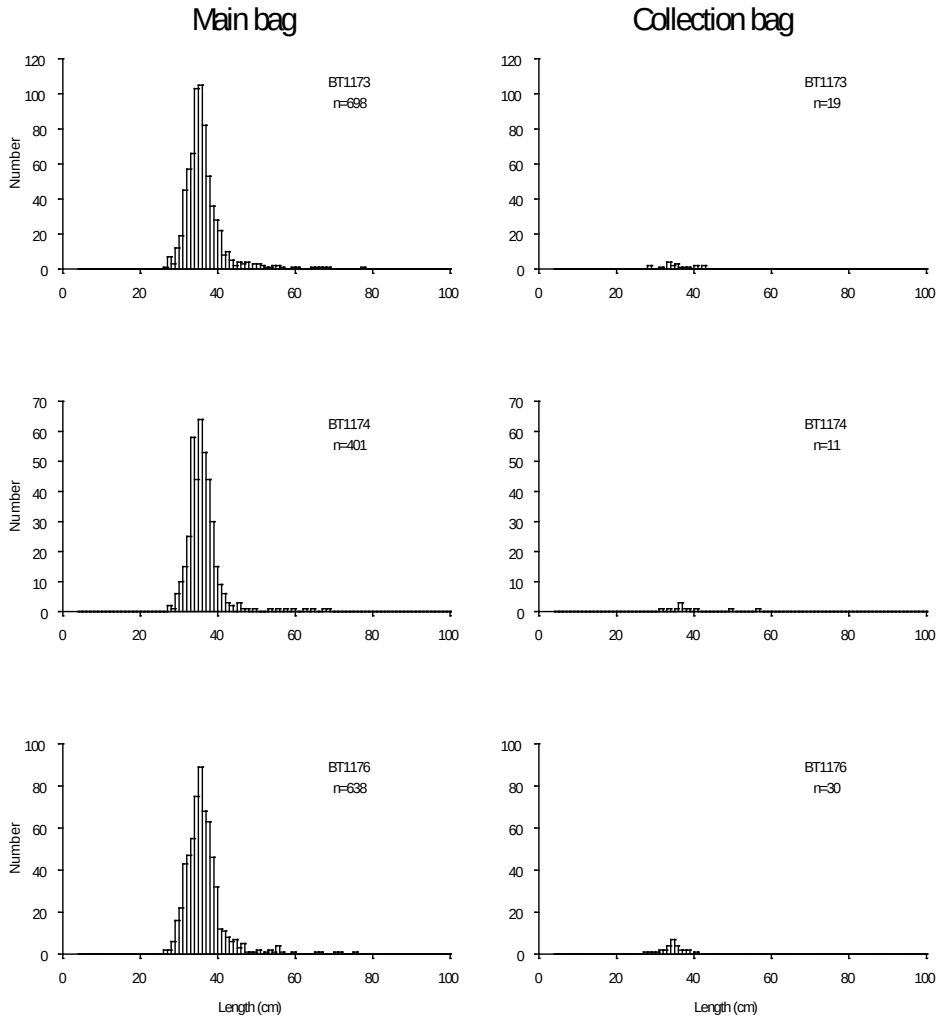

Fig. 7a. Continued.

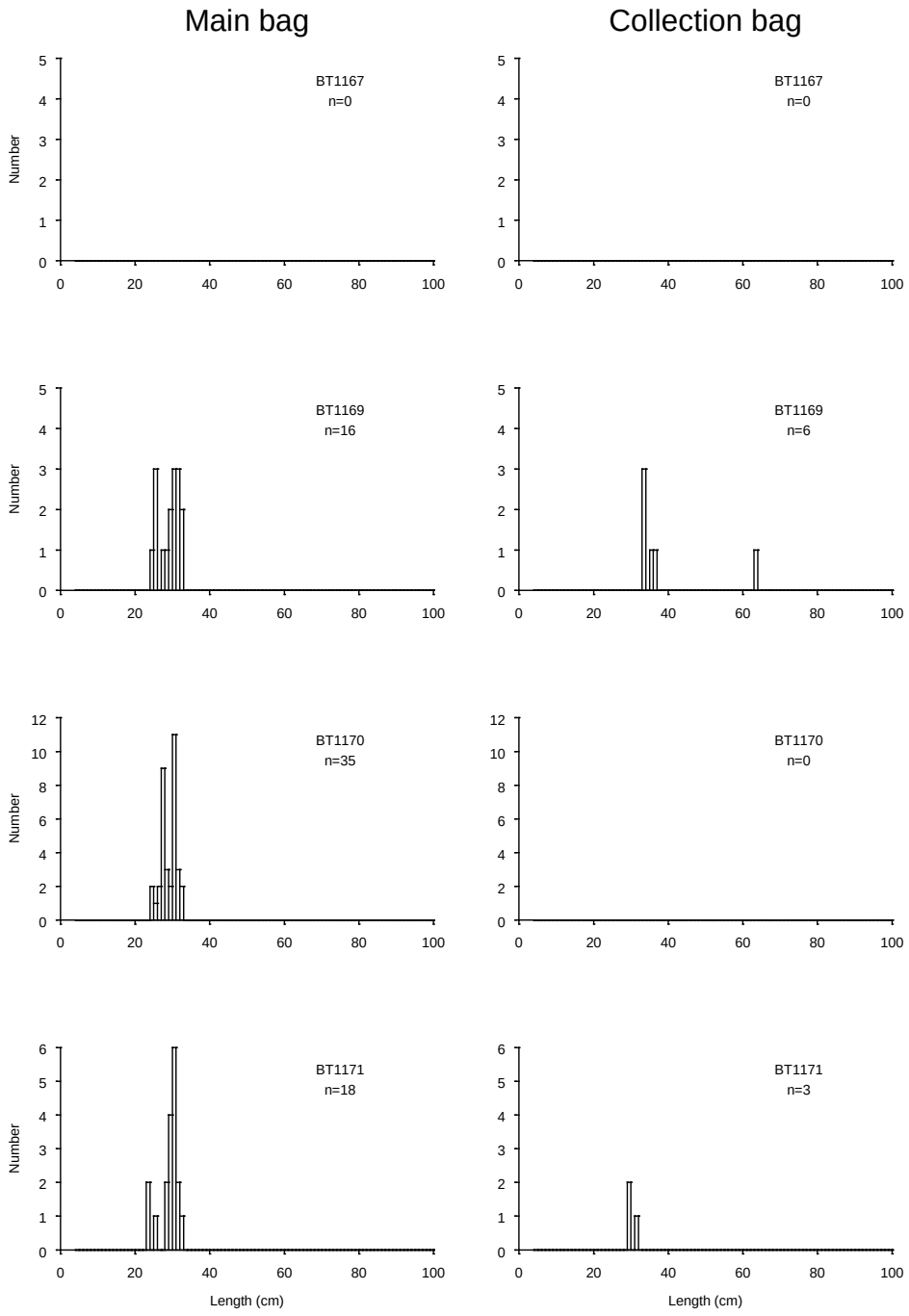

Fig. 7b. Area C. Length distribution of *M. paradoxus* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

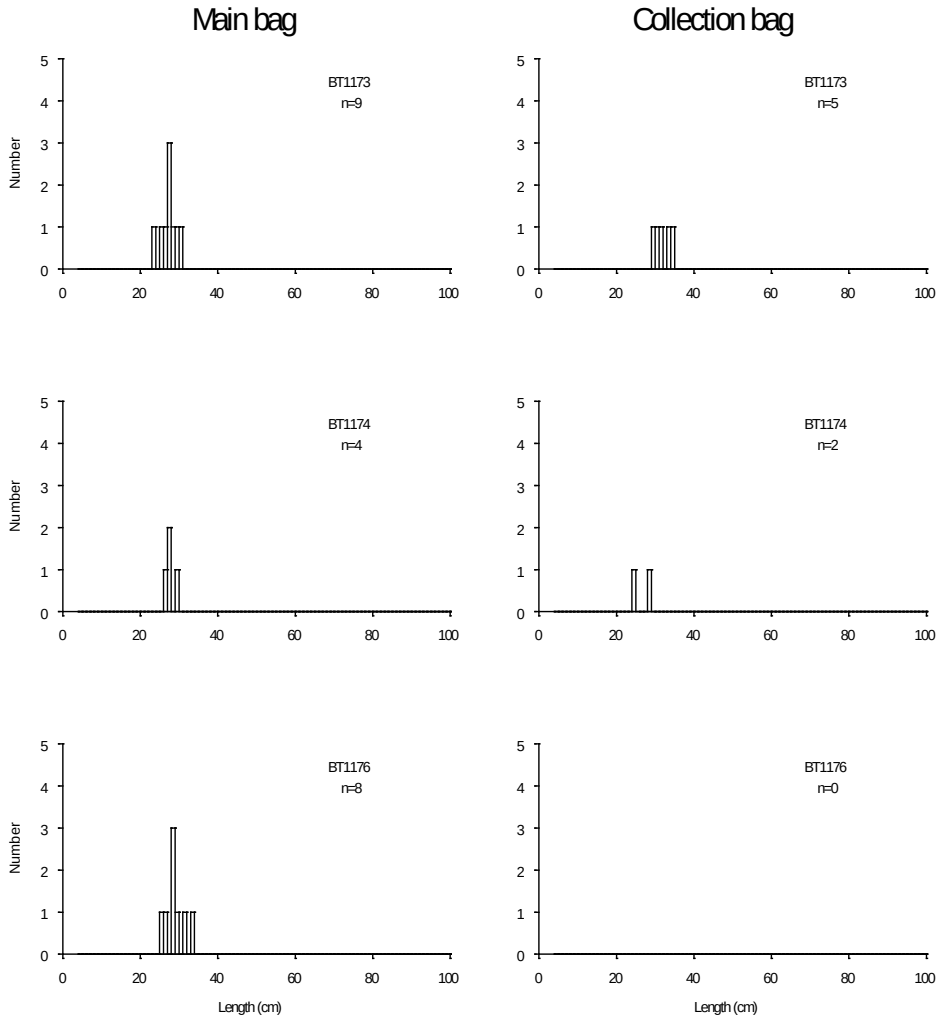

Fig. 7b. Continued.

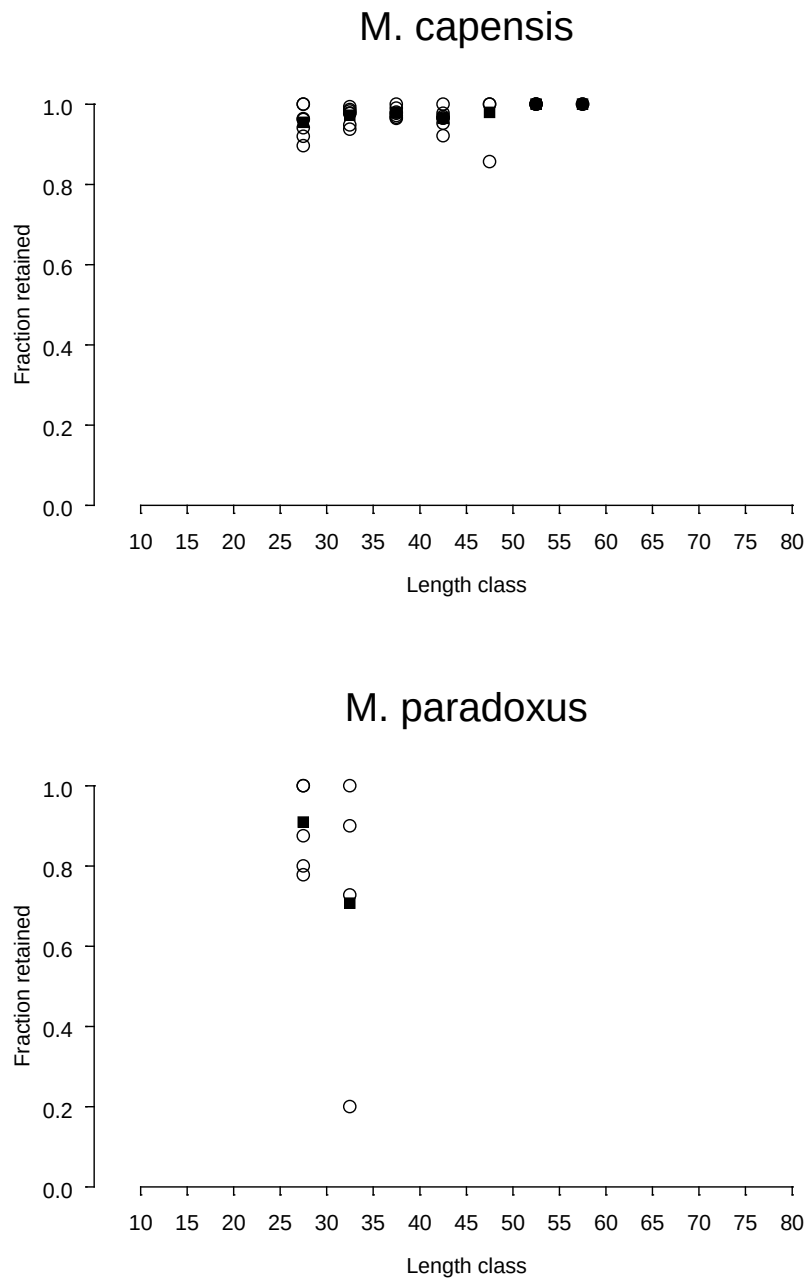

Fig. 7c. Area C. Fraction of the total catch (by number) that was retained in the main bag. Calculations were made for each 5 cm length interval. Only hauls with at least 5 fish in a length class are plotted. Open circles are individual haul observations, filled squares mean values.

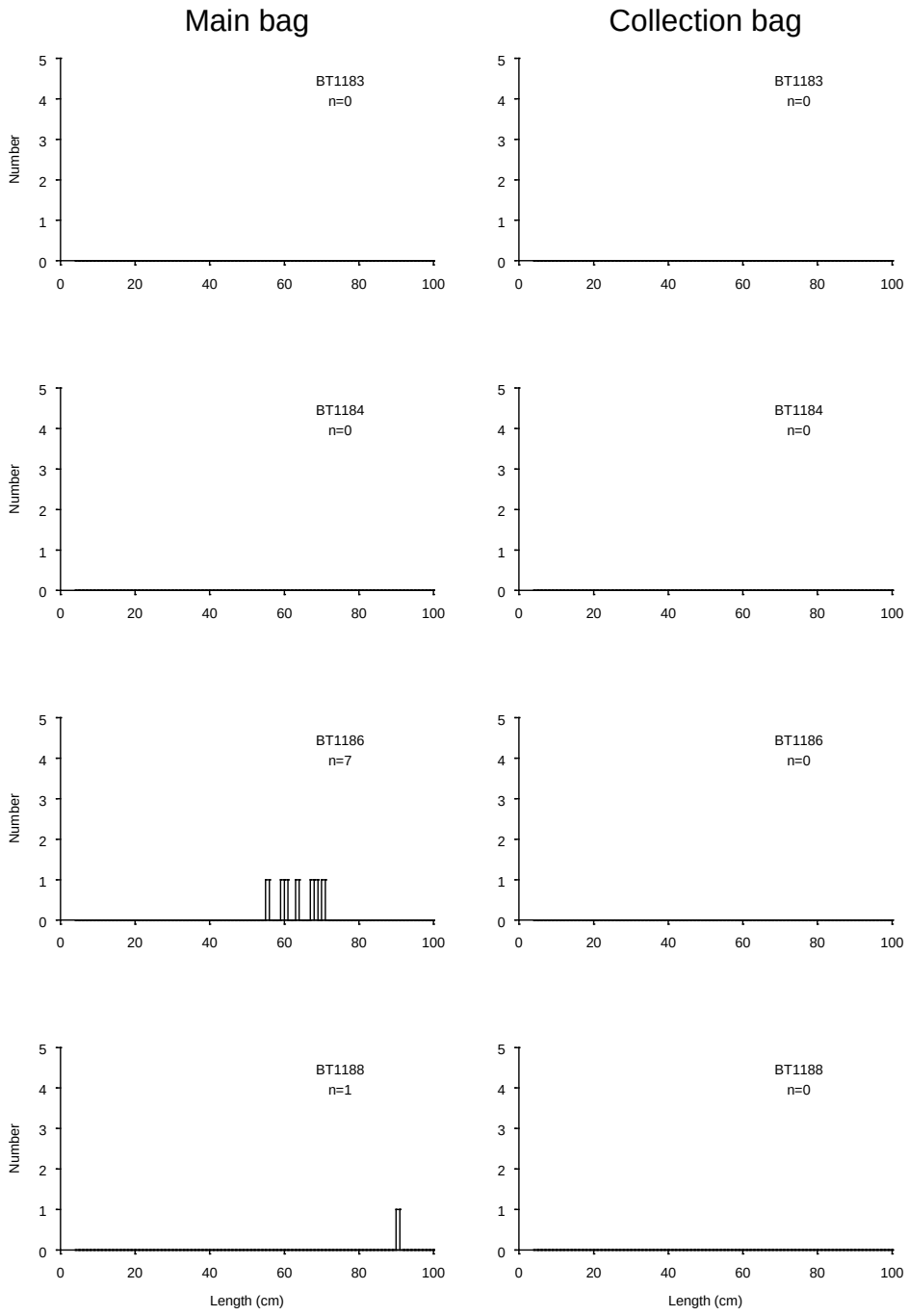

Fig. 8a. Area D. Length distribution of *M. capensis* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

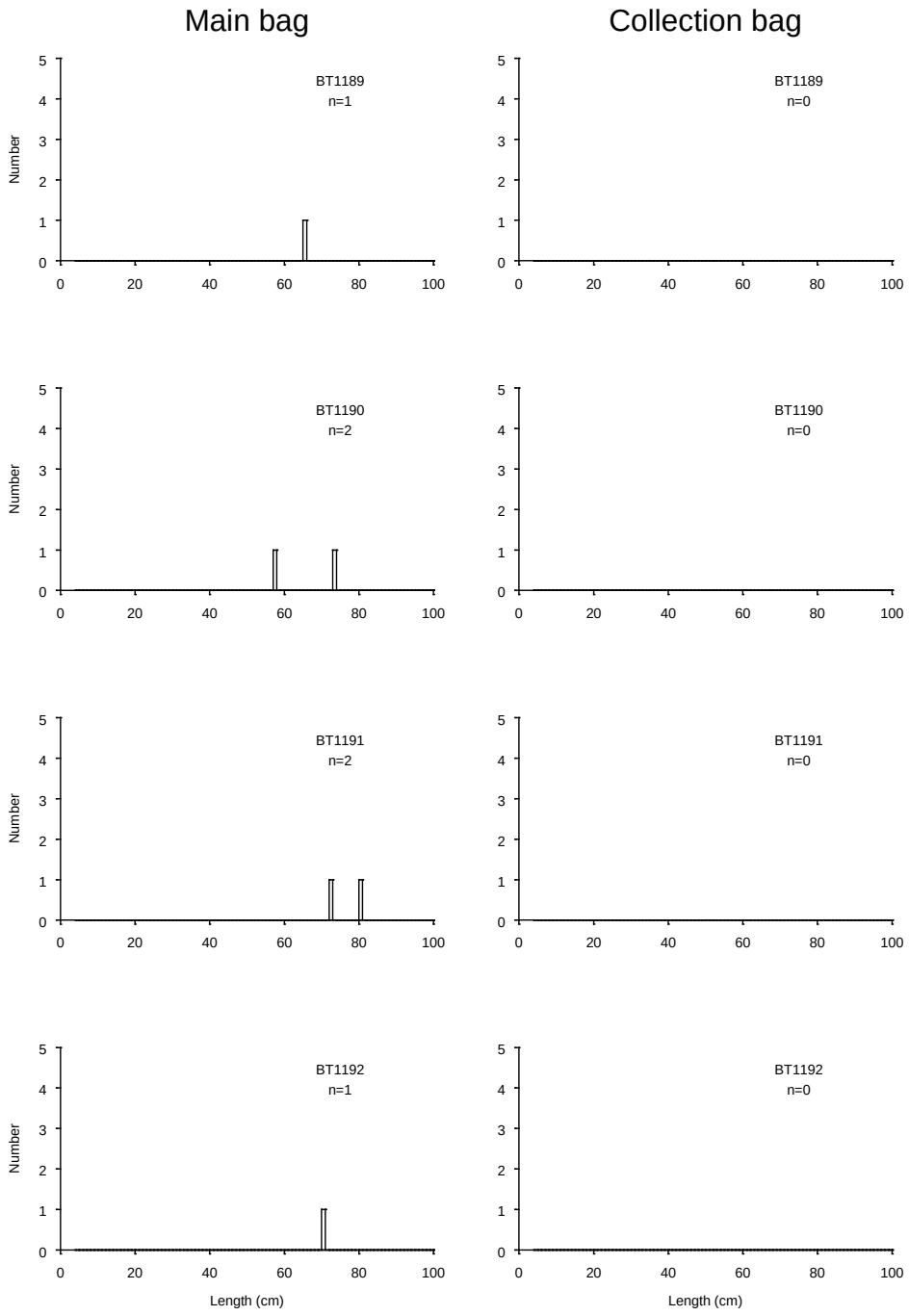

Fig. 8a. Continued.

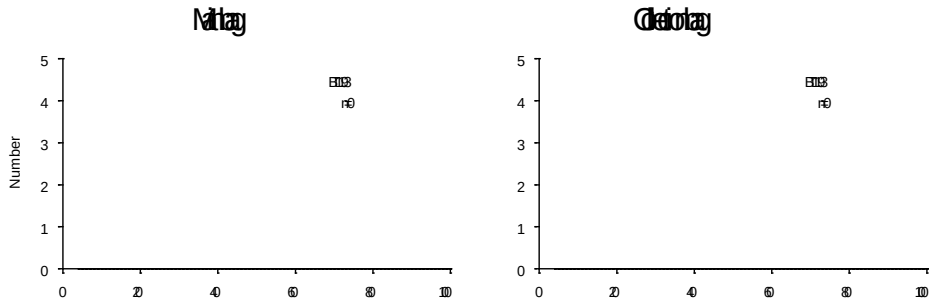

Fig. 8. Continued.

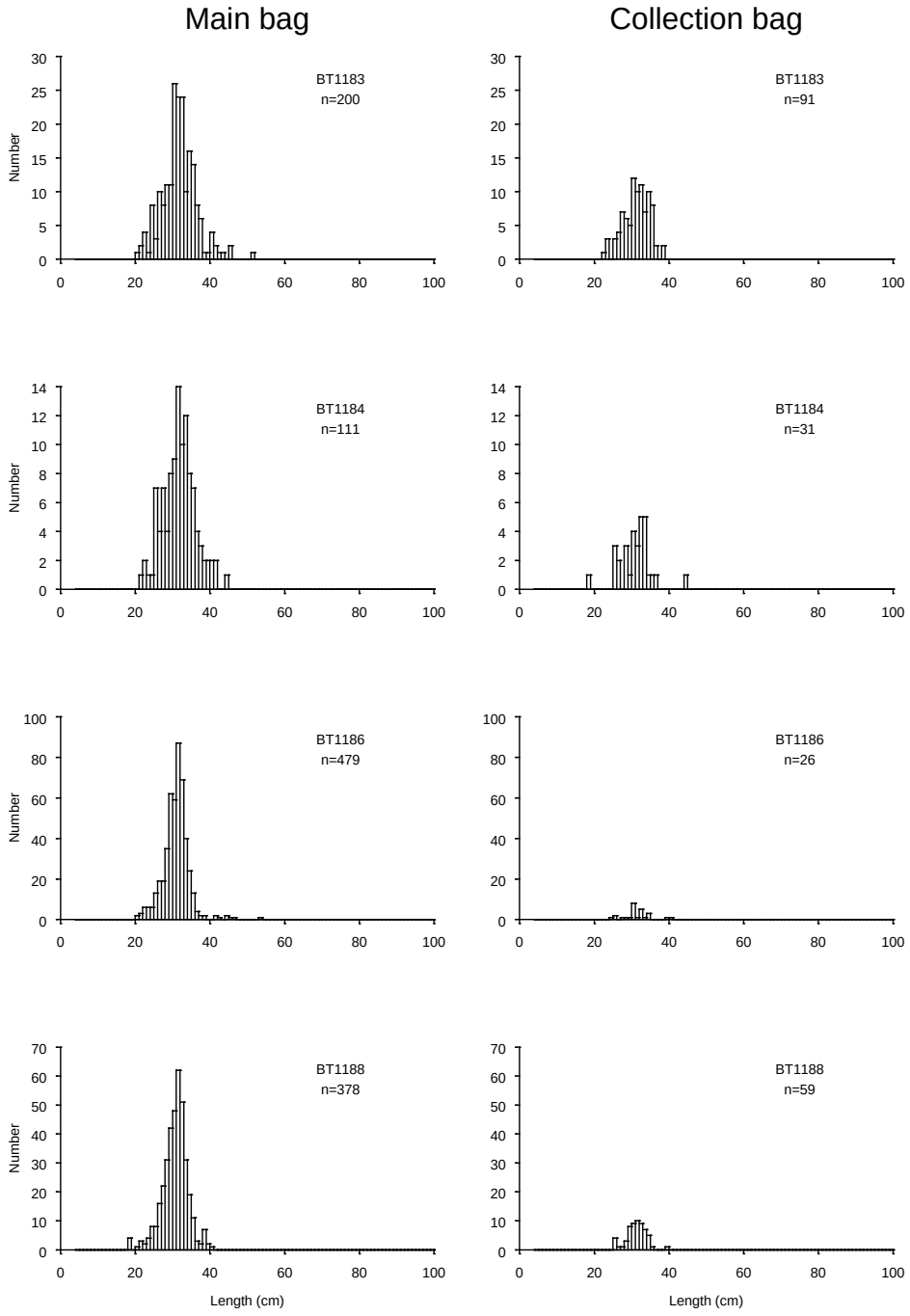

Fig. 8b. Area D. Length distribution of *M. paradoxus* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

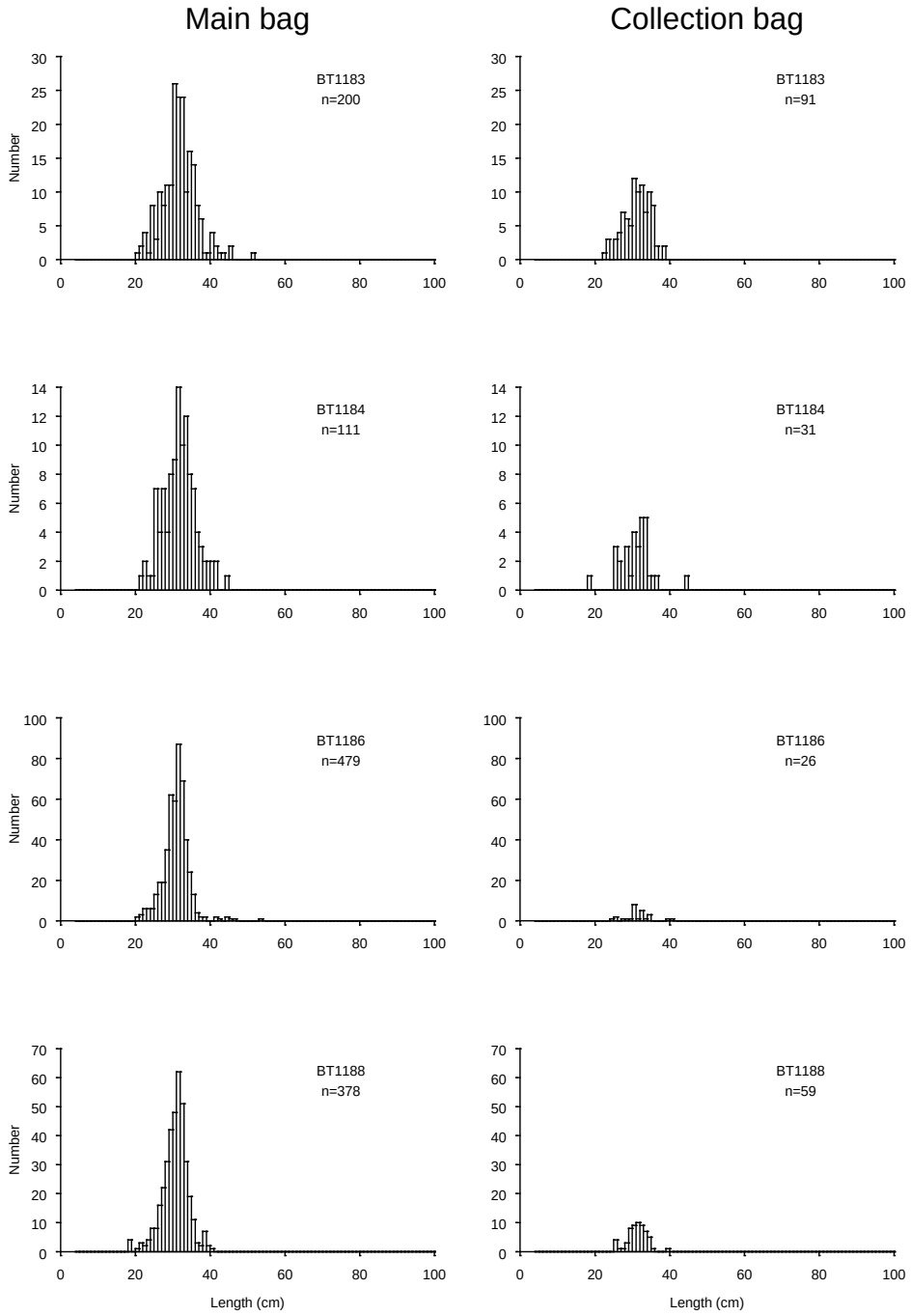

Fig. 8b. Continued.

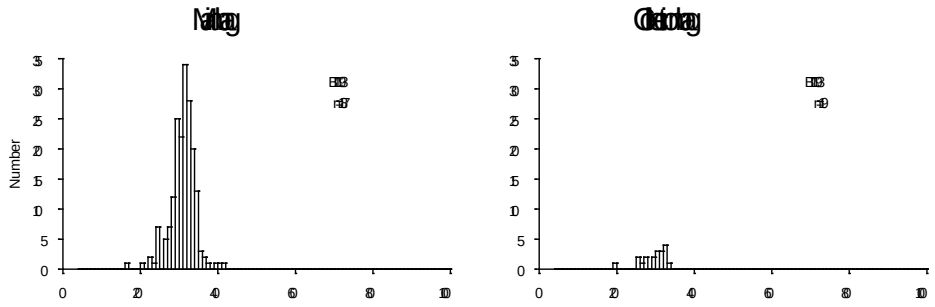

Fig. 8b. Continued.

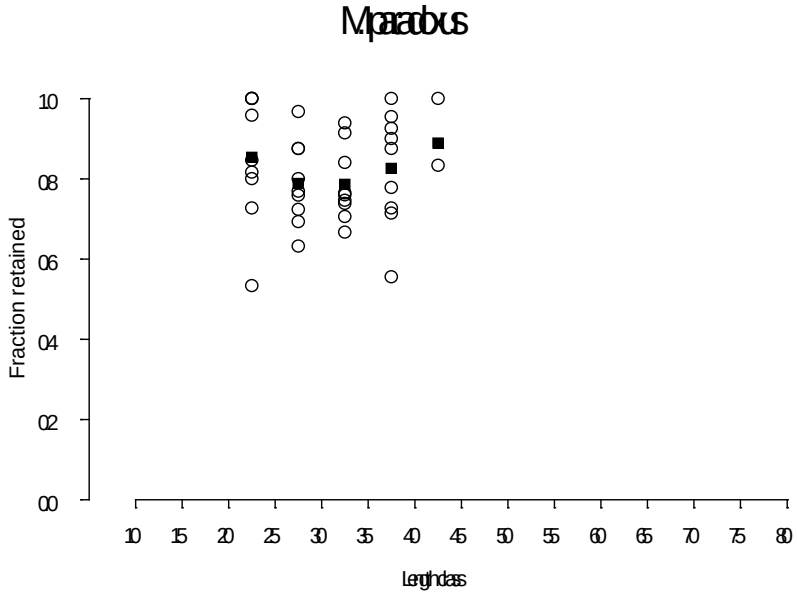

Fig. 8c. Area D. Fraction of the total catch (by number) that was retained in the main bag. Calculations were made for each 5 cm length interval. Only hauls with at least 5 fish in a length class are plotted. Open circles are individual haul observations, filled squares mean values.

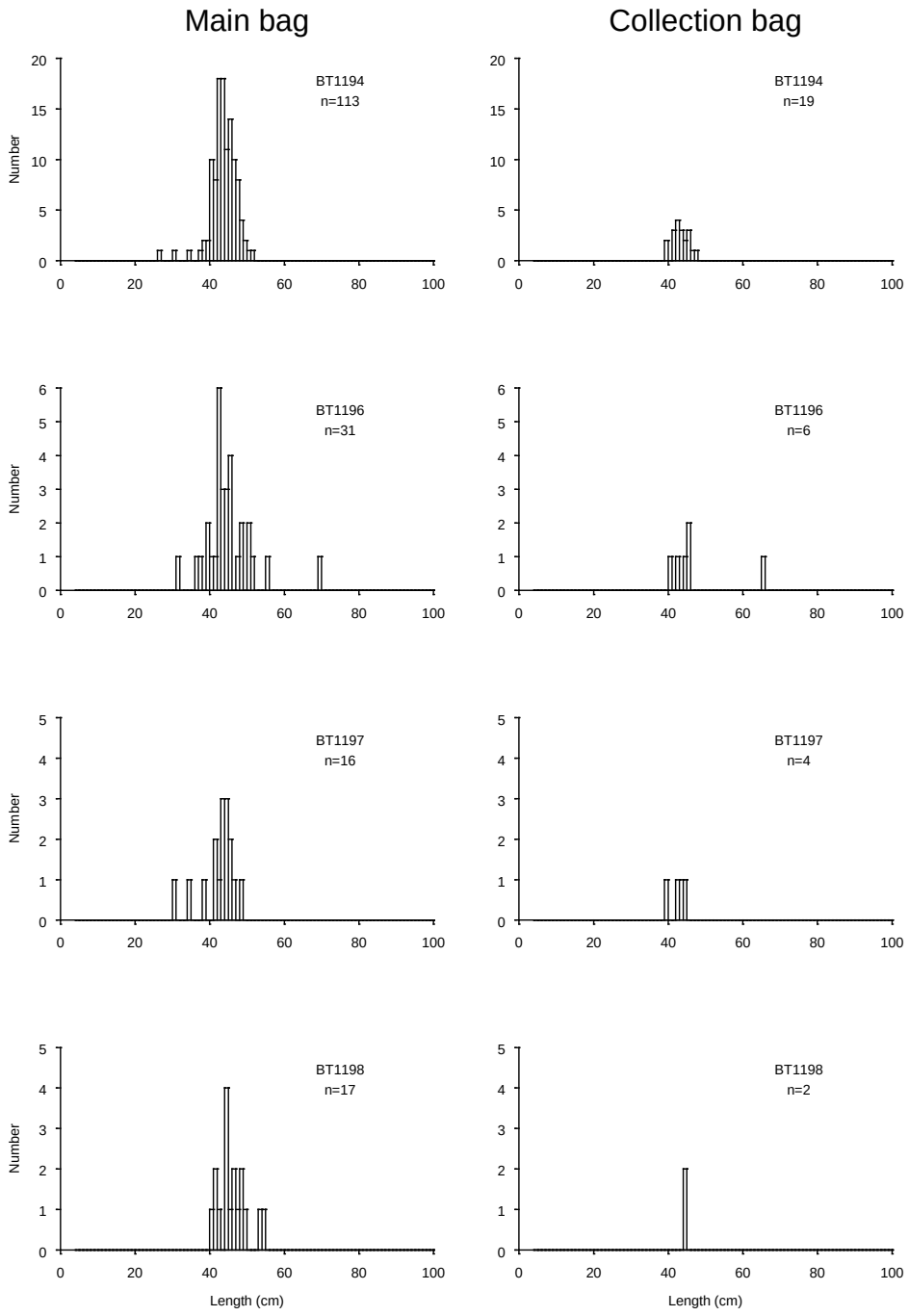

Fig. 9a. Area E. Length distribution of *M. paradoxus* caught in the main bag (left panel) and collection bag (right panel) for each of the hauls in this area.

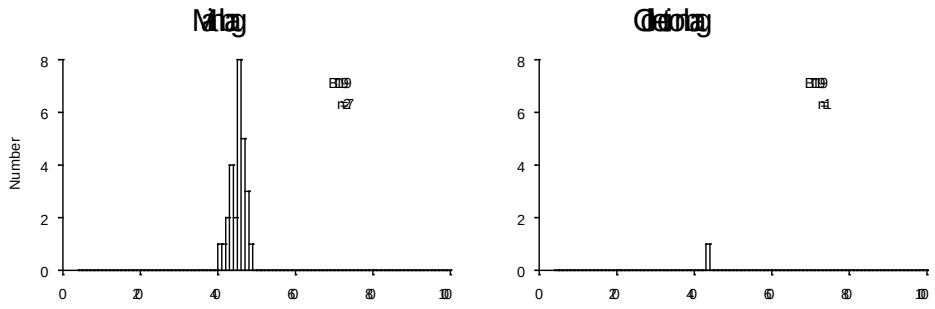

Fig. 9a. Continued.

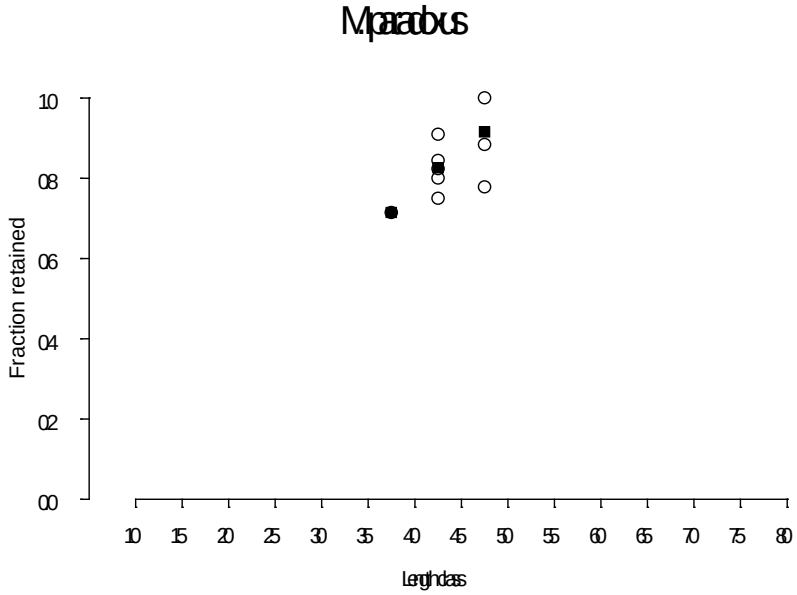

Fig. 9b. Area E. Fraction of the total catch (by number) that was retained in the main bag. Calculations were made for each 5 cm length interval. Only hauls with at least 5 fish in a length class are plotted. Open circles are individual haul observations, filled squares mean values.

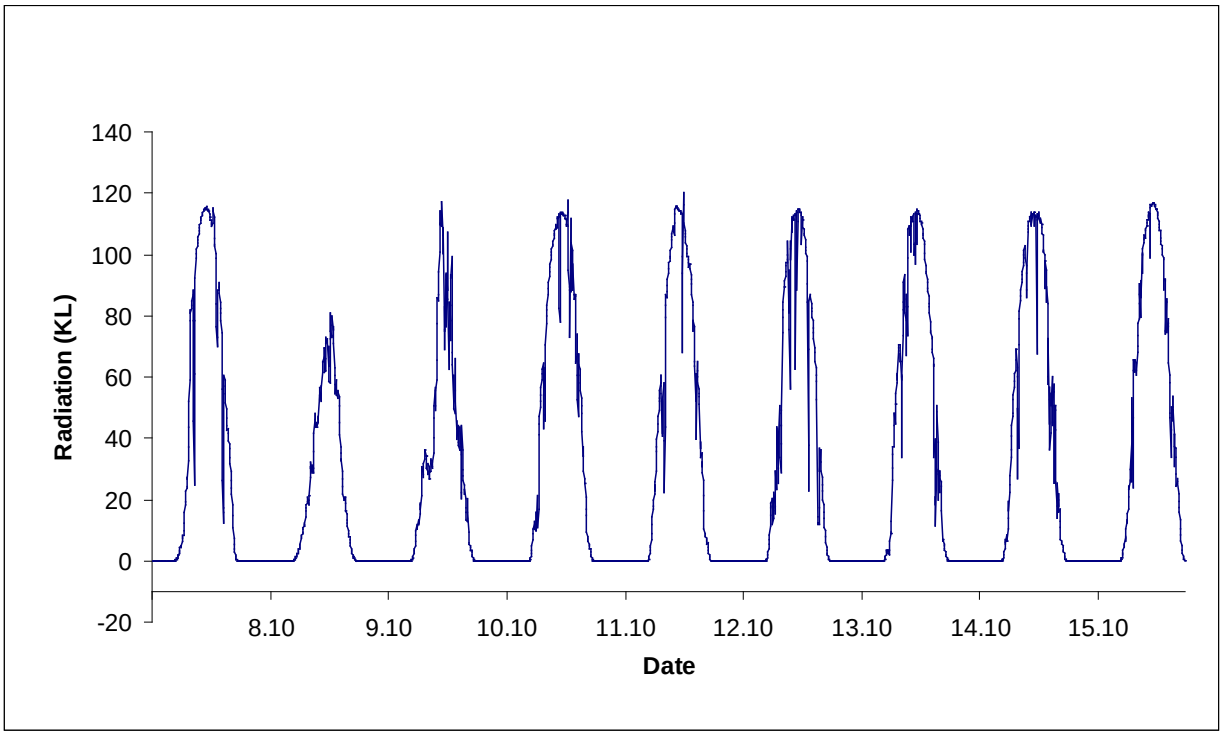

Fig. 10. Observed surface light intensity during the survey period.

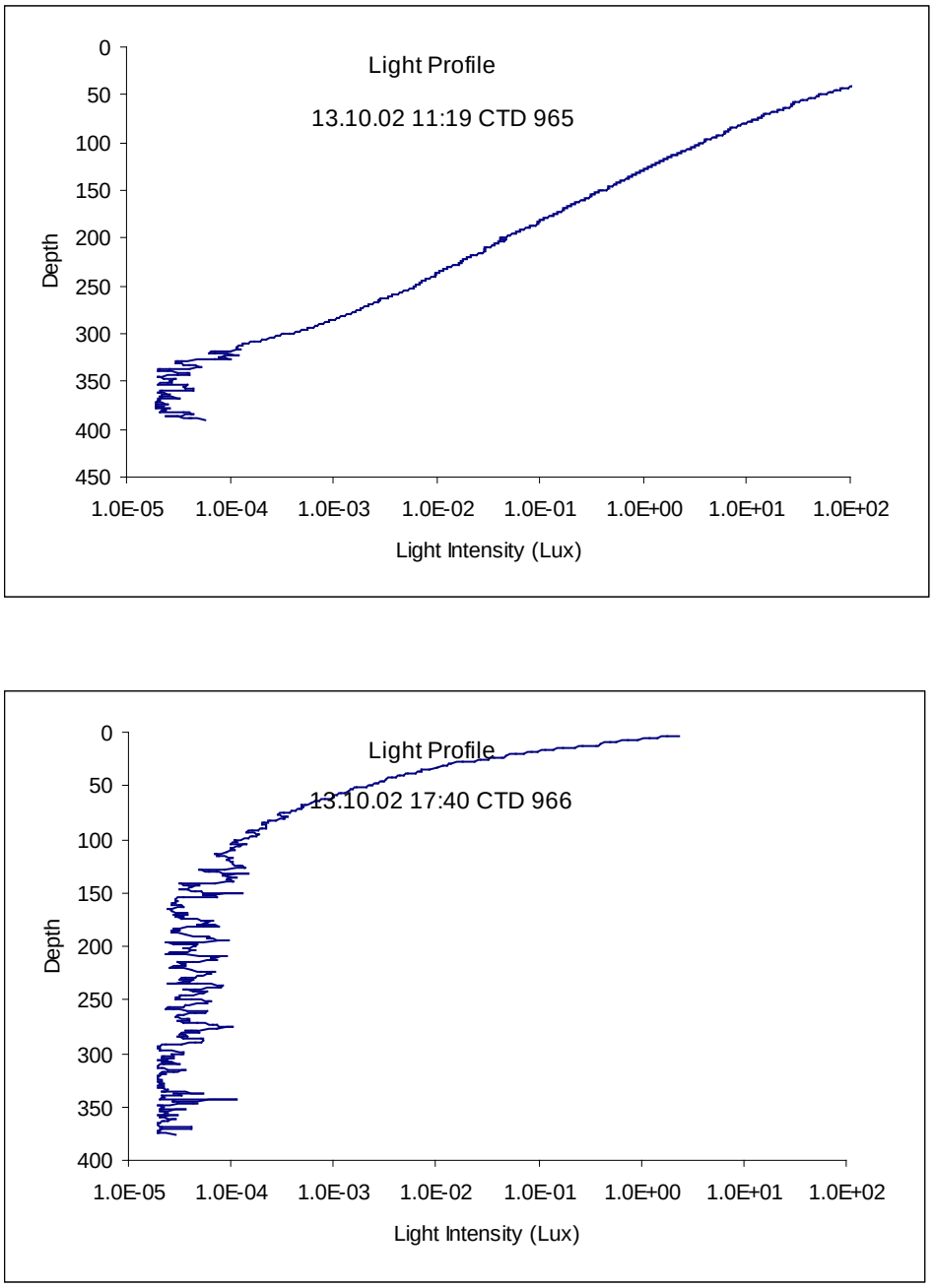

Fig. 11. Light intensity profiles from surface to bottom for daytime (upper graph) and night time (lower graph).Underwater Images

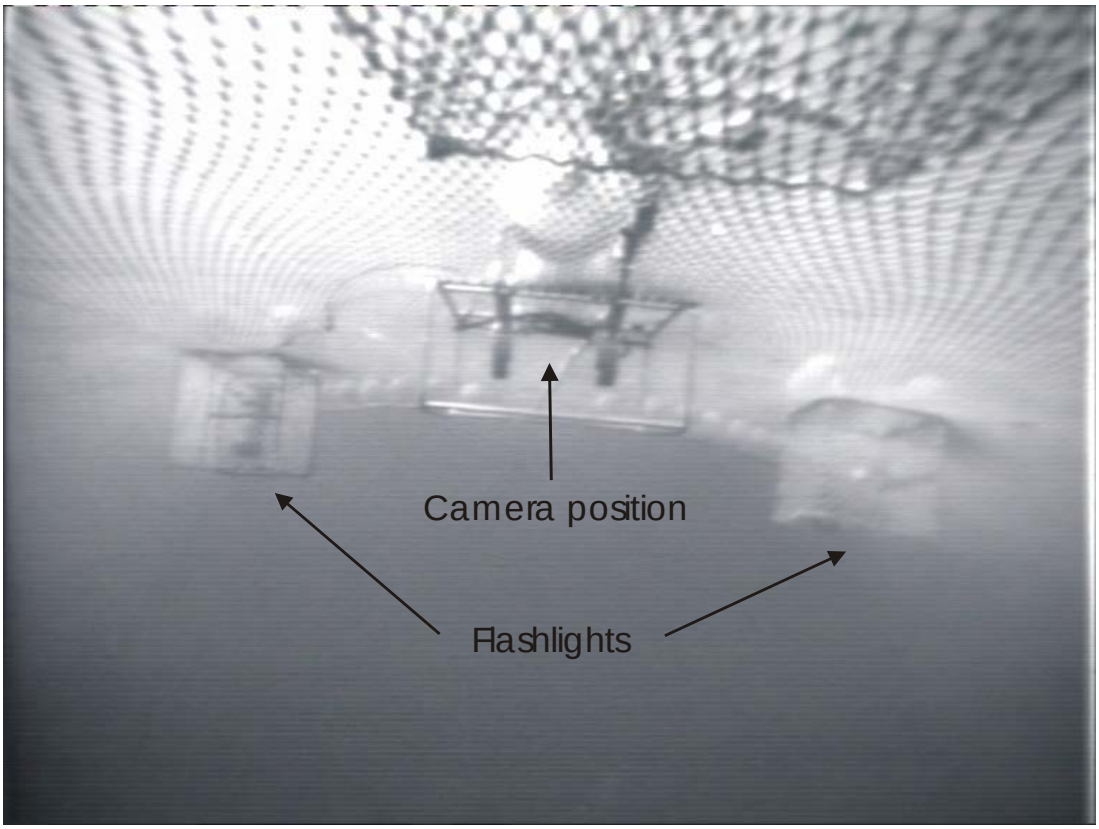

Image 1 Mounted camera and flashlights in the opening of the trawl.

Image 2 Indications of bioluminescence.

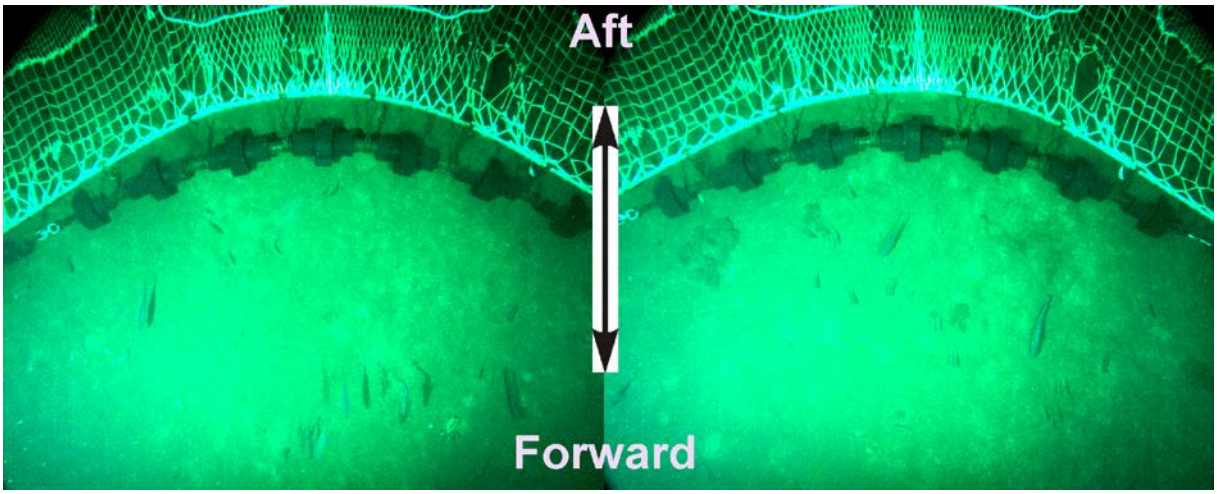

Image 3 Fish were mainly seen orientated away from the ground gear indicating that they try to avoid the trawl.

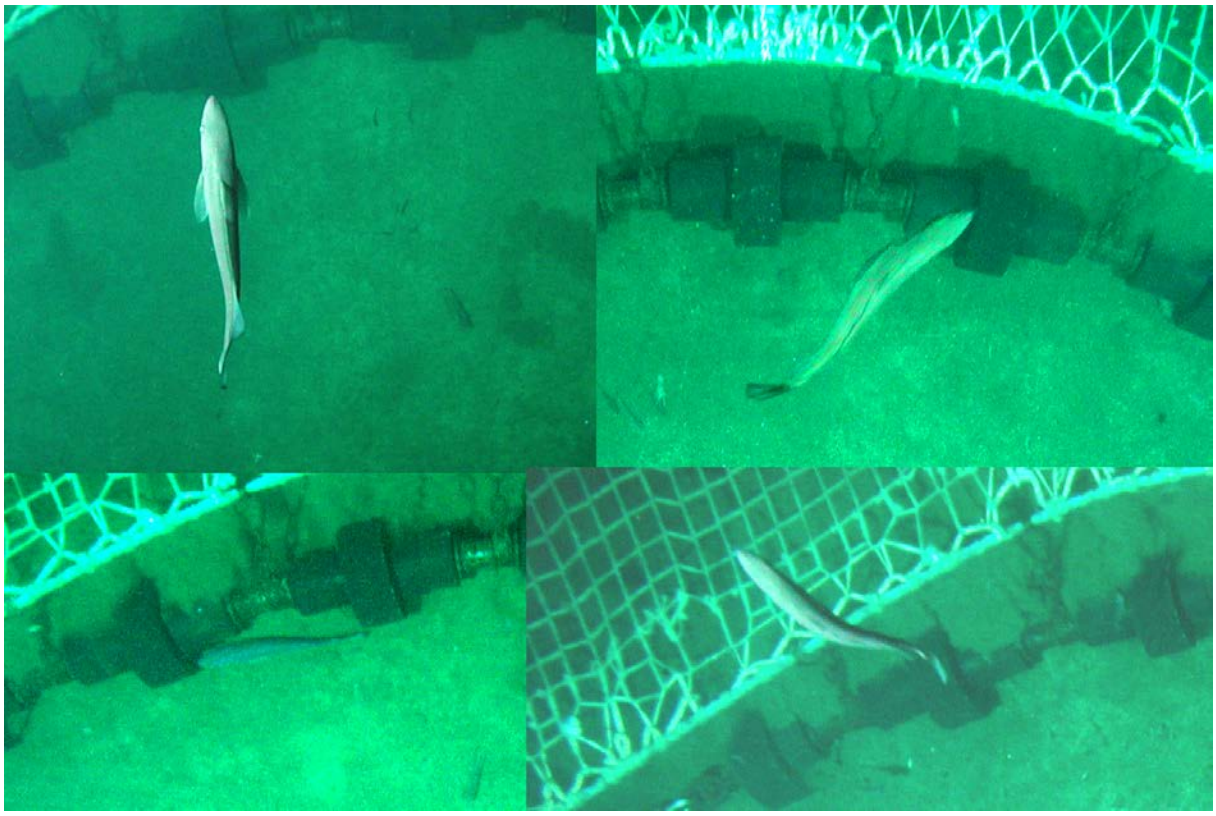

Image 4 Few hake were seen orientated towards the trawl.

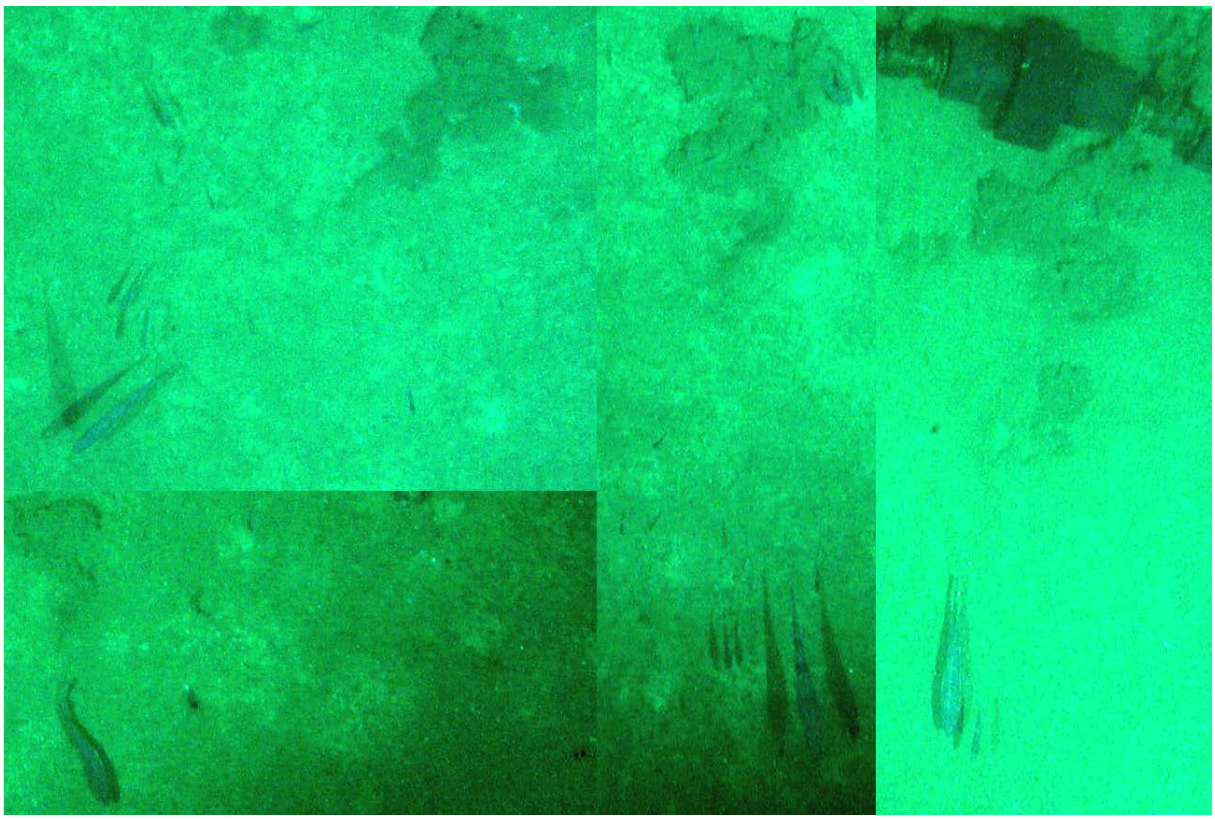

Image 5 Escape reaction of fish when the trawl is approaching.

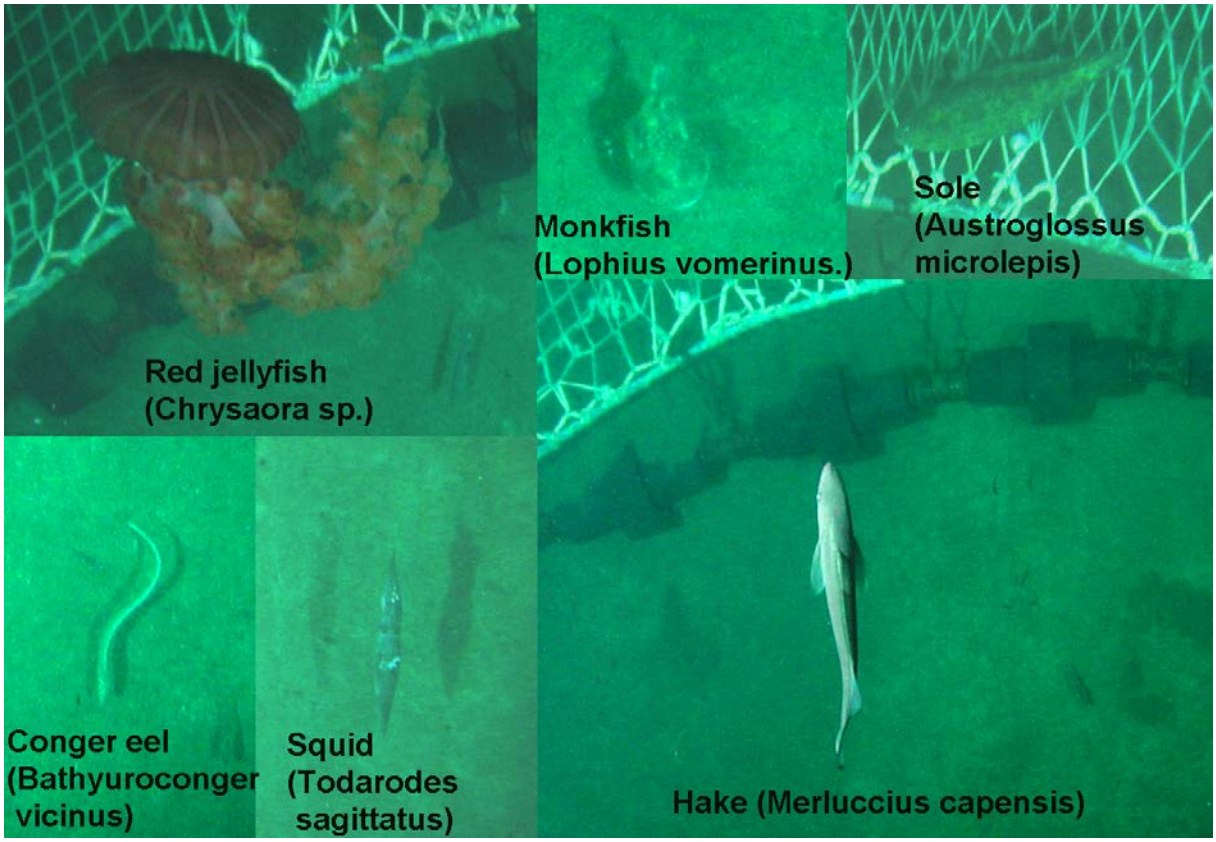

Image 6 Different species clearly identified on the images.

Appendix

Summary of trawl station information as well as Kg's of various species caught.

Station	1162		1163		1164		1166		1167		1169		1170		1171		1173	
Date	09.10.2002		09.10.2002		09.10.2002		09.10.2002		10.10.2002		10.10.2002		10.10.2002		10.10.2002		11.10.2002	
Start time (GMT)	07:01		08:13		10:39		14:35		06:37		10:41		12:18		13:35		06:32	
Start depth (m)	363		362		273		273		269		276		277		276		282	
Duration (min)	10		20		16		20		20		17		20		20		20	
Type of bag	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.
Merluccius paradoxus	33.35	2.55	25.15	2.45	1.85		1.48	1.27			2.64	6.36	5.65		2.91	0.53	1.21	1.16
Merluccius capensis	1.3		8.15		55.3	2.75	60.4	1.55	147.25	3.95	148.3	2.75	135.25	4.65	127.35	1.77	222.5	5.3
Lophius vomerinus	11.35	8.15	20.45	5.45	10.5	7.7	25.05	2.4	4.75	13.6	6.1	6.9	8.55	9.25	11.7	7.45	6.25	10.05
Genypterus capensis	0.73		2.48	1.01							1.46					0.33	2.9	
Trachurus capensis	3.05		9.00		0.69		0.49											0.71
Helicolenus dactylopterus	14.85	0.11	23.5		7.25		11.45	0.12	5.7	0.01	1.04	0.02	0.28	0.02	1.16	0.07	1.08	0.07
Beryx splendens	0.14								1.01		0.19		0.34					
Chlorophthalmus atlanticus	0.1		0.22	0.06			0.27		88	12.45	34	9.2	26.8	13.85	35.6	6.55	85.2	9.95
Caelorinchus simorhynchus	11.9	1.85	20.7	5.24	13.65	9.55	37.45	9	95	33.7	34.4	24.95	26.32	11.2	35.6	25.85	71.4	34.2
Deep sea mix	24.8	7.58	35.65	32.4	56.4	75.9	117.3	114.4	178	81.4	62	65.85	68	74.35	48.2	86.15	233.4	97.3
Epigonus telescopus	0.05	0.12	0.15	0.17										0.01				
Galeus polli	13.86	4.2	36.05	21.1	2.4	3.33	6.5	3.71	6.1	0.41	1.2	1.48	0.64	1.9	1.44	1.45	0.36	1.37
Hoplostethus cadenati	0.2		0.4	0.07														
Nezumia mirconychodon	2.58	2.32	19.8	8.2														
Notacanthus sexspinis	13.65	3.41	16.25	3.75														
Raja confundens	2.45	2.9	7.35		0.63													
Schedophilus huttoni	11.95		10.45		2.83													
Todarodes sagittatus	3.45		2.93		5.49		3.44		13.6	0.38	14.55	2.25	17	2.41	15.6	0.94	6.95	0.09
Ebinania costaecanarie			0.75	0.24														
Selachophidium guentheri			0.78	0.47														
Zeus capensis					0.06													
Squalius megalops						0.36												
Austroglossus microlepis							1.19											
Pterothrissus belloci							0.19											
Lepidopus caudatus									5.9									
Malacocephalus laevis										0.03				0.21				
Bassanago albescens										0.2	0.36							
Sepia australis										0.03								

Appendix

Station	1174		1176		1183		1184		1186		1188		1189		1190		1191	
Date	11.10.2002		11.10.2002		13.10.2002		13.10.2002		13.10.2002		14.10.2002		14.10.2002		14.10.2002		14.10.2002	
Start time (GMT)	08:37		13:44		09:03		10:30		14:57		06:38		08:24		09:45		11:21	
Start depth (m)	273		273		371		371		372		374		367		369		370	
Duration (min)	20		20		21		10		19		19		20		17		20	
Type of bag	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.
Merluccius paradoxus	0.57	0.28	1.17		47.55	20.5	27.05	6.7	94.95	4.8	74.1	12.25	53.4	17.4	79.85	23	31.75	11.7
Merluccius capensis	128.15	5.6	195	7.7					11.65		5		2.06		3.9		6.2	
Lophius vomerinus	6.6	18.6	4.75	20.27	10.4	10.95	7.6	1.93	15.05	22.85	8.1	13.3	1.17	8.55	2.6	26.15	0.68	14.2
Genypterus capensis						1.01	1.01		0.93		1.82		0.4				2.85	
Trachurus capensis			2.4															
Helicolenus dactylopterus	1.86	0.28	1.44	0.12	2.06		0.29		1	0.05	1.23	0.11	1.27		2.68		2.74	
Beryx splendens	0.21																	
Chlorophthalmus atlanticus	77.1	19.85	78.9	12.5													0.03	
Caelorinchus simorhynchus	47.1	57.9	186	45	3.71	2.46	2.1	0.23	6.4	1.3	4.18	1.38	8.7	1.69	10.55	3.4	4.96	2.53
Deep sea mix	63	76.75	77.1	117.15	2.25	72.05	21.75	28.5	22.05	38	17.15	29	28	39.15	30.2	44.6	18.25	19.85
Epigonus telescopus		0.03				0.06				0.05				0.06				
Galeus polli		0.55	0.42	0.07	2.87	6.85	1.92	1.31	0.27	0.38	0.21	0.39	0.2	0.53	0.82	0.4	0.24	0.39
Hoplostethus cadenati					5.1	1.84	5.27	0.73	0.47				4.08	0.27	7	0.43	4.94	0.37
Nezumia mirconychodon					6.51	21	4.2	2.99	4.65	4.11	2.15	5.25	6.8	6.1	6.6	6.4	3.8	3
Notacanthus sexspinis					0.14	0.07	0.24	0.04	0.25	0.1	0.67	0.45	0.87	0.62	1.07	0.14	0.23	0.29
Raja confundens										1.82		2.16	3.8					
Schedophilus huttoni							3.23								5			
Todarodes sagittatus	8.95	0.2	4.87	0.48	4.37	0.28	5.33		1.11				1.29	0.58	2.97	0.22	3.99	1.47
Ebinania costaecanarie					0.05	0.66	0.2	0.08	0.19				0.06	0.82	0.38	0.05	0.2	0.06
Selachophidium guentheri					0.03	0.15			0.06	0.05	0.1	0.11	0.05	0.08	0.05	0.19		0.17
Zeus capensis																		
Squalius megalops															0.67			
Austroglossus microlepis		0.72																
Pterothrissus belloci																		
Lepidopus caudatus	0.07																	
Malacocephalus laevis		0.03																
Centrolophus niger	2.02																	
Trachipterus jacksonsis	2.53		7.9															
Hyperoglyphe moselii		0.52		0.39														
Bathyuroconger vicinus		0.34		0.31														
Guentherius altivela		0.05																
Todaropsis eblenae					0.03													

Appendix

Station	1192		1193		1194		1196		1197		1198		1199	
Date	14.10.2002		14.10.2002		15.10.2002		15.10.2002		15.10.2002		15.10.2002		15.10.2002	
Start time (GMT)	12:46		14:13		03:25		06:06		07:36		09:26		11:18	
Start depth (m)	365		367		470		469		468		470		471	
Duration (min)	20		20		20		20		20		20		20	
Type of bag	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.	main	collect.
Merluccius paradoxus	43	19	37.35	3.39	64.1	10.4	20.25	5.25	8.2	2.45	11.85	1.17	16.35	0.57
Merluccius capensis		2.3												
Lophius vomerinus	0.7	2.15	2.95	26.15	6.50	24.75	1.78	12.75	7.4	13.5	3.5	4.43	3.45	22.05
Genypterus capensis	1.15		1.10								1.5	0.96		
Trachurus capensis														
Helicolenus dactylopterus	1.66		1.08		1.44		0.98		0.38		1		2.45	
Beryx splendens														
Chlorophthalmus atlanticus														
Caelorinchus simorhynchus	3.85	1.9	8.80	1.52	25.5	8.91	6.06	2.82	3.83	2.66	20.12	6.89	33	9.52
Deep sea mix	14.2	22.2	53.25	32.	6.78	7.05	5.78	18.51	7.22	22.16	27.6	10.44	15.3	11.73
Epigonus telescopus											1.6	3.2	4.5	7.82
Galeus polli	0.21	0.27	0.89		3.54	0.54	1.54	3.75	0.79	1.62	0.72	1.17	2.7	1.7
Hoplostethus cadenati	6.15	0.79	2.98		13.14	7.62	18.1	7.50	8.71	6.86	30.38	15.71	51.5	8.67
Nezumia mirconychodon	3.32	4.3	4.83	2.76	6.78	12.54	15.7	32.25	10.1	24.19	4.68	25.7	15.2	21.42
Notacanthus sexspinis		0.36	0.75	0.08	0.3		0.98	1.56	1.42	0.97	0.52		1	
Raja confundens					2.82	8.04	10.3						22.8	23.97
Schedophilus huttoni							5.25		5.65				34	
Todarodes sagittatus	2.83	0.27	1.53	0.41	8.3	2.1	3.36		3.2		3.6	4.68	11.1	
Ebinania costaecanarie		0.09	0.65	0.23			0.2				0.16			0.34
Selachophidium guentheri		0.1	0.05	0.07	6.87	5.31	6.80	5.61	5.76	4.84	5.8	2.25	2.4	0.17
Bassanago albescens										0.72	2.24			
Guentherius altivela														
Epigonus denticulatus					0.51	1.5	3.46	5.25	1.58	3.4				
Trachyrinchus scabrus					26.55	63.9	6.	17.55	10.46	22.5	29.2	33.08	82.5	78.63
Lithodes ferox					14.94	21.45	8.6	36.15	2.66	16.43		13.14	3.4	23.21
Myxine capensis			0.07			0.45								2.64
Chaceon maritae							2.							3.57
Caelorinchus matamae								1.56	1.08	0.88				
Curiraja parcomaculata												26.78		