ICES 1987 C.M. 1987/B:39

SYNERGISTIC EFFECTS OF DIFFERENT BAITS ON THE SAME HOOK IN THE LONGLINE FISHERY FOR HAKE (MERLUCCIUS MERLUCCIUS) AND TORSK (BROSME BROSME)

by

Jose M. Franco (*), Asmund Bjordal (**) and Svein Løkkeborg (**)

(*) Research Institute for Fish Science and Technology
(A.Z.T.I., A.B.)
Txatxarramendi Irla, Sukarrieta, Bizkaia
BASQUE COUNTRY

(**) Institute of Fishery Technology Research
Fishing Gear and Methods Division
P.O. Box 1964, 5024 Bergen
NORWAY

ABSTRACT

The effects of a combination of different baits on the same hook were tested in two different situations. A bait combination of sardine (Sardina pilchardus) and mackerel (Scomber scombrus) was used to catch hake (Merluccius merluccius) by semi-pelagique longline in the inshore fishery of the Basque Country. A different bait combination made with mackerel and squid was tried in a Norwegian bottom longline fishery. In both cases the bait combination showed significantly better catch rates than the traditional baits, although in the Norwegian longline trial mackerel and squid baited every second hook was at least as successful as the bait combination.

RÉSUMÉ

Les effects d'une combination de different appâts en la même hameçon ont eté verifiés en deux situations differents. On a utilisé une combinaison de sardine (Sardina pilchardus) et de maquereau (Scomber scombrus) pour capturer du merlu (Merluccius merluccius) au palangre demi-pelagique a la pêcherie artisanal du Pays Basque. Une differente combinaison de appâts, faite avec du maquereau et du calmar a eté eprouvé a la pêcherie norvegienne de palangre de fond. En l'un et l'autre cas la combinaison de appâts a montré des meilleurs rendements que les appâts traditionelles bien que a l'essai norvegien le maquereau et le calmar aux hameçons ont eu au moin, aussi de reussite que la combinaison de appâts.

Introduction

The type of bait is one of the main factors in the catching success in longlining (Bjordal, 1981) and together with bait size contributes to the species and size selectivity. High attractiveness and long durability on the hook are the determinants of a successful bait. Normally, the most used baits in longline fisheries are weak in some of these properties.

Fishermen have realized from experience that for some species a higher catch is obtained when different baits are used in combination instead of alone. Mackerel is the traditional bait used for torsk (Brosme brosme) and ling (Molva molva) in Norwegian bottom longline fishery, but in some areas a combination of mackerel and squid at a 4:1 ratio (every fifth hook is baited with squid) is used (Bjordal, 1983). Squid alone is regarded as a poor bait.

Similarly, sardine is the traditional bait used in hake (Merluccius merluccius) longline fishery in the Basque Country. Although in this case mackerel is considered as a poor bait for hake, it is used as bait with sardine on every second hook to catch red sea bream (Pagellus bogaraveo). In addition a combination of sardine and mackerel on the same hook is used by small longliners in the above-mentioned Basque fishery.

The principal aim of this study was to investigate the effectiveness of the sardine/mackerel bait combination on the same hook used in Basque fishery and test the same principle with a mackerel/squid combination in Norwegian longlining for torsk.

Materials and methods

Basque Country

This first part of the present study was carried out during the period 1/7 - 3/7 1986 in the Biskay Bay, on fishing grounds on the Basque continental shelf, where inshore longline fishing for hake takes place. The area is reserved for line fisheries (longlining and angling). The depth of the water where the longline was set varied between 90 and 130 m.

The longline used in the Basque Country is a semi-pelagic longline, designed to catch mainly hake. Attached sinkers and floats alternate along the line. The longline adopts a vertical zigzag, catching fish from the bottom up to 25 - 50 m. Gear parameters are specified in Table I.

Three fishing trials were performed from a small longliner (9 tonnes) which set 1400 hooks every day between 1530 and 1700 hours. All the trials were set in an approximate north-south course. The longline was hauled in by hand around 0630 hours the following morning.

Frozen sardine (Sardina pilchardus) and a bait combination made of frozen sardine and a fresh piece of filleted mackerel (Scomber scombrus) on the same hook were used as in commercial longlining (Fig. 1a).

From the 6 strings set every day, two were baited in a sequence of two hooks with sardine (termed Sardine B) followed by two hooks with the bait combination. The rest of the hooks were normally baited with sardine (termed Sardine A). A random position along the longline was assigned for those two strings (Fig. 2a).

Catch was recorded for every hook. Hooking position for hake was also noted.

Norway

Four fishing trials were carried out from a 28 foot vessel between the 4th and 11th of March 1987 on torsk inshore fishing grounds (about 8 nm west of Bergen). The depth of water varied between 60 and 180 m.

A standard bottom longline (Table I) containing 1000 hooks separated in 10 strings was used in the experiment. The longline was set between 0800 and 1000 hours and retrieved by hydraulic hauler on the same course two and a half hours later. Trials 1, 2 and 4 were set in south-north course and trial 3 in west-east direction.

Three different types of bait were used in the fishing trials (Fig. 1b): a piece of filleted frozen mackerel (24.3 ± 4.7 g); a hoop of frozen squid (13.9 ± 3.4 g); and a bait combination of about half of each of the former baits on the same hook (21.3 ± 3.1 g).

Each string was divided into two cells of 50 hooks, each containing two different bait arrangements. The design of the experiment consisted of two different comparison trials repeated twice: mackerel (Bait A) against the bait combination of mackerel and squid on the same hook (Bait C) and mackerel and squid baited on every second hook (Bait B) against the bait combination on the same hook (Bait C) (Fig. 2b).

Data from every hook was collected using a portable MICRONIC data terminal (Floen, 1985), specifying catch (cod, haddock, torsk, ling and a pool of other species), discarded fish and bait status (missing hook, bait loss, bait remnant and intact bait). Total length and hooking position for all the catch were also recorded.

Results

Basque Country

Table IIa shows the relevant points of the semi-pelagic long-line used by small longliners: a long soaking time and a very poor catch of hake, the main species, when compared with the overall catch, which included less valuable species such as mackerel (Scomber scombrus), scad (Trachurus trachurus) and blue whiting (Micromesistius poutassou).

The results from the 1980 hooks used to test the preference between sardine and the bait combination are shown in Table III. The bait combination gave significantly better catch rates for hake (121.7%, $P<0.001$) and also for other species (59.6%, $0.01>P>0.001$), without showing any selectivity (chi-square test, $X = 1.149$, $P>0.05$), when compared with Sardine A. The values decrease for hake (70.0%, $0.05>P>0.01$) and increase for the pool of other species (93.0%, $P<0.001$) when the bait combination was compared with Sardine B.

Table III also shows the results of comparing the hooking rates for Sardine A and Sardine B (the same traditional bait but in different arrangement) to test the possible influence of the bait combination (containing pieces of mackerel) on the neighbouring hook baited with sardine (Sardine B). The differences in catch rate (for hake, pool of other species and total catch) were not significant.

From the 670 specimen of hake examined, 84.9% were hooked in the mouth, 12.8% in the oesophagus and 2.2% elsewhere.

Norway

Table IIb shows basic data from the fishing trials. Only torsk were caught in sufficient number to allow statistical analysis.

Table IVa shows that when the bait combination of mackerel and squid on the same hook (Bait C) was tested against mackerel (Bait A), the former gave a much better catch rate for torsk (39.6%, 0.01>P>0.001 chi-square test). Mackerel presented a higher proportion of bait loss (37.2%, P<0.001) and a smaller of bait remnant and intact bait (97.2% and 19.3%, P<o.001 and 0.05>P>0.01 respectively) (Table IVb).

The average lengths were 47.3 cm and 47.7 cm for torsk caught on mackerel and on the bait combination respectively. There was no significant difference (ANOV, F(1,294)=.126, P>0.05). Length distributions are shown in Fig. 3a.

There was no significant difference between the bait combination and mackerel, neither for torsk (-19.1%, P>0.05) nor the pool of other fish (-34.5%, P>0.05) when mackerel and squid in a 1:1 ratio (Bait B) was compared with the bait combination (Bait C). Nor was there any significant difference between mackerel and squid (Table Va).

Bait status results between mackerel and the bait combination remained similar to the former comparison (Table Vb). On the other hand, squid gave higher frequency of intact bait but less of remnant bait than the bait combination.

In Fig. 3b. are shown the length distributions for torsk caught on mackerel, squid and the bait combination. The average lengths were 49.2 cm, 50.9 cm and 49.5 cm respectively. As in the former trials, there was no significant difference (ANOV, F(2,247) = .829, P = .4375).

Torsk caught in trial 4 (91 m mean depth) were significantly bigger than in trials 1 (121 m) and 2 (133 m) (ANOV, F = 3.57 P = .0290; Fig.4). Trial 3 was ignored in this calculation because was set in a west-east course, overlapping the other three trials.

Torsk exhibited a 38.8% of fish hooked in the mouth, 61.2% in the oesophagus and none of the 487 fish examined was hooked somewhere else.

Discussion

The use of a combination of different baits for catching hake and torsk with different gear and in different geografical situations presents slight different results. This could could be due to the fact that both species seem to have different feeding behaviour, especially as far as bait attack and hooking behaviour is concerned. The different hooking position for both species strongly supports this.

Basque Country

Although the total catch rate rose to around 15%, hake catches were very low in the Basque inshore fishery. The gear was far from saturation. Normally longlines baited with sardine gave absolute frequencies of 55.1% hooks with bait (remnant and intact) and 35.5% of bait loss after retrieving (Franco, unpublished results). On the contrary, the area suffers an overexploited fishery, the same as other fisheries fishing on the same stock (Lopez-Veiga, 1979).

The use of the bait combination of sardine and mackerel on the same hook increased the hake hooking rate up to 7.7%, improving the catch in a 121.7%. There was no species selectivity, and the catch of less valuable species was also increased (93%).

The piece of mackerel from the bait combination could provoke a possitive effect on the adjacent hook baited with sardine, and besides it is known (Scud, 1975; Fernø et al, 1976) that a hooked fish increase the attractiveness of the neighbouring hooks, so we would expect a higher catch rate for the sardine adjacent to the bait combination than for the sardine alone. Whether mackerel from the bait combination provoked any

possitive effect on the neighbouring hook baited with sardine is difficult to say due to the relative small size of the sample but appeared to be much less important than the synergistic effect produced when baited with sardine on the same hook. In a previous study (Franco, unpublished results), when mackerel and sardine in a 1:1 ratio were compared with sardine alone, mackerel gave a much better catch rate than sardine (80.4%, $P < .001$) for blue whiting (Micromesistius poutassou), another gadoid species, while there was no significant difference (8.8%, $P = .756$) between the sardine alone and the sardine combined with the mackerel (hake was caught in too small quantity to allow statistical analysis.

The synergistic effect of mackerel and sardine on the same hook could be related to bait loss prevention. Mechanical bait loss appears to be high for sardine since it is hooked through the eye, and in addition the soaking time is very long. On the other hand, escape from the hook is very high in longline (Johnstone and Hawkins, 1981). The piece of mackerel on the hook (see Fig. 1a) seems to produce a firmer bait, decreasing the bait loss.

Although it is time consuming, the use of the bait combination is profitable for small longliners that perform the baiting on the mainland the day before. It is not feasible for longliners that bait the hooks as they shoot the line.

Norway

The results obtained for torsk in the Norwegian longlining suggests different conclusions. Although the bait combination was almost 40% more successful than mackerel alone, which is the traditional bait, that increase was nullified when the mackerel was associated with squid on every second hook. There was no appreciable difference between the mackerel and squid catch rates, although Bjordal (1983) found a 9% difference between mackerel and squid catch rates, in favour of the later, when combined in a 4:1 ratio.

Size selectivity among the three types of bait was not detected.

The results clearly shows that the synergistic effect between mackerel and squid for catching torsk was accomplished independently of whether they were on the same hook or on adjacent hooks in a 1:1 ratio. The presence of squid appears to increase the attractiveness towards the baited hooks but it seems than other factors such as size and shape of the bait are greatly involved in the catching success.

The use of squid in combination with mackerel appears worthwhile in hand baiting, although due to the expense of the former, other than the 1:1 ratio should be tried.

Acknowledgements

We are greatful to the skippers and crews of "Lina" from Armintza (Basque Country) and "Tresness" from Syltøy (Norway) for their cooperation. This study was realizable in part thanks to a grant given by the "Research Institute for Fish Science and Technology, A.Z.T.I., A.B. of Sukarrieta (Basque Country).

References

BJORDAL, A. (1981). Engineering and fish reaction aspects of longlining. A review. Coun. Meet. int. Coun. Explor. Sea, 1981 (B:35), 1-22.

BJORDAL, A. (1983). Effect of different long-line baits (mackerel, squid) on catch rates and selectivity for tusk and ling. Coun. Meet. int. Coun. Explor. Sea, 1983, (B:31), 1-9.

FERNØ, A., JOHANNESSEN, A., OLSEN, K.L., SOLEMDAL, P., TIL-

SETH, S. and VALDEMARSEN, J.W. (1976).Fish behaviour in relation to long lines observed by TV. Coun. Meet. int. Coun. Explor. Sea, 1976 (B:38): 7 pp.

FLOEN, S. (1985). Experimental design for data collection and analysis in comparative longline fishing trials. Meeting in Bergen, May 28-31, 1985 of the ICES Ad Hoc WG on Artificial Bait and Bait Attraction.

JOHNSTONE, A.D.F. and HAWKINS, A.D. (1981). A method of testing the effectiveness of different fishing baits in the sea. Scottish Fisheries Information Pamphlet, 3: 7 pp.

LOPEZ VEIGA, E.C. (1979). Hake fishery off Galicia (NW Spain): an example of a very overexploited fishery. Inv. Pesq., 43(1): 161-170.

SCUD, B.E. (1978). Factors affecting longline catch and effort: III. Bait loss and competition. International Pacific Halibut Commission, Scientific Report, 64:26-66.

Table I. Gear parameters of Basque semi-pelagic longline and Norwegian bottom longline.

	Basque longline	Norwegian longline
MAIN LINE		
Mat.	Polyamide monofilament	Spun polyester
Diam.	1.5 mm	4 mm
Length	620 m per string	450 m per string
SNOOD		
Mat.	Polyamide monofilament	Spun polyester-nylon
Diam.	0.8 mm	1.5 mm
Length	0.8 m	0.5 m
Mount.	Swivel	Knot
HOOK		
Type	Round Type	Mustad-Harwich
Quality	530	7295
Size	No. 2/0	No. 7
Charact.	flattened, tinned	flattened, tinned
HOOK SPACING	2.7 m (230 hooks p. string)	4.5 m (100 hooks p. string)

Table IIa. Basic data from experimental trials performed in the Basque Country.

Trial	Date	Mean Depth (m)	Mean Soak.time (hrs)	No of hooks	Catch No of fish (*)	Catching rate % (*)
1	010786	110	16.1	1400	176 (67)	12.6 (4.8)
2	020786	110	16.3	1400	209 (47)	14.9 (3.4)
3	030786	110	16.5	1400	150 (67)	10.7 (4.8)

(*) Catch and catching rate for hake are indicated in brackets.

Table IIb. Basic data from experimental trials performed in Norway.

Trial	Date	Mean Depth (m)	Mean Soak.time (hrs)	No of hooks	Catch No of fish (*)	Catching rate % (*)
	040387	121	3.6	979	187 (164)	19.1 (16.8)
2	090387	133	3.5	979	162 (131)	16.5 (13.4)
3	100387	121	3.8	988	161 (123)	16.3 (12.4)
4	110387	91	4.1	988	143 (127)	14.5 (12.9)

(*) Catch and catching rate for torsk are indicated in brackets.

Table III. Catch rates for Sardine A, Sardine B and the Bait comb. in the Basque longline.

	Hake	Others	Total catch	Hooks
Sardine A				
Number	23	52	75	660
Catch rate	3.5	7.9	11.4	
Bait comb.				
Number	51	83	134	660
Catch rate	7.7	12.6	20.3	
Sardine B				
Number	30	43	73	660
Catch rate	4.5	6.5	11.1	
Sardine A / Bait comb.				
Diff. (%)	121.7	59.6	78.7	
Prob.	P<.001	.01>P>.001	P<.001	
Sardine B / Bait comb.				
Diff. (%)	70.0	93.0	83.6	
Prob.	.01>P>.001	P<.001	P<.001	
Sardine A / Sardine B				
Diff. (%)	30.4	-17.3	-2.7	
Prob.	P>.05	P>.05	P>.05	

Table IVa. Catch rates for Mackerel and the Bait combination in the Norwegian longline.

	Torsk	Others	Total catch	Hooks
Mackerel				
Number	124	22	146	985
Catch rate	12.6	2.2	14.8	
Bait comb.				
Number	171	32	203	973
Catch rate	17.6	3.3	20.9	
Diff. (%)	39.6	47.2	40.8	
Prob.	.01>P>.001	P>.05	P<.001	

Table IVb. Bait-status (relative percentages) for Mackerel and the Bait comb. in the Norwegian longline.

	Loss	Remnant	Intact	Hooks
Mackerel				
Number	460	135	208	803
Relat. perc.	57.3	16.8	25.9	
Bait comb.				
Number	256	236	220	712
Relat. perc.	36.0	33.1	30.9	
Diff. (%)	-37.2	97.2	19.3	
Prob.	P<.001	P<.001	.05>P>.01	

Table Va. Catch rates for Mackerel-Squid (1:1) and the Bait comb. in the Norwegian longline.

	Torsk	Others	Total catch	Hooks
M-S (1:1)				
Number	134	29	163	998
Catch rate	13.4	2.9	16.3	
Mackerel				
Number	71	15	86	489
Catch rate	14.5	3.1	17.6	
Squid				
Number	63	14	77	509
Catch rate	12.4	2.8	15.1	
Bait comb.				
Number	117	20	137	996
Catch rate	11.7	2.0	13.8	
M-S (1:1) / Bait comb.				
Diff. (%)	-12.5	-30.9	-15.8	
Prob.	P>.05	P>.05	P>.05	
Mackerel / Bait comb.				
Diff. (%)	-19.1	-34.5	-21.8	
Prob.	P>.05	P>.05	P>.05	
Squid / Bait comb.				
Diff. (%)	-5.1	27.0	-9.1	
Prob.	P>.05	P>.05	P>.05	
Mackerel / Squid				
Diff. (%)	-14.8	-10.3	-14.0	
Prob.	P>.05	P>.05	P>.05	

Table Vb. Bait-status (relative percentages) for Mackerel-Squid (1:1) and the Bait comb. in the Norwegian longline.

	Loss	Remnant	Intact	Hooks
M-S (1:1)				
Number	225	58	343	626
Relat. perc.	35.9	9.3	54.8	
Mackerel				
Number	152	45	102	299
Relat.perc.	50.8	15.1	34.1	
Squid				
Number	73	13	241	327
Relat. perc.	22.3	4.0	73.7	
Bait comb.				
Number	128	178	323	629
Relat. perc.	20.3	28.3	51.4	
M-S (1:1) / Bait comb.				
Diff. (%)	-43.4	205.4	-6.3	
Prob.	P<.001	P<.001	P>.05	
Mackerel / Bait comb.				
Diff. (%)	-60.0	88.0	50.5	
Prob.	P<.001	P<.001	P<.001	
Squid / Bait comb.				
Diff. (%)	-8.8	611.8	-30.3	
Prob.	P>.05	P<.001	P<.001	
Mackerel / Squid				
Diff. (%)	-56.1	-73.6	116.0	
Prob.	P<.001	P<.001	P<.001	

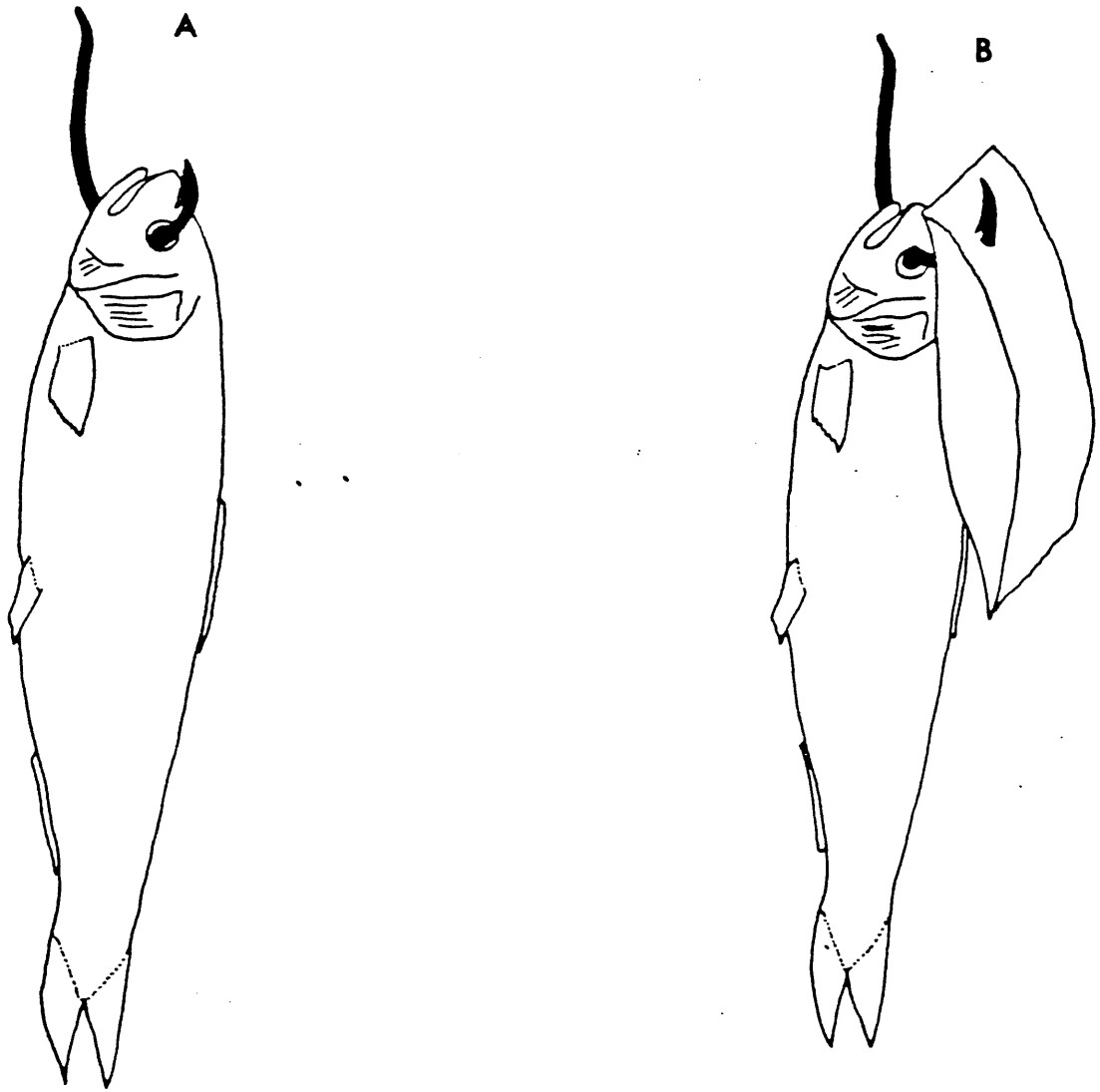


Fig. 1a. The two types of baits used in the Basque longline trials.
A = Sardine (Sardina pilchardus) alone.
B = Sardine and mackerel (Scomber scombrus) on the same hook.

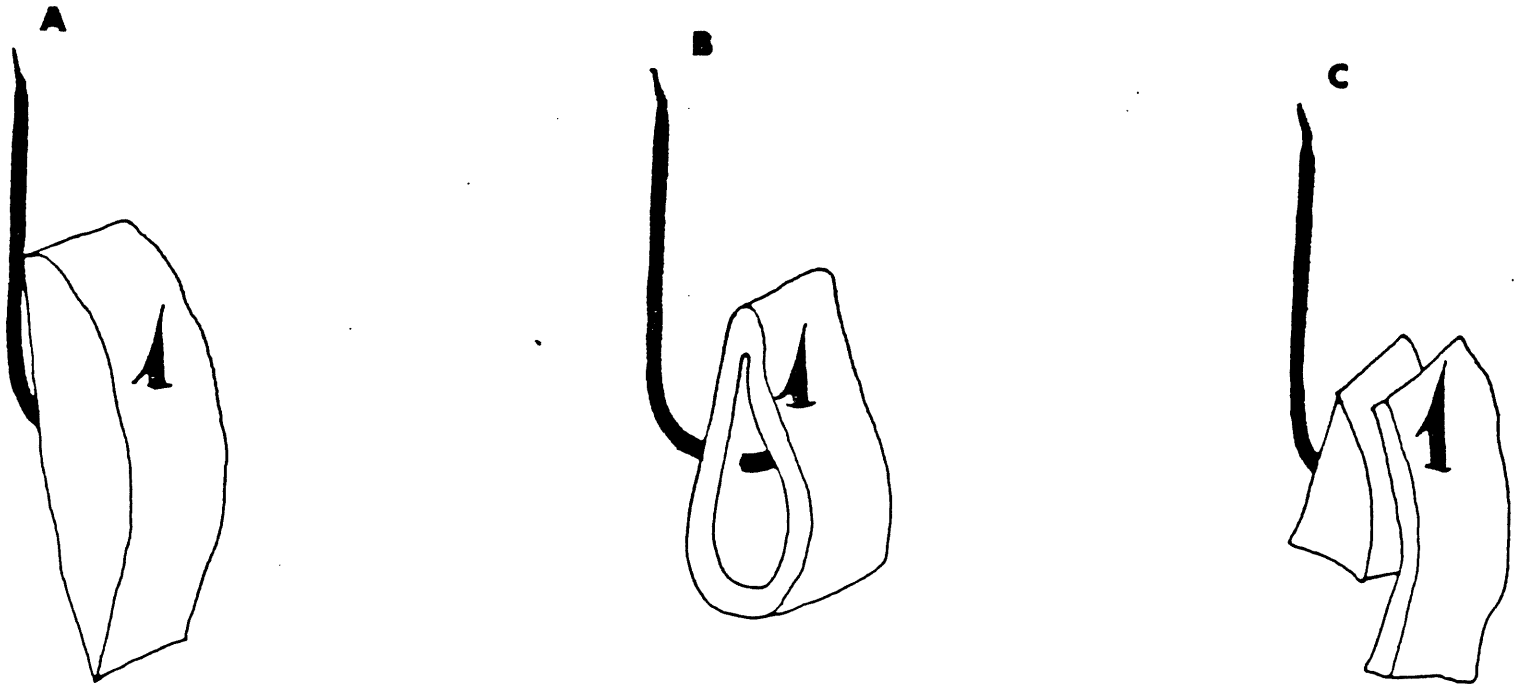
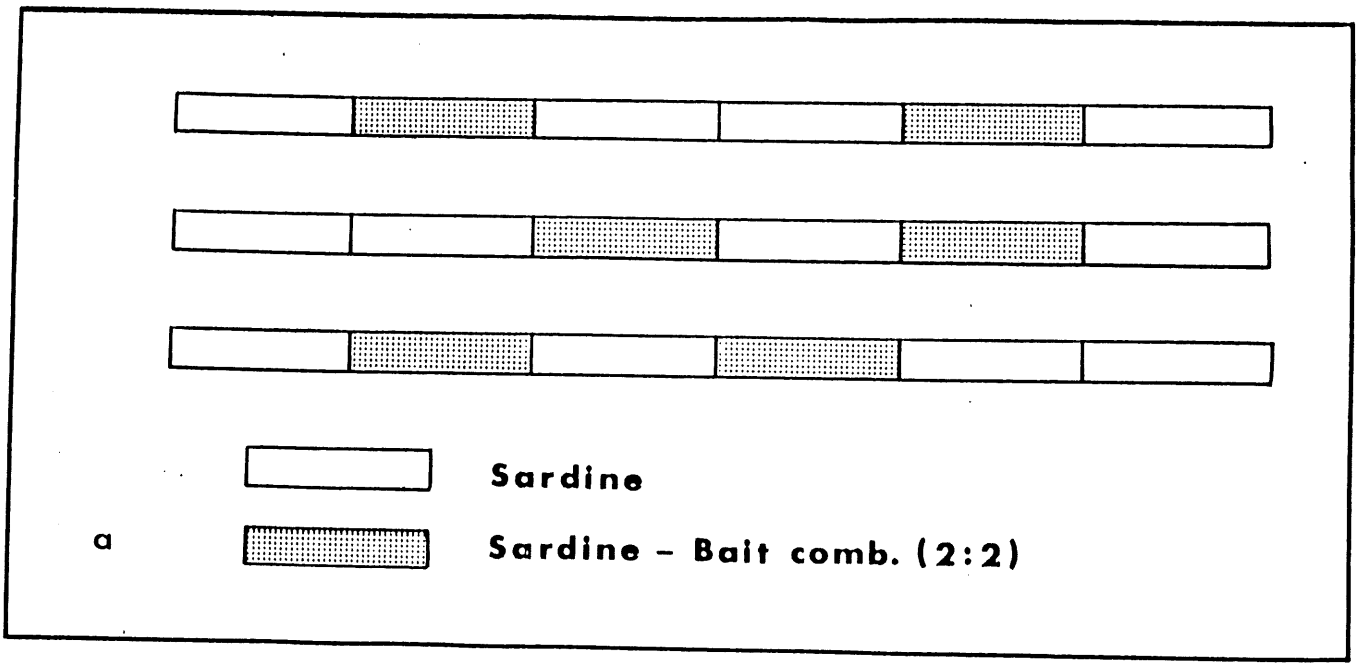


Fig. 1b. The three types of baits used in the Norwegian longline trials.
A = Mackerel alone.
B = Squid alone.
C = Mackerel and squid on the same hook.



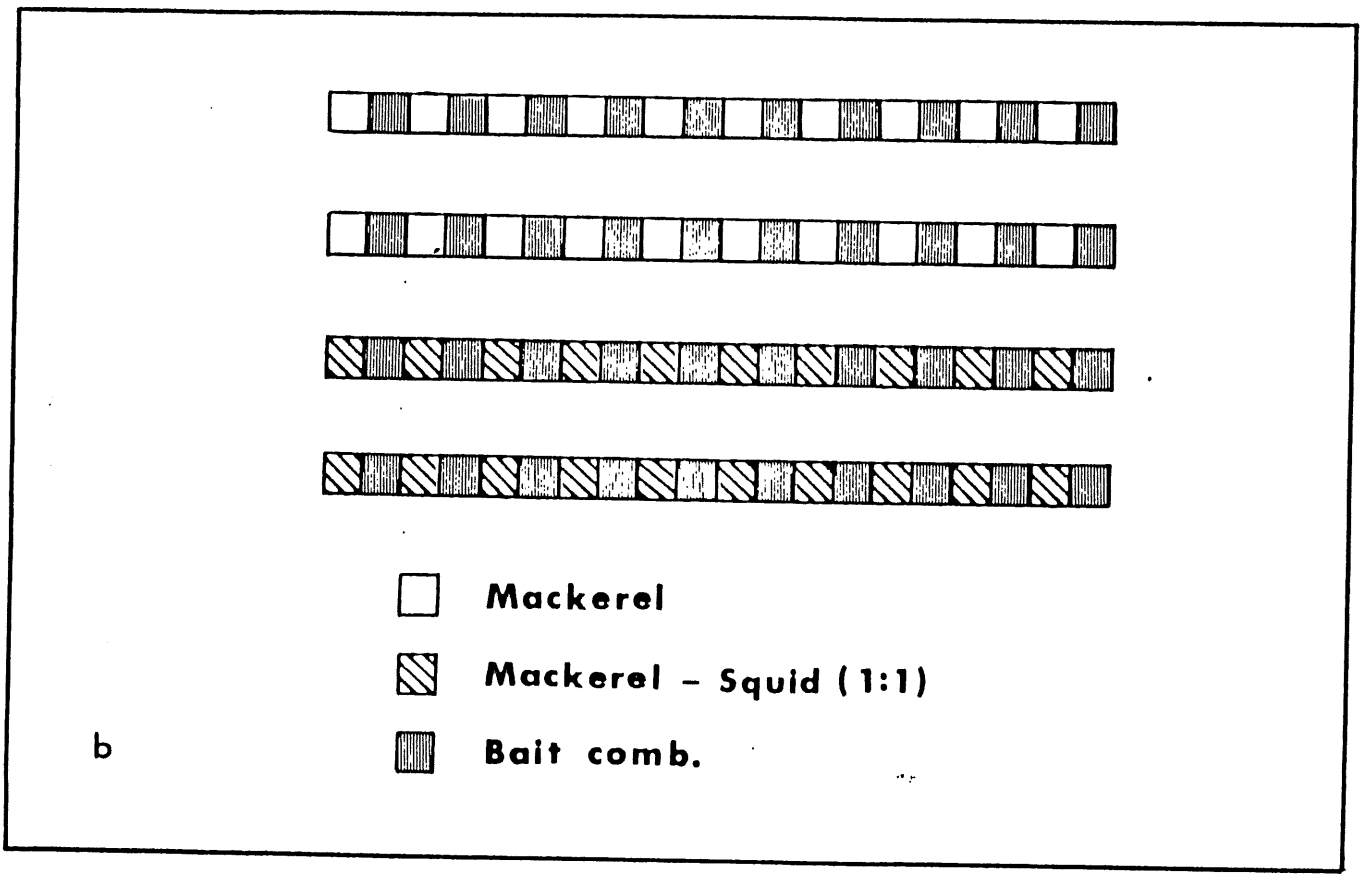


Fig. 2. Experimental design of the fishing trials.
a) Basque longline (cell = 230 hooks)
b) Norwegian longline (cell = 50 hooks)

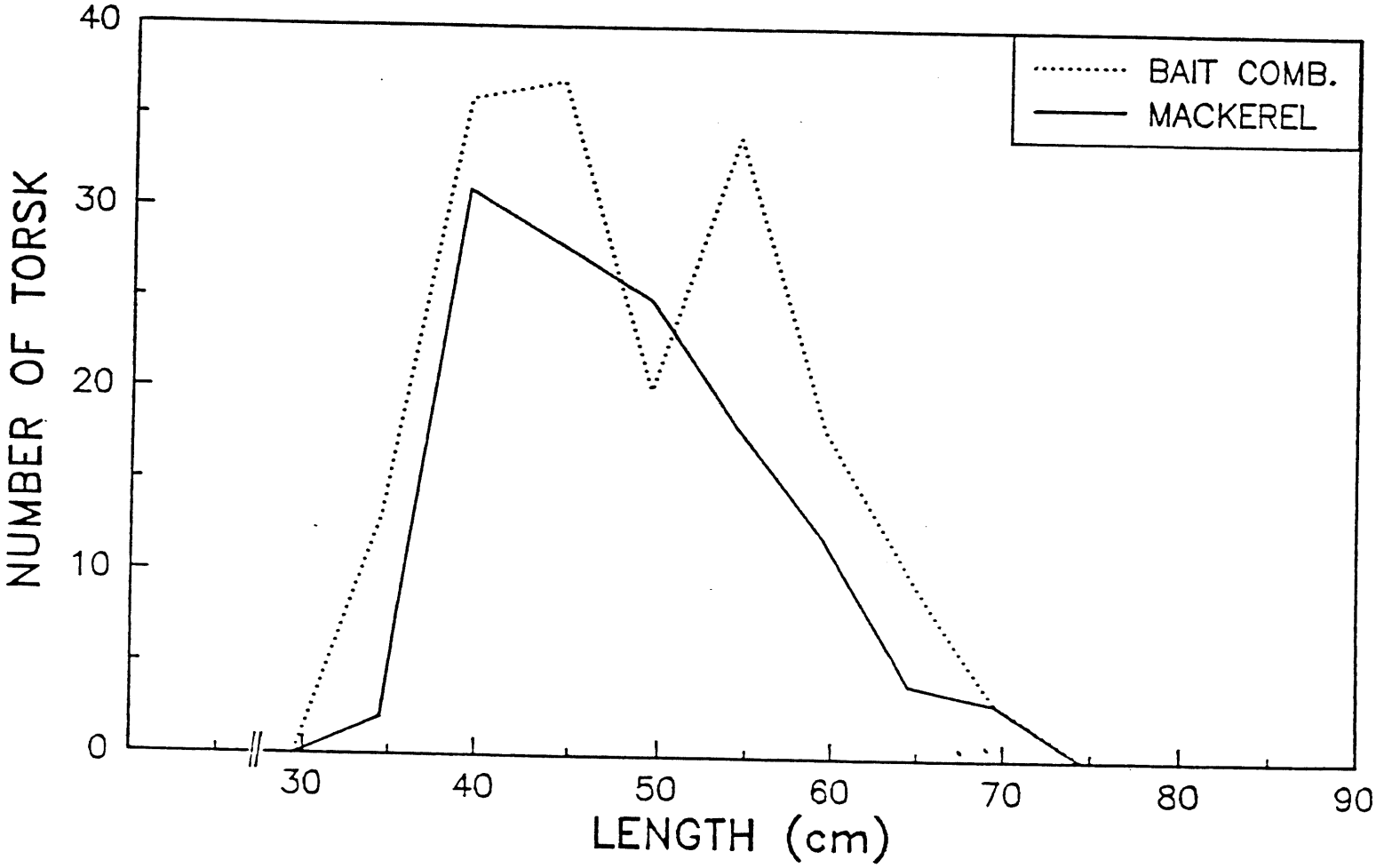


Fig. 3a. Length distributions of torsk caught in the Norwegian longline in the mackerel (Bait A)/Bait comb. (Bait C) comparison trials.

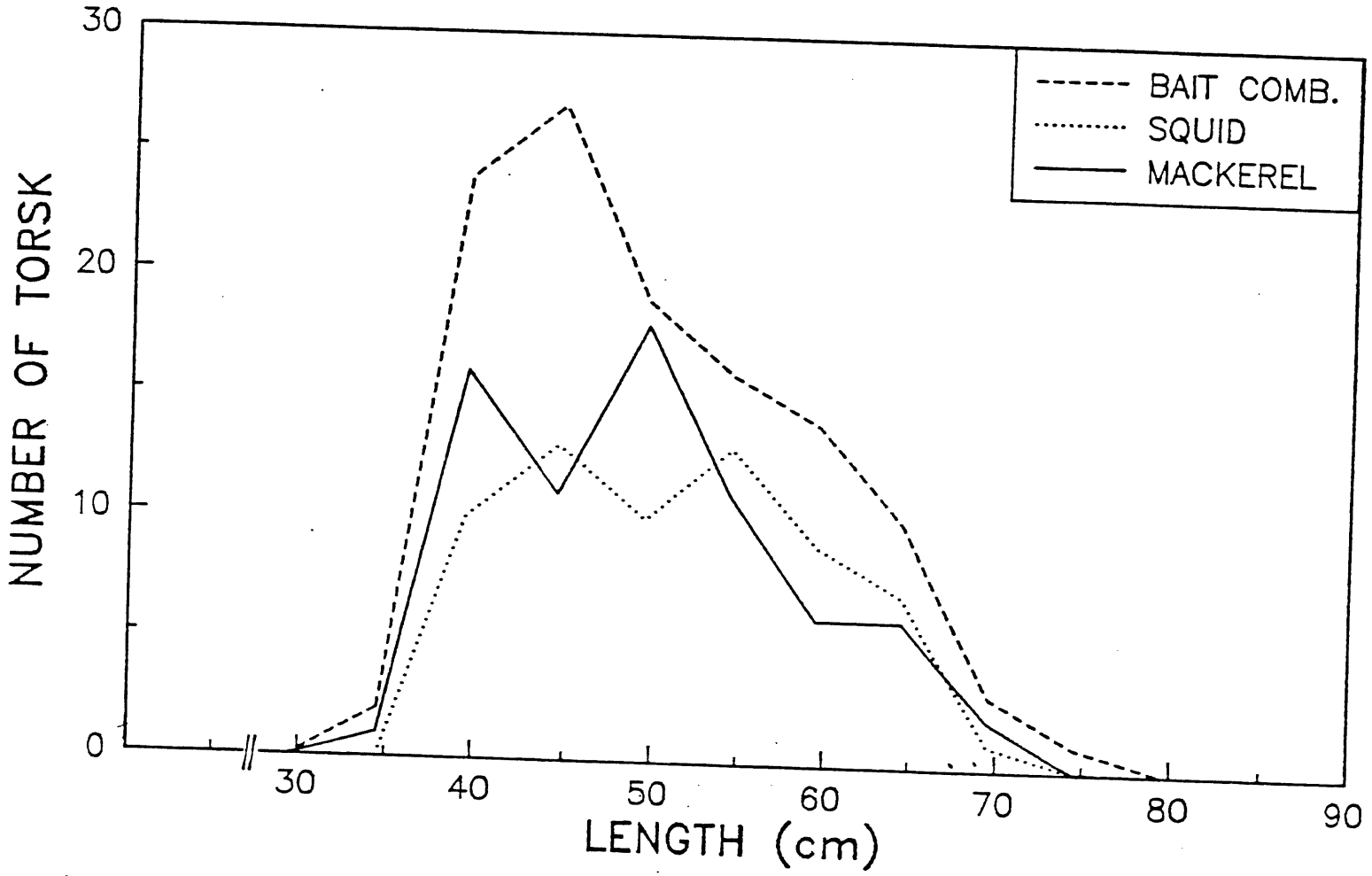


Fig. 3b. Length distributions of torsk caught in the Norwegian longline in the mackerel-squid (1:1) (Bait B)/Bait comb. (Bait C) comparison trials.

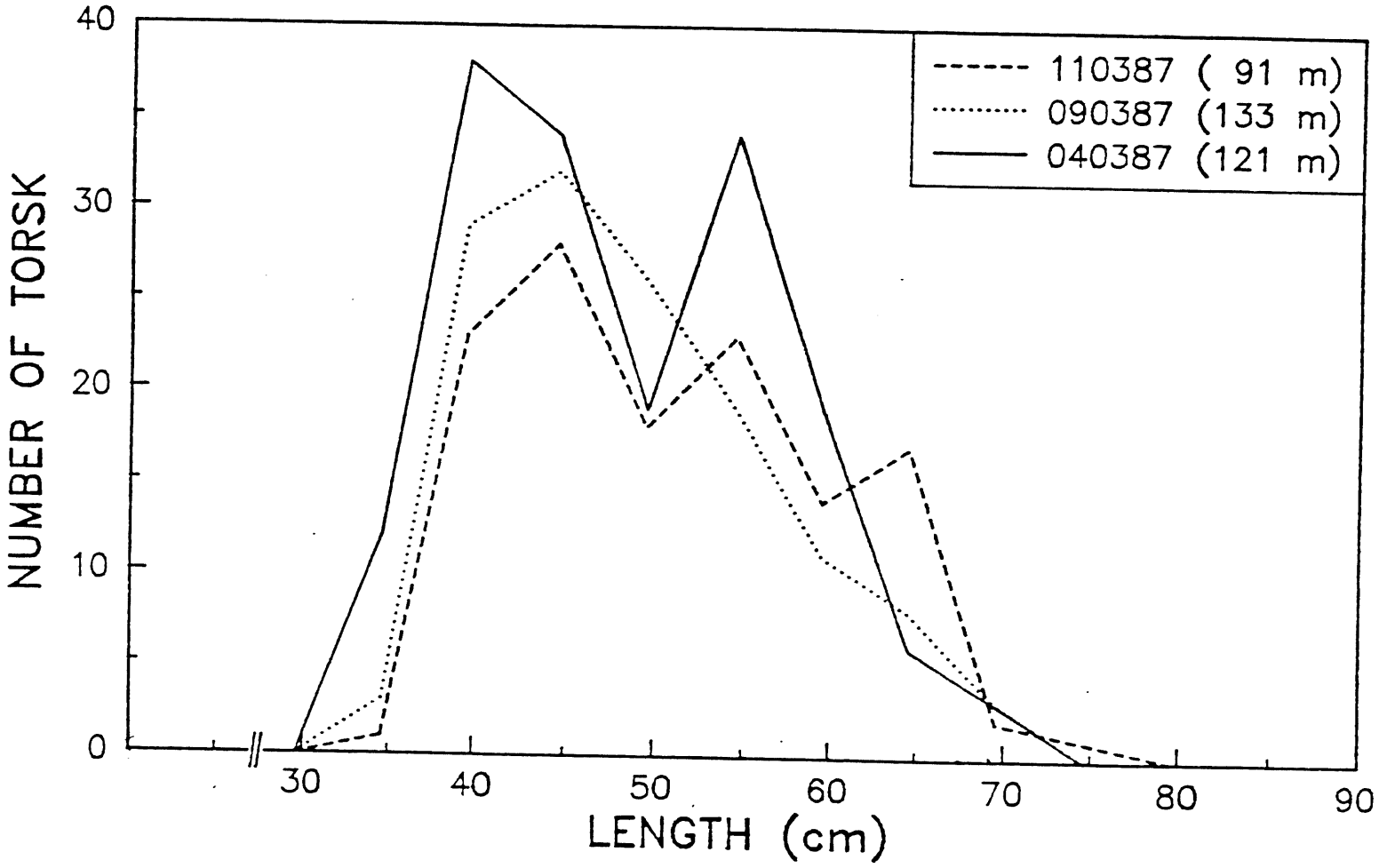


Fig. 4. Length distributions of torsk caught in the Norwegian longline in trials 1 (121 m), 2 (133 m) and 4 (91 m deep).