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On the recent stock development of *Sardina pilchardus*  
 Walbaum off Spanish Sahara

by

S. Holzlöhner

Institute for Deep Sea Fisheries and Fish Processing  
 Rostock, German Democratic Republic

In this paper a first information of the results of stock research on the sardine off Spanish Sahara from 1971 - 1975 is presented. Investigations were made on length and age structure as well as on the relation between males and females. Furthermore echo surveys were used in order to complete these stock investigations in a more quantitative way.

#### Material

The investigations presented in this paper were always executed in springtime and were concentrated in the northern part (northerly of 24°00'N) and middle part (22°30' - 24°00'N) off Spanish Sahara with the exception of 1971 where only intensive surveys in the southern part off Spanish Sahara (southerly of 22°30'N, Cap Blanco region) were carried out. Since 1972, especially since 1974 the works on sardine have been intensified. The results of investigations in the Cap Blanc region in spring and late autumn of 1974 are intended to be presented later.

The samples and echosurveys used in this paper were obtained from 1971 - 1973 on board the FRV "Ernst Haeckel", in 1974 as well as 1975 on board a factory trawler. All samples were taken by the pelagic trawl. Measurements were only done on total length. The age was determined by otoliths and supplementary in some cases scales were used.

#### Stock structure

The length distribution, age structure and male/female relation for all investigated years is demonstrated in the tables 1, 5 and 6 as well as in the figure 1. In the years 1973 - 1975 the length and age samples coming all from the northern and middle parts off Spanish Sahara were averaged. 1971 and 1972 the single samples or sample groups are demonstrated because of the wide distributed catch positions respectively different length and age structure in connection with the comparatively small basic material.

From 1972 - 1975 a trend of increase of the average length (14.5, 18.0, 19.2, and 20.1 cm) is striking. This is mainly caused by an increase of the age and partially by an increase of the growth.

1971 and 1972 only 1 and 2 year old sardines were found. 1973 the stock consisted of 95 p.c. sardines with an age of 2 years and 5 p.c. of 3 years. In the year 1974 the age group 3 was dominating with 70 p.c., the rest consisted of the age group 2 (29 p.c.) and 1 (1 p.c.). 1975 the age group 3 also dominated (67 p.c.) whereas the rest was composed by the age group 2 (24 p.c.), 4 (7 p.c.) and 0 (2 p.c.).

In the years 1971 - 1974 the male/female relation showed a dominance of the males (54 and 52 p.c.). In 1975 the portion of males was 51 p.c. comprehending the average of all samples from March until May. In May the females dominated somewhat (52 p.c.). In this connection it is of interest to know that we found the main spawning activity of the investigated spring season in the first part of May in the years 1974 and 1975.

Therefore we can suppose that in May the males and females do not separate by natural reasons. It will be of interest to follow the phenomenon of a possible reduction in males and to compare it with the trend in stock development on the Spanish Sahara sardine, too. As presented in the paper C.M. 1974/J: 10 we found a very striking trend of male reduction on the Channel sardine.

The comparatively wide length range in the year 1973 showing three tops (Fig. 1) is not caused by different age groups as appears from the outer impression. All tops belong to the year class 1971. The distinct differences in growth of these 3 groups (Fig. 2, Table 2) - the average length was 17.3; 18.4, and 19.3 cm - are probably caused by different birthtimes within the year 1971. Possibly there are relations to the phenomenon of spawning in portions.

The group having the top of 17.3 cm was possibly recruited by the main portion. According to the surveys and control hauls most of the shoals consisted of this group. In all cases one shoal group caught by one haul consisted of one of the three groups. However, in general there was no significant isolated area for each group in north-south direction, only the longer ones occurred somewhat deeper.

The average of the length in the year 1975 bases on the comparatively long period from March until May. The single averages for March, April and May are presented (Table 3, figure 3). The differences in length distribution especially the increase from April to May is caused not only by the growth within the spring season but also by fishing in different regions off Spanish Sahara. Southerly of 23°N, where the fishery mainly took place in May the sardine having the same age was somewhat longer than northerly.

A difference in the length distribution of males and females was generally found. Table 4 gives an example for the differences in the length distribution of the sexes. In the average the males are about 0.4 cm smaller than the females.

#### Distribution area

In the figures 5 - 9 all regions where sardine was found within the period of investigation are demonstrated. Echo surveys were used together with control hauls by research vessels from 1971 - 1973 and control and fishery hauls of a factory trawler from 1974 - 1975.

Though the echo surveys were not carried out everytime in form of previously indicated regular courses, we can suppose that with exception of 1971 the regions with sardine in the middle and northern part off Spanish Sahara were mapped out.

In our opinion the single groups of sardine didn't carry out any important migrations within the period of investigation. However steadily periods of several days with and without concentrations alternated. As we could point out these fluctuations were not caused by migrations. The true reason was the different formation and behaviour of shoals mainly in connection with feeding. This problem will be treated in a next paper.

There are not seldom periods where the sardine cannot be detected by the vertical echo-sounder because the shoals are too fast. Often it is even difficult to locate the shoals by the horizontal echo sounder because of the small size of the shoals. Therefore it is a problem to undertake an echo survey with one ship in a short fixed time in order to estimate the distribution area of the sardine. Better results can be received by using the echo surveys from searching and fishery activities for a long period as we did in 1974 and 1975.

Estimating the distribution area from 1972 - 1975 (Fig. 6-9) we got the following results (in nautical square miles):

<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>
450	2100	3200	2600

Although the echo survey in the year 1971 in the northern and middle region off Spanish Sahara was rough we can suppose that the distribution area was not larger than in 1972.

#### Discussion

An important stock increase in 1973 compared with 1972 off Spanish Sahara (Fig. 1 and 5-9) results from the changes in the age structure in the distribution area.

In this connection it is of interest to notice that in the period from 1963 - 1970 we investigated other species in the region of Cap Blanc and no sardines were found.

The year class of 1971 is extraordinary rich (Fig. 1). In 1973 it amounted to 95 p.c. and in 1974 to 70 p.c. of the catch stock in the northern and middle part off Spanish Sahara. Even in 1975 this year class amounted to 7 p.c.

Obviously owing to the extraordinary rich year class of 1971 the distribution area increased several times in 1973 compared with 1972 (Fig. 6 and 7). In 1974 the distribution area reached a maximum mainly due to very rich year class.

The year class of 1972 seems to be over the average, probably being still poorer than the previous one. In 1974 year class 1972 occurred with 29 p.c. and 1975 with 67 p.c.

Also the next year class of 1973 seems to be within the trend of good year classes and occurred with 24 p.c. in 1975.

The distribution area in 1975 showed signs of a decrease compared with 1974. The reason seems to be the decrease of the extraordinary rich year class of 1971 by the high fishery activity and by natural mortality. The year classes of 1972 and 1973 though good could not compensate the loss.

At present the strength of the year classes 1974 and 1975 cannot be estimated exactly.

Age groups ~~0 and 1~~ usually not present in the catch stock. Probably they are partly inside the territorial waters. By echo surveys and control hauls outside the fishing ground and outside the territorial waters we can assume as a preliminary that the year class of 1974 is under the average, but the year class of 1975 is better. The year class of 1975 seems to be better according to some observations of isolated occurrences of this year class in contrary to former years.

#### Summary

1. The sardine of the middle and northern part off Spanish Sahara, southerly of 22°30'N, showed an increase of length and of age from 1972 - 1975. The average length was in the single years 14.5; 18.0; 19.2; 20.1 cm. In the single years the stock consisted mainly of the following age groups: 1 and 2; 2; 3; 3.
2. The increase of length is mainly caused by the increases of the age and partly by an acceleration of the growth.
3. The main increase of the length could be recognized within the period 1972 - 1974 caused by the extraordinary rich year class 1971
4. The following year classes 1972 and 1973 are good but poorer than the 1971 one. According to preliminary results the year class of 1974 seems to be poor and the 1975 one better.

5. By reason of the extraordinary rich year class of 1971 the distribution area increased from 1972 - 1974 (450, 2100, 3200 nautical square miles). In 1975 the distribution area decreased somewhat (2600 nautical square miles) caused by the high fishery and natural mortality of the year class 1971. The good generations of 1972 and 1973 could not compensate the loss.
6. By reason of the presented analysis of the recent stock development of *Sardina pilchardus* of the middle and northern parts off Spanish Sahara we can presume a heavier stock decrease for 1976

Table 1: Length distribution of the Sardine off Spanish Sahara  
1971 - 1975 (o/oo)

Lt cm	1971		1972		1973	1974	1975	
	May/June	June	Jun./Jul.	June	June	May	May	March/May
	20°30'- 21°05'N	20°12'N	24°21'- 24°28'N	21°17'N	28°19'N	23°25'- 25°15'N	23°15'- 25°25'N	22°40'- 25°20'N
	40-96 m	80-90 m	35-50 m	80 m	44 m	40-78 m	30-65 m	30-75 m
5,5								1
6,0								
6,5								
7,0								
7,5								4
8,0								6
8,5			4					5
9,0		4	27					1
9,5		4	62					1
10,0		66	51	13				
10,5	1	158	82	81				1
11,0		195	74	229				1
11,5	2	195	66	242			1	
12,0	3	166	60	161			1	
12,5	3	137	42	129			3	
13,0	6	50	16	119			3	1
13,5	6	8	6	19		5	6	3
14,0	23	8	3	6		12	6	3
14,5	30		7	3		20	5	4
15,0	130	8	15		19	36	6	3
15,5	117		36		161	46	9	4
16,0	270		67		275	86	17	7
16,5	180		93		356	114	34	7
17,0	156		100		128	116	41	16
17,5	53		78		62	102	52	23
18,0	15		52			117	60	36
18,5	3		32			105	63	43
19,0	2		15			105	96	53
19,5			8			62	132	69
20,5			2			39	160	118
20,5			1			18	139	151
21,0						11	89	175
21,5						4	44	142
22,0						2	17	45
22,5							8	21
23,0							2	38
23,5							1	16
24,0								1
<b>total</b>	1000	999	1001	1002	1001	1000	998	1000
<b>mean</b>	16,52	11,99	14,50	12,24	16,70	18,05	19,24	20,05
<b>n fish.</b>	1346	241	2178	311	211	9536	13089	15247
<b>n sampl.</b>	6	1	5	2	1	29	55	80

Table 2 Different groups of length distribution in May 1973 (%)

Lt (cm)	group 1	group 2	group 3
13,0	2		
13,5	8		1
14,0	20	3	3
14,5	33	1	4
15,0	60	12	6
15,5	75	17	9
16,0	135	48	16
16,5	175	72	24
17,0	160	103	44
17,5	116	131	63
18,0	89	222	115
18,5	57	152	167
19,0	38	136	210
19,5	16	58	144
20,0	7	31	99
20,5	5	6	46
21,0	2	5	29
21,5	1	1	10
22,0		1	7
22,5			2
23,0			1
23,5			
24,0			
Total	999	999	1000
Lt $\bar{x}$	17,27	18,44	19,27
n. fishes	5237	1399	2914
n. samples	15	4	10

Table 3 Monthly length distribution 1975 (%)

Lt (cm)	III	IV	V
5,0		1	
5,5		1	
6,0			
6,5			
7,0		1	
7,5		11	
8,0		14	
8,5		12	
9,0		3	
9,5		4	
10,0		1	1
10,5		1	2
11,0		1	7
11,5			2
12,0			5
12,5			
13,0		3	
13,5		7	
14,0		9	
14,5	1	9	
15,0	2	6	
15,5	2	7	1
16,0	7	9	2
16,5	10	7	2
17,0	25	11	4
17,5	39	12	3
18,0	65	12	7
18,5	72	23	7
19,0	71	41	30
19,5	81	60	58
20,0	110	113	148
20,5	147	149	167
21,0	159	180	205
21,5	119	155	178
22,0	30	47	82
22,5	17	19	39
23,0	28	50	38
23,5	13	20	12
24,0	1	1	1
Total	919	1000	1000
Lt $\bar{x}$	20,54	19,79	21,20
n. fishes	6972	5837	2438
n. samples	16	38	26



Table 4 Length distribution of males and females in 1<sup>st</sup> decade of May 1975 (%)

Lt (cm)	♂	♀
15,0	1	2
15,5		
16,0	2	
16,5		
17,0	2	
17,5	5	
18,0	8	3
18,5	6	3
19,0	30	8
19,5	81	34
20,0	165	95
20,5	207	141
21,0	195	216
21,5	182	259
22,0	67	106
22,5	26	64
23,0	19	41
23,5	2	28
24,0	1	
Total	1000	1000
Lt $\bar{x}$	21,22	21,60
n. fishes	642	611
n. samples	10	

Table 5 Age distribution of the sardine off Spanish Sahara 1971 - 1975 (%) (preliminary)

Year	month	latitude	water- depth(m)	age groups					n aged		n measured	
				0	1	2	3	4	fishes	samples	fishes	samples
1971	V/VI	20°30'-21°05'N	40-96	0	3	97	0	0	100	1	1346	6
	VI	20°12'N	80-90	0	100	0	0	0	100	1	241	1
1972	VI/VII	24°21'-24°28'N	35-50	0	50	49	1	0	100	1	2178	5
	VI	21°17'N	80	0	100	0	0	0	98	1	311	2
	VI	28°19'N	44	0	0	100	0	0	50	1	211	1
1973	V	23°25'-25°15'N	40-78	0	0	95	5	0	900	9	9526	29
1974	V	23°15'-25°25'N	30-65	0	1	29	70	0	600	9	13089	55
1975	III-V	22°40'-25°20'N	30-75	2	0	24	67	7	500	6	15247	80

Table 6 Relation between males and females of the sardine off Spanish Sahara in the spring seasons 1971 - 1975 (%)

	1971 V/VI	1972 VI/VII	1973 V	1974 V	1975 III-V	1975 V
males	54	52	54	52	51	48
females	46	48	46	48	49	52
n (fishes)	200	600	900	6940	6238	2497
n (samples)	2	6	9	70	63	25

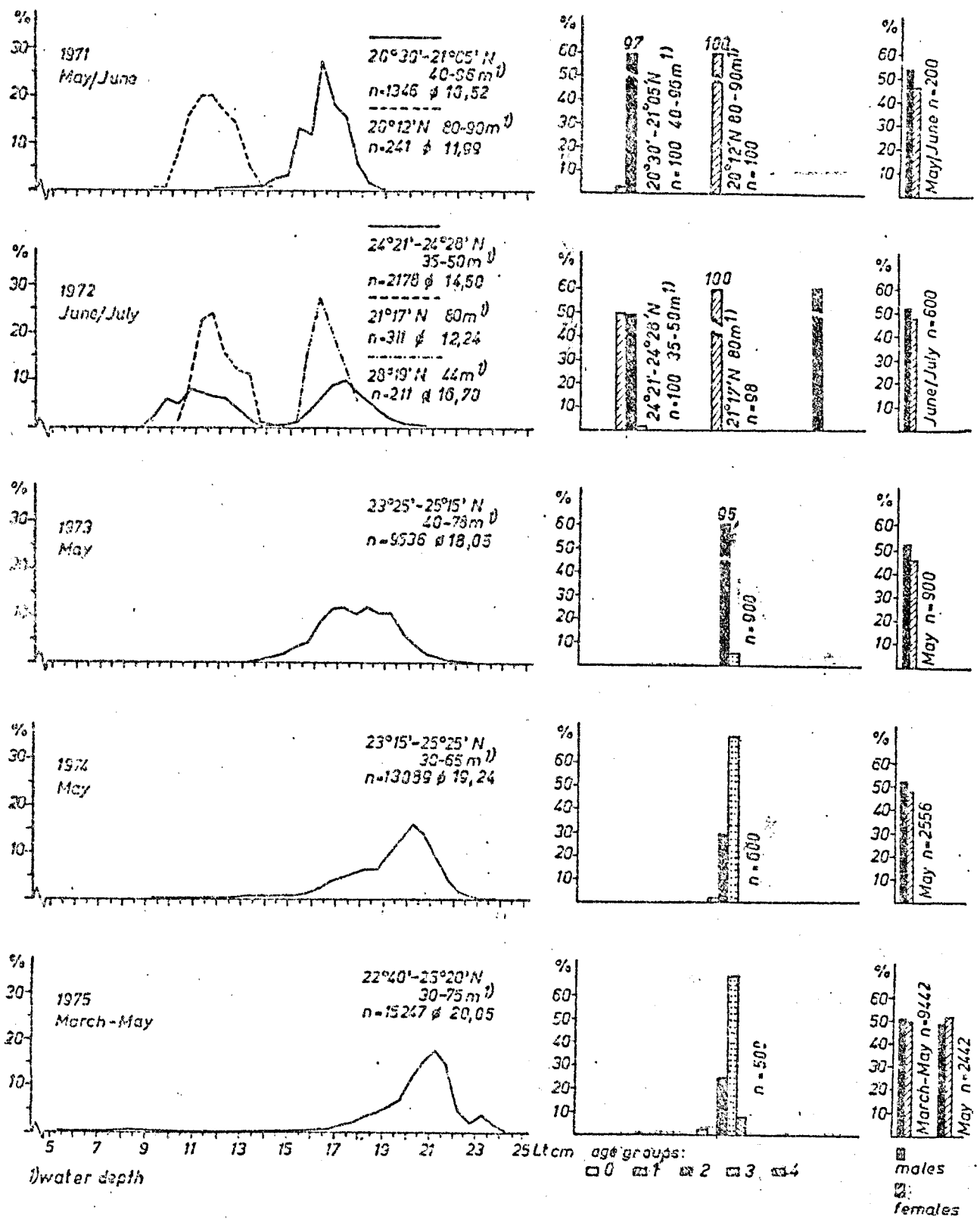


Fig. 1 Size and age structure and male/female relation of the sardine off Spanish-Sahara 1971-1975

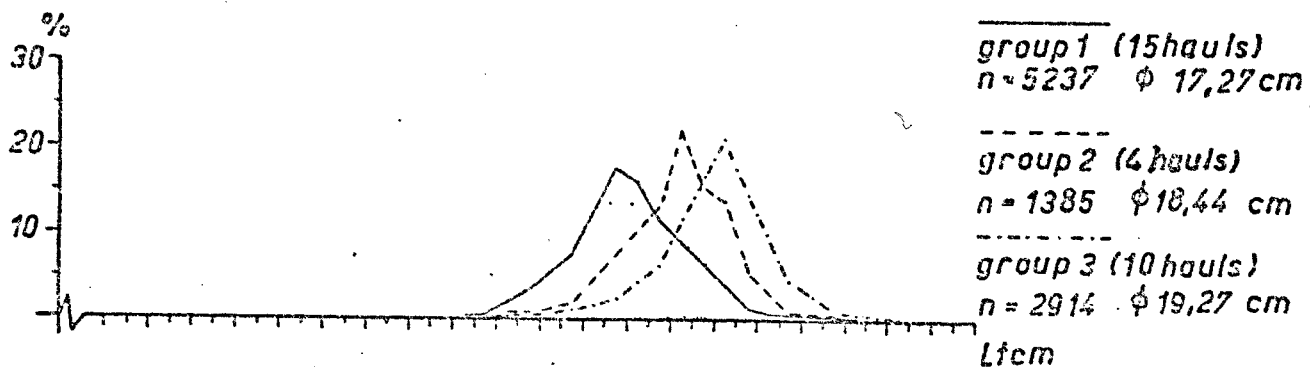


Fig. 2 Length distribution of sardine of haul groups in May 1973 off Spanish Sahara containing all mainly the yearclass 1971

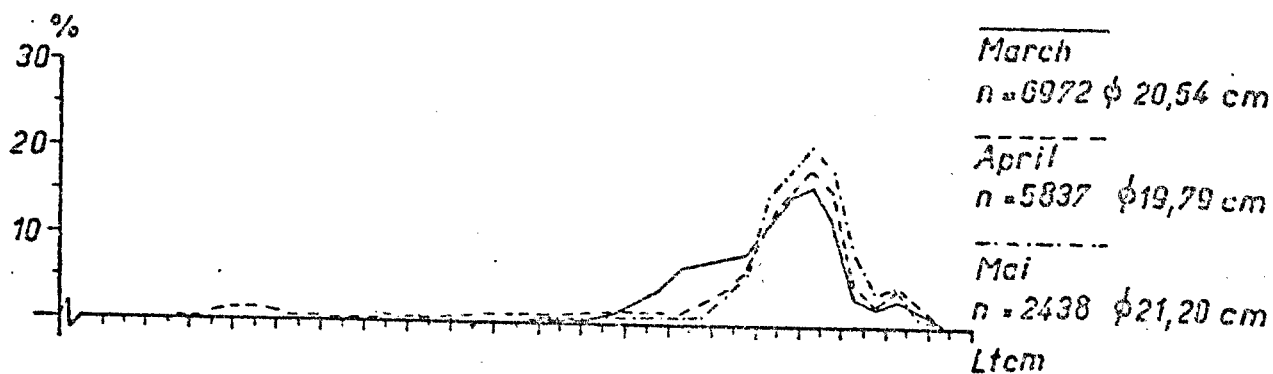


Fig. 3 Length distribution of the sardine off Spanish Sahara in March, April and May 1975

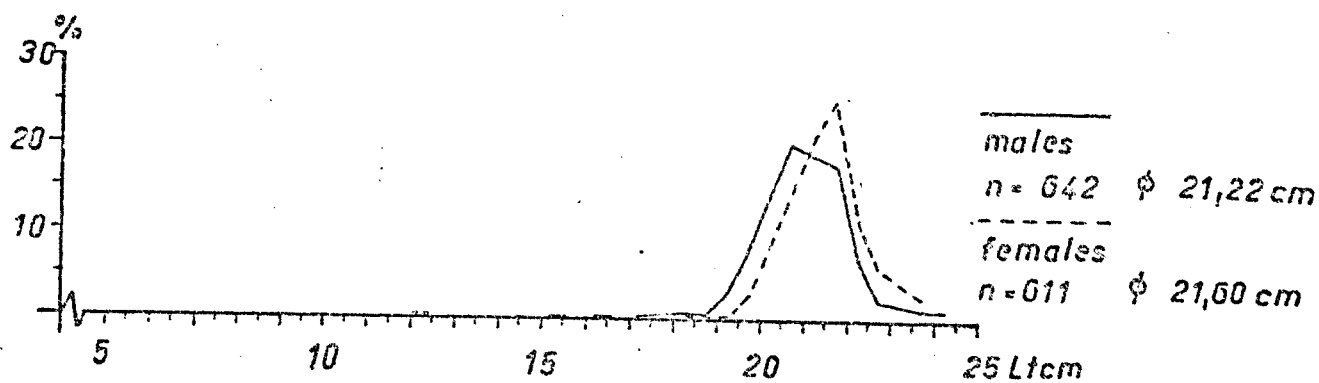


Fig. 4 Length distribution of males and females of the sardine in 1<sup>st</sup> decade May 1975 off Spanish Sahara



28° 38' N  
12° 27' W

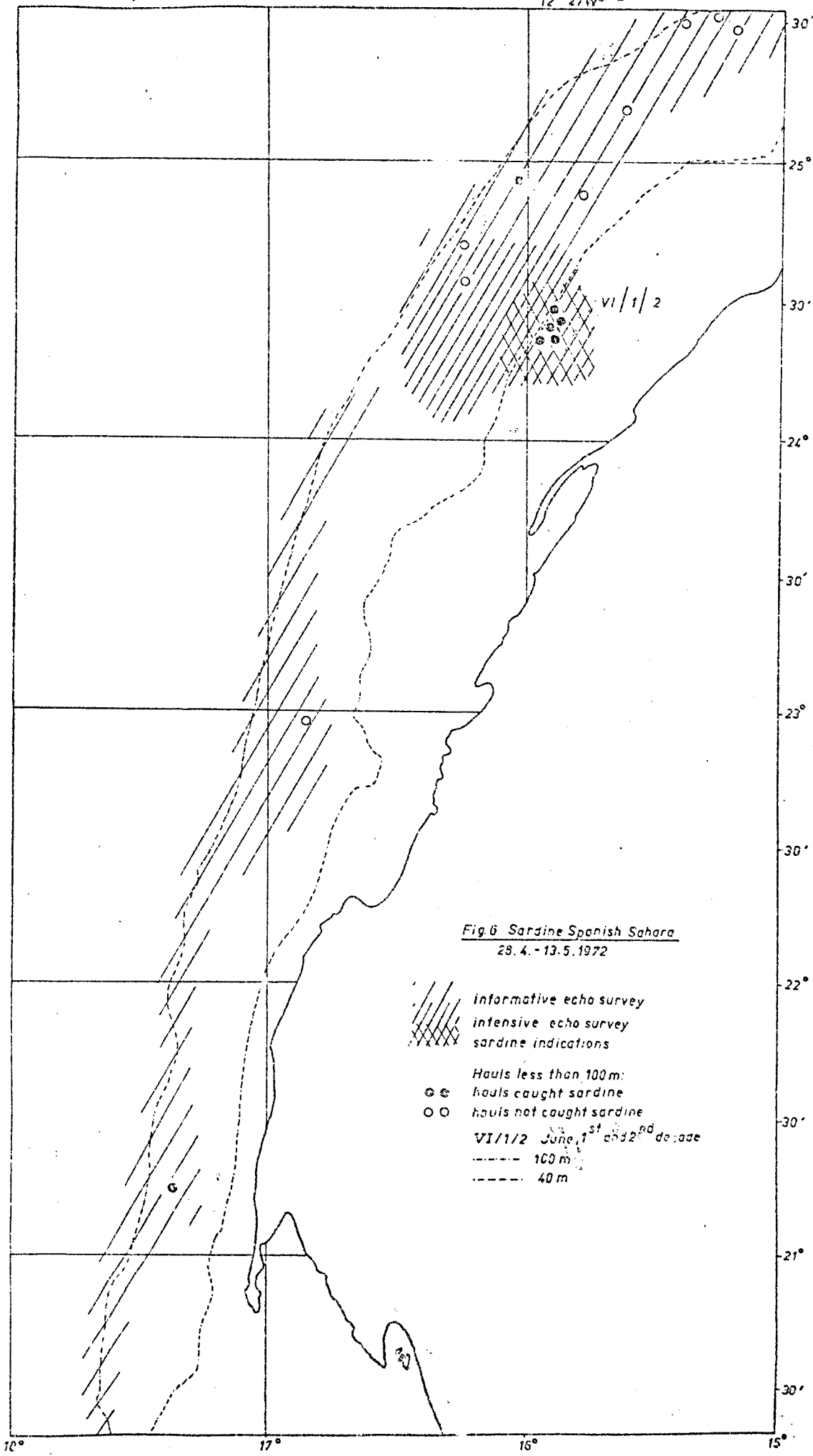








Fig. 6 Sardine Spanish Sahara  
28.4. - 13.5.1972

-  informative echo survey
-  intensive echo survey
-  sardine indications
-  Hauls less than 100 m:
  -  hauls caught sardine
  -  hauls not caught sardine
- VI/1/2 June 1<sup>st</sup> and 32<sup>nd</sup> de aze
- 100 m
- 40 m



