

# Sardine fishery by purse-seine on the Egyptian Mediterranean coast

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**ABSTRACT:** Purse-seine fisheries were investigated along about 190 km of the Mediterranean beach east and west of Alexandria. Fish landings by fishermen were surveyed between April 1977 and November 1978. Higher catches were obtained from May to July with a peak in June. Sardine constituted about 78 % and 69 % of total yield in 1977 and 1978 respectively. Sardine species recorded were *Sardinella aurita*, *S. maderensis*, *Sardina pilchardus*, and *Dussumieria acuta*. The first 2 species were commercially the most important and represented 41 % of total sardine catch in both years. Abundance, monthly variations, size distribution, age composition, survival and mortality rates of sardine catch were studied in 6 fishing sectors. Recommendations are made for purse-seine sardine fishery along the Egyptian Mediterranean coast.

## INTRODUCTION

The use of purse-seine has recently increased in Egyptian Mediterranean waters. Sardine constitutes the major part of the purse-seine catch (Wadie 1981). Although sardine can be considered of economic importance to Egypt, few investigations have been made to improve its fishery. Previous studies on sardine fishery along Egyptian Mediterranean coasts (El-Maghraby 1960, Rifaat 1960, Soliman 1970, Al-Sayes et al. 1979, Hashem & Faltas 1979) were conducted on relatively inshore sardine taken by either gill-nets or beach-seine. Knowledge of offshore sardine fishery (depth 12 to 35 fathom: ca 22 to 64 m) using light attraction and purse-seine is lacking. The present work aims to fill this gap and presents data that may be necessary or useful in management and development of sardine fisheries in Egypt.

## MATERIAL AND METHODS

The area of investigation extended from Rashid, about 48 km east of Alexandria, to El-Dabaa, 135 km west of Alexandria, covering 6 fishing sectors (Fig. 1). Sampling was made from 10 April to 23 October 1977 and from 1 March to 10 November 1978. Eleven purse-seiners were engaged in this survey in 1977 and 25 in

1978. Purse-seines used were 220 to 260 m long, 35 to 75 m deep, with a mesh size of 1.8 cm.

Commercial catches of various purse-seine operators in fishing grounds around Alexandria were landed at Eastern Harbour Fishing Center. Daily visits to this center were made during the investigation periods and information from the fishermen was obtained on: number of purse-seiners, their catches, fishing sites, number of fishing nights, duration of fishing operations, and total weight of each species in the catch. Random subsamples of constituent species were taken to the laboratory for biological examination.

Fish were sorted to species, measured to the nearest mm and weighed to the nearest g. For *Sardinella* species, scales were collected from behind the pectoral fin, below the lateral line (Soliman 1970), for age determination. Age was assessed by counting the annuli, 'year marks', under a binocular microscope (magnification  $\times 25$ ). Sex and maturity stages were studied macroscopically. Data for species other than sardine are not discussed here.

## RESULTS AND DISCUSSION

Purse-seine catch, for the 10 yr 1969 to 1978 represented on average about 26.5 % of landed marine fish in Egypt, consisting of 7.1 and 48.5 % of total catch

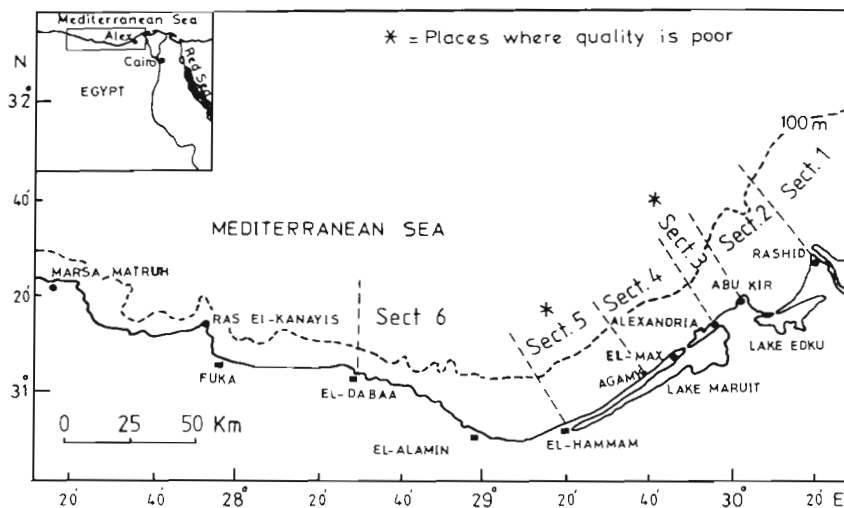


Fig. 1. Area of investigation

Table 1. Species composition of the commercial purse-seine catch during the fishing seasons of 1977 and 1978

Species	1977		1978	
	Catch (kg)	%	Catch (kg)	%
<i>Sardinella aurita</i>	304 181	38.0	588 854	37.5
<i>Sardinella maderensis</i>	27 226	3.4	58 311	3.7
<i>Sardina pilchardus</i>	284 379	35.5	414 836	26.4
<i>Dussumieria acuta</i>	10 050	1.2	14 998	1.0
Total sardine catch	625 836	78.1	1 076 999	68.6
<i>Engraulis encrasicolus</i>	59 286	7.4	201 632	12.8
<i>Boops boops</i>	44 469	5.6	129 909	8.3
<i>Trachurus mediterraneus</i>	21 302	2.7	66 552	4.2
<i>Scomber japonicus</i>	11 536	1.4	40 271	2.6
<i>Temnodon saltator</i>	17054	2.1	20 146	1.3
<i>Sphyraena spp.</i>	7 827	1.0	6 436	0.4
<i>Trachynotus ovatus</i>	7 741	1.0	17 346	1.1
<i>Euthynnus alletteratus</i>	3 888	0.5	9 120	0.6
Other fish	1 740	0.2	1 573	0.1
Total catch	800 679		1 571 285	

from the Mediterranean and Red Sea respectively (Statistical Reports prepared by Institute of Oceanography and Fisheries, Alexandria).

#### Species composition of the catch

Table 1 illustrates the catch composition of different fish species taken by purse-seine off Alexandria in 1977 and 1978. The higher yield for 1978 (about 1500 tons) than for 1977 (about 800 tons) may be correlated to the higher fishing efforts expended in that year, deduced from the following 2 factors: (1) the fishing season in 1978 started a month earlier (Mar) and ended a month later (Nov) i.e. 2 fishing months more than in 1977; (2) the total number of purse-seiners engaged in the 1978 fishery (25) was higher than in 1977 (11).

Sardine catch was 78 % of total landed catch (t.l.c.)

in 1977 and 69 % in 1978. The 4 species recorded in the combined catch were: *Sardinella aurita*, *S. maderensis*, pilchard *Sardina pilchardus*, and *Dussumieria acuta*. The first 2 are the commercially most important species representing about 41 % of total landed sardine catch in both years (Table 1). Abundance of *S. aurita* was nearly the same (38 % of t.l.c.) in 1977 and 1978. *S. maderensis* contributed 3.5 % of t.l.c. in both years. Pilchard decreased in the 1978 catch (26 %) compared to 1977 (36 %). Pilchard catch was of smaller fish, of lower commercial value. *D. acuta* represented about 1 % of sardine catch in both years (Table 1).

#### Seasonal catch fluctuations

Fig. 2 demonstrates the seasonal fluctuations of purse-seine landings in 1977 and 1978. Highest pro-

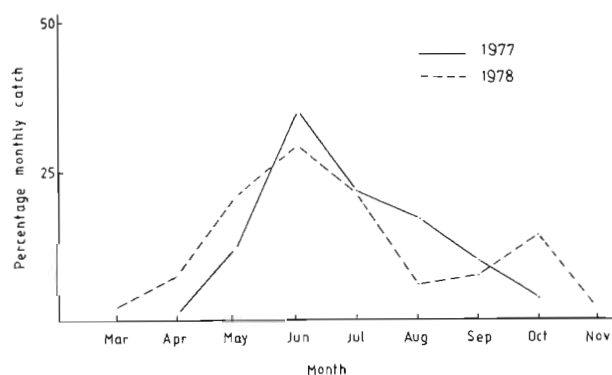


Fig. 2. Monthly fluctuations in purse-seine catch

duction was obtained from May to July with a peak in June (35 and 29 % of t.l.c. for 1977 and 1978 respectively). Another smaller peak was obvious in October 1978 (14 % t.l.c.).

### Species abundance

In the present study, the nightly catch (c.p.e., catch per effort, = average catch per boat per night), was used as an index of abundance and gives a good idea of the monthly production of various species of fish caught (Ricker 1975).

During 1977, *Sardinella aurita* and *Sardina pilchardus* were apparently the most abundant species in all months sampled, accounting for  $\frac{1}{2}$  ton night<sup>-1</sup>, except in July and October ( $\frac{1}{4}$  ton night<sup>-1</sup>) (Fig. 3). Pilchard reached a maximum apparent abundance in June (842 kg night<sup>-1</sup>). *Sardinella maderensis* appeared in the catch from June to September with a peak in July (about 128 kg night<sup>-1</sup>). *Dussumieria acuta* were landed from July to September, contributing about 23

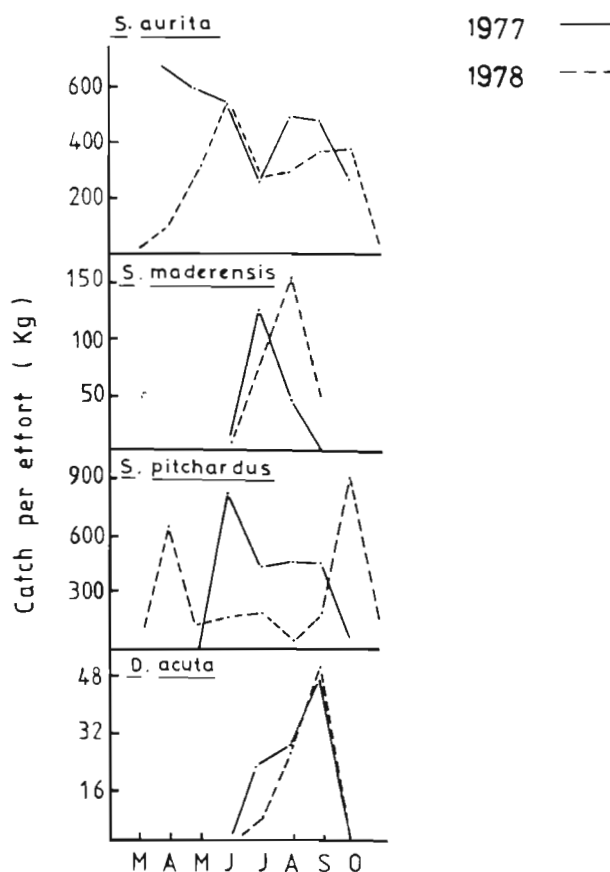


Fig. 3. Monthly abundance of sardine species caught by purse-seine

and 49 kg night<sup>-1</sup> in 1977 and 1978 respectively (Fig. 3).

During 1978, *Sardinella aurita* were landed in significant amounts from April (about 103 kg night<sup>-1</sup>) to October (378 kg night<sup>-1</sup>). Pilchard showed maxima of abundance in April (624 kg night<sup>-1</sup>) and October

Table 2. Apparent abundance (c. p. e. kg night<sup>-1</sup>) and percentage composition of the 4 sardine species from the different fishing sector, in 1978

Species	Fishing sector											
	1		2		3		4		5		6	
	Abund.	%	Abund.	%	Abund.	%	Abund.	%	Abund.	%	Abund.	%
<i>Sardinella aurita</i>	139.2	6.2	533.0	40.0	195.6	43.5	344.8	46.1	171.9	37.3	258.0	38.1
<i>Sardinella maderensis</i>	—	—	0.9	0.7	30.1	6.6	182.5	24.4	23.2	5.0	—	—
<i>Sardina pilchardus</i>	1718.6	76.4	425.3	31.9	28.8	6.4	11.2	1.5	15.1	3.3	—	—
<i>Dussumieria acuta</i>	21.5	1.0	16.3	1.2	—	—	7.5	1.0	1.0	0.2	—	—
Total catch * (kg)	130414		951957		34217		159986		209794		87419	
% of grand total catch	8.3		60.5		2.2		10.2		13.3		5.6	
Number of nights	58		714		76		214		456		129	
Catch per night (kg)	2249		1333		450		748		460		678	

\* Species other than sardines are included

(1008 kg night<sup>-1</sup>). Although pilchard were taken in large amounts, their catch was composed of small-sized fish of less commercial value. *S. maderensis* was obtained from July to October with a peak in September (53 kg night<sup>-1</sup>).

The higher overall c.p.e. for 1977 (1221 kg night<sup>-1</sup>) than for 1978 (954 kg night<sup>-1</sup>) showed the effect of increased effort in increasing total catch but in decreasing c.p.e. It may also be a sign of poor exploitation of purse-seine fishery in Egyptian Mediterranean waters.

**Species abundance in different fishing grounds**

From Table 2, which compares the 6 fishing sectors in 1978, it is clear that fishing effort was concentrated in Sector 2 (714 nights), contributing 60.5 % of total purse-seine catch. Sector 5 was next in effort expended (456 nights), providing 13 % of catch. Sector 1 showed minimum fishing effort (58 nights) and only 8 % of catch. Sector 1 was, however, the most productive region with a c.p.e. of 2249 kg night<sup>-1</sup>, followed by Sector 2 with 1333 kg night<sup>-1</sup>, but the catch at both

these sectors was mostly composed of small fish of lower value. Sectors 4 & 6 came next in their production (748 and 678 kg night<sup>-1</sup> respectively). Sectors 3 & 5 were characterized by low c.p.e. having 450 and 460 kg night<sup>-1</sup> respectively.

*Sardinella aurita* was abundant at Sectors 2, 3, 4, 5 & 6 and contributed about 40 % of each sector's total catch. Pilchard was taken in large amounts from Sector 1. *S. maderensis* was obtained mostly from Sector 4 and *Dussumieria acuta* from Sectors 1, 2, 4 & 5 but in small quantities.

**Size distribution**

During 1977 and 1978, the majority of *Sardinella aurita* had lengths of 10 to 22 cm with a range of 6 to 27 cm (Fig. 4). Size range of *S. maderensis* was 6 to 17 cm (Fig. 5), with mean about 12 cm. Pilchard sizes varied between 7 and 17 cm with modes around 8 to 13 cm (Fig. 6). *Dussumieria acuta* ranged in length from 12 to 17 cm (Fig. 7). Analysis of size/frequency distribution showed that sardine caught east of Alexandria were smaller than those taken far west of Alexandria. Various explanations were suggested: (a) in-

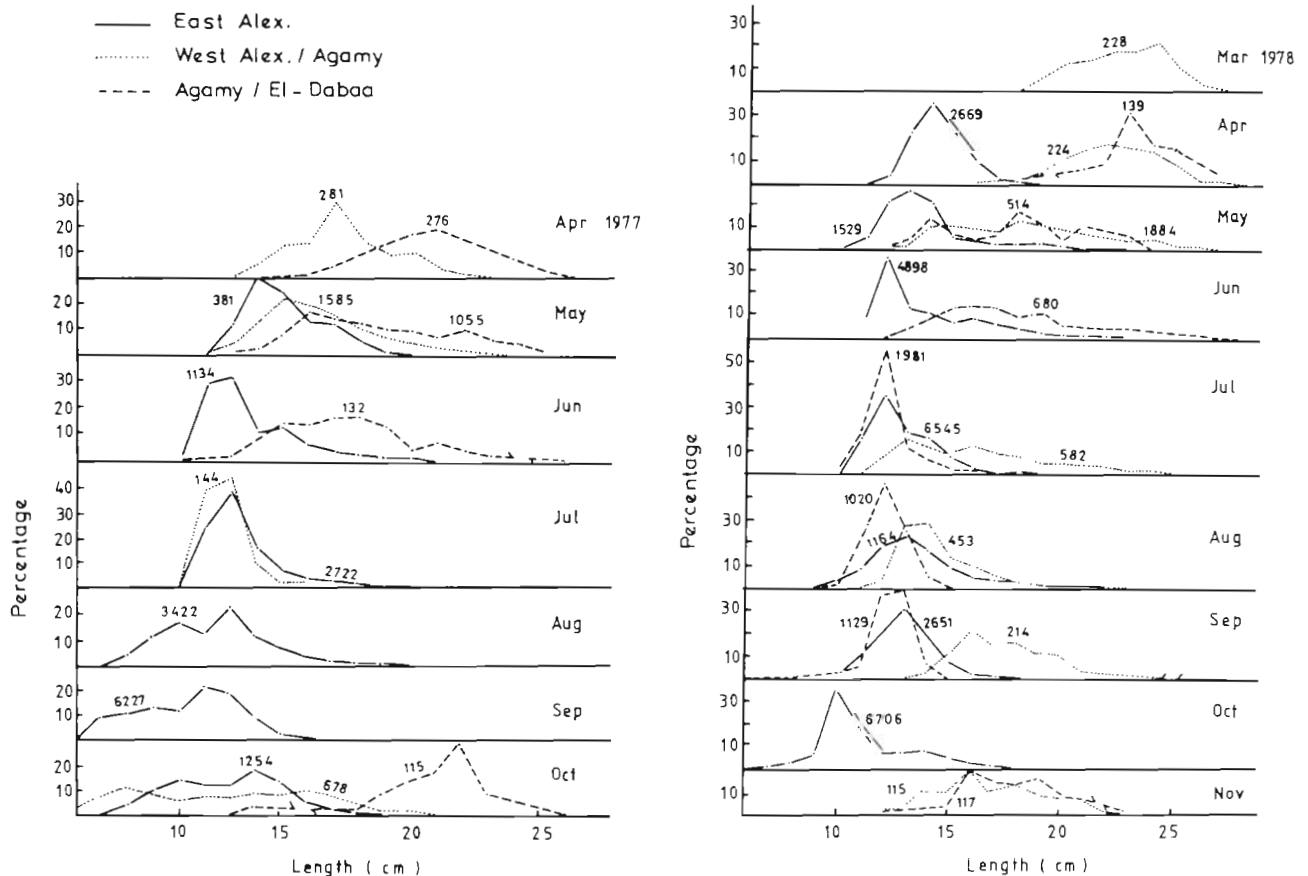


Fig. 4. *Sardinella aurita*. Size distribution during 1977 and 1978

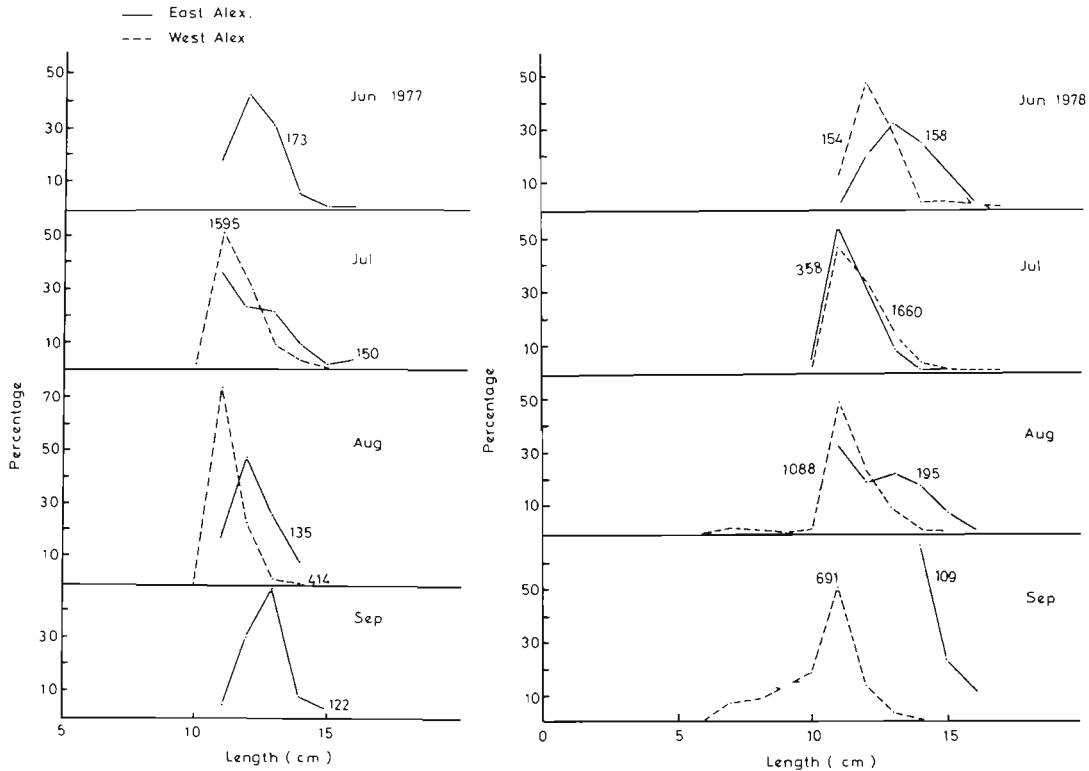


Fig. 5. *Sardinella maderensis*. Size distribution during 1977 and 1978

tensive fishing effort expended east of Alexandria; (b) fishing operations carried out at greater depths in the west; (c) larger fish distributed more westwards; (d) difference in growth rate; (e) movement of larger sardine westwards; (f) entry of new recruits into the eastern fishery. The first 2 hypotheses seem the most likely.

#### Age composition

The following will be restricted to *Sardinella aurita* and *S. maderensis* since they are commercially the most important species.

Analysis of data for 1977 revealed that *Sardinella aurita* of age Group I were dominating the catch east of Alexandria, while older age groups were more represented west of Alexandria. Recruits (Group 0) began to appear in July; in large numbers from August to October east of Alexandria (Fig. 8). *S. maderensis* catch mainly belonged to age Groups I and II in both regions (east and west of Alexandria). Recruits were taken during August to September in the catch west of Alexandria (Fig. 9).

Age composition varied from one locality to another. Dominance of older age groups of *Sardinella aurita* west of Alexandria may give evidence of lower exploitation in that area. On the other hand, *S. maderensis* older age groups were more represented in the catch

east of Alexandria than westwards. Similar results were obtained by Hashem & Faltas (1979) on sardine captured by gill-nets. The wide size-range of both species may indicate that the purse-seines used lacked selectivity due to their small mesh sizes (about 1.8 cm).

#### Survival and mortality rates

Computations were made from the abundance of successive age groups according to Ricker (1975). Instantaneous total mortality ( $Z$ ) was estimated from the slope of the descending right limb of the catch curve, and survival rate ( $S$ ) from the equation  $S = e^{-Z}$ .

For *Sardinella aurita* east of Alexandria, the slope of the catch curve (Fig. 10) was calculated, by the least squares method, to be 1.029. Accordingly  $Z = 1.029 \times 2.303 = 2.37$  and  $S = 0.093$  i.e. survival rate was about 9% at 1 yr old. West of Alexandria, Sector 4 (Fig. 10),  $Z = 1.2167$  and  $S = 0.296$ , i.e. about 30% survival rate at 1 yr old. For far western regions, Sectors 5 & 6 (Fig. 10),  $Z = 1.3198$  and  $S = 0.2672$ , i.e. 27% at 2 yr old. Similarly for *Sardinella maderensis*, east of Alexandria (Fig. 11)  $Z = 1.1388$  and  $S = 0.3102$  (32% survival at 1 yr old). West of Alexandria (Fig. 11),  $Z = 2.0591$  and  $S = 0.127$  (13% at 1 yr old).

The higher mortality rate of *Sardinella aurita* east of Alexandria than westwards may be due to the inten-

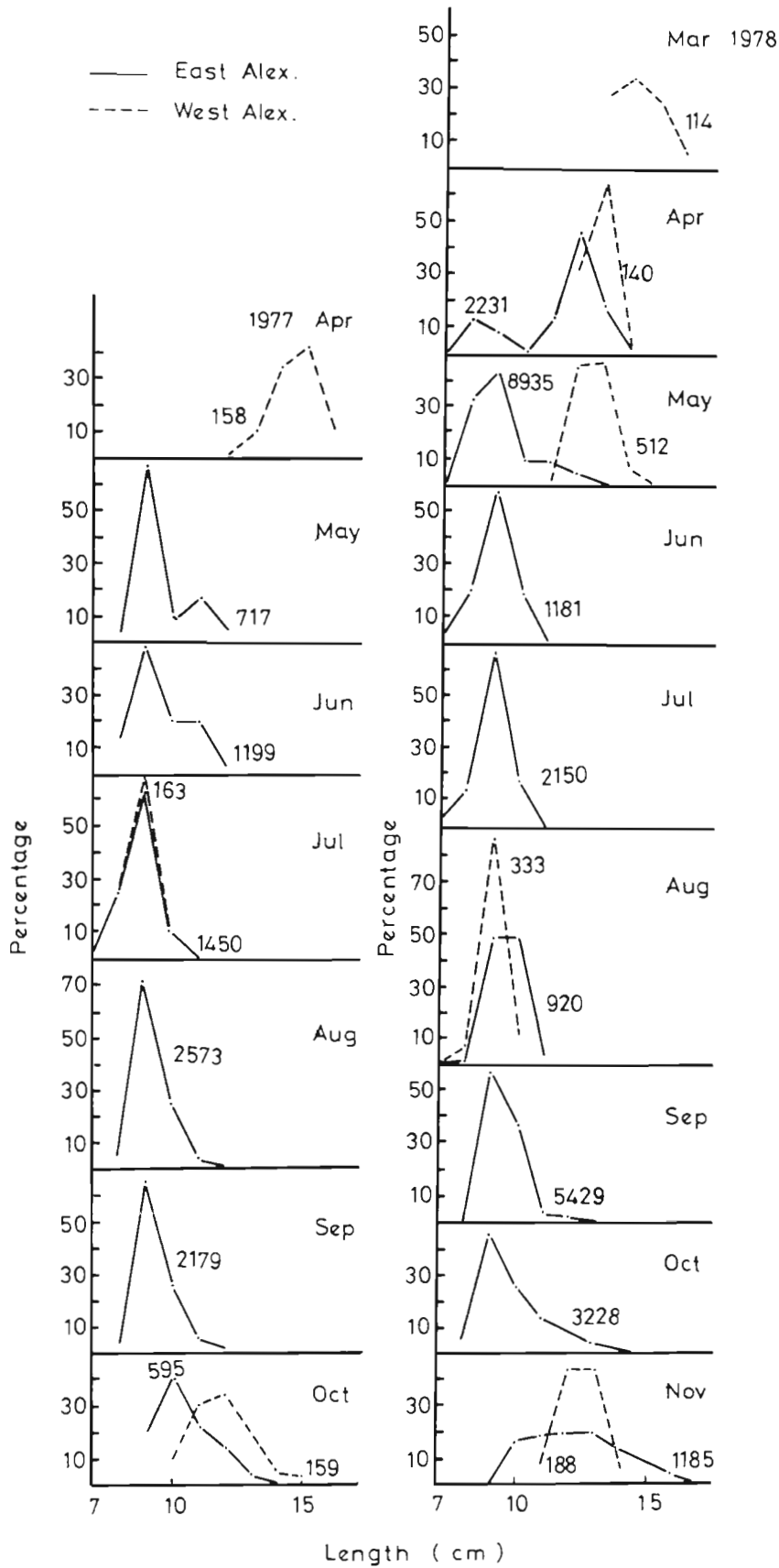


Fig. 6. *Sardina pilchardus*. Size distribution during 1977 and 1978

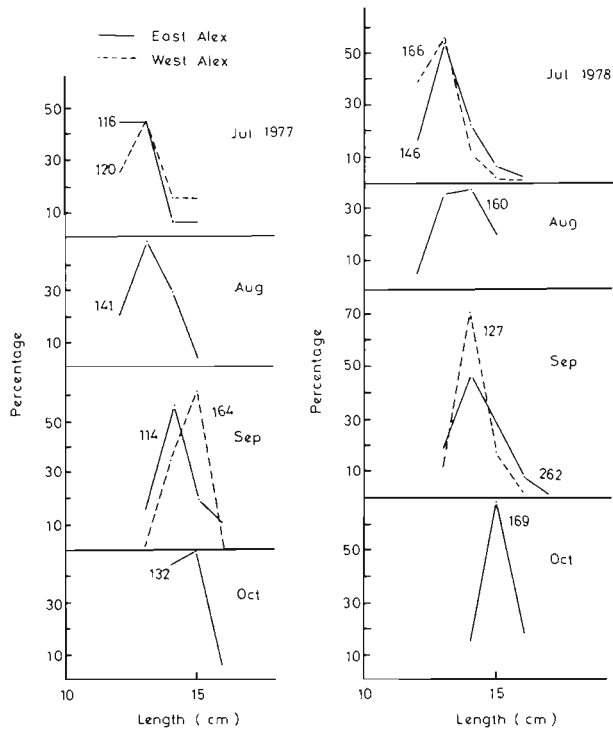


Fig. 7. *Dussumieria acuta*. Size distribution during 1977 and 1978

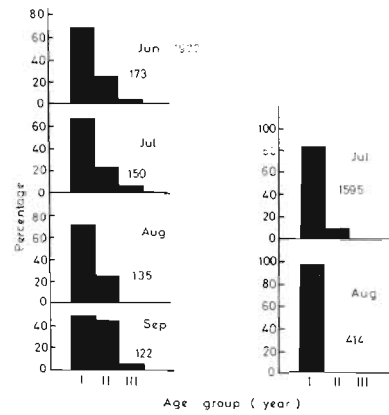


Fig. 9. *Sardinella maderensis*. Monthly age composition

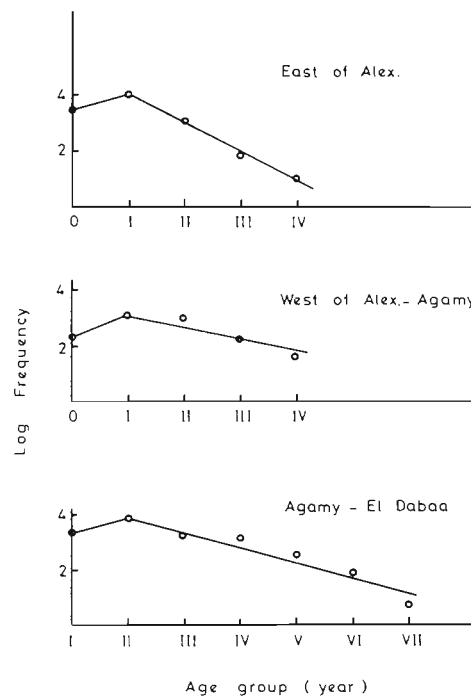


Fig. 10. *Sardinella aurita*. Catch curve in 1977

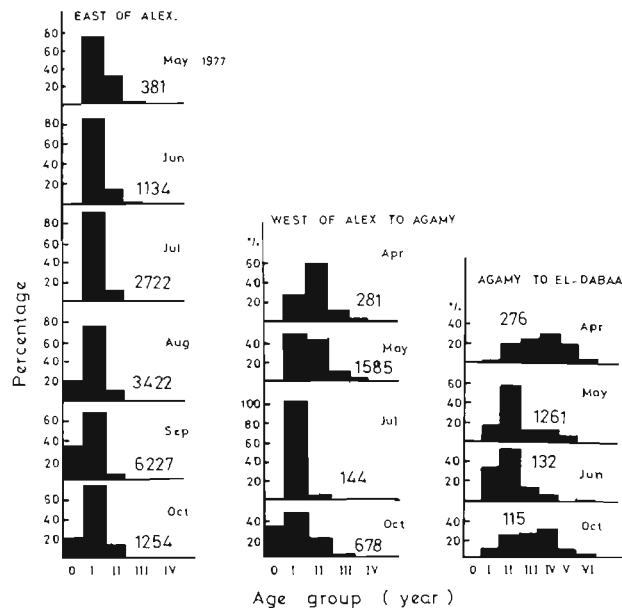


Fig. 8. *Sardinella aurita*. Monthly age composition

sive fishing operations. The reverse effect was shown by *S. maderensis* landings. The higher survival rate east of Alexandria as compared with western regions can probably be attributed to the concentrated fishing operations of this species west of Alexandria. Hashem & Faltas (1979) gave a comparatively lower survival rate (9 % at 1 yr old) for the same species taken by gill-nets.

### Spawning seasons

Spawning seasons were defined as those during which fully ripe fish were recorded in the catch. The monthly numbers of ripe fish examined indicated that the spawning season of *Sardinella aurita* extended from May to August with a peak in August (71.7 % of males and 51 % of females investigated were ripe). For *S. maderensis* breeding started in June (70 % of males and 55 % of females studied were ripe), and ended in August (50 % of males and 56 % of females were spent). The onset of spawning was in June for males and July for females.

For *Sardinella aurita* 68 % of males and 55 % of

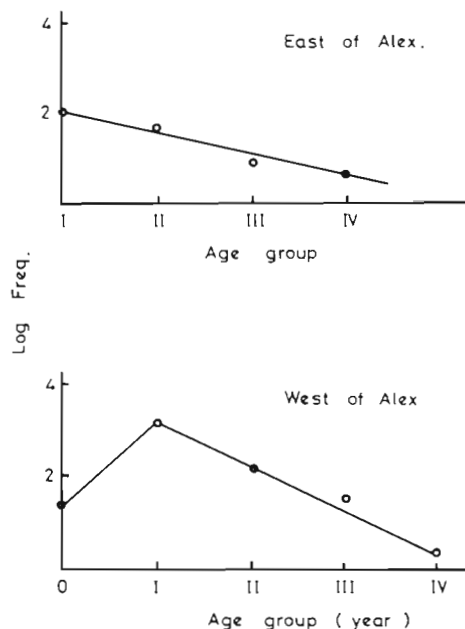


Fig. 11. *Sardinella maderensis*. Catch curve in 1977

females examined were mature at length 11.5 cm. For *S. maderensis*, minimum length recorded was 10.5 cm at which 80 % of fish analysed were mature. Referring these lengths to the corresponding age groups, fish over 1 yr old were considered to be mature.

## RECOMMENDATIONS

The establishment of new fishing sites in the far west of Alexandria (from Agamy to El-Dabba, Fig. 1) would be beneficial to purse-seine fisheries, as this is a less exploited area characterized by large-sized fish populations.

Since length at first maturity is about 11.5 cm, the minimum legal mesh size of purse-seine operated off Alexandria should be modified to release fish smaller than that length to protect a continuous recruitment for the spawning stock of both *Sardinella* species.

## CONCLUSIONS

Sardine constituted about 78 % and 69 % of total purse-seine landings from east and west of Alexandria in 1977 and 1978 respectively. The species found were: *Sardinella aurita*, *S. maderensis*, *Sardina pilchardus*, and *Dussumieria acuta*. The largest catches were

obtained from May to August with a peak period in June and July. The first 2 species are the most commercially important, representing about 41 % of sardine catch in both years. Although pilchard was fished in good amounts, their yield was composed of small-sized fish of less value. *S. aurita* was caught significantly from Sector 3 (Abu-Kir) particularly in June, *S. maderensis* from Alexandria westwards to Agamy from June to September, *S. pilchardus* from Sectors 2 (Rashid) and 3 (Abu-Kir) during June to October, and *D. acuta* from the same localities and during the same periods as pilchard, with highest catches in August and September. Age Group I dominated the catch of *S. aurita* east of Alexandria, while older age groups were more represented in the catch west of Alexandria. *S. maderensis* yield was mainly composed of 1 yr old fish in both areas.

Survival rate of *Sardinella aurita* was low east of Alexandria (9 % at 1 yr old), but it was high in far eastern regions (27 % at 2 yr old). On the other hand, *S. maderensis* survival rate was higher in the west (32 % than in the east (13 % at 1 yr old).

The breeding season extended from May to August for *Sardinella aurita* and from June to August for *S. maderensis*. Both species attain their first sexual maturity during their second year of life, at lengths of 11.5 and 10.5 cm respectively.

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