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ON THE FISHERY AND BIOLOGY OF *SARDINELLA DAYI* (REGAN) AT KARWAR, INDIA

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ABSTRACT

With the introduction of Purse-seiners in Karwar waters, *Sardinella dayi* has emerged as one of the important resources among lesser sardines. Detailed biological studies on growth, mortality and maturity made on this species indicate that fish attains a size of 145 mm, 160 mm and 180 mm in 1–year, 2–year and 3–year respectively; the total mortality rate ranging from 0.64 (1983) to 3.12 (1982), with the natural mortality (M) of 0.7961 from 1980 to 1983. Maturity studies show that this species has a protracted period of spawning extending from October-December and again from January to April on a reduced scale.

INTRODUCTION

IT HAS been estimated that the clupeoids comprising oilsardine, whitebaits, anchovies and lesser sardines contribute about a third of marine fish catches of India. The last group includes four species viz., *Sardinella fimbriata* (val.), *S. albella* (cuv. & val.), *S. gibbosa* (Blkr.) and *S. dayi* (Regan) and support the commercial catches at Karwar. After the introduction of purse seiners in the Karwar waters, it has assumed greater importance and forms a good fishery. Investigations were therefore initiated on the various aspects of its biology and results through 1979-83 are presented. Except for an account by Antony Raja and Lazarus (1975), no information on this species is forthcoming.

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MATERIAL AND METHODS

Shore-seines (*rampan, vendi*), drag-net (*qorubale*) and purse-seines are employed for catching *S. dayi* in the Karwar waters. Biweekly collections were made at the purse seine landing centre, Baithkol (Karwar). The estimates of total catch and catch per unit effort (cpue) were made by method followed by earlier workers (Sekharan, 1962; Sekharan and Dhulkhed, 1963).

From the Table 1 it is evident that the catches were comparatively good in 1981 (410 t), 1982 (361 t) and 1979 (359 t). In 1980 and 1983 catches declined to 280 t and 71 t. The cpue varied from 19 kg in 1983 to 545 kg in 1982. 1983 was the poorest. The seasonal mean values for five years fluctuated between 0.76 t (August) and 106. 3 t (May). In general the production months were May and October.

GROWTH STUDIES

In Fig. 1, the length frequency distribution of this species are given. Three to four broods manifest in the fishery. The modal progressions are given in the accompanying Table 2.

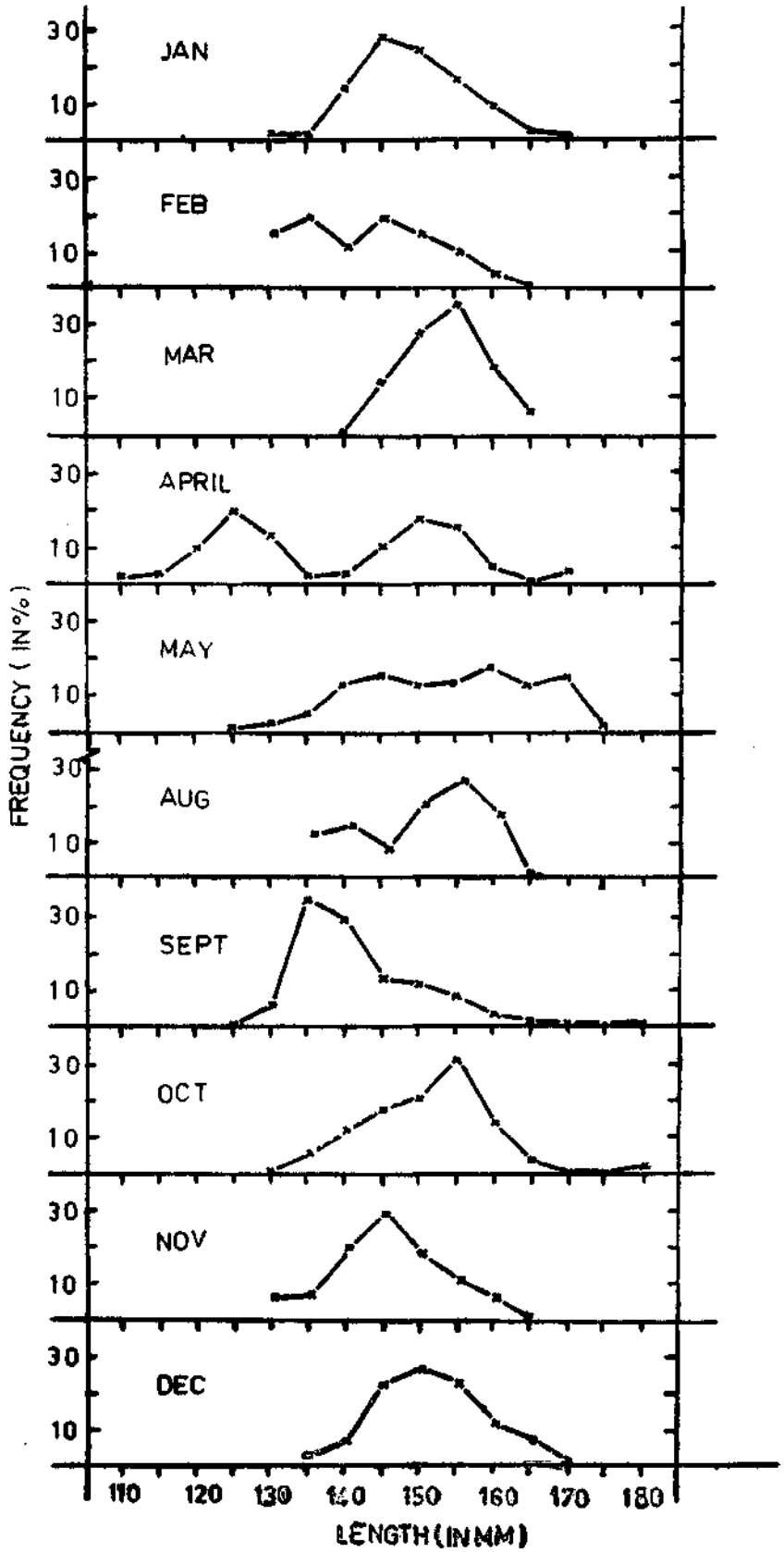

Fig. 1. Length frequency distri bution of *S. dayi* from 1979 to 1983

TABLE 1. *Purse seine catches (in tonnes) of* S. dayi *at Karwar*

Months	1979		1980		1981		1982		1983	
	C	C/E	C	C/E	C	C/E	C	C/E	C	C/E
Jan.	–	–	26.93	154	–	–	11.21	18	21.40	34
Feb.	–	–	75.88	454	1.93	4	36.28	53	1.74	4
Mar.	–	–	0.75	4	–	–	15.27	24	24.23	129
April	52.43	255	4.50	22	104.29	166	4.03	5	–	–
May	184.49	1318	0.06	0.24	136.55	254	210.23	238	0.13	0.6
Aug.	3.8	1900	–	–	–	–	–	–	–	–
Sept.	30.26	164	79.52	280	8.54	17	35.20	72	19.27	54
Oct.	53.96	155	68.77	213	146.93	216	–	–	–	–
Nov.	25.12	143	13.04	56	10.68	19	1.00	1.12	3.90	6
Dec.	8.66	42	10.52	15	1.00	2	47.51	74	–	–
Total	358.72	238	279.97	110	409.92	87	360.73	545	70.67	19

(C = catch in tonnes, C/E = catch per effort in kg)

TABLE 2. *Progression of modes of* S. dayi *at Karwar*

Year Class		Broods (in mm)	Modal progress
1977	155	(April, August, Sept.), 160 (May & Nov.)	1979
1978	125	(April), 130 (May), 140 (Aug., Sept. and Oct.), 145 (Nov. & Dec.)	1979
,,	155	(October & December)	1980
,,	170	(April), 180 (September & October)	1981
1979	130	(Oct.), 135 (Feb., April, May & Sept.) 145 (Jan., Feb., April, Nov. & Dec.)	1980
,,	150	(April, May, Nov & Dec.), 155 (Sept. & Oct.)	1981
1980	115	(May), 125 (May), 130 (April, Sept. and November)	1981
,,	150	(Jan., Feb., Sept., & Dec,,), 155 (March, April & Nov.), 160 (January & May)	1982
1981	125	(April), 135 (April, May), 140 (Sept.)	1982
,,	150	(Sept.), 155 (January & February)	1983
1982	140	(November), 145 (February & May)	1983

From the progression of modes and spawning periods (from October to December and January to April), it appears that the fish attains a size of 145 mm, 160 mm and 180 mm in 1-year, 2-year and 3-year respectively during its life.

ESTIMATES OF MORTALITY

For estimating the mortality rates, it is necessary that fishery after a certain length, be equally vulnerable to the fishing gear, mortality and recruitment be uniform and constant from season to season. On account of the wide fluctuations of fishery, the availability of all the year classes during different seasons was not uniform. Due to this difficulty, it was rather difficult to estimate the mortality rates. However, 0-year and 1-year were combined and estimates of mortality rates were made by the method of Beverton and Holt (1957) and as described by the author elsewhere (Annigeri, 1971).

From the age composition data, for estimating the natural mortality rate (M), Z-values plotted against the fishing effort (f) and M was determined from the intercept of the regression of these two variables. Four iteration processes were carried out to get improved values of total instantaneous mortality (Z) as below in Table 3 B.

Fishing mortality (F) values derived by subtracting the M from Z as shown in the above Table. These are shown in Fig. 2.

Biological Studies

Maturity cycle

For the five year period from 1979-1983 nearly 3060 fish were examined for maturity studies. Maturity stages were divided as immature (I, II), maturity (III, IV), mature (V, VI), spent (VII) and resting (II b). These stages are described below under spawning periodicity. The mature and spent fish were found from January to April and again from October to December, indicating as to their spawning periods. In the former period, it appears that the spawning is on a reduced scale, however the latter one is an active or intensive one. The pooled percentage of different stages that contributed during the above periods are shown below:

sharply separated in a single batch from the immature stock. It is seen that ova diameter range is upto 15 m.d. is in stage II and 30 m.d. for stage III being immatures and in the latter ovary yolk accumulation has commenced and the nucleus is invisible. In the former stage II, tiny transparent ova with visible nuclei are angular or irregular in shape. In stages IV and V ova diameter range extends upto 70 m.d. and are opaque or semi opaque. In stage VI, ova diameter range is upto 100 m.d. and ova are transparent due to vacuolation of yolk. A closer examination of ovaries in well advanced stages indicates multiple modes occurring during the August-December period. In 1979, from October-December, the mature ovaries in stage V showed 4 to 5 modes at 30,40, 50 and 60 m.d. within a range of 80 m.d. From Fig. 3

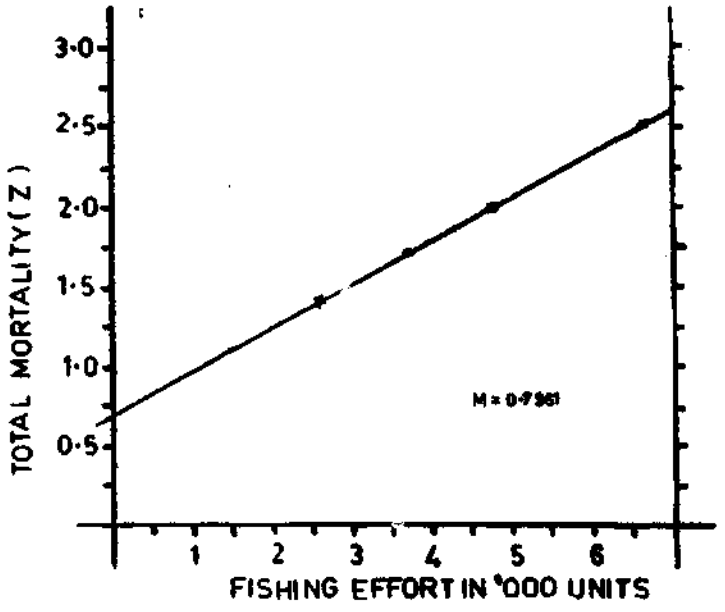

Fig. 2. Regression of total mortality on fishing effort for *S. dayi*.

Spawning periodicity

In Fig. 3, frequency polygons of ova diameter are presented. Where the spawning is of short duration and definite usually mature ova are

it is clear that trend of multiple modes prevailed in 1980, 1981 and 1982. In 1983, three ovaries in stage VI pooled together in the micrometer, ova diameter range upto 100 m.d. showed 5 modes at 5 m.d., 30 m.d, 40 m.d., 50 m.d. and

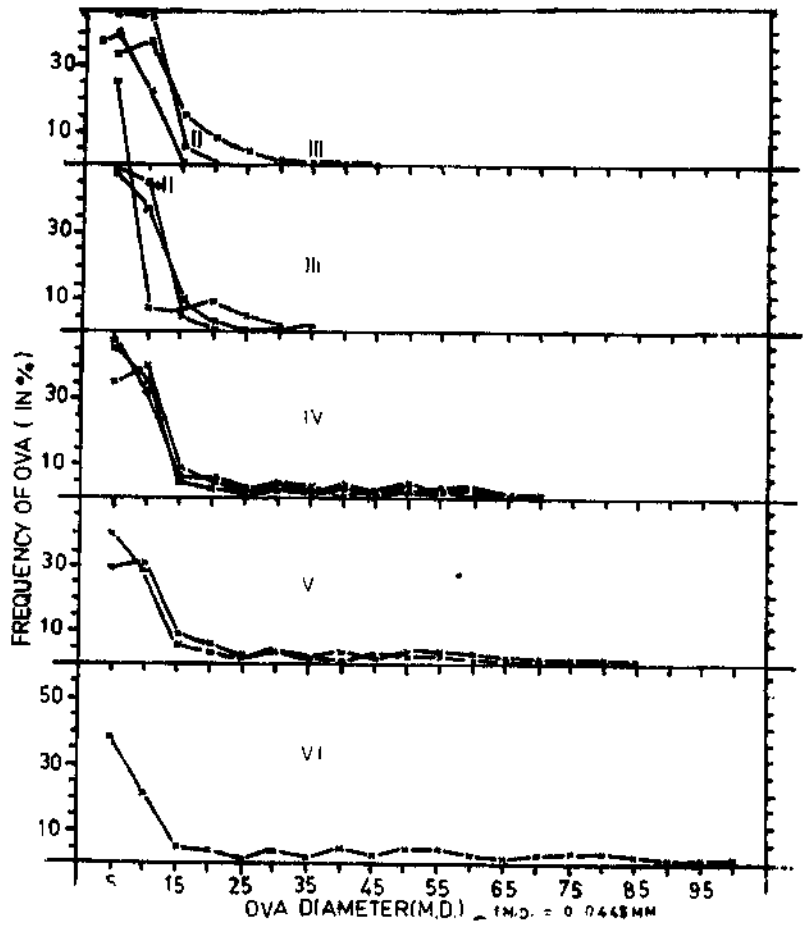

Fig. 3. Ova diameter frequency polygons for different stages of *S. dayi*.

TABLE 3 A. *CPUE (in numbers)*

Ages	1980	1981	1982	1983	1984
0 & 1-year	3506.44	1745.46	1441.00	498.09	696.44
II-year & above	264.12	239.92	321.20	81.56	219.41
Z - values	2.68	1.69	2.87	0.82	–

TABLE 3 B. *Z-values after iteration process*

Years	1980	1981	1982	1983	Natural Mortality (M)
Z-values	2.50	1.50	3.12	0.64	0.7961
F-values	1.7039	0.7039	2.3239	-0.1561	

80 m.d. This nature of withdrawal of eggs from the general egg stock suggests that this species has a protracted period of spawning extending from October-December and again from January-April on a smaller scale.

Fecundity

Usual method (Yuen, 1955) was followed for fecundity study. As there was no size difference of ova from anterior, middle and posterior regions of ovary, a small portion was weighed and estimation was made of ovaries of fishes of different lengths. The mature fishes in the size of 141-144 mm showed 14000 to 27750 ova. Specimens measuring 150-159 mm had 36000 to 58309 ova and fish measuring 163-173 mm showed egg production of 56831 - 66281. This trend clearly indicated that the total egg production appears to be higher as the fish increases in length.

January - February and again September-October time. From November onwards 'K' values showed decline indicating the spawning period in this species. During 1982, these values were lower in March - April, showing secondary spawning. During 1980, 1981 and 1982 high 'K' values were noticed in fish measuring 140, 150 and 135 mm in length (Fig. 5).

TABLE 4

	January - May	*August - December*
Immature	6.11%	6.83%
Maturing	2.32%	7.88%
Mature	4.48%	20.82%
Spent	8.37%	15.14%
Resting	13.44%	14.61%
Total	34.72%	65.28%

TABLE 5

	1980	1981	1982
♂	W = - 6.3996 + 3.2625 log L	W = - 4.3582 + 2.2114 log L	W = - 4.3525 + 2.3591 log L
♀	W = - 5.4967 + 2.7599 log L	W = - 5.6500 + 2.6899 log L	W = - 6.0753 + 3.4081 log L
Total	W = -5.7720 + 2.6323 log L	W = -4.1035 + 2.4801 log L	W = -5.2016 + 2.8901 log L
Size range	133-168 mm	128 - 180 mm	116 - 170 mm

Length-weight relation

The relation between L and W was calculated by the least square method and expressed in terms of log values. The number examined for 1980, 1981 and 1982 were 461, 374 and 307 respectively. The values for different years are given in Table 5.

Condition factor

The ponderal index or condition factor (K) was calculated by the formula used by Hickling (1930). In Figs. 4 and 5, seasonal variation and size-cum-distribution of 'K' values for 1980, 1981 and 1982 are shown. In 1980, 1981 and 1982 high 'K' values were observed in The values show fall in the subsequent size groups marking spawning condition. It appears from 'K' distribution that the spawning occurs in a fish measuring more than 140 mm in length.

General Observation

In earlier years there were no records of occurrence of *S. dayi* at Karwar except that of a brief account of Antony Raja and Lazarus (1975) who described *S. dayi* (Regan) and its close similarity with *S. mederensis* (Lowe) and *S. jussieui* (val.). It is observed from the average catch and cpue that this species is available more during January to June period

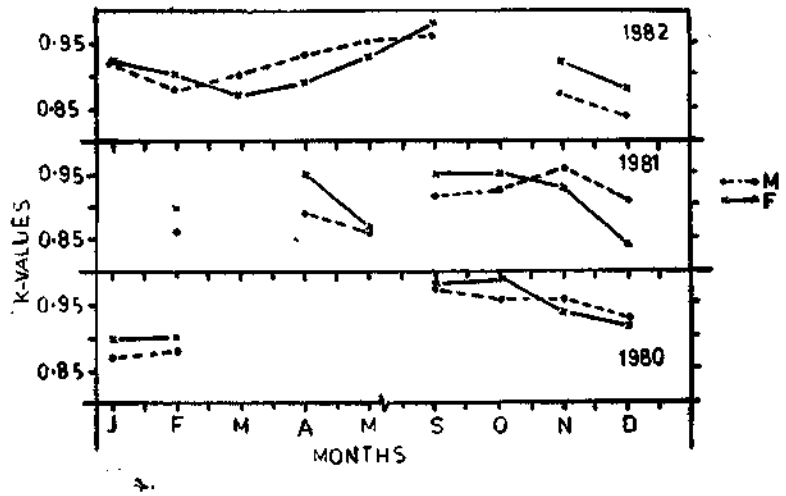

Fig. 4. Seasonal changes in 'K' value for *S. dayi* for males (m) and females (f).

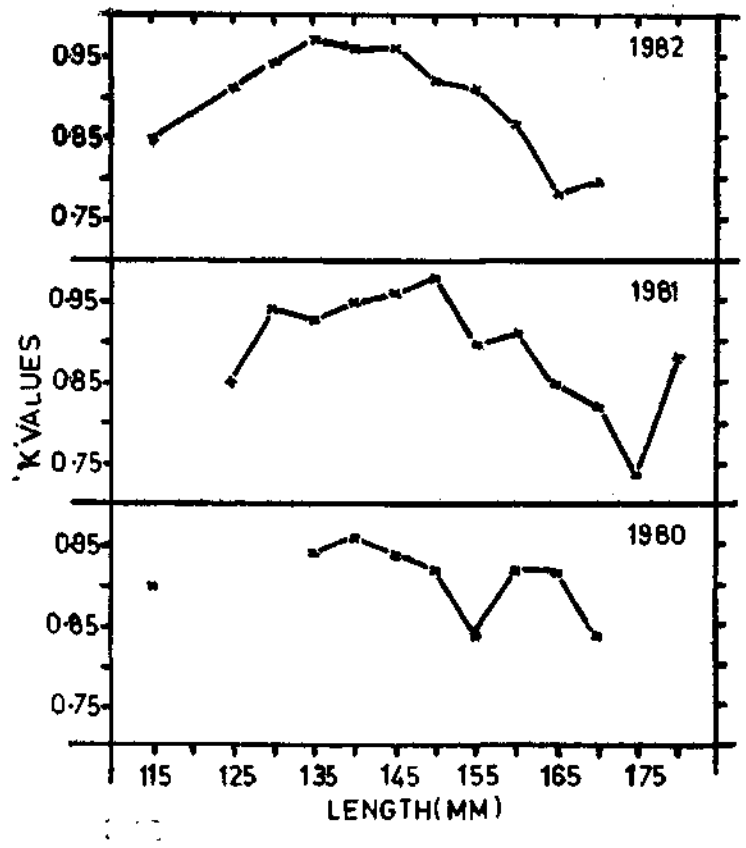

Fig. 5. The average values of 'K' in relation to length of *S. dayi*.

but in the second half of the year *i.e.*, from August - December, decline in the average catches. This may be due to short term annual fluctuations of availability of the fishery in the area. The fishery is supported by the 0 and 1- year old fishes. This has affected the 'Z' values for various years. The spawning in this species based on ova diameter study appears to take place from January to April on small scale and again from October-December on an intensive scale. This is in conformity with the seasonal distribution of 'K' values. Fecundity study revealed that number of eggs ranged from 14000 to 66280 in fish within a size range of 141-173 mm.

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