AN OVERVIEW OF SARDINES AND ANCHOVIES FISHERY ALONG THE INDIAN COASTS

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1. Introduction

The pelagic fisheries resources of India are largely of multispecies multisector fisheries. There are about 240 species contributing to the fishery. However, contribution of Sardine and Anchovies are significant. During 2003, Oil Sardine, other sardine and Anchovies respectively contributed 26%, 8% and 6% to the total pelagic fish landings.

The average annual marine fish production of India for the period 1985 to 2003 was 2.5 million tonnes (CMFRI, 2004) of which pelagic contributed 1.4 million tonnes with percentage contribution of 51%(Fifure-1). The growth in the production of the pelagic Vis- à -Vis the overall production during the last five decades are shown in Table 1. Fourteen species of Sardines are in the Indian waters. Out of 14 species, *Sardinella longiceps* (Oil Sardine) is the major single species fishery which contributes about 15% of the total marine fish production in the country. Other 13 species are termed as Lesser Sardines and contribute about 3-7% to the total marine fish catch. 28 species of Anchovies are recorded in the Indian waters. However, major contributions are due to *Stolephorus, Engraulis, Thryssa, Setipinna* and *Coilia* genera.

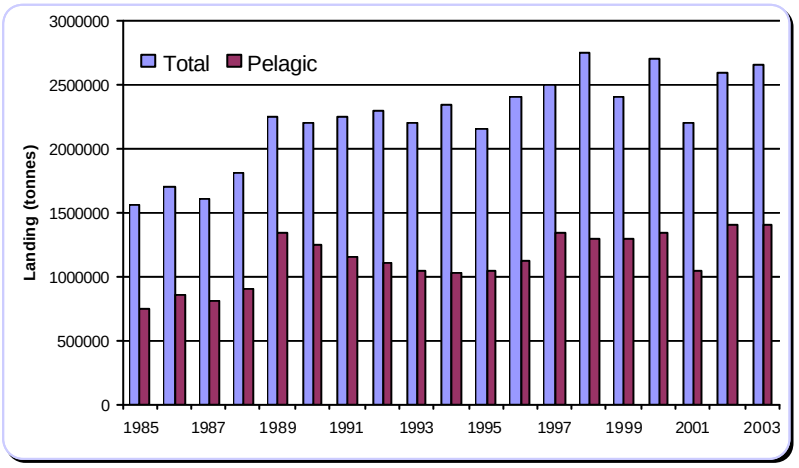

Figure 1: Total Marine and Pelagic fish landings in India during 1985-2003

Table 1: Decadal variation in the production and growth of pelagic and overall fish (1950 to 1999)

Period	Production (ton)		Relative growth (%)	
	Pelagics	Overall	Pelagics	Overall
1950-59	362,548	618,501	-	-
1960-69	527,211	814,721	+45	+31
1970-79	643,142	1,243,707	+22	+27
1980-89	819,093	1,579,836	+27	+27
1990-99	1,116,792	2258874	+36	+43

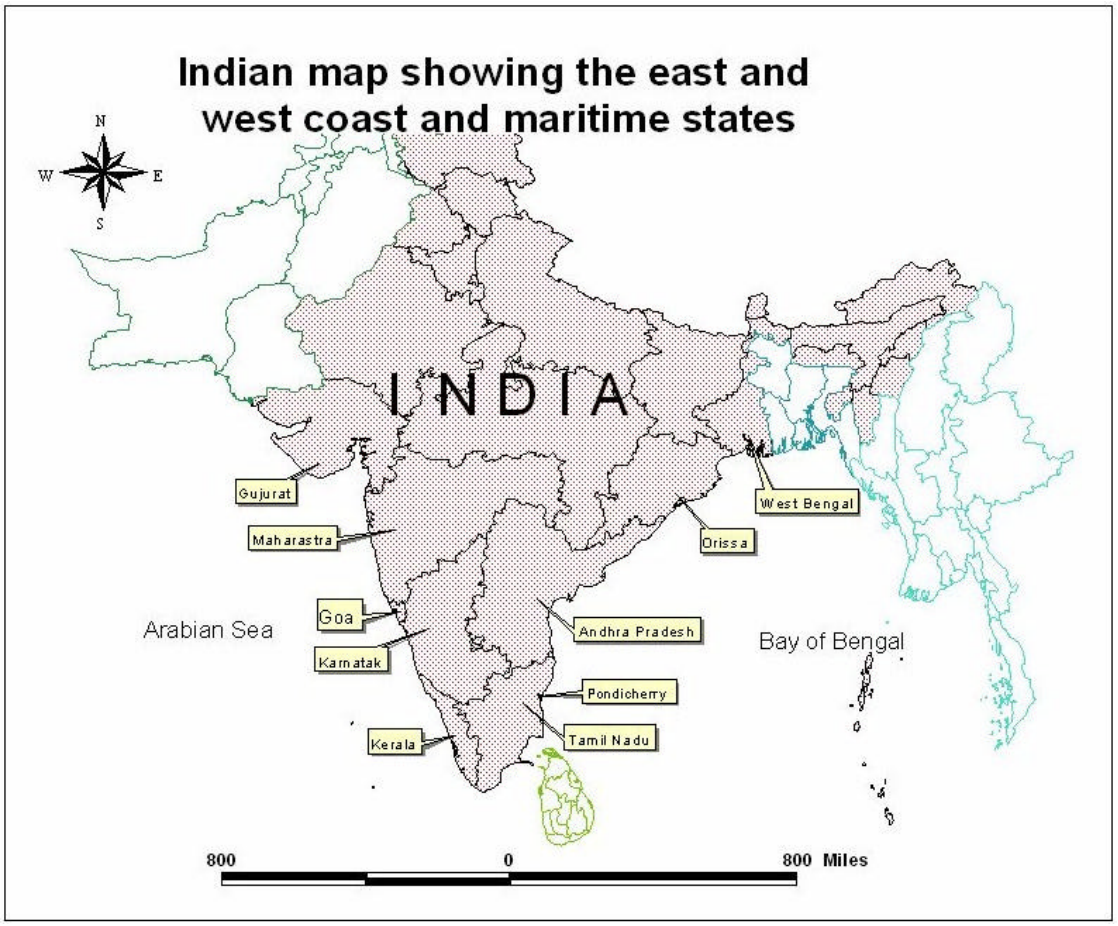

Figure 2: Indian map showing the east and west coast and the maritime states.

2. Production

Figure -2 depicts the coastal states along the Indian East and West coasts. Along the east coast four states such as West Bengal, Orissa, Andhra Pradesh, Tamilnadu, and

one Union Territory, Pondicherry, contribute to the total marine fish production. While on the west coast, the states contributing to the total marine fish production are Kerala, Karnataka, Goa, Maharastra and Gujarat. Figure -3 presents the all India fish landings of Oil Sardine, other Sardines and Anchovies during the period 1985-2003. It is clearly evident that contribution of Oil Sardine, a single species, is maximum as compared to other two groups. Productivity of Indian east coast differs from west coast and is evident from Figure-4a and Figure 4b. Along the east coast, landings of the three groups are maximum in Tamilnadu whereas it is maximum in Kerala along the west coast. This suggests that south-eastern and south-western coasts of India are most productive zones.

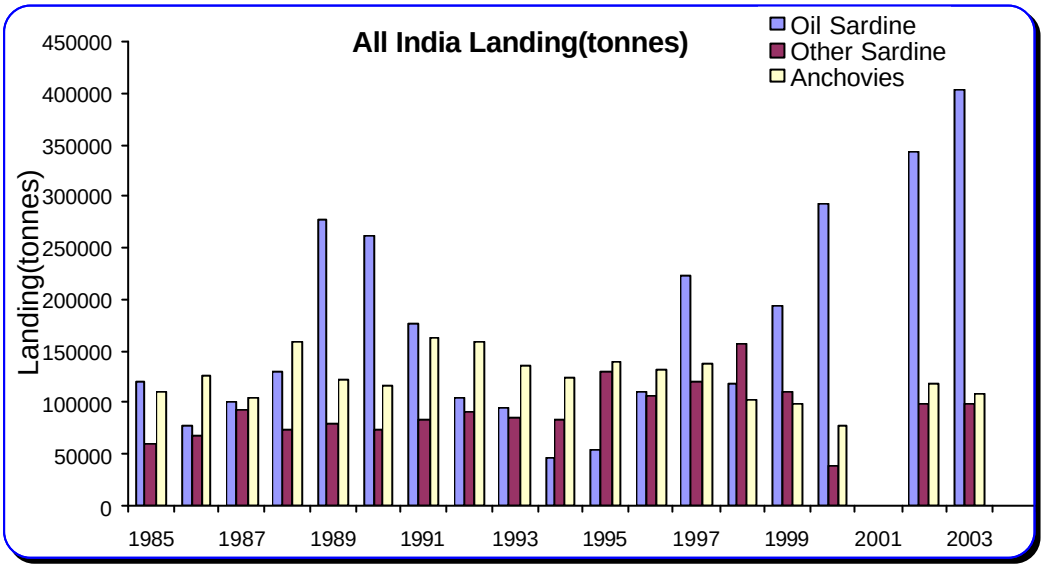

Figure 3: All India fish landings of Oil Sardine, other sardines and Anchovies during 1985-2003.

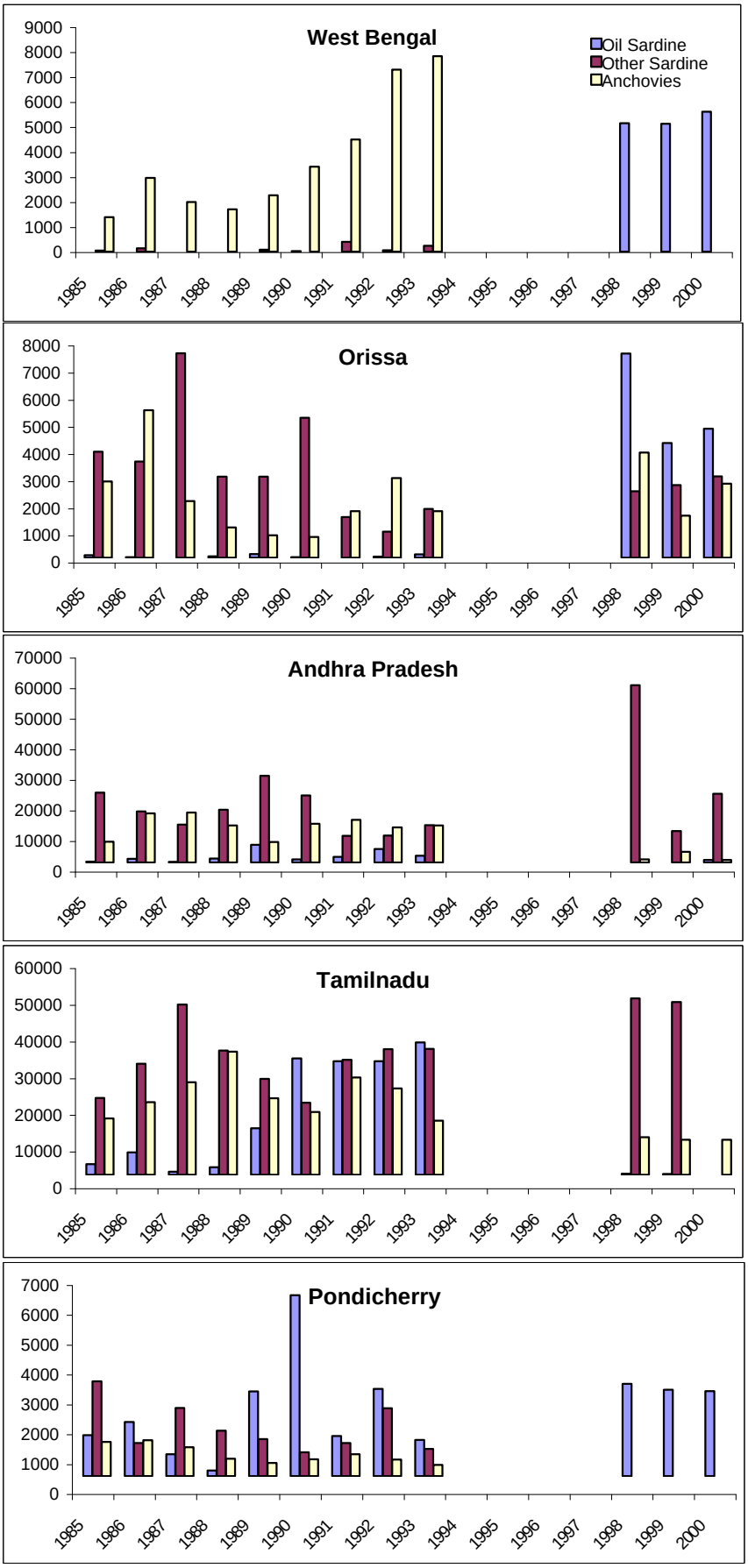

Figure 4a : Statewise (East Coast) landings of Oil Sardines, other sardines and Anchovies during 1985-2003.

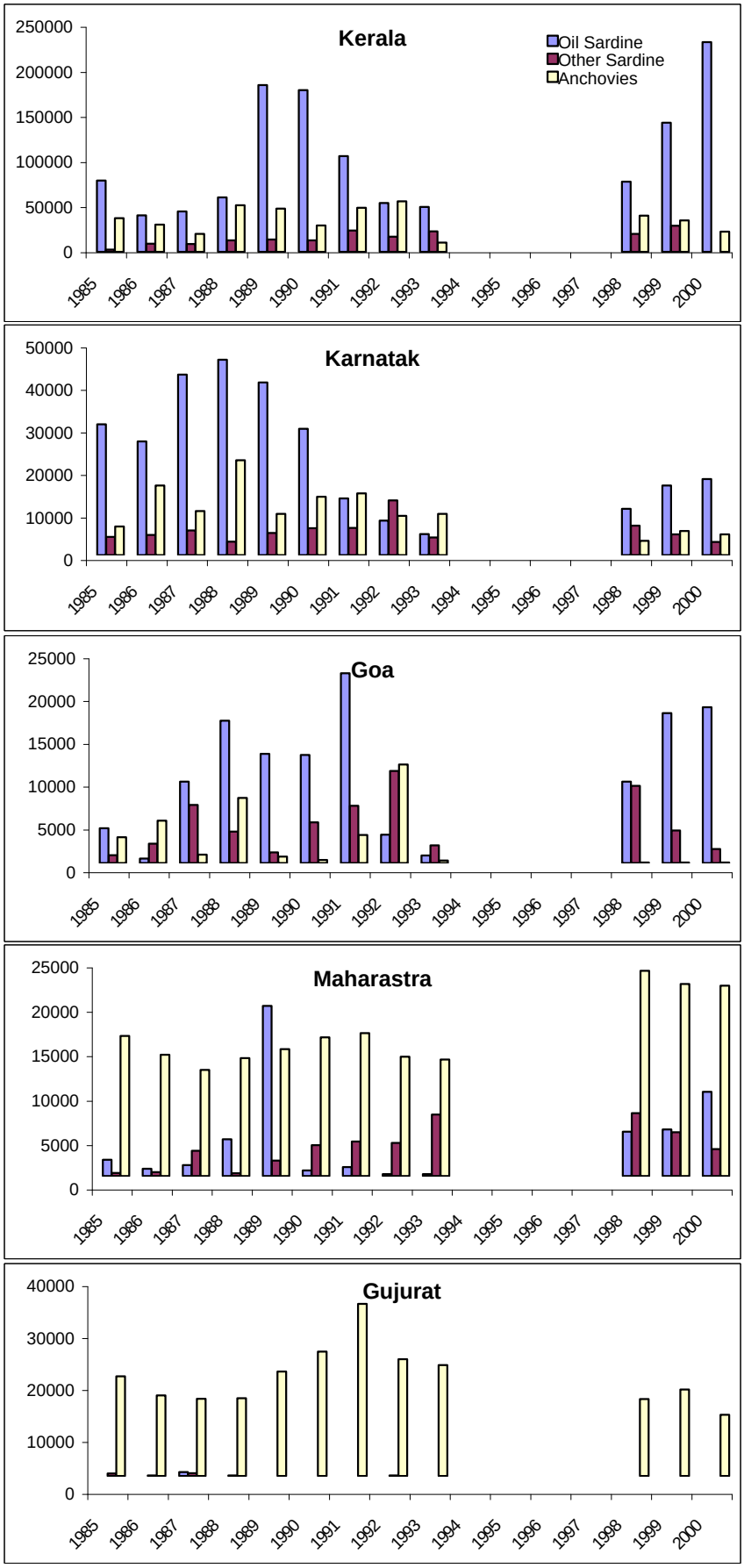

Figure 4 b: Statewise (West Coast) landings of Oil Sardines, other sardines and Anchovies during 1985-2003.

3. Fishery-biology of Sardines

Distribution

Oil Sardine (*Sardinella longiceps*) (Figure 5a) is restricted to the narrow coastal belt of about 15 km from the shore. Figure-5b gives the geographical distribution of Oil Sardine. *S. longiceps* has limited geographical distribution and mostly inhabits coasts of India, Andamans, Sri Lanka, North Borneo, Philippines and Seychelles. Oil sardine landing is maximum during post monsoon season followed by monsoon and pre monsoon. Depth wise exploitation of oil sardine further indicates that in the depth range between 11-20m maximum percentages of oil sardine are caught (Table-2).

Table 2: Depth wise exploitation of oil sardine

Season	(% of oil sardine caught from different depth zone)		
	<10m	11-20m	21-30m
Pre monsoon	2.9	85.1	12
Monsoon	6.2	61.1	32.7
Post monsoon	15.7	78.1	6.2
Annual	12.1	76.9	11

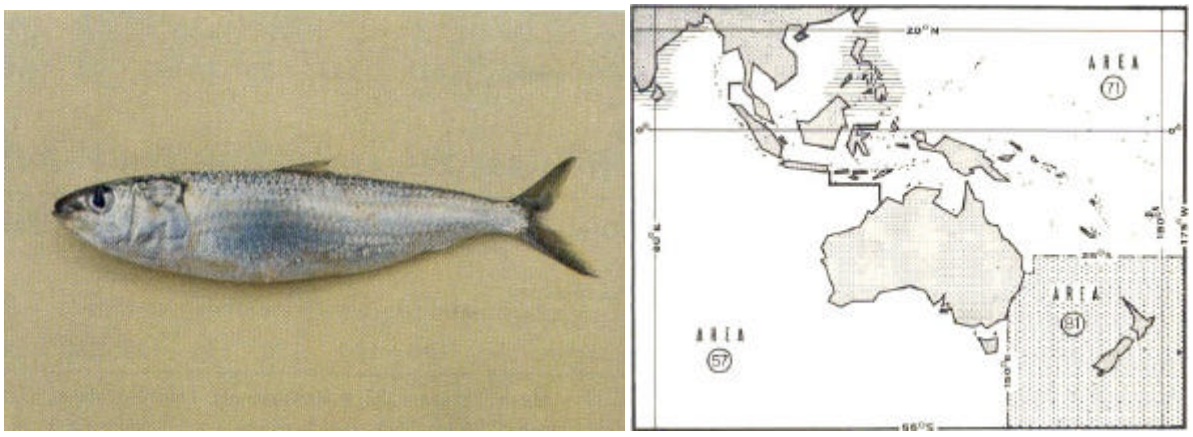

Figure 5: (a) *Sardinella longiceps* Val. and its (b) Geographical distribution.

Age and Growth

Oil Sardine attains different lengths at the end of the 1st, 2nd, and 3rd year which again varies with locations. Table-3 below gives the location-wise length-age relationship for the west coast.

Table-3: Location-wise length-age relationship for the west coast (Antony Raja, 1972)

Location		Length in (mm)		
		1st year	2nd year	3rd year
West coast	Kerala	125-130	165-175	180-190
	Karnataka	133-140	160-165	185-190

Table-3 depicts the age-growth relationship. It is observed that Oil Sardine attains maximum length within 1st year. Thereafter the growth is very slow and takes place at the rate of 10-15 mm per year. Rarely, the fish lives up to three years. The normal life span is 2 ½ years. It has been observed that species grow to an average size of 128 mm, 166 mm and 195 mm by the end of 1st, 2nd and 3rd year of life at monthly growth rate of 10.67 mm, 3.17 mm and 2.42 mm respectively.

Table-4: Growth rate of Sardine with age

Growth(mm)	**Age(Month)**
60-65	1
95-110	2
110-125	3
125-140	6
150-160	12
170-180	24

Length-weight

Length-weight relationship is of primary importance on setting up yield equation, in estimating the fish landings and in comparing population in space and time. Generally weight of fish varies as the cube of length. In Sardines, body depth in relation to length

increases more rapidly in the 20-34 mm groups than in the larger size groups. Value of regression coefficient obtained from the length-weight relationship for small fishes (20-39 mm) are 3.6 and for larger fishes (77-124 mm) is 3.0 (Antony Raja, 1971).

Maximum recorded length for east coast is 204 mm (Luther, 1988). The length of fishes again varies according to their catch in different years. Along the west coast the maximum length reported is 210 mm (Nair, 1953).

Consumption

Oil Sardine feeds mostly on planktons. When surface conditions are unfavorable, sardines resort to bottom feeding. Phytoplankton forms the chief food of the juvenile and adult forms. Diatom *Fragilaria oceanica* has been suggested as their favourable food. The abundance of Oil Sardines during certain years may be related to the blooming of this diatom. Preliminary observations on food and feeding habits of other sardine like *S. fimbriata* (Bennet, 1967) suggest that larger size groups have empty stomach. Copepods and other crustacean items are preferred food of the fish indicating plankton feeding habit.

Spawning

Main spawning grounds are beyond the conventional fishing zone. Adults move away from the near shore water for spawning. Spawning usually takes place at night. Preferably spawning takes place a few nights before and after the new moon. Spawning season begins by about June and continues till October. However, the peak of the spawning period is August-September. During south-west monsoon, salinity and temperature of the inshore water fall and these to a larger extent, act as favourable factors for the entry of spawners in the coastal waters. As a result, spawning season shifts slightly from year to year. Therefore, depending on the onset of the monsoon, spawning takes place a little earlier along southern-west coast than in northern-west coast. There is no shoaling or concentration of one sex in any month of the year, especially during spawning season. It is very rare to obtain mature individuals during the spawning seasons.

In case of other sardines, spawning grounds are not far off the coast. Each individuals spawns only once during the season.

Table-5 Calculated values of weight (gm) and fecundity (thousands) of sardine for different lengths (mm).

Length(mm)	Weight(gm)	Fecundity(thousands)		No. of ova per gram body weight
		Length basis	Weight basis	
150	31.3	27.1	28	894
160	37.8	31.9	32.4	857
170	45.3	37.1	37.6	830
180	53.6	42.8	43.3	808
190	63	49	49.7	789
200	73.3	57	56.8	775

Recruitment

The success of Oil Sardine fishery mainly depends on recruitment strength of early juveniles (50-100 mm) during post monsoon months. Along the south-western coast, recruitment starts early from late August, whereas in the north-western coast the recruitment starts late September. Multiple recruitments with the season are also observed, particularly for lesser sardines. From October onwards recruitment of juveniles intensifies and fishes of wide range of length are observed in the catches. Reproduction and recruitment are found to be closely related to each other. Recruitment depends upon the variability of mortality than on the fecundity.

Population Dynamics

(a) *Fecundity*

It is the egg lying capacity of the fish. Oil Sardine lays 70,000 to 75,000 eggs. Fecundity is directly proportional to the weight of the ovary, which in turn is related to the size of the fish. Therefore, older fish which attain larger size give higher values of fecundity. The fecundity range for one year old is 21,000 – 48,000 and the average is 32300. For two years old it ranges from 26400-62300 with an average of 45000. For a given length or weight the fecundity varies considerably even within the same season.

Antony Raja (1972b) studied the fecundity fluctuations in the Oil Sardine and showed that its relationship with length is curvilinear and with weight it is rectilinear. The regression coefficient of fecundity-length regression analysis ranges from 1.79 to 4.50 for a wide range of length of fishes. Covariance analysis between fecundity-weight indicates that there is no significant difference among the slopes which ranges from 0.053

to 1.209. Thus it can be stated that the fecundity of Oil Sardine is slightly more closely associated with width than with length. Table -5 explains the variation of fecundity with respect to different length and weight. It is observed that for every additional 10 mm increase in length the fecundity increases by 5-6 thousand. For other sardines like *S. fimbriata*, the fecundity ranges from 5300 to 16300 for smaller fish (135-145 mm). Larger fish (170-180 mm) however, give high values of fecundity (33700-41700).

(b) *Maturity*

Oil Sardine undergoes nine stages of maturity with distinct biological features in each stage. The stages are Immature (I), Developing Virgin (IIa), Spent resting (IIb), Maturing (III & IV), Mature (V), Running (VI), Partially spent (VIIa) and Spent (VIIb) (Antony Raja, 1971). Size at first maturity is estimated as 158 mm.

Table 6: Stages of sexual maturity, corresponding periods and lengths at maturity

Stage	Period	Length (mm)
I	Sept - March	127 - 149
II a	April - May	131 - 161
II b	Sept - April	152 - 188
III	May - June	144 - 185
IV	June - July	124 – 189
V	July - Sept	142 – 202
VI	July - Oct.	167 – 190
VII a	July - Sept	147 – 183
VII b	Aug - Nov	159 – 189

Maturity and age relationship for both east and west coast indicate that both Oil Sardine and other sardines mature at the age of 1 year. Indeterminate fish seems to feed more actively than fish in other stages of maturity (Table -7).

Table 7: Feeding Intensity and Maturity.

Maturity	Percentage of fish in different feeding intensity		
	Good	Moderate	Poor
Indeterminates	33	0	67
Immature	11	15	74
Maturing	12	17	71
Ripe	5	12	83
Spent fish	6	8	86

(c) *Mortality*

The instantaneous natural mortality rate, fishing mortality, natural mortality and catchability rates for Oil Sardine in the Indian waters are respectively 2.43, 0.98, 1.45 and 0.0023. Average mortality rate is 0.52. The average instantaneous rate of mortality for west coast is 2.99. However it was low (1.3-1.66) when traditional gear was in operation. The mortality rates however show wide fluctuation from year to year and it could be due to short to annual changes in the available stocks.

3. Fishery -biology of Anchovies

Andhra Pradesh and Tamilnadu along east coast and Kerala along west coast are the three coastal states of India which support 95% of the average annual catch of anchovies in the country. The contribution of genus *Stolephorus* is maximum.

There are two fishing seasons; January to May and September to November. The peak period of anchovy catch is however during September-November. Anchovy fishery shifts from south to north with progress in time. The fishery for anchovies is based mainly on 'O' year class fish.

The total length range varies form 25-100 mm. Juveniles are having length 30-34 mm and adults having 65-89 mm length along the west coast. Length range of 57-132 mm is observed in the Andaman Sea. Anchovies are fished upto a distance of 5 km from the shore and to a maximum depth of 30 meters.

Anchovies mostly feed on zooplankton. Copepods constitute a fairly good portion of the diet throughout the year and its percentage composition varies between 3.1-65.1%. The mean percentage composition of some important food items reveals that *Euphausids* (26.4-44%), *Pontella spp*. (10.4-17.3%), *Megalopa spp*. (9.1-13.4%), *Pseudodiaptomus spp.* (6.1-11.4%) and *Ladiocera spp*. (2.1-6.4%) are most prevalent in the diet. Feeding habits of juveniles are markedly different from adults. Juveniles mostly feed on copepods whereas adults feed on bigger organisms. Seasonal variation in the intensity of feeding is observed and is due to variation in availability of the organisms in a particular environment. Variation in food and feeding habits among the different species of same family is not uncommon.

Mature fish are seen throughout the year. A large number of mature females with advanced stage of ovary are noticed during a restricted period of July-August and again in December-January. Thus, spawning takes place during these two periods.

Recruitment of anchovies takes place during November-June/July at 32-47 length. The range of fecundity in mature fishes with size ranges 110-112 mm is 1171-3356 with a mean of 2068. With larger size range (130-205 mm) and with weight of 14-64g, the fecundity ranges from 3580 to 24180 with a mean of 10360. Eggs in anchovies are shed in batches. In many fishes the fecundity increases as thrice the length.

More males than females are observed among the smaller sizes measuring 99 mm. For sizes >100 mm the percentage of females dominate males. Females are abundant (82.5-100%) from the size group 115-119 mm onwards. This feature is due to migration of fish towards inshore waters after attaining sexual maturity. 50.0% of the fish are found mature at 140-150 mm length. Length recorded at 1st maturity is 117 mm. Growth rates of anchovy in left lobes of the testes and ovaries are faster than in the right lobes of the testes and ovaries. Different species however mature at different sizes.

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