ON THE OIL SARDINE FISHERY OF THE CALICUT AREA DURING THE YEARS 1955–56 TO 1958–59

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There were record catches of the oil sardine (*Sardinella longiceps* Val.) on the West Coast during the year 1957–58; the 1955–56 season had been poor while in 1956–57 the landings were moderate. The total landings in India from October 1957 to September 1958 amounted to about 238,631 metric tons (*vide Quarterly Reports of the C.M.F.R. Institute*), which represented the highest reported yield after the 1933–34 season. During 1957–58 was also witnessed an extension of the area of commercial abundance of the fish inasmuch as very good catches were reported even from centres outside the normal sardine zone. The 1958–59 season was however not as successful, and in Calicut was productive, but short. This paper deals with the fishery of the 1955–56 to 1958–59 seasons in the Calicut area, with special reference to catch, effort, surface salinity and temperature of sea-water and size- and age-composition of the landings.

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Methods

Vellayil (in Calicut) is a typical fishing centre of the region between Tanur and Quilandy (The distance between these two centres is about 60 km.). When there are no shoals in the coastal waters directly off Vellayil, the fishermen normally go 5–6 miles north or south and land their catches at Vellayil. Observations are conducted here every day by the Central Marine Fisheries Research Substation for estimating catch and effort. The following were the main types of units which landed oil sardine during the period referred to here:

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TABLE I

Types of fishing units

	Name of unit	Type	Operational range
1.	*Mathikkolli vala* with 2 main canoes *plus* some auxiliary ones	Boat-seine	Upto about 5 miles from shore
2.	*Arakkolli vala* with 2 canoes ..	Do.	Do.
3.	*Pattenkolli vala* with 2 canoes ..	Do.	Do.
4.	*Paithu vala* with 2 canoes ..	Do.	Do.
5.	*Thattum vala* with 2 canoes ..	Do.	Do.
6.	*Odam vala* with 2 canoes ..	Do.	Do
7.	*Veechu vala* with one canoe ..	Cast net	Do.
8.	*Mathichala vala* with one or two canoes ..	Gill net	Up to about 6 miles from shore

Of these, *Mathikkolli vala* is a boat-seine specially designed for sardine fishing when shoals are dense and numerous. *Pattenkolli vala* is also a boat-seine successfully operated for sardine, mackerel and prawns. *Mathichala vala* is the sardine gill-net (for further details of these and other nets *see* Hornell, 1938; and Nair and Chidambaram, 1950).

Estimation of catch

The landings were estimated on a daily basis by sampling and then summed up for every month. Usually 10–20% of the total number of operated units of each type were sampled. Then, the daily total catch (Y_d) in respect of each type of unit is

$$\frac{U}{n} \sum_{i=1}^{n} y_i. \qquad (1)$$

Where

y_i = the catch of i-th unit.

U = the total number of units operated.

and

n = the number of units observed.

The daily totals (Y_d) were then summed up to get the monthly estimated catch (Y).

Estimation of Effort

Effort (in terms of man-hours) also was estimated in the same way. The daily total effort in respect of a particular type of unit is

$$\frac{U}{n}\sum_{i=1}^{n} m_i h_i. \qquad (2)$$

where

m_i = the man-power of the i-th unit,

h_i = the duration of absence from port of the i-th unit,

U = the total number of units operated,

and

n = the number observed.

The fishing time as defined here includes the time spent on going to and coming from the fishing grounds. The daily totals are then summed up to give the monthly values (g).

Catch-per-unit of effort (in Weight)

This was estimated on a monthly basis (Y/g).

Length Frequency

During the first two seasons, samples of 50–100 sardine were collected usually twice a week. From August 1957 onwards, the procedure was modified so as to estimate the size-composition of the entire catch. As before, samples were collected at least twice a week, but those from different nets of the same type were pooled on each day of sampling. The sample weight (S_d) also was noted. Then the number of sardine of a particular length group (l_n) landed on each day of sampling was estimated by the formula,

$$l_n = Y_d \frac{l_d}{S_d}. \qquad (3)$$

where l_d = the number of fish of a particular length group in the sample.

The number of fish of a particular length group landed during each month (N) by each type of net was estimated as,

$$Y \frac{\Sigma l_n}{\Sigma Y_d} \quad (4)$$

which on division by g gave the catch-per-unit of effort in numbers. Only total length was taken into account and the measurements were grouped into 5 mm. size-classes.

THE FISHERY

1955–56

The fishery was poor during this year. The estimated catch at Vellayil was only about 500 metric tons, of which about 275 m. tons were landed in November and December. The season also came to a close unusually early (*see* Table II).

About 55% of the catch was landed by *Arakkolli vala*. The highest c.p.u.e. was recorded by *Mathikkolli vala* which, however, was operated only for three months.

1956–57

This year the oil sardine season had a longer duration and the catch at Vellayil doubled, compared to 1955–56. However, the commencement of the active season was somewhat delayed and it will be seen from Table IV that the January–March catch was much better than that of October–December. The peak was attained in January when about 49% of the annual total was landed. About 77% of the annual catch was accounted for by *Mathikkolli vala* which also registered the highest c.p.u.e.

1957–58

The catches were very heavy during this season. The statistics are given in Table VI. The estimated total at Vellayil from August 1957 to July 1958 was about 8,424 metric tons of which about 79% was recorded during the October–March period. It may be remembered here that the total sardine landings in India amounted only to about 7,412 metric tons in 1956 (Nair, 1958). During the 1957–58 season, the landings were so heavy all along the coast that the conditions amounted almost to a glut. In the Calicut area, the fishermen themselves curtailed sardine fishing operations to some extent during the October–March period. The actual catch could therefore have been greater.

TABLE II

Catch and effort at Vellayil during the year 1955–56

Months	*Mathikkolli vala*			*Arakkolli vala*			*Mathichala vala*			*Paithu vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August ..	–	–	–	..	..	..	..	..	..	124714	9·81	0·081
September ..	..	..	..	..	..	..	14478	27·75	1·917	49215	0·41	0·008
October ..	170	0·58	3·418	6852	45·15	6·589	4061	11·40	2·807	77602	2·41	0·031
November ..	1519	14·81	9·749	66963	123·09	1·838	403	1·18	2·935	..	..	..
December ..	4924	8·39	1·705	42307	109·35	2·585	9724	16·47	1·694	..	..	..
January ..	..	..	..	8254	4·25	0·514	18018	8·66	0·482	..	..	..
February ..	..	..	..	..	..	..	13948	..	..	..	..	..
March ..	..	..	..	..	..	..	10235	..	..	..	..	..
April ..	..	..	..	465	..	..	82	..	..	..	..	..
May ..	..	..	..	..	..	..	..	..	..	..	..	..
June ..	..	..	..	..	..	..	..	..	..	..	..	..
July ..	..	..	..	645	1·12	1·730	..	..	..	..	..	..
Total ..	6613	23·78	3·596	125486	282·96	2·255	70949	65·48	0·923	251531	12·63	0·050

Months	*Thattum vala*			*Arathattum vala*			*Nethal vala*			*Veechu vala*			Total catch
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	
August ..	23922	47·48	1·985	..	..	..	18792	6·23	0·331	..	..	..	83·52
September ..	56188	43·12	0·767	10158	18·28	1·799	..	..	..	24	0·25	10·583	89·81
October ..	62612	1·70	0·027	..	..	..	..	..	..	..	..	..	61·24
November ..	..	..	..	..	..	..	..	..	..	168	0·54	2·595	139·62
December ..	..	..	..	..	..	..	..	..	..	..	..	..	134·21
January ..	..	..	..	..	..	..	..	..	..	..	..	..	12·93
February ..	..	..	..	..	..	..	..	..	..	..	..	..	..
March ..	..	..	..	..	..	..	..	..	..	..	..	..	..
April ..	..	..	..	..	..	..	..	..	..	..	..	..	..
May ..	..	..	..	..	..	..	..	..	..	..	..	..	..
June ..	..	..	..	..	..	..	..	..	..	..	..	..	..
July ..	..	..	..	..	..	..	..	..	..	34	0·005	0·147	1·125
Total ..	142722	92·30	0·647	10158	18·28	1·799	18792	6·23	0·331	226	0·795	3·518	502·455

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch per unit of effort (in kg.).

TABLE III

Catch statistics in quarterly periods 1955-56

Months	*Mathikkolli vala*			*Arakkolli vala*			*Mathichala vala*			*Paithu vala*		
	g	Y	Y/g	g	Y	Y/g	g	Y	Y/g	g	Y	Y/g
August–October ..	170	0·58	3·418	6852	45·15	6·589	18539	39·15	2·112	251531	12·63	0·050
November–January	6443	23·20	3·601	117524	236·69	2·014	28145	26·33	0·936	..	..	..
February–April ..	..	..	..	465	..	..	24265	.	..	..	..	..
May–July ..	..	..	..	645	1·12	1·730	..	..	..	..	..	..
Total ..	6613	23·78	3·598	125486	282·96	2·255	70949	65·48	0·923	251531	12·63	0·050

Months	*Thattum vala*			*Arathattum vala*			*Nethal vala*			*Vechu vala*		
	g	Y	Y/g	g	Y	Y/g	g	Y	Y/g	g	Y	Y/g
August–October ..	142722	92·30	0·647	10158	18·28	1·799	18792	6·23	0·331	24	0·25	10·583
November–January	..	..	..	..	..	..	..	..	..	168	0·54	2·595
February–April ..	..	..	..	..	..	..	..	..	..	..	..	..
May–July ..	..	..	..	..	..	..	..	..	..	34	0·005	0·147
Total ..	142722	92·30	0·647	10158	18·28	1·799	18792	6·23	0·331	226	0·795	3·518

g = Effort (in man-hours). Y = Catch (in metric tons). Y/g = Catch-per-unit of effort (in kg.).

The various types of nets in which sardine were caught are mentioned in Table VI. Nearly 64% of the landings was accounted for by *Mathikkolli vala*. The other nets, excepting for gill-net and *Pattenkolli vala*, were operated almost entirely in the first half of the season. Gill-net catches were poor during the first half but improved considerably during the months April, May and June as will be seen from Table VII which gives the quarterly statistics for the important nets. The catch-per-unit of effort of *Mathikkolli vala* was at its peak during the first quarter and decreased thereafter. *Pattenkolli vala* showed the highest catch-per-unit of effort in the last quarter.

1958–59

The catch during this season, although above normal, was only about one-third of that of the previous season at Vellayil. The period of good catches was also of lesser duration, as much as 77% having been recorded in the months December and January (*see* Tables VIII and IX). Unlike

TABLE IV. *Catch and effort at Vellayil during the year 1956–57*

Months	*Mathikkolli vala*			*Arakkolli vala*			*Mathichala vala*			*Paithu vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August ..	..	..	..	966	3·16	3·213	1167	0·15	0·129	108723	0·34	0·003
September ..	..	..	..	9058	1·11	0·123	1150	0·09	0·079	77760	0·08	0·001
October ..	..	..	..	..	..	..	..	..	..	..	..	..
November ..	710	0·17	0·238	280	1·12	3·986	9565	1·58	0·164	..	..	..
December ..	27886	71·51	2·564	..	..	..	21859	4·79	0·219	..	..	..
January ..	124674	448·97	3·601	..	..	..	15147	7·06	0·466	..	..	..
February ..	54805	180·54	3·294	..	..	..	6466	4·39	0·679	..	..	..
March ..	8979	23·06	2·571	176	0·11	0·642	19330	26·88	1·391	..	..	..
April ..	6549	21·40	3·268	..	..	..	30246	51·07	1·688	..	..	..
May ..	2118	1·18	0·557	..	..	..	14156	23·72	1·676	..	..	..
June ..	..	..	..	..	..	..	1632	..	..	..	..	..
July ..	9360	55·15	5·930	..	..	..	..	..	..	74431	3·61	0·049
Total ..	235021	801·98	3·412	10480	5·44	0·519	119718	119·73	1·001	260914	4·03	0·015

Months	*Thattam vala*			*Odam vala*			*Vechu vala*			*Pattenkolli vala*			Total catch
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	
August ..	..	..	..	..	..	..	..	..	..	..	..	..	3·59
September ..	..	..	..	..	..	..	..	..	..	..	..	..	1·28
October ..	..	..	..	19486	0·11	0·006	..	..	..	..	..	..	0·11
November ..	..	..	..	58605	0·94	0·016	..	..	..	..	..	..	3·81
December ..	..	..	..	27577	53·33	1·934	481	1·01	2·108	..	..	..	130·64
January ..	33218	47·40	1·427	..	..	..	318	1·35	4·233	1857	1·87	1·009	506·65
February ..	..	..	..	..	..	..	202	1·16	5·762	..	..	..	186·09
March ..	..	..	..	..	..	..	1379	1·07	0·772	..	..	..	51·13
April ..	..	..	..	..	..	..	..	..	..	..	..	..	72·47
May ..	..	..	..	..	..	..	..	..	..	..	..	..	24·90
June ..	..	..	..	..	..	..	..	..	..	..	..	..	..
July ..	..	..	..	..	..	..	..	..	..	1008	2·65	2·629	61·41
Total ..	33218	47·40	1·427	105670	54·38	0·515	2380	4·59	1·929	2865	4·52	1·578	1042·07

Also in September 1956 and January 1957, *Ayalakolli vala* landed 2·23 metric tons of oil sardine; *Ayalachala vala* landed 1·55 metric tons of oil sardine in October and November 1956.
g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

TABLE V

Catch statistics in quarterly periods 1956–57

Months	*Mathikkolli vala*			*Arakkolli vala*			*Mathichala vala*			*Paithu vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August–October ..	..	..	..	10024	4·21	0·420	2317	0·24	0·104	186483	0·42	0·002
November–January	153270	520·65	3·397	280	1·12	3·986	45571	13·43	0·295	..	..	..
February–April ..	70333	225·00	3·199	176	0·11	0·642	56042	82·34	1·469	..	..	..
May–July ..	11418	56·33	4·933	..	..	..	15788	23·72	1·502	74431	3·61	0·049
Total ..	235021	801·98	3·412	10480	5·44	0·519	119718	119·73	1·001	260914	4·03	0·015

Months	*Thattum vala*			*Odam vala*			*Veechu vala*			*Pattenkolli vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August–October ..	..	..	..	19488	0·11	0·006	..	..	..	..	..	..
November–January	33218	47·40	1·427	86182	54·27	0·629	799	2·36	2·954	1,857	1·87	1·009
February–April ..	..	..	..	..	..	..	1581	2·23	1·410	..	..	..
May–July ..	..	..	..	..	..	..	..	..	..	1,008	2·65	2·629
Total ..	33218	47·40	1·427	105670	54·38	0·515	2380	4·59	1·929	2,865	4·52	1·578

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

the previous year, however, the *Pattenkolli vala* accounted for about 60% of the total. But, the highest catch-per-unit of effort was shown by *Mathikkolli vala*. As during the previous season, there was a tendency on the part of the fishermen to curtail the yield when the fishery was at its peak. *Chala vala* catches were better during the first half of the season than during the second half. In Table IX, the statistics in respect of important gear are summed up for quarterly periods. Both *Mathikkolli vala* and *Pattenkolli vala* recorded their highest catch-per-unit of effort during the November–January period. But the catch-per-unit of effort for gill-net was lower during this period, compared to the previous quarter.

Of the four seasons referred to here, the last two were much better than the first two. 1955–56 was the poorest, while 1957–58 was one of unusual abundance of oil sardine. The next season with a level of abundance comparable to that of 1957–58 was 1960–61, when for the July–June period,

TABLE VI. *Catch and effort at Vellayil during the year 1957–58*

Months	*Mathikkolli vala*			*Pattenkolli vala*			*Mathichala vala*			*Paithu vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August ..	8220	11·79	1·43	1045	2·29	2·19	..	..	..	205	0·35	1·70
September ..	..	..	..	18293	42·92	2·35	..	..	..	797	0·28	0·35
October ..	9892	224·24	22·67	8288	54·48	6·57	75	0·37	4·93	..	..	..
November ..	62986	402·75	6·41	.	..	..	..	..	..	..	..	..
December ..	112031	1289·43	11·51	4391	12·88	2·93	124	0·26	2·10	..	..	..
January ..	68349	1073·60	12·15	..	..	..	..	..	..	..	..	..
February . ..	64194	629·56	9·81	..	..	..	..	..	..	..	..	..
March ..	80744	1015·59	12·58	11866	25·94	2·19	..	..	..	..	..	..
April ..	74138	429·17	5·79	4989	24·73	4·96	8556	42·39	4·95	..	..	..
May ..	10359	184·86	17·85	1533	21·18	13·82	6770	25·74	3·80	..	..	..
June ..	30751	214·93	6·99	..	..	..	11259	61·62	5·47	..	..	..
July ..	..	..	..	45950	289·48	6·30	..	..	..	1617	18·00	11·13
Total ..	541666	5476·92	10·11	96355	473·90	4·92	26784	130·38	4·87	2619	18·63	7·11

Months	*Thattum vala*			*Nethal vala*			*Odam vala*			*Veechu vala*			Total Catch
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	
August ..	16519	79·24	4·80	19892	25·68	1·29	7459	12·06	1·62	..	..	..	131·41
September ..	60992	240·11	3·94	2632	8·04	3·05	8885	26·43	2·97	550	1·05	1·91	318·83
October ..	137459	1526·24	11·10	..	..	..	..	..	..	..	..	..	1805·33
November ..	69276	396·53	5·72	..	..	..	..	..	..	49	0·22	4·49	800·50
December ..	342	2·64	7·72	..	..	..	..	..	..	..	..	..	1305·20
January ..	..	..	..	..	..	..	..	..	..	250	4·20	16·80	1077·80
February ..	205	0·34	1·66	..	..	..	..	..	..	140	1·63	11·64	631·53
March ..	..	..	..	..	..	..	..	..	..	..	..	..	1041·53
April ..	..	..	..	..	..	..	..	..	..	..	..	..	496·29
May ..	..	..	..	..	..	..	..	..	..	..	..	..	231·78
June ..	..	..	..	..	..	..	..	..	..	..	..	..	276·55
July ..	..	..	..	..	..	..	..	..	..	..	..	..	307·48
Total ..	284793	2245·10	7·88	22524	33·72	1·49	16344	38·49	2·29	989	7·10	7·18	8424·24

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

TABLE VII

Catch statistics in quarterly periods 1957–58

Months	*Mathikkolli vala*			*Pattenkolli vala*			*Mathichala vala*			*Thattum vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August–October ..	18112	236·03	13·09	27626	99·69	3·57	75	0·37	4·93	214970	1845·59	8·59
November–January	263368	2766·78	10·51	4391	12·88	2·93	124	0·26	2·10	69618	399·17	5·73
February–April ..	219076	2074·32	9·47	16855	50·67	3·01	8556	42·39	4·95	205	0·34	1·66
May–July ..	41110	399·79	9·72	47483	310·66	6·54	18029	87·36	4·85	..	..	..
Total ..	541666	5476·92	10·11	96355	473·90	4·92	26784	130·38	4·87	284793	2245·10	7·88

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

the Kerala catch of oil sardine amounted to about 206,507 metric tons. On the other hand, in the July–June period of 1959–60, oil sardine catch in Kerala had been only about 32,163 metric tons.

In regard to total catch at Vellayil, *Mathikkolli vala* ranked first in 1956–57 and 1957–58 and *Pattenkolli vala* in 1958–59. Again in 1957–58 *Thattum vala* contributed to about 25% of the annual landings but its contribution was negligible in 1958–59. With regard to catch-per-unit of effort *Mathikkolli vala* ranked highest in all the years. *Pattenkolli vala* was only fourth in 1957–58 but moved up to the second position in 1958–59. There was thus a perceptible shift in the relative importance of the various nets during these years.

SALINITY AND TEMPERATURE

The monthly average temperature and salinity of the surface water at about the 8 fathom region off West Hill are given in Table X. As observed by previous workers (Chidambaram, 1950; Nair, 1952; Seshappa, 1953; George, 1953), surface temperature and salinity were low during the monsoon months and high from March to May. At Calicut the sardine season usually extends from September to February or March which almost coincides with the period of intermediate values of temperature and salinity. Chidambaram (1950) found that at Calicut oil sardine landings were good during the months when the average surface temperature was below 29° C. In 1957–58, there were six monthly total catches of more than 500 tons each and the mean temperature for these months fell within the range of 28·5–29·9° C. In 1958–59, total landings of more than 500 tons were recorded

TABLE VIII

Catch and effort at Vellayil during the year 1958–59

Months	*Mathikkolli vala*			*Pattenkolli vala*			*Chala vala*			*Paithu vala*			*Thattum vala*			Total catch
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	
August ..	..	..	..	36896	41·99	1·14	..	..	..	523	0·54	1·03	311	0·29	0·93	42·82
September ..	..	..	..	19458	26·93	1·38	..	..	..	..	..	..	..	..	..	26·93
October ..	..	..	..	17447	30·34	1·74	7232	29·57	4·09	..	..	..	..	..	..	59·91
November ..	16749	190·80	11·39	..	..	..	1833	3·10	1·69	208	0·33	1·59	1305	1·89	1·45	196·12
December ..	27296	368·71	13·51	31190	814·11	26·10	176	2·19	12·44	..	..	..	..	..	..	1185·01
January ..	29069	406·53	14·05	38106	620·34	16·28	..	..	..	..	..	..	..	..	..	1028·87
February ..	7749	97·32	12·56	10613	112·76	10·62	602	0·74	1·24	..	..	..	..	..	..	210·82
March ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May ..	..	..	..	9456	96·05	10·16	2022	4·17	2·06	..	..	..	..	..	..	100·22
June ..	..	..	..	959	0·91	0·95	449	0·51	1·14	..	..	..	..	..	..	1·42
July ..	..	..	..	3532	12·16	3·44	..	..	..	757	1·01	1·33	..	..	..	13·17
Total ..	80863	1065·36	13·17	167657	1755·59	10·47	12314	40·28	3·27	1488	1·88	1·26	1616	2·18	1·35	2865·29

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

TABLE IX

Catch statistics in quarterly periods 1958–59

Months	*Mathikkolli vala*			*Pattenkolli vala*			*Mathichala vala*		
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*
August–October	..	..	..	73801	99·26	1·33	7232	29·57	4·09
November–January	73114	968·04	13·24	69296	1434·45	20·70	2009	5·29	2·63
February–April ..	7749	97·32	12·56	10613	112·76	10·62	602	0·74	1·24
May–July ..	..	..	..	13947	109·12	7·82	2471	4·68	1·86
Total ..	80863	1065·36	13.17	167657	1755·59	10.47	12314	40·28	3.27

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

only in two months, *viz.*, in December and January when the average temperature was 29·1 and 28·8° C. respectively. During this year again, catches of more than 150 tons were recorded for four months and the mean temperature for these months varied between 28·5 and 29·1° C. It may be remembered here that the total catch in 1958–59 at Vellayil was only about one-third of that of 1957–58. In 1956–57, when the catch was only about one-eighth of that of 1957–58, there were four monthly totals of more than 60 tons each, the mean temperature for these months varying between 28·0 and 30·4° C. There was only one month when catch exceeded 500 tons and the mean temperature for that month was 28·0° C. The 1955–56 catch was only one-sixteenth of that of 1957–58. During this year, totals of more than 30 tons each were recorded for five months and their average temperature had values between 24·5 and 28·6° C.; on the other hand, there was no oil sardine catch in two other months which had mean temperature within these limits. Thus, generally speaking, the temperature range during periods of good catches had been 28–29° C. Again Table X shows that during the four years considered here, the mean temperature for months of comparatively better production rarely exceeded 29·5° C.

In 1957–58, the average salinity was between 33·08 and 35·04‰ for the six months when landings rose to more than 500 tons each. But three months with catches less than 500 tons each also had average salinity values within this range. Again, for the four months in 1958–59 when production

TABLE VIII

Catch and effort at Vellayil during the year 1958–59

Months	*Mathikkolli vala*			*Pattenkolli vala*			*Chala vala*			*Paithu vala*			*Thattum vala*			Total catch
	g	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	*g*	Y	Y/*g*	
August ..	..	..	..	36896	41·99	1·14	..	..	..	523	0·54	1·03	311	0·29	0·93	42·82
September ..	..	..	..	19458	26·93	1·38	..	..	..	..	..	..	..	..	..	26·93
October ..	..	..	..	17447	30·34	1·74	7232	29·57	4·09	..	..	..	..	..	..	59·91
November ..	16749	190·80	11·39	..	..	..	1833	3·10	1·69	208	0·33	1·59	1305	1·89	1·45	196·12
December ..	27296	368·71	13·51	31190	814·11	26·10	176	2·19	12·44	..	..	..	..	..	..	1185·01
January ..	29069	408·53	14·05	38106	620·34	16·28	..	..	..	..	..	..	..	..	..	1028·87
February ..	7749	97·32	12·56	10613	112·76	10·62	602	0·74	1·24	..	..	..	..	..	..	210·82
March ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
April ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
May ..	..	..	..	9456	96·05	10·16	2022	4·17	2·06	..	..	..	..	..	..	100·22
June ..	..	..	..	959	0·91	0·95	449	0·51	1·14	..	..	..	..	..	..	1·42
July ..	..	..	..	3532	12·16	3·44	..	..	..	757	1·01	1·33	..	..	..	13·17
Total ..	80863	1065·36	13·17	167657	1755·69	10·47	12314	40·28	3·27	1488	1·88	1·26	1616	2·18	1·35	2865·29

g = Effort (in man-hours). Y = Catch (in metric tons). Y/*g* = Catch-per-unit of effort (in kg.).

TABLE X

Monthly average surface salinity and temperature of the sea-water at the 8-fathom region off West Hill (Calicut) and oil sardine catches at Vellayil (Calicut) during the period 1955–59

Months	1955–56			1956–57			1957–58			1958–59		
	S‰	T° C.	Total catch	S‰	T° C.	Total catch	S‰	T° C.	Total catch	S‰	T° C.	Total catch
August ..	31·58	24·5	63·52	32·55	25·1	3·59	32·40	25·1	131·41	30·63	25·6	42·82
September ..	33·20	26·5	89·81	33·83	24·5	1·28	33·97	25·0	318·83	31·25	25·8	26·93
October ..	30·30	28·0	61·24	32·22	27·2	0·11	33·29	28·6	1805·33	35·19	25·0	59·91
November ..	33·56	28·6	139·62	31·21	28·8	3·81	33·08	29·2	800·50	33·39	28·5	196·12
December ..	33·53	28·0	134·21	33·71	28·5	130·64	34·40	29·1	1305·20	33·27	29·1	1185·01
January ..	33·31	28·0	12·93	33·06	28·0	506·65	34·47	28·5	1077·80	32·45	28·8	1028·87
February ..	34·18	28·6	..	34·02	28·8	186·09	34·56	29·3	631·53	33·69	28·8	210·82
March ..	34·43	29·6	..	34·63	29·7	51·12	35·04	29·9	1041·53	34·67	29·9	..
April ..	34·74	29·5	..	34·86	30·4	72·47	35·03	31·2	496·29	34·50	30·4	..
May ..	32·26	27·8	..	34·03	29·7	24·90	34·70	30·5	231·78	33·95	30·3	100·22
June ..	33·29	26·4	..	25·05	29·4	..	27·40	30·1	276·55	32·61	28·3	1·42
July ..	25·53	24·5	1·125	26·91	25·6	61·41	26·65	26·8	307·48	21·39	25·7	13·17

figure exceeded 150 tons each, the average salinity ranged between 32·45 and 33·69‰, but in June which had an average salinity value within this range, the catch was only about 1·4 tons. During the other two seasons also, no consistent relation between salinity and catch was seen.

Chidambaram (1950) has given the monthly mean surface temperatures of the sea-water at West Hill (Calicut) over the years 1932–33 to 1942–43. Weekly surface salinity and temperature at the 8-fathom region off West Hill for the period 1948–50 have been reported by George (1953) from which the monthly averages can be calculated. These monthly means are presented in Table XI along with the averages over the two periods 1955–57 and 1957–59 for comparison. It will be seen that from November to July the mean salinity was generally higher in 1948–50 than in 1957–59, the March value being the only exception. Compared to 1955–57, however,

TABLE XI

Monthly average surface temperature and salinity of sea-water off West Hill (Calicut) over the periods 1932–43, 1948–50 *and* 1957–59

Months	Salinity (S‰)			Temperature (°C.)			
	Average during 1957–59	Average during 1955–57	Average during 1948–50 (George, 1953)	Average during 1957–59	Average during 1955–57	Average during 1948–50 (George, 1953)	Average during 1932–43 (Chidambaram, 1950)
August ..	31·52	32·07	28·45	25·4	24·8	25·2	26·37
September ..	32·61	33·52	31·34	25·4	25·5	25·9	26·67
October ..	34·24	31·26	32·48	26·8	27·6	26·5	28·18
November ..	33·24	32·39	33·69	28·9	28·7	28·3	28·52
December ..	33·84	33·62	34·71	29·1	28·3	27·7	28·29
January ..	33·46	33·19	34·20	28·7	28·0	27·6	28·14
February ..	34·13	34·10	34·26	29·1	28·7	28·4	28·66
March ..	34·86	34·53	34·67	29·9	29·7	29·5	29·98
April ..	34·77	34·80	35·40	30·8	30·0	30·1	30·31
May ..	34·33	33·15	35·95	30·4	28·8	29·8	30·12
June ..	30·01	29·17	33·07	29·2	27·9	27·0	27·27
July ..	24·02	26·22	29·82	26·3	25·1	25·4	25·91

salinity was generally higher in 1957–59. On the other hand, the average temperatures recorded by the two authors mentioned above for the months November to July are generally lower than those for the corresponding months of the 1957–59 period, only the March value given by Chidambaram being slightly higher. It will also be seen that temperature was generally lower in 1955–57 than in 1957–59. Only future studies will show how far such changes are related to variations in the magnitude of the oil sardine fishery.

SIZE- AND AGE-COMPOSITION

1955–56 (Fig. 1)

Two principal modes A and C could be seen from August to October. In October, another mode B was also apparent besides these two. From

Fig. 1 three year-classes can be recognised, of which the group A was present from August to December and again in July. After October, the youngest fish represented by mode C were not observed and the fishery had to depend mainly on older sardine.

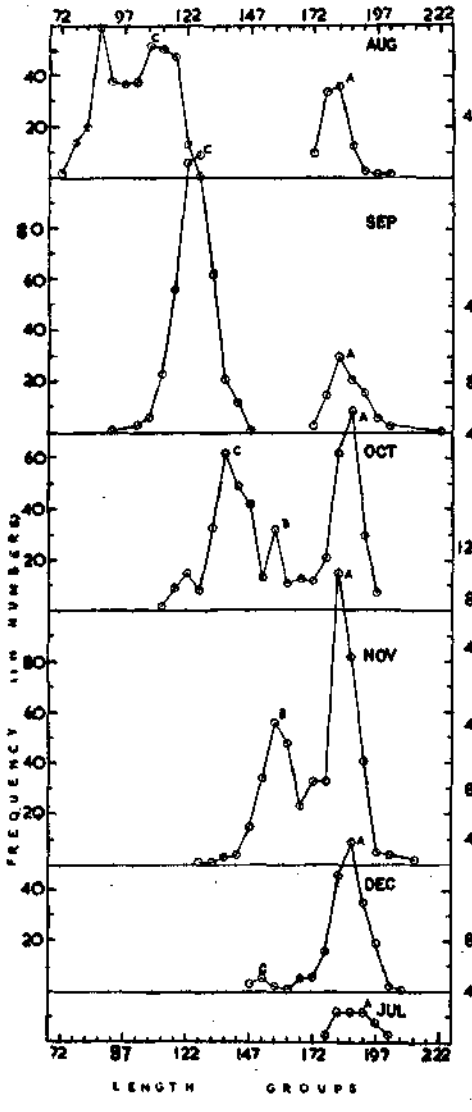

FIG. 1

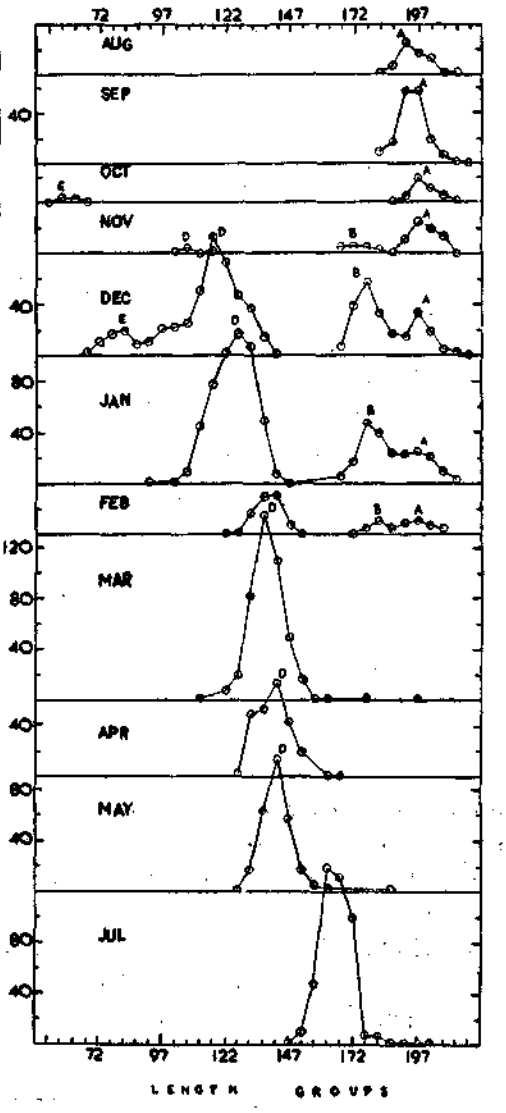

FIG. 2

FIGS. 1–2. Fig. 1. Size composition of the catches in 1955–56. Fig. 2. Size composition of the catches in 1956–57.

1956–57 (Fig. 2)

The group A could be traced right up to February. B was also present from November to February. But the contribution of these two groups to the seasonal catch was much less than that of the year-class D which first appeared in November and continued up to May.

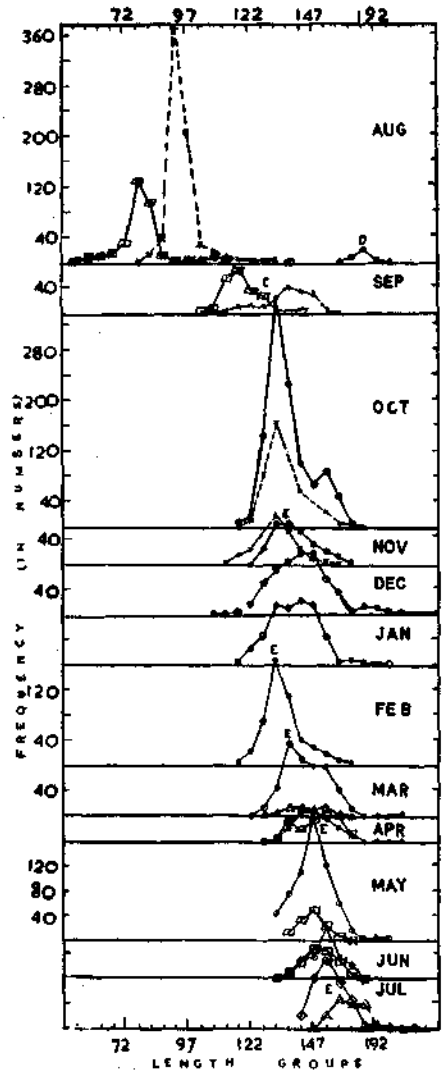

FIG. 3

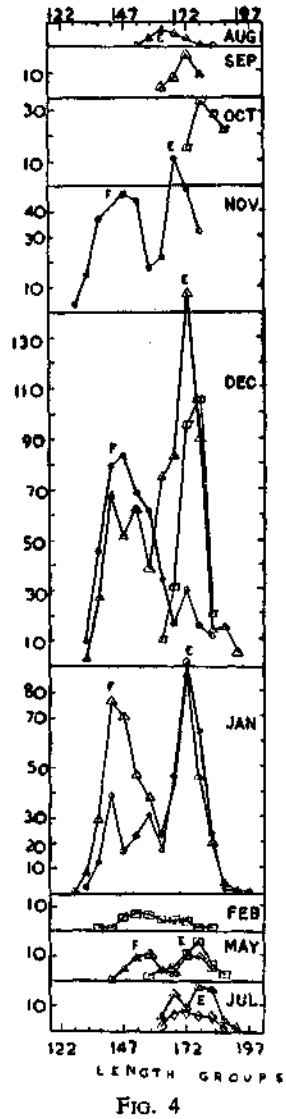

FIG. 4

FIGS. 3–4. Fig. 3. Size composition of the catches in 1957–58. Fig. 4. Size composition of the catches in 1958–59.
□—□ *Nethal vala.* ♦—♦ *Paithu vala.* ×—× *Thattum vala.* △—△ *Pattenkolli vala.* □—□ *Mathichala vala.* ○—○ *Mathikkolli vala.*

1957–58 (Fig. 3)

The catch-per-unit of effort in numbers is plotted in Fig. 3. Very young sardine appeared in the fishery in August when the size-range was also much greater than during the succeeding months. In October, the length-frequency distribution in respect of *Mathikkolli vala* and *Thattum vala* showed the same mode, 130–34 mm. This mode shifted progressively to the right during the succeeding months. Another mode at 165–69 mm. was observed in August but it could not be traced afterwards. From the figure it will be seen that from February onwards the landings of the various nets had more or less the same length-range. Their modal lengths varied to the extent of 5–10 mm. which is only to be expected.

Thus from the size-frequency distribution, two age-groups can be recognised. One had a modal length of 165–69 mm. in August in the *Mathikkolli vala* landings; but its contribution in later months was practically negligible. On the other hand the bulk of the catches was supported by a younger age-group (E). This was represented by a modal length of 130–34 mm. in October and 145–49 mm. in May in the *Mathikkolli vala* catch and 155–59 mm. in July in the *Pattenkolli vala* catch. But from Fig. 3, it can be seen that during the October–July period the monthly modal values representing this year-class in the catches of the various types of boat-seines were either the same or differed to the extent of only 5–10 mm. Again, the tendency was for the modes to be bigger with the progress of the season. Hence the value of 155–59 mm. can be regarded as a rough estimate of the modal size attained by this year-class in July, especially as *Pattenkolli vala* had recorded a smaller mode in March.) *Pattenkolli vala* is much more important than *Paithu vala* in the sardine fishery. Hence the value shown by the former is preferred.)

1958–59

The size-composition for monthly catch-per-unit of effort is shown in Fig. 4. From August–October, the size-frequency distribution was unimodal, but it was bimodal from November onwards. As may be seen from Table VIII, the bulk of the 1958–59 catches was landed by *Mathikkolli vala* and *Pattenkolli vala*. The landings of both the nets had a bimodal length-frequency distribution.

It would therefore be apparent that the 1958–59 fishery was supported by two year-classes. The older one was represented in the *Pattenkolli vala* catches by a modal size of 160–64 mm. in August 1958 and 175–79 mm. group in July 1959. Obviously this was the same age-group which had a

modal value of 155–59 mm. in the July 1958 catches of the same net. But then the monthly modal progression which led up to this value has already been referred to above, and also shown in Fig. 3. Hence it follows that the older of the two year-classes that supported the 1958–59 fishery was in fact the same which had dominated the earlier season (Group E). A new age-group represented by mode F entered the fishery in November at a modal length of 145–49 mm. in the *Mathikkolli vala* catches (The former age-group first appeared in the *Mathikkolli vala* catches in October 1957 at a modal size of 130–34 mm.). From Fig. 4 the contribution made by the older age-group to the catch in numbers would appear to have been almost equal to that made by the younger one. This is completely different from what was seen during 1957–58, when the older age-group practically disappeared from the fishery after August and the catches were supported mainly by the younger one.

The length-frequency data also suggest the possibility of there being two broods in an year. Thus, below mode C in August 1955, there is another mode at 87 mm. which can be traced to 122 mm. in October. The 1957–58 data also indicate this in another way. Mode E moves from 132 mm. in October to 142 mm. in January (It may also be noted that in October and November the modal values for *Mathikkolli vala* and *Thattum vala* are more or less the same). But in February, the mode is again at 132 mm., which moves on to 137 mm. in March; it can also perhaps be traced back to the mode at 92 mm. in August (of *Thattum vala*). The position of the modes in October–November of various years shown in the Table below, is also significant here (October–November is chosen in order to have the modal sizes for the same net).

Mode	Month and year	Size mm.
C	October 1955	135–39
D	November 1956	105–09
E	October 1957	130–34
F	November 1958	145–49

The Year-classes in 1957–58 *and* 1958–59

Nair (1952) has estimated the size of 1- and 2-year olds as about 10 and 15 cm. respectively. The present study also gives approximately the

same values. On this basis, the groups E and F represent the 1956- and 1957-year-classes respectively. A rough estimate of the relative strength of 1- and 2-year olds in 1957–58 and 1958–59 (when samples were weighed according to catches) is made here by breaking the monthly size-frequency curve for total catch at the lowest point between successive modes and then summing up the values for each separate curve (age-group) thus obtained. The results are given in Table XII. Only the *Mathikkolli vala* and *Pattenkolli vala* are taken into account here, as they were the most important nets in 1957–59.

TABLE XII

Catch-per-unit of effort of two nets in 1957–58 *and* 1958–59

Age-group	*Annual Catch-per-unit of effort*			
	Mathikkolli vala in		*Pattenkolli vala* in	
	1957–58	1958–59	1957–58	1958–59
I+	407	249	141	120
II+	12	165	2	152

The difference in age-composition of the two seasons is quite evident. The apparent anomaly in the representation of the 1956-year-class in the catches of *Pattenkolli vala* in the two seasons is perhaps due to the fact that samples for this net were available for six months in 1958–59 but only for two months in 1957–58 (*see* Figs. 3 and 4). But from the results for *Mathikkolli vala* it can be seen that the annual rate of decrease for the 1956-year-class between the two seasons was about 0·6 (0·92 in terms of instantaneous rates). More satisfactory estimates should be possible in future with data for a series of years treated according to strict statistical procedures.

DISCUSSION

The data presented here serve to indicate the effect of fluctuations in year-class strength on catch. This is of course not to deny the importance of ecological factors which may influence the time and place of appearance of sardine shoals. Thus Nair and Subrahmanyan (1955) have discussed the importance of food items, especially the diatom *Fragilaria oceanica*, in this connection. The oil sardine fishery off Calicut normally depends on

the abundance in the nearshore waters of the 10–15 cm. group; *i.e.*, one-year-olds. It will also be seen from Figs. 1–4 that one-year-olds form the recruit age-group at Calicut. These are immature sardine and their role has also been discussed by Nair (1952).

In 1955–56, one-year-olds (1954-year-class) apparently had a low level of abundance and were not observed after October. The fishery after that month had to depend on older fish; hence the low level of catches. One-year-olds were better represented in 1956–57, causing a rise in landings but were probably not sufficiently numerous as to influence the fishery of the next season. On the other hand the 1956-year-class appeared to be exceptionally rich, which was reflected in the record catch of 1957–58, the season of its recruitment; other age-groups were hardly evident in that year. How rich the 1956-year-class was, can also be judged from the fact that it continued in the fishery during the succeeding season also, when its contribution was almost equal to that of the age-group newly recruited during that year. There were less one-year olds in 1958–59 than in 1957–58 (*see* Table XII) as recorded both by *Mathikkolli vala* and *Pattenkolli vala* and but for the influence of the 1956-year-class, the catch also would have been poorer. Between these two seasons the 1956-year-class had a decrease rate of 0·6 as measured by *Mathikkolli vala*. Though this estimate has to be treated with some reservations, still it is of some interest in view of the present-day age-composition of catches.

According to Nair (1952), the spawning period of oil sardine is August–November. During the July–November period of 1956, catch was low in the Calicut area; at Vellayil it was only about 13 tons. That there had been no unusual abundance of spawners in the Calicut area in 1956 will be evident from this. The All-India catch had also been poor in 1956, being only about 7,412 tons, as stated earlier. It has been shown that the average salinity and temperature over the 1957–59 period were different when compared to those for the periods 1932–43, 1948–50 and 1955–57. Only future studies will show how far such changes favour the entry of oil sardine into the fishing grounds in large numbers. What is interesting here is the fact that the same year-class dominated the fishery in the same area in two different seasons.

It has been shown that in the 1958–59 season, both *Pattenkolli vala* and *Mathikkolli vala* recorded their highest catch-per-unit of effort during the November–January period. The catch-per-unit of effort of *Pattenkolli vala* trebled and that of *Mathikkolli vala* increased to about 1·5 times over their respective values for the last quarter of the 1957–58 season (*see* Tables VII

and IX). This increase in their catch-per-unit of effort and therefore the abundance of sardine in the fishing grounds can very well be explained by the fact that the 1957-year-class was recruited at this time (*see* Fig. 4). These nets were thus operating on both the 1956-and 1957-year-classes. But the catch-per-unit of effort of gill-net was lower during this period than during May–July. The probable reason for this is also obvious from Figs. 3 and 4. Both during the May–July and November–January periods gill-net was operating only on the 1956-year-class.

Summary

This study relates to the oil sardine fishery of the Calicut area for the years 1955–56 to 1958–59. The catch was poor in 1955–56, improved in 1956–57, was exceptionally good in 1957–58 but declined again next year, though not to the level of the 1956–57 season. These catch variations could be ascribed, at least to some extent, to fluctuations in year-class strength. At Calicut, one-year olds form the recruit age-group and the fishery normally depends on their abundance in the nearshore waters. The 1956-year-class appeared to be exceptionally rich, which was reflected in the record catch of 1957–58, the season of its recruitment. Its influence was felt during the succeeding season also when its contribution was almost equal to that of the 1957-year-class recruited into the fishery of that year (*i.e.*, in 1958–59). The monthly values for surface salinity and temperature for 1957–59 were slightly different from those reported for previous years. Generally speaking, periods of good catches over the four years considered here had a temperature range of 28–29° C. At the time of entry of the 1957-year-class into the fishery (November–January of 1958–59), the catch-per-unit of effort of *Mathikkolli vala* and *Pattenkolli vala* (boat-seines) recorded increases. From that time onwards these two nets were operating on both the 1956-and 1957-year-classes. The catch-per-unit of effort of gill-net did not show any increase during November–January of 1958–59 as this net was still operating only on 1956-year-class at that time.

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