ON THE DIURNAL VARIATION IN THE CATCHES OF SILVERBELLIES IN PALK BAY

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ABSTRACT

A comparison of the trawl landings from Palk Bay by day and night fishing showed a marked variation in the catches of silverbellies between the two. Another interesting feature noted was that even in night fishing, usually higher catches of silverbellies were observed on full moon nights than on new moon nights both in Palk Bay and Gulf of Mannar. From an analysis of the size groups of *Leiognathus jonesi* and *L. brevirostris* caught, it was seen that the proportion of smaller size group was greater in the night catches than in the day catches whereas the proportion of the larger size group was greater in the day catches than in the night catches. The diurnal variation in the catches of silverbellies shows that they stay at the bottom during day time and at nights good many of them migrate from there and rise to surface and sub-surface waters. This and the instances of sharp difference in the catch rates observed between full moon and new moon nights indicate a close link between light and the process of migration in silverbellies. The probable cause for the variation in the size groups in the catches by day and night fishing is pointed out. Fishing at the surface, sub-surface and midwater levels at night by using suitable gear is suggested for augmenting the production of silverbellies.

INTRODUCTION

Silverbellies occur in good quantities along the coast of Tamil Nadu and form a major fishery in the south east coast, particularly in the Mandapam region. They are caught both from Palk Bay and Gulf of Mannar and in the former the fishery extends from February-March to October-November and in the latter it extends from November to March, there being some overlapping in the fishery of the two regions during the beginning and end of the seasons. During the peak of the fishery which occurs during May to September in Palk Bay, silverbellies constitute a very high percentage of the trawler catches. Though at the beginning and end of the season normally only night fishing is carried out, during the rest of the period both day and night fishing are carried out.

During the course of the studies on the trawl catches from Palk Bay an interesting phenomenon of diurnal variation in the catches of silverbellies was observed. This feature has been noted in respect of North Sea herring fishery (Hjort, 1912; Lucas, 1936) and the herring fishery at Milford Haven (Hickling, 1946). The same phenomenon was also noted in respect of some young fishes

in Danish waters (Johansen, 1925). But for the account of Jayaraman *et al.* (1959) on the abundance of trawl catches from Bombay and Saurashtra waters in relation to light and tide factors, there is very little information on this aspect relating to fish catches from Indian waters. Hence an account of the diurnal variations noticed in the silverbelly fishery in Palk Bay during 1970-73 is given here.

Material and Methods

Estimates relating to the number of trawlers operated, the total catch, the catch of silverbellies and prawns landed by trawlers at Mandapam were made. Samples of silverbellies, drawn from both day and night catches were taken twice a week from the trawlers and analysed for their species composition, total length of individual species and sex and stage of maturity. Since the range in the size of the commercial boats (30-32'), their horse power (36-48 H.P.) and the total length of the trawls was small, their data were clubbed together. The catch per unit of effort (c.p.u.e.) referred to in the text is catch per boat per day which is derived by dividing the total catch for the month obtained by day or night fishing by the total number of boats operated during the day or night respectively for that month. The observations made in this paper relate to the period from May 1970 to December 1973.

Variations in the Catches by Day and Night Fishing

In Tables 1 & 2 are given details of the total catch, catch of silverbellies, catch of prawns and the c.p.u.e. of silverbellies and prawns obtained by trawlers from Palk Bay by day and night fishing respectively during the period from May 1970 to December 1973.

A comparison of the trawl catches of silverbellies from Palk Bay by day and night fishing showed a marked variation in the catches of silverbellies between the two. The c.p.u.e. of silverbellies obtained by day fishing showed a range of 765.0 Kg to 4584.7 Kg whereas the same by night fishing was 19.6 Kg to 307.4 Kg. Even during the peak fishing season i.e. from May to September, day fishing yielded much better landings of silverbellies than night fishing (Tables 1 & 2). While they constituted as much as 91 to 99% of the landings in day catches, the same for night catches came to 23 to 78%. The c.p.u.e. was significantly higher at this period in day fishing (765.0 to 4584.7 Kg) than in night fishing (54.5 to 307.4 Kg).

A comparison of the catch rates realised by day and night fishing within the same month (Table shown on page 258) also revealed sharp variations.

It is seen that in July 1971, the catch rate (c.p.u.e.) by day fishing exceeded that of night fishing by more than 4 times and in 1972 during May-August period the catch rate by day fishing was from 5.7 to 17.9 times that of night fishing. In 1973 also during May to October period the catch rates by day

TABLE 1. *Details of Catch (in Kg) of trawlers by day fishing from Palk Bay during* 1970-73 *period.*

Year and Month		No. of boats operated	Total catch	Catch of silver bellies	Catch of prawns	C.p.u.c. of silver bellies	C.p.u.c. of prawns
1970	May	474	10,22,065	9,81,396	11,145	2070.4	23.5
	June	810	9,38,358	8,72,563	2,259	1077.2	2.8
	July	1,216	19,77,314	18,75,249	3,619	1542.1	3.0
	August	1,150	13,92,129	12,94,127	5,387	1125.3	4.7
	September	444	3,69,653	3,39,659	1,439	765.0	3.2
1971	June	1,313	24,41,234	23,15,202	6,528	1763.3	5.0
	July	517	5,69,677	5,20,793	2,451	1007.3	4.7
1972	May	417	6,78,996	6,71,920	974	1611.3	2.3
	June	754	18,21,009	18,04,971	1,688	2393.9	2.2
	July	1,802	34,22,201	33,64,051	2,753	1866.8	1.5
	August	794	9,00,219	8,85,840	616	1115.7	0.8
1973	May	386	17,80,733	17,69,717	845	4584.7	2.2
	June	761	27,69,733	27,47,744	1,402	3610.7	1.8
	July	930	19,17,226	18,01,069	2,976	1936.6	3.2
	August	1,054	12,25,399	11,18,852	3,162	1061.5	3.0
	September	750	9,85,350	9,14,940	2,670	1219.9	3.6
	October	341	5,49,475	5,21,141	868	1528.3	2.5

fishing exceeded that of night fishing by more than 10 to 70 times. These figures clearly show that the landings of silverbellies by day fishing by far exceed that by night fishing.

It is also observed from tables 1 & 2 that the catch of prawns by night fishing was distinctly better than by day fishing. They constituted only 0.1-1.1% of the total landings by day fishing as against 5.7-37.8% by night fishing. The catch rates too for prawns by night fishing were distinctly better (9.5 to 74.0 Kg) as against those obtained by day fishing (0.8 to 23.5 Kg).

VARIATIONS IN THE CATCHES BETWEEN FULL MOON AND NEW MOON NIGHTS

Another interesting feature noted was that in night fishing usually higher catches of silverbellies were observed on full moon nights than on new moon nights both in Palk Bay and Gulf of Mannar. In Tables 3 & 4, figures relating

TABLE 2. *Details of Catch (in Kg) of trawlers by night fishing from Palk Bay during* 1970-73 *period.*

Year and Month		No. of boats operated	Total catch	Catch of silver-bellies	Catch of prawns	C.p.u.e. of silver-bellies	C.p.u.e. of prawns
1970	October	329	1,08,165	82,669	6,122	251.3	18.6
	November	34	5,354	3,093	713	91.0	21.0
1971	March	359	91,101	45,716	26,551	127.3	74.0
	April	584	1,76,693	1,21,727	14,566	208.4	24.9
	May	695	2,85,454	2,13,669	18,488	307.4	26.6
	July	752	2,67,281	1,82,275	31,808	242.4	42.3
	August	1,196	3,74,247	2,40,998	35,076	201.5	29.3
	September	1,171	3,93,009	2,44,156	49,584	208.5	42.3
	October	1.052	2,69,491	1,69,754	35,791	161.3	34.0
1972	February	921	89,634	25,434	20,883	27.6	22.7
	March	1,261	90,582	24,765	24,266	19.6	19.2
	April	1,271	1,42,344	75,285	24,377	59.2	19.2
	May	1,287	1,81,114	1,33,994	30,778	104.1	23.9
	June	2,654	4,56,874	3,54,735	57,686	133.7	21.7
	July	690	1,77,861	1,23,693	13,686	179.3	19.8
	August	1,302	4,24,855	2,55,812	38,967	196.5	29.9
	September	687	69,572	37,463	12,020	54.5	17.5
	October	642	76,038	44,414	12,017	69.2	18.7
	November	357	51,890	27,814	11,839	77.9	33.2
	December	112	13,542	3,423	5,125	30.6	45.7
1973	January	1,039	1,04,813	27,901	35,583	26.8	34.2
	February	600	58,819	24,045	14,615	40.0	24.3
	March	1,188	2,71,998	1,64,052	34,533	138.1	29.1
	April	1,097	1,73,289	1,23,870	25,127	113.0	22.9
	May	1,580	1,78,352	1,00,982	47,331	63.9	29.9
	June	1,868	2,57,004	1,71,063	46,752	91.6	25.0
	July	1,271	2,63,593	1,66,873	31,651	131.3	24.9
	August	899	1,52,489	90,365	14,198	100.5	15.8
	September	1,500	2,30,250	1,44,480	14,220	96.3	9.5
	October	1,581	2,10,490	1,13,956	26,381	72.1	16.7
	November	741	1,11,758	46,189	10,716	62.3	14.5

to total catch, catch of silverbellies and catch per boat of 'All fish' and silver-bellies obtained on full moon and new moon nights are given for Palk Bay and Gulf of Mannar respectively for the dates when observations were taken in 1970-73 period.

Year	Month	Day fishing Night fishing	No. of boats operated	Total catch (in Kg.)	Catch of silverbellies (in kg.)	c. p. u. e. Silver-bellies.
1971	July	Day fishing	517	5,69,677	5,20,793	1007.3
		Night fishing	752	2,67,281	1,82,275	242.4
1972	May	Day fishing	417	6,78,996	6,71,920	1611.3
		Night fishing	1,287	1,81,114	1,33,994	104.1
	June	Day fishing	754	18,21,009	18,04,971	2393.9
		Night fishing	2,654	4,56,874	3,54,735	133.7
	July	Day fishing	1,802	34,22,201	33,64,051	1866.8
		Night fishing	690	1,77,861	1,23,693	179.3
	August	Day fishing	794	9,00,219	8,85,840	1115.7
		Night fishing	1,302	4,24,855	2,55,812	196.5
1973	May	Day fishing	386	17,80,733	17,69,717	4584.7
		Night fishing	1,580	1,78,352	1,00,982	63.9
	June	Day fishing	761	27,69,733	27,47,744	3610.7
		Night fishing	1,868	2,57,004	1,71,063	91.6
	July	Day fishing	930	19,17,226	18,01,069	1936.6
		Night fishing	1,271	2,63,593	1,66,873	131.3
	August	Day fishing	1,054	12,25,399	11,18,852	1061.5
		Night fishing	899	1,52,489	90,365	100.5
	September	Day fishing	750	9,85,350	9,14,940	1219.9
		Night fishing	1,500	2,30,250	1,44,480	96.3
	October	Day fishing	341	5,49,475	5,21,141	1528.3
		Night fishing	1,581	2,10,490	1,13,956	72.1

It is seen that the range in the c.p.u.e. of silverbellies in Palk Bay on full moon nights was from 88.0 to 329.6 Kg and on new moon nights from 52.0 to 258.0 Kg, the catch rates obtained on full moon nights being higher than on the new moon nights. The c.p.u.e. obtained on the full moon nights of 14-10-70 and 15-7-73 were more than 4 times that of the following new moon nights. On other days also the difference between the two was marked. On Gulf of Mannar side too the range in the c.p.u.e. on full moon nights was from 8.9 to 167.0 Kg as against 4.3 to 89.0 Kg on new moon nights. On the full moon night of 20-11-72 the catch rate was more than six times that of the following new moon night and it was more than twice on the full moon nights of 11-1-71 and 2-11-71 than on the following new moon nights. Except on 2-12-71, in all cases the c.p.u.e. was higher on full moon nights than on new

TABLE 3. *Silverbelly landings (in Kg) by trawlers at Mandapam on full moon and new moon nights during 1970-73 period.*

Area: Palk Bay

Full Moon New Moon	Date	No. of boats operated	Total catch	silver-bellies catch	C.p.u.e. of "All fish"	C.p.u.e. of "Silver-bellies"
Full Moon	14-10-70	25	9,615	7,385	384.6	295 4
New Moon	30-10-70	13	1,800	899	138.4	69.2
Full Moon	8-7-71	54	24,461	17,798	453.0	329.6
New Moon	22-7-71	47	16,711	11,392	355.5	242.4
Full Moon	6-8-71	34	10,635	7,524	312.8	221.3
New Moon	20-8-71	54	17,712	10,508	328.0	194.6
Full Moon	4-10-71	54	15,899	10,325	294.4	191.2
New Moon	19-10-71	53	12,868	6,540	242.8	123.4
Full Moon	28-4-72	52	9,195	7,145	176.8	137.4
New Moon	13-5-72	72	11,186	8,745	155.3	121.4
Full Moon	28-5-72	64	10,816	7,949	169.0	124.2
New Moon	11-6-72	72	9,321	6,180	129.4	85.8
Full Moon	26-6-72	102	17,572	13,644	172.3	133.8
New Moon	10-7-72	90	9,321	6,180	103.6	68.7
Full Moon	17-2-73	40	7,224	4,760	180.6	119.0
New Moon	4-3-73	57	9,268	4,127	162.6	72.4
Full Moon	18-3-73	35	13,405	9,275	383.0	265.0
New Moon	3-4-73	52	15,393	13,416	296.0	258.0
Full Moon	17-4-73	44	7,042	4,955	160.0	112.6
New Moon	2-5-73	52	6,739	3,297	129.6	63.4
Full Moon	15-6-73	102	15,198	9,741	149.0	95.5
New Moon	30-6-73	75	11,115	5,925	148.2	79.0
Full Moon	15-7-73	25	7,785	6,350	311.4	254.0
New Moon	29-7-73	30	3,414	1,698	113.8	56.6
Full Moon	14-8-73	40	5,960	3,520	149.0	88.0
New Moon	28-8-73	25	3,060	1,500	122.4	60.0
Full Moon	12-9-73	50	11,940	8,700	238.8	174.0
New Moon	26-9-73	55	7,711	3,465	140.2	63.0
Full Moon	12-10-73	40	7,224	4,896	180.6	122.4
New Moon	26-10-73	55	6,798	2,860	123.6	52.0

moon nights and the reason for the exception could be that on the concerned full moon night some adverse factors could have come into play affecting the catch.

TABLE 4. *Silverbelly landings (in Kg) by trawlers at Mandapam on full moon and new moon nights during* 1970-73 *period.*

Area: Gulf of Mannar

Full Moon New Moon	Date	No. of boats operated	Total catch	Silver-bellies catch	C.p.u.e. of "All fish"	C.p.u.e. of "Silver-bellies"
Full Moon	13-11-70	24	5,939	2,506	247.4	104.4
New Moon	28-11-70	23	3,967	2,047	172.5	89.0
Full Moon	11-1-71	26	5,376	3,136	206.8	120.6
New Moon	26-1-71	11	1,234	594	112.2	54.0
Full Moon	10-2-71	13	1,739	948	133.8	72.9
New Moon	25-2-71	22	2,897	858	131.7	39.0
Full Moon	2-11-71	51	8,950	3,162	175.5	62.0
New Moon	17-11-71	34	4,703	970	138.3	28.5
Full Moon	2-12-71	20	2,636	444	131.8	22.2
New Moon	17-12-71	20	2,240	660	112.0	33.0
Full Moon	30-1-72	25	1,715	785	68.6	31.4
New Moon	15-2-72	35	2,580	600	73.7	17.1
Full Moon	20-11-72	35	8,617	5,845	246.2	167.0
New Moon	5-12-72	12	1,496	322	124.7	26.8
Full Moon	17-2-73	34	1,967	302	57.8	8.9
New Moon	4-3-73	24	1,445	104	60.2	4.3
Full Moon	10-11-73	33	2,849	1,199	86.3	36.3
New Moon	24-12-73	26	1,651	620	63.5	23.8

VARIATIONS IN THE DISTRIBUTION OF SIZE GROUPS OF *LEIOGNATHUS JONESI* AND *L. BREVIROSTRIS* OBTAINED BY DAY AND NIGHT FISHING

For the purpose of this study two size groups were taken into consideration viz., the smaller size group comprising of fish less than 60 mm in total length and the larger size group comprising of fish 60 mm and above in total length. The percentage proportion of the smaller and the larger size groups of *L. jonesi* and *L. brevirostris* obtained in day and night trawler catches in Palk Bay during the period 1971-73 is given in Figs. 1 & 2. It may be seen from the Fig. 1 that percentage of the smaller size group of *L. jonesi* was higher in the night catches than in the day catches. The smaller size group constituted 31.3 to 78.7% of the total in night catches and in day catches it constituted 7.0 to 44.7% of the total whereas the larger size group constituted 21.3 to 68.7% of the total in night catches and in day catches 55.3 to 93.0%. It is also seen that the smaller size group constituted more than 50% of the total in the night catches in 9 out of 12 months under consideration and reverse was

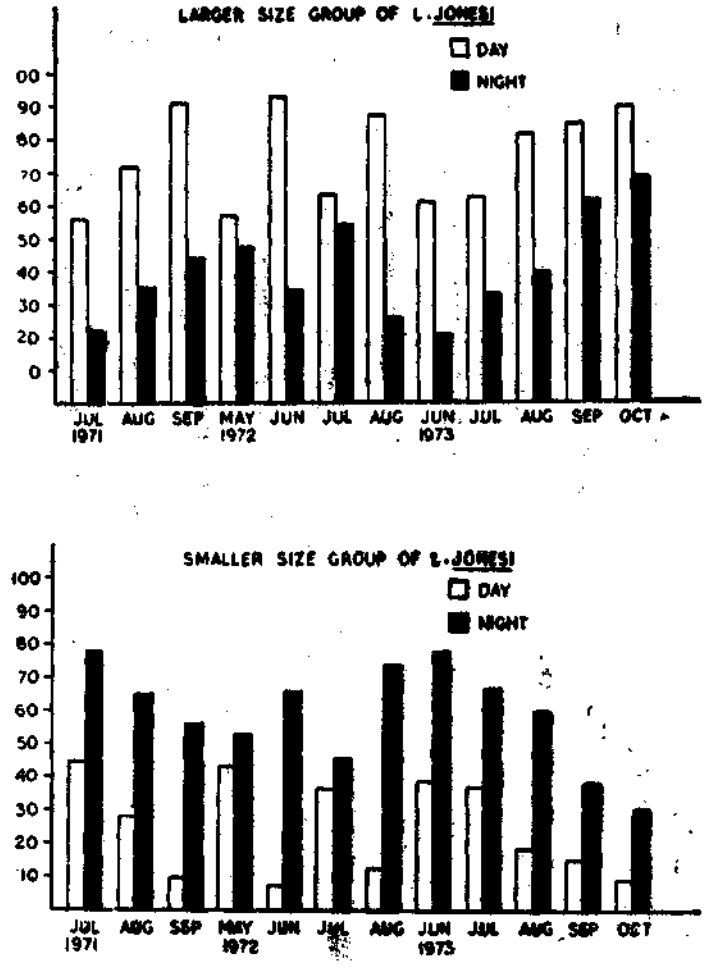

FIG. 1. Histogram showing the larger and smaller size groups of *L. jonesi* obtained in day and night catches from Palk Bay during 1971-73.

the case in the day catches in all the months i.e., the larger size group constituted more than 50% of the total. In the case of *L. brevirostris* also (the next important species after *L. jonesi*) it is seen that the proportion of smaller size group was more in the night catches than in the day catches (Fig. 2). The range in per cent of smaller size group in total catch in night catches was from 6.1 to 51.7% and in day catches it was from 1.8 to 13.6%. The corresponding range for the larger size group was from 48.3 to 93.9% and 86.4 to 100.0%. The above data show that there are variations in the migratory behaviour of smaller and larger sized silverbellies as seen in *L. jonesi* and *L. brevirostris*.

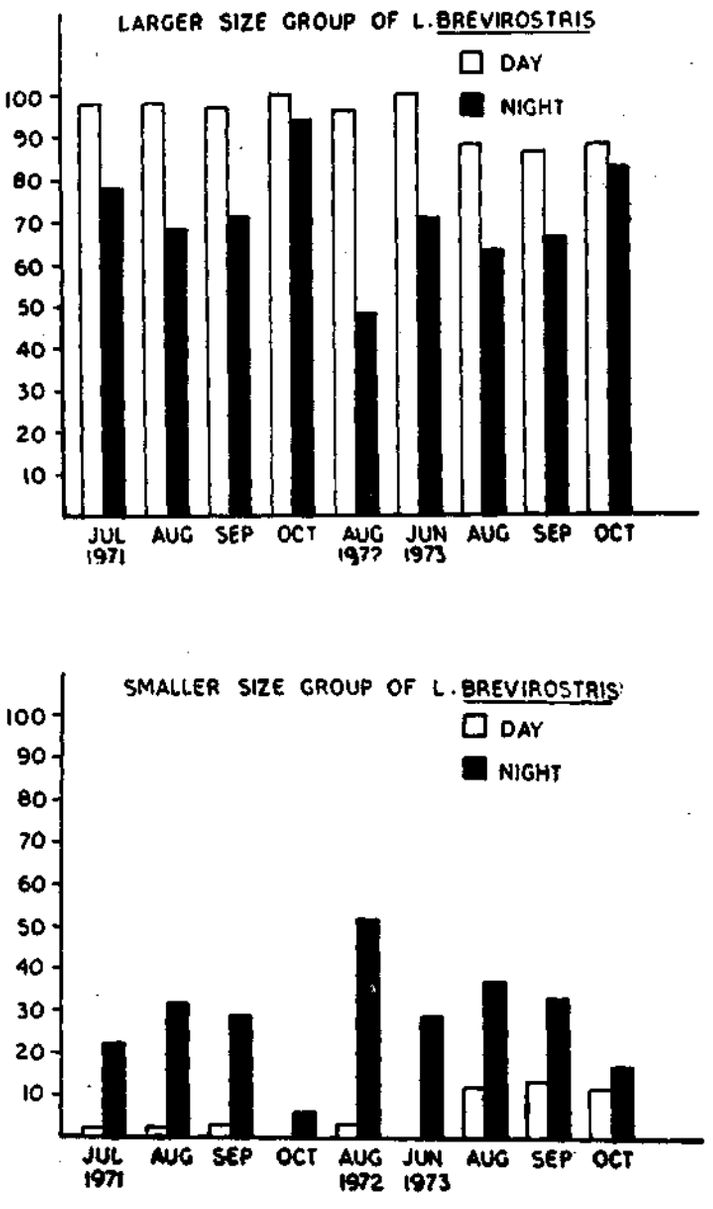

FIG. 2. Histogram showing the larger and smaller size groups of *L. brevirostris* obtained in day and night catches from Palk Bay during 1971-73.

Discussion

Variations in the abundance of trawl catches in relation to light and tide factors have been noted in respect of trawl fish caught off Bombay and Saurashtra (Jayaraman, *et al.* 1956). They found that "the yields of day trawling are better than those of night trawling and also that the catches are better during neap tide periods than during the spring tides". The observations made in regard to the catches of silverbellies by day and night over a period of more than three years showed the interesting phenomenon of diurnal migration. From the data it can be inferred that the silverbellies stay at the bottom during day time and a good portion of them migrates from there and rises to surface and sub-surface waters at nights.

As regards the influence of the moon in regard to the catches, Balan (1963) mentions that on the Calicut coast fishermen have reported about the very good catches of silverbelly, *L. bindus* during foggy nights and also during dark phase of the moon when shoals reveal their presence by luminescence in the surface and sub-surface waters. Sekharan (1971) found that the catches of the sardines, *Sardinella albella* and *S. gibbosa* in Mandapam area were very poor on the full moon day and some days prior and following that day. This is obviously due to the fish being able, on moonlit nights, to see the nets and thus avoid capture.

As regards the catches of silverbellies at Mandapam, as already mentioned, sharp difference in the catch rates was observed between full moon and new moon nights, the catches on full moon nights being usually much higher than on new moon nights both in Palk Bay and Gulf of Mannar. This coupled with the observation that the catches are better during day time than at night time indicates there is a close link between the light factor and the migration of silverbellies.

Lucas (1936) found that the proportion of large herring in the catches is greater by night than by day and suggested that "the diurnal variation of the total catches may be due to an upward migration of the herring at night which is more extensive in the small (and possibly immature) herring than in the larger ones". In the case of *L. jonesi* it was found that the proportion of the larger ones was greater in day catches than in night catches, the reverse being the case in respect of smaller ones i.e. their proportion was greater in night catches than in day catches. In *L. brevirostris* also the proportion of smaller size group was more in the night catches than in the day catches. It is apparent that the proportion of the larger size group becomes less in the night catches because of the tendency on the part of greater number of larger silverbellies to come to the surface and sub-surface waters resulting in the higher proportion of smaller ones (most of which stay at the bottom) being caught at night. It is interesting to note that in the case of herring the behaviour was just the

opposite i.e., the upward migration at night was more extensive in the smaller ones whereas in silverbellies it was more extensive in the larger ones.

Lucas (1936) suggests that the vertical migration in herring may be linked with that of plankton via change in illumination. It has been observed that silverbellies feed mainly on zooplankton, though at times bottom forms like polychaetes and amphipods also form a sizeable portion of the food. (Bapat & Bal, 1952; Kuthalingam, 1958; Venkatarman, 1960 and Balan 1963). The poor occurrence of small sized *L. jonesi* and *L. brevirostris* in the trawl catches during day time suggests their migration from the bottom to the upper layers beyond the level of the trawl. The upward migration of the juveniles during day time could be for the purpose of feeding on the plankton which has been known to descend to the lower layers of water during day time. But the observation that the migration of silverbellies to upper layers at night is more extensive in larger ones than in smaller ones throws a doubt whether the migration of larger ones could be for feeding on plankton. However before we can come to any positive conclusion as regards the relationship of the food factor with the migration of silverbellies, it is necessary to have a precise knowledge of the feeding habits of smaller and larger silverbellies.

At present, in Mandapam area, silverbellies are caught in trawls, shore seines and gill nets, the bulk of the catches being in trawls. The present investigations have shown that silverbellies migrate to upper layers of water in great quantities during night and thus they escape from being caught by trawls which operate at the bottom. Hence it is suggested that the trawls should be operated at the surface, sub-surface and midwater levels at night as they would result in obtaining good catches of silverbellies at night time also. Purse seine operations can also be undertaken in this area during night to augment the silverbelly landings. About 50 tonnes of silverbellies are required every day to feed the fish meal plant at Mandapam and to meet this requirement specially in the off season some boats could be induced to capture silverbellies in good quantities at night by offering remunerative prices.

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