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# THE ROLE OF GILLNET IN THE EXPLOITATION OF LESSER SARDINES

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## Introduction

The lesser sardines are caught in several types of gears. However, the gillnets have proved to be the most effective gear for catching these fishes. In Andhra Pradesh gillnets account for about 75% of the lesser sardine catch. In Visakhapatnam, however, about 95% of the annual lesser sardine catch is contributed by this gear. Here, gillnets with mesh sizes 15 mm, 18 mm, 20 mm, 23 mm, 25 mm, 28 mm, 30 mm, 33 mm and 38 mm are operated. The first two categories being employed for catching small sardines for use as bait in hooks and line fishing seldom land the catch, while operation of the last category is highly seasonal and rare. Season and duration of operation of the remaining five categories of nets also vary depending on the size of sardine occurring in the fishing ground. However, quite often the fishing fleet consisted of more than one category of gillnet, and the sardine samples obtained from fish assemblage centres had a fair spread of the size groups in the length frequency distribution with more than one modal size in spite of the known selectivity of the gillnet for a particular narrow size range. Therefore an attempt has been made to assess the distribution of the different length groups and modal sizes of fish occurring in the different meshed gillnets for the two dominant species of lesser sardines of Visakhapatnam area namely, *Sardinella fimbriata* and *S. gibbosa* as well as the reasons for the occurrence of secondary or minor modes in the frequency distributions. This account embodies the results of these studies as well as some suggestions to improve the lesser sardine landings along the north Andhra coast.

## Data base

For this account the length frequency data (total length) from different nets of known mesh size, as well as some of the results of studies on the fishery and biological characteristics of *S. fimbriata* and *S. gibbosa* obtained during the course of investigations on the lesser sardine fishery resources of Visakhapatnam area during 1983-'89 were utilized. Additional data on the mode of entanglement of the two species of sardines in gillnets were collected during 1991-'92. For this purpose, all the fish of a species that got entangled in each of the three different modes (as explained later) over a section of the gillnet of known mesh size were obtained and their total length measured for further analysis. The lengths were grouped into 5 mm intervals as 100-104 mm, 105-109 mm etc. and each size group was designated by its mid value as 102 mm and 107 mm etc.

## Size range and mean size of fish in different mesh sizes

Examination of the length frequency distri-butions of *Sardinella fimbriata* and *S. gibbosa* caught in the different meshed gillnets shows a remarkable difference as evident from the significant differences (95%) in the means of their distributions. However, all the distributions

exhibited certain degree of overlap with the adjacent ones. This overlap is evident from the 95% length ranges of the distributions ($\bar{X} \pm 1.96\sigma$) as shown in (Table 1 & Fig . 1 ). It may be noted from the table that the mean length of *S. gibbosa* caught in a particular size of mesh till 30mm is higher than that of *S. fimbriata*. This would indicate that the girth of body (circumference of fish at dorsal fin origin) for *S. gibbosa* in fish up to 154 mm total length is less than that of *S. fimbriata*. In other words, the depth of body of the two species at the same length of fish differs significantly. This is confirmed by published records (Nair, R. V. 1973, Indian Sardines, *CSIR Zoological Monograph* No. 2, 107 pp.). The author describes the depth of body in length as 3.5-4.0 for *S. gibbosa*, and 3.0-3.5 for *S. fimbriata*. Size at first maturity of the above two species has been estimated as 142 mm and 147 mm total length (size group) respectively, and fish beyond these sizes are considered as adults. Bulk of the adult *S. gibbosa* sampled had gonads in advanced stages of maturity and those of *S. fimbriata* were mostly in spent resting state. This difference in the state of gonadal maturity would have caused the difference (increase) in the girth of *S. gibbosa* resulting in the capture of the same of lesser length than *S. fimbriata* in gillnet with 33 mm mesh size.

**Modes of entanglement of fish in gillnet**

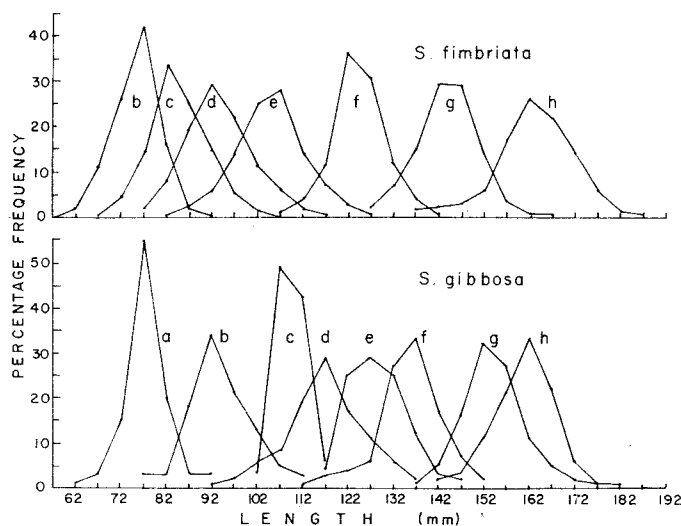Mode of entanglement of sardines was found to be variable and dependent on the length,



Fig. 1.  Length-frequency distributions of *Sardinella fimbriata* and *S. gibbosa* caught in different meshed gillnets: a, 15 mm; b, 18 mm; c, 20 mm; d, 23 mm; e, 25 mm; f, 28 mm; g, 30 mm; and h, 33 mm.

and therefore girth, of the species concerned. Present observations have revealed that among fish caught in gillnet of appropriate mesh size, the smaller fish of the school with body girth same as the mesh size got entangled in the net at the dorsal fin origin and larger fish (with girth greater than the mesh size) at the opercle, while fish of intermediate length (and of girth of body) got entangled in between the above two locations of the predorsal region (Tables 2,3 and Fig. 2). Several other factors such as state of maturity of gonads, fullness of stomach, sex, etc. are said to influence the girth of fish and thereby the location of entanglement of fish in a specific mesh (Nikolskii, G. V. 1919 (1988), *Theory of Fish Population Dynamics* , p. 167-169). Polygons of frequency distributions of the samples pooled from the three locations of entanglement show the occurrence of one or two modal sizes as well as a wide spread of the size range for fish caught in gillnet of a known meah size. These observations also indicate the advantage in the use of flexible yarn (as in the present case) in the fabrication of the gillnet. These results also point out the need to mix the catch (even of a known mesh) thoroughly before taking a sample for biological studies to avoid stratification of fish caught by the three modes of entanglement as well as to increase the size of the sample, and to fit a unimodal curve, if necessary, to the size frequency distribution.

Table 4 gives the percentage distribution of fish at the three locations of entanglement. From the table it may be seen for *S. fimbriata* that in the 20-28 mm mesh sizes the distributions of fish caught at the two extreme points of entanglement were nearly equal (41%), while those entangled in between formed only 18%. But in the large meshed nets (30 and 33 mm) 76% of the fish were caught at gill opening, 10% at the dorsal fin origin and 14% in between. Similar trend is noticeable for *S. gibbosa* also. The foregoing observations go to show that the location of entanglement of the sardine varies with the mesh size of the gillnet employed, and with the species and size of sardine occurring in the fishing ground at the time of its operation.

**Composition of juveniles and adult sardines in different gillnets**

From a study of the distribution of the different size groups of fish of the two common species of lesser sardines caught in the different meshed gillnets it has been noted that in the case

TABLE 1. *Length range, its mean and the related statistics for* S. fimbirata *and* S. gibbosa *caught in gillnets of different mesh sizes*

| Parameter | Mesh size (mm) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 15 | 18 | 20 | 23 | 25 | 28 | 30 | 33 |
| **S. fimbriata** | | | | | | | | |
| 1. No. of fish examined (N) | - | 938 | 1609 | 1834 | 1355 | 340 | 317 | 467 |
| 2. Length range (mm) | - | 57-92 | 67-107 | 72-117 | 82-127 | 107-142 | 127-167 | 137-187 |
| 3. Mean length ($\bar{x}$) | - | 75.3316 | 84.5979 | 93.5703 | 104.8044 | 124.4412 | 143.7981 | 162.9207 |
| (95% confidence limits) | | (±0.3343) | (±0.3141) | (±0.3408) | (±0.4246) | (±0.6317) | (±0.7412) | (±0.8055) |
| 4. Sample standard deviation ($\sigma$) | - | 5.2205 | 6.4260 | 7.4439 | 7.9710 | 5.9344 | 6.7223 | 8.8714 |
| 5. 95% length ranges of the distributions ($\bar{x} \pm 1.96\sigma$) | - | 65-86 | 72-97 | 79-108 | 89-120 | 113-136 | 131-157 | 146-180 |
| **S. gibbosa** | | | | | | | | |
| 1. No. of fish examined (N) | 95 | 38 | 33 | 210 | 69 | 162 | 1000 | 319 |
| 2. Length range (mm) | 62-92 | 77-112 | 102-117 | 92-137 | 117-147 | 112-152 | 132-177 | 137-182 |
| 3. Mean length ($\bar{x}$) (95% confidence limits) | 77.5789 (±1.0033) | 94.1053 (±2.3368) | 109.5758 (±1.1788) | 116.8095 (±1.1626) | 128.7391 (±1.5889) | 135.6111 (±1.1295) | 154.2150 (±0.4357) | 161.0596 (±0.7715) |
| 4. Sample standard deviation ($\sigma$) | 4.9130 | 7.0367 | 3.2848 | 8.5753 | 6.5842 | 7.3125 | 7.0263 | 7.0194 |
| 5. 95% length ranges of the distributions ($\bar{x} + 1.96\sigma$) | 68-87 | 80-108 | 103-116 | 100-134 | 116-142 | 121-150 | 140-168 | 147-175 |

TABLE 2. *Length-frequency distribution (%) of S.* fimbriata *entangled at the three locations in selected mesh sizes*

| Size group (mm) | Percentage entanglement at | | | Three locations comibined |
|---|---|---|---|---|
| | Opercle | Between opercle & dorsalfin | Dorsalfin origin | |
| (1) | (2) | (3) | (4) | (5) |
| 20 mm mesh size | | | | |
| 77 | | | 25.3 | 10.4 |
| 82 | | | 54.4 | 22.3 |
| 87 | | 39.0 | 20.3 | 16.1 |
| 92 | 18.5 | 61.0 | | 19.4 |
| 97 | 46.0 | | | 17.8 |
| 102 | 29.0 | | | 11.4 |
| 107 | 6.5 | | | |
| N | 151 | 77 | 158 | 386 |
| (1) | (2) | (3) | (4) | (5) |
| 23 mm mesh size | | | | |
| 82 | | | 17 | 6.6 |
| 87 | | | 27 | 11.0 |
| 92 | | 33 | 28 | 16.3 |
| 97 | | 67 | 28 | 21.3 |
| 102 | 38 | | | 17.0 |
| 107 | 22 | | | 9.8 |
| 112 | 24 | | | 10.7 |
| 117 | 16 | | | 7.3 |
| N | 150 | 54 | 142 | 356 |
| (1) | (2) | (3) | (4) | (5) |
| 28 mm mesh size | | | | |
| 102 | | | 2.0 | 0.9 |
| 107 | | | 4.9 | 2.0 |
| 112 | | | 30.1 | 12.2 |
| 117 | | 21.2 | 26.6 | 14.2 |
| 122 | 33.6 | 25.8 | 36.4 | 33.2 |
| 127 | 22.4 | 53.0 | | 19.0 |
| 132 | 25.8 | | | 10.5 |
| 137 | 10.5 | | | 4.3 |
| 142 | 7.7 | | | 3.1 |
| N | 143 | 66 | 143 | 352 |
| (1) | (2) | (3) | (4) | (5) |
| 30 mm mesh size | | | | |
| 132 | | | 83 | 10.7 |
| 137 | | 100 | 17 | 16.3 |
| 142 | 26 | | | 18.9 |
| 147 | 29 | | | 21.5 |
| 152 | 25 | | | 18.0 |
| 157 | 13 | | | 9.4 |
| 162 | 7 | | | 5.2 |
| N | 170 | 33 | 30 | 233 |

of *S. fimbriata* gillnets with mesh sizes upto 28 mm (inclusive) catch entirely juveniles, and gillnets with 30 and 33 mm mesh size have juvenile component (fish below 147 mm size

TABLE 3. *Length frequency distribution (%) of S.* gibbosa *entangled at the three locations in selected mesh sizes*

| Size group (mm) | Percentage entanglement at | | | Three locations comibined |
|---|---|---|---|---|
| | Opercle | Between opercle & dorsalfin | Dorsalfin origin | |
| (1) | (2) | (3) | (4) | (5) |
| 23 mm mesh size | | | | |
| 107 | | | 11 | 4.8 |
| 112 | | | 23 | 10.0 |
| 117 | | | 50 | 22.4 |
| 122 | | 82 | 16 | 19.7 |
| 127 | 30 | 18 | | 14.9 |
| 132 | 37 | | | 14.9 |
| 137 | 23 | | | 9.4 |
| 142 | 8 | | | 3.3 |
| 147 | 2 | | | 0.6 |
| N | 133 | 51 | 146 | 330 |
| (1) | (2) | (3) | (4) | (5) |
| 33 mm mesh size | | | | |
| 142 | | | 6.2 | 1.8 |
| 147 | | | 32.1 | 9.4 |
| 152 | | 17.6 | 39.9 | 15.3 |
| 157 | 14.5 | 30.1 | 19.2 | 19.1 |
| 162 | 26.8 | 47.8 | 2.6 | 24.1 |
| 167 | 35.5 | 4.4 | | 18.8 |
| 172 | 12.0 | | | 6.1 |
| 177 | 7.5 | | | 3.8 |
| 182 | 3.6 | | | 1.8 |
| N | 332 | 136 | 193 | 661 |

group) of 53 and 4% respectively in their respective frequency distributions. For *S. gibbosa*, only juveniles (fish below 142 mm size group) are caught in gillnets up to 23 mm mesh size (inclusive). Thereafter juvenile fish account for 94% in 25 mm mesh size, 73% in 28 mm mesh and practically none in 30 and 33 mm mesh gillnets (see Table 1 and Figs. 1, 2).

## Size composition and biological state of lesser sardines exploited by gillnet fishery

*S. fimbriata* of 45-196 mm total length occurred in the gillnet fishery but significant contribution of fish forming 1% and above in the annual length frequency distribution was in the size range of 67-137 mm and accounted for 97% of the catch by number of fish per unit effort. But adult fish formed only 2% of the annual gillnet catch (by number). Similarly, *S. gibbosa* of 75-183 mm length occurred in the gillnet fishery and fish in the length range of 92-172 mm contributed to 99% of the gillnet catch (by number). But adult fish formed as much as 52% of the annual catch
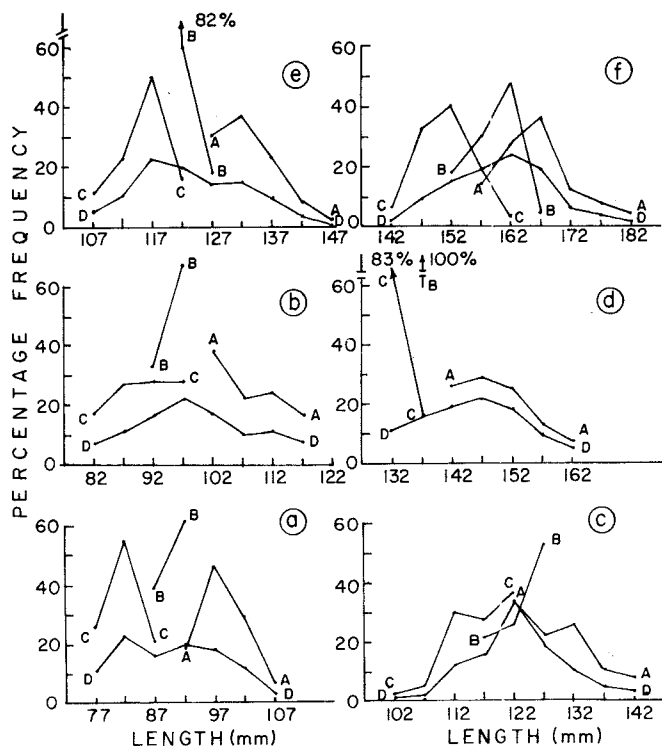
Fig. 2. Length-frequency distributions of sardines got entangled at operculum, a; between operculcum and dorsal fin, b; at dorsal fin, c; and frequencies pooled for entanglement at the three locations, d: for *S. fimbriata* caught in mesh sizes 20 mm (A), 23 mm (B), 28 mm (C) and 30 mm (D), and for *S. gibbosa* caught in mesh size 23 mm (E) and 33 mm (F).

TABLE 4. *Entanglement (%) of sardines at different locations of predorsal*

| Mesh size mm | No. of fish examined | Entanglement (%) at | | |
|---|---|---|---|---|
| | | opercle | Between opercle & dorsalfin | Dorsalfin origin |
| *S. fimbriata* | | | | |
| 20 | 386 | 39.2 | 19.9 | 40.9 |
| 23 | 356 | 44.9 | 15.2 | 39.9 |
| 25 | 363 | 37.5 | 18.7 | 43.8 |
| 28 | 352 | 40.6 | 18.8 | 40.6 |
| Pooled | 1457 | 40.5 | 18.2 | 41.3 |
| 30 | 233 | 72.9 | 14.2 | 14.9 |
| 33 | 208 | 79.3 | 13.0 | 7.7 |
| Pooled | 441 | 76.0 | 13.6 | 10.4 |
| All pooled (20-33 mm) | 1898 | 48.7 | 17.1 | 34.2 |
| *S. gibbosa* | | | | |
| 23 | 330 | 40.3 | 15.5 | 44.2 |
| 33 | 661 | 50.2 | 20.6 | 29.2 |
| Pooled | 991 | 46.9 | 18.9 | 34.2 |

(by number). Thus gillnetting off Visakhapatnam exerts its pressure more on juveniles of *S. fimbriata*, and on the sub-adults and adults of *S. gibbosa*. However, the latter species contributes to only 25% of the combined catches of lesser sardines by gillnet and boat seine of which the gillnet accounts for the bulk (88%) of its total annual landings at Visakhapatnam. From the foregoing observations it is clear that gill netting plays a vital role in the exploitation of lesser sardines, and *S. fimbriata* is the one species of lesser sardine subject to intensive exploitation off Visakhapatnam and the same appears to be true for the major section of the coast of Andhra Pradesh.

## General remarks

During the period 1985-'92 the estimated lesser sardine landings in Andhra Pradesh varied between 8,738 and 28,371 t with the average at 17,130 t, and formed 6-23% of the total fish landings, gillnet landings accounting for 34-92% of the annual lesser sardine landings with the average at 75% (Table 5). It may be noted further from the above table that both the catches of lesser sardines as well as their relative contribution to the total landings have decreased considerably in recent years. These observations indicate the need to regulate gillnet fishing. This may be initiated by discouraging operation of gillnets with mesh size below 28 mm, particularly those having 23 and 25 mm mesh size, for regular fishing. This way, a good proportion of the juveniles of *S. fimbriata* below 115 mm length would get a short lease of life to grow in length and weight and thus would contribute to the improvement of lesser sardine landings along the north Andhra coast.

TABLE 5. *Estimated lesser sardine landings and their contribution (%) to the total fish production, and gillnet's contribution to this group during 1985-'92 in Andhra Pradesh*

| Year | Lesser sardine catch (t) | % in the total fish landings | % contribution of gillnet to the lesser sardine landings |
|---|---|---|---|
| 1985 | 22,864 | 19 | 74 |
| 1986 | 16,723 | 11 | 79 |
| 1987 | 12,348 | 9 | 92 |
| 1988 | 17,258 | 14 | 67 |
| 1989 | 28,371 | 23 | 34 |
| 1990 | 21,894 | 19 | 96 |
| 1991 | 8,738 | 7 | 78 |
| 1992 | 8,843 | 6 | 77 |

Source of data : Fishery Resources Assessment Division of the CMFRI