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Selectivity Estimates for *Sardinella longiceps* (Valenciennes) in the Gill Net Fishery off Cochin

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Length frequency of sardine, *Sardinella longiceps* (Valenciennes), caught in gill nets with mesh size of 32, 34, 36, 38 and 40 mm operated off Cochin (Kerala) was recorded. Using this, the selectivity parameters of the nets of these mesh sizes were assessed. The size range of *S. longiceps* caught was 12 to 20 cm. The estimated selection factors ranged from 4.56 to 4.67 and the selection lengths ranged from 14.7 to 18.7 cm. Gill nets with mesh size less than 34 mm did not facilitate the escapement of *S. longiceps* which had not attained the stage of first maturity.

Key words: Gill net selectivity, mesh size, *Sardinella longiceps*, Cochin

Selectivity of fishing gear is an important tool for effective management of fisheries. The importance of selecting the optimum mesh size from the standpoint of conservation of resources has been stressed by several investigators. (Havinga & Deedler, 1948; Nomura, 1961; Burd, 1963). The selectivity of fishing gear has a direct influence on the exploited stock (Hamley & Regier, 1973; Hamley, 1975). The selective nature of gill nets was known as early as in 1882 (Collins, 1882) but its scientific study started with Baranov (1914). Later, selectivity of gill nets received much attention in various parts of the world (Baranov, 1948; Mc Combie & Fry, 1960; Regier & Robson, 1966, Mc Combie & Berst, 1969; Yatsu & Watanabe, 1987; Hamley & Regier, 1973; Hamley, 1975; Karunasinghe & Wijayaratne, 1991; Reis & Pawson, 1992). Studies on optimum mesh size were carried out in India for some commercially important species (Joseph & Sebastian, 1964; Khan *et al.*, 1989; Sree krishna *et al.*, 1972; Sulochanan *et al.*, 1968; Panikkar *et al.*, 1978; Mathai *et al.*, 1990; George, 1991; Mathai *et al.*, 1993).

Gill nets with small mesh are widely used in coastal areas of Kerala for the capture of anchovies, mullets, prawns, sardines, sciaenids and mackerel. Of these, gill nets for sardine, with mesh size in the range of 30 to 40 mm are operated throughout the year. The material used for gill nets of Kerala has changed from cotton (Satyanarayana & Sadanandan, 1962) to nylon multifilament (Vijayan *et al.*, 1993) and recently to nylon monofilament (Thomas & Hridayanathan, 2000).

Sardinella longiceps is a common species in the inshore waters of Kerala. The selectivity estimate for this important species has not been done so far but for a preliminary study by Joseph & Sebastian (1964). The main objective of this study was to determine of the optimum selection length, selection factor and probabilities of capture for *S. longiceps*, caught in polyamide monofilament gill nets of mesh size ranging from 32 to 40 mm and to arrive at the minimum size of mesh to be used to prevent capture of fishes below the size at first maturity.

Materials and Methods

The catch of gill nets was sampled for a period of 12 months at the fish landing

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centre at Beach road, Kannamaly, Cochin, during May 1998 to April 1999. Nets made of polyamide (PA) monofilament of 0.16 mm diameter and having a fishing height of 2.4 to 4.6 m and mesh sizes of 32, 34, 36, 38 and 40 mm, rigged with a hanging coefficient of 0.53 were selected for the study. The total length of individual fish was measured to the nearest mm (Sparre *et al.*, 1989). The lengths of 150 to 200 fishes obtained by random sampling every month were measured. The mesh sizes were determined by measuring the stretched meshes with a centimeter scale (FAO, 1978). Average of mesh measurements taken from 5 randomly chosen regions of the net was determined.

The selectivity was estimated by using the indirect method of Holt (1963). According to him, for gilling and wedging, the selection curves are bell shaped and can be described by the normal distribution $S(L) = \exp[-(L-Lm)^2 / 2s^2]$ where S(L) is the length based gear selectivity, L is the length interval midpoint, Lm is the optimum length for being caught and s is the standard deviation of the normal distribution.

The procedure for estimation of selection curve involved the following steps:

(i) Cb = number of fish of the length l in a net with larger mesh size (m_2)

Ca = number of fish of the same length l in a net with smaller mesh size (m_1)

(ii) Calculation of log ratios for successive fish lengths

$$Y = \ln (Cb/Ca)$$

(iii) Regression analysis of the log ratios against the interval midpoint and expressed as

$$Y = a + bL$$

where Y is the natural logarithm of ratio of catches, L is the mid point of the length class and a and b are constants.

(iv) The selection factor (SF) was calculated according to Jones (1984)

$$SF = (-2a) / [b\ (m_1 + m_2)]$$

where m_1 and m_2 are the mesh sizes of two gill nets with slightly different mesh sizes.

(v) The optimum selection lengths (L_1 and L_2) in the two gill nets were calculated from the following equations:

$$L_1 = SF \times m_1$$

$$L_2 = SF \times m_2$$

(vi) The standard deviation (s) of each probability function was calculated (Jones, 1984) as follows:

$$s = (L_2 - L_1)^{0.5} / b$$

(vii) Using the values for L_1, L_2 and s, the probability (P_1) of capture for a given length L in a gill net having a mesh size m_1 was calculated (Pauly, 1984).

$$P_1 = \exp\ [-(L-L_1)^2 / (2s^2)]$$

Similarly the probability of capture (P_2) for the mesh size m_2 was calculated as

$$P_2 = \exp\ [-(L-L_2)^2 / (2s^2)]$$

Selectivity curves were drawn using probability of capture against each length class.

The optimum selection length calculated for each mesh size was compared with the size at first maturity.

Results and Discussion

Percentage length frequency distribution of *S. longiceps* in gill nets of mesh sizes 32, 34, 36, 38 and 40 mm is given in Table 1. The total length of *S. longiceps* caught ranged from 12 to 20 cm. The modal length caught in the smallest mesh size of 32 mm was 15.5 cm and this increased with increasing mesh size to 15.5, 16.5, 17.5 and 18.5 cm in 34, 36, 38 and 40 mm. mesh size, respectively. Joseph & Sebastian (1964) recorded 12.1 to 20 cm as the size range of

Table 1. Percentage of length classes of *S. longiceps* caught in gill nets of different mesh sizes (n = 1688)

length class	Mesh size (mm)				
(cm)	32	34	36	38	40
12-13	1.85	0.00	0.00	0.00	0.00
13-14	9.26	0.53	0.61	0.00	0.00
14-15	28.70	11.11	2.76	0.41	0.00
15-16	48.15	55.03	22.09	3.72	0.71
16-17	11.11	28.04	41.41	16.53	5.67
17-18	0.93	4.76	30.37	33.06	27.66
18-19	0.00	0.53	2.76	30.99	36.17
19-20	0.00	0.00	0.00	14.05	28.37
20-21	0.00	0.00	0.00	1.24	1.42

Table 2. Results of the regression analysis between natural logarithms of relative catch ratios against class midpoints for *S. longiceps*

Mesh size combination (mm)	Intercept	Slope	Regression coefficient	Standard Deviation
32 & 34	-16.515	1.087	0.9536	0.882
34 & 36	-22.512	1.401	0.8697	0.680
36 & 38	-22.774	1.360	0.9380	0.698
38 & 40	-14.723	0.864	0.9823	1.157

Table 3. Selectivity estimates of *S. longiceps* for different mesh sizes

Mesh size (mm)	Optimum Selection length (cm)	Selection factor
32	14.7	4.60
34	15.6	4.59
36	16.4	4.56
38	17.5	4.60
40	18.7	4.67

S. longiceps caught in gill nets of mesh size 28 to 41.8 mm and the modal lengths recorded in the present study were lower than these. The slopes and intercepts of the plots of natural logarithms of catch ratios for different mesh size combinations against midpoints of class intervals, together with estimated values for standard deviation of catch ratios are given in Table 2.

The values for the optimum length, standard deviation and selection factors were taken as the average of the two combinations, which share the same mesh size except for the two extreme mesh sizes, 32 and 40 mm, as suggested by Pauly (1984). The results of the analysis are given in Table 3. The optimum selection length gradually increased with increasing mesh size from 14.7 cm in 32 mm mesh size to 18.7 cm in 40 mm mesh size. The selection factor ranged from 4.56 to 4.67. Mesh size of 32 mm had a high selection factor and it decreased in 34 mm mesh size. However, for mesh sizes 36 mm to 40mm, the selection

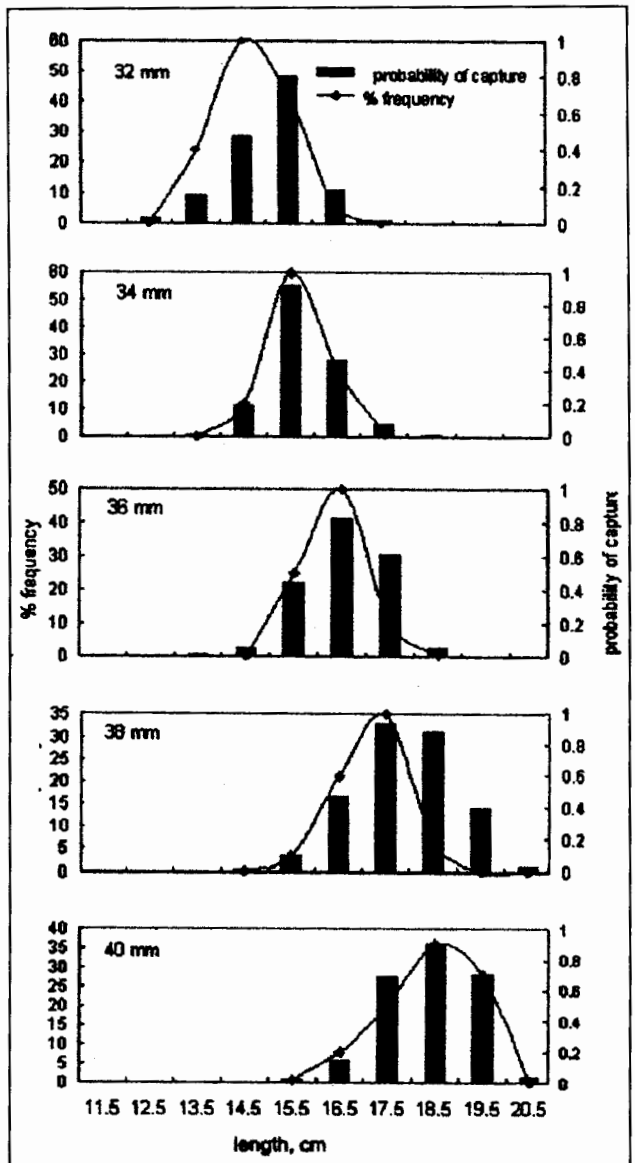

Fig. 1. Selectivity curves and observed length frequency distribution of *S. longiceps*, for different mesh sizes

factor increased gradually with increase in mesh size. This can be due to the change in body proportion due to sexual maturity (Strzyzewski, 1964; Dayaratne, 1988).

The estimated selectivity curves are presented and compared with the observed length frequency distribution of fish in Fig.1. In 32 mm mesh size, the length of fish showing the maximum probability of capture was 14.5 cm. This value gradually increased with increasing mesh size up to 18.5cm in 40 mm. The heights of the selectivity curves for different mesh sizes were uniform. The length class having the highest probability of being retained in a net of 32 mm mesh was 14-15 cm and the same in a net of mesh size 40 mm, was 18-19 cm. The mode of the observed length frequencies and calculated optimum selectivity length showed deviation only in mesh size of 32 mm where the mode of observed length frequency was 5.16% higher than the estimated mean selection length.

Somvanshi (1980) opined that the knowledge of minimum size at first maturity is of value in adjusting the mesh size of fishing gear to ensure that the smaller fish, which have not spawned at least once, may have an opportunity to escape. The reported size at first maturity of *S. longiceps* varies from 14 to 17 cm (Hornel & Nayidu, 1924; Nair, 1953; Raja, 1964; Annigeri, 1972; Dhulkhed, 1976). Qasim (1953) reported that the species attained sexual maturity at about the end of first year, approximately between 15 and 16 cm. Accordingly, the mid-value of this class was considered here as the size at first maturity. According to the estimated selection of gill net for *S. longiceps*, nets of mesh size of 32 mm retained 39.8% of fish whose total length was less than 15.5 cm. Nets of mesh size 34, 36, and 38 mm retained 11.6, 3.6 and 0.4% of individuals below the length at first maturity, respectively. Nets with 40 mm mesh size retained mature specimens only. Since the estimated optimum selection length of *S. longiceps* was above the size at first maturity except in the case of 32 mm, mesh sizes above 32 mm can be used safely to exploit the resource. However, 32 mm may not be used for exploitation of *S. longiceps* as it would not give effective protection to the fish, which has not attained the stage of first maturity.

The selectivity estimates showed that the mesh size currently in use could not protect the resources. However, in a multi-species fishery, the mesh size could be fixed on the above criteria for the most commercially important group only. In the small mesh gill net fishery sector, where different mesh sizes are used simultaneously to exploit a multitude of species, identifying the dominant group may need detailed investigations.

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