Mesh Selectivity Studies on Mackerel Gill nets

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Results of mesh selectivity in gill nets for the capture of mackerel *Rastrelliger kanagurta* (Cuvier) with nets made of nylon twine 210x1x2, 210x1x3 and 210x2x3 in mesh sizes 40,45,50,55 and 60 mm are discussed in this communication. 50 mm mesh size nets made out of nylon twine 210x1x2 were found optimum for the exploitation of commercially accepted size group with a total length of 190-200 mm. The peak value of gilled girth to mesh perimeter ratio for 50 mm nets was found to be 1.1. Linear regressions were fitted for conversion of length to weight and gilled girth to length. Twine size-mesh size relationship was also worked out. 88% of the mackerel caught and 66.1% of the total catch were obtained from dusk operations.

The need for the selection of suitable mesh size to increase the output of gillnets has been emphasised by several workers. Optimum mesh size for the commercial gillnet fisheries of *Sardinella.longiceps* (Joseph & Sebastian, 1964), *Scomberomorus.guttatam* (Sreekrishna *.et al.*, 1972), *S.commersoni* (Sulochannan *et al.*, 1975), hilsa and silver pomfret (Panicker *et al.*, 1978) and the freshwater fish *Barbus tor* (Khan *et al.*, 1989) has been worked out. Based on the studies conducted off Goa, the mesh size required for the exploitation of commercially important size group of mackerels was evolved, and presented in this communication.

Materials and Methods

Based on a survey of mackerel gill nets on the west coast, mesh sizes and twine

Table 1. *Design details of the experimental nets*

Net no.	Twine size Nylon	Mesh size (mm)	No. of meshes in length	No.of meshes in depth	Total no. meshes
1	210x1x2	40	1000	145	1,45,000
2	"	45	889	129	1,14,681
3	"	50	800	116	92,800
4	"	55	728	106	76,956
5	"	60	667	97	64,699
6	210x1x3	40	1000	145	1,45,000
7	"	45	889	129	1,14,681
8	"	50	800	116	92,800
9	"	55	728	106	76,956
10	"	60	667	97	64,699
11	210x2x3	40	1000	145	1,45,000
12	"	45	889	129	1,14,681
13	"	50	800	116	92,800
14	"	55	728	106	76,956
15	"	60	667	97	64,699

Mounted length	20m
Hung depth	5 m
Fishing area	100 m^2
Floats	Fish net floats cylindrical, 60x50 mm Buoyancy 125 g, one at every metre
Sinkers	Granite stone weight 100 g, one at every metre
Rope	Polyethylene 6mm dia

were selected for the experimental gear. The design details of the experimental nets are given in Table 1. Webbings were hung horizontally at a hanging coefficient of 0.5. Three nets in each mesh size and five nets in each twine size were operated simultaneously on a statistically designed method at a fishing depth ranging from 5 to 25 m off Dona Paula, Goa through November-December of 1985-86. The nets were operated as encircling gill nets from an outrigger country craft of 7.7 m OAL powered by an 8 hp outboard motor. The buoyancy of the head rope and the weight on the foot rope were kept constant throughout the period of experimentation. A total of 50 fishing operations were conducted, 25 at dawn and 25 at dusk. Morphometric data and weight of the fish caught by each net were recorded separately. The size groups of mackerels landed by the commercial gill net fishery were recorded regularly.

Results and Discussion

The output from the 15 different units is furnished in Table 2. The percentage length frequency distribution of marckerels computed from data recorded at the landing centres and those caught from the experimental nets are furnished in Table 3. The first and the third quartiles (Q1 and Q3) and the median (q2) of the catch of different meshed nets were worked out and are presented in Fig.1. The relation between mesh size and length of fish was worked out by the method of Baranov (1948) (Fig.1a). The graph drawn with the ratio of gilled girth to mesh perimeter for different mesh sizes is presented in Fig.2. Fig.3 shows the percentage weight frequency distribution of mackerels caught in nets of the various mesh sizes. Regression between the gilled girth and total length and relation between total length and weight were also worked out. Table 4 shows the catch particulars from dusk and dawn operations.

Table 2. *Output of different experimental nets*

Net no.	Twine size	Mesh Size mm	No. of mackerels caught	Wt. of mackerels caught kg	Weight of other fishes kg	Total weight kg
	Nylon					
1	210x1x2	40	25	2.025	63.520	65.545
2	"	45	123	10.340	50.650	60.990
3	"	50	274	22.690	31.745	54.435
4	"	55	130	18.840	10.240	29.080
5	"	60	66	9.830	8.820	18.650
6	210x1x3	40	12	0.950	53.150	54.100
7	"	45	36	2.415	31.440	33.855
8	"	50	197	16.810	22.920	39.730
9	"	55	119	12.530	13.680	26.210
10	"	60	132	17.860	5.950	23.810
11	210x2x3	40	9	0.715	40.970	41.685
12	"	45	72	5.230	38.520	43.750
13	"	50	147	11.460	23.870	35.330
14	"	55	94	8.980	9.240	18.220
15	"	60	59	8.690	8.460	17.150
Total			1495	149.365	413.175	562.54

A total of 1495 mackerels weighing 149.365 kg and 413.175 kg of other fishes were caught during the experimentation. The other fishes caught consisted of lesser sardine (*Sardinella albella*), 79.3% silver bar (Chirocentrus dorab), 6.45%, Caranx 5.31% Engraulids 2.64%, Decapterus sp. 1.33%, ribbon fish (Trichiurus savala) 1.22%, flying fish (Exocoetus spp.) 0,95%, oil sardine (Sardinella longiceps) 0.65% Belone spp. 0.29% silver belly (*Leiognathun* sp) 0.22%, *Mugil* sp 0.22% and miscellaneous fishes 1.42%. The miscellaneous fishes consisted mainly of the species of *Otolithus, Scomberomorus, Chorinemus, Pellona, Barracuda, Therapon, Loligo, Lactarius, Anodontostoma and Tachysurus.*

Mesh selectivity:

Baranov (1948) opines that mesh size is proportional to fish caught in it. According to him the mesh size is a function of the length of fish caught and can be presented as

$$a = kl$$

where 'k' is a constant, 'a' mesh bar in mm and 'l' the modal length in mm. Constant 'k' was calculated by experimenting with more than one probable mesh bar as 0.128. From Fig.1a the model size-group is 190-200 mm and its central value is 195 mm. The suitable mesh size for this length-group is 24.96 mm bar or 50 mm mesh.

Along the west coast of India, mackerel fishery is mainly supported by 180-200 mm size-group and the season generally lasts from August to March (Venkataraman, 1970). But Narayanankutty (1962) observed that the dominant size group of mackerels is almost always represented by modes between 185 to 225 mm. Devanesan & John (1940) remarked that mackerel attains maturity at about a length of 190 mm but Nair & Rao (1970) opined that the size at which mackerel attains sexual maturity along the west coast of India is between 190 mm and 224 mm with majority of observations falling at about 220 mm length. Thus taking biological considerations also

Table 3. *% length frequency distribution of mackerels caught in the experimental nets and local nets*

Size group	40 mm		45 mm		50 mm		55 mm		60 mm		Total		Local
mm	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	landing %
120	-	-	-	-	-	-	-	-	-	-	-	-	0.11
130	1	2.17	-	-	-	-	-	-	-	-	1	0.07	0.75
140	1	2.17	1	0.43	-	-	1	0.29	-	-	3	0.21	2.01
150	3	6.52	8	3.46	3	0.49	2	0.58	1	0.39	17	1.14	3.92
160	8	17.39	32	13.86	23	3.72	3	0.87	2	0.78	68	4.55	7.89
170	11	23.91	83	35.93	68	11.00	8	2.33	5	1.95	175	11.70	9.18
180	8	17.39	60	25.97	160	25.89	27	7.87	13	5.06	268	17.93	15.30
190	5	10.86	37	16.02	238	38.51	99	28.86	15	5.84	396	26.49	26.78
200	3	6.52	5	1.16	78	12.62	80	23.32	16	6.23	182	12.17	15.69
210	2	4.35	4	1.73	30	3.24	36	10.50	19	7.39	79	5.28	8.82
220	-	-	1	0.43	28	2.91	33	9.62	43	16.73	95	6.35	4.30
230	-	-	-	-	6	0.97	26	7.58	75	29.18	107	7.16	2.68
240	4	8.70	-	-	3	0.49	18	5.25	39	15.18	64	4.28	1.39
250	-	-	-	-	-	-	6	1.75	16	6.23	22	1.47	0.67
260	-	-	-	-	-	-	4	1.17	8	3.11	12	0.80	0.29
270	-	-	-	-	1	0.16	-	-	4	1.56	5	0.33	0.16
280	-	-	-	-	-	-	-	-	1	0.39	1	0.07	0.08

Table 4. *Catch particulars of dusk and dawn operations*

Type of operations	No. of operations	No. of mackerels	Wt. of mackerels kg	Wt. of other fishes kg	Total wt. of fishes kg	No.of mackerel	Average wt.of mackerels kg.	Average wt.of other fishes kg	Total wt. of fishes kg
Dawn	25	178	14.820	175.695	190.515	7.12	0.592	7.027	7.620
Dusk	25	1317	134.545	237.480	372.025	52.68	5.381	9.499	14.881
Total	50	1495	149.365	413.175	562.540				

into account, nets of 50 mm mesh are best suited for the exploitation of mackerels.

Mc Combie & Berst (1969) have chosen girth to investigate the relation between selectivity and the fit of the fish to the mesh. The ratios between gilled girth to mesh perimeter were plotted separately with percentage frequency distribution of the catch under different mesh sizes (Fig.2). The ratios show a range of 1.075 to 1.125 and the mean value is 1.1. The ratio gives the range between the maximum extensibility of the twine and the maximum compressibility of the fish body. For the nets of 50 mm mesh size, the efficiency indices show a higher value of the peak at 1.1., meaning at this ratio, 50 mm mesh gives the best holding effect to the predominant size group of mackerels.

Gilled girth - total length relation

A linear regression was fitted for conversion of gilled girth into length and length into gilled girth

$g = 0.9156\ l - 0.0516$

$l = 0.9035\ g + 0.4424$

where g = logarithm of the gilled girth

l = logarithm of the length

Length weight relation

Another regression was fitted for conversion of total length into weight and weight into total length.

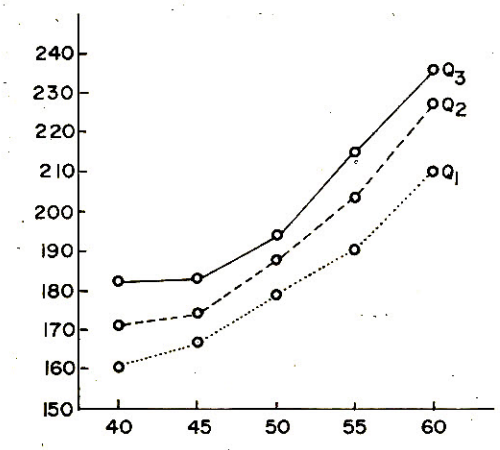

Fig. 1. Q_1; Q_3 and median (Q_2) of the catch in nets of different mesh sizes

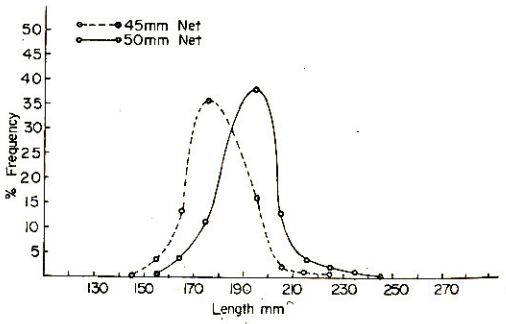

Fig. 1 a. Length frequency curves of Mackerel in 45 and 50 mm mesh nets

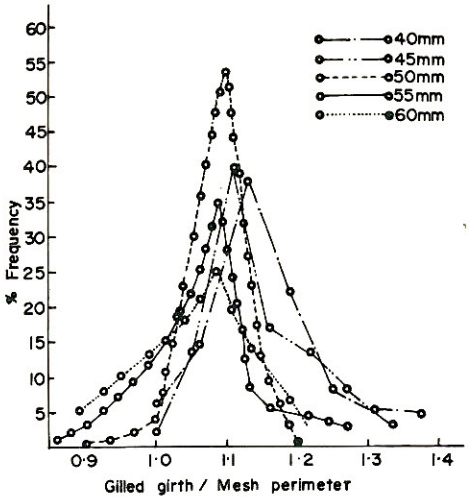

Fig. 2. Frequency distribution of Mackerel based on gilled girth/mesh perimeter

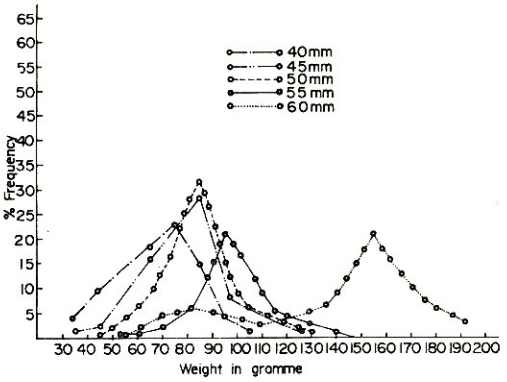

Fig. 3. Weight frequency distribution of Mackerel caught in nets of different mesh sizes.

$w = 2.5256\ l - 3.7520$ and
$l = 0.2399\ w + 1.8351$

where w = logarithm of the weight and l = logarithm of the length.

Thus if mesh size is given, gilled girth, length and weight of the fish to be caught can be calculated. The central value of the modal weight of mackerels caught by nets of 50 mm mesh size is 85 g (fig.3). From the equations we get its gilled girth as 55 mm and length 195 mm.

Mesh size-twine size relationship

Nets of twine size 210x1x2 caught 41.34% by number and 42.66% by weight of the total mackerels caught. It has also a 40.65% share of the total catch (Table 2).

Chi-square test was carried out to find whether the efficiency indices of all the three

Table 5. *ANOVA of catch of different nets*

	df	F(p<0.01)		Least significant (at 5%) difference	
		Dawn	Dusk	Dawn	Dusk
Mackerel	14, 23	2.495	2.730	0.3513	0.4019
Other fishes	14, 23	6.082	14.610	0.6194	0.5320
Total fishes	14, 23	5.278	12.800	0.6149	1.0392

Table 6. *Mean catch of Mackerel (logarithmic values) of 15 nets during dawn and dusk operations*

Net No.	Mean	
	Dawn	Dusk
1	0.1554	0.5556
2	0.5643	0.7721
3	0.6614	1.0983
4	0.2771	1.1314
5	0.4221	0.6863
6	0.0000	0.5678
7	0.3348	0.5403
8	0.5304	1.0673
9	0.2503	0.8084
10	0.1949	1.0211
11	0.1711	0.4051
12	0.2753	0.5962
13	0.5900	0.8230
14	0.1639	0.9118
15	0.0844	0.6406
Pooled	0.3117	0.7750

Table 7 *Mean catch of other fishes in dawn and dusk operation*

Net No.	Mean	
	Dawn Operation	Dusk operation
1	2.4468	2.6653
2	1.8626	2.2167
3	1.7562	1.9330
4	1.2404	1.3548
5	0.7212	1.4727
6	2.2367	2.5430
7	2.0628	2.4604
8	1.4641	1.8416
9	1.5911	1.2858
10	0.8828	2.1392
11	1.9422	2.4027
12	1.7420	1.9577
13	1.6054	1.9706
14	0.8307	0.6146
15	0.8141	0.3589

Table 8. *Mean value of total catch of 18 nets in dawn and dusk operation*

Net No.	Mean	
	Dawn	Dusk
1	2.4536	2.8312
2	2.0013	2.6609
3	1.9052	2.5801
4	1.2777	2.3476
5	1.0080	2.0182
6	2.2366	2.5679
7	2.0692	2.6103
8	1.5883	2.3514
9	1.5877	2.0942
10	0.9916	1.9540
11	1.9036	2.5381
12	1.8174	2.2292
13	1.9283	2.4624
14	0.9665	1.2906
15	0.8556	0.9194

twine sizes are equal. The calculated chi-square with degrees of freedom 2 is 56.37 which is significant at 0.1% level indicating that the efficiency of all the twines are not uniform.

According to Baranov (1960) there exists a definite relationship between twine diameter and the mesh bar in gill nets and has, empirically worked out a relationship of twine size (d) in mm and mesh bar (a) in mm in gill nets as

$$d/a = 0.01 \text{ to } 0.02$$

The value of 'k' in the relationship between the most efficient mesh bar 25 mm and the twine 210x1x2 is 0.014 and is well within the range of the values given by Baranov. The optimum requirements of mesh size and twine size are, thus well combined in the net 210x1x2 with mesh size 50 mm as confirmed by output.

Dusk - Dawn operations

Dusk operations landed 7.39 times by number and 9.07 times by weight more mackerels and 1.35 times more of other fishes than the dawn operations (Table 4). Sekharan (1962) while studying the landing of mackerels by drag nets off the coast of Mandapam stated that night hauls gave a much higher catch per unit of effort than day hauls. He attributed the decrease in the catches during day time to vertical migration. According to him either mackerels are able to evade capture more easily during day or that they approach the coastal waters in lesser numbers during day time than at night. Rounsfell & Everhart (1953)

stated that many species of fishes tend to move closer to the shore at night and consider dusk as the best time for feeding for both prey and predators. The former can feed stealthily and the latter can catch the prey unwares while the victim is actively feeding. The dawn breaking into the day gives a distinct disadvantage of the fish being seen by the predator.

The catch data of the 15 gill nets in the dawn and dusk operations, were subjected to statistical analysis using the ANOVA technique (Table 5). For the purpose of analysis, the catch data were converted to their logarithm values. This is done separately for the catch of mackerel, other fishes and total catch.

Table 4 illustrates that for dawn operations, nets of 50 mm mesh are superior, compared to other meshes irrespective of twine size experimented. Nets of 40 and 45 mm using nylon 210x1x2 and 210x1x3 landed heavy catches of *Sardinella albella.* If total catch is considered, nets of mesh sizes beyond 50 mm are less efficient. For dusk operations also 50 mm mesh nets were superior with 210x1x2 and 210x1x3 twines but along with55 mm and 60 mm nets in 210x1x3 and 210x2x2 twines respectively. The comparatively lesser efficiency of nets of over 50 mm mesh and good performance of 40 and 45 mm nets with regard to *S. albella* catch are repeated in dusk operations. For testing the significant difference between catch in dawn and dusk operations 't' test was employed. The 't' value for the pooled data of 15 nets was 6.338 which is highly significant ($p<0.001$) indicating that there is significant difference in the catch of mackerels in the dawn and dusk operations. The mean logarithm of catch for dusk operations was 0.7750 while the same for dawn operations was 0.3117. In all the 15 nets, the mean logarithm of catch of mackerel (Table 6) in dusk operations were higher than in dawn operations and significant ($p<0.005$).

For other fishes the 't' values for the pooled data is 36.850 which is highly significant ($p<0.001$). The mean logarithm of catch of other fishes for dawn and dusk operations were respectively 1.639 and 2.230 (Table 7). There is significant higher catch of other fishes in the dusk operations than in the dawn operations. The 't' value for the pooled data of total catch is 90.862 which is highly significant ($p<0.001$). The mean logarithm of total catch for dusk and dawn operations were 2.230 and 1.6394 respectively (Table 8) indicating that the total catch in dusk operations were significantly higher to that in dawn operations.

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