Effect of Variation in Mesh Size on Trawl Efficiency

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Result of comparative fishing trials with a bulged belly design with three different mesh ranges in the body and wing to study the effect of mesh size difference on the performance of gear is discussed. While there is no significant difference in catch rate, predictably the 40 mm mesh size trawl fared well when small sized fish like anchovies formed the major catch. The trawls with 60 and 80 mm mesh size gave better horizontal spread at a lower resistance showing savings in fuel.

Mesh size plays a significant role in the functioning of a trawl and has been engaging the attention of several research workers (Booremema, 1956; Jenson, 1949; Beverten, *et al.*, 1954; Dickson, 1962 and Panicker, *et al.*, 1965). Jenson (1949) came to the conclusion that the length at which the fish has a 50% chance of escaping through the mesh is directly proportional to the mesh size. While most of the workers concentrated on codend mesh selection, Dickson (1962) has discussed the effect of mesh sizes on the foreparts of the body of trawl in catch and resistance and opined that increasing the mesh size is another way of keeping the drag down. The tendency among commercial fishermen along the east coast is to reduce the mesh size. In order to work out optimum mesh size for normal functioning of the gear in relation to catch and resistance, fuel consumption, the present study was initiated.

Materials and Methods

Three 20 mm bulged-belly nets with varying mesh ranges (with 20 mm difference) in the body and wings were operated from a vessel (12 m O.A.L.) fitted with 60 HP Yanmar engine during 1982–84. Flat rectangular otter boards of 1300 x 700 mm weighing 50 kg each were used (Ramarao *et al.*, 1985). The fishing was conducted off Kakinada between 10–50 m depths. The horizontal opening was worked out as described by Deshpande (1960) and Benyami (1959). The towing resistance was measured with the warp load meter (Sivadas, 1970). The catch composition was recorded separately for the three nets. All the three nets were operated on the same day, keeping depth, length of warp, trawling speed, duration of each haul and course constant. For working out the quantum of diesel oil consumed per h, while towing each trawl net, a separate tank of 10 litre capacity was connected to the engine and the amount of oil used for each haul was noted (Table 2). Details of foreparts

Table 1. *Results of comparative fishing operations with 20 m bulged belly with three different mesh size*

Mesh size	40 mm	60 mm	80 mm
No. of hauls	72	72	72
Total trawling, h	72	72	72
Depth, m	10 to 50		
Range of warp, m	70 to 250		
Trawling speed, knots	2–2.5		
Average horizontal opening	17.16	17.22	19.22
Warp tension kg (both warps)	623	563	526
Total catch, kg	1,117.3	1,250.3	1,322.9
Catch/h, kg	15.5	17.4	18.4

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of 20 m bulged belly net with different mesh sizes are shown in Fig. 1. Codend with 20 mm mesh size was used for all the three nets. 10 m sweep lines were used on either side.

Results and Discussion

The results of comparative fishing operations are given in Table 1.

The percentage composition of fish (by weight) landed during the period of study

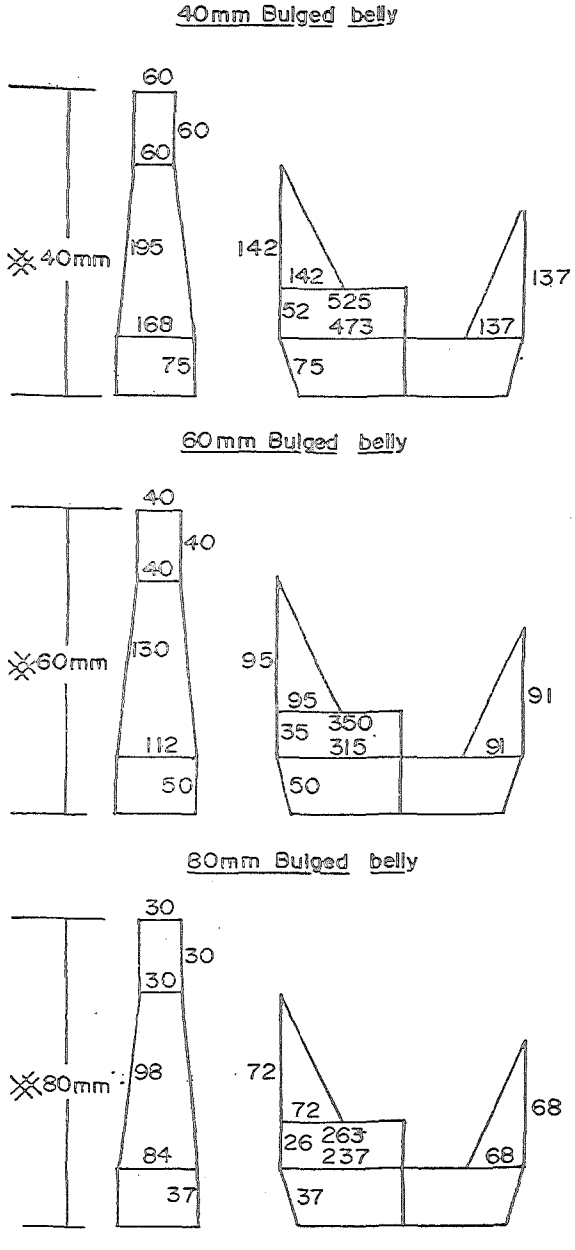

Fig. 1. 20 m bulged belly (Foreparts)

Table 2. *Oil consumption*

Mesh size	40 mm	60 mm	80 mm
Average catch/h, kg	14.4	15.2	17.0
Average quantity of diesel per haul, litre	7.4	7.0	7.1

is given in Table 3. The species were coded from 1 to 6 on the basis of the nets (80mm). The codes were assigned in ascending order of magnitude of percentage for this net. A plot of the percentage composition against the code is given in Fig. 2A. If the species composition remains the same for the three nets the curves will coincide. Using a transformation, the technique of analysis of covariance (Snedecor & Cochram, 1968) can be adopted to test whether these curves coincide or in other words whether the species composition remains the same. The plot corresponding to the 'angular' and 'logarithmic' transformation of the percentage composition are given in Fig. 2 B and C respectively. The log transformation shows maximum linearity in the plot (Fig. 2C) the correlation co-efficient 0.9866 for 80 mm and 0.987 for 60 mm being highly significant. The plot shows that a common straight line will fit the points corresponding to 80 mm and 60 mm nets. A common trend line for these points is shown in Fig. 2C. The point corresponding to 40 mm net do not fall close to the line showing a difference in the species composition of this net from that for other two nets. To test this, the analysis of covariance

Table 3. *Percentage composition of the species*

Species	40 mm	60 mm	80 mm
Trichiurus	7.6	9.7	15.4
Prawns	3.5	2.3	0.9
Silver-belly	13.5	18.3	22.7
Sciaenids	0.9	2.9	4.3
Anchovy	11.9	0.90	0.7
Miscellaneous fish	52.6	66.0	55.9
Total	100.0	100.0	100.00

Table 4. *Analysis of covariance: Species composition*

	d.f.	Σx^2	Σxy	Σy^2	Reg. Coeff.	Deviation from regression d.f	S.S.	M.S.
40 mm	5	17.5	3.325	1.96386	0.19000	4	1.332130	0.333030
60 mm	5	17.5	6.265	2.30248	0.35800	4	0.055062	0.013766
80 mm	5	17.5	7.230	3.06893	0.41314	4	0.081907	0.020477
						8	0.136969	0.017121
Pooled	10	35.0	13.495	5.37141	0.77114	9	0.168123	0.018680
	Difference between slopes					1	0.031154	0.031154
Between B	1	—	—	0.001415	—	—	—	—
W+B	11	35.0	13.495	5.37283	—	10	0.169539	—
	Between adjusted means					1	0.001416	0.001416

Comparison of slopes : $F = 1.82$ (d.f. = 1,8) N.S.

Comparison of elevations : $F = \frac{0.001416}{0.018680}$ (d. f. = 1,9) N.S.

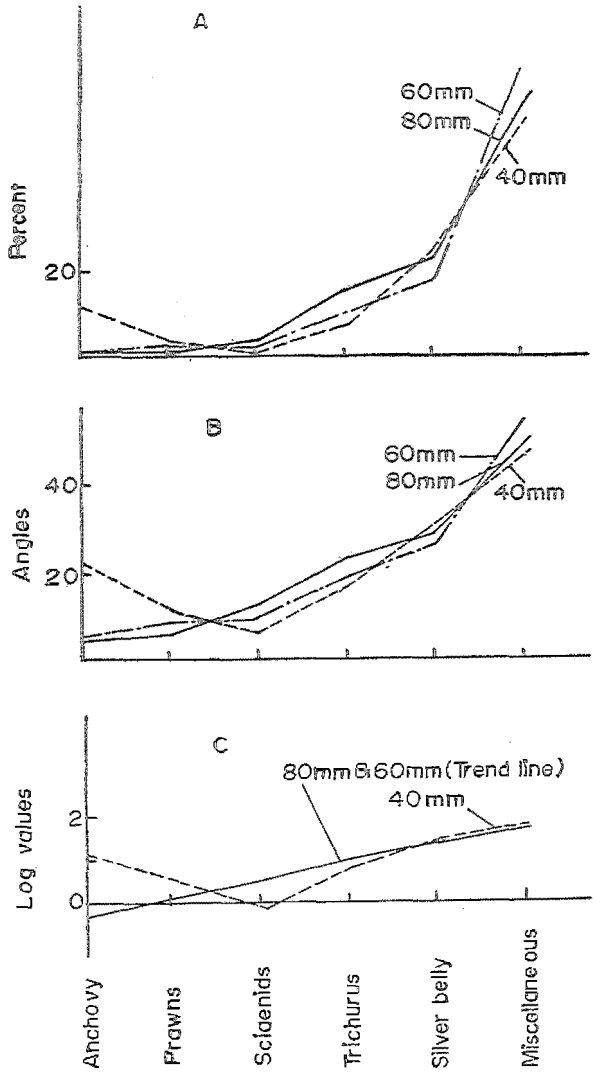

Fig. 2. Percentage composition (by weight) of specified species in total catch

is presented in Table 4. The residual variance for 40 mm net is widely different from the residual variance for the other two nets. This itself shows the difference of the net. Thus there is no need to consider the line corresponding to this net along with the lines for the other nets. The scatter points for 40 mm net in Fig. 2C clearly reveals this. Therefore whether the points corresponding to 60 mm and 80 mm nets have a common line was tested. The F values corresponding to the difference between slopes and difference between elevation of the lines are not significant (Table 4) showing that a common straight line fits the two sets of points. This shows that the species composition do not deffer significantly for 60 mm and 80 mm nets.

Anchovy catches form only less than 1% of the total catch for 60 mm and 80 mm nets against 11.9% of 40 mm net. Thus for small sized fish 40 mm nets appears to be more efficient (Table 3 and Fig. 2).

Relative efficiency of the net for different species and total catch

Friedman's test which is valid for the data as given in Siegel (1956) was applied to compare the relative efficiency of the nets for the specified species and total catch. (Analysis of variance F-test also confirmed the results). The results are presented in Table 5. For $n > 9$ and $k \geq 3$, the test criterion X_r^2 is distributed as chi-square with k-1

Table 5. *Friedman's test for comparing the efficiency*

Species	n	k	X_r^2
Anchovy	11	3	11.09**
Prawns	22	3	8.27*
Trichiurus	17	3	3.29
Sciaenids	7	3	4.07
Silver belly	21	3	0.93
Miscellaneous	35	3	5.70
Total catch	38	3	2.85

*Significant at 5% level
**Significant at 1% level

degrees of freedom. For scianieds for which $n<9$ the table for exact probabilities was referred to. Significant difference was observed in the case of anchovy and prawn catches. The difference in anchovy catch is perhaps due to ability of 40 mm net to prevent these small sized fish from escaping. The catch rate was low in 60 and 80 mm mesh nets. For small prawns also 40 mm mesh size net proved slightly better. But prawns and sciaenides were scarce during the period of operations and so no definite conclusion could be drawn. Overall picture shows that there is no significant difference in the total catch. If anchovy and small prawns form major portion of the landings, obviously the 40 mm net may show better catch rate. There is no difference in the species composition in the landings of 60 mm and 80 mm nets as shown by analysis of co-variance (Table 4) and since total catch for these nets do not differ much, the efficiency of these nets for the species considered and total catch can be considered the same. For miscellaneous fish the F value is very close to the value corresponding to 5% level for significance.

Fuel consumption

As shown in Table 2, the 40 mm net consumed 5.7% and 4.2% more HSD/h compared to 60 mm and 80 mm nets without much advantage in catch rate. This part of the study needs further confirmation.

The bigger mesh size net offered lesser resistance than the smaller mesh size trawl, the mouth opening is better in the 80 mm net. From the above it is apparent that there is no added advantage in reducing mesh size less than 60 mm in body and wings unless small sized fish like anchovies form major constituents in the landings. The present trend of the reducing mesh sizes in trawls may be aimed at small prawns with which the other small fish formed by-catch.

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