

ON THE RELATIVE UTILITY OF DIFFERENT METHODS TO INCREASE THE VERTICAL HEIGHT IN AN OTTER TRAWL

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INTRODUCTION

Ever since the introduction of shrimp trawling in India, efforts have been made to obtain wider horizontal spread for the trawl nets in order to cover a larger ground area at a relatively low towing speed. This, to a large extent, limits the height of the head line of the net in operation, which in turn, may not permit the capture of off-bottom fishes. For the effective exploitation of such fisheries, trawls having greater vertical height are perhaps more suitable. Various methods are in vogue for obtaining comparatively higher vertical opening in trawls. The traditional methods are the use of opening sticks between upper and lower edges of the nets at varying and graded distances (von Brandt 1962) and the use of mouth-stretcher (Hayashi 1933). Other methods developed are the use of a net kite for the capture of herring in European waters (Dickson 1959) kite and triangular gusset (Koyama and Takayama 1959), insertion of triangular wedges on the wings or splitting the wings along the selvages (Dickson 1959, Okonski and Sadowski 1959) and use of floats or float like devices having higher lift-drag

ratio (Phillips 1959, Catasta 1959, Grouse 1959 and Larsson 1959).

Taking into consideration the merits and demerits of the above methods, to suit local conditions, the following means were selected and studied comparatively.

- i) Introduction of triangular gussets on either end of the Upper bosom of a two seam trawl net;
- ii) Use of rectangular kite on the gusset net;
- iii) Use of additional float line on the gusset net; and
- iv) Introduction of side panels with wedge shaped wing ends making the net into a four seam type.

The results of these experiments together with the observations are incorporated in this communication.

MATERIALS FOR THE STUDY

Boat: A small gear research vessel 'Fish Tech No. 1' as described by Deshpande (1960 a), Sabastian *et al* (1965) and Narayanappa (1967) was used in fishing operations.

Gear: The basic gear taken up for investigations consisted of 12.75m (42.5') trawl net of the two seam type described by Satyanarayana & Nair (1962). To this net two triangular gusset pieces were added on either side of the upper bosum as shown in Text Fig. 1.

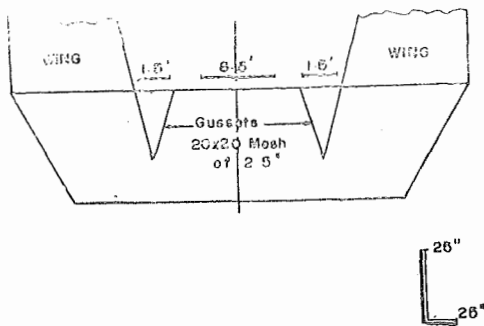


Fig 1. Position and attachment of gussets to the net.

This net with the new head rope of 13.66m (45.5') was taken as control gear. The head rope was rigged with 13 numbers of 5" dia aluminium alloy floats with buoyancy of 10.14 kg while the foot rope was weighted with 11.5 kg of lead and 2 kg of iron chain.

Kite: A kite having rectangular shape

made of teak (*Tectona* sp.) wood, as per the design details represented in Text Fig. 2., was used on the head rope of the net. The mode of its attachment is shown in Text Fig 3.

The false head line supporting the kite consisted of three sections namely 6 mm dia G. I. wire, 2m length in the centre with 9 mm dia synthetic rope, 3.2 m length on either side. 6 Nos of spindle shaped wooden floats made of Elavu (*Bombax malabaricum*) with buoyancy of 45.05 g each (Kuriyan and Satyanarayana 1961) and treated in coal tar were provided on each of the kapron ropes.

Float line: Separate float line used as third means consisted of 10.4 m length coir ropes of 13 mm dia, rigged with 12 numbers of aluminium alloy floats of 3" dia having buoyancy of 146.8g each (Satyanarayana & Kuriyan 1962). The attachment of this false head rope on the net is shown in Text Fig 4.

Four seam net: In the last method experimented, side panels of the specific-

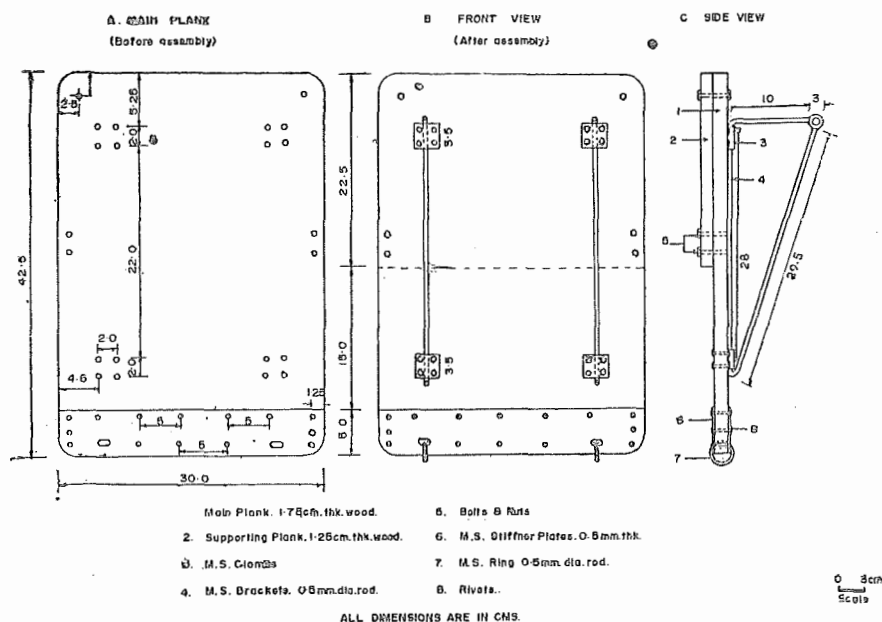


Fig 2. Design details of kite experimented.

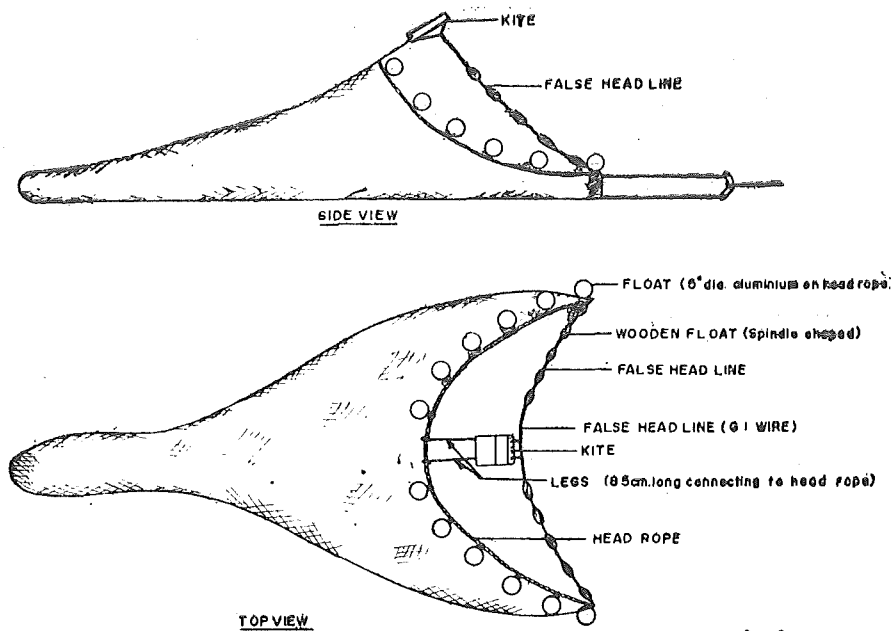


Fig 3

Fig 3. Method of kite's attachment to net in operation.

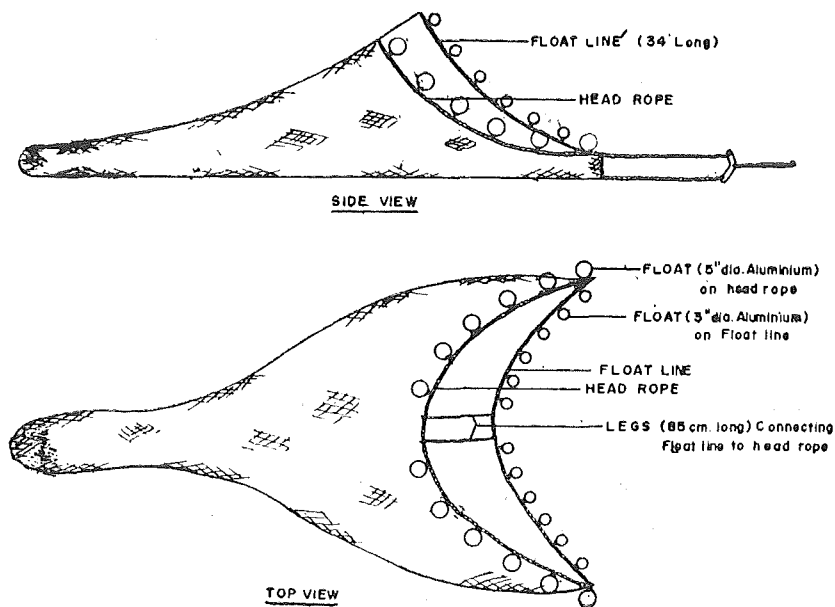


Fig 4

Fig 4. Mode of attachment of false head rope on net in operation.

ations given in Table I were inserted between upper and lower parts of the 12.75 m two seam net.

With the addition of the above, the net became a four seam type with wing ends tapered and wedge shaped cut provided on the top ends of the side panels.

The mesh sizes were $\frac{1}{2}$ to $\frac{1}{4}$ " more from the corresponding parts of the main netting. The dimension of ropes, buoyancy and lead were kept same as those of the control net.

Otter boards: Horizontal curved type (Mukundan *et al* 1967) were used in the

TABLE I SPECIFICATIONS OF SIDE PIECES

Name of piece. (from top to bottom)	Shape	No. of meshes		length	Mesh size	No. of pieces
		top	bottom			
Wingend (Extra piece)	Isoscelles triangle	10	0	5	3" (7.62 cm)	Two
Side (i) End* pieces.	triangular	8	0	8	3" (7.62 cm)	Four
„ (ii): Central	Rectangular	16	16	92	3" (7.62 cm)	Two
„ (iii): Corre- sponding belly piece	Trapezium	18	3	62	2.75" (6.85 cm)	Two
„ (iv): „	triangular	4	0	35	2" (5.08 cm)	Two

* Top of side consists of two right angular pieces of dimensions 8 M x 8 M, joined so that tapering sides form the central cut wedge.

course of the experiments for all the gear under study.

Fishing Rig: Fishing rig and accessories between the net and otter board used were essentially similar to the arrangement of Perumal & Sriram (1962), excluding the half bobbin. The corresponding specifications of built in legs, sweep wire and bridles were 7.2 m, 20 m, and 1.8 m, respectively.

EXPERIMENTAL PROCEDURE:

Comparative fishing operations with the aforementioned four gears were conducted adopting the crossover design with latin square arrangement. Thus each successful cycle of operation comprised of four consecutive operations within four days with four successive hauls on each day. A number of such cycles were attempted during the period from January to June 1967 and only 9 valid cycles comprising of 36 daily operations were obtained for consideration. In each cycle of comparative hauls, all the factors namely towing speed, time and direction of haul, ground and scope ratio were kept constant. For each haul, the horizontal spread between otter boards was obtained on the basis of the method adopted by Benyami (1959) and Deshpande (1960), while the resistance

of warp on board the vessel was measured by using the tension meter described by Satyanarayana & Nair (1965).

Fishing operations were made off Hope island within the depth ranges 12 to 30 m by releasing the warp of 60 to 110 m at a constant towing speed of 2 knots. The bottom was uniformly muddy. The weather and marine conditions remained fair without gales and swells during the period of experimentation.

RESULTS

The results of the experimental fishing are presented in Table II.

The table clearly indicate the superior catch rate with 'C' gear, followed by 'D'. It is significant that while warp resistance remained almost same, indicating uniform area of mouth opening, the horizontal spread decreased with the kite operated gear in comparison with the others.

DISCUSSION

a) Catch in relation to different gear

The catch rate is comparatively high with 'C' gear as would be evident from Table II. The catch with the 'B' gear is nearly half that of 'C', whereas the catch

TABLE II SHOWING RESULTS OF COMPARATIVE FISHING OPERATIONS

Gear	Gusset net as control- 'A' gear	Control net with kite- 'B' gear	Control net with separate float line- 'C' gear	Four seam nat- 'D' gear
Number of valid hauls	36	36	36	36
Total towing time (Hrs).	30	30	30	30
Average horizontal spread between otter boards (m)	20.79	19.16	20.18	20.32
% horizontal spread of O. B. in the total head rope length between the boards	48.67	45.04	47.50	47.73
Average warp tension of the gear (Kg).	322.5	326.1	327.4	325.4
Total catch of fise (Kg).	1,502.0	788.5	1,617.5	1,522.5
Catch/haul of 50 mts duration (Kg).	41.72	21.90	44.92	42.29
Catch/Tr. hour (Kg)	50.06	26.28	53.91	50.75

* From here onwards, each of the four experimented gear will be referred as A, B, C, D gear, as designated in the table.

rate of 'A' and 'D' gear are more or less similar.

The weight frequency distribution of catch per haul is given in Table III.

TABLE III FREQUENCY WEIGHT DISTRIBUTION

Weight range Kg.	Frequency distribution in gear			
	'A'	'B'	'C'	'D'
0-24	9	26	9	11
25-49	18	8	18	14
50-74	5	1	5	8
75-99	2	1	0	1
100-124	1	0	2	1
125-149	1	0	1	0
150-174	0	0	1	0
175-200	0	0	0	1

The perusal of the above table indicates the significant difference between the kite operated gear in comparison with the others. The frequency of low catch rate is more with 'B' gear. The trend for 'A' and 'C' gear is almost identical whereas 'D' gear exhibited a somewhat different nature.

The data were statistically analysed to study the variances and the analysis of variance is shown in Table IV.

The analysis reveals great significance at both 1% and 5% levels between the different gears experimented and between the days during the period of experimentation. Nonsignificance between hauls on each day indicates uniform fishing conditions for all four experimented gears on the same day. The fluctuating nature of fishing season itself is revealed by the variation between the days and cycles of operation. This is typical of this coast unlike west coast where well defined fishery nature exists.

b) Catch composition

The fish catch obtained in each of the gear was analysed for its composition. The percentage of different fishes in the catch of each gear is represented in pie diagram (Text Fig 5), whereas the catch composition per trawling hour from the four different gears is given in histogram (Text Fig 6).

TABLE IV ANALYSIS OF VARIANCE

Source of variation	d. f.	s. s.	M. S. C.	'F' Calculated	'F' Theoretical
Between gear	3	12,207	4,069.0	7.7310	3.977 at 1% and 3.978 at 5% levels
Between hauls	3	121	40.3	0.0766	" "
Between days	35	64,294	1,836.9	3.4890	1.836 at 1% and 1.539 at 5% levels
Error	102	53,701	526.4		
Total	143	1,30,323			

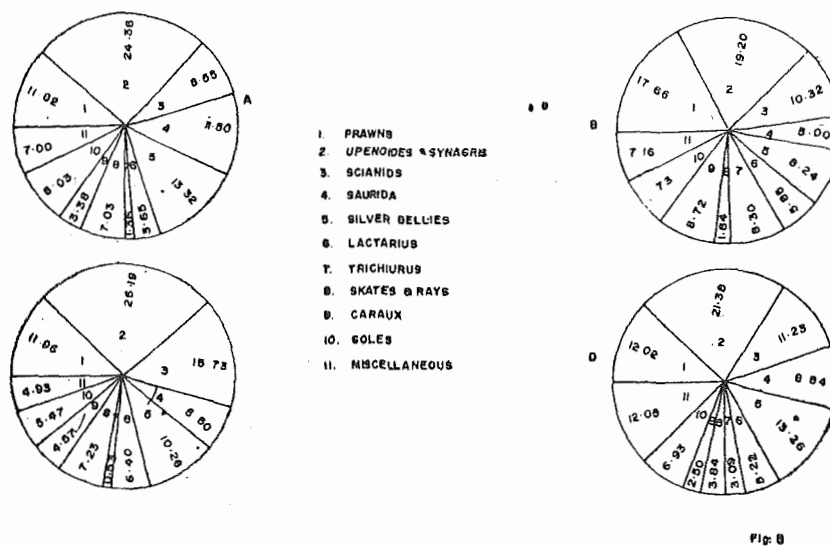


Fig. 5

Fig 5. Percentage catch composition in each gear operated.

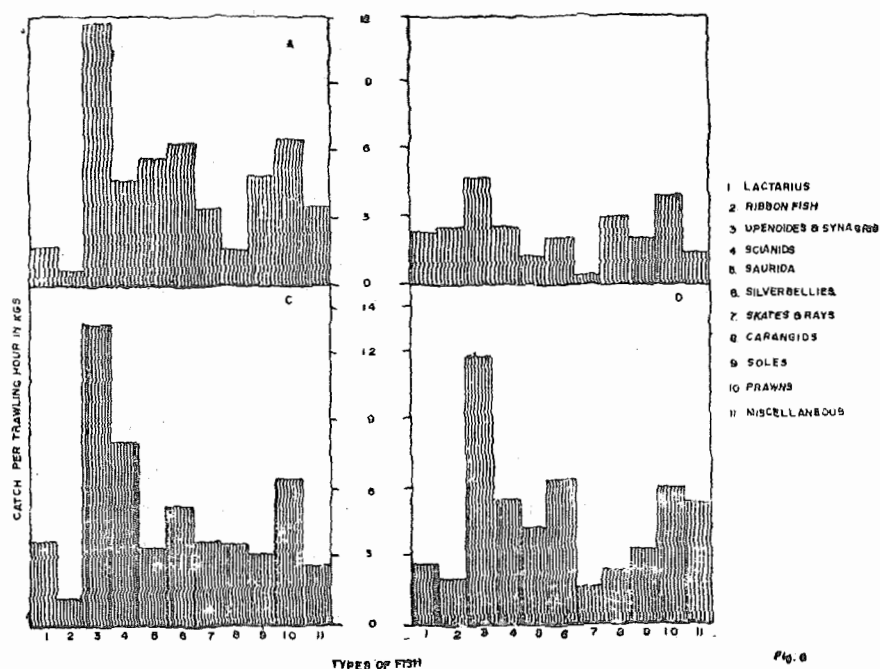


Fig. 6

Fig 6. The catch composition per one Trawling hour in the different gear experimented.

It is evident from the Fig 5 that though the catch composition essentially remains same in all the gear investigated each exhibited a somewhat different trend in obtaining different fishes. Ribbon fishes and carangids are found in higher quantities in 'B' gear though prawn is also more. The higher prawn content is primarily due to good catch on 8-6-67. Skates and rays are particularly less in this gear. Upenoides and silver bellies are also less. In the gear operated with additional float line (C-gear) upenoides, scianids and lactarius constitute nearly 50% of total catch. The general pattern of fish composition is same in both two seam and four seam gear except that in the latter gear ribbon fish, lactarius and scianids were slightly more.

Fig 6 which represents the true catch composition of the different gears in terms of one trawling hour, a slightly different picture is seen. The significant difference is in respect of prawn catch with 'B' gear in which the catch per trawling hour is only 4.00 kg, while those of A, C and D gears are 6.57, 6.51 and 5.97 kg respectively (Fig 6). But the percentage composition of prawn in B gear is 17.66 as against 11.82, 11.96 and 12.02 in other gears (Fig 5). This is in accordance with the trend of obtaining low catch rate of bottom forms with B gear. In general, the bottom dwelling fishes namely soles, skates, rays saurida and scianids besides prawns are captured in lower quantities with kite operated gear due to its increased vertical opening and less horizontal spread. The high catch of ribbon fish, lactarius and carangids in this gear support the general belief that these fishes are essentially of the off-bottom type. The figure also clearly indicates that the catches obtained in 'C' & 'D' gear are better represented in both bottom as well as off bottom fishes, indicating their utility for obtaining quality fishes.

c) Mouth opening of the nets and tension of gear:

Various methods are employed for working out the opening of the trawl mouth both horizontally and vertically (Benyami 1959, de Boer 1959, Hamuro and Ishii 1959, Scharfe 1959, Pradhan 1962, Takayama and Koyama 1959 and Deshpande 1960 b.) using instruments for measuring the above parameters, the following procedure was adopted for working out the horizontal spread between the wing ends and the vertical opening.

Methodology for estimating the spreads

The horizontal distance between otter boards was calculated by measuring the actual spread between two warps at a distance of 3' from the towing point and the length of warp payed out. The horizontal spread between wing ends which alone represents the true mouth opening, was calculated following the procedure of Takayama and Koyama (1959) and Pradhan (*Op. cit*) and as shown in Text Fig 7.

The horizontal spread calculated using the formula indicated in Fig. 7. is:

Gear:	'X'	'Y'
'A'	20.79 m	6.84 m
'B'	19.16 m	6.30 m
'C'	20.18 m	6.64 m
'D'	20.32 m	6.69 m

Resistance of trawl net principally depends on the area of the projectile mouth of the net in fishing with all rigging and towing speeds. In the present experiments, since the resistance is more or less identical (average nearly 325.0 kg) in all four types of gear experimented and trawling speed is kept constant in all operations, the area of the net mouth is assumed to be same. The mouth of net in operation may be of two shapes viz; rectangular or elliptical, when their area can be obtained by $(a \times b)$ or (πab) respectively, where

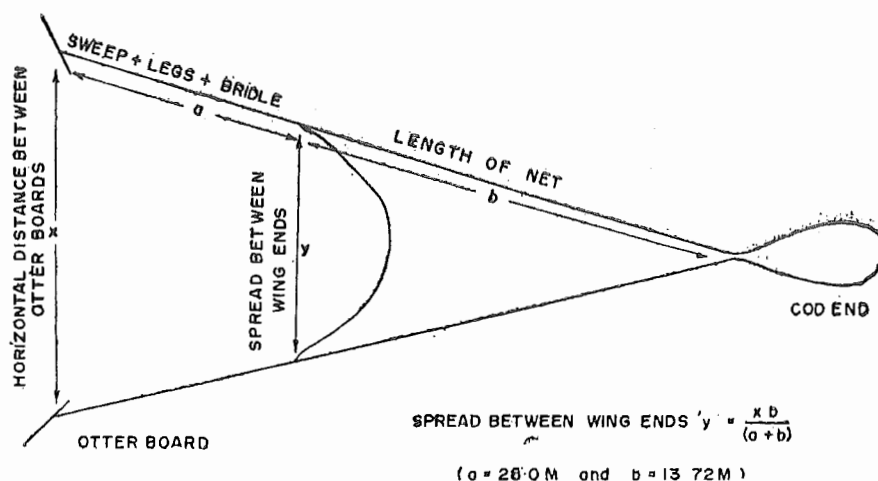


Fig. 7

Fig 7. Procedure for estimating the horizontal opening of the net between wings

'a' is horizontal axis ($\frac{1}{2}$ major axis) and 'b' is vertical axis ($\frac{1}{2}$ minor axis) and these would represent the horizontal and vertical spreads of the trawl mouth.

The formula for resistance may be taken as

$$R = K A \frac{D}{a} V^n, \text{ where}$$

R = Warp resistance in Kg (162.5 kg)

K = Proportionality factor [180 has been assumed and taken into account - Andrew (1967) and Treschev (1962)]

A = Projectile area of the net mouth.

D = Average dia of netting twine (1.27mm)

a = average mesh bar (26.92 mm)

V^n = Towing speed (1.06 m/s) and 'n' its index taken as 2.

The resistance 'R' obtained comprises those of warps, otter boards sweeps, net and its appendages and ground friction. Dickson (1964) obtained the net's share alone in the total drag as 58% while Scharfe (1959 b) calculated it to be 68% Basing on these, it is reasonably assumed that the net's share in our experiments is 50%. Using this percentage resistance, the mouth area of the gear has been calculated with the above formula:

$$162.5 = 180 \times A \frac{1.27}{26.92} \times 1.06^2$$

$$A = 17.03 \text{ sq m.}$$

Assuming the shape of the mouth to be rectangular and with the estimated values of horizontal spread 'Y' in each case, the vertical spread has been calculated and represented below :

Gear	Vertical spread
'A'	2.47 m.
'B'	2.71 m. ... 3.45 m (Elliptical)
'C'	2.57 m.
'D'	2.55 m.

Assuming the mouthshape of the net with kite operation as elliptical, the vertical opening has been calculated and obtained as 3.45 m. The assumption of rectangle is based on the use of 11 floats, which lift the head rope more or less uniformly and the assumption of ellipse in kite operation is effecting excess lift at the centre of the head rope. As a result of excess lift, the foot rope might have been worked away from the bottom with less chances to drag on the floor which accounted for less of bottom catch.

The estimated values are represented in Table V.

TABLE V ESTIMATED VALUES OF SPREAD OF THE GEAR

Item	'A' gear	'B' gear	'C' gear	'D' gear
Horizontal spread between otter boards (m)	20.79	19.16	20.18	20.32
Horizontal spread between wing ends (m)	6.84	6.30	6.64	6.69
Estimated vertical spread (m)	2.47	2.71 (a) 3.45 (b)	2.57	2.55
Warp tension (Kg)	322.5	326.1	327.4	325.4

(a) Value obtained on assuming the mouth opening as rectangular.

(b) Value obtained on the assumption that mouth opening is elliptical.

This table clearly indicates the effective vertical opening of the gear with kite. The other means employed also gave the gear more vertical opening which can be taken as optimum for getting good catch rate as well as more of off bottom fishes along with bottom dwelling forms.

The resistance of the kite is calculated and found to be only 4.378 kg which is very insignificant on comparison with the total resistance of the entire gear in water which is 326.1 kg. Hence this does not interfere in the resistance, but helps to achieve more vertical spread which in the case of our experiment, is nearly 1.0 m more than the control gear. Regarding the horizontal spread, a decrease of only 3.5% from otter board is obtained.

SUMMARY

Comparative fishing experiments to study the relative utility of different methods for increased vertical spread of bottom trawl and the availability of off bottom fishes in the region were made using gussets, kite, separate float line and side panels on a two seam net. The catch rates as well as composition of fish were studied. The opening of the trawl mouth, both horizontally and vertically, under different operating gears and towing tension on warps were measured and estimated for comparison purposes. Better catch rate with good quality fishes was obtained with the gear operated with separate float line. With kite, the vertical spread was

increased with less catch indicating poor concentration of off bottom fishes.

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