ON THE OPERATION OF SMALL SHRIMP TRAWLS IN SHALLOW WATERS-SCOPE-RATIO AND SIZE - DEPTH RELATION

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Studies on small trawls seem to be comparatively less. These trawls are generally operated in shallower waters, where due to the limitations in the length of warp that could be released, size restrictions have to be considered for their efficient functioning. An attempt has been made to assess the effective scope-ratio of length of warp required for the operation of trawls at shallower depth and to a judge the size of trawl suitable for use at lower depths.

INTRODUCTION

In bottom trawling the length of warp (cable) to be paid out is dependent on various factors like the nature and depth of the fishing ground, the weight of the gear, speed and direction of tow and possibly the thickness of the towing warp. To release warp of length from three to five times the depth is the general practice of many skippers. For the same depth often the length varies according to the personal whim of the concerned skipper or the species of fish to be caught. Such minor variations in the scope-ratio, while not affecting the trawling operations at greater depths, at lower depths there is a tendency to adversely affect the characteristics and fishing features of the gear.

Mechanised fishing was mostly utilised for the exploitation of the off shore waters and consideration of the size of trawl seems to have been given only in relation to the towing power available with the vessel. Generally small trawls are required for operations by smaller vessels which have provision only to operate not too far from the shore. Very often many a fishery congregate in the inshore waters and all the vessels in that vicinity, irrespective of their sizes, may aspire for their exploitation. It is only common knowledge that a very big trawl, with limitations to the length of warp that could be released, could only be operated less efficiently at lower depths; instead operation of two or more small trawls by the big vessel would be more advantageous. Hence it is imperative for the efficient function of the trawls in the inshore regions to adopt the the size of trawl in relation to the depth of

operation. Conversely to assess the size of trawl in relation to the depth may also be utilised benificially to indicate the size of the vessel suitable for successful and economic exploitation of a particular region, when deemed fit.

Walter (1963) presented a summary of the successful scope-ratios used during demersal fish and shell fish surveys. In these operations the depth varied from 15 to 100 fathoms and the average scope ratio of the cable of 1/2" diameter ranged from 5.3:1.0 to 1.7:1.0. Kullenberg (1953) has experimentally found out that the thicker wire runs more vertically and need not therefore be as long as a thinner wire. Wathne (1959) observed that a scope-ratio of 3:1 is not adequate for obtaining the maximum spread of the gear in shallow water. De Boer (1959) using various scope-ratios at a depth of 16.8 to 17.3 metres demonstrated a progressive increase of door spread with scope-ratios varying from 3.4:1.0 to 8.1:1.0. Johnston (1950) prepared a graph for use by fishermen engaged in trawling to indicate the required length of warp for a given depth upto 100 fathoms. The ratio of length of warp to depth varies widely at very little alteration of depth in shallow water as indicated by the hyperbola curve given by Miyamoto (1959). At lower depths, while there are limitations to the length of warp that could be released, a higher scope ratio is required to ensure the desired horizontal spread of the nets. Accordingly the size of the net has also to be restricted so that its efficiency may not in any way be retarded. Investigations related to these aspects are comparatively less. Therefore, to assess the suitability of the size of trawl for operation in shallow water was also taken up in the present scope-ratio investigations. The observations and findings of the above studies are incorporated in this communication.

The Gear And Their Operation

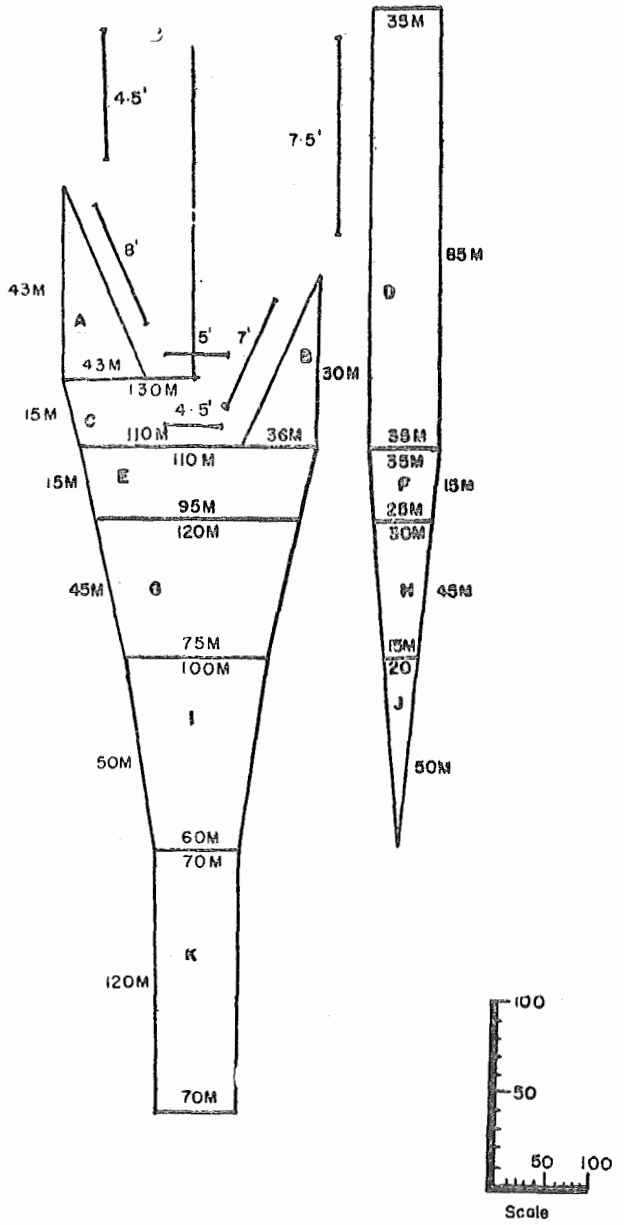
Three nets of the four seam type, which have similar design features, but proportionately bigger in size, were designed and fabricated. These nets are of 30' (9.11 m.), 40' (12.15 m.) and 50', (15.18 m.) in head rope length. Text Figures 1 to 4 give the design details of the nets and otter boards. Legs having 1/5th the length of head rope were provided for all the nets.

The operations were carried out with the vessel *Fishtech No. 2.* Flexible wire ropes of 6×19 construction, having a diameter of 3/8" were used as the towing warp.

Trawling operations were conducted at 5, 10 and 15 metres of depths, at the sea off Cochin, to the north of the entrance channel roughly between 10° - 2' and 10° - 5' North Latitudes and 76° - 10' and 76° - 15' East Longitudes, where the variations in depth are gradual and far apart.

All the three nets were operated under similar conditions, on the same day and on the same ground. A total of six hauls were made in each day with two hauls for each net i. e. each haul of one net is repeated in the opposite direction also and the average of the readings was only taken into account. On the subsequent day, operations were commenced with a change in the size of the net so as to ensure regular rotation for the three nets during successive operations. The relative towing speed and the duration of the tow were kept constant for all the hauls. At each depth initially the length of warp equal to three times the depth was released and this length was regularly increased by 5 metres for the subsequent series of hauls till the net dragged mud. The data collected were mainly depth of ground, towing course,

30Ft: FOUR SEAM TRAWL



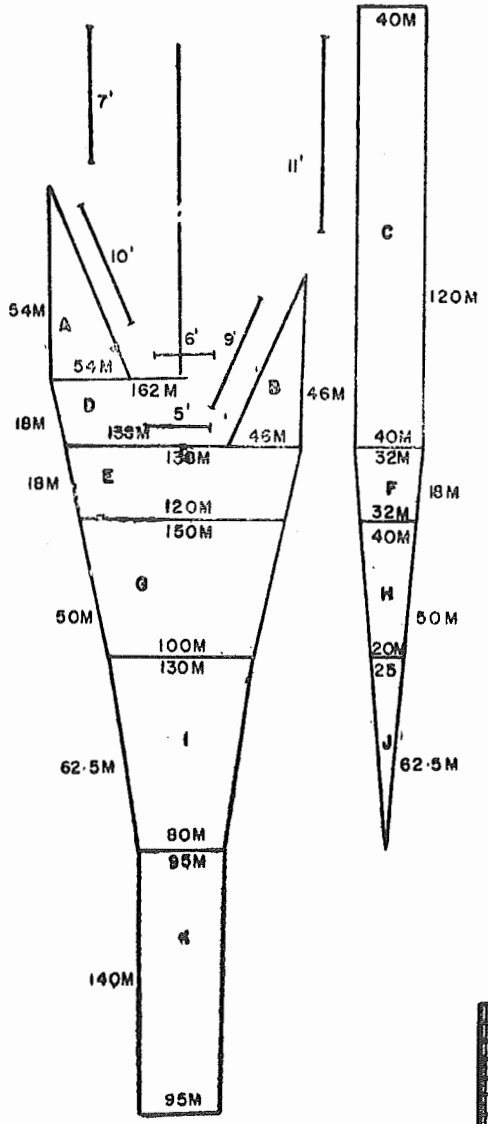
WEBBING	A	B	C	D	E	F	G	H	I	J	K
Mesh Size in Inches	2·5	2·5	2·5	2·5	2·5	2·5	2·0	2·0	1·5	1·5	1·25
Twine Size	20/8/3	20/8/3	20/8/3	20/8/3	20/9/3	20/9/3	20/9/3	20/9/3	20/9/3	20/9/3	20/10/3
Breaking Strength kg	11·2	11·2	11·2	11·2	12·54	12·54	12·54	12·54	12·54	12·54	14·10
Diameter in mm.	1·15	1·15	1,15	1·15	1·25	1·25	1·25	1·25	1·25	1·25	1·28

Floats 5" Dia. Aluminium No. Required 5 Sinkers 3/4" Bore Dia: 1/2 Lb Lead No. Required 35

ROPES	Material	Diameter
Foot Rope	Manila	3/4"
Head Rope	Manila	1/2"
Bloch Line	Manila	1/4"

Fig. 1

40 Ft: FOUR SEAM TRAWL



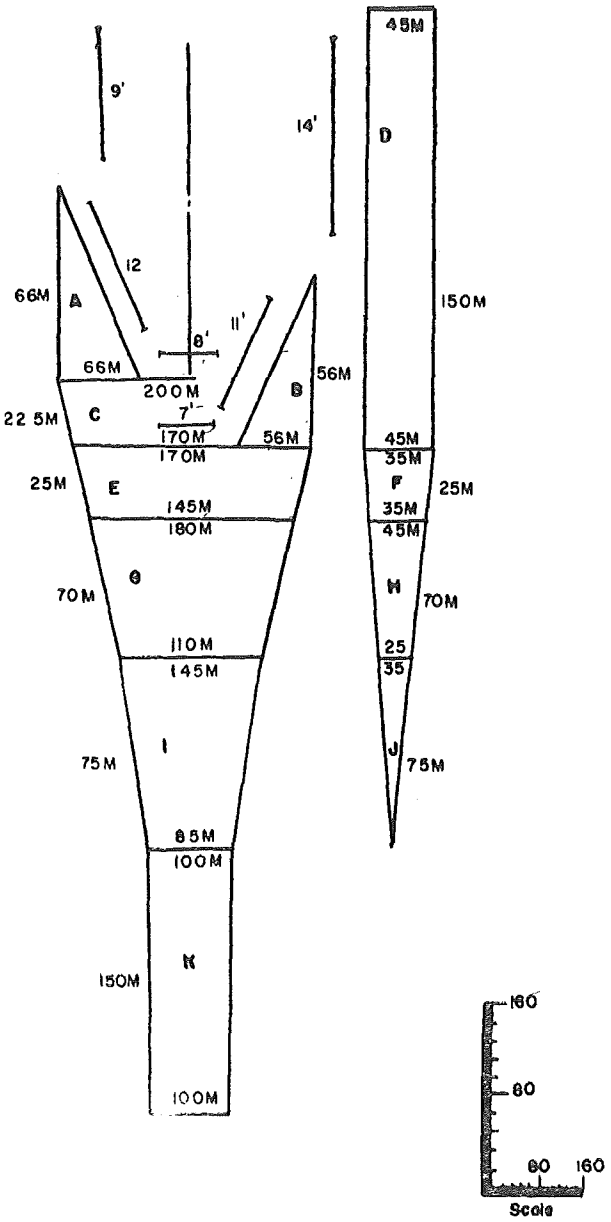
WEBBING	A	B	C	D	E	F	G	H	I	J	K
Mesh Size in inches	2·5	2·5	2·5	2·5	2·5	2·5	2·0	2·0	1·5	1·5	1·25
Twine Size	20/8/3	20/8/3	20/8/3	20/8/3	20/9/3	20/9/3	20/9/3	20/9/3	20/9/3	20/9/3	20/10/3
Breaking Strength kg	11·2	11·2	11·2	11·2	12·54	12·54	12·54	12·54	12·54	12·54	14·10
Diameter in mm	1·15	1·15	1·15	1·15	1·25	1·25	1·25	1·25	1·25	1·25	1·28

Floats 8" Dia Aluminium No Required 7 Sinkers 3/4" Bore Dia. 1/2 Lb Lead No. Required 45

ROPES	Material	Diameter
Foot Rope	Manila	3/4"
Head Rope	Manila	1/2"
Bloch Line	Manila	1/4"

Fig 2

50 Ft: FOUR SEAM TRAWL



WEBBING	A	B	C	D	E	F	G	H	I	J	K
Mesh Size in Inches	2·5	2·5	2·5	2·5	2·5	2·5	2·0	2·0	1·5	1·5	1·25
Twine Size	20/8/3	20/8/3	20/8/3	20/8/3	20/9/3	20/9/3	20/9/3	20/9/3	20/9/3	20/9/3	20/10/3
Breaking Strength kg:	11·2	11·2	11·2	11·2	12·54	12·54	12·54	12·54	12·54	12·54	14·10
Diameter in mm.	1·15	1·15	1·15	1·15	1·25	1·25	1·25	1·25	1·25	1·25	1·28

Floats 5" Dia Aluminium No Required 9 Sinkers 3/4" Bore Dia 1/2 Lb, Lead No. Required 55

ROPES	Material	Diameter
Foot Rope	Manila	3/4"
Head Rope	Manila	1/2"
Bloch Line	Manila	1/4"

Fig: 3

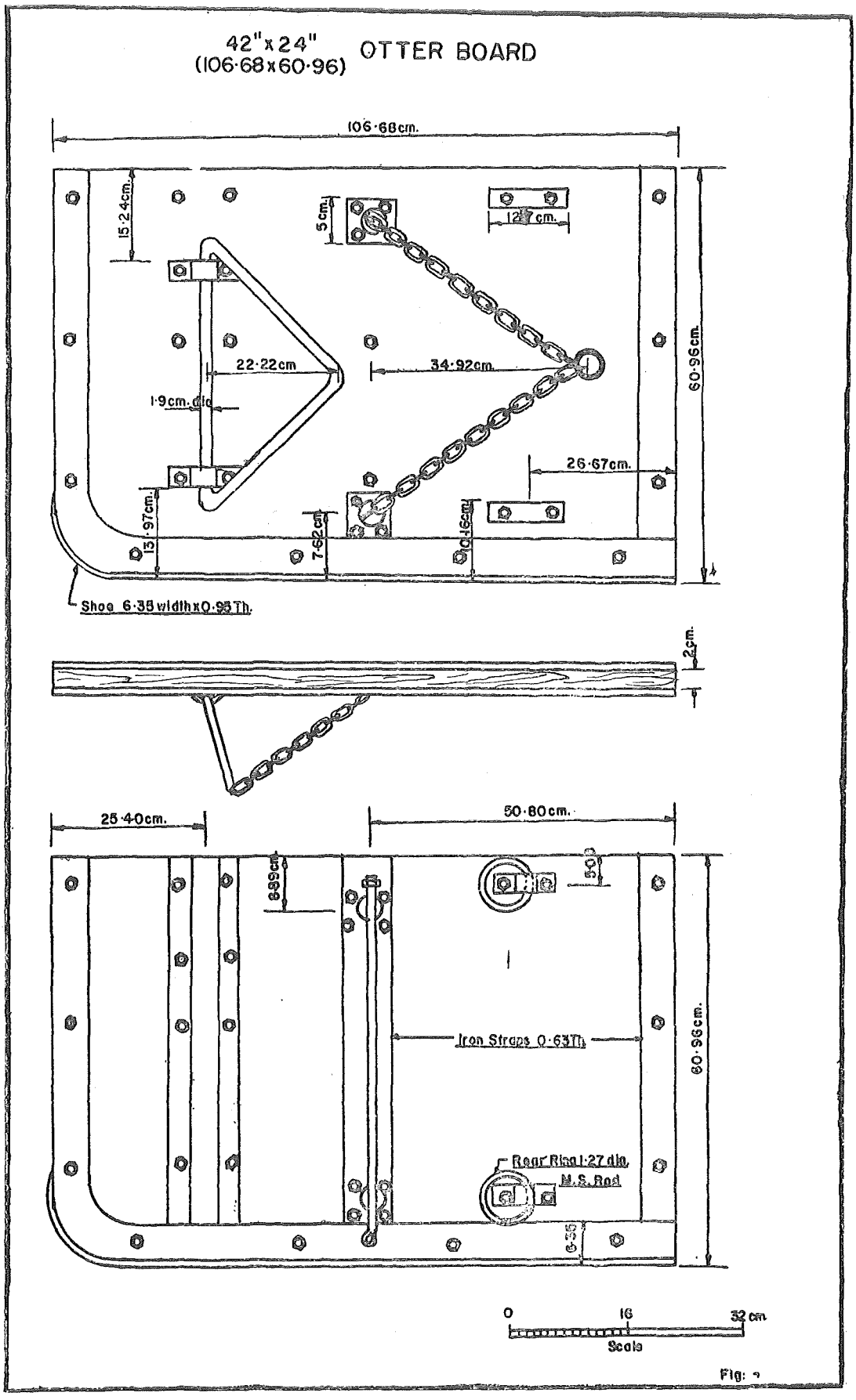

42"x24"
(106·68x60·96)
OTTER BOARD
106·68cm.
15·24cm.
5cm.
12·7cm.
22·22cm
34·92cm.
1·9cm.dia
26·67cm.
60·96cm.
13·97cm.
7·62cm
Shoe 6·35 width x 0·95 Th.
2cm.
25·40cm.
50·80cm.
8·89cm
5cm
Iron Straps 0·63Th.
60·96cm.
Rear Ring 1·27 dia.
M.S. Rod
6·35
0
16
32 cm.
Scale

Fig: 9

speed of tow, duration of tow, length of warp released, horizontal spread between otter boards, towing tension on the warps, and the RPM of the engine at the towing speed.

Accordingly at 5 metre depth 34, 24 and 20 hauls were respectively made for the 30', 48' and 50' nets before dragging in mud. The corresponding hauls for 10 meter depth were 38, 28 & 20 and for 15 meters depth 42, 38 and 28.

RESULTS AND DISCUSSION

The data collected for a total of 272 hauls were analysed and graphs drawn co-relating:

1. The horizontal spread and the length of warp released.

2. The tension on the warp and length of warp released.

The graphs are indicated in the Text Figures 5, 6 and 7.

In general the graphs present a more or less similar pattern of curve, which may be considered as an indication of the normal conditions under which the operations have been carried out.

1. *Scope-ratio*

The length of warp suitable for the operation of a net at a particular depth has been arrived at as under.

From the graph it may be seen that the behaviour of the net is regular to a certain increase in warp length after which the net is found to behave erratically even-though the net continues to function by the increase in the length of warp till it collapses and drags mud. So the length of warp prior to the erratic function of the net may be considered as the suit able or optimum length of warp required for that net at that depth.

Generally a net is considered to function efficiently when the horizontal spread is about 60% of the length of rope from otter board to otter board. The length of warp required for this spread may be considered as the suitable length.

From the observed readings corresponding values have also been calculated statistically and the graphs so drawn have also been utilised for assessing the optimum length of warp required by maximising the equation of the fitted polinomials suggested by Fisher and Yates (1957). For the observed data orthogonal polynomials of different degrees were fitted by the method of analysis of variance. (Table I & II).

Considering the above mentioned aspects, the optimum length of warp required for the operation of the three nets at the three depths have been arrived at as indicated below.

It may be seen that the scope ratio increases according to the decrease in depth and that the scope ratio decreases according to the increase in the size of the net. As the present series of experiments have been conducted to a depth of 15 metres only, the optimum scope-ratio of warp required for trawling within that depth can be expressed by the equation:

$$SR = 15.27 - 0.57\ D$$

Where SR = the ratio of length of warp to depth

D = depth of ground in metres.

2. *Size - depth relation.*

The following observations have been taken into consideration for arriving at the size-depth relation of trawl.

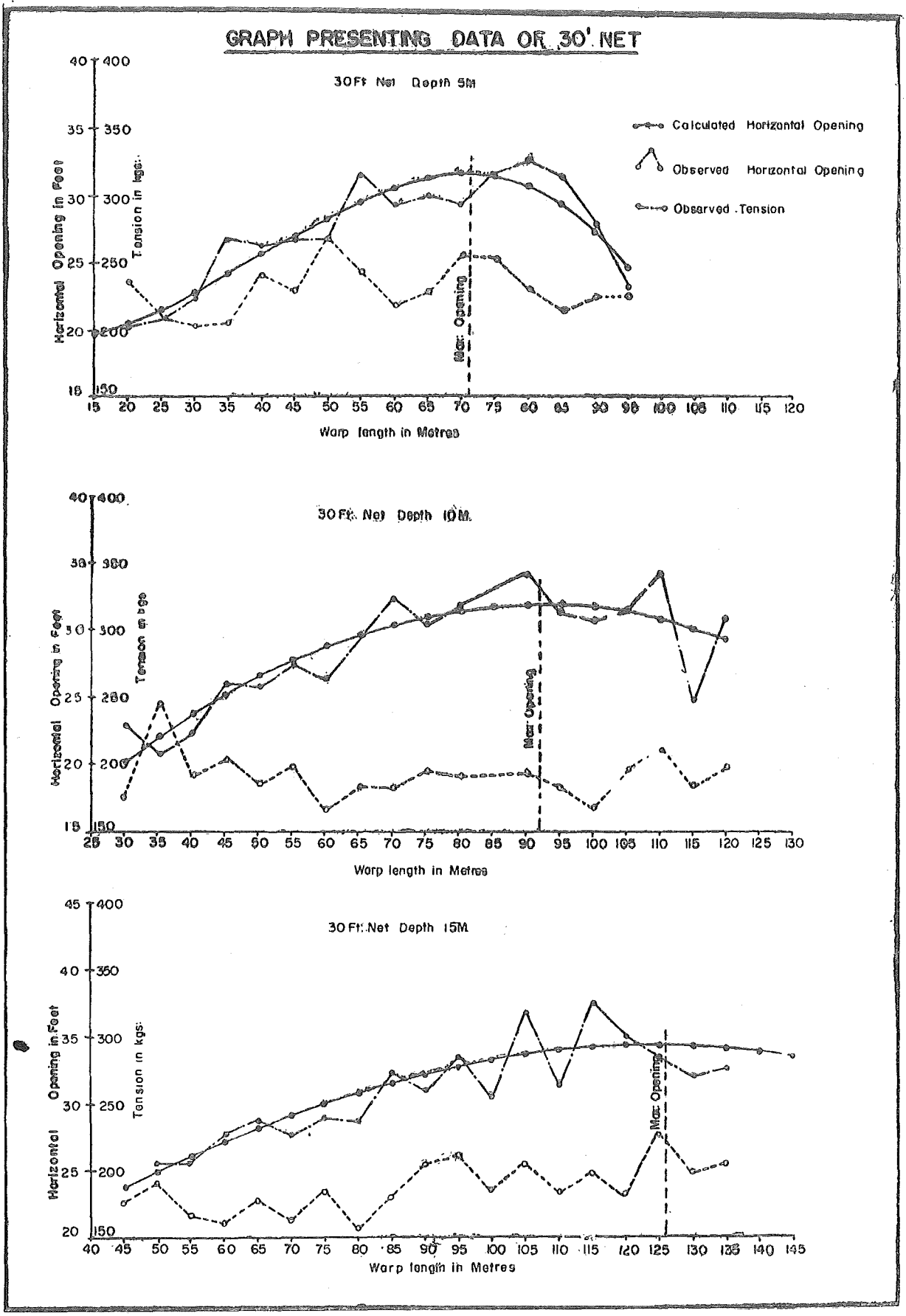

GRAPH PRESENTING DATA OF 30' NET
30Ft Net Depth 5M
Calculated Horizontal Opening
Observed Horizontal Opening
Observed Tension
Horizontal Opening in Feet
Tension in kgs.
Max Opening
Warp length in Metres
30Ft. Net Depth 10M.
Horizontal Opening in Feet
Tension in kgs
Max Opening
Warp length in Metres
30Ft. Net Depth 15M.
Horizontal Opening in Feet
Tension in kgs.
Max Opening
Warp length in Metres

Fig. 5

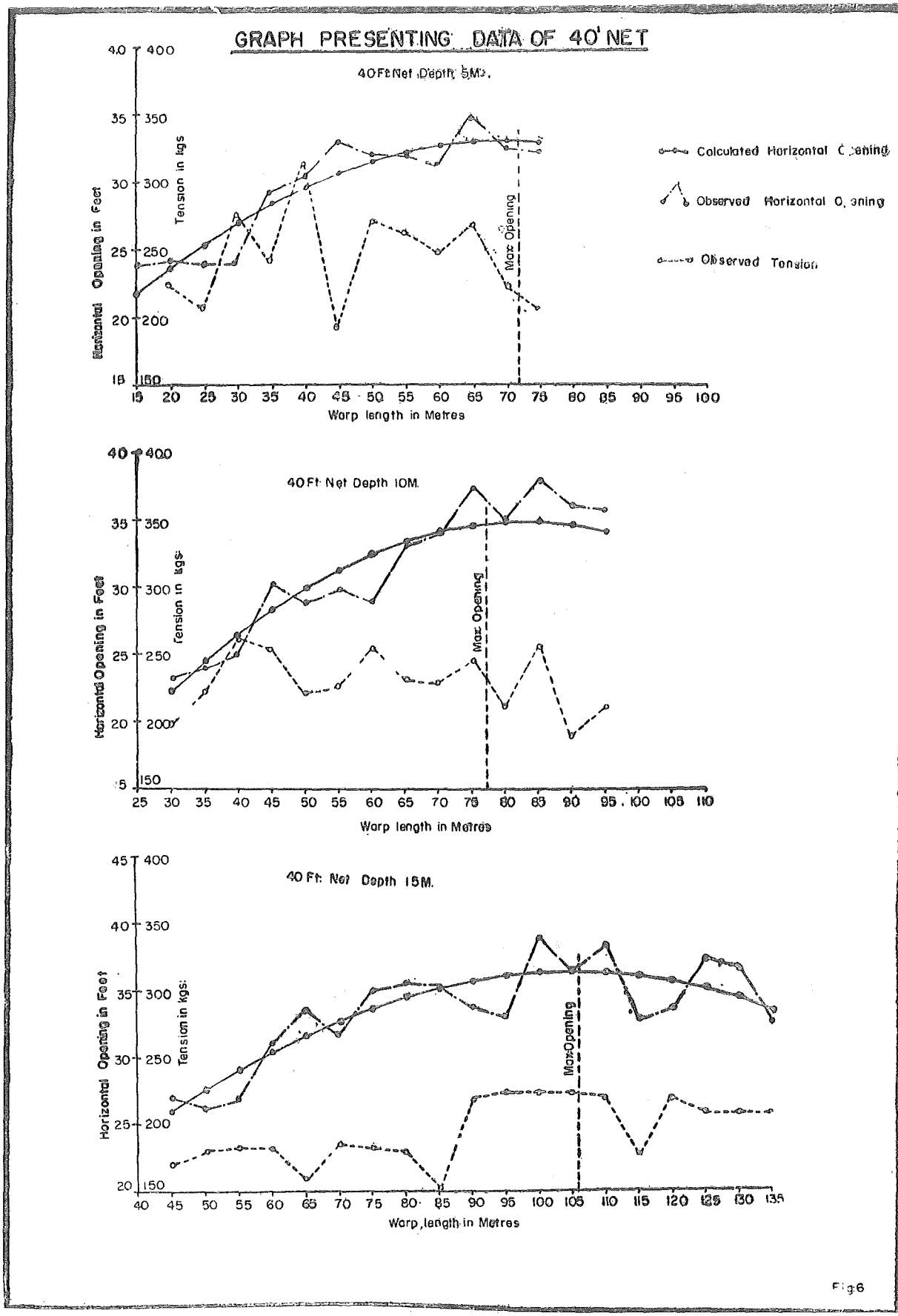
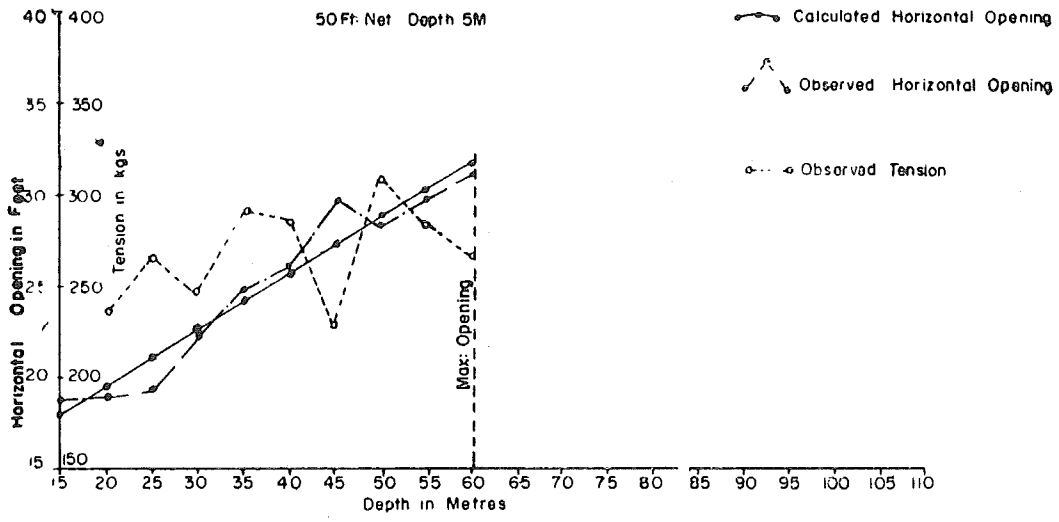
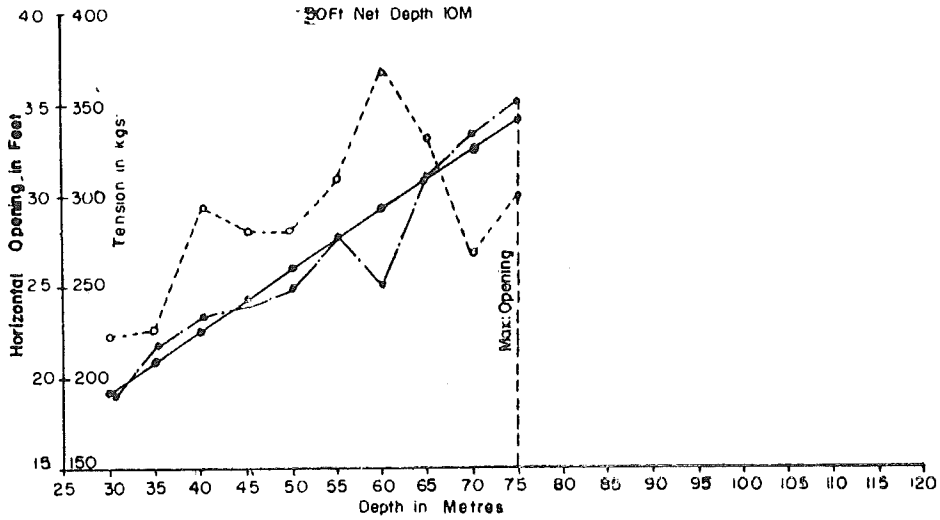

GRAPH PRESENTING DATA OF 40' NET
40 Ft Net Depth 5M.
Horizontal Opening in Feet
Tension in kgs
Max Opening
Calculated Horizontal Opening
Observed Horizontal Opening
Observed Tension
Warp length in Metres
40 Ft Net Depth 10M.
Horizontal Opening in Feet
Tension in kgs
Max Opening
Warp length in Metres
40 Ft Net Depth 15M.
Horizontal Opening in Feet
Tension in kgs
Max Opening
Warp length in Metres

Fig 8

GRAPH PRESENTING DATA OF 50' NET





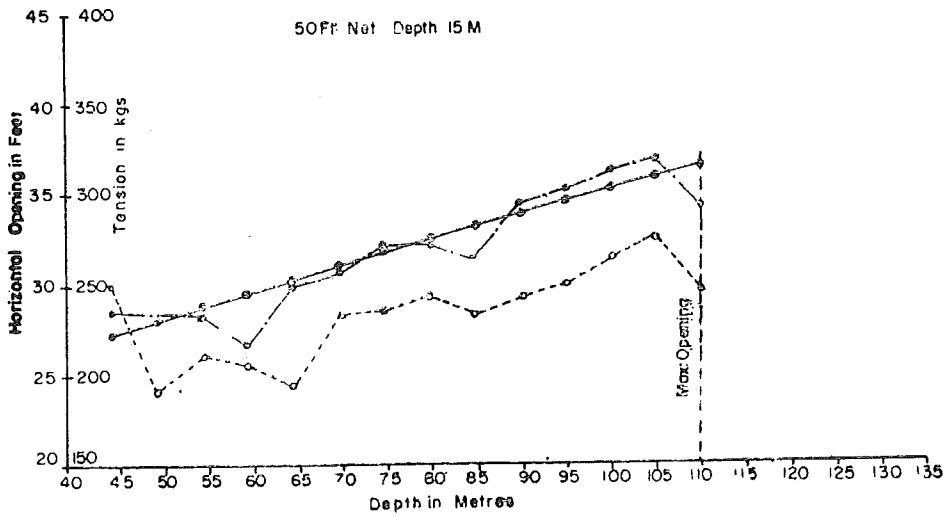


Fig 7

TABLE I ANALYSIS OF VARIANCE

Source	5 M. depth S.S.	D.F.	M.S.	F.	10 M. depth S.S.	D.F.	M.S.	F.	15 M. depth S.S.	D.F.	M.S.	F.
30′ NET												
Total	266.7	16			297.15	18			318.44	29		
I Degree	131.2	1	131.2	155.40**	150.90	1	150.90	34.52**	200.20	1	200.20	48.00**
II Degree	100.0	1	100.0	118.50**	75.16	1	75.16	17.19**	36.12	1	36.12	8.662**
III Degree	21.42	1	21.42	25.38**	5.491	1	5.491	1.26	1.15	1	1.15	<1
IV Degree	3.953	1	3.953	4.684								
Residual	10.127	12	0.854		65.60	15	4.370		80.97	17	4.17	
40′ NET												
Total	201.71	12			238.13	13			252.71	18		
I Degree	151.20	1	151.20	52.97**	175.70	1	175.70	73.35**	115.70	1	115.70	24.90**
II Degree	18.91	1	18.91	6.62*	31.20	1	31.20	13.03*	67.23	1	67.23	14.46*
III Degree	5.902	1	5.902	2.07	8.081	1	8.081	3.375	0.0684	1	0.0684	<1
Residual	25.698	9	2.855		23.95	10	2.395		69.71	15	4.647	
50′ NET												
Total	209.121	9			254.881	9			140.01	13		
I Degree	197.800	1	197.800	126.3**	231.700	1	231.700	89.80**	117.00	1	117.00	55.99**
II Degree	0.9501	1	0.9501	<1	5.122	1	5.122	1.986	0.014	1	0.014	<1
Residual	10.97	7	1.567		18.059	7	2.580		23.000	11	2.091	

*Indicates significant at 5% level.
**Indicates significance at 1% level.
S. S. = Sum of squares
D. F. = Degrees of Freedom
M. S. = Mean square
F. = Variance ratio

TABLE II

Size of net	Depth of operation	Equation of the Poly-nomial of good fit	Maximum spread	Corresponding warp length
30′	5 metres	$Y=29.6146+1.1002x-0.1136x^2-0.0124x^3$ where $x=\frac{X-55}{5}$	32.6′[a]	71.1[a] metres
30′	10 ,,	$Y=30.9538+0.5144x-0.0746x^2$ where $x=\frac{X-75}{5}$	31.8′[a]	92.2[a] ,,
30′	15 ,,	$Y=32.5073+0.5099x-0.0402x^2$ where $x=\frac{X-95}{5}$	34.1′[a]	126.7[a] ,,
40′	5 ,,	$Y=30.7671+0.9822x-0.0971x^2$ where $x=\frac{X-45}{5}$	33.3′[a]	70.3[a] ,,
40′	10 ,,	$Y=32.4100+0.8788x-0.1035x^2$ where $x=\frac{X-62.5}{5}$	34.3′[a]	83.3[a] ,,
40′	15 ,,	$Y=35.5331+0.4506x-0.0704x^2$ where $x=\frac{X-90}{5}$	36.3′[a]	106.0[a] ,,
50′	5 ,,	$Y=24.8300+1.5486x$ where $x=\frac{x-37.5}{5}$	31.8′[b]	60.0[b] ,,
50′	10 ,,	$Y=26.5300+1.6758x$ where $x=\frac{x-52.5}{5}$	34.1′[b]	75.0[b] ,,
50′	15 ,,	$Y=31.9286+0.7174x$ where $x=\frac{x-77.5}{5}$	36.6′[b]	110.0[b] ,,

(a) Estimated by maximising the equation of the polynomial fitted
(b) Observed maximum values

The 30' net has developed a maximum spread of 33' only in all the three depths and that may be considered as the maximum opening capacity of that net.

The 40' net had a spread of 33 ft. at 5m. depth, 35 ft. at 10 m. depth; and 36 ft. at 15 m. depth, which is an indication of the capacity of bigger nets to increase their openings according to the increase in depth.

A scrutiny of the graphs show that the 50' net has never obtained the maximum horizontal opening in all the three depths. This is suggestive of the fact that a net of size below 50 ft. can only be fixed as the suitable size for operation within 15 metres depth.

At 5 metres depth, all the three nets irrespective of their sizes have recorded a maximum horizontal opening of 33ft. only. This can be attributed to the limitation in the length of warp that could be released, due to the restricted depth.

Thus the range in the size of trawl for operation within 15 metres of depth have to be above 30' net and below 50' net.

From the analysis of the data the theoritical value of the size of trawl suitable for operation within 15 metres depth is calculated and found to be:

$$ST = 32.0 + 0.46\ D$$

where ST = Size of trawl in feet.

D = Depth of ground in metres.

But due consideration may also be given for the change in size, shape and angle of attack of the otter boards used along with the net for effecting the spread of the net. Accordingly a trawl net of size between 35 ft. and 45 ft. may be considered suitable for operation in this region.

ACKNOWLEDGEMENT

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