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EXPERIMENT ON MODEL CRAB BOTTOM GILL NETS IN THE CIRCULATING WATER CHANNEL

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CONTENTS

I. INTRODUCTION

Crab bottom gill nets used in the Gulf of Thailand can be divided into two types; one is the monofilament bottom gill net and the other is the multifilament bottom gill net. It has long been questioned as to whether the monofilament net was more effective and profitable than the multifilament net in catching swimming crab.

In order to compare their catching efficiency, tests on actual monofilament and multifilament crab bottom gill nets were carried out in the Gulf of Thailand on board M.V. PLALUNG. The results of the experiments showed that the multifilament gill net seemed to have a higher catching efficiency than the monofilament gill net from the abundance of crab caught. The different hang-in of the gill nets did not affect the catching efficiency.

However, in practice, a gill net can be set across or in line with the tide. In either position its shape will be modified by the dynamic water pressure which in turn may effect its fishing capacity.

To complete the study of gill nets and obtain more information on the behaviour of both types of net in the water flow, a model experiment in the circulating water tank was carried out.

The initial objective was to observe how the gill net works in tides. Analysis of the first set measurements revealed, however, that the resistance and headline height of nets were systematically related to the netting parameters.

Further measurements were performed on monofilament and multifilament nylon nets to determine the relationship between resistance and headline height on twine type, direction and water speed.

This paper presents the results of the model experiments on crab gill net and the methods used, e.g. experiment on fishing nets performed by all trainees so that those interested in the operation of the circulating water channel could acquire a practical understanding outside the lecture room.

II. MATERIALS AND METHODS

1. Experimental nets and rigging

Two types of model bottom gill nets, monofilament and multifilament nylon, were employed in this experiment. For each type there were three nets each with a different hang-in ratio, for convenience sake, they can be referred to as nets A, B, C. and nets D, E, F.

The 1:3 reductional model bottom gill nets were made according to Tauti's law of similarity for fishing nets (1934) and Kawakami's model for fishing net rope (1963). For the experiments in the circulating water channel, the length of headline of each net was fixed at one metre.

The specifications of each net are shown in Table 1. and Figures 1 and 2.

2. Measurement procedure

The resistance of net was measured by a strain gauge at the towing bridle. The calibration of the strain gauge was checked before any measurements were made.

The current speed was set during the tests by adjusting the speed of the impellers, forcing water to flow around in the tank, according to a previous calibration against a propeller linear regression graph (See Table 2). The current speed was varied between 100 and 600 r.p.m., in steps of 100 r.p.m. Resistance and height of each net were measured first at 600 r.p.m., and then at lower speeds. This was to ensure that the netting was not snagged and hung evenly. Zero speed measurements were not possible, as the floats pulled the netting into bundles and grossly distorted the headline.

The headline height was measured with a metre stick. The height was measured at two points; firstly 0.25 m. along the headline and secondly at the middle of the headline. (i.e. between two floats and at a float)

Photographs of each net were taken at most speed settings.

3. Setting of the experimental nets

In this experiment, each net was set in two manners, that is across and in line with the current.

When across the current, the net was connected with bridles to the pulleys underwater in the circulating water channel. The distance between the two pulleys was 120 cm.

When in line with the current one pulley was underwater in front of the net, with strain gauge attached, the other was behind the net without strain gauge. The setting of experimental nets and equipment can be seen in Figures 3 and 4 and the model experiment program in Table 3.

III. RESULTS AND DISCUSSION

1. Observations

All nets work in the same manner in flowing water in the same setting. When across the current, as the water speed increased, the meshes slipped behind, with the whole net forming a shape like that of a trawl net.

When in line with the current, as the water speed increased, the meshes slipped along the staples, and bunched at the end, forming a smooth curve.

At all current speeds, the headline height was lowest at the towing end of the net, and increased gradually along the net at a shallow angle.

As current speed was increased, the headline height fell, and the angle of the upper bridle to the horizontal was reduced.

2. Measurements and Analysis

2.1 Resistance of net (Drag of net)

Experiments on the six nets were conducted in two manners at seven current speeds per net. The net resistance data for each experiment were analysed using the linear regression method. The correlation equation, indicating the relationship between current speed V and resistance of net R is expressed as; $R = KV^n$.

K and n are the constants. The values of K and n indicate the size of resistance when the current speed is changed. A large value of n means the relationship between current speed and net resistance is very close. In other words, a large value of n means that the increasing rate of resistance of net is higher than a small value of n.

From the results of the data analysed (See Tables 4 and 7, and Figures 5 and 6), it can be seen that the average resistance of all nets set across the current is larger than that of the nets set in line with the current, also that the increasing rate of resistance of a net set across the current is a bit higher than that of a net set in line with the current.

With regard to netting material, the monofilament crab gill nets resistance seemed to be smaller than that of the multifilament nets for both settings. However the increasing rate of resistance of monofilament gill nets was higher than that of multifilament nets when set in line with the current. Furthermore when a net was set across the current, neither the netting materials of the monofilament nor the multifilament net had any affect on the increasing rate of resistance.

For different hang-in ratios, when the nets were set in line with the current, a higher hang-in ratio net seemed to be more resistant than a lower one. However, when the nets were set across the current, the resistance of the monofilament net with hang-in 40% and the multifilament net with hang-in 50% was smaller than that of the other four nets.

When comparing all the nets set in line with the current and across the current, the increasing rate of resistance of multifilament nets with hang-in 30% and 50% was lower than that of the other four nets.

2.2 Height of net

The height of net was measured at two points, namely at a float and between two floats. The results were analysed by the same method as the net resistance. The correlation equation, indicating the relationship between current speed V and height of net H is expressed as; $H = KV^{-n}$.

The height of net can be explained by the K and n values in Tables 5 and 6 and Figures 6 and 7. The calculated height of net can be seen in Tables 8 and 9.

From the results of data analysed for every condition of the two setting methods and current speeds, it can be seen that the height of all nets set in line with the current is higher than that of the nets set across the current. Also that the decreasing rate of height of nets set in line with the current is lower than that of the nets set across the current.

In respect of netting materials, the height of monofilament gill nets seemed to be greater than that of the multifilament nets for both settings. The decreasing rate of height of both gill nets was not very different judging from the slope of the graph and the n values.

As for the hang-in ratio, different values of net hang-in ratio have no effect upon the height of net and its rate of decrease.

IV. CONCLUSIONS

From the results of the model experiment, it can be concluded that the monofilament crab gill net has less net resistance and its height of net is higher than that of the multifilament under all current speed conditions.

As to gill net catchability, a bigger area net has a higher possibility in catch than a smaller area net. The monofilament net is therefore, more advantageous than the multifilament because its height expanse is greater which means that its area is larger.

In addition, the monofilament net is easier to haul up than the multifilament due to the size of net resistance.

In view of the results of operations, shooting the net in line with the current should be better than shooting across the current. This is because both the monofilament and multifilament nets have a smaller resistance and their height is greater when set in line with the current, which means that setting in line with the current has more potential for catch, and in addition they will be lighter when hauling up.

With regard to the hang-in ratio, the results of the model experiments cannot provide sufficient reasons to establish which percentage of hang-in is best for crab bottom gill nets.

However, since these conclusions came from the results of the model net in the test-tank, the effects of external factors in the environment on the actual gear are not included. For example the catchability of gill net is not only dependent on the area of gill net but also the kind and character of the threads, the color of the net, the shape, its movement, and the principles of behavior of aquatic animals in relation to the gill net.

V. ACKNOWLEDGEMENTS

We wish to thank the 1986-87 Regular Course trainees who helped us carry out this experiment. Thanks are also due to Messrs. Sirichai Thungjitchareonkul and Sujin Sae-ung, the special Fishing Technology trainees and the staff of the fishing workshop for preparing the circulating water channel.

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Table 1. Specification of monofilament and multifilament model bottom gill nets.

Net type / Net	A	B	C	D	E	F
Webbing						
Material	PA-MONO	PA-MONO	PA-MONO	PA-MULTI	PA-MULTI	PA-MULTI
Netting cord	ϕ0.2 mm	ϕ0.2 mm	ϕ0.2 mm	ϕ0.35 mm	ϕ0.35 mm	ϕ0.35
Mesh size (cm)	4	4	4	3.25	3.25	3.25
Hang-in ratio (%)	30	40	50	30	40	50
Mesh depth	9.5	9.5	9.5	12	12	12
Float line						
Line (mm)	PEϕ0.88	PEϕ0.88	PEϕ0.88	PEϕ0.88	PEϕ0.88	PEϕ0.88
Length (m)	1	1	1	1	1	1
Float material	PVA	PVA	PVA	PVA	PVA	PVA
Float size (mm)	ϕ10	ϕ10	ϕ10	ϕ10	ϕ10	ϕ10
Buoyancy/piece (gm)	0.8	0.8	0.8	0.8	0.8	0.8
Float interval (cm)	50	50	50	50	50	50
Sinker line						
Line (mm)	PEϕ0.88	PEϕ0.88	PEϕ0.88	PEϕ0.88	PEϕ0.88	PEϕ0.88
Length (m)	1	1	1	1	1	1
Sinker material	lead	lead	lead	lead	lead	lead
Sinking force (gm)	0.4	0.4	0.4	0.4	0.4	0.4
Sinker interval (cm)	10	10	10	10	10	10

Table 2. Relationship between revolutions per minute of propeller and current speed.

Revolutions per minute (r.p.m.)	Current speed (cm/sec)
50	9.634
100	13.868
150	18.102
200	22.336
250	26.570
300	30.804
350	35.038
400	39.272
450	43.506
500	47.740
550	51.974
600	56.208
650	60.442

Table 3. Model experiment program.

Net type	PA-MONO 30% (A)	PA-MONO 40% (B)	PA-MONO 50% (C)	PA-MULTI 40% (D)	PA-MULTI 40% (E)	PA-MULTI 50% (F)	
Setting (degree)	IN LINE WITH THE CURRENT 180° (I)				ACROSS THE CURRENT 90° (II)		
Current Speed (r.p.m.)	100 (1)	150 (2)	200 (3)	250 (4)	300 (5)	350 (6)	400 (7)

Table 4. Values of n and k for every condition (resistance and current speed) of crab bottom gill net.

Type of net	IN LINE WITH THE CURRENT		ACROSS THE CURRENT	
	n	k	n	k
A	1.7287	0.0605	2.0131	0.0655
B	2.1295	0.0200	1.8966	0.0694
C	2.1294	0.0261	1.9853	0.0721
D	1.5508	0.1187	2.0799	0.0659
E	1.5828	0.1167	1.8439	0.1333
F	1.5824	0.1369	1.7215	0.1685

Table 5. Values of n and k for every condition (height of net at float and current speed) of crab bottom gill net.

Type of net	IN LINE WITH THE CURRENT		ACROSS THE CURRENT	
	n	k	n	k
A	- 0.6334	116.0060	- 0.8388	194.8680
B	- 0.8286	236.3430	- 1.0036	305.0994
C	- 0.9244	279.3945	- 0.7937	139.1304
D	- 0.7932	157.5231	- 0.9309	148.0205
E	- 1.0398	315.5392	- 1.0303	186.5290
F	- 0.6943	106.4375	- 0.8669	119.0789

Table 6. Values of n and k for every condition (height of net between floats and current speed) of crab bottom gill net.

Type of net	IN LINE WITH THE CURRENT		ACROSS THE CURRENT	
	n	k	n	k
A	- 0.6587	109.9803	- 0.7555	133.5752
B	- 0.8758	240.4945	- 0.7780	124.9382
C	- 0.8105	170.9495	- 0.5936	66.5237
D	- 0.6369	84.5535	- 0.8452	107.0783
E	- 0.8105	133.2514	- 0.7916	80.1496
F	- 0.5477	61.3504	- 0.8204	94.3839

Table 7. Resistance of net from the linear regression calculation (gm).

Current speed (cm/sec) / Net type	13.1 (1)	18.1 (2)	22.3 (3)	26.5 (4)	30.8 (5)	35 (6)	39.2 (7)
Net A							
in line	5.7	9.0	12.9	17.5	22.6	28.2	34.3
across	12.9	22.2	33.9	48.0	64.9	84.0	105.6
Net B							
in line	5.4	9.5	14.8	21.4	29.5	38.8	49.4
across	10.0	16.8	25.0	34.7	46.2	58.9	73.0
Net C							
in line	6.9	12.4	19.3	28.0	38.5	50.6	64.4
across	13.2	22.6	34.2	48.2	65.0	83.8	104.9
Net D							
in line	6.9	10.5	14.6	19.1	24.1	29.4	35.1
across	15.4	27.2	41.9	60.1	82.2	107.2	135.7
Net E							
in line	7.4	11.4	15.8	20.8	26.4	32.4	38.8
across	16.8	27.7	40.8	56.1	74.0	93.7	115.5
Net F							
in line	8.7	13.3	18.6	24.4	31.0	37.9	45.4
across	15.4	24.6	35.2	47.5	61.5	76.6	93.2

Table 8. Height of net at float from the linear regression calculation (cm).

Current speed (cm/sec) / Net type	13.1 (1)	18.1 (2)	22.3 (3)	26.5 (4)	30.8 (5)	35 (6)	39.2 (7)
Net A							
in line	21.9	18.5	16.2	14.5	13.2	12.2	11.3
across	21.5	17.5	14.4	12.4	10.9	9.8	8.9
Net B							
in line	26.8	21.4	18.0	15.6	13.8	12.4	11.3
across	21.8	16.6	13.5	11.3	9.7	8.6	7.6
Net C							
in line	24.6	19.2	15.8	13.5	11.7	10.4	9.4
across	17.3	13.9	11.8	10.3	9.1	8.2	7.5
Net D							
in line	19.6	15.8	13.4	11.7	10.3	9.3	8.5
across	12.8	9.9	8.2	7.0	6.0	5.4	4.8
Net E							
in line	20.5	15.5	12.5	10.4	8.9	7.8	6.9
across	12.4	9.4	7.6	6.3	5.4	4.7	4.2
Net F							
in line	17.2	14.2	12.3	10.9	9.8	9.0	8.3
across	12.2	9.6	8.0	6.9	6.1	5.4	4.9

Table 9. Height of net between floats from the linear regression calculation (cm).

Current speed (cm/sec) / Net type	13.1 (1)	18.1 (2)	22.3 (3)	26.5 (4)	30.8 (5)	35 (6)	39.2 (7)
Net A							
in line	19.5	16.3	14.2	12.7	11.5	10.5	9.8
across	18.3	14.9	12.7	11.2	10.0	9.1	8.3
Net B							
in line	24.1	19.0	15.8	13.6	11.9	10.7	9.6
across	16.2	13.1	11.1	9.7	8.6	7.8	7.1
Net C							
in line	20.3	16.3	13.8	12.0	10.6	9.5	7.0
across	14.0	11.9	10.5	9.5	8.6	8.0	7.5
Net D							
in line	15.8	13.3	11.7	10.4	9.5	8.7	8.1
across	12.1	9.2	7.7	6.7	5.9	5.3	4.8
Net E							
in line	15.8	12.7	10.7	9.3	8.2	7.4	6.8
across	10.0	8.0	6.8	5.9	5.3	4.8	4.3
Net F							
in line	14.5	12.5	11.2	10.1	9.3	8.7	8.2
across	10.9	8.7	7.3	6.4	5.6	5.1	4.6

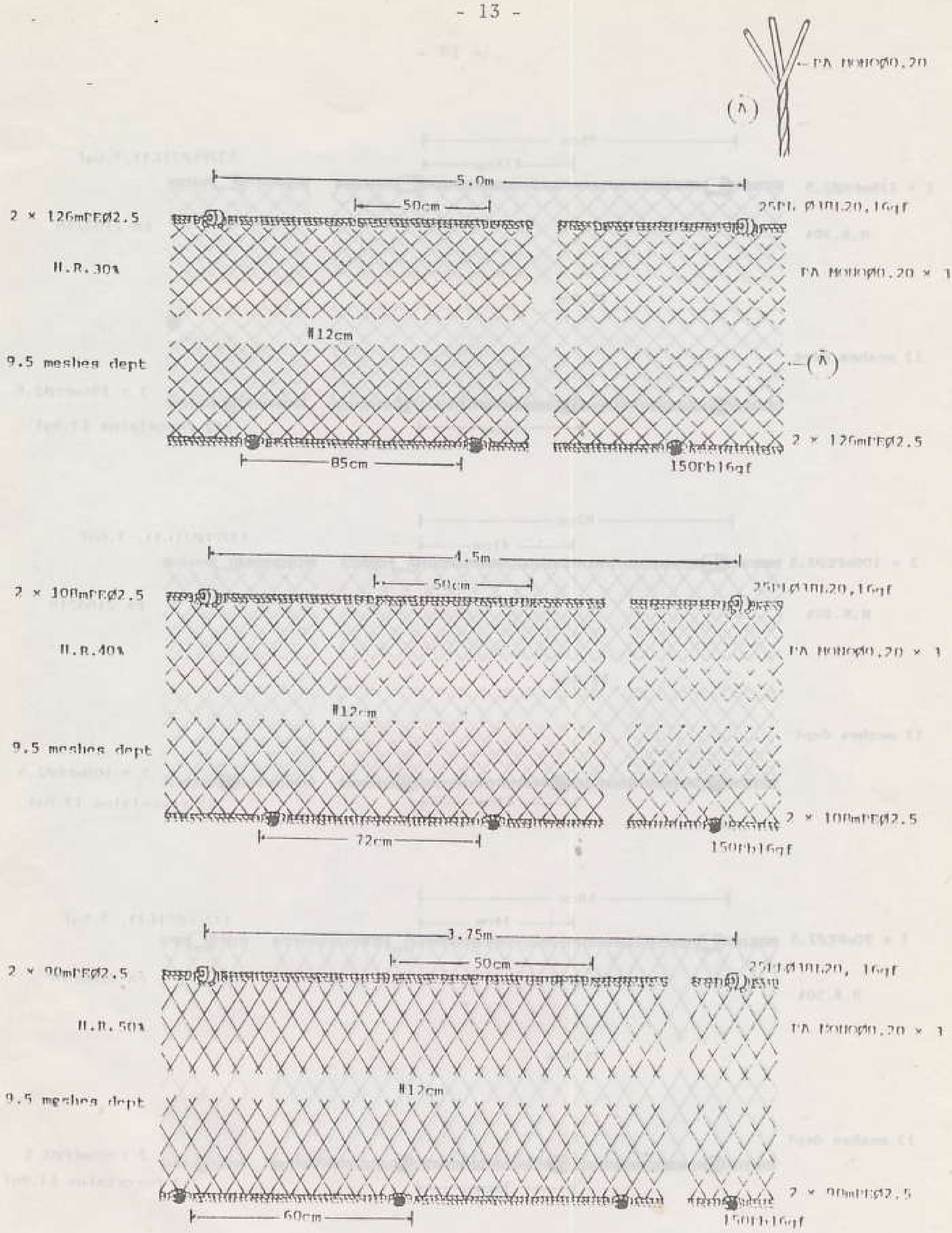

Figure 1. The construction of three types of monofilament bottom gill nets (Hang-in ratios 30%, 40% and 50%)

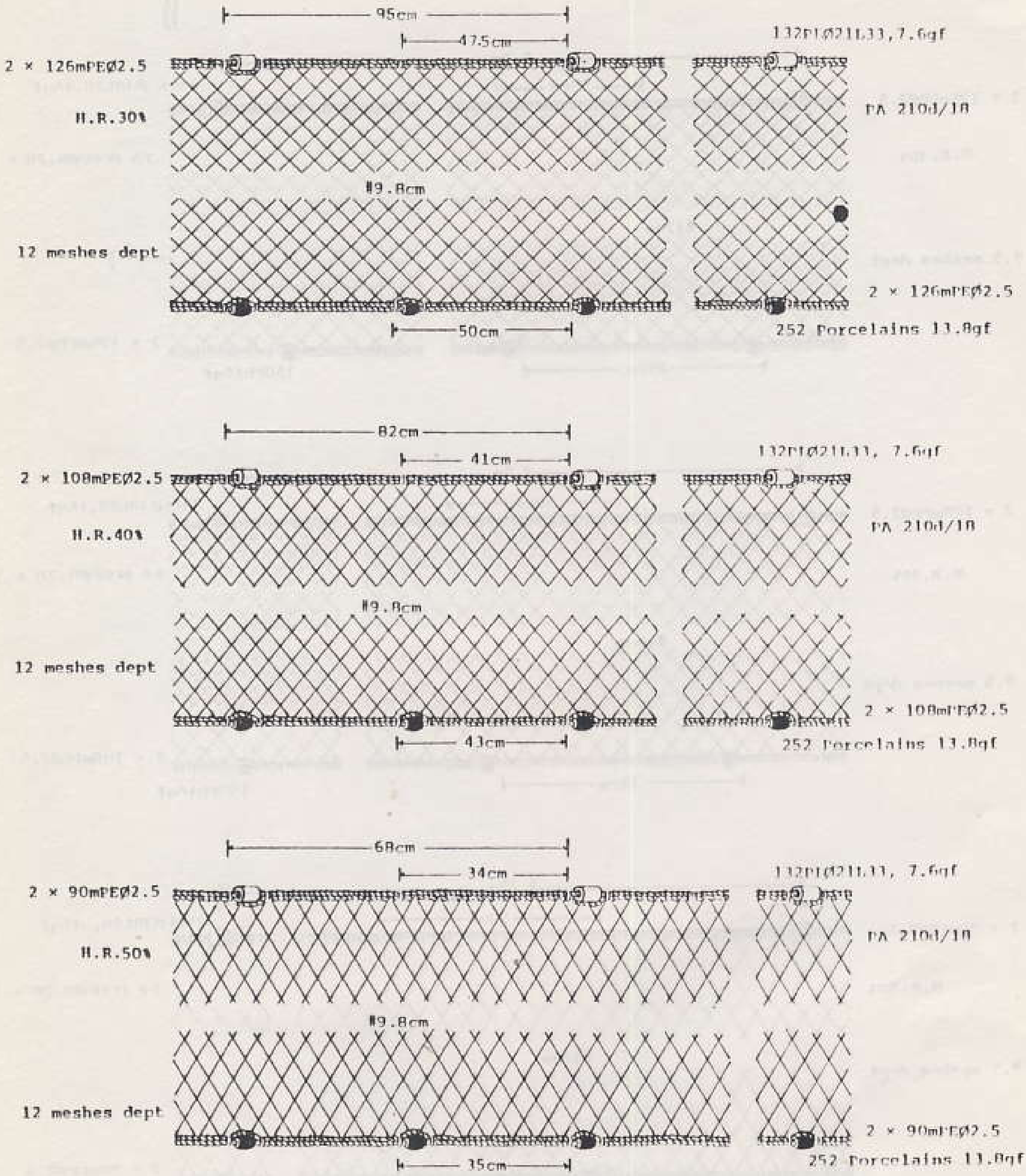

Figure 2. The construction of three types of multifilament bottom gill nets (Hang-in ratios 30%, 40% and 50%)

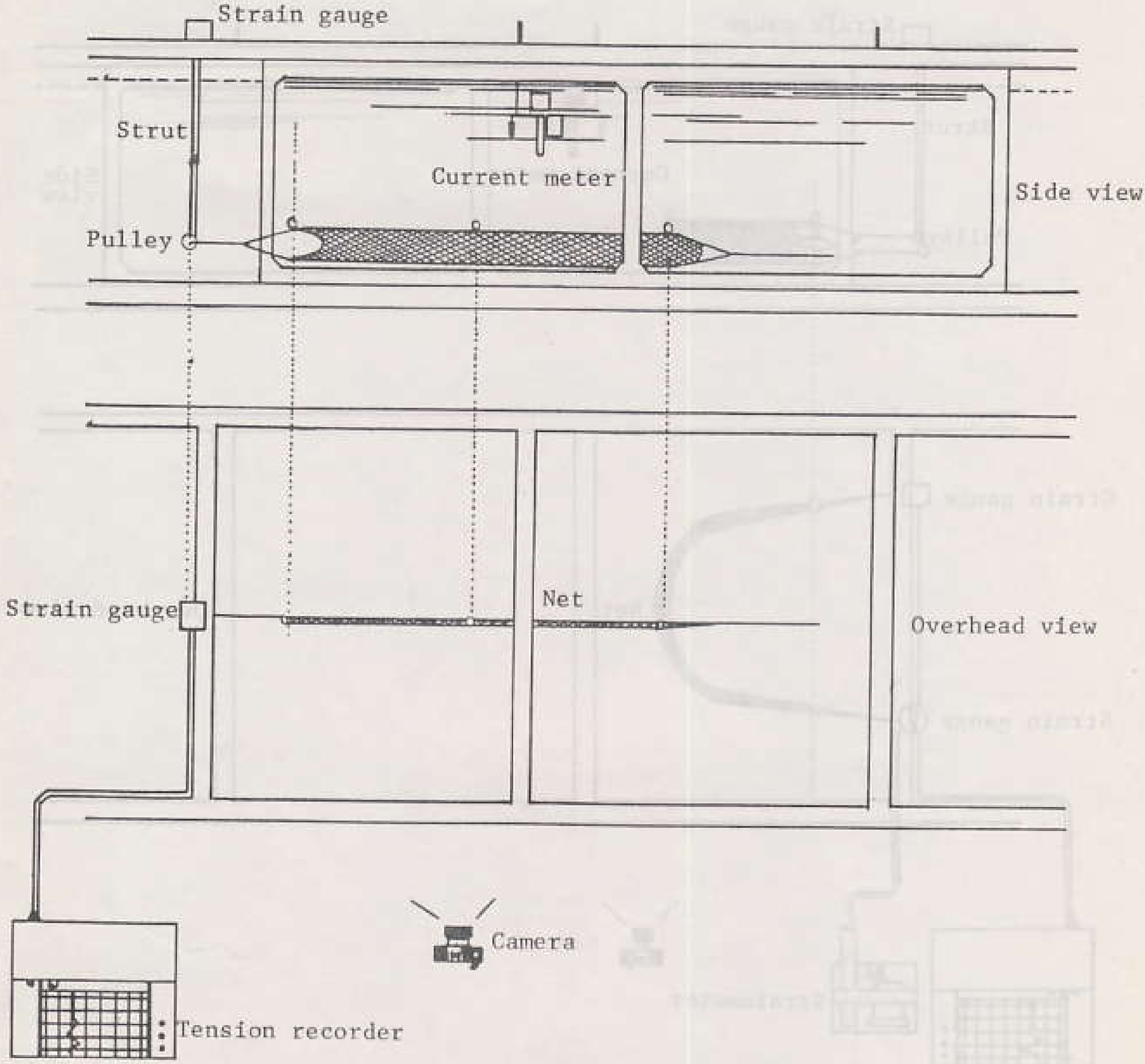

Figure 3. Arrangement of equipment for measuring the tension of net and photographing the shape of net set in line with the current.

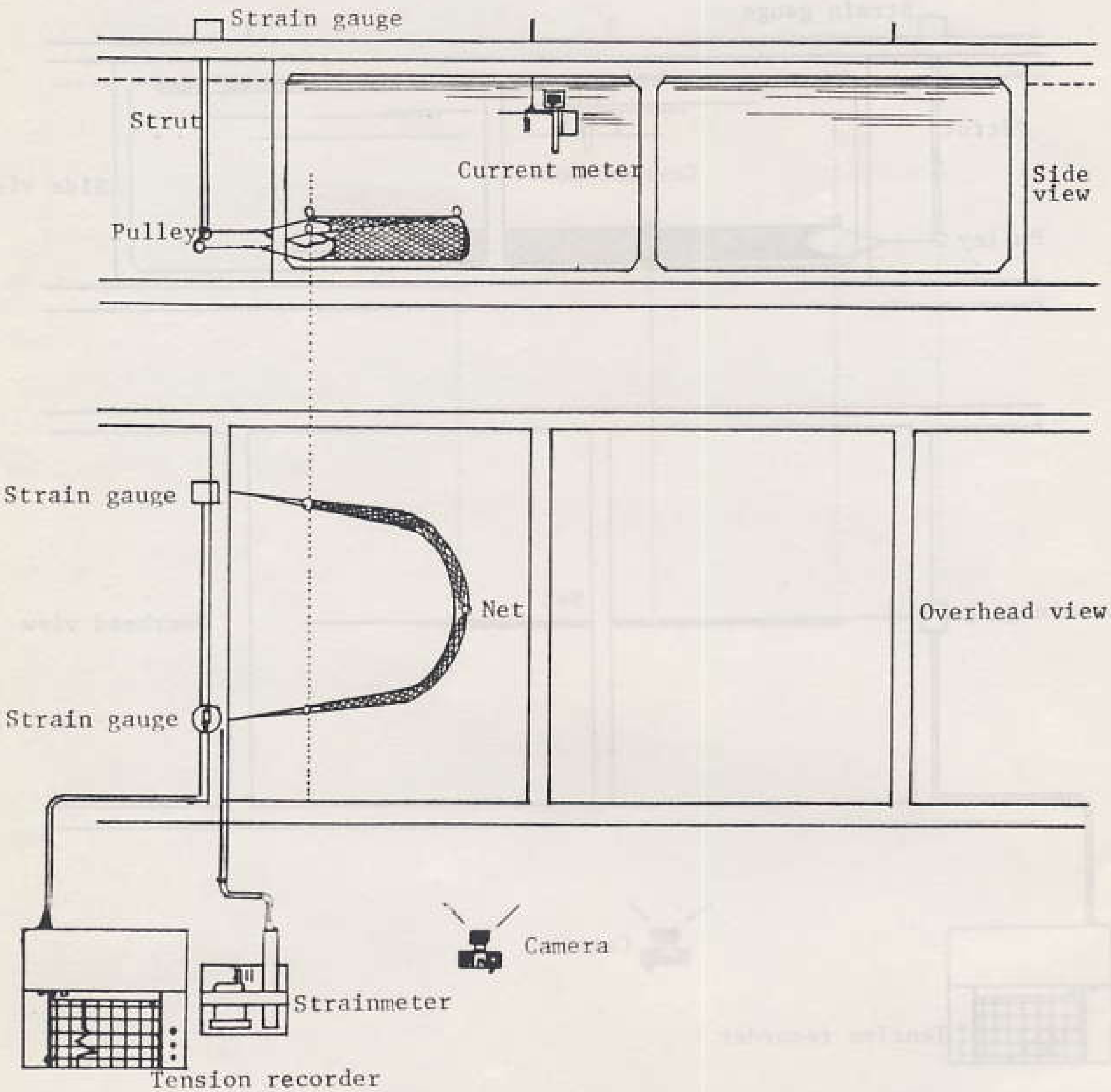

Figure 4. Arrangement of equipment for measuring the tension of net and photographing the shape of net set across the current.

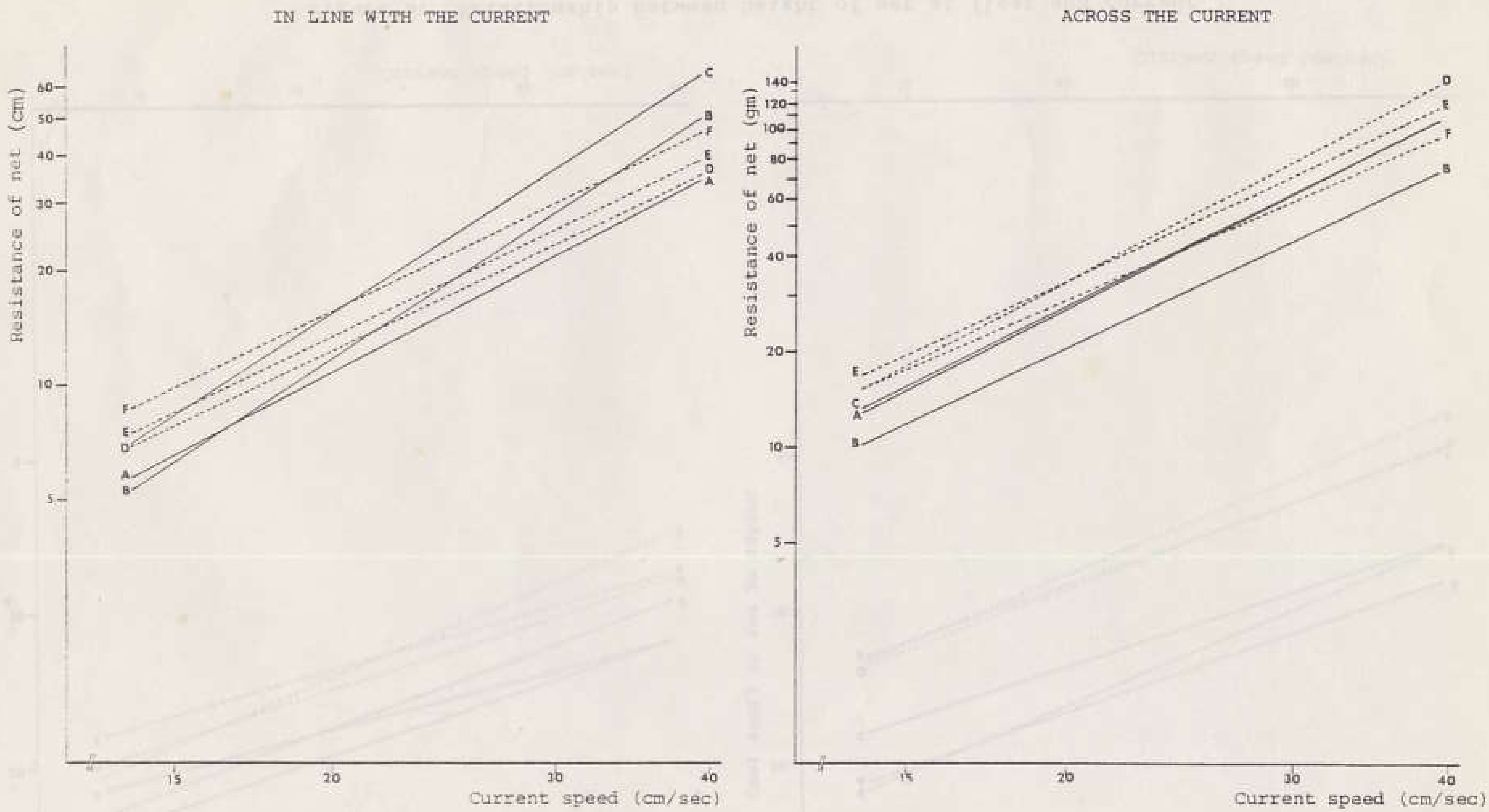

Figure 5. Relationship between resistance of net and current speed of crab bottom gill net when set in line with, and across, the current.

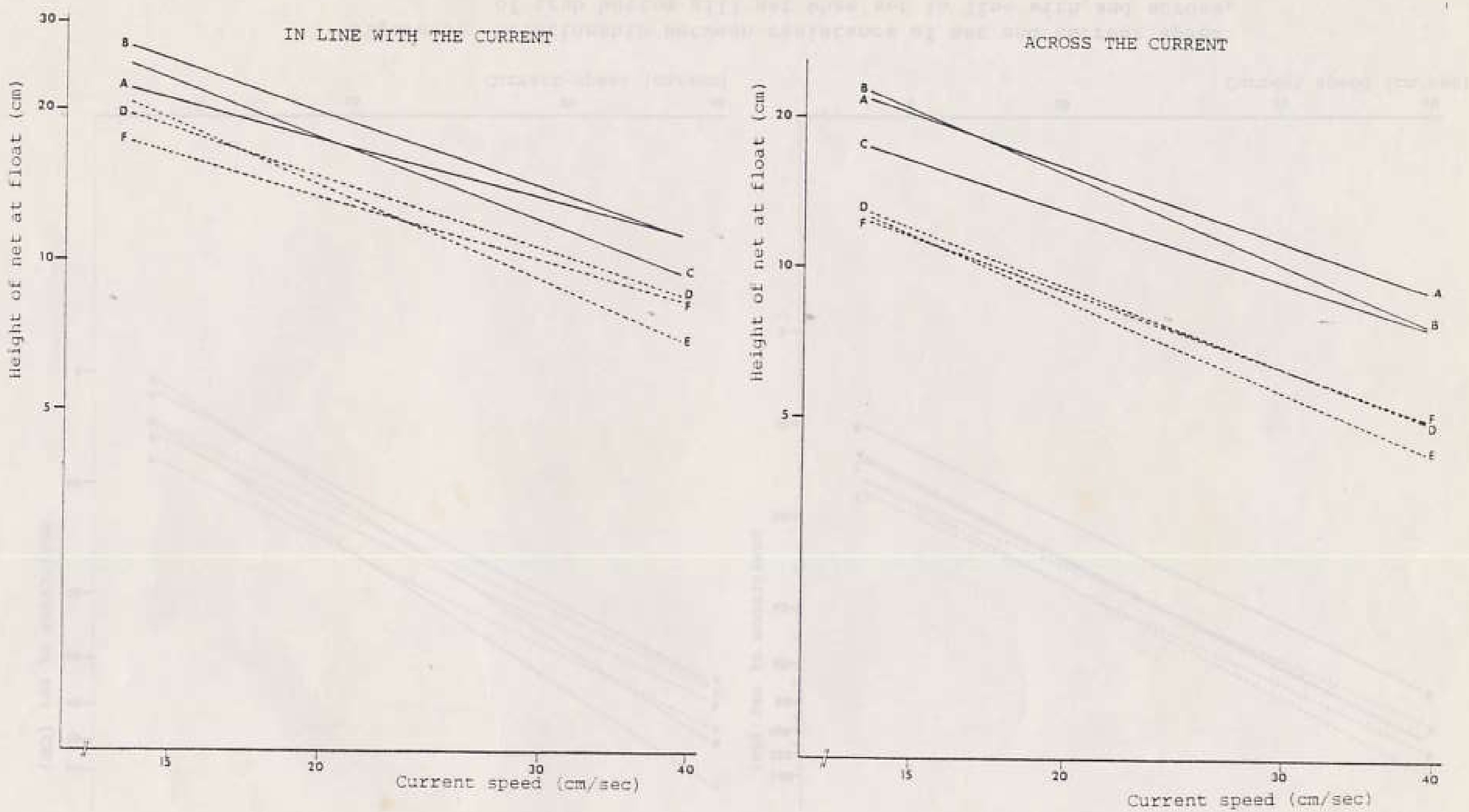

Figure 6. Relationship between height of net at float and current speed of crab bottom gill net when set in line with, and across, the current.

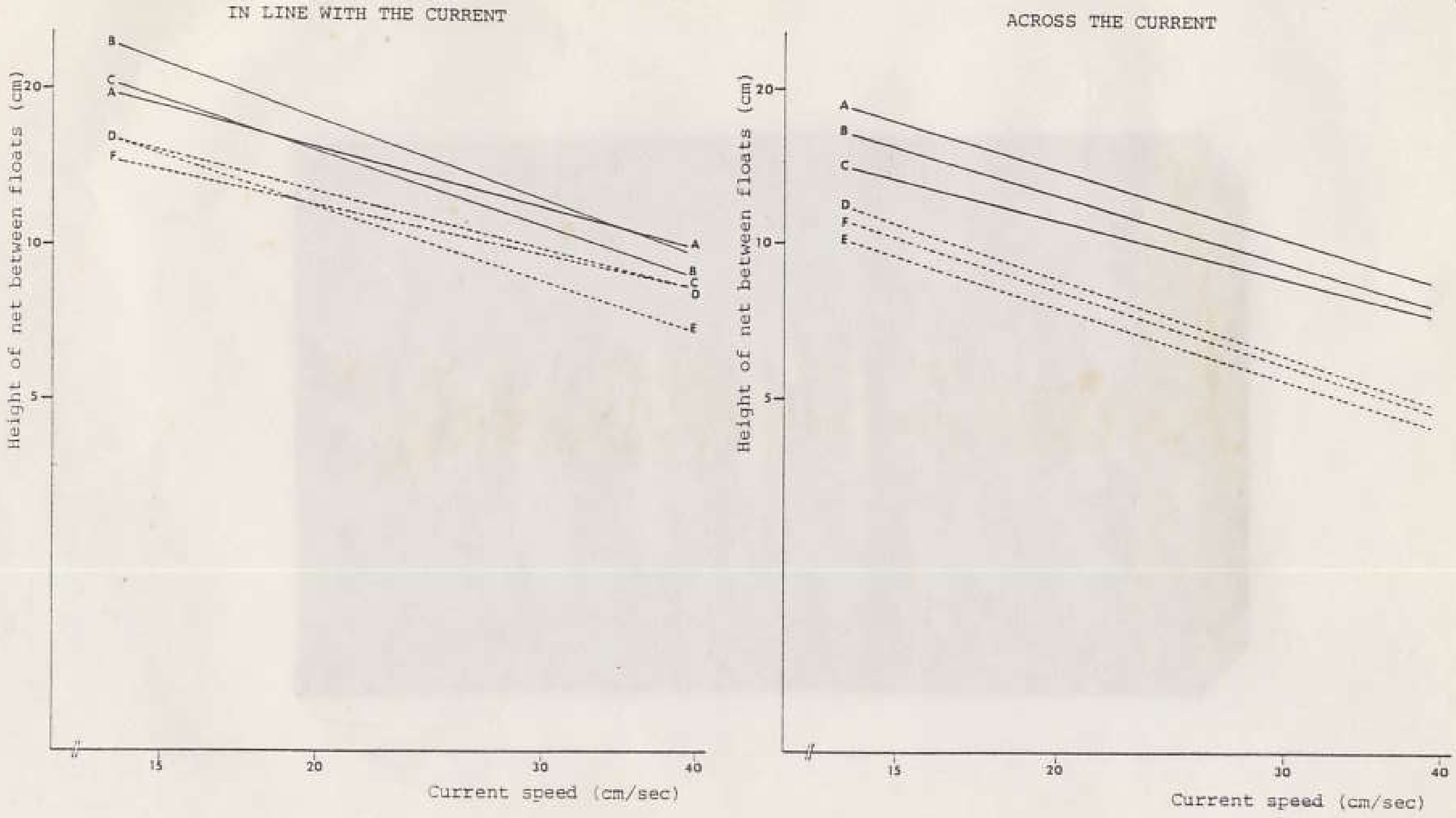

Figure 7. Relationship between height of net between the floats and current speed of crab bottom gill net when set in line with, and across, the current.