Study on

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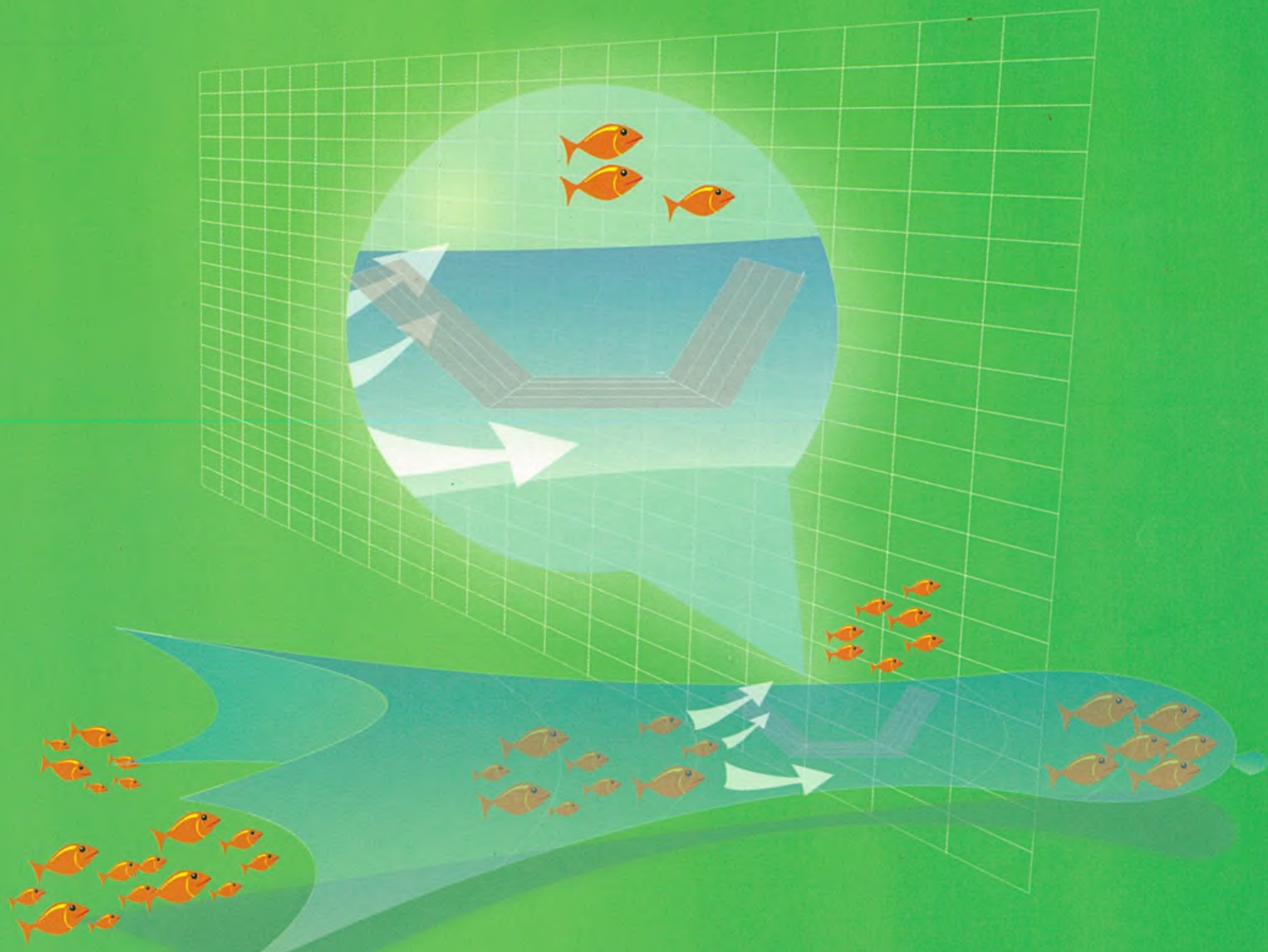

Southeast Asian Fisheries Development Center
Training Department

TD/RES/81

Study on Juvenile and Trash Excluder Devices (JTEDs) in the Philippines

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Introduction

Trawling is a highly efficient fishing method for catching shrimp and is used in many regions. The Southeast Asian region is in the tropical zone and is a multi species area and the fishermen, who operate shrimp trawls, do not want to lose their profit. Thus, they want to catch both fish and shrimp. It has been recognized for sometime that operating shrimp trawls in shallow coastal waters has an adverse effect upon on this area and more directly catches the juveniles of commercial and immature fish. To avoid the rapid decrease of fish stock, many types of BRDs (Bycatch Reduction Devices) have been developed to solve this problem.

After a successful collaborative project with SEAFDEC member countries on Turtle Excluder Devices (TEDs) in 1997 in line with the principle of responsible fishing, SEAFDEC/TD (Southeast Asian Fisheries Development Center/Training Department), Thailand, has continued to promote responsible fishing through selective devices namely the JTED (Juvenile and Trash Excluder Device) in Thailand, Brunei Darussalam, Vietnam, Malaysia and Indonesia. SEAFDEC/TD has carried out a series of experiments to release the juveniles, small fish and trash fish by conducting experiments using JTEDs installed in shrimp trawl nets. The first experiments were in the Gulf of Thailand using the rectangular shaped window and semi-curved JTEDs. The second series of experiments were conducted in the waters off the coast of Maura Town, Brunei Darussalam with a JTED that had been developed to be a rigid sorting grid JTED, the third series of experiments were carried out off Cat Ba Island in Hai Phong Province, Vietnam. These were followed by a fourth series of experiments conducted in the waters off the coast of Alor Setar, Kedah State of Malaysia. From the four series of experiments it was found that the rigid sorting grid JTED has a better separating performance than the rectangular and semi-curved JTEDs. In May 2002, SEAFDEC/TD organized a Regional Practical Workshop on Selective Fishing Devices associated with the FAO/GEF project to promote selective fishing devices under the responsible fishing technology and practices program. Training and demonstrations were given to the participants from member countries. Indonesia was selected as the first country to continue this project at Sorong in August 2002. The experiments were carried out in the coastal waters off Bintuni Bay, Arafura Sea, Papua, Indonesia. The results show the same as other past experiments. A second series of experiment was conducted in April 28 to May 8, 2003 in Manila bay, the Philippines, in cooperation with BFAR/Philippines.

Materials and methods

The experiment were carried out in Manila bay, at Latitude 14° 25' N to Latitude 14° 31' N and Longitude 120° 40' E to Longitude 120° 50' E. The gear used were shrimp-trawl nets on two Philippines trawlers. These were The Rose of the sea and J&J Batch 53, of overall length 9 m. and 11.58 m. with 90 HP engines. The towing speed was approximately 1.9 to 2.2 knots, with one hour per trawling. Each type of JTED was operated six times in daytime and four times at night using a rigid sorting grid with bar spacing of 1 cm. The semi-curved and rectangular shaped window were similarly tested. The total number of operations were forty-two. The modified JTEDs were designed to release juvenile, small fish and trash fish and retain the shrimp catches in the codend. However, the codend net in the Philippines shrimp-trawl is smaller than in other countries in the Southeast Asian region and the JTEDs were reduced in size by 25% from the original size to allow a comfortable fit. There were three types of JTED with five differences in this experiment; the semi-curved and rectangular shaped window JTEDs and the rigid sorting grid with bar spacing of 1, 2, and 3 cm. The size of the semi-curved JTED and rectangular shaped window were a 60 x 75 cm^2 built from rod of 10 mm diameter and the escape opening used a vertical soft grid of polyethylene rope with a diameter of 4 mm. both types have a bar space of about 1 cm. The rigid sorting grid JTEDs were modified from the NOFITRAOMSA/S Sort-X system that was developed in Norway. The rigid sorting grid JTEDs has three sections, the front and central sections are grids, the main frame is iron rod with a diameter of 10 mm and the grids are 4 mm diameter iron rod. The rear section is a net covered panel, PE 380d/12 mesh size 15 mm. The sides of the rigid sorting grid JTEDs are connected by chain between the front and the rear panel to set the shape and angle of at 45° (clockwise) to the horizontal plane and 50° (anti-clockwise) also to the horizontal plain. In this experiment the cover net, PE 250d/12 mesh size 15 mm, was designed to cover all the escape opening and codend that was attached to supporting hoops of 1.30 m. diameter.

Because of travelling time constraints the experiments were not conducted in a real fishing ground, but were conducted from 1 to 3 km from the shore, and the average water depth was 30 m. For these reasons the catch was not good. The Cardinalfishes, *Apogon sp.*, was selected to represent the juvenile and trash fish because it varies in size from small to larger than the selective bar space and was caught in most operations.

The escape rate from codend is given by following equation.

$$E = (Wv \times 100) / Wt \qquad (1)$$

Here, Wv is weight of catch in covernet and Wt is total weight.

The estimate of the trawl net selectivity curve using a linear model (described by Pope *et. al.* 1975 and Jones 1976). The method the most commonly used is by comparing the length compositions of the fish remaining in the codend and in the cover net, the probability of escape through the large mesh net can be estimated.

However by using the Ms-Excel program with solver (Tokai and Yasuzumi, 1999.) to help to adjust the data and produce the results of a selectivity curve.

1. Linearized model

Trawl selection curve was approximated by the following equation.

$$S = 1/\{1 + \exp(a + bl)\} \qquad (2)$$

where l is the total length of fish and a and b are constants. This equation is difficult to solve with computing. So, the equation is linearized by taking the logarithm.

$$\ln(1/S - 1) = a + bl \qquad (3)$$

In this model, the parameter is estimated by minimizing the following.

$$\sum_{i=1}^{n} [\ln\{(1/S) - 1\} - (a + bl)]^2 \qquad (4)$$

From equation 4, the regression coefficient "b" is obtained as.

$$b = \sum [(l - l)(y - y)] / \sum (l - l)^2 \qquad (5)$$

Where $y = \ln[(1/S) - 1]$, and y is average. The intercept "a" is calculated by the following equation.

$$a = y - bl \qquad (6)$$

2. Direct estimation using the Solver

Currently, the following logistic equation is used as a trawl selectivity curve.

$$S(l) = \exp(a + b\,l)/1 + \exp(a + b\,l) \qquad (7)$$

The parameters can be estimated by minimizing the following equation.

$$\sum_{i=1}^{n} [S - S(l)]^2 \qquad (8)$$

Using the Solver, this calculation can be made without any transform of the equation.

By applying a few algebraic manipulations it follows that there is a one to one correspondence between Length at which 50% of the fish entering the gear are retained (L_{50}) and the selection range.

$$L_{50} = a / b \qquad (9)$$

$$SR = 2 \ln(3) / b \qquad (10)$$

Results

The catch per unit effort (CPUE) vary from 12 – 29 kg/hr/haul. Comparison of the escape level from each JTED types in daytime and nighttime operation from the weight of catch in the covernet and codend (Table 1) found that in daytime the rigid sorting grid with bar space 1 cm has the smallest escape level of 33 %, for bar space 2 and 3 cm these are 77% and 79%. The escape rate from the semi-curved JTED is 45% and 55% for the rectangular shaped window JTED. At night, the escape rates for the rigid sorting grid with a bar space of 1 cm, the semi-curved and rectangular shaped window are 33%, 53% and 57%. (Fig. 1)

From the experiment in Manila bay, the Philippines it was found that usually the large size of the shrimp are retained in codend except when the rigid sorting grid has a bar space of 2 cm then some 22% of Giant tiger prawn and Green tiger prawn can escape, but for the small shrimp more than 55% can escape in all types of JTED. (Table 2)

The size selectivity of Cardinal fishes (Fig 2, 3 and 4) using a shrimp-trawl net with 1, 2 and 3 cm bar spacing rigid sorting grid, semi-curved and rectangular shaped window JTEDs with codend mesh size 2.8 cm in daytime were compared. The results indicate that L_{50} and SR of Cardinal fish caught by the trawl net with the rigid sorting grid 1, 2 and 3 cm was 7. 86, 11.46 and 9.82 cm for L_{50} and 1.10, 2.29 and 3.64 for SR. The L_{50} from semi-curved and rectangular shaped window JTEDs was 5.39 and 6.28 cm and the SR was 5.44 and 21.99. At night using a shrimp trawl with the rigid sorting grid bar space 1 cm, the semi-curved and the rectangular shaped window JTEDs. The results indicate that L_{50} was 7.18, 6.01 and 4.62 cm for the SR was 0.80, 5.64 and 24.68.

Table 1. Weight [a] of catches in covernet and codend from each JTED

Daytime

Catch category	Rigid sorting grid (1 cm.)		Rigid sorting grid (2 cm.)		Rigid sorting grid (3 cm.)		Semi-curved		Rectangular shaped	
	cover net	codend	cover net	codend	cover net	codend	cover net	codend	cover net	codend
Fish	20.01	26.90	63.16	9.44	63.44	6.69	50.32	46.04	50.70	29.20
Squid	0.44	3.39	9.64	1.80	9.67	6.71	6.83	7.58	4.62	3.08
Shrimp	0.38	3.41	6.82	9.84	3.57	1.08	0.01	9.53	1.66	2.48
Crab	0.13	9.59	4.79	5.40	3.42	4.66	0.51	3.78	0.86	10.70
Trash & Other	2.23	4.59	15.86	4.20	2.39	2.75	1.92	5.42	4.90	5.59
Total	23.18	47.87	100.28	30.68	82.50	21.89	59.60	72.35	62.75	51.05

Nighttime

Catch category	Rigid sorting grid (1 cm.)		Rigid sorting grid (2 cm.)		Rigid sorting grid (3 cm.)		Semi-curved		Rectanngular shape	
	cover net	codend	cover net	codend	cover net	codend	cover net	codend	cover net	codend
Fish	14.62	19.87	b	b	b	b	27.61	15.42	50.22	22.93
Squid	2.89	3.27	b	b	b	b	2.73	1.37	3.92	3.37
Shrimp	1.70	2.83	b	b	b	b	1.79	6.26	2.40	2.92
Crab	0.04	4.95	b	b	b	b	0.62	3.78	1.59	14.30
Trash & Other	2.26	12.83	b	b	b	b	0.79	2.97	8.33	6.76
Total	21.52	43.75	b	b	b	b	33.54	29.80	66.45	50.27

[a] Weight in kilograms
[b] Not operated

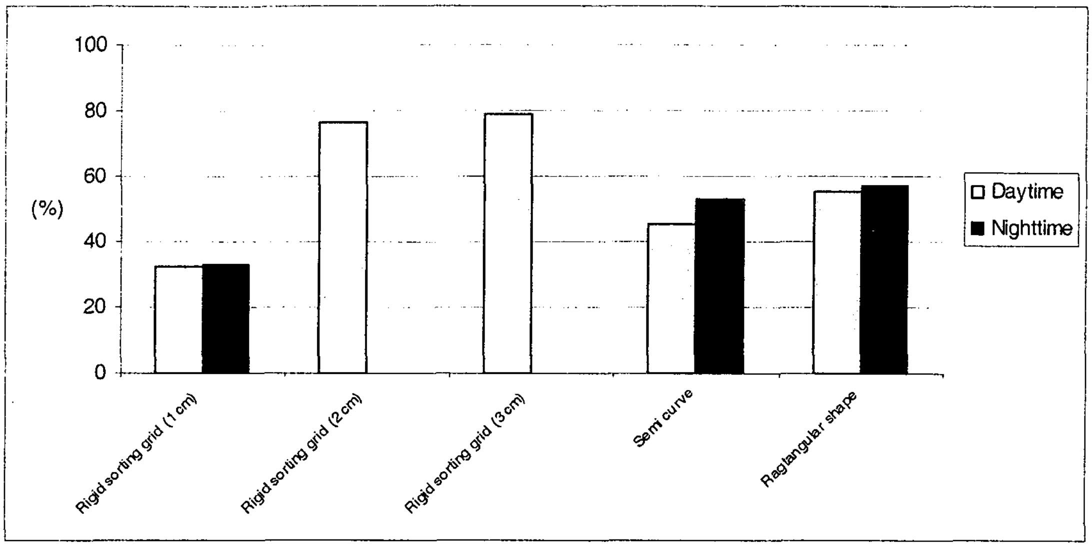

Fig 1. Percentage of the escape rate from each JTEDs in daytime and nighttime.

Table 2. Weight [a] of shrimp in the covernet and total weight from each JTED

JTEDs type	Giant tiger prawn		Greent tiger prawn		Indian white prawn		Kurama prawn		Shrimpless	
	covernet	total	covernet	total	covernet	total	covernet	total	covernet	total
Rigid sorting grid (1 cm.)	0.02	3.09	0.02	3.12	0.00	0.00	0.00	0.05	2.05	2.05
Rigid sorting grid (2 cm.)	1.88	6.73	3.82	8.31	0.00	0.45	0.00	0.00	1.13	1.18
Rigid sorting grid (3 cm.)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.57	4.65
Semi-curved	0.00	0.00	0.00	15.23	0.00	0.00	0.00	0.00	1.80	2.36
Rectangular shaped	0.00	0.53	0.76	2.68	0.00	0.15	0.00	0.14	3.30	5.95

[a] weight in kilogram (kg.)

Table 3. Length frequency distribution of Cardinal fishes when using the rigid sorting grid with a bar space of 1 cm JTEDs in daytime and nighttime.

Daytime

Length (cm.)	Rigid sorting grid (1 cm.)		Rigid sorting grid (2 cm.)		Rigid sorting grid (3 cm.)		Semi-curved		Rectangular shaped	
	covernet	codend	covernet	codend	covernet	(cm.)	covernet	codend	covernet	codend
1	0	0	0	0	0	0	0	0	84	0
2	5	0	0	0	23	12	0	0	0	0
3	80	0	242	0	4	0	0	12	9	22
4	371	0	1212	3	74	10	278	3	95	74
5	308	2	1874	29	530	73	1307	205	532	407
6	483	9	2881	49	1374	147	1599	482	1395	1431
7	325	24	1709	66	789	121	372	716	1118	1224
8	197	89	1299	78	416	39	215	639	785	1089
9	17	76	410	82	193	96	26	346	402	939
10	6	73	359	40	21	44	48	205	230	456
11	3	17	58	19	14	2	0	41	41	86
12	0	6	12	15	0	1	0	27	47	47
13	15	7	7	12	0	0	0	18	14	3
14	3	11	0	4	0	1	0	3	2	22
15	0	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0

Nighttime

Length (cm.)	Rigid sorting grid (1 cm.)		Rigid sorting grid (2 cm.)		Rigid sorting grid (3 cm.)		Semi-curved		Rectangular shaped	
	covernet	codend	covernet	codend	covernet	(cm.)	covernet	codend	covernet	codend
1	0	0	a	a	a	a	0	0	0	0
2	0	0	a	a	a	a	0	0	0	0
3	198	1	a	a	a	a	5	0	0	0
4	632	0	a	a	a	a	5	0	11	14
5	765	18	a	a	a	a	224	1196	38	100
6	523	34	a	a	a	a	572	340	230	262
7	366	50	a	a	a	a	509	498	183	336
8	41	104	a	a	a	a	194	756	283	463
9	7	120	a	a	a	a	136	264	204	289
10	0	179	a	a	a	a	18	114	155	232
11	0	32	a	a	a	a	5	85	55	14
12	0	21	a	a	a	a	10	7	35	10
13	0	14	a	a	a	a	0	2	54	14
14	0	29	a	a	a	a	0	2	18	4
15	0	4	a	a	a	a	0	0	12	0
16	0	0	a	a	a	a	0	0	0	0

[a] Not operated

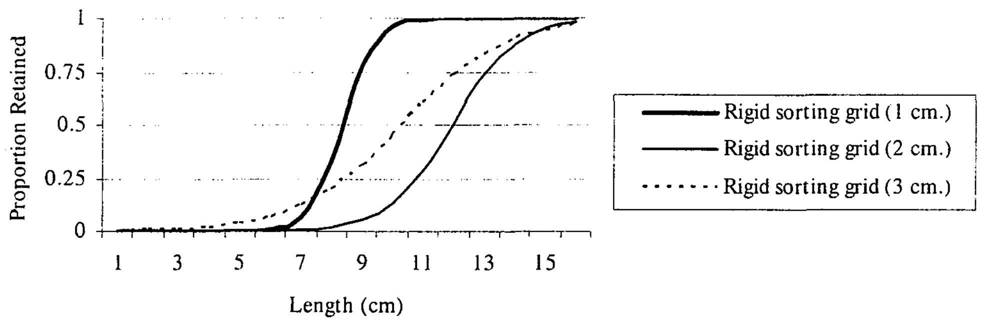

Fig 2. Selectivity ogive of *Apogon sp.* when using the rigid sorting grid JTEDs with a bar space of 1, 2 and 3 cm by using solver.

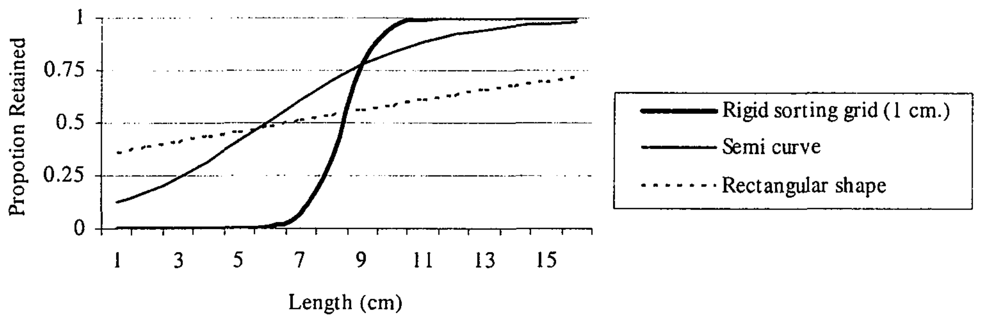

Fig 3. Selectivity ogive of *Apogon sp.* when using the rigid sorting grid with a bar space of 1 cm, semi-curved and rectangular shaped window JTEDs in daytime using the solver.

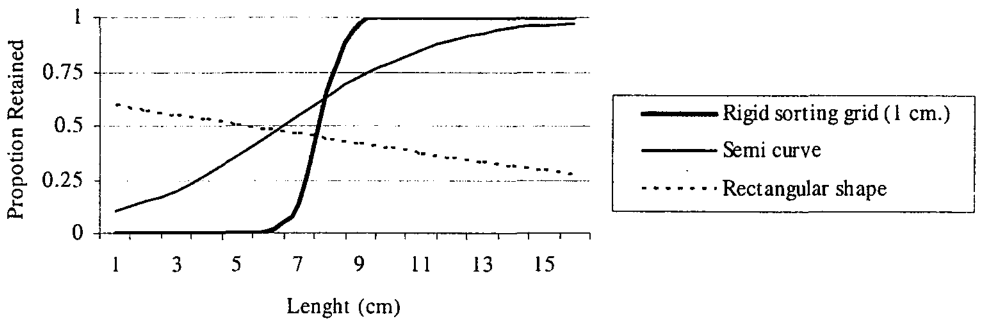

Fig 4. Selectivity ogive of *Apogon sp.* when using the rigid sorting grid with a bar space of 1 cm, semi-curved and rectangular shaped window JTEDs at night using the solver.

Discussion

This experiment indicated that all the JTED types could be used in shrimp-trawling because most of the large size shrimps are caught and retained in the codend. But because the fishermen do not want to loss their profit by allowing the fish to escape through the JTEDs do not find favour. Therefore, the rigid sorting grid 1 cm (escape level 33%) was a more suitable exclusion device than the other JTEDs (escape level more than 45%) and the fishermen can accept this result. However, the result from this experiment in the Manila bay, the Philippines shoes the same results as in the previous experiments that the rigid sorting grid 1 cm is the most suitable for shrimp-trawling.

In the case of the selection efficiency for each JTEDs by the result of SR. The SR increases from the rigid sorting grid 1, 2 and 3 cm to semi-curved and rectangular shaped window that means the rigid sorting grid 1 cm has a good selection efficiency and that gently decreases in the 2 cm, 3 cm, semi-curved and rectangular shaped window JTEDs. The results of this experiment show a strange form of selectivity curve, especially the curve from the rigid sorting grid 3 cm, semi-curved and rectangular shaped window. One of the reasons may be that collected data does not cover the lengths of fish sample and gives the selective curve that shape. Resource persons, who have an understanding in sorting, sampling and collecting data are also needed for a good results.

Observation of the rigid sorting grid 1 cm JTED in flume tank circulating water channel at Tokyo University of Fisheries (Fig 5) can give some data and more understanding of the characteristics of JTEDs under towing conditions. From the observed results the sorting grid frames were lifted a little bit by the current and caused the angle to change from 45° but the balance of the JTED should not change too much from the suitable form for allowing the selective mechanism to work as well as possible. From these results it can be considered that if there are some catches accumulated in front of the sorting grids or even any large volume of debris, the selectivity function would not operate except during hauling when some small fishes could pass through the selection grid. Therefore, some net expansion at the lower part of the net must be made to allow a gap. In an actual situation while towing, the "bouncing" of the net would help in opening and closing of the lower panel of the net under the sorting grids. This may also be a good performance to induce the function of selectivity. The ideal function of the sorting grid is to provide more encountering chances to the small fish before entering the grids or codend. So, the bouncing function can greatly help in the selectivity function. With a lower panel closed all the time may be a negative way for selection because there is no gap to allow the catch to pass through, meanwhile too much space opening also stops the selectivity function for the sorting grid as well.

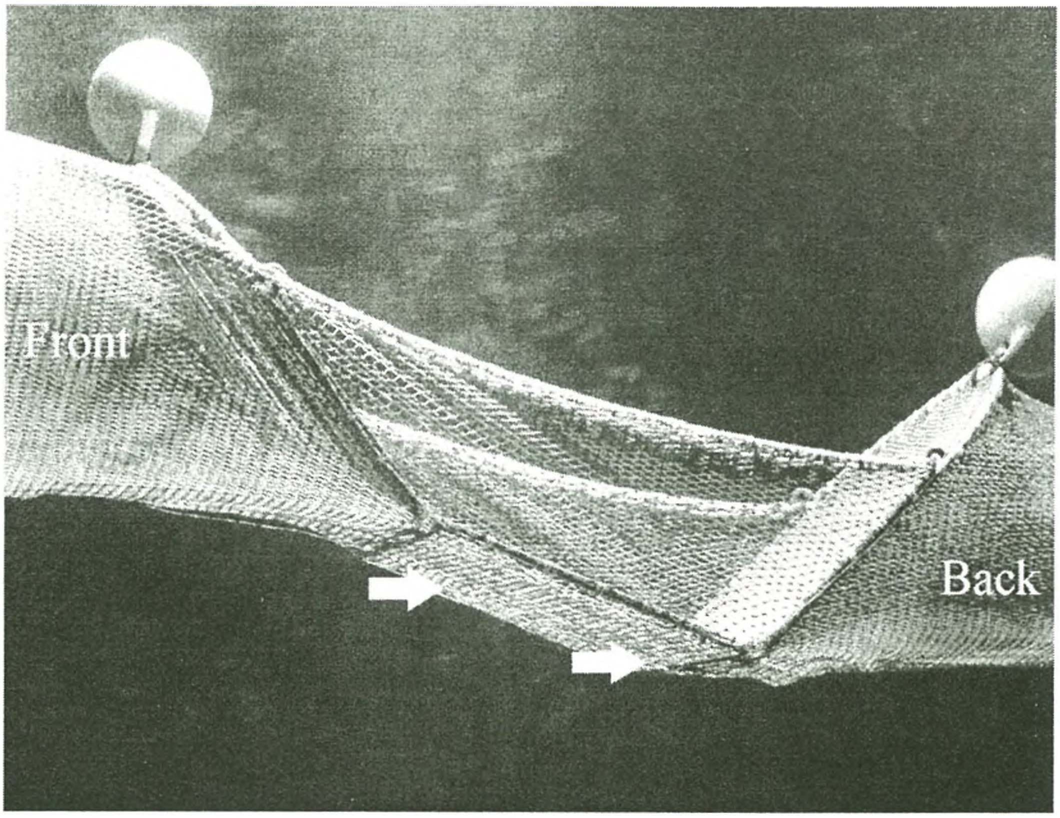

Fig 5. The rigid sorting grid JTEDs in the flume tank circulating water channel showing the lower part of the net with no gap (indicated by arrows).

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