Mem. Fac. Fish. Kagoshima Univ.,
Vol. 54, pp. 45～56 (2005)

Comparative Study on the Performance of Lampara Dasar (Indonesian Traditional Bottom Trawls)

Ahmadi[1,2], Shigeru Fuwa[1,*], Keigo Ebata[1], and Johnny Budiman[1,2]

Key words : Lampara Dasar, model, flume tank, gear efficiency, gear performance, net circumference

Abstract

Two 1/8 scale models of "Lampara Dasar", typical for the commercially used bottom trawls in Kotabaru of Indonesia, were selected and tested in a flume tank. They were to represent prototypes of two large trawls i.e. *Type A*, bottom trawl with a low engine power of 20 HP at a towing speed of 2 knots, and *Type B*, bottom trawl with a high engine power of 33 HP at a towing speed of 3 knots. They were composed of 2-seam panels with the same dimension and materials, however, gear construction and trawling conditions were different. The study was aimed to obtain some fundamental data of gear efficiency based on the physical characteristic and performance of trawls under different towing conditions. Results showed that in ordinary towing conditions (wing tips distance expands to be 53%), the net height of *Type A* was higher than that of *Type B* for both towing conditions. Similar conditions were also indicated in the projective area of net mouth and water filtering volume. Gear efficiency was measured by the ratio of net height to the net circumference. At a towing speed of 2 knots, the initial net height of *Type A* was 5.5% of net circumference and that of *Type B* was 4.8%. At a towing speed of 3 knots, *Type A* was 4.1% of net circumference and *Type B* was 3.4%. The ratio of *Type A* was considerably higher than that of *Type B* in all experimental conditions because it has a square part in the gear construction, and the net circumference was larger than that of *Type B*. Total net resistance of *Type B* was larger than that of *Type A* in both towing conditions.

Some studies on gear efficiencies and physical characteristics of trawl gears have been conducted. Higo[1)] suggested that the four-seam trawl has a better gear efficiency than the two-seam trawl in term of net mouth performance. Other factors which influence the net height opening were the distance between wing ends, towing speed and buoyancy. His conclusion was later supported by Nomura *et al.*[2,3)] Muchtar *et al*[4)] conducted the experimental model and mechanical comparison of four-seam trawl net and six-seam trawl net based on Japanese bull trawl ("*Teguri ami*"). The difference of the nets used in these experiments only on its constructions. They concluded that the net height of six-seam trawl net is higher than four-seam trawl net. Mangunsukarto[5)] carried out model experiment and field experiment aimed to obtain some fundamental suggestions on gear efficiency of three types of trawl nets in different size. He found that the four-seam trawl net has a better net height opening than other nets in the same wing tips distance of 40%. Miyamoto[6)] reported that the net mouth height between 60 to 100 cm would be sufficient to catch shrimp actually. The feasibility of employing the

[1] 鹿児島大学水産学部漁業基礎工学講座 (Department of Fundamental Fishing Technology, Faculty of Fisheries, Kagoshima University, 4-50-20 Shimoarata, Kagoshima 890-0056, Japan)
[2] 鹿児島大学大学院連合農学研究科 (The United Graduate School of Agricultural Science, Kagoshima University, 1-21-24 Korimoto, Kagoshima 890-0065, Japan)
* Corresponding author, Email: fuwa@fish.kagoshima-u.ac.jp

double rigged type shrimp trawl at the same fishing ground and the same trawler has advantage over the single rigged in terms of the sweeping area and catch ability.[7] Hu *et al*[8] examined the effect of drag coefficient of netting for dynamic similarity on model testing of trawl nets. These studies were aimed to determine the quality of trawls and other riggings of trawl parts. Typical bottom trawls in Kotabaru, Indonesia, have been very important commercial fishing gear for catching shrimp. In general, it was categorized in small size groups but it commons in 2-seam shrimp trawls. In marine fishery in 2001, "Lampara Dasar" was the third major fishing gear used in Kotabaru or about 17.1% (1,313) of total gear (7,692) after hook and lines 37.5% (2,882) and trammel nets 23.5% (1,809)[9]. However, at present many people do not know well about profile of "Lampara Dasar" due to no information of what full scale trawl or prototype look like under trawling conditions. In order to get new knowledge in this area of study, the authors carried out model experiments in a flume tank. The study was aimed to obtain some fundamental suggestions on the gear efficiency based on the physical characteristic and performance of trawls under towing conditions. From the standpoint of fishing gear, the expected results of model experiments could become a valuable information for improving and developing the construction of trawls.

Materials and Methods

Characteristics of two types of trawl gears

Two types of Kotabaru's bottom trawls were selected for study purpose. They were bottom trawl with a low engine power of 20 HP at a towing speed

Table 1 The differences in the gear constructions of two types of "Lampara Dasar"

	Type A	*Type B*
Frontal shape at the net mouth	Bottom shape is different from top shape. The bottom portion is shorter than the top one.	Bottom shape is similar to top shape, which the bottom portion tends to have a frontal shape.
Wing construction	Upper and lower wings are different in position, which lower wing put backward 1 m from the front edge. The lower wing is longer than upper wing.	Upper and lower wings are constructed with the same position and the same length. Both wing ends are attached in line with the side nets.
Square part	Available square part on the top body in lateral line with the bottom body. Net circumference is showed in dashed lines.	No square, the top and bottom bodies in the same position in lateral line. Net circumference is showed in dashed lines.
Body size	Bottom body (belly) is longer and wider than the top one (baiting)	Same body length, however, belly is wider than baiting of net.
Cod end size	Different, the bottom portion is shorter than the top one.	The bottom portion is the same length with the top one.

Table 2 The differences of two types of "Lampara Dasar" in the trawling conditions

	Type A	*Type B*
Boat sizes	1 GT L.B.D (9 × 1.5 × 1 m)	5 GT L.B.D (13 × 3 × 1.5 m)
Engine power	20 HP	33 HP
Trawling speed	2 knots (1.03 m/s)	3 knots (1.54 m/s)
The depth	6 - 10 m	10 - 20 m
The warp length	30 m	50 m
Trawling time	2 hours (4 times at daytime)	6 hours (2 times at nighttime)
Hauling methods	hand	line hauler
Number of crew	1	2 - 3

Table 3 The dimension of "Lampara Dasar"

Elements	*Type A*	*Type B*
Head rope (m)	14.0	14.0
Ground rope (m)	16.0	16.0
Total length of net (m)	16.0	16.0
Stretched net circumference (m)	17.5	19.3
Upper wing (m)	6.0	6.0
Lower wing (m)	7.0	6.0
Side net (m)	9.0	9.0
Baiting or belly (m)	6.5	6.0
Cod end (m)	2.5	4.0
Square (m)	1.0	-

Table 4 The specification of "Lampara Dasar"

Specification	*Type A*	*Type B*
Nettings		
Main net panels:		
Material	Polypropylene	Polypropylene
Mesh size (mm)	38	38
Twine diameter (mm)	1.08	1.08
Cod end:		
Material	Polypropylene	Polypropylene
Mesh size (mm)	25	25
Twine diameter (mm)	0.98	0.98
Head rope		
Material	Polyethylene	Polyethylene
Diameter (mm)	9	9
Ground rope		
Material	Polyethylene	Polyethylene
Diameter (mm)	10	10
Float		
Material	Plastic	Plastic
Diameter (mm)	100	100
Buoyancy (g)	500	500
Number	7	7
Material	Rubber	Rubber
Diameter (mm)	70	70
Buoyancy (g)	50	50
Number	6	6
Total buoyancy (kg)	3.8	3.8
Sinker		
Material	Lead	Lead
Weight (g)	17	17
Number	720	720
Total weight (kg)	12	12
Otter board		
Material	Wood	Wood
Length (cm)	70	70
Width (cm)	45	45
Weight (kg)	20	20
Number	2	2
Total weight (kg)	40	40
Warp		
Material	Polyethylene	Polyethylene
Length (m)	30	50
Diameter (mm)	8	8
Hand rope		
Material	Polyethylene	Polyethylene
Length (m)	2	2
Diameter (mm)	8	8

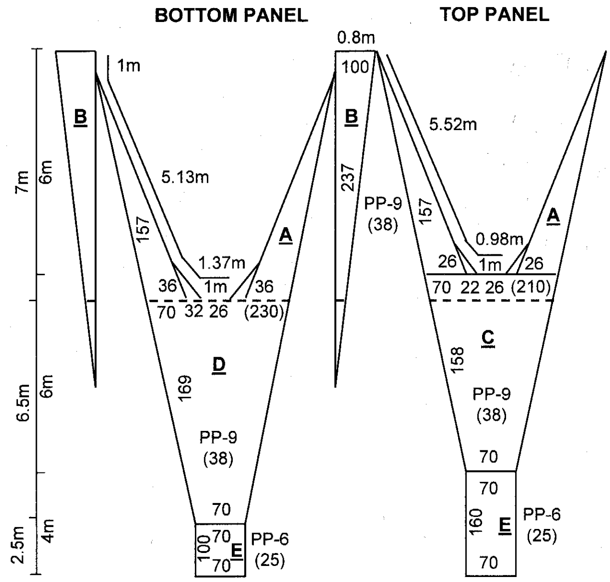

Fig. 1 Full scale net plan of "Lampara Dasar" *Type A*. The bracketed numbers were the mesh sizes (mm). Total length of net: 16 m, Head rope: 14 m, Ground rope: 16 m, Total buoyancy of floats: 3.8 kg and Total sinkers weight: 12 kg. The net panels: A. Upper and lower wings, B. Side net, C. Baiting, D. Belly, and E. Cod-end. Dashed lines indicate the net circumference.

of 2 knots (called *Type A*), which has commonly been adopted by fisherman, and the bottom trawl with a high engine power of 33 HP at a towing speed of 3 knots (called *Type B*), which was actually modified of *Type A*. Both type of nets were composed of 2-seam (top and bottom panels) with the same dimensions and materials, however, they have five differences in gear construction mainly in the net circumference (Table 1) and also differences in trawling conditions (Table 2). Target species are black tiger prawn, banana prawn, endeavour shrimp, giant seaperch/ barramundi, croakers/drums and red snappers. The nets were constructed without using the lacing lines. Lacing twine used for joining to both selvedges of belly-baiting and side nets. Actually, the lacing lines were originally meant to strengthen the netting for hauling. However, their function has been extended to increase the height of net opening by better distributing the towing forces which had previously been concentrated on the head

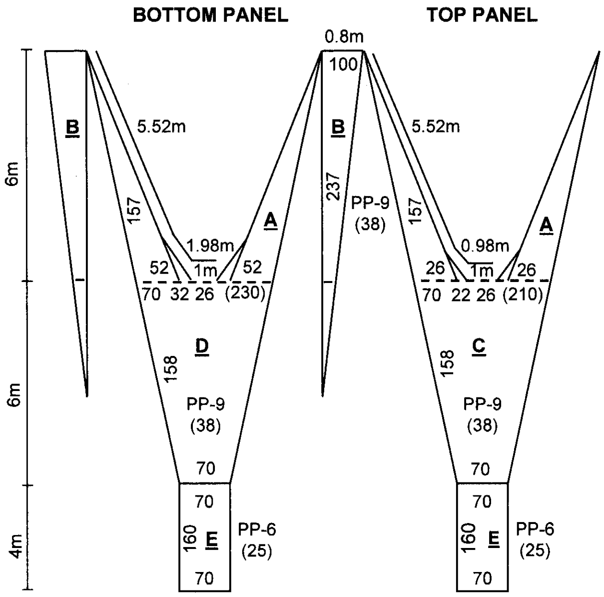

Fig. 2 Full scale net plan of "Lampara Dasar" *Type B*. The bracketed numbers were the mesh sizes (mm). Total length of net: 16 m, Head rope: 14 m, Ground rope: 16 m, Total buoyancy of floats: 3.8 kg and Total sinkers weight: 12 kg. The net Panels : A. Upper and lower wings, B. Side net, C. Baiting, D. Belly, and E. Cod-end. Dashed lines indicate the net circumference.

rope and ground rope. The dimension and specification of "Lampara Dasar" are described in Table 3 and Table 4 respectively. The full scale net plans of *Type A* and *Type B* are illustrated in Fig. 1 and Fig. 2. In the construction of a trawl, the ratio of head rope to ground rope is important factor for having a good performance of the net mouth. The suggested ratio of this is 0.87 for two-seam trawl and 0.83 for four-seam trawl[2]. In case of "Lampara Dasar", was 0.88 instead of the suggested ratio. The full scale float and sinker weight plans of *Type A* and *Type B* are shown in Fig. 3. In order to spread out the wing tips, the otter boards used. It made of wood (70 cm × 45 cm), the lower part fulfilled with cement mixed with leads to have touch connection power to the sea bottom and the upper part put two plastic floats with diameter 100 mm to hold it stands vertically and total weight was 20 kg per unit. The hand rope with 2 m long of Polyethylene diameter 8 mm, attached together with otter board. The otter

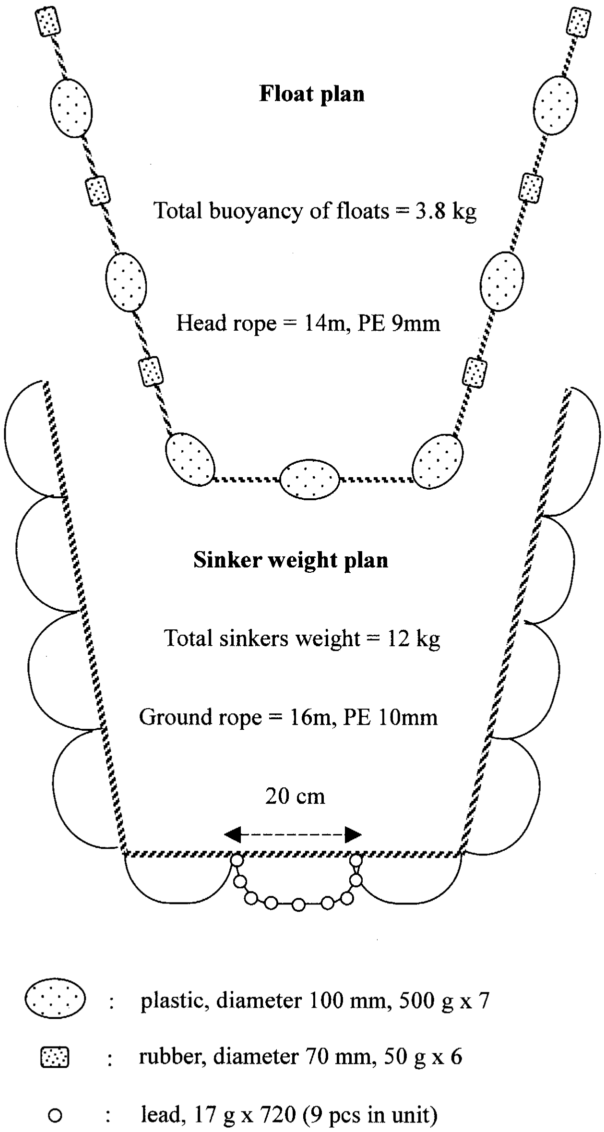

Fig. 3 Full scale float and sinker weight plan of *Type A* and *Type B*.

board full scale plans of *Type A* and *Type B* are shown in Fig. 4. The original full scale net plans were transformed into experimental model scale based on the Tauti's Comparative Method[10]. The ratio between experimental model scale (′) and full scale (″) were described as follows:

1. Reducing scale is λ' / λ''
2. Ratio of twine diameter, D and mesh size, L is $D'/D'' = L'/L''$
3. Ratio of velocity, V is $V'/V'' = \sqrt{D'/D''.(\rho'-1)(\rho''-1)}$
4. Ratio of rope diameter, D_1 is

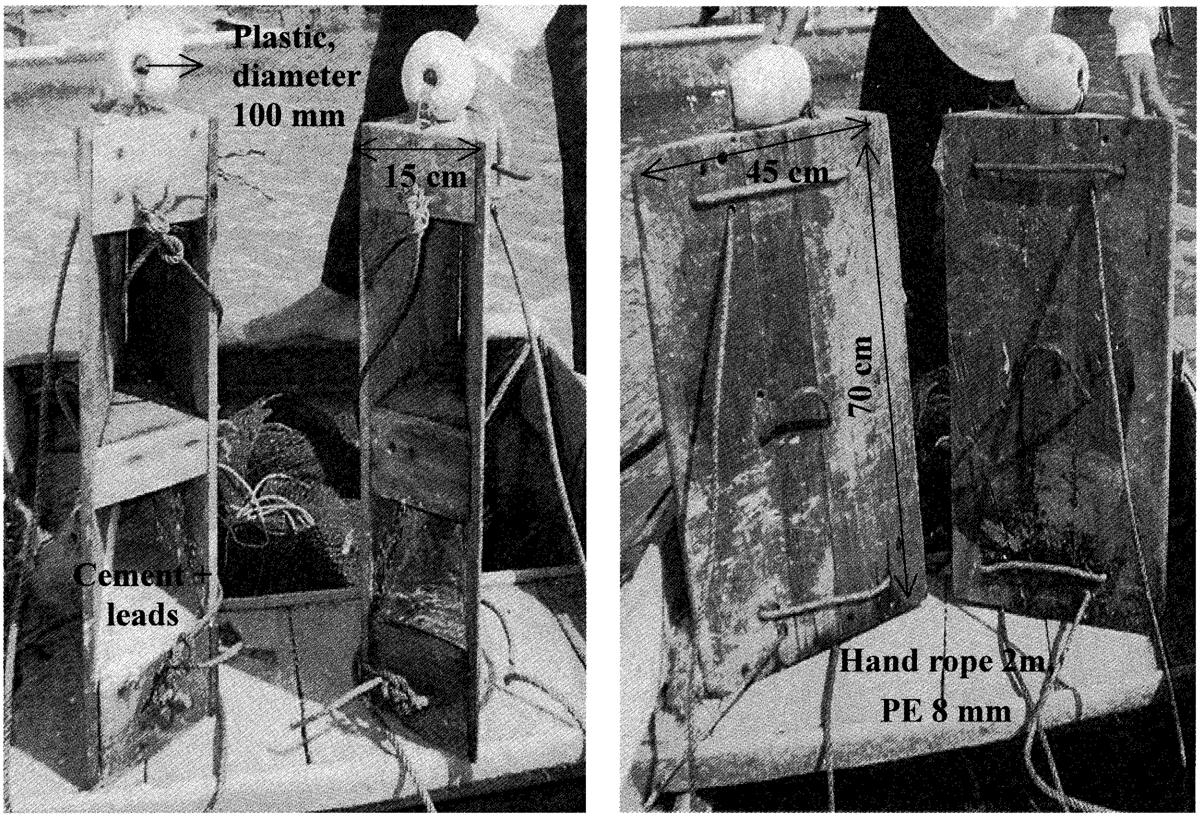

Fig. 4 The otter board full scale plan of *Type A* and *Type B*.

$D_1'/D_1'' = \sqrt{\lambda'/\lambda''.(\rho_1''-1)(\rho_1'-1).V'^2/V''^2}$

5. Ratio of sinking and floating power, F and that of the force acting on the net, R *is*

$F'/F'' = R'/R'' = (\lambda'^2/\lambda''^2)(V'^2/V''^2)$

Where ρ is the specific gravity of netting cord, and ρ_1 is the specific gravity of the rope.

Main dimensions of the model net

The main dimensions of the experimental model scale were as follows: the reducing ratio was 1/8, the ratio of twine diameter and the ratio of the bar length of the mesh size were 0.028 and the ratio of flow speed was 0.62 (Table 5). The comparative

Table 5 Main dimensions of the reducing ratio of the experimental condition.

Ratio	$\frac{\lambda'}{\lambda''}$	$\frac{D'}{D''}$	$\frac{V'}{V''}$
Type A	1/8	0.028	0.62
Type B	1/8	0.028	0.62

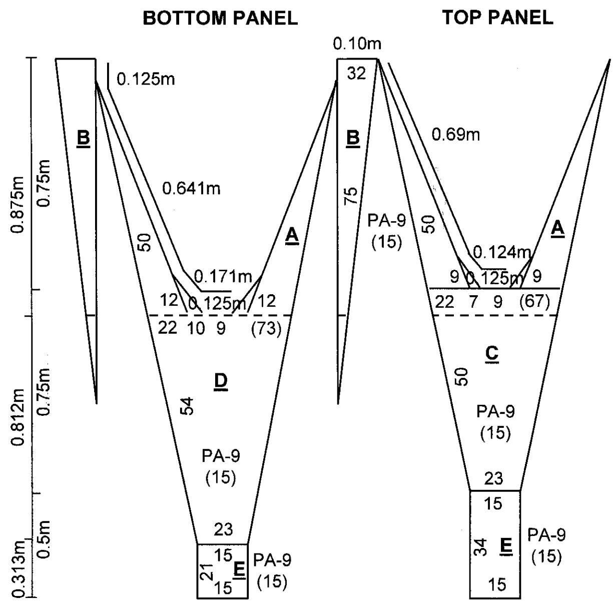

Fig. 5 Model scale net plan of *Type A*. The bracketed numbers were the mesh sizes (mm). Total length of net: 2 m, Head rope: 1.75 m, Ground rope: 2 m, Total buoyancy of floats: 23.67 g and Total sinkers weight: 74.49 g. The net panels: A. Upper and lower wings, B. Side net, C. Baiting, D. Belly, and E. Cod-end. Dashed lines indicates the net circumference.

Table 6 The comparative value of full scale and experimental model scale.

Type of net		Total length of net (m)	Stretched net circumference (m)	HR length (m)	GR length (m)	Total buoyancy of floats (kg)	Total weight of sinkers (kg)
Full scale	*A*	16	17.54	14	16	3.8	12
	B	16	19.25	14	16	3.8	12
Model scale	*A*	2	2.19	1.75	2	23.67×10^{-3}	74.49×10^{-3}
	B	2	2.41	1.75	2	23.67×10^{-3}	74.49×10^{-3}

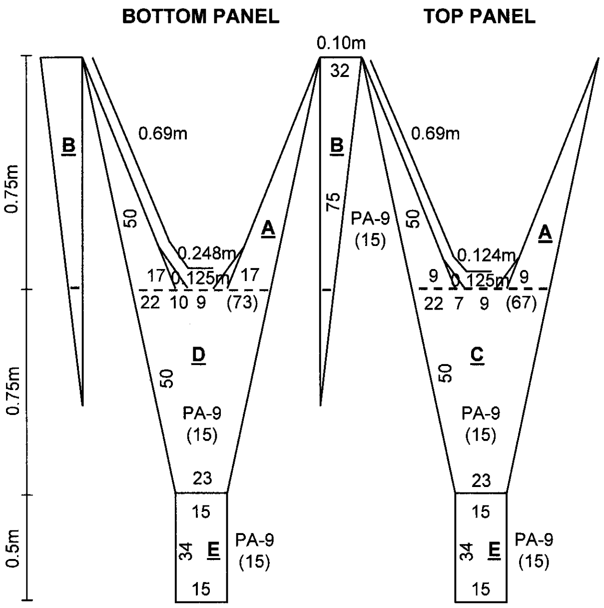

Fig. 6 Model scale net plan of *Type B*. The bracketed numbers were the mesh sizes (mm). Total length of net: 2 m, Head rope: 1.75 m, Ground rope: 2 m, Total buoyancy of floats: 23.67 g and Total sinkers weight: 74.49 g. The net panels: A. Upper and lower wings, B. Side net, C. Baiting, D. Belly, and E. Cod-end. Dashed lines indicate the net circumference.

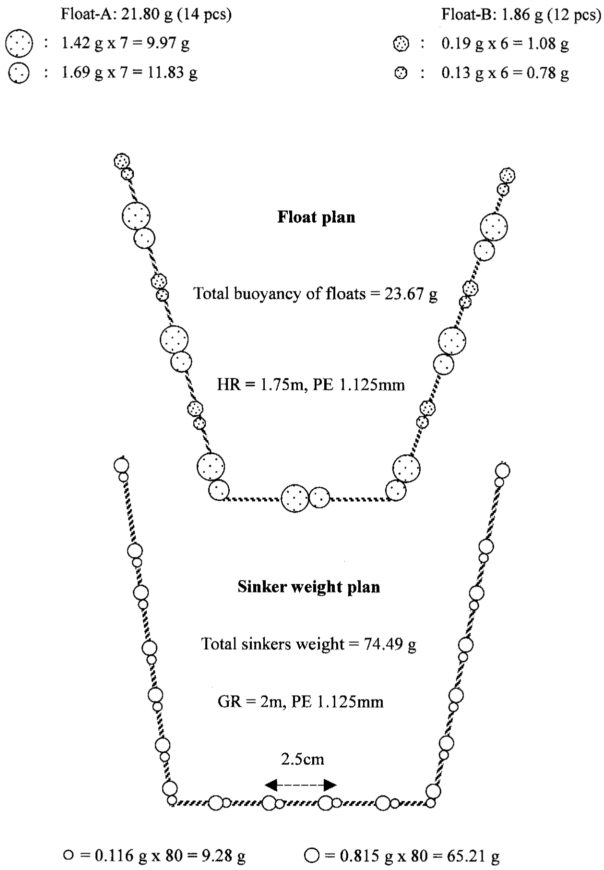

Fig. 7 Model scale float and sinker weight plan of *Type A* and *Type B* at 1/8 scale.

value of full scale and experimental model scale are described in Table 6. The model nets were constructed with Polyamide twine of 210 denier 9 ply, 15 mm stretched mesh with twine diameter 0.42 mm. The model scale net plans of *Type A* and *Type B* are illustrated in Fig. 5 and Fig. 6. Model net was built and rigged with a 1.75 m head rope and a 2 m ground rope of Polyethylene with rope diameter 1.125 mm. The ratio of the head rope to the ground rope equals 0.88. Total buoyancy of floats was 23.67 g, composed of a 26 floats along the head rope hold the net open vertically. Total sinkers weight in air was 74.49 g, consisted of a 160 small leads were attached to the ground rope in each 2.5 cm long with 80 intervals. Model scale float and sinker weight plans of *Type A* and *Type B* are illustrated in Fig. 7.

Experimental conditions

A series of experiments was carried out in a flume tank of this faculty. The central observation channel is 2 m wide and the right and the left water ways are each 1 m wide. The water flows symmetrically into the central section forming a straight water channel for experimental works. The flow is made by two sets of rotating propeller driven by an alternating

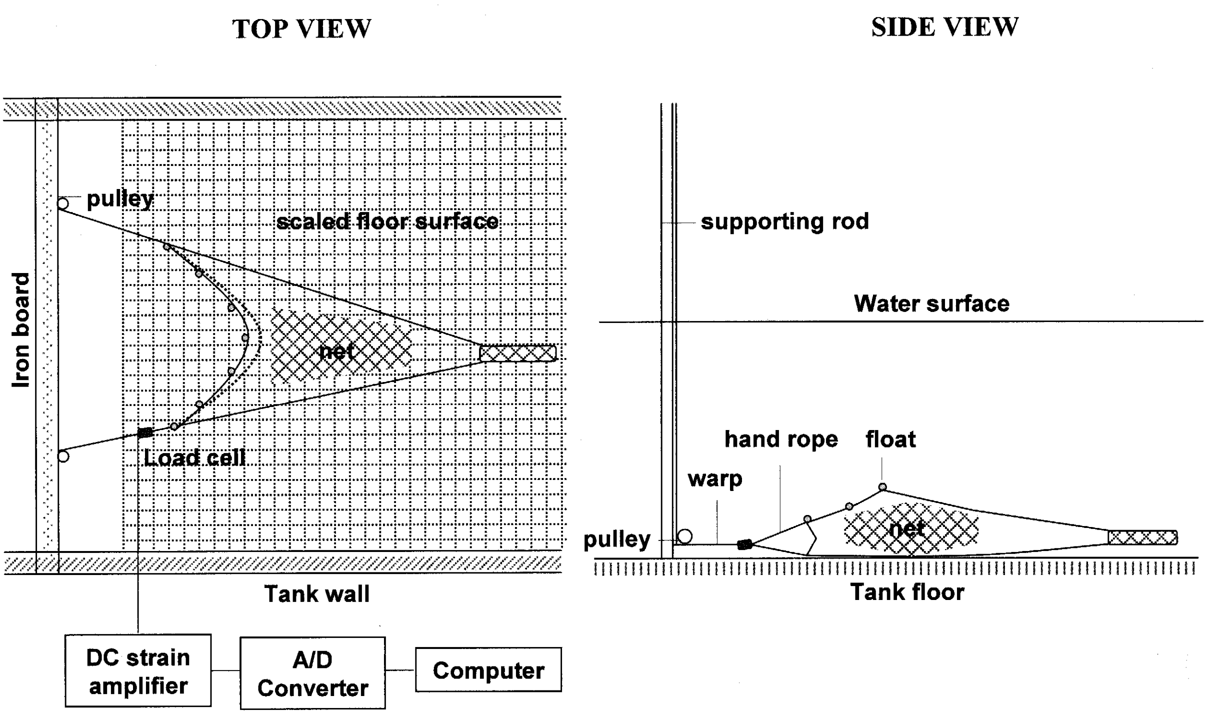

Fig. 8 The top view and side view of the experimental conditions.

current motor. The flow speed of 0 - 2.2 m/s can be accurately controlled and adjusted by an ultrasonic current meter. Both side walls of observing channel which are made of glass, a window situated at the center of the channel make it possible to take measurements and photographs. The experimental conditions can be observed from the top and side views (Fig. 8). The experimental model net was placed on the floor of observation channel under ordinary current. The floor whose diagram used to set up wing tips distance position properly and symmetrically, and also to measure coordinate of measured points from top view by using a glass boat. Flow speeds used in these experiments including towing speeds used in the actual fishing. Towing speed of *Type A* was 2 knots (64 cm/s in model scale) and that of *Type B* was 3 knots (96 cm/s) respectively. However, it was impossible to compare directly two different conditions of such towing speeds. Therefore, the experimental conditions were decided in higher and lower towing conditions. In this case, the flow speeds of *Type A* were 48, 56, 64, 72, 80, and 102 cm/s, whereas that of *Type B* were 48, 77, 83, 89, 96, and 102 cm/s respectively. The extra value in the highest towing speed of *Type A* (102 cm/s) and the lowest towing speed of *Type B* (48 cm/s) are given to enable both types compared to each other on the basis of comparison. It can be clearly shown by trendline of the curve. Wing tips distance is also important because it closely relates to the performance of net mouth opening. It is usually stated in percentage of head rope (H.R) length. Wing tips distances are determined based on the empirical method, which for normal fish is 40-50% of H.R and 50-60% for a shrimp trawl. In this experiment, wing tips distance was 46-66%. It fixed to be 46% (80 cm), 51% (90 cm), 57% (100 cm), 60% (105 cm), and 66% (115 cm) of head rope length respectively. In ordinary towing condition, a 53% was selected for comparison of net mouth height of both types. Actually, the measurement of wing tips distance have also been tried during trawling operation in

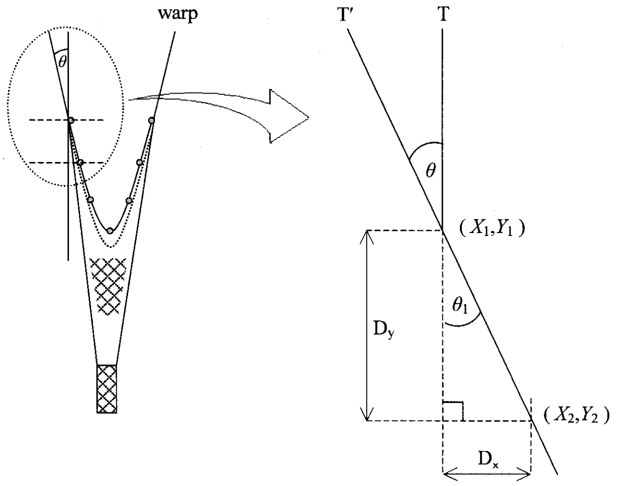

Fig. 9 The method used for calculating total net resistance. Tension of line was calculated by following formulas as follows:

$$T_1' \cos\theta_1 + T_2' \cos\theta_2 = R \text{ and } \theta_1 = Tan^{-1}\left\{\frac{X_1 - X_2}{Y_1 - Y_2}\right\}$$

Where T is tension of line, θ is attack angle of warp and R is total net resistance.

Kotabaru but unsatisfied due to inappropriate instrument used. In a flume tank, wing tips distance was adjusted to a desired distance by simply placing the supporting rod on the iron board which hold the towing line (warp) through the moveable pulley which connected to the hand ropes of wing tips and load cell. The height of net mouth was measured directly by using a laser point (laser beam sight level 230) and millimeter bar through the observation window. To measure it easily, 7 marked floats along the head rope were fixed to be the measured points of the net mouth height. The distances of each marked float were also measured (represented by the X and Y coordinates). The results of measurements on the net heights and distances later will be used to calculate the projective area of net mouth and then water filtering volume. Tension of line was measured indirectly by using three components such as load cell, DC strain amplifiers and analog digital converter, which connected and recorded into the personal computer (PC) and also through the instrumental calibration, later it will be used to calculate the total net resistance as shown in Fig. 9. The ratio of net height to the net circumference will be compared in relation to the gear construction and performance of trawls. It will be more emphasized for the discussion only.

Results and Discussion

Height of net mouth

The height of net mouth is defined as vertical distance from the head rope to the ground rope at the central point of head rope. The results of experiments showed that the height of net mouth of each individual net various depending on towing speed and distance between both wing tips. This phenomena can be seen clearly when towing speed and wing tips distance increased, the height of net became decreased. This tendency is common in all trawl nets. Each net has own characteristic in its curve and its decreasing rate. In ordinary towing condition (53%), the results of measurement on the net height showed that *Type A* was higher than that of *Type B*, with the initial values were 12 cm and *11.6* cm at a towing speed of 2 knots (64 cm/s), and then *9.0* cm and 8.3 cm at a towing speed of 3 knots (96 cm/s)

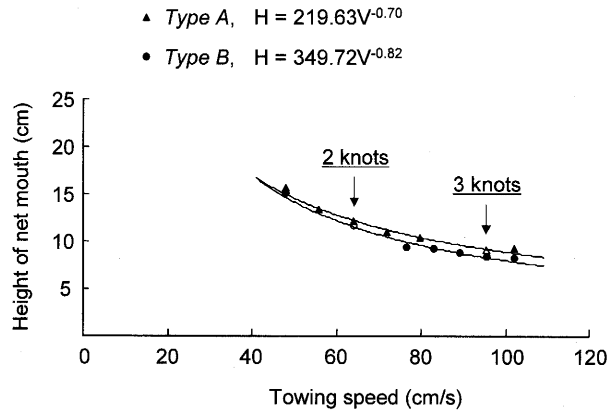

Fig. 10 Comparison between net mouth height of *Type A* and *Type B* when wing tips distance expands to be 53% of H.R.

▲, ● mean measured values and △, ○ mean estimated values respectively.

respectively (Fig. 10). The values in *italic* printed was the estimated values.

Projective area of net mouth

Projective area of net mouth is area of net mouth when trawl net is being towed by ship on trawling operation. From the standpoint of experimental model, the projective area of net mouth is defined as the area between both wing ends of trawl net under towing condition. In ordinary towing condition, *Type A* (9.16×10^2 cm^2) has the projective area of net mouth larger than *Type B* (*8.77×10^2* cm^2) at a towing speed of 2 knots. The similar consideration was also indicated at a towing speed of 3 knots, *Type A* (*7.20×10^2* cm^2) was larger than *Type B* (6.61×10^2 cm^2). It can be seen as Fig. 11.

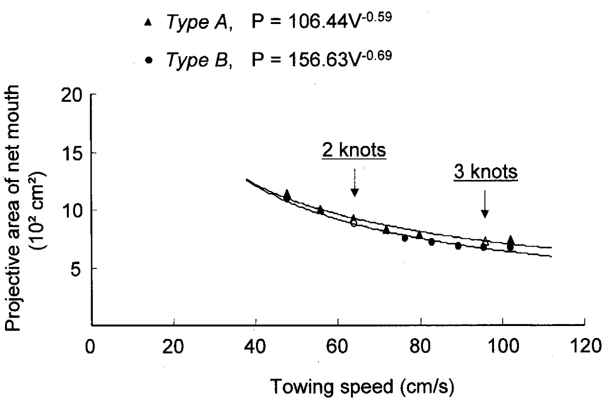

Fig. 11 Comparison between projective area of net mouth of *Type A* and *Type B* when wing tips distance expands to be 53% of H.R.
▲, ● mean measured values and △, ○ mean estimated values respectively.

Water filtering volume

Water filtering volume of *Type A* (58.44×10^3 cm^3/s) was slightly larger than *Type B* (*56.12×10^3* cm^3/s) at a towing speed of 2 knots. The differences were also compared in the same towing speed of 3 knots, *Type A* (*69.16×10^3* cm^3/s) was larger than *Type B* (63.25×10^3 cm^3/s). Those comparison can be seen in Fig. 12.

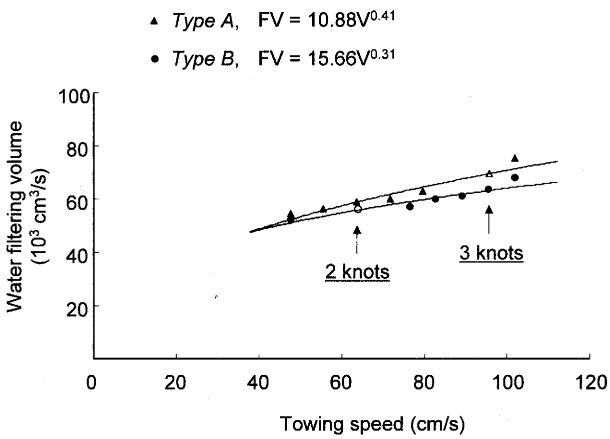

Fig. 12 Comparison between water filtering volume of *Type A* and *Type B* when wing tips distance expands to be 53% of H.R.
▲, ● mean measured values and △, ○ mean estimated values respectively.

Total net resistance

Total net resistance increases proportionally to towing speeds. When the towing speed increases intensively, it will bring a big volume of water entering into the net, the resistance of net increases remarkably, and in consequence, the force to make the net wide increases. Total net resistance is parallel to the flow in line with the cod end, but tension is not parallel, it more corresponds to the towing line and attack angle of warp. Total net resistance, which measured on the head rope was larger than the ground rope. It can be understood that trawl net when exerted by water forces, distribution of the towing forces more concentrated on the head rope, so that the upper part of net has tendency to lessen its room and in consequence, the angle of incidence becomes smaller than the lower one. The attack angle was much influenced by wing tips distances, the wider of wing tips distance, the bigger the attack angle of warp. In ordinary towing conditions, the differences total net resistance were compared in the same towing speed of 2 knots, *Type B* (*7.15×10^2* gw) was larger than *Type A* (6.34×10^2 gw). The similar consideration was also indicated in the same

Table 7 The results of measurements and estimations of the experimental model scale.

Variables	Equations for estimation	Measured	Estimated	Measured	Estimated
		Type A	*Type B*	*Type B*	*Type A*
		2 knots	2 knots	3 knots	3 knots
Height of net mouth (cm)	$H = \alpha V^{-\beta}$	12.0	*11.6*	8.3	*9.0*
Projective area of net mouth (cm^2)	$P = \gamma V^{-\eta}$	9.16×10^2	8.77×10^2	6.61×10^2	7.20×10^2
Water filtering volume (cm^3/s)	$FV = \varepsilon V^{\omega}$	58.44×10^3	56.12×10^3	63.25×10^3	69.16×10^3
Total net resistance (gw)	$R = \kappa V^{\varphi}$	6.34×10^2	7.15×10^2	12.69×10^2	11.42×10^2

Where:
H = height of net mouth; P = projective area of net mouth; FV = water filtering volume; R = total net resistance;
V = towing speed; $\alpha, \gamma, \varepsilon, \kappa$ = coefficient; and $\beta, \eta, \omega, \varphi$ = exponent.

The estimated values (which in *italic* printed) are obtained by applying the same value of the towing speed *Type A* toward *Type B* or otherwise in accordance with the respective equations for estimation.

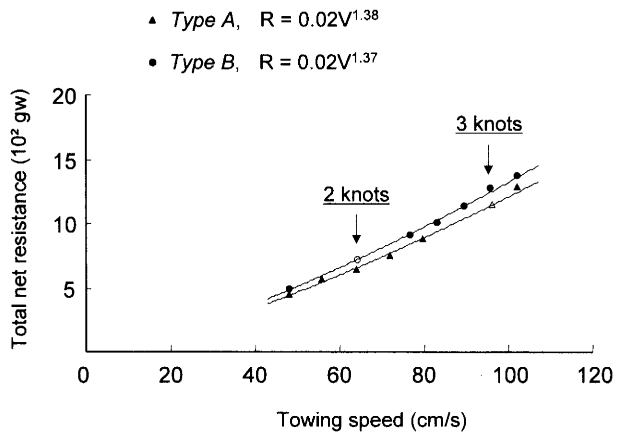

Fig. 13 Comparison between total net resistance of *Type A* and *Type B* when wing tips distance expands to be 53% of H.R.
▲, ● mean measured values and △, ○ mean estimated values respectively.

towing speed of 3 knots, *Type B* (12.69×10^2 gw) was larger than *Type A* (*11.42×10^2* gw). A such condition can be illustrated as Fig. 13. Those phenomena might be induced by the differences of frontal shape at the net mouth, *Type A* has different shape with the square part, which the bottom portion was shorter then the top one, whereas *Type B* has a similar shape (no square), which the bottom portion tends to have a frontal shape, so that the distribution of the towing forces on the head rope and ground rope of *Type B* was larger than that of *Type A*. Results of measurements and estimations of the experiments are summarized in Table 7.

The gear efficiency of the net

The net height is a basic factor to express the gear efficiency of the net. The two experimental model trawls which different in the gear constructions have already been examined. Accordingly, physical characteristics of these nets were not to be compared directly. The net circumference was determined as a main basic of comparison for other trawl dimensions. The difference can be compared by the non-dimension number of the ratio of total length of net to the net circumference. The results of calculation obtained were 0.91 for *Type A* and 0.83 for *Type B* respectively. However, due to the side net was constructed with a 100 meshes in 0.8 m wide, so it might cause an effect on the net shape and the net height opening. The hanging ratios obtained were 0.98 stretched length in depth and 0.02 stretched length in breadth. Even though for the purpose of catching shrimp, the net height is not necessary, however, in this area of study, the height of net mouth was also considered to be important thing because of having correlation to the difference of gear constructions and performances of trawls under different trawling conditions. In order to compare the gear efficiency of the net, authors calculated the ratio of net height (H) to the net circumference (a). The results of calculations indicated that at a towing

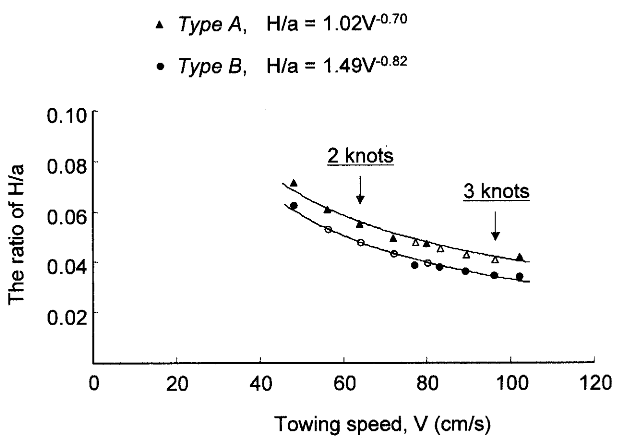

Fig. 14 Comparison between the ratio of net height (*H*) to the net circumference (*a*) of *Type A* and *Type B* when wing tips distance expands to be 53% of H.R.
▲, ● mean measured values and △, ○ mean estimated values respectively.

speed of 2 knots, the ratio of *Type A* was 0.055 or 5.5 % of net circumference and that of *Type B* was *0.048* or *4.8* % of it. At a towing speed of 3 knots, the ratio of *Type A* was *0.041* or *4.1* % of net circumference and that of *Type B* was 0.034 or 3.4 % of it respectively (Fig. 14). The value in *italic* printed was the estimated values, which obtained by applying the same value of the towing speed *Type A* toward *Type B* or otherwise. The equation used was $H/a = \alpha V^{-\beta}$, where H/a is the ratio of net height to the net circumference, V is towing speed, α is coefficient and β is exponent. The ratio of *Type A* was considerably higher than that of *Type B* in all experimental conditions because it has a square part in the gear construction and the net circumference was larger than that of *Type B*. From the empirical method, all trendlines of curves showed that *Type A* was higher than *Type B*. It can be explained by considering the different gear constructions of two types of trawl nets used in this study. *Type A* has square part of net body because of having the different upper and lower wings position, which possibly make the shape of net mouth different from *Type B*. Meanwhile, the upper and lower wings of *Type B* were constructed with the same position, which both wing ends attached in line with the side nets, and the bottom portion tends to have a frontal shape so that expansion of net to be less than *Type A*. A such difference will affect to the net circumference. The bigger net circumference, the higher net opening in the same buoyancy of floats. Beside that *Type A* is also more efficient than *Type B* in term of water filtering volume, which assumed that in one unit time of towing operation, the net will filter more shrimp/fish and other marine products. In perspective of the fundamental suggestions on the gear efficiency, the side net should first be properly reconstructed to have good the net shape with the appropriate hanging ratio and by better increasing the net height opening, for instance, by inserting triangle nets between the side net and baiting. The length of nets will also be afforded to the lacing lines which their function have also been extended to increase the height of net opening by better distributing the towing forces which had previously been concentrated on the head rope and ground rope. The increasing of net height opening was also requested by Kotabaru's fishing community to be able to increase the production not only shrimp but also fish especially in the same months of fishing seasons. According to fisherman's information, fishing season for shrimp is from August to January and fishing season for fish is from September to November.

Acknowledgments

Our gratitude to the Ministry of Education, Culture, Sports, Science and Technology (*Monbukagakusho*) for funding and supporting this study. The authors are much obliged to Mr.

Masataka MARUGI, of the Faculty of Fishery, Kagoshima university, for the guidance and any kindly assistance for experiment. Also, thankfulness to Mr. Sulaiman Nazam, Mr. Ahmad Rizani, Mr. Eddy Zainuddin, Mr. Syamsul Wahid and Mr. Ahmad Nawawi who helped collecting data and information on "Lampara Dasar" in Kotabaru, Indonesia.

References

1) Higo, N. (1971). Fundamental studies on the fishing efficiencies of the trawling nets. *Mem. Fac. Fish. Kagoshima Univ.*, **20**: 1-137.

2) Nomura, M., K. Mori, Y. Tawara, Y Osawa, Y. Shimada and K. Senga (1977). Factors of trawl net construction relating to the height of net mouth I. *Bull. Tokai Reg. Fish. Res. Lab.*, **91**: 53-66.

3) Nomura, M. K. Mori, Y. Tawara, Y. Osawa, Y. Shimada and K. Senga (1980). Factors of trawl nets construction relating to the height of net mouth II. *Bull. Nat. Res. Inst. Fish. Eng.*, **1**: 157-166.

4) Muchtar, A., H. Nishinokubi and K. Nakasai (1973). Study of the six-seam trawl - II. *Bull. Fac. Fish. Nagasaki Univ.*, **36**: 93-101.

5) Mangunsukarto, K. (1979). Comparative study on gear efficiency of three types of trawl nets. *Master Thesis, Fac. Fish. Kagoshima Univ.*, 1-101.

6) Miyamoto H. (1968). Report to the Government of India on establishment of a fishing gear research Laboratory. FAO TA 2599. 1-137.

7) Shahardin, Z.A. (1983). Model experiments on small shrimp trawls. Feasibility studies on the double rigged type over the single rigged type. *Master Thesis, Fac. Fish. Kagoshima Univ.*, 1-137.

8) Hu, FX., K. Matuda and T. Tokai (2001). Effects of drag coefficient of netting for dynamic similarity on model testing of trawl nets. *Fish. Sci.*, **67**: 84-89.

9) Anonymous (2001). The Annual Report. Marine and Fisheries Service of Kotabaru regency, South Kalimantan, Indonesia, 1-72 (*in Indonesian*).

10) Tauti, M. (1934). A relation between experiments on model and on full scale fishing net. *Bull. Jap. Soc. Sci. Fish.*, **3**: 171-177.