Preliminary Result on By Catch from Tuna Purse Seine Fishery in the Eastern Indian Ocean

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Abstract

The exploitation of tuna resources in the East Indian Ocean is now enhancing by many countries. From 1994 to 1999 (March), sampling tuna were collected from purse seine operation of the Training and Research vessel, MV SEAFDEC. The length distributions of skipjack, yellowfin and bigeye tunas were observed ranging between 36-70, 34-94 and 35-125cm, respectively. The catch was consisted of tuna in difference ages, the age between 1-2 year are the dominant catch. About 50% and 31% of total catch were young bigeye and yellowfin tunas. The bigeye, length between 34-100 cm and yellowfin, length 35-110 cm were in the recruitment phase or it can be said that more than 90% of bigeye and yellowfin tunas were in the pre-exploited stage.

The seine net using mesh size of 90 mm at bunt part and 105 mm at upper body part, can measure the nominal mesh perimeter of 180 mm and 210 mm, respectively. From the relationship between fish length and dorsal girth, the tuna greater than 25 cm will be captured and the main target of tuna purse seiner is skipjack. It's difficult to avoid captures of young tuna due to the overlapping between size of adult skipjack and young bigeye and yellowfin tuna. For reduce by catch of young skipjack and some of young bigeye and yellowfin tunas from seine net, the mesh size (stretched) at bunt part is expected to increase from 90 mm to 130 mm, then the young skipjack would be escape 100% and some of young bigeye 5.56% and yellowfin 4.17%.

Key words: Tuna purse seine, length frequency, height, young tuna, by catch, mesh selection.

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1. Introduction

The expansion of Tuna fisheries industry in Thailand as a consequence of the world market demand and lead to the encouraging of commercial tuna fisheries in East Indian Ocean. Comprising of the migration of tuna purse seiners from France, Russian, Taiwanese and etc., lead by Japanese tuna purse seiner in 1993 to the East Indian Ocean and landed at Phuket fishing port by tuna purse seiner was more than 40 purse seiners (Chanthawong, 1998).

The tuna catch product in the world was consisting of 25% of catch from Indian Ocean (5th world tuna conference, 1997). ASFDC[2] reported that the total catches from the tuna purse seiner which landed at Phuket fishing port from 1993 to 1997 found that the maximum catch was in 1994 about 24,000 tons and decreasing to 11,000 tons in 1997. Size distribution of catch was consisting of young tuna especially yellowfin tuna and bigeye tuna. This was related to the report of total catch from MV SEAFDEC in East Indian Ocean (Siriraksophon, 1997).

Although the East Indian Ocean are the recent exploited area which under the investigating of many countries but in reality the Indian Ocean was not the new tuna fishing ground area and tuna resources in the West Indian Ocean are now in the post exploited stage. While this area still in the initially period, the study and data record should be done together in regard to suitable fishing gear and technology for the sustainable fisheries resources management in this area.

2. Material and methods

The Training and Research vessel, MV SEAFDEC has carried out tuna purse seine in the East Indian Ocean between Latitude 3° N – 8° S and Longitude 80° – 97° E during the northeast monsoon season (October to March) since 1994 to March, 1999. Figure 1 was shown the sampling stations from 1994-1999.

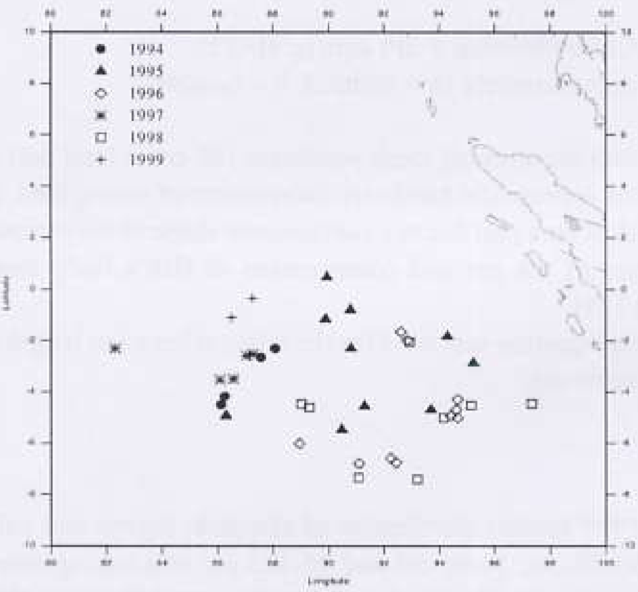

Fig. 1. Tuna sampling station in the East Indian Ocean from 1994 to 1999 (until March)

The tuna seine net were 1,267 m long and maximum depth of 230 m with stretched mesh size 105 mm at upper-body part and 90 mm at bunt part, nominal mesh perimeter were 210 and 180 mm, respectively.

Every operation the sampling tunas were collected from the first scoop and the following variables were recorded; fork length (cm) (Fig. 2a) was measured from the most anterior part of the fish to the tip of the median caudal fin rays by measuring board with a rigid head piece, weight (kg) was measured by spring balance and operational information such as position of capture, date and time, etc. In 1996, 1998 and 1999 the body width and height (cm) were additionally recorded, the position of width and height measurements was shown in Fig. 2 b and c.

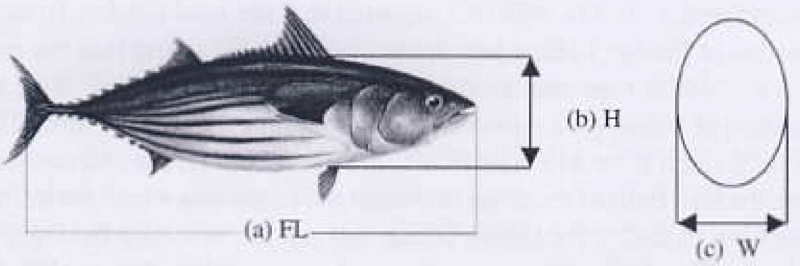

Fig. 2. Position of length measurements (cm), (a) FL; Fork length and H; Height, (b) W; Width

Length distribution of tunas was observed in relation to the age determination from size frequency distribution reported by Chi and Yang (1973) for estimated age of skipjack, Yukinawa and Yabuta (1963) for estimated age of bigeye tuna and Yabuta and Yukinawa (1957) for estimated age of yellowfin tuna (Table 1).

Percentage of catch was separated in each stage from length at estimated tuna reported by Raju (1964) and Kikawa (1953 and 1962) (Table 2).

The fish length and height were used for indicating the relationship between length and dorsal girth by calculated from fish height and width used the ellipse formula;

$$\text{Circumference} = 2\text{Pi}\ \text{sqrt}((a^2+b^2)/2),$$
$$\text{approximately } (a = \text{width}/2,\ b = \text{height}/2)$$

And observed with the nominal mesh perimeter 180 cm at bunt part and 210 cm at upper body part for consider the appropriate mesh size escapement of young tuna. As a consequence of an opportunity to enmesh at bunt part due to a confinement shape of the surrounding net. However, the stretching properties of the net and compression of fish's body can allow variation in escapement (Hamley 1975).

The simple linear equation was used for the relation between length and girth along with the mesh perimeter of seine net.

3. Results

From 1994 to 1999 lengths distribution of skipjack, bigeye and yellowfin tuna (Fig. 3) was mainly between 36-70 cm, 34-94 cm and 35-125 cm and having averaged size of 50.59, 56.05 and 56.49 cm, respectively. Modes of each species were following; skipjack 45 cm, bigeye 50 cm, and yellowfin 43 cm. From the length distribution and length at estimated ages (Table1) reported by Chi and Yang (1973), Yukinawa and Yabuta (1963) and Yabuta and Yukinawa (1957) show that the catch was consisted of tuna in difference ages (Fig. 4), the age between 1-2 year are the dominant catch then age between 0-1 year and 2-3 year, respectively.

Fig. 3. Length distribution in 1994 to 1999 (March) from MV. SEAFDEC purse seine fishery in East Indian Ocean.

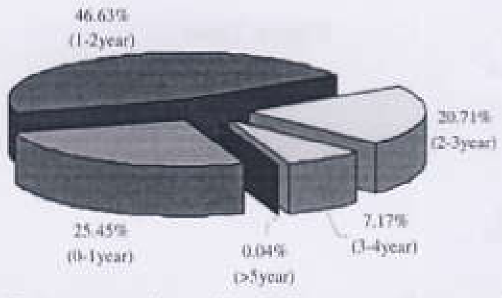

Fig. 4. Percentage of catch in difference age composition.

From the length at estimated tuna life stage (Table 2), the maturity size of skipjack reported by Raju (1964a) was more than 39 cm and maturity size of bigeye and yellowfin reported by Kikawa (1953 and 1962) were 91-100 and 80-110 cm, respectively.

Fig. 5. was shown the composite of catch in each species consist of tuna in mature and immature stage and found that a half of total catch was young tuna or in immature stage. All of bigeye caught and almost yellowfin caught were young tuna but only about 20% of young skipjack were caught.

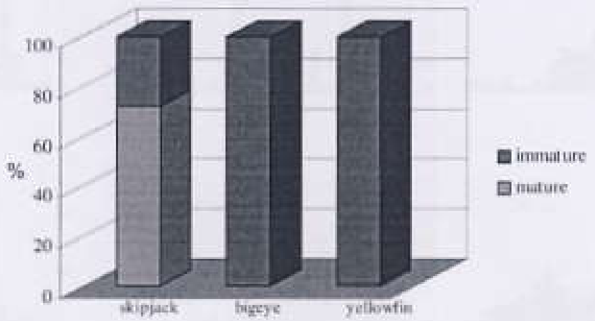

Fig. 5. Percentage of catch in difference age composition.

The linear relation between length and dorsal girth along with the mesh perimeter 18.0, and 21.0 cm was shown in Fig. 6.

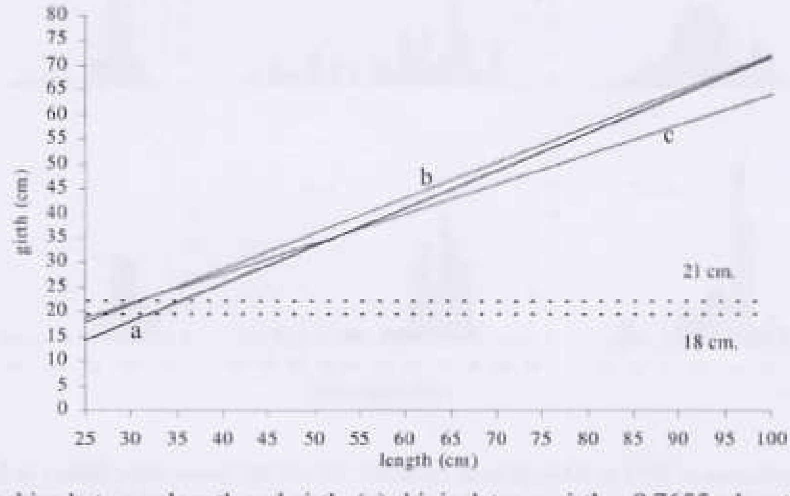

Fig. 6. Relationships between length and girth: (a) skipjack tuna; girth = 0.7655 x length – 4.7607; R2 = 0.8418, (b) bigeye tuna; girth = 0.7218 x length – 0.2161; R2 = 0.8940, (c) yellowfin Tuna; girth = 0.5997 x length + 3.9026; R2 = 0.9042. (-) Nomi0nal mesh perimeter 18 and 21 cm. was observed.

Table 1. Estimated of length (cm) at different ages by various area and authers

Skipjack Tuna

Source	Area	Length (cm) at estimated ages (year) 1	2	3	4	5
	Pacific Ocean					
Aikawa (1937)		26	34	43	54	-
Joseph and Calkins (1969)		31	51	64	72	-
Chi and Yang (1973)		**27**	**47**	**62**	**73**	**81**
Yao (1981). (Kawasaki's (1955) data)		42	58	66	71	-
Uchiyama and Struhsaker (1981)		44	68	83	91	-
	Atlantic Ocean					
Chur and Zharov (1983)		29	44	54	64	70
Bard and Antoine (1986)	East;equator	*40	*51	*59	*65	-
	East;northern	*40	*58	*68	*73	-
Cayre' et al., (1968)		49	57	64	-	-
	Indian Ocean					
Shabotiniets (1968)		-	-	40-45	40-60	-

* relative sizes

Bigeye Tuna

Source	Area	Length (cm) at estimated ages (year) 1	2	3	4	5
	Pacific Ocean					
Shomura, Keala (1963)		80-100	100-130	130-150	<130	-
Yukinawa, Yabuta (1963)		**58-72**	**72-104**	**104-125**	**125-140**	**<140**
Kume, Joseph (1966)		-	90-120	120-140	<140	-

Yellowfin Tuna

Source	Area	Length (cm) at estimated ages (year) 1	2	3	4	5
	Western and Central Pacific					
Moore (1951)		56	*104	*135	156	169
Yabuta and Yukinawa (1957)		***50**	***100**	***129**	***145**	**155**
Yabuta et al. (1960)		53	*92	*119	*139	154
White (1982)(General-Santos)		*64	*105	*132	*149	161
Yamanaka (1990)		*57	-	-	-	-
	Indian Ocean					
Bernard, Jacques and Jone (1995)	All individuals	54.5	89.7	119.2	144.0	-
	Females	54.3	90.1	118.0	142.2	-
	Males	53.5	89.7	120.4	146.5	-

* Estimates within the size range of the sample

This relationship indicate that the fish with girth length less than 18 cm corresponds to skipjack length less than 28.27 cm bigeye length less than 25.15 cm and yellowfin length less than 26.11 cm could escape from the bunt part. For the body part with mesh perimeter 21 cm the fish with girth less than 21 cm is corresponds to skipjack less than length 32.19 cm bigeye length less than 29.31 cm and yellowfin length less than 31.11 cm could escape.

From Raju (1964a) and Kikawa (1953 and 1962) (Table 2), the average length of young skipjack is less than 40 cm and young bigeye and yellowfin tuna is less than 100 cm therefore, the size of adult skipjack and young bigeye and yellowfin tuna is overlap. The linear relations between length and girth show that if the young skipjack (length less than 40 cm) is expected to escape from the net, length 40 cm is corresponds to the girth length 25.86 cm Therefore, the appropriate mesh size for young skipjack escapement is 13 cm (stretched mesh). But for release young bigeye and yellowfin tuna, the mesh size have to increase more and will allow adult skipjack to escape from net. So, the optimum mesh size for reduces young tuna was only appropriate for young skipjack and some of young bigeye and yellowfin tuna. The percentage of escapement of young skipjack is 100% and young bigeye and yellowfin tuna is 5.56% and 4.17%.

Table 2. Length (cm) at estimated tuna life stage by various area and authors.

Source	Area	Lengths (cm) at estimated tuna life stage		
		juvenile size	matuarity size	spawning size
Skipjack				
Yoshida (1964)	Pacific Ocean	-	-	43-50
Matsumoto (1984)		-	40	40-45
Raju (1964)	**Indian Ocean**	-	**40**	**40-45**
Shetty, Kawai and Tanabe (1993)	North-West Pacific Ocean	10-15	-	-
Chanthawong (1996)*			45	
NMFS (1999)**	Western Atlan- -tic Ocean	-	45-50	-
Bigeye Tuna				
Kikawa (1953)	**Pacific Ocean**	-	**91-100**	-
Nikaido (1991)		-	-	>100
Chanthawong (1996)*			100	
NMFS (1999)**	Western Atlan- -tic Ocean	-	100-125	-
Yellowfin Tuna				
Bunag (1956)	Central Pacific	-	70-80	-
Yuen and June (1957)	Western and Central Pacific	-	110-120	-
Kikawa (1962)	**Western and Central Pacific**	-	**80-110**	-
Chanthawong (1996)*			110	
NMFS (1999)**	Western Atlan- -tic Ocean	-	100	-

* Andaman Sea Fisheries Development Center

**National Marine Fisheries Survice, Highly Migratory Species Management Division, Silver spring USA

4. Discussion

The main target of tuna purse seine is skipjack but in reality the composition of tuna school is mixed. The seine net catch adult skipjack with young bigeye and yellowfin tuna as a consequence of the schooling of tuna were consisting of more than one species, particularly size of seine net was purpose for skipjack as the main target. Chanthawong (1996) reported that the distribution pattern of tuna in East Indian Ocean, the young skipjack was distributed in May to November and adult skipjack was distributed in northeast monsoon same as bigeye tuna. Young yellowfin and bigeye tuna was distributed throughout the year but plentiful in the end of southwest monsoon until mid-northeast monsoon. Therefore, the purse seines operation in northeast monsoon, particularly consisting of young yellowfin and bigeye tuna more than adult.

The overlap between size of adult skipjack and young bigeye and yellowfin tuna is conducive to the by catch trouble of seine net because if the young bigeye and yellowfin can escape from seine net that mean adult skipjack would be escape too. The by catch from purse seine will effect to tuna stock cause of the stock in recruitment phase was catch before substitutedin exploited phase. The tuna fisheries, particularly longline will take this effect cause of this gear will catch only adult tuna but stock in exploited phase can not replace by stock from recruitment phase. Some of by catch can reduce by modify the mesh size for the appropriate escapement of young skipjack and some bigeye and yellowfin tuna. But by catch from purse seine can not get over a difficult by modify mesh size unless changing to gear that can select size of target catch.

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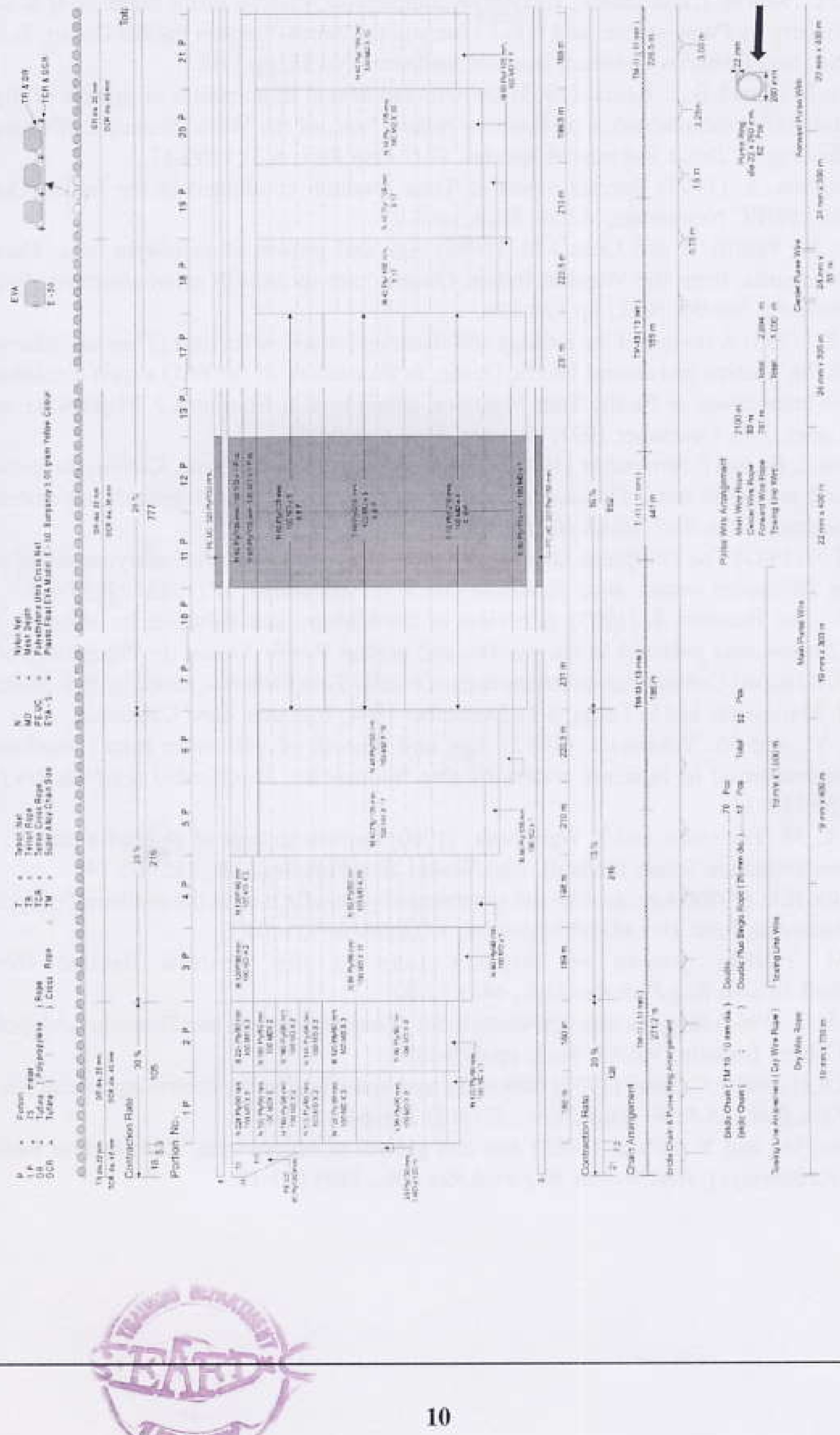

Schematic drawing of MV SEAFDEC purse seine used for skipjack and tuna in East Indian Ocean