

***SIZE DISTRIBUTION AND REPRODUCTIVE ASPECTS OF AUXIS SPP.
FROM WEST COAST SUMATERA, EASTERN INDIAN OCEAN***

Prawira A.R.P. Tampubolon, Dian Novianto, Hety Hartaty, Roy Kurniawan, Bram Setyadji, Budi Nugraha

Research Institute for Tuna Fisheries, Ministry of Marine Affairs and Fisheries, Indonesia

ABSTRACT

Auxis spp was the third largest catch of tuna fishing off the Sumatran West Coast after skipjack tuna (*Katsuwonus pelamis*) and scads (*Decapterus* spp). Two species were identified as frigate tuna (*Auxis thazard* Lacepede 1800) and bullet tuna (*Auxis rochei* Risso 1810). Both were extensively commercialized and exploited using gears such purse seine, troll line and lift net. The study of *Auxis* spp regarding the fish distribution and reproductive aspect were carried out based on the data of landed catch by purse seiner and lift netter. The samples were then measured and analyzed further during the period of January - December 2015 in three locations: Lampulo, Sibolga and Bengkulu. Results show that the size range of *A. thazard* and *A. rochei* were 19-65 cmFL and 15-39 cmFL, respectively. Both possess allometric growth pattern. The sex ratio analysis (male: female) resulted in significant difference for *Auxis thazard* whereas *Auxis rochei* was not significant ($p > 0:05$). Based on the individual size, the smallest mature fish of *A. thazard* was 26 cmFL and 23 cmFL for *A. rochei*. Furthermore, Spearman Karber method was applied to assess the first length of maturity based on the fish size when 50% of the population were mature. *A. thazard* has a bigger first length maturity (34,89 cmFL) than *A. rochei* (27,16 cmFL). Lastly, the fecundity was counted from both species. The fecundity of *A. thazard* was 27.534-720.800 eggs and *A. rochei* was 24.727-220.000 eggs. According to the eggs size distribution, both *A. thazard* and *A. rochei* were partial spawner.

Key words: Neritic tuna, size distribution, reproductive aspects, *Auxis thazard*, *Auxis rochei*, Sumatera, Eastern Indian Ocean.

INTRODUCTION

Fish resources is a common and also open access property. Everybody can utilize it in the same time and place. When it is considered to have a high-economical value, the pressure of the fisheries will be stronger. If it is not being managed well enough in a sustainable-manner, it will tend to be utilized excessively and would threaten the resource. Hence, an effective management is required to sustain the optimum productivity in the long run.

Auxis spp is a part of neritic tuna which is managed jointly by several countries through the Indian Ocean Tuna Commission (IOTC) (Herrera & Pierre, 2009). This particular species is an important commodity in small-scale fisheries along the Indian Ocean. *Auxis* was distributed throughout the tropical and subtropical waters. *Auxis* is the most abundant species in the Mediterranean Sea and the most widely exploited fish on a small scale tuna fisheries (Sabates & Recasens 2001).

To ensure the sustainability of this commodity, the reproduction aspects have to be revealed. Research on the reproductive biology of fish can provide critical data and information regarding the frequency of spawning, spawning success, spawning duration and the size of maturity (Mardlijah & Patria, 2012). Determining the gonadal maturity stage, in addition to describe the reproductive cycle, is also associated with the estimation of the age or size of the fish reached the maturity and spawning time (Abidin, 1986).

The aims of this study were to present the size distribution of *Auxis* and its reproduction aspects. The reproduction aspects were include gonad maturity, the length of first maturity, fecundity and egg diameter.

METHODS

The fish were collected from three spots along the west coast of Sumatera: Lampulo (Aceh), Sibolga (North Sumatera) and Pulau Baai (Bengkulu) from January 2015 to December 2015. The fish were obtained from the catch with purse seine and lift net fleet which were operated in eastern Indian Ocean (Figure 1). The data collecting included fork length, weight of the whole body, and gonadal aspects. Gonad samples were preserved and analyzed in Histology Laboratory of Research Institute of Tuna Fisheries. Female gonadal maturity stage was observed histologically based on the oocyte development criteria by Davis *et al.* (1996), which is classified the maturity of female gonad into five stages. (Appendix 1); while the gonadal maturity of the male fish was analyzed morphologically.

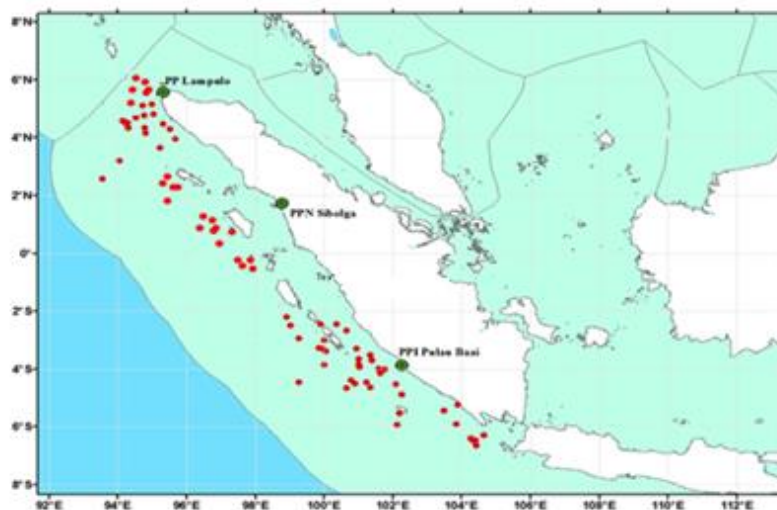


Figure 1. The sampling site

- **Length-Weight Relationship**

Length-weight relationships were calculated using the formula $W = aL^b$; W is the total weight (in kilogram) and L is the total length (in cmFL). Then, the regression coefficient b was tested using t-test. If the value of calculated t is more than the value of t in the table provided, the growth is considered allometric, and when the value of calculated t is less than the number of t in the table provided, the growth is considered isometric.

- **Length at first maturity (L_m)**

Length at first maturity (L_m) was analyzed using Spearman – Karber method (Udupa, 1986):

$$m = xk + X/2 - (X \sum p_i)$$

where: m: the log size at first maturity; xk: last log size at which 100% of fish are fully mature;

x: log size increment; p_i : proportion of mature fish for each size group

$$CL = \text{antilog} \left[m \pm 1.96 \sqrt{x^2 \sum \left\{ \frac{p_i \times q_i}{n_i - 1} \right\}} \right]$$

where: CL: Confidence limit; m: length at the first maturity; n_i : number of fish on length class-i;
 q_i : $1 - p_i$

- **Fecundity**

Fecundity was determined from mature female fish gonad. Fecundity was counted using gravimetric method. From Bagenal (1978):

$$F = (W_g/W_s) \times n$$

Where :

F = Fecundity (eggs)

W_g = Total gonad weight (gram)

W_s = Sample gonad weight (gram)

n = The eggs in the sample gonad (eggs)

- **Egg diameter**

Egg diameter was counted using binocular microscope using ocular micrometer. If the eggs was not perfectly rounded, the measurement using Pangni *et al.* (2008) formula:

$$D = (D_1 + D_2) / 2$$

Where :

D = Actual egg diameter (μm)

D₁ = Horizontal egg diameter (μm)

D₂ = Vertical egg diameter (μm)

RESULT AND DISCUSSION

The size of bullet tuna was about 15–39 cmFL , while the frigate tuna was 19 – 42 cmFL (Figure 2 and Figure 3). Most of the bullet tuna and the frigate tuna were 26-27 cmFL. The length weigh relationship for bullet tuna formed formula $W = 6,3 \times 10^{-6} \text{ FL}^{3,2567}$ and frigate tuna was $W = 9 \times 10^{-6} \text{ FL}^{3,1489}$. Based on the t-test with confidence level 95%, the growth of bullet tuna and frigate tuna were positive allometric.

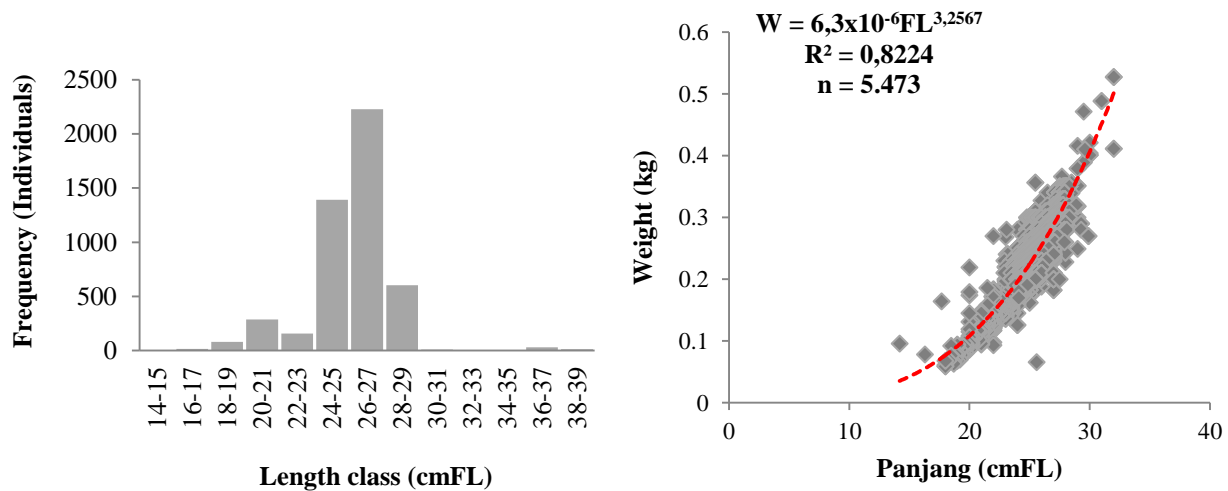


Figure 2. Size distribution and length-weight relationship of bullet tuna

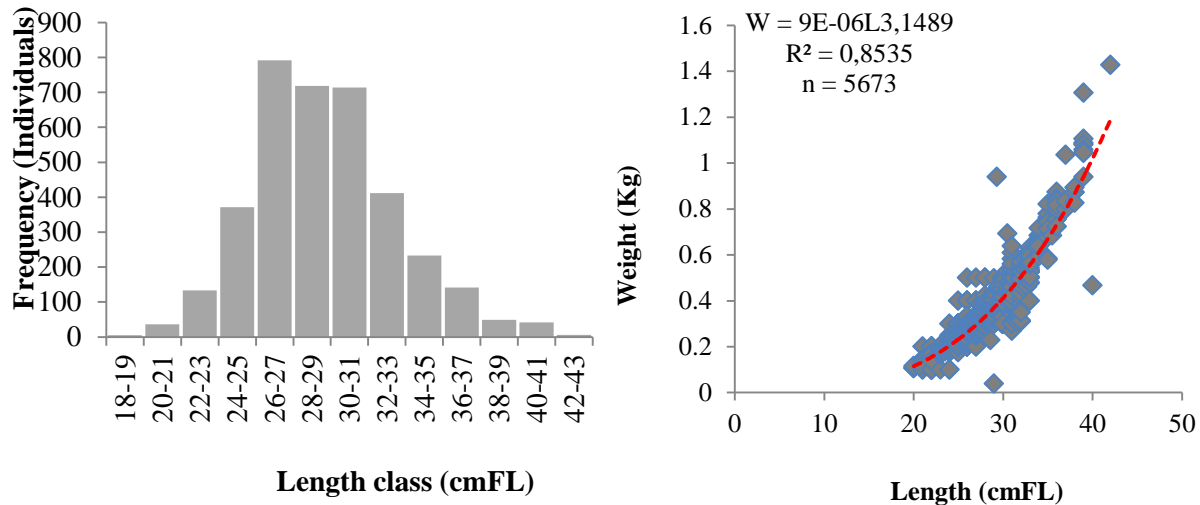


Figure 3. Size distribution and length-weight relationship of frigate tuna

Sex was determined by observing the primary sex organ. Not all dissected fish could be determined because some fish were still so young and the shape of the gonad still thread-like. Sex ratio of frigate tuna was 1,3: 1 and for bullet tuna was 1: 1,3 (Table 2). After testing with chi-square test, it was revealed that the sex ratio of frigate tuna was balanced; whereas the bullet tuna was unbalanced. Effendie (2002) stated that the sex ratio difference could be because of internal factors: fish behavior, mortality and growth; and external factor: food availability, population density and the balance of the food chain. But, the factors were not studied in this research. *Auxis thazard* in Mangalore waters was unbalanced (Muthiah, 1985).

Table 2. Sex ratio of frigate tuna and bullet tuna

Month	Frigate tuna		Bullet tuna	
	Male	Female	Male	Female
February	9	5	13	26
April	60	30	22	18
August	46	45	2	2
October	7	12	35	47

Length at first maturity (L_m) of the population was counted using Spearman – Karber method (Udupa, 1986). The size (L_m/L_{50}) was accorded to the size when 50% of the population had been mature. The length of first maturity of frigate tuna was 34,89 cmFL (in range: 33,41 – 36,43 cmFL) and bullet tuna was 27,16 cmFL (in range: 26,20 – 28,15 cmFL).

IOTC reported that the size of first length maturity for bullet tuna was 35 cmFL and for frigate tuna was 29–35 cmFL. For frigate tuna, the Lm from this study was still within the range of IOTC standard, however, the bullet tuna was different and shorter. Further research which using more samples could verify the reason of the difference.

In other location, according to researching report, the first length when *Auxis rochei* reached maturity was varied: 23 cmFL (Rohit *et al.*, 2014) and 35 cmFL (Macias *et al.*, 2005). While, *Auxis thazard* reached the first size of maturity at 38,5 cmFL (male) and 36,7 cmFL (female) (Deepti & Sujatha, 2012). Ghosh *et al.* (2012) reported the smallest frigate tuna had been mature at 29,7 cmFL with 697.531 – 1.163.438 eggs in the ovary.

The mature female gonad was analyzed further for counting the fecundity and egg diameter measurement. Fecundity of frigate tuna was 27.534 – 720.800 eggs and bullet tuna was 24.727 – 220.000 eggs (Table 2).

Table 9.4.5. Fecundity of bullet tuna (BLT) and frigate tuna (FRT)

No	Fish	Length (cmFL)	Weight (gram)	Fecundity (eggs)	No	Fish	Length (cmFL)	Weight (gram)	Fecundity (eggs)
1	BLT	27	350	220.000	1	FRT	38	1.132	670.353
2	BLT	25	250	24.727	2	FRT	33	540	145.696
3	BLT	25	240	30.545	3	FRT	33	564	72.578
4	BLT	24	189	47.509	4	FRT	41	1.250	361.432
5	BLT	24	181	37.971	5	FRT	39	1.132	393.000
6	BLT	26	232	50.881	6	FRT	36	771	202.017
7	BLT	24	182	52.200	7	FRT	31	485	27.534
8	BLT	23	163	52.320	8	FRT	33	688	34.099
9	BLT	24	203	46.060	9	FRT	34	712	63.888
10	BLT	26	227	38.165	10	FRT	34	677	51.041
11	BLT	24	196	57.470	11	FRT	41	1.274	720.800
12	BLT	25	185	25.520	12	FRT	32	544	116.044

The egg diameter of frigate tuna and bullet tuna were 0,01 – 0,55 mm (Figure 4). *Auxis* was pelagophil fish. Pelagophil fish does not take care of its young and has large amount of fecundity. Spawning frequency could be estimated from size distribution of egg diameter. Based on the distribution of the egg size which has more than one peak, it is known that the *Auxis* was partial spawner. *Auxis* spawn the eggs partially in a spawning season (Figure 4).

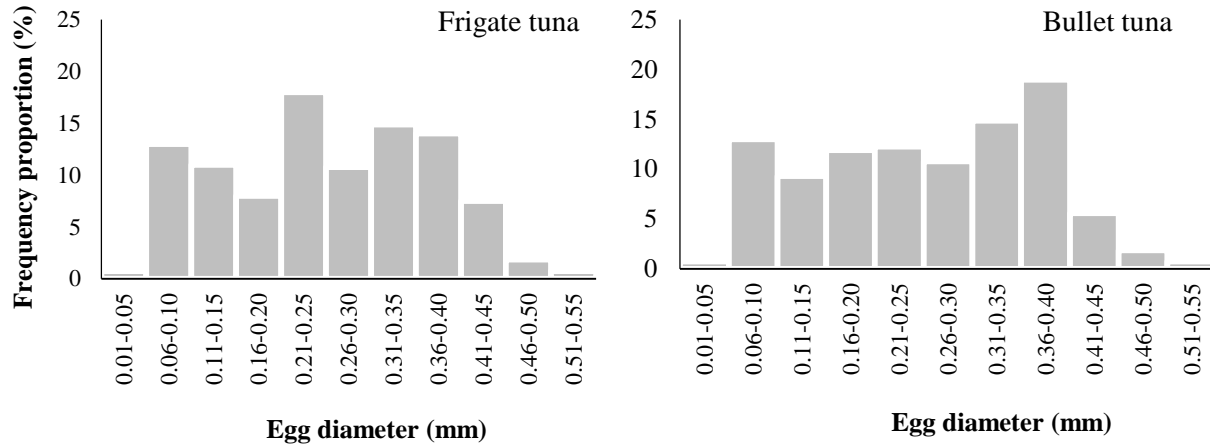


Figure 4. Egg diameter of frigate tuna and bullet tuna

REFERENCES

- Abidin, A. Z. 1986. The reproductive biology of tropical cyprinid from zoo lake. Kuala Lumpur, Malaysia. *J. Fish. Biol.* 29:381 – 392.
- Bagenal, T.B. 1978. *Methods for assessment of fish production in fresh water*. IBP. Handbook (3). Blackwell Scientific Publication, Oxford. 253 pp.
- Deepti VAI, Sujatha K. 2012. Fishery and some aspects of reproductive biology of two coastal species of tuna, *Auxis thazard* (Lacepède, 1800) and *Euthynnus affinis* (Cantor, 1849) off north Andhra Pradesh, India. *Indian J. Fish* 59(4): 67-76
- Effendie, M.I. 2002. *Biologi perikanan*. Yayasan Pustaka Nusatama. Yogyakarta. 112 pp.
- Ghosh S, Sivadas M, Abdussamad EM, Rohit P, Koya KPS, Joshi KK, Chellappan A, Rathinam MM, Prakasan D, Sebastine M. 2012. Fishery, population dynamics and stock structure of frigate tuna *Auxis thazard* (Lacepede, 1800) exploited from Indian waters. *Indian J. Fish.* 59(2): 95-100
- Herrera, M. & L. Pierre. 2009. *Status of IOTC databases for neritic tunas*. IOTC-2009-WPDCS-06. 46 pp. The paper presented in the 6th session of the Working Party on Data Collection and Statistics, Victoria-Seychelles, 26 – 27 November 2009.
- Macias, D., M.J. Gómez-Vives and J.M. de la Serna. 2005. Some reproductive aspects of bullet tuna (*Auxis rochei*) from the south western Spanish Mediterranean. *Col. Vol. Sci. Pap. ICCAT* 58(2): 484-495.

- Mardlijah, S. & M.P. Patria. 2012. Biologi reproduksi ikan madidihang (*Thunnus albacares* Bonnaterre 1788) di Teluk Tomini. *BAWAL Widya Riset Perikanan Tangkap*. 4(1): 27 – 34.
- Muthiah C. 1985. Maturation and spawning of *Euthynnus affinis*, *Auxis thazard* and *A. rochei* in the Mangalore inshore area during 1979-1982. In: E.G. Silas (Ed), Tuna fisheries of the Exclusive Economic Zone of India: Biology and stock assessment. *Bulletin of Central Marine Fisheries Research Institute*. 36:71-85.
- Pangni, K., B.C. Atse & N.G.J. Kouassi. 2008. Influence of brood stock age on reproductive success in the african catfish *Chrysichthys nigrodigitatus* (Claroteidae Lacepede, 1803). *Research Journal of Animal Sciences. Medwell Journals*. 2(5): 139 – 143.
- Rohit, P., G.S. Rao, & K. Rammohan. 2012. Age, growth and population structure of the yellowfin tuna *Thunnus albacares* (Bonnaterre, 1788) exploited along the east coast of India. *Indian J. Fish*. 59(1): 1 – 6.
- Sabates A, Recasens L. 2001. Seasonal distribution and spawning of small tunas (*Auxis rochei* and *Sarda sarda*) in the northwestern Mediterranean. *Scientia Marina* 65(2): 95-100
- Udupa, K.S. 1986. Statistical method of estimating the size at first maturity in fishes. ICLARM. Metro Manila. *Fishbyte*. 4(2): 8 – 10.

Appendix 1. The criteria of gonad maturity stage

Maturity Stage	Condition	Remarks
1	Immature	Small perinuclear oocytes with purple stained cytoplasm and a spherical nucleus. Peripheral nucleoli (small black dots) may be seen in the nucleus, along with differential staining of the cytoplasm, which might be precursors of yolk Vesicles
2	Early mature	An accumulation of pale purple stained yolk vesicles begins in the cytoplasm. These yolk vesicles initially concentrate at the periphery of the oocyte and spread inwards towards the nucleus. Peripheral nuclei are present.
3	Late maturing	Pink stained yolk granules (spheres) are present throughout the oocyte. The zona radiata is wide, turns pink and shows radial striations. The nucleus is centrally located.
4	Ripe	The nucleus migrates to the periphery of the oocyte and is usually replaced by a few large oil droplets. Sometimes you can see the yolk granules fusing to form yolk plates
5	Spent	The yolk coalesces completely (uniform pink stain). The oocyte significantly increases in size and appears irregular in shape (probably due to a loss of fluid during histological preparation)