

ANALYSIS OF SEX-RATIO BY LENGTH CLASS OF BIGEYE TUNA (*THUNNUS OBESUS*) IN THE INDIAN OCEAN

ANALISIS PERBANDINGAN NISBAH KELAMIN BERDASARKAN KELAS PANJANG TUNA MATA BESAR (*THUNNUS OBESUS*) DI SAMUDRA HINDIA

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ABSTRAK

Sejauh ini informasi mengenai aspek biologi ataupun perikanan dari tuna mata besar di Samudra Hindia, khususnya Indonesia, masih sangat terbatas. Makalah ini ditujukan untuk memberikan beberapa informasi mengenai aspek biologi tuna mata besar terutama mengenai perbandingan nisbah kelamin. Penelitian telah dilakukan melalui observasi ilmiah pada bulan Maret–April 2010 dengan cara mengikuti kapal rawai tuna komersial yang berbasis di Benoa. Total terdapat 159 tuna mata besar yang dapat diangkat dan diamati. Hasil penelitian menunjukkan bahwa perbandingan nisbah kelamin jantan dan betina tuna mata besar adalah 1:1,12 dan hasil studi mengindikasikan bahwa ikan tuna mata besar berukuran kecil (60–100 cm) dan besar (140–160 cm) berisi lebih banyak jantan dibandingkan dengan betina sedangkan yang berukuran sedang (100–140 cm) sebaliknya. Sebagai tambahan, kebanyakan ikan tuna mata besar yang tertangkap sudah matang secara seksual.

Kata kunci: Perbandingan kelamin, Tuna mata besar, Samudera Hindia

ABSTRACT

By far the information about Indian Ocean big eye tuna biology and fisheries especially in Indonesia is still very limited. This paper is an attempt to give some information of the biological observations, especially sex ratio of big eye tuna (BET) in Indian Ocean. Surveillance was conducted by scientific observers on March–April, 2010 following two commercial tuna longline vessels based in Port of Benoa. Total 159 of BET managed to be hauled and observed. The result showed that sex ratio of male and female BET was 1:1.12 and study indicated small size (60–100 cm) and large size (140–160 cm) of BET comprise of male more than female; while middle size (100–140 cm) dominated by female rather than male. In addition most BET caught were already reached their sexual maturity.

Keywords: Sex ratio, Bigeye tuna, Indian Ocean

INTRODUCTION

Big eye tuna (*Thunnus obesus*) (BET) are one of the most important component of tuna fisheries throughout the Indian Ocean compared to yellowfin tuna (*Thunnus albacares*) and southern bluefin tuna (*Thunnus maccoyii*).¹ They are widely distributed from tropical to subtropical waters, usually forming into big schooling, fast swimmer

(up to 50 km/hour), the reason why this species can covers a massive geographic area. It also the most economically valuable² and principal target species of the large longliners from Japan, China, and Taiwan and smaller longliners based in several Indian Ocean Island countries, especially Indonesia.³ The longline catch of big eye tuna (BET) in the Indian Ocean has increased from

approximately 40,000 tonnes in the late-1980s and early-1990s to ~100,000 tonnes in the late-1990s (IOTC Fish stat data set 1950–2000). Tuna production in 2010 reached up to 2.6 million ton and 400,000 ton (15.38%) came from Indian Ocean. Indonesia contributes more than 207,010 ton in 2010, rise up 1.84% from previous year. Port of Benoa contributes more than 60% of tuna production in Indonesia. During 2004–2010 data tuna landing showed trend of declining especially on bigeye tuna. Reached its peak on 2004 (approx. 5,292 ton) then started to decline afterward (2,168 ton in 2010).

Studies on sex ratio of BET in Indian Ocean have been conducted by several authors i.e. Notmoorn³ in Eastern Indian Ocean based on monthly basis landings at Phuket fishing port; Anrose & Kar⁴ in Andaman and Nicobar Waters; Fonteneau *et al.*² comparing from Atlantic and Indian Ocean; Arizet *al.*⁵ in South western Indian Ocean; and Faizah⁶ in Indian Ocean, specifically south of East Java, Bali, up to Nusa Tenggara. Knowing that given information is still limited, thus similar research covered more areas in Indian Ocean are imminently needed, either as a comparison or adding existing information.

This paper is an attempt to give some information of the biological observations, especially sex ratio of BET in Indian Ocean South Java and Nusa Tenggara.

METHODS

Surveillance was conducted by scientific observers on March–April, 2010 following two commercial tuna longline vessels which operated in Indian Ocean South of Java and Nusa Tenggara (Fig. 1) and based in Port of Benoa. Total 159 of BET managed to be hauled and observed, covers fishing ground, length (FLT) and determining of sex. Length was measured from tip of snout to tail fork (Fork Length Tape/FLT) using tape with accuracy down to 0.5 cm. Identification of species following Collette and Nauen⁷ and sex determination based on visual observation. Samples were taken onboard during the operation in Indian Ocean.

In this study hypothetically, sex ratio of male and female equal 1 at 95% of confident interval, test on proportion of sex-ratio was done using chi-square test described by Sugiyono⁸, following this equation:

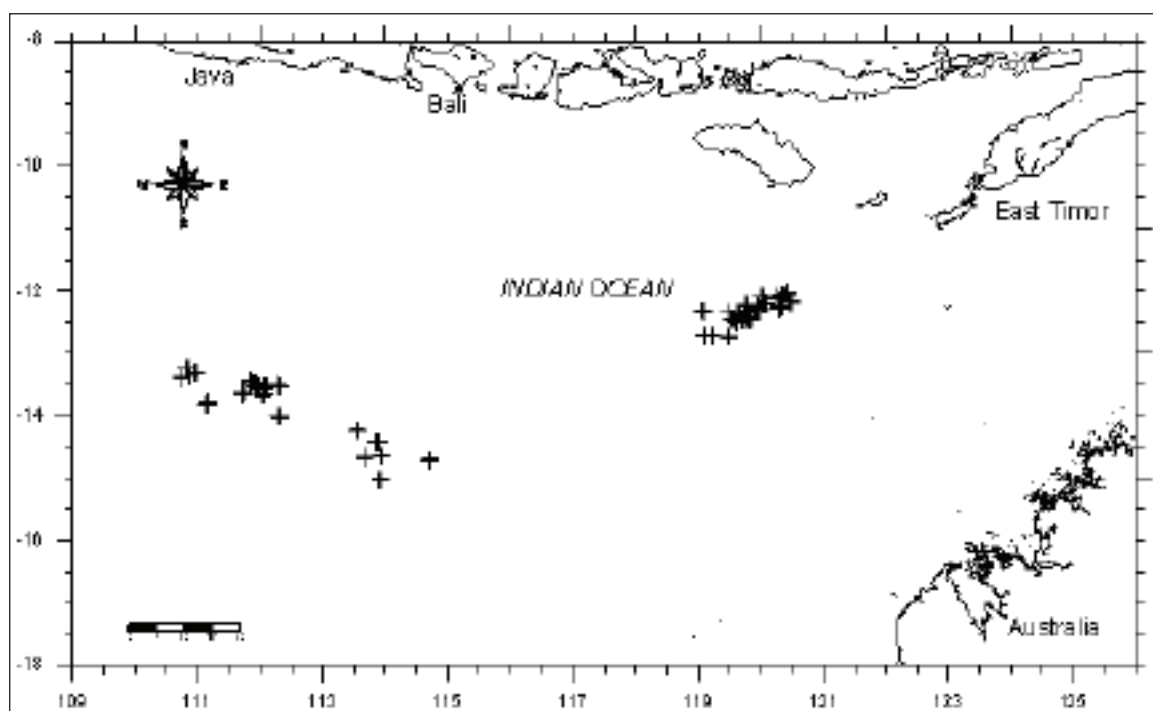


Figure 1. Distribution of bigeye tuna (+) caught by tuna longliners in Indian Ocean South of Java and Nusa Tenggara during research, March–April 2010.

$$\chi^2 = \sum_{i=1}^k \frac{(f_o - f_n)^2}{f_n} \dots\dots\dots(1)$$

where:

χ^2 : chi-square

f_o : value from sampling (observed)

f_n : value from calculation (expected)

RESULT AND DISCUSSION

Fishing grounds and size distribution

The fishing grounds were located from latitude 13° N to 16° S and longitude 110° to 122° E, the Eastern Indian Ocean (Fig. 1). Most of Indonesian

tuna longline vessels which based at Port of Benoa are operating in this area except few of them are heading to Banda waters⁹ and Western Sumatera.¹⁰ Fishing grounds are related with the fishes targeted (either fresh or frozen) i.e. bigeye tuna, yellowfin tuna, albacore, and group of billfishes which mostly came as frozen products. In searching for fresh tuna usually the fleets operate in Indian Ocean southern of Sumbawa to southern of Yogyakarta, but sometimes it could reach southern of Christmas Island to the border of Australian waters for about 2–4 months of fishing operation.¹¹ While for frozen tuna it reached up western part of Australia to southern part of Sri Lanka and Maldives for about 7–12 months per trip.

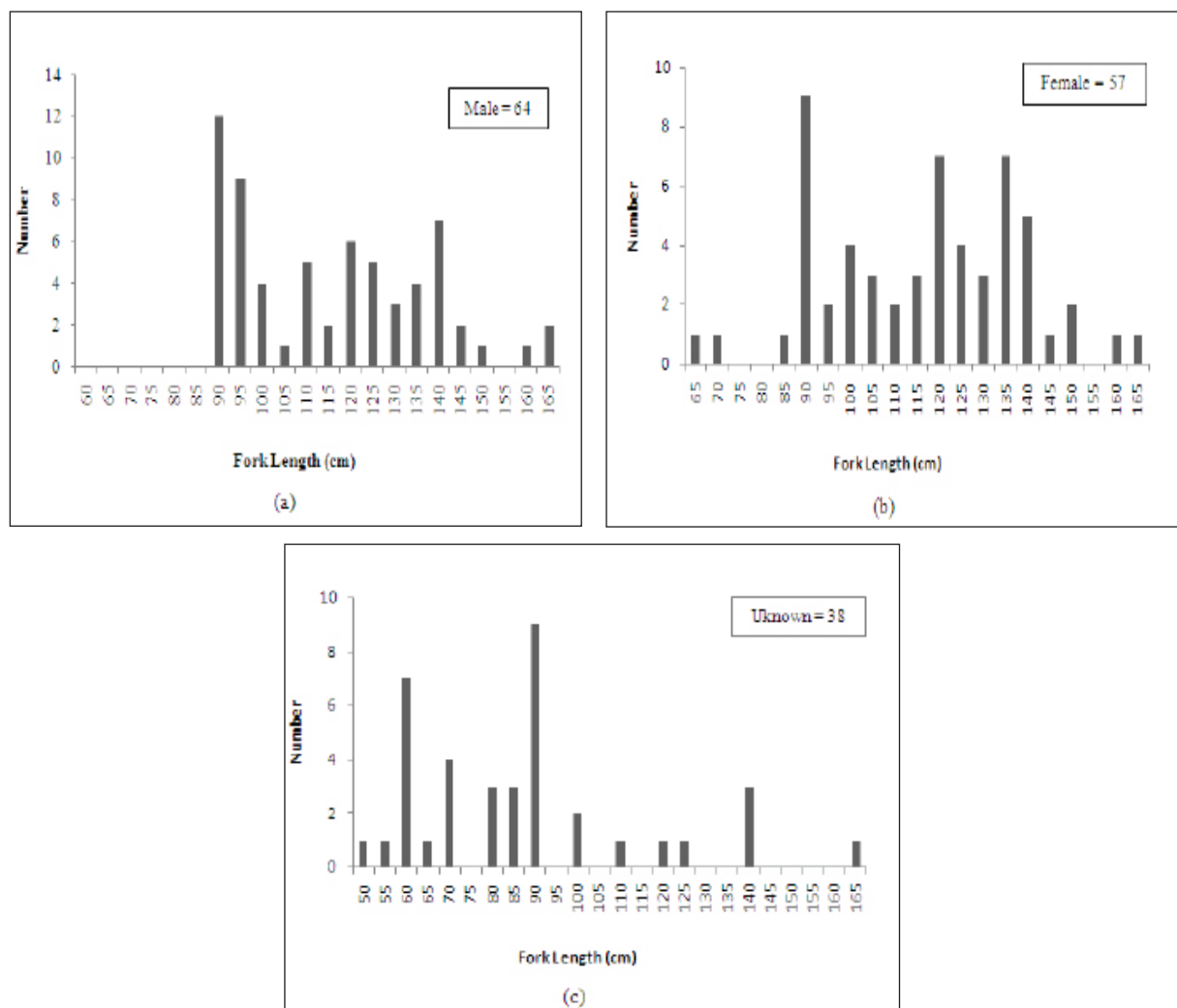


Figure2 . Length distribution of male (a), female (b), and unknown (pooled) sex (c) for big eye tuna in Indian Ocean

Base on sex, the length (FLT) range of male BET captured size up from 85–165 cm, female BET from 65–165 cm, and for unknown sex range from 50–165 cm (Fig. 2). This is considered similar with Nootmorn³ in Eastern Indian Ocean where length range of male and female are 85.55–174.82 and 83.38–158.23 cm respectively. But below compared to Faizah⁶ in similar location which length range overall was 124–147 cm and also in Andaman and Nicobar Waters proposed by Anrose & Kar⁴ (2010) where the males were in the FL range of 104–173 cm while the females were in the FL range of 122–172 cm.

Sex ratio vs. Size at First Maturity

Sex ratio of male and female BET was 1:1.12, lower compared to Nootmorn³ which the sex ratio for male and female BET in eastern Indian Ocean was 1:1.84. In general, the proportion of females is higher than the proportion of males for several length classes. Farley *et al.*¹² reported sex ratio of BET from longliner that found the proportion of male more than female (1.24:1) only in Coral Sea, while sex ratio in other areas (Southern Queensland/New South Wales, Western Australia, Southern of Indonesia Water) found proportion about 1:1. In addition, sex ratio by length class in present study indicated small size (60–100 cm) and large size (140–160 cm) of BET comprise of male more than female; while middle size (100–140 cm) dominated by female rather than male (Table 1).

Size at maturity (L_m) for bigeye tuna were varied, according to Nootmorn³ size at first maturity of female and male was observed from sampling data in eastern Indian Ocean equal 83.38 cm and 85.55 cm respectively, in Banda Sea a bit

higher, about 133.5–137.9 cm;¹³ in Pacific range from 91–100 cm¹⁴ while in West Pacific about 99.7 cm.¹⁵ Study by Zhu *et al.*¹⁶ in tropical Atlantic Ocean found that L_{50} for BET range from 94–120 cm. Sizes at first maturity used in this paper were following Farley *et al.*¹² Length at 50% maturity was 102.4 cm in females and 86.6 cm in males while length at 50% capture was 113.87 cm in females and 110.45 cm in males. Figure 3 shows that $L_m < L_{50}$ for all sexes. It could be interpreted that most of BET caught during the research already reach their sexual maturity which mean they had released their eggs/spawning before get caught.

Trend of fishing pressure of BET in Indian Ocean has led in into phenomenon that the fishes caught is getting smaller and mature early at younger ages as a way of adaptation to nature, field observation by interviewing longliners' crews and captains indicated that fishes are harder to find, smaller in size, with longer trips and further distances of fishing ground even this study prove otherwise. This happened because from previous study spawning of BET suspected to have high spawning potential,⁶ spawning appear to happen all year long and following partial pattern (partial spawner and multiple spawner).¹⁷

CONCLUSION

Sex ratio of male and female BET was 1:1.12 and study indicated small size (60–100 cm) and large size (140–160 cm) of BET comprise of male more than female; while middle size (100–140 cm) dominated by female rather than male. In addition most BET caught were already reached their sexual maturity.

Table 1. Sex ratio by length class of BET caught during research.

Length Class (cm)	Male	Female	Sex Ratio
60–80	0	2	0.00
80–100	25	16	1.56
100–120	14	15	0.93
120–140	19	19	1.00
140–160	4	4	1.00
160–180	2	1	2.00

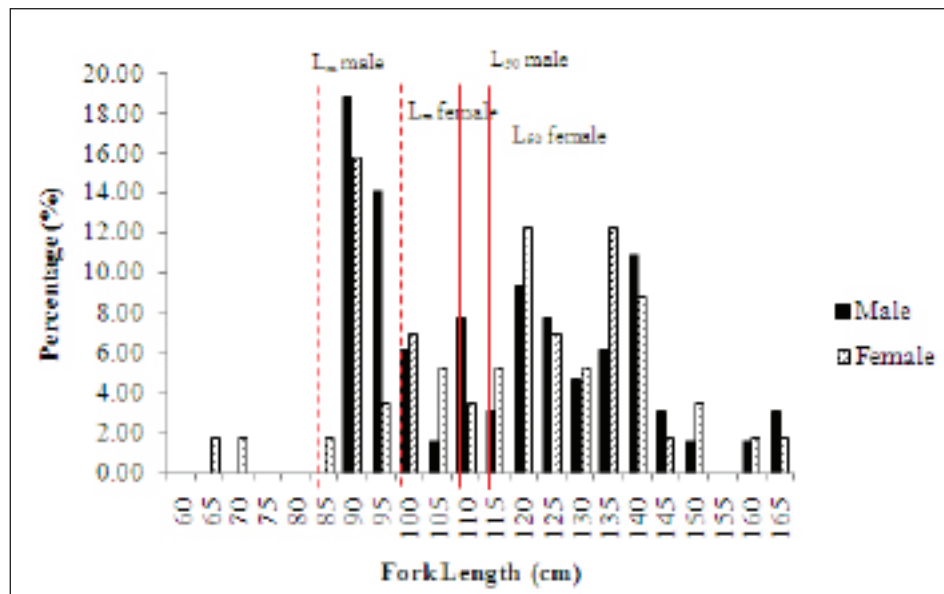


Figure 3. Sex ratio vs. length at first maturity of BET in Indian Ocean.

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REFERENCES

- ¹Nugraha, B. et al. 2010. Genetic diversity of big eye tuna (*Thunnus obesus*) based on mtDNA analysis with the PCR-RFLP technique. *Ind. Fish. Res. J.* 16(1): 25–32.
- ²Fonteneau, A. et al. 2004. A comparison of big eye stocks and fisheries in the Atlantic, Indian and Pacific Ocean. *IOTC–2004–WPTT–INF03*.
- ³Nootmorn, P. 2004. *Reproductive biology of bigeye tuna in the Eastern Indian Ocean*. IOTC Proceedings no. 7: 1–5. WPTT04–05.
- ⁴Anrose, A and A.B. Kar. 2010. *Some aspects of the biology of bigeye tuna (Thunnus obesus, lowe 1839) in Andaman and Nicobar Waters*. IOTC–2010–WPTT–41.
- ⁵Ariz, J et al. 2005. *Preliminary yellowfin tuna sex-ratio analysis from observer data obtained during the experimental cruise on Spanish longliners in the Southwestern Indian Ocean*. WPTT–2005–WPTT–20.
- ⁶Faizah, R. 2010. *Biologi reproduksi ikan tuna mata besar (Thunnus obesus) di perairan Samudera Hindia*. Thesis, Program Pasca Sarjana. Institut Pertanian Bogor.
- ⁷Collette, B. B. and C. E. Nauen. 1983. FAO species catalogue. Vol. 2. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos and related species known to date. *FAO Fish. Synop.*, 125 (2):137.
- ⁸Sugiyono. 2004. *Statistik Non Parametris Penelitian*. Penerbit CV Alfabeta Bandung. 158pp.
- ⁹Nugraha, B. and K. Wagiyono. 2006. Hasil tangkap sampingan (*by-catch*) tuna longline di perairan Laut Banda. *BAWAL*. 1 (2): 71 –75.
- ¹⁰Nugraha, B and E. Nurdin. 2006. Penangkapan tuna dengan menggunakan kapal riset M.V. SEAFDEC di perairan Samudera Hindia. *BAWAL*. 1(3): 95–105.
- ¹¹Novianto, D. et al. 2010. Komposisi ukuran, perbandingan jenis kelamin, dan tingkat kematangan gonad ikan todak berparuh pendek (*Tetrapturus angustirostris*) di Samudera Hindia. *BAWAL*. 3 (2): 123–128.
- ¹²Farley, J.H. et al. 2004. *Age and growth of big eye tuna (Thunnus obesus) in the eastern and western AFZ*. IOTC–2004–WPTT–INF04.
- ¹³Nugraha, B. and S. Mardijah. 2006. Hubungan panjang bobot, perbandingan jenis kelamin dan tingkat kematangan gonad tuna mata besar (*Thunnus obesus*) di Perairan Laut Banda. *Jurnal Penelitian Perikanan Indonesia*.
- ¹⁴Yuen, H.S.H. 1955. Maturity and fecundity of big eye tuna in the Pacific. *U.S. Fish. Wildl. Serv., Spec. Sci. Rept. Fish.* 150:30p.

- ¹⁵Sun, C.L. et al. 2006. Reproductive biology of big eye tuna in the Western and Central Pacific Ocean. Scientific Committee Second Regular Session. 7–18th August 2006, Manila, Phillipines.
- ¹⁶Zhu, G.P. et al. 2011. Size at sexual maturity of big eye tuna *Thunnus obesus* (Perciformes: scombridae) in the Tropical Waters: a comparative analysis. *Turkish Journal of Fisheries and Aquatic Sciences* 11: 149–156.
- ¹⁷Nishikawa, Y. et al. 1985. Average distribution of larvae of oceanic species of Scombroid fishes, 1956–1981. *Fish. Res. Lab.* 12: 99p.