Length-weight relationship of *Thunnus albacares*, landed along north Andhra Pradesh

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Original Article

Abstract

The length and weight of *Thunnus albacares* (Bonnaterre, 1788) off north Andhra Pradesh during 2012 - 2015 were studied and the length-weight relationship was found out. A total of 3,617 specimens were analysed and the reported length range was18 cm to 186 cm fork length. In the fishery, peak landings of size classes 41-50 cm and 111-120 cm were observed. Annual mean lengths ranged from 62.7 cm to 92.7 cm. The highest mean length of 92.7 cm was recorded in 2014 and the lowest mean length of 62.7 cm was recorded in 2015. Length-weight relationship was not found to differ significantly between sexes and the pooled relation was log W = log 0.016 + 2.996 log L. The growth pattern observed was isometric.

Keywords: Length, north Andhra Pradesh, Thunnus albacares, weight

Introduction

Tunas are landed in substantial amounts at Visakhapatnam, making it one of the major tuna landing centres in the country. *Thunnus albacares* (yellowfin tuna) contributes the most to the tuna landings. It is exclusively landed by catamarans and converted long liners and a very minor quantity is landed by trawl nets and bottom-set gillnets operated at depths nearing 150 m. *Thunnus albacares* is mostly exploited in the oceanic waters beyond the depths of 200 m off Visakhapatnam using hooks and lines and trolls operated mostly from non mechanized traditional craft (catamaran). Nearly 1200 such crafts operate from Visakhapatnam for hunting yellowfin tuna with their fishing operations extending to deeper waters of 200-300 meters depth towards the northern Andhra Pradesh and to beyond Kakinada, Andhra Pradesh.

Length-weight relationship studies are very much helpful to study the growth of fish stocks, population dynamics and will be of great help in determining one variable when the other variable is known for any particular species. It may also offer indications on taxonomic differences and the developmental physiological events occurred in the life history, such as metamorphosis and onset of maturity (Thomas *et al.*, 2003). In addition, it can

help in distinguishing populations, if any, spatially (Beverton and Holt, 1957). The weight of a normal fish has a curvilinear relationship with body length.

Though there are quite a few studies on the length and weight relation for *Thunnus albacares* from various sections of the Indian EEZ (Madan Mohan *et al.*, 1985; John and Reddy, 1989; Sudarsan *et al.*, 1991; John and Sudarsan, 1993; Pillai *et al.*, 1993; John, 1995; Pandian *et al.*, 2007; Abdussamad *et al.*, 2008; Sivadas, 2009), most of them are at least a decade back. Moreover, northern Andhra Pradesh leads the country in the annual landings for *Thunnus albacares*, however studies on length and weight relation from this region are scarce and are limited to only a couple of studies (Rohit *et al.*, 2009; 2012). The present study, therefore aims at testing the relationship between length and weight of *Thunnus albacares* off north Andhra Pradesh.

Material and methods

A total of 3,617 specimens of *Thunnus albacares* were collected randomly from weekly observation made at Lawsons Bay, Visakhapatnam Outer Harbour and Pudimadaka Beach, the important traditional yellowfin tuna landing centres at Visakhapatnam and from Kakinada Fishing Harbor, Dummulapeta and Bhairavapalem, the important fish landing centres at Kakinada during 2012 - 2015. Samples were collected randomly and were measured for the fork length of each fish in centimeters (cm). Length of specimens ranged from 18.0 cm to 186.0 cm. The total wet body weight of the fish was taken by means of an electronic balance and was recorded in grams (grams to 0.01 g precision). Length-weight relationship was calculated as $W = aL^b$ (Le Cren, 1951) from 1414 specimens, separately for both sexes and indeterminates. Length and weight ranges for samples used for estimating the relationship varied from 23 cm to 171 cm and from 157 g to 80.4 kg. Significant differences in the slopes of the regression lines for males, females and indeterminates were ascertained by Analysis of Covariance ANACOVA (Snedecor and Cochran, 1967). The parameters *a* and *b* were estimated by the least-square method from logarithmically transformed data, and the association degree between weight-length variables was calculated by the determination coefficient (r^2). The statistical significance level of r^2 and 95% confidence limits of the parameters *a* and *b* were estimated. Students - t test was performed to check the nature of the growth, to observe on whether, the value of the exponent (b) differed significantly from the isometric value of 3 or not.

Results

Length Frequency distribution

The length frequency distribution of different size ranges of *Thunnus albacares* for the year 2012 of the study period is shown

in Fig. 1. Specimens from 31-40 cm and 71-80 cm length range dominated the fishery and the highest length range observed was 161-170 cm. Juveniles were exploited during the months of July, August and December. In 2013, fishery commenced from 41-50 cm size ranges with minor changes in juvenile catch composition (Fig. 2). Throughout the year, all size classes were reflected more or less in equal numbers with peak landings of size classes 41-50 cm and 111-120 cm. Compared to 2012 and 2013, there was a decline in juvenile catches in 2014 and adults decreased in 2015 (Figs. 3 and 4). During 2014 and 2015, more catches were observed from length classes above 51-60 cm. In all the years, all length ranges were exploited with a single peak in the length frequency observed at a size range of 41-50 cm, which dominated the fishery. Overall exploitation of all length groups was observed throughout the study period (Fig. 5).
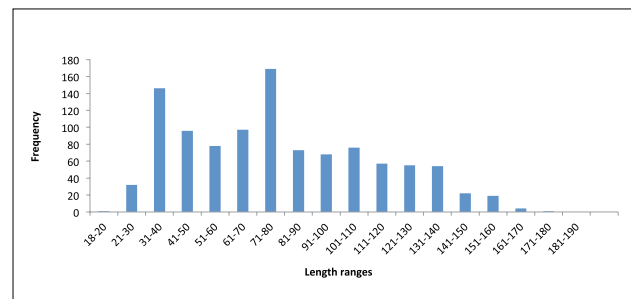

Fig.1. Length frequency of yellowfin tuna landed off northern Andhra Pradesh during 2012
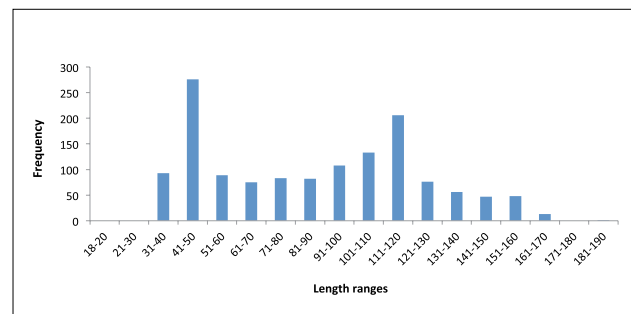

Fig. 2. Length frequency of yellowfin tuna landed off northern Andhra Pradesh during 2013
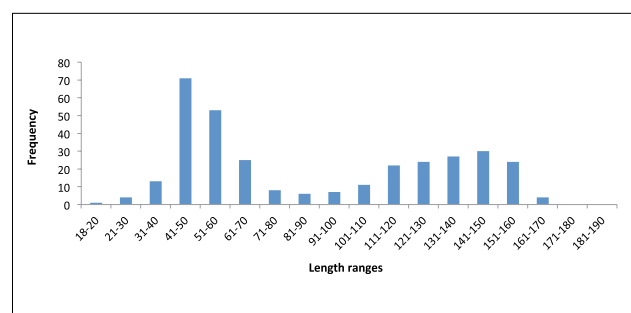

Fig. 3. Length frequency of yellowfin tuna landed off northern Andhra Pradesh during 2014
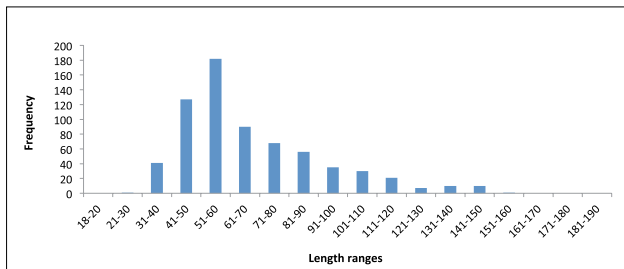
Fig. 4. Length frequency of yellowfin tuna landed off northern Andhra Pradesh during 2015
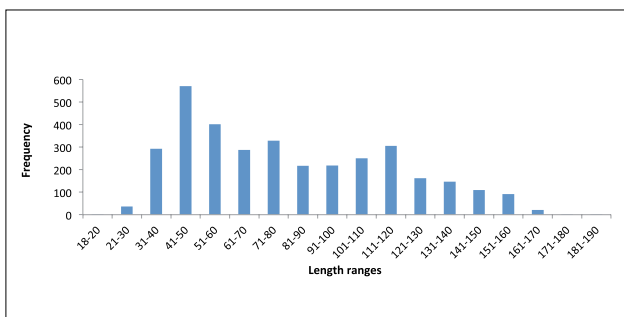

Fig. 5. Pooled length frequency of yellowfin tuna landed off northern Andhra Pradesh during 2012-2015

Mean Length

The annual mean lengths (cm) ranged from 62.7 cm to 92.7 cm. A gradual increase in mean lengths was observed from 2012 to 2014 with the highest mean length of 92.7 cm recorded in 2014 and the lowest mean length of 62.7 cm recorded in

2015. Highest mean lengths were recorded during October-April. Detailed annual and monthly mean lengths are depicted in Table 1.

Length-Weight Relationships

The following equations for males and females separately were obtained.

Male: $\log W = \log 0.017 + 2.980 \log L$ ($r^2 = 0.97$) (95% C. I.) (n = 730) (Fig. 6)
Female: $\log W = \log 0.015 + 3.005 \log L$ ($r^2 = 0.98$) (95% C. I.) (n = 502) (Fig. 7)
Pooled: $\log W = \log 0.016 + 2.996 \log L$ ($r^2 = 0.97$) (95% C. I.) (n = 1414) (Fig. 8)
Indeterminate: $\log W = \log 0.016 + 3.000 \log L$ ($r^2 = 0.95$) (95% C. I.) (n = 182) (Fig. 9)

Analysis of covariance (ANACOVA) was performed to test the significant difference in the length-weight relationship between the sexes and the relationship was found to be not significant.

The length-weight relationship for males, females and indeterminates were found to be not significantly different at 5% level. Slopes of the regression relation for males (t_{cal} =1.01; $t_{crit\,0.05}$ = 1.96), females (t_{cal} =0.29; $t_{crit\,0.05}$ = 1.96) and indeterminates (t_{cal} =0.02; $t_{crit\,0.05}$ = 1.96) were not significantly different from the statistical value of 3 indicating isometric growth. Therefore, a pooled equation for the population was arrived at which was: $\log W = \log 0.016 + 2.996 \log L$ ($r^2 = 0.97$) (95% C. I.).

Table 1. Annual and Monthly Mean Lengths during 2012-2015

	Mean Length (cm)					
Months	2012	2013	2014	2015	Mean	SE
January	116.8	95.9	140.0	56.2	102.2	17.8
February	89.7	88.1	55.5	61.9	73.8	8.8
March	93.5	113.8	114.8	37.4	89.9	18.2
April	118.2	96.4	87.7	86.8	97.3	7.3
May	74.4	88.9	83.2	67.4	78.5	4.7
June	88.9	91.0	63.4	46.0	72.3	10.8
July	55.5	65.3	55.2	64.6	60.1	2.8
August	59.6	63.6	62.6	73.3	64.8	3.0
September	78.4	47.1	119.9	53.9	74.8	16.5
October	69.6	96.4	113.0	87.2	91.6	9.1
November	72.0	108.7	78.6	59.6	79.7	10.4
December	43.5	142.9	138.8	70.1	98.8	24.9
Annual	80.0	91.5	92.7	63.7	82.0	6.7
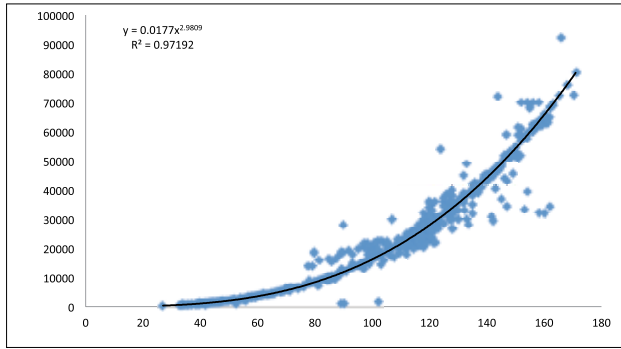
Fig. 6. Length-Weight relationship for males of *Thunnus albacares*
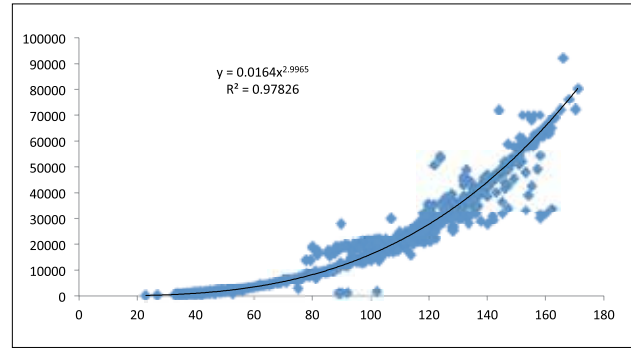
Fig. 8. Pooled Length-Weight relationship of *Thunnus albacares*
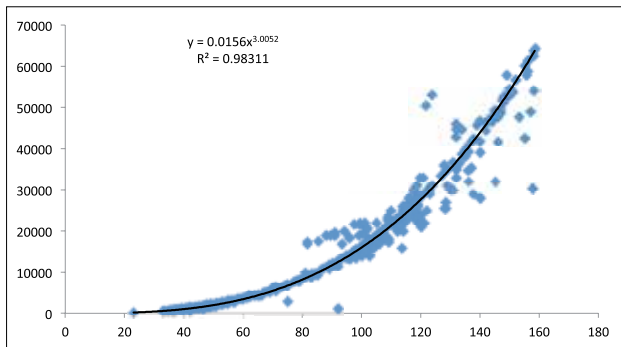
Fig. 7. Length-Weight relationship for females of *Thunnus albacares*
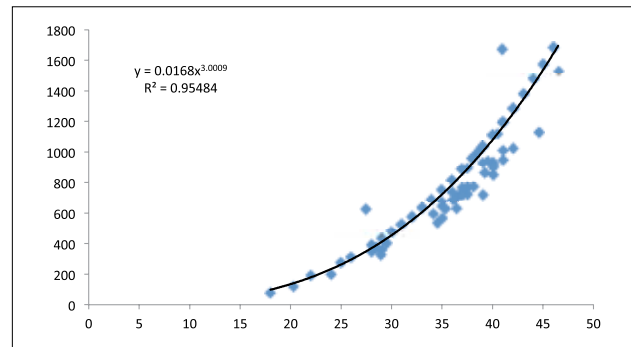
Fig. 9. Length-Weight relationship for indeterminates of *Thunnus albacares*

Discussion

The length range of 18-186 cm observed during the present study is almost similar and a little wider to that reported earlier from different sectors of Indian EEZ and other oceans. Madan Mohan *et al.* (1985) and Sivadas (2009) had reported length ranges from commercial vessels for male and female separately from different sectors of Indian EEZ which were comparatively lesser than the values obtained in the present study. Pillai *et al.* (1993) reported a length range of 32-128 cm in the Lakshadweep waters and John and Sudarshan (1993) recorded a length range of 60-180 cm in the oceanic waters of the Indian seas. In the oceanic sector of EEZ of India, based on the longline catches of survey vessels of FSI, various authors (John and Reddy, 1989; Sudarshan *et al.,* 1991; John, 1995) reported length ranges of 48-181 cm fork length which is narrower than that of the present study. Rohit *et al.* (2009, 2012) collected specimens of 30-190 cm and 20-185 cm fork lengths from the same region as of the present study, and reported a mean length of 106 cm and 101.9 cm, in tune with the present findings. Smaller length classes of *Thunnus albacares* in the Indian waters were landed by trawls and gillnets only. Large sized individuals were contributed by longlines and hooks and lines which were reported as 190 cm (103 kg), 156 cm (64 kg) and 125.9 cm (36 kg) by Rohit *et al.* (2009), Kar *et al.* (2012) and Abdel-barr *et al.* (2012) respectively. Similar observations were also reported

in the present study, where smaller individuals were caught in trawlnets and gillnets and larger ones in hooks and lines.

The length weight relationship indicated isometric growth and the value of 'b' was close to 3, similar to the values obtained by earlier workers. Length-weight relationships were almost similar between males, females and indeterminates and therefore a common relation was arrived at by pooling the relation for males, females and indeterminates (p value <0.05). Similar exponent values varying from 2.74 to 3.24 were reported by several authors from different sectors. Madan Mohan *et al.* (1985) recorded the exponent value to be as 2.961 for males and 3.010 for females from Minicoy waters. Sivadas (2009) reported length weight relationship of *Thunnus albacares* from Minicoy waters and observed the 'b' value as 2.939 indicating isometric growth for the species. From the long line catches of different sectors of Indian EEZ, John and Reddy, 1989; Sudarshan *et al.,* 1991; John and Sudarshan, 1993; John, 1995 and Pandian *et al.,* 2007 recorded the 'b' value as 2.805, 2.849, 2.831, 2.756 and 2.908, respectively. Rohit *et al.* (2009) estimated 'b' values of 3.12 from the Visakhapatnam coast of Andhra Pradesh and 2.976 for the eastern Indian coast in 2012. Length-weight relationship is influenced by changes in ecosystem and in biological phenomena like maturity stages, feeding behaviour and competition for food. The peak landings of size classes 41-50 cm and 111-120 cm in the present study are however,

different from earlier studies. Highest mean length recorded earlier from the same area was during November-January (Rohit *et al.,* 2009), which differed from October- April which was observed during the present study.

Acknowledgements

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