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# Fishery, biology and population characteristics of longtail tuna, *Thunnus tonggol* (Bleeker, 1851) caught along the Indian coast

E. M. ABDUSSAMAD, K. P. SAID KOYA, SHUBHADEEP GHOSH, PRATHIBHA ROHIT, K. K. JOSHI, B. MANOJKUMAR*, D. PRAKASAN, S. KEMPARAJU, M. N. K. ELAYATH, H. K. DHOKIA, MANJU SEBASTINE AND K. K. BINEESH
*Central Marine Fisheries Research Institute, Kochi - 682 018, Kerala, India*
**Kerala University of Fisheries and Ocean Sciences, Panangad, Kochi - 682 506, Kerala, India*
*e-mail: emasamad@rediffmail.com*

## ABSTRACT

Fishery, biology and population characteristics of the longtail tuna, *Thunnus tonggol* were studied during 2006-10. There is no targeted exploitation of the species along the Indian coast. *T. tonggol* was mainly landed as by-catch in gillnets (63.2 %), hooks and lines (20.3%), ringseines/purseseines (14.9%) and trawls (1.6%). Annual landings during the period varied between 6,073 and 9,140 t with an average of 7,332 t. About 81.5% of the total catch was realized from north-west coast alone. Fishery was supported by fishes of 23 - 111 cm length range with a mean length of 60.5 cm in gillnets. Size at capture was estimated as 51.3 cm and the optimum length for exploitation ($L_{opt}$) was 55.3 cm fork length (FL). The length-weight relationship ($W = 0.0147 L^{3.01}$) indicated isometric growth pattern for the species. The species is non-selective in feeding and feed on pelagic finfishes, crabs and cephalopods. Their size at maturity ($L_m$) is 51.1 cm and spawns round the year with major peak during October-November. Relative fecundity was 1,32,840 kg body weight$^{-1}$. Recruitment was almost round the year with peaks during May-June and August-September accounting 53.2% of the total recruitment. Mean size in the catch was larger than optimum size for exploitation; whereas size at capture is much lower, which necessitates caution to increase size at first capture. It can be achieved by increasing the minimum mesh size to 15 cm or more from the present 10/12 cm. Growth parameters of the species were: $L_\infty = 123.5$ cm ($F_L$), $K = 0.51$ year$^{-1}$ and $t_o = -0.0319$ years. Natural mortality (M) was 0.77 y$^{-1}$, total mortality (Z) 3.72 y$^{-1}$ and fishing mortality (F) 2.94 y$^{-1}$. Spawning stock biomass formed 65.4% of the standing stock. Study indicates scope for improving production of the species.

Keywords: Exploitation, Growth, Long tail tuna, MSY, Oceanic tuna, Sexual maturity, *Thunnus tonggol*

## Introduction

The longtail tuna, *Thunnus tonggol*, Bleeker, 1851 is an economically important species from commercial and recreational point of view. The species inhabit shelf and oceanic waters of tropical and temperate regions of the Indo-Pacific between 47° N and 33° S (Froese and Pauly, 2009) and generally occupy neritic areas of the oceans close to land masses (Yesaki, 1994). This species is the second smallest among the eight species of the genus *Thunnus* and reported to grow to 142 cm in total length and 35.9 kg in weight (IGFA, 2008). Being coastal in distribution, they support important artisanal and subsistence fisheries in several countries across the globe. The species is being exploited by commercial and artisanal fisheries in several countries throughout the Indo-Pacific (Yesaki, 1994; Griffiths *et al.*, 2009). Global catch increased substantially to around 100,000 t in 1985, which reached 248,000 t in 2007 (FAO, 2009). Estimated catch of longtail tuna from Indian Ocean increased steadily from mid 1950's, reaching around 20,000 t in the mid 1970's and over 50,000 t by the mid 1980's and peaked at 1,41,000 t in 2010. The average annual catch estimated for the period 2006-10 was 1,16,000 t. Along the Indian Ocean region, the highest contribution to longtail tuna catch is by Iran (34%) and Indonesia (31%) followed by Taiwan, Thailand, Oman, Pakistan, Malaysia, India and Australia. In Australia, they are considered as an important sport-fish, owing to their relatively large size and fighting ability (Griffiths *et al.,* 2007). As a reflection of their importance to recreational fisheries, longtail tuna was declared a "recreational only" species by the Government of Australia in 2006. Along the Indian coast, they were captured mainly from the outer shelf areas of the north-western coasts by artisanal and commercial fisheries. Their contribution to the tuna landings of the country was relatively low to the tune of only 6.5% .

Despite their regular occurrence in the fishery, except selectd reports on the fishery and size composition in the catch (Muthiah, 1985; Silas *et al.*, 1985a; Siraimeetan, 1985;

Pillai *et al*., 2005) and growth studies (Silas *et al*., 1985b), only limited studies have investigated their detailed biology and stock characteristics from Indian waters. Several reports are available on different aspects of population characteristics from Iran, Thailand, Malaysia, Oman and Australia, where the species is exploited in appreciable quantity (Supongpan and Saikliang, 1987; Prabhakar and Dudley, 1989; Yesaki, 1989; Khorshidian and Carrara, 1993; Hedayatifard, 2007; Griffiths *et al*., 2009).

In the light of growing commercial and recreational importance of the species, increasing exploitation at national and international level and lack of required scientific data for evaluating the stock and fishery, a comprehensive study was undertaken to generate data on fishery and biology of the species, aimed at assessment and management of the stock.

## Materials and methods

Fishery of longtail tuna was monitored along the five geographical marine fishing zones of the Indian mainland, north-west (NW), south-west (SW), south-east (SE), north-east (NE) and the Island territories during 2008-10. Data on effort, catch, length frequency distribution and biology of the species in the landings were collected. The national fishery data collected by the Central Marine Fisheries Research Institute (CMFRI) from the mainland coast and that collected by respective fisheries departments of Island territories were used as the baseline data for the study. Detailed information on various aspects of fishing was collected from fishers.

Unsorted samples representing all size groups were collected weekly from commercial landings for biological and length frequency studies. Measurements of length and weight of the species were made at the landing centres as well as in the laboratory. With respect to body length, the fork length (FL) is used in this paper unless otherwise stated. Length-weight relationship was estimated as per Le Cren (1951). Feeding behaviour was studied by gut content analysis as in Pinkas *et al.* (1971). Fishes were sexed by visual examination and chi-square test was employed to determine whether sex ratio was significantly different from the expected ratio of 1:1. The length at first maturity ($L_m$) was determined using logistic curve by considering fishes with ovaries at stages IV and V as mature. Fecundity was estimated using gonads at the advanced IV and V stages of maturity.

Population parameters were estimated from the length frequency data using the ELEFAN I module of FiSAT software and the Powell – Wetherall plot (Gayanilo *et al.*, 1997) and probability of capture and size at capture by logistic curve (Pauly, 1984). Modal progression analysis and VBGF model was used to evaluate age and growth. Empirical relationship proposed by Froese and Binohlan (2000) was used to estimate optimum size and age for exploitation of the species. The natural mortality (M) was estimated from the empirical formula suggested by Pauly (1980) by taking mean seawater temperature as 28 $^{o}$C. Catch curve analysis (Pauly, 1983; 1984) was used to estimate the instantaneous total mortality rate (Z). Yield-per-recruit (Y/R) and relative biomass-per-recruit (SSBR) were assessed using the Beverton and Holt (1957) model and standing and spawning stock biomass by length cohort analysis (Jones, 1990).

## Results and discussion

*Distribution*

The fishery data indicate that the longtail tuna is basically confined to the neritic regime**.** They are distributed all along the Indian coast including Andaman and Nicobar waters, with abundance along the west coast of the mainland. Trend in the fishery suggested large concentration of the species along the west coast accounting nearly 93% of the stock. The abundance increases towards northern sector (higher latitudes) with 83% of the stock along north-west coast. Recent observations indicated the presence of large concentration of small and medium sized longtail tunas on seamounts off the west coast, which offer relatively shallow areas and probably form their nursery/ feeding grounds.

*Fishery*

Longtail tuna formed a non-targeted incidental catch in many fisheries. They are generally caught along with seerfishes and coastal tunas from the neritic region and skipjack and small yellowfin tunas from sea mounts. They are being exploited mainly by gillnets (80.9 %), followed by hooks and lines (9.5%), trawls (6.0%), purseseines and ringseines (0.1%) (Fig. 1)and are landed almost round the year with peak, (accounting nearly 76% of the annual catch) during September-December period.

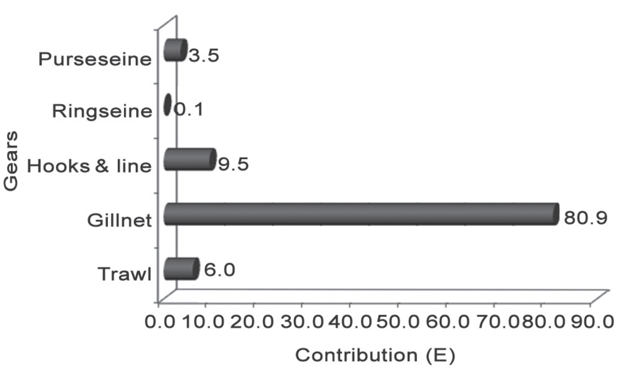


Fig. 1. Gear-wise landings of longtail tuna along the Indian coast during 2006-10

Longtail tuna formed the fifth dominant component of the coastal tuna fishery of India during 2006-10, constituting 6.5% of the total tuna landings. Annual production during the period ranged between 6,073 t (2009) and 9,140 t (2008) with an average annual catch of 7,332 t (Fig. 2). Landing was nominal during eighties and thereafter it improved over the years with considerable annual fluctuations. Growth in the fishery coincided with the introduction and expansion of gillnet fishery along the north-west coast targeting polynemids, seerfish and sciaeneids.

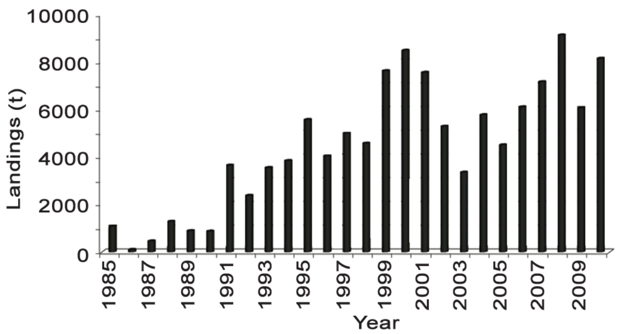


Fig. 2. Trend in longtail tuna landings along the Indian coast during 1985-2010

Fishery was mainly confined to Gujarat (74 .0%) and Andaman and Nicobar waters (6.2%) (Fig. 3). About 93% of the catch was realised from west coast and the production from east coast was insignificant (0.5%). Other major contributors to the fishery are Kerala and Maharashtra.

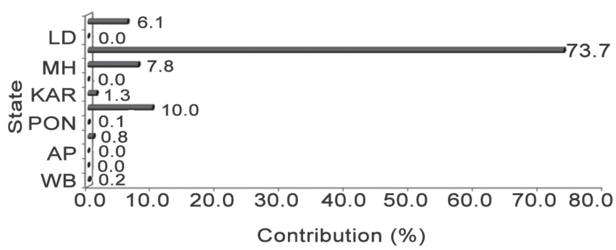


Fig. 3. State-wise contribution of longtail tuna to the total tuna species catch (2006-2010)

*Biology*

*Length distribution in the catch*

The catch of *T. tonggol* was supported by fishes of length range 23-111 cm with a mean length of 60.5 cm at national level (Fig. 4). Major share, accounting 72.8% of the catch in number, was represented by 51-73 cm length groups. Size of the fishes caught from the south-west coast was relatively small (23-97 cm) with a mean length of 50 cm compared to those caught from north-west coast (Fig. 5a). The size range tends to increase towards the northern sector and was supported by 23-111 cm fishes with 61.9 cm as mean along the north-west coast (Fig. 5b). Fishery was sustained mainly by 41-59 cm and 51-73 cm length range along the south-west and north-west coasts, respectively representing 84.2% and 75.6% of the catch in numbers. In the Gulf of Oman, fishery was supported by still larger fishes of 26-128 cm size with 74 cm as mean size and major contribution by 68-96 cm (Kaymaram *et al.*, 2011). It is clear from the length composition data that there is an obvious increase in size towards northern latitude. This can be attributed to the entry of young ones in the southern coast for feeding and their gradual movement northwards with growth. Information on the movements of longtail tuna in their distribution range is very scanty. In Australian waters, several studies have shown increase in their size with increasing latitude (southwards) along both east and west coasts (Serventy, 1942; 1956; Wilson, 1981a; Stevens and Davenport, 1991; Griffiths *et al.,* 2010). This and other information gathered supported the assumption that they undertake migration towards higher latitudes with growth and indicate that they probably form a common resource being shared by India, Pakistan, Iran and Oman.

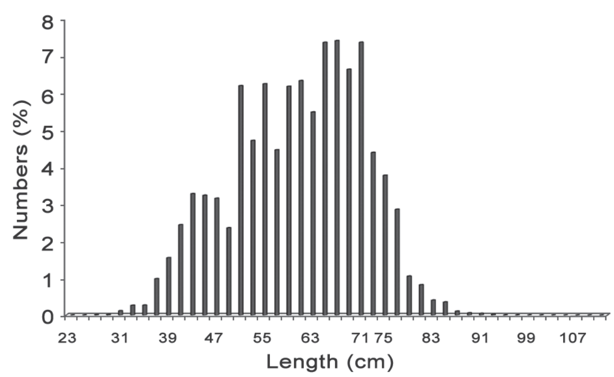


Fig. 4. Length frequency distribution of longtail tuna exploited along the Indian coast during 2006-'10

*Length-weight relationship*

Length-weight relationship for the unsexed population was estimated and expressed using the relationship, W = 0.0148 x $L^{3.0}$; W in g and length in cm (Fig. 6). The result indicated that the species follow a perfect isometric pattern in growth as evidenced from the value of b (3.0). The estimates from other areas (Table 1) also indicate isometric pattern of growth in the species. The numerical difference in the values of coefficient can be attributed to variation in the data set used for estimation.

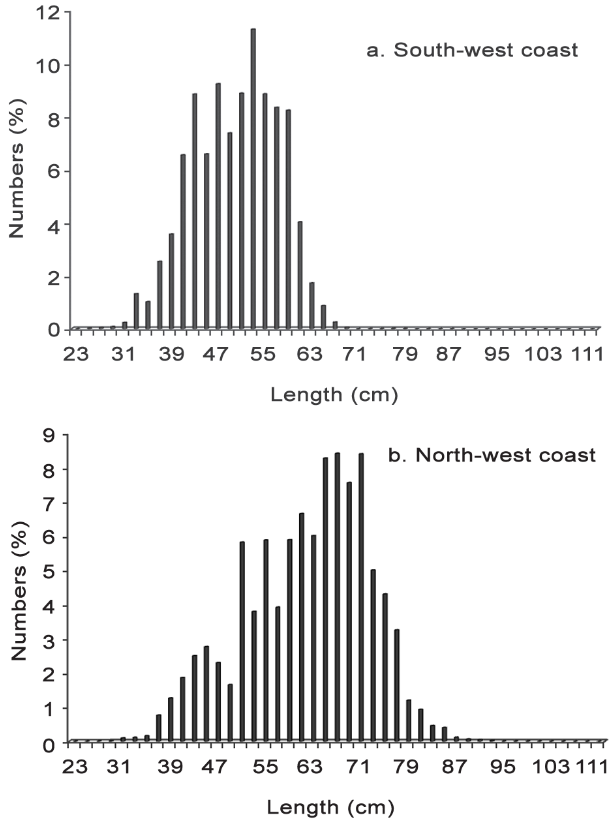


Fig. 5. Length frequency distribution of longtail tuna exploited along the (a) south-west and (b) north-west coasts of India during 2006-'10

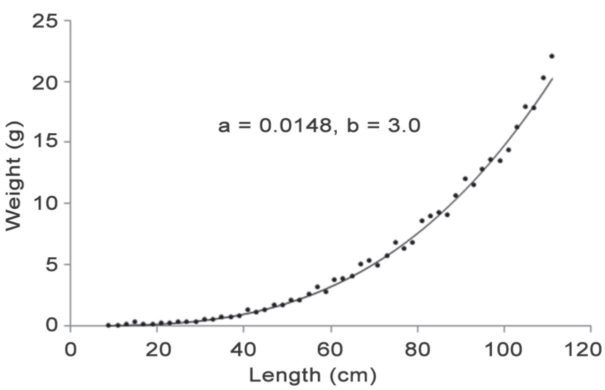


Fig. 6. Length-weight plot of longtail tuna exploited along the Indian EEZ

*Age, growth and longevity*

The growth parameters; asymptotic length ($L_\infty$), growth constant (K) and age at zero length ($t_o$) were estimated respectively as 123.5 cm, 0.51 year$^{-1}$ and -0.0319 years by modal length progression of cohorts over time. Growth was described by the von Bertalanffy model and it shows that the species grow relatively fast in length (Fig. 7). They attain 29.4, 50.6, 79.7, 97.2, and 107.7 cm by the end of 0.5, 1, 2, 3 and 4 years. However, growth in weight is slow compared to other species of the genera. Their longevity ($t_{max}$) in Indian waters was estimated as 4.5 years.

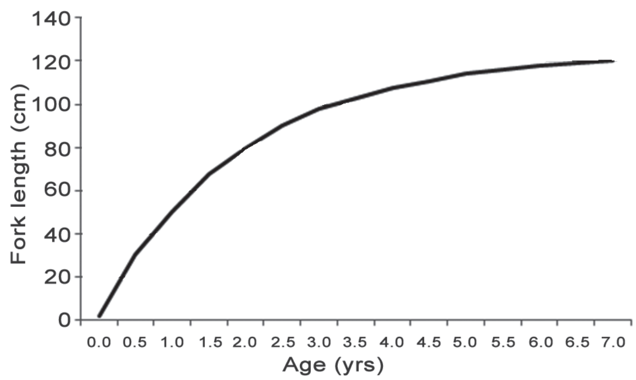


Fig. 7. Growth curve of longtail tuna

The age length data shows that minimum age of the fish in the catch is 4.5 months and maximum 4.5 years. Major share of the catch was supported by 12 to 20 month old fish (51-73 cm) with 1.3 year as mean age at national level and along the north-west coast. Along the south-west coast, relatively small fishes 9 to 15 month old with a mean age of one year supported the fishery.

Number of growth studies has been undertaken in countries where commercial longtail tuna fisheries are significant (Table 2). Modal length progression of cohorts over time and length-frequency analysis has been the primary method used to estimate growth. Few studies based on the hard part (otolith) were also undertaken by some workers. However, these studies provided conflicting results; with most suggesting the species as fast growing and short-lived (Wilson, 1981a; 1981b; Silas *et al.*, 1985b;

Table 1. Estimates of length-weight relationship of longtail tuna from different areas

| Authors | Area | Base length | a | b |
|---|---|---|---|---|
| James *et al.* (1993) | India | TL | 0.00008 | 2.71 |
| Khorshidian and Carrara (1993) | Iran | FL | 0.00150 | 2.43 |
| Darvishi *et al.* (2003) | Iran | FL | 0.00004 | 2.70 |
| Kaymaram *et al.* (2011) | Iran | FL | 0.00002 | 2.83 |
| Griffiths *et al.* (2011) | Australia | FL | 0.00005 | 2.82 |
| Present study | India | FL | 0.01480 | 3.00 |

Table 2. Summary of von Bertalanffy growth parameters, longevity and length-at-age (in cm) for longtail tuna

| Author | Area | Growth parameters | | |
|---|---|---|---|---|
| | | K | $L_\infty$ (cm) | $t_o$ |
| Wilson (1981a) | Papua New Guinea | 0.41 | 122.9 | -0.032 |
| Wilson (1981b) | Papua | 0.395 | 131.8 | -.035 |
| Silas *et al*. (1985b) | India | 0.49 | 93.0 | -.240 |
| Supongpan and Saikliang (1987) | Thailand | 1.44 | 58.2 | -.027 |
| Prabhakar and Dudley (1989) | Oman | 0.228 | 133.6 | - |
| Yesaki (1989) | Thailand | 0.55 | 108.0 | - |
| Itoh *et al*. (1999) | Japan | 1.70 | 55.0 | -0.089 |
| Griffiths *et al*. (2010) | Australia | 0.233 | 135.4 | -0.02 |
| Kaymaram *et al*. (2011) | Iran | 0.35 | 133.8 | |
| Present study | India | 0.51 | 123.5 | 0.0319 |

Yesaki, 1989; Kaymaram *et al*., 2011) as found in the present study and others as slow-growing and long lived (Prabhakar and Dudley, 1989; Griffiths *et al*., 2010). Estimated length-at-age also appears to vary distinctly between different studies and among regions (Table 3). Griffiths *et al*. (2010), through otolith analysis, suggested that the species may live more than 18 years, which contradicts strongly with previous works on the same and closely related species. Variation in the size composition data used for analysis would have affected the estimates of $L_\infty$ and growth constant ($K$). There is considerable uncertainty on the time interval between formation of two consecutive growth rings and also being a free moving species; which prefers to stay in an ideal environment, chance for forming annual rings are relatively poor. Therefore, interpretations based on such study need to be taken with utmost caution. Since the present estimates were made from a more reliable length frequency data representing all size groups in the fishery, the present estimate can be considered as more accurate. Moreover, the present estimate followed a median value .

*Food and feeding*

Examination of guts indicated that the species is non-selective in feeding habit and feeds on teleost fishes (82%), crustaceans (4.6%) and molluscs (13.4%). Sardines (*Sardinella* sp.), anchovies (*Thryssa* sp.), scads (*Decapterus* sp. and *Selar* sp.), ribbonfishes (*Trichiurus* sp.), flying fish, hemiramphids, small tuna (*Auxis rochei*), threadfin breams and small perches (*Lethrinus* sp.) dominate the fish components of their gut. Crustaceans represented in the food are penaeid prawns, *Acetes* sp., pelagic crabs and stomatopods. Squid, octopus and gastropods represented the molluscan component. Considerable variation was observed in the gut content over space and time indicating a highly opportunistic feeding habit, feeding on the available prey. Only limited studies have quantitatively investigated the feeding ecology of the species. Griffiths *et al*. (2007) reported the species as an opportunistic predator feeding on small pelagic fishes, cephalopods and crustaceans and also indicated variation in diversity and composition of the diet over space and time and with size of the fish.

Table 3. Summary of estimates of growth in length at age of longtail tuna

| Author | Area | Length-at-age | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Serventy (1956) | Australia | 38 | 51 | 62 | - | - |
| Chiampreecha (1978) | Thailand | 27 | 35 | 45 | - | - |
| Klinmuang (1978) | Thailand | 31 | 49 | - | - | - |
| Wilson (1981a) | Papua | 42 | 69 | 87 | 99 | 107 |
| Yesaki (1982) | Thailand | 30 | 47 | - | - | - |
| Silas *et al*. (1985b) | India | 42 | 62 | 74 | 81 | 86 |
| Supongpan and Saikliang (1987) | Thailand | 45 | 55 | 57 | 58 | - |
| Prabhakar and Dudley (1989) | Oman | 30 | 51 | 68 | - | - |
| Yesaki (1989) | Thailand | 46 | 72 | 87 | 96 | 101 |
| Wilson (1981b) | Papua | 44 | 73 | 92 | 105 | 114 |
| Griffith *et al.* (2010) | Australia | 27 | 66 | 91 | | |
| Present study | India | 51 | 80 | 97 | 108 | 113 |

*Sexual maturity and spawning*

Males and females are represented almost equally in the population and exhibit no sexual dimorphism in growth and maturity. Gonads in all stages of the development were observed throughout the year (Fig. 8). As evidenced by the presence of fishes with mature and spent gonads in the catch, they mature and spawn round the year with two peaks in spawning; during August-December and April-May. Few studies have investigated their timing of spawning in other areas (Yesaki, 1982; Cheunpan, 1984; Hedayatifard, 2007). The common trend in these studies is that spawning occurs over a period of several months during the warmest period of the year in a particular region *i. e.,* at the beginning and end of the monsoonal period. In the present study, fishes with gravid gonads were observed only less frequently in the catch, indicating probable migration of fishes to spawning grounds after attaining full gonadal development. These indicate certain degree of segregation of spawning population from rest of the stock. Based on the presence of large number of fishes with mature and spent gonads in the landings along south-west coast, it can be assumed that they apparently spawn along their southern distribution range along the Indian coast. Based on their observations, Yesaki (1982) and Itoh *et al*. (1999) proposed outer neritic zone as the possible spawning ground of the species.

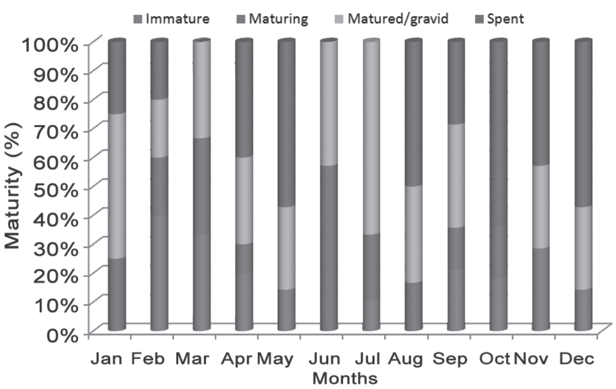


Fig. 8. Seasonal pattern of maturity (male-female pooled) in longtail tuna along the Indian coast during 2008-2009

Full sexual maturity and spawning was observed from 48 cm length onwards. Estimate of their size at maturity by logistic curve is 51.1cm (Fig. 9). Age of the fish at this size was 12.2 months. Two to three distinct batches of eggs were observed in the mature ovary indicating batch spawning in the species. Length at first maturity was determined by several workers from different areas. There seems to be large variation in their size and age at first maturity in different regions. They are reported to attain sexual maturity at 39.6 cm in the Persian Gulf and Oman Sea (Hedayatifard, 2007), 51 to 60 cm in Australia and Papua New Guinea (Serventy, 1956; Wilson, 1981a; Griffiths, 2010), 37 cm in Taiwan waters (Chiang *et al.,* 2011) and 40 to 43 cm in Thailand (Yesaki, 1982; Cheunpan, 1984). Estimates of age of the fish at maturity also varied between one and more than two years. This wide variation in size and age at maturity may be attributed to the prevailing water temperatures of the respective areas. However, for comparison such information is not available.

*Fecundity*

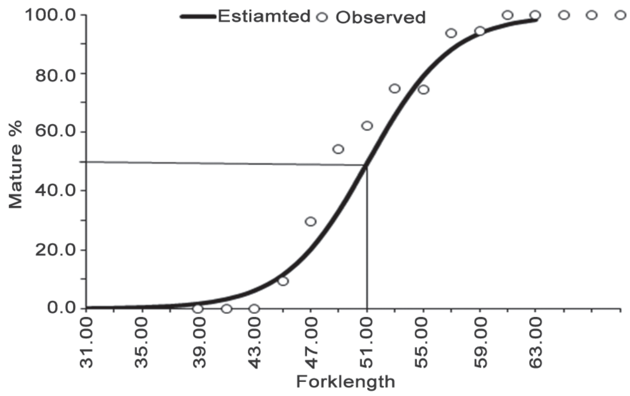


Fig. 9. Logistic curve for estimating size at maturity of longtail tuna (females) along the Indian coast

Fecundity estimate varied between 227,364 and 1092,891 eggs per fishes measuring 53.7 and 79.4 cm, respectively. The relative fecundity (number of eggs per kg body weight) found to increase with the size of the fish and it varied between 103,347 and 147,688 respectively in the smallest and largest fish studied with a mean of 132,840 eggs. This study shows that there is a positive relationship between fecundity and fork length. Only limited information is available on the fecundity of longtail tuna. Earlier estimates varied between 0.8 and 2.0 million oocytes for females ranging in size between 44 and 98 cm (Klinmuang, 1978; Wilson, 1981a; Hedayatifard, 2007). The present study and gathered information indicates that longtail tuna do have a protracted spawning period with high reproductive potential and can produce over one million eggs per spawning.

*Optimum size of exploitation and size at capture*

Based on the size at maturity, the optimum size ($L_{opt}$) and age for exploitation of longtail tuna is estimated as 55.3 cm and 1.13 years respectively. The estimate is quite reasonable, as this size enable nearly 80% of the recruit a chance to mature and spawn before being caught. The length at which 50% of the stock ($L_c$), became susceptible to gillnet fishery was estimated as 47.8 cm for south-west region and 51.9 cm for north-west region. Corresponding age of the species at these sizes are 0.93 and 1.03 years respectively. It was respectively 51.24 cm and 1.02 years for the Indian coast. The size at capture is small, compared to $L_{opt}$, and this condition allow only less than 50% of the recruit to mature and spawn before being caught and is not an ideal situation for an exploited stock. The ideal size at capture is $L_{opt}$ or beyond as it will improve the recruitment level, reduce the fishing mortality and theoretically increase the yield and spawning stock biomass. This can only be achieved by increasing the mesh size of the gillnet. However, the species being a by-catch in a multi-species fishery targeting other fishes, increase in mesh size may not be a viable option.

Introduction of a minimum legal length (MLL) is usually one of the few practical management options for regulating the size at first capture. In most cases where MLL has been successfully used as a management strategy to increase the sustainability of a stock, the MLL has been set at a length that corresponds to the length at which 50% of the population is sexually mature ($L_m$).

*Recruitment pattern*

Recruitment is bimodal with young ones being recruited into the fishery round the year with a major pulse in recruitment during May-June and minor pulse in August-September (Fig. 10). The major pulse produced 30.4% and the minor pulse 22.7% of the annual recruitment. The size of the species at recruitment is 28 cm during May-June and 23 cm during August-September. The growth rate of the species indicates that May–June recruit derived from the post-monsoon spawning and the August recruits from pre-monsoon months.

*Mortality and exploitation*

Natural mortality of the species was estimated by empirical equation as 0.77 $y^{-1}$. The natural mortality estimate is in line with that reported from Indian waters (0.8) by James *et al*. (1993), when, 28 °C was used as mean water temperature. These estimates are comparatively large compared to the estimates, 0.42 $y^{-1}$ and 0.49 $y^{-1}$ obtained from Oman waters when 25.5 °C was used as mean water temperatures (Prabhakar and Dudley, 1989; Khorshidian and Carrara, 1993). However, the total mortality estimate of 3.85 $y^{-1}$ (Table 4) seems to be in line with earlier estimates (3.84 and 3.13 $y^{-1}$) from other areas (Supongpan and Saikliang, 1987; Khorshidian and Carrara, 1993).

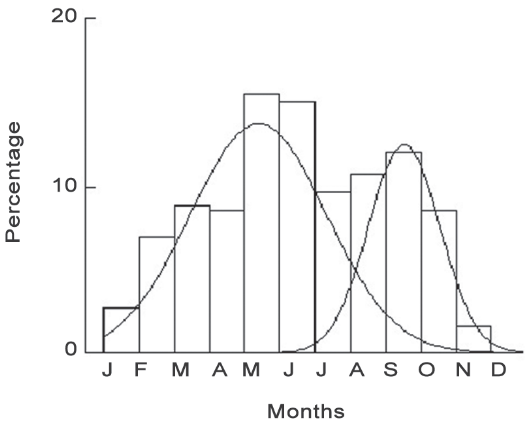


Fig. 10. Recruitment pattern of longtail tuna along the Indian coast

Fishing mortality ranged between 2.95 $y^{-1}$ (north-west coast) and 3.60 $y^{-1}$ (south-west coast) with a national mean of 3.08 (Table 4). Exploitation rate was relatively small (0.79 $y^{-1}$) for north-west region and large (0.82 $y^{-1}$) for south-west region with 0.79 $y^{-1}$ as national mean. Fishing mortality was more than three times of the natural mortality and can be attributed to the presence of large proportion of smaller fishes in the catch compared to the maximum size in the catch ($L_{max}$). Similar high values for fishing mortality and exploitation rates were reported for yellowfin tuna from Indian waters by Silas *et al.* (1985b), when length frequency data of yellowfin tuna caught by pole and lines, which comprised mainly of small length groups were used and hence it did not reflect the true fishery scenario. The exploitation rate, which will provide maximum yield ($E_{max}$) of the species, was estimated as 0.485.

*Yield per recruit and biomass*

Under the present fishing scenario, the relative yield per recruit (Y/R) increases steadily till the exploitation rate reach 0.63 and thereafter decline with increasing exploitation (Fig. 11). At this point, relative biomass per recruit declined to 32.5% of the pre-exploitation level and further lowered to 9.4% at the present level of exploitation. If the exploitation maintains at the $E_{max}$ level, the biomass per recruit will remain around 75% of the pre-exploitation level and give the highest yield and yield per recruit.

Table 4. Estimates of mortality, exploitation rates and size at capture in gillnets

| Region | F (Fish. Mortality) | M (Nat. mortality) | Z (Total mortality) | E (Expl. rate) | $L_{c50}$ |
|---|---|---|---|---|---|
| South-west | 3.603 | 0.774 | 4.377 | 0.823 | 47.8 |
| North-west | 2.946 | 0.774 | 3.720 | 0.792 | 51.7 |
| National average | 3.078 | 0.774 | 3.852 | 0.799 | 51.2 |

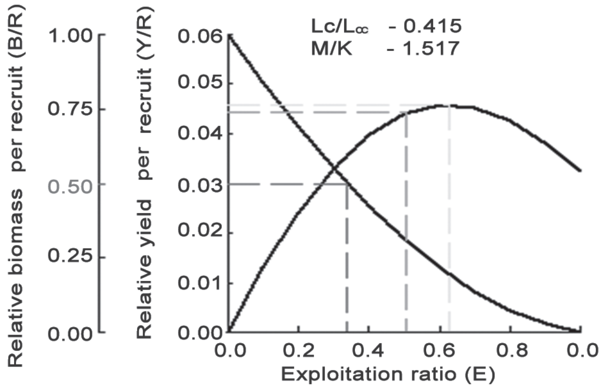


Fig. 11. Relative biomass per recruit and yield per recruit of longtail tuna stock exploited along the Indian coast

Estimates of standing and spawning stock biomass from the exploited grounds of south-west, north-west and national level shows the availability of large proportion of spawning stock biomass, to the order of 65.4% in the EEZ, which is sufficient to ensure successful reproduction and recruitment into population (Table 5). Availability of spawning stock biomass is very low (29.6% of the standing stock biomass) along the south-west coast, whereas it is 67% along the north-west coast.

Table 5. Estimates of standing and spawning stock biomass and recruitment of longtail tuna in the present fishing grounds

| Region | Spawning stock biomass (t) | Standing stock biomass (t) | Total yield (t) | Recruitment (Nos.) |
|---|---|---|---|---|
| North-west coast | 2593 | 3873 | 5793 | 34,29,687 |
| South-west coast | 72 | 243 | 619 | 523,222 |
| Indian EEZ | 3118 | 4765 | 7332 | 44,65,938 |

Despite a small size at first capture, presence of large spawning stock biomass indicates that stock remains stable and not overfished. Relatively early maturity and high fecundity also indicate that the present fishing level will not affect the recruitment.

Organised fishing for longtail tuna was not in vogue along the coast and is being exploited as by-catch for quite long time. Though the resource was available in good numbers along the sea mounts off west coast, presently they are not targeted as they are less lucrative for fishers. This provides a natural retrieve for the species along the region. However, only little is known on the biology of the species, the basic requirement necessary for evolving proper and timely management intervention on their fishery. Lack of such information on some tuna species has led to inadequate management and over-exploitation in many parts of the world (Fromentin and Powers, 2005; Dankel *et al*., 2008). The stock of southern bluefin tuna depleted due to overexploitation to the extent that the species is now listed in the IUCN Red List of Threatened Species as “critically endangered”. The present study provided considerable amount of information on such aspects and will aid in the proper understanding of the population and stock. However, reliable information on these aspects from other areas is also needed.

Despite large fishing mortality and exploitation rate, the study demonstrated that longtail tuna are currently being fished at biologically sustainable levels, with considerable scope for increasing their yield. Also there is considerable scope for developing recreational fishery, considering their predatory habit and fighting ability (Grffiths *et al.,* 2007) along the Andaman coast, where the species are available in nearshore waters. Along the mainland coast, they are not reported in such close vicinity and have scope for only commercial fishery. For sustaining the resource, exploitation of the species from sea mounts off the west coast where relatively smaller fishes predominate, should be maintained at the present level and at the same time measures may be adopted to minimise the capture of smaller fishes.

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