



Yellowfin tuna fishery by traditional fishermen at Visakhapatnam, Andhra Pradesh

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Abstract

Yellowfin tuna *Thunnus albacares* in the oceanic waters beyond the depths of 200 m off Visakhapatnam is exploited in recent years by the local fisherfolk. Hooks & line and trolls operated mostly from non-mechanized traditional craft (*catamaran*) are the main methods of exploitation. The average annual landing of yellowfin tuna by these crafts at Visakhapatnam was 1,515 t during 2004-2006. December followed by May recorded peak catches. A wide size group represented the fishery with the fork length measuring from 30 cm to 175 cm with a major mode at 135 cm. Fishes above 80 cm were found to be mature and the size at first maturity was estimated to be between 85 and 90 cm. Males were dominant with a male: female ratio of 1: 0.53. The length-weight relationship was $W = 0.017077L^{2.976}$. Food consisted of fishes (pelagic teleosts), crustaceans (crabs and shrimps) and molluscs (squids). The good returns from the fishery has encouraged the mechanized sector to venture into oceanic tuna fishing. The fishery is still in its infancy and more research has to be carried out to suggest proper management measures.

Keywords: Yellowfin tuna, fisherfolk, management measures, country craft

Introduction

Visakhapatnam, situated in northern coastal Andhra Pradesh, is an important marine fishing centre. The gears in operation along this coast are as diverse as the fishery, with the mechanized, motorized and non-mechanized gears gainfully exploiting the abundant finfish and shellfish resources of the region. The demersal resources had always been the mainstay of the fishery in the past. However, over the years, the contribution of the pelagic resources to the total catch has increased and presently it forms more than 56% of the total marine fish landings of Andhra Pradesh (CMFRI, 2007). While sardines, mackerel, engraulids and ribbonfish mainly constitute the smaller pelagics, the tunas, seerfishes and billfishes contribute to the catch of the large pelagics. Though the pelagic fishes are exploited by all the fishing subsectors, traditional fisherfolk from a few villages in Visakhapatnam District conduct targeted fishing for oceanic pelagics such as the tunas, seerfish,

billfish and dolphinfish. Several species of tunas contribute to the fishery of the region and the fishery is supported by coastal as well as oceanic species. The yellowfin tuna, *Thunnus albacares* forms the dominant species contributing 60-80% to the total tuna catch of the region. Though a number of publications on the fishery of tuna from Indian waters are available, most of them pertain to the smaller coastal tunas such as *Euthynnus affinis*, *Auxis* spp. and *Katsuwonus pelamis*.

Fishing for the yellowfin tuna by the traditional fisherfolk is in progress for the past seven years along the Andhra coast (Rohit, 2007; Rohit and Rammohan 2007). It has gained importance in the last four years and the catch is now contributing significantly to the marine fish landings as well as the export market. This is the first study on the yellowfin tuna (*Thunnus albacares*) landed by traditional craft.

Material and methods

The study covers a period of three years from 2004 to 2006. Weekly observations were made at Lawsons Bay, Visakhapatnam Outer Harbour and Pudimadaka Beach, the important traditional yellowfin tuna landing centres of Visakhapatnam. Details of craft, gears and species of tunas landed were collected from these centres. Yellowfin tuna landing estimates on the observation days were raised to the month and then to the year to estimate the annual tuna landings. Fork lengths were measured at the landing centre to estimate the annual size distribution. Wet weight, stomach condition and stage of gonad maturity were studied in 170 fishes. The data collected were analysed using standard methods for length-weight relationship, sex ratio, maturity condition, size at first maturity and feeding condition.

Results

Fishery: The fishermen targeting tunas operated in the coastal as well as oceanic waters. The coastal tunas comprising mainly of kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*) and skipjack tuna (*Katsuwonus pelamis*) were caught within a depth of 100 m. Spotted seerfish (*Scomberomorus guttatus*), dolphinfish (*Coryphaena hippurus*), flyingfish and carangids were also caught along with the coastal tunas. *Thunnus albacares* was the major oceanic tuna which was caught beyond 200 m depth. The other fishes caught along with this oceanic tuna included kingseer (*Scomberomorus commerson*), marlin (*Makaira indica*), sailfish (*Istiophorus platypterus*), wahoo (*Acanthocybium solandri*) and dolphinfish (*Coryphaena hippurus*).

Craft and gear used in the fishery: The craft used are either wooden catamarans (known locally as *teppalu*; overall length: 4-6 m) or fibre canoes (OAL: 6.5-7.5 m) which resemble the wooden catamaran in shape. The wooden craft are made of two or more logs which are strapped together with thick ropes before setting off for fishing. After fishing, the logs are untied and beached for drying until the next day's fishing (Sreekrishna, 2002). The fibre boats are similarly carried ashore and

kept ready for the next day's fishing. The craft are driven by huge sails mounted on board and on good windy days, these craft get a speed of more than 10 knots per hour. A few craft are now equipped with outboard engines (upto 10 hp). The outboard engines supplement the sails and are used sparingly. They are, however, very useful to reach the fishing grounds and back especially when the wind conditions are not favourable. Sails used are of different colours and made from old plastic bags. Pieces of bags are sewed together with monofilament threads and mounted on a wooden frame made of bamboo. The height of the sail varies from 10 to 12 m.

The narrow deck space (width: 1.5-2 m) is efficiently used to keep the gear, a small ice box that serves to store the baitfishes and a day's ration for the crew. The rest of the deck space is used to operate the lines and store the fishes caught. Gadgets such as compass and GPS are not used and the fishermen totally rely on their peer experience and the position of the sun to fix the direction of the fishing ground. The craft do not have fish hold to store the tunas caught.

Trolling as well as hooks & line operations are carried out from the craft. The craft engaged in trolling take 2 to 6 lines. The line made of polyamide monofilament twine is attached with a round bent barbed hook (no.1 or 2). A long line unit also made of polyamide monofilament twine consists of the main line and branch lines. The length of the main line ranges from 8000 to 10000 m with branch lines of 8 to 10 m. A distance of 15 to 20 m is maintained between the branch lines. Around 600 to 900 branch lines are operated at a time. Each branch line is attached with a round bent barbed hook (no.1, 2 or 4). Sardines (oil sardine, lesser sardine or rainbow sardine) are the baits used. In the absence of sardines, mackerel or small-sized flyingfish are used. The baits are usually iced and taken separately in insulated boxes. On nearing the fishing grounds, the lines are unrolled, baits attached to the hooks and are either dragged by the craft (trolling) or are allowed to drift alongside the craft (longlining). Generally, in longline operation, the lines with baited hooks

are released and the craft continue to move to deeper waters for some time. The lines are then allowed to drift for an hour after which they are hauled. Lines are generally set at a depth of 150 m and more.

Trolling is equally popular. The lines made of polyamide monofilament twine use hook size of no.1 or 2. On reaching the fishing ground, the lines are set and dragged by the craft. As soon as the fish bite, they are hauled and the fish are removed. The hooks are set once again and dragged, and this operation is repeated several times.

Catch and effort: Fishing by these traditional craft is on a daily basis. The crew consists of four or five members. When the weather is favourable, the fishermen take 3-4 hours to reach the ground and an equal time to return. If the craft are not equipped with an outboard engine and if the wind condition is not favourable, the duration is doubled. Normally, they set out for fishing by 4 am and return by 6 p.m. If catches during the day are poor, night fishing is carried out by sailing out at 6 p.m. and return the next day by 3 am. The operations are suspended when wind conditions are not favourable.

An estimated 1500 *teppalu* are engaged in oceanic tuna fishing in the observed fishing villages along Visakhapatnam coast and 600 to 700 craft operate every day. The total tuna landings includes both coastal (*E. affinis*, *Auxis* spp.) and oceanic tunas. The yellowfin tuna (*T. albacares*) forms the dominant species and contributes more than 60% to the total tuna catch. On an average each unit operating in the oceanic waters lands 2 or 3 yellowfin tunas, 1 or 2 billfishes, 3 or 4 dolphinfish and a few coastal tunas.

At Visakhapatnam outer harbour, the yellowfin catch ranged from 1,199 t to 1,709 t during 2004 - 2006 (Fig.1) with an annual average catch of 1,515 t. Overall, an estimated 6,500 t of yellowfin tunas were landed annually at the three fishing centres.

Fishing season: The traditional craft engaged in oceanic fishing operate throughout the year. However, landing of yellowfin tuna was higher

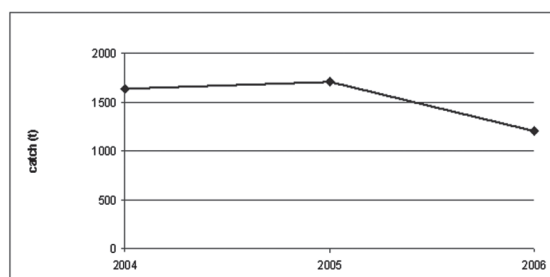


Fig.1. Annual landing of yellowfin tuna at Visakhapatnam

during October–January, followed by May - July (Fig. 2). The annual catch per unit at Visakhapatnam was 58 kg and during the peak fishing season it was 71 kg per unit.

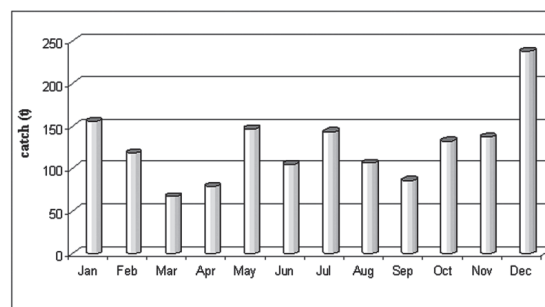


Fig. 2. Monthwise landing of yellowfin tuna at Visakhapatnam (2004-2006)

Biology

Size frequency distribution: The fork length of *T. albacares* during the study period ranged from 30 to 190 cm with mode at 130 cm (Fig. 3). The mean length was estimated at 106 cm. Monthly length frequency distribution showed that smaller

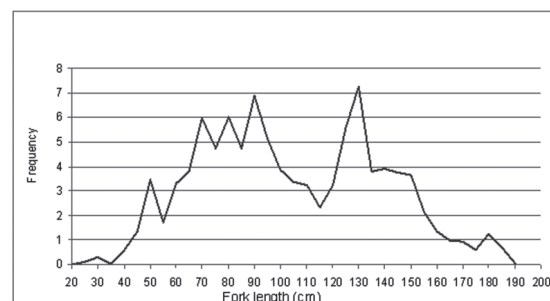


Fig. 3. Length frequency distribution of yellowfin tuna at Visakhapatnam

fishes (30-70 cm) were abundant during June-July and larger fishes (>100cm) during November-January. The weight ranged from 0.4 kg to 103 kg.

Length-weight relationship: The length weight relationship of the yellowfin tuna was estimated using the equation $W = aL^b$ where, W= weight in gram; L= fork length in cm; 'a' and 'b' are constants. The estimated length weight relationship was: $W = 0.017077L^{2.976}$

Sex ratio and maturity: Fishes were dissected to determine the sex as well as condition of gonadal maturity. Distribution of males and females in the catch was uneven with dominance of males at male: female ratio of 1:0.58.

Gonads were classified into four stages of maturity based on their size, volume and colour. Stage I- Immature: Eggs were not visible to the naked eye and the gonad occupied less than one fourth of the coelomic cavity, the entire gonad was pale pink in color. Male gonads were pale white, thin, elongated and occupied less than one fourth of the body cavity. Gonads weighed between 0.1 and 0.2% of the total body weight.

Stage II- Maturing: Gonads occupied half to three fourth of the body cavity. Eggs were visible to the naked eye in female gonads and yolk deposition had commenced giving a yellowish tinge to the gonad. Milt formation was observed among males and the gonad had a whitish appearance. Weight of gonad ranged from 0.2 to 0.7% of body weight.

Stage III – Mature: Gonads occupied the entire body cavity. Eggs were well developed and yolk filled. Gonad had bright yellow-orange colour and weighed 0.8 to 2% of body weight. Male gonads too occupied the entire body cavity and were milky white in colour. Milt easily extruded under light pressure.

Stage IV - Partially spent: Gonads occupied three fourth to half the body cavity. Gonads were loose and flabby to touch. Distal end of gonads had reddish tinge. Blood vessels were thick and prominently visible on female gonads. Male gonads were grayish. Gonad weight reduced to less than 0.8% of body weight.

The immature, maturing, mature and spent fishes formed 14.7%, 5.9%, 14.7% and 64.7% of the catch respectively (Fig. 4).

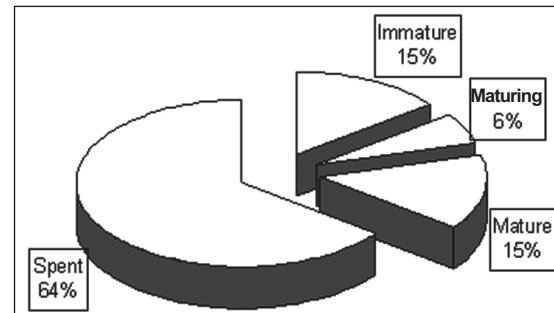


Fig. 4. Composition of gonad maturity stages in the yellowfin tuna landing at Visakhapatnam

Size at first maturity: Sex in yellowfin tunas could be distinguished when the fish attained a fork length of 40 cm and more. Gonads in mature condition were observed when the fish attained a fork length of 75-80 cm. However, 50% of fishes reached maturity at a fork length of 85-90 cm and above.

Food and feeding: Yellowfin tunas have highly muscular stomach with ridged inner wall to crush the food contents (Fig. 5). Stomachs were grouped as full, three-fourth full, half-full, one fourth full and empty based on visual examination of the stomach *in situ*. For food and feeding studies, 170 stomachs were analysed. Fishes with empty stomach formed 14.7%. One fourth full, half full, three fourth full and full stomachs formed 33.3%, 24.5%,

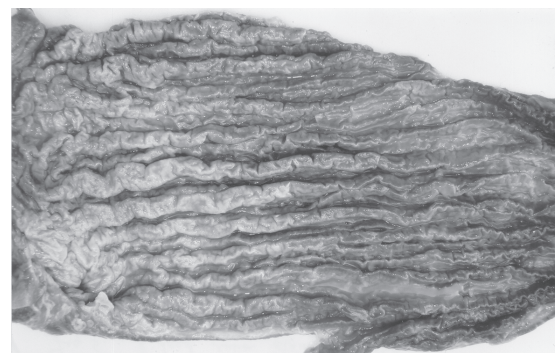


Fig. 5. Ridged inner stomach lining of yellowfin tuna

6.9% and 20.6% respectively (Fig. 6). Variety of prey constituted the food; the main constituents were crustaceans (42.5%), fishes (34.7%) and

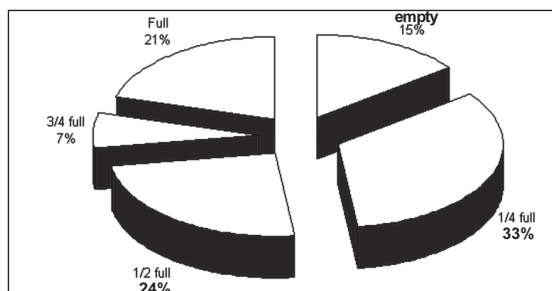


Fig. 6. Feeding condition of yellowfin tuna at Visakhapatnam

cephalopods (15.5%). Fully digested matter comprised 7.3% of the food contents (Fig.7). More than 50% of the stomachs grouped as empty had squid beaks in them. Presence of foreign bodies like nylon twine; small pieces of wood and plastic were observed in three stomachs.

Postharvest and disposal of catch: There is no postharvest facility on board the traditional craft.

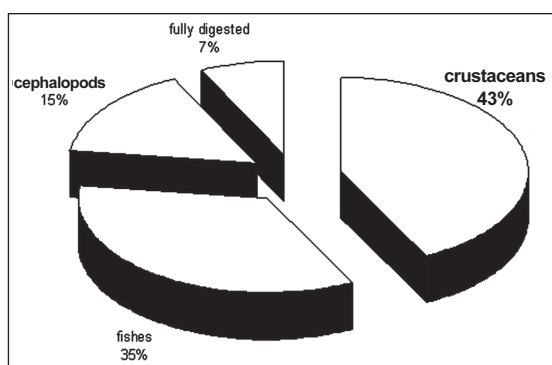


Fig.7. Major food components found in the stomach of yellowfin tuna at Visakhapatnam

Once the fish is hauled on board, it is benumbed, the hooks carefully removed and the fish is kept on the deck. The fishes are given a seawater bath periodically and brought to the shore. Depending on the time of catch, quality and market demand, a part of the catch is exported. Once the catch reaches the shore, it is disposed off to local fish merchants, who, in turn, take immediate action to preserve the quality of the fish and prevent further

deterioration. The merchants supply the tunas to processors, exporters, or to retailers who transport the catch to domestic markets. The processors have their own quality testers who test and certify the quality of the fish. The fishes are graded as first, second or third grade and exported, but not as *sashimi* grade. The graded fishes are gutted, washed properly, chilled and transported by road to Chennai from where they are exported to Japan, Philippines and the United States of America. A part of the ungraded fish is iced and sent to processing plants in Chennai where they are gutted, skinned, deboned and made into fish fillet, fish ribbons or canned. These processed value added products are exported to Southeast Asian countries. The remaining ungraded fish are iced and sent either to domestic markets in Kerala where the tuna meat is in good demand or sent for preparation of canned meat which fetch a good price in metro cities. Tunas have very little local preference in Andhra Pradesh.

Discussion

Targeted fishing for yellowfin tunas by the small non-mechanized craft operating along the Andhra coast is of recent origin. This is the first study made on yellowfin tuna landed at Visakhapatnam by the indigenous craft.

The yellowfin tuna landed at Visakhapatnam had a wide length range of 30-190 cm, a range wider than reported earlier at other centres. 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. The 'b' value obtained in the length weight relationship is close to 3 and comparable to the values obtained by earlier researchers (Silas *et al.*, 1985a, b; Sudarshan *et al.*, 1991; John and Sudarshan, 1993; Pillai *et al.*, 1993; Rohit and Rammohan, 2007). Table 1 gives the length-weight relationship for yellowfin tuna estimated by earlier workers. The weight proportionally increases with length and after attaining a fork length of 100 cm, the fish tends to maintain a rounded structure.

Uneven distribution of males and females with dominance of males as observed in the present

Table 1. Estimates of length-weight relationship of *Thunnus albacares* caught from Indian waters

Sl. No.	'a' value	'b' value	Reference	Location
1.	0.0002005	2.4201	Silas <i>et al.</i> , 1985a	Cochin
2.	0.0001036	2.6641	Silas <i>et al.</i> , 1985b	EEZ
3*.	0.000001655	2.2115	Madan Mohan & Kunhikoya, 1985	Minicoy
4.	0.000049557	2.8055	John & Reddy, 1989	Indian Seas
5.	0.00003852	2.7433	Pillai <i>et al.</i> , 1993	Indian Seas
6.	0.000040697	2.8496	Sudarshan <i>et al.</i> , 1991	West coast
7**.	0.00039528	2.8318	John and Sudarshan, 1993	Indian EEZ
8.	0.000003881	2.8507	Sudarshan and John, 1994	Indian EEZ
9.	0.000038062	2.8423	John, 1995	Andaman Sea
10.	0.00004626	2.8012	Govindraj <i>et al.</i> , 2000	Northwest coast
11**.	0.009196	2.9398	Sivadas, 2002	Minicoy
12.	0.008634	3.12	Rohit and Rammohan, 2007	Andhra coast
13	0.017077	2.976	Present study	Andhra coast

*length in mm; weight in g; **length in cm; weight in kg; in all other studies length in cm; weight in g

study has been earlier reported (Sudarshan *et al.*, 1991; John and Sudarshan, 1993). Reasons such as differences between growth rates of males and females, difference in mortality rates and reduced catchability of females have been attributed to this. The implications of such uneven distribution, if any, on the population is yet to be determined (IPTP, 1992).

Maturity and reproduction of yellowfin tunas occurring in the Indian waters has hardly been studied. In the present study, yellowfin tunas in all stages of gonad maturity were observed. Fishes with mature gonad were more during November-December and juveniles were more during April-May. Earlier studies have suggested that *T. albacares* attains maturity when it attains a fork length of 98-112 cm (Table 2). The length at first maturity (87.5 cm) observed in the present study is less compared to the size reported for the same species occurring in other regions.

Earlier studies by Pon Sirameetan (1985), Vijaykumar *et al.* (1992), John and Sudarshan (1993) and Silas *et al.* (1985b) have shown that crustaceans, especially pelagic crabs are the major food of yellowfin tuna. Fishes and cephalopods form the next important food items. The present study has confirmed this. It is also reported that the dense micronekton of the Deep Scattering Layer forms good forage and several species of epipelagic

Table 2. Length at first maturity reported for *Thunnus albacares*

Location	Length at first maturity (cm)	Reference
All equatorial western Pacific	104.57	Itano, 2000
Philippines and Indonesia	98.13	Itano, 2000
Equatorial western Pacific	107.86	Itano, 2000
Equatorial western Pacific	108.38	Itano, 2000
Equatorial western Pacific	107.22	Itano, 2000
Hawaii	112.54	Itano, 2000
Western Pacific Ocean	107.77	Sun chi-lu <i>et al.</i> , 2005
Bay of Bengal	87.50	Present study

fishes and cephalopods are prey to the yellowfin tuna (Roger, 1977; Menon, 2004).

The availability of yellowfin tuna grounds off Andhra coast and the ease with which the traditional fisherfolk capture these large oceanic species have encouraged some entrepreneurs to modify the existing large trawlers into longliners. These vessels are well equipped to locate the fishing grounds, have large deck space for operating the longlines, and storage facilities to preserve the catch in chilled condition. These crafts are equipped well to exploit the available oceanic yellowfin tuna and can remain out at sea for several days. The fishery has to be closely monitored and appropriate steps taken to optimise the effort as

well as catch with an aim to conserve this rich resource.

Acknowledgements

The authors are thankful to Dr. N.G.K. Pillai, Head, Pelagic Fisheries Division, CMFRI for support and encouragements, and Dr. E. Vivekanandan, Head, Demersal Fisheries Division CMFRI for suggesting improvements in the manuscript.

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Received: 24 April 2008

Accepted: 5 May 2008