Status of tuna resources (oceanic & neritic) & some biological aspects of selected tuna species in India

S. RAMACHANDRAN[1] A.B. KAR[2] A. TIBURTIUS[1]

[1]Fishery Survey of India, Govt. of India, Ministry of Fisheries, Animal Husbandry & Dairying, Fishing Harbour Complex, Royapuram, Chennai, India 600013

[2]Fishery Survey of India, Govt. of India, Ministry of Fisheries, Animal Husbandry & Dairying, Visakhapatnam, India 530001

Abstract

The present status of the tuna fishery (oceanic & neritic) in Indian waters is discussed with special reference to biological details of Thunnus albacares, Thunnus obesus, Katsuwonus pelamis,Thunnus tonggol, Euthynnus affinis, Auxis rochei and Auxis thazard.. The data collected during the exploratory tuna longline fishing survey in the Indian exclusive economic zone by the Fishery Survey of India (FSI) and the data on the tuna landings by the coastal fisheries collected by the Central Marine Fisheries Research Institute (CMFRI), the Andaman & Nicobar Administration and Lakshadweep Administration are also discussed. The landings of tuna stands at 1,07,375 tonnes during 2019 which is 18% lesser than the tuna landings (1,32,474 tonnes) during 2018.The oceanic tunas contribute 56.2% followed by neritic tunas (43.7%) to the total tuna catch in India during 2019. Biological studies carried out during the past 10 years till 2019 shows significant variation in L∞, growth coefficient (K) and mortality is imperative.

Key words: - Oceanic tuna, exploratory survey, *Thunnus albacares*, biological studies.

Introduction

In India, the small-scale and artisanal sectors largely contribute to the tuna fishery, deployingboth mechanized and motorized boats, using a variety of gears. The Lakshadweep group ofIslands located in the Arabian Sea (FAO Area 51) use mainly artisanal pole and line fishing targeting thesurface swimming oceanic species, predominantly the skipjack tunas (*Katsuwonus pelamis*). In the past one decade, efforts were made to convert the small-scale trawlers in to longliners to promote resource specific fishing within the country's EEZ. The present fishing pressure up to 100m depth is more, and there is no scope for further expansion of the fishing fleet in the shelf region, whereas, the oceanic/deep sea fishery is not exploited to the optimum level in India. Hence the targeted fishery in India turns to exploit the high value tunas and allied resources with technological upgradation, the entrepreneurs are getting attracted to diversify their fishing operation to harvest the tunas in the deep sea. Fisheries contribute about 0.9 percent to India's GDP. In 2019-20, the total marine fish production was 3.69 million tonnes (CMFRI, 2020), and the estimated value of marine fish landings during 2018 was estimated at INR 526.36 billion (approx. USD 7.35 billion) and INR

803.20 billion (approx. USD 11.20 billion) at retail market. India has also become a major global player in the seafood trade, with total seafood exports amounting to over 1.29 million tonnes, valued at over US$ 6678.6millionduring 2019-20. The tuna fishery in Indian waters is mainly contributed by the coastal fishery, oceanic fishery, pole and line fishery, troll-line fishery and also the gill net fishery. The coastal fishery contributes more to the overall tuna catches. The oceanic fishery is exclusively by longlining. While the smaller tunas and skipjack are the components in the coastal fishery, the large, deep-swimming yellowfin and bigeye tunas are the target species in the oceanic fishery (Ramachandran and Ramalingam 2019). As a result of the change in Government policies and also the encouragement from the Indian Government to the entrepreneurs for the exploitation of deep sea tunas as well as the scientific research showing the abundance of the tunas in the Indian seas, the oceanic tuna exploitation has gained momentum in the Indian EEZ and the country is emerging as a major tuna fishing country in the region. Present status of the neritic and oceanic tunas and some biological studies in India are discussed in this paper.

Materials and Methods

The data on the tuna and allied resources for the coastal fishery around mainland India was collected from the Central Marine Fisheries Research Institute (CMFRI, ICAR). The oceanic fishery data was from the, reports received by the Fishery Survey of India (FSI, Govt. of India) from the Indian owned tuna fishing vessels. For the island groups of Lakshadweep and Andaman & Nicobar, the landing data reported by the respective Union Territories are considered. The data on the fishing gear was collected from the Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India. The landing data was analysed to find out the percentage composition of the tunas. The area wise and gear wise species composition (both oceanic tunas and neritic tunas) was also studied.

Tuna longline fishery in India

In India, the dedicated exploratory longline fishery is practiced by the four fishing vessels of the Fishery Survey of India (Table. 1). The surveys undertaken during 2019 to assess the resource availability in the Indian EEZ are shown in **Fig. 1a & b**. Due to several reasons, the survey operations were limited during the reporting year. The biological parameters and growth and population parameters were collected from various research articles on tuna resources in India by FSI and CMFRI are presented here.

Results and Discussions

Gear wise landings of tuna resources

India's Exclusive Economic Zone (EEZ) covering 2.02 million sq.km contains diverse and multi-species fish stocks, exploited by multi-gear fisheries, which are mostly concentrated in the coastal areas i.e. <100m depth zone. Major fisheries exploit small pelagic (*e.g.* sardines,mackerels etc.,), demersals (*e.g.* ribbonfish, perches and crustaceans mostly shrimps). The fishing fleet structure is mainly comprised of mechanized (42,651), motorized (95,957) and non-motorized(25,689), operating from 1,547 landing centres in the 9 coastal States, 2 Union Territories (UTs) and the 2 Island groups (table 2).The tuna landings in 2019 was 1,07,375 t which declined by 18% from 2018. Tunas were mainly exploited by mechanized gill nets (55.0%), mechanized and motorized ring seines (23.1%), multi-day trawl and hook & line combination (9.0%) and motorized gill nets (7.0%) (table 3).Gillnets contributed 37.2 % to the total landings of tuna fishery, followed by trawls (18.5%) and small longlines (12.1%) (Fig. 4). Pole and line fishing practiced exclusively in the waters of the Lakshadweep Group of Islands, contributed 5.5% to the total tuna landings. Fish landings in Lakshadweep during 2019 was 22,929 t recording decline by 18% over the previous year (27,932 t).Other gears like small purse seines, ring seines and gillnet-cum-longlines also contributed to the tuna landings in small quantities during the year. Marginal spatial variation was observed in the tuna landings along the mainland coastline. The western coast of India (FAO area 51) contributed a larger share to the landings (51.3%) and the balance 48.7 %came from the east coast (FAO area 57) (table 5). *Euthynnus affinis* (38%), *Thunnus albaracres* (31%) and *T. tonggol* (22%)were the three main species dominant in the tuna fishery of north west coast of India during 2019 (table 4).

Species wise contribution of tuna resources

Considerable spatial variation was observed in the tuna landings along the mainland coastline. Tuna landings in 2019 were supported by seven species, four species (*Euthynnus affinis, Thunnus tonggol, Auxis thazard* and *Auxis rochei*) (fig.3) representing the neritic (46.7%) and three species (*Thunnus albacares, Thunnus obesus and Katsuwonus pelamis*) from the oceanic (53.2%) during 2019 (Fig.2). However, Kawakawa (*Euthynnus affinis*) contributed the maximum (29.6%) followed by skipjack tuna (*Katsuwonus pelamis*) (28.8%) and yellowfin tuna (*Thunnus albacares*) (24.3%) during the period 2019. Whereas during the year 2018, yellowfin tuna (*Thunnus albacares*) contributed 28.3% in the total tuna

landings followed by *Katsuwonus pelamis*(27.4%) and *Euthynnus affinis*(25.06%), *Auxis thazard* and *Auxis rochei* were 6.4% and 6.2% respectively. In North west coast of India, *Euthynnus affinis* (38%), *Thunnus albaracres* (31%) and *T. tonggol* (22%) were the three main species dominant in the tuna fishery. Tunas contributed 8% of the total fish production in India during 2019-20. Among the tunas, the oceanic tunas constituted 85% and neritic tunas 15%; with the skipjack (42%) and the yellowfin (38%) dominating the catches of Lakshadweep Islands.

Biological studies on tuna

The slope value for length weight relationship of *Thunnus albacares* from 2009 to 2019 was reported between 3.12 to 2.90 (table 6). whereas L∞ for *T. albacares* was reported between 173.3cm in Andaman waters, 193.9 cm in west coast of India and 197.4cm in East coast of India (table.7). The slope value for length weight relationship of *Katsuwonus pelamis* from 2012 to 2019 reported between 2.82 to 3.09 (table 6), whereas L∞ for *K. pelamis* was reported between 74.6 cm in Andaman waters, 92.0 cm in west coast of India and 81.9 cm in East coast of India and the natural mortality (M) estimated varied between 0.55 to 0.93 (table.7). Biological studies of other tuna species are furnished in table 6 and 7.

Recent trends in tuna fishery in India

- The landings of tuna and tuna like species during the year 2019 was 1,07,375t registering a decline of 18% than the previous year.
- In the Indian EEZ, the area 51 contributes more to the tuna catch than the area 57.
- Production of oceanic tunas in the Indian waters is steadily increasing which is due to targeted fishing and extension of fishing activities for the oceanic resources as well as the initiatives by the Govt. of India. Modification /diversification of the shrimpers to longliners and upgradation of the existing longliners for extended voyage period contributing to the enhance in tuna catches.
- The oceanic tuna landings during the year 2019 is 53.26% of the total landings where as neritic tuna contributes 46.7% to the total tuna landings.
- A considerable quantity of oceanic tuna is exported fetching higher revenue.
- Detailed biological studies and assessment of the tunas are carried out which are highly helpful for managing and regulating the tuna fishery in India.

Steps taken by India for sustainability in tuna fisheries

- All authorized tuna longliners are covered by the observer programme and the artisanal fishing vessels landing data are also carried out by the field samplers.

- Conservation of marine turtle is being implemented in India and all the five species of marine turtles reported from the Indian waters are protected under the law. The authorised longliners regularly record and report interactions with marine turtles. The entire stretch of the coastline where mass stranding of turtles takes place in India is protected through national and state legislation and no fishing activity is permitted to be carried out in such areas. Further, the Department of Forest and the Indian Coast Guard monitors the implementation of the conservation measures for protection of marine turtles. The coastal states where mass stranding takes place have also made it mandatory the use of Turtle Excluder Devices in the trawl nets.

- The Indian authorized longline vessels are implementing the conservation of thresher sharks (family Alopiidae) caught in association with fisheries.
- Conservation of cetaceans and whale sharks is being implemented and the national legislation prohibits capture and trade of marine mammals in Indian waters.

Conclusions

In India, the present level of exploitation of the fishery resources from the waters up to 100 m depth zone is near optimum and there is little scope for further expansion of the fishing fleet in the shelf region. Govt. of India is encouraging the fishers to equip themselves for harvesting the deep sea/oceanic resources. The increase in the oceanic tuna catch is indicative of that necessary R & D support is being provided by the government institutions such as FSI, CMFRI, CIFT etc. The data collection process and fine tuning of the data is being given importance by the Govt. of India. There was no reporting of sea bird interactions with the tuna fishery during the reporting period. Sea turtles, marine mammals and whale sharks, are protected under Schedule 1 of the Wildlife (Protection) Act of 1972 of India. The Central Marine Fisheries Research Institute of the Indian Council of Agricultural Research (ICAR-CMFRI), Fishery Survey of India (FSI) of the Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, Government of India and the Department of Fisheries of the coastal States and Union Territories (UTs) are the main agencies responsible for data collection and collation on

tuna fishery. Also, India is committed to the conservation and management measures for the tuna and allied resources in the Indian waters and sustainability in the tuna fishery.

Table.1. Tuna longline fishing / survey vessels in India

Name	*Matsya Vrushti*	*Yellowfin*	*Matsya Drushti*	*Blue Marlin*
LoA (Meter)	37.5	36	37.5	36
GRT (Tonnage)	465	290	465	290
BHP	1100	800	1100	800
Area of operation	North west coast of India	South west coast of India	East coast of India	Andaman waters
IOTC Registration Number	IOTC 003604	IOTC 003602	IOTC 003605	IOTC 003603

Table 2: Fishing fleet structure of India, 2018

Gear Type	**Mechanized**	**Motorized**	**Grand Total**
Bag net	464	83	547
Gillnet	1,854	7670	9,524
Hand line	0	3	3
Hook & line	65	462	527
Long line	37	84	121
Pole & line	1	79	80
Purse seine	110	2	112
Ring-seine	1	6	7
Trawl nets	4,868	30	4,898
Grand Total	**7,400**	**8,419**	**15,819**

Table.3. Tuna and allied resources nominal catch (gear-wise) (in tonnes) from the coastal and oceanic fishery 2018
(Source: FSI, CMFRI, State and UT Department of Fisheries, 2018)

Fish/group	LLEX	BS	GI	GIOF	LLFR	LLGI	PSRN	PSSS	TR	PL	HL	LLTU
Thunnus albacares (Yellowfin tuna)	7.34	--	3748.1	7581.6	6844.4	5534.1	1200.5	216.1	2064	2054	8139	99
Katsuwonus pelamis (Skipjack tuna)	0.15	--	2264.9	14665.4	1428.7	2656.8	769.6	--	1341.3	9567	3601	93
Thunnus obesus (bigeye tuna)	--	--	6.3	31.8	179.3	--	--	--	14.5	214.6	153	11
Euthynnus affinis (Kawakawa)	--	80.15	7400.6	4845.5	2029	1047.5	3880.6	10764	2695.5	314.7	150	--
Auxis rochei (Bullet tuna)	--	--	1918.4	205.2	597.5	186.4	741.3	4447.7	200.3	--	--	--
Thunnus tonggol Longtail tuna	--	--	1715.1	4508	141.6	4.8	--	1150	158.6	--	--	--
Auxis thazard Frigate tuna	--	--	1375.3	1058.9	209.3	268.6	137.4	4779.9	91.3	450	255	--
TOTAL	7.49	80.15	18428.7	32896.4	11429.8	9698.2	6729.4	21357.7	6565.5	12600.3	12298	203

LLEX: Exploratory Longline, BS:Boat seine , GI:Gillnet , GIOF: Offshore gillnet, LLFR: Drifting longline, LLGI: Gillnet/longline , PSRN: Ring seine , PSSS:Small purse seines , TR: Trawl , PL: Pole and Line , HL: Handline , LLTU: Tuna longline

Table.4 Coast wise catch of tuna from India during 2018

Species	Indian Ocean ,(West) Area -51	Indian Ocean (East) Area 57	Total
Thunnus albacare	21376	16112	37488
Katsuwonus pelamis	20040.9	16346.9	36387.8
Thunnus obesus	373.7	236.7	610.4
Euthynnus affinis	27351	5856.7	33207.7
Auxis rochei	6331.8	1964.9	8296.7
Thunnus tonggol	7546	132	7678
Auxis thazard	7408.6	1397.3	8805.9
TOTAL	69,052	25,934	94,986

Table. 5. Size range and length and weight relationship of tuna caught from Indian EEZ

Species	Area	Length range(cm)	Length=Weight relationship	Source
Thunnus albacares	Andaman & Nicobar waters	48-169	$W= 0.00002 \ L^{2.97}$	Kar *et al.*2012
	Bay of Bengal	25-190	$W= 0.008634 \ L^{3.12}$	Parthibha and Rammohan 2009
	East coast of India	47-191	$W= 0.00002 \ L^{2.90}$	Babu 2019
Thunnus obesus	Andaman & Nicobar waters	122-172	$W=0.00001 \ L^{3.09}$	Anrose and Kar 2010
Katsuwonus pelamis	Andaman & Nicobar waters	16.5-71.0	--	Pradeep *et al.*2017
	India	12-82	$W=0.00001 \ L^{3.09}$	Koya *et al.* 2012
	East coast of India	35-80	$W=0.000009 \ L^{2.82}$	Babu 2019
Auxis rochei	Indian waters	14-40	$W=0.0076L^{3.249}$	Jasmin *et al.* 2013
	East coast of India	16-53	$W=0.0006L^{2.07}$	Babu 2019
Thunnus tonggol	Indian waters	23-111	$W= -0.0148 \ L^{3.0}$	Abdussamad *et al.* 2012
Euthynus affinis	Indian waters	31.21-43.88	W=-1.931304+3.0558233 log L	Ghosh *et al.* 2010
	East coast of India	31-78	$W=0.011951L^{2.70}$	Babu 2019
Auxis thazard	Indian waters	18-55.9	W=-2.082723+3.171805 log L	Ghosh *et al.* 2012
	East coast of India	18-54	$W=0.0004L^{2.09}$	Babu 2019

Table.6. Growth parameters and population characteristics of tuna species

Species	Area	L∞(cm)	K/yr	t_0	Longevity (yrs)	Natural Mortality(M)	Source
Thunnus albacares	Andaman & Nicobar waters	173.3	0.39	-0.099	7.69	0.51	Kar *et al*. 2012
	Arabian sea	193.93	0.20	--	15	--	Somvanshi *et al* .2003
	East coast of India	197.4	0.30	-0.1157	10.1	0.4	Prathibha *et al* .2012
Katsuwonus peamis	East coast of India	194.8	0.54	-0.02	6		Babu 2019
	Andaman & Nicobar waters	74.6	0.59	-0.214255	4.9	0.93	Pradeep *et al*. 2017
	Indian waters	92	0.50	-0.0012	6	0.55	Koya *et al*. 2012
Auxuis rochei	East coast of India	81.9	0.59	-0.02	6	0.86	Babu 2019
	Indian waters	42.3	0.61	-0.0337	4	1.18	Jasmin *et al*. 2013
Thunnus tonggol	Indian waters	123.5	0.51	-0.032	--	0.77	Abdussamad *et al*. 2012
	Northwest coast	93	0.34			0.65	CMFRI 2020
Euthynus affinis	Indian waters	67.8	0.70	-0.26	5	-0.86	Vinodkumar *et al*.2014
	East coast of India	73.5	0.49	-0.03	6	0.86	Babu 2019
	Northwest coast	82.1	0.63			0.78	CMFRI 2020
Auxis thazard	Indian waters	57.95	1.2	-0.0075	--	1.65	Ghosh *et al*. 2012
	East coast of India	55.6	1.6	0.02	3	2.01	Babu 2019

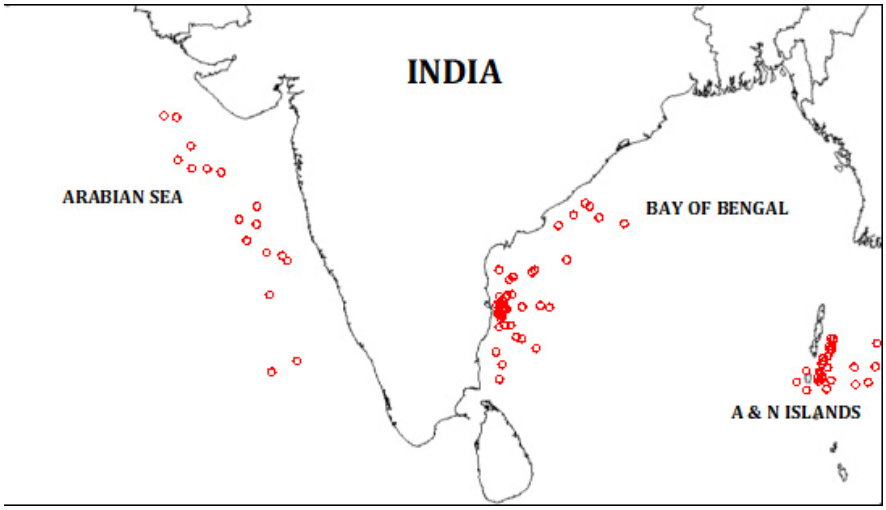

Fig. 1. shows records of *Thunnus albacares*;

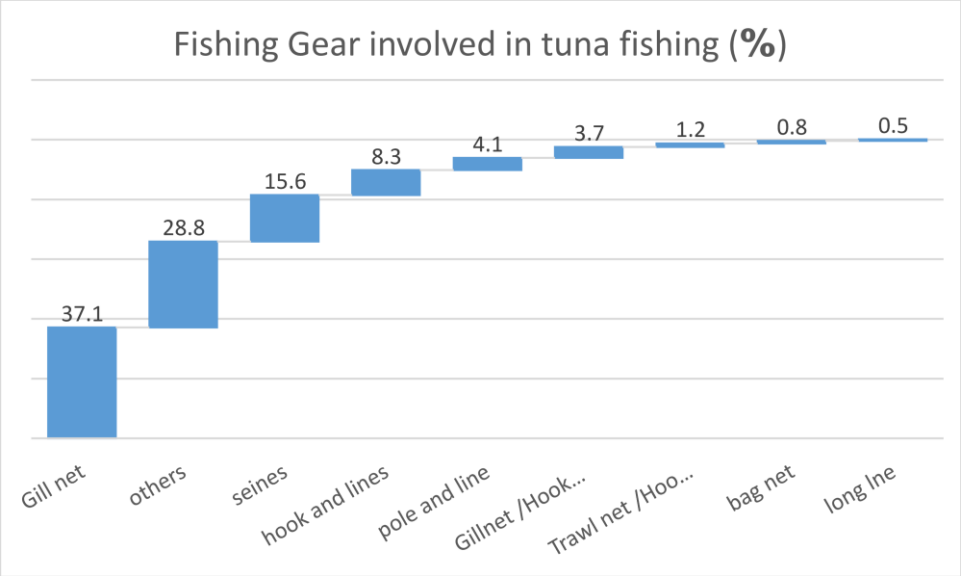

Fig. 2. Fishing gears envisaged in Tuna fishery in India during 2018

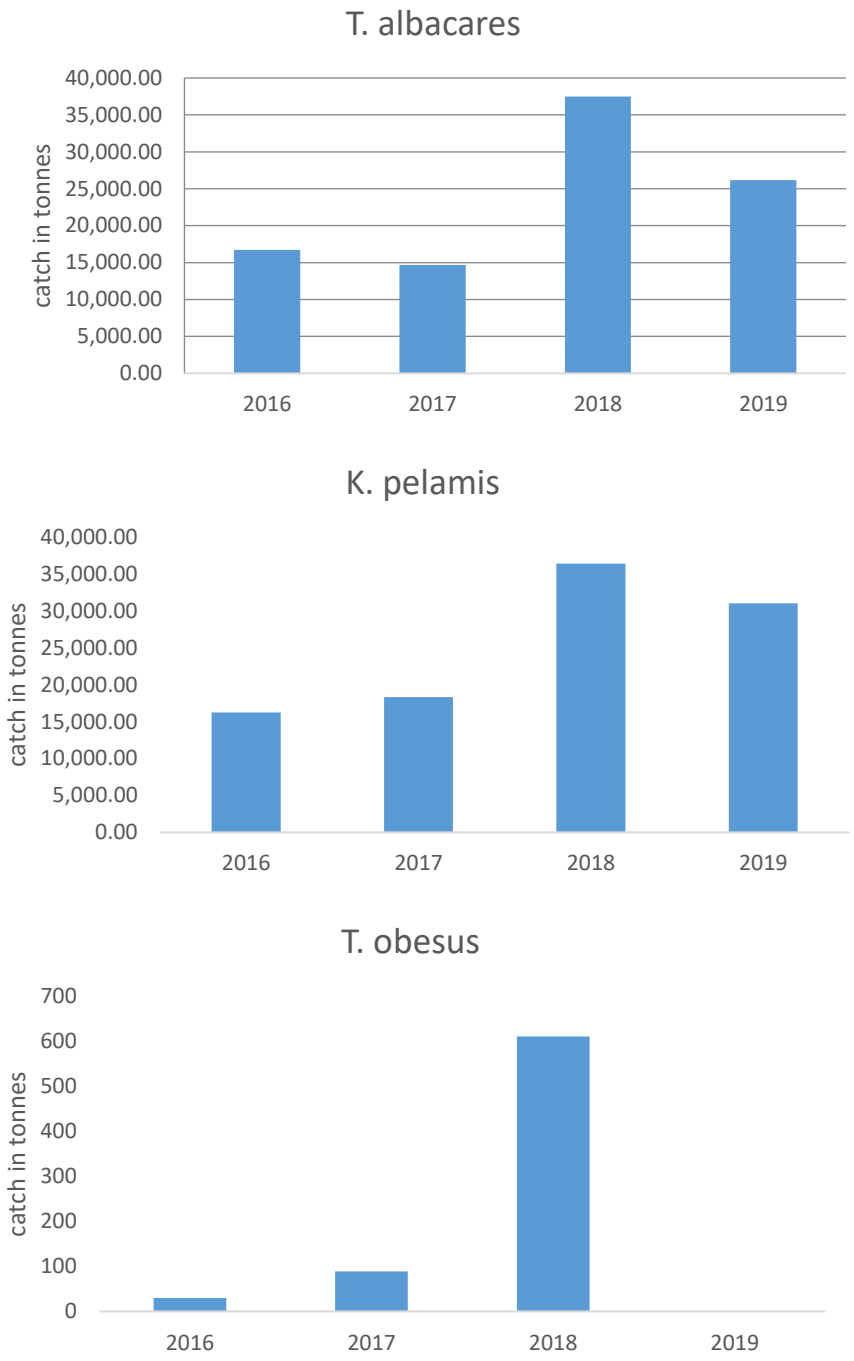

Fig. 3. Oceanic tuna landing in India during the period from 2016-2019

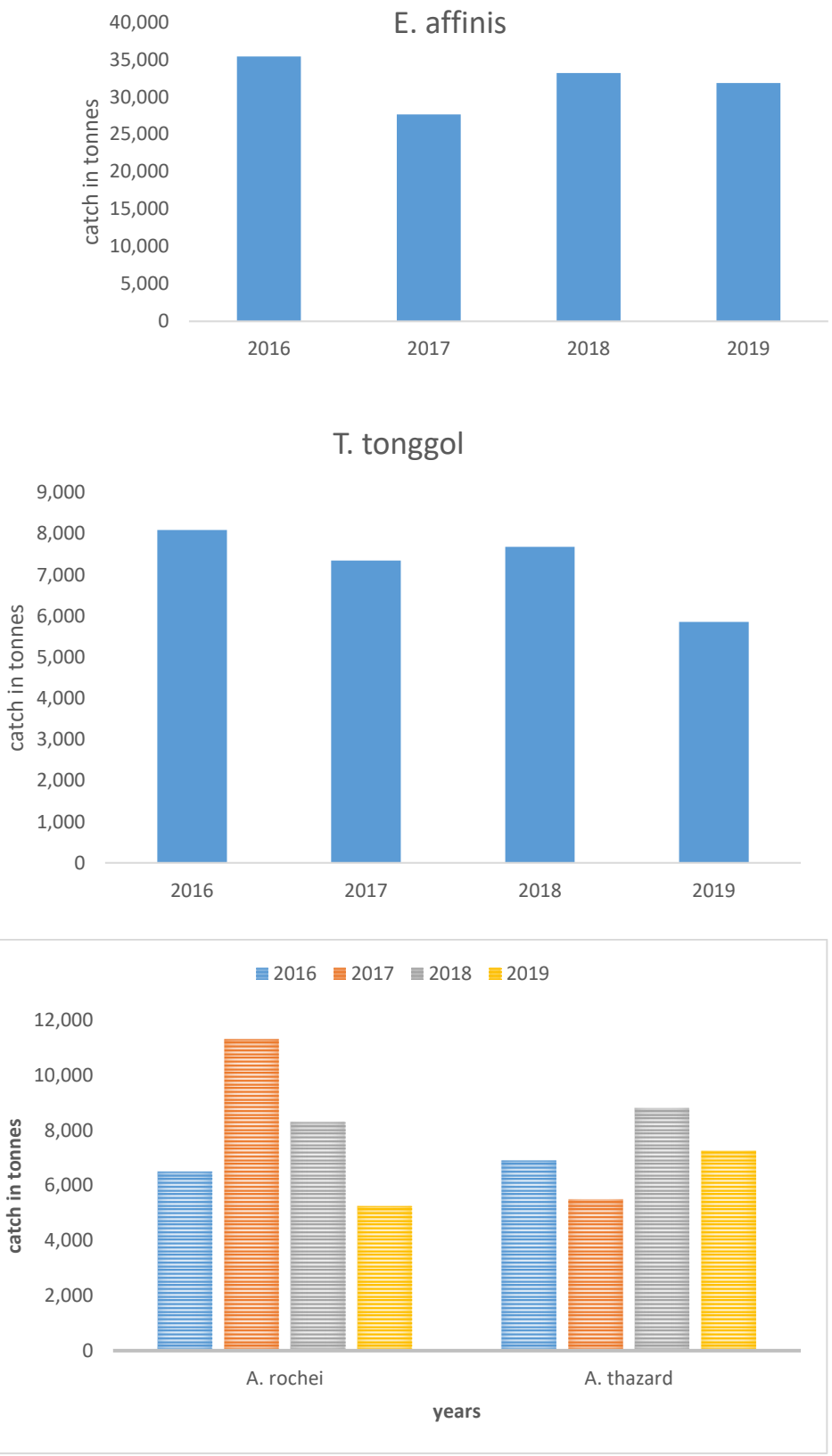

Fig.4. Neritic tuna landings in India during the period from 2016 - 2019

References:

Anon (2018). India's National Report to the Scientific Committee of the Indian Ocean Tuna Commission (IOTC), 2018.

Anrose 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.

Abdussamad, E.M. Prathibha Rohit, K.P. Said Koya and M. Sivadas (2012). Status and potential of neritic tunas exploited from Indian waters. IOTC–2012–WPNT02–10 Rev_1.

Babu,C 2019. Studies on some aspects of biology and fishery characteristics of tunas in Indian waters. Ph.D thesis, University of Madras. Pp 113.

Ghosh, S., Pillai, N. G. K. and Dhokia, H. K. (2010). Fishery, population characteristics and yield estimates of coastal tunas at Veraval. *Indian J. Fish*., 57 (2): 7-13.

Ghosh, S, M. Sivadas, E.M.Abdussamad, Prathibha R, K.P.Said Koya, K.K.Joshi, Anuleksmi C, Margaret M R, Prakasan D and Manju S(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, 2012.

Jasmin. S, Prathibha R, E.M.Abdussamad, K.P.Said Koya, K.K.Joshi, S.Kemparaju,, Prakasan D, M.N.K. Elayathu and Manju S(2013). Biology and fishery of the bullet tuna, *Auxis rochei* (Risso, 1810) in Indian waters. *Indian J. Fish.*, 60(2) : 13-20, 2013.

Kar A.B, Ramalingam L, Govindaraj, K and Prasad GVA (2012).Study of the growth and population parameters of yellowfin tuna (*Thunnus albacares*) in the Andaman and Nicobar waters based on the length frequency data. Report of the 14th IOTC proceedings. 24–29 October 2012, Mauritius. 17 pp.

Pradeep, H.D., Swapnil S Shirke, Annada Bhusan Kar(2017). Population parameters of *Katsuwonus pelamis* from Andaman waters. *J Fish* 5(2): 477–482.

Prathibha,R and Rammohan, K.(2009). Fishery and biological aspects of yellowfin tuna *Thunnus albacares* along Andhra coast, *India. Asian Fish. Sci*., 22(1): 235-244.

Prathibha, R. G Syda 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.

Ramachandran, S. Ramalingam,. (2019). Distribution, Abundance and some biological aspects of Bill fish species under the family Xiphiidae (*Xiphias gladius*) and Istiophoridae (*Istiophorus platypterus, Istiompax indica Makaira nigricans*) in Indian EEZ

Said Koya K.P, Joshi K. K, Abdussamad E.M, Prathibha, R, Sivadas M, Somy K, Ghosh, S, Mohammed Koya, Dhokia H. K, Prakasan D, Kunhi Koya, V.A and Manju Sebastine (2012) Fishery, biology and stock structure of skipjack tuna, *Katsuwonus pelamis* (Linnaeus, 1758) exploited from Indian waters. Indian J. Fish., 59(2): 39–47.

M. Vinod Kumar, M. K. Farejiya, Kiran S. Mali, K. Rama Rao, Pradnya A. Sawant and A. Siva (2017), Investigations on the age, growth and mortality parameters of Kawakawa Euthynus affinis (Cantor,1849) from the North west coast of India. IJAB.