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## Taxonomy and key for the identification of tuna species exploited from the Indian EEZ

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### ABSTRACT

Tuna samples were collected from the commercial landings at Kochi, Tuticorin, Mangalore, Visakhapatnam, Veraval and Lakshadweep at regular intervals during 2006-2010. Detailed morphometric data, viz., height of dorsal and anal fins, eye diameter, snout length, head height and height of body were collected. Otoliths were collected from eight species and analysed. Results indicated that structure and shape of the otoliths show species specific differences. Taxonomic details of tunas and tuna like species have been generated from the present as well as past studies and the species were redescribed with color photographs and keys for identification. The species included *Thunnus albacares* (Bonnaterre, 1788), *Thunnus obesus* (Lowe, 1839), *Thunnus tonggol* (Bleeker, 1851), *Sarda orientalis* (Temminck & Schlegel, 1844), *Katsuwonus pelamis* (Linnaeus, 1758), *Euthynnus affinis* (Cantor, 1849), *Auxis thazard* (Lacepède, 1800), *Auxis rochei* (Risso, 1810) and *Gymnosarda unicolor* (Rüppell 1836).

Keywords: Indian EEZ, Key for identification, Otolith, Species specific, Taxonomy, Tuna

### Introduction

Fisheries resources constitute one of the most important renewable resources from the nature. With increasing fishing pressure, the only option left for the sustainability of the fisheries, is their rational management of the fishery. Proper management is possible with a thorough knowledge of the dynamics of the fish stocks. For a meaningful study of the dynamics, knowledge of natural history of the species is necessary and this in turn can be acquired by the correct identification of fish species. This assumes greater importance in tropical seas where, a multitude of closely resembling species occurs. As even the closely resembling species may vary widely in biological characteristics, the role of taxonomy cannot be overstressed in studies on population dynamics. The present study, is an attempt towards understanding the diversity of tuna species of Indian seas with emphasis on developing a key for identification using minimum characters.

Day (1878), described four species of the family scombridae from the Indian waters and Munro (1955) described twelve species of tuna from neighbouring Sri Lanka. Several authors contributed to the taxonomy of tunas from the Indian seas during the past (Kishinouye, 1923; Smith, 1949; Fraser Brunner, 1951; Jones, 1958; Jones and Silas, 1960, 1963a,b,c; 1964; Silas, 1963b, c, 1964; Nair *et al.*, 1970). Comprehensive and thorough descriptions

on the family scombridae from the Indian seas have been made by Jones and Silas (1960; 1963a) and Silas and Pillai (1982). Most of the taxonomic descriptions were based on the morphological data of the specimens. Otolith studies are useful in validating taxonomic descriptions. Harkonen (1986) described otolith shapes for north-east Atlantic fishes. The morphological characteristics of fish otoliths are highly variable between species, ranging from simple disc shape in flatfish to irregular shape in other fishes (Hunt, 1992). Otolith growth is related to increase in size of the fish and generally follows an allometric increase in dimension (Chilton and Beamish, 1982). An attempt has been made in the present study to see if there are morphological differences between otoliths of eight species of tuna collected from the Indian coast. The present paper describes important taxonomic key characters along with otolith characters of tunas species of Indian seas.

### Materials and methods

Specimens for the study were collected from commercial landings at Kochi, Tuticorin, Mangalore, Vishakhapatnam, Veraval and Lakshadweep during 2006-2010. After noting colour and pigmentation of the fresh specimens, they were injected with 5% formalin and then stored in 5% formalin. After taking biometric data, the belly was cut open to note the sex. In most species,

30 specimens were examined for describing the species. However, for species, which are rare in the catches, the descriptions were, perforce, based on smaller numbers. In taking meristic and morphometric data, the methodology of Hubbs and Lagler (1947) was followed. All the linear measurements were made in the median longitudinal axis. Counts of pectoral rays, pelvic rays and lateral line scales were made only on the left side of the specimen. Height of dorsal and anal fins, eye diameter, snout length, head height and height of body were taken to the nearest mm using vernier calipers. Counts of lateral line scales and fin rays were made under a binocular stereozoom microscope. Otoliths of fish were collected using a sharp knife and a pair of forceps. A vertical cut was made at the top of skull (about 1 cm behind the eyes), to expose the brain and the otoliths removed carefully. The otoliths collected were cleaned with water and stored in a dry paper envelope. Photomicrographs of the otoliths were taken using binocular stereozoom microscope under 10x objective. Linear measurement of otolith was done using image analyser software. The classification and nomenclature by Collette and Nauen (1983) was adopted.

**Results and discussion**

*Key to tuna species of Indian seas*

A key for the identification of tuna species was developed including new findings and modifying past results available (Collette, 2001).

- 1a. Five to eleven narrow, dark longitudinal stripes on upper part of the body, no teeth on tongue ..... 2
- 1b. Body without stripes or dark spots above lateral line ..... 3
- 2a. Gill rakers 8-13, first dorsal spine 17-19, pectoral fins short ..... *Sarda orientalis*
- 2b. Gill rakers 11-14, first dorsal spine 13-15 ..... *Gymnosarda unicolor*
- 3a. First and second dorsal fins are widely separated, first dorsal spine 10-12 ..... (*Auxis*) ..... 4
- 3b. First and second dorsal fin base not separated, first dorsal spine 12-16 ..... 5
- 4a. Gill rakers 36- 42; 15 oblique dark wavy lines ..... *Auxis thazard*
- 4b. Gill rakers 43-48; 15 broad vertical dark bars ..... *Auxis rochei*
- 5a. Gill rakers 53-63, four to six dark longitudinal stripes on belly.....*Katsuwonus pelamis*
- 5b. Gill rakers 19- 45, no dark longitudinal stripes on belly ..... 6

- 6a. Body naked, several black spots on pectoral and pelvic fin bases ..... *Euthynnus affinis*
- 6b. Body covered with small scales behind the corselet, no black spots on body, pectoral rays 30-36 ..... (*Thunnus*) .... 7
- 7a. Ventral surface of liver with striations ..... 8
- 7b. Ventral surface of liver without striations ..... 10
- 8a. Gill rakers 31-43, pectoral fin short .... *Thunnus maccoyii*
- 8b. Gill rakers 23-31, pectoral fin moderate or long ..... 9
- 9a. Pectoral fins very long, caudal fin with white posterior border ..... *Thunnus alalunga*
- 9b. Pectoral fin short, caudal fin without white posterior border ..... *Thunnus obesus*
- 10a. Gill rakers 26-34; 20 broken vertical lines on body ..... *Thunnus albacares*
- 10b. Gill rakers 19 to 27, body with colourless elongate spots ..... *Thunnus tonggol*

A total of 9 species of commercially important tunas collected and identified from the seas around India are listed below:

*Description of species*

***Euthynnus* Lütken [C. F.] in Jordan & Gilbert, 1883**

(Type species: *Thynnus thunina* Cuvier, 1829)

***Euthynnus affinis* (Cantor, 1849) (Fig.1; Table 1)**



Fig. 1. *Euthynnus affinis* (Cantor, 1849)

*Thynnus affinis* Cantor, 1849, *Journal and Proceedings of the Asiatic Society of Bengal* v. 18 (pt 2); (type locality: Sea of Penang, Malaysia [Malacca Strait, eastern Indian Ocean]. Holotype (unique): BMNH 1860.3.19.214 (skin).

*Common name:* Kawakawa/Little tunny

*Description:* Body elongate, fusiform and robust. Two dorsal fins and first with 11 to 14 spines. First and second dorsal fins are separated by a narrow interspace. First dorsal fin spines are high in the front and lower towards the tail. 8-10 dorsal finlets present. Dorsal coloration is dark grey and back has a large patch of irregular wavy lines. Ventral colour is silvery grey with some dark spots found below

the pectoral fin. Otoliths are more elongated with median groove. (Fig.10 A). Otoliths have a larger semicircular postrostrum region and a smaller rostrum region. Ventral edge is flattened and dorsal edge with a median groove. Nucleus is located almost in the middle of the otolith.

**Distribution:** Widely distributed along the Indian coasts, contributing to the fishery, along with other species, especially along the west coast of India. Occurrence known from Veraval, Mangalore, Calicut, Cochin, Tuticorin, Mandapam, Porto Novo, Madras, Visakhapatnam and Kakinada.

**Thunnus** South, 1845, *Scomber thynnus* Linnaeus, 1758

(Type species: *Thynnus thunina* Cuvier, 1829)

**Thunnus albacares** (Bonnaterre, 1788) (Fig. 2; Table 1)



Fig. 2. *Thunnus albacares* (Bonnaterre, 1788)

*Scomber albacares* Bonnaterre, (ex Sloane) 1788, *Tableau encyclopédiqueet méthodique des troisrègnes de la nature. Ichthyologie.* (type locality: Jamaica [Caribbean Sea]). No types known. Based on 'Albicores' of Sloane 1707:11-12, Fig. 1.

**Common name:** Yellowfin tuna

**Description:** Body elongate, fusiform and slightly compressed. Two dorsal fins separated by a narrow interspace. Dorsal and anal fins are very long in large specimens. Pectoral fin is moderately long and reaching beyond second dorsal fin. Body with small scales. Caudal peduncle very slender. Dorsal colouration is metallic dark blue changing through yellow to silver on belly. Dorsal and anal fins, dorsal and anal finlets bright yellow. Otolith is horse shoe shaped (Fig. 10 B). It has smooth edged rostrum and postrostrum. Ventral edge is flattened and curved, whereas dorsal edge is perpendicular and curved towards upper side. Nucleus is in the middle of the otolith. Right lobe of liver much longer than left or central lobes (Fig. 11 A).

**Distribution:** Widely distributed along the Indian coast, contributing to the fishery, along with other species, especially along the west coast of India. Distribution known from Veraval, Mangalore, Calicut, Cochin, Mandapam, Tuticorin, Porto Novo, Madras, Visakhapatnam and Kakinada.

**Thunnus tonggol** (Bleeker, 1851) (Fig. 3; Table 1)



Fig. 3. *Thunnus tonggol* Bleeker, 1851

*Thynnus tonggol* Bleeker 1851, *Natuurkundig Tijdschriftvoo rNederlandsch Indië* v. 1, (type locality: Batavia [Jakarta, Java, Indonesia, Java Sea, eastern Indian Ocean]. Neotype: RMNH 6406. Neotype designated by Boeseman, 1964.

**Common name:** Longtail tuna

**Description:** Body fusiform and rounded. Two dorsal fins separated by a narrow interspace. Caudal peduncle long with a strong keel between 2 smaller keels. Second dorsal fin higher than the first dorsal. 9 dorsal and 8 anal finlets present. Dorsal colour is dark blue and ventral is silvery white with colourless elongate oval spots. Otolith shape similar to *T. albacares* (Fig.10 C). Rostrum is semicircular and forms a groove towards the nuclear region. Postrostrum is slightly oblique than in *Thunnus albacore*. Ventral edge is flattened with circular margin and dorsal edge is more pointed. Nucleus is situated more towards rostral side. Left lobe of the liver is small and curved downwards (Fig. 11 B).

**Distribution:** Widely distributed along the Indian coast, contributing to the fishery, along with other species, especially along the west coast of India. Distribution known from Veraval, Mangalore, Cochin, Tuticorin, Porto Novo, Madras, Visakhapatnam and Kakinada.

**Thunnus obesus** (Lowe, 1839) (Fig. 4; Table 1)



Fig. 4. *Thunnus obesus* (Lowe, 1839)

*Thynnus obesus* Lowe, 1839, *Proceedings of the General Meetings for Scientific Business of the Zoological Society of London* 1839 (pt 7); (type locality: Madeira, eastern Atlantic. No types known.



**Common name:** Bigeye tuna

**Description:** Body fusiform, robust and slightly compressed laterally. Two dorsal fins separated by a narrow interspace. 8-10 dorsal finlets. Pectoral fin moderately long in large specimens but very long in smaller specimens. Dorsal colour is metallic dark blue and ventral is whitish, a lateral iridescent blue band along sides in live specimens, finlets bright yellow edged with black. Left and right lobes of the liver are smaller in length than the middle lobe (Fig. 11 C).

**Distribution:** Widely distributed along the oceanic waters of Indian coast, contributing to the fishery, along with other species, especially along the west coast of India. It is known from Lakshadweep and Andaman Nicobar Islands.

**Sarda** Cuvier, 1829

(Type species: *Scomber sarda* Bloch, 1793)

**Sarda orientalis** (Temminck & Schlegel, 1844)  
(Fig. 5; Table 1)



Fig. 5. *Sarda orientalis* (Temminck & Schlegel, 1844)

*Pelamys orientalis* Temminck & Schlegel, 1844, Pl. 52, *Fauna Japonica, sivedescriptio animalium quae in itinere per Japoniam*. Parts 5-6; (type locality: Nagasaki, Nagasaki Prefecture, Japan. Lectotype: RMNH D2286 (dry). Paralectotypes: RMNH D842 (1, dry), 1244 (1, stuffed but in alcohol).

**Common name:** Striped bonito

**Description:** Body small and slender. Large mouth and upper jaw elongate reaching beyond the hind margin of eye. 7 to 9 dorsal and 6 to 7 anal finlets. Lateral line wavy. Body covered with minute scales. Dorsal side steel blue with 5-11 oblique stripes on back. Ventral side is silvery white. First dorsal fin solid black.

Otolith of *Sarda orientalis* differ from that of *E. affinis*, *T. albacore* and *T. tonggol* in morphology and structure (Fig. 10 D). Rostrum is small narrow tongue shaped, whereas the postrostrum is rectangular in shape with grooves along the margin. Ventral edge is stout and pointing and dorsal edge is flat with groove. Nucleus is in the upper portion of rostrum.

**Distribution:** Widely distributed along the Indian coast, contributing to the fishery, along with other species,

especially along the west coast of India. It is known from Mangalore, Calicut, Cochin, Tuticorin, Mandapam and Lakshadweep.

**Katsuwonus** Kishinouye, 1915

(Type species: *Scomber pelamis* Linnaeus, 1758)

**Katsuwonus pelamis** (Linnaeus, 1758) (Fig. 6; Table 1)



Fig. 6. *Katsuwonus pelamis* (Linnaeus, 1758)

*Scomber pelamis* Linnaeus 1758, *Systema Naturae*, Ed. X. v. 1; Pelagic, between the tropics. No types known. Spelled *pelamys* in early literature

**Common name:** Skipjack tuna

**Description:** Body elongate, rounded and robust. Two dorsal fins separated by small interspace 7 to 9 dorsal finlets and 7 to 8 finlets. A strong keel on each side at the base of caudal fin between 2 smaller keels. Dorsal colour is dark purplish blue and ventral is silvery white with 4 to 6 very conspicuous longitudinal dark bands. Otolith of *K. pelamis* is similar to the otolith of *E. affinis* and *T. albacore* (Fig. 10 E). It is short and rounded. Rostrum and postrostrum equal in size. Ventral edge flattened and pointed; dorsal edge flattened and circular. Nucleus is in upper side of rostrum.

**Distribution:** Widely distributed along the Indian coast, contributing to the fishery, along with other species, especially along the west coast (Lakshadweep) of India. It is known from Veraval, Mangalore, Calicut, Cochin, Vizhinjam, Tuticorin, Mandapam, Porto Novo, Madras, Visakhapatnam and Kakinada.

**Auxis** Cuvier, 1829

(Type species: *Scomber rochei* Risso, 1810)

**Auxis rochei** (Risso, 1810) (Fig. 7; Table 1)



Fig. 7. *Auxis rochei* (Risso, 1810)

*Scomber rochei* Risso 1810, *Ichthyologie de Nice, ou histoire naturelle des poissons du département des Alpes Maritimes* (type locality: Nice, France, Northwestern Mediterranean Sea. Holotype: MNHN A-5808).

**Common name:** Bullet tuna

**Description:** Body elongate, rounded and robust. Two dorsal fins separated by wide interspace. 8 dorsal finlets and 7 anal finlets. Pectoral fin short not reaching vertical line from anterior margin of scaleless areas. Dorsal colour is bluish and black on head. 15 broad vertical bars in the dorsal scaleless area. Ventral colour is white.

Otolith of *A. rochei* shows similarity to *A. thazard* and *K. pelamis* (Fig. 10 G). It has broad postrostrum and a medium rostrum. Dorsal edge is flattened and rectangular in shape. Ventral edge is also flattened with a small curve in the lower portion. Nucleus is in the middle of the otolith at equal distance from rostrum and postrostrum.

**Distribution:** Widely distributed along the Indian coast, contributing to the inshore fishery, along with other species, especially along the south-west and south-east coasts of India. It is known from Mangalore, Calicut, Cochin, Vizhinjam, Tuticorin, Mandapam, Porto Novo and Madras.

***Auxis thazard* (Lacepède, 1800)** (Fig. 8; Table 1)



Fig. 8. *Auxis thazard* (Lacepède, 1800)

*Scomber thazard* Lacepède (ex Commerson) 1800, *Histoire naturelle des poissons. v. 2;* (type locality: Kampung Loleba, Wasile District, Halmahera Island, Moluccas [Maluku], Indonesia, Halmahera Sea, western Pacific), 0°58'N, 127°56'E. Neotype: USNM 265418

**Common name:** Frigate tuna

**Description:** Body elongate, robust and rounded. Two dorsal fins separated by a wide interspace. 8 dorsal finlets. 15 oblique horizontal dark wavy line in the dorsal area. Dorsal colour is bluish and black on the head.

Otolith of *A. thazard* is slightly stouter than that of *A. rochei* (Fig. 10 H). Rostrum and postrostrum are almost equal in size and with curved edges. Dorsal and ventral edges are flattened with grooves near nucleus.

**Distribution:** Widely distributed along the Indian coast, contributing to the fishery, along with other species,

especially along the west coast of India. It is known from Veraval, Mangalore, Calicut, Cochin, Vizhinjam, Tuticorin, Mandapam, Porto Novo, Madras, Visakhapatnam and Kakinada.

***Gymnosarda* Gill, 1862**

(Type species: *Thynnus (Pelamis) unicolor* Rüppell, 1836)

***Gymnosarda unicolor* (Rüppell, 1836)** (Fig. 9; Table 1)



Fig. 9. *Gymnosarda unicolor* (Rüppell, 1836)

*Thynnus (Pelamis) unicolor* Rüppell, 1836, Pl. 12 (fig. 1) *Fische des RothenMeeres. Frankfurt-am-Main,* (type locality: Jeddah, Saudi Arabia, Red Sea. Holotype (unique): SMF 2739 (stuffed).

**Common name:** Dogtooth tuna

**Description:** Body elongate and moderately compressed. Two dorsal fins and the interspace small. Large mouth with upper jaw ending in line with the middle of eye. Interpelvic process large and single. Dorsal colour is blue black and ventral side is silvery. No lines, spots and other markings on the body. Otolith of *G. unicolor* is unique, petal shaped (Fig. 10 F). Rostrum is small and tapering and postrostrum is large with spherical margin. Nucleus is in the rostrum side

**Distribution:** Widely distributed along the Indian coast, contributing to the fishery, along with other species, especially along the west coast of India. It is known from Andaman and Nicobar Islands, Calicut, Cochin and Lakshadweep.

The present study on the taxonomy of tuna species of India is an attempt to provide adequate descriptions of all known species from Indian waters, and also to sort out various issues relating to identification of species. Key for the identification of different species have been developed using minimum characters as compared to the previous studies (Jones and Silas, 1960; Silas and Pillai, 1982; Collette and Nauen, 1983; Collette, 2001). The description of the otolith and the photographs are of the first of its kind on the taxonomy of tuna species which shows species specific differences in morphology and structure. The results of studies on the otolith might provide information related to the taxonomy as well as other biological aspects of tuna species.

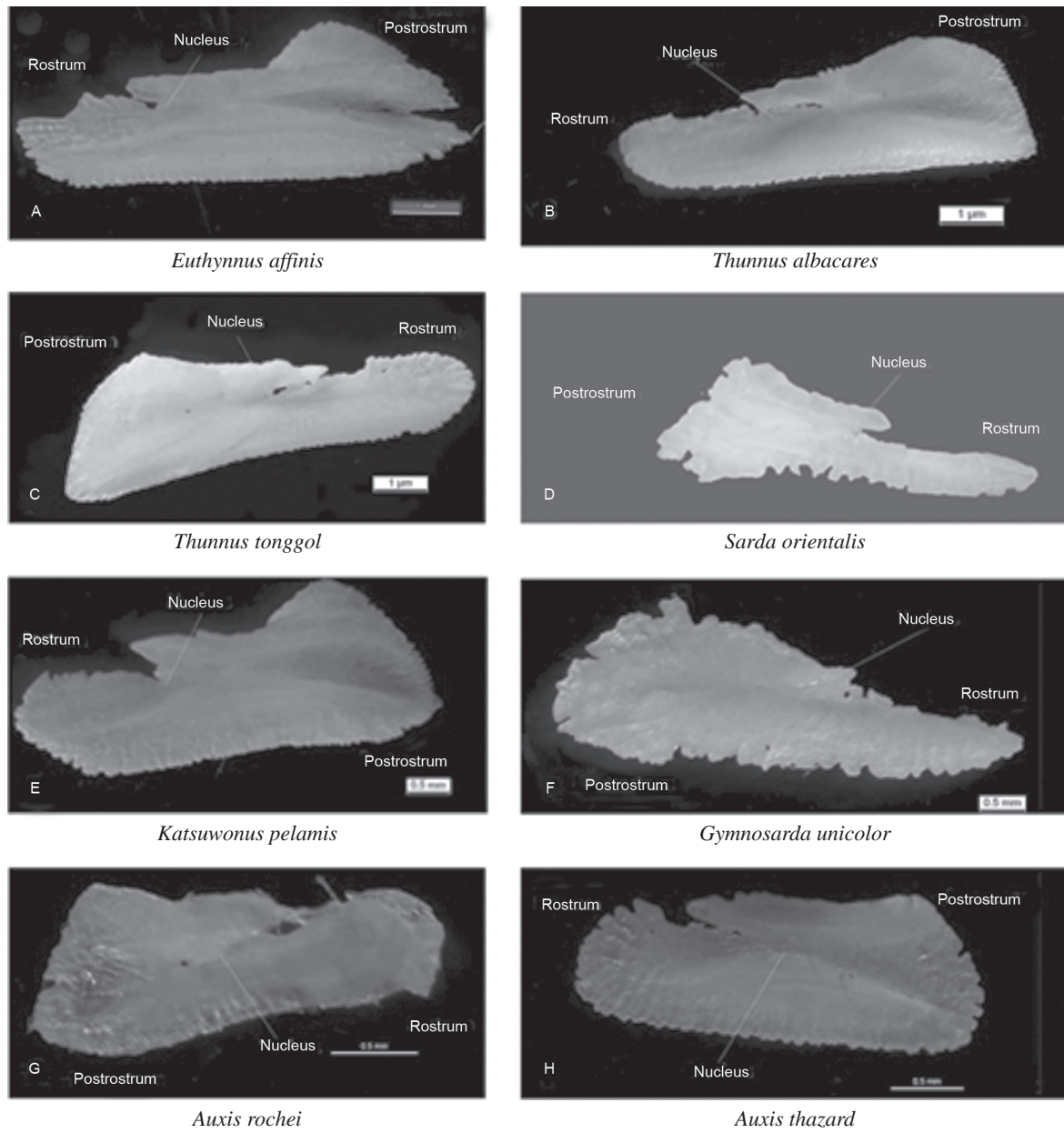


Fig. 10. A-H. Photomicrographs of otoliths of tuna species collected from the Indian seas during 2006-2010

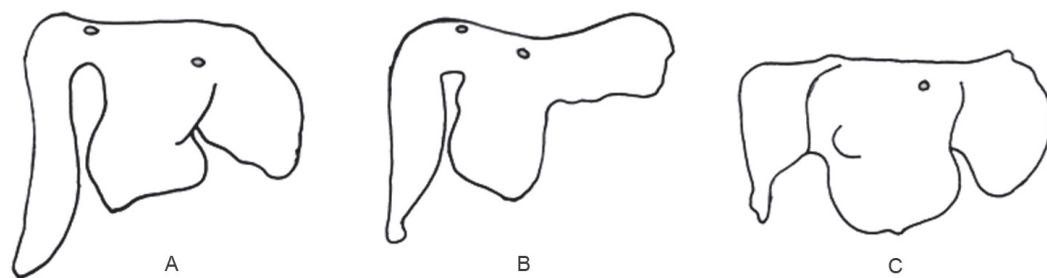


Fig. 11. Liver morphology of (A) *Thunnus albacares*, (B) *Thunnus tonggol* and (C) *Thunnus obesus*



Table 1. Taxonomic characters of tuna species occurring along the coast of India

Species	Gillrakers	First dorsal spines	Markings on upper body	Markings on lower body	Length of pectoral fin	Finlets
<i>Euthynnus affinis</i>	53-63	11-14	Wavy lines on the back	Lower body with 4-6 dark longitudinal stripes on belly	Pectoral fin short and broad	Dusky
<i>Thunnus albacares</i>	26-34	12-14	Dark blue	20 broken vertical lines	Moderately long	Yellow
<i>Thunnus tonggol</i>	19-27	13-15	Dark blue	Silvery white with colourless elongate oval spots	Short to moderately long	Yellow
<i>Thunnus obesus</i>	23-31	14-16	Metallic dark blue	Whitish lateral iridescent blue band along sides	Moderately long	Bright Yellow with black edge
<i>Sarda orientalis</i>	8-13	17-19	5 to 11 dark oblique stripes	Silvery white	Short	Dusky
<i>Katsuwonus pelamis</i>	53-63	14-16	Dark purplish blue	4 - 6 longitudinal dark bands	Short	Dusky
<i>Auxis rochei</i>	43-48	10-12	Bluish	15 broad vertical dark bars	Short	Dusky
<i>Auxis thazard</i>	36-42	10-12	Bluish	15 oblique dark wavy lines	Short	Dusky
<i>Gymnosarda unicolor</i>	11-14	13-15	Blue black	No lines dots	Short	Blackish

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