



CHAPTER 17

Taxonomy of Billfishes

Billfishes are one of the apex predators in the pelagic food chain, distributed worldwide in the epipelagic waters of tropical and subtropical oceans. These fishes can disperse widely throughout the world oceans and spawn over broad geographic regions during a protracted season (Nakamura 1985). Billfishes are commonly seen within 200 m of the ocean water layer above thermocline but the occurrence up to 800 m is also reported. They are characterized by a prolonged upper jaw forming a long rostrum called bill and using the long bill to attack and stun their prey by moving their heads in various directions to make the prey unconscious and form a hassle-free prey capture. Sexual dimorphism is reported in billfishes with large sized females.

General remarks on the taxonomy of billfishes

The term billfish is the common name given to large predatory marine fish comprising the families Istiophoridae and Xiphiidae of the Perciformes order (Collette et al., 2006). The order Perciformes is the most diverse order of ray-finned fishes such as Perches, basses, Tunas, Mackerels, Cichlids etc. The suborder Scombroidei typified the fishes that have an upper jaw that is not protrusible, with the premaxilla fixed as an adaptation to feeding upon larger fishes. The fastest swimming fish in the world include tuna, swordfish and sailfish are also members of the suborder Scombroidei (Nelson 2006). Nelson (2006) placed the two families of billfishes (Istiophoridae and Xiphiidae) under the suborder Scombroidei within the order Perciformes. Though billfishes are morphologically and genetically distinct from scombroids, Collette et al., (2006) placed the group in a separate suborder Xiphioidei. The suborder Xiphioidei are characterized by elongated premaxillary bill or rostrum in adults; dorsal-fin origin over the back of the head, first dorsal lacking true spiny rays, presence of two anal fins, low pectorals on the body, inferior mouth, pelvic fins with one spine and two rays or reduced, isthmus free gill membranes and 24-26 vertebrae. Nelson (2006) had recognized three genera under the family Istiophoridae; *Istiophorus* characterised by a sail-shaped dorsal fin which is taller than body depth and very long pelvic fins. *Tetrapturus* was noted by dorsal fin height higher than that of body depth and *Makaira* distinguished by the reduction in first dorsal fin height as not as high as the body depth. While Collette et al. (2006) and ITIS (2008) acclaimed Istiophoridae be into five genera; *Istiophorus* (sailfish), *Istiompax* (Black marlin), *Makaira* (Blue marlin), *Tetrapturus* (spearfishes) and *Kajikia* (Striped marlin). The family Istiophoridae typified by a rounded bill or rostrum; embedded scales in the adult fishes; the presence of a determined lateral line throughout life; the presence of jaw teeth; elongate pelvic fins; very long dorsal fin base

may be either sail-like or depressible into a groove; no. of vertebrae, 24 and presence of two keels on each side of the caudal peduncle.

The swordfish (*Xiphias gladius*) is the only member of Xiphiidae characterised by a depressed bill; absence of pelvic fins and girdle; lack of scales in the adult fishes; no. of vertebrae 26; toothless jaws in the adult fishes and a single medium keel on each side of the caudal peduncle.

Taxonomic Hierarchy

Kingdom :Animalia
Subkingdom :Bilateria
Infrakingdom :Deuterostomia
Phylum :Chordata
Subphylum :Vertebrata
Infraphylum :Gnathostomata
Superclass :Actinopterygii
Class :Teleostei
Superorder :Acanthopterygii
Order :Perciformes
Suborder :Xiphioidae
Family :Istiophoridae, Xiphiidae
Genus :*Istiompax* Whitley, 1931 – black marlin
 :*Istiophorus* Lacepède, 1801 – sailfish
 :*Kajikia* Hirasaka and Nakamura, 1947
 :*Makaira* Lacepède, 1802 – marlins, blue marlin
 :*Tetrapturus* Rafinesque, 1810 – spearfishes
 :*Xiphias*, 1758 - Linnaeus

The taxonomic studies recognized one extant species in the family Xiphiidae and nine extant species in the five genera, in the family Istiophoridae with one species in *Istiophorus*, two species under *Kajikia*, four species in *Tetrapturus* and one species in *Makaira* and one under the genus *Istiompax*. Nelson et al., 2004 identified only one worldwide species in *Istiophorus* (*I. platypterus*), Collette et al. (2006) also support that there is no genetic evidence to support distinguishing two species of sailfish. Apart from this, (Collette et al., 2006) did the phylogenetic analysis of billfishes using nuclear and mitochondrial gene sequence showing that, *Makaira* is not monophyletic and that it might be better to either member of Istiophoridae into two genera with blue marlin grouped with the sailfish. ITIS (2008) likewise recognizes the five genera of family Istiophoridae, *Istiompax* (black marlin), *Istiophorus* (sailfish), *Kajikia*, *Makaira* (blue marlin, marlins), and *Tetrapturus* (spearfishes). ITIS (2008) also follows Collette et al. (2006) in placing Istiophoridae together with Xiphiidae in the suborder Xiphioidae.

The species distinguished under the suborder Xiphioidae are;

Family: Xiphiidae: *Xiphias gladius* Linnaeus, 1758 - Swordfish

Family: Istiophoridae

Istiophorus platypterus (Shaw in Shaw and Nodder, 1792)- Sailfish

Istiompax indica (Cuvier, 1832) -Black marlin

Makaira nigricans Lacépède, 1802 -Blue marlin

Kajikia albida (Poey, 1860) -White marlin
Kajikia audax (Philippi, 1887) -Striped marlin
Tetrapturus angustirostris Tanaka, 1915 -Shortbill spearfish

Tetrapturus belone Rafinesque, 1810 -Mediterranean spearfish
Tetrapturus georgii Lowe, 1841 -Roundscale spearfish
Tetrapturus pfluegeri Robins and de Sylva, 1963 -Longbill spearfish

There is no targeted fishery of billfishes along the Indian coast but it occurs as the bycatch of longlines, troll and oceanic drift gillnet fishery. In India, species of billfishes reported commonly are *Istiophorus platypterus* (Indo-Pacific Sail fish), *Tetrapturus audax* (Striped marlin), *Istiompax indica* (Black marlin), *Makaira nigricans* (Blue marlin) and *Xiphias gladius* (Sword fish). Rare landings of *T. angustirostris* was also reported.

General terms and measurements categorised for billfish taxonomy

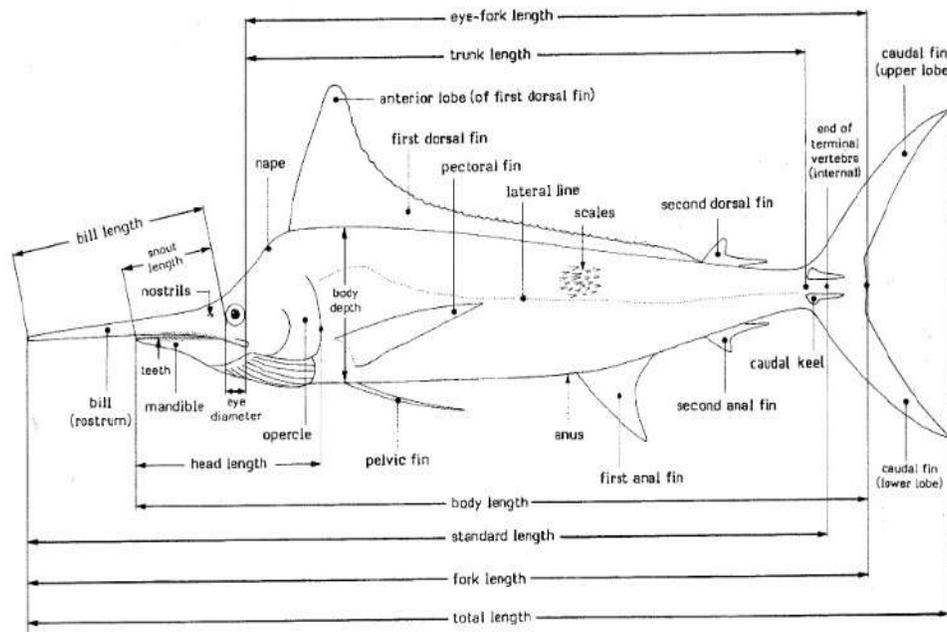


Fig 1. Schematic illustration of billfish with its measurable traits

Lower Jaw Fork Length (LJFL) or body length is the common measurement practised at the landing centre to collect the length-frequency data. Most of the billfishes landed with chopped upper jaw or bill. Figure 1, illustrated the morphometric measurements collected to generate the morphometric of the fish. The major measurements taken are Total length (TL), Fork Length (FL), Standard Length (SL), Body length or Lower Jaw Fork Length (BL, LJFL), Head Length (HL), Body Depth (BD), Snout Length (SL), Bill Length (BL), Eye Diameter (ED), Pre orbital length (PROL), Post orbital length (POL), Interorbital length (IOL), Lower jaw- Dorsal fin origin length (LJDF), Lower jaw- anal fin origin length (LJAF), Lower jaw- Pelvic fin length (LJPL), Lower Jaw- Pectoral fin length (LJPF), Lower Jaw – Caudal fin Length (LJCF), Length of pelvic fin (PVL), Length of Pectoral fin (PFL), First dorsal fin height (DH), Anal fin height (AH) and Caudal Fin length (CFL).

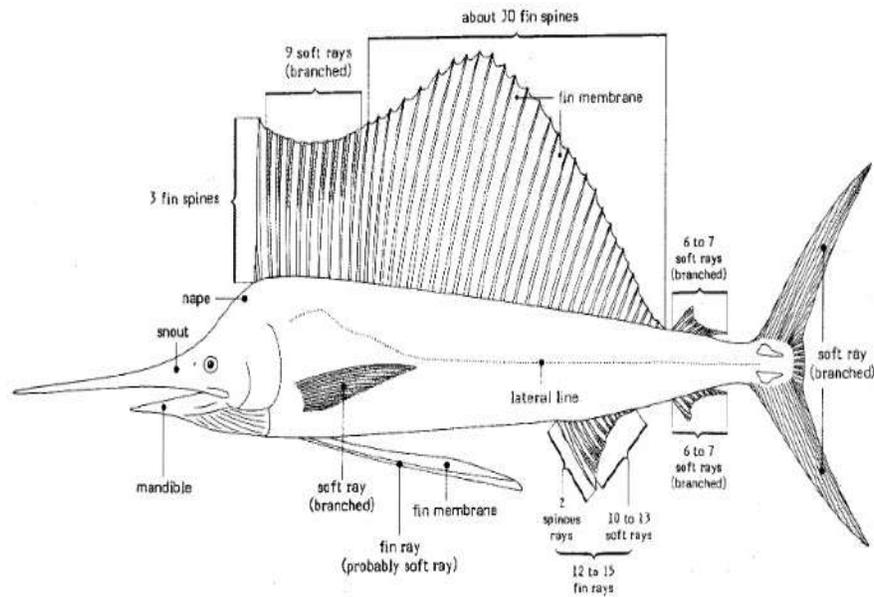


Fig. 2: Schematic illustration of Billfish with its countable traits

The major countable traits of billfishes are dorsal fin spines and rays, Pectoral fin rays, Pelvic fin rays, Anal fin spines and rays, Caudal fin rays and Branchiostegal rays. Gill rakers are absent in billfishes.

Specific body features of billfishes characterised for billfish identification

1. **Air bladder:** Single chambered air bladder in Swordfish while in Istiophorids the air bladder is made up of many bubble-shaped small chambers.
2. **Bill:** The bill is flat in Swordfish and round in Istiophorids
3. **Body length:** Usually following the dimension given by Rivas (1956). It is measured from the tip of the lower jaw to the posterior margin of the middle caudal rays (LJFL)
4. **Body width:** Body width at the origin of pectoral fins, pelvic fins and first anal fin may be used to find out the greatest body width. Body width will be compared with the length of the first dorsal fin to identify the different marlin species.
5. **Caudal keel:** The presence of a large median caudal keel in Xiphiidae and a pair of caudal keels in Istiophorids forms one of the major identifying characteristics of two families
6. **Caudal notch:** It is shallow and small in Istiophorids while it is rather large and deep in *Xiphias*.
7. **No. of caudal vertebrae:** The vertebrae which bear haemal spines ventral to the vertebral centrum and the caudal vertebrae lack pleural ribs. The number of haemal spines varies from species to species, it is 15 or 16 in *Xiphias*, 12 in *Istiophorus* and 13 in *Makaira* spp.

8. **Fin grooves:** In istiophorids, the first dorsal, first anal and pelvic fins fold down into grooves while it is not developed in *Xiphias gladius*
9. **Hypural plate:** The caudal fin rays are inserted distally on the expanded ends of the fan-like plate of hypural bones forms the hypural plate and it consists of four hypural bones in *Xiphias gladius* and five in Istiophorids
10. **Lateral apophyses:** the transverse flanges that extend laterally from the anterior part of each vertebral centrum. It varies from species to species. Figure 3 represent the variations in lateral apophyses of each billfish species
11. **Lateral line:** The lateral line appears looped or reticulate in marlins, single lateral line in other Istiophorids and *Xiphias* it appears as a single lateral line in juvenile stages and disappeared in the adult stages.

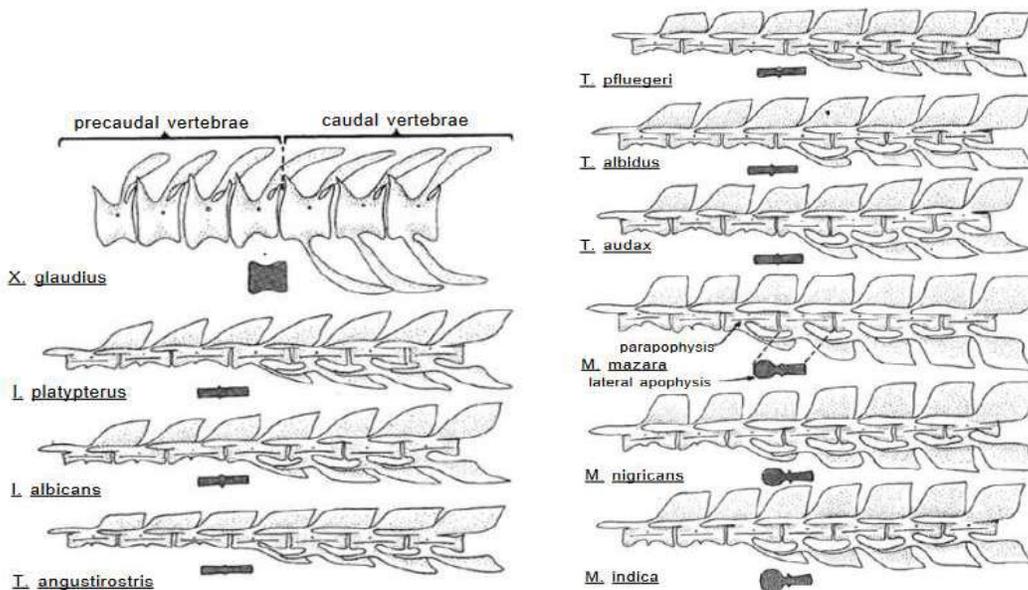


Fig.3 Lateral apophyses of different billfish species (Source FAO)

12. **Precaudal vertebrae:** the abdominal vertebrae which lack haemal bones called the precaudal vertebrae which are 10 or 11 in *Xiphias*, 12 in Istiophorids and *Tetrapturus* spp. and 11 in Marlins
13. **Scales:** The scales of billfishes are different from other Perciformes which are elongate, pungent with sharp posterior points. The arrangement and shape of the scales are useful characteristics for billfish identification. *Xiphias gladius* has no scales in the adult stage.
14. **Viscera:** Well developed internal organs in billfish. The intestine is coiled and, gonads are symmetrical in *Xiphias*, while in Istiophorids, the intestine is undulated and symmetrical gonads in *Istiophorus*, *Makaira* and apparently in *Tetrapturus* sp. In *T. angustirostris* and *T.pfluegeri* the gonads are asymmetrical and Y shaped.

Field identification characters of billfish species

Istiophorus platypterus (Indo-Pacific sailfish): Body laterally compressed, First dorsal fin tall, sail-like with 42-48 rays, marked with dark spots and remarkably higher than greatest body depth. Bill is long, slender and round in cross-section. Pelvic fins are very long, narrow and

reach up to the anus. No gill rakers, small file like teeth on jaws and palatines and presence of two caudal keels. Second dorsal fin with 6-7 rays and origin before the second anal fin.



Fig.4: *Istiophorus platypterus*

Istiompax indica (Black marlin): Body not strongly compressed, elevated nape, bill long, round in cross-section. Pectoral fins are rigid, sickle-shaped and not folding flat on the body. Pelvic fins are shorter than pectoral and depressible into ventral grooves. Two dorsal fins, first with 34-44 rays and height is half or less of the body depth. Second dorsal fin with 5-7 rays with its origin slightly in front of second anal fin. Presence of two strong caudal keels on each side and body densely covered with thick scales. No blotches or dark stripes on the body. The meat colour is white.



Fig.5: *Istiompax indica*

Makaira nigricans (Blue marlin) (**Fig. 6**): Body not very compressed, but with the elevated nape. Two dorsal fins, first dorsal fin height is equal to half or 3/4th of the body depth and with 39-43 rays. Pectoral fins are long, narrow and nearly straight folding flat on the body. Pelvic fins are shorter than pectoral fins. The lateral line forms a complicated pattern that looks like chicken wire and it is obvious in sub-adults and become obscure in adults. Second dorsal fin origin slightly behind second anal fin. Pelvic fins are shorter than



pectoral fins and presence of two strong caudal keels on each side. The presence of round spots or bars on the body is one another diagnosing characteristics of blue marlin. The meat colour is white.

Kajikia audax (Striped marlin): Body laterally compressed, thinner than black and blue marlin. Two dorsal fins, first dorsal height is greater than or equal to body depth and with 37-42 rays. Bill is long, sharp and round in cross-section. Long pelvic fins as long as pectoral fins. Second dorsal fin origin slightly backward of second anal fin. Two strong caudal keels on each side. Body with rows of round dots stripes and densely covered with elongate scales.

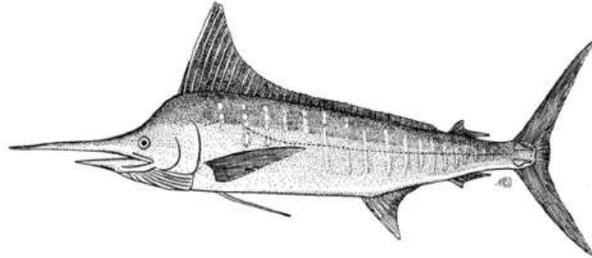


Fig.7: *Kajikia audax* (Source FAO)

Tetrapturus angustirostris (Shortbill spearfish): Body laterally compressed, long and slender with an elongated dorsal fin. Bill is very short and round in cross-section. Head profile between the pre-orbital and origin of first dorsal fin flat. First dorsal fin with 45-50 rays with pointed anterior lobe and its height greater than that of body depth. The anal opening is far anterior to the first anal-fin origin. The second dorsal fin position is far beyond the second anal-fin origin. Pectorals are short and narrow. Pelvic fins are slender and twice the length of pectoral fins. Caudal peduncle with two strong keels on each side. Single visible lateral line and dense bony scales on the body.

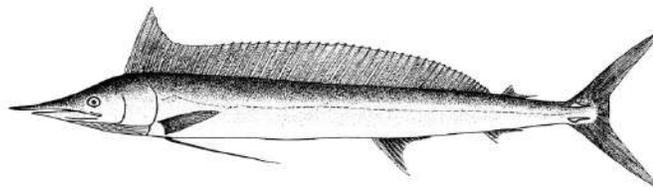


Fig.8: *Tetrapturus angustirostris* (Source FAO)

Xiphias gladius (Swordfish): Single species belongs to the family Xiphiidae, easily distinguished from the istiophorids by its extremely flattened long bill, elongate cylindrical body, very large eyes, low pectoral-fin insertion and absence of pelvic fins. Scales, jaw teeth absent in adults. Narrow based falcate first dorsal fin in adults well separated from the second dorsal fin. Presence of single large median caudal keel on both sides.



Fig.9: *Xiphias gladius*

***Kajikia albida* (Poey, 1860):** Anterior lobe of the first dorsal fin is higher than that of the remainder of the fin, the distance between the anal opening and first anal fin is smaller than that of the first anal fin height.

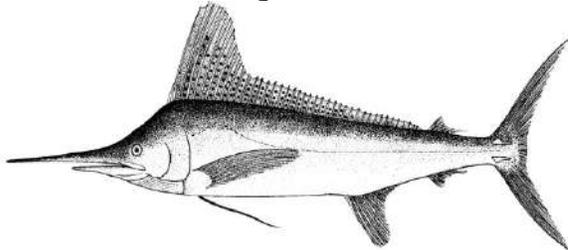


Fig.10: *Kajikia albida* (Source FAO)

***Tetrapturus belone* Rafinesque, 1810:** Bills are very short, forms only 18% of body length, pectoral fins narrow and short, which is 15% of body length. The distance between anal-fin origin and anus is equal to anal-fin height.

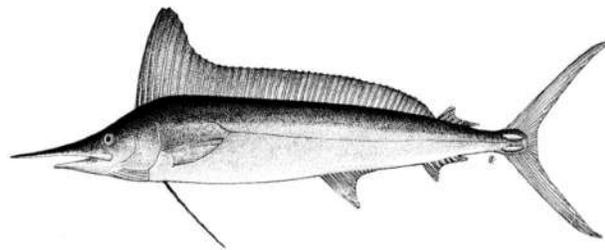


Fig 11: *Tetrapturus belone* (Source FAO)

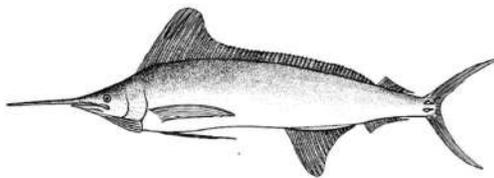


Fig.12: *Tetrapturus georgi* (Source FAO)

***Tetrapturus georgi* Lowe, 1841:** Tip of first dorsal and anal fin rounded and first dorsal fin unspotted. The distance between the anal opening and anal fin origin is nearly equal to half of the anal fin height. The scales on the mid-body is soft and round

***Tetrapturus pfluegeri* Robins & de Sylva, 1963:** Bill is long and it is equal to or more than head length. Pectoral fins are wide, long and rounded, which is 18% longer than body length. The anal opening is far anterior to the first anal-fin origin and the distance is equal to anal-fin height.

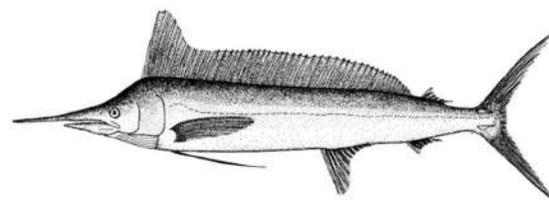


Fig.13: *Tetrapturus pfluegeri* (Source FAO)

Conclusion

A comprehensive insight on the taxonomy of billfishes revealed that billfishes under the suborder Xiphioidae comprise two families Xiphidae and Istiophoridae with ten extant species. One extant species in Xiphidae and nine in Istiophoridae apportioned under five genera. Billfishes are distinct genetically and morphologically to be placed in a separate suborder,

Xiphoidei. The two families identified under the suborder Xiphoidei are easily distinguished with their family characteristics.

The family Xiphiidae differs from the Istiophorids by the presence of a single median keel, sword-like bill, lack of pelvic fins, well separated dorsal fin and single large swimbladder. The recent phylogenetic study of billfishes identified two major clades: first clade as blue marlin+ Sailfish and second clade - all the rest (as *Tetrapturus*). Within the first clade; Blue marlin (*Makaira*) separated from Sailfish (*Istiophorus*) and in the second clade; Black marlin (*Istiompax*), Striped and white marlin (*Kajikia*) and four spearfishes (*Tetrapturus*) were identified. So altogether five genera were recognised under the family Istiophoridae. There is always controversy over the Atlantic and Indo-pacific populations of Sailfishes and marlins, whether same species or not. Even though some morphometric variations were reported between the sailfish population at Atlantic and Indo-Pacific oceans, there is no genetic evidence in the sailfish mtDNA control region to indicate that, both are separate species. Earlier studies had separated Atlantic blue marlin (*Makaira nigricans*) from Indo-Pacific blue marlin (*Makaira mazara*) based on the reticulate lateral line pattern in Atlantic blue marlin and a simple loop pattern in the latter one. However, the mtDNA genotypes study can't provide enough evidence to separate them as different species. There are several Regional Fisheries Management Organisations (RFMOs) establishes to conserve and manage tuna and billfish stocks all over the oceans due to its worldwide distributions and prevalent economic values.

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