1. INTRODUCTION

This review covers the 12 species of billfishes recognized to date, even though the taxonomic status of one of them (Tetrapturus georgei) is still somewhat uncertain. A thirteenth form, the so-called "Hatchet marlin", often mentioned in recent literature, is also briefly presented (see page 5), but cannot be recognized as a valid species on the basis of the presently available data.

The systematic part of the present catalogue is based primarily on Nakamura, Iwai and Matsubara (1968), Nakamura (1974) and Nakamura (1983), while the remaining information, particularly that on biology and fisheries of the various species, stems from the author's personal experience and pertinent literature available to him. In order to avoid overcharging the text with literature citations, every effort was made to restrict these to papers considered to be of specific relevance to the biology and fisheries of the species in question. Many other important papers, particularly on systematics, anatomy, distribution and the more general aspects of biology and fisheries, although omitted in the text, have been included in the bibliography. Although great care was paid in evaluating the published and unpublished information used in this review, some misjudgements and incorrect interpretations will undoubtedly have occurred.

For more detailed information on billfish taxonomy, stocks, biology and fisheries, the reader is referred to specialized periodical publications such as the Bulletin of the Far Seas Fisheries Research Laboratory (Shimizu, Japan), the Fishery Bulletin of NMFS, NOAA, US Department of Commerce (Seattle, USA), and the more comprehensive papers on billfish taxonomy and biology, such as the Proceedings of the International Billfish Symposium, Kailua-Kona, Hawaii, 9 to 12 August 1972, edited by R.S. Shomura and F. Williams (NOAA Technical Report NMFS SSRF-675), "The sailfish, the swashbuckler of the open sea", by J.B. Tinsley (1964), "Billfish, marlin, broadbill, sailfish", by C.O. Mather (1976) and "Systematics of the Billfishes (Xiphiidae and Istiophoridae)" by I. Nakamura (1983).

Acknowledgements

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The fishermen and fisheries technicians who have helped the author in the course of his billfish studies and have given him invaluable information on fisheries, behaviour and biology of these fishes, in particular Mr Guillermo M. Adachi (Manzanillo Game Fishing Club, Mexico); Mr Peter Goadby (Game Fishing Association of Australia); Messrs Jack Izatt, John Covacevich, David Hopton, Peter Nielsen and Joe Bethune and Ms Daphnie Nielson (Cairns Game Fishing Club, Australia); Messrs Toshiro Sato, Wataru Ichikawa, Shoji Nakano and Michio Kuroiwa (Japan Marine Fisheries Resources Research Center); Mr Elwood K. Harry (President of the International Game Fish Association); Messrs Shojiro Shimura and Soroku Togo (Fisheries Agency, Government of Japan); Messrs Seki Araki, Ryoichi Shugyo and Tsuneo Okabe (Nishidomari Fishermen's Cooperative, Tsushima, Japan).

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1.1 Plan of the Catalogue

This catalogue is arranged alphabetically by genera and species. Each of the multispecies genera is introduced with general descriptive remarks, illustrations of diagnostic features, highlights on the biology, and relevance to fisheries. The information pertaining to each species is arranged by paragraphs, as follows: (1)scientific name, (2) synonymy, (3) FAO species names, (4) field marks, (5) diagnostic features, (6) geographical distribution, (7) habitat and biology, (8) size, (9) interest to fisheries, (10) local species names, (11) literature, and (12) remarks.

(1) **Scientific name :** Reference is given to the original description of each species so no confusion will arise as to precise identification.

(2) **Synonymy :** Synonims and different name combinations are listed (misidentifications and other nomenclatorial problems are discussed under (11) remarks).

(3) **FAO species names :** English, French and Spanish names for each species, to be used primarily within FAO, were selected on the basis of the following criteria: (i) each name must apply to one species only, in a worldwide context; (ii) the name should not lead to confusion with other groups. Wherever possible, the names selected were based on vernacular names (or parts of names) already in existence within the areas where the species is fished. FAO species names are, of course, not intended to replace local species names, but they are considered necessary to overcome the considerable confusion caused by the use of a single name for many different species, or several names for the same species.

(4) **Field marks :** A few obvious field characters of use in field identification extracted from "Diagnostic Features" at various levels.

(5) **Diagnostic features :** Distinctive characters of the species are given as an aid for identification, accompanied by pertinent illustrations. Species identifications should be attempted only after consultation of the illustrated key to genera and species. Reference to FAO Species Identification Sheets is given wherever relevant.

(6) **Geographical distribution :** The entire known geographic range of the species, including areas of seasonal occurrence, is given in the text and shown on a small map. In cases where only scattered records of occurrence are available, interrogation marks have been used to indicate areas of suspected distribution.

(7) **Habitat and biology :** The known depth range of the species,and information on salinity and temperature of its habitat are given where known. Information on biological aspects, such as migrations, spawning seasons and areas, food, predators and longevity is also included.

(8) **Size :** The maximum known, as well as the common body length and weight (if available) are given. Body length is measured from the tip of the lower jaw to the tip of the caudal rays in the middle of the fork of the tail. The all-tackle angling record and length at first maturity are given where known.

(9) **Interest to fisheries :** This paragraph gives an account of the areas where the species is fished and of the nature of the fishery; its importance is either qualitatively estimated or actual figures of annual landings are provided. Data on utilization (fresh, dried, frozen, canned, etc.) are also given where available. Here too, the quality and quantity of the information available vary considerably with the species.

(10) **Local species names :** These are the names used locally for the various species. The present compilation is necessarily incomplete, since only a fraction of the local names used throughout the world is actually published. In many cases, local names are available only for species supporting documented fisheries. Apart from possible omissions due to limitations of literature available, some of the names included may be somewhat artificial (i.e. through transliteration of indigenous words into English). The local species name is preceeded by the name of the country concerned (in capital letters) and, where necessary, by geographical specifications (in lower case). Whenever possible, the language of the transcribed vernacular name is added in parenthesis. When more than one name is used within a country, the official name, if available, is underlined.

(11) **Literature :** This includes references to the most important publications relevant to the species, the emphasis being on biology and fisheries. Additional references are included in the bibliography. In the case of a few uncommon species, only systematic papers are available.

(12) **Remarks :** Important information concerning the species and not fitting in any of the previous paragraphs is given here. For instance, in some cases the scientific name used in the present catalogue, although nomenclaturally correct, is not the best known. Other nomenclatural problems, such as the use of subspecies, are discussed.

1.2 **General Remarks on Billfishes**

The term “Billfishes” has been widely accepted by both, commercial and sports fishermen as well as scientists, to apply to the large fishes of the families Xiphiidae and Istiophoridae, characterize d by the prolongation of the upper jaw, much beyond the lower jaw into a long rostrum which is flat and swordlike (swordfish) or rounded and spearlike (sailfishes, spearfishes and marlins). Needlefishes, (Belonidae) are also sometimes referred to as billfishes, but they are easily distinguished from the true billfishes by having both jaws prolonged, the dorsal and anal fins both single and similar in size and shape, and the pelvic fins inserted far behind the pectorals.

The billfishes include 12 species arranged in four genera and two families as follows (see also Fig.1):

Phylum Chordata

Superclass Gnathostomata

Class Osteichthyes

Subclass Actinopterygii

Infraclass Teleostei

Division Euteleostei

Superorder Acanthopterygii

Order Perciformes

Suborder Xiphioidei

Family Xiphiidae

Genus Xiphias

Xiphias gladius - Swordfish (worldwide)

Family Istiophoridae

Genus Istiophorus

Istiophorus albicans - Atlantic sailfish (Atlantic)

Istiophorus platypters - Indo-Pacific sailfish (Indian and Pacific oceans)

Genus Tetrapturus

Tetrapturus albidus - White marlin (Atlantic)

Tetrapturus angustirostris - Shortbill spearfish (Indian and Pacific oceans)

Tetrapturus audax - Striped marlin (Indian and Pacific oceans)

Tetrapturus belone - Mediterranean spearfish (Mediterranean Sea)

Tetrapturus georgei - Roundscale spearfish (Atlantic)

Tetrapturus pfluegeri - Longbill spearfish (Atlantic)

Genus Makaira

Makaira indica - Black marlin (Indian and Pacific oceans)

Makaira mazara - Indo-Pacific blue marlin (Indian and Pacific oceans)

Makaira nigricans - Atlantic blue marlin (Atlantic)

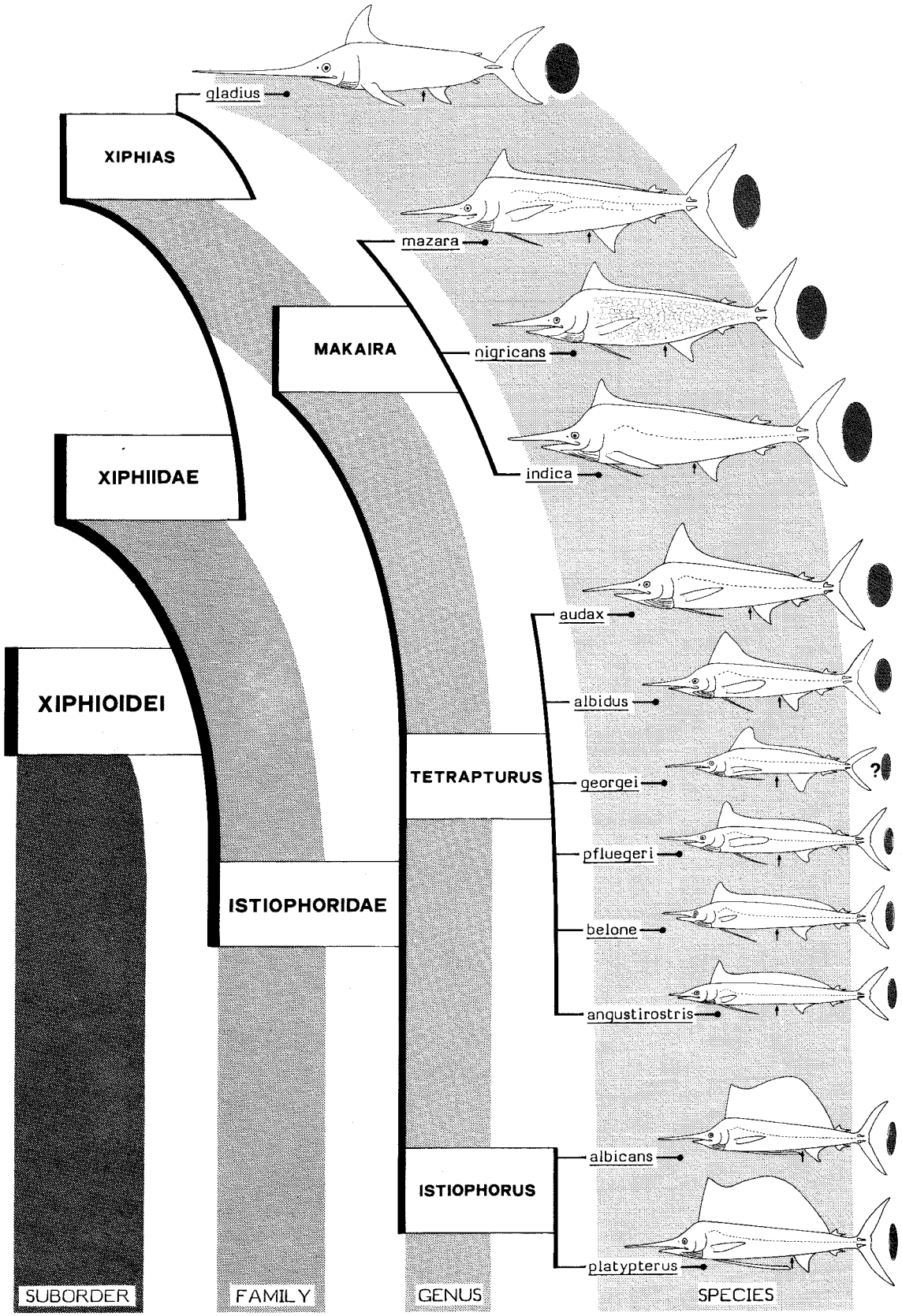
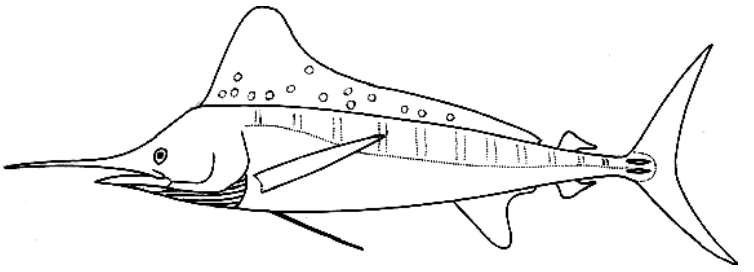


Fig.1 Classification of billfishes

Sizes of drawings correspond roughly to maximum lengths of species; screened oval areas show cross-sections of bodies at level of pectoral fin bases (arrows show position of anus)

Another billfish has recently been reported by several authors (Robins, 1974; de Sylva, 1974; McClane, 1974; Pristas, 1980) from the western Atlantic Ocean, particularly in the Gulf of Mexico. This might be either a new species or an aberrant form of Tetrapturus albidus. Venezuelan and Cuban fishermen have since long referred to this fish as the "Hatchet marlin" or "Axe marlin". It is characterized chiefly by the truncate shape of the anterior lobes of the first dorsal and anal fins (Fig.2) However,in the absence of conclusive taxonomic evidence, a final decision on the status of the Hatchet marlin cannot be made at this time and further study on this problem is urgently needed.



"Hatchet marlin" redrawn from McClane (1974) Fig.2

Xiphias gladius (Family Xiphiidae) differs from all species of the Family Istiophoridae in both external and internal features. Some superficial phenetic similarities, especially between Makaira and Xiphias seem to be due to convergent evolution. As regards the relationship between the three istiophorid genera Tetrapturus, Istiophorus and Makaira, various different opinions have been advanced. Generally, the sailfishes are included in the genus Istiophorus, the small spearfishes in Tetrapturus and the large (blue and black) marlins in Makaira. The smaller marlins striped and white), have been placed by many authors in either of the genera Tetrapturus and Makaira. On the basis of the present author's recent studies (Nakamura, 1983) it seems clear that these two species, T. albidus and T. audax should be included in the genus Tetrapturus together with the small spearfishes, T. angustirostris, T. belone, T. pfulegeri and T. georgei (fig.1).

It is likely that enlargement of the body as well as acquirement of the capability for fast swimming have been an evolutionary trend in billfishes (see maximum body sizes of living billfishes in Fig.3).

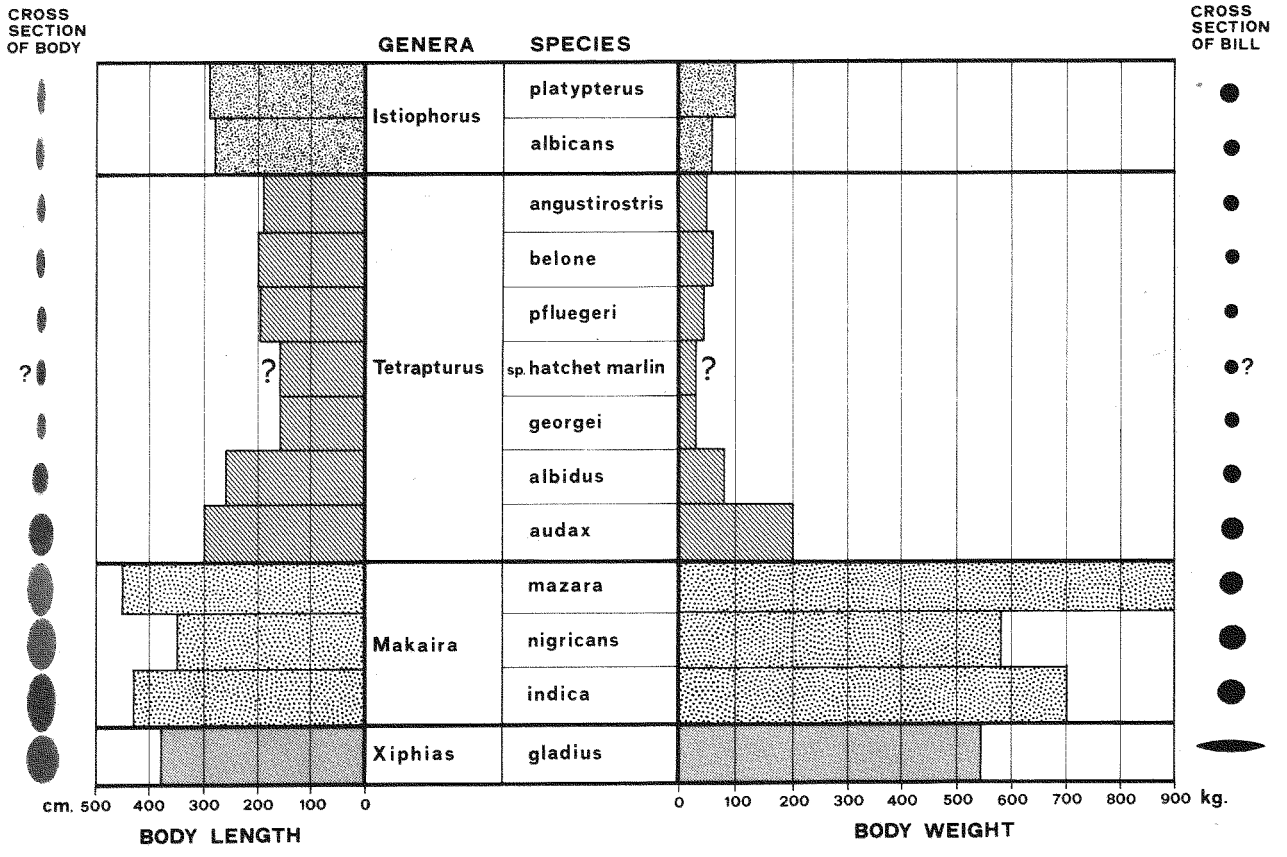


Fig.3 Comparison of approximate maximum recorded body length and maximum recorded body weight (both are not always coincidental with each other) in billfishes. The cross-sections of body and bill of each species are shown schematically on left and right, respectively (modified after Nakamura, 1983, Fig.54)

Furthermore, it has been shown that as billfishes grow larger, their bodies become much more robust, particularly in the case of Makaira indica (see Fig.4).

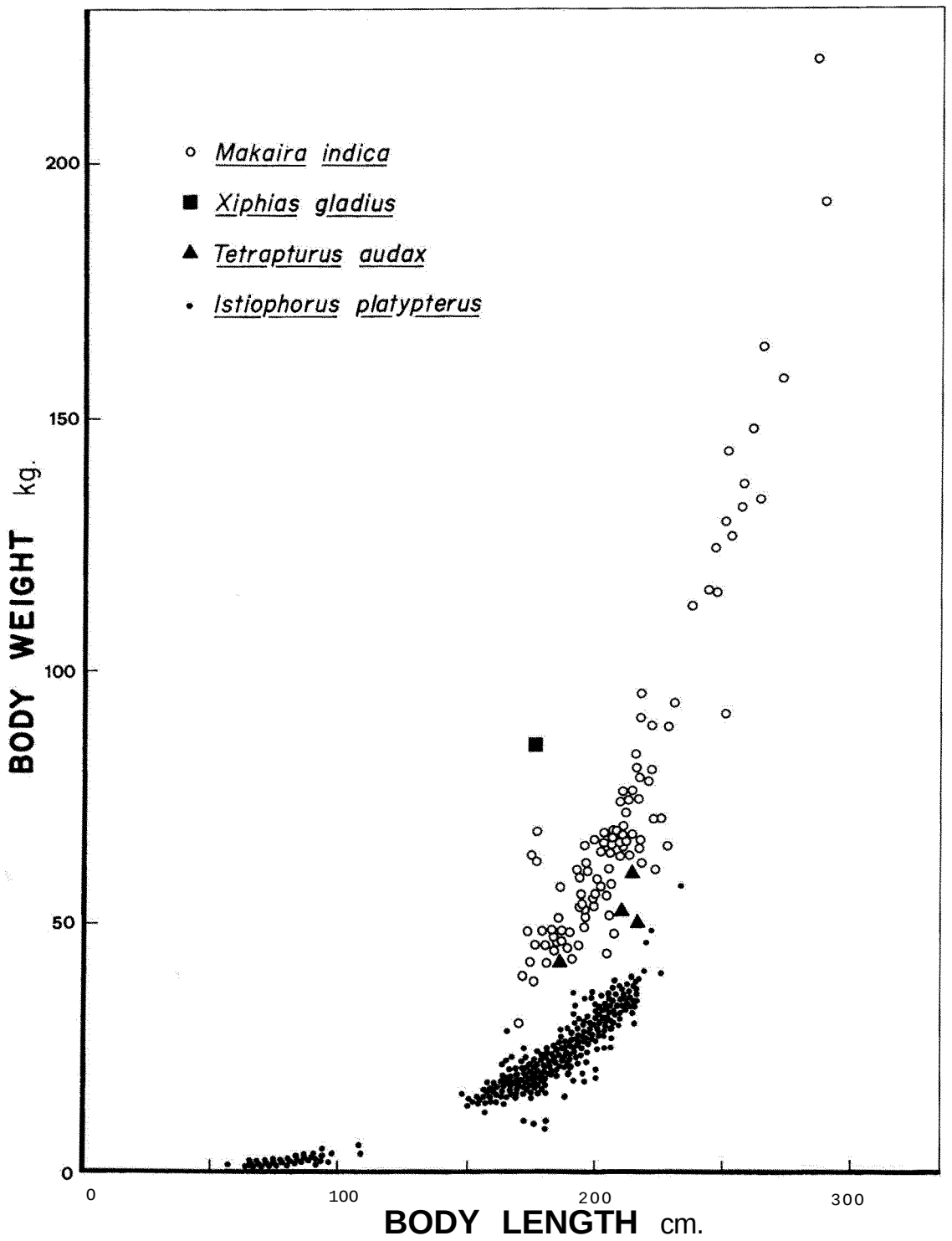


Fig.4 Length-weight relationships of billfishes caught by setnets and landed at Nishi-Maizuru Fish Market, Kyoto Pref., Japan between August 1976 and November 1978. Smaller I. platypterus (less than 110 cm body length) were weighed whole, the other large fishes of all species were weighed without gills or guts, and sometimes without the tip of the bill

Billfishes are primarily oceanic, epipelagic species inhabiting tropical and temperate waters, and seasonally also the cold waters of all oceans. They are usually confined to the water layers above the thermocline, but some may occur at greater depths (to below 800 m). The general distribution patterns of billfishes are summarized in Fig.5. While Xiphias gladius is cosmopolitan, the istiophorids have more restricted distributions. Although some billfish experts recognize only one cosmopolitan species of sailfish Istiophorus platypterus, the present author prefers, for the time being, to retain the traditional distinction between I. platypterus for the Indo-Pacific sailfish and I. albicans for the Atlantic sailfish, because there is evidence of some morphological differences between these two forms (see pages 16, 21, 23 and 24). If we consider the presence of spawning grounds to be a major element in the delimitation of principal areas of distribution, we may conclude that five of the species of Istiophoridae are confined to the Pacific and Indian oceans, six (if we recognize Tetrapturus georgei as valid) to the eastern atlantic and five (if we recognize the Hatchet marlin as valid) to the western central Atlantic. Furthermore, three species, Makaira indica, Tetrapturus angustirostris and Tetrapturus audax have been shown to occur incidentally as "invaders" int the eastern Atlantic, which brings to 10 the number of species found at least occasionally in the Atlantic Ocean.

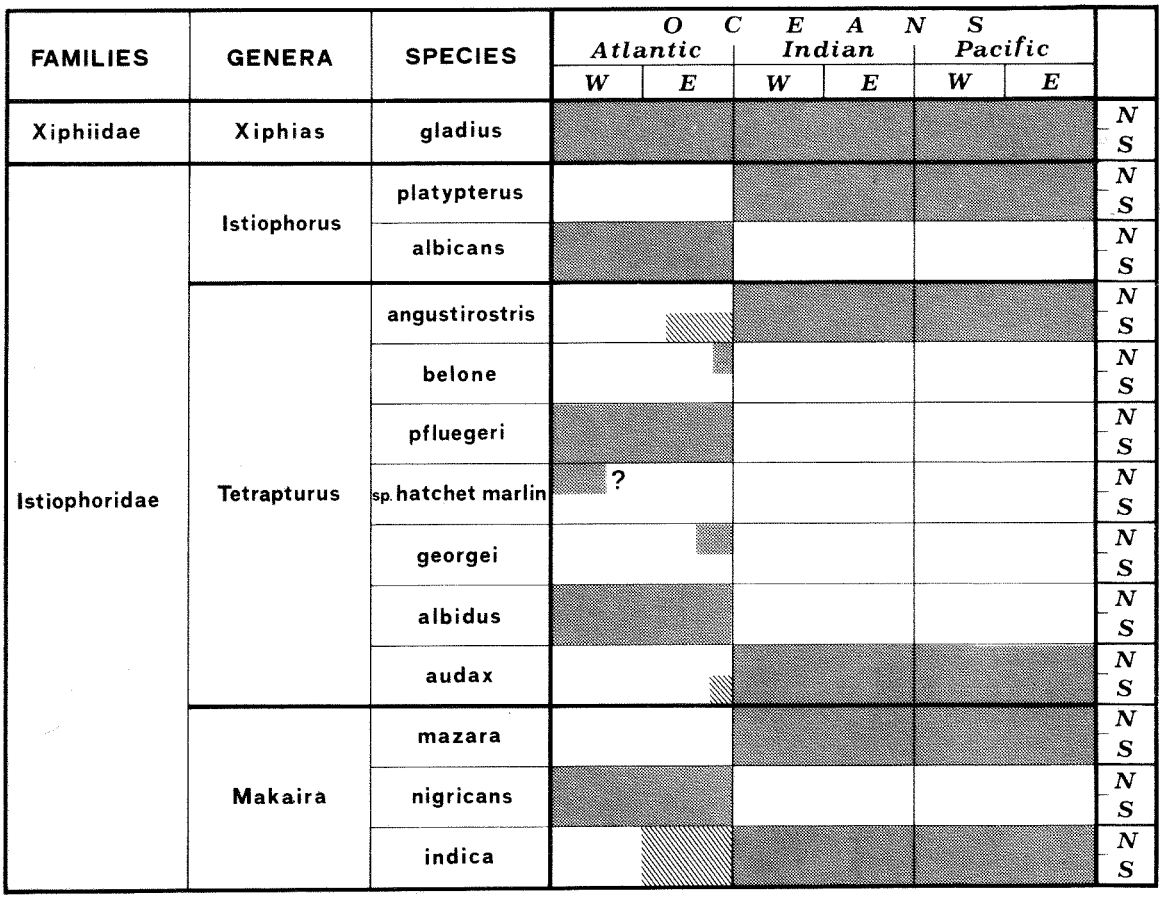


Fig.5 Schematic representation of the distribution of billfishes

W: Western; **E**: Eastern; **N**: Northern Hemisphere; **S**: Southern Wemisphere;

Principal distribution areas (including spawning grounds);

Areas of occasiona1 distribution, or invasion, (no spawning)
(modified after Nakamura, 1983, Fig.61)

Istiophorus albicans, I. platypterus, and Makaira indica migrate seasonally towards coastal waters, while T. angustirostris, M. mazara and M. nigricans are the most typically oceanic species. Roughly speaking, the migration pattern of all billfishes involves seasonal movements into temperate or cold waters for feeding and back to subtropical or tropical waters for overwintering and spawning. Although being among the largest and fastest bony fishes known from the sea, they seldom perform transoceanic migrations as is typical for the large tunas.

All species are dioecious (the sexes are separate) and their mating display is not completely known. None of the species are known to show sexual dimorphism in morphological features or colour pattern, but females of many species attain larger sizes than males. Batch-spawning of most species takes place in tropical and subtropical waters. The eggs are very small (about 1 mm in diameter) and pelagic, hatching out into planktonic larvae.

Billfishes are active and voracious predators, using their long rostrum for attacking their prey. Most likely there are no true, regular predators of billfishes, although they are preyed upon occasionally by many large oceanic fishes, such as tunas, wahoo, skipjack and dolfinfishes, particularly during their younger stages. The young are also taken sometimes by adult billfishes.

Being excellent foodfish, all species are of some importance to fisheries. Their commerical value is particularly high in Japanese markets. Most of them are exploited commercially by longliners and all are regarded as excellent and exciting targets by sportsfishermen. The recent world production of billfishes fluctuates around 95,000 metric tons per year (Table I) of which more than 90% is taken as bycatch in tuna longline fisheries. This bycatch represents in weight about 10% of the actual tuna catches (genus Thunnus). Japan produced about 70% of the world's catch and is the principal consumer country for these fishes. The species predominating in the catches are Xiphias glaudius, Makaira mazara, and Tetrapturus audax, accounting for about 40%, 23% and 17%, respectively, of the toal world catch.

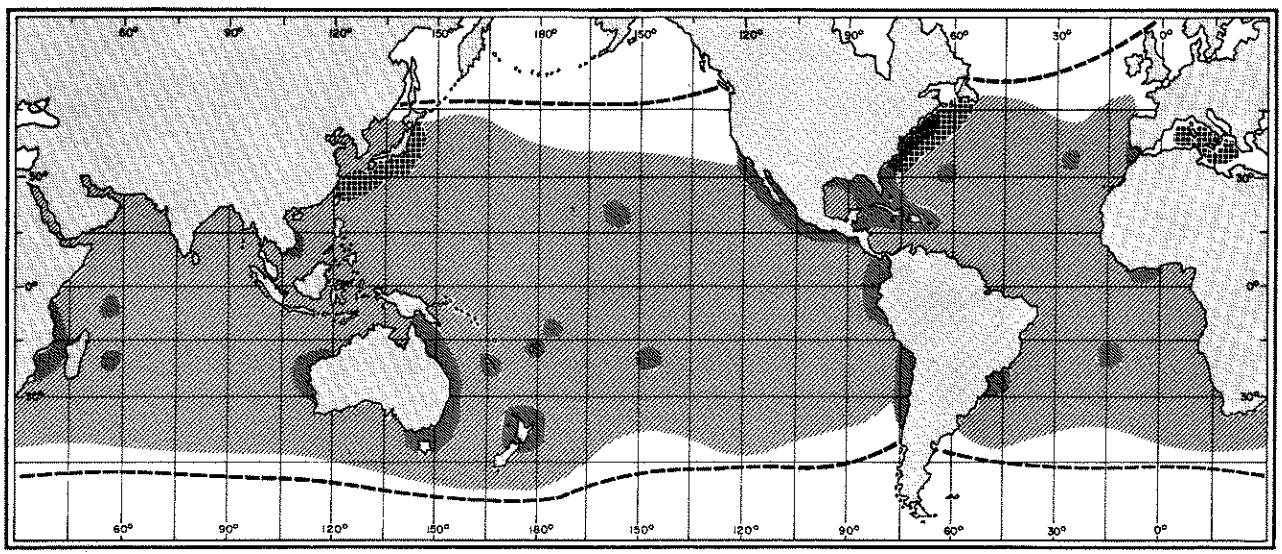
TABLE I

Estimated world catch of billfishes and tunas in metric tons (source : FAO, 1983, 1984)

Systematic Category	1978	1979	1980	1981	1982
Istiophorus albicans	267	2 823	1 320	1 091	920
Istiophorus platypterus	10 516	7 961	7 767	6 438	7 214
Makaira indica	2 909	3 440	2 465	2 453	2 373
Makaira mazara	18 193	18 654	21 109	21 413	20 727
Makaira nigricans	1 842	2 160	2 328	2 218	2 448
Tetrapturus albidus	204	93	119	121	131
Tetrapturus audax	15 426	15 988	18 429	15 664	15 460
Istiophoridae n.e.i.*	5 920	5 339	6 062	6 350	7 320
Subtotal Istiophoridae	55 277	56 483	59 599	55 748	56 593
Xiphias gladius	40 279	37 922	36 402	37 726	40 321
Subtotal Xiphiidae	40 279	37 922	36 402	37 726	40 321
Total Billfishes (Xiphioidei)	95 556	94 405	96 001	93 474	96 914
Thunnus alalunga	222 775	191 014	182 084	186 125	183 481
Thunnus albacares	521 466	537 987	522 412	560 274	535 725
Thunnus atlanticus	78	105	300	845	807
Thunnus maccoyii	32 415	35 475	39 186	37 226	29 005
Thunnus obesus	210 358	195 635	201 021	175 047	182 940
Thunnus thynnus	35 601	35 485	32 479	44 478	41 365
Thunnus tonggol	34	48	9	368	4 020
Total Thunnus	1 022 727	995 749	977 491	1 004 363	977 343
Ratio: Xiphioidei/Thunnus	0.093	0.095	0.098	0.093	0.097

*n.e.i.= not elsewhere identified

Billfishes are caught with a variety of fishing methods, such as longlining, trolling, harpooning, drift-netting, set-netting and others. The most important fishing method used in commercial fisheries is surface-longlining which was gradually developed by Japanese, Chinese (fishermen from Taiwan Province) and Korean fleets originally operating in the northwestern Pacific and then extending to other Pacific areas and to the Indian and Atlantic oceans. This method is also extensively used by other fishing nations, particularly the USSR and Cuba. On the other hand, sportsfishing is exclusively effected by trolling. Figure 6 represents the general distribution of commercial and sportsfishing areas for billfishes. The commercial longline fisheries cover nearly the entire natural distribution areas of the species, while all other fisheries are more restricted. The areas where commercial longline fisheries overlap with sportsfishing have recently been subjected to conflicts of interests in relation to the extension of Exclusive Economic Zones, and hence, fishing rights, to 200 miles offshore.



Surface longline fishertes Principal sportfishing grounds Harpoon fishing grounds

------ Approximate natural distribution of billfishes based on literature and personal communications from fishermen

Fig.6 Schematic illustration of the world's commercial and sport fisheries for billfishes (modified after Nakamura, 1983, fig.62)

Virtually all billfishes are highly appreciated for the excellent quality of their flesh. Fish over 20 kg are generally used for "sashimi" (sliced raw flesh with soy sauce and green mustard) and materials for "sushi" (sliced raw flesh with green mustard on vinegar-boiled rice balls). The colour of billfish flesh is usually paler than that of tuna. One of its advantages is that it does not change colour as easily as tuna flesh, thus withstanding longer periods of transportation and having a longer market shelf-life than tuna meat.