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BARRACUDAS (PISCES: SPHYRAENIDAE) OF THE INDIAN OCEAN AND ADJACENT SEAS—A PRELIMINARY REVIEW OF THEIR SYSTEMATICS AND ECOLOGY[1],[2]

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ABSTRACT

A preliminary review of the barracudas of the Indian Ocean and adjacent seas is presented. With the notable exception of the study of Williams (1959), the majority of published identifications of barracudas from this region have been incorrect because of a virtual lack of illustrations and because of inadequate original descriptions.

All species are relegated to the genus *Sphyraena* Röse. A tentative key to the Adults of the 11 species which occur in this region is presented. These species are: *forsteri, africana, acutipinnis, obtusata, flavicauda, novaehollandiae, barracuda, bleekeri, qenie, jello and idiastes.* All other nominal species described from the Indian Ocean are tentatively synonymized with these species. The identity of *putnamiae, toxeusa, dentatus,* and *koehleri* has not yet been resolved.

Barracudas are important to man for food and recreation. However, they present a threat because they attack swimmers and bathers. In certain Indo-Pacific regions, as well as in the Caribbean, several species have been implicated in ciguatera (ichthyosarcotoxism), or poisoning caused by eating freshly captured specimens. The poisoning is believed to be associated with the food habits and ecology of certain species. However, published literature determining which species are dangerous to man or are poisonous to eat, and which geographic areas are responsible, is inadequate to identify the species involved. It is urged that adequate series of study specimens be collected from all parts of the Indo-Pacific, together with records of attacks and poisonings for those areas, so that distributional and ecological analyses can be effected.

INTRODUCTION

THE barracudas (Pisces: Family Sphyraenidae) are important food and sport fishes of the tropical, subtropical, and occasionally, temperate world oceans. Some are either common or reach a large size, thus providing a delicious commodity, yet some species are dangerous to eat at times because, depending on where and when they are caught, they are involved in ciguatera (ichthyosarcotoxism) poisoning, which is apparently due to the diet of certain species. Some species are frequently toxic, while other species are never poisonous.

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Further, because of their large size (to 2 meters) and their speed (to 12 meters/sec) they are dangerous to man, and many cases of attacks on man are documented. However, the identities of only a few individuals are known in such cases of poisoning or attack. The difficulties are reflected in the identification of these pike-like marine fishes, all of which look alike, and descriptions by many authors might well apply to any of the 69 nominal species which have been described. Of these, about 20 species are valid and about half occur in the Indian Ocean and adjacent seas. Some are worldwide, but many members are Indo-Pacific endemics, and a few may be confined to island groups, a peculiar attribute in a semi-pelagic family containing species which are often worldwide.

No taxonomic key or distributional and ecological analysis can be undertaken on the barracudas of the Indian Ocean and adjacent seas without adequate study specimens. The present paper is designed primarily to stimulate interest of others in obtaining good series of these hard-to-collect species, hopefully so that a worldwide revision of the family, now in preparation, can be completed. This revision will include detailed illustrations of the postlarvae, juveniles and adults of all species, complete synonymies, biological and ecological notes, and accounts of their zoogeography and evolutionary trends.

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MATERIALS AND METHODS

In addition to type and other materials examined or data obtained from the above-mentioned sources, numerous specimens collected in the Indian Ocean during the International Indian Ocean Expedition cruises have been sent from the Smithsonian Institution Sorting Center. Other specimens have been purchased through the Smithsonian Carangid Project, U. S. Government Public Law 480 funds. Additional specimens for comparative purposes were furnished through the Guinean Trawling Survey.

In the treatment of barracudas of "adjacent seas," this is herein meant to include the so-called Indo-Pacific, or that region of the Indian Ocean from East Africa to the Red Sea, the Persian Gulf and Arabian Sea, eastward to the Bay of Bengal, and from Indonesian seas northward to the Yellow Sea, eastward to include Micronesia, Melanesia, and the Hawaiian Islands, and southward to Australian waters.

TAXONOMY

The barracudas have traditionally been placed in a single genus, *Sphyraena* Röse 1788. Fowler (1903), Whitley (1947), and Smith (1956) have erected various genera for this family, but there is little evidence to disagree with other analyses of the family (Schultz, 1953; Williams, 1959; de Sylva, 1963) that all species should be relegated to the genus *Sphyraena*. Generic names proposed by Fowler, Whitley, and Smith include *Australuzza* Whitley, *Agriopsphyraena* Fowler (subgenus), *Indosphyraena* Smith, *Callosphyraena* Smith, and *Sphyraenella* Smith. However, while not indicative of the generic characteristics they were originally intended to identify, they may indeed suggest important phyletic trends at the subgeneric level, which can only be covered in the proposed world-wide revision.

Two basic problems have permeated barracuda taxonomy: the great similarity among species—all have sharp, well developed teeth, all have two dorsal fins, and most appear to have no distinctive pattern of shading—and the lack of large jars by collectors. The first drawback has resulted in descriptions which are insufficient to differentiate among most species, while the second has encouraged the description of juveniles as new species, or of several ontogenetic stages of the same species.

No comprehensive review of the barracudas of the world is available. Schultz (1953) based his material only on specimens in the U. S. National Museum, and used fin lenghths as diagnostic characters which are, at best, useful to delineate growth stadia. Smith (1956) followed the same pitfalls for Indian Ocean barracudas. Williams (1959), although he purported to cover only the western Indian Ocean, had the greatest insight into the taxonomic problems of the family, and clearly has done the most to elucidate taxonomic as well as biological problems. Williams also had the distinct advantage of being able to evaluate freshly caught specimens. He observed the important trenchant colour differences characteristic of many barracuda species, and thus could relate fresh material to preserved specimens.

Barracudas, as previously mentioned, do not show the great diversity in adaptive radiation typical of many tropical fishes. The main taxonomic characters useful in identifications, as well as those dividing the sub-groups, may not be useful in delineating phyletic lines. This can only be ascertained when all species of the family are studied.

In the following sections, a provisional key is presented which should be useful for identifying specimens larger than 15-20 cm. No attempt has been made to interpret the relative ontogenetic changes in the position or length of fins, which may well result in further synonymizing of certain species.

Under species accounts, the species synonymies include citations to original descriptions which I am provisionally considering to be synonyms. Variations in orthography are noted for species names. Nominal species of *Sphyraena*, their type locality, and probable identity considered as of this writing are summarized in Table 1.

TABLE 1. *Summary of nominal species of* Sphyraena *of the tropical Indo-Pacific and their probable identities*

Name	Type Locality	Probable Identity
Sphyraena acutipinnis Day 1876	Malabar, India	*
S. affinis Ruppell 1835	Red Sea	*S. barracuda*
S. africana Gilchrist & Thompson 1909	Natal, South Africa	* +
S. agam Ruppell 1835	Red Sea	*S. barracuda*
S. akerstromi Whitley 1947	Western Australia	*S. barracuda*
S. altipinnis Ogilby 1910	Northern Australia	*S. genie* +
S. aureoflammea Seale 1909	Philippines	*S. obtusata*
S. barracuda (Walbaum) 1792	West Indies	*
S. bleekeri Williams 1959	East Africa	*
S. brachygnathos Bleeker 1854	Batavia	*S. flavicauda* +
S. chinensis Lacépède 1803	China?	*S. flavicauda* +
S. chrysotaenia Klunzinger 1884	Red Sea	*S. obtusata*
S. commersoni Cuvier 1829	India	*S. barracuda*
S. dentatus Saville-Kent 1893?	Australia	undeterminable +
S. dussummieri Cuvier 1831	Indian Seas	*S. barracuda*
S. flavicauda Ruppell 1835	Red Sea	*
S. forsteri Cuvier 1829	Otaiti	*
S. goodingi Seale 1906	Marquesas	*S. forsteri*
S. grandisquamis Steindachner 1866	New South Wales	*S. flavicauda*

Name	Type Locality	Probable Identity
S. helleri Jenkins 1901	Hawaii	*S. africana* +
S. idiastes Heller & Snodgrass 1903	Galapagos Islands	*
S. japonica Cuvier 1829	Japan	undeterminable
S. jello Cuvier 1829	South India	*
S. kadenar Thiollière 1857	Moiou (New Guinea)	*S. barracuda*
S. kenie Klunzinger 1884	Red Sea	*S. qenie*
S. langsar Bleeker 1854	Indonesia	*S. flavicauda* +
S. lineata Stead 1908	New South Wales	*S. obtusata* +
S. macrolepis Ehrenberg & Hemprich 1899	Red Sea	*S. flavicauda*
S. megalolepis Peters 1876	Australia?	*S. flavicauda*
S. microps Marshall 1953	South Queens land	*S. barracuda*
S. natalensis Von Bonde 1923	Natal, South Africa	*S. africana*
S. nigripinnis Temminck & Schlegel 1843	Japan	undeterminable +
S. novaehollandiae Günther 1860	Port Phillip Bay, Victoria (Australia)	* +
S. nuageuse Liénard 1843	Ile de France	*S. barracuda*
S. obtusata Cuvier 1829	India	*
S. permisca Smith 1956	South Africa	*S. jello*
S. pinguis Günther 1874	China	*S. obtusata*
S. putnamiae Jordan & Seale 1905	Hong Kong, China	*?
S. qenie Klunzinger 1870	Red Sea	*
S. raghava Chaudhuri 1917	Orissa State, eastern India	*S. idiastes*
S. schlegeli Steindachner 1896	Japan?	*S. obtusata* +
S. snodgrassi Jenkins 1901	Hawaiian Islands	*S. barracuda*
S. strenua De Vis 1883	Queens land	*S. flavicauda*
S. tessera Smith 1956	South Africa	*S. qenie*
S. toxeuma Fowler 1904	Sumatra	*S. forsteri*
S. waitii Ogilby 1908	Port Jackson, Australia	*S. africana* +

*= valid species

+ = tentative

PROVISIONAL KEY TO THE BARRACUDAS OF THE INDIAN OCEAN AND ADJACENT SEAS*

1a. First gill arch with platelets, each bearing several small spines (Fig. 1a); a well-defined dusky blotch underneath base of pectoral fin..... .....*Sphyraena forsteri* Cuvier

1b. First gill arch without spine-covered platelets as above; either one or two (rarely three) gill rakers or none.....2

2a. Gill rakers absent.....7

2b. Gill rakers present.....3

*The probable identity of *Sphyraena putnamiae* Jordan and Seale, 1905, *Sphyraena toxeusa* Forster, 1844 (?), *Sphyraena dentatus* Saville-Kent, 1893 (?), and *Sphyraena koehleri* Curtiss, 1938, has not yet been ascertained, and they are not included in this key. They are rare, if valid, species, and their status is discussed briefly in the text following accounts of other species.

3a. A single gill raker at angle of first gill arch (Fig. 1b).....4

3b. Two (rarely three) gill rakers on first gill arch (Fig. 1c).....6

4a. Lateral line pores 120-128, usually 124-127; depth of body 6.5-8.5 times in standard length.....5

4b. Lateral line pores 130-155, usually more than 135; depth of body 9.5 times in standard length.....*Sphyraena novaehollandiae* Günther

5a. Preopercle with a skinny flap beneath its posterior edge (Fig. 2a)..... .....*Sphyraena africana* Gilchrist and Thompson

5b. Preopercle without skinny flap beneath its posterior edge (Fig. 2b)..... .....*Sphyraena acutipinnis* Day

6a. Pectoral fin reaches past origin of first dorsal fin; height of dorsal fin equal to or greater than postorbital length.....*Sphyraena obtusata* Cuvier

6b. Pectoral fin does not reach to origin of first dorsal fin; height of dorsal fin less than postorbital length.....*Sphyraena flavicauda* Rüppell

7a. Lateral line pores more than 100; no black splotches on lower sides of body.....8

7b. Lateral line pores less than 100; usually 80-90; sides with several inky blotches beneath laternal line.....*Sphyraena barracuda* (Walbaum)

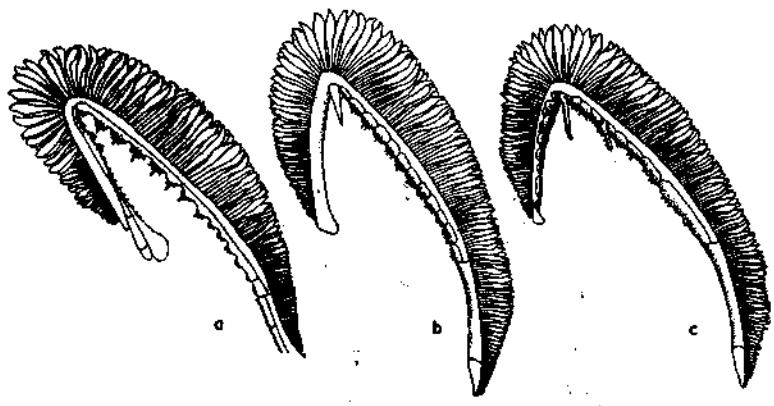

Fig. 1. First gill arch of selected species of *Sphyraena*. a, *Sphyraena forsteri*; b, *Sphyraena africana*; c. *Sphyraena obtusata* and *Sphyraena flavicauda*.

8a. Origin of first dorsal fin distinctly behind the origin of pelvic fins; sides marked with vertical or angled bars, or with chevrons.....9

8b. Vertical line at origin of first dorsal fin intersects at or only slightly behind origin of pelvic fins; sides without vertical or angled bars, or chevrons..... .....*Sphyraena idiastes* Heller and Snodgrass

9a. Preopercle smoothly rounded (Fig. 2c); dark bars on sides not in the form of chevrons.....10

9b. Preopercle obliquely rounded (Fig. 2d); sides with chevron-shaped markings .....*Sphyraena bleekeri* Williams

10a. Lateral line pores 120-130, usually 127-130; sides of body with angled vertical bars reaching below lateral line forming an SS-pattern; dorsal fins and anal fin usually dark, the last two anal rays pale..... .....*Sphyraena qenie* Klunzinger

10b. Lateral line pores 130-140, usually 135-140; sides of body with serpentine pattern; dorsal fins dusky to pale.....*Sphyraena jello* Cuvier

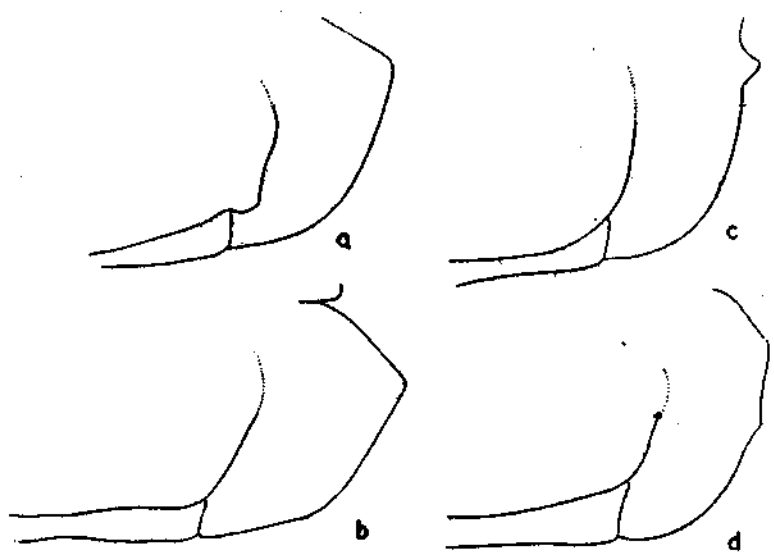

Fig. 2. Shape of preopercle of selected species of *Sphyraena*.
a. *Sphyraena africana;* b. *Sphyraena acutipinnis;* c. *Sphyraena qenie* and *Sphyraena jello;* and d. *Sphyraena bleekeri.*

SPECIES ACCOUNTS

Sphyraena forsteri Cuvier, 1829 (Fig. 3a)

Sphyraena forsteri Cuvier, 1829: 261, based on *Esox sphyraenoides* of Banks library. Type locality: Otaiti. Redescription and designation of neotype by Klausewitz and Bauchot (1967).

Sphyraena toxeuma Fowler, 1904: 502-504, Pl. IX, middle figure. Type locality: Padang, Sumatra.

Sphyraena goodingi Seale, 1906: 18, Fig. 4. Type locality: Nukuhiva, Marquesas Islands.

(?) *Sphyraena toxeusa* Seale, 1910: 269. Borneo. *?Lapsus calumnae* for *S. toxeuma* Fowler, 1904.

This species is readily identified by the distinctive spinigerous platelets on the first gill arch and the inky blotch underneath the base of the pectoral fin. Cuvier's original description made no mention of either character and, in fact, his brief description could apply to several species. Schultz (1953), Smith (1956), and Williams (1956) in their reviews concurred on this inadequacy, and agreed that *toxeuma* Fowler was the first unmistakable description which was applicable to this barracuda. Klausewitz and Bauchot (1967) located a specimen of *forsteri* in the Muséum National d'Histoire Naturelle, Paris. which they designated as a neotype.

Sphyraena forsteri occurs only in the Indo-Pacific; it is recorded with certainty from East Africa to India, the East Indies, the Philippines, the Marquesas, and northeastern Australia. It probably occurs throughout the entire Indo-Pacific. As Williams (1959) pointed out, it is more active at night, and greater intensity of collecting at night should clarify its distribution.

Williams (1957, 1965) took this large-eyed species (*"S. toxeuma"*) close to shore or over shallow banks, and frequently near the bottom. Spawning season in the Indian Ocean is presumably November to April in East African waters, corresponding to the northeast monsoon season. As with most large barracudas, they seldom seem to be captured on hook and line during the spawning season, and hence the estimated time of the reproductive period is based on extrapolation. *S. forsteri* feeds mainly on fish, but penaeid shrimps and squids are eaten occasionally. In East Africa it reaches 640 mm S. L. and a weight of 4 pounds, and a modal weight of 2 pounds.

Based on literature records of the Indo-Pacific, de Sylva (1963: 128) listed *S. forsteri* as among those which are reported to be toxic when eaten. Because of the uncertainty of identifications of this barracuda, as well as most others, speculation on its poisonous qualities is unwarranted.

Sphyraena novaehollandiae Günther, 1860 (Fig. 3b)

Sphyraena novae-hollandiae Günther, 1860: 335. Type locality: Hobson's Bay, Port Phillip (Victoria), Australia.

This species has never been adequately described, and its redescription, based on a complete size series of fresh material is badly needed and until then it seems desirable to maintain this slender barracuda as a distinct species. It is closely related to other slender barracudas of the *acutipinnis-africana-helleri* complex which have a single gill raker and the origins of their first dorsal fin and pelvic fins almost in opposition. The distinguishing characters used to separate these taxa from one another and from *novaehollandiae* are the body depth, the number of lateral line scales, the relative position of the pectoral fin

tips to the first dorsal and pelvic fins, the relative position of the origin of the first dorsal and pelvic fins, the length of the maxillary bones, and the shape of the preopercle. With the exception of the lateral line scale count—which is in need of critical analyses in these species—the remaining characters may be shown to vary ontogenetically. If the other nominal species of all these slender species are shown to be growth stadia of the same taxon, then *S. novaehollandiae* would be the name of this barracuda.

It is known with certainty only from the type locality, which was based on a dried skin of 344 mm S. L., but there are museum identifications of this species from New Guinea and Indian Seas. In Australia it is reported to grow to 3 feet, but several other species, whose identification is similarly problematical, also occur there. Its flesh is reportedly delicious and never toxic when eaten.

Sphyraena africana Gilchrist and Thompson, 1909 (Fig. 3c)

(?) *Sphyraena japonica* Cuvier 1829: 261-262. Type locality: Japan (?).

(?) *Sphyraena novaehollandiae* Günther, 1860: 335. Type lacality: Hobson's Bay, Port Phillip (Victoria), Australia.

(?) *Sphyraena helleri* Jenkins, 1901: 387-388. Type locality: Honolulu, Hawaii.

(?) *Sphyraena waitii* Ogilby, 1908: 29-30. Type locality: Port Jackson, New South Wales.

Sphyraena africana Gilchrist and Thompson, 1909: 255-256. Type locality: South Africa.

Sphyraena natalensis von Bonde, 1923: 10-11, Pl. III, Fig. 2. Type locality: Natal coast.

As discussed under the account of *S. novaehollandiae*, the status of this nominal species has not been investigated. Williams (1959) used the name *africana* for the East African barracuda with a single gill raker, and discussed the problem of identifying the taxon which was associated with the description of *S. japonica* Cuvier. Most authors agree that *japonica* Cuvier is presently unidentifiable, and have concluded that *africana* is the first name applicable to the Indo-Pacific barracuda with a single gill raker, with its first dorsal fin and pelvic fins in opposition, and a rounded preopercle. But *S. novaehollandiae* Günther, *S. helleri* jenkins, and *S. waitii* Ogilby are all similar to *africana* and to one another; these are in need of critical comparasion over a large size range. While *japonica* probably should not be applied to this taxon, and assuming *novaehollandiae* is a distinct species, then the identity of *S. helleri* and *S. waitii* would have to be determined, as the description of these shows them to be extremely close to *S. africana*, or identical with it, and thus either name may be a senior synonym. To this synonymy may possibly be added *S. acutipinnis* Day 1876, the type of which lacks a preopercular flap (Fig. 2b), yet this may be an ontogenetic feature.

The *"africana"*-type barracuda would appear to be distributed throughout the Indo-Pacific although, clearly, the distribution of the one or more species involved must await the study of additional material. Williams (1959) reported that *africana* in East African waters was taken at night on handlines by fishing on or just above the bottom in shallow bays over sandy bottom. As in the case of *S. forsteri*, intensive night-time fishing should prove to clarify the distribution of the species. According to Williams (1959), it grows to 300 mm.

Sphyraena acutipinnis Day, 1876 (Fig. 3d)

Sphyraena acutipinnis Day, 1876: 342, Pl. 79, Fig. 1. Type locality: Sind, Pakistan.

Smith (1956) and Williams (1959) discussed the probable identity of this species, the location of the type of which was unknown. Talwar (1968) located the type (434 mm S. L.) in the collections of the Zoological Survey of India. He redescribed the type, asserting that it was distinct from all other Indo-Pacific sphyraenids, although close to *africana*, from which it could be distinguished by the absence of a preopercular flap in *acutipinnis*. Because, as discussed previously the presence of this flap may be a function of growth, all species with a single gill raker and a preopercular flap may be junior synonyms of *acutipinnis*.

The species is known only from the type.

Sphyraena obtusata Cuvier, 1829 (Fig. 3e)

(?) *Sphyraena chinensis* Lacépède, 1803, Pl. 10, Fig. 2., after Richardson.

Sphyraena obtusata Cuvier, 1829: 258-259.

Sphyraena pinguis Günther, 1874: 153-159. Type locality: Chefoo, China.

Sphyraena obtusa Bleeker, 1875: 79 (*Lapsus calumnae?*).

Sphyraena schlegeli Steindachner, 1896: 209. Type locality: Japan?

Sphyraena aureoflammea Seale, 1909: 502-503. Type locality: Zamboanga, Mindanao, Philippines.

This species and the following (*S. flavicauda*) represent a species pair which is very difficult to understand. The original description of Cuvier (1829) was essentially inadequate to differentiate it from several other species, and hence subsequent authors have either used *obtusata* for any small barracuda with a skinny preopercular flap and two gill rakers or have decided that the description of *obtusata* was insufficient and have then used subsequent descriptions. Although the nomenclatorial problem is beyoned the scope of the present paper, I believe that specimens of *obtusata* are sufficiently well described by Cuvier's contemporaries (especially Bleeker) to conclude that *obtusata* should be used for the species described here. The name *chrysotaenia* has been used by various workers as the first applicable name (Williams, 1959). The type of *chrysotaenia*, however, represents a young stage of *flavicauda*.

This wide ranging barracuda is confined to the Indo-Pacific. It schools in large numbers in the smaller stages, and larger ones are taken on handlines just off the bottom (Williams, 1959). It grows to about 230 mm.

Sphyraena flavicauda Rüppell, 1835 (Fig. 3f)

Sphyraena flavicauda Rüppell, 1835: 100, Table 25, Fig. 3. Type locality: Red Sea.

Sphyraena langsar Bleeker, 1854a: 367. Type locality: Batavia.

Sphyraena brachygnathos Bleeker, 1854a: 368. Type locality: Batavia, Java.

Sphyraena brachygnathus Kner, 1865: 139. (new spelling).

Sphyraena grandisquamis Steindachner, 1866: 23-25. Type locality: Port Jackson, Australia.

Sphyraena megalolepis Peters, 1876: 842. Type locality: "New Ireland."

Sphyraena chrysotaenia Klunzinger, 1884: 128-129, Table ix, Fig. 3. Type locality: Red Sea.

Sphyraena strenua De Vis, 1884: 287. Type locality: Moreton Bay, Australia.

Sphyraena lineata Stead, 1908: 47, Pl. xv. Type locality: New South Wales.

S. flavicauda and *S. obtusata* (=*S. chrysotaenia* of Williams, 1959) have been widely confused. William's (1959) methods of separation of the two seem the best (at least for adults), and his key characters are used here. Their taxonomic history is discussed in part by Williams (1959) and serves to clarify much of the problem. The synonyms listed herein appear to be various ontogenetic stages of *flavicauda*. This problem is in need of critical examination and is currently under study. The types of all but one nominal species (*S. strenua*) have been examined.

It has schooling habits similar to those of *S. obtusata*. Adults (over 200 mm) are taken at night, while younger specimens are caught in beach seines. It grows to about 300 mm.

Sphyraena barracuda (Walbaum, 1792) (Fig. 4a)

Esox barracuda Walbaum, 1792: 94. Type locality: West Indies.

Sphyraena sphyraena var. *picuda* Bloch and Schneider, 1801: 110, Table 29, based on Parra, vol. 35, p. 90. Type locality: southern America, West Indies.

Sphyraena sphyraena var. *plumerii* Bloch and Schneider, 1801: 110, based on Bloch, Table 396. Type locality: Antilles.

Sphyraena becuna Lacépède, 1803, 5: 325, Pl. 9, Fig. 3. Type locality: Martinique.

Sphyraena becuna Cuvier, 1829, 3: 251-252. Type locality: Antilles, Brazilian coast.

Sphyraena barracuda Cuvier, 1829, 3: 253-257. Type locality: Brazil.

Sphyraena commersonii Cuvier, 1829, 3: 260-261. Based on Lacépède, 1803, Pl. 8, Fig. 3. Type locality: Indian Seas.

Sphyraena dussumierii Valenciennes, 1831. Type locality: Indian Ocean.

Sphyraena affinis Rüppell, 1835: 98-99. Type locality: Red Sea.

Sphyraena agam Rüppell, 1835: 99, Table 25, Fig. 2. Type locality: Red Sea.

Sphyraena kadenar Thiollière, 1843. Type locality: Moiou, Melanesia.

Sphyraena nuageuse Liénard, 1843: 64. Type locality: Île de France.

Sphyraena snodgrassi Jenkins, 1901: 388. Type locality: Honolulu, Hawaiian Islands.

Sphyraena akerstromi Whitley, 1947: 131-136, (in part), Pl. xi, Fig. 1. Type locality: Lowendal Island, Western Australia.

Sphyraena microps Marshall, 1953: 54-55, Pl. 2, Fig. 3. Type locality: Moreton Bay, South Queensland.

The systematics and ecology of *S. barracuda* are discussed extensively by de Sylva (1963). Few new data have accrued for the Atlantic Ocean form. Williams (1965) presented excellent biological data on 210 specimens taken from East Africa, noting that this species feeds on fishes inhabiting fringing coral reefs. Throughout its range it is a solitary species (in the adult stage), and is caught virtually only during the day. Because of the large size it reportedly attains in the Indian Ocean (over 50 pounds), it is potentially dangerous, and indeed has such a reputation (Klunzinger, 1884; Smith, 1956) in western parts of the Indo-Pacific. Because in the Atlantic and western Pacific Oceans it has been implicated in cases of poisoning in man, data are needed on records of poisoning as well as attacks by identifiable specimens.

Sphyraena bleekeri Williams, 1959 (Fig. 4b)

Sphyraena bleekeri Williams, 1959: 122-126, Pl. II D. Type locality: Msuka Bay, North Pemba (Tanzania), East Africa.

Williams (1959) was the first to recognize that this common Indo-Pacific barracuda with the chevron-shaped markings was distinctively different. No previous description, possibly save for that of *altipinnis* Ogilby, could possibly apply to *bleekeri*. Based on my studies of specimens in European museums, *S. bleekeri* has frequently been identified as almost every Indo-Pacific barracuda, but usually as *jello* Cuvier. Yet there is no consistency in identifications of *jello* are indeed *bleekeri* these records must be discarded except where identifications of the specimens have been confirmed in the light of Williams' new species.

This widespread species has been identified in collections throughout the Indo-Pacific from South Africa to the Red Sea, Persian Gulf, Arabian Sea and northern Australia. It is one of the most cosmopolitan of all Indo-Pacific barracudas. A very close relative, *Sphyraena ensis* Jordan and Gilbert (1882), apparently is confined to the eastern Pacific.

Only Williams' (1959, 1965) research deals with the biology of this small, schooling species. It is normally taken at night on handline, near the bottom, although those taken by trolling were taken during daylight. It reaches a length of about 890 mm S. L. and a weight of about 8 pounds, with a modal weight of 2 pounds. *S. bleekeri* feeds primarily on fishes.

Sphyraena qenie Klunzinger, 1870 (Fig. 4c)

(?) *Sphyraena nigripinnis* Temminck and Schlegel, 1843: 34, Pl. 13, Fig. 1.

Sphyraena qenie Klunzinger, 1870: 823. Type locality: Red Sea.

Sphyraena genie Peters, 1876: 842. (New spelling or *lapsus calumnae*?)

Sphyraena kenie Klunzinger, 1884: 129. (New name for *qenie*).

(?) *Sphyraena altipinnis* Ogilby, 1910: 8. Type locality: Aru Islands, North Australia.

Sphyraena tessera Smith, 1956: 43, Pl. II, Fig. 6. Type locality: Assumption Island, Indian Ocean.

Sphyraena jello altipinnis Whitley, 1964: 40 (New combination).

The status of *S. nigripinnis* has never been resolved. Smith (1956) and Williams (1959) discussed the nomenclatorial history of the species. Neither decided what to do with the name *nigripinnis*, but agreed that *qenie* Klunzinger, 1870 may be the first identifiable description of the taxon.

S. qenie is closely related to *S. jello* Cuvier, which is a well-defined species. Smith (1956) described *tessera*, which Williams (1959) synonymized with *qenie*. Still undetermined is the identity of the unfigured *S. altipinnis* Ogilby, which may be a valid species, or a synonym of *jello* or *qenie*. The present writer has several juvenile specimens from the Indian Ocean in which the colour pattern cannot be attributed to any known species, but which appears to be intermediate between that of *qenie* and *jello*. Only supplemental specimens will help to solve the problem.

S. qenie probably occurs throughout the Indo-Pacific. Williams (1959) recorded it from the Red and Arabian Seas, East Africa, and the western Pacific Ocean. It is a solitary form, taken by trolling close to fringing reefs and in the open ocean. Because it is usually caught at night, its true distribution should be clarified as collecting is expanded.

Sphyraena jello Cuvier, 1829 (Fig. 4d)

Sphyraena jello Cuvier, 1829: 258. Based on Russell's "Jellow", Pl. 174. Type locality: Pondicherry (Vizagapatam), India.

(?) *Sphyraena altipinnis* Ogilby, 1910: 8. Type locality: Aru Islands, North Australia.

Sphyraena permisca Smith, 1956: 45, Pl. II, Fig. 8. Type locality: Bazaruto, Mozambique, East Africa.

It is curious that this species should have been misidentified so frequently. The type, in the Muséum National d'Histoire Naturelle, Paris, clearly shows the vertical, serpentine bars characteristic of the species. Yet, as in the case of *S. qenie*, the juveniles sometimes display considerable variation in colour pattern from published descriptions, and possibly these are in reality neither *jello* nor *qenie*. The identity of *altipinnis* Ogilby has not been resolved (see under previous account), and possibly this is a synonym of *jello*.

Although *S. jello* is reported to occur throughout the Indo-Pacific, it is actually quite rare in collections, most specimens so identified being *S. bleekeri*. It is thus meaningless to discuss the range of *jello*, except to point out that it seems to be somewhat more common in the Arabian Sea and Bay of Bengal than to the south and east.

This is a large barracuda, growing to at least 1250 mm and a weight of 22 pounds, with a modal weight of 8 pounds (Williams, 1965). It is taken mostly by surface trolling during daylight hours, close to the land, on edges of reefs and shallow banks. The strikingly banded young "sometimes occur in fair-sized shoals on shallow banks" (Smith, 1956). They school in tight groups over reef

areas. Williams (1959, 1965) noted that underwater observations show the species to be much more numerous throughout the year than catches would indicate to the casual observer.

It has been suspect in cases of poisoning and attack (de Sylva, 1963), but as in other cases the identity of the culprit could not be confirmed from the literature. There is convincing circumstantial evidence, however, that this species may indeed be responsible for poisoning in and attacks upon humans.

Sphyraena idiastes Heller and Snodgrass, 1903 (Fig. 4e)

Sphyraena idiastes Heller and Snodgrass, 1903: 190-191, Pl. II. Type locality: Galápagos Islands.

(?) *Sphyraena raghava* Chaudhuri, 1917: 500-504. Figs. 20-21. Type locality: Chilka Lake, Satpara, Orissa Lake, India.

Sphyraena idiastes Heller and Snodgrass was described from the Galápagos Islands, and has since been reported only from the tropical eastern Pacific. It is closely related to several other eastern Pacific species, but has no close relatives in the Indo-Pacific except for *Sphyraena raghava* Chaudhuri, with which it appears identical. Differences appear only in fin position which may be attributable to the length difference in the types of *S. idiastes* ("length 480 mm") and of *S. raghava* (210 mm S. L.). It is difficult to relate the excellent, detailed description of *S. raghava* to any known Indo-Pacific sphyraenid, and it has neither been cited nor sighted since. Apparently Chaudhuri was unaware of the description of *idiastes* by Heller and Snodgrass. Until the types can be examined, *S. idiastes* is now reported from India on the basis of its being a senior synonym of *S. raghava*. There are no records attributable to either form between the Galápagos and India, or elsewhere.

NOTES ON OTHER SPECIES

Sphyraena toxeusa Forster is reported by Seale (1910: 269) as "a valuable food fish of Borneo; not yet recorded from the Philippines." I have been unable to locate the original description of this species, and Seale's reference (q. v.) is the only reference to this spelling I have found in the literature. Possibly the citation is a *lapsus calumnae* or a misprint for *sphyraena toxeuma* Fowler.

Sphyraena dentatus was described by Saville-Kent (1893), according to Schultz (1953: 279), yet Saville-Kent here ascribed this species description to De Vis (date?). I have been unable to locate the original description.

Sphyraena koehleri Curtiss, 1938 is cited by Fowler (1949: 72) as a synonym of *S. forsteri* Cuvier. The original description has not been seen by me, and therefore I have not attempted to determine the species identity.

Sphyraena putnamiae Jordan and Seale, 1905, from its description and figure, appears to be a phylogenetic offshoot which has no close relatives. I have not yet examined the type. The original description, which does not divulge the presence or absence of gill rakers, indicates 152 lateral scales, yet the illustration shows only 135-137. The dorsal fin origin is behind that of the pelvic fins, but in front of the pectoral fin tips (Fig. 4f). I have found no other specimens in museums, or literature descriptions which could be this species, although in some respects it is reminiscent of *S. bleekeri* Williams.

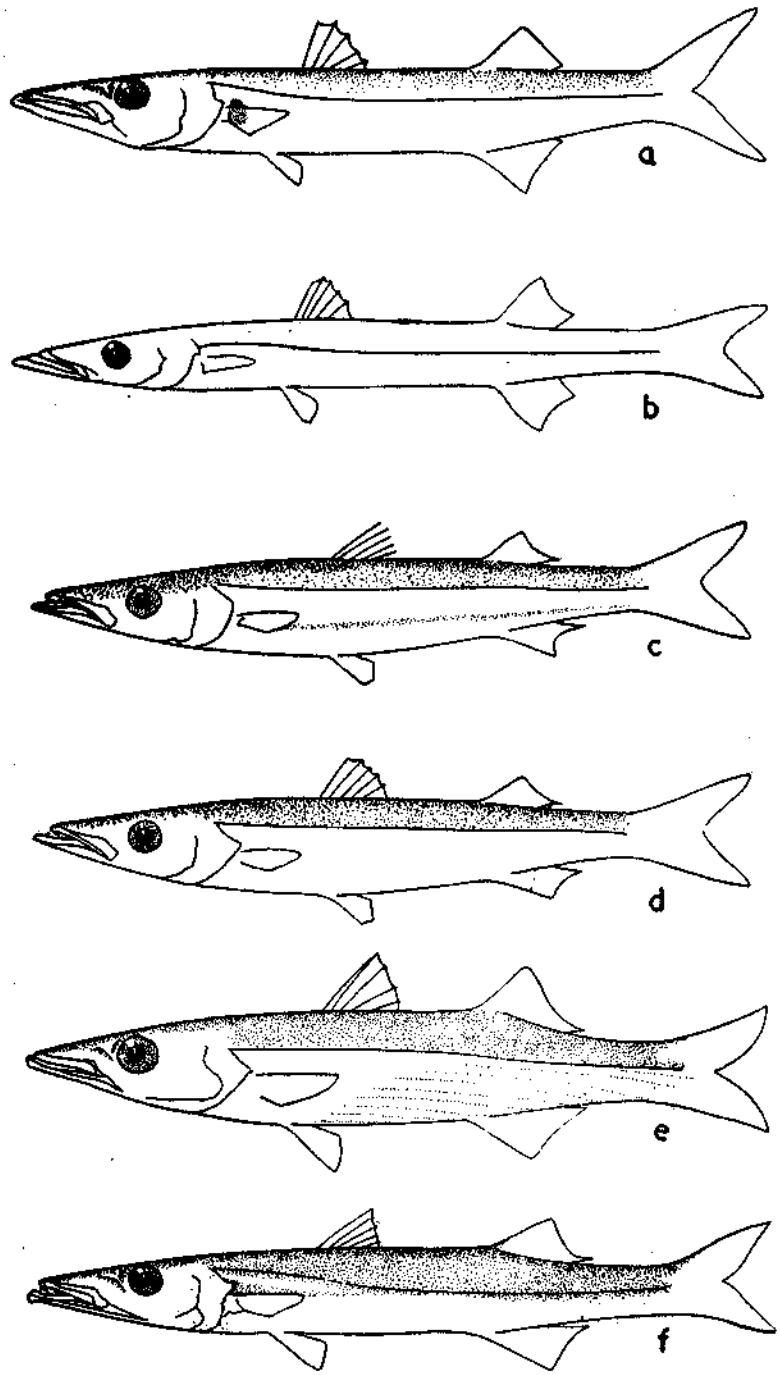

Fig. 3. Diagrammatic sketches of barracudas of the Indian Ocean and adjacent seas. a. *Sphyraena forsteri* 220 mm S L., Gulf of Siam, Thai-Danish Expedition, Sta 1051. Universitetets Zoologiske Museum, Copenhagen; b. *Sphyraena novaehollandiae*, about 750 mm, after Smith (1965 : 40. Fig 1); c. *Sphyraena africana*, 305 mm S.L , after Williams (1959, Pl I C); d. *Sphyraena acutipinnis*, 434 mm S. L , Pakistan based on description and figure of the type by Day (1876 : 342, Pl. 79, Fig. 1) and redescription of the type by Talwar (1968); e. *Sphyraena obtusata*, 180 mm S.L , Mozambique Channel, International Indian Ocean Expedition. Anton Bruun Sta. 409 K; and f. *Sphyraena flavicauda*, 330 mm S. L., Red Sea, Strait of Jubal, International Indian Ocean Expedition, Sta. HA - 32.

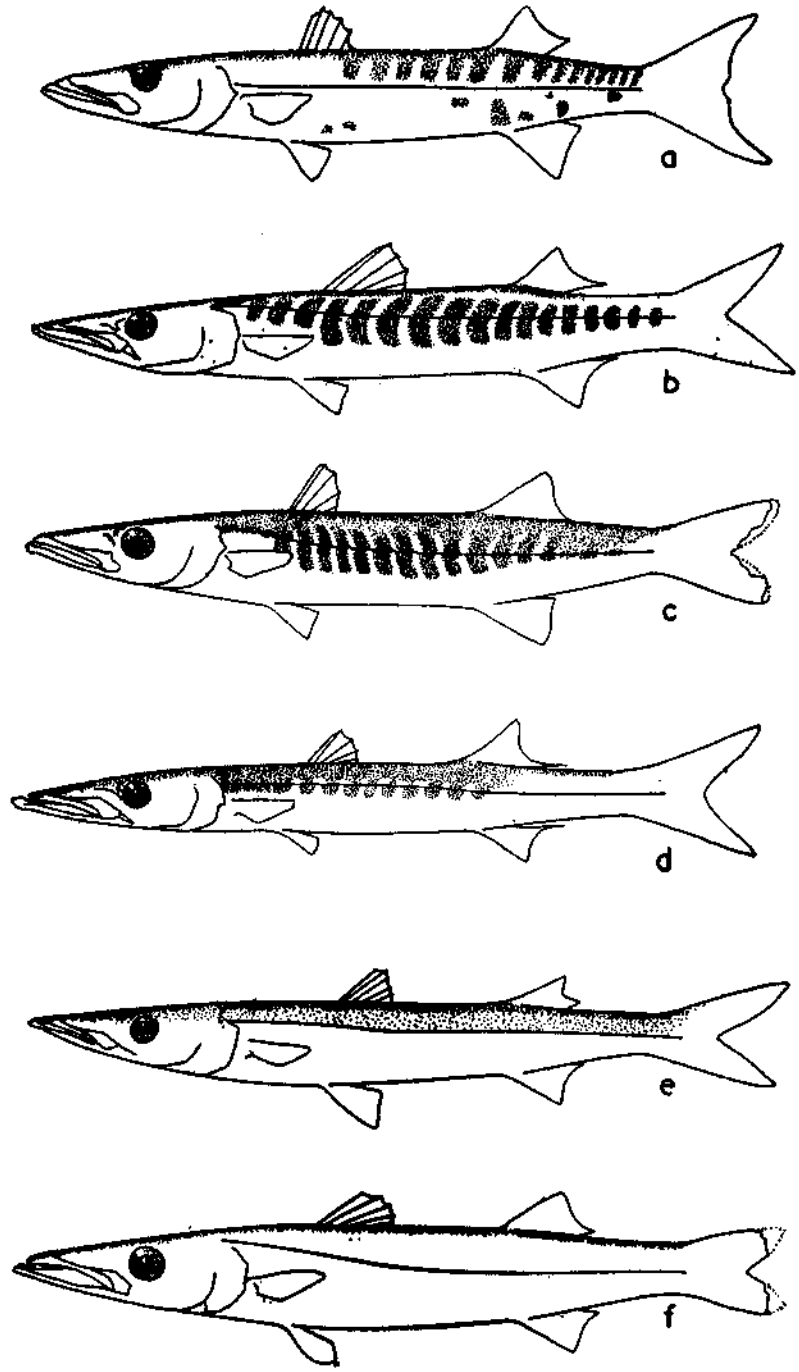

Fig. 4. Diagrammatic sketches of barracudas of the Indian Ocean and adjacent seas. a. *Sphyraena barracuda*, about 900 mm, after de Sylva (1963) and other drawings; b *Sphyraena bleekeri*, 457 mm S. L. Mahé Island, Seychelles, International Indian Ocean Expedition, Sta. F-118; c. *Sphyraena qenie*, 292 mm S. L., Makassar, Celebes, Siboga Expedition Sta. 71. Zoologisch Museum Amsterdam No. 109. 661; d. *Sphyraena jello* 500 mm, Muséum National d'Histoire Naturelle, Paris, No. 3554 A, Malabar, India; e *Sphyraena idiastes*, length (?) 480 mm, based on illustration by Heller and Snodgrass (1903, Pl. II); and f. *Sphyraena putnamiae*, length (?) 240 mm, based on illustration by Jordan and Seale (1905, Pl. XIII).

GENERAL BIOLOGY AND ECOLOGY

As far as known, all barracudas have similar life histories. Spawning evidently occurs over deep water at the edge of continental shelves, and the eggs drift inshore to develop. Young of 1-2 cm long are found living in mangrove, grass beds, or other sheltered nursery areas. After varying periods inshore, depending upon the species, they move offshore onto the coral reefs, and become semi-migratory, over deep water, or along the shallow slope water of the continental shelf. Adults of some species, especially *S. barracuda*, may become pelagic and swim hundreds of miles from shoal water.

Barracudas are ecologically divided into the solitary and schooling species, which on a world-wide basis partly follow phyletic lines, and which can be further divided into species which are active diurnally or nocturnally; they are tentatively grouped as follows:

a) *Solitary diurnal*: *barracuda, jello*

b) *Solitary nocturnal*: *forsteri, qenie, africana, novaehollandiae*?, *acutipinnis*?

c) *Schooling diurnal*: *obtusata, flavicauda*

d) *Schooling nocturnal*: *flavicauda*?, *bleekeri*

The large solitary diurnal species (*barracuda* and *jello*) are important as sport fishes, in addition to their being important commercially when taken by driftlines or handlines. There is some evidence that these two species may be predominantly, or even exclusively, involved in cases of fish poisoning (ciguatera), discussed subsequently, and that the other species, especially the schooling forms, are never toxic when eaten. The reason for this would appear to be associated with food habits and the large size attained by these toxic species of barracuda.

TOXIC AND DANGEROUS ATTRIBUTES OF BARRACUDAS

Certain barracudas may be poisonous when eaten. This type of poisoning, known as ciguatera in the Caribbean especially, and medically as ichthyosarcotoxism, results from persons having ingested perfectly fresh barracuda, as well as a number of other predators, or coral reef fishes (de Sylva, 1963; Halstead, 1967). It has nothing to do with bacterial decomposition or the reproductive cycle of the fish (except in the Tetraodontidae, in which the poisonous nature is distinct from ciguatera). The scientific consensus is that barracudas and other predators, as well as certain reef fishes, become toxic as a result of food they have ingested. The origin of the toxin is unknown, but is believed to originate with several species of bluegreen or green algae and subsequently transmitted through the food web by various means.

Poisonous fishes occur only in certain places, which may lose toxicity only to regain it subsequently. Some regions are always toxic, while other areas never have poisonous organisms. Depending on the species eaten and the size, poisoning can be severe and sometimes fatal. There is no way to detect toxic fishes, and no antidote for the poisoning other than symptomatic medical treatment.

Besides causing a public health problem and undue suffering, in regions which harbour poisonous fishes there is often a reluctance to eat *any* fishes, thus

destroying a valuable seafood market and aggravating a protein shortage already facing large portions of the world. It thus behooves us to learn more of the ecology of fish poisoning and the cause and prevention.

As Fish and Cobb (1954) wrote, there is probably more controversy over the toxicity of barracuda than any other fish species. Such controversy is in reality applicable to many fish species and is understandable considering the peculiar spatial and temporal distribution of poisonous fishes. In the Atlantic Ocean, only the great barracuda (*S. barracuda*) has been involved in poisoning (de Sylva, 1963), but in the Indo-Pacific the problem is complicated by the larger number of species and the difficulty of identifying them. In the Indo-Pacific *S. barracuda* has been identified as being poisonous (Hashimoto, 1956), as has *S. jello* (de Sylva, 1963: 128). *S. forsteri* has been implicated, but it appears that these were misidentifications of *S. barracuda*. Very possibly large barracuda species which are solitary daytime feeders of those coral-reef habitats (Hiyama, 1943) harbouring toxic fishes are responsible for poisonings, while small schooling nocturnal forms are never poisonous to eat.

In many parts of the Indo-Pacific, especially in the Indian Ocean, persons eat barracuda without suffering ill effects, although this may be because medical authorities or the poisoned persons do not recognise or report the outbreaks. It is easy to see why the identity of so few barracuda species has been ascertained when even ichthyologists cannot determine the species.

Fishes dangerous to man through their voraciousness or from their poison apparatus have been long feared, and are well known throughout the Indo-Pacific. Halstead (1967) discussed the problem at length, and for species such as sharks the solution to the problem of identification of the attacker may be in sight. Yet barracudas have attacked man and have caused fatalities throughout the tropics (de Sylva, 1963) and, again except in the Caribbean, where *S. barracuda* is the only large sphyraenid, the identity of the attacker and its ecology are unknown.

Because identification of any species must precede synthesis of ecological knowledge, it is urged that a systematic programme of collecting data on the identification of poisonous and dangerous tropical marine fishes and the etiology of these occurrences be investigated. A data center could be instrumental in implementing such a study. We know that barracudas—and other organisms—are poisonous and dangerous, but we do not know which ones are a problem, or under what conditions. This information is needed if the resources of the Indo-Pacific are to be intelligently developed for mankind. Perhaps the concept of such a data-synthesizing center could be the function of the present symposium.

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DISCUSSION

V. BALAN: Is colour an important character for identification? What is the largest size and weight?

W. KLAUSEWITZ: In addition to the usual characters, colour differences between species seems to be quite important. Size varies with species but specimens of more than two metres are not uncommon.

P. S. B. R. JAMES: There is a monograph on barracuda by Dr. Donald P. de Sylva himself where lot of information on these points is given.

V. BALAN: I would like to have some information on poisonous barracudas.

S. JONES: Non of the Indian barracudas appear to be poisonous. Atleast there are no instances known or recorded.

W. KLAUSEWITZ: What are the species and their areas of occurrence along the Indian coast?

S JONES: A few species occur at several places along the Indian coast but do not constitute a fishery by themselves. They have been noticed around Lacadives also.