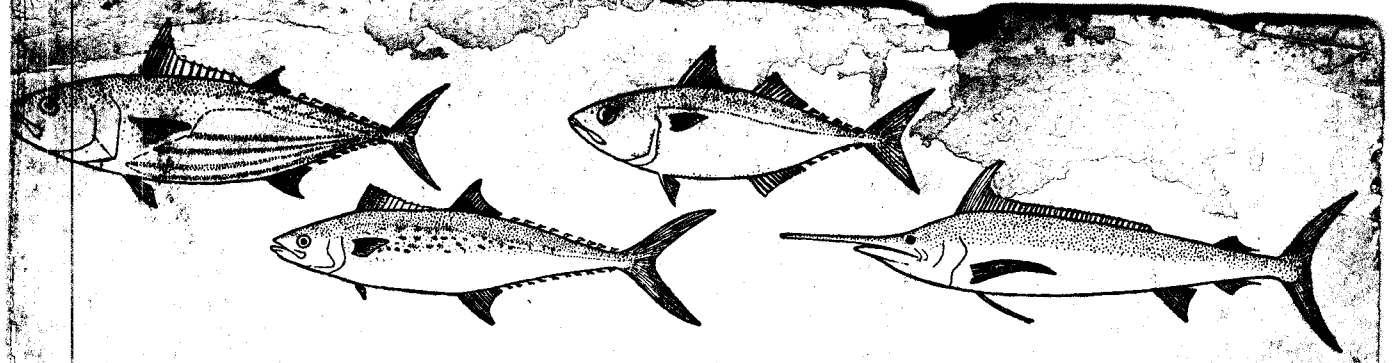
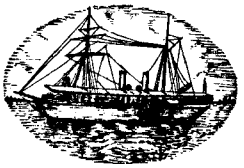


SYMPOSIUM ON SCOMBROID FISHES

PART I



MARINE BIOLOGICAL ASSOCIATION OF INDIA
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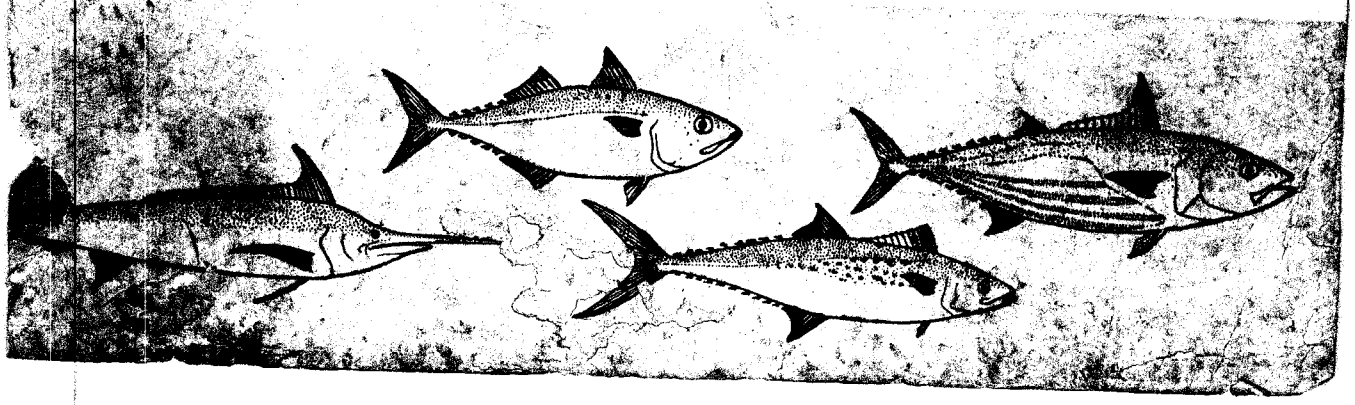
S. INDIA

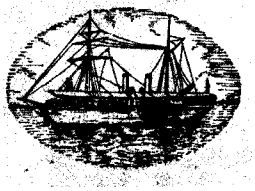


PROCEEDINGS OF THE

SYMPOSIUM
ON
SCOMBROID FISHES

HELD AT MANDAPAM CAMP FROM JAN. 12—15, 1962

PART I



SYMPOSIUM SERIES 1
MARINE BIOLOGICAL ASSOCIATION OF INDIA
MANDAPAM CAMP
S. INDIA

A SYSTEMATIC REVIEW OF THE SCOMBROID FISHES OF INDIA

BY

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INTRODUCTION

From the standpoint of marine fishery resources there can be no doubt that scombroid fishes constitute the most important single element. Large scale exploitation of a greater part of this natural resource, especially of the truly pelagic species comprising tunas and billfishes has been in vogue for the past several decades, mainly by Japan and the United States of America. The importance of this potential wealth in the Indian Ocean has been forcefully drawn attention to by the extensive fishing operations carried out by the Japanese longline fishery fleets in the high seas of the Indian Ocean, and by exploratory offshore fishing operations carried out by some countries bordering the Indian Ocean.

Both at the symposium and conference on the biology of tunas and related fishes held recently at Dakar (Nov. 1960), and Honolulu (Aug. 1961) attention was drawn by workers to the urgent need for knowing more about the species occurring in the different geographical areas to help understand the precise distribution of the species, the occurrence of populations if any, etc. While regional reviews of scombroid fishes have been carried out in the Pacific and Northern Atlantic by several workers, the Indian Ocean has till recently remained a veritable blank. The recent regional works from this area (Munro 1943 ; Serventy 1941, 1956 ; Deraniyagala 1952 ; Fourmanoir 1957 ; Williams 1959 ; and Jones and Silas, 1960, 1961) ; a review of scombroid fishes of the world by Fraser-Brunner (1950); and the work on Pacific scombroid fishes mainly by Kishinouye (1923); Nakamura (1938, 1949); Godsil and Byers (1944); Godsil (1954) ; Royce (1957) ; Robins and de Sylva (1960), etc., have helped us in our knowledge about the species of scombroid fishes occurring in the Indian Ocean.

In this review we have covered the mackerels, tuna and related species, seerfishes, wahoo, and the billfishes occurring in Indian seas. Along with nomenclatorial discussions, meristic and morphometric data for the different species are given wherever possible. The key for the identification of the species has been made comprehensive and includes all species recognised as valid from the Indian Ocean. Since our knowledge of the precise distribution of the different species in the Indian Ocean itself is far from complete, this course has been adopted to aid future investigators in their field identification. An outline of the classification followed is also given and all the species are illustrated.

The discussion includes comparison of scombroids of the Indian Ocean and those occurring in the Pacific and Atlantic.

KEY TO THE IDENTIFICATION OF MACKERELS, TUNAS, SEERFISHES AND BILLFISHES FROM INDIAN OCEAN

1*a*. Upper jaw strongly produced into a rounded 'spear' or a powerful flat 'sword'; no finlets behind second dorsal and second (soft) anal ; pelvics when present reduced to one, two or three spines (Istiophoridae and Xiphiidae) ... 28

1*b*. Upper jaw not produced into a 'spear' or 'sword'; finlets present behind second dorsal and anal; pelvics present, with one spine and five rays (Scombridae) ... 2

2*a*. A deep groove midventrally along abdomen in which the pelvic fins can be concealed (moderately large cycloid scales covering body, about 50 along lateral line; pelvic fins black and enormous in young, normal in adult; two small lateral caudal keels developed only in very large specimens).
...*Gasterochisma melampus* Richardson

2*b*. No deep groove along abdomen ... 3

3*a*. Caudal peduncle on each side with a median keel and two smaller lateral keels ... 6

3*b*. Caudal peduncle on each side with only two small lateral keels ... 4

4*a*. Teeth present on vomer and palatines; total number of gill rakers on outer gill arch of each side less than 50; gill rakers of moderate length and not visible when mouth is opened; an osseous and moderately stiff anal spine present.
...*Scomber japonicus* Houttuyn

4*b*. Vomer and palatines edentulous; total number of gill rakers on outer gill arch of each side exceeds 50; gill rakers elongate, "feather-like" and conspicuously visible when mouth is opened; osseous anal spine absent ... 5

5*a*. Length of head distinctly greater than depth of body; latter 23% to 27% in fork length; snout pointed; dark stripes or rows of dusky spots along upper half of body; outer margin of first dorsal dusky.
...*Rastrelliger kanagurta* (Cuvier)

5*b*. Length of head distinctly shorter than depth of body; latter 28.5% to about 34% in fork length; snout short and bluntly rounded; no dark stripes or regular rows of dusky spots along upper half of body; outer margin of first dorsal black.
...*Rastrelliger brachysoma* (Bleeker)

6*a*. Two lateral lines, an upper and a lower, latter commencing from former in a line below anterior part of first dorsal and deeply decurved following lower contour of body, eventually joining upper lateral line near peduncular keel; vertebrae 31.
...*Grammatorcynus bicarinatus* (Quoy and Gaimard)

6*b*. Lateral line single, running straight, decurved or slightly undulating; vertebrae 38 to about 54 ... 7

7*a*. Teeth in jaws slender, conical, scarcely or not compressed; corselet scales well developed ... 8

7*b*. Teeth in jaws strong, compressed, subtriangular or knife-like; corselet obscure ... 22

8*a*. First and second dorsal fins widely separated by distance exceeding length of base of first dorsal 9

8*b*. First and second dorsal fins contiguous or separated by only a narrow interspace not exceeding diameter of orbit ... 10

9*a*. Corselet scales abruptly taper immediately below end of first dorsal and continue as a very narrow band having not more than four or five rows of scales in a line below origin of second dorsal ; total gill rakers about 39-42 (mean 39.8).

...*Auxis thazard* (Lacépède)

9*b*. Corselet scales gradually taper behind first dorsal and continue as a wide band with 7 to 12 rows of scales in a line below seventh dorsal finlet (counting from base of caudal) ; total gill rakers about 40–47 (mean 44.8).

...*Auxis thynnoides* Bleeker

10*a*. Distance from tip of snout to end of maxilla 50% or more of head length ; end of maxilla surpasses vertical below middle of orbit ... 11

10*b*. Distance from tip of snout to end of maxilla considerably less than 50% of head length ; end of maxilla does not surpass vertical below middle of orbit ... 13

11*a*. Vomer with villiform teeth ; dorsal and anal finlets 9 or 10/7 or 8.

...*Cybiosarda elegans* (Whitley)

11*b*. Vomer edentulous ; dorsal and anal finlets 6 to 8/5 or 6 ... 12

12*a*. Dorsal with 18 or 19 spines ; end of maxilla surpassing vertical below posterior border of orbit ; 6 to 9 horizontal dark stripes on upper half of body appear as short broken bars in juveniles.

...*Sarda orientalis* (Temminck and Schlegel)

12*b*. Dorsal with 12–14 spines ; end of maxilla reaching to vertical below posterior third of orbit ; no dark stripes on body.

...*Gymnosarda unicolor* (Rüppell)

13*a*. Body completely scaled ; those of corselet and lateral line usually larger ... 14

13*b*. Body naked except for corselet and lateral line (exception *Allothunnus*) ... 19

14*a*. Anterior insertion of second dorsal nearer to posterior end of caudal keel than to posterior margin of orbit ... 15

14*b*. Anterior insertion of second dorsal nearer posterior margin of orbit than to posterior end of caudal keel ... 17

15*a*. Pectoral short, not exceeding length of head excluding snout and falling short of vertical below anterior insertion of second dorsal by distance equalling almost its own length ; preoperculum distinctly rounded along posterior margin.

...*Thunnus* (*T.*) *thynnus orientalis* (Temminck and Schlegel)

15*b*. Pectoral elongate, one to one half times length of head and surpasses vertical below anterior insertion of second dorsal ; preoperculum more or less angular at lower posterior margin. ... 16

16*a*. Gill rakers on lower limb 19–21 ; surface of liver markedly striated ; vent rounded ; distance between tip of pectoral and end of caudal keel much less than head length.

...*Thunnus* (*T.*) *alalunga* (Bonnaterre)

16*b*. Gill rakers on lower limb 16–18 ; liver marked with faint striations on margin only ; vent elliptical ; distance between tip of pectoral fin and end of caudal keel greater than head length.

...*Thunnus* (*Parathunnus*) *obesus mebachi* Kishinouye

17*a*. Total gill rakers 19–26 of which 13–19 on lower limb, (generally 15–17) ; air bladder absent; finlets with hardly any yellow being predominantly dusky.
...*Thunnus* (*Kishinoella*) *tonggol* (Bleeker)

17*b*. Total gill rakers 27-32 of which 19 to 22 on lower limb, (generally 20–22) ; air bladder present ; finlets lemon yellow with narrow dusky edging. ... 18

18*a*. Pectoral surpassing vertical below anterior insertion of second dorsal ; anal and second dorsal not elongate and shorter than pectoral.
...*Thunnus* (*Neothunnus*) *albacares macropterus* (Temminck and Schlegel)

18*b*. Pectoral falls short of vertical below anterior insertion of second dorsal ; anal and second dorsal greatly elongate, being considerably longer than pectoral.
...*Thunnus* (*Neothunnus* ?) *itosibi* (Jordan and Evermann)

19*a*. First dorsal with 17 spines ; body outside corselet uniformly scaled ; total gill rakers 73–75 (24–25+48–51) ; sides of body devoid of any conspicuous colour pattern.
...*Allothunnus fallai* Serventy

19*b*. First dorsal with 15 spines ; body outside corselet naked ; total gill rakers not exceeding 60 ; body with conspicuous colour pattern ... 20

20*a*. Four to six conspicuous longitudinal stripes on lower half of body ; palatine edentulous ; gill rakers 15–17+33–42.
...*Katsuwonus pelamis* (Linnaeus)

20*b*. No dark stripes on lower half of body, instead a few conspicuous black spots may be present on each side of body behind corselet below pectoral base ; palatine with teeth ; gill rakers 7–12+22–30. ... 21

21*a*. Teeth present on vomer ; gill rakers 7–10+22–25.
...*Euthynnus affinis affinis* (Cantor)

21*b*. Teeth absent on vomer ; gill rakers 10–12+29–30.
...*Euthynnus alletteratus* (Rafinesque)

22*a*. First dorsal with XIII–XXII spines ; gill rakers present ; gill lamellae not reticulated ; lateral line slightly undulate or with a deep inflection behind second dorsal ... 23

22*b*. First dorsal with XXIII–XXVII spines ; gill rakers absent; gill lamellae reticulated; lateral line with a deep inflection beneath X–XV first dorsal spines.
...*Acanthocybium solandri* (Cuvier)

23*a*. First dorsal with XIX–XXII spines ; posterior margin of pectoral deeply excised forming two distinct lobes.
...*Scomberomorus niphonius* (Cuvier)

23*b*. First dorsal with XIII–XVII spines ; posterior margin of pectoral not deeply excised. ... 24

24*a*. Lateral line with a deep inflection below posterior end of D_2 to second or third dorsal finlet behind it; gill rakers 2 to 6 (generally 3 or 4) on lower limb of outer arch ; side of body of juveniles with large black blotches merging to form distinct dark vertical irregular stripes in adult.
...*Scomberomorus commerson* (Lacépède)

24*b*. Lateral line not deeply inflected along its course. ... 25

25*a*. Body marked with few broad vertical bands on its upper portion ; D_1 with XIII–XV (generally XIV) spines.

...*Scomberomorus semifasciatus* (Macleay)

25*b*. Body marked with diffuse rounded blotches, spots, or dark short longitudinal streaks or bars ; D_1 with XV–XVII (generally XVI or XVII) spines ... 26

26*a*. Distance from anterior insertion of second dorsal to caudal fork shorter than or rarely equalling second predorsal length ; sides of body with irregular rows of horizontal black streaks or broken bars ; caudal keel conspicuously broad.

...*Scomberomorus lineolatus* (Cuvier)

26*b*. Distance from anterior insertion of second dorsal to caudal fork distinctly longer than second predorsal length ; sides of body with diffuse rounded blotches or dark rounded or oval spots ; caudal keels not conspicuously broad. ... 27

27*a*. Gill rakers 4–7 (generally 6) on lower limb of outer gill arch, length of maxillary distinctly more than half head-length ; lateral line simple, devoid of any branching ; side of body with about three rows of large diffuse blotches.

...*Scomberomorus queenslandicus* Munro

27*b*. Gill rakers 7–10 (generally 8–9) on lower limb of outer gill arch ; length of maxillary hardly half length of head ; lateral line with short wavy posteriorly directed pseudo-branches (tracts of cutaneous mucous canals) ; sides of body with more than three rows of round or oval black spots.

...*Scomberomorus guttatus guttatus* (Bloch and Schneider)

28*a*. Upper jaw conspicuously elongated into a long flattened spear or 'sword'. elliptical in cross-section ; pelvic fins absent ; caudal peduncle with a single large keel on each side (Xiphiidae).

...*Xiphias gladius* (Linnaeus)

28*b*. Upper jaw elongated into rounded spear ; pelvic fins present ; caudal peduncle with a pair of a lateral keels on each side (Istiophoridae). ... 29

29*a*. First dorsal fin remarkably high and 'sail-like' with anterior rays markedly shorter than middle rays ; longest middle ray two or more times as long as greatest depth of body.

...*Istiophorus gladius* (Broussonnet)

29*b*. First dorsal fin of moderate height never exceeding in height 1.5 times greatest depth of body. ... 30

30*a*. Anterior lobe of first dorsal higher than depth of body at dorsal fin origin ; vertebrae—12 precaudal and 12 caudal ; size small, generally, much less than 160 kg. (*Tetrapturus*). ... 31

30*b*. Anterior lobe of first dorsal low, less than depth of body and more so in larger individuals ; vertebrae—11 precaudal and 12 caudal ; size large, attaining about 900 kg. (*Makaira*). ... 33

31*a*. Bill short, length from anterior margin of eye to tip equal to or hardly greater than length of mandible ; premandibular length of bill contained three times or more in preorbital distance (orbit to tip of mandible).

...*Tetrapturus angustirostris* Tanaka

31*b*. Bill long, length from anterior margin of eye to tip distinctly more than (atleast 1.5 times) length of mandible ; premandibular length of bill almost equal to or greater than preorbital distance. ... 32

32*a*. Height of middle rays of first dorsal fin less than 0.5 (about 0.25) height of anterior lobe of fin ; sides of body with vertical light stripes ; length of pectoral in young and adults greater than depth of body.

...*Tetrapturus audax* Philippi

32*b*. Height of middle rays of first dorsal fin more than 0.5 or equalling height of anterior lobe of fin ; sides of body devoid of vertical light stripes ; length of pectoral much less than or hardly equalling depth of body.

...*Tetrapturus* sp.

33*a*. Pectoral fin rigid forming a right angle with side of body and cannot be folded flat against side without breaking joint ; lateral line simple ; chambers of air-bladder arranged in several layers.

...*Makaira indica* (Cuvier)

33*b*. Pectoral fin not rigid and easily folds back against side ; lateral line complicated, forming hexagonal branchings not easily discernible in adults ; chambers of air-bladder arranged in a single layer.

...*Makaira nigricans* (Lacépède)

The scheme of classification adopted here is as follows :

Order PERCIFORMES

Suborder Scombroidei
- Family Scombridae
  - Subfamily Gasterochismatinae
    - Genus *Gasterochisma* Richardson, 1845
  - Subfamily Scombrinae
    - Genus *Scomber* Linnaeus, 1758
    - Genus *Rastrelliger* Jordan and Dickerson, 1908
    - Genus *Grammatorcynus* Gill, 1862
  - Subfamily Thunninae
    - Genus *Auxis* Cuvier, 1929
    - Genus *Cybiosarda* Whitley, 1935
    - Genus *Sarda* Cuvier, 1829
    - Genus *Gymnosarda* Gill, 1862
    - Genus *Thunnus* South, 1845
      - Subgenus *Thunnus* s. str.
      - Subgenus *Parathunnus* Kishinouye, 1923
      - Subgenus *Kishinoella* Jordan and Hubbs, 1925
      - Subgenus *Neothunnus* Kishinouye, 1923
    - Genus *Allothunnus* Serventy, 1948
    - Genus *Katsuwonus* Kishinouye, 1923
    - Genus *Euthynnus* Jordan and Gilbert, 1882
  - Subfamily Scomberomorinae
    - Genus *Scomberomorus* Lacépède, 1802
    - Genus *Acanthocybium* Gill, 1862

Family Istiophoridae
Genus *Istiophorus* Lacépède, 1802
Genus *Tetrapturus* Rafinesque, 1810
Genus *Makaira* Lacépède, 1802
Family Xiphiidae
Genus *Xiphias* Linnaeus, 1758

ORDER PERCIFORMES

Suborder *SCOMBROIDEI*

Family Scombridae

Subfamily Gasterochismatinae

Genus **Gasterochisma** Richardson, 1845

Gasterochisma Richardson, 1845. *Ann. Mag. Nat. Hist.*, (Genotype : *Gasterochisma melampus* Richardson).

Lepidothynnus Günther, 1889. *Challenger Rep.*, 31 : 15 (Genotype : *Lepidothynnus huttoni* Günther).

Chenogaster Lahille, 1903. *Ann. Mus. Nac. Buenos Aires*, Ser. 3, 2 : 376 (Genotype : *Chenogaster holmbergi* Lahille).

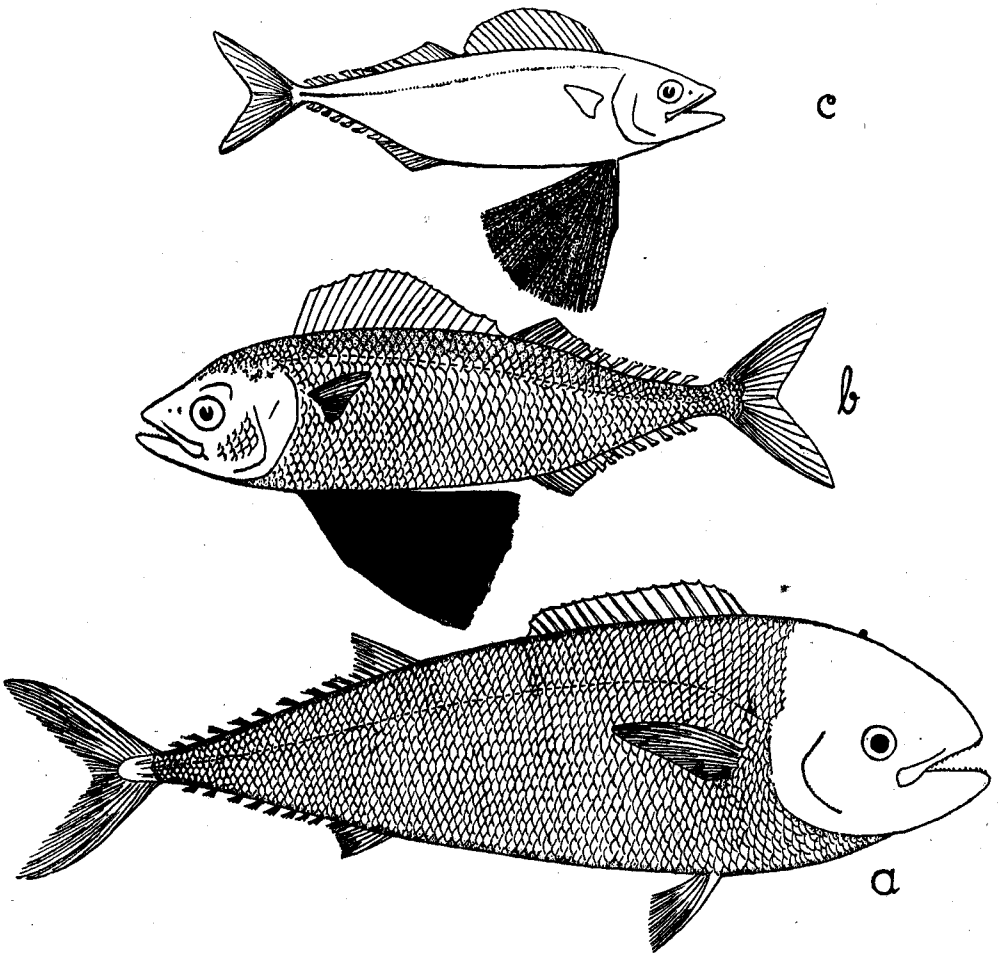
Body oblong to moderately elongate and compressed from side to side ; head with dorsal profile arched, compressed above into a ridge ; eyes lateral, rather small ; mouth horizontal, wide, cleft not extending behind level of eye ; maxilla not covered by preorbital ; in young, jaws with slender conical teeth in single row ; patches of strong teeth on palatines, vomer and tongue ; opercles not serrated ; dorsal fins contiguous in young, but distinctly separated in adults ; first dorsal with 17 to 19 flexible spines ; six to eight finlets present behind second dorsal and anal ; a deep intermuscular groove along abdomen in which pelvic fins can be completely concealed ; in young pelvic fins conspicuously large while in adults they are reduced and normal as in other scombroids ; interpelvic process separate, but minute ; anal low, shorter than second dorsal ; caudal keels wanting in young, but a pair of lateral caudal keels present on each side in adults ; caudal fin bilobed, lobes widely crescentic ; moderately large cycloid scales covering whole body, cheeks, and postorbital part of head ; lateral line well defined ; air bladder present ; gill arches with numerous small teeth ; pyloric caecae numerous and branched ; vertebrae 45.

DISTRIBUTION : Same as for species.

REMARKS : The genus is monotypic, and is thus far known only from the southern seas.

BUTTERFLY MACKEREL

Gasterochisma melampus Richardson, 1845



Text Fig. 1. *Gasterochisma melampus* Richardson. (*a*). Adult (after Günther 1889 given as *Lepidothynnus huttonii*) ; (*b* and *c*) Juveniles (after Fraser-Brunner, 1950 ; and Munro, 1958 respectively).

SYNONYMS :

Gasterochisma melampus Richardson, 1845 : 346 (Type locality : Port Nicholson, New Zealand) ; 1846. 60, pl. xxxvii, figs. 1–3
Stead, 1907 : 21, pl. 6
Waite, 1913 : 220, pl. 8
Barnard, 1927 : 804, pl. 30, fig. 3
McCulloch, 1934 : 78
Norman, 1937 *in* Norman and Fraser : *Giant Fishes, Whales and Dolphins*, 156
Smith, 1949 : 302, fig. 844
Fraser-Brunner, 1950 : 141, fig. 3, a and b
Graham, 1953 : 301–303, fig.
Whitley, 1956 : 56–71 (1955–56), fig.

Anon. 1958. *Fisheries Newsletter*, 17 (6) : 5 (Photo of juvenile from Victoria, Australia)

Munro, 1958 : 110, fig. 740 (2 figs.)

Lepidothynnus huttoni Günther, 1889 : 15, pl. vi, figs. A, A1 (type locality : New Zealand)

Chenogaster holmbergi Lahille, 1903 : 376 ; 1905, 461 (Argentina)

Chenogaster boulengeri Lahille, 1913 : 7, fig. 2, pl. 3 and 4 (Argentina)

Available information about this species is limited mainly to stray records of its occurrence in widely separated localities. Some idea as to the general variability and changes during growth may be had from the data given in the accompanying table (I), and figure 1.

TABLE I

Characters	Authors						
	Richardson* (1845)	Stead* (1907)	Günther (1889)	Barnard (1927)	Smith (1949)	Fraser-Brunner (1950)	Munro (1958)
Depth of body in length	...	...	ab. 3.5	3.5–3.75	3.5	...	3.9–4.1
Head in length	...	...	3.5	4.0	...	...	4.0–4.1
Eye in head	...	...	16.5	6.25–7.0	...	...	5.5–7.4
Eye in snout	...	...	...	2.5–3	...	...	...
Pectoral in head	...	...	1.5	1.3	ab. 2.0	...	...
Pelvic in length	2.5	2.8	8.75 (fig.)	6.0	...	3.0 8.25 (fig.)	3.0–9.3 (fig.)
Lateral line scales	...	...	78–80	80	...	50	64–70
L. tr.	...	...	6/13 (below D_2)	8–9/15–16	...	...	7/19
D_1	...	...	XVII	XVII	XVII	XVI–XIX (fig.)	XVII–XVIII
D_2 + finlets	...	...	2,7+7	10–11+6–7	10–11+6–7	–+8	1,9–10+6–8
A + finlets	...	...	2,9+7	II, 10+6–7	II, 10+6–7	–+8	I–II,9–10+6–8
Gill-rakers	...	...	?	?	?	7+18	Absent
Length	...	...	65.5 inches	43 inches	...	...	...

* Not seen in original.

The markedly large black pelvic fins so characteristic of young up to about 16 inches (40.7 cm.) (Barnard, 1927) becomes reduced to normal size as in other scombroids in adults, although Graham (1953) opines that this need not be the case. The first dorsal which is high and contiguous with the second in the young gets distinctly separated from it and in adults appears low. The scales are moderately large and in a specimen about 167 cm. long it is about 4.0 cm. broad. Most authors have given the lateral line count as between 64 and 80. Fraser-Brunner (1950) mentions 50 which is also depicted in the figure of the young fish illustrated by him, the count being low for the species. It is not known whether an increase in the number of scales is associated with growth.

Fraser-Brunner (1950) has also shown XIX spines in the first dorsal in the young fish illustrated, but XVII and XVIII appears to be the normal count. Most authors have

overlooked the gill-rakers, but Fraser-Brunner (1950) has given the count as 7+18, while Munro (1958) mentions that they are 'absent'. The caudal keels, a pair on each side are present in the adults.

The species is said to attain about two metres in length. Graham (1953) mentions of a fish 1.3 metres long weighing 56.6 kg. and a 1.67 metres long specimen weighing 90.7 kg.

The colour of *G. melampus* is given as : "……the head is steel-blue ; the upper surface above the lateral line is blackish, silvery below the belly. The pectoral fins are silvery, the ventrals black in some examples and in others almost transparent. The tail may be black or brown and sometimes tipped with white and here again the tail varies considerably and may be hyaline, *i.e.*, resembling glass" (Graham, 1953). Further he mentions that "Hutton……records one Butterfly-fish with six to eight vertical blackish bands. I have not seen a specimen with this ornamentation but one I saw did have a faintly marked blackish band past way along the body and below the lateral line".

G. melampus is considered an excellent sport fish. According to Graham (1953) it rarely takes dead bait or is hooked in deep water apparently preferring to chase fast-moving live fish or bait. In a 1.67 metre, 90.7 kg. specimen he has seen several smoothhound dogfish in its stomach, the largest weighing 3.6 kg. Further, red cod, barracouta, octopus and squid have also been observed as stomach contents. One fish weighing 13.6 kg. had its stomach crammed to capacity with surface forms of whalefeed (*Munida gregaria*) (Crustacea).

Little is known about the habits of this species. Along New Zealand coast occasional strandings of larger specimens are not uncommon.

DISTRIBUTION : New Zealand ; Australia (Queensland, New South Wales, Victoria and Tasmania) ; South Africa (Table Bay), and Argentina.

REMARKS : On account of its disjunct, though vide distribution in the southern oceans, and its occurrence in the southern colder waters of the Indian Ocean, (from where it has been recorded from the Australian and South African Waters) the species qualifies for inclusion in this account.

SUBFAMILY SCOMBRINAE

Genus **Scomber** Linnaeus, 1758

Scomber Linnaeus, 1758. *Syst. Nat.* Ed. 10: 297 (Type: *Scomber scombrus* Linnaeus. Designated by Gill, 1861: 125.)

Pelamys Klein, 1775. *Neuer Schauplatz der Natur*, 1: 176 (Type: *Scomber scombrus* Linnaeus : Designated by Jordan and Evermann, 1917: 37) (inadmissible)

Cordylus Gray, 1854. *Cat. Fish. Gronow.*, 163 (Type : *Cordylus scombrus* Gray) (*nec Cordylus* Gronow, in Reptiles).

Pneumatophorus Jordan and Gilbert, 1882. *Proc. U. S. Nat. Mus.*, 93 (Type: *Scomber pneumatophorus* De la Roche.)

Body elongate, fusiform, covered with very small thin scales ; similar scales on cheeks also, but corselet absent ; adipose eyelids well developed ; mouth wide, teeth small, slender uniserial in jaws ; similar teeth on vomer and palatines ; broad preorbital overlapping maxillary ; fleshy lobe on each side of lower jaw near junction with maxillary ; gill rakers

moderately long and slender, not visible when mouth is opened ; first dorsal with IX-XIV spines separated from rayed second dorsal by distance equal to about length of its base ; 5 or 6 detached finlets behind second dorsal and anal ; anal similar to second dorsal except first ray modified as short spine ; pectorals and pelvics small, former high or on level with eye ; caudal peduncle slender, median keel absent while two small lateral keels present on each side ; caudal forked.

DISTRIBUTION : Tropical and temperate seas.

REMARKS : For a long time the genus *Scomber* was also used to include species at present referable to *Rastrelliger* Jordan and starks (1908). However, both genera can be easily distinguished by the undermentioned key diagnosis given by Fraser-Brunner (1950) :

(i) " Teeth on vomer and palatines. Gill rakers long and slender less than 35 on lower limb of first branchial arch. Body robust, fusiform, the depth less than length of head.

...*Scomber.*

(ii) Vomer and palatines edentulous. Gill rakers long, feather-shaped, more than 35 on lower limb of first branchial arch. Body compressed, the depth about equal to the length of head."

...*Rastrelliger.*"

The genus *Scomber* thus separated would constitute a more or less natural grouping with the generic characters already given. However, some authors have recognised *Pneumatophorus* Jordan and Gilbert as a separate genus (Starks, 1921 ; Jordan and Hubbs, 1925 ; several Japanese workers) although it was originally described as a subgenus of *Scomber*, which some workers, (*e.g.*, Fowler, 1936) have adopted. The only important difference attributed between *Scomber* and *Pneumatophorus* is the absence or presence of the air-bladder respectively (Starks, 1922). All other characters show considerable overlap (*e.g. Scomber* thus restricted will have 11 or 12 dorsal spines while *Pneumatophorus :* 9–12). The importance of the presence or absence of air-bladder for causing generic distinction may be questioned on the basis of work carried out on other scombroid groups. For instance, in the genus *Scomberomorus* it is known (Munro, 1943) that the presence or absence of air-bladder may be useful in discriminating at the species level and even geographical races of species may or may not have the air-bladder ! Another instance may be cited among tunas, where but for the absence of air-bladder, *Kishinoella* Jordan and Hubbs shows no notable difference from *Thunnus* worthy of separate generic status.

Hence we are in agreement with Fraser-Brunner (1950) ; de Beaufort (1951) ; and other workers in considering *Pneumatophorus* a synonymy of *Scomber*.

Jordan and Hubbs (1925) while recognising seven species of *Pneumatophorus* remark that " A more extended comparison of these mackerel from various parts of the world has been needed. We have.....examined all the specimens at our disposal. These material seems to comprise seven species, of which two are represented in Japan, and so far as we know confined to the waters of that country. They are *P. tapeinocephalus* and *P. japonicus*. Besides these we have specimens from Australia, Hawaii, and Socorro Island, off the Coast of Mexico which seem to belong to a Polynesian species, which may be provisionally known by the old name *australasicus* of Cuvier and Valenciennes. The other species are nearer

japonicus. Each of them occupies a special faunal area : *P. colias* European ; *P. grex* Western Atlantic ; *P. peruvanus* sp. nov., Peru ; *P. diego* California."

The elaborate characters they have tabulated for separating the species draw attention to only the very close resemblance between the samples they had examined from the different faunal areas, although good series of specimens appear to have not been available to them for examination in all cases.

De Beaufort (1951) recognised two species under *Scomber*, *S. australasicus* and *S. janeseba* Bleeker. The material of the former species studied by him appeared to differ from the description of the so-called *australasicus* in the palate being practically without teeth and the anal spine being very feeble. The second species *S. janesaba* is considered by some authors to be the young of *S. japonicus*, but the latter has only IX dorsal spines, while the former is said to have X-XI. But, doubt as to whether this difference holds good has been raised by de Beaufort (1951) who remarks that ".....Steindachner and Doderlein (*Denkschr. Akad. Wien.* XLIX, 1884, p. 177) speaking of *S. colias* from Japan which is possibly identical with *janesaba*, say that the last dorsal spines sometimes disappear in older specimens without leaving a trace. If this is true, it adds to our difficulties in distinguishing between species of *Scomber*." The disappearance of the last one or two spines of the first dorsal in large adults cannot be ruled out as such a tendency is seen in certain other scombroids (*e.g. Scomberomorus* spp.) wherein the last one or two spines are stumpy and almost completely covered by the skin and hence liable to be overlooked. Besides, Abe and Takashima (1958) indicate that in the range of IX or X, the latter is the most frequent count met for the typical *Pneumatophorus japonicus japonicus* (=*S. j. japonicus*). However, their data are not tabulated size-wise and hence it is difficult to say whether the lesser count of IX is more characteristic of large adults. In the light of these, we fully support de Beaufort's (1951) following statement that " we are greatly in need of a revision of the Indo-Pacific species of *Scomber* and for that the whole genus too, but this can only be done at the hand of a very large material and on statistical basis."

Atleast one species of *Scomber* occurs in the Indian seas, although the specific identity of the species is not well established. Further, we are not quite sure whether the several species (of *Pneumatophorus*) described from various faunal regions represent only distinct populations or sub-populations of a single species. The position appears to be the same as in the case of the bluefin tuna (p. 35) discussed later on in this work. As such we feel that the course to follow at present in *Scomber* taxonomy would be to recognise only two species—*Scomber scombrus* Linnaeus and *S. japonicus* as was done by Fraser-Brunner (1950). The primary distinction between the two being the absence or presence of air-bladder, this character needs special checking for the Indo-Pacific forms at present lumped under *S. japonicus*, as *S. scomber* is at present recognised only from the Atlantic and the Mediterranean. If any of the Indo-Pacific forms lumped under *S. japonicus* lacks air-bladder the following are suggestive:

(1) Granting that the character is a dependable one, *S. scomber* has a wider distribution and quite likely some of the nominal species placed in the synonymy of *S. japonicus* may need reassigning under *S. scomber*, or may even have to be recognised as different species.

(2) Alternative would be that the presence or absence of air-bladder need not be of specific importance and as in the case of another scombroid, *Scomberomorus commerson* it may or may not occur in different geographical races of the same species. If so, the

other characters separating *S. scomber* from *S. japonicus* will need reappraisal. Fraser-Brunner's (1950) key to the species runs as follows:

"(i) Scales of shoulder enlarged as a more or less distinct corselet. Air-bladder present. Dorsal spines 9 or 10. Head larger, contained 3 to 3½ times in length of fish.

...japonicus

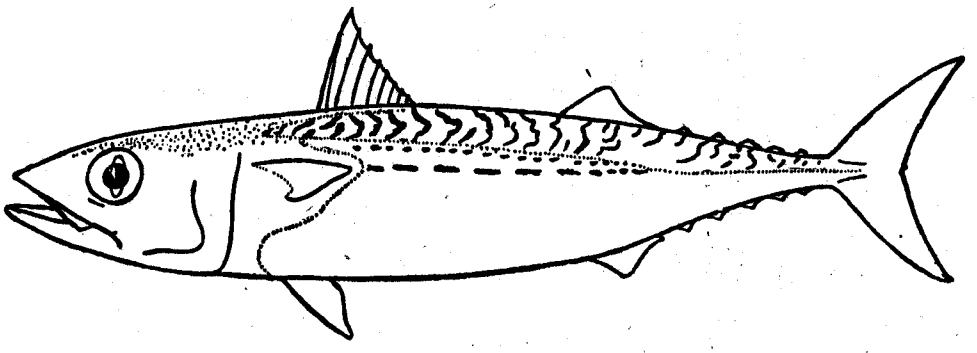
(ii) No corselet. No air-bladder. Dorsal spines 10 to 13. Head smaller, contained 3½ to 4½ times in length of fish.

...scombrus."

We are not in a position to comment on the nature of the corselet scales which may be a valid distinction between the two species. However, Fraser-Brunner (1950) was definitely wrong in giving the dorsal spines for *S. japonicus* as 9 or 10 while considering *P. tapeinocephalus* and *P. australasicus* (both with 11 or 12 dorsal spines) (Jordan and Hubbs, 1925) or the latter with 10–12 spines (Munro, 1958b) as junior synonyms. In fact Abe and Takashima (1958) show that the dorsal spines in *P. japonicus tapeinocephalus* is variable from 10–14! (most frequent count — 12). The ratio of length of the head in body length may also vary, for, in *S. australasicus*, Munro (1958b) gives it as 4–4·25 while for *S. japonicus* of which the former is considered a synonymy, Fraser-Brunner gives the ratio as 3–3·5. All these again point to the chaos and the need for a thorough reappraisal.

CHUB MACKEREL

Scomber japonicus Houttuyn, 1782



Text Fig. 2. *Scomber japonicus* Houttuyn (after Fraser-Brunner, 1950).

The following synonyms are listed by Fraser-Brunner (1950) under this species:

Scomber auratus Houttuyn, 1782 (not '1780' as given by Fraser-Brunner)
Scomber colias Gmelin, 1788
Scomber lacertus Walbaum, 1792
Scomber pneumatophorus De la Roche, 1809
Scomber macrophthalmus Rafinesque, 1810
Scomber grex Mitchell, 1815
Scomber capensis Cuvier and Valenciennes, 1831
Scomber australasicus Cuvier and Valenciennes, 1831
Scomber maculatus Couch, 1832

Scomber pneumatophorus major Temminck and Schlegel, 1842 (should be '1844')
Scomber pneumatophorus minor Temminck and Schlegel, 1842 (should be '1844')
Scomber saba Bleeker, 1854
Scomber janesaba Bleeker, 1854 (Species spelt as *janeseba* by de Beaufort, 1951)
Scomber diego Ayres, 1856
Scomber dekayi Storer, 1867
Pneumatophorus peruanus Jordan and Hubbs, 1925
Scomber gigas Fowler, 1935

The undermentioned scientific names given by Rosa (1950), and de Beaufort (1951) also are synonyms of *Scomber japonicus* as provisionally considered here.

They are :

(1) Under *Scomber colias* Gmelin-(Rosa, 1950)
Pneumatophorus colias de Buen, 1926
Pneumatophorus grex Jordan, Evermann, and Clark, 1930
Scomber gracilis Swainson, 1839
Scomber (Pneumatophorus) colias de Buen, 1930
Scomber undulatus Swainson, 1839

(2) Under *Scomber japonicus* Houttuyn-(Rosa, 1950)
Pneumatophorus japonicus Jordan and Jordan, 1922
Pneumatophorus tapeinocephalus Soldotov and Lindberg, 1930
Scomber delphinalis Richardson, 1846
Scomber uam Thiolliere, 1857

(3) Under *Scomber australasicus* Cuvier and Valenciennes-(Rosa, 1950)
Pneumatophorus australasicies Phillipps, 1927
Pneumatophorus australasicus Jordan, Evermann, and Clark, 1930
Scomber antarcticus Castelnau, 1872

(4) Under *Pneumatophorus diego* (Ayres)-(Rosa, 1950)
Pneumatophorus japonicus diego LaMonte, 1945

(5) Under *Scomber australasicus* Cuvier and Valenciennes-(de Beaufort, 1951)
Scomber australiensis Peters, 1876 (apparently an error in spelling)

Day 1888 (p. 790) and 1889 (p. 205) records *Scomber janesaba* Bleeker from Indian waters and gives the meristic counts as : "D. 9–10/1/11 + v–vi. A. 1/10–11 + v–vi. L. I. ca. 180." Vomer and palatine are said to have well developed teeth. *S. janesaba* is also recorded from the Red Sea by Klunzinger (1871 : 442 ; 1884 : 110), and de Beaufort (1951) from Java. The general distribution of *S. janesaba* is given by the latter author as ; " Red Sea, Persian Gulf, Coasts of India, China, Japan, Riu Kiu islands, Australia (Honson's Bay) ?, Hawaii ?" We have tentatively placed *S. janesaba* in the synonymy of *S. japonicus*. Other important references to *S. japonicus* from the Indian Ocean are : Barnard, 1927: 794 (*as S. colias*) ; Smith, 1949 : 300 (as *S. japonicus*), Fraser-Brunner, 1950 : (as *S. japonicus*) Rosa, 1950 : 87 – 92 (as *S. japonicus*, and *S. australasicus*) ; and Munro, 1958b : 19 (as *S. australasicus*).

It may be mentioned here that Rivas (1951) while recognising *Scomber colias* from North Western Atlantic, considered *S. lacertus, S. pneumatophorus, S. macrophthalmus, S. grex, S. maculatus, S. undulatus* and *S. dekay* as its synonyms.

Genus **Rastrelliger** Jordan and Starks in Jordan and Dickerson, 1908

Rastrelliger Jordan and Starks in Jordan and Dickerson, 1908. *Proc. U.S. Nat. Mus.*, 34 : 607 (Type : *Scomber brachysoma* Bleeker)

Body compressed from side to side ; body and cheek covered with small scales, eyes with well developed adipose eyelid, mouth large, maxillary reaching nearly vertical below posterior edge of eye ; teeth small, present in jaws ; vomer and palatines edentulous ; gill rakers long, numerous and feather-like and visible when mouth is opened. Spinous first dorsal and soft rayed second dorsal separated by distance equalling length of base of former ; anal devoid of spines ; five or six dorsal and anal finlets ; pectorals short with broad base ; pelvics with a spine and 5 rays ; caudal deeply forked.

Jordan and Hubbs (1925) place the genus *Rastrelliger* under a separate subfamily Rastrelligerinae as opposed to subfamily Scombrinae under which they include only *Scomber*, and *Pneumatophorus*.

DISTRIBUTION : Indo-Pacific (not recorded from Western Coast of North and South America or Eastern Pacific).

REMARKS : We recognise two species of *Rastrelliger*, *R. kanagurta* (Cuvier) and *R. brachysoma* (Bleeker) from Indian seas. A detailed study of these species is presented in a separate contribution by us at this Symposium (Jones and Silas, 1962*a*) to which reference is invited.

INDIAN MACKEREL

Rastrelliger kanagurta (Cuvier) 1817

(Plate I, Fig. A)

The following are considered synonyms of this species :

Scomber canagurta Cuvier, 1829
Scomber loo Lesson, 1830
Scomber moluccensis Bleeker, 1856
Scomber reani Day, 1870
Scomber microlepidotus Day, 1876
Scomber chrysozonus Peters, 1877

Detailed references, synonymy, morphometric and meristic characters, etc., are given by Jones and Silas (1962*a*). For an annotated bibliography on this species reference may be made to Jones and Rosa (1962).

DISTRIBUTION: Indian Ocean, Western and Central Pacific (eastwards upto Hawaii).

SHORT-BODIED MACKEREL

Rastrelliger brachysoma (Bleeker), 1851

(Plate I, Fig. B)

SYNONYMS :

Scomber neglectus van Kampen, 1907

For detailed synonymy, morphometric and meristic characters, and other details, reference may be made to Jones and Silas (1962*a*).

DISTRIBUTION: Andaman Sea, Indonesia, Philippines, and eastwards to Fiji.

Genus **Grammatorcynus** Gill, 1862

Grammatorcynus Gill, 1862. *Proc. Acad. Nat. Sci. Philad.*, 1862:125 (Type: *Thunnus bilineatus* Rüppell =*Thynnus bicarinatus* Quoy and Gaimard).

Nesogrammus Evermann and Seale, 1907. *Bull. Bur. Fish.*, 24 (1906), 1907:61 (Type: *Nesogrammus piersoni* Evermann and Seale)

Monotypic. The double lateral line on each side of the body is the most diagnostic character of this species which on the basis of osteological studies (Kishinouye, 1923) has been shown to be more related to the true Scombrinae than to Gasterochismatinae, Thunninae, and Scomberomorinae.

DISTRIBUTION: Indo-Pacific (not recorded from West Coast of North and South America-Eastern Pacific.)

DOUBLE-LINED MACKEREL

Grammatorcynus bicarinatus (Quoy and Gaimard)

(Plate IV, Fig. C)

SYNONYMS:

Thynnus bicarinatus Quoy and Gaimard, 1824 : 357 (Type locality : Sharks Bay, Western Australia)

Thynnus bilineatus Rüppell, 1835:39 (Type locality: Red Sea)

Grammatorcynus bilineatus Gill, 1862:125
Kishinouye, 1915 ; 1923
Hardenberg, 1935:137

Nesogrammus piersoni Evermann and Seale, 1907 : 61 (Type locality: Bulan, Sorsogen Province, Luzon, Philippines)

Grammatorcynus bicarinatus McCullouch, 1914 : 266 ; 1922 : 106; Silas, 1962e (See for synonymy)

Grammatorcynus bicarinatus (in part) Fraser-Brunner, 1950 : 156 ; de Beaufort, 1951 : 215

Nesogrammus thompsoni Fowler, considered by some a synonym of *G. bicarinatus* is in fact a gempylid, being a junior synonymy of *Lepidocybium flavobrunneum* (Smith) as shown by Munro (1949).

The species synopsis for the double-lined mackerel prepared by Silas (1962e) besides giving firsthand data about it based on material from the Andaman Sea, summarises existing information about the species.

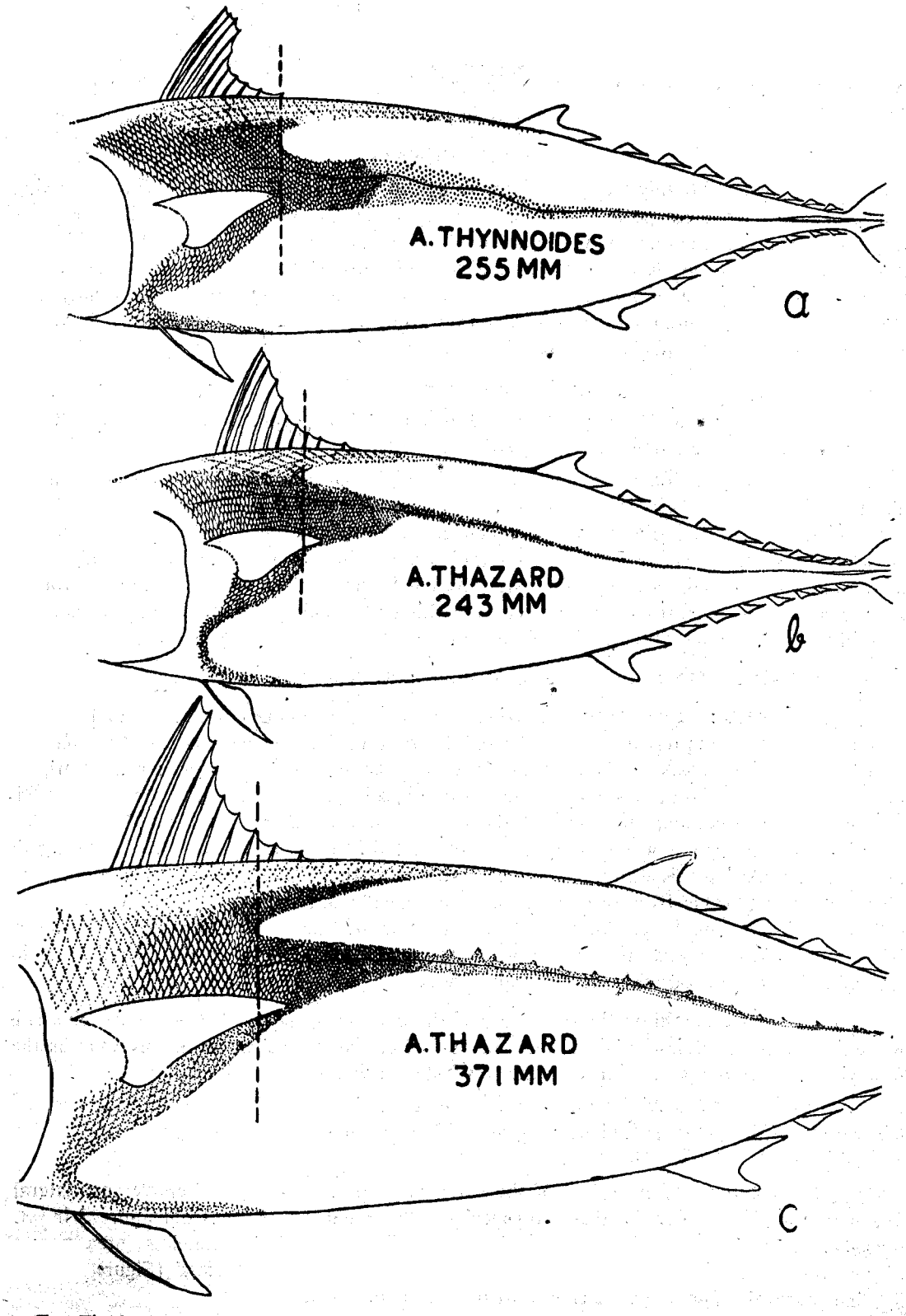
The finray and gill raker counts for specimens from the Andaman Sea are:

D_1. XI – XII; D_2. i – ii, 9 – 10 + 6 – 7; P_1. 23 – 35;
A. i – ii, 10 – 11 + 6 – 7; gill rakers 2 – 4 + 1 + 15 – 16.

The known range for the species is given by Silas (1962e) as :

D_1. XI – XII; D_2. i – iii, 6 – 11 + 6 – 7;
P_1. i – iii, 21 – 24; P_2. I, 5; A. i – iii, 8 – 11 + 6 – 7;
Gill rakers 19 – 21 (2 – 4 + 1 + 15 – 16). Vertebrae 31 (13 + 18).

References to the species from the Indian Ocean and contiguous seas besides those given under synonymy are: Günther (1860), Roux-Estevi and Fourmanoir (1955); Munro (1958b), Jones, Silas and Dawson (1960) Jones and Silas (1960, 1962b), Silas (1962e).



Text Fig. 3. Forward extent of the scaleless portions above lateral line in relation to pectoral fin in specimens of *Auxis thazard* and *Auxis thynnoides*.

DISTRIBUTION: In Indian Ocean and contiguous waters: Red Sea, Andaman Sea, West Coast of Java, and West Coast of Australia. In Pacific Ocean; East Coast of Australia, New Guinea, Marshall Islands, Sulu Sea, Philippines and Riu Kiu Islands, Japan.

SUBFAMILY *THUNNINAE*

Under this Subfamily we (Jones and Silas, 1960) recognised twelve genera comprising tunas and closely related species. Of these twelve genera, *Orcynopsis* Gill is the sole genus not represented in the Indian Ocean. Three of the genera then recognised, *Parathunnus* Kishinouye, *Neothunnus* Kishinouye and *Kishinoella* Jordan and Hubbs are relegated in this work as subgenera of *Thunnus* South. The remaining genera of the subfamily are: *Auxis* Cuvier, *Cybiosarda* Whitley, *Gymnosarda* Gill, *Sarda* Cuvier, *Allothunnus* Serventy, *Euthynnus* Lutken and *Katsuwonus* Kishinouye.

Genus **Auxis** Cuvier, 1829

Auxis Cuvier, 1829. *Regne Anim.* 2nd Ed., 2:199 (Type: *Scomber rochei* Risso, 1810 Type designated by Gill, 1861:125).

Body elongate, fusiform and robust; caudal portion remarkably short; snout short and hardly compressed; mouth small, jaws equal; teeth minute, mostly uniserial on jaws; palatine edentulous gill rakers long, slender numerous; scales forming well developed corselet; body outside corselet naked; first and second dorsals separated by a wide gap; second dorsal and anal markedly short and followed by six to nine finlets; caudal, pectorals, and pelvics small; lateral line slightly curved with small undulations; tongue flat, smooth and silvery, air-bladder absent. Vertebrae 39.

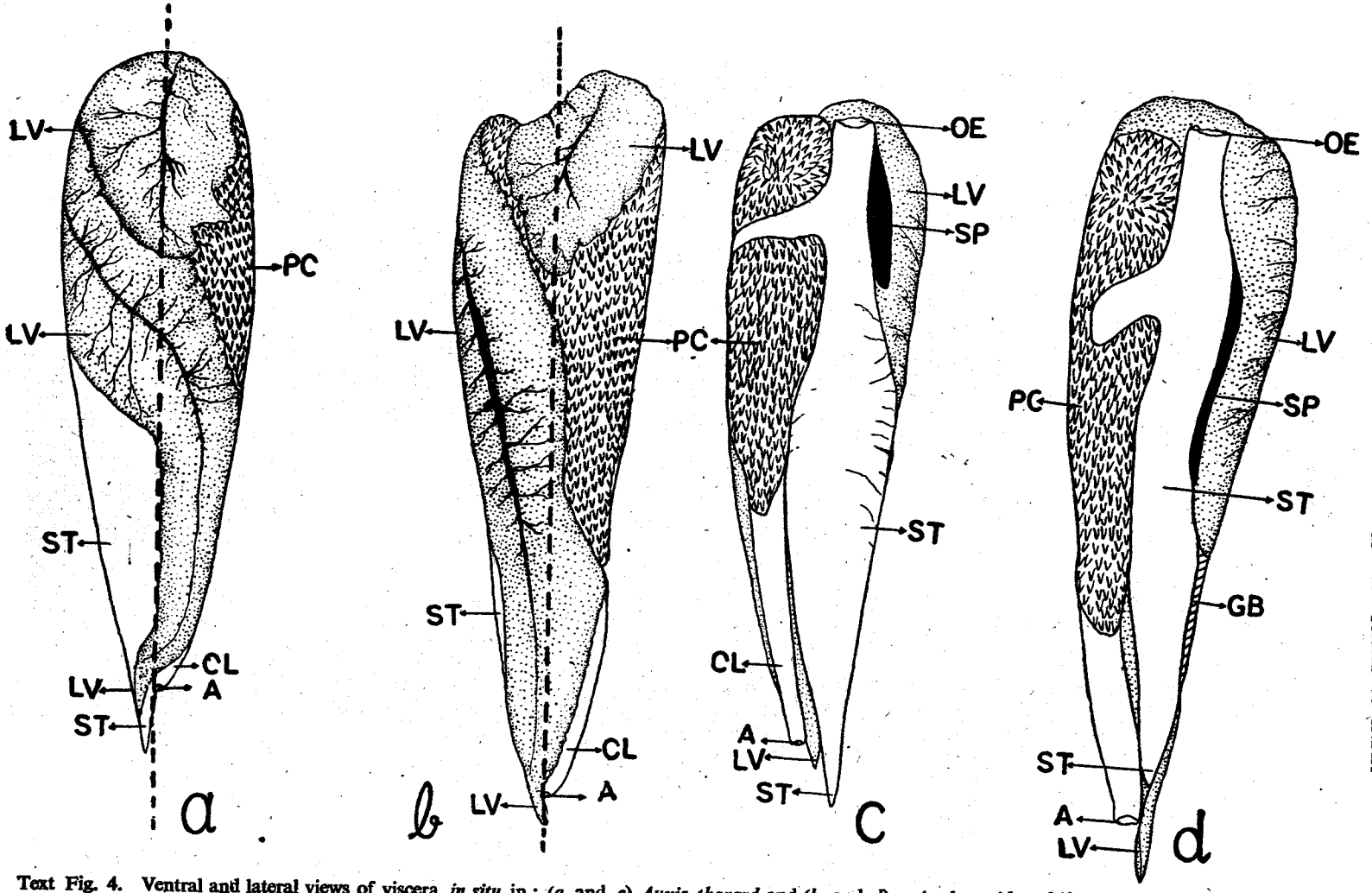
DISTRIBUTION: Indo-Pacific, Atlantic, and Mediterranean.

REMARKS: Two forms of frigate mackerels, a short corseletted and a long corseletted one are at present recognised from the Indo-Pacific and denoted as *Auxis thazard* (Lacépède) and *A. thynnoides* Bleeker respectively. The Atlantic and Mediterranean frigate mackerel appears to be the short corseletted form for which the name *A. thazard* has been used, although detailed comparison between the typical *A. thazard* from the Sunda Sea (from near New Guinea from where the species was first described) and those from the mediterranean and Atlantic is wanting. It is also surprising that while the two forms mentioned above are recognisable from throughout the Indo-Pacific distributional range of the genus, only one type should be known from the Atlantic and Mediterranean. However, Matsumoto (1959) suggests the likelihood of the occurrence of the long corseletted form in the Atlantic as well, but this needs confirmation.

Intermediate conditions in the nature of the corselet in the two species may give rise to some doubts in species identification. In that case, the gill raker counts as well as the following characters not mentioned in the 'key' should facilitate identification:

(1) For *A. thazard* the gill rakers number 9–10 and 29–32 in the upper and lower limbs of the outer arch giving a total of 39–42 while in *A. thynnoides* they are 8–12+ 31 – 36, and 40 – 47 respectively.

(2) The forward extension of the scaleless portion of the body above the lateral line was found to differ in the two species. As could be seen from figure 3 in *A. thynnoides* a vertical line drawn through the anterior end of the scaleless area passes downwards not touching the tip of the pectoral fin, while in *A. thazard* (Figure 3 b, c.) the line passes through the posterior third or fourth of the fin.



Text Fig. 4. Ventral and lateral views of viscera *in situ* in : (*a*, and *c*) *Auxis thazard* and (*b*, and *d*) *A. thynnoides*., 243 mm. and 255 mm. in length respectively (A = Anal opening; CL.=Colon ; GB = Gall bladder; LV = Liver ; OE = Oesophageal end ; PC = Caecal mass ; SP = Spleen and ST = Stomach).

(3) The viscera *in situ* in specimens of about the same length in both the species shows differences in the disposition of the organs (Figure 4). In *A. thazard* (Figure 4 a & c.) when viewed from ventrally, the right lobe of the liver takes a complete loop crossing over the mid-ventral longitudinal axis while in *A. thynnoides* the right lobe does not show such a curve and even the hepatic vein does not fall in line with the mid-ventral longitudinal axis. In the former, the stomach (whether containing food or empty) extends to slightly behind the level of the anal opening as the right lobe of the liver, while in *A. thynnoides* the stomach is shorter, the distal end hardly reaching the vent, though the right lobe of the liver may slightly extend backwards, but apparently not surpassing a line above origin of anal fin. The caecal mass in *A. thynnoides* is more developed and occupies a greater space than in *A. thazard* in which species the spleen unlike in the former is smaller. The left lobe of the liver in *A. thazard* is relatively longer than in *A. thynnoides*. In a lateral view, part of the gall-bladder can be seen in the latter species (Figure 4 d) while it is not so in *A. thazard*.

(4) In general body form, *A. thynnoides* is more rounded and robust while in *A. thazard* the body is more compressed from side to side (Figure 5). Six cross-sections (A–F) taken at almost identical locations of the body in a specimen each of *A. thazard* (243 mm.) and *A. thynnoides* (255 mm.) illustrate further differences between the two species. The shape of the visceral cavity is totaly different in the two species. Besides, in *A. thazard* (Figure 5-bottom) it appears to be slightly asymmetrical consequent probably to the looping of the liver ventrally, and accommodation in the form of narrow cavities for the liver and stomach above the origin of the anal fin is seen. There appear to be slight differences in the disposition of the coloured portion of the muscles in both the species. However, as the specimens are formalin preserved over a period of time, much of the latter details are not discernible. Sections through the origin of the second dorsal (fig. 5 d) in both the species show that in *A. thynnoides* the number of myotomes cut are slightly more than for *A. thazard*.

Godsil (1954) has drawn attention to certain other anatomical differences between the long corseletted and short corseletted forms. Godsil (1954) and Matsumoto (1959) comment that the gill raker counts for *A. thazard* from the Eastern Pacific are higher than are for specimens from the Central and Western Pacific, very closely approximating to the condition seen in *A. thynnoides*. This would need further investigation as Wade (1949) described two specimens from the Pacific coast of Central America (Schaefer and Marr, 1948 collection) showing higher gill raker counts as *A. thynnoides*.

The close similarity between the two species may be responsible for several discrepancies in species identity in earlier literature and there is a great need for a more detailed comparison between these two species as well as in the same species on a global basis.

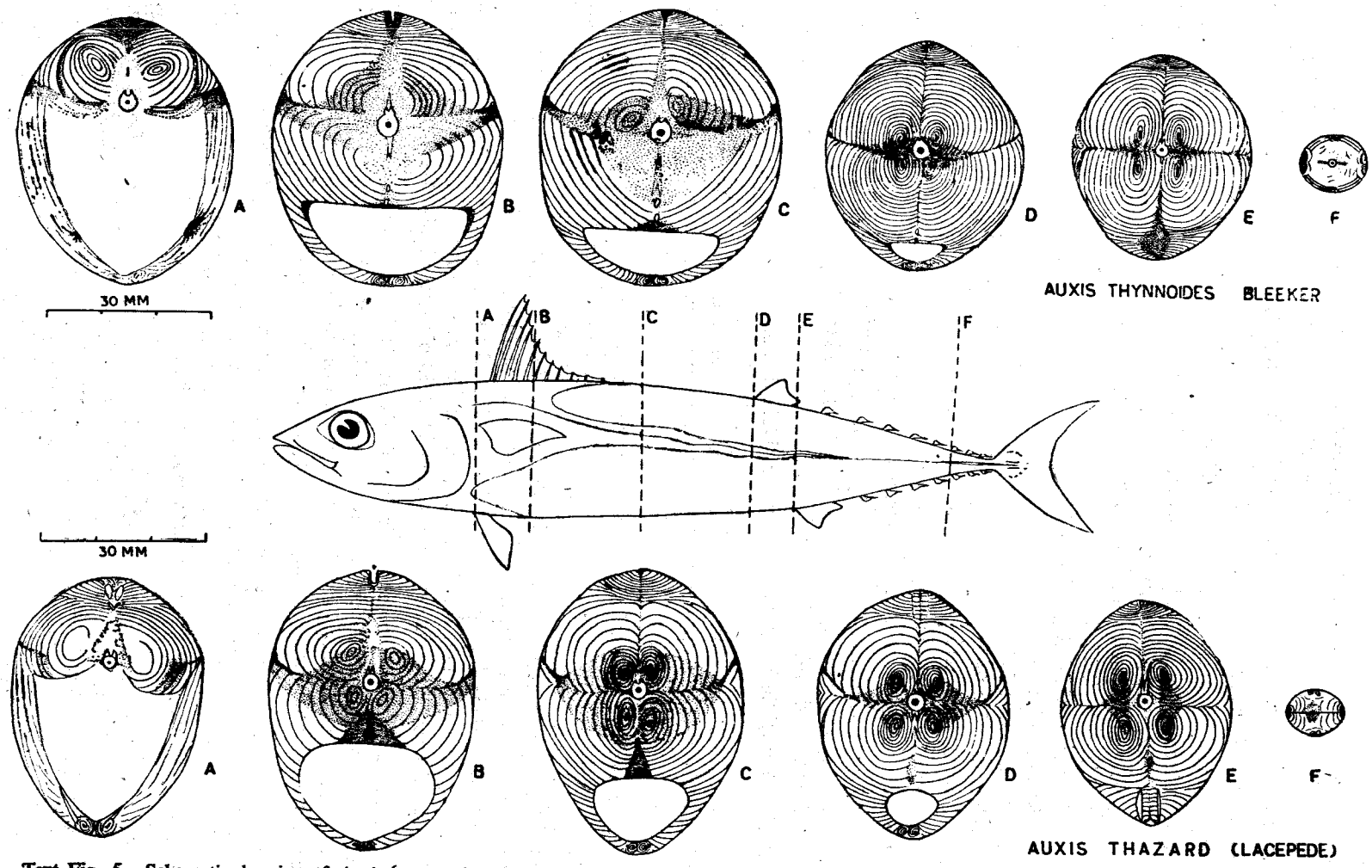
SHORT CORSELETTED FRIGATE MACKEREL

Auxis thazard (Lacépède), 1802

(Plate II, Figs. B & C)

SYNONYMS :

Scomber thazard Lacépède, 1801 : 9 (Type locality : New Guinea)
Scomber bisus Rafinesque, 1810 : 45 (Type locality : Palermo)
Scomber rochei Risso, 1810: 165 (Type locality : Nice)
Thynnus rocheanus Risso, 1826: 417 (Type locality: Nice)



Text Fig. 5. Schematic drawing of *Auxis* (central figure) indicating locations, from where 6 cross-sections of the body were made in *Auxis thynnoides*, and *A. thazard*, illustrated alongside showing differences in body shape and shape of abdominal cavity.

Auxis vulgaris Cuvier, 1831: 139 (Type locality : Mediterranean)

Auxis taso Cuvier, 1831 : 146 (Type locality : New Guinea)

Auxis tapeinosoma Bleeker, 1854 (Type locality: Japan)

Auxis rochei (in part) Günther, 1860: 369

Auxis rochei (in part) Steindachner, 1884: 180

Auxis thazard Jordan and Evermann, 1896: 867
Steindachner, 1896: 210
Meek and Hildebrand, 1923: 313
McCulloch, 1922: 104
Fowler, 1928: 132 ; 1934: 416
Smith, 1949: 298
Rivas, 1951: 215
Herre, 1953: 247
Munro, 1955: 219 ; 1958 b: 18
Jones and Silas, 1960: 377 ; 1962*b* (MS.)

Auxis tapeinsoma (*nec* Bleeker) Herre, 1931: 33

Auxis hira Kishinouye, 1915: 23 (Type locality: Hokkaido to Kyushu, Japan Sea, Ogasawaras and Ryukyus ; South Seas?) ; 1923: 462
Jordan and Hubbs, 1925: 221

Auxis thazard (in part) Fraser-Brunner, 1953: 152-53

Most of the data for the species are given under the genus. Additional references pertaining to the species from the Indian Ocean and contiguous Seas are : Williams (1960) ; Ranade (1961).

A. thazard is a seasonal visitor to the coastal waters, and is usually caught in shore seines, drift nets and in trolling. It is the more common of the two species of the genus and collections have been examined by us from various parts along the West Coast of India from Gujarat to Cape Comorin, from the East Coast from Tuticorin and from the Laccadive Sea, but no appreciable difference has been noticed. The fin rays and gill raker counts are D_1. X–XI ; D_2. 11–13+8 ; P_1. 24 ; A. 13+7 ; Gill rakers (total) 39-42 (as 9–10+29–32). Rivas (1951) gives the counts for *A. thazard* from the Western North Atlantic as : D IX–XI ; dorsal finlets 8 or 9 ; anal finlets 7, gill rakers 29 to 33 on lower limb of first arch.

It may be mentioned here that de Beaufort's (1951) description of the species given under *A. thazard* actually refers to *A. thynnoides* Bleeker. A question which may be difficult to settle is whether Lacépède's type of *A. thazard* from New Guinea actually refers to the short corseletted form, although it is currently believed to be so.

In view of the very close similarities between *A. thazard* and *A. thynnoides*, and the way in which both have been confused in the past, it will be an extremely difficult task to unravel all references pertaining to one or the other species to be listed under the section 'Synonymy.' Hence only the more important works are referred to.

DISTRIBUTION : In Indian Ocean and contiguous waters : East Coast of South Africa from Natal Coast northwards ; Gulf of Aden ; West and East Coasts of India, Laccadives ; Ceylon, South West Sunda Sea? ; West Coast of Australia. The general distribution also includes Atlantic, Mediterranean and the Pacific.

LONG CORSELETTED FRIGATE MACKEREL

Auxis thynnoides Bleeker, 1855

(Plate II, Fig. A)

SYNONYMS :

Auxis thynnoides Bleeker, 1855: 301 (Type locality : Ternate)
Munro, 1958b: 18
Jones and Silas, 1960: 378 ; 1962b (MS.)
Jones, 1962f (MS.)

Auxis thazard (*nec* Lacépède) Jordan and Evermann, 1900
de Beaufort, 1951: 226–27.

Auxis thazard (in part) Fraser-Brunner, 1950: 152-53
Rosa, 1950: 69-74
Rivas, 1951: 215-16

Auxis rochei (in part) Günther, 1860: 369

Auxis tapeinosoma (*nec* Bleeker) Herre and Herald, 1951
Jones, 1958: 189-94 ; 1960: 357-47
Williams, 1960
of Japanese workers.

Auxis maru Kishinouye, 1915: 24 ; 1923: 463-64

For long a problematic species, its position in the system is now better defined. Jones (1962f) summarises our knowledge about this species from which it would appear that much more has been written about it in literature than one would expect.

Unlike *A. thazard*, this species is rarely seen in the commercial catches, but when it occurs it is seen in very large shoals and considerable quantities are landed by shore seine. We have measured specimens upto about 300 mm. from the West Coast of India, but much larger specimens have atleast on one occasion been noticed in the fish curing yard at Vizhingam on the South West Coast of India.

Body proportions expressed as percentages of total length (to fork) for 13 specimens from the South West Coast of India are as follows :—

Head 23.7–26.8 ; snout 6.0–7.6 ; eye 4.2–5.2 ; snout to end of maxilla 8.2–9.1 ; height of body 17.1-21.0 ; first predorsal distance 21.9-31.1 ; second predorsal distance 61.0–63.7 ; preanal distance 66.7–69.4 ; prepelvic distance 25.0–29.5 ; prepectoral distance 25.0–28.3 ; distance between pelvic and anal origins 39.4–42.3 ; height of longest (first) dorsal spine 11.0–16.0 ; height of second dorsal 4.3–5.1 ; length of pectoral 11.9–13.3 ; length of anal 4.0–5.1 ; and width of body at pectoral base about 16.0 18.0 per cent in total length.

The fin ray and gill raker counts for specimens we have examined from South West Coast of India are :

D_1. X–XI, D_2. 13+8 ; A. 13+7 ; Gill rakers 8–12+31–36 (=40–47) (See Tables II and III for more details.)

This may be compared with the following counts given for the species from other areas (Table–II).

TABLE II

	D1	D2 + finlet	A + finlet	Gill-rakers
Japan (Kishinouye, 1923)	IX - X	10 - 12 + 8	13 + 7	10 + 36
Philippines (Wade, 1949)	X - XI	10–12+7–8	2, 10 - 12 + 7	10 - 12 + 1 + 31 - 35 (= 42 - 48)
Indonesia (de Beaufort, 1951)	X	11 + 6 - 9	14 + 6 - 8	...
Hawaii (Matsumoto, 1960)	X - XI	10 - 11 + 8	12 - 13 + 7	10 - 11 + 1 + 32 - 36 (= 43 - 48)

TABLE III

Range and mean gill raker counts for specimens of *Auxis thazard* and *A. thynnoides* from Indian waters

Species	No. of specimens	Range (R) Mean (M)	Gill rakers		
			Upper limb	Lower limb	Total
Auxis thazard	10	R	9 - 10	29 - 32	39 - 42
		M	9.6	30.2	39.8
Auxis thynnoides ...	13	R	8 - 12	31 - 36	40 - 47
		M	9.5	34.5	44.8

While there is considerable overlap in the number of gill rakers on the upper limb of the first branchial arch in both the species, the range on the lower limb is low for *A. thazard*. The total number of gill rakers also consequently shows a similar trend with the mean for *A. thazard* being about 40 and for *A. thynnoides* about 45.

In a few larger adults of *A. thazard* from South West Coast of India it has been found that the corselet instead of abruptly tapering, gradually narrows somewhat as in *A. thynnoides* to a vertical below mid-distance between posterior end of base of first dorsal and second dorsal origin from whence it is narrow with hardly one or two scales on either side. These conditions are shown in Plates II C and VI C and Fig. 3 a & b. Such intermediate conditions as also slight overlap in gill raker counts could evidently give rise to difficulties in specific determination. In such eventualities, additional characters discussed under the genus should facilitate identification.

DISTRIBUTION : Records from the Indian Ocean are rather few. Along the Indian coast we have collected the species from Malpe near Mangalore (S. Mysore) ; Calicut, Quilandy, Vizhingam (Kerala State) ; and Colachel and Cape Comorin (Madras State). In the Pacific Ocean it has a much wider distribution. Its occurrence in the Atlantic is suspected (Matsumoto, 1959).

Genus **Cybiosarda** Whitley, 1935

Scomberomorus (*Cybiosarda*) Whitley, 1935. *Rec. Aust. Mus.*, 19 (4):? (Proposed as a subgenus of *Scomberomorus*, but later (Whitley 1936) elevated to generic status. Type species : *Scomberomorus* (*Cybiosarda*) *elegans* Whitley).

The genus is placed under the subfamily Scombrinae as a synonym of *Gymnosarda* by Fraser-Brunner (1950). Munro (1958) has included it under the family Sardidae, while Jones and Silas (1960, 1962b) consider it a genus of subfamily Thunninae of family Scombridae.

We feel that *Cybiosarda* should be retained as a distinct genus, although Fraser-Brunner (1950) relegated it to the synonymy of *Gymnosarda* Gill. The presence of villiform teeth in the vomer, the greater number of dorsal and anal finlets (9 or 10/7 or 8), and XV or XVI dorsal spines in *Cybiosarda* should differentiate it from *Gymnosarda* in which genus the vomer is edentulous, the dorsal and anal finlets fewer (6 or 7/6 or 7), and the dorsal spines number XII–XIV.

The genus is monotypic and additional details are given under the species.

LEAPING BONITO

Cybiosarda elegans (Whitley), 1935

SYNONYMS :

Scomberomorus (*Cybiosarda*) *elegans* Whitley, 1935. 19 (4) :? (Type locality : New South Wales, Australia).

Cybiosarda elegans Whitley, 1936
Serventy, 1941: 43
Ogilby and Marshall, 1954: 89
Munro, 1958b: 17
Jones and Silas, 1960: 379 ; 1962b (MS.)

Gymnosarda elegans Fraser-Brunner, 1950: 149;
Rosa, 1950: 53

By its occurrence along the West Coast of Australia, this species qualifies for inclusion in this account. Munro (1958b) gives the following body proportions and meristic counts for the species. Depth 3.7 to 4, head 3.5 to 4.5 in length without tail. D_1. XV–XVI, D_2+finlets 17–18+9–10 ; A.+finlets 15–16+7–8 ; P_1. 22–24 ; gill rakers 3–4+8–10.

Jaws composed of curved conical teeth arranged uniserially ; palatines with 3 rows of fine sharp teeth ; pear shaped patch of villiform teeth on vomer. Corselet developed, lateral line almost straight joining peduncular keel ; a pair of lateral caudal keels on each side present.

According to Serventy (1941) it is said to be an excellent sport fish and specimens between 3/4 and 2 lbs. are usually taken in trolling, and shoals of many hundreds are often seen. Serventy further remarks that it " ..... is the one tuna whose flesh is appetizing in the fresh condition. The meat is white and may be smoked quite well ".

DISTRIBUTION : In Indian Ocean and contiguous waters : along the West Coast of Australia atleast as far south as Fremantle. In the Pacific Ocean : East Coast of Australia as far south as Sydney or Shell Harbour, New South Wales.

Genus Sarda Cuvier, 1829

Sarda Cuvier, 1829. *Regne Anim.*, 2 : 199 (Type : *Sarda pelamys* = *Scomber sarda* Bloch)

Pelamys Cuvier, 1831. *Hist. Nat. Poiss.*, 8 : 149 (Type : *Pelamys sarda*=*Scomber sarda* Bloch) (*nec Pelamys* Daudin, a genus of snakes).

Palamita Bonnaparte, 1831. *Giruale Arcadio*, P. 107 (Type : *Scomber sarda* Bloch).

Creotroctes Gistel, 1848. *Naturg. Thierr.*, p. 10 (Type : *Scomber sarda* Bloch) (*Creotroctes* Gistel proposed to replace *Sarda* Cuvier)

The generic diagnosis would be : Body elongate, compressed from side to side, covered with scales, corselet well formed, caudal slender, strongly keeled ; mouth large, maxilla extending to or surpassing vertical below hind border of eye ; teeth in jaws strong, conical and very slightly compressed ; vomer edentulous, palatines with a single row of strong conical teeth, gill rakers well developed, first dorsal with XVIII – XXII spines ; both dorsal and anal short followed by 7–9/5–9 finlets respectively. Vertebrae 44 or 45.

DISTRIBUTION : Warm and temperate waters of the Indo-Pacific, Atlantic and Mediterranean.

ORIENTAL BONITO

Sarda orientalis (Temminck and Schlegel), 1844

(Plate VIII, Fig. A)

SYNONYMS :

Pelamys orientalis Temminck and Schlegel, 1844 : 99 (Type locality : Japan)

Scarda chiliensis var. *orientalis* Steindachner and Doderlein, 1885 : 11 (typographic error for *Sarda*)

Pelamys chiliensis (*nec* Cuvier) Day 1876–78 : 253 ; 1889 : 208

Sarda chilensis (in part) Barnard, 1927 : 801

Sarda velox Meek and Hildebrand, 1923 : 320 – 21 (Type locality : Panama City, Panama – Specimen purchased from Market)

Sarda orientalis serventyi Whitley, 1945 : 41 (Type locality : Albany, W. Australia)

Sarda orientalis Kishinouye, 1915 : 12
Fraser-Brunner, 1950 : 147
Rosa, 1950 : 44–45
Jones, 1960 : 337–47
Jones and Silas, 1960 : 378–80 ; 1962b (MS.)
Smith, 1961 : 299
Silas 1962a (MS.), 1962f (MS.)

Available information about the oriental bonito may be had from two recent contributions on the species by Silas (1962a; 1962f) wherein, detailed synonymy, description, aspects of the biology of the species, etc., are dealt with. The meristic counts for the Indian specimens given by Silas (1962a) are : D_1. XVII–XIX ; D_2 + finlets. 14–16 + 7–8 (exceptionally 9) P_1. 23–25 ; A + finlets. 13–16 + 5–7 ; gill rakers 1–4 + 8–10.

For typical Japanese specimens, Kishinouye (1923) gives the counts as : D_1. XIX, D_2 + finlets 15 + 7–8 ; A + finlets 15 + 5–6 ; gill rakers 4 + 9 ; vertebrae 25 + 20 = 45.

Some of the earlier workers have confused both *S. orientalis* and *S. chilensis*, but the position has now been clarified (Godsil, 1955 ; Silas, 1962a, f)

DISTRIBUTION : " East Coast of South Africa, Seychilles, Somalia and Gulf of Aden, West Coast of India, South West Coast of Australia, Philippines, Japan, Hawaii, Pacific Coast of Central America and Galapagos Islands besides two records from the Atlantic". (Silas, 1962f).

Genus **Gymnosarda** Gill, 1862

Gymnosarda Gill, 1862 *Proc. Acad. Nat. Sci. Philad.*, 125 (Type : *Thunnus unicolor* Rüppell) (*nec Scomber unicolor* Geoffroy St. Hilaire, 1809 which is the type of *Orcynopsis* Gill 1862–syn. *Pelamichthys* Giglioli 1880)

Fraser-Brunner (1950) treated *Cybiosarda* Whitley as a synonym of *Gymnosarda*, but as already mentioned, we consider these two as distinct genera. Diagnostic characters include : " Body elongate, fusiform, anteriorly robust with large head.....maxilla extending to vertical below anterior third of eye ;.....teeth in jaws large slightly curved, but nearly conical in shape, villiform teeth present on tongue and palatines ; vomer edentulous ; eyes large ; body appearing naked except for greatly reduced corselet and lateral line ; scales in corselet elongate and concealed under skin which is usually drawn into longitudinal furrows on either side of dorsals ; lateral line conspicuous and undulating posteriorly ; two dorsal fins more or less contiguous.....first dorsal with XII–XIV spines of which 3rd spine longest ; dorsal finlets 6 or 7 and anal finlets mostly 6 ; pectorals not exceeding head length; interpelvic process developed, simple or bifid posteriorly ; caudal relatively slender, with a well developed median keel and a pair of low lateral keels on either side ; caudal lobes more or less vertical, posterior margin being a wide arc, gill rakers few, strong ; gill membranes free, operculum slightly undulating at hind margin ; vertebrae 38 (19+19)" (Silas, 1962 a).

The genus is monotypic.

DISTRIBUTION : Indo-Pacific.

REMARKS : The systematic position of the genus has been subject to varied treatment as Kishinouye (1923) placed it among the Cybiidae ; Fowler (1942) under subfamily Sardinae ; Fraser-Brunner (1950) under subfamily Scombrinae ; Munro (1960b) under family Katsuwonidae, and Jones and Silas (1960) under subfamily Thunninae.

DOGTOOTH TUNA

Gymnosarda unicolor (Rüppell), 1838

(Plate IV, Fig. D)

SYNONYMS :

Thynnus (*Pelamis*) *unicolor* Rüppell, 1838: 40 (Type locality : Djedda, Red Sea)
Pelamys nuda Günther, 1160: 368 (Type locality : Red Sea) (Species name proposed to replace *T. unicolor* of Rüppell which was considered to be preoccupied by *Scomber unicolor* Geoffroy. 1809)
Gymnosarda nuda Kishinouye, 1915: 13
Scomber vau Curtiss, 1938: 57 (Type locality : Ocean outside reef, off Tautira)
Gymnosarda unicolor Fowler, 1949 73
Jones, Silas and Dawson, 1960: 136
Jones and Silas, 1960: 380-81 ; 1962b
Silas, 1962g (MS.)

For detailed synonymy reference may be made to Silas (1962g) who also gives the body proportions for the species (for specimens from Indian seas) expressed as percentages of total length as follows :

" Head 24.8—28.1 ; first predorsal distance 28.1—31.8 ; second predorsal distance 54.3—58.8 (in one instance 62.1) preanal distance 61.0–67.0 prepelvic

distance 27.0—31.7 ; greatest depth of body 19.6—24.8; length of pectoral 16.6—19.9 ; height of second dorsal 9.9—11.8 ; height of anal 9.7—11.6 ; diameter of iris 3.8—6.0 per cent in total length."

For a redescription of the species, and information on aspects of the biology of it reference is invited to Silas (1962g).

DISTRIBUTION : In Indian Ocean and contiguous seas : East Coast of Africa off Mafia, South of Zanzibar, Minicoy Island in the Laccadives, Maldives ; Bases reef South East of Ceylon ; off Port Blair Andamans ; St. Davis ; Reunion ; Maurice ; Madagascar ; Comeros ; Banes Castor et Leven ; Hawkins Bank ; Rodrigues ; North East Seychelles Plateau ; South Amirante Bank ; St. Brandon and Constant Bank, Mauritius, Seychelles, Aldabra. From the Pacific Ocean it has been recorded from several localities from Riu Kiu Islands (Japan) in the North to Tahiti in the South East (after Silas, 1962g).

Genus **Thunnus** South, 1845

Thynnus Cuvier, 1817. *Regne Anim.* 2nd Ed. 313 (Type species : *Scomber thynnus* Linnaeus–by absolute autonomy) (Preoccupied by *Thynnus* Fabricius, 1775, a genus of Hymenoptera, Insecta)

Orcynus Cuvier, 1817. *Regne Anim.* 2nd Edn : 314 (Type species : *Scomber germo* Lacépède = *Scomber alatunga* Gmelin [= *Thunnus* (*T.*) *alalunga*]. Designation by Jordan, 1888, *Proc. Acad. Nat. Sci. Philad.*, 180. (Preoccupied by *Orcynus* Rafinesque, 1815 as a substitute for *Scombroides* Lacépède in Fishes).

Thynnus South, 1845. *Encyclop. Metrapol.*, 5 : 620 (Type species : *Scomber thynnus* Linnaeus). (Proposed to replace *Thynnus* Cuvier which is preoccupied.

Orcynus Gill 1862. *Proc. Acad. Nat. Sci. Philad.*, 238 (Type species : *Scomber thynnus* Linnaeus) (*nec Orcynus* Cuvier).

Albacora Jordan, 1888. *Proc. Acad. Nat. Sci. Philad.*, 180 (Types species : *Scomber thynnus* Linnaeus) (Substitute name for *Thynnus* Cuvier which is preoccupied).

Germo Jordan, 1888. *Proc. Acad. Nat. Sci. Philad.*, 180 (Type species : *Scomber alatunga* Gmelin [= *Thunnus* (*T.*) *alalunga*] proposed as a substitute for *Orcynus* Cuvier, 1817, which is preoccupied by *Orcynus* Rafinesque, 1815).

Parathunnus Kishinouye, 1923, *J. Coll. Agric. Tokyo Univ.*, 8 : 442 (Type species : *Thunnus mebachi* Kishinouye, 1915 [= *T.* (*P.*) *obseus mebachi*].

Neothunnus Kishinouye, 1923. *J. Coll. Agric. Tokyo Univ.* 8 : 445 (Type species : *Thynnus macropterus* Temminck and Schlegel, 1844 [= *T* (*N.*) *albacares macropterus*]

Kishinoella Jordan and Hubbs, 1925. *Mem. Carnegie Mus.*, 10 (2) : 219 (Type species : *Thunnus rarus*, Kishinouye, 1915 [= *T.* (*K.*) *tonggol* Bleeker].

Semathunnus Fowler, 1933. *Proc. Acad. Nat. Sci. Philad.*, 85 : 163 (Type species : *Semathannus guildi* Fowler [= *T.* (*N. ?*) *itosibi* ? Jordan and Evermann, 1926].

Whitley (1955) resurrected the obscure name *Thinnus* S. D. W (ood?) 1837 to replace *Thunnus* South (18'5). Since the name *Thunnus* is so widely current and well known we would suggest a ruling suppressing *Thinnus* in favour of *Thunnus*.

Parathunnus Kishinouye, *Neothunnus* Kishinouye, and *Kishinoella* Jordan and Hubbs were originally proposed as genera and they have been accepted in this sense by most recent workers (Jordan and Hubbs, 1925 ; Jordan and Evermann, 1926 ; Serventy, 1941a, 1942a.b ; Godsil and Byers, 1944 ; Fowler, 1949 ; Rosa, 1950 ; Godsil, 1954 ; Munro, 1957, 1958a ; Jones and Silas, 1960 ; and others). However, some (Fraser-Brunner, 1950 ;

and others) treat them as sub-genera of the genus *Thunnus*. Fowler (1936) considers them as synonyms of *Germo* Jordan. The salient differences between *Thunnus, Germo, Parathunnus, Neothunnus,* and *Kishinoella* are well covered in the 'key' to these genera given by Jordan and Hubbs, (1925) wherein, the first two genera are separated from the remaining three as the cutaneous blood vessel in these pass through the myotome of the fifth vertebra and the surface of the liver is straited with fine venules (*versus* cutaneous blood vessels passing through myotome of seventh vertebra and surface of liver not striated with venules). Further *Thunnus* is said to have short pectoral fins about half length of head and falling short of vertical below origin of second dorsal and anal with dorsal and anal lobes low while in *Germo* the pectoral fin is very long, ribbon-like, reaching to the anterior dorsal and anal finlets and the dorsal and anal lobes are moderately long. The remaining three genera were separated as follows :

" Posterior cardinal vein not contiguous with the cuverian ducts. Vascular plexus on the inner side of the liver ; pectorals long, reaching to near end of second dorsal, dorsal and anal lobes moderate, about half head.

... *Parathunnus*

Posterior cardinal vein contiguous with the cuverian ducts ; vascular plexus in the haemal canal.

Air bladder well developed, long and narrow ; pectorals long, extending beyond middle of second dorsal ; dorsal and anal lobes much elongated, as long as head ; gill rakers about 30.

... *Neothunnus*

Air bladder wanting ; gill-rakers about 26 ; pectoral fin shorter, reaching to near end of spinous dorsal ; head shorter ; mouth smaller.

... *Kishinoella.*"

Fraser-Brunner (1950 p. 142) who treats these as subgenera, mentions in addition that in *Parathunnus* the origin of the anal fin is midway between the hind margin of the gill cover and the end of the caudal keels or "very slightly anterior" while in *Neothunnus*, and *Kishinoella* the origin of the anal fin is distinctly anterior to the point midway between hind edge of gill cover and end of caudal keels, the tail being longer than in *Parathunnus* and subgenus *Thunnus*.

Godsil (1954) in his key to the genera of the family Thunnidae draws attention to the fine peripheral markings on the ventral surface of the liver in *Parathunnus* (in *P. mebachi*) which "..... may disappear in stale specimens."

However, additional information on these true-tunas given by de Sylva (1955), Rivas (1961) and others indicates that the differences between the species have been unduly magnified resulting in the recognition of a number of monotypic genera. No doubt, phylogenetically the species recognised under these genera or subgenera form a close-knit group and as such we feel that it will be desirable to place all these under a single genus *Thunnus* as advocated by Fraser-Brunner (1950). As will be evident from the discussions under the species given below, stability of nomenclature below the species level and in one or two instances at species level has not been attained. It is not yet clear whether populations recognised from different faunal areas should be given recognition as distinct species. A great and urgent need is the comparison of good series of samples both morphometrically as well as biochemically (blood

typing, etc.) from the different faunal areas to get a clearer picture. Until such time, we propose retaining *Parathnnnus*, *Neothunnus*, and *Kishinoella*, as subgenera of genus *Thunnus*. Here again, Rivas (1961) opines that *Parathunnus* and *Neothunnus* may be synonyms. We propose the following grouping under the genus *Thunnus*.

Genus **Thunnus** South

Subgenus *Thunnus* S. str.
T. (*T.*) *thynnus thynnus* (Linnaeus)-Atlantic, Mediterranean.
T. (*T.*) *thynnus orientalis* (Temminck and Schlegel)—Indo-Pacific.
T. (*T.*) *alalunga* (Gmelin)—Atlantic, Mediterranean, Indo-Pacific.

Subgenus *Parathunnus* Kishinouye
T. (*P.*) *obesus obesus* Lowe—Atlantic.
T. (*P.*) *obesus mebachi* Kishinouye—Indo-Pacific.
T. (*P.*) *atlanticus* (Lesson)—Atlantic.

Subgenus *Neothunnus* Kishinouye
T. (*N.*) *albacares albacares* (Bonnaterre)—Atlantic.
T. (*N.*) *albacares macropterus* (Temminck and Schlegel)—Indo-Pacific.
T. (*N.*) *itosibi* (Jordan and Evermann)—Indo-Pacific.

Subgenus *Kishinoella* Jordan and Hubbs
T. (*K.*) *tonggol* (Bleeker)—Indo-Pacific.

ORIENTAL BLUEFIN TUNA

Thunnus (Thunnus) thynnus orientalis (Temminck and Schlegel), 1844

(Fig. 6 a, b)

SYNONYMS :

Thynnus orientalis Temminck and Schlegel, 1844 : 94 (Type locality : Nagasaki, Japan).
Boeseman, 1947 : 91 (on the type specimen in Leiden Museum)

Thunnus maccoyii Castelnau, 1872 : 104 (Type locality : from Melbourne market caught off coast of S. Australia)

Orcynus schlegelii Steindachner and Doderlein, 1885 : 11 (Type locality : Southern Japan)

Orcynus thynnus Kitahara, 1897 : 1

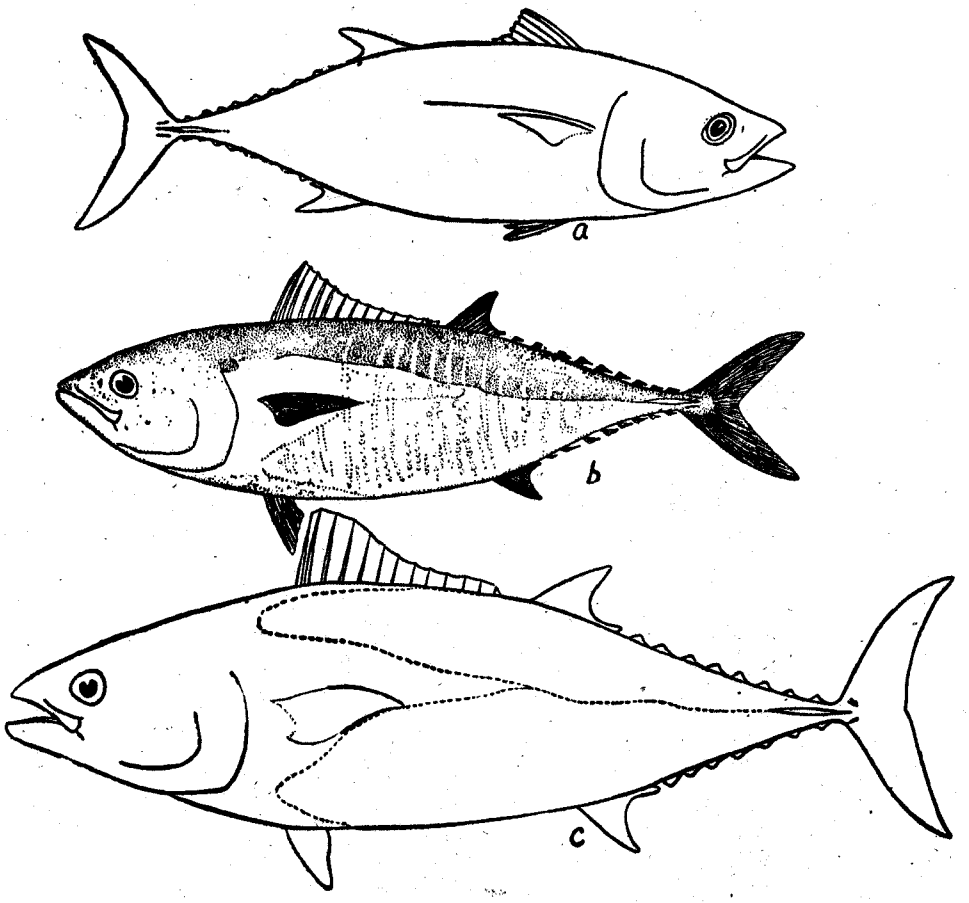
Thunnus schlegelis Fujita et al., 1905 : 21

Thunnus orientalis Kishinouye, 1915 : 17 ; 1923 : 437
Jordan and Evermann, 1926 : 14
Rosa, 1950 : 11–12

Thunnus saliens Jordan and Evermann, 1926 : 10–11 (Type locality : Catalina, California)
Roedal, 1953 : 88

Thunnus phillipsi Jordan and Evermann, 1926 : 13 (Type locality : Bay of Islands, New Zealand)

Thunnus maccoyii Jordan and Evermann, 1926 : 13
Serventy, 1941 a : 27 ; 1941b : 1–2
Rosa, 1950 : 13–14



Text Fig. 6. (*a*). *Thunnus* (*T.*) *thynnus orientalis* (Temminck and Schlegel) (after a photograph of *Thunnus maccoyii* Castelnau kindly sent by C.S.I.R.O., Australia); (*b.*) *T* (*T.*) *thynnus orientalis* (after Kishinouye, 1923); (*c*). *T.* (*T.*) *thynnus thynnus* (Linnaeus) from the Atlantic (after Fraser-Brunner, 1950).

Thunnus thynnus (in part) Barnard, 1927 : 798
Godsil and Byers, 1944 : 89–102
Molteno, 1948 : 16
Smith, 1949 : 298
Rosa, 1950 : 1–8
Herre, 1953 : 252
Thunnus Thunnus thynnus (in part) Fraser-Brunner, 1950 : 143
Thunnus (*Parathunnus*) *obesus* (in part) Fraser-Brunner, 1950 : 144
Thunnus thynnus maccoyii Serventy, 1956 : 1–43
Munro, 1958 b : 19
Thunnus thynnus orientalis Jones and Silas, 1960 : 381–82

The nomenclature and status of bluefins from various parts of the world are in a state of chaos. *Thunnus thynnus* (Linnaeus) is recognised as the typical bluefin from the Eastern Atlantic and Mediterranean, while the Western Atlantic (off North American Coast) bluefin is considered by some workers to be a distinct species *T. secundodorsalis* (Storer).

Serventy (1956) opined that *T. coretta* (Cuvier and Valenciennes) should replace *T. secundodorsalis*, but the former is now considered a synonymy of *Thunnus atlanticus*. At least three specific or subspecific names are currently in use in fishery literature to denote the bluefins from the Pacific and Eastern Indian Oceans namely, *T. orientalis* (from Japanese waters) ; *T. saliens* (from California coast) ; and *T. maccoyii* (from around Australia and New Zealand). The last said finds mention in Japanese fishery literature as the *Indomaguro*.

No attempts have been made to check the status of the bluefin from the Indian Ocean, although in the eastern part the *Indomaguro* and *T. maccoyii* may be considered identical. We have elsewhere (Jones and Silas, 1960) considered it best to denote the bluefin from the Indian Ocean as *T. thynnus orientalis* and would still advocate this course for the very reason that no comparisons of *T. maccoyii* or *T. saliens* have been made with *T. orientalis* from Japanese waters, the latter name being the oldest available for the Indo-Pacific bluefins, and thus having priority. The general body form, profile, short pectorals, etc., are very characteristic of bluefins throughout the world, while slight differences in gill raker counts, and a few body proport ons have been noted by Godsil and Holmberg (1950), Serventy (1956), and Mather (1959), between bluefins from the Atlantic, Pacific Coast of California, and Australia but with considerable overlap in ranges. It is highly questionable whether the said differences would suffice to denote bluefin from the geographical areas as distinct species as considered by some recent workers and also currently used in certain fishery literature in the Pacific.

The range of gill raker counts on the lower limb of outer arch which may vary from 22 to 31 would appear to show different modes for the different geographical areas which has led Serventy (1956) to recognise a single worldwide species of bluefin with at least 6 subspecies as follows :

Sub-species	*Area of occurrence*	*Gill-raker counts (Mode)*
Thunnus thynnus thynnus (L.) ...	European Seas ...	13/24–26 = 37–39
T. t. coretta (C. and V.) ...	North America, Atlantic Coast ...	
T. t. Sub sp. ...	South Africa ...	
T. t. saliens Jordan and Evermann ...	North America, Pacific Coast ...	12/23–24 = 35–36
T. t. orientalis (Temminck and Schlegel) ...	Asiatic Coast of North Pacific ...	12–13/24–26 = 36–39
T. t. maccoyii (Castelnau) ...	Australia and New Zealand ...	11/22–23 = 33–34

According to Serventy (1956) "The South African population has remained unnamed, but from a consideration of the morphological differentiation which has gone on in similar isolated populations (*vide* in particular the work of Godsil and Holmberg) it will probably require designation as a new subspecies when its characters have been worked out." Smith (1961), gives the meristic counts of *T. thynnus* from Cape Waters as "D. XII–XV, 12–14+8–10. A. I–II, 11–12+7–9. 26–31 slender gill-rakers." More information is required on the bluefin from Central and Western Indian Ocean.

The data given by Mather (1959) would suggest the following to be the modes for gill raker counts for bluefin from the Eastern and Western Atlantic.

Eastern Atlantic : 12/25–27 = 37–39
Western Atlantic : 13/25–27 = 38–40

TABLE IV.

Gill raker frequencies for *T. t. maccoyii* (after Serventy, 1956)

	Gill rakers																						
	Upper limb					Lower limb								Total									
No.	9	10	11	12	13	21	22	23	24	25	26	27	28	31	32	33	34	35	36	37	38	39	40
E. Australia	2	16	38	19	4	4	35	32	7	1	...	...	...	3	12	26	15	17	3	3	...	...	...
S. Australia	...	1	11	2	2	2	4	6	2	2	...	...	...	...	3	3	5	1	2	2	...	...	...
W. Australia	8	48	105	52	3	18	74	87	32	4	...	...	1	6	41	52	63	34	18	1	...	...	1
Total	10	65	154	73	9	24	113	125	41	7	...	...	1	9	56	81	83	52	23	6	...	...	1

The fin formula for *T. t. maccoyii* is given by Serventy (1956) as D.XII—XIV, 14–15+8–9 ; A. 14–15+7–8 ; P_1. 28–34, the most usual counts being : D.XIV, 15+8 ; A. 14+18 ; P_1. 32.

Fraser-Brunner (1950) relegated *T. maccoyii* and *T. phillipsi* as synonyms of *Thunnus* (*Parathunnus*) *obesus* Lowe, 1839. Serventy (1956) has shown that the first two are conspecific and has drawn attention to the fact that Fraser-Brunner had inadvertently placed *maccoyii* in the synonymy of *T.* (*P.*) *obesus*. The type of *T. phillipsi* (Jordan and Evermann, 1916, pl. 2, fig. 4) is considered to have facial abnormality, a kind which Serventy has also noticed in occasional specimens of '*Thunnus germo* Lacépède' from Australia.

As in the N. E. Atlantic tunny (fig. 6 c), the median lobe of the liver in *T. maccoyii* is more pointed, but the right lobe is less developed as in *T. orientalis* and *T. saliens*.

While regional differences in the bluefins are recognised by Serventy (1956), his examination of Australian specimens has led him to suspect that some of the detailed morphological differences such as the shape of the air-bladder between the Australian and Californian specimens of bluefins drawn attention to by Godsil and Holmberg (1950) could also be due to differences in the size of the specimens studied. "Supplementary findings of Godsil and Holmberg (1950, p. 45) suggest that some of these supposed differences, such as curvature of the dorsal wall, also vary with size. Examination of additional specimens suggests that their further diagnostic characters, concerning the arterial systems, be in this category, and that though there may be differences in the various regional groups the differences for the recognition of particular individuals are not decisive."

Few workers have commented on the colour of the bluefin from the Pacific and Serventy's (1956) observations show how easily this character could mislead one to identify a bluefin as an yellowfin. According to him "There are differences in colour between the various populations which deserve attention though they have not been fully studied by authors. Godsil and Holmberg draw attention to this character but were prevented from using it fully owing to their material having been in a frozen condition for sometime. The Australian fish have none of the rows of pale spots on the abdomen and flanks of the

California fish (*vide* Walford 1937, Plate 34) which also appear to occur on the Atlantic fish (Godsil and Holmberg 1950, p. 7) and on the Japanese (Kishinouye 1925, should be 1923, p. 438) where the belly is greyish with many pale transverse lines and rows of pale dots in alteration" (Fig. 6 b). There are also marked regional differences in fin colour. The Californian fish lack any marked yellow colour on the fins and finlets-hence the local common name of "bluefin." The Japanese fish differ from them in that the second dorsal fin has a yellow tip and the dorsal finlets are yellow. This yellow colouration is even more extensively developed in the Australian fish ; there is a yellow tinge on the second dorsal fin, both the dorsal and ventral series of finlets are yellow, and the caudal fin has a bright yellow stripe. This difference in fin colouration between Australian and Californian fish has been noted by fishermen with first-hand experience of both and has caused a great deal of confusion in identification (many local reports of yellowfin tuna have proved to be misidentification of the southern bluefin).

Large-scale fishing for the *Indomaguro* (*T. maccoyii* of Australia) is carried out at two centres in the Eastern Indian Ocean by the Japanese, the first 10°S to 17°S and 113°E to 120°E and the second 20°S to 30°S and 100°E to 110°E. Mimura (1961) suspects that although the fish in both these areas may belong to the same population, two spawning groups may exist as noticeable from differences in length/weight and gonad weight of specimens caught from these areas.

While evidence at present tends to picture the bluefins as six isolated populations or subspecies or species it may be mentioned that unlike the yellowfin, the bluefin occurs in waters with temperature as low as 12°C. Our knowledge is so inadequate as to even speculate whether there could be mixing between bluefin from Eastern Atlantic and Western Atlantic or between Eastern Atlantic and the Cape Seas (South Africa), or between the latter and that of the Eastern Indian Ocean. Little is known about the movements of the bluefin in the Pacific, though at present they are presumed to be localised.

The distinction between bluefin from these isolated areas is mostly very subtle and it is our contention that until good series from all these areas as well as from the Central and Western Indian Ocean are critically examined, it will be better to use the oldest name available for the bluefin from the Indo-Pacific, namely, *T. orientalis*, and on account of the considerable similarity between the bluefin, of the Indo-Pacific and Atlantic to consider those from the former as a subspecies of *T. thynnus*.

ALBACORE

Thunnus (Thunnus) alalunga (Bonnaterre), 1788

SYNONYMS :

Scomber alalunga Bonnaterre, 1788 : 139 (Type locality : Mediterranean)

Scomber alatunga Gmelin, 1789 : 1330 (on Alalonga Cetti, 1777, *Hist. Nat. Sardin*, 3 : 191, Locality : Sardinia (According to Jordan and Evermann, (1926). Species name misprint for *alalunga*)

Scomber germon Lacépède, 1800 : 598 (Type locality : unknown)

Scomber germo (Commerson) Lacépède, 1802 : 1 (Type locality : South Pacific Ocean-Lat. S. 27°, Long. 103°)

Orcynus germon Cuvier, 1819

Orcynus alalonga Risso, 1826 : 419 (also *O. alalunga*)

Thynnus alalunga Cuvier, 1831 : 120
Thynnus pacificus Cuvier, 1831 : 133 (Type locality : South Pacific Ocean—Lat. S. 26°-S. 27° Long. 103°)
Günther, 1860 : 366
Thunnus alalunga South, 1845
Orcynus pacificus Cooper, 1863
Albacora alalonga Dressler and Fesler, 1889 : 438
Germo alalunga Jordan and Evermann, 1896 : 871 ; 1926 : 15 (synonymy in part)
Meek and Hildebrand, 1923 : 316
Fowler, 1936 : 621 (synonymy in part)
Molteno, 1928 : 29
Smith, 1949 : 299
Orcynus germo Kitahara, 1897 : 1
Germo germo Jordan and Seale, 1905 : 175
Jordan and Evermann, 1926 : 16
Thunnus alalunga, Jordan, Tanaka and Snyder, 1913 : 120
Jones and Silas, 1960 : 382
Germo germon Waite, 1913
Thunnus germo Kishinouye, 1923 : 434
Serventy, 1941 : 23
Godsil and Byers, 1944 : 71–87
Thynnus germo Jenkins, 1925 : 65
Germo alalonga Barnard, 1927 : 799
Thunnus germon McCulloch, 1934 : 79
Germo germon steadi Whitley, 1933
Thunnus (*T.*) *alalunga* Fraser–Brunner, 1950 : 142 (synonymy in part)
Thunnus alalunga germo Munro, 1958 : 19

Besides the works listed above, the following may be consulted for aspects of the biology of the albacore from the Indian Ocean and contiguous waters : Ueyanagi (1955) ; Suda (1956) ; Mimura (1957) ; Yabe (1958) ; Kurogane and Hiyama (1959), and Hiyama and Kurogane (1961).

There are no definite records of this species from the Indian Coast. Apparently it is a southern species found more towards the southern latitudes, just south of the equator. However, Japanese tuna long-line fishery data (Anon, 1959) indicate that during certain months (March–May) albacore may occur in the catches a few degrees to the north of the equator also. Throughout the year the albacore was found to occur in appreciable abundance between latitudes 1°N and 12° S to 15° S and from 52° E of Gr. to 120°E. Even within this area, the seas south-west of Sumatra and south of Java were found to yield the maximum catches of albacore, in one sector the maximum rate of catch being over 11 per 100 hooks used. Some workers have treated the Atlantic albacore as *T. alalunga* and the Pacific as *T. germo*, but hitherto no detailed comparisons have been instituted and even so it is highly doubtful from available data whether more than one species of albacore exists.

Hiyama and Kurogane (1961) opine that in the Indian Ocean the albacore south of Sunda Islands belong to the same population as the ones from the equatorial areas of the Indian Ocean. They find marked differences between the albacore from the Indian Ocean and the Pacific in head length and relative position of the fins. Also the relative growth rate of the Indian albacore is more than that of the Pacific. The Indian Ocean albacore differ from those

of the northwest Pacific in having larger head and more posteriorly positioned fins and these differences along with their disjunct distribution have led them to consider albacore from both these areas as belonging to two distinct populations. Since samples from the Indian Ocean and the South West Pacific show greater agreement in morphometric characters, they suspect that albacore from these two areas may be the same with possibilities of regular mixing.

Mimura (1957) draws attention to two fishing grounds for the albacore in the Indian Ocean, one along the equator (April–September) and the second south of Lat. 8° S (January–March). From the southern waters off Sunda Islands (Indian Ocean) Ueyanagi (1958) obtained two albacores, one with ripe ovaries and the second with nearly ripe ones from an examination of which he deduces that the spawning of albacore takes place in that area. ".....in February atleast in part." Yabe *et al.* (1958) reported the occurrence of a juvenile albacore 258 mm. (vertebral length) from the stomach of a female short-nosed spearfish 130 cm. long collected on 20–3–1957 at 25° 13′ S and 90° 43′ E. Suzuki *et al.* (1958) give data on blood groups of albacore based on 20 specimens collected from Eastern Indian Ocean. Shimadu and Higasa (1960) have studied the Riboflavins in the liver and kidney of albacore from Eastern Indian Ocean, while Watanabe (1960) gives data regarding the composition of food in 21 specimens of albacore from the same area. For the results on exploratory fishing for the albacore in the mid-Indian Ocean reference is invited to Kataoka (1957).

The optimum temperature for albacore appears to be 18° C – 21° C, but the species may occur in waters with temperature range from 10° C – 28° C.

BIGEYE TUNA

Thunnus (Parathunnus) obesus mebachi Kishinouye 1915

(Plate III, Fig. A)

SYNONYMS :

? Thynnus sibi Temminck and Schlegel, 1844 : 97 (Type locality : Nagasaki, Japan).
Boeseman, 1947 : 93 (on the type specimen of *T. sibi* in the Leiden Museum, which he considers as belonging to the species *Germo alalunga* (Gmelin) (= *Thunnus* (*T.*) *alalunga*)

? Orcynus sibi (*nec* Temminck and Schlegel?) Kitahara, 1897 : 1–2

? Thunnus sibi (*nec* Temminck and Schlegel?)
Jordan and Snyder, 1901 : 64
de Beaufort, 1951 : 222–23
de Sylva, 1955 : 34–40

Thunnus mebachi Kishinouye, 1915 : 19 (Type locality : Ryukyu ; Formosa ; Japan Sea?)

Germo sibi Jordan, 1922 : 33

Parathunnus mebachi Kishinouye, 1923 : 442
Godsil and Byers, 1944 : 104–119
Munro, 1957 : 145–148

Parathunnus sibi Jordan and Hubbs, 1925 : 218
Jordan and Evermann, 1926 : 17.
Herre, 1953 : 251

Parathunnus obesus mebachi Jones and Silas, 1960 : 383

Thunnus obesus (in part) Collette, 1961 : 13–14

We agree with Fraser-Brunner (1950) : Rivas (1961) ; Collette (1961) and others that only one species of bigeye tuna may be recognised from the Atlantic and the Indo-Pacific. Although the specific names *sibi* and *mebachi* have been used to denote the Pacific bigeye tuna, we have elsewhere (Jones and Silas, 1960) used the name *mebachi*, as a subspecies of *T. obesus*. This may call for some explanation which we give below :

Günther (1860) considered *Thynnus sibi* Temminck and Schlegel as a dubious species, but Boeseman (1947) re-examining the type specimen definitely attributes it to the albacore *Germo alalunga* (Gmelin) (= *T.* (*T.*) *alalunga*). The reasons given by Kishinouye (1923) for considering his species *Thunnus mebachi* (= *Parathunnus mebachi*) as valid are that : " Kitahara 1897 identified this species with *Thynnus sibi* of Schlegel 1844, but the latter author writes that the species is very common, during summer months, and is caught in hundreds at a time by means of nets of large dimension. This statement is not adequate for the present species. Moreover there are no decisive characters in the description by Schlegel, except the long pectorals and remarkable height of the body. Probably Schlegel confounded this species with *Neothunnus macropterus*. Cunningham 1910 considers this species to be identical with *Thynnus obesus* Lowe of the Atlantic ; but our species differs from the latter in the colour of the second dorsal and the anal atleast. According to Cunningham these fins have ' some black at edges, but little or no yellow '. The descriptions of *Thunnus obesus* by Lowe 1889 as well as Cunningham are very incomplete. It is allied to the present species in having large eyes and a short, thick set figure. But as other important structures of *Thynnus obesus* Lowe are unknown, it is impossible to ascertain the relation between these two species."

Comparison of samples of the bigeye tuna from the Indian Ocean with those from the Atlantic is wanting. A specimen of bigeye we had examined (Jones and Silas, 1960) shows characters more akin to the Atlantic *T. obesus* than to *P. mebachi* figured by Godsil and Byers (1944). The latter appears to have a markedly larger pectoral. Roedel and Fitch (1961) have drawn attention to the desirability of making a comparative examination of the livers of the bigeye tunas from the Atlantic and the Pacific since the description of the nature of the striations of the liver for the Atlantic bigeye given by Mather (1959) and the Pacific bigeye given by Godsil and Byers (1944) indicates likely differences. Until such time that the position can be still further clarified, we advocate the use of the name *mebachi* in a subspecific sense instead of *sibi*.

Hiyama and Kurogane (1961) found that morphometrical comparison of the big eye tuna from the Indo-Pacific based on samples taken from various fishing grounds did not lead to any conclusive results since the samples were inadequate. However, certain trends are indicative, such as, " Among the bigeye tuna from the Equatorial area of the Indian Ocean, as well as the yellowfin tuna, the eastern fish differ from the western fish in having larger heads and more posteriorly positioned fins. The fish from the waters south of the Lesser Sundas differ greatly from those from the Equatorial area. The former have a shorter head and more anteriorly positioned fins than the latter. The differences between the fish from the area south of the Lesser Sundas and from the Banda Sea and also Palao area are not so great as we saw between the former and the Equatorial Indian Ocean ones."

Fujii and Higasa (1959), and Fujii, Mimoto, and Higasa (1959) have carried out biochemical studies on bigeye tuna based on material from the Indian Ocean. Serological studies have been attempted by Suzuki and Morio (1960) while Mimura (1957), Kataoka (1957), Nakagome (1959 *b*), and others have given data on bigeye tuna from parts of the Indian Ocean dealing with length frequencies in the catch, annual and periodic variations in fishing conditions for bigeye, etc. Reference may also be made to the following works for information on the

shoaling habits, food, etc. of bigeye from Indian Ocean : Maeda (1955) ; Yabe, Ueyanagi, Kikawa and Watanabe (1958), and Watanabe (1960).*

DISTRIBUTION : Warmer waters of Indo-Pacific.

NORTHERN BLUEFIN

Thunnus (Kishinoella) tonggol (Bleeker), 1852

(Plate IV, Figs. A & B)

SYNONYMS :

Thynnus argentivittatus Cuvier, 1831. Lectotype as selected by Schaefer and Walford, 1950 : (Type locality : Malabar Coast, India)
Thunnus tonggol Bleeker, 1852 : 356 (Type locality : Sea of Batavia) : 1852 : 89 ; 1861 : 52 ; 1866 : 356
Günther, 1860 : 364
Duncker, 1904 : 158
Thunnus thynnus (*nec* Linnaeus) Ogilby, 1908 : 24 ; 1912 : 58
Thynnus rarus Kishinouye, 1915 : 287 (Type locality : Nagasaki, Japan)
Neothunnus rarus Kishinouye, 1923 : 448
Deraniyagala, 1933 : 49
Thunnus maccoyii (*nec* Castelnau) McCulloch and Whitley, 1925 : 142
Kishinoella rara Jordan and Hubbs, 1925 : 219
Jordan and Evermann, 1926 : 26
Herre 1945 : 148
Thunnus maccoyii (in part) McCulloch, 1926 : 599 ; 1929 : 263
Neothunnus tonggol Jordan and Evermann, 1926 : 22
Thunnus (*Neothunnus*) *rarus* Delsman and Hardenberg, 1934 : 336
Thunnus nicholsoni Whitley, 1936 : 30 (Type locality : Lindeman Island, Queensland)
Thunnus tonggol Tortonese, 1939 : 326
de Beaufort, 1951 : 225–26
Mendes, 1954 : 148
Kishinoella tonggol Serventy, 1941*a* : 33 ; 1942*a* : 94–100 ; 1942*b* L : 101–112
Rosa, 1950 : 38-39 (Synonymy in part)
Herre, 1953 : 249–50
Munro, 1955 : 220 ; 1958*a* : 19
Jones and Silas, 1960 : 384
Thunnus (*Kishinoella*) *tonggol* Fraser-Brunner, 1950 : 145
Deraniyagala, 1952 : 103
Thunnus argentivittatus Rivas, 1961 : 131–32

The history of *Thynnus argentivittatus* Cuvier has been ably summarised by Rivas (1961) who following the suggestion put forward by Schaefer and Walford (1950) recognises it as the Indian yellowfin tuna. On the contrary, we find that Cuvier's *T. argentivittatus*, the lectotype of which was designated by Schaefer and Walford (1950) and examined and reported on by Rivas (1961) is closely akin to *Thunnus* (*Kishinoella*) *tonggol* than to the Indo-Pacific yellowfin

* Since this paper was sent to press we find that S. Kume (1962. *Rept. Nankai Reg. Fish. Res. Lab.*, No. 15: 79-84) has successfully carried out artificial fertilization of bigeye tuna (*Parathunnus mebachi*) from the Western Indian Ocean (between Lat. 3°-6° N., Long. 61°-64°E) in February 1961.

tuna designated here as *Thunnus* (*Neothunnus*) *albacares macropterus*. In fact, we consider *tonggol* and *argentivittatus* as being conspecific and have tentatively placed the latter as a senior synonymy of *tonggol*, our reasons for this action being :

(1) *T.* (*K.*) *tonggol* is quite common along the Malabar coast during certain seasons when it is caught in drift net and hook and line while the yellowfin is hardly ever caught in the coastal waters.

(2) The gill raker count of the lectotype, namely 8 + 18 = 26, fits in well within the range for *tonggol* from Indian waters as shall be presently shown, and the number is too low, for the yellowfin which has a total count of about 29 to 32 gill rakers on each side.

(3) Rivas (1961) has given additional gill-raker counts for three specimens (designated by him as topotypes) of *T. argentivittatus* from the Karachi coast as 6 + 17 = 23. Here again the total gill raker count is too low for a yellowfin. Actual examination of the lectotype and topotypes for characters such as (*a*) presence or absence of air bladder ; (*b*) body colouration ; etc., may aid in confirming our view-point regarding the conspecificity of *T. argentivittatus* and *T. tonggol*. If proven, the specific name *argentivittatus* will have priority over *tonggol*, but we would advocate the suppression of the former in favour of the latter widely current name.

The description of *Kishinoella zacalles* given by Jordan and Evermann (1923) is based on a single specimen out of about a dozen examined by them. Their photograph (plate 7) is of another specimen based on which the following key characters for the species were drawn up by them to distinguish it from *K. rara*. " Pectoral fin longer, 3 1/3 in length to base of caudal, reaching to below the first dorsal finlet, dorsal lobe a little lower than anal, its length about half pectoral ; caudal lobes long, 4 in body ; gill rakers 30 ; silvery markings in the form of about 20 narrow vertical cross streaks." The following diagnosis was given by them for the species : " Head $2\frac{1}{2}$ to base of caudal ; depth $3\frac{1}{3}$; head rather pointed, postorbital narrow ; body plump, the flesh rather soft ; pectoral $3\frac{1}{3}$ in body ; maxillary $2\frac{1}{2}$ in head ; eye 2 in snout, $6\frac{1}{2}$ in head ; dorsal lobe half pectoral, $7\frac{1}{2}$ in body, 2 in head ; D. XII, I, 12 ; A.1, 11 ; finlets small 9/9, the first very small, adnate to dorsal, caudal keel very large, pectorals pointed, reaching vent and to middle of soft dorsal ; gill rakers 9 + 21 = 30".

" Colour steel blue above, grey below, the 20 pale silvery cross streaks, each half to one-third the interspaces, fading anteriorly and posteriorly barely extending on corselet ; head silvery, pectoral silvery, tipped and edged with black ; spinous dorsal yellow ; soft dorsal yellow ; silvery at base and very slightly dark edged ; finlets above and below dull olivaceous yellow, slightly dark edged ; ventral short, silvery in front with yellow inside, shaded with pink and black, cross-streaks on body fainter in larger examples. No air-bladder." The above description has been cited to draw attention to 2 salient points in the description, namely:

(1) The gill raker count of 9 + 21 = 30 ; and

(2) The colouration, especially the vertical cross-streaks.

These two points are of importance as certain authors have treated *K. zacalles* as a doubtful synonymy of *T.* (*K.*) *tonggol*, (Rosa, 1950) or as a definite synonymy of the latter (Collette, 1961). We do not agree with either of these courses for several reasons. Serventy (1956) has given the total gill-raker counts for Australian specimens of *K. tonggol* as 19–25 with the mode at 22 and Silas (1962c) gives the counts for *T.* (*K.*) *tonggol* taken on troll line in the Gulf of Mannar

as 22–27 (6 — 8 + 16 — 19) with the mode at 7 + 18 = 25. These counts are much on the lower side when compared to that known for *K. zacalles*. The colour pattern of *tonggol* is totally different from that of *K. zacalles* given above, being present on the sides of the body as a number of rows of short silvery (whitish on preservation) bars or streaks.

Strangely enough there appear to be no records of *K. zacalles* after its original description to help to solve the problem as to whether there exists such a species at all. The absence of air-bladder is perhaps an important character which prompted Jordan and Evermann to place *zacalles* under the genus *Kishinoella* ; however, it may be worthwhile to re-examine fresh specimens approximating to *K. zacalles* for this character. Barring this, we see considerable similarity between the *K. zacalles* and the bigeye tuna *T. (Parathunnus) obesus mebachi* and to some extent to the yellowfin tuna. Although recognised as a distinct species, *Thunnus (Kishinoella) zacalles* by Fraser-Brunner (1950), for reasons given above we consider this, as a dubious species.

The meristic counts for *T. (K.) tonggol* given by de Beaufort (1951), Deraniyagala (1952), Munro (1955, 1958*a*), Serventy (1956), Ranade (1961), and Silas (1962*c*) indicate the following formulae for the species from the Indian Ocean :

D_1. XI — XIV ; D_2 + finlets 14–15 + 8 — 9 ;
P_1. 29 — 35 ; A + finlets 12 — 14 + 8 — 9 ; gill rakers 5 — 8 + 14 — 19 (= 19 — 27)

T. (K.) tonggol contributes to a minor fishery along the West Coast of India and in the Gulf of Mannar. For more information on aspects of the biology of this species from Indian Waters reference is invited to Silas (1962*c*) and Jones (1962*d*).

DISTRIBUTION : In Indian Ocean and contiguous seas. Somali coast of Africa ; Gulf of Aden ; Karachi coast of Pakistan ; West Coast of India from Kutch to Cape Comorin ; Gulf of Mannar and South East Coast of India ; Ceylon ; Laccadives ; Maldives ; Andamans ; Malay Coast ; Singapore, Java Sea and West Coast of Australia. In the Pacific Ocean it has been recorded from several localities from Western and Central Pacific.

YELLOWFIN TUNA

Thunnus (Neothunnus) albacares macropterus (Temminck and Schlegel), 1844

(Plate III, Fig. B)

SYNONYMS :

Thynnus macropterus Temminck and Schlegel, 1894 : 98 (Type locality : Nagasaki, Japan)
Boeseman, 1947 : 93 (on the type specimen in Leiden Museum)
Oreynus macropterus Kitahara, 1897 : 2
Germo macropterus Jordan and Seale, 1906 : 228
Thunnus macropterus Jordan, Tanaka and Snyder, 1913 : 121
Kishinouye, 1915 : 19
Mendes, 1954 : 148
Neothunnus macropterus Kishinouye, 1923 : 446
Serventy, 1941*a* : 25 ; 1941*b* : 5–6
Munro, 1955 : 219
Jones and Silas, 1960 : 385–87

Germo albacora (in part) Molteno, 1948 : 20
Smith, 1949 : 299
Fourmanoir, 1957 : 227

Thunnus albacora (in part) Fraser-Brunner, 1950 : 144–45

Thunnus macropterus (in part) de Beaufort, 1951 : 223–25

Thunnus (*Neothunnus*) *argentivittatus* Deraniyagala, 1952 : 102–103 (part synonymy and description) (*nec Thynnus argentivittatus* Cuvier, 1831, et Schaefer and Walford, 1950).

In addition to the references given under the ' synonyms ' other important works dealing with aspects of the biology and fishery of the yellowfin from the Indian Ocean and contiguous seas are : Hirano and Tagawa (1952) ; Wheeler and Ommanney (1953) ; Royce (1953, 1961) ; Maeda (1955) ; Tsuruta (1955, 1961) ; Kataoka (1957) ; Kurogane and Hiyama (1958) ; Jones (1959); Tsuruta and Tsunoda (1960) ; Watanabe (1960) ; Yabuta, Yukinawa, and Warashina (1960), Hiyama and Kurogane (1961) ; Jones and Kumaran (1962) ; Silas (1962c) (1962d) ; Silas and Ummerkutty (1962) and Thomas (1962).

On the basis of morphometric studies of the yellowfin from the Indo-Pacific Royce (1961) found that ".....the yellowfin from the Pacific show a continuous cline in morphology along the Pacific Equator, whereas, the samples removed from the Equator differ erratically from the equatorial cline. However, the dimensions are within the range of characters in the cline or are so close to one end or other of the cline that there appears to be no evidence of genetically isolated stocks in the Pacific." Further, from the Indian Ocean, Royce found his sample from off Somaliland (north-east Africa) to be the most diverse when compared to 23 other samples from various parts of the Indo-Pacific and one from Angola, Africa. According to him, " It is similar to one or more Central Pacific equatorial samples in head length, snout to second dorsal, but has very short pectoral, second dorsal and anal fins. Somaliland fish also have a very long distance from the snout to the insertion of the anal, an especially deep body and a long distance from the snout to the insertion of the ventrals. It is very different from the sample from the other side of Africa near Angola.....". However, the specimens having been drawn from a smaller size group and the sample itself inadequate, it is not known whether yellowfin from North East Coast of Africa constitute a distinct population.

Tsuruta (1961) found greater similarities in morphometrical characters between yellowfin from South West of Madagascar (south west Indian Ocean) and Angola (south-east Atlantic).

" Hiyama and Kurogane (1961) are of the opinion that there are a number of independent or semi-independent populations of yellowfin within each ocean distributed in rather localised waters, intermingling with each other, because of the positive difference of morphometrical features between the adjoining populations." They find that the yellowfin from the equatorial area of the Indian Ocean show differences as follows : ".....the eastern fish have a large head, more posteriorly positioned ventral and pectoral fins and longer fins than the western. The yellowfin tuna from the areas south of the lesser Sunda Islands differ from the Equatorial ones in having a shorter head and more anteriorly, positioned fins. The specimens from the lesser Sundas are rather similar to those from the vicinity of the Andaman Islands with respect to the length of the dorsal and anal fins. Accordingly it is probable that the yellowfin tuna inhabiting the waters adjacent to the Lesser Sundas belong to a population distinct from that of the Equatorial Indian Ocean, and that the Western Equatorial ones are somewhat different from the Eastern Equatorial ones, with some intermingling between them."

These observations draw attention to the need for more intensive study on populations of yellowfin tuna from the Indian Ocean as the picture is far from clear.

Reasons are given in this account (p. 39) for considering *T. argentivittatus* Cuvier (1831) *et* Schaefer and Walford (1950), *et* Rivas (1961) to be a senior synonymy of *T.* (*Kishinoella*) *tonggol* (Bleeker). However, the specific name *argentivittatus* has at one time or other been used to denote yellowfin from this area (Deraniyagala, 1952), the Atlantic (South, 1845 ; Rivas, 1951 ; Beebe and Tee-Van, 1936) and the Eastern Pacific (Nichols and Murphy, 1922).

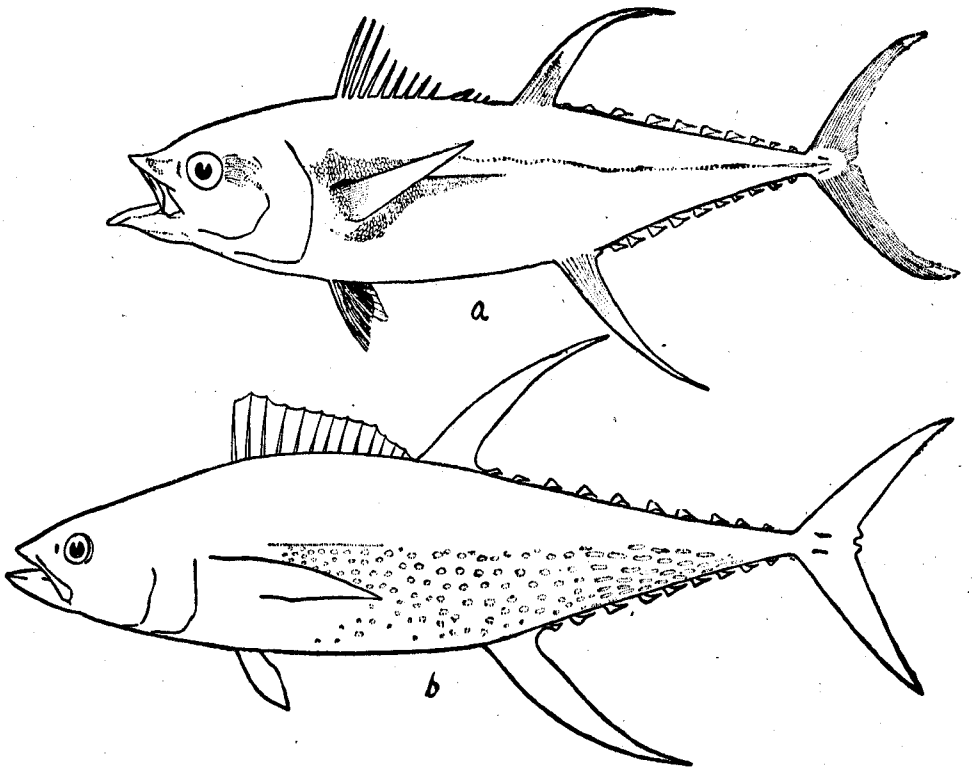
We consider the yellowfin as a single species *T. albacares* (Bonnaterre, 1788) having a world wide distribution, and tentatively recognise the Indo-Pacific form as belonging to a subspecies *T. a. macropterus* (Temminck and Schlegel).

DISTRIBUTION : Warmer waters of the Indo-Pacific. Oceanic, rarely occurring in coastal waters.

ITOSIBI

Thunnus, (Neothunnus?) itosibi (Jordan and Evermann), 1926

(Plate I c ; Text fig. 7)



Text Fig. 7. *Thunnus* (*Neothunnus*?) *itosibi* (Jordan and Evermann). (*a*). specimen from Madras, mounted in the Madras Government Museum and labelled *Thynnus macropterus* (after Jones and Silas, 1960) ; (*b*). Specimen from South Africa (after Barnard ; 1934).

SYNONYMS :

Neothunnus itosibi Jordan and Evermann, 1926: 22–23 (Type: a photograph of a specimen weighing 321 pounds in Honolulu market, Hawaii)
Molteno, 1948 : 33
Jones and Silas, 1960 : 387–88
Semathunnus guildi Fowler, 1933 : 163 (Type locality : Tahiti)
Thunnus macropterus (in part) Delsman and Hardenberg, 1934 : 339
de Beaufort, 1951 : 223–25
Scomber guildi Curtiss, 1938 : 60
Semathunnus itosibi Tinker, 1944
Neothunnus albacora (in part) Barnard, 1947 : 378–80
Neothunnus macroptorus (in part) Fowler, 1949 : 73
Germo itosibi Smith, 1949 : 299
Thunnus (*Neothunnus*) *albacora* (in part) Fraser–Brunner, 1950 : 144
Thunnus albacares (in part) Rivas, 1961 : 136–139

Contrary to general practice, we have not relegated *itosibi* to the synonymy of the Indo-Pacific yellowfin tuna since available data are not conclusive in showing that they are one and the same, merely representing different growth stages. Data obtained from Andaman Waters indicate that specimens of " yellowfin " 111.5 cm. show the excessively elongate second dorsal and anal fins, while yellowfin [*T.* (*N.*) *a. macropterus*] about 130 cm. still show the short second dorsal and anal. More information is needed and until such time this species is given tentative recognition. Since Jordan and Evermann (1926) made no remarks regarding internal anatomical features, its placement under subgenus *Neothunnus* is also tentative.

DISTRIBUTION : General—Indo-Pacific. In Indian Ocean from off the coast of South East Africa, Madras Coast, India, Andaman Sea, Seas around Sunda Archipelago.

Genus **Allothunnus** Serventy, 1948

Allothunnus Serventy, 1948, *Rec. Canterbury Mus.*, 5 (3) 131–135. (Type species : *Allothunnus fallai* Serventy).

Generic diagnosis : body more elongate than *Katsuwonus*, covered completely with minute scales, corselet well-developed, gill rakers more numerous than in any other genus of Thunninae being about 71–75 ; dorsal spines 17 ; vertebrae 41 (?).

Serventy (1948) showed that the affinities of *Allothunnus* was more towards *Katsuwonus* (*e.g.*, in the increased number of gill rakers ; 41 (?) instead of the usual 39 vertebrae etc.). However, Fraser–Brunner (1950) remarks that *Allothunnus* is " in effect, a *Thunnus* with greatly increased number of gill-rakers and reduced dentition (evidently a plankton feeder)."

DISTRIBUTION : As for species.

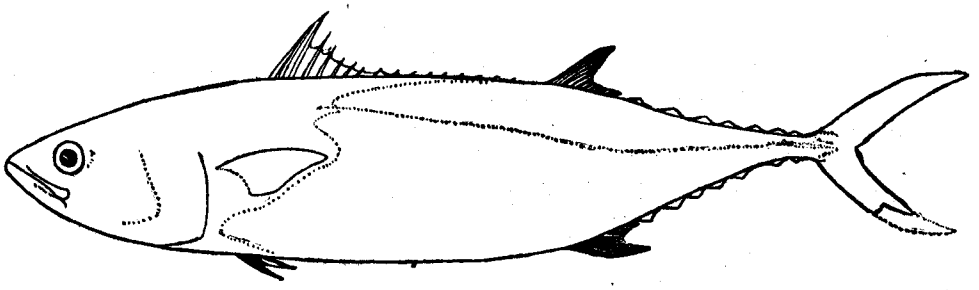
SLENDER TUNNY

Allothunnus fallai Serventy, 1948

(Text fig. 8)

SYNONYMS :

Allothunnus fallai Serventy, 1948 : 131–135 (Type locality : Timaru, South Island, New Zealand)
Fraser-Brunner, 1950 : 148
Rosa, 1950 : 49
Talbot, 1960 : 257–59
Smith, 1961 : 570



Text Fig. 8. *Allothunnus fallai* Serventy (outline taken from photograph given by Serventy, 1948).

Serventy (1948) gives the meristic formulae as : D. XVII, 12 + 7 ; A. 14 + 7 ; P_1. 25.; gill rakers 25 + 48 and 24 + 51 on left and right sides respectively of the type specimen. The tongue, vomer, and palatines are edentulous while teeth on jaws are very minute. Air-bladder is absent.

Talbot (1960) recorded *Allothunnus fallai* from South African waters and gives the gill raker counts as 22–23 + 48–53.

DISTRIBUTION : From South Western Pacific : New Zealand waters south of Lat. 43° S. From Indian Ocean and contiguous seas ; South Africa off Cape.

Genus **Katsuwonus** Kishinouye, 1915

Katsuwonus Kishinouye, 1915. *Sui. Gak. Ho.*, 1 : 21. (Type species ; *Katsuwonus pelamys* (Linnaeus) [= *Scomber pelamis* Linnaeus = *Katsuwonus pelamis* (L.)].

Generic diagnosis : Body fusiform and rounded in cross-section ; scattered scales on body outside corselet and lateral line present ; first and second dorsal more or less contiguous ; vomer and palatines edentulous ; gill rakers 14 to 18 + 34 to 40 ; vertebrae 20 + 21 (= 41) conspicuous dark longitudinal bands along lower half of body ; dark markings on back absent. Monotypic.

DISTRIBUTION : Atlantic, Mediterranean ; Indo-Pacific.

REMARKS : The genus *Katsuwonus* was proposed by Kishinouye (1915) on account of difference in osteology, circulatory systems, etc., evinced by the *Katsuo* (= *Scomber pelamis* Linnaeus) as compared to the genus *Euthynnus* under which it had been relegated till then. Later, additional differences were tabulated by Kishinouye (1923), and *Katsuwonus* and *Euthynnus* were separated as follows :

> " Both epaxial and hypaxial blood-vessels under the skin are equally well-developed, teeth in both jaws only, vertebrae 20–21—*Katsuwonus*. Hypaxial blood vessels under the skin are atrophied ; blood vessels run just above the lateral median line of the body, teeth in both jaws ; palatines and sometimes on the vomer too, epihaemal spines well developed, vertebrae 20–19—*Euthynnus*."

Detailed investigations of the osteology and other anatomical features of *K. pelamis* by Godsil and Byers (1944) and Godsil (1954) confirm Kishinouye's observations on *Katsuwonus* and also draw attention to more differences between this genus and *Euthynnus*.

Some authors (Deraniyagala, 1933 ; de Beaufort, 1951) consider *Scomber pelamis* Linnaeus as a species of *Euthynnus* while others (Fraser-Brunner, 1950 ; Fourmanoir, 1960) treat it as belonging to subgenus *Katsuwonus* of genus *Euthynnus*. However, we follow Kishinouye

(1923), Godsil and Byers (1944), Rivas (1951), and Godsil (1954) in considering *Katsuwonus* as a distinct genus more allied to *Euthynnus* than to *Thunnus*.

It is pertinent to mention here that Kishinouye (1923) and Godsil (1954) have placed *Katsuwonus*, *Euthynnus*, and *Auxis* under a separate family Katsuwonidae as opposed to Thunnidae, both families being distinguished by the following diagnostic characters given in Table V.

TABLE V

Differences between Families Thunnidae and Katsuwonidae

Family Thunnidae	*Katsuwonidae*
1. Body wholly covered with scales.	1. Body naked outside of corselet.
2. Second dorsal and anal high.	2. Second dorsal lower than the first.
3. Vertebrae 18 + 21.	3. Vertebrae generally 20 + 19.
4. Transverse process present, first vertebra short, anchylosed to the skull, alisphenoids meet at the ventral median line.	4. ?
5. ?	5. Some intermuscular bones are divided into two, distal and proximal, epihaemal spine developed between the centrum and haemal arch in most vertebrae, network of haemal processes well developed.
6. Air-bladder generally present.	6. Air-bladder wanting.
7. Intestine folded, spleen showing, totally or in part in ventral view.	7. Intestine straight without a fold in it and spleen dorsolateral to stomach so that it is entirely concealed in ventral view.

*Characters (1–6) are taken from Kishinouye (1923, p. 432) and (7) from Godsil (1954, p. 184).

Some of the characters given by Kishinouye (1923) for both families have exceptions. No doubt, *Katsuwonus*, *Euthynnus* and *Auxis* form a natural group, but we doubt whether such a group should be given family status.

OCEANIC SKIPJACK

Katsuwonus pelamis (Linnaeus), 1758

(Plate V, Fig. C)

SYNONYMS :

Scomber pelamis Linnaeus, 1758 : 296–7 (Type locality : " In pelago inter tropico ")
Scomber pelamys Bloch and Schneider, 1802 : 23
Scomber pelamides Lacépède, 1802 : 14
Thynnus vagans Lesson, 1828 : 279 (1829)? (Type locality : Tahiti)
Thynnus pelamys Cuvier, 1831 : 113
Temminck and Schlegel, 1844 : 96
Bleeker, 1856 : 41
Günther, 1860 : 364 ; 1876 : 151
Day, 1876–78 : 252 ; 1889 : 206–207
Macleay, 1881 : 191
Pelamys pelamys Bleeker, 1865 : 289
Gymnosarda pelamis Jordan and Evermann, 1896 : 868

Katsuwonus pelamys Kishinouye, 1915 : 21

Katsuwonus pelamis Kishinouye, 1923 : 453–56
Serventy, 1941 : 39
Rosa, 1950 : 63–68
Munro, 1955 : 219 ; 1958d : 18
Jones and Silas, 1960 : 383 ; 1962*c* (MS)

Gymnosarda pelamys Barnard, 1927 : 797–98

Euthynnus pelamis Fowler, 1928 : 132 ; 1936 : 616
Deraniyagala, 1933 : 50
Smith, 1949 : 298
de Beaufort, 1957 : 217–18
Steinitz and Ben-Tuvia, 1955 : 9
Fourmanoir, 1957 : 223

Katsuwonus vagans Fowler, 1949 : 73

Euthynnus (*Katsuwonus*) *pelamis* Fraser-Brunner, 1950 : 152
Deraniyagala, 1952 : 104
Williams, 1956 : 42–43

Euthynnus (*Katsuwonus*) *pelamys* Fourmanoir, 1960 (MS)

In an account entitled " Synopsis of biological data on skipjack *Katsuwonus pelamis* from the Indian Ocean ", by Jones and Silas (1962*c*) a reference to which is invited for further details the meristic counts for specimens from Indian Seas (Laccadive Sea) are given as :

D_1. XV–XVI ; D_2 + finlets 13–14 + 8–9 ;
A. + finlets 13–14 + 7–8 ; P_1. 26–28 ; gill rakers 14–18 + 34–39 (= 50–55).

The body proportions expressed as percentages of total length (snout to fork) for 10 specimens ranging from 283–458 mm. are as follows :

Head 29.6 to 30.7 ; first predorsal distance 33.6 to 34.9 second predorsal distance 60.5 to 62.9 ; preanal distance 64.2 to 67.5 ; prepelvic distance 32.9 to 35.6 ; greatest depth of body 23.0 to 26.3 ; length of pectoral 13.1 to 16.7 distance between origin of pectoral and first dorsal 13.1 to 15.5 ; base of first dorsal 24.5 to 28.4 ; base of second dorsal (excluding finlets) 7.4 to 9.1 ; base of second dorsal including finlets 31.8 to 34.9 ; caudal spread 25.6 to 26.5 ; longest (first) dorsal spine 13.0 to 15.6 ; length of second dorsal 6.0 to 9.3 ; length of anal 4.6 to 8.4 ; length of pelvic 10.3 to 11.9 ; least depth of caudal peduncle 1.9 to 2.2 ; greatest width of caudal peduncle at keel 3.5 to 4.5 ; length of maxilla 10.2 to 11.9 ; diameter of iris 4.3 to 5.9 ; longest gill filament 6.7 to 7.4, per cent in total length.

Some workers have used *K. vagans* to denote the Pacific representatives of *Katsuwonus*, but it is now well recognised that in all the oceans, *K. pelamis* shows no marked variations to enable separation into different species. However, there can be no doubt that eventual analysis may throw light on the existence of different populations.

DISTRIBUTION : General : Atlantic, Mediterranean and Pacific. In Indian Ocean and contiguous seas ; off South and East Coast of Africa, Gulf of Aden ; Red Sea ; Laccadives ; Maldives ; Gulf of Mannar ; Seychelles, Mauritius ; Reunion ; Madagascar ; Seas around Sunda Archipelago ; Western Australia. Larvae have been collected in the open seas from several localities.

Genus **Euthynnus** Lütken in Jordan and Gilbert, 1882

Thynnichthys Giglioli, 1880. *Cat. Pesci. Ital.*, p. 25 (Type species: *Thynnus thunnina* Cuvier = *Scomber alletteratus* Rafinesque). (Name preoccupied by *Thynnichthys* Bleeker, 1859 — a genus of Cyprinidae, Pisces).

Euthynnus Lütken, *in* Jordan and Gilbert, 1882. *Bull. U.S. Nat. Mus.* No. 16 : 429 (1883). (Type species : *Thynnus thunnina* Cuvier = *Scomber alletteratus* Rafinesque, Orthotypic. (Genotype wrongly given by Jordan : Genera of Fishes, pt. 4, p. 42, 1920, as " Orthotype *Thynnus pelamys* L.")

Wanderer Whitley, 1937. *Austral. Zool.*, 8 (4) : 229 (Type species : *Wanderer wallisi*, Whitley Orthotypic).

Body fusiform, elongate, corselet well developed ; lateral line single, rest of body naked ; teeth minute, uniserial on jaws ; present or absent on vomer and palatines ; pectorals short, hardly half head length, two dorsals more or less contiguous, second dorsal and anal lobes short, followed by 8 or 9 dorsal and 6 or 7 anal finlets ; gill rakers well developed ; gill membranes free.

DISTRIBUTION : Atlantic, Mediterranean, Indo-Pacific.

REMARKS : The genus *Euthynnus* has at one time or other been placed under the family Scombridae (Fowler, 1936 ; Smith, 1949 ; Fraser-Brunner, 1950 ; Rivas, 1951 ; Jones and Silas, 1960) ; or under family Katsuwonidae (Kishinouye, 1923 ; Jordan and Hubbs, 1925) or family Thunnidae (Fowler, 1949 — Subfamily Katsuwoninae) or under family Sardidae (Whitley, 1937). We consider *Euthynnus* as a distinct genus of subfamily Thunninae.

Fraser-Brunner (1949) recognised two species, namely *E. affinis* (Cantor) with the subspecies *E. a. affinis* (Cantor), *E. a. yaito* Kishinouye, and *E. a. lineatus*, Kishinouye ; and *E. alletteratus* Rafinesque with two subspecies *E. a. alletteratus* (Rafinesque) and *E. a. auro-littoralis* Fraser-Brunner. Later, in 1950 he treated *Katsuwonus* Kishinouye as a subgenus of *Euthynnus* recognising only *E. (E). affinis*, *E. (E.) alletteratus*, and *E. (K.) pelamis*. We consider *Katsuwonus* as a separate genus.

The differences between the Atlantic and Indo-Pacific representatives of *Euthynnus* appear to be relative and not clear cut. Fraser-Brunner (1950) distinguished the two species as follows :

" A. Vomerine teeth present. Gill rakers 7 to 12 + 22 or 23. Thoracic spots all below base of pectoral.....1. *affinis*.

B. No vomerine teeth. Gill rakers 10 to 12 + 29 to 30. Uppermost thoracic spots level with pectoral base.....2. *alletteratus*."

At the same time, the single species concept has led some authors to apply the specific name *E. alletteratus* (or *E. alleteratus*) for the Indo-Pacific forms of *Euthynnus* as well. We feel that Fraser-Brunner's review of the genus (1949, 1950) nor that by Kishinouye (1923) and Godsil (1954) give us a clear final picture. As in the case of other tunas, a lot more remains to be known and we may summarise some of these problems as under.

1. Fraser-Brunner's (1950) account would show that the differences between the Atlantic and Indo-Pacific forms in the number of gill rakers is very clear cut. This need not be the case for, Rivas (1951) gives the gill raker count in *E. alletteratus* from W. Atlantic as 25 to 29 on lower limb of the first arch. We have elsewhere (Jones and Silas, 1960) given the count for *E. affinis* as 22 to 25 on the lower limb of the first arch for specimens from Indian waters,

These suggest the possibility of overlap in the range between *Euthynnus* from the Atlantic and the Indo-Pacific. However, one interesting feature is, that as far as is known, in the typical *E. affinis* as well as in *E. yaito* recognised as its subspecies, the range of gill raker counts is almost identical. In *E. lineatus*, Godsil's data (1954) indicate that the number on the lower limb is higher, the range being 7–11 + 1 + 23–29, in which similarity is seen with the high count of 10–12 + 1 + 25–30 (combined data from Fraser-Brunner, 1950; Godsil, 1954; and Rivas, 1951) in *E. alletteratus*. It will be well worth obtaining more data on gill raker counts for *Euthynnus* from the different faunal areas.

2. The presence or absence of vomerine teeth is given considerable importance in separating *E. affinis* and *E. alletteratus*. In some specimens of *E. a. affinis* that we have examined from the Indian coast, the vomerine band of teeth is very poorly developed, especially in larger specimens. However, two specimens kindly sent to us by Mr. Soong Ming Kong from Malaya (the area from where Cantor, 1850, described *Thynnus affinis*) have the vomerine teeth very well developed as a distinct uniserial band. Kishinouye (1923) remarks that vomerine teeth are also present in *E. yaito* and *E. lineatus*, but absent in *E. alletteratus* from the Atlantic. According to de Beaufort (1951), Chabanaud (1925) found vomerine teeth both in *yaito* and *alletteratus*, but recorded other differences, such as the number and length of the gill rakers, the number of teeth in the jaws, the distance between the articulation of the first pectoral ray and the opercle, the form of emargination of the corselet and the relative development of the caudal keel. Steindachner (1896) found vomerine teeth present in *E. alleteratus* (*nec* Rafinesque) from Japan, but absent in specimens from St. Thomas (W. Indies) and Nice (Mediterranean). Godsil's (1954) detailed study also corroborates this view of the absence of vomerine teeth in the Atlantic *E. alletteratus*. De Beaufort (1951) remarks that "Klunzinger.....misses them, as well as palatine teeth, in two specimens of 750 mm. length from the Red Sea, and suggests that they are only present in young ones." Whitley (1937) described a new genus and species, *Wanderer wallisi* (= *Euthynnus affinis affinis*?) from Australian waters and remarks that his species lacks vomerine teeth. However, the gill raker count of 9 + 23 is in agreement with that of *E. affinis*. All these point to the uncertainty that still surrounds even a salient character used in species discrimination in *Euthynnus*.

3. Fowler (1934, 1936) and Smith (1949, 1961) have recorded *Euthynnus alletteratus* from South African waters including Natal Coast. They do not, however, recognise *E. affinis* from that coast. Fowler's (1936) description of *E. alletteratus* is based on material from St. Thomas, West Indies and not from South Africa, having gill rakers 8 to 10 + 24 or 25. These are low counts for *E. alletteratus* when compared to the figures given by Fraser-Brunner (1950) but is more in agreement with what Rivas (1951) mentions. However, the total count deduced from Fowler's data definitely is on the lower side as is the case for the Indo-Pacific *E. affinis*. Smith (1949) mentions "About 25 gill rakers" on the lower limb of the outer gill arch in *E. alletteratus* and since he apparently follows the single species concept, his specimens could either be *E. a.lletteratus* or *E. affinis*. His mention of "1–5 dusky spots below pectoral sometimes present, may all be absent" and the accompanying colour figure (pl. 65, fig. 830) wherein the spots below the pectoral are shown much below the pectoral base, suggest that he may be dealing with *E. affinis* and not *E. alletteratus*. All the same, as an element of doubt has been introduced as to whether one or both the species occur in South African waters (S.W. Indian Ocean) we have tentatively included *E. alletteratus* also in this account. It is not unlikely that in South African waters of Indian Ocean *E. alletteratus* may show overlap in distribution with that of *E. affinis*, similar to *E. affins affinis* and *E. a. yaito* in the Western Pacific and the latter and *E. lineatus* in the Eastern Pacific.

4. The number of vertebrae is another important character in separation of species in *Euthynnus*. Available data which on the whole is meagre indicate the range as 36 to 39 but generally 39. In *E. lineatus*, Godsil (1954) found that of 29 specimens examined 27 had 37 vertebrae and one each had 36 and 38 vertebrae. This character by itself is significant in separating *E. lineatus* specifically from other members of the genus, although Godsil has drawn attention to several other distinguishing features as well. In seven specimens of *E. alletteratus* and in eight specimens of *E. yaito* Godsil found the vertebrae to number 39. Delsman (1931) gives 19 + 19 = 38 as the count for *Euthynnus thunnina* (= *E. affinis*) from Indonesian waters, but 2 specimens we have examined from the Indian Coast (Tuticorin) have 39 vertebrae. Since this character happens to be of diagnostic value within the genus, there is a great need for making proper vertebral counts in *Euthynnus* from the different faunal areas.

5. Having examined a specimen of *E. yaito* kindly sent to us by Mr. J. C. Marr from Hawaii (Plate V, Fig. B) we are at a loss to distinguish the species from *E. affinis*. From existing literature also there is difficulty in separating *affinis* from *yaito*, and in the Western Pacific, it is hard to say where the distribution of *affinis* ends and that of *yaito* begins. It has been suggested that they may be synonymous, but until such time that this is proven, we consider it desirable to retain *yaito* as a subspecies of *E. affinis*. These preliminary observations lead us to recognise the following species and subspecies under the genus *Euthynnus*.

(1) *Euthynnus alletteratus* (Rafinesque)—Atlantic ; Mediterranean ; South Western Indian Ocean around South Africa (?).

(2) *Euthynnus affins affinis* (Cantor)—Indian Ocean ; Western part of Western Pacific.

(3) *Euthynnus affinis yaito* Kishinouye—Pacific Ocean.

(4) *Euthynnus lineatus* Kishinouye—Eastern Pacific.

ATLANTIC LITTLE TUNNY

Euthynnus alletteratus (Rafinesque), 1810

SYNONYMS :

Scomber alleteratus Rafinesque, 1810 : 40 (Type locality : Palermo, Sicily). (also given as *Scomber alletteratus* by Rafinesque, 1810 in *Caratteri Nuov. An. Sicil.*, pl. 2, fig. 3)
Thynnus leachianus Risso, 1826 : 414 (Type locality : Nice)
Thynnus thunnina Cuvier, 1831 : 104 (Type locality : Mediterranean)
Thynnus brasiliensis Cuvier, 1831 : 110 (Type locality : Brazil)
Thynnus brevipinnis Cuvier, 1831 : 112 (Type locality : Mediterranean)
Gymnosarda alletterata Jordan and Evermann, 1896 : 869
Euthynnus alletteratus Jordan, Evermann, and Clark, 1930 : 258
Fraser-Brunner, 1950 : 150–51
Rivas, 1951 : 216–17
Euthynnus alletteratus Fowler, 1936 : 616–17
Smith, 1949 : 298 (*E. alleteratus* — in part?)
Euthynnus alletteratus alletteratus, Fraser-Brunner, 1949 : 622–27
Euthynnus alletteratus aurolitoralis Fraser-Brunner, 1949 : 622–627 (Type locality : Accra, Gold Coast, W. Africa)

The specific name *alletteratus* has been spelt differently as *alleteratus, alliteratus, alleterata, alletterata,* and *alliyterata.* See Rosa (1950 : 56–57) for more detailed synonymy.

The salient characteristics and distribution of this species have already been mentioned in the 'remarks' under the genus.

LITTLE TUNNY OR MACKEREL TUNA

Euthynnus affinis affinis (Cantor), 1880

(Plate V, Fig. A)

SYNONYMS :

(?) *Scomber quadripunctatus* Geoffroy St. Hilaire, 1827, pl. 24, fig. 3 (Type locality : Red Sea, Egypt)

Thynnus affinis (Cantor, 1850 : 1088, (Type locality : Sea of Penang)
Günther, 1860 : 363

Auxis taso (*nec* Cuvier) Bleeker, 1850 : 8

Thynnus thunnina (*nec* Cuvier) Bleeker, 1852 : 36
Day ; 1876–78 ; 252 ; 1889 : 205–206
Günther, 1876 : 150 ; 1889 : 17
Klunzinger, 1884 : 111

Pelamys thunnina (*nec* Cuvier) Bleeker, 1865 : 289

Euthynnus alletteratus (*nec* Rafinesque) Deraniyagala, 1933 : 51
Serventy, 1941 : 104
Fourmanoir, 1957 : 222–23

Wanderer wallisi Whitley, 1937 : 229 (Type locality : off North Bother Mountain, New South Wales, Australia—Holotype purchased from Sydney Fish Market)

Euthynnus affinis affinis Fraser-Brunner, 1949 : 623
Williams, 1956 : 41–42
Jones and Silas, 1960 : 389

Euthynnus (*Euthynnus*) *affinis* Fraser-Brunner, 1950 : 150 (Recognises a typical subspecies and subspecies *yaito*, both figured)

Euthynnus affinis (in part) Rosa, 1950 : 58–62

Euthynnus alletteratus affinis (in part) de Beaufort, 1951 : 218–21

Euthynnus alletteratus affinis Mendes, 1954 : 147
Munro, 1958*b* : 18

Euthynnus affinis Wheeler and Ommanney, 1953 : 61–63
Munro, 1955 : 219
Steintz and Ben-Tuvia, 1955 : 9
Jones, 1960 : 101–106

Euthynnus alletteratus (in part ?) Fowler, 1934 ; 1936 : 617–619
Smith, 1949 : 298

Euthynnus yaito (*nec* Kishinouye) Blanc and Postel, 1958 : 369–370

The problem of nomenclature has not yet been fully settled in the case of the little tunny. As Whitley (1937) has drawn attention to, the name *Thynnus affinis* of Cantor [*J. Asiat. Soc. Bengal*, 18, 1849 (Dec. 1850) : 1058] is preoccupied by *Thynnus affinis* Guerin-Meneville, 1838, for a species of insects. This being so, according to the Rule of Zoological Nomenclature, the name *Thynnus affinis* is not available for the little tunny. However, we feel that it should stand as *Euthynnus affinis*, and being widely current, it will be desirable to retain the name. In case the name *affinis* has to be replaced, *yaito* has a better claim than *wallisi* which was characterised as not having vomerine teeth. The problem does not end there for de Beaufort (1951) shows that *affinis* may have to give way to *quadripunctatus* of Geoffory St. Hilaire, " who figured *Scomber quadripunctatus* (*Descr. Egypte, Poissons*, 1814, Tab. 24, Fig. 3) after a specimen from the Red Sea." Eventually if it is found that the present assumption that the little tunny from

the Indian Ocean is specifically distinct from *E. alletteratus* from the Atlantic, a special ruling to validate the specific name *E. affinis* and its retention in preference to *quadripunctutus* may be necessary.

Our observations and those of various authors who have reported on *Euthynnus affinis* from the Indian Ocean (Cantor, 1850 ; Day, 1878, 1889 ; Deraniyagala, 1933, 1952 ; Fraser-Brunner, 1949, 1950 ; Morrow, 1954 ; Munro, 1955, 1958*b* ; Steinitz and Ben-Tuvia, 1955 ; Williams, 1956 ; Blanc and Postel, 1958 ; and Jones and Silas, 1960) indicate the following meristic counts for *E. affinis* :

D_1. XIV ; D_2 + finlets 11–14 + 8–9 ; A. + finlets 12–15 + 6–8 ;
P_1. 24–28 ; Gill rakers 7–10 + 22–25.

In six specimens of *E. affinis* from the Gulf of Aqaba, Red Sea, Steinitz and Ben-Tuvia (1955) give the gill-raker counts as 23 (3) ; 24 (2) and 30 (1). Presumably these refer to the number of rakers on the lower limb of the outer gill arch and if so, the number of 30 for a specimen of *E. affinis* (403 mm. in length) is very unusual, unless by mistake in this particular instance the rakers on the upper limb have also been included.

The little tunny from the Reunion is recorded by Blanc and Postel (1958) as *Euthynnus yaito* with gill raker count of 8 + 1 + 24 = 33.

As regards the black spots below the pectoral, it is highly variable and we have examined specimens in which they are totally absent on both sides or some in which as many as 8 may be present.

DISTRIBUTION : General distribution is—Indian Ocean and Western Pacific. In Indian Ocean and contiguous seas it is widespread from the entire East Coast of Africa, Red Sea, Gulf of Aden, Karachi Coast of Pakistan ; East and West Coasts of India ; Ceylon, Andamans, Burma Coast ; Malaya, Indonesian waters south of Java, Western Australia and in between these areas from the Laccadives, Maldives, Scychelles, Aldabra, Madagascar, Mauritius, Reunion, etc.

SUBFAMILY *SCOMBEROMORINAE*

The Scomberomorinae includes the spanish mackerals or seerfishes coming under the genus *Scomberomorus*, and the wahoo under the monotypic genus *Acanthocybium*.

Genus **Scomberomorus** Lacépède, 1802

Scomberomorus Lacépède, 1802 *Hist. Nat. Poissons*, 3 : 296 (Genotype : *Scomberomorous pulmieri* Lacépède, 1802 : *Scomber regalis* Bloch, 1793).

Cybium Cuvier, 1829 *Regne Animal*, 2 (Ed. II) : 99 (Genotype : *Cybium Commersonii* Cuvier).

Other generic synonyms are :

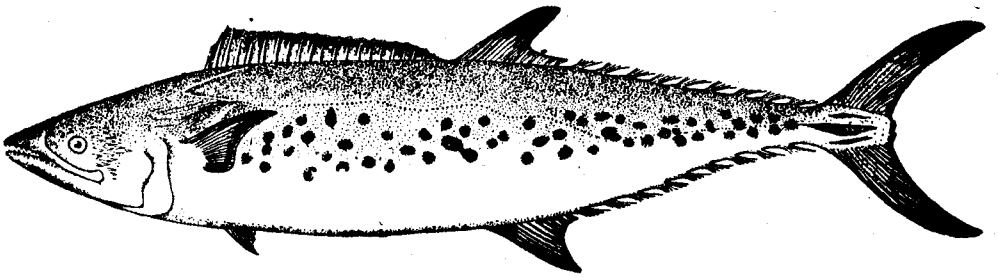
Polipturus Rafinesque, 1815
Apolectus Bennett, 1831 (*nec* Cuvier)
Apodontis Bennett, 1831
Cibium Troschel, 1849
Chriomitra Lockington, 1879
Sierra Fowler, 1904
Sawara Jordan and Hubbs, 1925
Indocybium Munro, 1943
Pseudosawara Munro, 1943

Lepidocybium Gill (1862) given as a synonym of *Scomberomorus* by Fraser-Brunner (1950) and as a subgenus of *Scomberomorus* by Munro (1943) is a Gempylid (Family Gempylidae) as later shown by Munro (1949).

The nomenclatorial status of the genus *Scomberomorus* Lacépède, which has priority over *Cybium* Cuvier, has been discussed in detail by us recently (Jones and Silas, 1961) and as stated therein we are not in favour of the splitting of the genus into subgenera as proposed by some of the previous workers. The characters at the generic level of all the species occurring in the Indian, Pacific and Atlantic Oceans are basically the same and therefore the seerfishes dealt with in this account are described under *Scomberomorus* without giving any subgeneric status.

SAWARA OR JAPANESE SPANISH MACKEREL

Scomberomorus niphonius (Cuvier), 1831



Text Fig. 9. *Scomberomorus niphonius* (Cuvier) (after Munro, 1943).

SYNONYMS :

Cybium niphonium Cuvier, 1831 : 180–81 (after a Japanese painting).
Kishinouye, 1923 : 42.
Cybium niphonicum Kner, 1869 : 144 (species name mis-spelt).
Cybium gracile Günther, 1873 : 378 (Type locality : Cheefoo, China).
Scomberomorus niphonius Tanaka, 1912 : 154–157.
Sawara niphonia Jordan and Hubbs, 1925 : 214.
Munro, 1958 : 20.
Scomberomorus gracilis Tortonese, 1939 : 321–322.
Scomberomorus gracileus Chu, 1931 : 107 (Species name mis-spelt).
Scomberomorus (*Sawara*) *niphonius* Munro, 1943 : 86.
Rosa, 1950 : 104.
Scomberomorus (*Scomberomorus*) *niphonius* Fraser-Brunner, 1950 : 159.

This species is included here on account of its recent record from Western Australia between Cape Leveque and Abrolhos Island (Munro, 1958). Better known from Japanese waters, the following combination of characters easily distinguishes it from other scomberomorinae from the Indo-Pacific :

(1) First dorsal with XX–XXII spines. An exception appears to be Kishinouye's (1923) mention of XIX spines.
(2) The posterior margin of the pectoral fin is deeply excised forming two distinct lobes.

(3) Swim-bladder absent.
(4) Gill rakers 2–3 + 9–11.
(5) As in the case of the pectoral, the postero-ventral margin of the preopercle is deeply excised, a feature more pronounced than in other species of *Scomberomorus*.
(6) Vertebrae 22 + 28 (= 50).
(7) Scales covering body comparatively large.
(8) Body covered with anastomosing spots about size of pupil of eye and confined to a band along middle of side.

Munro (1943, 1958) gives the fin ray counts for Australian examples as : D 20–22 + 16–19 + 9–10 ; A. 15—18 + 9 ; P_1 23. For specimens from Japan it is : D 22 + 16 + 8 ; A. 17 + 8 ; P_1 21 or 23 (Tanaka, 1912), and D 19 + 15 + 9 ; A. 15–17 + 8 (Kishinouye, 1923).

This species is of special interest on account of two reasons : First, due to its apparent disjunct distribution and secondly the difference of opinion of some of the earlier workers regarding the nature of its lateral line. On these, Munro (1943) comments that : " There may remain a little doubt as to whether Australian specimens belong to the same species as those from Japanese and Chinese waters. The break in the geographical distribution might suggest specific distinction, but making allowances for minor variations the morphological differences between Australian and Japanese examples are not great. Markings, colouration, gill raker counts, body proportions, shape of pectoral fin and preopercle indicate synonymy. It is possible that the nature of the lateral line may prevent these two species from being conspecific. Although the lateral-line is reported to be branched in oriental specimens, there is no evidence of such branching in examples caught in Queensland waters. This character apparently is of some importance since Jordan and Hubbs (1925) used this feature to separate their subgenus *Sawara*. At the same time it is well worth noticing that Tortonese (1939) reinstated Günther's name "*gracilis*" for application to an oriental specimen which lacked branching of the lateral line. As stated earlier, it is very probable that the branching of the lateral-line is not as noticeable or as regular as described by Kishinouye and followed by later authors. Australian examples fit well enough the descriptions and resemble in the main essentials the illustrations of Cuvier and Valenciennes (1831), Günther (1860, 1873), Temminck and Schlegel (1884), Tanaka (1912), Kishinouye (1923), Fowler (1936) and Tortonese (1939). As already suggested in the description of the subgenus *Sawara*, there appears to be insufficient justification for considering *S. niphonius* and *S. gracilis* separate species. Also, it is reasonable that the Australian form is similarly conspecific."

Jordan and Hubbs' (1925) definition of the genus *Sawara* (type *C. niphonium*) runs as follows : " This genus differs from *Scomberomorus* in lacking the air-bladder, and in the presence of sharp branch canals placed at right angles along the course of the lateral line." The branch canals of the lateral line are depicted in Kikkawa's drawing of *C. niphonium* published in Kishinouye (1923 : fig. 32) as being distinct and running antero-posteriorly, perhaps giving rise to some of the confusion. As mentioned by Munro (1943) the lateral line branches in *C. niphonium* are " apparently true ramifications as are seen well developed in *Acanthocybium* or vestigially in older age groups of *S. commerson*." The nature of the branching is definitely different from that seen in *S. guttatus guttatus*.

DISTRIBUTION : In Indian Ocean and contiguous seas : Western Australia between Cape Leveque and Abrolhos Island ; and along coast of Northern Territory of Australia.

In the South Pacific, North New South Wales, Queensland and Torres strait. In North Pacific Ocean according to Rosa (1950) " Coast of U.S.S.R. around Vladivostok, Coast of Korea, both coasts of Japan, on Honshu, Shikoku and Kyushu, a few stragglers found as far north as Hokkaido, Coast of China ".

SEERFISH OR BARRED SPANISH MACKEREL

Scomberomorus commerson (Lacépède)

(Plate VII, Fig. C)

SYNONYMS :

Scomber commerson Lacépède, 1800 : 598–603, pl. 20, fig. 1 (Based on MS. drawing by Commerson. Type locality : Mauritius as given by Cuvier)

Scomber commersoni Bloch and Schneider, 1801 : 545–46 (after Lacépède)

Scomber commersonii Shaw, 1803 : 589–590 (after Lacépède—' Pacific Ocean ')

Scomber maculosus Shaw, 1803 : 592 (based on *Konum* of Russell, 1803, *Fish. Vizag.*, 2 : 27, pl. 135 : Coromandal Coast, Bay of Bengal)

Cybium commersonii Rüppell, 1828 : 94–95 ; 1835 : 41
Cuvier, 1829 : 200 ; 1831 : 165–70
Bleeker, 1849 : 77 ; 1850 : 100 ; 1851 : 212 ; 1853 : 42 ; 1858 : 246 ; 1859 : 64
Pollen, 1850 : 5
Jerdon, 1851 : 136
Günther, 1860 : 370
Day, 1865 : 69–70 ;1876–78 : 255 ; 1889 : 211
Playfair and Günther, 1866 : 67
Klunzinger, 1871 : 444 ; 1884 : 112–13
Karoli, 1881 : 162
Sauvage, 1891 : 320
Gilchrist, 1902 : 128
Duncker, 1904 : 158
Gilchrist and Thompson, 1909 : 284
Maxwell, 1921 : 274
Gudger, 1929 : 517
Delsman, 1931 : 402, 407
Anon. (Agric. Marketing in India, Market. Ser. 24), 1941 : 37

Cybium commersoni Cantor, 1850 : 1090
Robinson, 1916 : 63
Jordan and Hubbs, 1925 : 214
Sorley, 1933
Munro, 1955 : 221 ; 1958*a* : 20 ; 1958*b* : 262
Fourmanoir, 1957 : 225
John, 1959 : 133

Cybium konum Bleeker, 1851 : 343 ; 1853 : 42 ; 1855 : 345 ; 1858 : 242, 246 ; 1859 : 64

Scomberomorus konum Bleeker, 1851 : 357 ; 1852 : 39

Cybium Konum Kner, 1865–67 : 144

Scomberomorus commersonii Swain, 1883 : 306
Gilchrist and Thompson, 1917 : 395

Cybium commersonii (in part) Saville-Kent, 1893 : 291, 311

Scomberomorus commersoni Jordan and Seale, 1906 : 288
Thompson, 1918 : 112
Barnard, 1927 : 802
Norman and Fraser, 1937 : 153
Munro, 1942 : 33–48
de Beaufort, 1951 : 230–32
Copley, 1952 : 166–67
Deraniyagala, 1952 : 97–98 (*S. commersonii comersoni* on p. 97 apparently an error)
Herre, 1953 : 244
Mendes, 1954 : 148

Scomberomorus commersonii (in part) Stead, 1908 : 98

Cybium multifasciatum Kishinouye, 1915 : 9 (Type locality : Off the coast of Yamaguchi Perfecture, Japan)

Cybium commerson Kishinouye, 1923 : 416
Whitley, 1936 : 32–38

Scomberomorus (*Cybium*) *commerson* Whitley, 1927 : 5
Munro, 1943 : 74–82
Rosa, 1950 : 97–100
Fraser-Brunner, 1950 : 161

Scomberomorus commerson Paradice and Whitley, 1927 : 82
Delsman and Hardenberg, 1934 : 340, 342
Marchand, 1935 : 77
Fowler, 1935 : 380 ; 1938 : 102
Herre and Myers, 1937 : 21
Tortonese, 1939 : 322
Smith, 1949 : 301
Herre, 1953 : 245–46
Wheeler and Ommanney, 1953 : 66
Williams, 1956 : 43–44
Anon 1960 (Rep. Aden Protectorate Fish. Dept. 1947–58) : 11
Jones, 1961 : 113–117
Jones and Silas, 1961 : 194–195

Scomeromorus (*Scomberomorus*) *commersoni* Deraniyagala, 1933 : 40

Scomberomorus commersonii Scott, 1959 : 113

For a discussion on the ' synonymy ' reference is invited to Munro (1943). The references listed above are not exhaustive, but the more important works pertaining to the Indian Ocean are listed.

The low gill raker count of 2 to 6 rakers on the lower limb of the outer arch (generally 3 or 4) and the deep infliction of the lateral line below the posterior end of the second dorsal to second or third finlet behind it, help in easily distinguishing this species from its congeners.

Jones (1961) has shown that the finlets in *S. commerson* get differentiated even at an early stage of 14.4 mm. The lateral line is discernible in juveniles about 42 mm. in length and as in adults shows the characteristic infliction below the posterior end of the second dorsal. We have noted abnormalities in the lateral line in more than one instance. This is seen mainly in the form of discontinuity in the line or in a second branching (up to 5 or 6 cm.) of the main lateral line below the second dorsal fin. As mentioned by Munro (1943) and depicted by Deraniyagala (1933, 1952) very large examples of *S. commerson* evince a type of vestigial branching of the lateral line (the branches running more or less at right angles to the main lateral line) as seen in *Acanthocybium solandri*. The scales along the lateral line in 3 specimens were found to number 228, 235 and 244.

The body colouration in juveniles and adults differs greatly. In the former generally several large dusky blotches are seen on the side of the body. In adults these merge to form dark irregular vertical stripes, their number differing, depending on the size of the specimen. In young about 400 mm. there may be as few as 20 bars while in a specimen 1.5 metres long about 65 have been counted.

The fin ray count for the species is : D_1 XIV—XVII ; D_2 14–19 + 9–11 ; A. 14–18 + 8-10 ; P_1 20–24. No marked deviation in fin ray counts is noticeable from place to place. The vertebrae are 20 + 25=45.

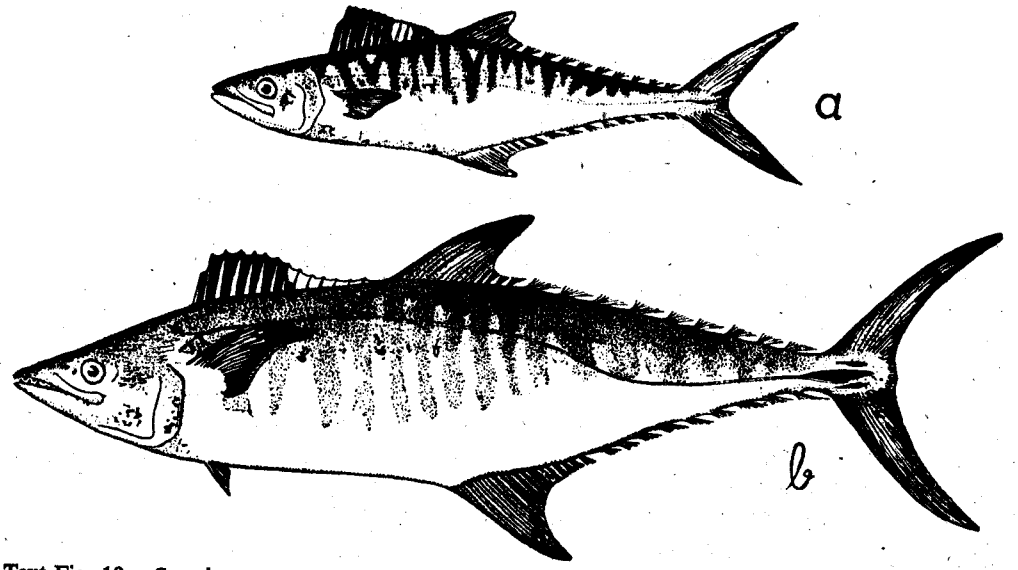
The gill-rakers though few are variable both with age as well as in specimens of the same size. Jones (1961) found the following combinations in specimens 54.5 to 278 mm. in length ; 0 + 2 ; 0 + 3 ; 1 + 3 ; and 1+4 ; in this case the larger number is apparently more characteristic of the larger examples. In specimens over 300 mm. it was invariably seen that one of the rakers was situated at the angle of the upper and lower limbs of the outer gill arch. In order to avoid confusion this raker is indicated separately as+1 and the following combinations have been encountered : 0 + 1 + 4 ; 0 + 1 + 5 ; 1 + 1 + 2 ; 1 + 1 + 3 ; 1 + 1 + 4 ; 1 + 1 + 5 and 1 + 1 + 6 ; but 0 + 1 + 4 ; 1 + 1 + 3 and 1 + 1 + 4 are the more frequent counts.

Munro (1942) and Jones (1961) have dealt with eggs, larvae and juveniles of *S. commerson*. Although important as one of our prime food fishes, little information is available about the biology of this species from Indian waters or far that matter from other areas. The collection of larvae and early juveniles less than 100 mm. (14.4 — 91.50 mm.) (Jones, 1961) from off Vizhingam along the South West Coast of India during the months January–March points to this area being one of the likely spawning areas of this species. No proper figures of landings of this species or for that matter any species of *Scomberomorus* are available from the Indian Coast. Earlier data listed under '*Cybium* sp. or *Scomberomorus* sp.' or ' Seerfish ' may be taken as being composite involving more than one species.

DISTRIBUTION : *S. commerson* is the most widely distributed species of the genus. In Indian waters it is caught all along the Indian Coast and Andamans and may also occur in the Laccadives. The general distribution of the species is from the Red Sea, East Coast of Africa as far south as Cape of Good Hope, and eastwards through Mauritius and the Coast of India, Ceylon, Burma, Malaya to the Australian coast and further eastwards to Fiji, New Caledonia, Solomon Islands ; and in Western Pacific along the Sunda Archipelago, Thailand Coast, Philippines, Taiwan and Japan.

BROAD-BARRED SPANISH MACKEREL

Scomberomorus semifasciatus (Macleay), 1883



Text Fig. 10. *Scomberomorus semifasciatus* (Macleay) (*a*) juvenile, and (*b*) adult (after Munro, 1943).

SYNONYMS :

Cybium semifasciatum Macleay, 1883 : 205–206 (Type locality : Lower Burdekin River, Queensland)

Cybium tigris De Vis, 1884 : 545 (Type locality : Cape York)

Scomberomorus semifasciatus McCulloch and Whitley, 1925 : 142
McCulloch, 1929 : 264

Scomberomorus tigris McCulloch and Whitley, 1925 : 142
McCulloch, 1929 : 264

Cybium commersonii Saville-Kent, 1893 : 291–311, Pl. 46, fig. 1 (*nec* Lacépède)

Scomberomorus commersonii Stead, 1908 : 98, Pl. 46 (*nec* Lacépède)

Cybium guttatum Rendahl, 1921 : 16 (*nec* Bloch and Schneider)

Scomberomorus (*Indocybium*) *semifasciatus* Munro, 1943 : 91–95
Rosa, 1950 : 107

Scomberomorus (*Scomberomorus*) *semifasciatus* (in part) Fraser-Brunner, 1950 : 150

Indocybium semifasciatum Munro, 1958 : 20

Munro (1943) has given reasons for considering *Cybium tigris* De Vis a synonym of *S. semifasciatus*. As shown by Silas (1962), Fraser-Brunner's action of synonymising *Cybium koreanus* Kishinouye, 1923 under *S.* (*S.*) *semifasciatus* was unwarranted as the affinities of *C. koreanus* are more towards *S. guttatus* in the nature of the lateral line, body colouration, vertebral counts, etc.

S. semifasciatus is characterised by the following fin ray counts (Munro, 1943) : D. 13 — 15 + 17–20 + 8–10. A. 20–22 + 8–10. P_1. 22–23: the average (*i.e.*, modal) fin formula

being : D 14 + 19 + 9. A. 21 + 9 ; P_1 23. The gill raker count is said to be 2 — 3 + 7 — 9 with the most usual count being 2 + 8. The vertebral count was found to be 44 (1 specimen) or 45 (3 specimens) in the following combinations : 19 + 25 and 19 + 26 respectively.

The distinctive features of this species are, the body colour, the shape of the pectoral, the great depth of the body between the origin of the second dorsal and anal fins, the head which appears to be relatively small, the large caudal lobes and the conspicuously broad fleshy lateral keels on either side of the tail.

The characteristic colouration in life for immature specimens less than 100 mm. is given by Munro (1943) as follows : " Cranial regions and upper regions of the back are pale green with a bronze sheen and marked with about twelve to twenty broad vertical bands of dark grey. These bars are confined to the region of the body above the lateral line and their number increases with age. The cheeks and belly are silvery white. The snout is a dark slate grey and there is a patch of green above the orbit. The spinous dorsal fin is jet black with contrasting areas of white in its central region. The second or soft dorsal fin is cream with yellow anteriorly. The anal fin and all the finlets are of a transparent white. The caudal flukes are creamy white at their margins and dusky or blackish near the hypural. The pectoral fins are dusky." With increase in size " the bronze-green colouration of the back turns to a greenish blue. The vertical bands on the back are most marked in specimens less than 500 mm. length and in larger fish there is a tendency for these markings to become less distinct, break into spots or fade out more or less completely. Above 700 mm. dead fish assume a drab greyish-yellow blotchy appearance with little or no evidence of markings."

The pectoral fin unlike most other scomberomorinae is not falcate. In larger specimens the margins of the fin are rounded. The anterior or upper margin is distinctly convex and lower or posterior margin is slightly concave or even sigmoid in outline.

DISTRIBUTION : In Indian Ocean and contiguous seas : Western Australia and Northern Territory of Australia. In South Pacific Ocean along the coast of Queensland, Australia.

STREAKED SPANISH MACKEREL

Scomberomorus lineolatus (Cuvier), 1831

(Plate VII, Fig. A)

SYNONYMS :

Cybium lineolatum Cuvier, 1831 : 170 (Type locality : Malabar)

Cantor, 1850 : 1092

Bleeker, 1852 : 22, 40

Günther, 1860 : 370

Day, 865 : 69 ; 1878 : 256 ; 1889 : 212

Cybium interruptum Cuvier, 1831 : 172 (Type locality : Pondicherry)

Jerdon, 1851 : 136

Günther, 1860 : 371

Day, 1878 : 254 (description and part synonymy) ; 1889 : 210 (description and part synonymy)

Scomberomorus lineolatum Gilchrist and Thompson, 1917 : 395
Thompson, 1917 : 395

Scomberomorus lineolatus Barnard, 1927 : 803
Fowler, 1934 : 415
Smith, 1935 : 210 (?)
de Beaufort, 1951 : 235–36
Scott, 1959 : 114
Jones, 1961 : 117
Jones and Silas, 1961 : 187–204

Scomberomorus (*Sawara*) *interruptus* Deraniyagala, 1933 : 41

Scomberomorus (*Indocybium*) *lineolatus* Munro, 1943 : 68

Scomberomorus (*Scomberomorus*) *guttatus* (in part) Fraser-Brunner, 1950 : 160
Rosa, 1950 : 111–112

Scomberomorus interruptus Deraniyagala, 1952 : 99–100
Mendes, 1954 : 148

Indocybium lineolatus Munro, 1955 : 221 (description and part synonymy)

Indocybium lineolatum John, 1959 : 134

Scomberomorus sp. Williams, 1956 : 44–45

Scomberomorus lineolatus Williams, 1960 : 184–191 (description and part synonymy)

The description and figure of *Scomberomorus leopardus* (Shaw) Smith, 1949 (p. 301) as shown by Silas (1962) are referable to *Scomberomorus guttatus* (Bloch and Schneider). Fourmanoir (1957) has followed Smith (1949) in his description of *Cybium leopardus* which consequently also becomes a synonymy of *S. guttatus*.

For specimens of *S. lineolatus* we have examined from the Indian coast, the meristic counts vary as follows :

D_1 XVI–XVII ; D_2 19–20 + 8–9 ; A. 18–20 + 8–11 (11 finlets exception) ; P_1 23–24 ; gill rakers 2–3 + 8–10 ; vertebrae 21 + 28 (= 49).

Munro (1943 and 1955) and de Beaufort (1951) have given the gill raker count as 2 + 9 = 11 ; while for East African specimens, Williams (1960) mentions 2 + 1 + 8–11 = 11–14 as the range.

Day (1865, 1878) and Munro (1943) give the pectoral count as 21, while others have mentioned 23 (Deraniyagala, 1952) ; 24 (de Beaufort, 1951 ; Munro, 1955) and 22–26 (Williams, 1960).

The dorsal and anal counts given by various authors (Table VI) differ but some of the differences atleast may be accounted for as due to the differences in the methods of counting used.

TABLE VI
FIN RAY COUNTS IN *S. lineolatus*

Author	Year	D_1	D_2 + finlets	A + finlets	Species
Günther ...	1860	XVI	16 + 9	16+10	*C. lineolatum*
Günther ...	1860	XVI	17 + 9	18+9	*C. interruptum*
Day ...	1865	XVI	16 + 9	16 — 20+10	*C. lineolatum*
Day ...	1873	XVI	18 + 9	18+9	*C. interruptum*
Day ...	1873	XVI	16 + 9	16+10	*C. lineolatum*
Day ...	1788	XVI	19 — 20 + 8 — 9	19+8 — 9	*C. interruptum*
Day ...	1878	XVI	16 + 9	19+10	*C. lineolatum*
Barnard ...	1927	XVI	16 + 9 — 10	16+10	*S. lineolatus*
Munro ...	1943	XV — XVII	18 — 20 + 8 — 9	19 — 21+8 — 10	,,
de Beaufort ...	1951	XV	15 — 17 + 9	19 — 21+9	*C. lineolatus*
Deraniyagala ...	1952	XV — XVII	18 — 20 + — 10	20+9 — 10	*C. interruptus*
Munro ...	1955	XV — XVII	18 — 20 + 9 — 10	20+9 — 10	*I. lineolatus*
Williams ...	1960	XV — XVII	19 — 21 + 8 — 9	18 — 21+8 — 9	*S. lineolatus*
Jones and Silas ...	1961	XVI — XVII	19 — 20 + 8 — 9	18 — 20+8 — 11	*S. lineolatus*
Total range ...	...	XV — XVII	15 — 20 + 8 — 10	16 — 21 + 8 — 11	...

The diagnostic characters of the species are :

(1) Body colouration consisting of blackish narrow streaks or broken bars along the sides of the body ;

(2) Both in young as well as adults a markedly rounded ridge runs from the side of the pointed snout to the end of the operculum in line with the base of the pectoral fin.

(3) When compared to the other Indian species of the genus, the caudal keels are conspicuously large. In this it probably shows affinities with *S. semifasciatus.*

(4) The lateral line is simple, with slight undulation in the posterior half and does not show branching as in adult *S. commerson* or " pseudobranching " as in *S. g. guttatus.*

(5) The gill rakers are better developed in *S. lineolatus* than in *S. g. guttatus* and *S. commerson.*

(6) The pectoral fin is scaled for a greater part as in *S. regalis* (Bloch) from the Atlantic.

(7) Invariably in most of the freshly caught juvenile and adult specimens of *S. lineolatus,* the ventral profile between the pelvic and anal fin is slightly concave.

It may also be mentioned that Silas and Ummerkutty (1962) have found that atleast four or five out of every ten *S. lineolatus* examined have the parasitic copepod *Brachiella thyni* Cuvier in the pectoral axil of one or both sides.

The air-bladder is wanting in *S. lineolatus.*

Hardly anything is known about the biology of this species. Jones (1961) has shown that the description and figures of post-larvae and juveniles of *S. lineolatus* given by Kuthalingam (1959) have nothing to do with that species or for that matter to any species of *Scomberomorus.* Consequently his observations on the food and feeding habits of post-larvae and juveniles are referable to some other non-scomberomorinae. Similarly his reference to adults of *S. lineolatus* measuring 100 mm. to 128 mm., is also doubtful as we have not come across fully mature adults although specimens upto about 700 mm. have been examined.

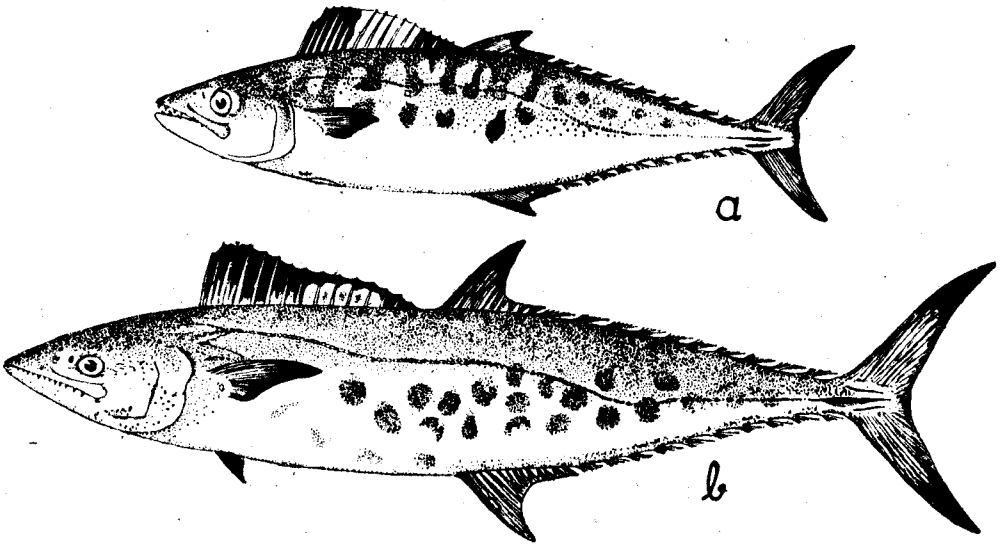
DISTRIBUTION : All along the Indian coast, but generally rarer than *S. g. guttatus* and *S. commerson.* The general distribution is given by Williams (1960) as : British East

African Waters ; Natal Coast of South Africa ; ? Mozambique channel and Madagascar ; Ceylon, India to the East Indies.

Although in the section on 'Synonymy' we have listed references to *S. lineolatus* from South African Waters (Gilchrist and Thompson, 1917 ; Barnard, 1927 ; Fowler, 1934 ; Smith, 1935) more information is needed on this species from that area. It is felt that *S. lineolatus* and *S. guttatus* both occur in S.E. African waters, but have been confused. For further discussion reference is invited to Silas (1962).

QUEENSLAND SCHOOL MACKEREL

Scomberomorus queenslandicus Munro, 1943



Text Fig. 11. *Scomberomorus queenslandicus* Munro. (*a*) juvenile and (*b*) adult (after Munro, 1943).

SYNONYMS :

? *Cybium guttatum* Macleay, 1881 : 193 (Port Jackson, Australia)
? *Scomberomorus guttatus* McCulloch, 1934 : 79 (N. S. Wales, Australia)
Scomberomorus (*Cybium*) *Queenslandicus* Munro, 1943 : 82 (Type locality : Cape Cleveland, North Queensland, Australia)
Rosa, 1950 : 101
Cybuim queenslandicus Munro, 1958 : 20

S. queensandicus qualifies for inclusion here on account of its occurrence along the Coast of Western Australia. Munro (1943) while describing this species, recognised its very close affinities to *S. commerson* from which he distinguished it as follows :

	S. queenslandicus	*S. commerson*
1. Vertebral count ...	20 + 28 = 48	20 + 25 = 45
2. Markings ...	Almost three rows of diffuse blotches	Numerous wavy vertical bands on belly
3. Lateral line ...	Not deeply inflicted	Deep infliction below 2nd and 3rd dorsal finlets
4. Anal fin count ...	17–20, mode at 19	16–18, mode at 17
5. Gill rakers ...	Normal = 1 + 6	Normal = 1 + 4

Slight differences between *S. queenslandicus* and *S. commerson* were also noted for the following characters :

(1) Snout is slightly shorter than in *S. commerson.*

(2) The eye diameter larger than in *S. commerson.*

(3) First dorsal fin inserted slightly further back than in *S. commerson.*

(4) The caudal fin very slightly larger than in *S. commerson.*

Munro (1943) has given the fin formula for *S. queenslandicus* as : D. 15–17 + 16–20 + 9–10. A. 15–20 + 9–10. P_1. 20–23 and the average fin formula (*i.e.* modal) as : D. 16 + 18 + 10 ; A. 19 + 10 ; P_1. 21-22. Gill-raker formula is 0 + 4 to 1 + 7 with 0 + 6 being most common. Of nine specimens examined for vertebral counts from East Coast of Australia, Munro (1943) found 8 to have 20 + 28 = 48 and one 20 + 29 = 49 vertebrae. A single specimen examined from Sharks Bay, Western Australia had lesser precaudal count namely 19 + 29 = 48 and according to Munro " This slight variation may be significant in that it might indicate the existence of two races of this species, one from the east coast and the other from the west. It would be foolish to conclude this from such little material."

The colour when freshly caught is as follows : " Cranial regions and upper part of the back are an irridescent bluish green and the cheeks and belly are a silvery white. In adult fish the sides are marked with about three rows of bronze-grey indistinct blotches, each a little larger than the orbit. The membrane of the spinous dorsal fin is jet black with large contrasting areas of intense white between the sixth and last spines. The second dorsal fin and the finlets are pearly grey with darker margins. The caudal fin is of similar colour. The ventrals, anal fin and anal finlets are white. The pectoral fins are greyish, being darkest on their inner surface." The body markings appear to alter with age as an example of 95 mm. is said to lack the bronze-grey blotches of the older fish.

The species also attains maturity at a small size and examples about half metre in length weigh 3 to 4 lbs. Munro (1958) remarks that this species which is found in coastal waters and estuaries is taken by trolling and in set nets.

DISTRIBUTION : In Indian Ocean and contiguous waters : Coast of Western and Northern Australia ; In South Pacific Ocean : Australia along the Coast of Queensland and New South Wales.

SPOTTED SPANISH MACKEREL

Scomberomorus guttatus guttatus (Bloch and Schneider), 1801

(Plate VII, Fig. B)

SYNONYMS :

Scomber guttatus Bloch and Schneider, 1801 : 23 (Type locality : Tranquebar, S.E. Coast of India).

For detailed synonymy reference may be made to Silas (1962) wherein the following species are also considered synonyms of *S. guttatus guttatus* :

Scomber leopardus Shaw, 1803.

Cybium kuhlii Cuvier, 1831.

Cybium croockewiti Bleeker, 1850.

Silas (1962) also considers *Cybium koreanum* Kishinouye a subspecies of *S. guttatus.*

Jones and Silas (1961) give the meristic counts for *S. guttatum* (= *S. g. guttatum*) from Indian waters as follows : D_1. XVI–XVII ; D_2. 20–21 + 7–9 ; P_1. 21–23 ; A. 19–20 + 7–9 ; gill rakers 1–3 + 7–10. The most frequent counts are : D_1 XVI ; D_2 finlets 8 ; P_1. 21 ; A. finlets 8 ; gill rakers 2 + 8–9. The total vertebral count varies and is 48 or 49, but the total range for the species is from 45 to 51 (Kishinouye, 1923 ; Delsman, 1931 ; Munro, 1943).

For further details regarding *S. g. guttatus* reference is invited to Silas (1962).

DISTRIBUTION : In Indian waters *S. g. guttatus* occurs all along the Indian Coast and the Andaman Islands. The general distribution of the species ranges from Iranian Gulf, Madagascar and South East Africa, Seychelles, Coast of India, Ceylon, Burma, Mayala, Indonesia, Philippines, China and Taiwan. Earlier references to its occurrence in Australian waters have been shown to be erroneous by Munro (1943).

Genus **Acanthocybium** Gill, 1862

Acanthocybium Gill, 1862. *Proc. Ac. Nat. Sci. Philad.*, 125 (Genotype : *Cybium sara* Bennett).

The genus is monotypic and has the following diagnostic characters : as in the sword-fish *Xiphias gladius* the lamellae of the gills are reticulated ; gill rakers are absent ; intermuscular bones are inserted on the ribs ; vertebrae 54–66. Additional characters are the elongate, more or less compressed body covered with minute scales ; beak-like long snout, large mouth ; jaws with strong trenchant teeth which are compressed, closely set in a single series and each slightly serrated ; vomer and palatine with villiform teeth ; spinous dorsal with XVII–XXIII spines ; second dorsal and anal small followed by 8 to 10 and 7 to 9 finlets respectively.

The reticulated nature of the gill lamellae led Jordan (1933) to elevate *Acanthocybium* to family status as Acanthocybiidae, a course which has been adopted by some workers (Munro, 1958*b*). Others (Jordan and Hubbs, 1925, Fowler, 1949) have placed *Acanthocybium* under a subfamily *Acanthocybinae* of the family Cybiidae and Thunnidae respectively. We (Jones and Silas, 1960, 1961) have elsewhere treated the genus as belonging to the subfamily scomberomorinae along with the genus *Scomberomorus* Lacépède, and herein also advocate the same system. External morphology, anatomy and osteology (Kishinouye, 1923 ; Conrad, 1938 ; Fraser–Brunner, 1950 ; etc.) show that although possessing certain specialised characters, the phylogenetic affinities of *Acanthocybium* are more towards *Scomberomorus* than to any other scombroid group. Hence, the need for a higher category to place *Acanthocybium* may not arise here and if used may tend to obscure the natural relationships.

DISTRIBUTION : Circumtropical. Details given under species.

WAHOO

Acanthocybium solandri (Cuvier), 1831

(Plate VI, Fig. A)

SYNONYMS :

Cybium Solandri Cuvier, 1831 : 192 (Type locality : unknown ; based on MS. of Solander)

Fourmanoir, 1957 : 226–27

Scomber lanceolatus (Solander) Cuvier, 1831 : 192 (name given in text)

Cybium sara Lay and Bennett, 1839 : 63 (Type locality : Loo Choo)
Cybium petus, Poey, 1860 : 234 (Type locality : Havana, Cuba)
Acanthocybium petus Poey, 1868 : 363
Cybium verany Doderlein, 1872 : 1 (Type locality : Palermo, Mediterranean)
Acanthocybium solandri Jordan, 1884 : 119
Jordan and Evermann, 1896 : 876
Boulenger, 1897 : 272
Kishinouye, 1923 : 411
Fowler, 1928 : 135 ; 1931 : 325 ; 1934 : 400 ; 1938 : 67 ; 1949 : 74
Deraniyagala, 1933 : 45 ; 1949 : Pl. 21, fig. D.; 1952 : 100–101
Hardenberg, 1934 : 292
Smith, 1949 : 301 ; 1956 : 721
Fraser-Brunner, 1950 : 162
Rosa, 1950 : 75–77
de Beaufort, 1951 : 228
Rivas, 1951 : 276–77.
Roughley, 1951 : 111
Herre, 1953 : 245
Wheeler and Ommanney, 1953 : 66
Mendes, 1954 : 147
Munro, 1955 : 220 ; 1958*a* : 263 ; 1958*b* : 17
Williams, 1956 : 45
Iversen and Yoshida, 1957 : 370–79
Jones and Kumaran, 1959 : 49
John, 1959 : 133
Jones, Silas and Dawson, 1960 : 134
Rao, 1960 : 132
Jones and Silas, 1961 : 192
Silas, 1962*c* (MS.)
Acanthocybium forbesi Seale, 1912 : 283 (Type locality : Coast of Leyte, Philippines)
Acanthocybium sara Kishinouye, 1915 : 9
Jordan and Starks, 1917 : 441
Jordan and Hubbs, 1925 : 213
Scomber amarui Curtis, 1938 : 58 (Type locality : open sea off Tautira, Tahiti)
Acanthocybrium solandri Copley, 1952 : 168 (generic name misspelt)

The meristic counts for this species are as follows : D_1. XXIII XXVII ; D_2. III, 9–10 + 8–10 ; A. III, 9–10 + 1–9 ; P_1. ii. 21 ; P_2. 1, 5. Vertebrae 23–33 + 31–34 (= 54–66).

Other external characteristics which may assist in distinguishing *A. solandri* from species of *Scomberomorus* are :

(1) The anterior two-thirds to three-fourths of the first dorsal is uniformly high when the fin is lifted erect.

(2) The pectorals are short.

(3) The lateral line decurves to the midlateral part of the body below the middle of the first dorsal. Short lateral branchings, at right angles all along the lateral line are seen.

(4) The caudal fin is lunate as in *Auxis* and not forked.

(5) Anterior insertion of second dorsal is midway between base of pectoral and base of caudal.

Hardly anything is known about the biology of this species except what has been given by Iversen and Yoshida (1957). Almost all works on the species listed pertain to the description of the species from different locations.

The ' World Record Marine Fishes ' published by the International Game Fish Association, gives the all tackle record for *Acanthocybium solandri* as 53 kg. (139 lbs.) the length of the specimen being 6 ft. 9 in. and girth 33 in. caught at Marathon, Florida, in May 1960. However, specimens usually taken by handlines or trolling are smaller in size. The seven specimens examined by Rao (1960) ranged from 1054 mm. to 1205 mm. weighing between 7.31 and 11.43 kg. The largest specimen, a spent female, taken in troll line fishery along the Tuticorin coast, Gulf of Mannar reported by Silas (1962*c*) is 1540 mm. weighing 16.8 kg.

DISTRIBUTION : In Indian Waters Jones and Silas (1961) record the species from " the west coast from Vizhingam, Colachel and Cape Comorin ; on the east coast from Tuticorin, Gulf of Mannar ; Minicoy Island in the Laccadive Archipelago ; and Port Blair, Andamans." From other parts of the Indian Ocean and contiguous seas it has been recorded from several localities, namely, the Gulf of Aden, Coast of East and South Africa ; Madagascar ; Mauritius ; Seychelles ; Maldives ; Ceylon ; Sunda Archipelago ; and Western and Northern Australia. It is also known from the tropical and temperate waters of the Pacific and the Atlantic and also from the Mediterranean.

FAMILY ISTIOPHORIDAE

The family includes the spearfishes and sailfishes in which the rostrum is shorter and cylindrical, the body covered with narrow, partly embedded scales ; caudal peduncle with two fleshy keels on each side ; air-bladder large, consisting of many separate divisions ; pelvics with 1 to 3 rays.

Genus **Istiophorus** Lacépéde

Istiophorus Lacépéde, 1802. *Hist. Nat. Poiss*, 3 : 374 (Genotype : *Istiophorus gladifer* Lacèpéde = *Scomber gladius* Broussonnet).

Notistium Hermann, 1804. *Observ. Zool.*, 304 (Type : *Guebuca Marcgrave* = *Histiophorus americanus* Cuvier (Type given as *Scomber gladius* by Jordan and Evermann, 1926).

Histiophorus Cuvier and Valenciennès, 1833. *Hist. Nat. Poiss.*, 8 : 213 amended spelling (Type : *Istiophorus gladifer* Lacèpède).

The genus can be easily distinguished from other members of the family by the very high dorsal fin in which some of the branched rays are higher than the unbranched rays of the anterior lobe ; pelvic fins with two or three rays which are not coalesced into one ; and pelvic fins 1.5 times or more length of pectoral.

Day (1878) recognised two genera, *Histiophorus* Lacépéde and *Xiphias* Linnaeus under the family Xiphiide. The genus *Histiophorus* as treated by him is composite as it was defined to include also a species at present referable to the genus *Makaira*. Two species of sailfish, namely, *H. gladius* (Broussonnet) and *H. immaculatus* Rüppell were recognised by him.

Jordan and Evermann (1926) in recognising nine species of *Istiophorus* viz., *I. gladius* (Broussonnet) (East Indies), *I. americanus* (Cuvier and Valenciennes) (Cape Cod to Brazil) *I. grey* n. sp., (Pacific Coast, Mexico), *I. wrighti* n. sp., (West Indies), *I. immaculatus* (Rüppell) (India), *I. maguirei* n. sp., (West Indies), *I. orientalis* (Temminck and Schlegel) (Japan), *I. volador* n. sp. (West Indies), and *I. eriquius* Jordan and Ball n. sp., (Hawaii), remarked that " The preliminary paper which makes up this paper is done almost entirely on a basis of photograph. No one knows what changes the sail fishes undergo in the process of development and it is quite possible that some characters used by us in the following key are matters of age not indicating specific distinction." During the last 35 years the position has not changed a bit in that no review of sailfishes on a global basis has been undertaken. However, contributions on billfishes published from various parts of the world indicate the following possibilities :

(1) The genus *Istiophorus* may be monotypic represented by one species *I. gladius* with subspecies.

(2) The genus *Istiophorus* is represented in the Atlantic by *I. americanus* and the Indo-Pacific by *I. gladius*. Subspecific categories may be recognised under these two species from these two different areas respectively.

(3) The genus *Istiophorus* is represented by several species.

As in the case of the tunas and seerfishes, here again, the concept of the different categories such as, species, subspecies, geographical races etc., is still in a nebulous state and until such time that these are studied satisfactorily based on reviews on a global basis, lack of agreement may exist.

We have examined sailfishes from different parts of the Indian Coast and Andaman Sea and are able to recognise only one species, *I. gladius*.

SAILFISH

Istiophorus gladius (Broussonnet)

(Plate VIII, Fig. C)

SYNONYMS :

Scomber gladius Broussonnet, 1786 : 454, pl. 10 (Type locality : " La Mer des Indes ". According to Jordan and Evermann (1926) " based on a specimen and a drawing by Sir Joseph Banks ") Bloch, 1793 : 81

Xiphias velifer Bloch and Schneider, 1801 : 93 (after Broussonnet 1786)

Istiophorus gladifer Lacépède, 1802 : 374 (after Broussonnet 1786)

Histiophorus indicus Cuvier and Valenciennes, 1831 : 293 (after Broussonnet 1786)

Histiophorus immaculatus Rüppell, 1835*a* : 116 (Type locality : Red Sea. Based on juvenile 18 inches long) ; 1835*b* : 71 ; 1835*c* : 42
Günther, 1860 : 514
Klunzinger, 1871 : 469
Day, 1878 : 199 ; 1889 : 132
Goode, 1883 : 21
Copley, 1952 : 172
Mendes, 1954 : 147

Histiophorus gladius Günther, 1860 : 513 (Synonymy—in part)
Playfair, 1867 : 865
Klunzinger, 1871 ; 468 ; 1884 : 122

Goode, 1883 : 21
Day, 1878 : 198 (Synonymy—in part) ; 1889 : 132
Duncker, 1903 : 155
Thompson, 1918 : 118
Maxwell, 1921 : 274
Barnard, 1927 : 807
Sorley, 1933
Copley, 1952 : 171
Munro, 1955 : 222
Fourmanoir, 1957 : 220
John, 1959 : 134

Histiophorus granulifer Castelnau, 1861 : 42 (Type locality : Cape of Good Hope, S. Africa).

Istiophorus gladius McCulloch, 1921 : 137 ; 1922 : 106 ; 1934 : 80
Jordan and Jordan, 1922–25 : 30
Jordan and Evermann, 1926 : 38
Deraniyagala, 1933 : 54 ; 1952 : 106
Fowler, 1936 : 80 ; 1938 : 105
Smith, 1949 : 315 (In part?)
Rosa, 1950 : 153
Munro, 1958 : 19
Jones, 1959 : 204 ; 1959 : 255
Scott, 1959 : 116
Jones, Silas and Dawson, 1961 : 136
Jones and Kumaran, 1962
Silas and Rajagopalan, 1962
Silas, 1962 (Helminth parasites)
Silas and Ummerkutty, 1962 (Copepod parasites).

Istiophorus immaculatus Jordan and Evermann, 1926 : 44.
LaMonte and Marcy, 1941.
Rosa, 1950 : 152.

We have examined sailfish landed at various fishing centres along the Indian Coast (Ratnagiri, Malpe, Calicut, Vizhingam, Colachel, Tuticorin) and from the Andaman Sea (Car Nicobar) and are able to recognise only a single species, *I. gladius*. Both *Xiphias velifer* Bloch and Schneider, and *Istiophorus gladifer* Lacépède are after Broussonnet's account of *Scomber gladius*, and as such are its synonyms. *Histiophorus indicus* Cuvier and Valenciennes is partly based on Broussonnet's account and partly on material studied by Cuvier form the type specimen in London. As commented by Jordan and Evermann (1926) the need for substituting a new name *H. indicus* for *S. gladius* did not arise firstly on account of the name *gladius* being preoccupied in *Xiphias* and not in *Scomber*. Secondly, even if a new name was required, *velifer* and *gladifer* were already available.

The same authors comment on *Histiophorus granulifer* Castelnau based on a mutilated skeleton cast ashore in a storm at Cape of Good Hope as follows : " Head well preserved in the Museum at Cape Town. Length m. 1.07 ; depth mm. 35 ; length of beak from eye mm. 67. Beak a little flattened above, pointed at tip, covered below and on sides with granulations, those below finer and more close-set than similar granulations on upper jaw. Skeleton resembles entirely that figured by Cuvier and Valenciennes (*Tetrapturus*) (Castelnau)."

" This may be *Istiophorus gladius* ; it is not likely to be *Makaira herscheli* ".

Day (1878, 1889) recognised *I. maculatus* (Rüppell) originally described from Red Sea. Jordan and Evermann (1926) based on Day's description of the species from Indian Waters (Madras) recognised this as one of their nine species of *Istiophorus*. We have here relegated *I. immaculatus* to the synonymy of *I. gladius* for the following reasons :

1. Rüppell's type of *H. immaculatus* is said to be a specimen of 18 inches in which " The dorsal fin is much higher than the body. The height of the body is one-tenth of the total length; the length of the head about one-third. Dermal production lanceolate. Colouration uniform ; dorsal blackish, immaculate." (Günther 1860—after Rüppell) Jones (1959) describing a specimen of *I. gladius* 432 mm. (17 inches) long remarks that " The dorsal fin is black and the characteristic blotches found in the fin of the adult fish are seen only in a few places". Deraniyagala's (1952) figure of a post larval sailfish slightly less than 13 cm. (5 inches) in length shows only five conspicuous blotches on the dorsal while the rest of the fin is colourless. It would thus appear that in juveniles and young, colouration of the dorsal fin may be a highly variable character. Added to this the likelihood of the few blotches disappearing in preservative would make reliance on this character for species determination in this instance useless.

Aside from this, the dorsal and anal fin ray counts of *H. immaculatus*, namely D. 47/7 ; A. 10/7, also show close agreement with Jones' specimen of *I. gladius* for which the counts are, D. 48/7 ; A. 11/7 besides which between the two anal fins, five small stub-like detached rays are present " which are not discernible in the adult ", and could be easily overlooked in juveniles of this size.

2. Day's (1878) description of *Histiophorus immaculatus* is based on a 5 feet 9 inches mounted specimen in the Madras Museum showing the following characters :

" B. vii., D. 47/7, P. 16, V. 3, A. 10–11/7, C. 17 ". " Length of head (including the snout 1/3, height of body 1/10 of the total length. *Eyes*—diameter about 1/3 in the postorbital portion of the head. A very slight ascent from the snout to the base of the first dorsal fin. The maxilla reaches to below the hind edge of the orbit. *Teeth*—generic. *Fins*—Length of base of dorsal fin about 1/3 of the total length, eleventh to the fifteenth* dorsal ray the longest, and atleast three times higher than the body ; the last few rays are low and reach to the base of the second dorsal fin. Ventral elongated. *Scales*—dermal production lanceolate. *Lateral line*—at first makes a very strong curve but becomes straight above the hind extremity of the pectoral fin. *Colours*—gray, dorsal and ventral blackish."

But for the colour characteristics, all other features mentioned by Day for his *H. immaculatus* agree fully with the characters of similar sized specimens of *I. gladius* we have examined. In the course of examining scores of specimens of sailfish in fresh condition from the east and west coasts of India, we have never come across one in which the dorsal fin is immaculate, although, slight variations in the disposition, size and number of spots are seen. Having not examined the type specimen at the Madras Museum, we are not sure whether the normal spots have been obliterated or painted over by the application of any preservative during the process of preparing the mount for exhibition.

In separating *I. gladius* and *I. orientalis*, the diagnostic character used by Jordan and Evermann (1926) was that in the former the " Interspace between dorsal fins with a series of

* Not " (11th to 13th) " as given by Jordan and Evermann (1926).

six to 12 short, stiff, stub-like spines....." Interspace between dorsals considerable almost equal to height of lobe and with no stubs or spines between the fins." "In addition, in *I. gladius* the sides of the body was said to have no pale bars " while in *I. orientalis* the " colour steel-blue, with numerous cross-bars each of four to six round blue spots." The number of dorsal spines in the two species is given as XLII to XLVIII and XLI respectively.

De Beaufort (1951) gave one more additional diagnostic character to distinguish the two species, namely, " Upper profile of head gradually ascending to dorsal " (*H. gladius*) and " Upper profile of head steeply ascending to dorsal " (*H. orientalis*). The dorsal counts were given as XLV and XLIV–XLVIII for the two species respectively. The distribution of *H. orientalis* was given by him as " Singapore ; Java (Bay of Jacarta, Wijnkoop's Bay) ; Banda ! —Japan, Siam ? Hawaii." A figure of a fish with a wide gap between the two dorsals equalling the distance from the origin of the second dorsal to fork or slightly more than half the length of the longest dorsal spine is shown, while adding the following remarks : " It is possible that this species is only a synonym of *H. gladius*, as has already been supposed by Klunzinger and Lütken. As I have seen no specimens besides the skull and some other parts of the skeleton, I abstain from giving an opinion."

Our acquaintance with the Indian sailfish which we consider to be a single species, *I. gladius* leads us to the following conclusions as regards the status of *I. orientalis*.

1. The gap between the two dorsal fins on which primary stress has been given in distinguishing certain sailfish species in highly variable, especially with age. Juveniles show the two fins to be continuous (Jones, 1961 ; Deraniyagala, 1952) while in adults, both immature and mature the gap may be of varying distances. In specimens at Tuticorin we have seen this gap to vary in width from that equalling almost eye diameter to slightly more than base of the second dorsal. Even so, it has been generally noticed that one or two of the last dorsal rays may be hidden in the deep groove between the two dorsals. In any case, the last exposed ray of the first dorsal is never elongate, as shown in the figure given by de Beaufort (1951), but the posterior rays are gradually reduced in length in a graded series as clearly illustrated for the typical *I. orientalis* by Temminck and Schlegel (coloured plate LX, reproduced in black and white by Jordan and Evermann (1926, pl. 15, fig. 1). In fact, in this feature, the similarity between the Japanese *I. orientalis* and the Indian *I. gladius* is well exemplified. Nakamura's (1938 : 1955) excellent figure of *I. orientalis* from Formosan Waters also shows the absence of this so-called wide gap and abrupt ending of the first dorsal. Illustrations of *I. orientalis* by Japanese workers, *viz.*, Tanaka (1911–14) ; Okada *et al.* (1938) and others show that the gap between the dorsals is less than or hardly equal to the distance of the base of the second dorsal.

The morphometric data for *I. orientalis* from the Central Pacific given by Royce (1957) also show the same trend of the free interspace between the two dorsals being extremely narrow. Thus while the narrow free interspace seems to be a widespread phenomenon in Indo-Pacific sailfishes we are unable to state whether there could be a valid species evincing the condition of wide interspace as observed by Jordan and Evermann (1926), and de Beaufort (1951).

2. While Jordan and Evermann (1926) gave the dorsal count of *I. orientalis* as XLI, later workers have shown that it is variable and number XLV–XLVII (Nakamura, 1938) ; XLIV–XLVIII (de Beaufort, 1951). This gives the range for this character as XLI–XLVIII, while it is XLII–XLVIII in *I. gladius*, the overlap being considerable.

3. *I. orientalis* is credited with having numerous cross bars each of four to six round blue spots. A majority of the freshly caught specimens of *I. gladius* we have examined clearly

showed this character while those subjected to long exposure after capture showed faint markings, but in all cases the round black spots on the dorsal fin were present. This again breaks down another supposed distinction between the sailfish from Indian Seas and the Pacific *I. orientalis.*

4. The degree of ascent of the dorsal profile of the head may show slight differences. In *I. gladius* we have examined the ascent is not abrupt and steep, as shown in the illustrations of *I. orientalis* by Temminck and Schlegel (plate LX), but is more like that figured by Nakamura (1938 : pl. 13, fig. 2) for *I. orientalis* from Formosan Waters. Variations in this character with size may be expected as in juvenile *I. gladius* the profile of the head is more or less straight (Jones, 1961) while in adults it shows a gradual slope to the origin of the dorsal.

5. Fowler (1928) and Royce (1957) have rightly synonymised *I. eriquius* Jordan and Ball (in Jordan and Evermann, 1926) from Hawaii with *I. orientalis* (= *I. gladius*). According to Royce (1957) " There seems little doubt that the species occurring in the Central Pacific should be *orientalis* which most authors have used. On the basis of a cast in the Bishop Museum, Jordan and Ball *in* Jordan and Evermann (1926), also describe *eriquius* from Hawaii in which the dorsal fin is subtruncated behind with only 34 dorsal spines. The photo in Jordan and Evermann (P. 101) suggests that the posterior part of the dorsal fin was missing from the cast. Further, there are no reports from Hawaiian fishermen of two species of sailfish. We, therefore, regard *eriquius* as a synonym of *orientalis.*"

6. Royce (1957) has also synonymised *Istiophorus brookei* Fowler (1934) with *I. orientalis* (= *I. gladius*) with no comments. Scrutiny of Fowler's description and figures indicates that besides the diagnostic colouration of the body (about 16 to 17 vertical light lines extending to the upper and lower edges of the body), the pectorals in *I. brookei* are more elongate. Much reliance cannot be placed on the colour characteristics in view of its variability with size and duration after capture. In view of our limited knowledge about the growth changes in the sailfishes from the Indo-Pacific, it is not possible to comment on the importance of the length of the pectoral in these specimens. In general *I. brookei* shows hardly any differences from *I. gladius* and both may be considered conspecific, although the possibility of racial differences could exist.

7. Jordan and Evermann (1926) speaking of their new species *I. greyi* remarked that " The species is apparently new to science. It is very close to the Japanese *Istiophorus orientalis* being distinguished by the shorter ventrals and by the absence of cross-lines of blue spots. The second dorsal and anal are, perhaps, smaller than in *I. orientalis.*" As type, a photograph copy of plate LXXVI of Zane Grey's " Tales of Fishing Virgin Seas ", of a specimen weighing 135 pounds and 10 feet 1 inch long taken by Grey near Cape San Lucas, Lower California, was designated. Unfortunately there is discrepancy between the description of the colouration of the species, and the type shown in the aforesaid photograph in the matter of body colouration. On p. 37 as Key character they mention that in *greyi* " color, plain steelblue " and on p. 2 for a specimen 10 feet (from tip of sword to centre of tail) caught near the tip of Baja California " in fresh (based on photographs) state as " color, dark, without markings on body....." However, the photographs of the type mentioned above and reproduced in their work on plate 14, very clearly show the cross-lines composed of light spots on the body ! In the absence of morphometric details, the supposed differences between *I. greyi* and *I. orientalis* in the length of the pelvics and size of the second dorsal and anal cannot be commented on and in our view will not merit distinction of species-status.

In view of these points raised, we feel that :

(*a*) For reasons given under items 1–4, that *I. gladius* and *I. orientalis* are conspecific.

(*b*) *I. brookei, I. eriquius* and *I. greyi* which are shown to be no way specifically distinct from the Japanese *I. orientalis* automatically become synonyms of *I. gladius.*

It is further held that only one species of sailfish may be recognised from the Indo-Pacific, but the possibilities of difference in sub-populations or regional differences as seen for tunas and seerfishes existing cannot be ruled out.

Finally, the validity of the specific name *Istiophorus gladius* for the Indo-Pacific sailfish is questionable. According to Fowler (1928) " The description and figure by Broussonnet are not accompanied by any specific name, simply being referred to *Scomber* (*Acad. Sci. Paris, Mem.* p. 450, pl. 10, 1786 (1788), type loc., sea of Indies). The *Scomber gladius* Bloch (*Nat. auslandichen Fische,* pt. 7, p. 81, pl. 345, 1793) the next name though composite is largely referred to *Xiphias* ". Since *I. gladius* is now widely current, it is hoped that proper ruling will be made to validate the specific name *I. gladius* Broussonnet for the sailfish by the Committee on International Zoological Nomenclature.

Some anatomical features of *I. gladius* from Indian Seas are given elsewhere (Silas and Rajagopalan, 1962) along with morphometric measurements and meristic counts.

For 10 specimens of *I. gladius* examined by Silas and Rajagopalan (1962) the first dorsal (total) counts are 46 (4) and 47 (6). The juvenile specimen examined by Jones (1961) had a dorsal count of 48. For Ceylon specimens Deraniyagala (1952) mentions IV, 40–44 (= 44–48) as the number. As already drawn attention to, the low count of 34 for *I. eriquius* may be on account of part of the fin missing from the cast. Barring this, the fin ray count for the *I. gladius* from the Indo-Pacific as recognised here may be given as follows :

D_1. XL–XLVIII ; D_2. 6–7 ; P_1. 15–19 ; P_2. I–1–2.
A_1. III, 10–11 ; A_2 6–7 ; Vertebrae 24 (12 + 12).

It may be mentioned that *I. gladius* is the most common of all billfishes caught along the Indian Coast.

Genus **Tetrapturus** Rafinesque, 1810

Tetrapturus Rafinesque, 1810 : 54 (Genotype *Tetrapturus belone* Rafinesque) (Spelling amended to *Tetrapturus* by Bonaparte, 1841 : 19 ; and *Tetrapturus* by Agassiz, 1843 : 7, 89–92, table E. Misprints *Tetrapturus* Verany, 1847: 492 ; and *Tetrapturus* Radcliffe, 1926 : 112).

Skeponopodus Nardo, 1832 : 99 (Nomen nudum) ; 1833 : 415 (Type : *Skeponopodus typus* Nardo (= *Tetrapturus belone* Rafinesque) ". Type species by virtue of the name *typus.*" (Robins and de Sylva, 1960). (amended spelling *Scheponopodus* Canestrini, 1872 : 112).

Pseudohistiophorus de Buen, 1950 : 171 (Genotype : *Tetrapturus illingworthi* Jordan and Evermann (= *T. angustirostris* Tanaka).

From the Atlantic, Robins and de Sylvia (1960) recognise three species of spearfishes under the genus *Tetrapturus*, namely *T. belone* Rafinesque, *T. albidus* Poey and *T. audax* Philippi. The last two species have been treated by several workers under the genus *Makaira* which Robins and de Sylva (1960) have restricted to include only the blue marlin, *Makaira* (*Makaira*) *nigricans* Lacépède and the black marlin, *Makaira* (*Istiompax*) *indicus* Cuvier. Among reasons given

are that species of *Tetrapturus* are small, generally much less than about 136 kg. while the two species of *Makaira* attain about 900 kg. If this course is adopted, the following additional synonyms of *Tetrapturus* (— after Robins and de Sylva, 1960) will have to be accepted :

Marlina Grey, 1928 : 47 [Genotype : *Tetrapturus mitsukurii* (= T. *audax* Philippi), type species by monotypy ; the use of *Marlina* at the Generic level is probably a slip].

Kajikia Hirasaka and Nakamura, 1947, 13–14 [Genotype : *Kajikia formosa* (= *Tetrapturus audax* Philippi), type species by monotypy].

Lamontella Smith, 1956: 32 [Genotype: *Tetrapturus albida* (*Sic*) Poey, type species by original designation and monotypy].

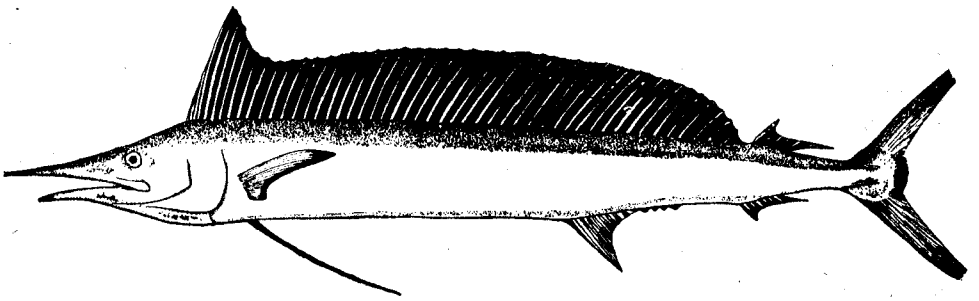
Thus reconstituted to embrace four species, the generic diagnosis of *Tetrapturus* as given by Robins and de Sylva (1960) is as follows :

" Anterior lobe of spinous dorsal fin higher than body depth at dorsal fin origin, the lobe portion of the fin rounded ; 12 precaudal and 12 caudal vertebrae ; flesh red (except in *audax*) ; size small, usually much less than 300 lbs."

La Monte (1955) had given importance to the relative length of the pectoral in separating the genera *Tetrapturus* and *Makaira*. Robins and de Sylva (1960) have shown that the pectoral fin shows marked allometry in the spearfish, and as the genus *Tetrapturus* as reconstituted by them includes *angustirostris* with the short pectoral, this character may not be considered as being of generic significance.

SHORTBILL SPEARFISH

Tetrapturus angustirostris Tanaka, 1914



Text Fig. 12. *Tetrapturus angustirostris* Tanaka (after Tanaka, 1935).

SYNONYMS :

Tetrapturus angustirostris Tanaka, 1914 : 324 (Type locality : Sagami Sea, Japan),
Nakamura (1938) 1955 : 24
Royce, 1957 : 520
Yabe *et al.*, 1958 : 32
Robins and de Sylva, 1960 : 405.

Tetrapturus illingworthi Jordan and Evermann, 1926 : 32 (Type locality : Coast of Hawaii)

Tetrapturus kruassi Jordan and Evermann, 1926 : 33 (Type locality : Hawaii)

Tetrapturus brevirostris Fowler, 1928 : 136 (in part) (*nec Histiophorus brevirostris* Playfair 1866 : 53, 145)
Day, 1878 : 199
Jordan and Evermann, 1926 : 33
de Beaufort, 1951 : 237

We agree with the synonymy and references given for *T. angustirostris* by Royce (1957) except that *Tetrapturus brevirostris* de Beaufort, 1951 : 238 (850 mm. specimen) in de Beaufort and Chapman (1951) should find a place elsewhere, the main reason being the low dorsal count (D, XXXIX).

There can be hardly any doubt that *T. illingworthi* and *T. kraussi* are synonyms of *T. angustirostris* as has rightly been shown by Royce (1957). Jordan and Evermann's (1926) dorsal counts of XLIV for *T. illingworthi* probably do not take into account the II or III shorter spines in front of the longest spine of the anterior lobe. So also their dorsal count for *T. kraussi* given as ' Dorsal XVII ' should be an error and is probably XLVII. Here again, we are not sure whether the anterior short spines have been taken into account.

The reason for the inclusion of this species in the present account is its record by Yabe *et al.*, (1958) from Eastern Indian Ocean from Lat. 25° 13'S., Long. 99° 83' E.

Meristic counts for the species based on previous works are given below :

D_1. XLVII-LIII + ; D_2 6 ; A_1. II, 12 ; A_2. 7 ; P_1. 18 ; P_2 1, 2 ; Vertebrae 24 (12 + 12).

For a descriptive account and morphometric measurements of the species reference is invited to Tanaka (1915 : 1935) ; Nakamura (1937 : 1955) ; and Royce (1957). However the salient characteristics of the species are : The moderately elevated dorsal fin which is high throughout, the posterior rays almost equalling the height of the anterior lobe ; the anterior dorsal lobe being higher than the depth of the body beneath it, the vent situated in front of the anal fin origin by a distance equal to or greater than anal fin height (about 9.6% body length) ; dorsal profile from tip of bill to dorsal fin origin more or less straight ; bill short, slightly exceeding length of lower jaw ; length of premandibular portion of bill contained three times or slightly more in preorbital distance and the pectoral fin which is short being markedly shorter than the pelvics.

As regards colour, Tanaka (1915) remarks that "……in life, back lead-black ; sides brownish, with fine whitish vermiculate maculations, and lower half silvery white ; two dorsals and ventrals blackish, without spots ; two anals whitish ; inner surface of pectoral blackish, but outer whitish ; caudal blackish proximally but whitish distally." Royce (1957) notes that " Immediately after death *T. angustirostris* is a brilliant, deep metallic blue on the back and first dorsal with silvery gray on the sides and white on the belly. In about an hour this rapidly fades to a dark, slate gray on the back and to black on the first dorsal. We have seen no evidence of stripes and, according to Nakamura (1949), it never has them."

DISTRIBUTION : Japan South of 35° N. latitude ; Formosa ; Philippines ; Eastern Indian Ocean (lone record from Lat. 25°13' S., Long. 99° 83' E). Eastwards, Baja California (Craig, 1958 : 275 — 280) and Chile (Robins and de Sylva 1960 : 404).

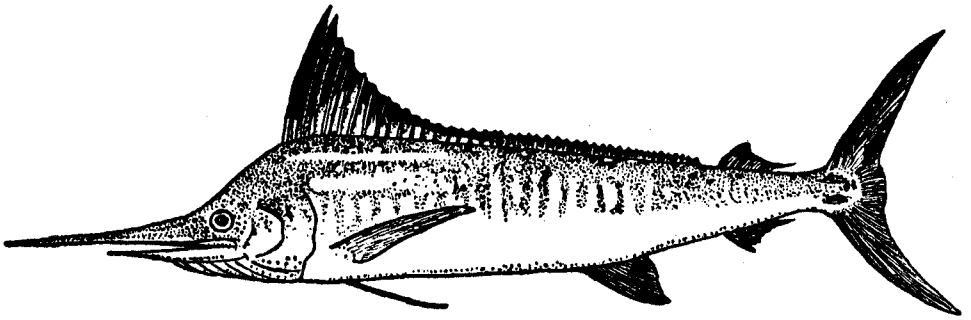
Size : On account of the small size, the species has been even suspected to be the young of marlins (LaMonte and Marcy, 1941). No doubt, it appears to be the smallest of known bill fishes as the maximum weight recorded for any specimen appears to be 114 lbs. (52 kg.) for a specimen from Central Pacific (Royce, 1957). The same author also mentions the modal weight for 177 specimens as approximately 38 lbs. (17 kg.). Nakumura (1937) has described a ripe female measuring 152 cm. weighing 27 lbs. (12 kg.) and also figured the ripe ovaries, eggs and tests of the species.

REMARKS : There still lurks the probability that the question of the correct nomenclature for the Pacific shortbill spearfish discussed here as *T. angustirostris* has not yet been

finally settled. Robins and de Sylva (1960) report of having examined a photograph of a " spearfish " caught in the Mediterranean near Split, Yugoslavia showing both the bill and pectoral fin short, diagnostic features of *T. angustirostris*. " If unbroken, the bill is about 14 per cent of body length. The pectoral fin is partly erect but appears to be 12 or 13 per cent of body length. Superficially this fish resembles *angustirostris*. The possibility is raised of *T. belone* being a distinct Mediterranean species or senior synonymy of *angustirostris*." Either course will necessitate the proposal of a new name for the Western Atlantic form at present designated as *T. belone*. In the absence of actual material and the possibility of the photograph of the fish from Split turning out to be that of a young blue marlin, they have rightly refrained from coming to any unwarranted conclusions. This only draws attention to yet one more unsettled problem in billfish taxonomy.

STRIPED MARLIN

Tetrapturus audax, Philippi, 1887



Text Fig. 13. *Tetrapturus audax* Philippi, the striped marlin (after Nakamura, 1938).

SYNONYMS :

Tetrapturus audax Philippi, 1887 : 35, pl. 8, figs. 2–3 (Type locality : Iquique, Coast of Chile)

Robins and de Sylva, 1960 : 406

Histiophorus audax Delfin, 1901

Tetrapturus mitsukurii Jordan and Snyder, 1901 : 303 (Type locality : Misaki, Sagami, Japan)

Tetrapturus ectenes Jordan and Evermann, 1926 : 34 (Type locality : About Hawaiian Islands)

Makaira grammatica Jordan and Evermann, 1926 : 55 (Type locality : Hawaii)

Makaira holei Jordan and Evermann, 1926 : 63 (Type locality : Pacific Coast of Mexico, and Lower California, U.S.A.)

Makaira mitsukurii Jordan and Evermann, 1926 : 61

Nakamura, 1938 : 27 ; 1951 : 36

Deraniyagala, 1940 : 69 ; 1951 : 140 ; 1952 : 107

Rosa, 1950 : 132–34

Mendes, 1954 : 147

Morrow, 1954 : 819 ; 1957 : 72–87 ; 1957 : 89

Munro, 1955 : 223

LaMonte, 1958 : 396
Ueyanagi, 1959 : 130–145

Makaira zealandica Jordan and Evermann, 1956 : 65 (Type locality : Bay of Islands near Russell, New Zealand)

Marlina mitsukurii Grey, 1928 : 47

Istiophorus ludibundus Whitley, 1933 : 83 (Type locality : New South Wales, Australia)

Istiophorus audax Fowler, 1944 : 499

Kajikia formosana Hirasaka and Nakamura, 1947 : 13 (Type locality : Formosa)
Nakamura, 1949 : 61
Ueyangai, 1957 : 107–112

Kajikia mitsujukrii Hirasaka and Nakamura, 1947 : 14
Nakamura, 1949 : 60
Nakamura, Yabuta and Ueyanagi, 1953 : 1–8
Ueyanagi, 1953 : 1–5, 1954*a* : 1954*b*

Makaira mitsukurii (in part) Herre, 1953 : 255

Marlina audax Smith, 1956*a* : 30

Makaira audax Smith, 1956*b* : 758
Royce, 1957 : 528–532
Munro, 1958 : 19
Williams, 1959 : 762

While several authors have treated the striped marlin under the genus *Makaira*, for reasons already mentioned, we follow Robins and de Sylva (1960) in relegating it under the genus *Tetrapturus* to which genus also belong the species *T. angustirostris*, *T. belone*, and *T. albida*.

That the specific name *T. audax* Philippi has priority over *T. mitsukurii* Jordan and Evermann, has been well established (Smith, 1956, Royce 1957). In young *T. audax* the middle rays of the dorsal fin are relatively high when compared to the blue and black marlin and it is this character that led to the descriptions of new species, namely *Tetrapturus ectenes* Jordan and Evermann, *Makaira grammatica* Jordan and Evermann and *Kijikia formosana* Hirasaka and Nakamura, all of which are synonyms of *T. audax*.

Jordan and Evermann (1926) described *M. holei* and *M. zelandica* as being closely allied to *M. mitsukurii* (*T. audax*). The descriptions and photographs of the types (from mounted specimens) indicate differences from *T. audax* mainly in body colouration. In other features, such as : the anterior lobe of the dorsal being high and equal to or greater than the depth of the body ; the mandible being more than 50% of the length of spear ; the height of the first anal being distinctly shorter than that of the anterior lobe of the dorsal, etc. it may be seen that specific distinction from *T. audax* is not possible. It is well-known that body colouration in species of marlins differs with age and depending on the duration after capture. Colouration depicted on mounted specimens may not be quite accurate and as such much reliance cannot be placed on this character in the present instance.

We have not seen the original description of *Istiophorus ludibundus* Whitley, but follow Royce (1957) in placing this as a doubtful synonymy of *T. audax*.

Careful analysis of records as mentioned by Robins and de Sylva (1960) and others indicates that the striped marlin is definitely a smaller species as compared to the blue and black marlins, not attaining more than about 350 lbs. Records of weight over this attributed to the striped marlin have been shown to be erroneous and in fact refer to the blue marlin

M. nigricans which also when fresh shows faint vertical light bands on the body causing it to be confused with *T. audax*. Munro's (1958) mention of " 14 feet or 976 lb." for this species should probably refer to *M. nigricans*.

Further Munro (1958) remarks that " An example from N.T. (Northern Territory of Australia) reported to be the short-nosed spearfish, *Tetrapturus angustirostris* is presumably the young of this species (figure 763A)." Munro is right in drawing attention to the malidentification of this fish as *T. angustirostris*, but from the figure given by him (after Whitley) it cannot be said with certainty that it represents the young of *T. audax*. For one reason, the height of the anterior lobe of the dorsal is hardly two-thirds the depth of the body. As would be seen from the work of Ueyanagi (1957) on the young of *Kajikia formosana* (= *T. audax*) the high anterior lobe of the dorsal is very characteristic of also juveniles of *T. audax*. Another difference appears to be the very short pelvic fin which appears to be hardly one-third the length of pectoral in the Western Australian specimen. In adult striped marlin the pelvics about equals the length of the pectoral, while in juveniles it is still longer, but this may not be an important character.

Silas and Rajagopalan (1962) report on two specimens of the striped marlin landed at Tuticorin, Gulf of Mannar, during 1961. The species is known to occur in Ceylon waters (Deraniyagala, 1962) and recent definite records of its occurrence from East and South African Waters are made by Smith (1956*a*) ; and Williams (1959).

Royce (1957) mentions that occasionally the high median dorsal rays are retained in medium sized adult striped marlin off California and off Mexico.

Nakamura, Yabuta and Ueyanagi (1953) have given the relation of spawning season and the sex-ratio in *Kajikia mitsukurii* (= *T. audax*). According to them the ratio of the male rapidly increases and decreases at the beginning and end of the spawning season, respectively. Sexual segregation after spawning is suggested. Ueyanagi (1953) has shown that as in other marlins and the swordfish (*Xiphias gladius*) the males are smaller in *Kajikia mitsukurii* (= *T. audax*) but the difference is not so pronounced.

Morrow (1957) found that in certain morphometric and meristic characters the striped marlin (*M. mitsukurii*) from Peru and Northern New Zealand waters represents separate populations. His study also shows that the pelvic fin in the blue marlin stops growth after reaching a certain length and its length is therefore not related to the length of the adult fish.

Kamimura and Honma (1958) and Honma and Kamimura (1958) have also indicated the independence of populations of striped marlins both of the North and South Pacific for they remark that " the striped marlin of North and South Pacific constitute the extremely separated populations with each other, and furthermore it is suggested that they may belong to different species." The main criteria for the distinctions are that in the equatorial region the hooked rate is very low ; the spawning grounds are located far apart and the spawning seasons in both areas differ by about 6 months [according to Ueyanagi (1959), peak spawning period in the N. Pacific is from May to August in areas approximately between 20° — 30° N. lat. and in South Pacific from October to January in areas around 20° S. lat.] ; and size groups and growth patterns also differ.

Japanese longlining records indicate that in the Indian Ocean the striped marlin is taken over a wide area between 10° N. lat. and 10° S. lat. and South West of the Sunda Archipelago still further southwards. Good fishing is reported from the Andaman Sea ; South West of

Java and Sumatra and south of Ceylon. However the information is scanty when compared to the available data on species of tunas.

Ueyanagi (1959) has recorded larvae of the striped marlin from the Eastern Indian Ocean but spawning seasons are little known although it is suggestive that atleast in the Banda–Flores Seas and adjacent seas of Timor Island, spawning occurs during January-February.

Morrow (1952*b*) ; Hubbs and Wisner (1953), Yabuta (1953) and Royce (1957) have given details of the food of the striped marlin and all mention fish as constituting the most predominant item while cephalpods (squids) and shrimp are of very minor importance.

DISTRIBUTION : Tropical and temperate waters of the Indo-Pacific.

Tetrapturus sp.

We tentatively refer to this a problematic species we have encountered from Indian Waters. Three specimens have been examined from Tuticorin Coast, Gulf of Mannar, and details of anatomical features have been discussed elsewhere (Silas and Rajagopalan, 1962). The external characteristics are :

1. *Size* : Small, largest specimen measuring 1231 mm., weighing 31 lbs. (14 kg.). Body much compressed from side to side as in *Istiophorus gladius.*

2. *Dorsal fins* : Dorsal fin uniformly high without a distinct anterior lobe. Both anterior as well as mid-rays distinctly higher than greatest depth of body. Total count for the dorsal in the specimens is 41 + 7. Both dorsals are dusky except the interspinous membrane between the last three or four spines which is conspicuously whitish. About 3 or 4 dark circular blotches are present on the first dorsal, the blotches resembling those seen in the sailfish *I. gladius.*

Pectorals : With 21 rays each ; markedly short, tip not surpassing vertical below 18th dorsal spine ; and length about 0.75 anterior height of dorsal ; shape slightly falcate ; colour light greyish with upper margin dusky. The fins lie flat against the sides of the body and are not rigid as in *M. indica.*

Pelvics : With I, 1 ray each ; elongate, two times or more length of pectoral and black in colour.

Anal : 13 + 6 ; height of anterior anal about same as length of pectoral. Origin of second anal vertically below that of second dorsal or slightly behind ; distal part of the anterior few rays of the first anal is dusky, but the margin and rest of the fin and second anal are hyaline.

Caudal : is deeply forked with both lobes equal. Colour dusky.

Head : Spear is slender with teeth on either margin and below ; mandible moderately long and about 1.5 to 1.6 in spear length ; eyes large, diameter about 7.5 in headlength from tip of mandible and about 2.75 in post-orbital length of head. Predorsal profile of head very gently sloping.

Vent : is situated at the posterior end of the mid-ventral groove. The distance between the vent and first anal origin is about 1/3 head length (from tip of mandible).

The height of the body is from 7.0 to 7.5 in the length from the tip of the mandible.

Scales : Lanceolate and appear ' deciduous ' as in preserved specimens they are easily shed. The lateral line is well defined and runs straight for some distance from above upper

angle of opercle before curving downwards above the posterior third of the pectoral and then straightening and running along mid-laterally to the caudal peduncle.

The air-bladder is in the form of many chambers arranged in a single layer. Besides these characteristics Silas and Rajagopalan (1962) have drawn attention to some pecularities in the disposition of the visceral organs in this form as compared to other known billfishes from this region.

While we fully recognise that the specimens we have encountered are young ones, the specimens differ from other marlins as follows :

From the black marlin *M. indica* it differs in (1) the flexible pectoral base ; (2) the uniformly high first dorsal ; (3) the short pectoral ; (4) the elongate pelvics ; (5) the slender bill ; (6) the chambers of the air-bladder arranged in a single layer.

From the blue marlin *M. nigricans* it differs in (1) the uniformly high first dorsal ; (2) the markedly short pectorals ; (3) the elongate pelvics ; (4) the laterally compressed body ; (5) the body colour when fresh devoid of faint transverse bands ; (6) the mandible which is more than 50% of the bill length, (7) significantly in the simple unbranched lateral line ; (8) the anterior insertion of the second dorsal being vertically above or slightly ahead of that of the second anal and (9) the anterior insertion of the anal being nearer to the base of the caudal than to posterior end of operculum.

From *T. audax* it differs in (1) the uniformly high first dorsal ; (2) the markedly short pectorals ; (3) the body colour when fresh devoid of vertical stripes ; (4) the relatively elongate pelvics ; (5) the more slender body the depth of which is about seven times or more in fork length from tip of mandible.

From *T. angustirostris* it differs in (1) the bill being distinctly longer than the mandible ; (2) the first dorsal count being much lower (49 versus 53) ; and (3) the anterior insertion of the second dorsal being slightly behind that of the second anal.

It is likely that some of the above noted differences may reflect juvenile characteristics. However, until more material becomes available, we consider it best to denote this as *Tetrapturus* sp.

TWO SPECIES OF DOUBTFUL VALIDITY

1. **Marlina jauffreti** Smith, 1956

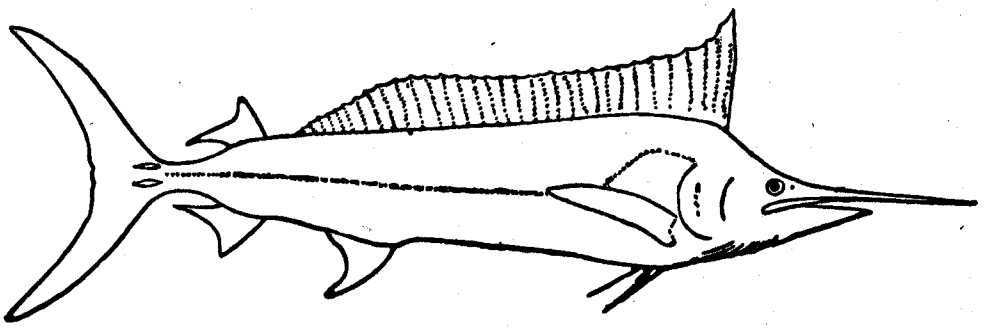
Smith's description of this species is cited below :

" A 168 lb. fish (Fig. H, plate 1), taken at Mauritius in February, 1956, has the general appearance of a Striped Marlin. The photograph is not clear in all essential details, but as far as it is possible to judge, the origin of the anal fin is barely nearer caudal base than head, the second dorsal and anal are relatively remote from caudal base while the lower jaw appears as shorter and the spear stouter than in a typical *audax* ; they are in fact indicative of the " Blue " Marlin. In favour of its identity as *audax* are the stripes, the second anal is clearly in advance of the second dorsal, the pelvics are fairly short, the dorsal fin is almost as deep as the body, and distinctly but not much longer than the distance between the origins of the second dorsal and upper caudal lobe. This fish may have softened in the heat, so that the body below the dorsal is probably bulged out, and the caudal peduncle unduly elongated. The discrepancies from the typical *audax* are hightened by the contrasted white hind border of the dorsal which

the captor notes was distinct. There are also unusual white patches on the body. An examination of the actual specimen would doubtless clear up all doubts, but meanwhile I propose to name this *Marlina jauffreti* n.sp. (after its captor, M. M. Jauffret of Mauritius who states that *audax* is well-known there, and that this fish is different, another specimen having been caught there)."

On this Williams (1959) remarks that "I must point out that *Marlina jauffreti* Smith 1956, from Mauritius, was named purely on the details of a marlin visible in a not very clear photograph and a few notes received by Smith. Although a new species of marlin may be present in Mauritius waters, the establishing of a new species of fish on the basis of a photograph and without access to the fish itself at a later date (it appears to have been destroyed) is likely to introduce confusion to the system of nomenclature and is to be depreciated, especially in such a closely related group as the marlins." We are in full agreement with this view. Further it is felt that although superficial resemblance to *T. audax* is noticeable in some of the characters mentioned by Smith, the following characters, namely, (1) the mandible short, being hardly 50% of the spear-length ; (2) the anterior insertion of the second dorsal and anal are relatively remote from the caudal fork ; and (3) the height of the anterior lobe of the dorsal fin is distinctly shorter than the greatest depth of body, indicate the affinities of *M. jauffreti* to the blue marlin *Makaira nigricans*. It will not be surprising if they turn out to be conspecific.

2. **Tetrapturus tenuirostratus** Deraniyagala, 1951



Text Fig. 14. *Tetrapturus tenuirostratus* Deraniyagala (after Deraniyagala, 1952 : figure erroneously labelled by him as *T. acutirostratus*).

SYNONYMS :

(?) *Histiophorus brevirostris* (*nec* Playfair) Day, 1878

Makaira indicus (in part) Deraniyagala, 1933 : pl. 3, fig. 1 (young)

Tetrapturus brevirostris (Playfair) Deraniyagala, 1949 : pl. 23, fig. b

Tetrapturus tenuirostratus Deraniyagala, 1951 : 139, pl. 1, fig. b.; pl. 2, fig. b. (Type locality : Indian Ocean. Type a mounted specimen in the British Museum of Natural History)

(?) *Tetrapturus brevirostris* (in part) de Beaufort, 1951 : 238

Tetrapturus acutirostratus Deraniyagala, 1952 : pl. 27 (apparently plate figure is wrongly labelled as *acutirostratus* for *tenuirostratus*)

Tetrapturus tenuirostratus Deraniyagala, 1952 : 105

Makaira mitsukurii La Monte, 1955

Tetrapturus brevirostris (in part) Munro, 1955 : 223

This is certainly a doubtful species and would need closer study based on more material. Part of the confusion has been created by Deraniyagala himself by not (1) indicating the size of the type specimen, (2) by without proper clarification reproducing the same figure of a fish at different times under different magnifications (although reproductions are of same size) thus throwing confusion and doubt on the size of the specimen. The figure (*b*) on plate 23 (Deraniyagala, 1949) is undoubtedly the same as fig. 1 on plate 3 (Deraniyagala, 1933) and the reduced figures measure 15.2 cm. (fork to tip of spear while the reduction indicated are 1/15 and 1/8 respectively), (3) incidentally the coloured figure on plate 27 wrongly labelled as *acutorostratus* bears strong resemblance to the two figures mentioned above and the figure which is 23 cm. (fork to tip of spear) is said to be 1/14 natural size.

In view of these discrepancies it is not surprising that it has not been possible to precisely determine the identity of this problematic species.

La Monte (1955) reported the occurrence of the striped marlin *Makaira mitsukurii* (= *T. audax*) on the basis of *T. tenuirostratus* which she considered as the young of the former. The differences we could point out are : the anterior lobe of the dorsal being shorter than the depth of body ; the height of the first anal being slightly more than 0.75 height of anterior lobe of dorsal ; the pelvics being much shorter than the pectoral ; the absence of distinct vertical stripes on the body ; and the median first dorsal rays being more than half height of the anterior lobe of the dorsal. Deraniyagala (1952) gives the size as " Total length 2,640 mm. " and if the aforesaid are characteristic of this size specimen, there can be no doubt that *T. tenuirostratus* is distinct from *T. audax*. However, we have noted an element of doubt as regards the sizes and hence the problem remains unsettled.

Neither do certain statements made by Smith (1956*b*) help in clarifying the matter. He has suggested several alternatives to solve the confusion in marlin taxonomy. One is that the black and blue marlins belong to one species *Istiompax indica* (*I. i. indica* the black marlin and *I. i. ampla* the Atlantic blue marlin) in which case Indo-Pacific blue marlin may be the same as the Atlantic blue marlin or " more likely either *Istiompax indica tenuirostratus* (Deraniyagala), or *I. indica howardi* (Whitley), or if neither of these be accepted, *I. indica glauca* nov., the type of the latter a photograph of a specimen 1226 lbs. in weight, from Eden, N.S. Wales, Australia, shown on plate 70 in Roughly 1951." The last said photograph we see is clearly that of the blue marlin *Makaira nigricans*.

Another alternative given by Smith (1956) is that " The ' Black ' and the ' Blue ' are not proved to be distinct species : *nigricans* Lacepede becomes valid and the indeterminable young becomes *Makaira nigricans* Lacépède, the black *M. nigricans herscheli* (Gray) ; the blue of the Atlantic *M. n. ampla* (Poey), and the blue of the Indo-Pacific, (if it be different), *M. n. tenuirostrata* (Deraniyagala) or *M. n. howardi* (Whitley) or possibly *M. n. glauca* nov., as in B. 2 (should be A. 2) above....."

The proposal of yet another new name *glaucus* does not help in clarifying the position of *T. tenuirostratus* which until restudied based on fresh material may have to be considered a species of doubtful validity.

Genus **Makaira** Lacépède, 1803

Makaira Lacépède, 1803. Hist. Nat. Poiss., 4 : 688 (Type : *Makaira nigricans* Lacépède, Based on notes and a sketch of a specimen washed ashore on the Ila du Ra' sent to Lacépède by MM. Traversay, Fleurian — Bellevue, and Lamathe). The spelling of

the generic name was amended to *Machaera* by Cuvier and to *Macaria* by Nardo (1833).

Istiompax Whitley, 1931. *Rec. Austral. Mus.*, 18 (Type : *I. australis* Whitley).

Marlina Hirasaka and Nakamura, 1947. *Bull. Oceanogr. Inst. Taiwan* 3 : 15 (Type : *Makaira marlina* Jordan and Hill) (*nec Marlina* Grey 1928 — a synonym of *Tetrapturus* Rafinesque, 1810).

Eumakaira Hirasaka and Nakamura, 1947. *Bull. Oceanogr. Inst. Taiwan*, 3 : 16 (Type : *E. nigra* Hirasaka and Nakamura).

Probably *Zanclurus* Swainson, (1939 : *Hist. Nat. Fish.*, 2 : 239 : Type : *Z. indicus*) is also a synonym of *Makaira* as restricted here.

Jordan and Evermann (1926) recognised 16 species under the genus *Makaira* of which four were described as new and several ".....very imperfectly described and await better definition." Although a generic description was not given, the key characters used by them for separating *Makaira* from *Tetrapturus* and *Istiophorus* were : " Dorsal fin low, the lobe high, its anterior spines thickened, and others progressively shortened to the last ; ventrals much shorter than pectorals."

Nakamura (1949) divided the family Istiophoridae into two subfamilies, Tetrapturinae and Marlinae, the former to include the genera *Tetrapturus, Istiophorus* and *Kajikia*, and the latter *Marlina* and *Eumakaira*. The general grouping of the genera appears natural enough as later workers (Robins and de Sylva, 1960) have shown, but the need for the two subfamily divisions has been questioned and at the same time current nomenclature used for some of the genera is different.

Robins and de Sylva (1960) have followed in the main Nakamura (1938, 1949) in recognising two species, the blue marlin *M.* (*M.*) *nigricans* (denoted as *Eumakaira nigra* Nakamura and treated in Japanese literature as the " Black Marlin " and popularly known in Japanese as *Kurokajiki* or *Kurokawa*), and the black marlin *Makaira* (*Istiompax*) *indica* [denoted as *Marlina marlina* (Jordan and Hill) and treated in Japanese literature as the " White marlin " and popularly known in Japanese as *Shirokajiki*] under the genus *Makaira*, which thus corresponds with the subfamily Marlinae. Hence the key characters used by Nakamura (1949) for Marlinae to distinguish it from Tetrapturinae would partly cover the generic diagnosis of *Makaira* on the one hand and *Tetrapturus* and *Istiophorus* on the other as given below :

(1) " Vertebrae are 12 + 12 = 24. The body is slender with the height of the first dorsal exceeding the depth of the body. The anterior portion of the first dorsal has a concave outline. The lateral line is single and clearly discernible. The ventral fins are generally well developed.....Subfamily Tetrapturinae.

(2) Vertebral formula 11 + 13 = 24. Body stout, height of first dorsal less than body depth ; height of the fin decreases sharply posterior to the 4th or 5th ray. Lateral line obscure, may be single or complex. Ventral fins generally short..... Subfamily Marlinae."

The genus *Makaira* as recognised here has as generic diagnosis the characters given by Nakamura for the subfamily Marlinae in addition to the other characters drawn attention to by Robins and de Sylva (1960), namely, (1) compared to other Istiophoridae, species of *Makaira* attain a very large size of about 2,000 lbs. (907 kg.) (while species of *Istiophorus* and *Tetrapturus* do not attain more than about 300 lbs. (136 kg.) ; (2) the bill of *Makaira* (" Makairinae ") shows positive allometry (*versus* negative allometry in " Tetrapturinae ").

As only two species of the genus are known the question of subgeneric subdivisions into *Makaira* s. str., and *Istiompax* appears superfluous.

DISTRIBUTION : Warmer waters of the Indo-Pacific and Atlantic.

BLACK MARLIN

Makaira indica (Cuvier), 1831

(Plate VIII, Fig. D)

SYNONYMS :

Tetrapturus indicus Cuvier, 1831 : 286 (Type locality : Sumatra—based on a drawing by Sir Joseph Banks)

Histiophorus brevirostris Playfair, 1866 : 53 (Type locality : Zanzibar)

Makaira marlina Jordan and Hill, *in* Jordan and Evermann, 1926 : 59 (Type locality : Pacific coast of Mexico from Cape San Lucas southward)

Istiompax australis Whitley, 1931 : 8 (Type locality : Australia)

Tetrapturus mitsukurii Tanaka, 1933 : 163 (*nec* Jordan and Snyder)

Makaira australis Fowler, 1934 : 400, 402

Makaira indicus (in part) Deraniyagala, 1933 : 55

Makaira nigricans tahitiensis Nichols and LaMonte, 1934*a* : 1 (Type locality : Tahiti)
Rosa, 1950 : 144

Makaira nigricans marlina Nichols and LaMonte, 1935*b* : 328
Rosa, 1950 : 143
Morrow, 1954 : 819
Williams, 1959 : 763

Makaira ampla marlina Nichols and LaMonte, 1941 : 8

Makaira ampla tahitiensis Nichols and LaMonte, 1941 : 8

Marlina marlina Hirasaka and Nakamura, 1947 : 15
Nakamura, 1949 : 63
Ueyanagi and Yabe, 1959 : 162 ; 1960 : 167–173
Ueyanagi, 1960 : 85

Makaira herscheli Smith, 1949 : 315, fig. 875 (*nec* Gray, 1835)

Makaira indica Fowler, 1949 : 74
Deraniyagala, 1952 : 107
Munro, 1955 : 223
Silas and Rajagopalan, 1962

Makaira indica (in part) Rosa, 1950 : 140
Mendes, 1954 : 147

Istiompax dombraini Whitley, 1954 : 60 (Type locality : Australia) 1955 : 295

Makaira mazara (in part) LaMonte, 1955 : 336

Makaira mazara tahitiensis (in part) LaMonte, 1955 : 342

Makaira herschelii Smith, 1956 : 27 (*nec* Grey, 1835)

Istiompax marlina Royce, 1957 : 524
Munro, 1958 : 19
Makaira marlina marlina Morrow, 1957 : 89
Makaira marlina tahitiensis Morrow, 1957 : 89
Istiompax brevirostris Morrow, 1958 : 358
Istiompax indicus Morrow, 1959 : 321
Black Marlin : Williams, 1959 : 78
Makaira (*Istiompax*) *indica* Robins and de Sylva, 1960 : 406

The black marlin *Makaira indica* is a very distinct species that can be easily recognised by the Key characters given on p. 6, as well as the combination of characters detailed below : the bill is shorter and stouter than in other marlins or spearfishes and in larger examples the lower jaw from tip to angle of mouth is half length of bill ; the body is markedly deep above the pectoral and humped resulting in the dorsal profile of the head showing a steep ascent to origin of dorsal fin ; in larger specimens the height of the anterior lobe of the dorsal fin hardly equals the distance between its origin and that of pectoral ; origin of the first anal fin is situated almost midway between the head (end of opercle) and the base of the caudal ; the lateral line is simple ; and the air bladder is foam-like with several layers of small chambers, all enclosed within a thick membrane.

Nakamura (1938) has given the meristic counts for this species as : D. III, 10–12, XXIII–XXV, 7 ; A. II, 10–11, 7 ; V–I, 2 ; Vertebrae 24 (11 + 13).

Rivas (1956) mentions that in *Makaira marlina* the dorsal spines number from 33 to 41 but are usually 37 to 40 and anal spines 10 to 14, usually 12 or 13.

Two specimens examined by Silas and Rajagopalan (1962) at Tuticorin had 36 and 37 dorsal spines. The same authors have drawn attention to certain anatomical features of the black marlin in relation to other Indian istiophorids in addition to giving morphometric data for Indian bill fishes to which reference may be made.

The chaotic state in which bill fish nomenclature has been till now will be evident from the numerous combination of names used by earlier workers to denote the black marlin. Part of the confusion has stemmed from the use of popular names in English to denote this species. Japanese workers have used the term ' white marlin ' (in Japanese *Shirokajiki*) on account of the whitish body colour when fresh which incidentally also figured as the prime factor in the description of the ' Silver marlin ' *Makaira nigricans tahitiensis* Nichols and LaMonte, 1935. At present, the term ' White Marlin ' is used to denote *Tetrapturus albidus* Poey from the Atlantic. The terms Pacific black marlin, giant black marlin and black marlin have been used by American workers to denote the present species. At the same time, what is currently known as the blue marlin — *Makaira nigricans* Lacépède from the Atlantic and the Indo-Pacific has been denoted by some workers as the black marlin.

It should be admitted that *M. indica* and *M. nigricans* are more closely allied than they are to other istiophorids. However, Hirasaka and Nakamura (1947) drew attention to some principal differences between the species *Makaira marlina* (= *M. indica*) and the blue marlin and striped marlin *M. ampla* (= *M. nigricans*) and *M. audax* (= *Tetrapturus audax*) respectively. The main characters involved are, the considerably broader shoulder gridle in *marlina* and its articulation with the pectoral fin restricting its movement and making it ' rigid ' ; the fusion

of both the halves of the pelvic girdle ; and the air bladder consisting of several layers of small chambers (*versus* flexible pectoral ; both halves of pelvic girdle separated by broad space and air bladder chambers in single layer).

These differences led them to propose the genus *Marlina* which unfortunately is preoccupied. According to Royce (1957) the differences noted by Hirasaka and Nakamura " Warrant retention of *marlina* in a separate genus ; however, the generic name *Marlina* cannot be applied to this genus. In the first place, its use is prevented by Zane Grey's introduction of the name *Marlina mitsukurii* in 1928. Since he used the name solely in this combination and prior to 1928 when such a proposal was permitted, *mitsukurii* is the haplotype of *Marlina* Grey. In the second place, Whitley (1931 : 18) proposed the genus *Istiompax* for *I. australis*, a new species, recognised as a synonym of *Makaira marlina* Jordan and Hill. Therefore, the generic name *Istiompax* has precedence over *Marlina* Hirasaka and Nakamura (*non* Grey)."

Robins and de Sylva (1960) recognised *Istiompax* Whitley as a subgenus of *Makaira* with a single species *M. (I.) indicus* (black marlin) and one other species for the genus, *M. (Makaira) nigricans* (blue marlin). Some authors including Smith (1956) have considered the above two as conspecific. However Morrow's studies on the pectoral girdle of these fishes (marlins) clearly indicate that for reasons given by Hirasaka and Nakamura (1947) and additional points (See Morrow, 1957) they certainly merit specific distinction. Since only two species are involved, we consider it best to treat these under the genus *Makaira* as *M. indica* and *M. nigricans* instead of :

(1) relegating each species to a different genus (*Istiompax* and *Makaira*) respectively, or

(2) relegating each species to a different subgenus under one genus *Makaira* as *M. (Istiompax) indica* and *M. (M.) nigricans.*

Ueyanagi and Yabe (1959, 1960) were the first to draw attention to larvae possibly referable to *M. indica.* Later, Ueyanagi (1960) gave a more detailed account of the larvae and spawning areas of *Marlina marlina* and also indicated the fishing grounds for the species in the Western Paciffic and Indian Ocean. Of four additional larvae of the black marlin examined by Ueyanagi (1960), one was obtained from the southern waters off Ceylon and another from south of Sunda Islands, indicating likely spawning grounds. The rigid pectoral of the adult appears to be characteristic of also early larvae by which it could be easily separated from larvae of other istiophorids.

No detailed study is available on the food, maturity etc., of the black marlin from the Indian Ocean. Records from various parts of the Pacific indicate that the species may attain over 1500 lbs. (681 Kg.) and available data show that males are smaller, generally not attaining more than 320 lbs. (Royce, 1957). In the Pacific, Royce (1957) mentions of an instance where a 157 lb. (71 Kg.) 154 cm. yellowfin tuna was found in the stomach of a black marlin 402 cm. long. Other instances of tunas forming food are also mentioned.

Information on fishing condition for the black marlin in the Indian Ocean may be had from the ' Average year's fishing condition of tuna long-line fisheries 1958 edition ' edited by Nankai Regional Fisheries Research Laboratory (1959) ; for other areas reference may be made to Nakamura (1949) (Western Pacific, Indian Ocean) ; and Royce (1957) (Central Pacific).

DISTRIBUTION : The known distribution of *M. indica* closely follows the pattern of *M. nigricans* in the Indo-Pacific ranging through most of the temperate and tropical parts of these oceans. In Indian coastal waters specimens have been taken off Bombay and in the Gulf of Mannar.

BLUE MARLIN

Makaira nigricans Lacépède, 1803

(Plate VIII, Fig. B)

SYNONYMS :

Xiphias ensis Lacépède, 1802: 296 (Based on spear only found on west coast of France)?
Makaira nigricans Lacèpède, 1803 : 688–91, pl. 13, fig. 3 (Type locality : La Rochelle, France)
Morrow, 1959 : 1–11
Xiphias makaira Shaw, 1805 : 104 (after Lacépède's *Makaira nigricans*)
? *Histiophorus gracilirostris* Cuvier, 1831 : 308 (Based on spear only from La Rochelle, West Coast of France)
Makaira velifera Cuvier, 1832 : 43 (after Lacèpéde, 1803)
Tetrapturus hersehelii Gray, 1838 : 313 (Type locality : Cape of Good Hope, South Africa)
Tetrapturus amplus Poey, 1860 : 237, 243–44, 1861 : pl. 15, Fig. 2 (Type locality : Coast of Cuba)
Tetrapturus mazara Jordan and Snyder, 1901 : 305 (Type locality : Misaki, Japan)
Istiophorus nigricans Ribeiro Miranda, 1915
Makaira herseheli Thompson, 1918 : 118 Barnard, 1927 : 808
Makaira mazara Jordan and Evermann, 1926 : 53
Morrow, 1959 : 322–23
? *Makaira ensis* Jordan and Evermann, 1926 : 57
? *Makaira gracilirostris* Jordan and Evermann, 1926 : 58.
Makaira nigricans ampla Conrad and LaMonte, 1937 : 207
La Monte, 1937 : 207
Makaira ampla ampla LaMonte and Marcy, 1941 : 2
Morrow, 1957 : 90
Makaira ampla mazara LaMonte and Marcy, 1941 : 2
Morrow, 1957 : 44 ; 1957 : 89
Eumakaira nigra Hirasaka and Nakamura, 1947 : 16 (Type locality : Formosa)
Nakamura, 1949 : 65
Nakamura, Yabuta and Ueyanagi, 1953 : Yabuta, 1954
Ueyanagi, 1957 : 91–102 ; 1957 : 103–106
Ueyanagi and Yabe, 1959 : 151–69
Makaira perezi de Buen, 1950 : 171–75
Makaira nigricans mazara Rosa, 1950 : 141
Makaira mitsukurii (in part) Herre, 1953 : 255
Istiompax howardi Whitley, 1954 : 58
Makaira ampla LaMonte, 1955 : 334
Rivas, 1956 : 59–73
Royce, 1957 : 535–38
de Sylva, 1958 : 412–15
Munro, 1958 : 19
Makaira mazara (in part) LaMonte, 1955 : 336
Makaira herscheli Fourmanoir, 1957 : 220–21
Makaira herschelii Morrow, 1958 : 356
Makaira indica (in part) Scott, 1959 : 117

Xiphias ensis Lacépède and *Histiophorus gracilirostris* Cuvier, are given as doubtful senior and junior synonyms of *Makaira nigricans*. Of these, Jordan and Evermann (1926) remark that " The nominal species *Makaira ensis* known by the spear only, which is very long, and *Makaira gracilirostris* from the same region and with the spear even more slender, cannot be inserted in the Key (Their " Analysis of the species of Makaira ") for lack of other information. The two are probably identical, and *M. ensis* is very likely valid. *M. nigricans* is, very doubtfully, figured with a much stouter spear. The name *ensis* has priority over *nigricans*. Morrow in his several works on the blue marlin does not comment on Lacépède's *X. ensis* but shows that *nigricans* is the name for the blue marlin. Jordan and Evermann (1926) published a photograph of the skull of the type specimen of *M. ensis* in which the length of the spear is about 15 times its width at the base. Of *Makaira gracilirostris* (Cuvier) they remarked that : " This species is based on the spear of a spearfish or sailfish said to have been 25 to 30 feet long, the length of the spear 25 to 26 times its width at base, its sides more rounded than usual ; lower jaw 2/5 length of upper. It is from La Rochella and is probably identical with *Makaira ensis*, though the spear is still longer ; *Makaira nigricans* from the same locality has the spear much shorter. A spear from the Seychelles, said to be similar to *gracilirostris* is mentioned by Cuvier and Valenciennes but the original type specimen came from France, if we read the description correctly. Lütken regards *gracilirostris* as probably a distinct species, but it is not likely that it is really different from *ensis* also recorded from La Rochelle, although its spear may be longer." It is our opinion that these species names based only on the spears should under no circumstance be resurrected.

Morrow (1959) has shown that *T. herschelii* Gray, *T. amplus* Poey, and *M. perezi* de Buen are synonyms of *M. nigricans* Lacépède. To this list may be added *Eumakaira nigra* Hirasaka and Nakamura and as Rivas (1956) has shown *I. howardi* Whitley also. Slight differences in the structure of the pectoral girdle between the blue marlin from the Pacific and the Atlantic Oceans have been observed by Morrow (1957) leading to the recognition of two subspecies, the Atlantic blue marlin *Makaira a. ampla* and the Pacific blue Marlin *M. a. mazara*. However, there are hardly any external differences between the Atlantic and Pacific forms which led Rivas (1956) and Royce (1957) to synonymise the two forms, an action which seems to us to be justifiable as we recognise only a single circumtropical species *M. nigricans* with no subspecies.

Diagnostic characters of *M. nigricans* are :

(1) Large size females of the species attaining between 1,500 and 2,000 pounds while males are smaller weighing 300 lbs. or less.

(2) Pectoral fin flexible and can be adpressed to the side of the body without any difficulty.

(3) Anterior lobe of the first dorsal is less than the greatest depth of the body.

(4) The anterior lobe of the first anal fin is almost equal to the anterior lobe of the first dorsal. Regarding this Royce (1957) remarks that it is the best character for distinguishing between " *ampla* from *audax* " for " In *ampla*, the height of the first anal averaged 86 percent of the height of the first dorsal with a range of 76 to 100 per cent ; in *audax*, the range was from 50 to 76 per cent with an average of 66 per cent."

(5) An additional difference between the blue and striped marlins drawn attention to by Royce (1957) is in the relative height of the middle rays of the first dorsal with growth. " The centre of the first dorsal fin is low and in our specimens

there is a suggestion of an actual decrease in the average length of the 20th ray with the growth of the fish up to 200 cm.; but in specimens of more than 200 cm. fork length the length of the 20th ray is nearly constant. The average length of the ray in *ampla* is approximately 6 cm. with the range in our specimens from 3 to 9 cm.; in *audax*, which has a similar growth pattern, the range is from 8 to 14 cm. with an average of 10 cm."

(6) Unlike the black marlin and the striped marlin, the spear in the blue marlin is relatively longer in relation to the length of the mandible, the latter being less than half the spear length. This according to Royce (1957) is on account of the growth relation of mandible/spear in the striped and black marlins being approximately isometrical whereas in the blue marlin the mandibular growth is definitely negatively allometric.

Additional characters mentioned are that the dorsal profile in the blue marlin does not show the high elevated ' hump ' as seen in the black marlin, but the profile is slightly more arched than in the striped marlin.

Another important, but more easily noticeable character is the peculiar lateral line pattern of the blue marlin of which Rivas (1956) writes that " unlike other species of marlin, *Makaira ampla* (= *M. nigricans*) does not possess a visible, simple lateral line running along the middle of the sides of the body. Instead, the lateral line is inconspicuous, complex and forms a reticulate pattern covering the sides of the body. It is fairly visible only when a patch of skin is removed and held up to the light. Both Atlantic and Pacific specimens were found to be similar in this character." Similar complicated reticulate or hexagonal pattern of lateral line was also noted by Hirasaka and Nakamura (1947) while describing *Eumakaira nigra*, which as already mentioned is a synonym of the blue marlin *M. nigricans*.

Body colouration is not a diagnostic character. In life " the predominant colour of the upper parts is a brilliant, deep metalic blue which fades rapidly after death to a lead-grey colour mixed with brown whenever the fish has been rubbed or scraped. Stripes usually are present on the sides immediately after death but are rarely conspicuous, and generally some are so faint that it is difficult to count them " (Royce, 1957).

Silas and Rajagopalan (1962) record one young blue marlin from Tuticorin Coast, Gulf of Mannar showing the above diagnostic characters. Morphometric and meristic data for the specimen are given by them along with certain anatomical features.

What little is known of the food of the blue marlin (Nakamura, 1942 ; Royce, 1957; Krumholz and de Sylva, 1958) indicates that fish constitutes the predominant item with cephalopods (squids) next in the order and rarely shrimps.

For size attained by the blue marlin reference may be made to Nakamura (1949) ; Nakamura *et al.* (1953) ; Ueyanagi (1953) ; Yabuta (1954) and Royce (1957). Little is known about the spawning habits of the species other than what has been mentioned by Nakamura (1942; 1951). For osteological characters of the blue marlin reference is invited to Nakamura (1938) and Morrow (1957), and for details regarding the anatomy of the alimentary tract and reproductive organs, to LaMonte (1958).

The structure and disposition of the scales in the blue marlin are discussed at length by LaMonte (1958) while Krumholz (1958) has given data on the relative weight of the viscera of the blue marlin of different sizes and also in relation to other Atlantic marlins. De Sylva

(1958) has compared the juvenile blue marlin with adult blue marlin and white marlin from the Atlantic.

Data on Japanese longline fishery shown in the atlas prepared by the Nankai Regional Research Laboratory (Yabuta 1954) indicate good fishing grounds for the blue marlin in the Indian Ocean over a wide area, especially south west of Sumatra and Java ; the Andamans and Nicobar Islands ; 4° N. and S. of the equator and off the N. Western Coast of Australia.

DISTRIBUTION : Throughout the warmer waters of the Indo-Pacific and the Atlantic.

FAMILY XIPHIIDAE

Genus **Xiphias** Linnaeus

Xiphias Linnaeus, 1958. *Syst. Nat.* ed. 10 : 248 (Genotype : *Xiphias gladius* Linnaeus).
Phaethonichthys Nichols, 1923. *Amer. Mus. Novitates*, 19, pl. 1, Oct. 19, 1923 (Genotype : *Phaethonichthys tuberculatus* Nichols) (*nec* Bleeker, 1879).

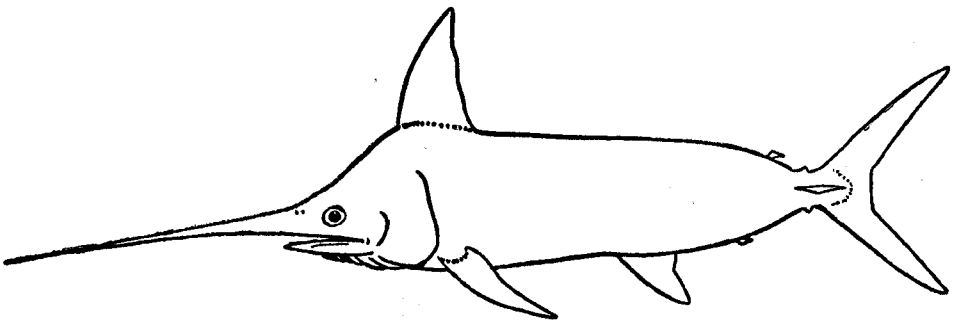
Body elongate, compressed, with long pointed rostrum which is depressed, elliptical in cross-section ; young with lower jaw produced, but not equalling rostrum ; scales absent in adults ; posterior spines of first dorsal lost with age leaving only anterior high falcate lobe ; second dorsal and anal short ; latter divided in adult ; detached finlets absent ; a single median conspicuous caudal keel on each side ; pectorals moderately long, about equalling height of first dorsal lobe ; pelvics absent ; teeth wanting ; branchiostegal membranes not united ventrally ; gill lamellae of each arch united as a single plate by reticulation ; air-bladder present ; pyloric caecae numerous ; intestine zig-zaging a few times ; vertebrae 26 (16 + 10) ; monotypic.

DISTRIBUTION : Tropical and temperate seas. Cosmopolitan.

SWORDFISH

Xiphias gladius Linnaeus, 1758

(Plate IX, A & B; Text Fig. 15)



Text Fig. 15. *Xiphias gladius* Linnaeus, the swordfish (after Deraniyagala, 1952).

SYNONYMS :

Xiphias gladius Linnaeus, 1758 : 248 (Type locality : ' Habitat in Oceano Europae ')
Cuvier, 1831 : 255
Günther, 1860 : 511–12

Gray, 1871 : 338–39
Lutken, 1880 (1883) : 575–79 ; 1880 : 441–447
Goode, 1883 : 289–386
Haley, 1887 : 132-D
Day, 1878 : 198 ; 1889 : 130
Thompson, 1918 : 119
Regan, 1924 : 224
Jordan and Evermann, 1926 : 71
Barnard, 1927 : 805
Deraniyagala, 1933 : 57 ; 1936 : 1937 ; 1951 : 140–41 ; 1952 : 108
Copely, 1935 : 1936 : 19–23 ; 1952 : 169–70
Fowler, 1936 : 648–49
Gudger, 1940 : 218–315
Rich, 1947 : 7–15, 30–98
Smith, 1949 : 314 ; 1956*a* : 1065 ; 1956*b* : 251
Rosa, 950 : 63–167
Nakamura, *et. al.*, 1951 : 264–71
Yabe, 1951 260–63
Arata, 1954 : 183–243
Munro, 1955 : 222 ; 1958 : 19
Taning, 1955 : 438–450
Williams, 1956 : 46
Maeda, 1957
Royce, 1957 : 518–519
Jones, 1958 : 357–61
Yabe *et. al.*, 1959 : 107–150

Xiphias platypterus Shaw and Nodder, 1792 : III, pl. lxxxliii (Brazilian and East Indian Seas, Northern Ocean)
Shaw, 1804 : 101

Xiphias imperator Bloch and Schneider, 1801 : 93, pl. 21 (Mediterranean Sea : Based on young swordfish copied originally from Aldrovandi)

Xiphias rondeletii Leach, 1818 : 58

Ziphius gladius Hector, 1875

Ziphias gladius Cheeseman, 1876 : 219–20

Phaethonichthys tuberculatus Nichols, 1923 : 1 (Type locality : Rapa Island, Austral. group, South Seas. Based on fragmentary portion of young swordfish taken from gullet of red-tailed ocean bird)

Xiphias estara Phillipps, 1932 (Type locality : New Zealand)
Whitley, 1954

Xiphias thermaicus Serbetis, 1951 : 269–73 (Type locality : Gulf of Thermaicus)

We recognise only a single cosmopolitan species which is very distinctive from other billfishes and can be easily recognised by the Key characters given on p. 6.

Day (1878) while citing a few instances of attack by ' swordfish ' on ocean-going vessels remarked that *Xiphias* has " Not as yet been found in the seas of India." *X. gladius* is a truly oceanic species and its occurrence in coastal waters is rare. A few stray records of its occurrence in Ceylon waters are mentioned by Deraniyagala (1937, 1952). Till recently there appears to be no authentic record of the species from Indian waters although malidentifications of

marlins (spearfishes) as swordfish may be found in Indian ichthyological literature. Jones (1958) first reported on *X. gladius* larvae from the Laccadive sea. Since then, during exploratory fishing operations conducted in the Laccadive Sea, two adult swordfish were obtained on 25–1–1960 (in drift net), and 7–4–1960 (in long-line) and the former is figured here (Plate IX).

The rostrum or sword is usually one-third the total length inclusive of rostrum or slightly less than or about 2 times in length from tip of mandible to base of caudal. Munro (1955) mentions the fin-ray counts as " D 40 + 4 ; A. 18 + 4 ; P_1 2 + 14 " apparently this being for early juveniles as in adults the first dorsal count is II, 15 (Deraniyagala, 1952) as the posterior rays are lost with age being coverd by the skin.

The species attains about 5 metres in length and weighs well over 1,200 lbs. For recent works on aspects of the biology of this species reference may also be made to Nakamura (1938, 1955) ; LaMonte and Marcy (1941), Nakamura, *et al.* (1951) ; Yabe (1951) ; Arata (1954) and Tibbo, Day and Doucet (1961). Gregory and Conrad (1937) have made a comparative study of the osteology of the swordfish and the sailfish. Pugnacity of the swordfish is well known and the subject has been dealt with at length by Gudger (1940) and Rich (1947). More recently Smith (1956*a*) has also given instances of the pugnacity of marlins and swordfish.

Organised fishery for swordfish exists only in parts of the Mediterranean and in the North Western Atlantic off the Coast of United States and Canada. Stray catches have been reported from Japanese longline fishery from various parts of the Indo-Pacific.

Recent investigations by Nakamura *et al.*, 1951 and Taning, 1955, tend to indicate that while the known breeding areas of *Xiphias* as evidenced from collection of larvae are to be found in tropical waters where northern and southern summer surface isotherm is 24° C. or more, the adults are largely dispersed in more temperate waters.

General Remarks

We have, in the foregoing account, made an attempt to give briefly along with our own observations the available information on the systematics of the scombroid fishes known to occur in the Indian Ocean region and the taxonomical problems confronting some of the species. A review of the taxonomical literature in India on scombroids would show that there has been hardly any change during the next eight decades since the publication of Day's *Fishes of India* in 1878. The tendency has been obviously due to either ignorance or apathy, to conveniently assign any scombroid to one or the other of the species listed in the above publication till " incursions " by some species into the ichthyological literature of this region within the last one decade especially on account of the work of de Beaufort (1951). It could perhaps be said with some amount of justification that the picture has begun to change within the past two or three years based on the contributions from this institute though this has brought in its wake fresh problems requiring elucidation. All scombroids are pelagic fishes and many of the larger species are oceanic while a few are circumtropical in distribution. Most, if not all the oceanic species in the Indo-Pacific are common to both the oceans. It is now evident that tunas and marlins occurring in the Indian region are not confined to the few listed in the earlier literature and that the apparent discontinuous distribution of many in all probability may be due to want of any proper search for them.

While above is the case with reference to systematics, the position with regard to the biology of scombroids is still worse with the possible exception of the Indian mackerel which in view of its economic importance has received certain amount of attention.

This is probably because fishing in this country is confined to coastal waters where none of the scombroids except the mackerel form a fishery of any magnitude. Tunas, the most potentially important fishes, and marlins and seerfishes occur only in stray numbers or as seasonal catches but never form major fisheries. Only in the island of Minicoy an organised tuna fishery exists mainly for the oceanic skipjack.

The world catch of tuna now stands at about 8,00,000 tons and the demand for it is constantly on the increase. India's share at present is negligible but her central position in the Indian Ocean offers her considerable advantage over other countries for the development of the latent oceanic fisheries of this region. It needs no emphasis that for the scientific development of any fishery and its maintenance at the optimun sustainable level, systematics, is the foundation on which all other aspects of study should be based. Therefore it is high time that more attention is paid to the study of the systematics of the scombroid fishes of this region than hitherto.

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THE PAPER WAS READ BY DR. E. G. SILAS

DISCUSSION

Mr. G. P. WHITLEY : It appears to me that the picture of the seerfish shown with the broadly rounded pectoral fin looks very much like *S. semifasciatus*.

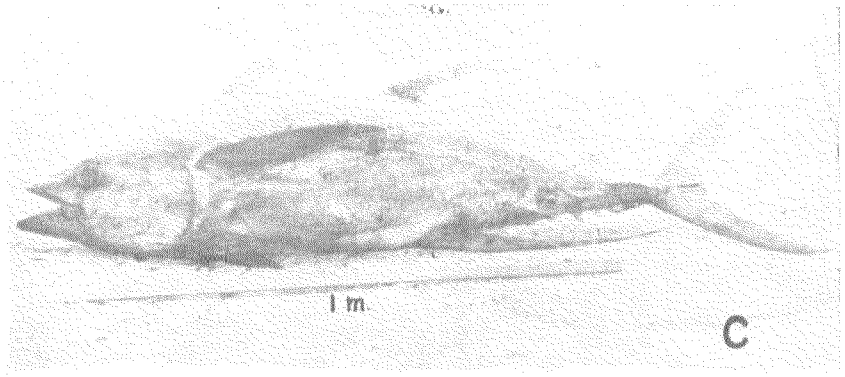
Dr. E. G. SILAS : The one you have referred to is *S. commerson*. *S. semifasciatus* has characteristic distinct vertical bands on each side of the body, in addition to having a higher gill-raker count and the lateral line not decending abruptly below or behind the second dorsal. When species of *scomberomorus* are compared, the affinities between *S. commerson* and *S. semifasciatus* are greater and it may not be surprising if studies based on good series of specimens show that *S. semifasciatus* is only a subspecies of the widely distributed *S. commerson*. The work on the taxonomy of scombroid fishes has had the drawback of not being based on good series of specimens from different locations along the distributional ranges of the different species, mainly on account of the large size of the specimens.

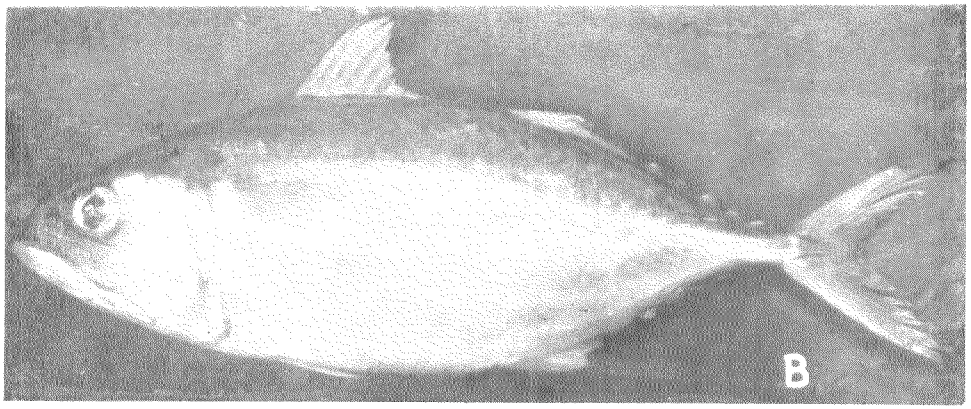
Dr. W. M. CHAPMAN : Yes, I thought one of the things that came out of the Hawaiian Symposium last summer that was useful was the offer of the Japanese scientists to send specimens from their far-flung fisheries around the world to the U.S. National Museum for extensive systematic work. I do not think there is any possible way of working out the systematics of scombroid fishes absolutely until some one person has specimens of all the species he can examine.

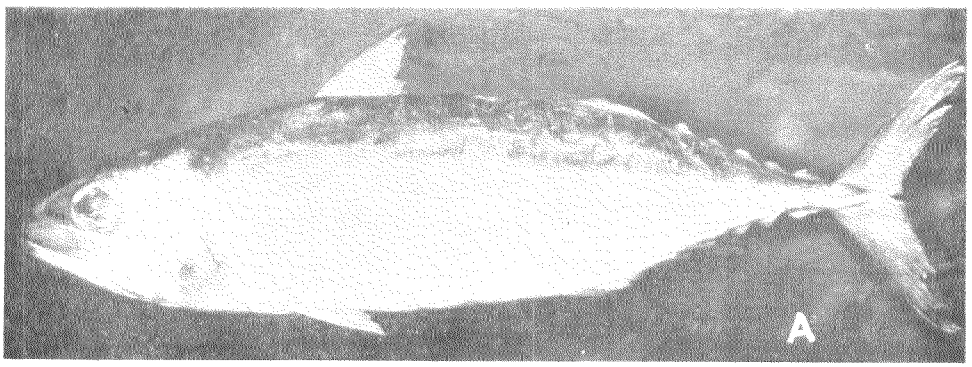
DR. S. JONES : This is one group that should be studied on a global basis and we should have the material from all the oceans. It might be desirable to have not only one centre but more than one centre for the study as well as the deposition of representative reference material so that workers from different regions could have easy access to these as it may not be possible for all to go to one place.

Mr. RODNEY JONKLAAS : Dr. Silas, you mentioned that there is some variation in the dorsal fin of the sailfish *Histiophorus*. Has any study been made with reference to sex and the length of the dorsal fin or the distance between the first and second dorsal fins.

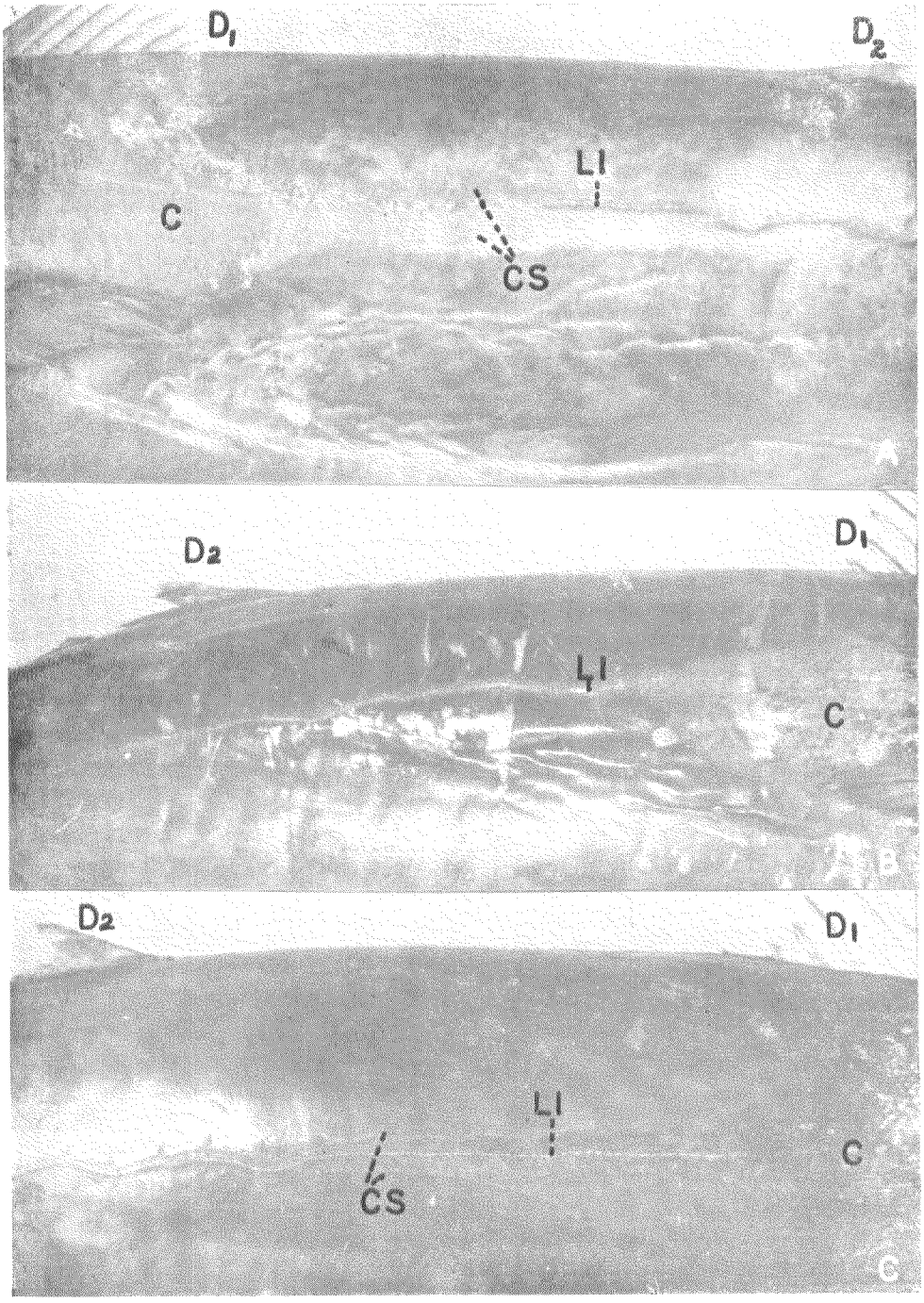
Dr. E. G. SILAS : To my knowledge there is no study of sexual dimorphism in *I. gladius* with special reference to the shape of the dorsal fin. I have not come across any noticeable difference in the shape of the dorsal fin in male and female specimens of *I. gladius* caught off Tuticorin although difference in the maculation of the fins may be seen from specimen to specimen. In young juveniles of *I. gladius* described by Deraniyagala (1952) and Jones (1959) from Ceylon Waters and the Laccadive Sea, the first and second dorsal fins are contiguous. In half grown and adults, a gap between these fins is seen. However, the mid-dorsal groove in this gap conceals a few of the stumpy last rays of the first dorsal fin, from which it would appear that the difference in the distance between the dorsal fins may have something to do with the size or age of the specimen.



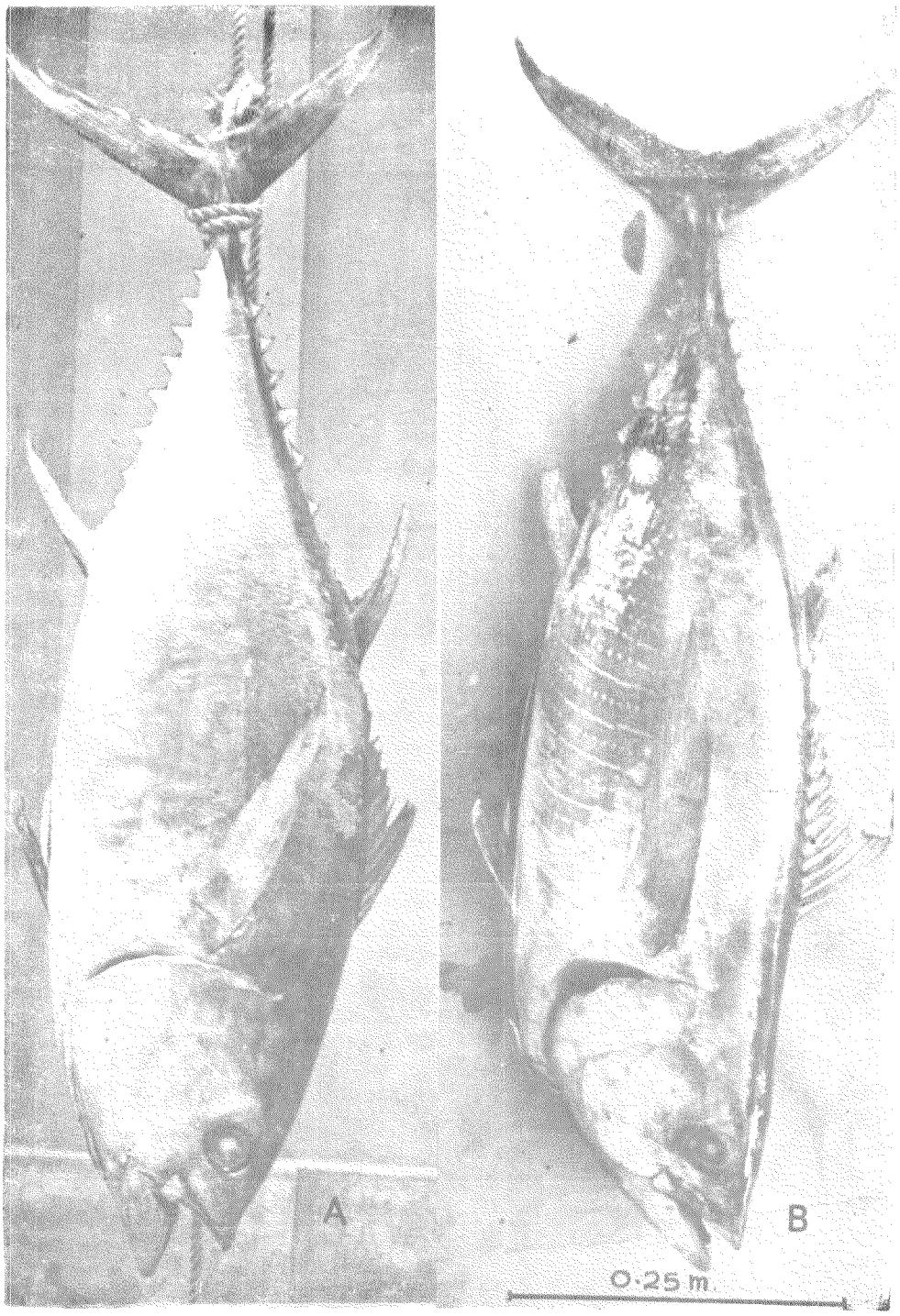




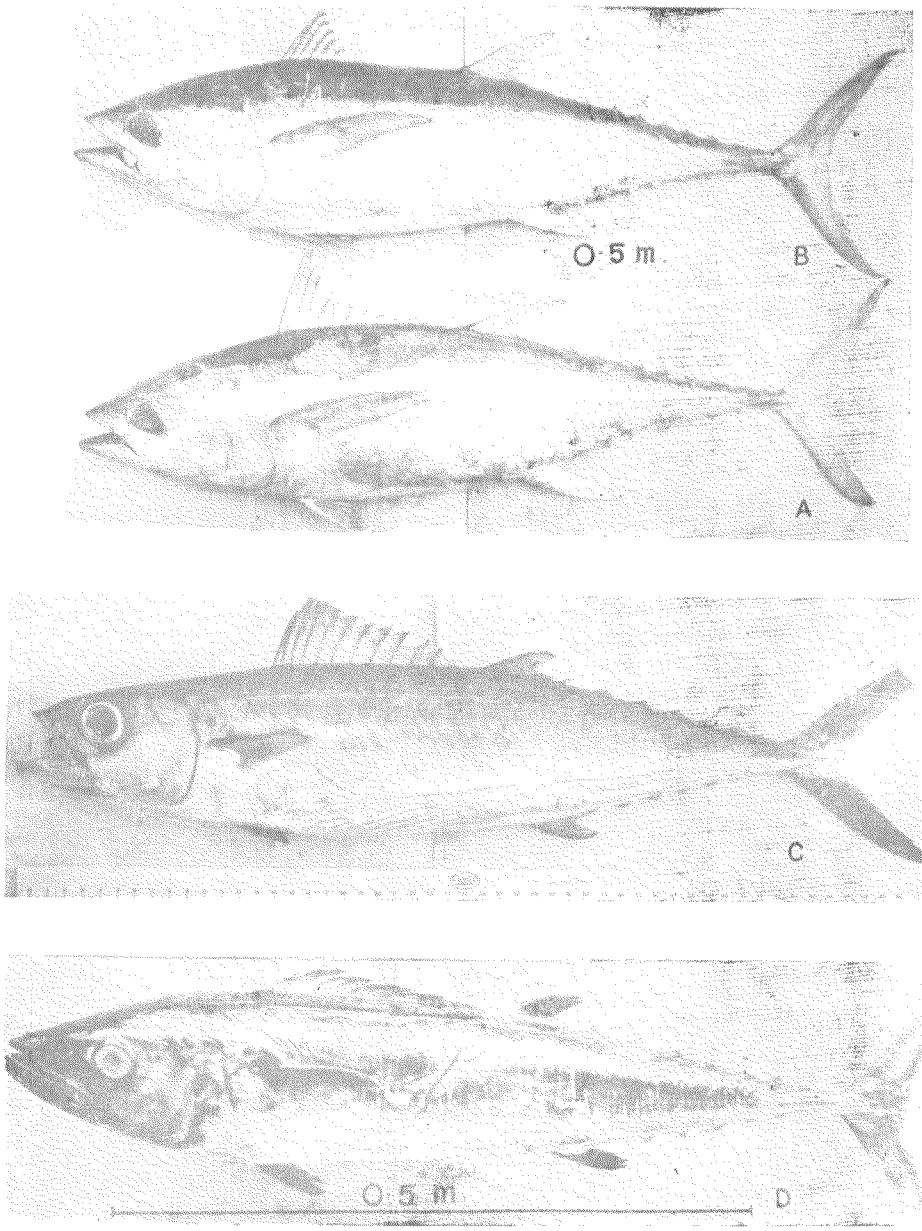
A. *Rastrelliger kanagurta*, 236 mm. from Andamans ; B. *R. brachysoma* (Bleeker) 213 mm. from Andamans ; C. *Thunnus* (*Neothunnus*?) *itosibi* Jordan and Evermann), from Andaman Sea.



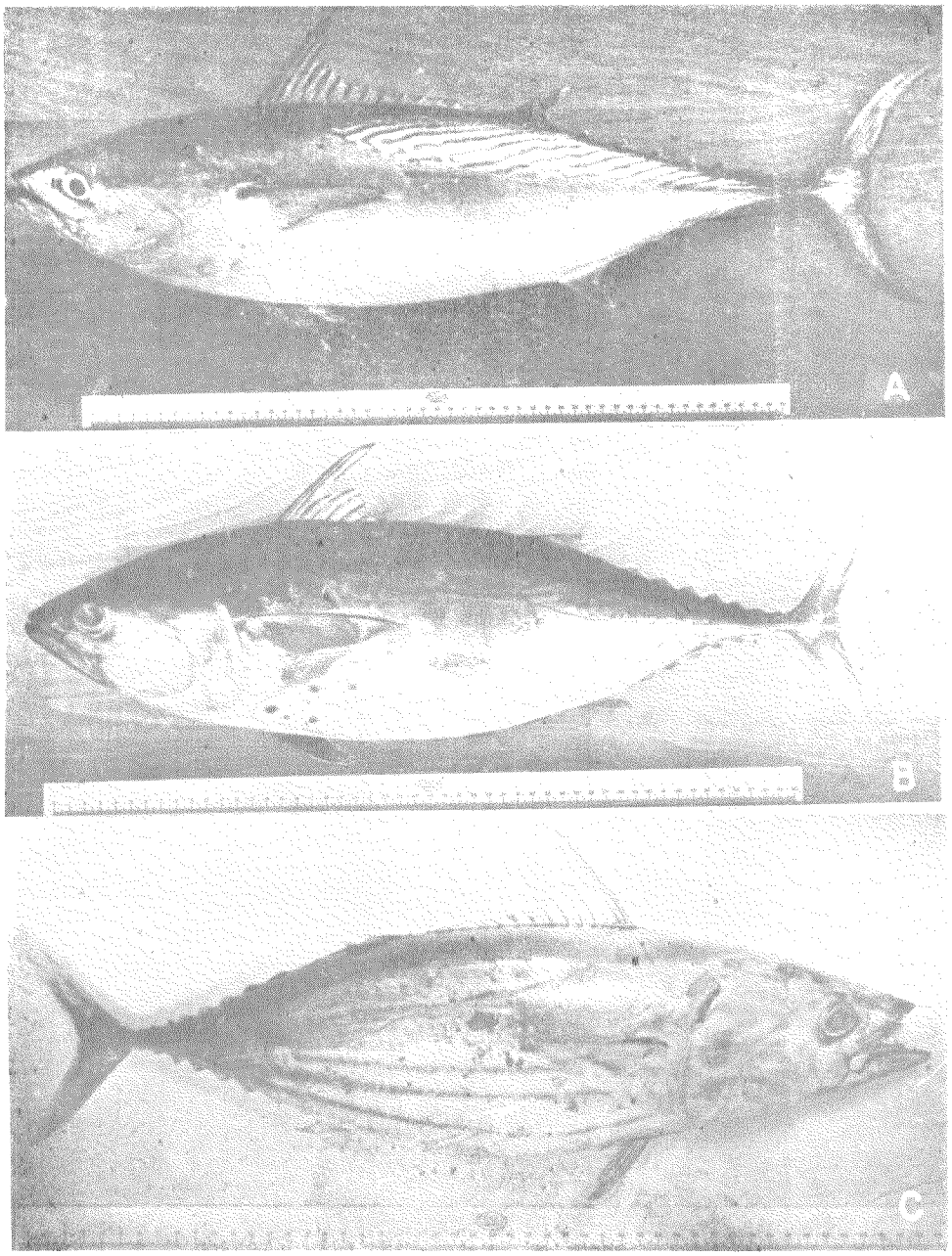
A. Part of side of body of *Auxis thynnoides* (Bleeker) showing the broader and gently tapering corselet ; (B and C). Two types in the abrupdly constricted and norrowly tapering corselet of *Auxis thazard* (Lacepede). (D_1 = first dorsal fin ; D_2 = second dorsal fin , C = corselet ; C.S = corselet scales ; L. I. = lateral line).



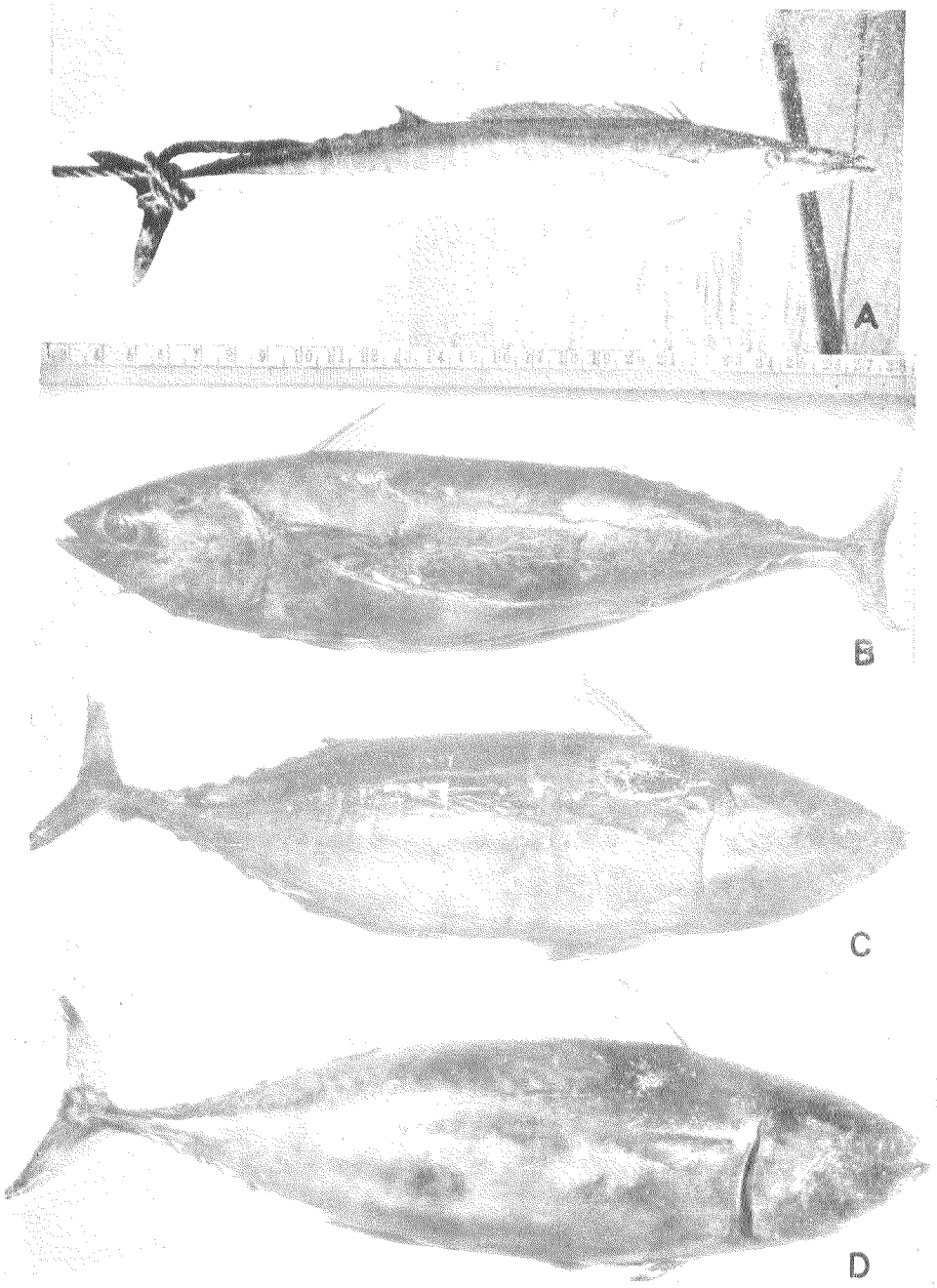
A. *Thunnus* (*Parathunnus*) *obesus mebachi* Kishinouye, 173 cm. long from Laccadive Sea ; B. *Thunnus* (*Neothunnus*) *albacares macropterus* (Temminck and Schlegel), from Laccadive Sea.



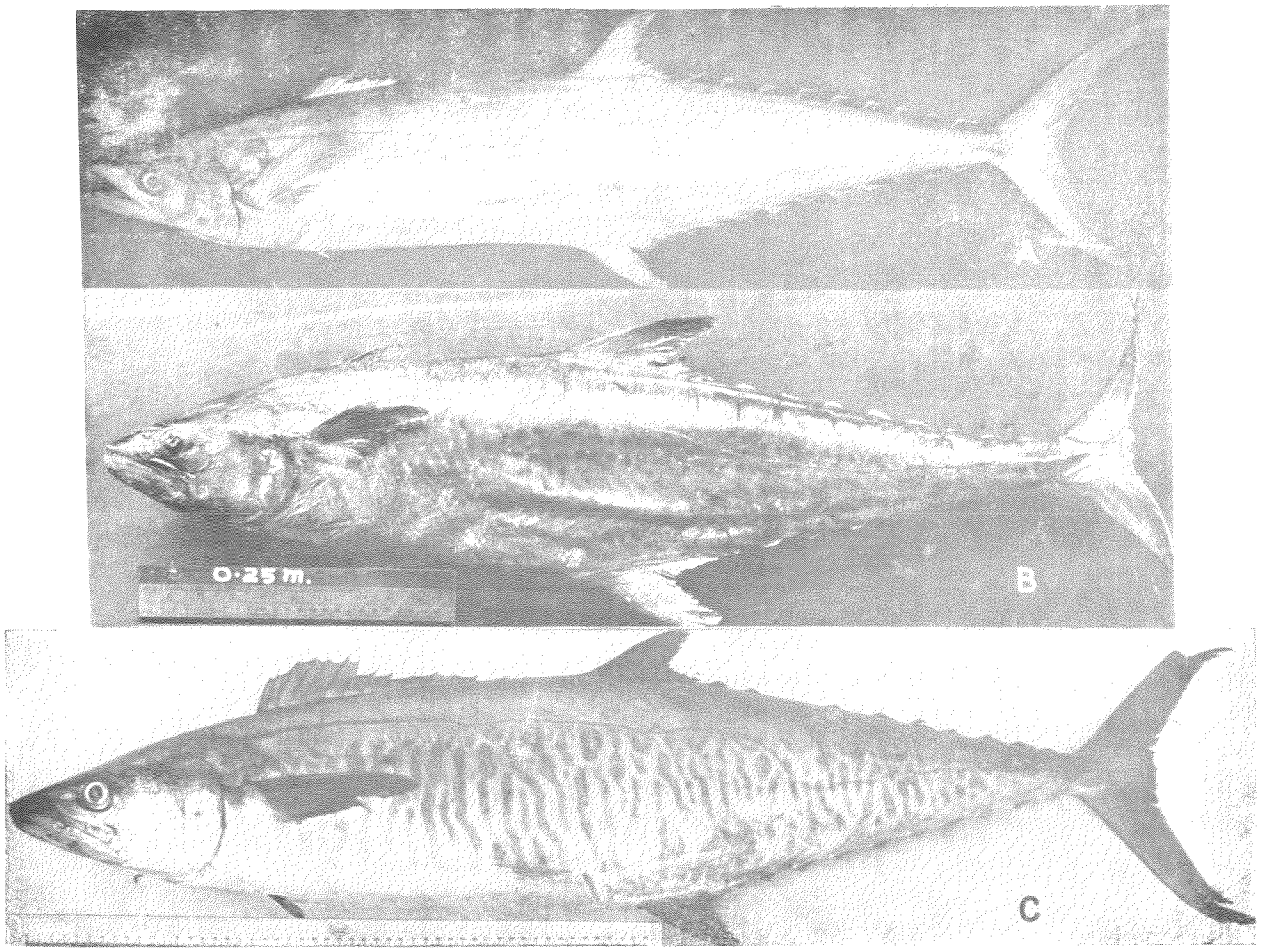
A. *Thunnus* (*Kishinoella*) *tonggol* (Bleeker) 792 mm. long from off Mangalore, south west coast of India ; B. Same species—specimen 783 mm. caught at Mangalore with abnormality in the first dorsal fin (with the last few rays missing) ; C. *Grammatorcynus bicarinatus* (Quoy and Gaimard), 449 mm. long (female) from Port Blair, Andamans ; D. *Gymnosarda unicolor* (Rüppell), 680 mm. long from Port Blair, Andamans.



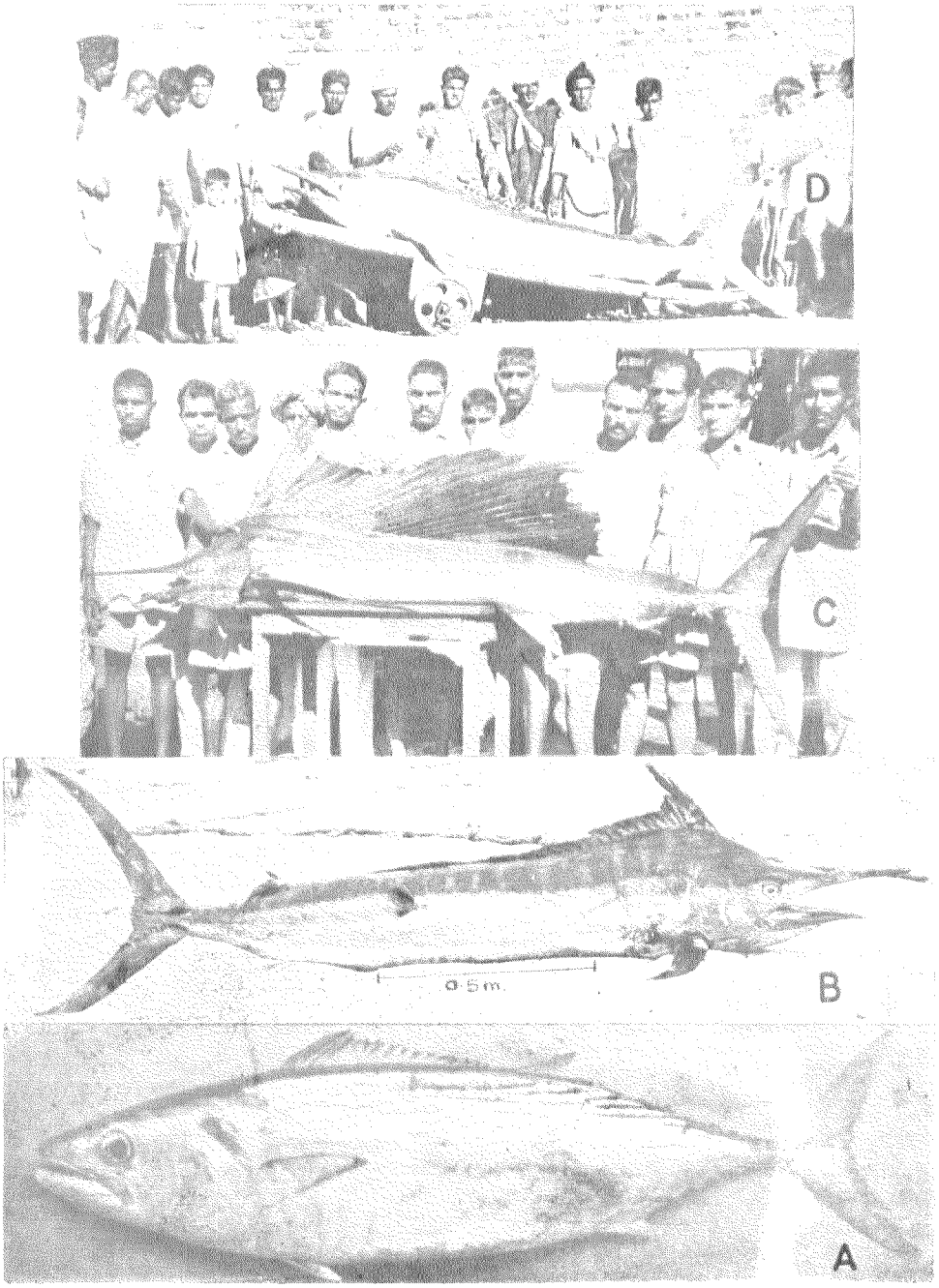
A. *Euthynnus affinis affinis* (Cantor) from Pudumadam, Gulf of Mannar showing complete absence of the usual black spots below the base of the pectoral and outside corselet ; B. *Euthynnus affinis yaito* Kishinouye from Hawaiian waters (specimen kindly sent by Mr. J. C. Marr) ; C. *Katsuwonus pelamis* (Linnaeus) from Minicoy, Laccadive Sea.



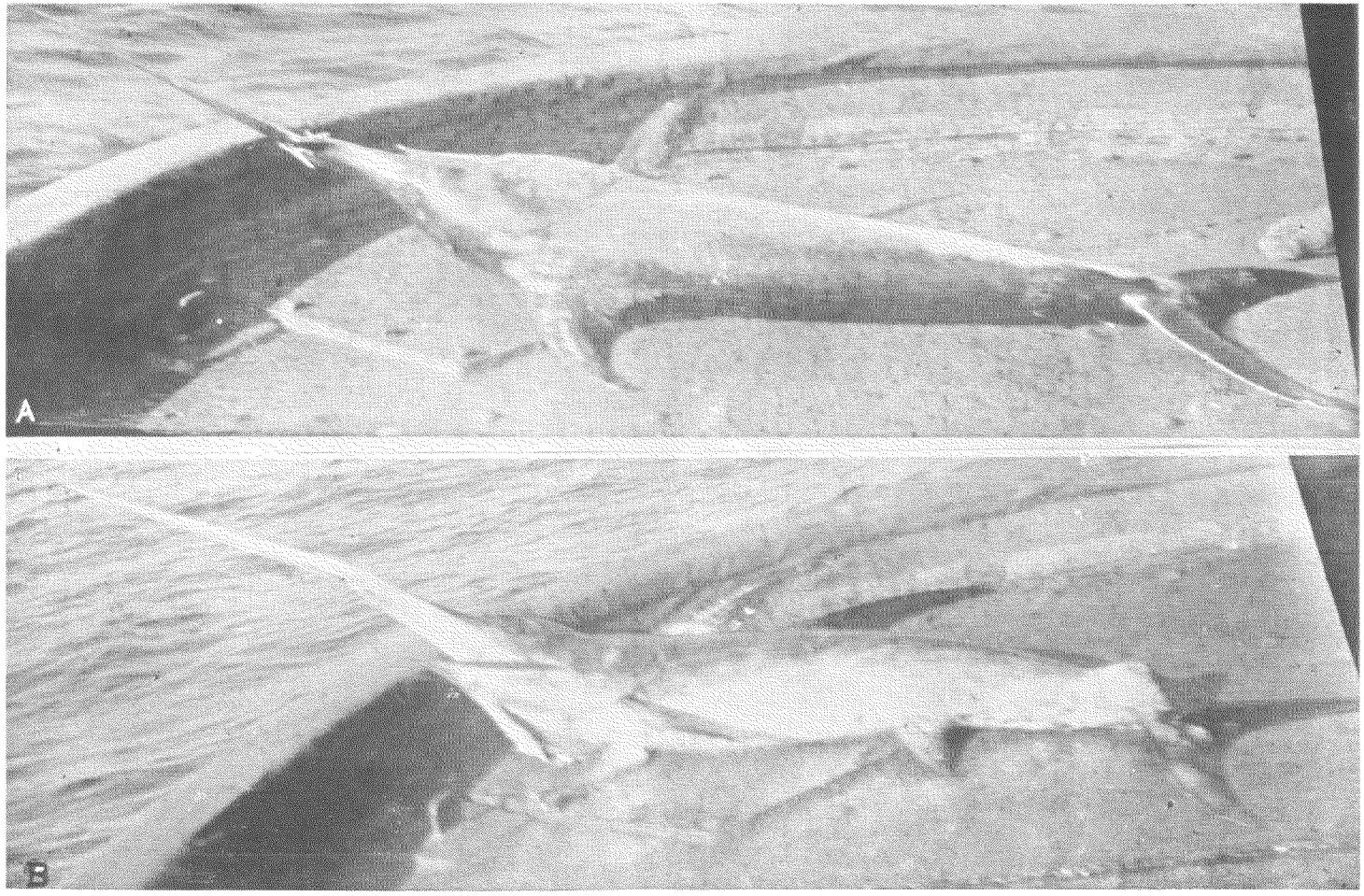
A. *Acanthocybium solandri* (Cuvier) from between Port Blair and Mayabundur, Andamans ; B. *Auxis thynnoides* (Bleeker) from Vizhingam, south west coast of India ; C and D *Auxis thazard* (Lacèpède) from Vizhingam showing differences in the disposition of corselet scales.



A. *Scomberomorus lineolatus* (Cuvier) 740 mm. long from off Rameswaram, Palk Bay; B. *Scomberomorus guttatus guttatus* (Bloch and Schneider) from Veraval, Gujarat coast, Arabian Sea; C. *Scomberomorus commerson* (Lacèpéde) male, 810 mm. long from Andamans.



A. *Sarda orientalis* (Temminck and Schlegel) female, 386 mm. from Vizhingam, South West Coast of India; B. *Makaria nigricans* Lacepede, the blue marlin from off Tuticorin, Gulf of Mannar (after Silas and Rajagopalan, 1962); C, Sailfish *Istiophorus gladius* (Broussonnet) caught off Bombay; D. Black marlin *Makaira indica* (Cuvier) caught off Bombay (C and D—by courtesy, Dr. S. B. Setna).



A and B. Two views of the swordfish *Xiphias gladius* Linnaeus caught in the Laccadive Sea.