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SYNOPSIS OF BIOLOGICAL DATA ON FRIGATE MACKEREL
Auxis thazard (Lacépède) 1802 (INDIAN OCEAN)

Exposé synoptique sur la biologie de l'auxide
Auxis thazard (Lacépède) 1802 (Océan Indien)

Sinopsis sobre la biología de la melva
Auxis thazard (Lacépède) 1802 (Océano Indico)

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1 IDENTITY

1.1 Taxonomy

1.1.1 Definition

Phylum VERTEBRATA

Subphylum Craniata

Superclass Gnathostomata

Series Pisces

Class Teleostomi

Subclass Actinopterygii

Order Perciformes

Suborder Scombroidei

Family Scombridae

Genus Auxis Cuvier 1829Species Auxis thazard (Lacépède)
1802

1.1.2 Description

- Genus Auxis Cuvier 1829

(type Scomber rochei Risso = Scomber thazard Lacépède; type locality Lat. 6-7°S. off the coast of New Guinea).

"Body robust, fusiform, almost cylindrical in cross section, only slightly compressed. Head large tapering rapidly to a pointed snout. Mouth moderately oblique, end of maxillary not covered by preorbital. Teeth small pointed present on jaws. Occasionally few teeth on vomer. Gill rakers, close set, long and slender. Lateral line without a distinct arch, slightly curved and with small undulations. Caudal peduncle with small lateral keels. Body scaled anteriorly, forming a corselet. Corselet with a posterior prolongation of scales along lateral line. Fins small, first dorsal fin roughly triangular in shape and not continuous or closely adjoining second dorsal. Second dorsal and anal each followed by eight or seven finlets" (Wade 1949).

The fishes of the genus Auxis are the smallest of the tunas. They are easily distinguished from the rest of the tunas by: (a) the wide interspace, almost equal to length of head, between the first and second dorsal fins; and (b) the axillary scales between the pelvic fins, which are about equal in length to the pelvic fins, whilst in the rest of the tunas they are about one half of the length of these fins.

- Auxis thazard (Lacépède) 1802
(Major morphological features described under

the genus are omitted from the account of the species given below.)

Depth 3.9 to 4.5, head 3.2 to 3.8 in standard length. Eye 5.0 to 5.85 in head, 1.25 to 1.66 in snout and 1.25 to 1.7 in the flatly rounded interorbital space. Snout 3.62 to 4 in head. Maxilla reaches to a point under the anterior half of the eye and is 3 in head. Single row of small pointed teeth in each jaw, none on palate. Jaws almost equal. First and second dorsal spines subequal, equal to snout and eye; following spines rapidly decreasing in size, eighth usually shorter than the pupil. Second dorsal fin very low, about three times its base distant from first dorsal; first ray of second dorsal about 5 in head. Anal similar to second dorsal, first ray about 5.2 in head. Pectorals short, roughly triangular, about 2 in head and shorter than postorbital; origin of pectoral before that of first dorsal. Pelvics thoracic, about 2.5 in head, origin somewhat behind that of pectorals. Caudal lunate, upper lobe about 1.8 in head. Body naked except for the corselet of scales anteriorly. Rear margin of the corselet runs from base of second dorsal to above end of pectoral; thence there is a posterior prolongation of the corselet along the lateral line; below the pectoral tips the corselet margin curves to above the pelvic base from where it turns posteriorly and finishes well behind the tips of the pelvics. The prolongation of the corselet along the lateral line tapers abruptly between first and second dorsal fins, and under the origin of the second dorsal is not more than 4 irregular scale rows wide. Scales large and imbricated above pectoral base. Gill rakers about 1.75 in length of gill filaments.

(specimens 300-400 mm standard length)

For meristic characteristics see section 1.3.1.

Color (a) Immediate postmortem: Head blue-black above, silvery below. Body blue-black along back, silvery white on sides and belly. Blue-black wavy mackerel-like markings on naked area of sides above the lateral line. (b) Preserved in formalin: "Deep greyish brown dorsally, gradually becoming lighter laterally. Below the corselet light greyish brown becoming almost pinkish ventrally. Irregular bars of markings above and behind the corselet. A black mark close to postero-

ventral border of eye. First dorsal brown along the anterior spines. White patch around the base of the anal fin and finlets" (Jones 1958).

1.2 Nomenclature

1.2.1 Valid scientific name

- Auxis thazard (Lacépède) 1802

1.2.2 Synonyms

Scomber thazard Lacépède 1802

Scomber rochei Risso 1810 (not seen by author)

Scomber bisus Rafinesque 1810 (not seen by author)

Auxis vulgaris Cuvier 1831

Auxis taso Cuvier 1831

Auxis tapeinosoma Bleeker 1854

Auxis hira Kishinouye 1915

Auxis thazard partim Fraser-Brunner 1950

1.2.3 Standard common names,

- vernacular names

1.3 General Variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

Meristic counts have been given by several authors and are shown in Table II.

Table I
Common and Vernacular Names

Country	Standard Common Name	Vernacular Name(s)
Australia	Frigate mackerel	Leadenall
Ceylon	Frigate mackerel	Ragodwa (Sinhalese)
East Africa	Frigate mackerel	Sehewa (Kiswahili) also refers to <u>Euthynnus</u> and <u>Katsuwonus</u> spp.
India	Frigate mackerel	Churai, Urulan-churai, Kutteli-churai (Tamil)
Seychelles		Bonite folle
Somalia (Mijurtein coast)		Tubani (Somali)

Table II
Meristic Counts of Auxis thazard

Area and Author	First dorsal fin	Second dorsal fin	Anal fin	Gillrakers	Vertebrae
South Africa Fowler 1934	XII	iv, 10+7-8	iv, 10+7	10+31 = 41	-
East Indies de Beaufort and Chapman 1951	X	11+6-9	14+6-8	-	-
Ceylon Munro 1955	X	11+6-9	14+6-8	30 lower limb	-
Australia Munro 1958	X-XII	12+8	13+7	10-11+28-32	-
India Jones 1958	X	13+8	ii, 11+7	40	-
South Africa Smith 1960	XI	11-12+8	13+7	30 lower limb	-
East Africa Williams MSS. 1960 and 1962	-	finlets 7-9	-	9-10+30-31 = 39-41	38-39

2 DISTRIBUTION

- Eggs - No data

2.1 Delimitation of the total area of distribution and ecological characterization of this area

- Larvae

Auxis thazard has been recorded from the following areas of the Indian Ocean: South Africa, Natal and occasionally Cape Province; Mauritius; the coasts of Tanganyika, Kenya and the Zanzibar Protectorate; Seychelles group including Aldabra Island; coast of Somalia and Gulf of Aden; Indian west coast and Laccadive and Maldive Archipelagos; Indonesian Archipelago; and Australia, except south coast. It is interesting to note that the frigate mackerel is not recorded from the Comoro Islands or Mozambique Channel (Fourmanoir, 1954 and 1957) or l'Île Europa (Fourmanoir, 1952). The known distribution suggests, however, that the species is likely to be found in these areas, and also in the Bay of Bengal and along the Malayan coast.

The only published records are those of many indetermined larvae of Auxis sp. taken by the Dana Expedition in September and October 1929 in the waters off the west coast of Sumatra and Java (Matsumoto 1959).

- Adults

The geographical distribution of A. thazard thus covers the tropical and subtropical Indian Ocean, and the extreme southern boundary of distribution is approximately a line drawn from Cape Agulhas, South Africa, to Cape Leeuwin, Western Australia.

A. thazard is most commonly found inshore penetrating bays and estuaries, as in South Africa (Molteno 1948), Ceylon (Department of Fisheries 1958), Australia (Serventy 1941, Roughley 1951) and off the west coast of India (Nayar 1958), where they are usually caught in beach seines. In the Seychelles group, shoals were seen in the areas of relatively shallow water between the islands (Wheeler and Ommanney 1953). In East Africa, however, the species has been seen within the 200 m line at the same time as other large shoals of tuna-like fishes (Williams MS. 1962) and over deep water about 40 km from the 200 m line (unpublished data).

Generally the tropical and subtropical waters of the Indian Ocean are characterized by a scarcity of plankton offshore. Except for areas of vertical mixing of water masses (e.g. upwelling off Somalia and in the Gulf of Aden) strong development of phytoplankton and subsequent zooplankton is restricted to the immediate coastal areas. Preliminary results in East African surface waters (E.A.M.F.R.O. 1961) show a decrease of plankton dry weight with increasing distance offshore. In the Java area maximum zooplankton abundance was found at 40 to 65 km offshore just outside the zone of rich phytoplankton (Delsman and Hardenberg, 1934).

The inshore occurrence of the frigate mackerel in South Africa and Australia is in the southern summer; similarly in East Africa occurrence is in the period December to March and off the Indian west coast in November to May.

It would appear that A. thazard is found mainly in waters adjacent to land masses, but on occasions may be present in the open ocean. The occurrence of the species so close inshore that it is taken by beach seines seems to be strictly seasonal between November and May.

2.2 Differential distribution2.3 Behavioristic and ecological determinants of the general limits of distribution and the variations of these limits and of differential distribution

- 2.2.1 Areas occupied by eggs, larvae and other junior stages: annual variations in these patterns, and seasonal variations for stages persisting over two or more seasons. Areas occupied by adult stages: seasonal and annual variations of these

As with most tunas, temperature appears to be the limiting factor in the distribution of Auxis thazard. The extreme southern boundary of the geographical distribution lies at about Lat. 36°S (see section 2.1) and is extremely close to the position of the 20°C isotherm for the greater part of the year, including the southern summer (Sverdrup, Johnson and Fleming 1942). The occurrence of frigate mackerel in South Africa and Australia at this season coincides with the

Time of maximum water temperature. Even in East Africa and the Seychelles, where the surface water temperature rarely falls below 24°C, the frigate mackerel occurs in the months of the NE monsoon when the temperature is maximal, 29-30°C.

According to Matsumoto (1959), the surface water temperatures were 24.5°C and 29°C at stations where larvae of Auxis sp. were taken off the west coasts of Sumatra and Java by the Dana Expedition in 1929.

The inshore appearance of frigate mackerel in East Africa also occurs at the time of greatest fertility of the surface waters.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality (hermaphroditism, heterosexuality, intersexuality)

Auxis thazard is heterosexual. No known external characters for distinguishing males and females.

3.1.7 Spawning grounds

The only recorded Indian Ocean larvae of Auxis sp. were distributed close to land masses - Sumatra and Java (Matsumoto 1959). As the larvae were recently hatched it was presumed that the spawning sites were in the immediate vicinity. However, the recording of some larvae from mid-Pacific and Atlantic areas suggested that the species also spawns away from land masses.

3.2 Larval history

3.2.1 Account of embryonic and juvenile life (prelarva, larva, postlarva, juvenile)

A description of the morphology of Auxis larvae and postlarvae on a world-wide basis was given in Matsumoto (1959). As only a very small number of the total larvae examined originated from the Indian Ocean, an account is not given here.

3.3 Adult history

3.3.3 Competitors

In East African coastal waters large mixed shoals of small yellowfin, T. albacares, little tuna, E. affinis, and skipjack, K. pelamis, are present throughout the year (Williams, MS. 1962). However, during the NE monsoon frigate mackerel are also present either separate or mixed with the other tuna. It is probable therefore that the other tunas are competitors for food with the frigate mackerel at that time of the year.

3.3.4 Predators

In Indian waters, Jones (1958) recorded that

specimens of Auxis sp. were found in the stomach of a sailfish, Istiophorus gladius.

Specimens and remains of specimens of A. thazard have been found in the stomachs of East African longline caught sailfish, Istiophorus gladius, black marlin, Makaira indica, and striped marlin, Tetrapterus audax, (Williams MS 1962). The species has also been found in the stomachs of the dolphin fish, Coryphaena hippurus, caught at the surface, but the average size was much less than those fish in billfish stomachs. On at least one occasion large shoals of dolphin fish were seen at the surface actually chasing and feeding on shoals of frigate mackerel.

3.5 Behavior

3.5.1 Migration and local movement

The only information available is that showing an inshore movement or occurrence at the time of maximum surface water temperature. (See sections 2.2.1 and 2.3.)

3.5.2 Schooling

From observations made in East African waters the schooling is strong and disciplined. Certainly on approaching a surface shoal in a fishing vessel the fish seemed to form into a more compact group at the time of sounding.

Shoals in East Africa have comprised from 100 to 1000 individuals; in the Seychelles area shoals were said to be "large" (Wheeler and Ommanney 1953). In Australian waters shoals numbered several hundred individuals (Serventy 1941), whilst in Ceylon (Department of Fisheries 1958) as many as 5000 individuals (mixed frigate mackerel and little tuna) may be taken in one haul of a beach seine.

4 POPULATION (STOCK)

4.2 Size and density

4.2.1 Average size

In South and East African waters the average size of the species is 300 to 400 mm length and 0.75 to 1 kg weight; in Australian waters average weight is 0.5 to 1.5 kg.

4.2.3 Average density

(See section 3.5.2.)

5 EXPLOITATION

5.1 Fishing Equipment

5.1.1 Fishing gear

The main method of fishing for frigate mackerel in the Indian Ocean is the beach seine and this obviously depends on the seasonal inshore appearance of the species. It is the commonest method in use in South Africa, India, Ceylon and Australia. In Ceylon, at least, the net is used for mixed shoals of small tuna and not exclusively for frigate mackerel.

In East African waters A. thazard is rarely caught by surface trolling; in the Seychelles, Wheeler and Ommanney (1953) stated that fishermen had not yet developed an effective method of capture for the species. Molteno (1948) found that in South Africa frigate mackerel readily took light spinners, although Serventy (1941) stated that this was not so in Australian waters.

Jones (1958) recorded that off the Indian west coast A. thazard is a minor catch in drift nets set from catamarans at night. In addition the species was sometimes caught on handlines with a No. 5 hook baited with Anchoviella.

5.1.2 Fishing boats

No boats used specifically for the frigate mackerel fishery.

5.2 Fishing areas

Only in Ceylon and India is a specific attempt of any importance made to catch the mixed shoals of frigate mackerel and little tuna.

5.2.1 General geographic distribution

(See sections 2.1 and 2.2.)

5.2.2 Geographical ranges (latitudes, distances from coast, etc.)

(See sections 2.1 and 2.2.)

5.2.3 Depth ranges

The vast majority of catches are made by beach seines in shallow water. The small number taken by drift nets, trolling and handlines are from the surface waters close to the coast.

During the NE monsoon in East Africa, frigate mackerel have been taken from the stomachs of longline-caught billfish (see section 3.3.4) which were known to have been feeding between the surface and the first main thermocline, which is at about 70 m at that time of the year.

5.3 Fishing seasons

5.3.1 General pattern of fishing season

Appears to coincide with maximum surface water temperatures (see section 2.3).

5.3.2 Duration of fishing season

(See section 5.3.3.)

5.3.3 Dates of beginning, peak and end of season

South Africa, Australia	- southern summer December to March
India, Ceylon	- October/November to May
East Africa (occurrence)	- November/ December to March

5.3.5 Factors affecting fishing season

As the season approximates to the time of maximum surface water temperature, it will probably be affected by annual or other fluctuations in climatic and oceanographic conditions.

5.4 Fishing operations and results

5.4.2 Selectivity

The beach seine nets used in Ceylon and India are not selective and the catches represent the whole population of tuna and other fish present in the area surrounded by the net. The miscellaneous other methods of fishing used are not selective.

5.4.3 Catches

During the season, in northeast and northwest Ceylon a mixed catch of frigate mackerel and little tuna, E. affinis, may total 5000 individuals. One such catch may make the entire season a profitable one for the fishermen (Ceylon Department of Fisheries 1958).

No statistics are available from other areas.

5.4.4 Past and present factors of effect on operations and results

In India and Ceylon the incentive for the fishing of mixed shoals of frigate mackerel and little tuna is the great demand in Ceylon for the species as salted and sun dried fish, where the 1958 price was Rs. 100 to 120 (U.S. dollars 21 to 26) per 50 kg (Ceylon Department of Fisheries 1958; Nayar 1958).

Roughley (1951) stated that in Australia the species "is scarcely likely to figure as a

canning fish of any value because of the small size". In South Africa, Molteno (1948) reported that the species was not considered for canning because it is colored and highly flavored.

5.5 Fisheries management and regulation

Roughley (1951) writing of the frigate mackerel in Australia said "its commercial exploitation has yet to be demonstrated". This appears to be true throughout the Indian Ocean. In addition virtually no biological work, except of a taxonomic nature has been undertaken.

At the CCTA Symposium on Thunnidae held in Dakar in December 1960, it was decided that research into the exploitation and biology of the frigate mackerel should be recommended. The species is wholesome, and the red flesh and strong flavor is acceptable in most of the countries bordering the Indian Ocean. Considerable reserves must exist as it is probably the most abundant of all tunas.

