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(Distribution restricted) SAST - Tuna

SYNOPSIS OF BIOLOGICAL DATA ON LITTLE TUNA
Euthynnus affinis (Cantor) 1850 (INDIAN OCEAN)

Exposé synoptique sur la biologie de la thonine
Euthynnus affinis (Cantor) 1850 (Océan Indien)

Sinopsis sobre la biología del atunito
Euthynnus affinis (Cantor) 1850 (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 Euthynnus (Lütken) Jordan and Gilbert 1882
Species Euthynnus affinis (Cantor) 1850

1.1.2 Description

Genus Euthynnus (Lütken) Jordan and Gilbert 1882

Type Thunnus thunnina Cuvier and Valenciennes 1831 = Scomber alleteratus Rafinesque 1810

Euthynnus affinis (Cantor) 1850

Body robust, almost cylindrical in cross section; head somewhat compressed, pointed. Depth 3.6 - 4.58 in total length, 3.6 - 4 in standard length. Head 3.5 - 3.8 in total length, 3.2 - 3.5 in standard length. Eye 5.6 - 6.8 in head, 1.5 - 2 in snout, 1.5 - 2.1 in slightly convex interorbital space. Mouth oblique; jaws about equal; maxilla reaching to vertical through centre of eye. A single series of conical teeth in jaws, those in the lower slightly the stronger. Minute teeth on vomer and palatines. Gill rakers well developed, close set and slender, about 1.5 in length of corresponding gill filaments.

First dorsal spine broadest and longest - about equal to length of postorbital; following spines decreasing rapidly to eighth, the length of which is about half eye diameter; remaining spines subequal, last one minute and may be partly obscured or buried in the fin groove. Margin of fin strongly concave. First dorsal fin is separated from the second by a narrow interspace about equal to or less than the eye diameter Second dorsal fin low, longest ray anteriorly (about half length of first dorsal spine) and median rays the shortest; fin margin concave. Anal fin similar to second dorsal and origin under end of that fin. Both second dorsal and anal followed by a number of detached finlets. Pectorals 1.5 - 2.1 in head; pelvics short 2 - 2.5 in head, origin under or only slightly behind that of pectoral. Caudal broadly lunate; caudal peduncle with large median keel and two smaller ones either side of it.

Lateral line with no distinct arch but undulations above pectorals and below second dorsal fin.

Body naked except for the lateral line and the corselet of scales anteriorly. The rear margin of the corselet is formed by a line from the base of the second dorsal fin to a point slightly behind the pelvic fins, but with two deep emarginations which almost divide the corselet into three sections. The first emargination on the back reaches a point under approximately the eighth dorsal spine and is bordered below by the lateral line. The second emargination is wide covering almost the whole space between the pectorals and the pelvics, reaching forward in front of the vertical through the origin of the pelvics. The scales forming the corselet are well developed only on the back.

(specimens 375 - 750 mm standard length)

For meristic characteristics see Section 1.3.1 - Meristic counts.

Color. Immediate postmortem: Head and body blue-black, bluish to silvery white below. Posterior to the corselet margin above the lateral line there are a number of blue-black wavy broken lines (directed upwards and backwards) - these are very like those found in the common mackerel. In addition, there may be from one to six small dusky or black spots on the naked area below the level of the pectoral fin - the spots may be absent in some specimens or may vary from one side of the fish to the other. Pelvics blue-black except inside edges, dusky to whitish; other fins bluish-dusky.

1.2 Nomenclature

1.2.1 Valid scientific name

Euthynnus affinis (Cantor) 1850

1.2.2 Synonymy [1/]

Thynnus affinis (Cantor) 1850

Thynnus thunnina Bleeker 1850 (nec. C.V.)

Reference to the Indian Ocean species is also made by the following authors:

(a) under E. Alleteratus (Raf.)

Fowler 1934; Roughley 1951; Qureshi 1952; Central Fisheries Department, Pakistan 1953 and 1955; Fourmanoir 1954 and 1957; Smith 1956 and 1960.

(b) under E. alleteratus affinis (Cantor) de Beaufort and Chapman 1951

(c) under E. yaito Kishinouye

Blanc and Postel 1958

1.2.3 Standard common names, vernacular names

Table I
Common and vernacular names

Country	Standard common name(s)	Vernacular name(s)
Australia	Mackerel tuna, little tuna	
Ceylon	Lesser bonito, mackerel tuna	Atavalla, Ragodura, Sureya (Sinhalese), Shurai (Tamil).
Comoro Is.	Bonito	Mibassi, Mpassi
East Africa	Bonito, little tuna	Sehewa (Kiswahili) - also refers to Auxis and Katsuwonus spp.
India	-	Suraly (Tamil).
Madagascar	Bonite	Thonnine
Malaya	-	Tongkol; Ikanayer, Sembak, Choreng, Kembel-mas, Tombal-mas (Malay).
Mauritius	Bonito	Bonite
Pakistan (West)	Dwarf bonito	Dawan, Chooki, Jukko
Seychelles	Little tunny, bonito	Bonite
Somalia Mirjurtein coast	-	Shirwa, shirwi (Arabic)
Mogadiscio	-	Maba'adi (Somali); Jeidha (Somali), also refers to small Thunnus albacares and Megalaspis cordyla.

[1/] The whole problem of the synonymy of E. affinis is complicated by the indecisions regarding the relationships of E. affinis and the West Pacific form E. yaito Kishinouye, and the application by many authors of the name of the Atlantic form E. alleteratus (Raf.) to fish in the Indian Ocean. Taxonomic studies on E. affinis and E. yaito are now being carried out by Dr. F.H. Talbot (South African Museum) and Mr. F. Williams (E.A.M.F.R.O., Zanzibar). It seems likely that, as Matsumoto (1959) pointed out, E. yaito will prove to be co-specific with E. affinis.

1.3 General variability

1.3.1 Subspecific fragmentation (races) varieties, hybrids)

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

Morrow (1954) from a small sample of East African E. affinis, found that there were no significant differences between mean fin counts of males and females, except in the total anal count where the difference was significant at the 5 percent level.

Table II

Meristic counts of Euthynnus affinis

Country and author	First dorsal fin	Second dorsal fin	Anal fin	Pectoral	Gillrakers
Ceylon					
Deraniyagala 1952	XIV-XV	2.10+VIII	3.11-12+VII	28	lower 22-24
Munro 1955	XV	II, 18+8	II, 12+7	2, 24	lower 24
East Africa					
Morrow 1954	XIV-XV	11-12+8	12-14+6-7	-	-
Williams 1956, MS 1962	XV-XVI	11-13+8	13-14+6-7	-	7-10+22-23 = 29-33
India					
Day, 1873, 1878-88	15	3/10-11+8	3/11+7-8	26	-
Indonesia					
de Beaufort and Chapman 1951	XV	2.11+8	2.12+7	24	lower 24
Indo-Pacific					
Fraser-Brunner 1949, 1950	-	-	-	-	7+10+22-23
Madagascar					
Fourmanoir 1957	XV	11-13+8	II-III, 11-12+7-8	-	lower 25
Pakistan (West)					
Cent. Fish. Dep. 1955	15	3/10-11 + viii	3/11+viii	26	-
Red Sea					
Steinitz and Ben-Tuvia 1955	15-16	8-9 finlets	7 finlets	-	lower 23-24
Réunion					
Blanc and Postel 1958	-	-	-	-	8+1+24=33
South Africa					
Smith 1960	XV-XVI	11-13+8	II-III 10-12+6-8	-	lower 25

2 DISTRIBUTION

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

Euthynnus affinis has been recorded from the following areas in the Indian Ocean: Natal and northern part of Cape Province, South Africa; Madagascar and Mozambique Channel; Mauritius and Réunion; Comoro Is.; coasts of Tanganyika, Kenya and the Zanzibar Protectorate; Seychelles group, including Aldabra Island; Red Sea, Gulf of Aden, Arabian Sea; West Pakistan; west, south and sout east coasts of India; Laccadive and Maldive Archipelagos; Ceylon; Andaman and Nicobar Is.; west coasts of Malaya; Indonesian Archipelago; Australia except south coast.

The geographical distribution of E. affinis covers the tropical and subtropical Indian Ocean. The extreme southern boundary is approximately a line drawn from East London, South Africa (Lat. 33°S) to Perth, Western Australia (Lat. 32°S).

Generally the tropical and subtropical waters of the Indian Ocean are characterized by a scarcity of plankton offshore. Except in areas where vertical mixing of water masses takes place (e.g. upwelling off Somalia), 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 in 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).

2.2 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.

- Eggs — No data
- Larvae

The only published records are those for E. yaito (? = E. affinis) (see section 1.2.2) taken by the Dana Expedition in September and October 1929 in the waters off the west coasts of Sumatra and Java (Matsumoto 1959).

- Adults

In most of the areas (Madagascar, East Africa, Somalia, Arabian Sea, Seychelles, Mauritius, Australia) from which it is recorded, E. affinis is normally found between the 40 m and 250 m lines. The commonest method of capture is surface trolling. Only in South Africa (juveniles only), West Pakistan, India and Ceylon does the species come very close inshore and is taken by beach seines (at least for part of the year).

In East Africa, Madagascar, northwest and north Australia, the species is present throughout the year, but has a marked abundance at one period. In East Africa this is from November/December to April/May. In the Seychelles and Somalia the occurrence of E. affinis is restricted to the period October/November to May; similarly in the extreme southern parts of the range - South Africa, Mauritius and West Australia, occurrence is restricted to the months of the southern summer.

However, in areas such as West Pakistan and Ceylon, E. affinis is present throughout most of the year, but the distribution both in local position and distance offshore varies according to the season. In Ceylon (Deraniyagala 1952; Department of Fisheries 1958) shoals are found close inshore in March and April in the northeast and northwest of the island and offshore in November to May on the south and west coasts. In West Pakistan the fish occur off the Makran in August to October, offshore in November to January, then further south east off Sind in February and March.

2.3 Behavioristic and ecological determinants of the general limits of distribution and of the variations of these limits and of differential distribution

As with most tunas, temperature appears to be the limiting factor in the distribution of E. affinis. The extreme southern boundary of geographical distribution lies at about Lat. 32-33°S (see section 2.1). In the southern summer, which is the period of occurrence of the species in these

extreme southern areas, the distribution closely follows the 22°C isotherm (Sverdrup, Johnson and Fleming 1942). In the southern winter the 22°C isotherm is found in a more northerly position and the little tuna is absent from the areas occupied in summer.

The greatest abundance of E. affinis in East African waters is at the time of increasing or maximum temperature (28-30°C) and of greatest fertility of the surface waters. In the Seychelles, occurrence of the species (which coincides with the breeding season) is also at the time of highest surface temperature - November to May. In Somalia the season is the same but the temperature of the surface water is lowest or just beginning to rise; however, the abundance of tuna is due to considerable mixing of surface and subsurface water and subsequent macrozooplankton abundance at relatively shallow depths. Although observations in the area (Ogilvie, Fraser-Brunner and Byrd 1954) were scant, it was thought that temperature differences at subsurface levels, particularly in the critical thermocline region, might be associated with annual variations in tuna catches.

No data is available for West Pakistan or Ceylon to account for the change in location of the shoals of E. affinis during the year.

According to Matsumoto (1959) the temperature was 24.5°C and 29.0°C at stations off the west coasts of Java and Sumatra where Euthynnus larvae were caught.

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.1.1 Sexuality (hermaphroditism, heterosexuality, intersexuality)

E. affinis is heterosexual. No external characters distinguish the sexes.

3.1.2 Maturity (age and size)

Wheeler and Ommanney (1953) reporting on 75 specimens of E. affinis taken in the Seychelles group, found that sexual maturity occurred between 50-65 cm total length and probably in the third year of life. In 37 East African specimens, Williams (1956, and unpublished data) found that sexual maturity was reached between 55 and 60 cm total length, whilst in Mauritius de Baissac (MS. 1960) records mature specimens at 55 cm.

3.1.6 Spawning

- Spawning seasons (beginning, end, peak)

Published data on the spawning season of E. affinis is restricted to the western part of the ocean. Evidence presented by Wheeler and Ommanney (1953) for the Seychelles showed an extended breeding season during the period of the northwest monsoon - October/November to April/May with the peak from January to March. Similarly in East Africa Williams (MS. 1962) shows an extended spawning season from January to July - the middle of the northeast monsoon period to the start of the southeast monsoon.

In the Madagascar area breeding fish were taken in November and December (Fourmanoir 1957) and in Mauritius in December (de Baissac MS. 1960). However, in the Eastern Indian Ocean the taking of recently hatched larvae in September and October (1929) (Matsumoto 1959), perhaps suggests a different season in that area.

3.1.7 Spawning grounds

- Coastal, (surface, vegetation, shore, shoal sand, shelter)
- Oceanic (surface, bottom)

Data from the Western Indian Ocean (Seychelles, East Africa, Madagascar, Mauritius) shows that the spawning grounds for E. affinis are coastal, at least inside the 200 m line.

Matsumoto (1959) considering the world-wide distribution of Euthynnus larvae, found that they were always taken close to land masses, and that this indicated similar localities for the spawning of the adults. This seems true for E. affinis.

3.2 Larval history

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

Of the larvae described as E. yaito in Matsumoto (1959), only a very small proportion was taken in the Indian Ocean; they are not discussed here. (At time of writing E. yaito is still regarded as the West Pacific form, and data on larvae are given in Species Synopsis No. 7).

3.3 Adult history

3.3.3 Competitors

In East African waters it appears that the competitors with E. affinis are the other fish found in the surface shoals of mixed species (Williams MS. 1962); these fish are skipjack (K. pelamis), small yellowfin (T. albacares), frigate mackerel (A. thazard), and Megalaspis cordyla (Carangidae).

In Ceylon shoals are formed of E. affinis and A. thazard and presumably the latter is a direct competitor for food.

3.3.4 Predators

In East Africa, specimens of Euthynnus have been taken from the stomachs of longline-caught striped marlin (Tetrapterus audax) and white sharks (Carcharinus spp.).

3.3.6 Greatest size

Greatest recorded size appears to be from the Seychelles (Wheeler and Ommanney 1953) - 87 cm, 19 lb. Smith (1960) states that Euthynnus grows to at least 120 cm, but this is most doubtful even for the Atlantic form E. alleteratus under which Smith's remarks are listed.

3.4 Nutrition and growth

3.4.1 Feeding (time, place, manner, season)

The shoals of small tunas, including E. affinis, found in East African surface waters (inside the 200 m line) during daylight hours, were invariably feeding on shoals of small fishes (Williams 1956, MS. 1962). The position of these shoals was usually given away by the presence of diving sea birds (terns). These feeding shoals of small tuna were normally moving very fast and at times up to 8 to 10 knots with frequent and abrupt changes in direction. When feeding right at the surface little tuna often become frenzied, hurling themselves out of the water to chase the small fish which also were continually leaving the water whilst being pursued. Feeding is heaviest in the early morning and late afternoon.

Feeding shoals were seen throughout the year in East Africa but appeared to be most abundant in the period December to March.

Fourmanoir (1957)reported that in Madagascar waters shoals of little tuna were seen actively feeding at the surface during daylight hours and that the shoals moved rapidly - at least up to 5 knots.

3.4.2 Food (type and volume)

Data on the food of E. affinis is all from the western part of the ocean.

Fourmanoir (1954) reported that stomach contents of little tuna examined in the Comoro Is. in April were mainly small Priacanthidae (Pisces) and larvae of Squilla sp. (Crustacea, Stomatopoda). The same author (1957) found in the Madagascar region that E. affinis was actively feeding on the small fishes - Anchoviella indica, Stolephorus sp. and Sardinella spp. as well as small squid and Squilla larvae.

In East African waters (Williams MS. 1962) 34 stomachs were examined qualitatively, 10 (29.4%) were empty; in the 24 with contents, the percentage occurrence of food groups was as follows: Fish 71%, Squid 21%, Crustacea 21%, zooplankton organisms 8%. The majority of the fish were Atherina sp. and Clupeids - 25 to 100 per stomach. Crustacea were mainly Squilla larvae.

Wheeler and Ommanney (1953) examined the stomachs of 57 specimens caught in the Seychelles. 25 stomachs (43.8%) were empty, whilst in the 32 with contents the percentage occurrence of food items was as follows:

	Percent of Occurrence
Flying fish	6.3
Blue mackerel (Caesio caerulaureus)	9.4
Dipterygonus sp.	3.1
Box fish (Ostraciontidae)	3.1
Eel remains	3.1
Unidentifiable fish remains	34.3
Cephalopod remains	12.3
Macroplanktonic crustacea, Megalopa larvae, etc.	25.0
Gastropods (small)	3.1

Leaves of the turtle grass (Cymodocea sp.) were found in one stomach, and this, coupled with the presence of box fishes, eels and small gastropods, suggested to the authors that E. affinis, in addition to surface feeding, frequently looked for food along coral or sandy bottoms.

Ogilvie, Fraser-Brunner and Byrd (1954) examined the stomachs of 102 specimens taken in the waters off north Somalia. Only 5 (4.9%) were empty and in the 97 with contents the percentage occurrence of food items was as follows:

	Percent of Occurrence
Thrissocles baelema	19.5
Hepsetia pinguis	12.3
Sardinella sirm	53.6
Selar crumenophthalmus	21.6
Silago sihama	18.5
Mugil sp.	6.1
Leiognathus sp.	5.1
Prawns	4.1
Unidentified remains	16.2

From this analysis Ogilvie, Fraser-Brunner and Byrd concluded that E. affinis fed both at the bottom and at the surface.

From the available data it appears that E. affinis in the western Indian Ocean normally feeds at the surface on small shoaling fishes and zooplankton, but in two areas at least (Seychelles and Somalia) it also feeds on fishes and other food items obtained on or near the bottom.

3.4.3 Relative and absolute growth patterns and rates

For ten specimens of E. affinis caught in East African waters Morrow (1954) calculated the weight/length relationship to be:

$W = 1.63 \times 10^{-6} \quad L^{3.16}$ where W = weight in pounds and L = length in centimetres.

Wheeler and Ommanney (1953), as a result of specimens taken in the Seychelles, suggested the following rates of growth;

? 0 - 25 cm	1st year
?25 - 45 cm	2nd year
45 - 65 cm	3rd year
65 cm and over	4th year and above

This of course assumed "that the growth pattern of the young bonito is of the normal shape, proceeding at even rate in the earlier years" (see also section 3.1.2).

3.5 Behavior

3.5.1 Migration and local movements

The occurrence of little tuna in the southern areas of the distributional range - Cape Province, South Africa and Southwest Australia - appears to be the result of migration which follows the southward movement of approximately the 22°C isotherm in the southern summer.

The marked seasonal occurrence of E. affinis in the Seychelles and north Somalia indicates migrations or local movements about which little is known at present.

In Ceylon and West Pakistan there appears to be considerable local movement of shoals of E. affinis, according to the season, both in locality and distance offshore.

(See section 2.2.1 - Areas occupied by adult stages: seasonal and annual variations of these).

3.5.2 Schooling

Observations in East African waters show that with small E. affinis the schooling is strong and disciplined, but this does not seem to be so with larger fish. In this area, shoals of mixed species may include small yellowfin tuna (T. albacares), skipjack (K. pelamis), frigate mackerel (A. thazard) and Megalaspis cordyla (Carangidae) as well as E. affinis. It is interesting to note that in shoals of mixed species the individuals were of much the same size.

In Ceylon mixed shoals of little tuna and frigate mackerel are very common.

Fourmanoir (1957) reported that around Madagascar shoals of little tuna were almost always distinct from other species of tuna. However, in June, to the east of Nosy-Bé, yellowfin tuna were taken at the same time as little tuna.

Shoals in East Africa appear to number 100 to 1,000 or more individuals, whilst in Ceylon as many as 5,000 individuals (mixed little tuna and frigate mackerel) may be taken in one haul of a beach seine.

4 POPULATION (STOCK)

4.1 Structure

4.1.1 Sex ratio

In both East African and Seychelles areas the small catches appear to indicate no significant departure from the expected 1 : 1 sex ratio.

4.1.2 Age composition

The only area where age of E. affinis has been estimated is the Seychelles (Wheeler and Ommanney 1953). Of the specimens caught during that survey about 70 percent of the males and 40 percent of the females were reported to be in their fourth year or more, whilst most of the remainder were in their third year.

4.1.3 Size composition

The main size groups and the overall size range of the catch of E. affinis in various areas are given in Table III.

In four areas at least it seems that the population is made up of two main size groups.

4.2 Size and density

4.2.1 Average size

(See section 4.1.3).

Table III

Size composition of catches of Euthynnus affinis

Area and Author	Main size groups	Overall size
Australia		
Roughley 1951	2.2 - 4.1 kg 5.4 - 6.6 kg	up to 76 cm and 8.2 kg
East Africa		
Morrow 1954	-	51 - 71 cm at 1.9 - 5.2 kg
Williams, MS 1962 1/	1 - 2.2 kg 3.6 - 5.4 kg	40 - 78 cm at 1 - 7.3 kg
Madagascar		
Fourmanoir 1954	-	up to 80 cm
Seychelles		
Wheeler and Ommaney 1953	45 - 65 cm over 65 cm	43 - 87 cm at 1 - 8.6 kg
Somalia		
Ogilvie, Fraser-Brunner and Byrd 1954	50 cm at 3 - 4 kg	up to 79 cm and 6 kg

1/ Shoals of mixed species of tuna.

5 EXPLOITATION

5.1 Fishing equipment

5.1.1 Fishing gear

Surface trolling with either a natural bait or an artificial lure forms the commonest method of capture in Madagascar, Comoro Is., East Africa, Somalia, Seychelles and Australia. In Somalia handlines and longlines are also used.

In Ceylon and also on the west coast of India beach seines are the commonest gear used for the mixed shoals of little tuna and frigate mackerel which occur close inshore. The seines are large, with a 3 to 5 m cod end, 7 to 13 m wings, and hauling ropes of 500 m, and usually require 20 to 70 men for hauling operations.

In West Pakistan (Qureshi 1952) surface trolling, longlines, handlines and beach seines are all used for the capture of little tuna.

The small numbers of fish caught in Mauritius and South Africa (juveniles) are from general beach seine hauls.

5.1.2 Fishing boats

No craft are used specifically for the little tuna fishery.

5.2 Fishing areas

In Madagascar, Somalia, Seychelles, West Pakistan, Indian west coast and Ceylon specific attempts are made to catch the little tuna. In other areas catches are largely incidental and taken during other routine fishing.

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 from surface trolling inside the 200 m line or from beach seines in very shallow water. The small numbers taken by handlines and longlines are from the surface waters down to about a maximum of 60 m.

5.3 Fishing seasons

5.3.1 General pattern of fishing season

In the southern areas of the distributional range - South Africa and Southwest Australia - the species occurs and is fished only during the southern summer when surface water temperatures are maximal for those areas.

In the Seychelles, the species has a marked occurrence and the fishing season occurs during the northwest monsoon when the surface water temperature is highest - 29 to 30°C. However, the minimum temperature recorded in the area during the southeast monsoon of 23 to 24°C is still much higher than those in southern areas such as southwest Australia in the southern summer. The peak of the fishing season also coincides with the peak of the spawning season.

In north Somalia the season is during the northeast monsoon at the time of minimum surface temperatures, when enrichment of local waters due to vertical mixing of surface and subsurface water results in an abundance of zooplankton.

In West Pakistan, west coast of India and Ceylon, E. affinis is taken throughout the year but variations take place in locality and distance offshore of the shoals. In East Africa, Comoro Is., and Madagascar, E. affinis is also taken throughout the year, but abundance appears to be greatest at the time when temperatures are maximum, and at least in East Africa this is when maximal fertility is reached in the surface waters.

(Also see section 2.3)

5.3.2 Duration of fishing season

Table IV

Area	Duration
South Africa Mauritius S.W. Australia	3 - 4 months (occurrence)
N. Somalia Seychelles	6 - 7 months
W. Pakistan	8 months

In all other areas: present throughout most of the year but with pronounced peaks of abundance.

5.3.3 Dates of beginning, peak and end of season

Table V

Area	Duration
South Africa Mauritius Southwest Australia	Occurrence in southern summer December to March
North Somalia Seychelles	November/December to April/May Peak in Seychelles February to April
West Pakistan	August to March with peaks in Augustto October and February-March
Ceylon	Throughout the year but on northeast and northwest coasts, peak in March and April and on south and west coasts peak from November to May
East Africa	Throughout the year, peak of occurrence in November/December to April/May
Madagascar Comoro Is. Australia	Throughout the year but no data regarding seasonal peaks

5.3.5 Factors affecting fishing season

The duration and limits of the season or peaks of abundance are affected by annual or other fluctuations in the climatic and oceanographic conditions in the areas concerned.

5.4 Fishing operations and results

5.4.2 Selectivity

The beach seine nets, principally used in Ceylon, are not selective and the catches represent the whole population of tuna and other species of fish present in the area surrounded by the net. The other methods of fishing (surface trolling, handlines, longlines) are not selective for the little tuna.

5.4.3 Catches

During the season in northeast and northwest Ceylon a mixed catch of little tuna and frigate mackerel with a beach seine may total 5,000 individuals. One such catch may make the entire season a profitable one for the fishermen (Department of Fisheries 1958).

In the Seychelles, Wheeler and Ommanney (1953) reported that E. affinis, with the dolphin fish (Coryphaena hippurus), formed the bulk of pelagic fishes taken during the northwest monsoon period.

Ogilvie, Fraser-Brunner and Byrd (1954) give some data on catches made experimentally off the north Somalia coast from December 1952 to April 1953, principally as a result of trolling, but with some longlining and live bait fishing.

No. of days fishing	42
No. of fish	2,209
Total weight	6,717 kg
Average weight	3.04 kg
No. of hours fishing	359
No. of fish per hour	6.15
Weight per hour	18.98 kg

Both from the point of view of numbers and individuals, and frequency of occurrence in the catches, E. affinis "was by far and away the most common of the commercial fishes of the area available to the gear used, during the season".

No other statistics are available.

5.4.4 Past and present factors of effects on operation and results

In India and Ceylon the incentive for the fishing of mixed shoals is the great demand for the species as salted and sundried fish in Ceylon, where the 1958 price was Rp. 100 - 120 (U.S. dollars 21 - 26) per 50 kg (Department of Fisheries 1958).

In West Pakistan the little tuna is considered a valuable food fish; in East Africa this is also true but catches are very small.

In Australia and South Africa the incentive to fish for little tuna is low as the "dark meat" of strong flavor is not esteemed even when canned.

In Somalia E. affinis has been canned successfully even though the fish are small and the flesh is dark and coarse. However, the canneries are unwilling, except in very poor tuna seasons, to accept little tuna in quantity, in case this might encourage the local fishermen to give up searching for the commercially more valuable "light meat" tunas such as yellowfin (T. albacares) and longtail (T. tonggol). A small amount of little tuna is salted and sundried for local consumption.

5.5 Fisheries management and regulations

In all areas where E. affinis is not utilized in the fresh state (either due to non-acceptability of the dark flesh - South Africa and Australia - or low population density - Somalia) catching of the species has not been encouraged as canneries do not want large quantities for processing due to the difficulties in finding markets for the "dark meat" pack.

However, it was pointed out at the CCTA Symposium on Thunnidae held in Dakar, December 1960, that markets for "dark meat" tuna packs are growing, especially in Southern Europe.

This same meeting recommended investigations into methods of exploitation and the biology of the little tunas (Euthynnus spp.). Certainly in most of the countries bordering the Indian Ocean, bar South Africa and Australia, the red meat and strong flavor is readily acceptable. It was suggested that little tuna be processed as fish sticks or as a product like the Japanese "Katsuwebuschi" for local sale, and export within the Indian Ocean area.

Roughley (1951) pointed out that in Australian waters the little tuna occurred in commercial quantities and could be successfully canned. Ogilvie, Fraser-Brunner and Byrd (1954) reached similar conclusions in Somalia. In East African waters, Williams (1956: MS 1962) pointed out that there are large shoals of tuna, including little tuna, as yet unexploited.

It seems that there are large reserves of E. affinis in the Indian Ocean unfished mainly due to the difficulty in the past of finding suitable markets. Morgans (1954) estimated Euthynnus and Sarda spp. represented about 0.5 percent of all fish by weight in the Indian Ocean.