SYNOPSIS OF BIOLOGICAL DATA ON ORIENTAL BONITO
Sarda orientalis (Temminck and Schlegel) 1842 (INDIAN OCEAN)

Exposé synoptique sur la biologie de la pélamide
Sarda orientalis (Temminck et Schlegel) 1842 (Océan Indien)

Sinopsis sobre la biología del bonito
Sarda orientalis (Temminck y Schlegel 1842 (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
Suborder Scombroidea
Subfamily Thunninae
Genus Sarda Cuvier
Species Sarda orientalis
(Temminck and Schlegel) 1842

1.1.2 Description

- Genus Sarda Cuvier 1829

(Tautotype: Scomber sarda Linnaeus)

Synonyms: Pelamys Cuvier

Palamita Bonaparte, 1831.
Type: Scomber sarda Linnaeus
(Type designation by Jordan, 1919).

Creotroctes Gistel, 1848.
Type: Scomber sarda Linnaeus
(Genus proposed to replace Sarda Cuvier).

"Body elongate, but rather short and compressed in young specimens. Scales minute, and a small corselet more or less distinct. The caudal keel is thick and naked. Teeth in both jaws are large, compressed, strongly curved inward but not trenchant. Near the anterior end of the lower jaw, the row of teeth is is bent inwards and approaches the symphysis. The vomer is toothless, but a single row of rather strong curved teeth on the palatines. Tongue also toothless. Many dark longitudinal more or less oblique stripes are found in the dorsal part of the body. Verbetrae of the caudal peduncle have lateral keels...." (Kishinouye, 1923).

The genus has been placed under the family Cybiidae by Kishinouye (1923); under family Thunnidae, subfamily Sardinae by Fowler (1949); and under family Scombridae - subfamily Scombrinae, by Fraser-Brunner (1950).

- Species Sarda orientalis
(Temminck and Schlegel)

Body proportions expressed as thousandths of total length (measured as suggested by Marr and Schaefer, 1949) for 45 specimens ranging in length from 80 mm to 497 mm collected from Vizhingam from the south west coast of India are given in Table I.

The disposition of the different organs of the viscera in an adult male 497 mm long is shown in Figure 1a. There is hardly any difference between this and those given for the typical specimen of S. orientalis from Japan by Godsil (1955) except that part of the gall-bladder lying alongside the intestine is also clearly seen. The right lobe of the liver is slightly longer than the left. (Figure 1b latter viewed from dorsally with lobes detached). The stomach is hidden from view, but is an elongate organ.

Silas (1962) has drawn attention to changes in the shape and disposition of the visceral organs in specimens of S. orientalis ranging from 80 mm to about 400 mm. Air-bladder is wanting.

There are marked differences between juvenile and adult body colourations. According to Jones (1960) in the smallest juvenile - 80 mm long - "The body bears twelve transverse bands which are broad at the dorsal aspect and taper laterally to become imperceptible on reaching the sides of the abdomen and above the anal. One of the larger juvenile specimens measuring 158 mm in standard length and 174 mm in total length collected from Vizhingam..... The transverse bands referred to the previous stage have subdivided into more or less horizontal streaks, which ultimately unite to give rise to the lines so characteristic in the adult. In a specimen 262 mm in total length all the lines immediately above the pectoral fins have already been formed as in the adult". (Figures 2a and 2b). In specimens between 250 mm and 300 mm examined by the author from Vizhingam on the south west coast of India, the sides of the body are characterised with 5 to 7

Table I

Body measurements expressed in thousandths of total length in different size groups of Sarda orientalis (Temminck and Schlegel) (After Silas, 1962)

Characters	Size groups (mm) 50 - 100	150 - 200	201 - 250	251 - 300	351 - 400	451 - 500
Head Length	1 : 319	24:275-319 (299)	3:291-307 (299)	13:288-306 (302)	2:295-312 (303)	2:294-299 (296)
Snout to origin of D_1	1 : 310	23:271-315 (297)	3:291-311 (300)	13:300-311 (306)	2:298-312 (305)	2:294-310 (302)
Snout to origin of D_2	1 : 610	24:532-619 (586)	3:569-599 (587)	13:593-626 (604)	2:588-604 (596)	2:590-608 (599)
Snout to origin of A	1 : 709	24:623-721 (684)	3:688-698 (692)	13:686-710 (699)	2:688-710 (699)	2:688-694 (691)
Snout to origin of P_2	1 : 341	23:302-350 (330)	3:318-354 (334)	13:311-339 (328)	2:311-337 (324)	2:322-336 (329)
Greatest depth of body	1 : 225	24:204-233 (218)	3:213-240 (226)	13:214-234 (224)	1:215	2:204-209 (206.5)
Length of P_1	1 : 101	24:67-121 (107)	3:103-124 (112)	13:115-126 (129)	2:127-131 (129)	2:124-137 (130.5)
Height of D_2	1 : 73	24:51-80 (64)	3:64-80 (73)	13:54-86 (70)	2:82-84 (83)	2:86-87 (86.5)
Height of A	1 : 78	23:58-81 (64)	3:60-71 (66)	13:64-79 (71)	2:80-87 (83.5)	2:86-91 (88.5)
Diameter of iris	1 : 56	24:39-56 (43)	3:43-50 (46)	13:43-49 (46)	2:49-51 (50)	2:41-42 (41.5)

In each column the number of specimens is given followed by range and the mean is indicated in parenthesis.

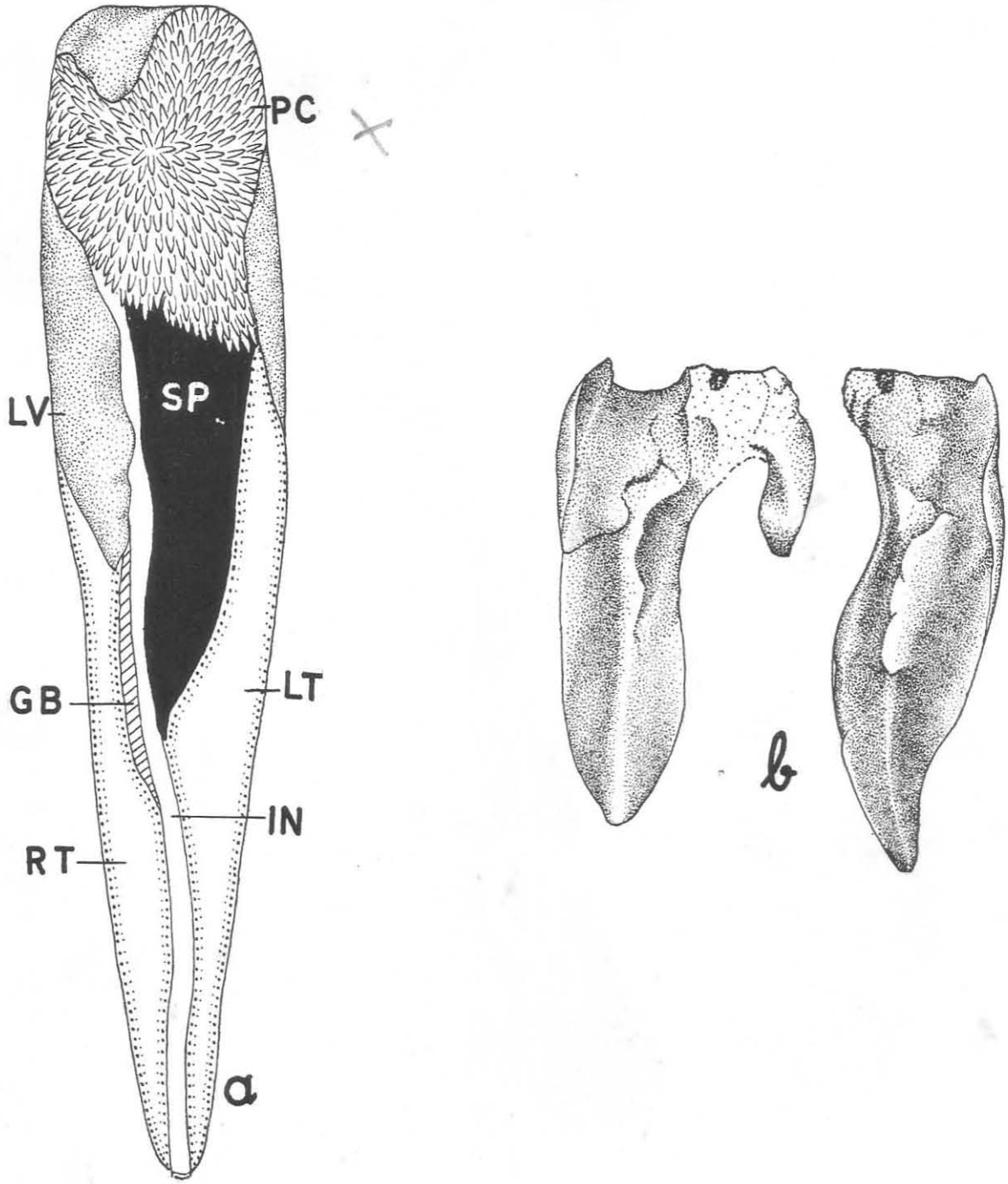

Figure 1. Sarda orientalis (Temminck and Schlegel)

a) Ventral view of Viscera in situ in a specimen 497 mm. (GB = gall-bladder; IN = intestine; LT = left testes; LV = liver; PC = caecal mass; RT = right testes; SP = spleen.)

b) Dorsal view of liver of same with right lobe detached showing relative lengths of the three lobes.

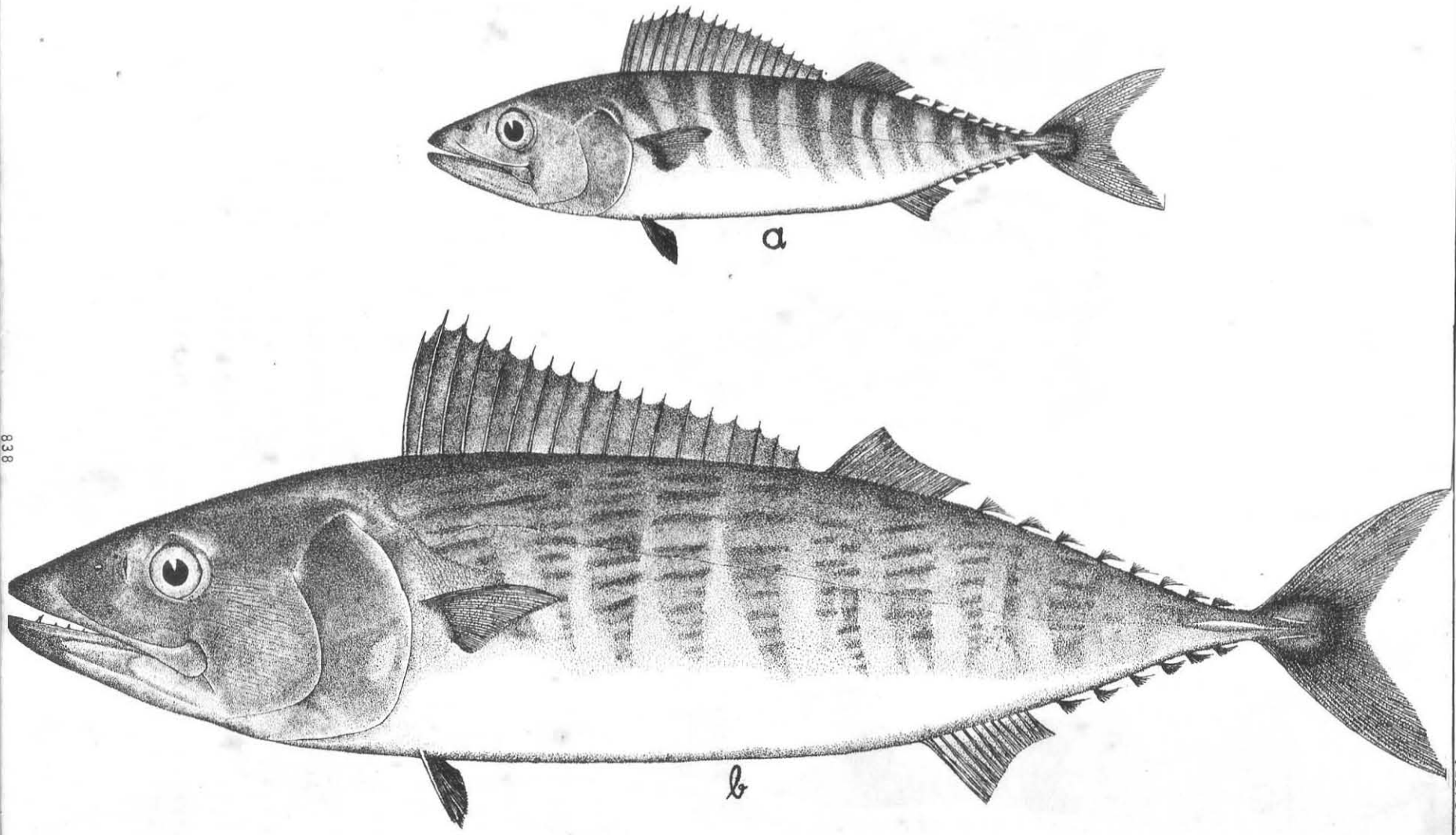

Figure 2. Sarda orientalis (Temminck and Schlegel)
a) and b) Lateral view of specimen 80 mm and 158 mm showing variation in early juvenile colouration (after Jones, 1960).

longitudinal stripes along the upper half running horizontally. Below the stripes, in the lower half of the body the interrupted bars are still evident. The tips of the second dorsal, dorsal finlets, anal and anal finlets are whitish. The interspinous membrane of D_1 is blackish throughout except for the narrow basal area between the first eight spines which is light dusky. The outer margin of the pectoral is also whitish while the pelvics are colourless. In formalin, dorsally the body is blackish while laterally it is dusky and ventrally yellowish brown which in life appears more or less silvery. According to Day (1878) "The upper half of the body with about eight broad, straight, blue lines passing backwards and a little upwards, silvery below the lateral-line where, however, there are similar lines but very faint."

The corselet is not prominent, but well formed, its posterior extension reaching to below tip of pectorals. The lateral line takes a loop above level of mid-pectoral from which it gently slopes to the caudal keel slightly undulating.

Posterior teeth on each side of the lower jaw are more prominent than those towards the symphysis as well as those on each side of the upper jaw. However, more teeth appear to be present in the upper jaw (10 - 14 on each side) than in the lower jaw (7 - 12 on each side).

The gill rakers are small, the longest being only about half the length of the longest gill filament.

For osteological characters as well as other anatomical features of S. orientalis, reference may be made to Kishinouye (1923) and Godsil (1955).

For meristic characters see section 1.3.1

1.2 Nomenclature

1.2.1 Valid scientific name

Sarda orientalis (Temminck and Schlegel)

1.2.2 Synonyms

Pelamys orientalis Schlegel, 1850
Günther, 1860

*Scarda chilensis var. orientalis Steindachner and Doderlein, 1885
(* Typographic error for Sarda)

Pelamys chilensis (nec Cuvier) Day, 1878,1889

Sarda chilensis (Partim) Chabanaud, 1944; Barnard, 1927

Sarda chilensis (nec Cuvier) Smith, 1949

Sarda orientalis Kishinouye, 1923
Fraser-Brunner,1950
Godsil, 1955
Smith, 1961
Jones and Silas, 1960, 1962
Talbot, 1962

Sarda velox Meek and Hildebrand,1923

Sarda orientalis serventyi Whitley, 1945, 1962

The species S. chilensis and S. orientalis have been confounded by some workers, but now it is quite clear that throughout the Indo-Pacific only two species, or two species complexes - namely the S. orientalis complex and the S. chilensis complex - exist while a third species, S. sarda is known only from the Atlantic and Mediterranean. S. orientalis may easily be distinguished from S. chilensis by the fewer gill rakers (total 8 - 13 versus 20 - 27) the absence of gill teeth (versus present in S. chilensis) and other anatomical differences drawn attention to by Godsil (1955). But for the disjunct distribution, the available data is insufficient to consider the Western Australian representatives of the species as distinct, although Whitley (1945) has used the subspecific name S.o. serventyi to denote the same. Godsil's (1955) work throws more light on the close affinity between S. orientalis as well as S. velox and it is highly doubtful whether both are not conspecific. We consider the latter a synonym of S. orientalis.

1.2.3 Standard common names, vernacular names

See Table II

Table II

Common and vernacular names

Country	Standard common name	Vernacular name(s)
Australia (Western)	Oriental bonito	
India	Oriental bonito	Vari choora (Malayalam)
Mauritius - Seychelles		Brasse-a-dents (Creole name)
Somali		Sinufa
South Africa, Republic of	Bonito	

1.3 General variability

1.3.1 Subspecific fragmentation (races, varieties, hybrids)

- Meristic counts

Variability in meristic counts in specimens ranging in length from 80 mm to 497 mm from Vizhingam on the south west coast of India is given in Tables III, IV and V.

The meristic characters given above hardly throw any light on infra-specific variations. The only noteworthy difference appears to be the higher anal finlet counts for the South African specimens (6 - 9) while in both Indian and western Australian specimens it ranges from 5 - 7. The meristic data given for the typical S. orientalis from Japanese waters by Kishinouye (1923) (D.19, 15, 7-8. A.15, 5-6. Gill rakers 4+9: Vertebrae 25+20) and Godsil (1955) (D.18, 15-16, 8.A.15, 6-7, gill rakers 2-3+1+8-9) (total 11-13 or 14) draw attention to the absence of any marked deviations from the typical form from Japanese waters, except that mentioned above for South Africa. Hardly any difference in the modal count of gill rakers is seen. Godsil (1955) mentions 3+1+8 = 12 as the modal count for the five specimens from Japanese waters examined by him. As will be seen from Table IV, the modal count of this character for specimens from Indian seas appears to be 3+9 = 12.

Differences in body colouration are attributable to the different growth stages. Some of the changes from juvenile to adult may be seen in Figures, 2a, 2b, and 3.

Albinism, melanism or rubism have not been observed, nor has natural hybridization ever been noted.

- Abnormalities

Only two types of abnormalities were met with namely, the occasional absence of a finlet (Figure 4a) or the marked shortening of the pectoral fins (Figure 4b). The latter may be compared with the normal condition as shown in Figure 4c.

Table III

Meristic counts for specimens from Indian seas
(After Silas, 1962)1/

Characters range	Dorsal spines	Second dorsal rays	Dorsal finlets	Pectoral rays	Anal rays	Anal finlets
	17 18 19	14 15 16	7 7+1 8 8+1	23 24 25	13 14 15 16	5 5+1 6 6+1 7
Number of specimens	2 37 7	20 7 3	7 5 31 1	3 28 13	4 18 6 1	2 3 36 2 1
	N = 46 M = 18.1	N = 44 M = 14.43	N = 44 M = 7.86	N = 44 M = 24.2	N = 29 M = 14.13	N = 44 M = 6.02

1/ For calculating mean, when dorsal and anal finlet counts are given as 5+1, 6+1, 7+1 and 8+1, these are treated as 6, 7, 8 and 9 respectively.

Table IV

Gill raker count for Sarda orientalis from three centres along the south west coast of India
(After Silas, 1962)

A

Locality	Gill rakers on upper and lower limbs of outer gill arch												No. of specimens
	1+8	2+8	3+8	4+8	1+9	2+9	3+9	4+9	1+10	2+10	3+10	4+10	
Cape Comorin	-	-	-	-	-	-	2	1	-	-	-	-	3
Vizhingam	1	2	3	-	3	6	14	2	-	1	4	1	37
Calicut	-	-	-	-	-	-	2	-	-	-	-	-	2
No. of specimens	1	2	3	-	3	6	18	3	-	1	4	1	42

Table IV (continued)

B

Locality	Gill rakers						
	Upper limb				Lower limb		
	1	2	3	4	8	9	10
Cape Comorin	-	-	2	1	-	3	-
Vizhingam	4	9	21	3	6	25	6
Calicut	-	-	2	-	-	2	-
No. of specimens	4	9	25	4	6	30	6
	N = 42 M = 2,7				N = 42 M = 9		

Table IV (continued)

C

Locality	Total No. of gill rakers					
	9	10	11	12	13	14
Cape Comorin	-	-	-	2	-	-
Vizhingam	1	5	9	15	6	1
Calicut	-	-	-	2	1	-
No. of specimens	1	5	9	19	7	1

N = 42 : M = 11.7

Table V

Meristic counts in Sarda orientalis from various parts of the Indian Ocean

Author and Area	D_1	D_2	D_2 filets	P_1	A	A filets	Gill rakers
Smith, 1948 (South Africa)	XVII-XIX	14-16	6-9	-	ii-iii, 10-12	6-9	- + 8
Munro, 1958 (West Australia)	XVII-XIX	15	7-8	22-27	15	5-6	2-4+7-9
Silas, 1962 (South west coast of India)	XVII-XIX	14-16	7-8 (exceptionally 9)	23-25	13-16	5-7	2-4+8-10

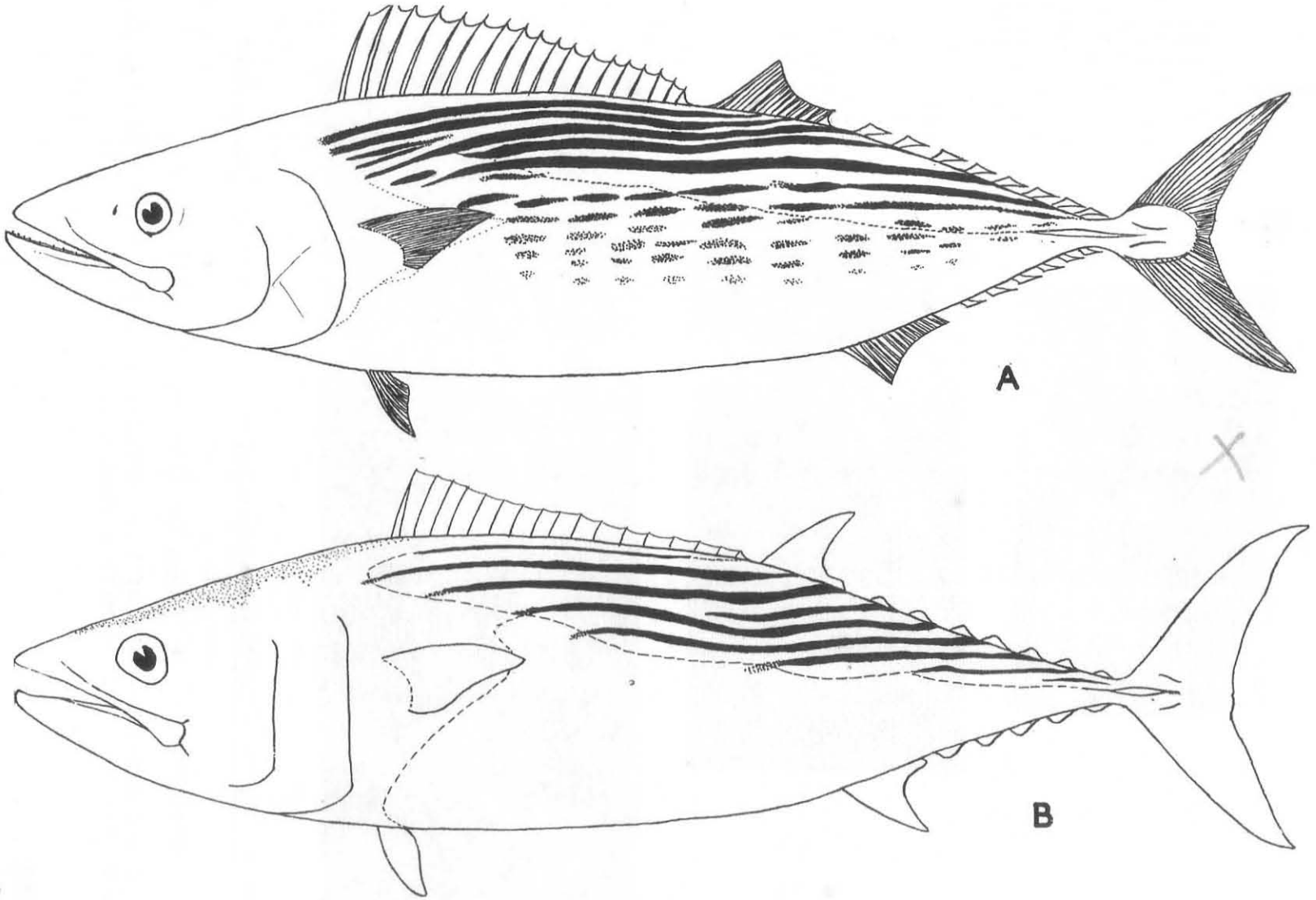

Figure 3. Sarda orientalis (Temminck and Schlegel)

A) Juvenile 245 mm long (after Jones and Silas, 1960).
B) Adult showing difference in colour pattern on side of body (after Fraser-Brunner, 1950).

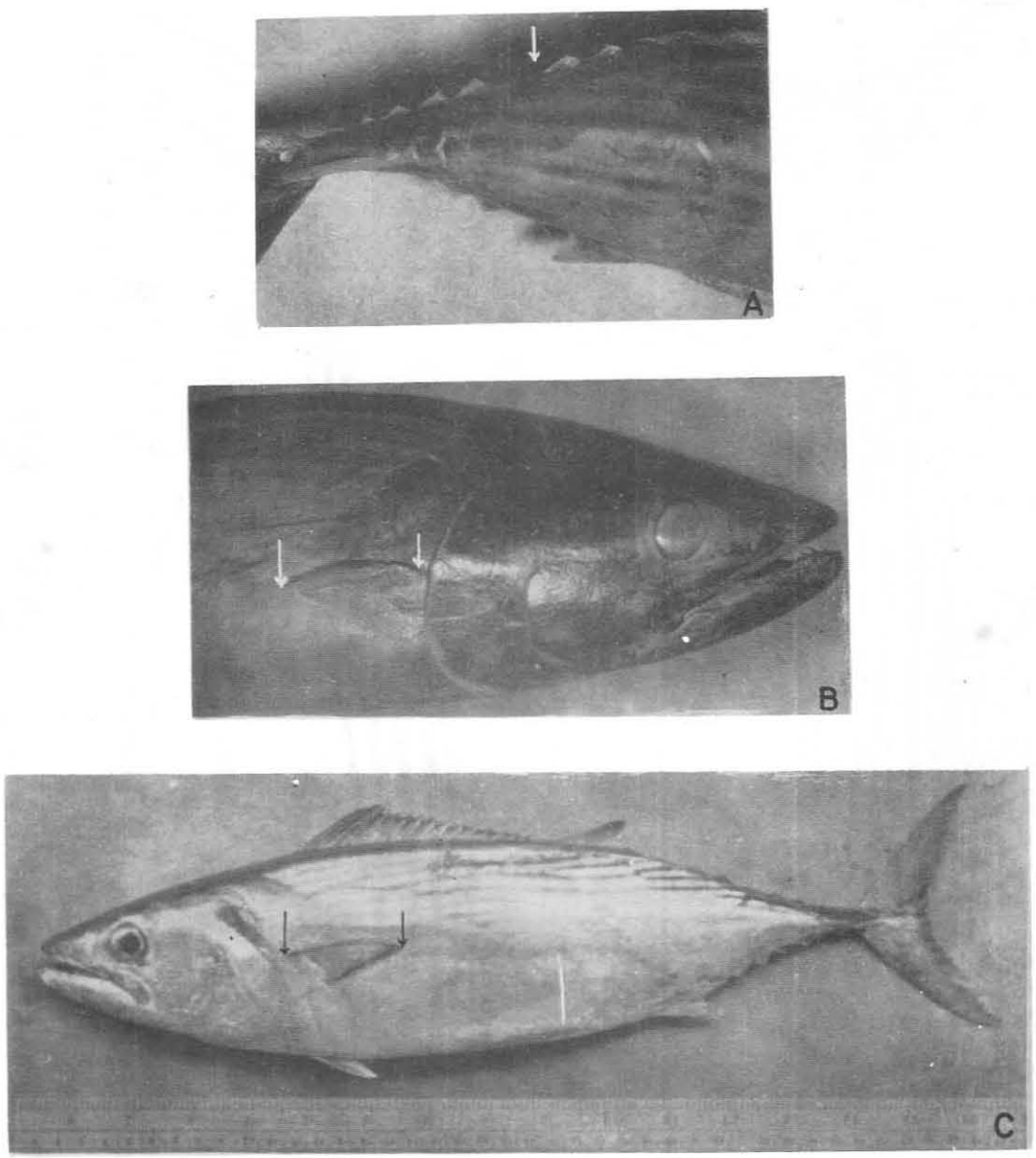

Figure 4. Sarda orientalis (Temminck and Schlegel) - Abnormalites:

(A) Post anal part of body showing absence of dorsal finlet.

(B) Head and anterior part of body showing markedly short pectoral fin which may be compared with normal condition seen in (C).

2 DISTRIBUTION

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

As shown in Figure 5 the areas of occurrence are: east coast of South Africa; Seychelles; Somali and Gulf of Aden; west coast of India and south west coast of Australia. Surprisingly the species has not been reported from the British East African coast nor from Indonesian waters. More information is needed about the spatial distribution of this species, of which large schools of juveniles and adults enter coastal waters seasonally.

2.2 Differential distribution

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

- Eggs

Eggs of S. orientalis have not been identified from the plankton from any area although from the available information on spawning of this species (Silas, 1962; Rao, 1962) it is likely that eggs may be encountered in the plankton of the coastal waters off south west India, especially during the months June-August. See under 3.1.6 and 3.1.7.

- Larvae and other junior stages

No information regarding larvae from the Indian Ocean.

Juveniles 80 mm and over have been reported on by Jones (1960), and Silas (1962) from Cape Comorin, Vizhingam and Calicut on the south west coast of India. Available data indicate that juveniles are caught with shore seines in places along the south west coast of India each year mainly during October and November

- areas occupied by adult stages seasonal and annual variations of these

See under 2.1

In south western Australia, Whitley (1962) remarks that it is found from "Rottnest Island in the north to as far east as Doubtful Island Bay. The normal northern limit appears to be Busselton" Further, speaking of the distributional patterns of S. orientalis and S. chilensis, Whitley (1962) remarks that:

"Only one occurs in the Indian Ocean, but both are found in the Pacific. In the Pacific Ocean S. chilensis is a temperate to warm-temperate species which exhibits the phenomenon of bipolarity or antitrophicality (vide Hubbs). The northern and southern hemisphere populations are separated by S. orientalis (Syn. velox) which in this ocean has a pantropical distribution. Walford (1937 Marine Game Fishes of the Pacific Coast, p.21) believed that the various forms were limited by physical factors and that the tropical form could not stand cool waters. That this is by no means the whole story is evident from the distribution pattern in the Indian Ocean. There are no forms of the chilensis complex and instead of being confined to the tropical belt as it is in the Pacific, S. orientalis extends both north and south into more temperate waters - into waters where in corresponding parts of the Pacific, a form of chilensis might be expected to occur. This indicates that temperature limitations need not prevent the occurrence of S. orientalis in any particular habitat and that biological competition from similar species has to be reckoned with. It is clear that the optimum environment of S. orientalis is the region of the tropics, from which it can exclude the penetration of its allies of the chilensis complex. On the other hand they can successfully resist the entry of orientalis into their optimum environment, where S. orientalis alone occurs, it inhabits alike tropical and temperate water".

Distributional data would indicate the occurrence of S. orientalis at least for a part of the year in coastal waters, when a seasonal fishery for it may exist, as along the south west coast of India but to a lesser extent along the Somalia coast. Its occurrence in other areas is apparently sporadic or rare.

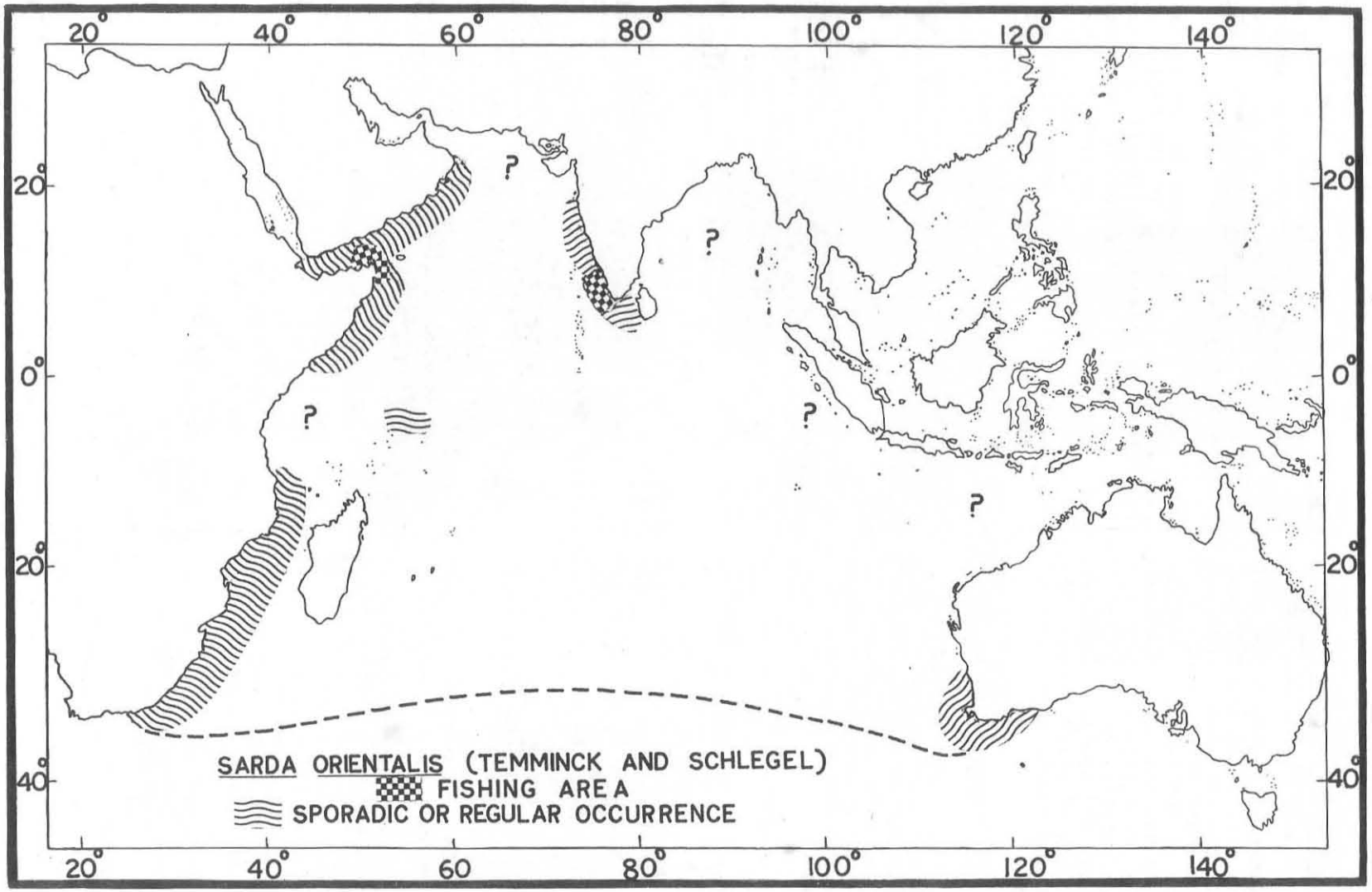

Figure 5. Map showing the distribution of Sarda orientalis in the Indian Ocean.

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

The temperature spectra for bonitos are given by Rosa and Leavastu (1962) as ranging between 12°C and 25°C and by Kishinouye (1933) (for S. orientalis) as between 13.5°C and 23°C. From Figure 5, as well as the information given under section 2.2.1 it will be seen that in the Indian Ocean S. orientalis is found in the northern hemisphere between 0°N and ca 37°S which means that it is found in temperate waters in the southern hemisphere. On the south west coast of India, the occurrence of fully mature adults (June-September) precedes the appearance of juveniles and half-growns (October-November) and it is likely that these incursions could be both for feeding as well as spawning (Silas, 1962).

3 BIONOMICS

3.1 Reproduction

3.1.1 Sexuality (hermaphroditism heterosexuality, intersexuality)

S. orientalis is heterosexual. No externally observable characters are known to help distinguish males and females.

3.1.2 Maturity (age and size)

Silas (1962) reports that maturing ovaries containing transparent ova were seen in specimens above 386 mm while between 480 mm and 605 mm most of the specimens collected in August-September 1960 and 1961, were in ripe running condition or had already spawned, some showing signs of recovering. However, the age of the investigated mature specimens is not known.

3.1.3 Mating (monogamous, polygamous, promiscuous)

Polygamous. No information is available about prespawning or spawning behaviour.

3.1.4 Fertilization (internal, external)

External. As in the case of other scombroids, the eggs should be pelagic.

3.1.5 Fecundity

Two attempts (Silas, 1962 and Rao, 1962) have been made in estimating the fecundity of the oriental bonito from Indian seas, and the data are summarised in Tables VI and VII. The fish is said to attain at least a metre in length but the estimates are only of smaller sizes ranging from 386 mm - 605 mm; a larger number of eggs may be expected in still larger specimens. The number of ova per spawning in two specimens with ripe ovaries is estimated by Silas (1962) as 0.08 - 0.15 million while Rao (1962) found this to vary from 0.21 - 0.28 million in four specimens. The total number of ova produced during the breeding season has been estimated by these workers as 0.24 to 0.64 million and 0.91 to 1.15 million respectively. See Figures 6a to 6e for illustrations of ripe ovary.

- Relation of gonad size and egg number to body size and to age

Available data are summarised in Tables VI and VII. Total number of ova produced during the breeding season was found to show an increase with the size of the fish by Rao (1962). When evaluated in terms of number of eggs per 1,000 g of body weight, (Table VI) this was not found to be the case for the specimens examined by Silas (1962).

3.1.6 Spawning

- Spawning seasons (beginning, end, peak)

Among several ovaries of S. orientalis examined by Rao (1962) from Vizhingam during 1959-1960, only four were in ripe running condition. The definite duration of the spawning season is not yet fully known, although Rao (1962) opines that like Euthynnus affinis and Auxis thazard the oriental bonito also spawns in the local waters (off Vizhingam, south west coast of India) "from April to September and possibly in other months of the year with a peak in July - August". Supporting evidence is also given by Silas (1962) by the collection of fish with ripe ovaries or partly spent ovaries from the same area in 1960 and 1961 during the months of August - September. Larval collections are wanting. However, the occurrence of early juveniles in this area during October - November reported on by Jones (1960) and Silas (1962) is also interesting.

- Number of spawning per year, frequency

"The study of ova diameter frequency polygons of ripe spawning (or ripe running) and recovering ovaries indicates that in the most advanced stage (ripe - stage V (Figure 7, I) the most advanced mode containing ripe ova is the most prominent, while more than one mode is seen for the maturing ova. In the ripe running condition (spawning - stage VI) (Figure 7, II and III) the most advanced mode is seen to be completely separated from the maturing eggs which in turn show two or more modes. Three recovering ovaries (stage VII) (Figure 7, IV, V and VI) in which there are indications of previous spawning by the presence of degenerate large eggs also show the most

Table VI

Counts of ovarial eggs in five mature specimens of Sarda orientalis from Vizhingam, south west coast of India (After Silas, 1962)

Date of collection	13-9-61	20-8-60	8-9-60	1-8-60	25-8-60
Total length (mm)	386	490	-	545	605
Body weight (g)	899	1446	-	-	-
Weight of ovaries (g)	53.650	85.720	89.140	72.750	84.400
No. of countable ovarial eggs in gram of roe	4533	4525	7550	8900	4890
No. of eggs in ovaries (in thousands) to be spawned in a season	2432	3879	5126	6475	3980
No. of eggs per 100 g of body weight (in thousands)	2705	2682	-	-	-
No. of eggs of the most advanced mode in gram of roe	-	-	990	2131	160
No. of eggs of the most advanced mode in ovaries	-	-	88248	155030	13024
Remarks	spent-recovering?	maturing	ripe running?	ripe running	spawning (partially spent?)

Table VII

Estimated number of ova produced per spawning and during the breeding season by individual fish of Sarda orientalis (After Rao, 1962)

Fish Number	SO. 10	SO. 13	SO. 16	SO. 11
Fish length (m)	48.0	51.0	54.0	55.0
Fish weight (g)	1.14	1.37	1.83	2.06
Number of ova produced per spawning (millions)	0.21	0.23	0.25	0.28
Total number of ova produced during the breeding season (fecundity) (millions)	0.91	0.93	1.03	1.15

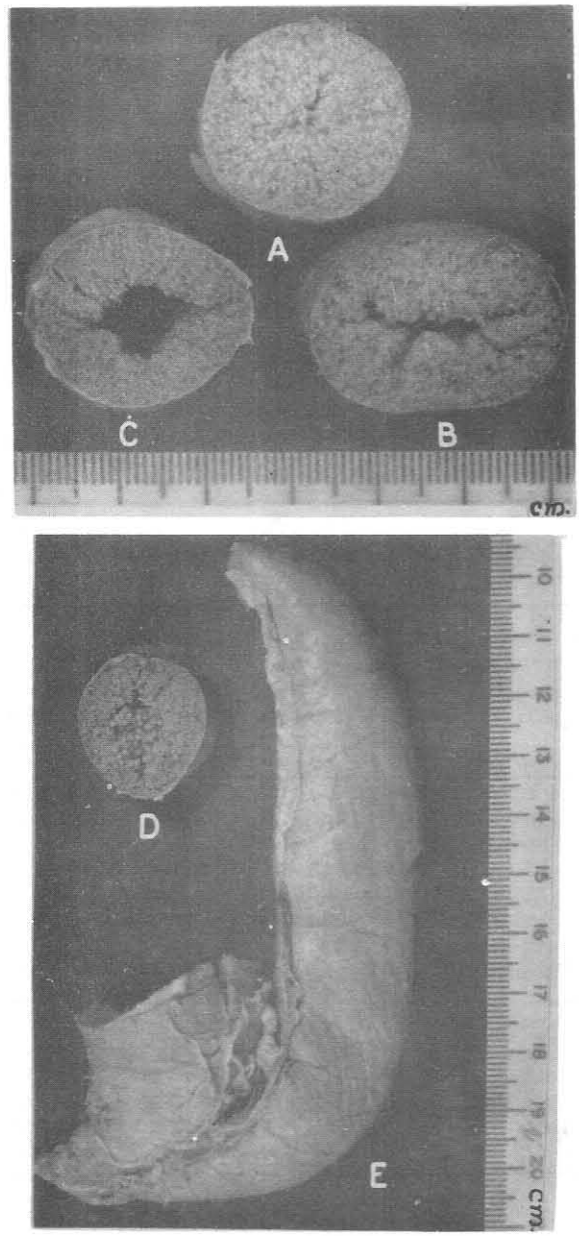

Figure 6. Sarda orientalis (Temminck and Schlegel)

(A) and (B) Cross section of ovaries of specimens 368 mm and 490 mm respectively showing distribution of larger transparent ova throughout the ovary and the formation of the central lumen into which the ripe eggs migrate.

(C) Cross section of ovary of specimen 605 mm showing central lumen from which ripe ova have been removed.

(D) Same before removal of ripe ova.

(E) Ovary of same specimen (part of right ovary removed for showing cross sections (C) and (D).

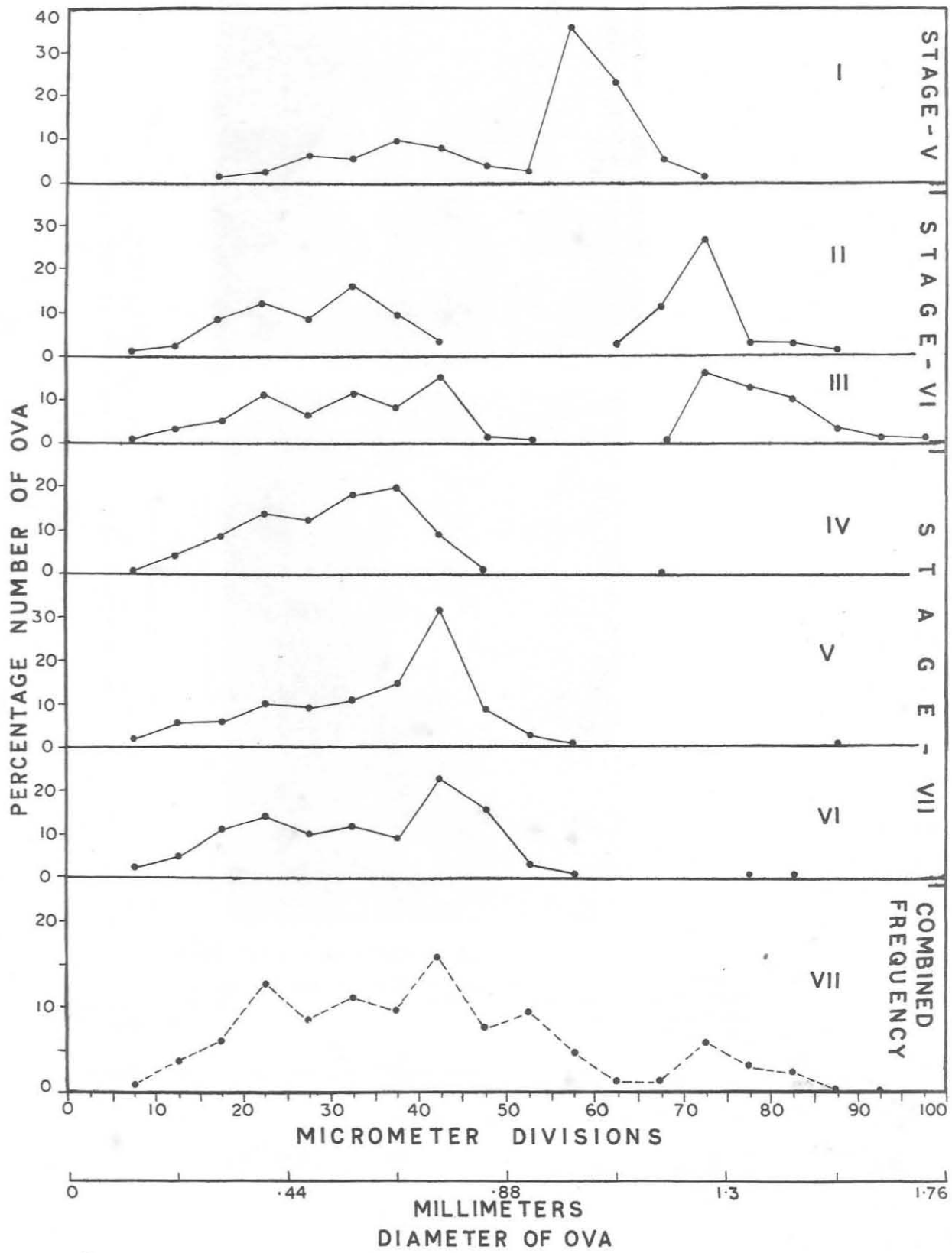

Figure 7. Sarda orientalis (Temminck and Schlegel)

Frequency polygons of diameters of the eggs in the ovary of 6 mature specimens collected at Vizhingam. (The combined frequency is also shown). (After Silas, 1962)

advanced mode as the most prominent one as seen in stage V (Figure 7, I). The combined frequency (Figure 7, VII) shows the most advanced mode containing the ripe ova to be well demarcated from maturing batches, which in turn show several modes. If it were to be presumed that during a spawning season the ova over 5 microdivisions or about 0.11 mm are to mature and spawn, it is clear that in S. orientalis all the ova do not ripen at one time, but as seen by the number of modes, mature in batches. Spawning season may be an extended one and the preliminary data suggest fractional spawning during a season". (Silas, 1962).

Rao (1962) has also arrived at somewhat similar conclusions after studying the ova diameter frequency of ripe running ovaries of two specimens of S. orientalis from Vizhingam.

The smallest specimen in the sample examined by Silas (1962) which had a few large eggs, probably remenants of an earlier batch of eggs spawned was 386 mm. This would need confirmation, but if subsequent observations could corroborate this then it is likely that the species attains maturity and is ready for spawning even before attaining 386 mm. The ripe running specimens examined were 49 cm to 60.5 cm (Silas, 1962). Four specimens examined by Rao (1962) were between 48 cm to 55 cm.

According to Silas (1962) the spent and recovering ovaries had very few large degenerate eggs of the last spawned batch.

3.1.7 Spawning grounds

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

- Oceanic (surface, bottom)

Capture of females with ripe, ripe running and recovering ovaries along the south west coast of India (Trivandrum to Cape Comorin) indicates that the sea off this coast is one of the spawning grounds of this species. No information is available from other areas of the Indian Ocean. Spawning grounds may extend from coastal to oceanic situation, and it may not be wrong to denote the species as a neritic pelagic spawner.

3.1.8 Egg: structure, size hatching type, parasites and predators

"The ripe ovum of S. orientalis is very large. In fresh condition they are spherical, more or less transparent with homogenous yolk while in preserved material the ovum appeared translucent and slightly pale yellow in colour. Its diameter in fresh and preserved condition averaged 1.13 mm and 1.04 mm respectively. Each ripe ovum contained a single, spherical and colourless oil globule which has an average diameter of 0.29 mm." (Rao, 1962). Silas (1962) found ripe ova with 1.33 mm diameter which had burst from follicles and were lying loose in the lumen of the ovary to have a cluster of small oil globules at one of the poles (Figures 8B and 8C) their number varying between 3 and 14 with an average of about 8 and ranging in diameter from 0.06 mm to 0.23 mm. Several eggs had oil globules of the same size as those shown in the above figures. The structure of the eggs does not indicate that they are degenerate, but their diameters were slightly more than that found for ripe eggs by Rao (1962) and this combined with the number of oil globules may indicate that they are eggs retained over a longer period and are probably in the early stages of resorption. Eggs partly degenerate collected from recovering ovaries show scattered oil globules of different sizes. An early ripe ovum (diameter 0.9 mm) in which the oil globule is not discernible is shown in Figure 8A.

3.2 Larval history

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

No information is available about embryonic life, nor on prelarva, larva and post larva.

Earliest juvenile on record is 80 mm (total length including caudal 89 mm) figured and described by Jones (1960) (Figure 2a). For colouration see under 1.1.2. Variations in body colour in the juvenile are indicated in Figures 2a, 2b and 3a. Most of the juveniles caught in shore seines along the south west coast of India range between 150 mm to 290 mm.

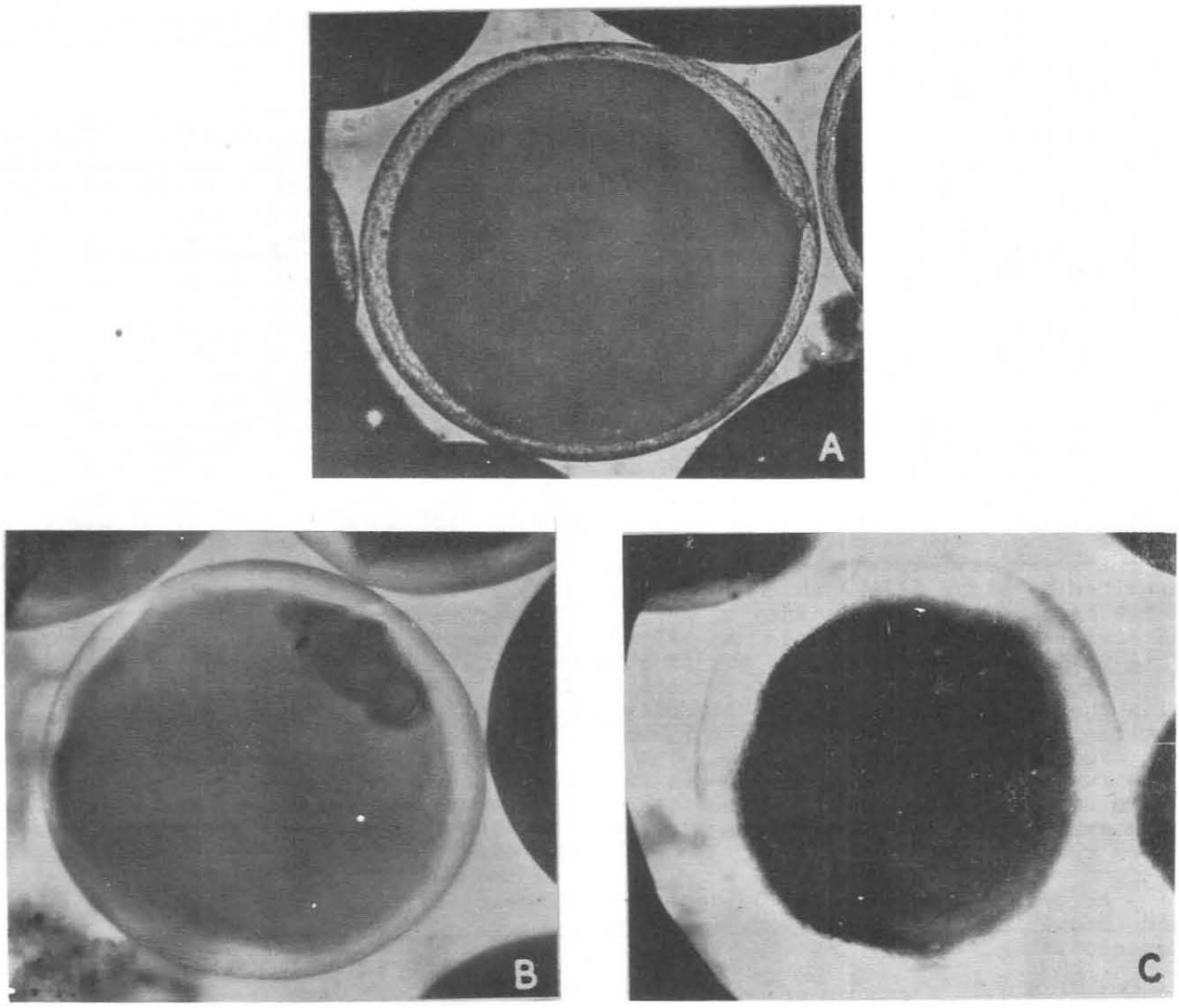

Figure 8. Sarda orientalis (Temminck and Schlegel)

(A) Mature ovum with diameter of 0.9 mm (Stage V).

(B) and (C) Ripe ova, diameter 1.3 mm lying loose in the lumen of the ovary showing cluster of oil globules (each about 0.15 mm in diameter) at one pole (stage VI) (after Silas, 1962)

- Feeding

Jones (1960) remarks that the food of the juvenile S. orientalis consists of larval and juvenile fish and crustaceans. Kumaran (1962) found that Anchoviella tri was the most common fish that occurred in the stomach contents of juveniles, while stomatopod larvae were present as a minor item.

- Parental care

The species as other scombroids may not exhibit any parantal care.

- Parasites and predators

See under 3.3.5 for parasites collected from juveniles and adults. No information is available on predators.

3.3 Adult history

3.3.3 Competitors

During the season when juveniles are caught along the south west coast of India large numbers of juveniles of the little tunny, Euthynnus a. affinis are also caught along with them in shore seines. Adult S. orientalis are very often caught in this area along with adult E. affinis, Auxis thazard, Kishinoella tonggol and Scomberomorus spp. in shore seines as well as gill nets. A certain amount of competition for food may be expected between these species.

3.3.5 Parasites and diseases

Silas (1962) records a species of monogenetic trematode (Capsala sp.) from the gills, palate and inner wall of the operculum of juvenile and adult S. orientalis collected from Vizhingam, south west coast of India. Silas and Ummerkutty (1962) have recorded the parasitic copepods Caligus bonito Wilson (adults and chalimus stages), and Parapetalus sp. from the gills and buccal cavity of juveniles and adults collected from the same area.

Information is not available on diseases.

3.3.6 Greatest size

Large specimens caught in shore seines and drift nets off south west coast of India are less than 700 mm. However, the fish is said to attain a larger size as Smith (1948) mentions under S. chilensis (= S. orientalis) "Attains at least 40 inches".

Regarding Japanese specimens Kishinouye (1923) mentions "Grow to a length of about 80 cm and to a weight of 1.5 g to 3.0 g."

3.4 Nutrition and growth

3.4.2 Food (type, volume)

Jones (1960) remarks that adults feed on young and small sized fishes, crustaceans and squids.

3.5 Behaviour

3.5.1 Migration and local movements

Information is wanting. See under 3.5.2.

3.5.2 Schooling

Schools of adults and young appear along the south west coast of India, between Trivandrum and Cape Comorin from about July to December, the schools of juveniles appearing especially in October-November when they enter bays and inshore areas and are caught in shore seines. More information is needed.

3.5.3. Reproductive habits

No information except data given under 3.1.6.

4 POPULATION (STOCK)

4.2 Size and density

4.2.1 Average size

Average size of adults caught at Vizhingam and other centres along the south west coast of India is about 45 cm. More information is wanting.

4.6 Relation of population to community and ecosystem, biological production, etc.

The term neritic-pelagic may be applied to the habitat of S. orientalis. Within this realm, it may be said to belong to the surface and mid-water community as most other scombroids. The area of occurrence of S. orientalis off south west coast of India is an area of high productivity. In this area, the fishery for this species also coincides with that for the little tunny Euthynnus affinis affinis (Cantor), the northern bluefin or Indian longtailed tunny Kishinoella tonggol, and few other scombroids, especially Scombromorus spp. Most of these prey on smaller fishes and as such it is likely that a certain amount of competition may exist between these species. More information is needed.

5 EXPLOITATION

5.1 Fishing equipment

5.1.1 Fishing gear

Adult S. orientalis are usually caught in drift nets (gill nets) and also shore seines when schools enter bays along the south west coast of India. Juveniles are also caught in shore seines and gill nets. Along the South African coast, where this is regarded as a sport fish, Smith (1948-1961) remarks that the fish "fights well when hooked". The species has also been taken by trolling (Wheeler and Ommanney, 1953).

5.1.2 Fishing boats

No special boats appear to be in use for fishing for the oriental bonito.

5.2 Fishing areas

5.2.1 General geographic distribution

See under 2.1. The only areas where the oriental bonito forms a seasonal minor fishery is along the south west coast of India and as indicated by Rosa and Laevastu (1961) along the Somali coast of Africa.

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

Along the west coast of India, stray catches of S. orientalis may be made from various localities from as far north as Ratnagiri, but regular catches are only made south of Trivandrum to Cape Comorin (Ca.77°E - 77°50' E; 8°N to Ca. 8°5'B) where fishing is carried out as far as 20 km from the coast. Information is not available about the other areas.

5.2.3 Depth ranges

Along the south west coast of India fishing is carried out in waters less than 200 m deep.

5.3 Fishing seasons

5.3.1 General pattern of fishing season

Along the south west coast of India the available information points to the fishing season for adult S. orientalis to be from about July to September, although stray specimens may be caught during the months of April, May and June. It is likely that there may be changes in the pattern of the fishing season from year to year within this period.

5.3.2 Duration of fishing season

Se under 5.3.1.