SCALES AND OTOLITHS OF THE 'KOTH' *OTOLITHOIDES BRUNNEUS* (DAY) AS AGE INDICATORS*

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Growth rings on the scales and otoliths of 'Koth' have been recorded by Karandikar and Thakur (1951). Mention of growth checks on the scales of this fish and their probable utility in age determination has also been made by Seshappa (unpublished). Studies on the scales and otoliths of 'Koth' from the local 'dol' net catches landed at Bombay and the catches of the trawlers working along the Bombay coast were begun by the author in February 1958 with a view to assess their value in age determination of the fish. Material for the present study was also collected subsequently from the gill-net catches at Bedi in the Gulf of Cutch.

Five to six scales each from the pectoral region of 554 fish, ranging in size from 5·0 to 150·5 cm., were examined. Scales of 'Koth' are found to lack zonations of wide and narrow sclerites, the concentric markings of the rings being abrupt breaks in the pattern of the circuli. This feature in the scales has been reported in *Lates calcarifer* also by Australian workers (Ommaney, 1957). Generally, 'Koth' above 30 cm. in length (total length) had one or more clear rings on their scales. A maximum of twelve rings were counted on the scales of a fish of 149·0 cm. in length. The progressive increase in the number of scale rings with fish size was evident from the observed mean fish size for each ring, from the first to the twelfth (*vide* Table I).

The mean fish sizes for the first three scale rings, *i.e.*, 41·8, 60·0 and 74·1 cm. respectively, more or less correspond to the first three modes in the length frequency curves of 'Koth' from the catches landed at Bombay. The modes of the curve for the 1958–59 catches were at 38·5, 59·5 and 80·5 cm., for the 1959–60 catches at 24·5, 59·5 and 87·5 cm. and for the 1960–61 catches at 31·5, 59·5 and 73·5/80·5 cm.

In order to check the annual nature of the formation of the scale rings, counts of circuli in the 'terminal zone' of the scale (Pl. III, Fig. 1) from 305

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TABLE I

Distribution of scale rings of 'Koth', Otolithoides brunneus *at various size groups**

Size group in cm.	Number of rings												
	0	1	2	3	4	5	6	7	8	9	10	11	12
5·0– 27·9 ..	44	..	..	..	..	..	..	..	..	..	..	..	..
28·0– 34·9 ..	40	24 (2)	..	..	..	..	..	..	..	..	..	..	..
35·0– 41·9 ..	35	55 (4)	..	..	..	..	..	..	..	..	..	..	..
42·0– 48·9 ..	10	33 (18)	.. (1)	..	..	..	..	..	..	..	..	..	..
49·0– 55·9 ..	2 (1)	4 (17)	2 (11)	..	..	..	..	..	..	..	..	..	..
56·0– 62·9 ..	..	.. (3)	1 (46)	.. (6)	..	..	..	..	..	..	..	..	..
63·0– 69·9 ..	..	..	.. (20)	.. (10)	..	..	..	..	..	..	..	..	..
70·0– 76·9 ..	..	..	.. (5)	.. (6)	.. (1)	..	..	..	..	..	..	..	..
77·0– 83·9 ..	..	..	.. (2)	1 (11)	.. (3)	..	..	..	..	..	..	..	..
84·0– 90·9 ..	..	..	..	.. (6)	.. (9)	..	..	..	..	..	..	..	:
91·0– 97·9 ..	..	..	..	..	.. (4)	..	..	..	..	..	..	..	..

98·0–104·9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
						(4)	(4)								
105·0–111·9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
						(3)	(10)								
112·0–118·9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
						(2)									
119·0–125·9	..	..	..	..	..	..	1	2	..	..	..	..	..	..	..
126·0–132·9	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
								(1)	*4*	*4*					
133·0–139·9	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..
								2	*8*	(1) *22*	(2) *16*	*3*			
140·0–146·9	..	..	..	..	..	..	..	..	..	..	2	2	1	..	
										(1) *4*	*5*	*4*	*1*		
147·0–153·9	..	..	..	..	..	..	..	..	..	..	1	..	2	1	
												1	*1*		
Number of fish — Dol net catches, Bombay 265 ..	Total	131	116	3	1	..	1	2	2	..	3	2	3	1	
Trawler catches, Bombay (214) ..		(1)	(44)	(85)	(39)	(26)	(14)	(1)	..	(2)	(2)	..	..	..	
Gill net catches, Bedi *75* ..		..	..	..	..	..	..	*2*	*12*	*30*	*21*	*6*	*2*	..	
Combined total 554 ..		132	160	88	40	26	15	5	14	32	26	10	5	1	
Mean fish size in cm. ..		..	41·8	60·0	74·1	83·1	107·9	127·1	134·7	136·1	138·5	142·0	148·2	149·0	

* Figures in brackets denote fish from the trawler catches off Bombay; and figures in Italics denote fish from the Gill-net catches off Bedi (Gulf of Cutch). Figures not marked denote fish from the 'Dol' net catches off Bombay.

juvenile and adolescent 'Koth'* were made, as done by Perlmutter and Clarke (1949) in *Sebastes marinus*. The fish were then grouped into two categories, (i) those with < 10 circuli in the terminal zone of the scale and (ii) those with > 10 circuli in the terminal zone. The width of the sclerites was more or less uniform irrespective of the season when they were formed and the number of circuli in the scale increased with the growth of the fish. Consequently the period, when scales with the smaller counts of circuli (< 10 circuli) in the 'terminal zone' were dominant, would represent the period closely following the formation of an annulus. Curve A in Fig. 1 shows

FIG. 1. Correlation between period of annuli formation in the scales and period of low feeding activity in *Otolithoides brunneus*. (A) shows monthwise percentage number of juvenile and adolescent fish with < 10 circuli in the 'terminal zone' in their scales. (B) shows monthwise percentage of average fulness of stomach (points method) of juvenile fish from the inshore waters of Bombay.

that this period was between November and February. Studies on the feeding habits of the fish revealed that this period of scale annuli formation as judged from the circuli counts more or less coincides with the periods of low-feeding activity. The average fulness of stomach of juvenile 'Koth' from the inshore catches of Bombay, calculated month-wise, was found to be least during February 1958, December and January in 1958–59 and December,

* The fish attains first maturity at the size of about 120 cm.

TABLE II

Distribution of the first six rings on the otoliths of 'Koth', Otolithoides brunneus *at various size groups.**

Size groups		Number of rings					
		1	2	3	4	5	6
3·0– 6·9 ..		5	..	..	..	..	..
7·0–13·9 ..		61	5	..	..	..	..
14·0–20·9 ..		35	22	..	..	..	..
21·0–27·9 ..		11	20	2	..	..	..
28·0–34·9 ..		..	8 (1)	31	..	..	..
35·0–41·9 ..		..	2	52 (1)	4	..	..
42·0–48·9 ..		..	..	15 (4)	13	.. (1)	..
49·0–55·9 ..		..	..	6 (3)	5 (6)	.. (4)	..
56·0–62·9 ..		..	..	1 (1)	1 (8)	.. (12)	..
63·0–69·9 ..		..	..	..	.. (5)	.. (7)	.. (1)
70·0–76·9 ..		..	..	..	.. (2)	.. (2)	.. (4)
77·0–83·9 ..		..	..	..	..	.. (1)	.. (4)
84·0–90·9 ..		..	..	..	..	..	.. (6)
No. of fish — 'Dol' net catches, Bombay 299 ..	Total	112	57	107	23	..	..
Trawler catches, Bombay 73 ..		..	1	9	21	27	15
Combined total 372 ..		112	58	116	44	27	15
Mean fish size in cm. ..		13·8	23·4	39·3	45·5	61·5	80·3

* Figures in brackets denote fish from trawler catches off Bombay and figures not marked denote fish from 'Dol' net catches off Bombay.

January and February in 1959–60 (Fig. 1 B). The annual lowering of feeding intensity can thus be made out as a probable cause for the formation of the scale annuli. It is also of interest to note that the period from November

to February happens to be the period of lowest bottom and surface temperatures in the Dwaraka region, where there is a good fishery for 'Koth' (Jayaraman and Gogate, 1957 and Jayaraman *et al.*, 1959).

Otoliths of 372 fish were studied by the method followed by Fairbridge (1951). With a few exceptions all of them showed clear rings which increased progressively in their number with the size of the fish (Pl. III, Fig. 2 and Table II). The otoliths contain concentric opaque and hyaline zones. The concentric hyaline zones were counted as rings. The clearer pattern of rings in the otoliths of younger fish enabled its study better and there was clear indication to show that 2 to 3 rings were formed in the otoliths by the time the scale developed only a single ring. While the otoliths of very small 'Koth' studied showed a clear ring it was evident that the first scale ring appeared only when a much larger size was attained by the fish. A comparison of Tables I and II shows the disparity in the distribution of rings on the scales and otoliths of 'Koth'. The occurrence of more number of rings in the otoliths than on the scales is perhaps an indication as Saetersdal (1953) pointed out that "the otolith is a more sensitive instrument than the scale, and records smaller differences in the conditions of the fish than does the scale". The formation of more than one ring on the otoliths in the first year of life of fishes such as *Clupea pilchardus*, where 2 to 4 rings are formed in the first year, *Pleuronectes platessa* and *Drepanosetta platessoides*, is reported by Kotthaus (1958 and personal communication). The present studies clearly indicate that the scales of 'Koth' are more reliable than the otoliths as age indicators.

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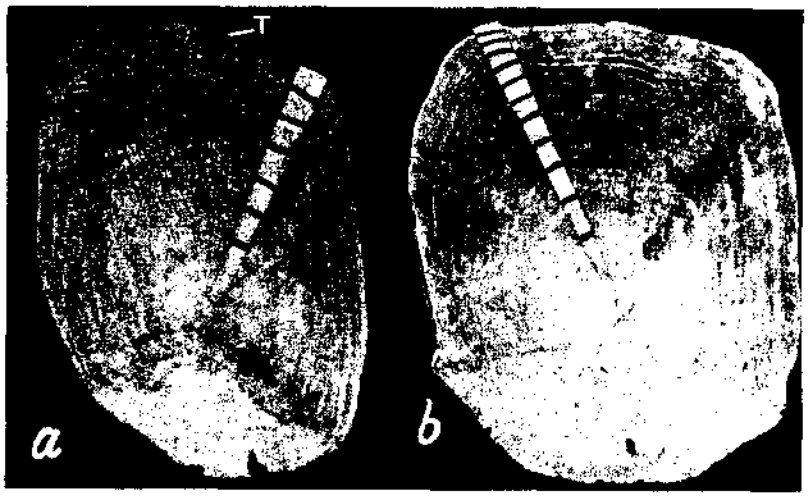

FIG. 1. Photographs of scales of *Otolithoides brunneus* (scales used as negatives). (*a*) Scale showing 6 rings, ×5. (Total length 125·0 cm. female captured on 6–3–1959 from Dwaraka region by the bull trawlers 'Arnala and Paj'). *T*, terminal zone. (*b*). Scale showing 11 rings, ×4. (Total length 146·5 cm. Sex not known, captured on 30–11–1958 from Satpati—examined at Crawford Market, Bombay.)

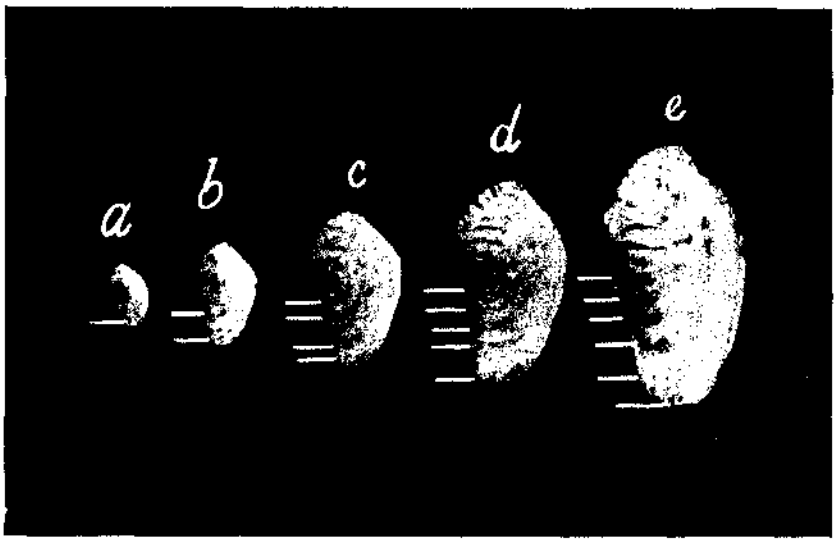

FIG. 2. Photograph of otoliths of *Otolithoides brunneus*, ×1·4. The external sculpturing on the otoliths are seen as shaded markings, which are seen darker at the opaque growth regions and are marked here as rings. The external prominences at the opaque growth regions are clearly seen because of the diffused lighting technique used in photographing these otoliths.

(*a*) Otolith showing one ring—Fish length: 11·2 cm.; (*b*) Otolith showing two rings—Fish length: 20·7 cm.; (*c*) Otolith showing four rings—Fish length: 35·5 cm., male; (*d*) Otolith showing five rings—Fish length: 45·9 cm., female; (*e*) Otolith showing six rings—Fish length: 63·4 cm., male.

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FURTHER OBSERVATIONS ON THE FISHERY AND BIOLOGY OF '*CHOODAI*' (*SARDINELLA* spp.) OF MANDAPAM AREA

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Introduction

The sardines, locally called *Choodai*, constitute one of the important groups of fishes supporting the fisheries of the Mandapam area. *Sardinella albella* and *Sardinella gibbosa* are the two important species forming the fishery. Previous studies on sardines in the area include observations made by Devanesan (1932) on the food and feeding habits and Chacko (1946) on the bionomics of *S. gibbosa*. Investigations have been in progress since 1952 at the Central Marine Fisheries Research Station (Sekharan, 1955 and 1959) on the *Choodai* fishery. The present study was undertaken from May 1958 to March 1960 as a continuation of the work.

Material and Methods

Random samples of *Choodai* from commercial catches were obtained from Pullamadam, Thangachimadam and Dhanushkodi in the Palk Bay and from Rameswaram Road and C.M.F.R.S. area in the Gulf of Mannar. It may be pointed out here that " torch fishing " with handnets were sparingly operated in the fishing centres during the period of study and the gillnets accounted for a very insignificant proportion of the total catch. Bulk of the sardine catch were landed by shore seines operating within two miles from shore. The fishery usually starts in April in the Palk Bay and lasts till October. From November to March it is continued in the Gulf of Mannar coast.

All random samples taken from the commercial catches were measured for length frequency observations and detailed study was done only on selected samples. The standard length, *i.e.*, the length from the tip of the snout to the end of the silvery area on the caudal peduncle was recorded in millimetres. Head length was measured from the tip of the snout to the posterior edge of the operculum. In many cases the fishermen's records of catch have been used while calculating the monthly landings. Gut contents of 580 specimens preserved in 5% formalin as soon as they were landed were studied. After