

AGE AND GROWTH OF THE JUVENILES OF KOTH *OTOLITHOIDES BRUNNEUS* (DAY) IN BOMBAY WATERS

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ABSTRACT

The age and growth of the juveniles of 'Koth', *Otolithoides brunneus* (Day), were determined by three methods: 1) length-frequency distribution 2) scales 3) otoliths. The length attained at the completion of I to IV years of life as deduced from the length-frequency studies were 40.0, 60.0, 80.0 and 95.0 cm, respectively. The corresponding length calculated from scales for the same were found to be 40.7, 57.8, 75.6 and 91.3 cm. By the time the scales develop one ring the otoliths showed three 'larval rings'. The period of formation of the first scale ring corresponds to that of the fourth ring in the otoliths. The period of formation of the rings in the scales was found to coincide with the winter months, October to February. The formation of the rings may be due to the low temperature prevailing during this period.

The value of L_{∞} obtained by using Walford's growth transformation is 198 cm. The K and L_{∞} values estimated by von Bertalanffy equation were 0.14 and 206.4 cm respectively.

INTRODUCTION

Otolithoides brunneus (Day), locally called 'Koth', occurring along the Bombay and Saurashtra waters, is a sciaenid, growing to a size of over 160 cm and supporting a fishery of some importance (Jayaraman *et al* 1959, Bhatt *et al* 1967, Rao *et al* 1966, 1972). Karandikar and Thakur (1951) studied the anatomy of 'Koth'. Kutty (1961, 1967) studied the age and growth of this species by using the scales and otoliths. He also made a brief report on certain other aspects of its biology. Jayaprakash (1973) made a preliminary study on the use of vertebrae of this species for age determination. Apart from the above works there is no literature available on the biology of this fish. Hence investigation was undertaken by the author from January 1970 on its biology. This paper deals with the age and growth of the juveniles based on a study of length-frequency distribution, scales and otoliths.

The length-frequency study is based on 4191 specimens collected at random from the landings of local trawl catch at Sassoon Docks for 36 months at an average of four samples a month, each consisting of about 30 specimens.

The fish were measured for total length. Scales occurring along the pectoral region were found to be more useful than those from other regions. Scales were mounted dry between two slides after cleaning in 5% KOH. They were studied under low power binocular microscope. The length of the scales in mm (anterior to posterior end) were noted. The otoliths of this species are very large in size. The rings on them are visible, as concentric depressions and ridges, even to the unaided eye. Hence they were examined with the help of a hand lens. However, various techniques like grinding on a carborundum (Menon 1950), heating (Lawler and McRae 1961), mounting in media like glycerine (Gottlieb 1956), xylol, and cedarwood oil (James 1967) were tried. But these techniques were found to yield the same result as in the previous case.

RESULTS

Length-frequency studies

It may be mentioned here that the fishery of 'Koth' *O. brunneus* in Bombay waters is mainly constituted by juveniles. Young juveniles make their appearance in the inshore areas of Bombay from April onwards. Indications are that the spawning of 'Koth' commences about the end of the southwest monsoon extending over several months (Kutty 1967, Rao 1967). Fig. 1 gives

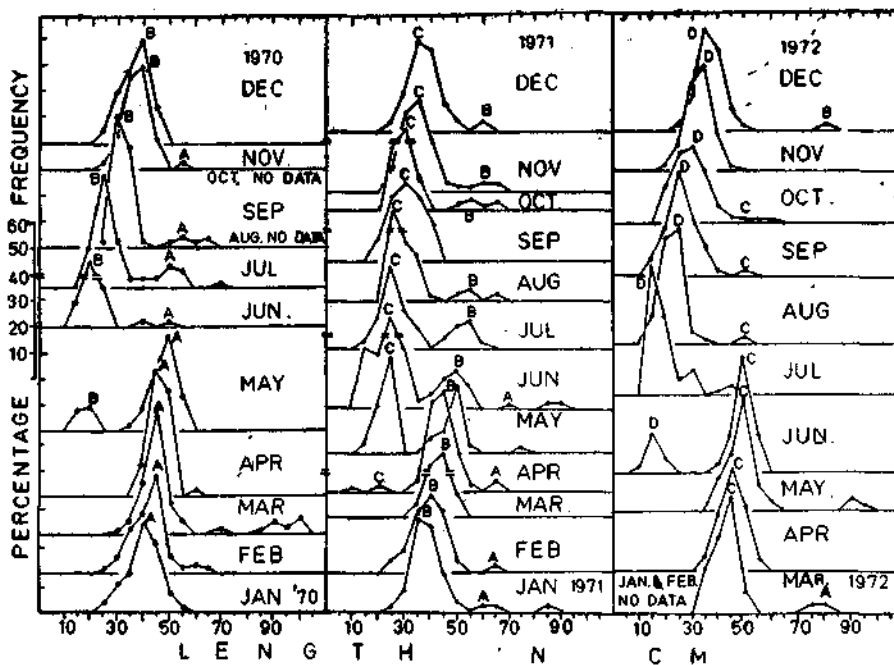


FIG. 1. Monthly length-frequency distributions of *O. brunneus* from the landings of local trawlers at Sassoon Docks from January 1970 to December 1972.

length-frequency data from January 1970 to December 1972. During May 1970, two modes A and B are seen. By May 1971, B shifts to the position occupied by A in May 1970, indicating that the differences in age between the two is one year. Similarly there are two modes B and C in April 1971. Mode C shifts to the position occupied by B in one year again indicating the age difference between the two to be one year. Therefore, the age difference, between C and D in June 1972 would also appear to be one year. Mode A which was at 40 cm in January 1970 appears at 65 cm in January 1971, and 80 cm in January 1972, and B which was at 40 cm in December 1970, is seen at 60 cm in December 1971 and 80 cm in 1972, conforming to the growth pattern of A. It would then be seen that the group with a modal size of 40 cm grows to about 60-65 cm at the end of one year and 80 cm at the end of the second year. Fig. 2 shows that the mode A takes the position of B in January, B that of C in January, and C that of D. From mode C in December to mode E the growth is 20 cm in 15 months showing a monthly

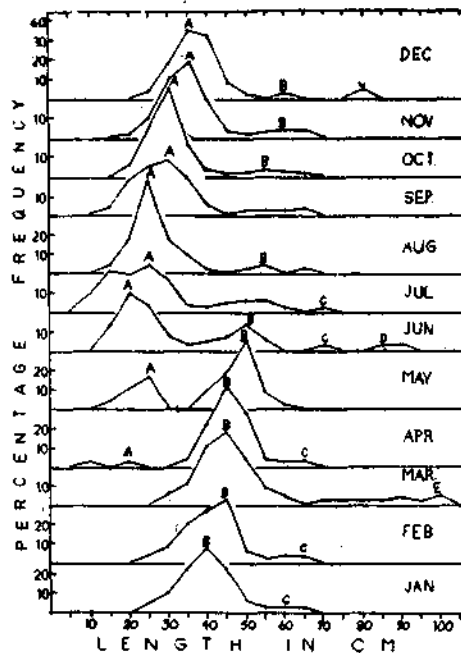


FIG. 2. Monthly pooled length-frequency distributions of *O. brunneus* from the landings of local trawlers at Sassoon Docks for the period 1970-1972.

growth of 1.3 cm. Hence at the completion of the 4th year the fish should attain 95 cm. As already stated, the post-monsoon period (October to January) is the spawning season for 'Koth'. Therefore, B, C and D which first appear at the size of 15-20 cm in April-June period (Fig. 1) are probably the

products of spawning of the preceding postmonsoon season and are 4-6 months old. It would appear that the size at the end of first year is 40 cm, at the end of second year 60 cm, at the end of the third year 80 cm and at the end of fourth year 95 cm.

Scale and otolith studies

The scale-length-fish-length relationship (Scale length in mm from anterior to posterior end) was calculated from scales of 252 specimens of various size groups ranging from 8 to 92 cm. They were grouped into 17 size groups with 5cm intervals. The scatter diagram of the points (Fig. 3 C) clearly shows that the relationship is linear. The equation $L = a + bS$ (where L = fish length in cm, S = scale length in mm and a and b are constants) was calculated by the least square method. The result was:

$$S = -1.2909 + 1.1913 L$$

$$L = 1.0878 + 0.8330 S$$

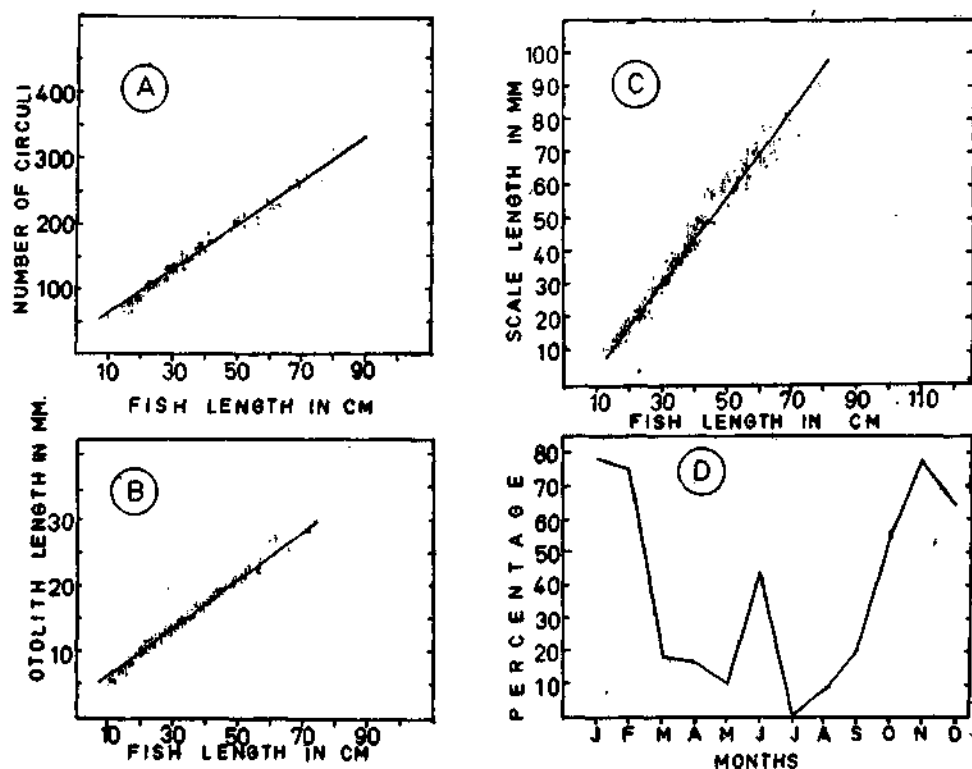


FIG. 3. A. Fish length and number of circuli in the scales of *O. brunneus*. B. Fish-length and otolith-length relationship. C. Fish-length and scale-length relationship. D. Monthwise percentage of fish with less than 10 circuli in the terminal zone in the scales.

Similarly, the relationship between the fish length and the number of circuli in the scales (Fig. 3 A) was found to be:

$$C = 0.8607 + 0.8439 L$$

$$L = -1.0042 + 1.1780 C$$

(where L = fish length in cm, and C = number of circuli).

To determine the otolith-length-fish-length relationship (Fig. 3 B) a total of 363 otoliths were studied and the result was as follows:

$$O = -0.0605 + 0.8152 L$$

$$L = 0.0768 + 1.2247 O$$

(where L = fish length in cm, and O = otolith length in mm).

In the equation for the fish-length-scale-length relationship the value of constant 'a' is 1.08. This may represent the fish length in centimeters when the scale length is zero. The smallest specimen observed by the present author measured 4.9 cm. Scales have already been formed in this specimen with a total number of 20 circuli.

Rings on scales and otoliths

In the scales, rings are in the form of abrupt breaks in the pattern of circuli. There is no zonation of either wide-spaced sclerites representing the period of faster growth or closely spaced sclerites during slow growth. The number of radii increases towards the outer side. In general, majority of the radii are found to be slightly bent in the region of the rings. The mean length of the fish at age I to IV calculated are 40.7, 57.8, 75.6 and 91.3 cm respectively. Table 1 gives the distribution of the first four rings in the scales at various size groups.

The otoliths show rings as concentric opaque and hyaline zones. In some of the otoliths the opaque zones can be recognised as concentric prominent ridges and the hyaline zones in the form of concentric deep canals or depressions. The hyaline zones were noted as rings. Table 2 gives the average length of the fish with I to V rings in the otoliths as 15.7, 23.3, 31.3, 42.2 and 52.2 cm, respectively. It is clear that prior to the formation of the first growth check in the scales, the otoliths showed three extra hyaline zones termed as 'larval rings' formed as result of the change in the juveniles from a pelagic to a semidemersal habitat. The fourth and fifth rings in the otoliths correspond to the first and second rings in the scales. These extra rings in the otoliths have been observed by Kutty (1961) also.

Time of formation of the rings on scales

A total of 232 scales of various size groups were studied for this purpose. Monthwise, they were categorised into two: those with more than

TABLE 1. *Distribution of the first 4 rings in the scale of Otolithoides brunneus at various size groups.*

Size groups in cm	No. of fish observed	Number of rings				
		0	1	2	3	4
8-12	6	6	—	—	—	—
13-17	35	35	—	—	—	—
18-22	53	53	—	—	—	—
23-27	63	63	—	—	—	—
28-32	76	66	10	—	—	—
33-37	93	54	39	—	—	—
38-42	54	5	49	—	—	—
43-47	26	1	25	—	—	—
48-52	26	—	14	12	—	—
53-57	25	—	9	16	—	—
58-62	17	—	—	17	—	—
63-67	12	—	—	8	4	—
68-72	7	—	—	2	5	—
73-77	12	—	—	2	10	—
78-82	11	—	—	1	10	—
83-87	3	—	—	—	2	1
88-92	5	—	—	—	1	4
93-97	1	—	—	—	—	1
98-102	1	—	—	—	—	1
103-107		—	—	—	—	—
Total number	526	283	146	58	32	7
Mean fish length cm		—	40.7	57.8	75.6	91.3

10 circuli in the open margin (terminal zone), and those with less than 10 circuli in the terminal zone. The terminal zone is the scale margin beyond the outermost ring. The time of formation of the rings would represent the period when scales with the lesser number of circuli in the terminal zone were prominent. Figure 3 D shows that the scales with the lesser number of circuli in the terminal zone were prominent from October to February.

Walford's Growth Transformation

The calculation of parameters K and L_{∞} in 'Koth' from l_1 , l_2 , l_3 and l_4 values of 40.0, 60.0, 80.0 and 95.0 cm at the end of 1 to 4 years, respectively, were carried out by adopting Walford's (1946) method. The length at yearly intervals were plotted against those of the succeeding

TABLE 2. *Distribution of the first 5 rings on the otoliths of 'Koth' Otolithoides brunneus at various size groups.*

Size groups in cm.	No. of fish observed	Number of rings				
		1	2	3	4	5
8-12	7	5	2	—	—	—
13-17	51	24	24	3	—	—
18-22	72	9	33	30	—	—
23-27	116	1	73	42	—	—
28-32	82	—	16	50	16	—
33-37	123	—	9	109	5	—
38-42	57	—	—	32	25	—
43-47	39	—	—	4	34	1
48-52	23	—	—	—	18	5
53-57	10	—	—	—	4	6
58-62	5	—	—	—	—	5
63-67	3	—	—	—	—	3
68-72	2	—	—	—	—	2
73-77	—	—	—	—	—	—
Total	590	39	157	270	102	22
Mean fish length cm.		15.7	23.3	31.3	42.2	57.2

year based on the above values. Figure 4 shows that the intersection with the bisector (L_{∞}) appears to be at 198 cm. By fitting the von Bertalanffy equation to the data of growth in length, following Beverton (1954) the estimated values of K and L_{∞} are 0.14 and 206.4 cm respectively. The largest specimen observed by the present author measured 163 cm in total length.

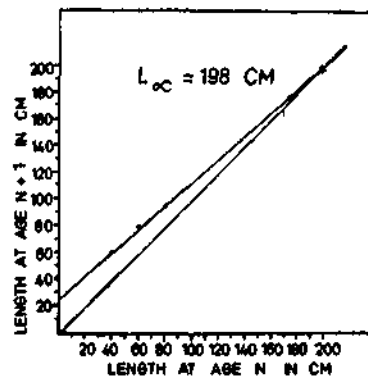


FIG. 4. Walford's growth transformation curve for *O. brunneus*.

DISCUSSION

Qasim (1973) stated that most of the tropical fishes have a short life span of 2-3 years and mature when they are 1-2 years old, except a few species such as *Otolithoides brunneus*, *Trichiurus haumela*, *Pseudosciaena diacanthus* and *Lethrinus lentjan*, and those fishes from inland waters of northern India showing a well defined seasonal cycles of growth.

Kutty (1961) found the average length of the fish with 1 to 13 rings in the scales of *O. brunneus* to be 41.8, 60.0, 74.1, 83.1, 107.9, 127.0, 134.7, 136.1, 138.5, 142.0, 148.2, 149.0 and 152.0 cm respectively, whereas the mean fish length for I to VI rings on the otoliths observed by him were 13.8, 23.4, 39.3, 45.5, 61.5 and 80.3 cm. The first three modes in the length-frequency distribution observed by him were found to be at 38.5, 59.5 and 80.5 cm in 1958-59; 24.5, 59.5 and 73.5|80.5 cm in 1960-61. The present study shows close agreement in the length attained at the end of I to IV years of life as deduced from length-frequency distribution and the mean length calculated from scales. A comparison of Tables 1 and 2 shows the disparity in the distribution of rings on scales and otoliths. There is clear indication that three extra hyaline zones known as 'larval rings' are formed in the otoliths by the time the scale developed the first ring. The first scale ring appeared only when a much larger size was attained by the fish. There is a corresponding agreement between the mean lengths for 4th and 5th rings in the otoliths on one hand and the 1st and 2nd rings in the scales on the other. One of the causes for the formation of 'larval rings' as stated by Saetersdal (1958) is that the otolith being a more sensitive organ than the scales records smaller changes in the conditions of the fish than does the scales. Gottlieb (1956) referred to it as 'larval ring' in red mullet (*Mullus barbatus*). Fairbridge (1951) observed this peculiarity in New South Wales tiger flathead, *Neoplatycephalus macrodon*. According to these authors such 'larval rings' are formed due to the change in the habitat from planktonic larval life to demersal mode of life. Kotthaus (1958) is of opinion that the causative factors for the formation of 2 to 4 secondary rings in the otoliths before the completion of first year of life in redfish (*Sebastes marinus*), Plaice (*Pleuronectes platessa*), Adriatic sardine (*Clupea pilchardus*) and *Drepanopsetta platessoides* are the regular migrations connected with changes in the food supply. Hubbs (1921) reported interesting false annulus formation called 'natal annulus' formed at birth in some members of the family Embiotocidae. He thought that the embryonic food supply is cut off and temporary reduction in the food supply occurs until the young fish becomes adapted to capturing food in its new environment. Rao (1966) observed a narrow hyaline zone outside the nucleus of otolith in some of the juveniles (10-20 cm) of 'Ghol', *Pseudosciaena diacanthus*, another sciaenid of Bombay and Saurashtra waters. 'Larval rings' have been noticed in *Polynemus heptadactylus* by Kagwade (1971).

The rings in the scales are formed during the period from October to February. This observation is in accordance with that of Kutty (1961) who cited two causative factors responsible for the formation of annuli in the scales, 1) the lowest feeding intensity in the juveniles during the above period as observed by him, and 2) the prevailing low temperature and high salinity during November to February (Jayaraman and Gogate 1957, Jayaraman *et al* 1959). The present author has not observed any decrease in the feeding intensity in the juveniles during November to February. It seems that the prevailing low temperature, high salinity and upwelling taking place off Bombay (Jayaraman and Gogate 1957, Jayaraman *et al* 1959 and Rao *et al* 1969) are the main causative factors which contribute to the formation of rings on scales.

Longhurst (1964) calculated the K value of 'Koth' based on 11 years growth data on scales studies made by Kutty (1961) to be 0.25-0.28. The K and L_{∞} values estimated by Rao (1966) based on the above data are 0.1744 and 170.25 cm respectively and he showed that the value of K obtained by Longhurst were pretty high. (Longhurst in a personal communication to Rao stated that there was some arithmetical error in his own calculation of K value of 'Koth'). The present study using the length-at-age data based on the length-frequency distribution showed values of K and L_{∞} to be 0.14 and 206.4 cm respectively. Specimens beyond the fifth-year groups were not available during the present study.

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