STUDY ON THE BIOLOGY OF *JOHNIEOPS VOGLERI* (BLEEKER) OF BOMBAY WATERS

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ABSTRACT

Johnieops vogleri in Bombay waters attains an average size of 158 mm, 240 mm and 290 mm at the end of 1, 2 and 3 years as shown by the length-frequency method, and 164.4, 220.6 and 276.6 mm as indicated by the scales. The time of annulus formation in the scales was during May to September which coincides with low intensity of feeding, spawning activities of the fish and the prevailing monsoon. Juveniles prefer crustaceans and, as they grow, show the piscivorous tendency. Lower intensity of feeding is noticed during the spawning season. Fifty percent of the fish mature at 159 mm in length. The relative condition of the fish is correlated to the spawning activities. Fecundity varied from 26,028 to 581,298 eggs. The distribution of sexes observed during different months of the year is not significant except during October and November. Among 130-179 mm size groups, males preponderated, whereas females were more among 220-249 mm size groups.

INTRODUCTION

Maharashtra accounts for 10,684 (1966-73 period) tonnes sciaenids annually. The fishery is supported by larger species like *Nibea dicanthus* (Lac.) and *Otolithoides biaurites* (Cantor). However, the fishery to a great extent is constitued by smaller species (locally known as 'Dhoma') viz., *Otolithes cuvieri, O. ruber, Johnieops sina, J. vogleri, J. osseus ,Johnius glaucus, J. belengerii, J. dussumieri, J. carutta* and *Pennahia aneus*. In the Bombay region Dhoma forms about 30 to 40% of the trawl catches.

Although *J. vogleri*, is one of the major species constituting Dhoma fishery. no information on its biology is available. In view of this, investigations were initiated on this species from the Bombay waters from 1973 through 1975 and the results are presented here.

MATERIAL AND METHODS

Catches were estimated month-wise based on the weekly sampling of 50-60% of the rawl units landed at Sassoon Docks, Bombay. Total lengths (from the tip of the snout to the tip of the caudal fin) were grouped at 20 mm intervals and the month-wise percentage of each group was calculated.

Scales were collected from below the tip of the pectoral fin. They were cleaned by keeping them in potassium hydroxide solution for 15 minutes, then washing in water and finally rubbing with cloth. Annuli were clearly visible to the naked eye when the scales were held against the light. For circuli count, scales were mounted dry in between two glass slides and viewed through binocular microscope. Scale-length measurements were taken from four to five scales from each fish, with a fine divider and a ruler divided into half-millimeter, and average length noted. 'Index of Preponderance' method (Natarajan and Jhingran 1961) was followed for food analysis. For purposes of study on food in relation to size groups, the data were analysed for each 20 mm size groups and the index of preponderance calculated. The intensity of feeding was determined in relation to the degree of distension of stomachs. Stomachs were grouped under the categories; full, ¾ full, ½ full, ¼ full, trace, empty and everted. The fishes with the first three categories of stomachs were considered to have fed actively and the rest to have fed poorly.

Ova-diameter measurements from 12 ovaries in the mature and ripe stages (IV-VI) were made as by Prabhu (1956).

Relative condition (Kn) was calculated using Le Cren's (1951) formula, $Kn = W|\hat{W}$ where W represents observed weight, $\hat{W}$ the calculated weight derived from the length-weight relationship. The mean Kn values for both sexes were worked out separately for various months and in relation to various size groups.

Fecundity study was based on 40 ovaries (preserved in formalin) of IV-V stages of maturity of specimens ranging from 158 to 302 mm. Fish were grouped into 10 mm and 20g intervals. For deriving various relationships of fecundity, computations were based on the formula $Y + a L^b$ where Y is the factor to be found out, L is the variable involved, a is a constant and b is an exponent.

Study on the sex ratio was undertaken employing the X^2 method of Fisher (1970), as followed by Dhulkhed (1968). The observed sex ratio in each month and in different size groups was tested against the expected ratio of 1 : 1 by the usual Chi-square equation $(O-E)^2/E$.

FISHERY

The month-wise catch and catch per unit of effort of *J. vogleri*, landed by the trawllers at Sassoon Docks, Bombay, during the period July 1973-September 1975, are given in Table 1. The estimated catch for the year 1973 (six-month period, July-December) was 105.1 t with a monthly average of 17.5 t. Catch and catch per unit effort were highest in November and lowest in July. During 1974, about 69.3 t were landed with an average monthly landing of 6.9 t, first and third quarters witnessing good catches. About 63.5 t were landed during 1975, the monthly average being 7.1 t. The highest catch of 10.7 t was in March, and fishery was good during the first and second quarters.

TABLE 1. *Trawl landings of* J. vogleri *at Sassoon Docks, Bombay during* 1973-75.

Months	1973		1974		1975	
	C	C|E	C	C|E	C	C|E
Jan	—	—	6330	4.0	8009	4.5
Feb	—	—	14900	8.8	5332	3.3
Mar	—	—	4760	4.9	10732	6.8
Apr	—	—	6675	3.8	9405	8.3
May	—	—	3120	1.7	3990	3.9
Jun	—	—	2205	1.5	10434	11.6
Jul	1290	1.3	7155	5.6	4280	3.0
Aug	2057	1.5	2196	1.5	7207	6.5
Sep	3672	2.0	13810	8.0	4164	4.0
Oct	28140	13.2	8145	4.3	—	—
Nov	38360	19.7	—	—	—	—
Dec	31590	18.0	—	—	—	—
Total	105109	10.6	69296	4.4	63553	5.2

C = Catch in Kg. C|E = catch per unit effort.

AGE AND GROWTH

From Fig. 1, depicting length-frequency distribution, two batches of recruitment, viz., 15 to 35 and 95 to 115 mm, are seen in June-August period of

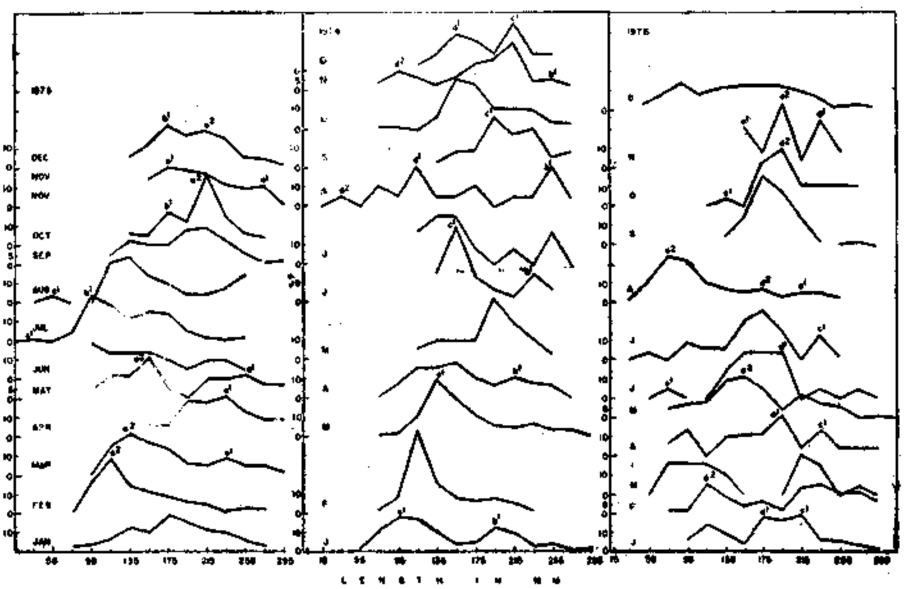

FIG. 1. Monthly length distribution of *J. vogleri* during 1973-75.

every year. The former brood would have resulted from the spawning during June-July and the latter from that in October-November as spawning occurs in these period in the area (see section: spawning). Hence it is probable that the broods representing modes a2, c1 and d2 and b1, d1 and e1 might be the products of spawning during June-July and October-November periods of 1972, 73 and 74, respectively. Taking this into consideration it can be said that mode c1 at 35 mm in July 73 would be 1-2 months old. This mode shifted to 115 mm in February 74, and further, to 155 mm in June 74 and 235 mm in June 75, in exactly one and two years respectively. Mode d1 at 115 mm in August 74 would be 8 months old and progressed to 155 mm in December 74; 195 mm in June 75 and 235 mm in December 75, in 1 year, 1½ years and 2 years respectively. Mode d2 at 35 mm in August 74 might be the juveniles just recruited to the fishery. This mode moved to 155 mm in March 75, in 8 months; 175 mm in September 75, in 14 months, and 195 mm in December 75, in 1½years. Modes a2 , b1, and e1 also showed simliar or more less comparable rate of pogression to other modes described above. In Table 2 are given the observed model lengths and calculated lengths based on the growth rate obtained from the preceding model position. From this it can be seen that a brood of 115 mm size might be 8 months old and would attain an average size of 158 mm, 206.3 mm and 240 mm at the end of 1, 1½ and 2 years of its life, respectively. Further, the growth rate during the third year worked out to 5 mm per month as seen from the progression of mode a1 at 235 mm in March 73 to 275 mm in November 73 (in 9 months). From this it is reasonable to assume that the fish adds 60 mm in length during the third year to attain a size of 290 mm.

TABLE 2. *Modal length in mm at* 8, 12, 18, *and* 32 *months of* J. vogleri

Broods/ months	8	12	18	24	32	Remarks
c1	115	155	215	235	—	* Calculated length based on the growth rate obtained from the preceeding modal position
b1	—	163.6*	221.6*	255	—	
a2	115	155	206.4*	—	—	
a1	—	—	—	235	275	
d2	115	155	195	—	—	
d1	115	155	195	235	—	
e1	—	155	—	—	—	
Average length	115	158	206.3	240	275	

Scales

The scales are angular or square shaped and the rings are in the form of transparent zones which can be traced completely around the scale. In the lateral fields, the cross over like a thin transparent line as in the case of the scales of California corvina, *Menticirrhus undulatus,* and spot-fin croaker, *Roncador stearnsi,* shown by David (1962). In the anterior margin the circuli in the ring are somewhat widely spaced than the circuli in the preceding and following zones of the ring (annulus), so that the annulus transmits light and appears as thin and transparent line. The circuli in the rings are often broken. False translucent lines prominet only in the anterior margines were observed, but they were invariably not traceable in the middle and posterior region of the lateral fields.

The results (Table 3) indicate that the first ring forms at a mean length of 164.4 mm, the second and third at 220.6 and 276.6 mm, respectively. The results closely agree with those obtained from the length-frequency studies.

TABLE 3. *Distribution of rings in the scales of* J. vogleri *at different size groups.*

Size groups	No. of fish	Number of rings			
in mm	observed	0	1	2	3
66-85	2	2	—	—	—
86-105	2	2	—	—	—
106-125	21	19	2	—	—
126-145	11	—	11	—	—
146-165	21	—	21	—	—
166-185	42	—	37	5	—
186-205	34	—	14	20	—
206-225	39	—	1	38	—
226-245	26	—	1	25	—
246-265	10	—	1	6	3
266-285	11	—	—	2	9
286-305	3	—	—	—	3
Total number	222	23	88	95	15
Mean fish length	—	—	164.4	220.6	276.6

Time of ring formation was determined by the method followed by Jayaprakash (1976). According to him, the time of formation of the rings would represent the period when the scales with lesser number of circuli in the terminal zone were prominent. From Fig. 2 it can be seen that during May-September high percentage of scales with minimum width of less circuli was encountered and this period would indicate the beginning of a fresh annular zone.

The relationship between scale length and fish length was established from scales of 204 specimens by using the equation Fl = a + b Sl (where Fl = fish length in mm, and Sl = scale length in mm and a and b are constants by the least square method. The results are:

Sl = −1.9745 + 1.2051 Fl
Fl = 1.6512 + 0.8118
The correlation coefficient r = 0.98.

FIG. 2. Monthwise percentage of fish with less number of circuli in the terminal zones of scales of *J. vogleri*.

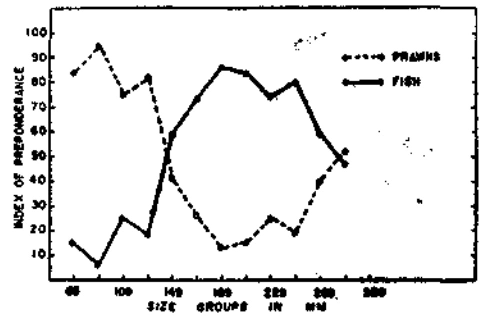

FIG. 3. Index of preponderance of teleostean fish and prawns in the food items of *J. vogleri* in relation to different size groups during 1973-75.

Length-Weight Relationship

This relationship was calculated based on the data of 364 males and 267 females by applying the formula $W = a L^b$ where W is the weight of the fish in grams, L is the length of the fish in mm and a and b are constants. The values are:

Males: Log W = −5.5781 + 3.2861 Log L
Females: Log W = −5.5521 + 3.2808 Log L

Coefficient correlation r for males and females was 0.995 and 0.996, respectively.

Relationship between total length and standard length

The regression equation for total length and standard length was calculated by the method of least squares and could be expressed by the formulae

Sl = −0.1927 + 1.0443 Tl

Tl = 0.1870 + 0.9564 Sl, where Sl = standard length and Tl = total length. The correlation coefficient r was 0.99.

Food and Feeding Habits

A total of 734 fish were examined for food study of which 188 fish had empty stomach, 98 had everted stomach, 148 had food full, $\frac{3}{4}$ full or $\frac{1}{2}$ full. The remainder had food in $\frac{1}{4}$ or trace.

Diet composition

It is seen from Table 4 that, by and large, *Bregmaceros macclellandi*, other teleostean fish and fish remains constituted the main food items. To a lesser extent, the crustaceans especially *Acetes indicus*, prawn remains and *Squilla* spp. and *Eupagurus* spp., were observed. Also observed in the diet at times were *Sepia* spp. and gastropod shell pieces. While the teleostean remains, prawn remains and *Acetes indicus* were encountered almost throughout the year in different proportions, *B. macclellandi* was conspicuously absent in the food items in the month of August every year (Table 5).

Food in relation to size groups

Fig. 3 shows the index of preponderance in relation to size groups. It can be seen that in fish of 60-139 mm size groups (0-year class), the index for prawns, the dominant food item, ranged from 71.88 to 90.95 and fish diet ranged from 7.84 to 27.04. With growth, the proportion of prawn diet decreased markedly whereas that of fish diet increased. This was seen in specimens of 140-239 mm (1- and 2-year groups) in which the fish constituted the greater volume

TABLE 4. *Index of preponderance of food items of* J. vogleri *during* 1973-'75 *(pooled data).*

Food items	% of volue	% of occurrence	Index of preponderance
Bregmaceros macclellandi	21.26	13.76	23.57
Trypauchen vagina	4.24	1.68	0.57
Stolephorus spp.	1.71	1.52	0.20
Polynemus heptadactylus	2.89	0.45	0.10
Trichiurus spp.	3.17	0.45	0.11
Other teleostean fishes	3.49	1.52	0.11
Fish remains	18.84	23.24	37.16
Acetes indicus	12.41	17.73	17.73
Parapenaeopsis stylifera	3.92	1.83	0.57
Solenocera indica	4.18	1.68	0.56
Other prawns	2.32	0.60	0.06
Prawn remains	10.65	19.57	16.79
Eupagurus spp.	0.53	0.61	0.02
Crab	0.76	0.45	0.02
Squilla spp.	5.12	3.51	1.44
Sepia spp.	1.33	0.61	0.06
Gastropod shells	0.08	0.30	0.01
Mud	0.79	4.89	0.31
Digested matter	1.20	5.50	0.53

TABLE 5. *Month-wise Index of Preponderence of different food items of* J. vogleri *for* 1973-75.

Food items*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1973												
1	—	1.1	10.2	—	—	—	—	—	9.8	64.1	41.5	—
2	18.0	12.0	79.6	76.7	—	—	54.4	25.0	63.8	12.6	5.7	—
3	77.0	76.0	1.2	—	16.7	—	8.8	—	—	2.8	34.0	—
4	2.6	8.3	6.6	11.1	83.3	—	19.6	50.0	21.8	10.7	17.8	—
5	2.3	2.2	22.0	12.0	—	—	2.5	—	—	5.1	0.7	—
6	—	—	0.2	—	—	—	—	—	—	0.6	0.2	—
7	0.1	0.2	0.3	—	—	—	14.7	25.0	4.6	4.2	0.1	—
1974												
1	—	36.8	84.8	32.6	—	—	65.2	—	—	—	30.4	—
2	65.0	40.0	6.3	7.1	43.8	73.3	26.2	—	96.8	74.0	50.2	78.3
3	—	8.3	0.2	5.4	—	2.4	—	—	—	4.7	4.9	9.2
4	35.0	12.3	3.9	24.4	49.3	24.3	7.3	—	2.8	18.6	10.9	12.5
5	—	2.6	4.2	—	—	—	—	—	—	0.7	—	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	—	—	0.6	30.5	6.9	—	1.3	—	0.5	2.0	3.7	—
1975												
1	35.3	7.1	100.0	—	44.8	2.8	—	—	8.3	27.4	26.4	—
2	39.2	2.9	—	7.1	2.7	7.6	—	9.9	43.8	17.9	18.7	80.1
3	1.8	58.2	—	—	0.5	7.8	27.6	12.7	22.2	20.5	5.0	10.7
4	21.2	22.3	—	9.5	48.9	81.8	72.4	74.5	9.7	24.2	46.3	6.8
5	2.5	9.5	—	—	2.7	—	—	—	—	7.9	1.6	1.8
6	—	—	—	83.3	—	—	—	—	13.9	—	—	—
7	—	—	—	—	0.3	—	—	3.0	2.1	2.1	2.1	0.5

* Food items: 1- *Bregmaceros macclellandi*, 2- Other fish and teleost fish remains, 3- *Acetes indicus*, 4- Other prawns and prawn remains, 5- Other crustaceans, 6- Molluscs 7- Misc. (mud and digested matter).

and was found to be more frequent as compared to prawn component, the index being 56.90 to 82.38. In 240-299 mm group (2-3 year class), in addition to the fish and prawns, stomatopods, mainly *Squilla*, were also noticed. Mud particles were found in smaller amounts in fish measuring 120-279 mm. The food of 160-279 mm groups to a lesser extent consisted of gastropod shells and *sepia* spp.

Feeding intensity

The percentage of occurrence of empty stomachs and actively-fed fish in different months in the period 1973-75 is given in Fig. 4. It may seen that feeding intensity was high during the months February, December, January and April and poor from June to October indicating that feeding intensity decreases during the monsoon season, which is also the spawning season of this species. Feeding intensity is higher prior to and after spawning season.

The condition of disgorged and everted stomachs was observed and their percentage of occurrence is given in Fig. 4. It is seen that the percentage was high during April, July and August.

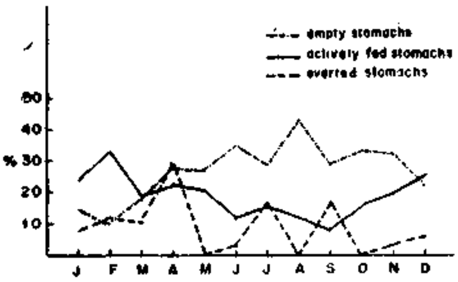

FIG. 4. Monthly average percentage of empty and everted stomachs and actively fed individuals of *J. vogleri*.

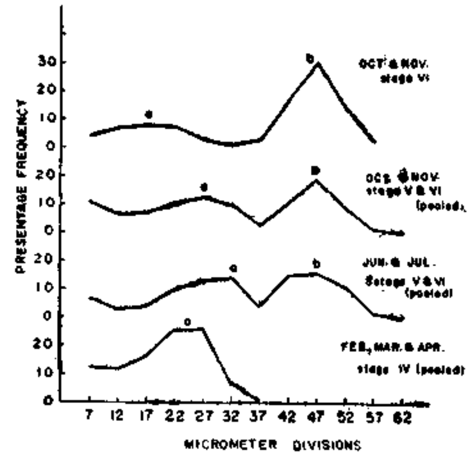

FIG. 5 Ova-diameter frequency polygons of *J. vogleri*.

Everted stomachs were mostly encountered in size groups beginning from 140-149 mm, higher percentage recorded being in 190-199 (23.07%); 200-209 (21.73%) and 230-239 (17.00%) mm size groups.

SPAWNING

Fig. 5 shows the frequency polygons of ova-diameter measurements from IV-VI stages of ovaries. In stage IV, the mode a at 27 m.d., representing mature condition, is clearly separated from the general egg stock. In stages V-VI, in addition to the mode a, another mode b at 47 m.d. is discernible. These eggs were fully ripe with a few oil globules. This indicates that from the mature egg stock, one batch of ova grows faster and gets ready for spawning during the ensuing season. The rest of the mature eggs may spawn subsequently taking some more time to attain the ultimate stage since these eggs are already in mature condition. Therefore, the spawning in this species seem to be restricted to a short period with an indication of a second spawning, the duration in between being short.

Mature fish (IV) were available throughout the year (Table 6). Fish in oozing condition were observed in June and July and again in October-November. This suggests that *J. vogleri* spawns twice a year, i.e., June-July and October-

November. This is further supported by the occurrence of juveniles of 15-35 and 95-115 mm length during July-August in the local trawl and 'Dol' net catches and the low Kn values during this period.

MINIMUM SIZE AT MATURITY

292 females of *J. vogleri* were examined for determining the minimum size at maturity. The percentage of mature fish occurring in various size groups is given in Fig. 6. It is seen that 50% of the fish matures at 159 mm length which closely corresponds to the length (141-160 mm) as evidenced from the relative condition.

TABLE 6. *Monthly percentage of occurrence of different stages of maturity in* J. vogleri *during* 1973-75.

	STAGE					
Month	I-II	III	IV	V	VI	VII
Jan	44.8	3.4	48.3	3.4	—	—
Feb	40.4	10.6	44.7	4.3	—	—
Mar	22.9	14.3	37.0	25.7	—	—
Apr	—	10.0	50.0	40.0	—	—
May	48.0	4.0	32.0	16.0	—	—
Jun	11.1	—	72.2	11.1	5.6	—
Jul	25.8	—	45.7	14.3	5.7	8.6
Aug	87.5	—	—	12.5	—	—
Sep	17.8	17.9	42.9	17.9	—	3.6
Oct	5.2	2.6	48.7	35.9	7.7	—
Nov	12.1	—	48.5	27.3	6.1	—
Dec	34.5	3.4	41.4	20.7	—	—

RELATIVE CONDITION

Mean Kn values for various months and in relation to various sizes are plotted in Figs. 7 and 8. It can be seen from Fig. 7 that the Kn values for females is high in April and falls abruptly in May followed by a slight rise in June. Subsequently, the values are low up to November: In males, high value is seen in May which decreases gradually reaching the lowest in August. The low values continue up to November with some degree of fluctuations in between. The values for males and females rise in December and declines in January.

The rise in the value in April in the case of females and in May in the case of males may be due to fat formation prior to maturation. The low value observed in May for females may be attributed to the loss of weight by the early spawners. The low values from June to November in both sexes might be due to the spawning activities of the fish. The lowest value obtained for males in August was based on the observation of a single specimen. The rise in the values in December may be due to active feeding as observed from the stomach-content analysis. The low value recorded in January could be related to some other physiological changes in the body other than the maturation process or to a sampling error.

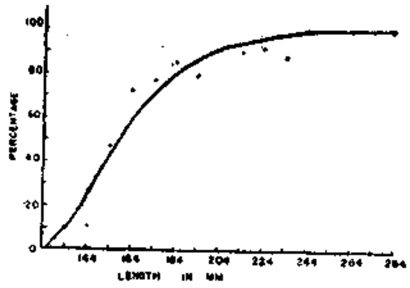

FIG. 6. Maturity curve of *J. vogleri*.

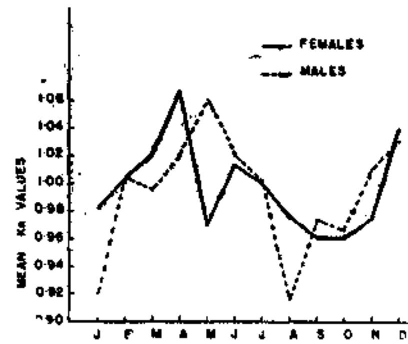

FIG. 7. Mean Kn values of *J. vogleri*. during different months.

Fig. 8 shows the Kn values for females and males in relation to different siz groups. It is seen that the value for immature females (81-100 mm size group) is high and there is a decline in the next size group (101-120 mm). This is also found to be in immature state and the drop in Kn value might be associated with physiological activities of the fish other than the maturation of gonads. The increase in the value in the next size group (121-140) indicates the building up of fat prior to maturation. Thereafter, the value decreases in the 141-160 mm size class and this is perhaps due to the spawning activities of the fish. The rise in values noticed in the 161-180 mm size group and fall in the 201-220 mm size class indicate that the fish spawns again at 210 mm when it is about two years old. The fluctuation in the Kn values for males follows a similar pattern as observed in the case of females.

Sex Ratio

Sexes could be differentiated from 80-89 mm size group onwards. Out of 730 fish examined 387 were males and 343 females. The male to female ratios for 1973, 74 and 75 were 1.5 : 1; 1 : 1 and 1 : 1.2, respectively.

The results indicated below show that the observed proportion of males in different months of year is not significant.

Chi-square test for the proportion of males in the monthly samples during 1973, 74 *and* 75 *and combined data for three years.*

Years	degrees of freedom	X^2
1973	10	10.1490
1974	10	10.0636
1975	11	18.4716
1973-75	11	17.7639

The analysis of sex ratio in each month and in different size groups indicated a significant departure from the expected 1 : 1 ratio during October and November 1973 (due to the dominance of males) December 74 (females predominated) at 5% level and July 75 (females predominated 1% level). When the data for three years were pooled, variation was noticed in October and

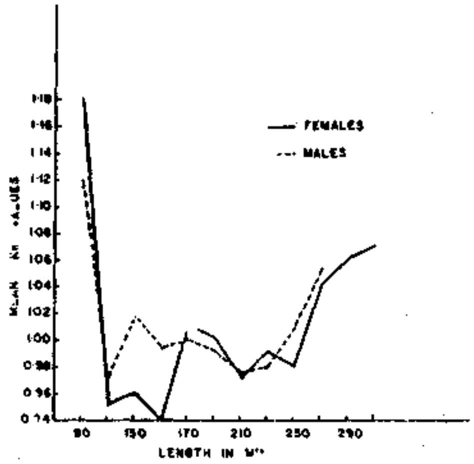

FIG. 8. Mean Kn values of *J. vogleri* at various lengths.

November. This might be due to the influence of predominance of males during this period in 1973. Significant deviation was noticed at 1% level in the 130-139 to 170-179 mm size groups indicating the predominance of males, whereas at 5% level in the 220-229 to 240-249 mm size groups, the females showed predominance.

Fecundity

The total stock of eggs varied from 26,028 to 581,295. It was noticed that fecundity varied in fish of the same length but generally increased with length. The relationship between fecundity (F) and length (L) was found to be;

$$\text{Log } F = -3.7132 + 2.5432 \text{ Log } L$$

The correlation coefficient r was 0.6717. The exponential value is slightly higher than that in the length-weight relationship, this is attributed to fecundity which increases at a rate higher than that of the body weight in relation to length.

The relationship between ovary weight (OW) and fecundity (F) was expressed as:

$$\text{Log } F = 1.1533 + 1.1779 \text{ Log } OW$$

The value of correlation coefficient r is 0.9598.

The relation between fish weight (FW) and ovary weight (OW) was
Log OW = −0.5314 + 0.6523 Log FW.
Correlation coefficient r = 0.7178.

The fish weight (FW) and fecundity (F) relationship could be expressed as:

Log F = 0.3368 + 0.8658 Log FW
Correlation coefficient r = 0.7480.

The relation between fish length (FL) and ovary weight (OW) was

Log OW = −2.6425 + 1.5188 Log FL
Correlation coefficient r = 0.5647.

Fish-length-gonad-length relationship

The relation between fish length and the length of ovary and testis was established from 224 females and 175 males. The relationship could be expressed for males as Y = −1.2489 + 1.2800 X (the correlation coefficient r = 0.9800) and for females as Y = −1.7090 + 1.4840 X (correlation coefficient r = 0.9850).

Discussion

Difference of opinion prevails regarding the causative factors for the formation of rings in the scales of fish. While Rao (1966) attributed the cause to low feeding in the case of juveniles and spawning in adults of *Pseudosciaena diacanthus*, Rao (1968) is of opinion that fast growth or accelerated growth of the fish for short periods in the case of juveniles as well as adults (after spawning) or destruction of sclerites at the end of a growth period in some cases may be the causative factors in the above species. Kutty (1961) ascribed to low feeding and prevailing low temperature the probable causes in *Otolithoides brunneus*. Jayaprakash (1976) while working on the same species has observed that prevailing low temperature, high salinity and upwelling seem to be the causative factors as he has not observed any low feeding intensity during the months of ring formation. According to Seshappa and Bhimachar (1951, 1914 and 1955) the ring formation in the Malabar sole, *Cynoglossus semifasciatus* is associated with starvation and monsoon conditions. Seshappa (1958 and 1959) has observed that the rings in *Rastrelliger kanagurta* are formed as a result of the physiological strain coupled with growth, ripening of gonads and spawning activity. The present study has shown that in *J. vogleri* the ring is formed during May-September. This period coincides with low feeding intensity (June-August), spawning (June-July) as well as monsoon period (June-September). Thus the probable cause for ring formation may be the complexity of factors associated with low feeding, spawning and monsoon conditions leading to physiological stress in the fish.

J. vogleri is a carnivore like other sciaenids found in Indian waters. When young, it feeds primarily on crustaceans, especially prawns, and with growth it shows piscivorous tendency. This type of food habit is seen in other sciaenids such as *O. brunneus* (Jayaprakash 1974) and *P. diacanthus* (Rao 1968). The bottom-feeding habit of this fish is evident from the presence of mud particles and organisms like *Eupagurus* spp. and *Squilla* spp., and gastropod shells. *B. macclellandi* and *A. indicus*, the two predominant food items are abundant in the Bombay waters during the first and fourth quarters which is reflected in the stomach contents during these periods. This indicates that *J. volgeri* has no preference or selection of food, but feeds mainly on the available food.

Everted and disgorged condition of stomachs, reported in various other sciaenids (Rao 1961, Suseelan and Somasekharan Nair 1969 and Jayaprakash 1974) was observed in *J. vogleri* also. The percentage of everted condition was low among juveniles, but was fairly common in size groups 140-149 mm onwards. Rao (1961) also reported that the percentage of everted condition is small and insignificant among juveniles but common in big-sized specimens of *P. diacanthus*. Rao (1961) and Jayaprakash (1974) have attributed this condition, respectively, in *P. diacanthus* and *O. brunneus*, to the sudden change of pressure and shock when they are hauled up from bottom waters.

The studies on ova-diameter frequency indicate that spawning in *J. volgeri* is twice in a year. According to Hickling and Rutenberg (1936), Dejong (1939) and Prabhu (1956) fishes which have two spawning seasons will have in addition to the ripe batch of eggs another batch which has undergone more or less half the process of maturation. This condition is seen in *J. vogleri*. Appa Rao (1967) reported that the maturing process in *J. carutta* has two stages, viz., differentiation of a batch of eggs as a mature group and further differentiation of another batch from the mature group. He observed that the last batch alone got liberated during the ensuing spawning season. Rao (1963) stated that in *P. diacanthus* there were at least two batches of eggs to be spawned in the same spawning season extending over a prolonged period from June to September. Devadoss (1969) reported that in *J. dussumieri* spawning occurs twice a year. He has observed in addition to the batch of ripe eggs another batch of eggs halfway to maturity. The present observation in *J. volgeri* that spawning is twice during June-July and October-November is also similar to the findings of Devadoss (1969). This has been further supported by the availability of fish with oozing gonads during the above periods and the occurrence of juveniles measuring 15-50 mm during July-August and December-January. This suggests that the two batches of eggs, having modes at 27 m.d. and 47 m.d. are to be released in two spawning seasons i.e. June-July and October-November.

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