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Note

Length weight relationship, relative condition, size at first maturity and sex ratio of Indian mackerel *Rastrelliger kanagurta* from Calicut

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Abstract

Length weight relationship, relative condition, size at first maturity and sex ratio of Indian mackerel *Rastrelliger kanagurta* was studied based on the data collected from the ring net and trawl net catches landed at Puthiappa in Calicut during the period July 2001 to December 2004.The length weight relationship for the pooled male and female was $W = 0.0000014\ L^{3.38}$ and that of indeterminate category was $W = .000044\ L^{2.67}$. The condition factor per length group the highest value was at 145 mm and in the monthly values, the lowest in May in the samples from both ring net and trawl net. Sex ratio showed deviation from 1:1 in certain months. The size at first maturity was estimated to be 173 mm for both the sexes.

Various aspects of the biology of Indian mackerel *Rastrelliger kanagurta* have been studied from India by different workers (Devanesan and John, 1940; Radhakrishnan, 1962; Pradhan, 1956; Rao *et al.*, 1962; Rao, 1967; Udupa, 1986; Gopakumar *et al.*, 1999; Yohannan and Abdurahiman, 1998; Prathibha and Alli, 2004). Unlike earlier years, the mackerel fishery has undergone noticeable changes with the expansion of fishing area and introduction of new gears such as ring seine. More over, trawl net contributes a significant part of mackerel landings. The present study brings to focus the length- weight relationship, relative condition, size at first maturity and sex ratio of this species. A comparison of the results with the previous studies is also given.

Materials and methods

The data were collected twice in a week from the trawl net and ring net catches landed at Puthiappa landing centre during the period July 2001 to December 2004. Total length of the fish was measured in mm and the weight in grams. Maturity was determined based on the macroscopic appearance of the gonads. Fishes in maturity stages 1 to 111 were treated as immature and 1V and above as mature. The young ones in which sex could not be identified were treated as indeterminate. The length-weight relationship was found out separately for indeterminate and immature and mature categories of males and females following the equation $W = a\ L^b$. Analysis of variance was carried out to test the equality of regressions lines. The condition factor was found out using the equation Kn = W/W^ where W is the observed weight and W^ the estimated weight. The monthly condition factor was calculated based on the data for one year from November 2003 to November 2004. The month wise sex ratio observed in different gears was subjected to x^2 test to know whether it varied significantly from 1:1 ratio. The size at first maturity was found out using Spearman-Karbar formula as given by Udupa (1986)

Results

Length weight relationship: The relationship was found out as:

Immature Male: $W = 0.0000014\ L^{3.39}$ ($n = 140$, $r^2 = 0.87$)

Female: $W = 0.0000036\ L^{3.21}$ ($n = 143$, $r^2 = 0.88$).

The size of male ranged from 132 to 205 mm and weight from 21 to 107 g and that of female ranged from 137 to 208 mm and 25 to 95 g respectively. But when these were subjected to ANOVA, they were not found significant at 5 % level. Hence a common equation was calculated as $W = .0000021\ L^{3.32}$ ($n=283$, $r^2 = 0.88$)

For mature male and female, the equation was:

Male: $W = 0.0000012\ L^{3.14}$ ($n = 257$, $r^2 = 0.92$)

Female: $W = 0.0000021\ L^{3.43}$ ($n = 260$, $r^2 = 0.93$)

The males ranged in size from 150 to 280 mm and weight from 40 to 270 g. The size of females varied between 160 and 290 mm and weight between 47 and 281g. The ANOVA revealed that the difference between the regressions was not significant. So the common formula after pooling them was:

$W = 0.0000012\ L^{3.41}$ (n=517, $r^2 = 0.92$)

Since there was no significant difference between the regression equations of immature and mature fishes, the data were pooled and a common equation was calculated which is $W = 0.0000014\ L^{3.38}$ (n = 800, $r^2 = 0.98$)

However, the difference between the regression equations of indeterminate and pooled male and female fishes was significant. So a separate equation for the indeterminate was derived as $W = 0.000044\ L^{2.67}$ (n = 155, $r^2 = 0.82$). The size of indeterminate ranged from 91 to 165 mm and weight varied between 7 and 52 g.

Condition factor (Kn): The values of the condition factor per length class (Fig. 1) varied between 0.9 and 1.18. The highest value was at 145 mm. The monthly Kn values (Fig.2) showed the lowest in May and the highest in March from the pooled samples from both ring net and trawl net.

Sex ratio: Sex ratio was found out separately for both immature and mature male and female. For this 1378 fishes from ring net and 1981 fishes from trawl net were observed. In the immature fishes, the ratio was found significant in September 2002 and in September, October and December 2003 and in 2004 the deviation was not significant. In the overall total, the ratio was found significant. In mature fishes, the ratio was significant in March 2002, March, June, August and December in 2003 and January, April to June and November in 2004.

Size at first maturity: Size at maturity of male was 172.7 mm with confidence limit of 171.13 and 174.27 mm and for females 173.4 mm with confidence limit of 172.1 and 174.7 mm (Tables 1, 2, 3).

Discussion

The length weight relationship shows that the typical cubic law is not followed indicating allometric growth. According to Lizama *et al.* (2002) the highest values of condition factor, as a general rule, occur in the lowest lengths or rather in the juvenile classes. Vazzoler (1996) opined that the lowest K values during the more devel-

Table 1. *Maturity stage distribution and computation of mean size at first maturity of male mackerel*

Length group (mm)	Mid-length (mm)	Log mid-Length (x1)	No.of fish sampled (n1)	No.of immature fish	Fully mature Fish(r1)	Proportion mature(p1)	x=x1+1-x1	q1=1-p	p1q1/n1-1
125	127.5	2.10551	2	2					
130	132.5	2.122216	5	5					
135	137.5	2.138303	6	6					
140	142.5	2.153815	6	6					
145	147.5	2.168792	7	7					
150	152.5	2.18327	10	10			0.01	0	0
155	157.5	2.197281	4	4	0	0.000	0.01	1	0
160	162.5	2.210853	13	5	8	0.615	0.01	0.385	0.02
165	167.5	2.224015	20	3	17	0.850	0.01	0.15	0.007
170	172.5	2.236789	44	5	39	0.886	0.01	0.114	0.002
175	177.5	2.249198	71	9	62	0.873	0.01	0.127	0.002
180	182.5	2.261263	98	12	86	0.878	0.01	0.122	0.001
185	187.5	2.273001	101	9	92	0.911	0.01	0.089	0.001
190	192.5	2.284431	70	10	60	0.857	0.01	0.143	0.002
195	197.5	2.295567	69	13	56	0.812	0.01	0.188	0.002
200	202.5	2.306425	46	4	42	0.957	0.01	0.043	0.001
205	207.5	2.317018	31	3	28	0.903	0.01	0.097	0.003
210	212.5	2.327359	43	1	42	0.977	0.01	0.023	0.001
215	217.5	2.337459	37	0	37	1.000		0	
Total						10.5195			0.042

m 2.337459 +0.01/2-(0.01*10.519)=2.237269
Antilog 2.237269= 172.7mm
Confidence limit Antilog (2.2337459+/-1.96Sqrt0.01^2*0.042=174.3 & 171.1mm

Table 2. *Maturity stage distribution and computation of mean size at first maturity of female mackerel*

Length group (mm)	Mid-length (mm)	Log mid-length (x1)	No. of fish sampled (n1)	No. of immature fish	Fully mature Fish(r1)	Proportion mature (p1)	x=x1+1-x1	q1=1-p	p1q1/n1-1
125	127.5	2.10551	2	2					
130	132.5	2.122216	6	6					
135	137.5	2.138303	1	1					
140	142.5	2.153815	17	17					
145	147.5	2.168792	17	17					
150	152.5	2.18327	8	8		0.000	0.01	0	0
155	157.5	2.197281	21	20	1	0.048	0.01	0.952	0.0023
160	162.5	2.210853	25	18	7	0.280	0.01	0.72	0.0084
165	167.5	2.224015	36	10	26	0.722	0.01	0.278	0.0057
170	172.5	2.236789	43	7	36	0.837	0.01	0.163	0.0032
175	177.5	2.249198	49	3	46	0.939	0.01	0.061	0.0012
180	182.5	2.261263	65	13	52	0.800	0.01	0.2	0.0025
185	187.5	2.273001	72	4	68	0.944	0.01	0.056	0.0007
190	192.5	2.284431	96	15	81	0.844	0.01	0.156	0.0014
195	197.5	2.295567	92	2	90	0.989	0.01	0.011	0.0001
200	202.5	2.306425	69	1	68	0.986	0.01	0.014	0.0002
205	207.5	2.317018	58	1	57	0.983	0.01	0.017	0.0003
210	212.5	2.327359	40	1	39	0.975	0.01	0.025	0.0006
215	217.5	2.337459	43	0	43	1.000			
Total						10.346			0.0266

m 2.337459 +0.01/2-(0.01*10.346)=2.238999

Antilog2.23899= 173.4mm

Confidence limit Antilog(2.238999+/-1.96Sqrt0.01^2*0.0266=174.7 & 172.1mm

oped gonadal stages might mean resource transfer to the gonads during the reproductive period. In the present observation, the highest value was found at 145 mm. In other size groups, the values were almost similar. The mature fishes obtained in the present study belonged either to the partially spent or fully spent stages and the lower values found in the higher size groups might be due to energy transfer to the gonad. The deviation of sex ratio from the general 1:1 was observed in one or two months in a year. But here this was observed in different months

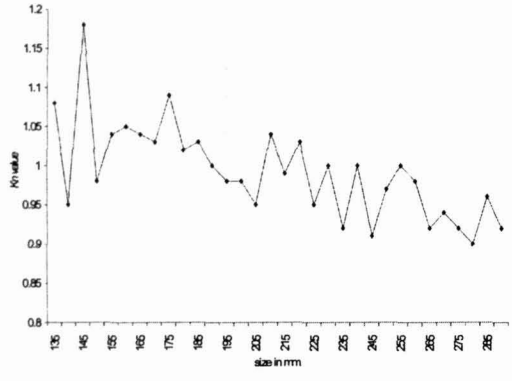

Fig.1. Condition factor per length group

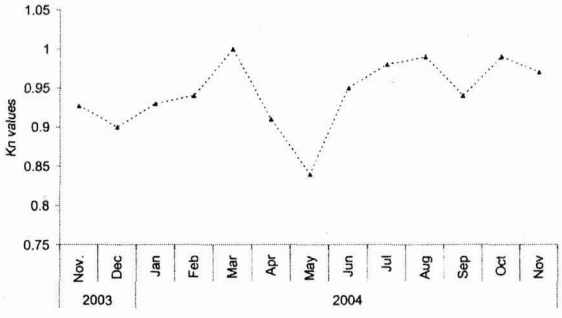

Fig.2. Monthly *Kn* values

Table 3. *Size at maturity reported by earlier workers*

Author	Size at maturity
Devanesan and John, 1940	19.9 cm
Pradhan, 1956	22.4 cm
Radhakrishnan, 1962	21-22 cm
Rao *et al.*,1962	20 cm
Rao, 1967	21.7cm
Udupa,1986	20.62 cm with con.limit 20.1 & 21.2 cm
Gopakumar *et al.*,1999	223 mm
Prathibha Rohit & Alli C.Gupta, 2004	180 mm
Present study	172.7mm with con.limit 171.1 & 174.3 mm for male 173.4 mm with con.limit 172.1 & 174.7 mm for female

in different years indicating no clear pattern. So it was not clear whether it was due to sampling or due to any behavioral peculiarity.

The present observation of size at first maturity between 171 and 175 mm agrees with that given by Prathibha and Alli (2004). Moreover in Calicut, the smallest mature fish observed was at 150 mm. Such occurrence of mature fish of smaller sizes were not uncommon here as during the present study. It was seen in July 2001, March, May, July and November in 2002, January to April and July and December in 2003 and January, March, April and June in 2004.

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