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Age and growth of *Lactarius lactarius* (Bloch & Schneider, 1801) from Karnataka, south-west coast of India

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ABSTRACT

Age and growth of *Lactarius lactarius* was studied separately for males and females from the Karnataka coast using monthly length composition data collected from three major fish landing centres *viz.,* Mangalore, Malpe and Karwar. The growth of *L. lactarius* was studied from length frequency data by ELEFAN I programme, and also by modal progression analysis using Gulland and Holt (1959) model after separating the modes using Bhattacharya (1967) method. The growth parameters estimated for males were: L_α = 240 mm, K = 1.01yr^{-1} and t_0 = -0.0151; for females: L_α = 285 mm, K = 0.91 yr^{-1} and t_0 = -0.0183 and for unsexed fishes (juveniles, males and females pooled) were: L_α = 294 mm, K = 0.84 yr^{-1} and t_0 = -0.0215. The recruitment pattern showed two recruitment pulses every year, the major one during March and the minor one during June-August. The von Bertalanffy growth formula fitted to *L. lactarius* indicated the fish to attain a length of 168 mm at the end of 1 year, 240 mm at the end of 2 years and 271 mm at the end of 3 years of its life. The estimated life span appears to be 3.57 years.

Keywords: Age and growth, *Lactarius lactarius*, Karnataka, Recruitment pattern

Introduction

Fish belonging to the Family Lactariidae commonly called whitefish/false trevally/big-jawed jumper is represented by a single species *Lactarius lactarius* (Bloch and Schneider, 1801). The species is widely distributed in Indian waters forming local fisheries of considerable importance in different regions along the Indian coast and has high demand in coastal markets. *L. lactarius* is a small-sized fish that moves in shoals in inshore waters, occurs up to a depth of 100 m and is exploited mainly by trawlnet along the coast of Karnataka. During 1990-99, *L. lactarius* formed 1.2% of the total marine fish production and 7.3% of the demersal fish production from Karnataka (Zacharia, 2003). The total whitefish production by all gears was 1,552 t in 1997-98 and 1,386 t in 1998-99. Studies on the age and growth of *L. lactarius* are very few from India and no published information is available from other parts of the world. James *et al.* (1974) studied the growth from Mangalore waters following monthly modal progression. Pauly (1978) estimated the growth parameters of *L. lactarius* using the published length frequency data of Rao (1966) from Waltair. Kartha (1975) and Neelakantan (1981) studied the growth rate from Karwar waters by tracing the monthly progression of modes. Reuben *et al.* (1993) estimated the growth of *L. lactarius* from Andhra-Orissa coast using the length frequency data analysed by the ELEFAN method. In the present study, an attempt has been made to estimate the growth parameters for males and females separately as well as for unsexed fishes and the growth parameters obtained were compared with previous estimations.

Materials and methods

Length composition data

Data on length frequency of *L. lactarius* were collected once a week for two years (September 1997 to August 1999) from the commercial fish catches at Mangalore, Malpe and Karwar fish landing centers. For getting sex-wise length frequency data, 100-150 specimens were brought to the laboratory on each day of observation, sexed and length-weight measurements were taken. Total length (TL) from tip of snout to the tip of upper caudal lobe was measured to the nearest mm. A total of 4,890 specimens of males (length range 80-215 mm TL) and 3,730 specimens of females (length range 80-265 mm TL) were used for the study. The length frequency data were grouped in 10 mm class interval. Growth was estimated separately for males, females and also for unsexed fishes comprising both juveniles and adults. For determining the growth parameters for unsexed fishes, a total number of 9,627

specimens in the length range of 50-265 mm TL were measured including juveniles. The length measurements from the three landing centers were pooled and used for analysis.

Estimation of growth parameters

The growth parameters were analysed using the ELEFAN I module of FiSAT software (Gayanilo and Pauly, 1997) without prior decomposition of data and also through modal progression analysis after decomposition of multi-cohort samples into their component distributions following the procedure adopted by Isa (1988) and detailed by Sparre and Venema (1992).

The growth parameters were tested for their reliability by comparing with the available growth records of the same species and growth performance index by the equation:

Munro's phi prime index, $\Phi = \log_{10} K + 2 \log 10\ L_{\alpha}$

where, K is expressed on an annual basis and L_{α} in cm.

Using the growth parameters, the recruitment pattern was obtained by projecting the length-frequency data backward on to a one-year axis (Pauly, 1982).

Results and discussion

Distribution of length

The month-wise length frequency distribution of males and females of *L. lactarius* caught in different gears at Mangalore, Malpe and Karwar are given in Tables 1 and 2 respectively. The total length of males ranged from 80 to 219 mm. Major modes were seen in the length class 140-149 mm during 1997-98 and 130-139 mm in 1998-99. In the case of females, the length range was from 80 to 239 mm in 1997-98 and 80 to 269 mm in 1998-99. Major modes were at 135 mm in 1997-98 and 155 mm in 1998-99. The length of the smallest fish recorded in the commercial catch was 50 mm and maximum length class observed was 260-269 mm. In certain months (May 1998), up to three modes were seen in the length frequency data.

Estimation of growth parameters

Male

The L_{α} obtained by Powell-Wetherall method was 240.3 mm and Z/K =5.265. The L_{α} obtained from ELEFAN I with highest R_n value (0.242) was 245 mm and K =1.1 yr^{-1}. The selection parameters obtained by estimating the probabilities of capture were L_{50} = 131 mm and L_{75} = 141 mm and using these values, the data were corrected for selection. The modes in the length-frequency data were separated for each month using Bhattacharya's method and through modal progression analysis, the means were grouped for each cohort. In certain months, up to 3 cohorts were seen. The monthly modes were connected and used to generate growth increment data. The growth parameters estimated using the Gulland and Holt plot were L_{α} = 240 mm and K = 1.01 yr^{-1}. The growth parameters obtained by Gulland and Holt plot were taken to represent the growth in male *L. lactarius*.

The life span estimated for male was 3 years. From the equation, male *L. lactarius* attains length of 154 mm at the end of first year, 209 mm at the end of second year and 229 mm at the end of third year of life. Since the length at first maturity (L_m) has been estimated at 131 mm (Zacharia and Jayabalan, 2007), the fish are able to spawn before attaining one year of age.

Female

The L_{α} obtained by Powell-Wetherall method was 283 mm and Z/K 6.0. ELEFAN I showed L_{α} = 295 mm and K = 0.84 yr^{-1} with an R_n value of 0.245. The selection parameters for the probability of capture were L_{50}=125 and L_{75}=136 mm. The modes in the length-frequency data were separated for each month using Bhattacharya's method and through modal progression analysis, the means were grouped for each cohort. The monthly mean values of cohorts were connected and used to generate growth increment data. Gulland and Holt plot indicated L_{α} to be 285 mm and K, 0.91 yr^{-1}. The growth parameters obtained through Gulland and Holt plot method were taken to represent the growth in female *L. lactarius.*

The life span estimated for female was 3.3 years. From the growth equation estimated, female *L. lactarius* attains length of 172 mm at the end of first year, 240 mm at the end of second year and 267 mm at the end of third year of life. Since the length at first maturity has been estimated at 133 mm (Zacharia and Jayabalan, 2007), the fish is able to mature and spawn before they complete one year of its life.

Unsexed fishes

The estimated growth parameters in unsexed sample of *L. lactarius* using Powell-Wetherall method were L_{α} = 280 mm and Z/K = 5.875 (Fig. 1). Using the different options in ELEFAN I, the best (R_n = 0.205) value of VBGF parameters obtained were L_{α} = 285 and K = 0.78 (Fig. 2). Monthly mean values obtained in different months by the Bhattacharya analysis are shown in Table 4. The monthly mean values of cohorts estimated by the Bhattacharya analysis were connected (Fig. 3) and used to generate growth increment data. The growth parameters, L_{α} and K estimated using the Gulland and Holt plot were 294 mm and 0.84 yr^{-1} respectively (Fig. 4) and these values were considered as the growth parameters for *L. lactarius* along Karnataka coast. The von Bertalanffy growth curves drawn with the selected growth parameters are shown in Fig. 5.

Table 1. Length-frequency data of male *L. lactarius* landed by different gears pooled for Mangalore, Malpe and Karwar during 1997-98 and 1998-99

Length range (mm)	1997-98												
	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Total
70-79													0
80-89				3	1								4
90-99		2		1	5		2		3				13
100-109	1	13	8	4	6	3	3	1	15			3	57
110-119	9	37	54	13	1	10	15	20	16		2	2	179
120-129	21	61	123	59	10	17	40	44	16		8	16	415
130-139	33	32	103	110	30	12	53	40	28		3	10	454
140-149	54	20	63	97	69	63	41	33	36			5	481
150-159	54	12	33	41	67	55	61	33	30				386
160-169	16	1	33	16	33	49	24	14	15				201
170-179	3		11	5	6	16	17	15	6				79
180-189	2		6	3	3	5	8	1	2				30
190-199			1	3		4	2	1	3				14
200-209			1	1		1	2						5
210-219			1				1	1					3
220-229													0
Total	193	178	437	356	231	235	269	203	170	0	13	36	2321
Length range (mm)	1998-99												
	Sep-98	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Total
70-79													0
80-89		5							2				7
90-99		21	4							1			26
100-109	1	46	6		2	2	7	2	14	5			85
110-119	13	63	30		15	7	24	10	30	5	6		203
120-129	9	50	84	15	18	25	33	33	54	1	4	11	337
130-139	10	41	108	92	31	52	93	59	52	1	7	16	562
140-149	10	24	46	97	36	44	85	49	48	3	12	4	458
150-159	5	13	34	74	48	46	70	71	44	3	5		413
160-169	1	10	11	35	29	57	47	28	28	3	32		281
170-179		6	8	15	10	34	13	24	5	1	1	1	118
180-189		2	4	9	4	14	4	9	10	3			59
190-199			1	2		6	3	1		2			15
200-209			1			1	2						4
210-219						1							1
220-229													0
Total	49	281	337	339	193	289	381	286	287	28	67	32	2569

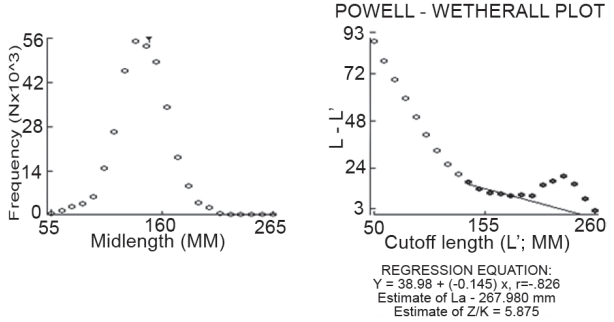


Fig. 1. Estimation of L_α and Z/K of *L. lactarius* (sexes pooled) using Powell-Wetherall Plot

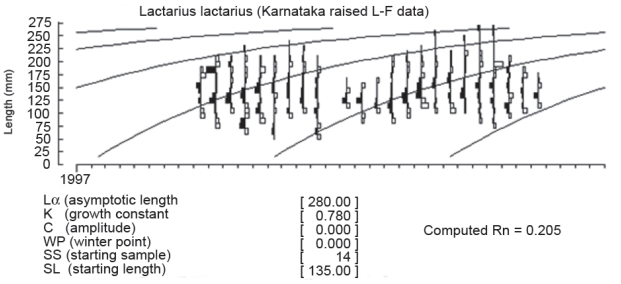


Fig. 2. Estimation of L_α of *L. lactarius* (sexes pooled) using ELEFAN I method

Table 2. Length-frequency data of female *L. lactarius* landed by different gears pooled for Mangalore, Malpe and Karwar during 1997-98 and 1998-99

Length range (mm)	1997-98												
	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Total
70-79													0
80-89				1					7			2	10
90-99		1		0			1		19			3	24
100-109	1	14	4	0	1		4	2	29			8	63
110-119	7	18	21	5	1	1	6	10	20			14	103
120-129	27	54	65	34	6	6	13	15	19		10	19	268
130-139	15	48	91	34	13	6	9	20	16		6	13	271
140-149	7	17	62	35	42	19	12	29	19		3	9	254
150-159	10	8	39	32	22	33	24	13	10		0	3	194
160-169	13	11	12	18	17	34	41	25	20		1		192
170-179	0	8	14	11	18	24	31	9	12				127
180-189	2	17	7	5	0	17	22	6	4				80
190-199		1	12	3	4	7	4	4	3				38
200-209		1	3	1	1	6	3	4	3				22
210-219				0			2	1					3
220-229				1			0	1					2
230-239							1						1
240-249													0
Total	82	198	330	180	125	153	173	139	181	0	20	71	1652

Length range (mm)	1998-99												
	Sep-98	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Total
70-79													0
80-89		1											1
90-99		10							1				11
100-109	3	26	4				2		14	5	1		55
110-119	32	41	24		5	5	3	9	20	5	7	1	152
120-129	28	28	48	7	1	14	8	29	40	4	7	4	218
130-139	13	22	58	41	8	20	34	38	28	0	9	8	279
140-149	8	23	64	54	17	20	44	41	44	4	5	10	334
150-159	8	27	27	69	38	32	31	46	92	4	4	4	382
160-169	4	13	29	52	36	39	27	39	39	5	7	4	294
170-179		14	11	15	18	44	29	11	32	3	0	4	181
180-189		5	5	14	6	13	14	15	9	3	1		85
190-199		3	3	6	3	16	7	2	1	0			41
200-209		1	3	5	2	8	3	4	0	1			27
210-219			2	0	0	4	1	1	0				8
220-229				1	0		2	0	0				3
230-239					0		1	0	0				1
240-249					0		1	0	0				1
250-259					1			0	1				2
260-269								2	1				3
Total	96	214	278	264	135	215	207	237	322	34	41	35	2078

Table 3. Length-frequency data of *L. lactarius* (unsexed) for 1997-98 used for the estimation of growth parameters

Length range (mm)	1997-98												
	Sep-97	Oct-97	Nov-97	Dec-97	Jan-98	Feb-98	Mar-98	Apr-98	May-98	Jun-98	Jul-98	Aug-98	Total
50-59						6			1				7
60-69				9		17			10				36
70-79		1		65		9			4				79
80-89		5		42	1				19			2	69
90-99	2	19		2	7		6		29			3	68
100-109	8	48	12	6	35	7	34	6	48			11	215
110-119	23	62	78	19	38	16	31	36	36		2	16	357
120-129	49	115	200	93	40	25	55	59	44		18	35	733
130-139	48	80	202	144	59	27	87	60	60		9	23	799
140-149	61	37	125	132	119	86	92	62	64		3	14	795
150-159	64	20	72	73	100	92	97	46	50			3	617
160-169	29	12	23	34	57	87	69	39	46		1		397
170-179	3	8	20	16	24	40	50	24	18				203
180-189	4	17	8	8	3	22	30	7	7				106
190-199		1	13	6	4	11	6	5	6				52
200-209		1	4	2	1	7	5	4	3				27
210-219							3	2					5
220-229				1				1					2
230-239							1						1
240-249													
250-259													
260-269													
Total	291	426	757	652	488	446	566	351	444	0	33	107	4568

Length range (mm)	1998-99												
	Sep-98	Oct-98	Nov-98	Dec-98	Jan-99	Feb-99	Mar-99	Apr-99	May-99	Jun-99	Jul-99	Aug-99	Total
50-59													
60-69													
70-79									9				9
80-89		7						5	23				35
90-99		31	4					14	32	3			84
100-109	5	72	12		2	2	10	34	45	12	1		195
110-119	61	106	57	2	20	12	31	37	74	13	13	1	427
120-129	49	90	137	22	19	39	50	66	114	5	11	15	617
130-139	34	74	169	133	40	72	138	97	92	1	16	24	890
140-149	23	54	111	151	55	64	133	90	107	7	17	14	826
150-159	17	43	63	143	94	78	108	117	142	7	9	4	825
160-169	5	24	44	87	73	96	79	67	78	8	9	4	574
170-179		20	19	30	30	78	45	35	41	4	1	5	308
180-189		7	9	23	14	27	21	24	21	6	1		153
190-199		3	4	8	4	22	12	3	2	2			60
200-209		1	4	5	4	9	6	4		1			34
210-219			2			5	1	1					9
220-229				1	2		2						5
230-239							1						1
240-249							1						1
250-259					1				1				2
260-269								3	1				4
Total	194	532	635	605	358	504	638	597	782	69	78	67	5059

Table 4. Results of the Bhattacharya analysis carried out for *L. lactarius* and the monthly means obtained for sexes pooled

Date	Mean legth (mm)			
	1	2	3	4
9/15/1997	125.47	157.5	-	-
10/15/1997	110.3	174.02	-	-
11/15/1997	127.75	159.83	198.57	-
12/15/1997	74.69	135.08	188.02	-
1/15/1998	109.5	156.67	201.11	-
2/15/1998	62.49	118.91	159.44	-
3/15/1998	112.12	152.49	192.61	-
4/15/1998	128.08	165.75	213.16	-
5/15/1998	63.93	155.72	199.55	-
7/15/1998	127.36	156.8	-	-
8/15/1998	108.76	-	-	-
9/15/1998	119.98	150.64		-
10/15/1998	107.3	155.75	188.11	-
11/15/1998	127.75	176	-	-
12/15/1998	151.69	190.25	-	-
1/15/1999	126.2	158.52	209.69	-
2/15/1999	132.8	168.91	210.97	-
3/15/1999	137.63	181.75	243.13	-
4/15/1999	107.05	157.35	214.74	-
5/15/1999	87.72	132.3	163.91	190.44
6/15/1999	107.16	168.5	191.38	-
7/15/1999	122.93	151.83	-	-
8/15/1999	135.47	169.25	-	-

The life span estimated using the equation, $t_{max} = 3/K$ (Pauly, 1983) is 3.57 years. VBGF equation indicated *L. lactarius* to attain a length of 168 mm at the end of first year, 240 mm at the end of second year and 271 mm at the end of third year of its life (Table 5). The von Bertalanffy growth curves drawn with the selected growth parameters are shown in Fig. 5. As there is no published information on sex-wise growth parameters for *L. lactarius*, in the present study. growth parameters for males and females were calculated separately. The values show a slight difference in growth rate between sexes. While the values of L_α were 240 and 285 mm for males and females, the growth coefficient (K) obtained were 1.01 and 0.91 and the values of the t_0 were -0.0151 and -0.0183, respectively. The maximum size of males observed in the fishery was

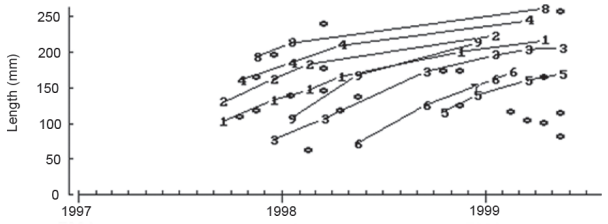


Fig. 3. Linking of means in modal progression analysis of *L. lactarius* (sexes pooled)

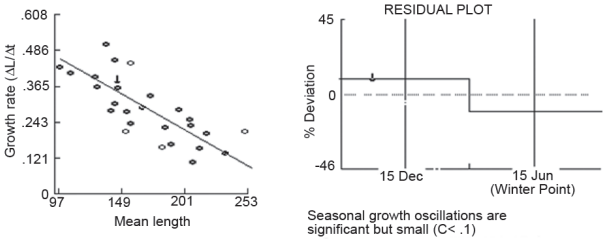


Fig. 4. Estimation of growth parameters using G & H plot for *L. lactarius* (sexes pooled)

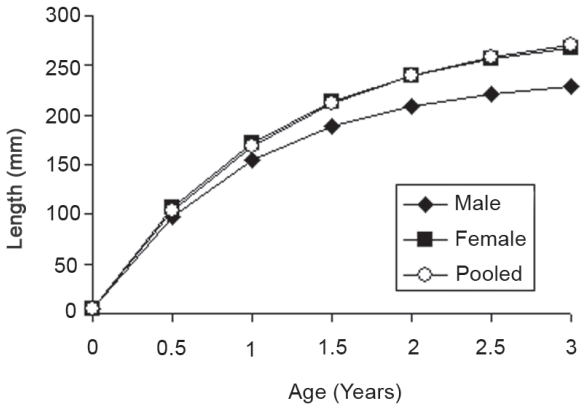


Fig. 5. The VBGF curve of *L. lactarius* (sexes pooled) with selected growth parameters.

Table 5. Selected VBGF growth parameters for *L. lactarius* and lengths calculated against age

Parameters/Sex	Male			Female			Sexes pooled		
L_α (mm)	240			285			294		
K yr^{-1}	1.01			0.91			0.84		
t_0	-0.0151			-0.0183			-0.0215		
	Age (years)								
	1	2	3	1	2	3	1	2	3
Length attained (mm)	154	209	229	172	240	267	168	240	271

215 mm whereas females measuring up to 265 mm size were encountered. The analysis of length-frequency data is not a dependable technique if the sample size is small (Jones, 1981). In the present study, more than 3,700 females, more than 4,800 males and more than 9,600 unsexed individuals were utilised.

The length frequency analysis of *L. lactarius* from Waltair showed the fish to attain 160-180 mm at the end of 1st year of life and the commercial catches mainly consisted of 0-year class (Rao, 1966); whereas, *L. lactarius* from Mangalore waters (James *et al*., 1974) had a growth rate of 12.0 mm per month in the first year reaching the size of about 150 mm at the end of 1 year and 270 mm at the end of second year. Though, fish measuring above 270 mm were not represented in the commercial landings, the life span of the species is estimated to be 3 years and the commercial fishery was based on 0-year and 1-year old fish along the Mangalore coast (James *et al.,* 1974).

The growth of *L. lactarius* from Karwar waters estimated by tracing the modes in the commercial catches (Kartha, 1975) indicated 90 mm growth after 6 months as the juveniles had a growth rate of 15 mm per month till they attain size of 125 mm and thereafter with lesser growth rate of 6.9 mm per month. Along the Karwar coast, *L. lactarius* attained a length of 150 mm at the end of first and 270 mm at the end of second year of its life (Neelakantan, 1981). The fishery was also observed to consist mainly of individuals measuring less than 150 mm in length and was supported by 0-year class along Karwar coast.

Even though several authors have described the growth rate of *L. lactarius* from different parts of India by tracing the monthly progression of modes, the estimate of von Bertalanffy growth parameters available are only that of Pauly (1978) based on the published data of Rao (1966) from Waltair and Reuben *et al*. (1993) from Andhra Pradesh-Orissa coasts. The growth parameters estimated by Pauly (1978) were, L_α = 320 mm, K=0.85 yr^{-1} and t_0 = -0.18. The L_α, K and t_0 estimated by Reuben *et al.* (1993) using modal progression analysis were 269.5 mm, 0.629 yr^{-1} and –0.2741 years respectively and the fishery was represented by fish of 1 to 3 years of age and the longevity was estimated as 4.8 years. Table 6 compares the growth parameters of *L. lactarius* estimated by earlier workers with that of the present study.

Comparison of growth parameters

Since published information on sex-wise growth parameters were not available for *L. lactarius*, the results of the present estimates are compared with the results of sexes combined available from literature (Table 6). The Φ value ranged from 2.66 (Reuben *et al.,* 1993) to 2.94 (Pauly, 1978). The values obtained in the present study were 2.76 for males, 2.87 for females and 2.86 for unsexed fishes.

The Φ enables a comparison of estimates of growth parameter of one stock with the other and their compatibility. It is also possible to estimate K indirectly for a specific stock of given species from the mean value of Φ estimated from other stocks of the same species used in conjunction with an estimate of L_α obtained through the method of Wetherall (1986) and is an index of growth performance. The values obtained in the present study (2.76 for males, 2.87 for females and 2.86 for unsexed) lie well within this range. The growth estimates and index indicate

Table 6. Comaparison of growth parameters of *L. lactarius* with the results available from literature

L_α (mm)	K (yr^{-1})	t_0	Sex	Temp	L_{max}	L_m	L_m/L_α	Φ	Area
270	0.629	-	P	27	270	168	0.62	2.66	India, AP-Orissa, 1976-79
320	0.854	-	P	28	280	167	0.52	2.94	India, Waltair, 1966 *
285	0.91	-0.015	F	29.5	265	134	0.47	2.87	India, Mangalore, 1997-99
240	1.01	-0.0183	M	29.5	215	132	0.56	2.76	India, Mangalore, 1997-99
294	0.84	-0.0215	P	29.5	265	133	0.45	2.86	India, Mangalore, 1997-99

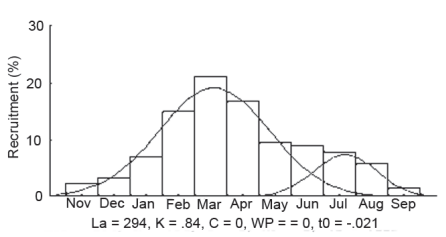
M = Male; F = Female; P = Pooled (unsexed)

** Estimate made by Pauly (1978) based on published data of Rao (1966)*

that the growth parameters obtained by Gulland and Holt plot after separation of modes through Bhattacharya method are comparable with parameters obtained by other methods. The growth parameter estimates from the present study along the Karnataka coast when compared with the results from east coast show slightly faster growth rate.

Recruitment pattern

With the estimated growth parameters of L_α = 294 mm, K = 0.84 yr^{-1} and t_0 = -0.0215, the recruitment pattern obtained by employing FiSAT is given in Fig. 6. Recruitment to the fishery takes place throughout the year. Nevertheless, two pulses are seen in the recruitment pattern every year. The major one corresponds to March (21.5%) and a minor one is observed during June-August. This is in close agreement with the results of maturation and spawning which indicate peak season of spawning of *L. lactarius* during November-March (Zacharia and Jayabalan, 2007). Small fishes, at a growth rate of 20 mm in the initial months may attain 50 mm after 2-3 months and get recruited to the fishery. The length frequency data (Table 3) show occurrence of smaller fish (50-59 mm) in February and May, which further corroborates the present observation.



Absolute Time	Percent Recruitment
1 Nov	2.36
2 Dec	3.26
3 Jan	7.05
4 Feb	15.15
5 Mar	21.34
7 May	16.92
8 June	9.57
9 Jul	9.05
10 Aug	7.89
11 Sep	5.81
12 Oct	1.58
	0.00

Fig.6. Recruitment pattern of *L. lactarius* (sexes pooled) with percentage recruitment during different months.

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References

Bhattacharya, C. G. 1967. A simple method of resolution of a distribution into Gaussian components. *Biometrics*, 23: 115-135.

Gayanilo, Jr., F. C. and Pauly, D. 1997. The FAO-ICLARM Stock Assessment Tools (FiSAT) Reference Manual. *FAO Computerized Information Series (Fisheries)*. No.8. Rome, FAO, 262 pp.

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Gulland, J. A. and Holt, S. J. 1959. Estimation of growth parameters for data at unequal time intervals. *J. Cons. CIEM*., 25(1): 47-49.

Isa, M. B. M. 1988. Population dynamics of *Nemipterus japonicus* (Pisces: Nemipteridae) off Kedah State, Malaysia. Contributions to Tropical Fisheries Biology. In: Venema, S. C., Moller, J., Christenson and Pauly, D. (Eds.), Papers by the participants of FAO/DANIDA follow-up training courses in stock assessment in the tropics. *FAO. Fish. Rep*., (389): p 126-140.

James, P. S. B. R., Shanbhogue, S. L. and Gupta, T. R. C. 1974. Biology and fishery of *Lactarius lactarius* (Schneider) off Mangalore, India. *Indian J. Mar. Sci*., 3 (1): 72-79.

Jones, R. 1981. The use of length composition data in fish stock assessment (with notes on VPA and Cohort analysis). *FAO Fish. Circul.*, No. 734.

Kartha, K. N. R. 1975. Growth rate in *Lactarius lactarius* (Schneider) at Karwar. *Indian J. Fish*., 22 (1): 284-286.

Munro, J. L. and Pauly, D. 1983. A simple method for comparing the growth of fishes and invertebrates. *ICLARM Fishbyte*, 1(1): 5-6.

Neelakantan, B. 1981. *Studies on the false trevally, Lactarius lactarius (Bloch & Schneider) from the Karwar waters*. Ph. D. Thesis, Karnatak University, Dharwad 1-249 pp.

Pauly, D. 1978. A preliminary compilation of fish length growth parameters *Ber. Inst. Fur Meereskunde*, No.55, 200 pp.

Pauly, D. 1982. A method to estimate the stock recruitment relationships of shrimps. *Trans. Amer. Fish. Soc*., III : 13-20.

Pauly, D. 1983. Length converted catch curve – A powerful tool for fisheries research in the tropics (Part 1). *ICLARM Fishbyte,* 1 (2) : 9-13

Rao, T. Appa 1966. On some aspects of the biology of *Lactarius lactarius* (Schneider). *Indian J. Fish*., 13 (1&2): 334-349.

Reuben, S., Vijayakumaran, K. and Chandra Sekhar, M. 1993. Growth, maturity and mortality of false trevally *Lactarius lactarius* Bloch & Schneider from Andhra Pradesh-Orissa coast. *Indian. J. Fish*., 40 (3): 156-161.

Sparre, P. and Venema, S. C. 1992. Introduction to tropical fish stock assessment, Part I, Manual. *FAO Fish. Tech. Pap.,* 306: 376 pp.

Wetherall, J. A. 1986. A new method for estimating growth and mortality parameters from length-frequency data. *ICLARM Fishbyte*, 4(1): 12-14.

Zacharia, P. U. 2003. *Studies on the fishery, biology and population dynamics of the whitefish Lactarius lactarius (Bloch & Schneider, 1801) along the Karnataka* coast. Ph. D. Thesis submitted to the Mangalore University, Mangalore, 188 pp.

Zacharia P. U. and Jayabalan, N. 2007. Maturation and spawning in the whitefish, *Lactarius lactarius* (Bloch and Schneider, 1801) (Fam: Lactariidae) along the Karnataka coast, India. *J. Mar. Biol. Ass. India,* 49 (2)*:* 166-176.