

Biology & Fishery of *Lactarius lactarius* (Schneider) Off Mangalore

P. S. B. R. JAMES, S. L. SHANBHOUE & T. R. CHANDRASEKHARA GUPTA

College of Fisheries, University of Agricultural Sciences, Mangalore

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Data on age and growth, feeding habits and spawning of *L. lactarius* based on material collected from trawl catches off Mangalore are presented. Based on length frequency studies, the life span of the species has been fixed as 3 yr, attaining a size of 150 mm TL (total length) at the end of 1st yr, and 270 mm 2nd yr. Fish in the 3rd yr of life are few in the commercial catches, the fishery being mainly based on 0 and I+ yr old fish. Males are fished more than females. Larger fish appear to be available in deeper waters. The species is best captured in otter trawls up to a depth of 30 m. Good catches are obtained during October to December. *L. lactarius* breeds almost throughout the year off Mangalore; all individuals may not breed at the same time. Peak spawning appears to take place from January to May. Size at first maturity is about 131 mm TL. Maximum number of eggs found in a mature fish is 78221. The fish feeds mainly on juveniles and adults of teleostean fishes and shrimps. Juveniles feed more on crustaceans. The variety in prey increases with age of fish. Occurrence and distribution of the fish appear to be influenced by the forage organisms to some extent.

STUDY of trawl fish catches landed at Mangalore indicates that *Lactarius lactarius* (Schneider) is one of the important quality fishes landed in fairly good quantities. Though the species contributes to fairly good percentage of the fish catches at several other places along the east and west coasts of India, available information on its biology and fishery is meagre. Therefore, as a part of a general study of the trawl fish catches off Mangalore, observations have been made in the present investigation, on the age and growth, reproduction, food and feeding habits and fishery of *L. lactarius* during the period January 1970 to May 1971. Some observations have also been made on the occurrence of juveniles and the food of the species in other months of 1971 and 1972. Earlier studies¹⁻⁵ deal mainly with the food of the species. Rao⁶ provides an account of some aspects of the biology of the fish collected at Visakhapatnam.

Age and Growth

Sexes were not treated separately as the sample size was small in a number of months. As no clear seasonal marks were found on the hard parts (scales and otoliths), only the length frequency analysis was made for the determination of age and growth of the species. Total lengths of the fish collected at random every week from the commercial fish catches by trawl nets landed at the Government Ice Factory, Mangalore, in different months, were grouped into class intervals of 10 mm and the percentage in each length group calculated. Throughout the investigation, samples were collected only at this centre. Since the spawning period of the species is prolonged, extreme care was taken to apply this method and interpret the results therefrom, because of frequent overlapping of various groups entering the fishery. The only possible way in this case was to trace the progression of a few important modes in the length frequency curves as far as possible (after they enter the commercial fishery) and find

the average monthly growth rate from which approximate values of average size at different ages were calculated.

Length frequency distributions—A single mode was found in January 1970 (Fig. 1) at 151-160 mm class interval, the fish ranging from 121-200 mm total length (TL). Total size range in February was very wide, from 71 to 220 mm, with only the 151-160 mode prominent as in the preceding month. The histogram for the month indicated addition of both smaller as well as larger fish into the commercial catches. The abundance of very small fish and very large fish was however negligible compared to the middle sizes. In March, the population was represented by two groups, with modes at 121-130 mm and 151-160 mm, the former dominating. The mode at 121-130 mm evidently represented the new recruits forming a significant group after their appearance in the fishery in February. The size range of fish in this month was 81-210 mm. In April, two modes were seen at 131-140 and 161-170 mm, the total size range being 41-210 mm. The size groups in the fishery in March and April were similar. In April, a shift in the modes and entry of juveniles in small numbers could be seen. In May, while the mode at 131-140 mm, seen in the previous month, was stationary, the one at 161-170 mm merged with the other. However, in this month, a smaller group made its appearance with a mode at 101-110 mm which was evidently the result of recruitment of the previous month. Young fish continue to get recruited in this month also. Due to intervening rough condition of the sea during the south-west monsoon and resultant suspension of sea fishing, samples of fish were not available for study during June to August. The number of fish in September was too small but a prominent mode was found at 101-110 mm. While this mode represented the growth of new recruits in April and May, no larger fish were represented in the catches in this month. The total size range was 91-130

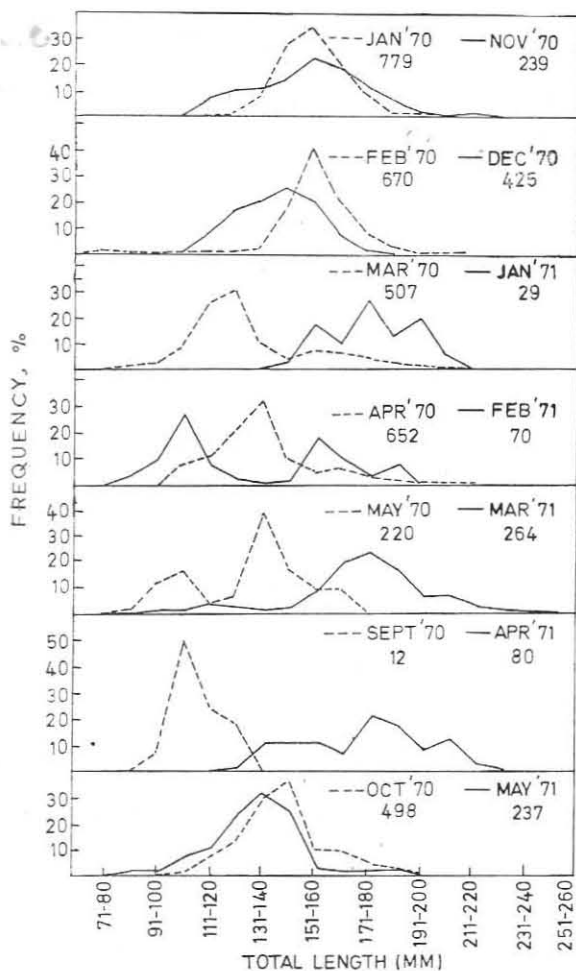


Fig. 1 — Length frequency curves for *L. lactarius* from January 1970 to May 1971

mm. In October, a mode was seen at 141-150 mm, with a total size range of 101-190 mm.

The single mode seen in October continued in November also but with a shift to 150-160 mm. The fish varied in size from 111 to 220 mm. In December also, only a single mode was present but at 141-150 mm, the size ranging from 101 to 210 mm. In January 1971, 3 modes were seen at 151-160, 171-180, and 191-200 mm with a total size range of 141-210 mm. However, the size of the sample was small to take cognizance of the modes. There were 3 modes in February at 101-110 and 151-160 and 181-190 mm, the first one representing newly recruited fish. The size range was 81-190 mm. In March, there were 3 modes at 111-120, 171-180 and 201-210 mm, the first representing the new recruits. In April, 3 groups at 141-150, 171-180, and 201-210 were prominent, the smallest group merged with the next group. The size range was 121-220 mm. In May, a single mode was seen at 131-140 mm with a total size range of 81-190 mm. Large fish were very few in this month.

Rate of growth and life span — Since the fish spawns over a prolonged period and also individual fish spawns more than once, there is a possibility of overlap of the modes in length frequency curves resulting from broods recruited at different periods. However, in the absence of other suitable methods to determine the age and rate of growth, some of the

modes in the length frequency curves were traced with caution over short periods to arrive at the following conclusions.

In March 1970, there was a mode at 121-130. This mode progressed to 131-140 in April, thus showing an increment of 10 mm in one month. Similarly in February 1971, there was a mode at 101-110 which shifted to 111-120 in March. It was not represented in April, but the mode at 131-140 in May could be traced back to the one at 111-120 in March. From this, it can be inferred the fish grows by 30 mm in 3 months (10 mm/month) after entry into the fishery. Therefore, in an year it is expected to attain a size of $12 \times 10 = 120$ mm. But growth must have been faster than this before it entered the fishery. If a maximum growth of 15 mm is presumed for a month, the size it would attain would be $12 \times 15 = 180$ mm. However, an average growth of 12.5 mm/month would show that it attains $12 \times 12.5 = 150$ mm in an year. Therefore, it is possible to estimate an approximate size of at least 150 mm at the end of 1 yr.

In March 1970 there was a mode at 151-160, which according to the above observations completed 1 yr. Following this group, in April it could be recognized at 161-170, indicating an increase of 10 mm in a month. In February 1971, there was a mode at 151-160. It was not represented in March but in April it was indicated at 171-180. This progression of 20 mm in 2 months indicates a growth of 10 mm/month. Therefore, in the second year of life, the length increment is equal to $12 \times 10 = 120$ mm. Hence the fish attains a size of $150 + 120 = 270$ mm TL at the end of second year of life.

The length frequency curves indicated that the commercial catches include few fish above 270 mm TL, which from the above conclusions should be in the 3rd yr of life. Since the fish above this size were limited in the samples, growth in 3rd yr of life was difficult to estimate. Therefore, it could reasonably be concluded that the life span of the species may be at least 3 yr.

Reproduction

Maturity — The maturation process was mainly studied by tracing the development of ova to maturity by ova-diameter studies and collection of data on the distribution of maturity stages month-wise and according to size. The methods described by Clark⁷ and Prabhu⁸ were adopted.

The characteristics of different stages of maturity of female *L. lactarius* are given in Table 1.

Development of ova to maturity — The size distribution of ova in various stages of maturity is shown in Fig. 2. Size of ova varied from 2 oc. m.d. (ocular micrometer divisions) in stage I to 60 oc. m.d. in stage VI (one oc. m.d. = 0.016 mm). Except in stage I, ova smaller than 4 oc. m.d. were not measured as these were the transparent, immature ova present in all the ovaries. Ova in stage I were up to a maximum of 12 oc. m.d., a great majority of them were in the size group of 4 to 6 oc. m.d. Size of ova in stage II reached a maximum of 36 oc. m.d. The polygon for this stage indicated the withdrawal of a batch of ova with a modal size at 26 oc. m.d. to undergo maturation with a faint indication of a 2nd mode at 14 oc. m.d. The ova diameter frequency polygon for stage III indicated a total

of 3 modes, beginning from 1st at 26, 2nd at 14 and the 3rd at 8 oc.m.d. At this stage, while the first 2 modes remained at the same size as in the previous stage, a third mode appeared rather prominently at 8 oc.m.d. In stage IV, 3 modes were seen at 32, 20 and 8 oc.m.d. While the 1st and 2nd modes progressed further, the smallest mode remained at the same size as in stage III. Further, in this stage, there was an indication of sharper separation of the largest group of ova from the rest, while the 2nd and 3rd groups of ova remained somewhat indistinctly separated one from the other. Stage V

polygon indicated 3 batches of ova with modes at 41, 23 and 11 oc.m.d. implying a shift in all the 3 modes over the previous stage. The development of ova to maturity, as seen in the ploygon of this stage was more rapid in the case of the largest group of ova compared to that of the 2 smaller succeeding groups. In stage VI, all the 3 groups of ova consistently represented from stage III onwards were seen with modes at 44, 20 and 14 oc.m.d. At this stage, the 1st and the 3rd mode progressed further while the mode of the 2nd group of ova moved towards smaller size, presumably indicating that certain large ova of this group were merged with the first group. The size range of the largest group of ova was very wide (31 to 60 oc.m.d.). The fully ripe, transparent ova found in this stage measured 0.70 to 0.98 mm diam. in fresh condition. A single oil globule was present in such ova and varied in size from 0.16 to 0.20 mm diam. In a partially spent ovary (stage VIIA) there were 2 modes at 20 and 38 oc.m.d., the mode of the largest group of ova showing a shift backwards from 44 oc.m.d. found in stage VI. This indicates elimination of certain number of large ova in the act of spawning. In a fully spent ovary (stage VIIB) the size range of ova extended from 1 to 15 oc.m.d. with a mode at 5 oc.m.d.

Development of ova to maturity as traced above indicated that as maturity progresses, 2 groups of ova are differentiated first from the general ova stock (stage II). As the size of the largest group increased (stage III), one further group slowly differentiated from this group and in stage IV at least 3 groups made their appearance. However, these groups were not distinctly separated from each other as in stages V and VI. This multiplicity of modes indicated that the maturation process is a continuous one and that the fish releases the eggs in batches over a prolonged period. Since the spent

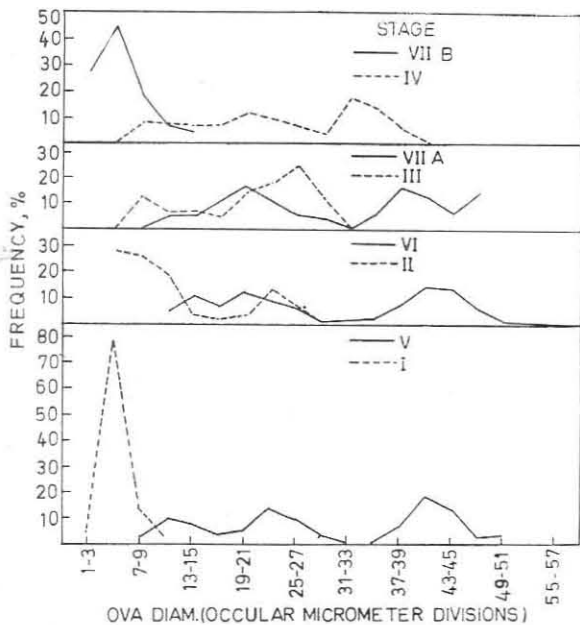


Fig. 2 — Ova-diameter frequency polygons of the ovaries of *L. lactarius* in various stages of maturity

TABLE 1 — CHARACTERISTICS OF MATURITY STAGES OF *L. lactarius*

Maturity stage	Macroscopic appearance of ovaries	Microscopic appearance of ova	Total size range of ova (mm)	Size range of largest group of ova (mm)	Mode of largest group of ova (mm)
I	Thin, transparent, occupy about $\frac{1}{3}$ body cavity	Irregular, fully transparent, with clear nucleus, invisible to naked eye	Up to 0.192	—	0.080
II	Slightly thicker than previous stage, flat, transparent, occupying about $\frac{1}{3}$ body cavity	Somewhat spherical with commencement of deposition of yolk granules, invisible to naked eye	0.016-0.480	0.304-0.480	0.368
III	Yellowish, turgid, occupy more than $\frac{1}{2}$ body cavity	Largest group spherical, opaque, with full deposition of yolk, visible to naked eye	0.016-0.528	0.256-0.528	0.416
IV	Yellowish, with prominent blood vessels, fully packed with ova, occupy about $\frac{3}{4}$ body cavity	Spherical, semitransparent, yolk vacuolated	0.016-0.672	0.448-0.672	0.512
V	Faint yellow, occupy more than $\frac{3}{4}$ body cavity, ovarian wall thin	Spherical, semitransparent with narrow perivitelline space	0.016-0.816	0.496-0.816	0.656
VI	Orange in colour, fully occupy body cavity, ovarian wall very thin	Fully transparent with single oil globule	0.016-0.960	0.496-0.960	0.672-0.688
VIIA	Yellowish, occupy more than $\frac{1}{2}$ body cavity, partially empty	Spherical, opaque with full deposition of yolk	0.016-0.768	0.496-0.768	0.608
VIIB	Irregular, shrunken, almost empty, blood shot, occasionally with blood vessels loosely hanging in lumen of ovaries and also protruding through genital opening	Small and transparent, few granular	0.016-0.240	—	0.080

ovary (stage VII B) contained mostly the immature ova, it must be presumed that all the ripe ova were eliminated in spawning and that such a fish would take a longer time to spawn compared to the partially spent fish which would take a shorter time to spawn again because of the presence of some mature ova. Therefore, the partially spent ovary (stage VII A) represented an intermediate stage in the process of elimination of ripe ova in batches during spawning.

Size at first maturity — For this study, the fishes were grouped according to a size interval of 10 mm and the percentage occurrence of different maturity stages in various size groups was tabulated separately for females and males (Table 2).

Data on the maturity (sexual development leading to spawning) of the female for 2 yr indicated that females mature from about a size of 131 mm TL. The smallest female fish in spent conditions was also noticed in the size group 131-140 mm. Therefore, the size at first maturity for the female was about 131 mm TL. Pooled data for 2 yr in the case of males indicated that the smallest mature fish occurs in the size group 121-130 mm TL though the smallest spent fish is noticed only in the next size group, viz. (131-140). While it could safely be concluded that the size at first maturity of male may also be about 131 mm TL, it is possible, males may mature slightly earlier than females.

Spawning — Ova-diameter frequency polygon of stage IV of *L. lactarius* showed at least 3 groups of ova which were, however, not distinctly separated from each other. In stage V and VI also the different groups merged one into the other, indicating that maturation process is a continuous one and that the fish release the eggs in batches over a long period. This was further supported by the occurrence of fish in different stages of maturity together over a number of months, thus suggesting absence of periodicity in spawning. During the period January 1970 to May 1971, 1343 males and 659 females were examined for the distribution of maturity stages (Fig. 3).

Presuming that mature male fish are available during the south-west monsoon period also (June to August because they are in that condition prior to and after this period) it can be concluded that mature males (stage III and above) occur almost throughout the year, with peak occurrence from November to January. Data on the occurrence

of spent fish (both partially spent and fully spent — stages VII A and VII B) also revealed that such fish are found in a number of months. They were, however, predominant from January to April.

Data on the maturity of female fish indicated the occurrence of mature female fish (stage III and above) and spent fish (stages VII A and VII B) in most of the months, as in the case of the male. Mature fish were in significant numbers from October to April, whereas spent fish were in larger number from January to May.

Occurrence of juveniles during January 1970 to December 1972 is given in Table 3. Very small juveniles (15 to 62 mm TL) appeared in the catches in several months. Therefore, based on a study of the distribution of maturity stages (especially mature and spent) through an year, the ova diameter frequency curves in different stages, periods of occurrence of ripe ova and the occurrence of juveniles it could be concluded that *L. lactarius*, spawns almost throughout the year (Table 4) with a possible peak spawning time from January to May.

Fecundity — For this study ovaries of advanced prespawning stages (III, IV, V and VI) from mature fish were utilized. Ovaries were weighed without moisture in the preserved condition. A piece of ovary was then weighed separately and the number of mature ova in the piece was first determined. From this number and the total weight of the ovary of fish, the total number of mature ova was determined to indicate the fecundity.

Data from 28 fishes in the size range 163 to 214 mm TL, weighing 60 to 124 g were collected. The number of mature ova ranged from 9000 to 79000.

Sex ratio — Details of sex ratio in the commercial catches from January 1970 to May 1971 are given in Table 5. It was found that males were more than females in most of the months.

Food and Feeding Habits

Stomach contents of 390 fishes in the size range 41 to 298 mm TL were examined during January 1970 to May 1971. Stomach contents were identified up to the species level wherever possible. All the unidentifiable fishes were grouped under 'fish remains'. The larger fishes were separately treated from juvenile fishes. Quantitative analyses were done by the volumetric (displacement) method and the occurrence method and the results thus obtained

TABLE 2 — PERCENTAGE OCCURRENCE OF FEMALES AND MALES OF *L. lactarius* IN DIFFERENT STAGES OF MATURITY IN VARIOUS SIZE GROUPS (MM) DURING 1970 AND 1971

(Figures represent range values)

Stage	Female				Male			
	Size group		Percentage occurrence		Size group		Percentage occurrence	
	1970	1971	1970	1971	1970	1971	1970	1971
I	91-170	121-150	2.8-100.0	37.5-100.0	91-190	81-180	3.8-100.0	1.6-100.0
II	121-180	121-210	3.4-23.8	12.5-64.3	111-180	111-200	2.7-55.8	5.9-77.5
III	131-230	161-300	5.0-100.0	54.5-100.0	121-180	141-200	0.5-26.7	4.1-7.7
IV	161-200	171-220	1.2-6.6	9.1-10.0	141-170	171-190	0.5-2.5	1.5-2.1
V	161-210	161-220	0.9-11.2	19.0-40.0	141-170	171-190	2.0-5.1	1.5-2.1
VI	171-190	181-210	2.4-5.0	3.6-9.5	—	151-190	—	2.1-14.3
VII	131-200	141-160	6.6-35.0	50.0	131-200	141-220	1.4-100.0	25.0-100.0

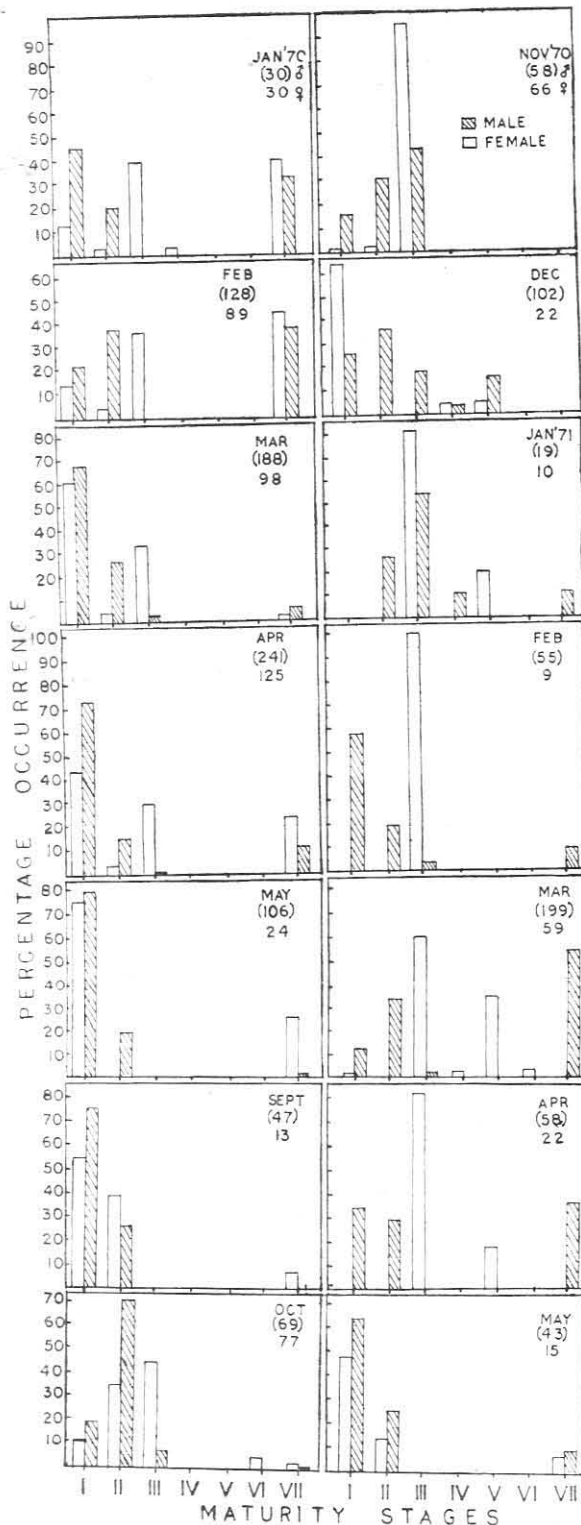


Fig. 3 — Percentage occurrence of females and males of *L. lactarius* in different stages of maturity during January 1970 to May 1971

were combined to indicate the relative importance of items of food by the Index of Preponderance following the method of Natarajan and Jhingran⁹. The results are given in Table 6.

Qualitative analyses of food of the species indicated that the food consisted of teleostean fishes, prawns, shrimps, mysids and stomatopods. Though the species is known to be highly carnivorous, the

TABLE 3 — OCCURRENCE OF JUVENILES OF *L. lactarius*
 [Values represent average of 3 yr (1970-1972). Range values are given in parentheses]

Month	Size (TL, mm)	Probable age (months)
January	39.3 (30-45)	3.13 (2.4-3.6)
February	44.6 (35-62)	3.53 (2.8-4.9)
March	36.6 (25-44)	2.9 (2.0-3.5)
April	35.0 (15-55)	2.8 (1.2-4.4)
May	33.3 (30-45)	2.93 (2.4-3.6)
June to August	—	—
September	79.0 (74-88)	6.3 (5.9-7.0)
October	86.0 (81-91)	6.8 (6.4-7.2)
November	86.7 (55-103)	6.9 (4.4-8.2)
December	47.0 (39-58)	3.7 (3.1-4.6)

— = No data.

TABLE 4 — CORRELATION OF THE PERIODS OF OCCURRENCE OF MATURE FISH, SPENT FISH, RIPE OVA AND SPAWNING ACTIVITY OF *L. lactarius*

Month*	Occurrence of mature fish (stage III and above)	Presence of ripe transparent ova in ovaries	Occurrence of spent fish (stage VII A and B)	Spawning activity† as deduced from occurrence of juveniles
January	+	+	+	—
February	+	—	+	+
March	+	+	+	+
April	+	+	+	+
May	—	—	+	—
September	—	—	+	+
October	+	+	+	+
November	+	+	—	+
December	+	+	—	+

+ = Present and — = absent.

*June to August no data.

†Spawning activity: absent in June, present in July and August.

variety of organisms it feeds on in this area is limited. Except one or two, all the items of food also occurred in the trawl catches in the area along with *L. lactarius*. However, all the organisms found in the trawl catches did not form the food of this species, indicating certain amount of selectivity in preying. The analyses suggested that the fish feeds more often on teleostean fishes and their juveniles than on other items. Next to fishes *Acetes* formed an important item of the food of the species. All the others were found in meagre quantities only.

As to the seasonal differences in the diet, the data indicated that fishes and juvenile fishes form regular food in all the months. Fishes like *Leiognathus* and *Scomberomorus* were found in the stomachs only in certain months, the former from

TABLE 5 — SEX RATIO OF *L. lactarius* (JANUARY 1970 TO MAY 1971)

Month	Males	Females	Ratio	
			Male	Females
1970				
January	30	30	1	1.00
February	128	89	1	0.69
March	188	98	1	0.52
April	241	125	1	0.51
May	106	24	1	0.22
June to August	—	—	—	—
September	47	13	1	0.27
October	69	77	1	1.10
November	58	66	1	1.10
December	102	22	1	0.21
1971				
January	19	10	1	0.52
February	55	9	1	0.16
March	199	59	1	0.29
April	58	22	1	0.40
May	43	15	1	0.34

— = No data.

January to April and the latter from October to December. *Acetes* formed the food in a number of months while others formed the food only occasionally.

Data on the condition of feed (Table 7) indicated neither significant seasonal variations in this respect nor any relationship with reproductive cycle. Percentage occurrence of empty stomachs was fairly high in almost all the months.

Details of percentage occurrence of various food items in the stomach contents of *L. lactarius* in different size groups (Table 8) indicated fishes, juvenile fishes and *Acetes* as favourite items of food of the fish of almost all sizes. All the other items of food were consumed by fish above 80 mm TL but mostly by fish above 130 mm TL. Thus smaller fishes had limited variety of items as food compared to larger fishes (above 130 mm TL). Therefore, with increase in age, the diet of the fish changed.

Fishery

Based on an analysis of length frequency distribution, the maximum life span of the species was

TABLE 6 — RELATIVE IMPORTANCE OF FOOD ITEMS IN THE STOMACH CONTENTS OF *L. lactarius* (January 1970 to May 1971)

(Figures represent per cent values. Figures in parentheses indicate number of fish examined)

	January		February		March		April		May		October 1970	November 1970	December 1970
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971			
	(61)	(9)	(85)	(9)	(34)	(23)	(44)	(16)	(19)	(10)	(32)	(21)	(31)
Juvenile fish remains	8.85	52.57	76.54	5.94	14.53	—	24.34	10.28	—	92.50	3.98	94.36	97.09
Fish remains	90.18	10.98	20.15	3.91	78.56	81.83	74.42	11.44	90.03	7.39	52.26	0.78	1.27
<i>Leiognathus</i>	0.08	—	0.21	—	6.71	0.94	0.62	—	—	—	—	—	—
<i>Leiognathus bindus</i>	—	—	—	—	—	16.30	—	4.76	—	—	—	—	—
<i>Nemipterus japonicus</i>	—	—	—	—	0.04	—	—	—	—	—	—	—	—
<i>Scomberomorus commersoni</i>	—	36.56	—	34.69	—	—	—	—	—	—	38.98	4.01	1.44
<i>Stolephorus</i>	—	—	0.29	51.57	—	0.09	—	70.17	—	—	—	—	—
<i>Thrissocles</i>	—	—	0.42	—	—	—	—	—	—	—	—	—	—
<i>Acetes</i>	0.28	—	0.68	—	—	0.56	0.64	—	9.22	—	4.26	—	—
<i>Metapenaeus</i>	—	—	—	—	—	—	—	3.40	—	—	—	—	—
<i>Mysis</i>	—	—	—	—	—	—	—	—	—	—	—	0.85	—
<i>Ovatosquilla nepa</i>	0.26	—	0.01	—	—	0.09	—	—	—	—	0.49	—	—
Prawn remains	0.26	—	—	3.91	—	0.18	—	—	—	—	—	—	0.17
<i>Loligo</i>	—	—	—	—	0.14	—	—	—	—	—	—	—	—
<i>Alima</i> larva	0.04	—	—	—	—	—	—	—	—	—	—	—	—
Semidigested matter	0.01	—	—	—	0.04	—	—	—	0.74	—	—	—	—

TABLE 7 — PERCENTAGE OCCURRENCE OF STOMACHS OF *L. lactarius* IN VARIOUS DEGREES OF FULLNESS

Condition of feed	January		February		March		April		May		October 1970	November 1970	December 1970
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971			
No. of fish	77	11	97	12	49	39	64	21	24	10	40	24	33
Full	14.29	9.09	14.43	16.66	8.16	5.13	12.50	4.76	12.22	—	15.00	25.00	3.03
$\frac{3}{4}$ full	6.49	—	10.30	8.33	18.37	10.26	9.37	9.52	—	—	12.50	16.66	9.09
$\frac{1}{2}$ full	10.39	9.09	13.71	16.66	4.08	5.13	3.93	9.52	4.16	20.00	2.50	8.33	12.13
$\frac{1}{4}$ full	20.78	27.27	20.62	8.33	14.29	7.69	23.44	23.81	25.00	40.00	7.49	8.33	33.34
Little	27.27	36.37	28.87	25.00	24.49	30.77	20.31	28.58	37.50	40.00	42.49	29.17	36.37
Empty	20.78	18.18	12.37	25.00	30.61	41.03	31.25	23.81	20.84	—	20.10	12.50	6.06

TABLE 8—PERCENTAGE OCCURRENCE OF FOOD ITEMS IN THE STOMACH OF *L. lactarius* IN VARIOUS SIZE GROUPS (1970-71)

Size group TL mm	Total No. of fishes		Juvenile fish remains		Fish remains		<i>Leiognathus</i>		<i>L. bindus</i>		<i>Stolephorus</i>		<i>S. commersoni</i>		<i>Thrissoctes</i>		<i>Aceles</i>		Prawn remains		<i>Oratosquilla-nepa</i>		
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971	
41-50	2	—	50.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50.0	—
51-60	3	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
61-70	2	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
71-80	2	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
81-90	3	—	25	—	25	—	25	—	—	—	—	—	—	—	—	—	25	—	—	—	—	—	—
91-100	1	1	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
101-110	9	5	20.0	50.0	40.0	33.32	—	—	—	—	—	—	—	—	—	—	40.0	—	—	16.66	—	—	—
111-120	14	—	21.42	—	78.58	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
121-130	18	5	42.10	80.0	42.10	20.0	5.26	—	—	—	—	—	—	—	—	—	5.26	—	—	—	—	—	—
131-140	36	4	45.94	50.0	43.24	25.0	—	—	—	—	25.0	5.41	—	—	—	—	2.70	—	—	—	—	—	—
141-150	50	4	34.24	25.0	49.06	50.0	—	—	—	—	25.0	2.69	—	—	—	—	11.32	—	—	—	—	—	—
151-160	54	10	39.57	30.0	43.50	40.0	2.30	—	—	—	20.0	—	—	2.30	—	—	5.17	—	2.30	10.0	4.60	—	—
161-170	57	4	41.94	—	32.25	50.0	3.22	—	—	—	25.0	6.45	—	1.61	—	—	6.45	—	4.83	25.0	1.61	10.0	—
171-180	35	9	28.96	10.0	50.0	60.0	5.24	—	—	—	10.0	—	—	2.620	—	—	10.53	10.0	—	—	2.62	—	—
181-190	17	5	33.33	—	33.33	40.0	5.55	—	—	—	—	—	20.0	—	—	—	16.66	20.0	—	20.0	5.55	—	—
191-200	11	6	63.63	—	27.27	66.66	—	—	—	—	16.66	9.10	16.66	—	—	—	—	—	—	—	—	—	—
201-210	8	8	12.50	22.22	50.0	22.22	12.50	—	—	33.34	—	11.11	—	—	—	—	25.0	—	—	—	—	—	—
211-220	1	3	—	—	33.33	—	33.33	—	—	33.33	—	—	—	100	—	—	—	—	—	—	—	—	—
221-230	—	2	—	—	—	50.0	—	—	—	—	—	—	—	50.0	—	—	—	—	—	—	—	—	—
231-290	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
291-300	1	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

*In addition to the above, a few items of food were also recorded only once during the period. They were (size group) in 1970 *L. brevirostris*, 1.61% (161-170) *Nemipterus* 5.55% (181-190), *Loligo*, 2.7% (131-140); *Alima* larva, 2.69% (141-150) semidigested matter, 4.60% (151-160); in 1971 *Metapenaeus*, 11.11% (201-210); *Lucifer*, 100% (91-100).

estimated to be 3 yr attaining a size of 150 mm TL at the end of 1st yr and 270 mm TL at the end of 2nd yr. The size at the end of 3rd yr could not be determined. Total size range in the commercial catches was 83 to 298 mm TL, while the dominant size range was 100 to 210 mm TL. Therefore, the fishery was based on 0 and I+ yr old fish; 2 yr fish were rare in the catches. Though the commercial fishery was based on 0 and I+ yr old fish, attainment of maturity before the completion of 1 yr (around 131 mm) and the fairly high fecundity appeared to allow for necessary recruitment. Juveniles occurred in inshore waters in a number of months. Recruitment in large number took place in February and May. Large fish were found in the months of February and March in comparatively deeper water (more than 30 m). Males were fished more than females. Fishing season extended from September to May but peak catches were obtained from October to December. The species was best caught in otter trawls normally up to a depth of 30 m off Mangalore. Catch data indicated that the catches of the fish fluctuate from year to year. Since the species is purely carnivorous, feeding mostly on fishes, their juveniles and shrimps, the abundance and distribution of the species is likely to be influenced by similar phenomena for the forage species.

Discussion

Based on length-frequency studies it was observed that *L. lactarius* at Waltair attains a size of 16-18 cm at the end of 1st yr of life and the commercial catches mainly consisted of 0-yr group⁶. In the present study, however, a length of 15 cm at the end of 1st yr has been estimated. Off Mangalore, the commercial catches include fish above 18 cm also and the commercial fishery is based on the 0-yr as well as 1-yr old (I+) fish; 2-yr old fish (II+) are rare in commercial catches.

Mature specimens of *L. lactarius* were reported to be available during November to April and specimens with running ovaries in February and March⁶; mature ova form a single distinct mode separated from other stock of eggs. Based on these observations, it was concluded that the spawning period was not prolonged and that peak spawning takes place from February to April⁶. Occurrence of fish measuring less than 5 cm during April to June was mentioned as supporting evidence. However, the present observations indicate that the fish spawns almost throughout the year. This conclusion is supported by ova diameter studies of mature fish where, the largest group of ova is followed by smaller groups

which must be taking the place of the largest group in succession. Since there is a gap between the largest group and the next largest group, spawning must be taking place in batches. The conclusion is further supported by the occurrence of juveniles, mature and spent fish almost throughout the year as shown in Tables 3 and 4. Juveniles are found not only from April to June but at other times also. However, occurrence of young ones only during a short period off Waltair and in a number of months off Mangalore may be due to differences in gear from which the samples are obtained at the two localities. The peak spawning period is January to May in the present study and this agrees with the February to April period reported by Rao⁶. Therefore, the low values in ponderal index reported by Rao during February to April agree more with the peak than with the spawning period in general. Mature fish as well as fish in spawning condition are found in inshore waters off Mangalore indicating that the fish spawns in inshore areas. A similar phenomenon was also reported from Visakhapatnam.

Based on observations on 18 specimens, the average fecundity was given as 56218 eggs (range, 19155-104195)⁶. Egg counts in 28 fishes in the present study, however, show a range of 9000 to 79000. The sex ratio in commercial catches at Mangalore indicate that generally, in most months, males are fished more than the females though the ratio is not 2:1 as reported at Visakhapatnam⁶.

Similar observations on the food of the species are recorded at both the places. A significant observation off Mangalore was the occurrence of immature fish in large numbers in the inshore waters in May and June 1973 and this appears to be correlated with occurrence of shoals of *Acetes* which were recorded in the inshore waters as well as in the Nethravathi estuary and on which the fish was found to have fed heavily.

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