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MATURATION AND SPAWNING IN A TROPICAL LOACH, *LEPIDOCEPHALUS THERMALIS* (CUV. & VAL.)

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Five stages of maturity have been delineated for females of a tropical loach, *Lepidocephalus thermalis* (Cuv. & Val.). Progression of the modes in each stage of maturity has been traced from ova-diameter studies. The size at first maturity for female is around 45 mm. Probable spawning season of the loach traced on the basis of the occurrence of ripe and spent individuals, and from a study of gonadosomatic index, has been found to be rather prolonged. Sex ratio of the population is I male : 2 females. Fecundity studies indicate that the number of ova produced is related to length and weight of the fish as well as those of the ovary, of which the best relationship is between fecundity and weight of the ovary.

INTRODUCTION

While studies on the reproduction of larger species of freshwater fishes like major and minor carps, catfishes and murrels have been attempted by earlier workers (Ibrahim 1956, Qasim & Qayyum, 1961, Qayyum & Qasim, 1964 a, b, c, Bhatt, 1968, 1970, 1971 a, b, Parameswaran, *et al.* 1972, Sobhana & Nair, 1974), those of smaller species belonging to the family Cobitidae have hitherto been neglected. This is probably because they are comparatively less important economically. In view of the paucity of information on the reproductive biology of the cobitids, that occur in a wide variety of habitats, the present study was undertaken and this paper reports the finding on a tropical freshwater loach, *Lepidocephalus thermalis*.

MATERIALS AND METHODS

Regular biweekly samples of *L. thermalis* were collected from streams around Trivandrum city for a period of one year from April 1972. The specimens were examined through various months for the total length, weight, state of maturity of the gonad and the length and weight of gonads.

Measurements of ova from anterior, middle and posterior regions of the ovary showed no difference in the distribution of ova in the different regions of the ovary. Hence 500 ova from the middle portion of each ovary were found to be sufficient to represent all stages.

The percentage occurrence of different stages of maturity during different months was noted and grouped into 3 mm interval length groups to indicate the minimum size at first maturity. A quantitative assessment of the condition of the ovary, employing the technique of gonad-index, i.e. by expressing the gonad weight as per cent of body weight, has been worked out. For the study of development of ova, the method adopted by Prabhu (1956) was followed.

Ripe specimens were used for the studies on fecundity of the fish. The number of mature ova which are about to be spawned, with considerable amount of yolk deposition were taken for estimating fecundity as was done by Kagwade (1968). For each specimen used, the weight of the preserved ovaries was noted, a portion of the ovary was, then, weighed separately and all mature ova contained in the latter were counted, from which the total number of ova in the pair of ovaries was computed. The relationships between fecundity and the total length and weight of the fish and length and weight of the ovary were then estimated (Jhingran, 1961).

RESULTS

In classifying the maturity stages it was found convenient to have five stages as suggested by Qasim (1973). Qayyum and Qasim (1964 a, b, c) and Bhatt (1968, 1970, 1971 a, b) have also recognized only five stages to several freshwater fishes.

The maturity stages of females were determined on the basis of the colour, shape, size and microscopic structure of the ovary. As it was found difficult to fix maturity stages of males, only females were dealt with in the study.

Stage I — Immature virgins

Ovaries are transparent, elongated structures occupying only a small portion of the body cavity. Ova transparent, yolk totally absent and the diameter ranging between 16-240 μ.

Stage II — Maturing virgins and recovering spent

Ovaries are pale yellow in colour, occupying about one-fifth of the body cavity. Maturing group of ova are distinguishable to the naked eye. The largest ovum measures 592 μ in diameter.

Stage III — Ripening

Ovaries occupy about half of the body cavity and appear distinctly yellowish in colour. Ova, very distinct and the largest ones measure 648 μ in diameter.

Stage IV — Ripe

Ovaries are massive structures, reddish yellow in hue with a large supply of blood vessels. They occupy the entire body cavity and enclose the intestine. Ovaries are fully packed with large ova, the maximum size being 768 μ.

Stage V — Spent

Ovaries are quite shrunken and blood-shot in appearance. Majority of the ova are small and transparent, invisible to the naked eye and belong to the immature stock. Scattered among them a few large whitish granular ova are also discernible.

Development of Ova to Maturity

Ova diameter measurements, taken from ovaries of different maturity stages, are grouped into 50 μ intervals and the frequency polygons drawn (Fig. 1).

In Stage I (Fig. 1A) which is immature, there are only immature ova ranging in diameter from 16 to 240 μ. The measurements of ova showed a mode at 100 μ. During the maturation process, this batch of ova gets separated, with a mode at

550 μ in Stage II (Fig. 1B). The maximum size of ova during this stage is about 592 μ. As the ovary passes to Stage III (Fig. 1C), a second group of ova gets separated from the original immature stock. The first group now has a mode at 600 μ and the second group at 350 μ. In Stage IV (Fig. 1 D) the first mode progresses further to show a peak at 650 μ, while the second remains stationary indicating that there is no growth. Thus the first group of eggs gets distinctly separated from the second group which ultimately follows it. The first mode, evidently constituting the mature group of eggs, would spawn in the ensuing spawning season.

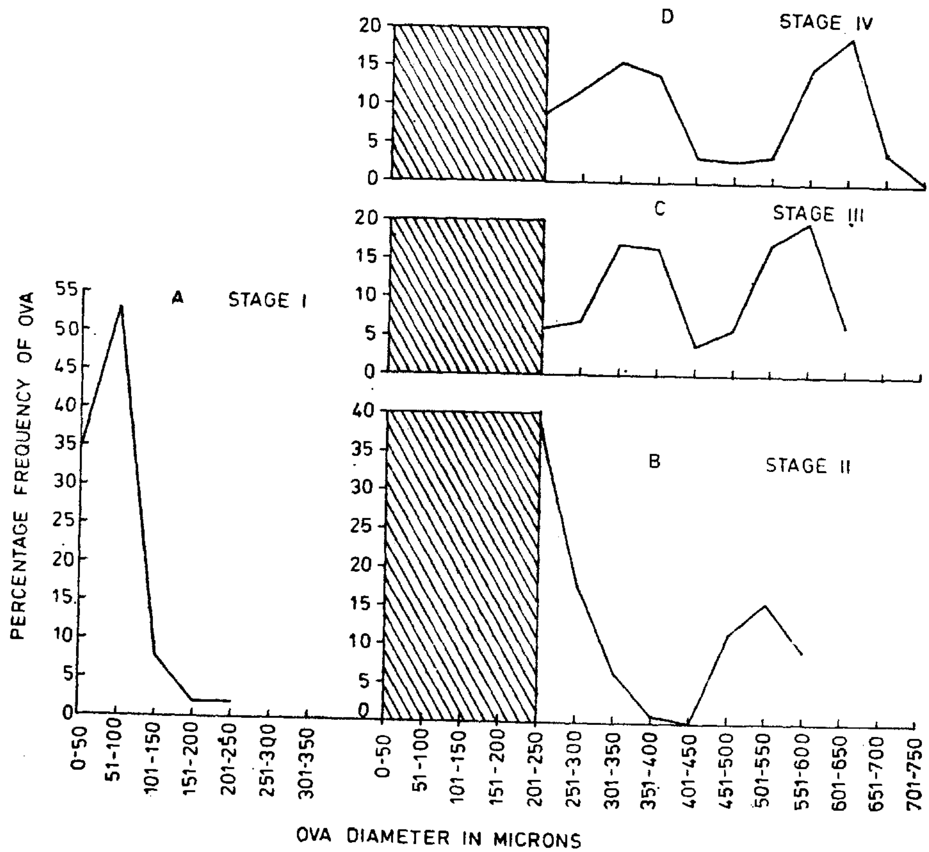

FIG. 1. Ova diameter measurements from ovaries of different stages of maturity (Stages I to IV) of *L. thermalis*

Minimum Size at First Maturity

The percentage occurrence of the females at various stages of maturity is presented in Table I. Fish belonging to Stages II and III are grouped under maturing fish.

TABLE I

Percentage occurrence of female L. thermalis *in different stages of maturity in various size groups*

Total length (in mm)	No. of specimens	Immature (%)	Maturing (%)	Mature (%)
30 — 32	4	100	—	—
33 — 35	10	80	20	—
36 — 38	20	70	30	—
39 — 41	28	93	7	—
42 — 44	28	68	32	—
45 — 47	42	48	36	16
48 — 50	50	32	32	36
51 — 53	44	6	30	64
54 — 56	17	6	23·5	70·5
57 — 59	7	—	43	57
60 — 62	3	—	—	100

From the data presented in Table I it would appear that all specimens, measuring 32 mm and less, are in the immature stage. From 33 mm onwards they pass into the maturing stage. In the 45-47 mm size group while a greater percentage of the fish are in the immature and maturing stages, 16 % have attained maturity. From this size onwards, the percentage of mature fish increases. Thus the females of this species attain maturity when they reach a length of 45 mm.

The percentage of mature female in each size group is presented in Fig. 2. It can be seen that the percentage of mature fish below 45 mm is generally low when compared to fish above 45 mm. The length at which 50 % of the fish attain maturity is regarded as the length at first maturity (Kagwade, 1968). Therefore, it is clear from Fig. 2 that minimum size for the attainment of maturity for at least 50 % of female *L. thermalis* is around 45 mm (TL).

Spawning Season

The monthly percentage occurrence of the five stages (females 45 mm or more in TL alone are included in the calculation) presented in Table II shows that the different stages do overlap without any specific order which undoubtedly suggests that the spawning period for the species is considerably prolonged. Moreover, this continuous occurrence of all the stages throughout the year indicates that the spawning period of one individual may not coincide with the spawning period of another individual. But from the numerical variations in the occurrence of Stage IV specimens, periods of the spawning activity could be detected. From April to October incidence of Stage IV specimens is high. The spent females occur from June to November; therefore these months may be considered as the breeding period of the species concerned.

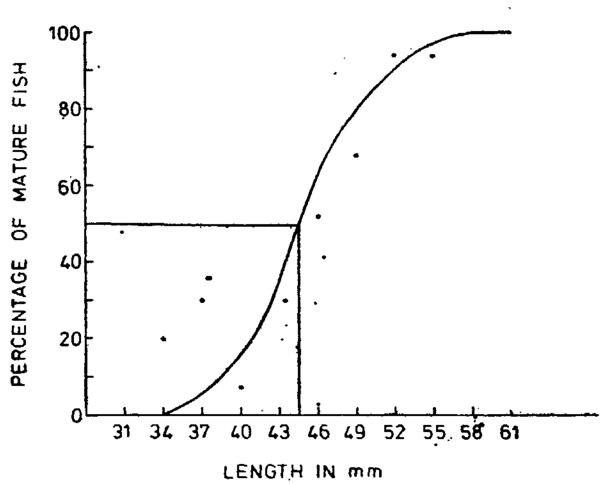

FIG. 2. Percentage occurrence of mature females of *L. thermalis* at various length groups.

The gonado-somatic index calculated month-wise (only for mature females) for the period of investigation is plotted in Fig. 3. The comparatively high average values of gonado-somatic index obtained from April to October reveal intense gonadal activity during the period. The gonad index is low during the

TABLE II

The monthly percentage occurrence of female L. thermalis *in different stages of maturity*
[Females 45 mm and above only considered]

Months	No. of specimens	Stages of maturity				
		Immature (%)	Maturing (%)	Ripening (%)	Ripe (%)	Spent (%)
April	19	10·5	—	21	68·5	—
May	22	9	9	9	73	—
June	16	—	6	12·5	69	12·5
July	10	—	—	20	60	20
August	18	5·5	5·5	17	66·5	5·5
September	10	30	—	20	30	20
October	23	—	9	13	74	4
November	10	—	20	40	10	30
December	11	64	18	9	9	—
January	8	62·5	12·5	12·5	12·5	—
February	7	42·5	28·5	14·5	14·5	—
March	19	42	10	15·5	32·5	—

period November to March, suggesting a general collapse of the gonad consequent on prolonged spawning activity. High activity of the ovary of *L. thermalis* is thus restricted to a period of nearly 7 months from April to October. This is in conformity with the observations drawn from the different maturity stages.

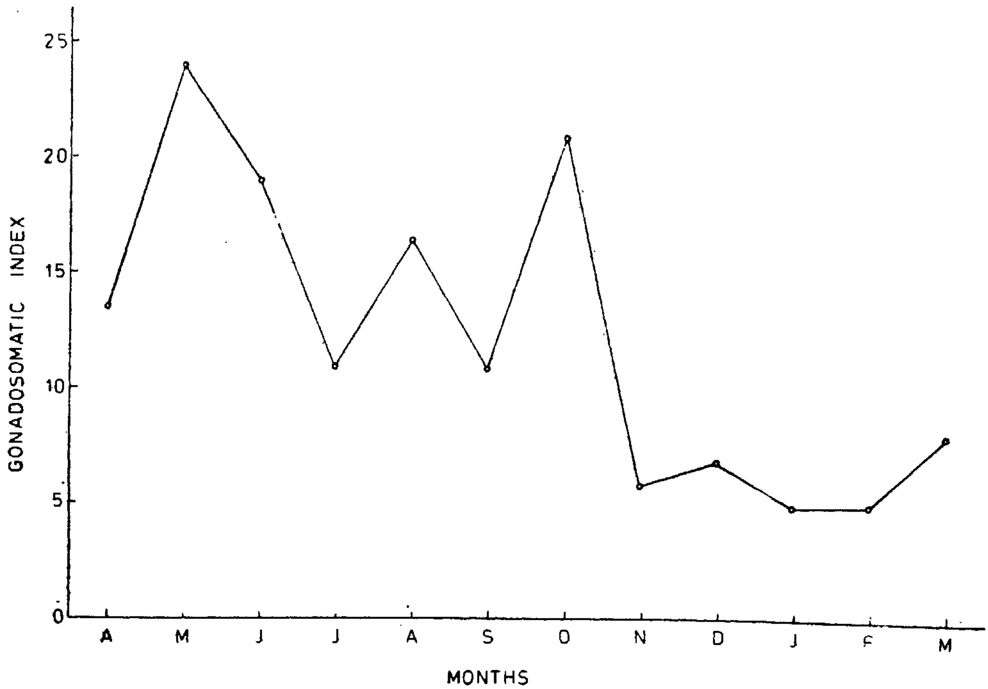

FIG. 3. Monthly average gonado-somatic index of female *L. thermalis*.

Each monthly sample contained fish in at least three different stages of maturity. This observation suggests that the spawning in this species is asynchronous.

Spawning Frequency

From the percentage size frequency distribution of intraovarian eggs, plotted in Fig. 4, it is apparent that there are two distinct groups of eggs represented by the modes 'a' and 'b' besides the general immature stock. The batch of eggs under mode 'a' is in ripe condition, ready to be shed, while the second batch of ova at mode 'b' is the maturing group which is likely to be shed subsequent to the spawning of the first batch, as there is no indication of these eggs getting reabsorbed. Thus there occurs a secondary spawning. As the time required for the eggs at mode 'b' to attain maturity may be more or less half that of the time required for the ova at mode 'a' to attain maturity (de Jong, 1939), it is likely that this species spawns twice during the prolonged spawning season.

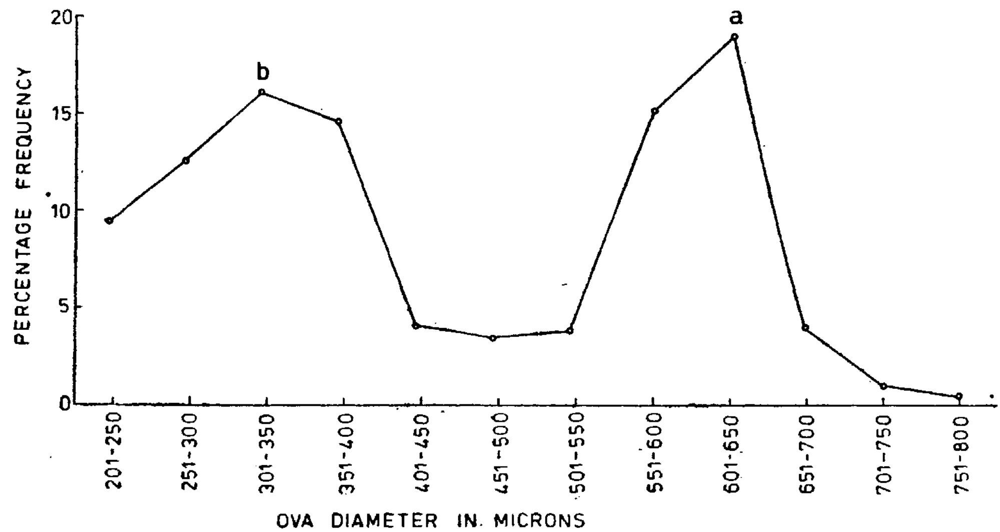

FIG. 4. Ova diameter measurements of 1000 ova from mature ovary of *L. thermalis*

Sex Ratio

Sexes are found to be disproportionate in the collection, the females far outnumbering the males. The males and females in the population have a ratio of almost 1 : 2.

Fecundity

Ten specimens with Stage IV ovaries were used for the study, the results of which are presented in Figs. 5, 6, 7 and 8.

The average number of ova in an ovary ranges from 4400 to 8200.

The relationship between fecundity *(F)* and total length of fish *(L)* can be expressed as

$$F = 613{\cdot}2042 \quad L - 31961{\cdot}2431$$

Coefficient of correlation $r = 0{\cdot}7700$

The relationship between fecundity and weight of the fish *(W)* can be expressed as

$$\log F = 1{\cdot}1042 \quad \log W + 3{\cdot}4743$$

Coefficient of correlation $r = 0{\cdot}7854$

The relationship between fecundity and length of ovary (L_o) can be expressed as

$$\log F = 2{\cdot}8333 \quad \log L_o - 0{\cdot}2816$$

Coefficient of correlation $r = 0{\cdot}7125$

The relationship between fecundity and weight of ovary (W_o) can be expressed as

$$\log F = 0{\cdot}7820 \quad \log Wo + 1{\cdot}8054$$

Coefficient of correlation $r = 0{\cdot}9261$

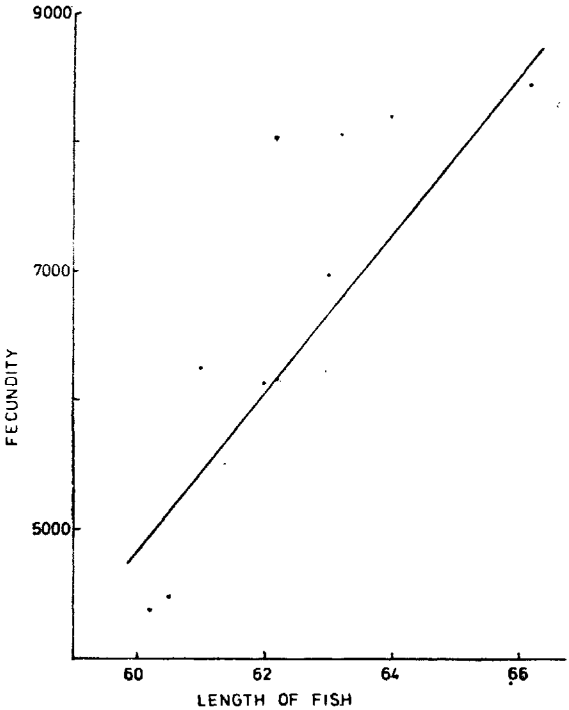

FIG. 5.

Relationship of fecundity to length of fish in *L. thermalis*.

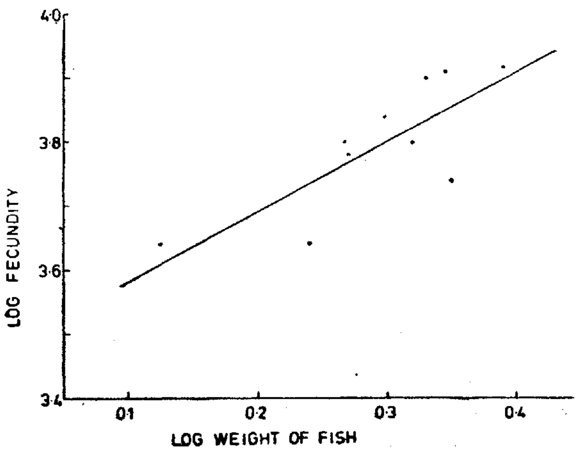

FIG. 6.

Relationship of fecundity to length of fish.

Discussion

The occurrence of large number of mature females with advanced stages of oocytes in the ovary, the comparatively high gonado-somatic values during the period April to October, and the occurrence of spent individuals from June to November lead one to the conclusion that the spawning of *L. thermalis* extends for a period of nearly seven months. The presence of two distinct batches of ova indicates that the fish spawns more than once during the breeding season. As no resorption of maturing ova takes place the above mentioned conclusion on the frequency of spawning seems to be reasonable. Thus *L. thermalis* fits in the category 'c' of Prabhu (1956), Karekar and Bal (1960) and category II of Qasim and Qayyum (1961).

Here, there is a general preponderence of females over males. Qasim (1966) noted such a disparity in sex ratio in *Ophiocephalus punctatus*, *Barbus stigma* and *Callichrous bimaculatus*. Qasim attributed the higher incidence of one sex in the population to the sexual difference in growth rate and found in all the three cases that the sex which outnumbered the other attained a much bigger size, a condition noticed during the present study also with the difference that the maximum size recorded for the males is 58 mm while that for the females is only 62 mm.

The fecundity factor of any of the cobitid has not yet been reported, hence there is no scope for comparison. The coefficient of correlation between the fecundity and the above mentioned characters are significant and hence linear

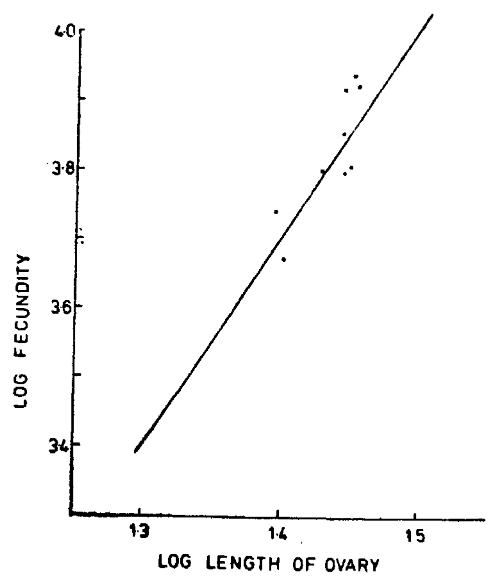

Fig. 7.

Relationship of fecundity to length of ovary in *L. thermalis*.

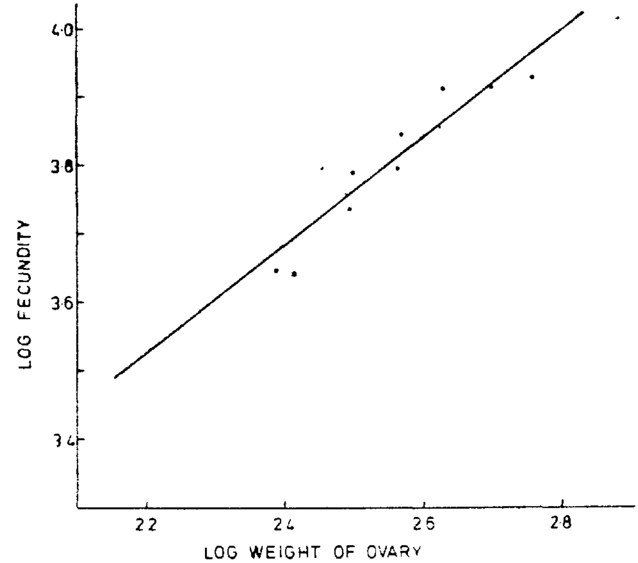

FIG. 8.
Relationship of fecundity to weight of ovary in *L. thermalis.*

relationship is justified. Thus it seems that fecundity is determined by length and weight of fish as well as length and weight of ovary. Variations in the relation between fecundity and the above-mentioned characters have been reported. Jhingran (1961) found a proportional increase in fecundity with increase in length and weight of the Gangetic anchovy *Setipinna phasa*. Mathur (1964) observed that egg production in *Hilsa ilisha* was somewhat more highly correlated with weight than with length of fish. The fecundity studies in *Herklotsichthys punctatus* revealed a close relationship with weight of the ovary rather than with the length and weight of the fish (Marichamy, 1971). The results of the present study indicate that the number of eggs increases with the weight of the ovary.

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