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Maturation Biology and Spawning Ethos of A Hillstream Loach *Lepidocephalus Guntea* (Ham-Buch) From River Mandal, Pauri Garhwal, Uttarakhand

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Abstract: The paper deals with studies on maturation biology and spawning behaviour of an important hill stream loach *Lepidocephalus guntea* (Ham-Buch) from river Mandal in District Pauri Garhwal Uttarakhand. It was observed that there was a continuous growth of ova throughout the year. Seven maturity stages in the fish were observed with single mode each month. Gonado-somatic index (GSI) and Dobriyal Index (DI) were calculated to find out the month of peak maturity, spawning frequency and spawning season. It was confirmed by tabulation of fishes in different maturity stages each month and also by physical observations in the field. It was concluded that June was the month of peak maturity and spawning takes place during July- August. Rare spawning was seen even in First week of September. Size at first maturity was 60-61 mm.

Keywords: Loach • *Lepidocephalus guntea* • GSI • DI • Maturation • Spawning season • Spawning frequency

Introduction

Reproductive biology is an important aspect of fishes which is essential to be investigated for their culture and management. If we know the annual maturation cycle of fish we can easily manage its culture aspect by making proper arrangement for egg hatching and further spawn maintenance. Fish exhibit different types of spawning pattern which may be of annual nature, biannual nature or may be multiple breeding months in one single year. Thus the pattern of development of ova to maturity is also different in different fishes. The spawning behavior of fish includes the study of the month, frequency and ecology of spawning.

Nikolsky (1963) divided the fishes in to several ecological groups, like the lithophils (spawning on stony grounds), the psammophils (spawning on sand) and the pelagophils (spawning in water column), depending upon the nature of their breeding grounds. Such studies are generally conducted through macroscopic and microscopic observations of gonads. On the higher technical version the histology of gonads is also performed which gives perfect idea about development of ova to maturity.

Some important contributors on the maturation and spawning biology of fish in the recent past are Sobhana and Nair (1974), Vasudevappa and James (1980), Thakre and Bapat (1981), Dobriyal (1983), Nautiyal (1983), Singh et.al.(1985), Dobriyal and Singh (1987, 89, 93), Dobriyal et. al. (2000, 2009), Thapliyal and Dobriyal (2003),Kumar et. al (2006) and Singh et.al. (2012). Present study is conducted on the maturation biology of the hillstream loach *Lepidocephalus guntea* of which other biological characteristics are already explored (Dobriyal, 2011, 2012, 2013).

Materials and Methods

After taking morphometric data of fish and its gonads, the testes and ovaries were preserved in 4 % formalin solution. For macroscopic studies, following indices were calculated

(i) Gonado-Somatic Index (GSI): The Gonado-Somatic Index (GSI) has been observed to indicate the spawning period and frequency. The weights of the bodies as well as of the gonads (Testes and ovaries) were noted. The GSI values were calculated with the help of following equation:

Gonado-Somatic Index (GSI) = Weight of Gonads x 100/ weight of body

(II) Dobriyal Index (D.I.)

Dobriyal index was calculated as proposed by Dobriyal et.al. (1999)

D.I. = $\sqrt[3]{}$ GW (Cube root of average gonad weight)

Where,

D.I.= Dobriyal Index $\sqrt[3]{}$ GW = Cube root of the average weight of gonads calculated for each month for male and female fish separately.

For microscopic study, three samples of ova were collected from anterior, middle and posterior region of ovary and minimum of 100 eggs from each sample were measured by means of an ocular micrometer.

Determination of Maturity stages

The maturity stages were determined based on ICES scale (Wood, 1930) as follows:

7 stages were determined as Immature I and II, Maturing I and II, Mature I and II (Spawning) and Spent stage.

Spawning season and frequency

The GSI, DI, occurrence of fish of different maturity stages round the year, availability of spent fishes and the occurrence of eggs and fry in their natural habitat were the means used for determination of spawning behaviour.

Size at first Maturity

The percentage occurrence of mature male and female fish in various size groups during pre-spawning and spawning time was taken in to consideration for the determination of size at first maturity. 50 % level in the maturity was considered as size at first maturity. It was calculated by interpolating the drawn regression line at 50% level of maturity.

Results and Discussion

Gonado- Somatic Index (GSI)

GSI is the prime index calculated macroscopically which is based on the weight of body and gonads. The monthly average values for *Lepidocephalus guntea* are presented in Table 1. For male fish, the maximum GSI value was 4.532 ± 0.981 in the month of August and minimum 0.117 ± 0,068 in September. Similarly for female fish, the maximum GSI value was 8.782 ± 0.917 in the month of August and minimum 0.171 ± 0,087 in September.

Results of GSI shows that the fish matures fully in August month and spawns in between August-September as at that time the value was lowest

Dobriyal Index

DI is another index which is slightly more efficient than GSI as there is no body weight involved in this. The monthly average values of DI are presented in Table 2. DI for male fish was observed maximum 2.134 ± 0.842 in July and minimum 0.114 ± 0.041 in the month of November. For female fish the DI was also high in July month (4.983± 0.495) and minimum in November (0.342 ± 0.141).

Table 1: Monthly values of Gonado-Somatic-Index (GSI) for *L. guntea* during August 2011 to July 2012

S.No.	Months	GSI (Male)	GSI (Female)
1	Aug.	4.532±0.981	8.782±0.917
2	Sep.	0.117±0.068	0.171±0.087
3	Oct.	0.159±0.072	0.209±0.060
4	Nov.	0.421±0.116	0.657±0.139
5	Dec.	0.682±0.158	0.957±0.019
6	Jan.	0.898 ± 0.207	1.454±0.129
7	Feb.	0.964±0.271	1.988±0.468
8	Mar.	1.117±0.217	3.571±0.417
9	Apr.	1.612±0.321	4.001±1.009
10	May	2.917±0.211	5.456±1.517
11	Jun.	3.312±1.710	6.754±2.541
12	Jul.	3.989±0.997	7.201±1.817

Table 2: Monthly values of Dobriyal Index (DI) *L. guntea* during August 2011 to July 2012.

S.No.	Months	DI (Male)	DI (Female)
1	Aug.	2.004±0.482	4.612±0.673
2	Sep.	0.312±0.221	1.423±0.417
3	Oct.	0.212±0.087	0.564±0.211
4	Nov.	0.114±0.041	0.342±0.141
5	Dec.	0.399±0.052	0.758±0.279
6	Jan.	0.498±0.172	1.009±0.287
7	Feb.	0.656±0.232	1.204±0.332
8	Mar.	0.827±0.256	1.449±0.212
9	Apr.	0.987±0.421	2.464±0.432
10	May	1.041±0.615	3.422±0.687
11	Jun.	1.404±0.471	4.324±0.712
12	Jul.	2.134±0.842	4.983±0.495

(Mean ± Standard deviation)

Thus in comparison of GSI and DI, there was a difference. As per DI the fish matures fully in July and starts spawning in August and moves on to September, which is actually observed in nature. The difference might be due to the fact as discussed by Dobriyal et.al. (1999) that in DI, the body weight is not considered. It is purely based on gonad weight. Body weight being a denominator value may allow shooting up of GSI being down not only by spawning stress but also through physiological and environmental stress, low food availability, etc.

Development of ova to maturity

On the basis of ova diameter measurement regularly following the ICES scale of Wood (1930), the maturity of fish is divided in 7 stages (Table 3)

In the first immature stage, range of ova diameter was 3-10 (1 omd = 0.016 mm) with a peak at 6 omd. In second stage, the peak was at 10 omd with ova diameter range from 5 -16. The maturing stage 1 and 2 were stage third and fourth and both had peaks at 24 and 38 omd respectively. Fifth stage was Mature 1 which had a range of ova diameter from 25-67 omd with single peak at 51. It showed that there was a continuous progression of ova with no hindrance in between.

Table 3: Different maturity stages in *L. guntia* during August 2011 to July 2012.

Maturity stages	Ova diameter (Omd) (1 Omd = 0.016mm)	Peaks
I - Immature 1st	3 - 10	6
II - Immature 2nd	5 - 16	10
III - Maturing 1st	9 - 36	24
IV - Maturing 2nd	15 - 58	38
V - Mature 1st	25 - 67	51
VI - Mature 2nd/	29 - 98	70
Spawning	14 - 54	26
VII - Spent Condition		

Spawning stage is considered as stage sixth, which also had a peak at 70 omd with range of variation from 29-98. In this stage only few fish were observed spent. The final spent stage (Stage 7th) was observed in August- September where range of eggs observed was 14-54 omd with a peak value at 26. ICES based seven stages of maturity are reported by Various workers (Sunder , 1984 in *Schizothorax curvifrons*; Dobriyal and Singh, 1987 in *Barilius bendelisis*; Negi and Dobriyal, 1997 in *Crossocheilus latius*; Desai, 2000 in *Tor tor*; Uniyal, 2003 in *Tor chelynoides*; Vinchi, 2005 in *Gadusia chapra*).

Season and frequency of Spawning

Spawning frequency is calculated on the basis of percentage occurrence of fishes in different maturity stages round the year (2011-12). The matured stages were observed in July (82.5%) and spent (90 %) in September (Table 4). As there is only single peak mode of mature (July) and spent fishes (August-September), it is concluded that there is single frequency of spawning in *Lepidocephalus guntea* in river Mandal, Garhwal Himalaya, Uttarakhand. It was observed that monsoon triggers the spawning in *Lepidocephalus guntea* and breeds intermittently from August – September. This observation was also supported by GSI (Single mode in August) and DI (single mode in July).

Table 4: Percentage occurrence of different maturity stages of *L.guntia* during August 2011 to July 2012

S.N	Months	% of fish							No. of fish examined
		Stage I	Stage II	Stage III	Stage IV	Stage V	Stage VI	Stage VII	
1	Aug.	-	-	-	-	6.2	70.8	23.0	
2	Sep.	-	-	-	-	02.0	08.0	90.0	
3	Oct.	-	-	-	-	-	02.5	97.5	
4	Nov.	100	-	-	-	-	-	-	
5	Dec.	90.0	10.0	-	-	-	-	-	
6	Jan.	30.0	60.0	10.0	-	-	-	-	
7	Feb.	15.4	44.6	40.0	-	-	-	-	
8	Mar.	-	25.2	56.8	18.0	-	-	-	
9	Apr.	-	-	40.5	52.5	7.0	-	-	
10	May	-	-	10.5	40.5	51.0	-	-	
11	Jun.	-	-	-	20.0	70.0	10.0	-	
12	Jul.	-	-	-	-	15.5	82.5	02.0	

Several reports are available on the season and frequency of spawning in Indian fishes. Earlier reports are made by Hora and Mishra (1938) who reported that *Tor khudree* breeds during August to September. Hora (1940) opined that the three species of *Tor* (*Tor putitora* and *Tor mosal*) also breed during same period (August to September). Sarojini (1957) reported breeding in *Mugil parsia* during December to March. Dobriyal and Singh (1987) reported *Barilius bendelisis* as double spawner. Nautiyal (1984) reported *T. putitora* a post monsoon spawner in Nayar river.

Size at first maturity:

For estimation of size at first maturity, the percentage occurrence of mature (male and female) fishes during pre spawning and spawning season in various size groups are presented in the Table 5 and 6.

Table 5: Percentage occurrence of mature (Males) of . *L.guntia* during pre-spawning and spawning season in various size groups during August 2011 to July 2012

Size Groups (mm)	Mid Point (mm)	No. of mature fish	Percentage of mature fish	No. of fish examined
51-55	53	01.00	33.33	03
56-60	58	02.00	33.33	02
61-65	63	02.00	50.00	04
66-70	68	03.00	60.00	05
71-75	73	03.00	75.00	04
76-80	78	02.00	100.00	02
81-85	83	02.00	100.00	02

The size at first maturity was calculated by interpolating 50% level of maturity to the regression line. It was determined to be 61 mm for males and 60 mm for females (Figs. 1 and 2).

Table 6: Percentage occurrence of mature (Females) of *L. guntia* during pre-spawning and spawning season in various size groups during August 2011 to July 2012.

Size Groups (mm)	Mid Point (mm)	No. of Mature fish	%age of mature fish	No. of fish examined
51-55	53	01	33.33	03
56-60	58	02	40.00	05
61-65	63	02	50.00	04
66-70	68	03	75.00	04
71-75	73	04	80.00	05
76-80	78	04	80.00	05
81-85	83	04	100.00	04

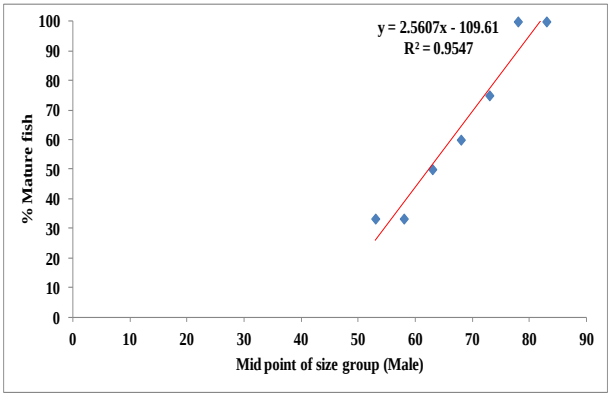

Fig 1: Size at first maturity in *Lepidocephalus guntea* (Male)

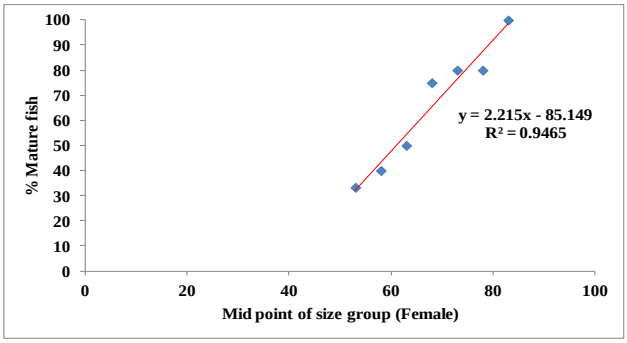

Fig 2: Size at first maturity in *Lepidocephalus guntea* (Female)

The spawning grounds could not be located in the present study as it become difficult to find it in nature as the same spawning season belongs to a number of species. Eggs were observe under stones and in shallow pockets of lateral waters but species specific cannot be mentioned. However on the basis of pattern of spent fish available, it can be concluded that the fish is triggered for spawning by monsoon flood having lower pH value and soil smell. Singh et al (1985) observed that a specific combination of several factors triggered spawning in hillstream fishes, which includes the temperature, pH, velocity and turbidity. They opined that in *Glyptothorax pectinopterus* the spawning takes place in rising water, which becomes more turbid due to which the spawned eggs are less conspicuous to the predators. According to Shrestha (1986) mahseer spawns in semi-stagnant waters along the river bank interspersed with gravel and stones to which the eggs attach in batches, the depth range being 2 meters to 3.5 meters in general with possibly extending up to 5.5 meters. Dobriyal and Singh (1989) concluded that in catfish *Glyptothorax pectinopterus* spawns in the flooded and high velocity of water of Nayar.

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