ORIGINAL RESEARCH ARTICLE

Reproductive traits of an endangered loach, *Triplophysa kashmirensis* (Hora, 1922) in Kashmir Himalaya

Abstract

In this study, a total of 180 specimens of Triplophysa kashmirensis were studied. The total length of specimens varied from 54.85 mm to 130.17 mm for the weights 2.21 g and 21.03 g respectively. Maximum GSI (gonadosomatic index) value was demonstrated in the month of November with the peak value of 1.23 in males and 20.67 in females. The absolute fecundity varied from 561 to 11,386 eggs and relative fecundity from 914 to 1441 eggs per gram body weight. The average absolute fecundity recorded was 3,851.61 ± 266.61 whereas average relative fecundity was 418.45 ± 19.25 per gram body weight. The resultant average sex ratio, male: female was 1:0.8, indicating a significant dominance of males. The length at first maturity (L50) for females of Triplophysa kashmirensis was estimated at 86 mm.

Key words*: Triplophysa kashmirensis, Gonadosomatic Index, fecundity, sex ratio*

Introduction

India is one of the 17 global mega biodiversity hotspots and is home to many freshwater fish species. About 2,246 indigenous finfish species have been recorded from India, of which 765 inhabit the freshwater resources of country [1]. The first account of fishes inhabiting cold waters of India was given by Hamilton (1822). Heckel (1838) while describing the fish fauna from Kashmir valley documented two scale less fish species called *Cobitis marmorata* and *Cobitis vittata*. He later renamed them as *Triplophysa marmorata* and *Triplophysa kashmirensis*. *Triplophysa kashmirensis* is distinguished from *Triplophysa marmorata* in having longer length of lateral line and caudal peduncle. Its ground colour is pale yellowish. Markings consist of brownish or greyish blotches of different sizes. The species remain attached to the stones. In India the distribution of genus *Triplophysa* has been reported only in the upper drainage of the river Indus in Jammu and Kashmir and Lahul and Spiti area of Himachal Pradesh [2]. *Triplophysa kashmirensis* is one of the important cyprinid fish species, indigenous to Kashmir which is found in almost all fresh water ecosystems of Kashmir. It is locally called as "Ara Gurun". It is freshwater benthopelagic fish and lives among pebbles and shingles at the bottom of clear rocky streams but some drift into lakes among the hills and this has made these fishes secondarily modified for life in deeper waters [3]. Genus *Triplophysa* belongs to the family Balitoridae and sub-family Nemacheilinae [4]. The *Triplophysa* species of Kashmir occurs in river Jhelum and its tributaries and are also found in spring waters e.g. Veerinag and Kokernag springs etc. The river Jhelum is having innumerous tributaries on its left and right bank. The important tributaries are: Brangi, Aripath, Aripal, Dal Lake, Nagin Lake, Anchar Lake, Wullar Lake, Manasbal Lake.

Triplophysa kashmirensis is one of the important Small indigenous fish (SIF) species endemic to Kashmir. Small, indigenous fish are particularly important for nutrition because they are eaten whole, with bone, head and eye, thereby providing a rich source of calcium and other micronutrients [5]. The fish is also being eaten in dried form in Kashmir valley. The dried form of *Triplophysa kashmirensis* forms a good and cheaper choice of protein in harsh winters of the valley. Its integration into polyculture systems can prove to be prudent as it can result in overall pond fish production. It was with this background that a detailed study on the reproductive biology of *Triplophysa kashmirensis* was undertaken.

Reproduction is very vital for sustenance, replenishment and progeny maintenance of every living organism including fish. Size at age of 1st maturity and temporal variations in the

gonadosomatic index (GSI) and gonadal maturity are used to assess the reproductive pattern of the fish species. Conservation and survival of any fish species depend more importantly on its reproductive potential. Knowledge of fecundity, the gonadosomatic index (GSI) and observation of gonadal development are important for the proper management of fisheries resources. GSI helps in understanding the maturity stage and exact time of spawning. Gonadal maturation represents a series of cyclic morphological changes, where the gonads undergo gradual growth and ripeness [6].

Materials and Methods

The experiment was carried out in Fishery Resource Management Laboratory, Faculty of Fisheries, SKUAST Kashmir (India). Every month a total of 30 specimens of *Triplophysa kashmirensis* (Fig. 1) were collected from torrential streams of Kashmir (India). After collection, the specimens were immediately preserved in 10% formalin until they were examined in the laboratory

Gonado Somatic Index

The fish specimens (both male and female) were dissected open and their gonads (Fig. 2) were collected to record their length and weight. GSI (Gonado Somatic Index) was estimated using the formula as given by Desai [7]:

$$GSI = \frac{\text{Weight of gonad}}{\text{Total weight of fish}} \times 100$$

Fecundity

The gravimetric method was used for estimating fecundity, which is based on the relation between ovary weight and the density of oocyte in the ovary [8, 9]. Fecundity was estimated by counting number of mature ova from a known weight of mature/ripe ovary. The subsamples of ovary were obtained from the anterior, middle and posterior regions of the ovary [10]. The subsamples were then spread evenly on a counting slide with a few drops of water and the number of mature ova were counted and average number of three portions was used to determine the absolute fecundity by the following formula:

$$\text{Absolute fecundity} = \frac{\text{No. of ova in the subsample x Total ovary weight}}{\text{Weight of subsample}}$$

Relative fecundity i.e. number of eggs/1 g of body weight (unit body weight or ovary weight) was obtained by dividing absolute fecundity with total weight of fish (in grams).

$$\text{Relative fecundity} = \frac{\text{Absolute fecundity}}{\text{Weight of fish}}$$

Length at first maturity (L_m)

Length at first maturity (L_m), which is the minimum size at which fish attains maturity was estimated by examination of the maturity stages. Female specimens in the stage III and above were considered as mature in this study. Data collected for 6 months was pooled and percentage of cumulative frequency was plotted against the length groups. Size at which 50% of fish population matured was considered as the length at first maturity (L_m).

The statistical analysis of the data was carried out by using Microsoft excel and SPSS for

windows.

Results

Gonadosomatic index (GSI)

During present study the monthly variation of GSI of female and male specimens of *T. kashmirensis* is given in Table 1. The graphical representation is given in Figures 3 and 4 respectively. In females the mean GSI was found to be minimum in the month of August (7.54) with the gradual rise to 20.67 in the month of November. From November to January the value of GSI showed a decreasing trend indicating the onset of spawning season. In males the GSI was found to be minimum in the month of August (0.76) and maximum in the month of November (1.23).

Fecundity

Fecundity was studied by examining mature ovaries. A small portion was cutted from the anterior, middle and posterior regions of the ovary and was considered as one sample. After recording weight, the sub samples were teased out and were dispersed in small amount of water. The mature ova were counted and total number of ova was calculated. The results showed the total number of mature eggs varied from 561 to 11386 in individuals of 2.21-18.21 grams. The mean absolute fecundity value of 74 specimens was 3851.61 ± 266.61. The mean relative fecundity (number of ova/gram of body weight) was found to be 418.45 ± 19.25 with highest of 1441 and minimum of 914 (Table 2). Fecundity also showed a statistically significant difference ($p \leq 0.05$) in different months. The mean absolute fecundity was recorded maximum in the month of November (5487.12 ± 708.64) while as it was recorded lowest in August (1909.38 ± 260.90). Similarly the mean relative fecundity was recorded maximum in the month of September (483.00 ± 40.75) while as it was recorded minimum in the month of December (307.27 ± 58.67).

Length at first maturity (L_m)

A total of 74 females of *T. kashmirensis* were examined for the estimation of minimum length at first maturity. Females in stage III and onwards were considered mature in the present study. A maturity curve was plotted by taking the cumulative percentage of mature females against their mean of length groups at 10 mm intervals. The length at which 50% of the fish attained maturity was estimated to be 85 mm for the females. Percentage distribution of maturity stages according to different length groups is shown in Table 3 and Figure 5.

Discussion

Gonadosomatic Index (GSI)

The mean monthly GSI value in females fluctuated from 7.54 in the month of August to 20.67 in November and in males from 0.76 in August to 1.23 in November. Based on GSI values and gonadal conditions, December to January appears to be the spawning season for *T. kashmirensis.* Teleosts exhibit different spawning periodicity and are seasonal breeders. In Indian subcontinent most of the freshwater fishes are monsoon breeders [11]. Most of the Garhwal Himalayan hill stream fishes spawn during summer and monsoon months as *Tor tor* and *Tor putitora* during April to July, *Labeo dyocheilus* and *L. dero* during March to June, *Barilius* spp. during April-June, *Glyptothorax pectinopterus* and *Pseudocheilus sulcatus* during April to August [12].

In Schizothoracids, diversity in spawning season and periodicity exists because of varied ecological environments. According to Jhingran (1982), *Schizothorax richardsonii* in Himachal Pradesh spawns from March to June, in Kumaon waters, it spawns from July to December and in Garhwal Himalaya from July to September [13]. *Schizothorax niger* exhibits spawning from mid-April to May end (Malhotra, 1966). *S. plagiostomus* of Bhakra reservoir breeds twice in a year i.e. from July to August and from December to January (Bhatnagar,

1964). Similarly, two breeding seasons (from September to October and February to March) in *S. plagiostomus* of Nepal waters have also been reported [14]. While studying breeding biology of in *Schizothorax niger* GSI recorded was found to be highest during February (14.35) which is the peak breeding season of the fish, then it decreased gradually upto June attaining its lowest value in June (3.88), females exhibited higher GSI value than males [15]. In *Schizothorax niger* the maximum GSI values were recorded during spawning season of fish i.e. February and March with peak values of 13.80 in females and 6.77 in males in March. The mean maximum GSI values of 6.19 and 11.12 for males and females respectively were reported during the month of April in *Schizothorax labiatus* from river Jhelum, Kashmir [3f16].

The values of gonadosomatic index increase with the maturation of the fish and become maximum during the peak of maturity and decrease abruptly and sharply when the fish becomes spent and females generally exhibited comparatively higher GSI values than males [17, 18, 19, 20]. Similar observations were recorded during the current study on *T. kashmirensis* which showed the maximum recorded GSI in the month of November (1.23 in males and 20.67 in females) and minimum GSI in the month of August (0.76 for males and 7.54 for females.

Fecundity

Many fishery biologists have worked on the fecundity of different fish [21, 22, 23]. The knowledge of fecundity is one of the most important part of the reproductive biology. Fecundity is not a constant feature but it fluctuates with variations in environmental conditions and species specific factors [24]. Even within a stock, fecundity may vary annually [25]. Fecundity is usually known to vary within species, with location and latitude and also with the spawning time [26]. Different fish species reflect marked differences in their reproductive patterns and exhibit different reproductive potentials in terms of fecundity [27].

In the current study, the average absolute fecundity of *Triplophysa kashmirensis* was estimated at 3851.61 ± 266.61 eggs and average relative fecundity at 418.45 ± 19.25 per gram of body weight. The absolute fecundity of *Schizothorax niger* from Dal Lake Kashmir was reported to vary from 1550 to 3444, while relative fecundity ranged from 24 to 124 eggs per gram body weight with a mean value of 53 [15]. The mean absolute and relative fecundity of *Schizothorax labiatus* from River Jhelum was estimated at 10323 and 42 respectively [16]. In *Schizothorax richardsoni* the fecundity ranges from 2248 to 8726 in fishes of 160-245 mm TL and 40- 110 g in weight [28]. Therefore both absolute and relative fecundity of *T. kashmirensis* during the present study showed a much variation with respect to local Schizothoracines.

Length at first maturity

Length at first maturity (L_m) is the mean length at which fish of a given population develop ripe gonads for the first time. This is an important parameter influencing fecundity of fish and has to be assessed as shifts in the age or size at maturation and has been documented for a number of exploited populations [29]. The knowledge of minimum size of maturity is important in adjusting the mesh size of fishing gear to ensure that the smaller fish which have not spawned even once may have an opportunity to escape [30]. Size and age at 1st maturation, and mortality directly influence the reproductive potential of a fish population [31]. Ecological conditions such as the water temperature and photoperiod have been reported to influence the sexual maturity of fish [32, 33].

In the present study, the length at which 50% of the female fishes attained maturity was estimated to be 85 mm. L_m was estimated as ≥ 150 mm for *S. esocinus* [34]. The value of L_m in *S. niger* was found to be 178.14 mm for males and in females it was 167.32 mm [35]. The

value of L_m for *Schizothorax labiatus* was estimated at 196 mm [16].

Conclusion

The average gonado-somatic index (GSI) was estimated to be 1.01 in males and 16.66 in females. The average absolute fecundity was recorded as 3851.61 whereas the average relative fecundity was recorded as 418.45. The fish spawned during the short period of time with peaks during December and January. These months form the spawning period of the fish and shows that the fish is an annual breeder. Length at first maturity L_m was estimated to be 85 mm.

Table 1. Monthly variation of gonadosomatic index of *Triplophysa kashmirensis.*

Month	Male GSI Range (Mean)	Female GSI Range (Mean)
August	0.30-1.53 (0.76)	2.71-18.82 (7.54)
September	0.40-2.90 (0.82)	6.12-25.70 (13.97)
October	0.23-1.26 (0.93)	10.50-24.38 (16.27)
November	0.92-2.23 (1.23)	8.27-33.90 (20.67)
December	1.02-2.86 (1.05)	12.23-25.24 (15.70)
January	0.50- 2.03 (0.63)	5.61-37.59 (8.29)

Table 2. Monthly variation in the Absolute and Relative Fecundity of *Triplophysa kashmirensis*

Month	No of Samples	Absolute Fecundity	Relative Fecundity
		Mean ± SEM	Mean ± SEM
August	14	1909.38 ± 260.90	426.36 ± 38.84
September	12	3141.54 ± 267.71	483.00 ± 40.75
October	10	2557.75 ± 358.46	332.02 ± 31.53
November	17	5487.12 ± 708.64	423.95 ± 37.83
December	11	3498.55 ± 583.49	307.27 ± 58.67
January	16	4835.06 ± 508.27	451.80 ± 45.09
Average		3851.61 ± 266.61	418.45 ± 19.25

Table 3. Length-wise percentage distribution of maturity stages in *Triplophysa kashmirensis* (females).

Length group (mm)	No. of females examined	Maturity Stages				
		I	II	III	IV	V
50-60	7	57	43	-	-	-
61-70	9	40	50	10	-	-
71-80	6	10	60	30	-	-
81-90	10	10	40	20	20	10
91-100	11	-	35	45	10	10
101-110	10	-	30	10	30	30
111-120	9	-	18	10	60	12
121-130	12	-	-	18	27	55

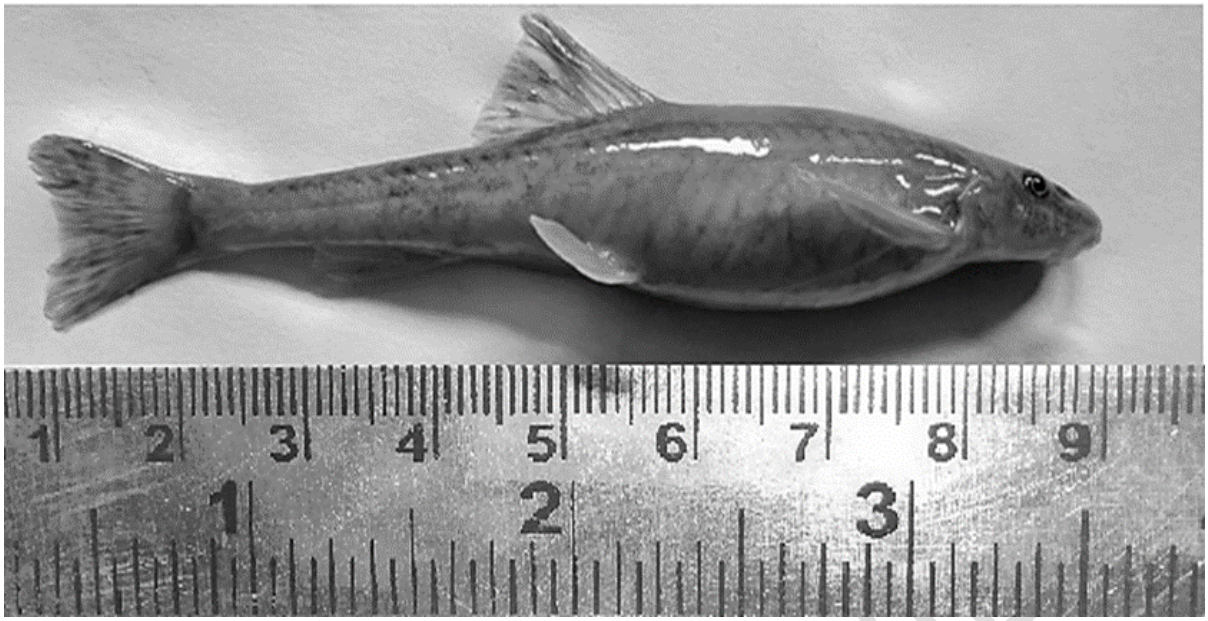

Fig. 1. Specimen of *Triplophysa kashmirensis* Hora, 1922.

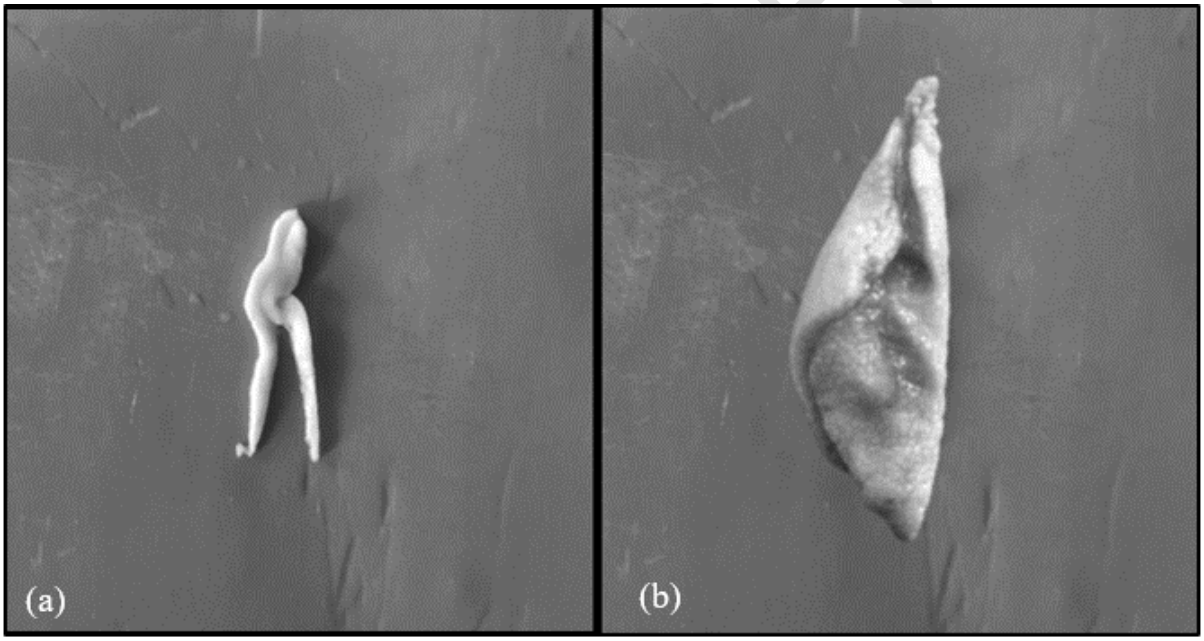

Fig. 2. (a) Male gonad (b) Female gonad.

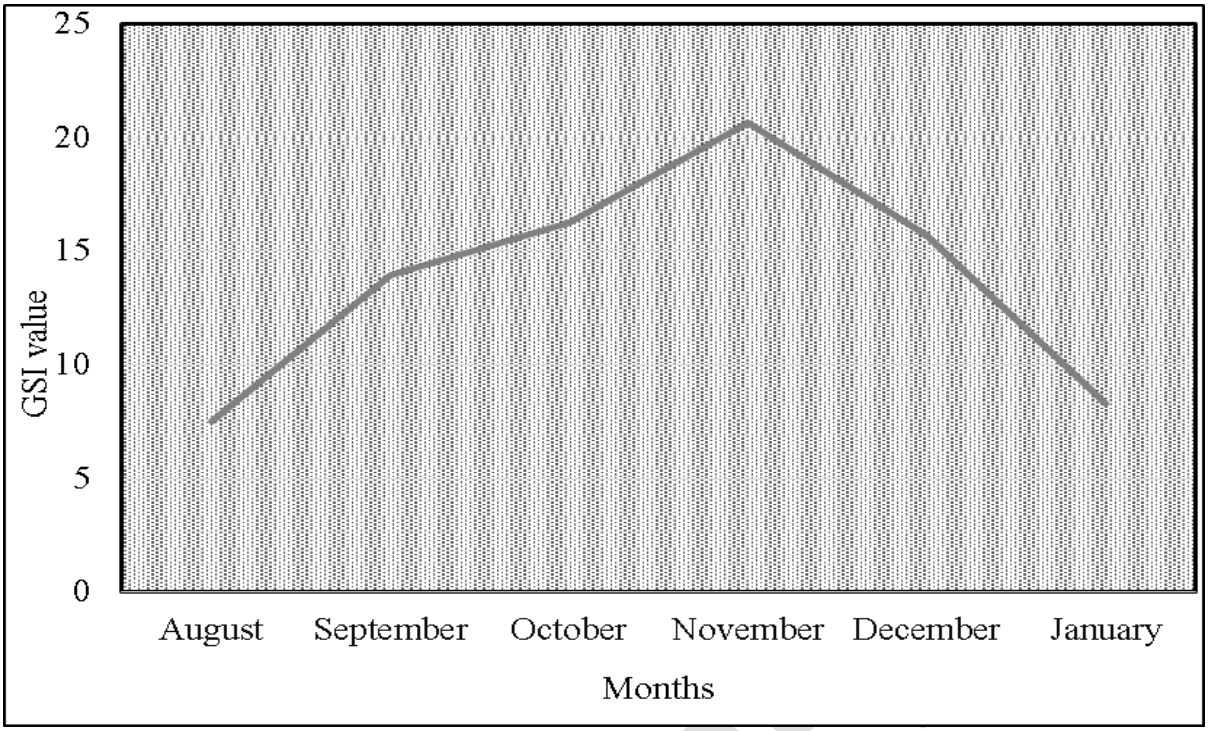

Fig. 3. Monthly variation in GSI of *Triplophysa kashmirensis* (Female).

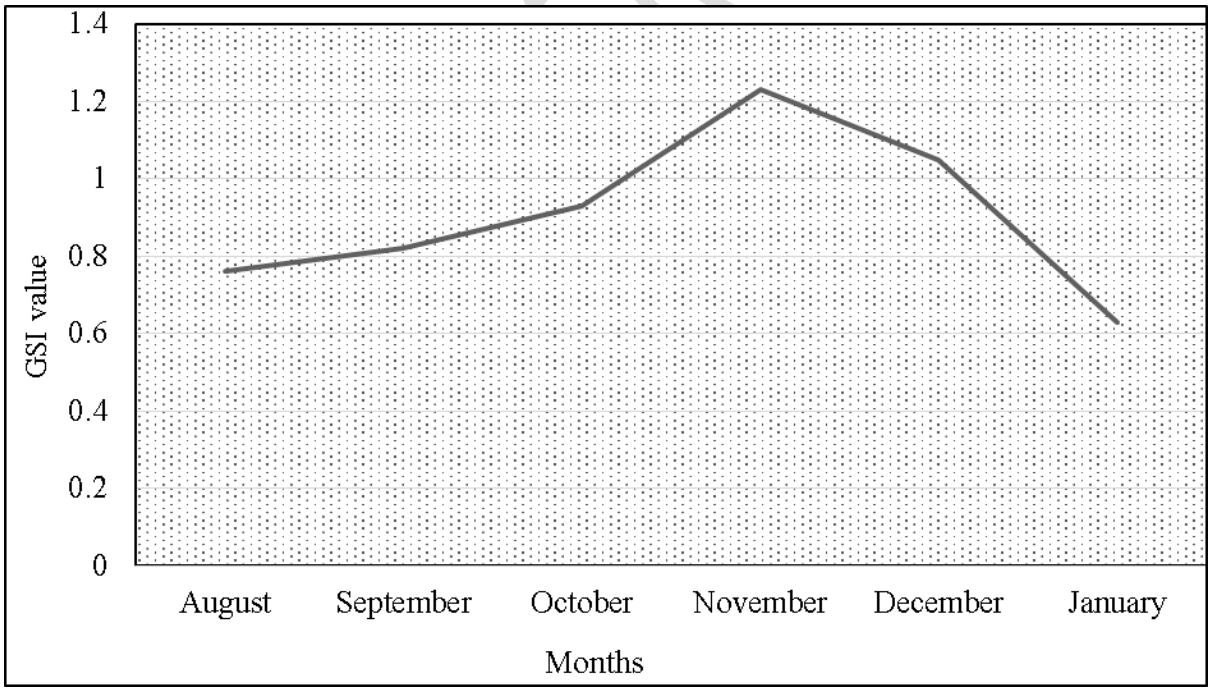

Fig. 4. Monthly variation in GSI of (Male).

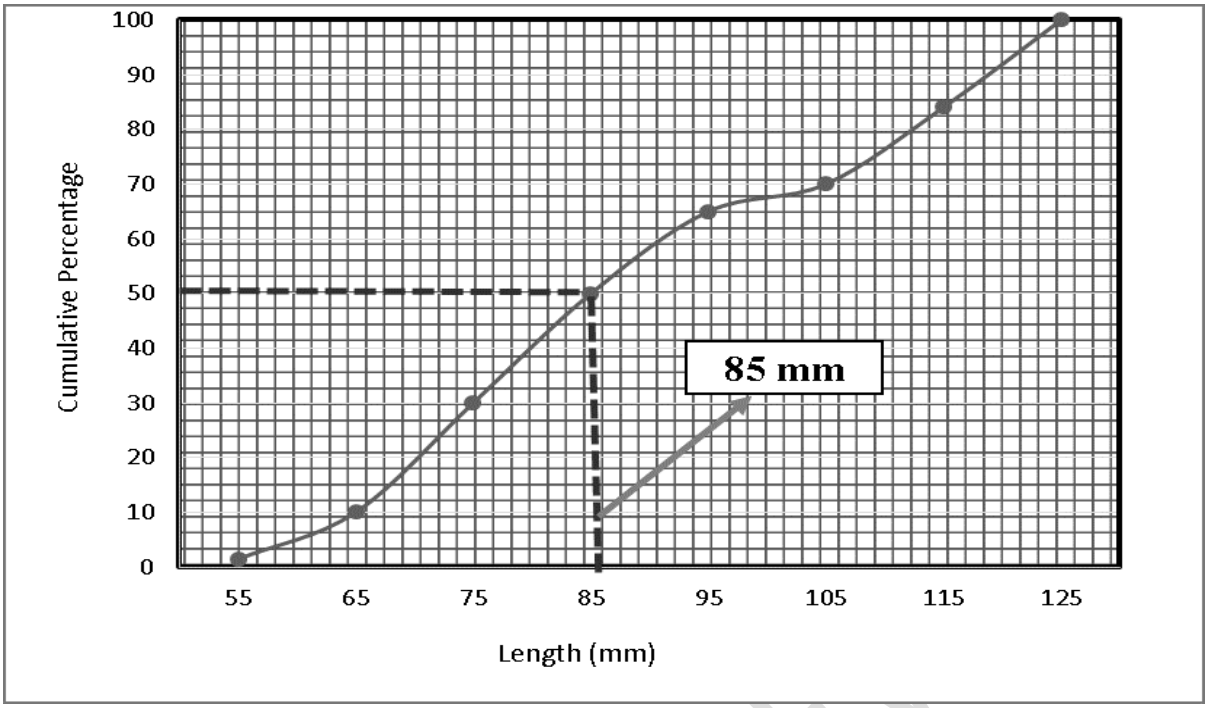

Fig. 5. Length at first maturity (L_m) in *Triplophysa kashmirensis* (females).

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