International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 16-10-2021, Accepted: 01-11-2021, Published: 17-11-2021
Volume 6, Issue 6, 2021, Page No. 74-77

Gonadosomatic index of minor carp *L. boggut* from Kalu Dam, Ahmednagar District, Maharashtra, India

S A Kawade[1*], A K Pandarkar[2]
[1] Department of Zoology, Sharadchandra Pawar Mahavidyalaya, Lonand, Khandala, Satara, Maharashtra, India
[2] Department of Zoology, New Arts, Commerce and Science College, Ahmednagar, Maharashtra, India

Abstract
The study on gonadosomatic index showed that the weights of the ovaries follow regular cyclical changes in relation to the oogenetic activity in the gonad. This is indicated by the seasonal changes in the index values. In September, October, November, December, and January when the gonads are in the resting stage, the index is minimum (1.3134, 1.2571, 1.2849, 1.2956, and 1.3584 respectively). In maturing stage from February to April, the index increases (7.0336, 9.3535, and 9.6860 respectively) as a result of the high level of cellular activity in the ovaries. In May, it was 9.0872 and reaches to value 13.9404 and 19.0376 in June and July respectively, due to the increase in the number of oocytes of stage VI, indicating the spawning. In August and September, the values of the index decreases 6.8301 and 1.3134 respectively, indicating simultaneous lyses of unspawned oocytes. In the present study, cyclical variations in the gonadosomatic index of female fish of *L. boggut* from Kalu dam near Ahmednagar showed that weights of the ovaries followed regular cyclical changes concerning the oogenetic activity in the gonad. This was indicated by the seasonal alterations in GSI.

Keywords: *L. boggut*, gonadosomatic index

Introduction
Gonado - somatic index is one such measure that can be used to assess the degree of ripeness of the ovary. If a measurable relation exists between the ovary weight, at a particular stage of maturity, and the weight of the fish it would be possible to compare the change in the growth of the gonad for the fish of comparable size and thus the stage of maturity based on ova diameter could perhaps be approximated without the laborious measurements of ova diameter. Gonado-somatic index (the percentage of gonad weight to the total weight of the body) as an indicator of the breeding period in fish calculated at different intervals for adult female fish after taking the total weight of each fish (Gupta, 1974) [10].
Environmental changes greatly influence the production of eggs varies not only among different species but also within the same species. This depends upon the length and weight of the gonads (Barmanh and Saikia, 1995) [2]. Maturity determination by gonadosomatic ratio has proved tobe a significant tool in the life of fishes. Gonads undergo regular seasonal cyclic changes in weight, particularly in females which help to indicate the spawning season (Dadzie *et al*., 2000) [6]. The method of studying the spawning season is to follow the seasonal changes in gonadal weight to body weight which is expressed as the gonado-somatic index (Ahirrao, 2002) [1]. Gonadosomatic index (GSI) is one of the important parameters of fish biology, which gives a detailed idea regarding the fish reproduction and reproductive status of the species and helps in ascertaining the breeding period of fish (Shankar and Kulkarni, 2005) [19]. The gonadosomatic index measures the cyclic changes in gonad weight concerning total fish weight and can be used to determine spawning periods (Smith, 2008). The objective of the present work was to determine the maturity and spawning period influenced by different seasons in the fish *Labeo boggut*.
Among those who have worked on gonado - somatic index is Chubb and Potter (1984) [5] and Marcus and Kusemiju (1984) [16]. The reports indicate that so far no attempt has been done to evaluate the gonado-somatic index of *Labeo boggut*. Therefore, in the present study, an attempt has been made to find out monthly changes in the gonado-somatic index of *Labeo boggut*.

Material and Method
For this study, during the fortnight collection of the adult fishes as given in the study of annual reproductive cycles; an additional 2 to 3 number of different female fishes were caught. Immediately individual fish was weighed to the nearest 0.1 gm.
The fish was then dissected for ovary lobes. Immediately the weight of the lobes was determined to the nearest 0.01 gm. All the fishes were like-wise processed in each fortnight. The data on full-moon and no-moon of each month were then averaged to calculate, Gonadosomatic Index (GSI) (as given by Pillay and Nair, 1971) using the formula GSI = (GWt / TWt – GWt) x 100 where GWt = gonad weight and TWt = total fish weight.

Results
Monthly changes in the Gonadosomatic Indices of *L. boggut* is expressed in table 1 and Figs, 1 and 2. In the females of *L. boggut* the gonadosomatic index in November was 1.2849, increased to 1.2956, 1.3584, 7.0336, 9.3535, 13.9404, and increased further to reach peak 19.0376 from January to July respectively; but in August it rapidly decreased to 6.8301. From September to October, the values further decreased to 1.3134 and minimum (1.2571).

Table 1: Monthly Changes in the mean gonadosomatic indices of *L. boggut*.

Sr. No.	Months and Year	GSI	
		L. boggut	
		Female	Male
1	November 2014	1.2849	1.0498
2	December	1.2956	1.0558
3	January 2015	1.3584	1.6132
4	February	7.0336	5.5349
5	March	9.3535	7.7223
6	April	9.6860	7.7252
7	May	9.0872	7.6930
8	June	13.9404	6.5514
9	July	19.0376	6.5840
10	August	6.8301	5.8723
11	September	1.3134	1.3148
12	October	1.2571	1.0432

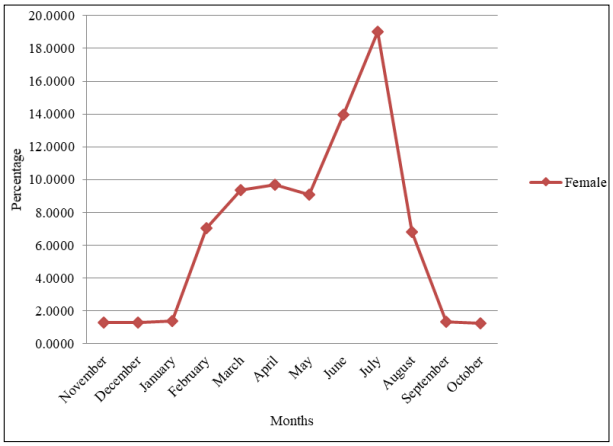

Fig 1: Monthly values of gonado-somatic indices of *L. boggut.* Female

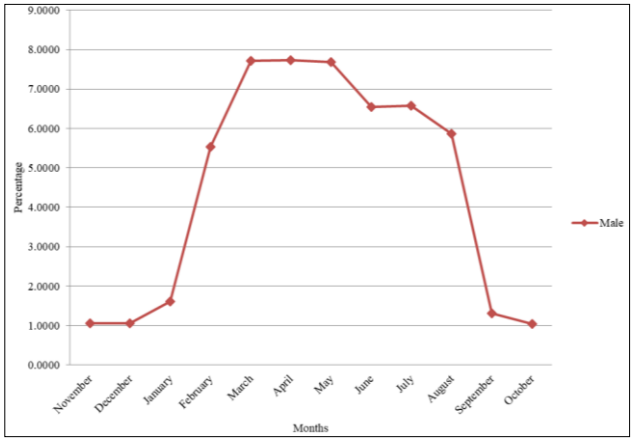

Fig 2: Monthly values of gonado-somatic indices of *L. boggut.* Male

In the males of *L. boggut* gonadosomatic index was 1.0498 in November, slightly increased to 1.0558 in December and further subsequently increases 1.6132, 5.5349, 7.7223, (high) 7.7252, and 7.6930 from January to May. In June it sharply declined to 6.5514 and again increased to 6.5840 in July. In September the index was 1.3148, decreased to 1.0432 in October.The study revealed that in both the sexes, females showed high values of indices than the males; and both the sexes of *L. boggut* showed high values. The indices in *L. boggut* were high from November to July for females, while the males showed high values of indices from November to May.

In *L. boggut*, female showed a peak gonadosomatic index in June and July and male in March to May. The monthly changes in the gonadosomatic indices suggest that the spawning season of *L. boggut* spreads over a long period, beginning in February and extending to October, with the main peak season in June and July in females and March to May in males.

Discussion

Many workers from India and abroad studied the gonadosomatic index (GSI) of freshwater and marine fishes because of their economic importance as food to human beings. While studying the GSI the workers took into account the ovary weight, oocytes stages in development, and other environmental factors chiefly the rainfall, food availability, and level of water in the fish habitat which is discussed below:

The seasonal changes in GSI of *Mastacembelus armatus* (Lacepede) [10] from Muzaffarnagar (U.P., India) (Gupta, 1974) showed a percentage rise from 0.85 in February to 3.2 in March, reaching the peak percentage of 10 in May when the ovary was fully developed. The author reported that there was a sudden fall towards the end of June which indicated that the spawning had already commenced. In July it had a value of 3.15. By the end of August, there was again an increase in the ovary weight, and in October it showed a value of 4.2%. There was again a sudden fall in November so that the ovary attained the minimum weight in December. After this, the ovary passed through post-spawning phase. There was little fluctuation in the ovary weight until February. Further, the author observed that the index of male *M. armatus* followed an identical pattern. The female GSI of silver carp, *Hypophthalmichthys molitrix* from Government fish seed farm at Hadapsar, Pune (Singh, 1991) [21] showed a rise in value from February to April coinciding with the maturation of gametes and as these gametes mature the index increased in May and June. As the gametes spawned out the index decreased from July to September. In a tropical freshwater catfish, *Mystus cavasius* (Siluriforms: Bagridae) from Guntur, India (Sharma *et al*., 1996) [20], the GSI value reached the maximum on the eve of spawning and the minimum value was observed in the spent adults. The study further showed that the variation in the weight of immature ovaries in different adults was very limited. Just as the GSI value was low. As the spawning season approaches, the differences in weights between the ovaries of different maturing adults become wider, indicating that all the adults do not mature at the same time. It was observed that during the spawning season that extends over three months, the larger females spawn a little earlier than the smaller females. The GSI provides additional evidence of the period and duration of the spawning season. Chavan and Muley, (2014) [4] while studying gonadosomatic index of fish *Cirrhinus mrigala* (Hamilton), estimated GSI values for both males and females. GSI values ranged from 0.06 to 2.0 in males and 0.08 to 24.00 in females. The GSI showed one peak in July. Higher values of GSI were observed during June to august indicating the period of maturity, spawning, and its extension. The GSI declines in *C. mrigala* during October to December 2012 indicated that during these months the weight of gonad was minimum probably due to dormancy of gonads in post-breeding season.

In the present study, cyclical changes in the gonadosomatic index of female fish of *L. boggut* from Kalu dam near Ahmednagar showed that weights of the ovaries followed regular cyclical changes in relation to the oogenetic activity in the gonad. This was indicated by the seasonal changes in GSI. In November, December and January, when the gonads were in the resting stage of maturity the values of GSI were minimum (1.2849, 1.2956, and 1.3584 respectively). In the maturing stage during the months from February to April, the values increased (7.0336, 9.3535, and 9.6860 respectively) possibly as a result of the high level of cellular activity (as stated by Bhatti and Al-Daham, 1978) [3] in the ovaries. In late May, when the ovaries were in the spawning stage, the values again increased (9.0872) and reached in June (13.9404) due to the increased number of oocytes of stage V and VI in the ovaries (refer to the histology of gonads). In July, August, September, and October the values of GSI and the ovary weight declined (19.0376, 6.8301, 1.3134, and 1.2571, respectively) indicating the spawning and lyses period in which loss of oocytes of stage V occurred in the process of spawning-post-spawning. It was further seen that the maturity stages chosen in the study did fit an expected and logical pattern of the weight change in the gonad providing an additional degree of confidence in the maturity assessments. The reports are also available on many other fishes from Indian waters and abroad showing that the GSI increases with the progressive development of the gonads in both males and the females until the gonads are ripe and the index then declines sharply in the spawning and the spent fishes (Tan, 1985; Etim *et al*., 1989; Khan *et al*., 1990 and Ikoni, 1996) [24, 7, 8, 12, 13, 11]. However, in the multispawner fishes, it was shown that the changes in GSI were non-seasonal breeding e.g. in *Carassius carassius* (Shaheena, 2012), in *Channa gachua* (Ghanbahadur *et al*., 2013) [9, 14], in *Nemacheilus moreh* (Kharat and Khillare, 2013) [14] and *Channa marulius* (Tiwari *et al*., 2014) [25], etc. Further, in the present study - it was observed that the GSI value increased in May which apart from the fully grown vitellogenic oocytes, was probably due to uptake of fluid by some of the fully-grown oocytes, which resulted in their swelling and becoming hyaline (as stated by Macer, 1974) [15]. However, in June and July almost all oocytes were fully vitellogenic and therefore it is likely that the GSI reached a peak value. The decline in August, September, and October was probably related to a decrease in the number of large vitellogenic follicles in the ovary due to spawning (according to Sumpter and Dodd, 1979) [23], sometimes accompanied by atresia, especially of the larger vitellogenic follicles. In addition to these observations, it was also noted that the GSI exhibited a maximum value during May and June just before and during the beginning of the rainy season (as per Etim *et al*., 1989) [7, 8] which corresponded to South-west monsoons and the rising flood (as stated by Khan *et al*., 1990 and Ikoni, 1996) [12, 13, 11].

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