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Gonadosomatic Index as a Determinant of Spawning Season in the Milieu of Ovarian Dynamics of Indian Freshwater Spiny Eel *Mastacembelus armatus* (Lacepede)

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Abstract Gonadosomatic index is a less expensive and alternative method than histological observation for the determination of spawning season in fish species. *Mastacembelus armatus*, an indigenous fish species of southern Asia, also resides in Indian subcontinent. This fish species is facing an alarming declining in their number in the last decade. Due to its moderate cost, It is mainly taken by the lower income group of people of the society. Reproductive care, by artificial breeding, has been taken for those fish species having a high cost in the market or becoming less in number in nature for business purposes or preserving the biodiversity, respectively. The present study was undertaken to understand the spawning season of the fish *Mastacembelus armatus* by calculating the gonadosomatic index, so in recent future artificial breeding can be done in this fish species. The mean GSI value for testes is 0.95 ± 0.06, 1.42 ± 0.22, 2.10 ± 0.38 and 0.72 ± 0.08 in growth, maturation, spawning and resting phase respectively. The mean GSI value for ovary is 1.38 ± 0.4, 2.86 ± 0.84, 12.50 ± 1.70 and 1.80 ± 0.15 in growth, maturation, spawning and resting phase respectively. In this study it was found that spawning season include one peak in a year and mainly it falls in the months of June to August in both the sexes.

Keywords Gonadosomatic Index, *Mastacembelus armatus*, Spawning Season

1. Introduction

In recent years man has to depend more on aquaculture opposed to wild fish and this has led to the commendable scientific effects to achieve sustainability in aquaculture production. Management and conservation of fish together with its breeding biology are essential for successful culture and mobilization of seed resources. Both environmental and hormonal factors are extremely important in regulating reproductive behaviour and spawning in fishes. Various central mechanisms translate environmental cues into chemical messengers which function to activate and maintain the reproductive organs. In this regard the functional relationship between the hypothalamus and pituitary gland is important, and the pineal gland plays a positive role in regulating sexual maturation. Therefore environment, hypothalamus, pituitary and gonad are the four principle factors which are interrelated and behave together (Lal and Pandey,1998). The function of pituitary is mostly controlled by the hypothalamus through the synthesis and release of gonadotropin- releasing hormone (GnRH), therefore, acting as a major initiator of the hormonal cascade controlling the reproductive axis.

Pituitary gonadotrophic hormones and GnRH are important in implicating these hormones in gonadal maturation and sex steroid production which plays a very important role in gametogenesis, final maturation of oocytes and spermiation (Parhar et al., 2003; Lethimonier et al., 2004). Gonadal activities in teleost fishes primarily depend on the function of pituitary gonadotrophs and that the pituitary and the gonads exist in a mutual state of excitation and inhibition (Farbridge et al., 1985; Kaneko et al., 1986).

Mastacembelus armatus is an indigenous fish species of Southern Asia, also resides in Indian subcontinent belonging to the family mastacembelidae under the order Synbranchiformes. It is popular as a table fish in rural parts of India and as having good nutritional value, used to fetch moderate price in markets. It has also been admired as an aquarium ornamental fish. The species prefers to avoid light as far as possible and likes to hide away by bury themselves in sand during the day time. Therefore, for evaluating commercial potentialities it is necessary to know every aspect of its reproductive physiology. Seed production in captivity is the best solution to overcome declination of their population in nature.

2. Materials and Methods

Adult male (average length 15.2 to 15.8 cm) and mean body weight (50g to 75g) and female (average length 17.5 to 17.7 cm) and mean body weight (55g to 70g) of *M. armatus* were procured fortnightly throughout the year from particular pond of Asansol near Chapui village, the size of the pond is 50 mtr x 40 mtr x 10 mtr, in order to avoid ecological variations than can affect development of hypothalamus, pituitary and gonads. The fishes were collected during the second week of every month from January 2018 to December 2018. To study the gonadosomatic index, fishes were sacrificed and testes and ovaries of the fishes were dissected-out minutely, after giving an incision along the mid-ventral line. Total body weight of the fish and testes and ovaries were taken separately with the help of digital weighing balance (AND EK – 300 GD) to calculate the gonadosomatic index (GSI) from the following formula

GSI= (Total weight of the gonad/total body weight of the fish - total weight of the gonad) x100.

3. Results and Discussion

In the male fish, the reproductive organs consist of paired testis which are soft and elongated structures, whitish coloured lying in the body cavity. It leads posterio – ventrally into two vas deferens that unite to form a spermatic duct opening to the exterior through the urinogenital aperture. Each testis is attached to the dorsal body wall by mesorchium. In females the ovaries are elongated andsemi transparent in appearance. A pair of mesenteries suspended them dorso – laterally to the body cavity. The ovary is connected to the oviduct and the oviducts from each bilateral ovary are joined leading to genital pore.

3.1. Gonadosomatic Index (GSI) of Male *Mastacembelus armatus*

In the present investigation seasonal fluctuations in the gonadosomatic index in *M. armatus* have been encountered in different months and reproductive phases (figure 1). During the annual cyclical changes the GSI values vary from 0.62 ± 0.04 to 2.10 ± 0.38. However, lowest GSI value has been observed in November and recorded to 0.62 ± 0.04 i.e. resting phase. Improvement of GSI value has been observed during December i.e. beginning of growth phase and recorded to 0.82 ± 0.05. During January, the GSI value increases to 0.95 ± 0.06 and during February the GSI shows the value 1.14 ± 0.19. During early March, i.e. beginning of maturation phase the GSI value increases to 1.25 ± 0.98. In the maturation phase i.e. April and May the testicular activity increases and the GSI values are recorded to 1.42 ± 0.22 to 1.55 ± 0.46 respectively. During spawning phase i.e. in the months of June and July the GSI values reached to 1.75 ± 0.75 to 2.10 ± 0.38 respectively due to maximum proliferation of spermatozoa. However the GSI value slightly declined to 1.85 ± 0.07 during the end of spawning phase i.e. August. In September the GSI value declines to 0.86 ± 0.03 while in October the value further decreases to 0.72 ± 0.08.

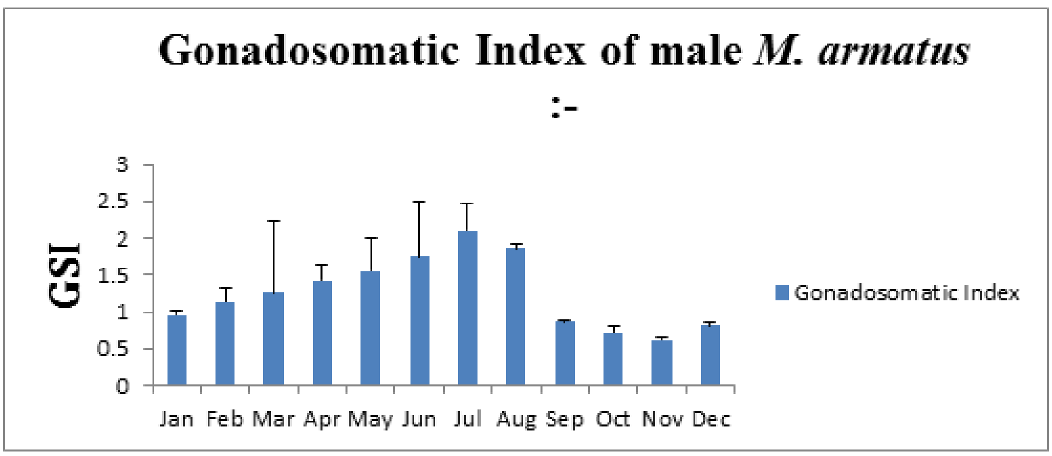

Figure 1. Graph of the Gonadosomatic Index of male *M. armatus*

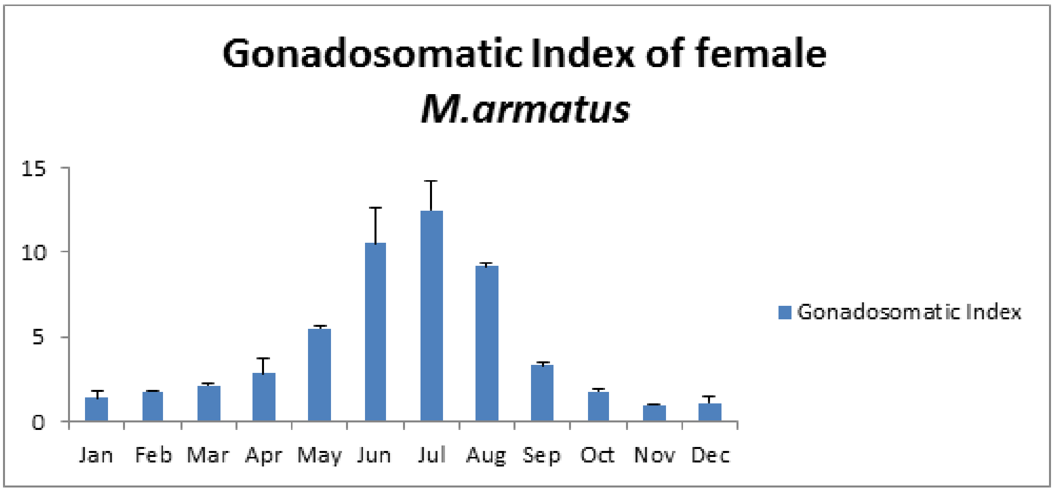

Figure 2. Graph of the Gonadosomatic Index of female *M. armatus*

3.2. Gonadosomatic Index of Female *Mastacembelus armatus*

During the present investigation it has been observed that the values of GSI in *M. armatus* undergoes changes during growth, maturation, spawning and post – spawning phases (figure 2). However, the highest value (12.50 ± 1.70) has been noticed during July when the ovaries remained packed with fully mature follicles. The lowest GSI value (0.98 ± 0.078) has been noticed during the resting phase in November. In December the yolky follicles reabsorbed and the oogonia including early perinucleolar oocytes start to increase in number and the GSI recorded to 1.12 ± 0.34. In January and February when growth phase advances the mean GSI value increases and the values are recorded to 1.38 ± 0.4 and 1.80 ± 0.02 respectively. During the month of March i.e. onset of maturation phase the GSI further increases to 2.10 ± 0.16. In the month of April and May the GSI value rises from 2.86 ± 0.84 to 5.51 ± 0.137 at the time of full maturation phase. With the onset of spawning phase i.e. during the month of June the GSI value increased sharply and recorded to be 10.54 ± 2.11 when the ovaries constituted with full of mature follicles. In July the GSI further increased to 12.50 ± 1.70 but in August the GSI falls resulting to 9.14 ± 0.24. During September i.e. beginning of post – spawning phase the GSI value decreases to 3.30 ± 0.18 followed by 1.80 ± 0.15 in October and the ovaries suffer from regression state.

The GSI has been considered to be a good marker of reproductive activity and a model to study the gonadal development and reproductive efforts in many teleosts. In the present investigation the GSI value of testes during the onset of resting phase considerably declines due to thread like structure of the testes when practically active spermatogenetic activity virtually ceases. However, during growth phase the active division of spermatogonial cells mitotically and eventual formation of resultant primary and secondary spermatocytes, the testes gradually increases in volume and weight from the growth phase onwards which is reflected in the gradual increase in the value of GSI. Further, subsequent formation of advanced stages as well as proliferation of spermatogenetic cells the highest GSI in the spawning phase has been recorded. Similar changes of GSI value have been described by various authors (Mukhopadhyay, 1984; Ganguli and Chakrabarti, 1995; Chakrabarti, 2014). GSI value declines sharply due to spermiation and/or release of spermatozoa (Treasurer, 1990).

In the present observation the declining trend of GSI value in female has been encountered during post – spawning to resting phase when the ovary is found to be regressed condition. The GSI increased gradually from the end of growth phase due to maximum proliferation of oogonial cells early and late perinucleolar oocytes. These findings are consistent with other teleosts also (Mayer et al., 1990; Chakrabarti and Gupta, 1994; Chellappa et al., 2005). In the present investigation, it has been found that GSI in the ovary reached to its highest value during spawning phase when the ovarian follicles are packed with mature follicles. Similar observations have also been made by some workers (Lee et al., 2008; Lone and Hussain, 2009). This increment of GSI during spawning period is mainly due to various nutrients in the ooplasm of developing oocytes (Htun – Han, 1978) and also due to vitellogenesis along with increment of oocyte diameter. The more or less same Phenomena has been advocated by many authors (Shacley and King, 1977., Noortis, 1984 and Janssen, 1994). The GSI recorded to declination from September onwards and this phenomenon may occur due to discharge or resorption of yolky oocytes.

4. Conclusions

Fish production in captivity is an essential prerequisite for the increasing population globally. Indigenous fish species of the pond and ditches are the main source of protein in the rural areas of India. With demanding globalization these fish species are facing critical problem of survivality. Induced breeding has been taken for those fish species which are economically important or number has been reduced drastically. From this research finding it has been established that in *Mastacembelus armatus*, both in male and female the spawing season show a single peak in the months from June to August. Induced breeding program possibly show the best result in this period for this fish species.

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