



Synchronicity of Condition Factor with Reproductive Development in Rainbow Snakehead (*Channa bleheri* Vierke, 1991)

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ABSTRACT

Background: Condition factor is an important factor to determine the general well being of any species. It is influenced by different factors like feeding, age of the fish, season, development of gonads etc. Reproductive development on other hand is a crucial factor in determining the condition of fish as gonad weight has certain impact on increasing the weight of fish as well as the condition of the fish. The experiment was thus to determine whether there is any synchronicity of reproductive development in the near threatened snakehead *Channa bleheri* with respect to its condition factor value.

Methods: The condition of *C. bleheri* was closely monitored based on length-weight data round the year. The gonadal development of the species was determined calculating the Gonado-Somatic Ratio (GSR) as well as histological observation of the gonads.

Result: It was found that the value of condition factor was directly proportional to the gonadal development which signifies the importance of gonad development in determining the fish condition. As there are many established factors that determine a fish condition, the inputs drawn out from the reproductive development can help to determine the condition of the fish.

Key words: *C. bleheri*, Condition factor, GSR.

INTRODUCTION

Channa bleheri, also known as rainbow snakehead is a colourful Channid species distributed in certain pockets of Dibrugarh, Tinsukia district of Assam and Dikrong River in Arunachal Pradesh, India (Vishwanath and Geetakumari, 2009). The species has been assessed as Near Threatened in the IUCN Red List of Threatened Species (Chaudhry, 2010) due to its overexploitation in aquarium trade and anthropogenic impacts on their natural habitats. Kalita *et al.* (2018) reported that the increasing demand of this fish for the ornamental trade both for the domestic and overseas markets has lead to the rapid decline of their populations from the wild. National Bureau of Fish Genetic Resources (NBFGFR), India, enlisted the fish as one of the endangered species of India (Lakra *et al.*, 2010). These existing threats lingering upon the species necessitates time bound intervention to restore its population in their natural habitat. Development of the gonadal stages at different season has direct impact on the fish condition (Barnham and Baxter, 2003). Cube-law describes a classic method of determination of fish condition in respect to different life stages, sexes, stages of gonad development and different seasons (Le Cren, 1951). Fishes, before and after reproductive, begin to show a marked departure from the cube law and that changes arising from season changes and body sizes. Attempts have been made to understand the gonadal changes in few *Channa* species (Parmeswaran and Murugesan, 1976; Srivastav *et al.* 1998, Al Mahmud *et al.* 2016; Milton *et al.* 2017). As growth pattern and condition is directly correlated with length and weight of fishes, development of gonads ought to have influence on these parameters.

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MATERIALS AND METHODS

Sample collection

Experimental fishes were collected from different water bodies of Dibrugarh and Tinsukia district of Assam, India. A total of 283 specimens were taken under study.

Condition factor (K)

K factor was determined following Ricker (1975):

$$K = \frac{W}{L^3} \times 100$$

Where

W= Fish weight in g.

L= Total length in cm.

Gonado-somatic ratio (GSR)

The gonado-somatic ratio is calculated for each month using following formula. At least 7 number of male and female each month was taken under study:

$$\text{GSR} = \frac{\text{Gonad weight}}{\text{Total weight}} \times 100$$

Histology

For histological studies the sections of the gonads were fixed in 10% buffered formalin solution at room temperature. Small pieces of ovary (6-8 mm) and testicular follicle (4-6 mm) were fixed in Bouin's solution for 48 h and subsequently processed for histology following Degani (1994). The central portion of the gonads was taken for histological examination which was put in different cassettes. The sections were then dehydrated through increasing grades of ethanol (30%, 50%, 70%, 90% and absolute ethanol) and then clarified with xylene. The samples were then embedded in paraffin blocks and sectioned at 4-5 μm thickness using a semi-automated microtome. Two types of stains were used in the process viz. eosin and haematoxylin followed by periodic acid Schiff (Milton *et al.* 2017). After mounting in DPX the slides were examined and photographed under LEICA DM 750. The developmental stages of gonads were observed under the microscope as immature, maturing, mature and spent stages (Navarao *et al.* 1989).

RESULTS AND DISCUSSION

The stages of gonadal development are described in Table 1 and are divided into five stages as was found in *Mystus montanus* (Arockiaraj *et al.*, 2004) and *Channa gachua* (Milton *et al.*, 2017) i.e. Pre-mature (Immature), Pre-spawning (maturing), Pre-spawning (mature), Spawning (ripe), Post-spawning (spent). The gravid stages were found from April to June which is the potential time of breeding of this species (Stage IV). Spent stage was observed in the end of July and August (Stage V), while maturing ovary appeared in the months from September to January till the end of February (Stage II). From the end of February and March mature ovary was found (Stage IV). The stages found in *Channa bleheri* correspond with the stages were also reported by various workers (Kesteven 1960; Navarao *et al.* 1989; Arockiaraj *et al.* 2004; Milton, *et al.* 2017).

Fulton (1904) laid the concept of allometry in fishes that is influenced by the increase in weight in respect to length during spawning season. There is a gradual increase in the

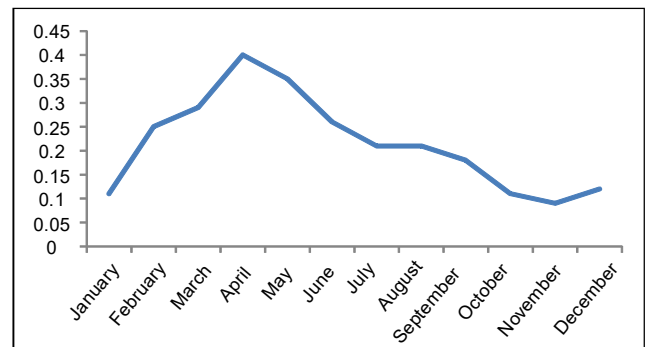


Fig 2: Gonado-somatic ratio (GSR) of male fish in different months throughout year.

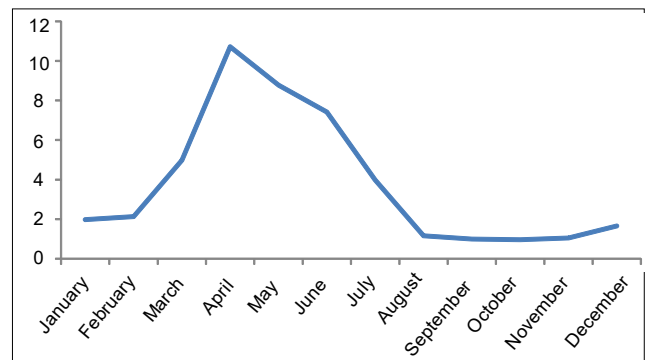


Fig 3: Gonado-somatic ratio (GSR) of female fish in different months throughout year.

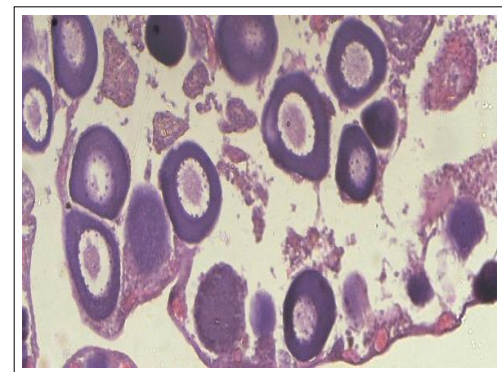


Fig 4: Chromatin nucleolar stage.

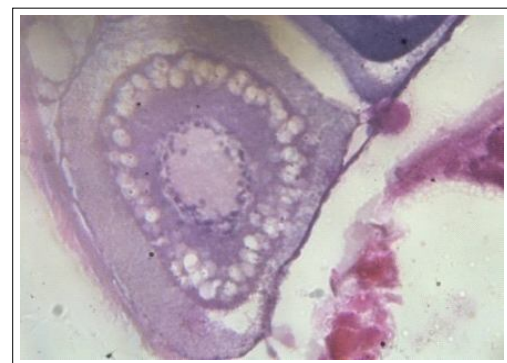


Fig 5: Early peri-nucleolar stage.

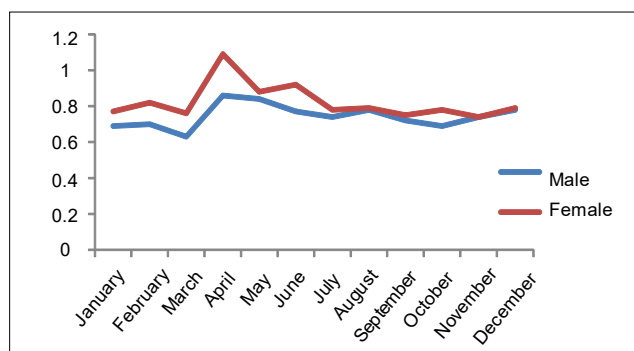


Fig 1: Month wise condition factor value of male and female fishes.

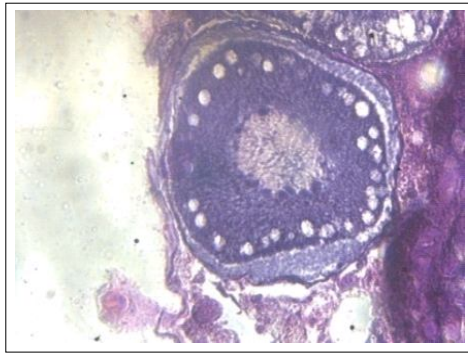


Fig 6: Late peri-nucleolar stage.

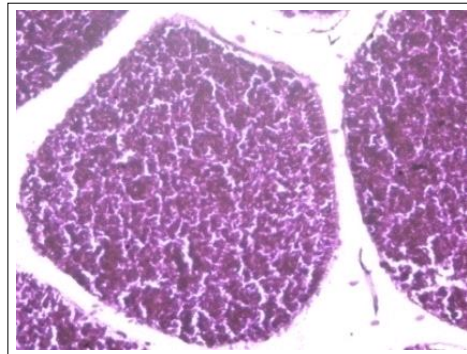


Fig 10: Early yolk granular stage.

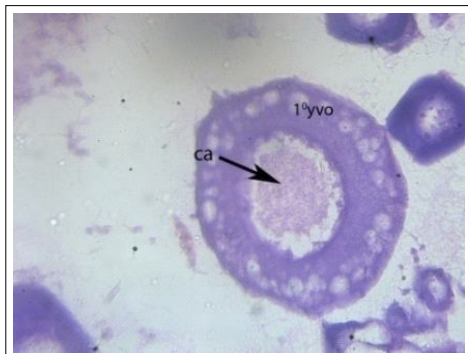


Fig 7: Early yolk globular.

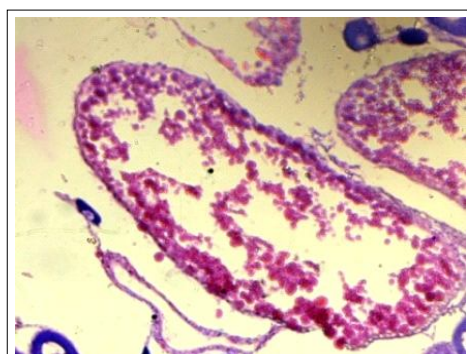


Fig 11: Late yolk granular stage.

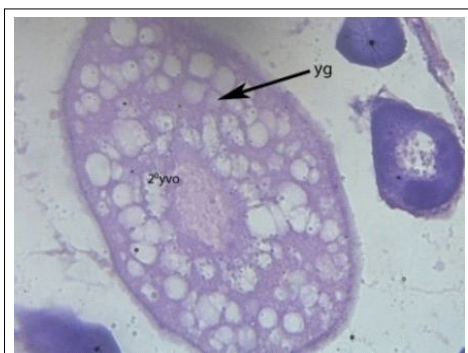


Fig 8: Late globular stage.

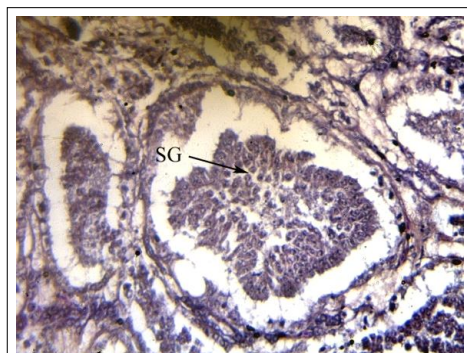


Fig 12: Spermatogonia (SG).

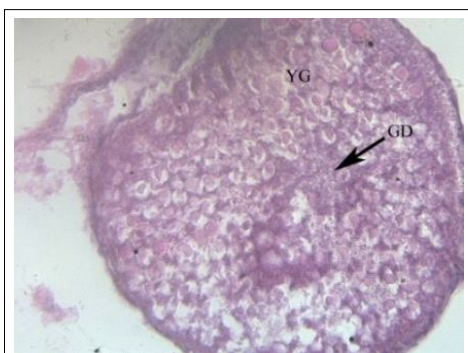


Fig 9: Yolk vesicular stage.

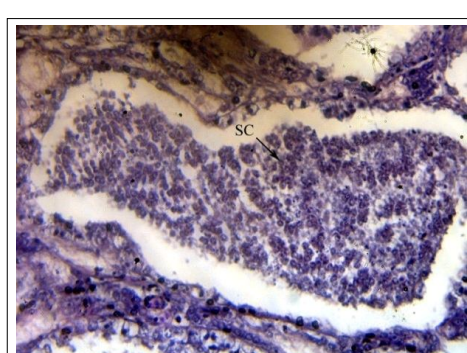


Fig 13: Spermatocytes (SC).

Table 1: Reproductive stages, macroscopic appearance and histological examination of male and female gonads in different months.

Stage no.	Stage	Period		Macroscopic appearance	Histological examination
		Male	Female		
I	Pre-mature (immature)	September to December	October and November	Very small sexual organs close to the vertebral column. Testes and ovaries transparent, colourless to grey. Eggs invisible to naked eye.	Primary oocyte development with monolayer follicle of stage I was seen; from tunica albuginea the development of ovigerous lamellae was evident. Ova diameter ranges between 12-27 μ m. Contains many Spermatogonia (SG), with few Spermatocytes (SC) sparsely scattered.
II	Pre-spawning (maturing)	January to Early February	December to Early February	Testes and ovaries translucent, grey-red. Length half, or slightly more than half of the length of the ventral cavity. Single eggs can be seen with magnifying glass. Single fishes (resting adult) also is categorised in this stage.	Oogonia, nucleolar chromatin and perinuclear oocytes developed quickly; cortical alveoli appeared scarcely in few oocytes. Ova diameter ranges between 60-72 μ m. Mixture of Spermatocytes (SC) and Spermatids (ST) mostly present in this stage.
III	Pre-spawning (mature)	Late February to March	Late February to March	Testes reddish white. No milt drops appear under pressure. Ovaries orange reddish. Eggs are closely discernible and opaque. Testes and ovaries occupy about two-thirds of the ventral cavity.	Ovaries ruled by late perinuclear oocytes and primary yolk vesicle; hardly any secondary yolk vesicle oocytes present. Ova diameter ranges between 162-178 μ m. Spermatids (ST) and Spermatozoa (SZ) were found in equal amount.
IV	Spawning (ripe)	April to June	April to Early June	Sexual organs filling ventral cavity. Testes white, drops of milt fall with slight pressure on the belly. Eggs completely round, some already translucent and ripe.	Ovary mostly occupied by tertiary oocytes; complete. Developed eggs with yolk globules; few previtellogenic stages developed for the succeeding season. Ova diameter ranges between 213-222 μ m. Spermatozoa (SZ) was found to be present enormously in this stage.
V	Post-spawning (spent)	July and August	Late June to September	Gonad flaccid and shrinking. Ventral cavity not fully empty. No opaque eggs left in ovary.	Post-ovulatory follicles present, oocytes experiencing atresia and type I and II atretic oocytes. Only remaining spermatozoa were found.

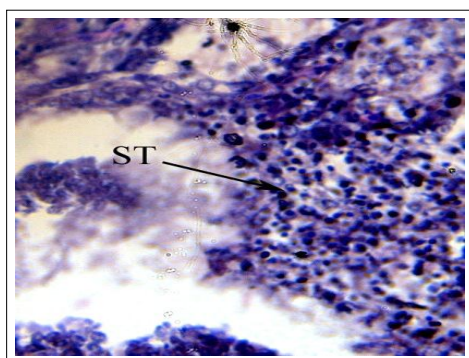


Fig 14: Spermatids (ST).

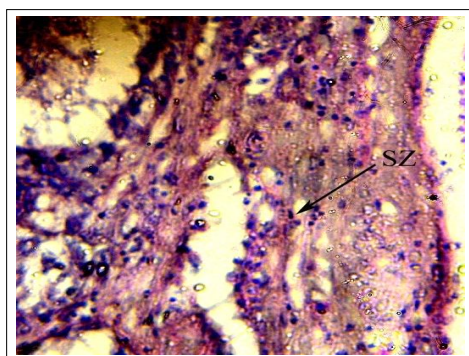


Fig 15: Spermatozoa (SZ).

value of condition factor as well as gonado-somatic ratio (GSR) from April to June as shown clearly in Fig 1, 2 and 3. The weight of the fishes is directly related to its condition factor value with highest value attained at the time of spawning (Wege and Anderson, 1978). Use of histological studies in estimating the gonadal stages in fishes had become more reliable and consistent (Tomkeiwicz *et al.* 2003). On observing microscopically four different stages of gonads were found as was also found in *Channa striata* (Al Mahmud *et al.* 2016) and *Channa gachua* (Milton *et al.* 2017). There is a gradual increase in the value of condition factor as the fishes approached spawning season (Froese, 2006). Histological examination showed that the chromatin nucleolar, early peri-nucleolar and late peri-nucleolar stages in female appeared early when the GSR value was low in September to December (Fig 4, 5 and 6), while spermatogonia and spermatocytes appeared from December to Early February (Fig 12 and 13). Advanced stages like yolk globular and yolk vesicular stages appeared from late February and March (Fig 7, 8 and 9), while spermatids started appearing in male. The mature stages *i.e.* yolk granular stages in female (Fig 10 and 11) and spermatids and spermatozoa started appearing from April to June (Fig 14 and 15). There was a significant difference in GSR value for samples collected in different months ($P < 0.05$). The systematic rise in the GSR values in both the sexes prior to breeding season with prominent increase in females from January to March (Fig 2 and 3) was synchronous with histological gonad development in the two sex.

The gonad condition of *Channa bleheri* that was found throughout the year is presented in Table 1.

CONCLUSION

From our study it is observed that gonad development has close relation with the growth pattern and condition factor in *C. bleheri*. The understanding of developmental changes in a species will open new insights about the species. The data generated in our study hope to develop better management strategies for conservation of this important species.

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