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Full Length Research Paper

Photoperiodic Regulation of Ovarian Function in the Teleost Fish *Channa punctatus* (Bloch)

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ABSTRACT
Photoperiod is considered as the most important factor that entrains animal rhythms, including the reproductive cycle. Sexual maturation in teleost fish is controlled by endogenous rhythms. These are synchronized via environmental cues, of which photoperiod is considered the most important resulting in synchronous spawning within each population at approximately the same time every year. In fish, pineal organ acts as a phototransudcer conveying photoperiod information to the brain via neural pathways and via the release of melatonin. Pineal organ as an interface between the environment and the organism plays an important role in seasonal maturation of gonads. Results of experimental studies on pineal-gonadal interaction in different species of fish are not identical and moreover, most of the information on this topic is from the species that inhabit the temperate climates. Tropical species have not extensively been investigated in this regard. Hence, the objective of the present study was to observe the effect of photoperiod on gonadal status in commercially important teleost fish *Channa punctatus* (Bloch). The results clearly reveal that *Channa punctatus* is a seasonal breeder and long-days stimulate and short-days inhibit gondala function in this species.

Key words: Photoperiod, Fish reproduction, Ovarian Follicular Kinetics, Pineal gland

INTRODUCTION
In seasonally breeding animals reproductive function is influenced by seasonal variation in photoperiod (Sundararaj and Sehgal, 1970). The changes in the duration of light and dark phases (L:D) associated with seasonal cycles variation in L:D are known to influence the pineal gland function in most vertebrates result in a different secretory profile of the pineal hormone melatonin: the nocturnal release of the hormone is longer in duration in winter than in summer. It is clear that the pineal gland acts as a phototransducer in vertebrates and its hormone melatonin is secreted in the absence of light which in turn is responsible for neuroendocrine control of reproductive physiology. Experimental evidences suggest that the gland plays a vital role in the regulation of both the circadian and seasonal rhythms in a variety of species (Morgan and Williams, 1989; Namboodiri *et al*, 1991; Bartness *et al*, 1993; Reiter, 1993) and in the endocrine control of reproductive physiology (Kinson and Peat, 1971; Hoffman, 1973; Brzezinski and Wurtman, 1988; Matthews *et al*, 1993). Melatonin is secreted into the blood with an endogenous and individual rhythm synchronized by the LD cycle: the plasma concentration of the hormone reach a peak during the night hours and lowest amplitude during the day. The persistence of high concentrations of melatonin is proportional to the duration of darkness (Goldman, 1991; Reiter, 1991, 1993; Pevet, 1993). The pineal gland through its hormone secretion 'informs' the animals about the current phase of day and the year (Reiter, 1991).

In fish, pineal organ acts as a phototransudcer conveying photoperiod information. Results of experimental studies on pineal-gonadal interaction in different species of fish are not identical and moreover, most of the information on this topic is from the species that inhabit the temperate climates. Tropical species have not extensively been investigated in this regard. Hence, the objective of the present study was to observe the effect of photoperiod on gonadal status in commercially important teleost fish *Channa punctatus* (Bloch) from Gulbarga which lies N latitude 17°.

MATERIAL AND METHODS
The teleost fish Channa punctatus (Bloch) were collected from Bheema river and kept for acclimatization to laboratory conditions in glass aquaria for two weeks prior to their use in the experiments. During this period they were treated with antibiotic chloramphenicol (5 mg/l of water), as prophylactic agent. The fish were held in aquaria and placed in chambers with facility for automatic regulation of photoperiod. During the course of experiment the animals were fed with live earthworm on alternate days and the water of the aquaria changed daily. The water temperature was maintained at 21 ± 1° C. 24 fish were divided into 3 groups of 8 each and held in LD 12:12 (lights on at 06.00 and off at 18.00) control group, LD 18:06 (lights on at 06.00 and off at 24.00) long-days and LD 06:18 (lights on at 06.00 and off at 12.00) short-days. The fish were autopsied after month-long exposure. The ovaries were dissected out and immediately weighed on an electronic balance and fixed in Bouin's fluid. The tissues were later on embedded in paraffin wax for histological study. Five micron thick paraffin sections were stained in haematoxylin and eosin. Follicular kinetics was studied in histological sections of the ovaries. The follicles were classified as previtellogenic,

vitellogenic or atretic based on their histomorphology. At least 8 fish from each group were used for this purpose. The counting of the follicles was done in 20 slides from anterior, middle and posterior segments of the ovary. The statistical analysis was done by using a computer program for ANOVA and Schiff's Pairwise Comparison test. The gonadosomatic index (GSI = Ovarian weight/100 g body weight) was calculated for each group for comparison.

RESULTS

Ovarian weights/ Gonadosomatic Index (or GSI) increased ($P<0.01$) in the fish held in LD 18:06 (long photoperiod) when compared to the GSI of the fish held in LD 12:12 (figure-1a). The GSI of the fish held in LD 06:18 decreased ($P<0.01$) when compared either with those of control (LD 12:12) or long photoperiod (LD 18:06) exposed groups of fish.

Ovarian follicular kinetics study reveals that the previtellogenic follicle number increased drastically ($P<0.01$) in the ovary of fish exposed to long photoperiod (LD 18:06) but this number decreased ($P<0.01$) in the group which was exposed to LD 06:18 when compared to control or long photoperiod exposed (LD 18:06) fish (figure-1b). The vitellogenic follicle number increased ($P<0.01$) in the long photoperiod exposed group when compared to control (figure-1c). There was a drastic decrease ($P<0.01$) in the number of vitellogenic follicles in the short photoperiod exposed group when compared to both control and long photoperiod groups. The number of atretic follicles were almost nil in the fish exposed to long photoperiod and increased significantly ($P<0.01$) in the fish exposed to short photoperiod (figure-1d).

Long days exposed fish had an increase ($P<0.01$) in the GSI, previtellogenic, vitellogenic follicle numbers and decrease in the atretic follicles and the result was vice-versa in the fish exposed to short photoperiod where as fish held in LD 12:12 had an increase in GSI, previtellogenic, vitellogenic and atretic follicles when compared to fish held in LD 06:18 and decreased when compared to fish held in LD 18:06. The results of follicular kinetics and the GSI values correlate with each other.

DISCUSSION

Exposure of fish to longphotoperiod (LD 18:06) resulted in an increase ($P<0.01$) in the Gonadosomatic index (GSI). The increase in the GSI correlates with the data of follicular kinetics which shows that the longphotoperiod exposed fish ovary had an increase in the number of previtellogenic, vitellogenic follicles and a decrease ($P<0.01$) in the number of atretic follicles, indicating that long photoperiod (18:06) has a stimulatory effect on the gonadal growth in *Channa punctatus*. Similar results have been observed by Fenwick (1970) in *Carassius auratus* in which long photoperiod increase gonadal size. Sundararaj and Vasal (1976) reported that long photoperiods increase gonadal activity in *Heteropneustes fossilis*, while retarded in the short photoperiodic exposed fish (Sundararaj, 1981). Guraya *et al*, (1976) observed an acceleration of gonadal growth in *M. tengara*. Similarly, Garg and Jain (1985) and Srivastava and Singh (1992) found that photoperiodic manipulation affected gonadal function. Long days in general were found to stimulate gonads. In another study Sundararaj and Sehgal (1970) opined that photoperiod possibly is the primary factor responsible for ovarian recrudescence, while temperature is only facilitatory.

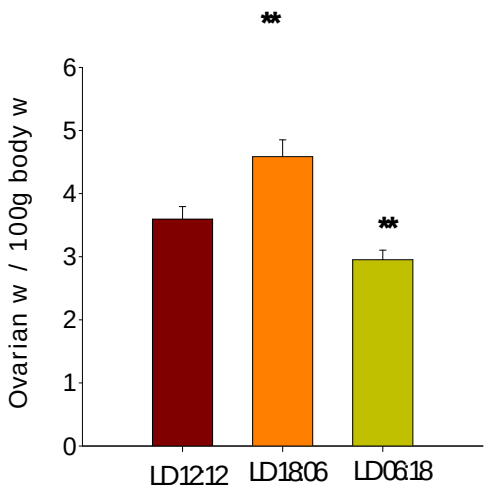
Short photoperiod (LD 06:18) had an inhibitory effect on the activity in this fish as evaluated by gravimetric analysis and follicular kinetics. Similar results were reported by Sundararaj (1981) in the *Heteropneustes fossilis*. Short photoperiods were found to be inhibitory to gonadal functions even in *Cirrhina reba* (Verghese, 1975), in *Channa punctatus* (Garg, 1989; Srivastava and Singh, 1992).

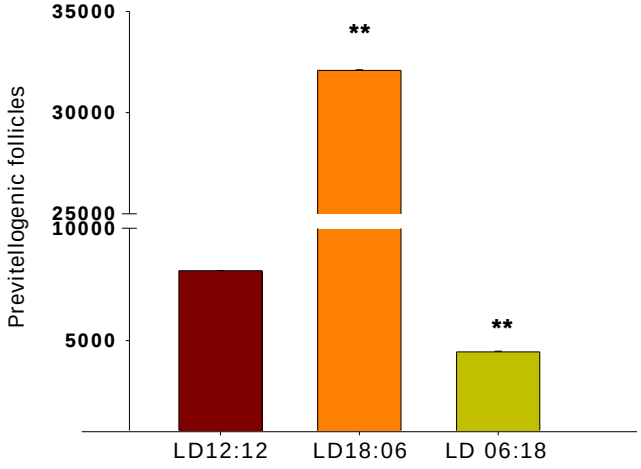
It is clear from the data that long-days stimulate and shortdays inhibit gonadal function in *C. punctatus*. *Channa punctatus* is a seasonal breeder. Studies on seasonal changes in gonadal activity indicate that gonads are mature and full of vitellogenic follicles during summer when days are long and during winter the gonads are regressed and do not contain vitellogenic follicles. In Gulbarga where this study was conducted the lengths of photoperiod do not vary as markedly as in temperate regions. During summer the days are longer only by an hour. It is interesting that the species exhibit photoperiodicity even in environment where seasonal fluctuations in photoperiodic lengths are not very marked.

The mechanism/s by which photoperiod influences reproductive physiology in animals is not completely understood. Basically there has to be a mechanism by which fluctuations in day lengths are perceived and signaled to the neuroendocrine system for 'tuning' rhythms in physiological processes. There is ample evidence to suggest that pineal gland in vertebrates serves as an interface between the photoperiodic environment and the organism (Reiter, 1991). Perhaps pineal through its rhythmic secretion of the hormone melatonin play an important role in the transduction of photoperiodic signal to the neuroendocrine system (Goldman *et al*, 1984)

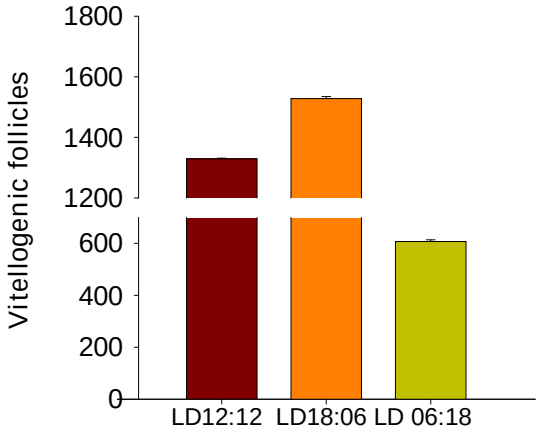
Figure-1 : (a) Gonadosomatic Index (GSI: Ovarian w/ 100g body w), (b) Previtellogenic follicles, (c) Vitellogenic follicles and (d) Atretic follicles of control (LD 12:12) fish, long photoperiod exposed (LD 18:06) and short photoperiod exposed (LD 06:18) fish. P <0.01 Control vs long photoperiod / short photoperiod

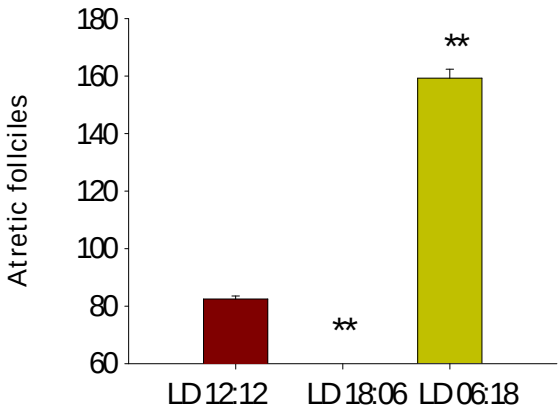
(a) (b)





(c) (d)





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