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Seasonal Changes in Total Serum Calcium, Inorganic Phosphate Level and Gonosomatic Index of Bank Myna, *Acridotheres ginginianus* (Latham) with Reference to Natural Photoperiod.

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Abstract: Studies on seasonally breeding wild birds of Indian sub-continent have been grossly neglected in terms of cyclic changes in total serum Ca, Pi and GSI with respect to natural photoperiod. Bank myna is one of the commonest wild seasonal breeder of Northern Indian plains. The bird breeds during April to July. With the advent of summer (in March) and increasing natural photoperiod a marked rise in total serum Ca level of female Bank myna has been recorded. The value reached a peak level of 14.85±0.369 mg/100ml in May, the breeding peak. Male Ca values also recorded a gradual increase corresponding with increasing natural photoperiod and reached a maximum level of 11.26±0.348 mg/100ml in May. Serum Pi values of female birds rose up to 7.65±0.263 mg/100ml and males up to 6.61±0.182 mg/100ml during the breeding period. Both sexes of Bank myna documented gradual increase in GSI along with increasing natural photoperiod. In May, GSI of female was recorded 3.89±0.270 whereas male GSI was 1.98±0.213. High degree of gonadal regression has been observed in birds of both sexes from August to December. Least GSI of 1.24±0.177 in females and 0.724±0.136 in males was recorded in November. Gonadal regression was copuled with reduction in total serum Ca levels. Least Ca value of 7.75±0.235 mg/100ml in females and 7.66±0.202 mg/100ml in males were recorded during November (non-breeding period). Serum Pi values of non-breeding female birds was 6.25±0.133 mg/100ml and that of male bird was 6.20±0.125 mg/100ml. We concluded that natural photoperiod influenced total serum Ca, Pi and GSI of the Bank myna, a seasonally breeding *Passerine* bird of North Indian plains.

Keywords: Photoperiodic control, GSI, Serum calcium, Serum inorganic phosphate, Bank myna.

Introduction

Increasing photoperiod is an important seasonal event for seasonal breeders, however continued long photoperiod cause gonadal regression through photorefractoriness (Williams et al. 1987, Beebe et al. 2005). Dawson et al. (2001) suggested that seasonal breeding in birds involve photoperiodic control, non-photoperiodic control and endogenous circannual rhythmicity. In addition, the seasonal availability of certain dietary substances influencing onset of breeding and egg laying is emphasized (Caro et al.

2006). Dhondt and Hochachka (2001) suggested that certain birds acquire calcium shortly before and during laying by eating extraneous calcium and do not store calcium for egg production.

Avian breeding season is mostly of shorter duration. During the period, high calcium kinetics occur in laying birds to supply the material to eggshell (Dacke 2000, Sugiyama and Kusuhara 2001). The hormones with greatest involvement in avian calcium regulation are parathyroid hormone (PTH), vitamin D_3, and especially estrogen in females (Dacke 2000, Johnstonand and Ivey 2006) with calcitonin playing a minor and uncertain role (De Matos 2008). Increased sexual activity of female birds accompanies increased circulating estrogen level (Whitehead and Fleming 2000). Estrogen treatment increases total plasma calcium in birds (Dhande et al. 1997, Bacon et al. 1980). Therefore, measurement of increased levels of calcium and phosphorus provides an indirect measure to study estrogenic activity (Hannon 1979) and thus of breeding season. The plasma inorganic phosphate is one of the most important element of body fluid and is precisely regulated with plasma calcium levels (Dacke 2000).

Calcium regulation in laying and non-laying birds differs considerably. Except few reports (Dhande et al. 2003, 2006), the variations in total serum calcium (Ca) and inorganic phosphate (Pi) levels of wild seasonal breeders of Indian sub-continent have been much neglected. Objective of the present study was to record the influence of varying natural photoperiod on total serum Ca, Pi levels and gonosomatic index (GSI) of Bank myna. It is the commonest and abundantly present wild *Passerine* seasonal breeder of Northern and Central Indian plains.

Material and Methods

The study was started in first week of March, before the onset of breeding season and continued for one year. Adult Bank myna, weighing 50-65 g were locally captured with the help of a bird catcher throughout the study period. Every month 12 birds were taken in account (6 males and 6 females). Blood samples from both sexes were collected from the heart in disposable syringes by making an incision in the thoracic region after ether anaesthesia. The syringes with blood samples were kept vertically up for 4 hrs that allowed the coagulated haematocritic part to settle down, while serum separated above it. Apical part of syringe was then cut with a sharp blade and serum sample was taken for estimation by a micropipette. Total serum calcium (Ca) level was estimated by the method described by Moorehead and Biggs (1974) and total serum inorganic phosphate (Pi) was estimated by the method of Daly and Ertingshausen (1972), on Erb Chem-5 plus V2 semi Automatic photometer using Erba Ca and Pi kits.

The body weight and gonadal weight of birds were recorded regularly for determining Gonosomatic index (GSI) by using the following formula-

$$\text{Gonosomatic Index} = \frac{\text{Total gonadal weight}}{\text{Total body weight}} \times 100$$

Photoperiod is calculated from calendar displaying local sunrise and sunset time.

Results

Gonosomatic Index and Natural Photoperiod: Curves drawn for photoperiod and GSI closely corresponds each other (Figs. 1 and 2). A gradual increase in GSI of female birds have been recorded from March to May. GSI of 3.89±0.270 was documented in May, the breeding peak (Bose and Das 2012). Decreasing natural photoperiod influenced regressive changes in female reproductive structure. High degree of regression in ovary has been observed among winter birds. Least GSI of 1.24±0.177 was recorded in November (Fig. 1).

Serum Calcium: Total serum Ca of non-breeding (winter) female Bank myna ranged between 7.75±0.235 mg/100 ml (in Nov.) to 8.96±0.280 mg/100 ml (in Feb.). Higher values were recorded during breeding season with a maximum of 14.85±0.369 mg/.100 ml in May (Fig. 3).

Total serum Ca level of non-breeding males ranged between 7.66+0.202 mg/100 ml (in Nov.) to 8.23+0.185 mg/100 ml (in Feb.). During the entire non-breeding season, Ca values of male closely followed females (in the same month). Male Ca values increased during breeding season yet were unable to keep pace with the rise in breeding females and reached a maximum of 11.26±0.348 mg/100 ml in May (Figure-3).

Serum inorganic phosphate: Serum Pi values of non-breeding male and female birds do not show any significant differences. However, in most months the Pi values of females remained higher than males. Marked increase in serum Pi value of females was recorded during the breeding season.

Serum Pi of non-breeding female birds ranged between 6.25±0.133 mg/100 ml to 6.71±0.187 mg/100 ml. A maximum of 7.65±0.263 mg/100 ml was recorded in May, the breeding peak. Males do not show any significant change in serum Pi values (6.20±0.125 mg/100 ml to 6.61±0.182 mg/100 ml; Figure-3).

The GSI of male birds recorded a gradual increase from March to May attaining a peak of 1.98±0.213 and then show a fall. Testes in breeding peak recorded increase in weight and appears as white coloured bean shaped prominent structure (Bose and Das 2012). Least GSI of 0.724±0.136 is observed in November during non-breeding period (Fig. 1).

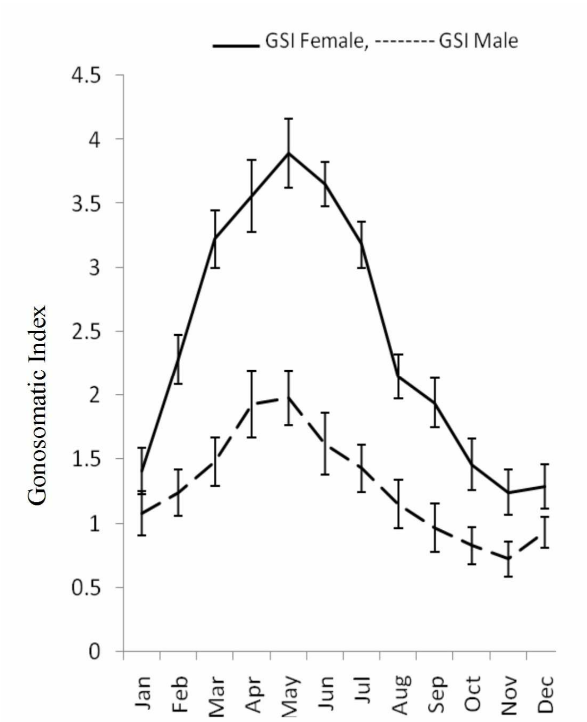

Figure 1: Gonosomatic index of female and male Bank Myna showing seasonal variation. Values are mean ± SD of six specimens.

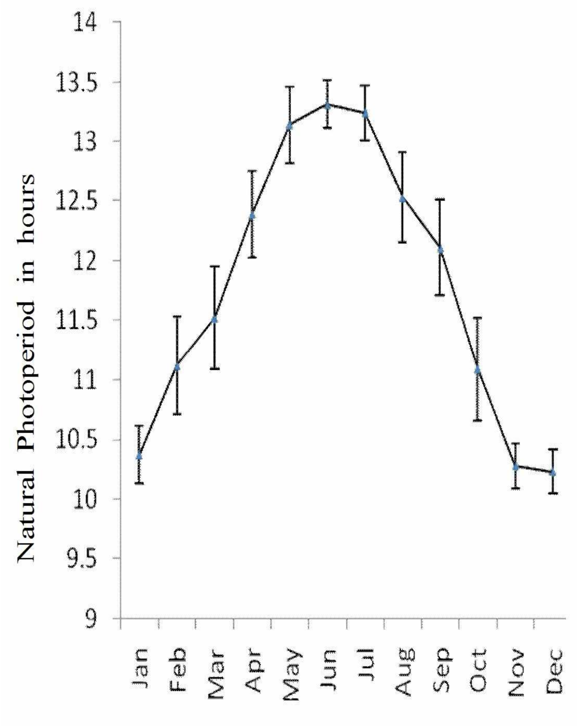

Figure 2: Natural photoperiod in hours. Values are mean ± SD of six specimens.

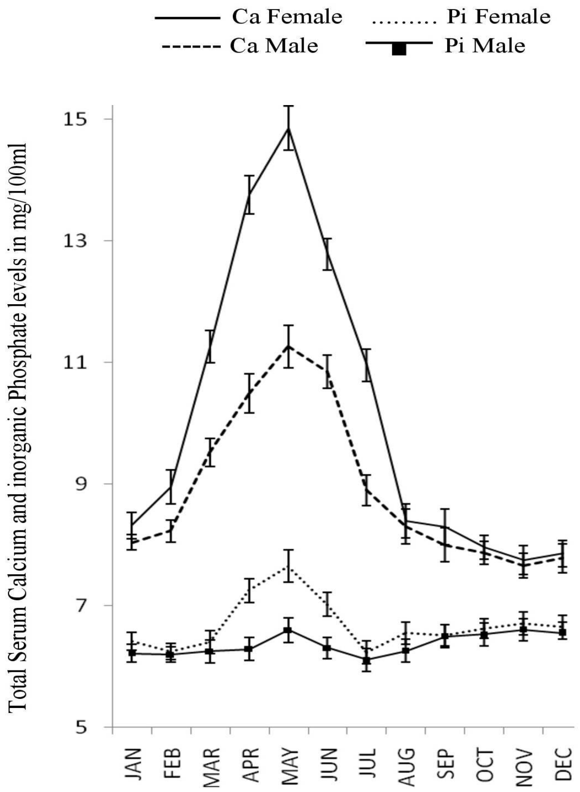

Figure 3: Curves showing seasonal variation in total serum calcium and inorganic phosphate levels of Bank Myna. Values are mean ± SD of six specimens.

Discussion

With the advent of summer (in March) and increasing natural photoperiod the female Bank myna showed a marked rise in serum Ca level and reached a peak level of 14.85 ±0.369 mg/100 ml in May, (the laying period). De Graw et al. (1979) observed a constant plasma calcium level in White crowned sparrow between July and following March, but during spring the level was elevated and was also more in egg laying females. The increased level of serum Ca in female Bank myna was also coupled with increase in GSI. Recrudescence of gonads indicates elevated estrogen level. Whitehead and Fleming (2000) reported gradual increase in plasma estrogen concentration with sexual maturity. Estrogen is also reported to increase Ca uptake in the gut by activating 25, dihydroxy-1-α-hydroxylase (Tanaka et al. 1978) and sitmulates the production of blood calcium binding proteins (Bacon et al. 1980). However maximum serum Ca level of female Bank myna recorded (14.85±0.369 mg/100 ml) was less as compared to breeding Canada Goose 22.57 ± 1.67 mg/100 ml (Mori and George 1978) and breeding Grey Quail 17.66 ± 0.38 mg/100 ml (Dhande et al. 2006).

During the entire non-breeding season and especially in winter the normal total serum Ca level of both the sexes of Bank myna recorded (a minimum of 7.75± 0.235 mg/100 ml in females and 7.66 ± 0.202 mg/100 ml in males) was low when compared to earlier reports. Non-breeding female Canada Goose reported to have 9.43±0.17 to 11.10±0.32 mg/100 ml and male have 9.22±0.27 to 10.57±0.69 mg/100 ml (Mori and George 1978), capative female thick-billed Parrots have 1.37 to 2.09 m mol/l (Lauren et al. 2004), non breeding female Grey Quail have 9.46±0.15 mg/100 ml to 11.78±0.13 mg/100 ml and male have 8.50±0.11 mg/100 ml to 11.22±0.08 mg/100 ml (Dhande et al. 2006) of total plasma Ca levels. The total plasma Ca of young Sudanese geese were recorded as 7.73±0.11 mg/100 ml and in adults as 8.16±0.12 mg/100 ml of plasma total calcium (Bakhiet et al. 2006), is in consonance with results obtained in non-breeding Bank myna.

Males also displayed rise in serum Ca level with the onset of breeding season (summer) and reached a peak level of 11.26 ± 0.348 mg/100 ml. Photoperiod influences spermatogenesis in males (Farner et al. 1977) and significantly increases the concentration of circulating gonadotropins (Follett et al. 1977). Besides testosterone, large quantities of progesterone and small quantities of estradiol-17β have also been measured in testicular homogenates of chicken (Tanabe et al. 1979). This probably influenced the rise of serum Ca in sexually active male Bank myna also. The males during breeding period have significantly higher GSI than non-breeding winter birds.

A gradual increase in GSI of female Bank myna was recorded with increasing photoperiod, during March to May. It derives support from the studies of Morris (1978) who observed that pullets raised under increasing photoperiod initiate laying earlier than birds raised under constant photoperiod. No further gonadal recrudescence is observed in Bank myna during June was probably because of constantly long photoperiod (Bose and Das, 2012). Williams et al. (1987) also reported that juvenile *Sturnus vulgaris* raised under constant long days showed no gonadal development. However, birds transferred from short to long day showed gonadal development, followed by gonadal regression.

Dawson et al. (2001) suggested that in most non-tropical avian species increasing photoperiod is the predominant factor that stimulates secretion of gonadotropin releasing hormone and consequent gonadal maturation. They also suggested that in tropical and opportunistic breeders, the endogenous circannual rhythmicity may be more important.

Mongin and Sauveur (1974) showed that laying hens prefer to consume calcium rich diet. Canada Goose also obtained dietary calcium from calciphilous plants growing in their breeding grounds (Mori and Gorge 1978). Caro et al. (2006) also noted the significance of diet in two populations of birds (Mediterranean blue tits), one starts laying earlier if able to get calcium rich diet. Dhodt and Hochachka (2001) documented that *Passerines* acquire calcium shortly before and during laying, thus need to eat extraneous calcium from the surrounding. Blue Jay and Steller's Jay were the most frequent extraneous calcium users they reported.

Rise in serum Pi level in breeding females can be attributed to the bone resorption activity influenced by PTH (Taylor 1970) and estrogen (Wilson and Thorp 1998). In the avian kidney, estrogen increases kidney responsiveness to PTH (Elaroussi et al. 1993). During non-breeding season the serum Pi recorded a gradual increase from August to December. It can be attributed to reduction in net tubular secretion of Pi due to reduced parathyroid activity. This is further supported by the results of PTX stimulated renal phosphate resorption (Renfro and Clark 1984, Clark and Mok 1986).

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