Unit V  Summary

Organismal evolution favors the selection of modifications that enhance individual survival of organisms by ensuring their temporal or spatial adaptation to environmental conditions in most suitable manner. The spatial adaptations are generally structural while temporal adaptations include repetitive changes caused by either earth's revolution around the sun or by earth's rotation on its own axis. This exposes organisms inhabiting the planet earth to daily and seasonal environmental cycles of light dark, high-low temperature etc. Most organisms have evolved a mechanism to cope with the temporal programs (daily and seasonal periodicities) so as to adjust their behavioral and physiological activities in anticipation of the daily/seasonal environmental changes, these adaptive strategies known as biological rhythms. Light affects various life history stages of most animals including seasonal breeders. The annual changes in environmental daylength are reasonably predicted, but availability of food and other environmental factors also modify their annual phenology. The daily (namely, sleep-wake cycles, locomotor activity etc.) and seasonal rhythms (reproductive cycle etc.) are synchronized by day length throughout in most long-lived organism.

Seasonal breeding is widely studied in birds inhabiting temperate and tropical environments. In short and long day species studied, an action will be
triggered when the photoperiod falls below the critical photoperiod (short day breeders), whilst in others an action will not occur until the photoperiod had passed the length of critical photoperiod (long day breeders).

Photoperiodic time measurement enables organisms to assess and use day length as an anticipatory cue to time seasonal events in their life histories. Endogenous physiological oscillations brings various seasonal activities associated with birds life in a way to cope optimally with the environmental demands imposed on the species such that there is close association between physiological and behavioural functions and the environmental light dark cycle.

While a proximate factor acts to increase fitness, the evolutionary cause is called the ultimate cause. Food is another ultimate factor that affect the anticipation and culmination of breeding events. Subtropical seasonal breeders also include post-monsoon breeders, in which breeding initiates under long days but occurs after the after monsoon. Earlier studies implicated an endogenous sensitivity in the photo-gonadal responses of a post-monsoon breeder, blackheaded munia (Lonchura malacca malacca) (Gupta, 2013). This thesis detailed studies undertaken to investigate the extent of involvement of the photoperiod with respect to seasonal reproduction and locomotor activity in this bird. The thesis comprised five units.

Unit I included General Introduction depicting the background around which the study was designed. It discussed the ubiquitous biological rhythms as adaptive strategies. It indicated how suitable it was, to conduct study on bird inhabiting the Indian subcontinent and the advantages of post-breeding blackheaded munia as an experimental model.

Unit II comprised a review of literature with a brief survey of different types of
present day information on biological clocks. There is an overview of biological clocks, their importance, types, their role as synchronizer, clock components and properties, two models of entrainment, circadian photoreception and seasonality: an Indian perspective depicting role of photoperiod in regulating seasonality in birds with mention of important studies on Indian birds and clarification of concept of photoperiodic time measurement. The circadian photoreception includes a brief mention of some important studies like loss of rods and cones could not abolish entrainment ability of mice, discovery of retinal ganglion cells (RGC6) as photosensitive and probably act as primary photoreceptors for the circadian system. An overview of Indian subcontinent stretching between tropical and subtropical belts is also mentioned.

Emphatically, the timing of the seasonal events in birds in India also depends on the geomorphic characters, climate and proximate factors like food availability etc. There is an explanation of control system of the internal oscillator, through a brief mention of different models of entrainment, which play an essential role in the proposed photoperiodism explanation. These explanations do not completely explain seasonal breeding in munia, it does not fit into classical long day or short day “designations” and is therefore different in its photoperiodic responses as compared to other classical long day species, it may be possible that it has or does not have a photoinducible phase for gonadal stimulation, which is explained in the few other birds.

Unit III deals with General Materials and Methods including information about bird. Methods of data collection including recording of locomotor activity rhythms from experiments conducted under natural illumination conditions and under artificial setting of light-dark conditions and observation of parameters
such as body weight, testis size, food intake are described followed by brief update on statistics used to test the reliability of experiments performed.

Unit IV comprises three chapters.

Chapter -1: Seasonality in Reproduction

The present study therefore had a straightforward protocol to describe the histological and anatomical description of the male gonads in blackheaded munia. The main objectives were to (1) describe the anatomical changes and correlate them to the annual changes in environmental daylength at 28° N, as this may add to our present understanding of the that regulate the seasonal programming in the black headed munia (2) collect data on biweekly changes in body weight and food intake (g bird⁻¹ day⁻¹), in relation to annual variations in day length at Ghaziabad (29° N) in group of birds held under natural illumination conditions. The testis exhibit a seasonal pattern of growth and involution corresponding to changes in annual changes in photoperiod and that food intake during a particular life history stage corresponded to nutritional requirements of a particular phenology.

Chapter- 2: The Response mechanism and photoperiodic time measurement.

The chapter II was intended to investigate the nature of photoperiodic clock in munia using conventional tools of photoperiodic time measurement. Two experiments were performed. In experiment 1, two groups of birds were exposed to 6L:18D and 6L:30D with food ad libitum for a period of 30 days, with TV measured on Day 0 and 30. There was significant increase in testis size under 36 hour cycle than in 24 hour cycle suggesting that there is photosensitive phase in circadian rhythm of photoperiodic photosensitivity of munia. In experiment 2, three groups of birds were exposed to 3L:18D, 3L:21D and 3L:27D with food ad libitum for a period of 48 days. Observations on testicular volume were made on day 0, 24 and 48. There was significant increase in testis size under non-24 than in 24 hour cycle also suggesting presence of photosensitive phase in circadian rhythm of photoperiodic photosensitivity of munia, which may not
have similar phase with classical long day seasonally breeding birds. The present experiments although add to the understanding of photoperiodic responses of munia but are not conclusive in determining the photoinducible phase in CRPP of blackheaded munia. The study suggests that daylength plays a role in initiation of gonadal growth in munia.

Chapter- 3: Locomotor activity rhythms as a marker.

Locomotor activity of caged animals is among the easiest assays of circadian rhythmicity (Daan and Aschoff, 1975). In many species the natural activity is more or less restricted to light phase of the day- day-active species or to the dark phase of the day-night-active species. In such species, activity rhythm is often marked by onset and end of active phase that is more or less well defined at a given point in the daily cycle. In the present study, locomotor activity behaviour (=perch hopping activity) of male blackheaded munia was recorded to test its daily rhythm patterns. Two experiments were performed. In experiment 1A, activity of munia was recorded under long days, (14L: 10D; 14 hours of light: 10 hours of darkness) and short days (10L: 14D). Through experiment 2, it was aimed to describe seasonal trend in daily pattern of activity/ rest cycle under natural illumination conditions (NDL). It was observed that light duration affects the daily activity of birds. Since it was not possible to tear apart the essential (feeding and drinking) and non-essential (flight) activity of individual birds, sum of total bouts of activity were taken as a parameter to compare activity in two light regimes. Hourly activity during daytime was more under 10L: 14D than under 14L: 10D. The activity was skewed towards the mornings than in the evenings. The daily pattern of activity under NDL corresponded to the seasonal daylength. Daylength regulates seasonal locomotor activity patterns in blackheaded munia.