How Finches Behave Differently in Dark-Light Condition?

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Received: September 16, 2022, Manuscript No. JBTW-22-74920; **Editor assigned:** September 19, 2022, PreQC No. JBTW-22-74920 (PQ); **Reviewed:** October 04, 2022, QC No. JBTW-22-74920; **Revised:** January 02, 2023, Manuscript No. JBTW-22-74920 (R); **Published:** January 10, 2023, DOI: 10.35248/2322-3308.12.1.009

Abstract

Circadian rhythms respond primarily to light and dark and affect most living things. These are more synchronized in birds than mammals. Circadian clock functions as a timing reference allow organisms fluctuations in their environments and are the basis for the transduction of seasonality from photoperiod. Organisms maximize their fitness by synchronizing their physiology and behavior with the abiotic and biotic features of their environments. This can be possible by endogenous circadian clocks, when they prevailing with light, food and socio environments, determine temporal patterns of events during the day in daily functions as activity rest, sleep wake and feeding patterns. At the regulatory level, circadian clocks govern changes in physiology and behavior within each day; hence, behavioral and physiological functions exhibit daily and circadian rhythms under periodic daily Light Dark (LD) cycles and constant dim light or darkness, respectively.

Keywords: Physiology • Darkness • Circadian rhythms • Light dark • Photoperiod

Introduction

Circadian rhythms are oscillations in the certain activities of organisms with a period close to 24 h. Circadian rhythms have some basic characteristics. First, the rhythm is an innate property of the organism and is maintained under constant natural and artificial conditions. Second, the period length is temperature compensated, so that it is maintained at a constant rate throughout the physiological range of external temperature [1]. Third, circadian rhythms are fully synchronized with the outside world by light. These rhythmic characteristics of the organisms to maintain own rhythm for these predictable environment changes. In the temperate latitudes, the photoperiodic cycle (LD) within a 24 hour period synchronizes diurnal rhythmicity in many species. Although the temperature and other environmental factors can synchronize the rhythm with the environment under certain conditions, light is the predominant and perhaps the only physiologically relevant environmental cue for synchronizing the circadian rhythm with the light dark cycle [2]. We aimed to find circadian activity of passerine finches in captivity in different photoperiod. For this study, we will take three model species which are "photosensitive" in nature.

We studied to determine the effect of constant dim and bright light illumination on circadian behavior of highly photosensitive baya weaver bird (*Ploceus philippinus*), black headed munia (*Lonchura malaca malaca) and red headed* bunting (*Emberiza bruniceps*). We analyzed the data of locomotors activity of these under the effect of different photoperiods (12 L:12 D and 8 L:16 D) for a period of 30 days [3]. Group I (n=4), black headed munia were kept in group II (n=4) and black headed munia were kept in Group III (n=4). These birds were acclimatized for 4 weeks and were subjected to artificial photoperiodic chambers (60 cm^3 × 45 cm^3 × 35 cm^3) at different photoperiod. In which two groups of them (blackheaded munia and Indian weaver bird) providing short day conditions (8 h light:16 h darkness; 8L: 16D) and (under 12 h L light:12 h darkness; 12 L:12 D). Food and water were provided ad libitum. Food mainly consisted of seeds of *Setaria italic* and *Oryza sativa*. Fluorescent tubes or CFL lamps (14 watt cool compact fluorescent lamp; model B22 BC from Philips India Ltd.) were used for providing during artificial lightening condition. The spectral range of light is between 400 nm and 700 nm and intensity is 250 lux. Temperature is about 30°C-35°C. The ON and OFF activity of light was regulated by automatic time switches (Müller clock, Germany). Light intensity was measured by the radiometer (model no. Q203 from Macam Photometrics Ltd., Scotland).

Case Presentation

The locomotors activity was considered as a reliable assay for study of circadian property and it was measured easily under captive condition. The chronobiology Kit software from Stanford Software Systems, Stanford, California, USA, was used to recording and analysis of the locomotors activity of bird [4]. The recording of locomotors activity (actogram) was double plotted. Circadian period and activity profile (daily and day/night profile) were observed for 30 days under 12 L:12 D and 8 L:16 D photoperiod. Activity count was analyzed by Kit analyze program. We measured the locomotors activity strength by The ACTCNT program of the chronobiology Kit. For this, the counts recorded at during the specified period of 24 h (daily profile), 12 h/12 h (day/night) and 8 h/16 h (day/night) (0–12 or hour 12–24; hour 0=time of the light on at the beginning) for 30 days for each bird, and then the mean (± SE) for the group was calculated. The statistical tools applied in this work included the mean, standard error and one way RM ANOVA with and without Newman–Keuls post hoc tests. Significance was taken at $p<0.05$. Statistical analysis was carried out using graph pad prism software (version 3.0 La Jolla, CA, USA).

Daily profile of Indian weaver bird under 12 L:12 D photoperiod significant response was observed in two of the four individuals; RKPNI 12 and 15 ($F_{3, 69}$=16.54, $p<0.0001$; one way RM ANOVA). In black headed munia under 12 L:12 D Photoperiod significant response was observed in two of the four individuals; RKPNI 14 and 16 ($F_{3, 69}$=17.98, $p<0.0001$; one way RM ANOVA). But the marginal significant response noticed in one of the four individuals under 8 L:16 D ($F_{3, 69}$=3.865, p=0.0130; one way RM ANOVA). The comparison of day and night total activity count in baya weaver and black headed munia showed the maximum activity in weaver bird under 12 L:12 D photoperiod. The minimum activity was noticed in red headed bunting under 8 L:16 D photoperiod during the daytime activity count. But, there is no significant difference in day and nighttime activity count between weaver bird, black headed munia and red headed bunting (p=0.1138; student unpaired t-test) (Figure 1).

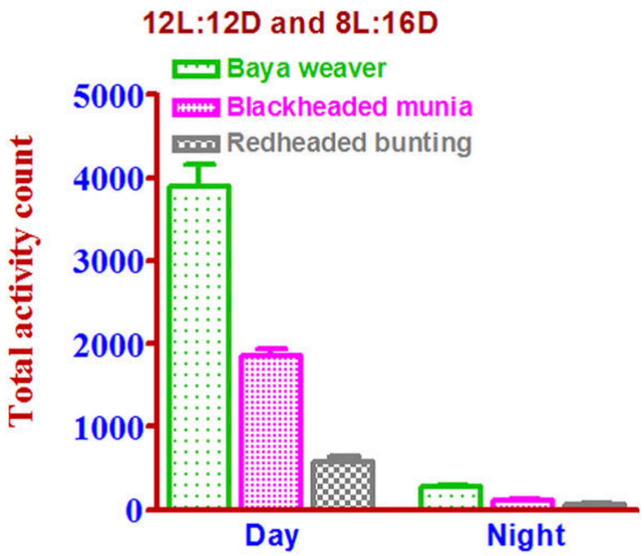

Figure 1. Day/night activity count (values are means ± SE) under 12 L: 12 D and 8 L:16 D in weaver bird, black headed munia and red headed bunting for a period of 30 days.

In this experiment, we analyzed the data of circadian rhythm of weaver bird, black headed munia and red headed bunting birds under different light regimes: 12 L:12 D and 8 L:16 D photoperiod. We found that birds were active during the daytime and locomotors activity was completely absent during the nighttime. The circadian periodicity was seen in all birds under 12 L:12 D and 8 L:16 D in all birds in all species. Similarly, modifications of the expression of the behavioral rhythm under different light were observed in some species of Japanese quail. In general, avian circadian and photoperiodic responses depend on the subjective interpretation of day and night illumination; hence, the photo phase contrast rather than on the day light intensity alone as has been studied in different birds such as Japanese quail, *Coturnix c. japonica*; black headed bunting, *Emberiza melanocephala*; and Indian weaver bird, *Ploceus philippinus*.

Results and Discussion

The effect of light wavelength on seasonal reproductive phenomenon has been well documented in migratory black headed buntings (*Emberiza melanocephala*). After analysis of data, we observed in that the daily and total activity count was high in Indian weaver bird and low in red headed night migratory bunting species. So, some physiological and behavioral character varies from bird species to species when bird housed individually in locomotor activity cages [5]. These data analyses are further required to be performed to validate this phenomenon. The present study was performed to determine the effect of constant dim and bright light illumination on circadian behavior of Indian weaver bird, *Ploceus philippinus*. The effects of constant dim and bright light on the expression of the circadian rhythm were investigated in these experiments. Few earliest finding suggest that the circadian behavior of Indian weaver bird is regulated by the light intensity and other environmental factors. All birds are diurnal species and its activity was restricted during the daytime. In general, the activity onsets and offset followed to the timing of light onset and offset. It also revealed by daily and day night profile graphs. All birds showed rhythmicity under LD phase. In LD condition, all birds of both the groups were active during the daytime period (L) under 12 L and 8 L photoperiod during experimental period. In 8 h light period, activity movement of red headed bunting was confined only during light period and birds were active only during the daytime. After analysis of data, we observed that the daily and total activity count was high in Indian weaver bird and low in red headed night migratory bunting species [6]. So, some physiological and behavioral character varies from bird species to species when bird housed individually in locomotor activity cages. These data analyses are further required to be performed to validate this phenomenon. Under 12 L:12 D photoperiod, significant response was observed in two of the four birds in daily profile of baya weaver bird and also in black headed munia but the marginal significant response noticed in one of the four birds under 8 L:16 D. The comparison of day and night total activity count in baya weaver bird and black headed munia showed the maximum activity in weaver bird under 12 L:12 D photoperiod [7].

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Conclusion

After analysis of data, we observed that the daily and total activity count was high in Indian weaver bird and low in red headed night migratory bunting species. So, some physiological and behavioral character varies from bird species to species when bird housed individually in locomotor activity cages. These data analyses are further required to be performed to validate this phenomenon.

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Cite this article: Singh G. "How Finches Behave Differently in Dark-Light Condition?". J Biol Todays World, 2023, 12(1), 1-2.