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A study on photoperiod- induced effects on seasonal responses of migratory redheaded bunting, *Emberiza bruniceps* (Brandt)

Abstract

In chapter 1, three studies were performed. In first study, seasonal changes in daily food consumption have a direct bearing with energy requirement of bird that is in turn associated with life history stage of birds. We compared seasonal changes in daily food intake in adult male migratory redheaded bunting (*Emberiza bruniceps*). The birds were held under short days (8L:16D; 8 h of light and 16 h of darkness) and two hourly food consumption was measured to profile their daily food intake. This study was carried out to establish how the circadian pattern of food consumption varied depending on birds' physiological state and effect of photoperiod in adult male redheaded buntings. Redheaded buntings DFEP and locomotor activity were compared in pre-migratory months of February (spring) and September (autumn). The results suggest that September (photorefractory) birds exhibit clear bimodality in their feeding behavior as compared to (photosensitive) birds in February. Another experiment compared bird's DFEP held under short (8L:16D) and long (16L:8D) days for 5 weeks and suggested that under long days, prolonged hours of photo phase render adaptive advantage to birds for positive energy budgeting. The present study clearly establishes the circadian nature of feeding behavior and that it modulates over seasons. The bimodal (i.e. morning and evening peaks of food consumption suggest morning–evening food entrainable oscillators, however this needs to be investigated with mechanistic approach in future studies. in second study a satiety hormone leptin was used to tweak bird's response system simulate effect of annual changes of photoperiod. For this bunting were held under 14L: 10D (long day) to photo-induce the state of migration. Murine leptin (in PBS) or PBS were injected in long day birds twice daily for fife days during migratory state. Although, a physiological response to injection of a chemical resulted in overall decline in flight activity, the intensity of response was higher in PBS injected birds than the leptin injected birds. During migration, leptin may appear to be related with maintenance of body weight and better flight. In third study tested response of circadian system in photorefractory buntings to the level of entrainment of circadian photoperiodic oscillator through a complete and its skeleton photoperiods by measurement of activity behavior and diurnal change in melatonin secretion was observed.

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In chapter 2, Daily behavioral and physiological changes in bird may reflect in biofluid metabolite composition. Locomotor activity, food intake and body temperature of group (n=7) of male migratory redheaded buntings held under short days (8L:16D, SD) were monitored besides blood sampling at midday (ZT 4: 4 hours zeitgeber time starting ZT-0 as lights 'on') and midnight (ZT16). The birds exhibited higher activity and increased feeding during daytime with negligible activity and feeding at night. Gas chromatography mass spectrometry and chemo-metric analyses of bird serum revealed higher levels of lipid (palmitic, oleic and linoleic acids) and protein (uric acid and proline) catabolites in daytime serum samples as compared to night samples. Higher night-time levels of short chain fatty acids indicated utilization of glucose and lipolysis in night fasted birds. High night-time levels of taurine, a sulphur amino acid has adaptive advantage to night migratory song birds. The diurnal differences in metabolite patterns suggests differential energy expenditure during day and renders survival benefit to buntings as night migrants. We propose a GCMS method that could be useful to unravel different annual life-history stages including migration.

In chapter 3, two studies were performed. First study investigated whether a climatic change in temperature, affected daily food intake in migrating male redheaded buntings. Groups of adult male birds (n=18) were photoinduced into migratory phenotype under increasing spring day lengths (NDL);as the birds began to exhibit night restlessness, Zugunruhe, these were allocated into groups, either with ambient (NDL, variable daily temperature: maximum- 29-44 °C and minimum- 16-33 °C; for food intake(6 birds) and activity recording, 6 birds) until two weeks after they concluded migration or with constant temperature (NDT, 22±1°C; for food intake (6 birds)) conditions. As daylength increased March onwards, daily food intake increased (hyperphagia) in NDL and NDT groups. Study suggested that constantly suboptimal temperature despite increasing Daylength, NDT appeared to affect feeding and body weight of migratory bunting. birds as compared to NDL birds, suggesting that altered ambient temperature affects daily food intake in migrating buntings. It appears that birds continued hyperphagia to meet adversaries of low temperature, to meet energy demands these gained body weight, this contined even after migration activity competed. In the second study, the histological differences of fat tissue in male redheaded buntings between spring and autumn migration were observed. Two groups of buntings (n= 7) were held under natural (Spring group Sm)/artificial (12L:12D; Autumn group Am) photoperiodic conditions for52 weeks. Birds of group Sm were transferred NDL --- 10L:14D, SD) for 3 weeks, --- 13L:11D, LD to photo-induce spring migratory behavior (*Zugunruhe*). Birds of group Am were

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transferred from 12 L: 12 D, ED --- 14L:10D, LD 3 weeks --- 11L:13D, SD to photo-induce autumn migratory behavior (*Zugunruhe*). Cells of visceral and subcutaneous adipose tissue of spring migrants had a significantly larger area and diameter than that of autumn migrant. High food intake during spring migration enable birds to store enough fat to support longer flight bouts, were as during autumn migration low food intake lead to less fat storage and shorter flight bouts. Which results in longer migration duration during autumn compare to short migration duration during spring.