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Males Inhabiting in Dark are More Preferred by Females for Sexual Pairing in Japanese Quail: Evidence from Ptilochronology

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Abstract: ***Sexual pairing decisions in Japanese Quail (Coturnix coturnix japonica) were assumed to be dependent on the overall nutritional condition of a bird. This could be evaluated by a tool called ptilochronology. Males were reared in different photoperiod regimes, other parameters such as ambient temperature, quality and quantity of food remained constant. Sexual selection experiments were conducted and rectrices were plucked for ptilochronology study. Results revealed that females preferred to pair with the males reared in longer dark duration.***

Keywords: Ptilochronology, sexual selection, photoperiod, Japanese Quail, growth bar.

1. Introduction

Multiple signals or cues are used by females for mate choice (Candolin 2003). Males display individual quality through their ornamentation depending on their body condition, which facilitates the females to make mate choice (Zahavi 1975). Bird plumage is useful to study the correlation between the body condition and behavioral process like mate selection. Brighter feathers demonstrate better nutritional condition in male House Finches, Carpodacus mexicanus (Hill et al. 1994). Mate choice is influenced by the interaction of plumage coloration with the signaling environment along with the inherent properties of the sender (Heindl et al. 2003).

The trait demonstrating male quality during sexual selection must be its honest signal to be an useful indicator (Grafen 1990). Structural plumage coloration is proved to be an honest indicator of male quality in Blue-black Grassquit, Volatinia jacarina (Doucet 2002). Siefferman et al. (2007) provided empirical evidence that environmental quality can influence the development of the structural coloration of feathers in Eastern bluebirds (Sialia sialis) and that males may be more sensitive to environmental fluctuations than females.

Ptilochronology (Grubb 1987) has been proved to be an effective tool to know the overall nutritional condition of the birds. A fundamental assumption behind the logic of ptilochronology is that there is a positive relation between the nutritional condition of a bird, as indexed by the growth rate of its feathers, and its biological fitness (Grubb 1989). The method is a non-invasive technique wherein by plucking the central rectrix the birds are allowed to grow a replacement feather, also known as the 'induced feather'. The induced feather is also plucked for evaluating data (i.e. average daily growth bar width, number of fault bars, total length). The feather comprises alternate light and dark bands. A pair of consecutive dark and light bands represents 24 hours of growth, termed as a 'growth bar' (Michener and Michener 1938); which represents the nutritional condition of the bird during those 24hrs. of feather growth (Wood 1950). Sometimes there appear translucent bands produced by stressful events during feather formation called 'fault bars'. They weaken feathers and increase their probability of breakage, and thus could compromise bird fitness by lowering flight performance (Serrano et al. 2005).

Male characteristics are considered to be an honest signal of male quality, that (signals) can be used by the females for mate selection. Ptilochronology (growth bar width) has proved to be a potentially honest signal of bird quality (here 'quality' refers to ability to confer genes to the next generation by attracting one or more mates per breeding season, by surviving for many breeding seasons, or both; Grubb 2006). Growth bar width in males is positively correlated with individual quality and hence total reproductive success in a season (Takaki et al. 2001).

We implemented ptilochronology (Grubb 1987) to study sexual selection in Japanese Quail. Exogenous parameter such as photoperiod was evaluated in order to elucidate their influence on the nutritional condition of the quail. This nutritional condition data was then correlated with the sexual selection trials in captive Japanese Quail. In paired trials, females showed their preference between a control and a treated/manipulated male.

2. Literature Survey

Michener and Michener (1938) provided evidence that each pair of bands, that is each growth bar constitutes a 24-hour period of feather growth. Wood (1950) suggested that in each growth bar darker bands are derived from material laid down in the follicle during the day hours and lighter bands consist of material laid down during the night hours. Grubb (1988) provided evidence for the first time in Downy woodpeckers (Picoides pubescens), that feather growth bars indicate nutritional condition of free ranging birds concluding that males normally have a better nutritional condition as compared to females during winter. Grubb et al. (1991) studied the effect of seasonality, temperature, photoperiod, and bird's age and sex on daily growth of induced feather in Northern Cardinals (Cardinalis

cardinalis). It was found that feather growth, length and mass were significantly varied with age, sex and season. Also ambient temperature influenced feather growth more than photoperiod.

3. Material and Methods

Forty-five female and 40 male Japanese Quail (Coturnix coturnix japonica) approaching maturity (3-4 weeks) were obtained from local quaillary. The males and females were housed separately in groups of 10-12 for acclimatization in a well ventilated room (20ft. x 20ft), at Sevadal Research Centre, Nagpur (21.070 N, 79.270E), located centrally in India. During the acclimatization process, the birds had access to ad libitum feed with balanced composition and water, light: dark (L: D) 15: 9 and temperature approximately 300 C (±5°C); for 8 days (Recommended by Central Avian Research Institute (CARI), Izatnagar, India).

For experimentation, the males were caged individually in specially designed cages (1 x 1.5 x 2 ft), arranged in two rows, such that control (C) and experimental (E) birds faced each other; where controls were the males reared in controlled food, temperature and light conditions and experimentals were the males with manipulated food, temperature and light conditions according to the experiments designed. The central passage (7.5 x 1.5 x 2 ft), created by placing the cages in two rows, was used only by females during the selection experiments.

After acclimatization, their control rectrices were plucked. Birds were then held under different photoperiod regimes. According to duration of photoperiod, experiment was held in two parts-

PART-I (Expt 2aP): With a photoperiod of L: D=17:7, and
PART-II (Expt 2bP): With photoperiod L: D=13:11.
After that selection experiments were conducted. Finally, induced feathers were plucked for ptilochronology evaluation.

During experimentation, other parameters such as quality and quantity of food, ambient temperature were kept constant. The balanced diet was given to the birds during this experiment in a fixed quantity of 30 gm per quail per day. The temperature was maintained at 30°C (±3°C).

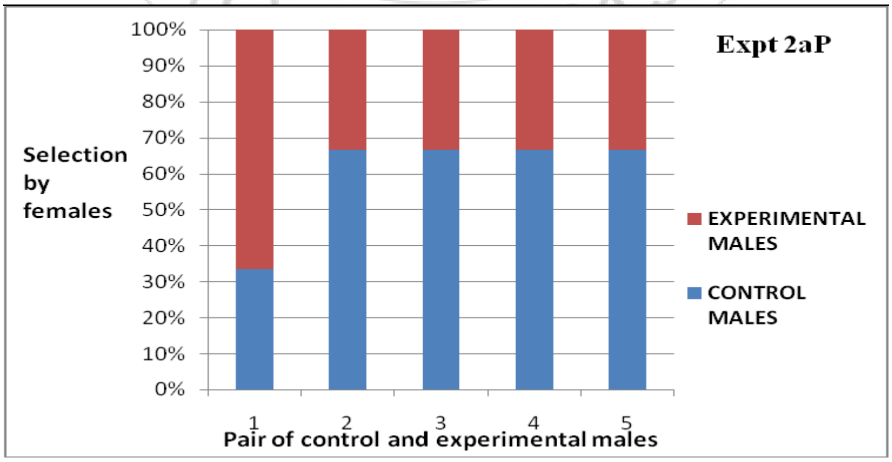
Results

Females when released for sexual selection trials were allowed to spend ca. 15 min (±5 min) in the central passage. During the first two minutes they walked the length of the passage looked at both males and then displayed their choice by either crouching near the chosen male or, if excited, hit the glass in order to try and reach the selected male.

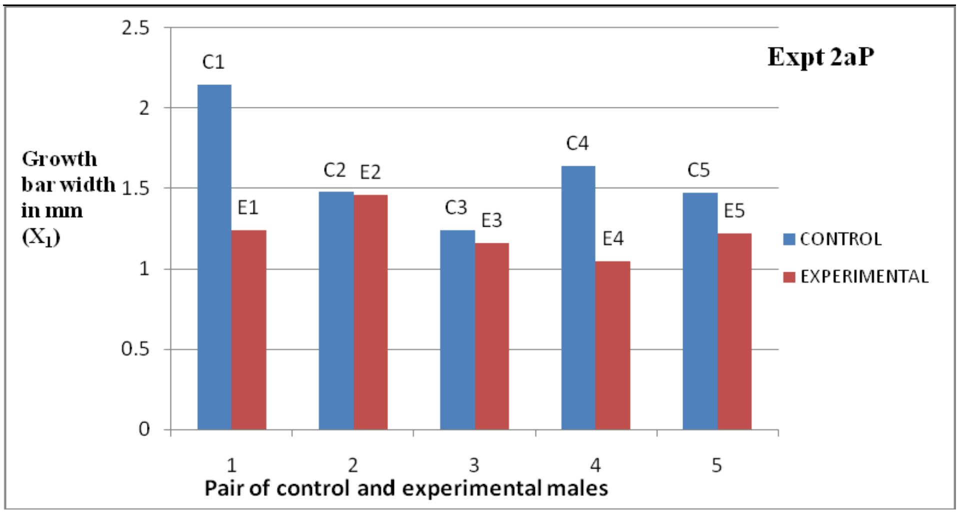
Sexual selection decisions of females were not significantly affected by the extended light period of 17 hrs ($t = 1.499$, $P = 0.104$, $n = 5$). But photoperiod of nearly equal light and dark duration (L: D=13:11) significantly affected the selection decisions in females ($t = 2.447$, $P = 0.035$, $n = 5$).

Photoperiod significantly affected the growth bar width, both when L: D=17:7 (control, 1.596±0.261 and experimental males, 1.226±0.261), $t = 2.256$, $P = 0.270$, $n = 5$ and when L: D=13:11 (control, 1.346±0.1208 and manipulated males 1.198±0.1208), $t = 1.937$, $P = 0.044$, $n = 5$.

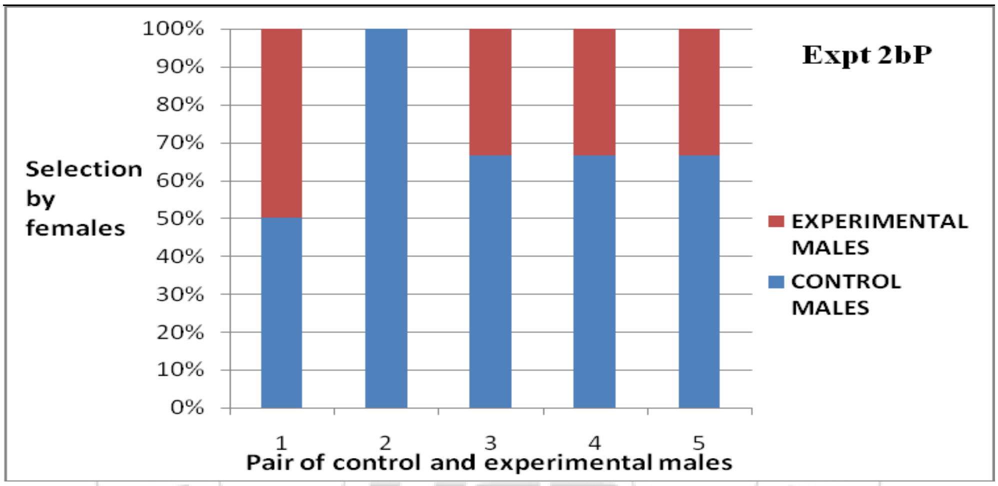
In part I of experiment, in which birds were exposed to longer light period, 67% selection of control males were done by females in 4 pairs, and 34% in 1 pair out of total five pairs. In part II of experiment, where males were provided with shorter light duration, 100% selection of control males were done in 1 pair, 67% selection in 3 pairs and 50 % in 1 pair. The resuls indicate that females prefered control males over the experimental males in both shorter and longer light periods. Ptilochronology of this experiment revealed that control males grew wider growth bars as compared to the experimental males in both the cases of shorter and longer light period.



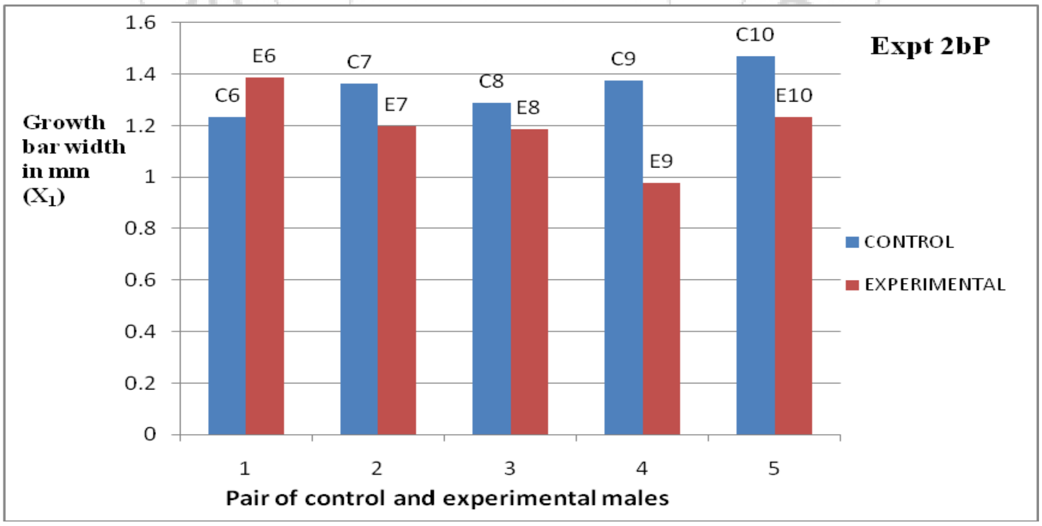
Graph 1: Selection of control (C) or experimental (E) males by females in Expt-2aP.



Graph 2: Comparative growth bar width of control (C) and experimental (E) males in Expt-2aP.



Graph 3: Selection of control (C) or experimental (E) males by females in Expt-2bP.



Graph 4: Comparative growth bar width of control (C) and experimental (E) males in Expt-2bP.

4. Discussion

Ball et al. (2008) discussed the twofold effects of the lengthening periods of daylight in temperate zone birds in spring on the reproductive physiology of birds (reference in Dawson et al. 2001). Some are 'photo stimulated' birds which are reproductively active due to the stimulating effects of lengthening days whereas some are 'photo refractory', in which reproductive systems are regressed due to long days. Based on Dawson (2001), my results prove that Japanese Quail are photo refractory birds, in which they develop an inhibitory effect under extended light periods. This supports our results that sexual selection is the independent function of extended photoperiods.

White et al. (1992) found in American Tree Sparrows that the period of growth, but not the rate of growth, of induced feathers was greater under exposure to short periods of photoperiod. Also regrowth of contour feathers in Japanese Quail, was studied by Honda et al. (1982) who suggested that shortened daily photoperiods may have stimulated hormonal conditions characteristic of the period of fall molt. Grubb et al. (1991) considered day length to be one of the factors influencing feather growth in Northern Cardinals. Feather growth of Japanese Quails in our experiment too was dependent on photoperiod. Growth bar comprises of a pair of consecutive light and dark band, representing 24 hours of feather growth (Michener and Michener 1938). Out of which darker bands are derived from the material laid down in the follicle during the day and lighter bands consist of material laid down during the night (Wood 1950). Thus width of feather growth bars is dependent on the duration of light to which the birds were exposed during feather growth.

5. Conclusion

In this photoperiod experiment of photoperiod, females preferred to mate with the males with wider growth bars independent of the light and dark duration of 17:7 and 13:11 (Graph 1, Graph 2, Graph 3, Graph 4). In both sets of experiments, in shorter as well as longer light duration, males selected by the females had wide growth bars as compared to the experimental males. And in both parts of experiments, control males were inhabited in longer dark duration. Thus it is proved that females preferred males reared in longer dark duration.

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