Luteinizing Hormone is Regulated by Supplementary Information, Not Photoperiod, in Male Rufous-winged Sparrows, *Aimophila carpalis*

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Timing of Reproduction in Birds

- Changes in day length control seasonal reproductive development and regression in most birds studied
- Exposure to long days (LD; >12 h of light per day) stimulates gonadotropin-releasing hormone I (GnRH) release from the hypothalamus, resulting in FSH and LH release from the anterior pituitary gland
- Less is known on the role of non-photoperiodic information on the timing of reproduction
- Gonadotropin-inhibiting hormone (GnIH) is a recently identified hypothalamic peptide that can inhibit LH release
- It is presently unknown if and when GnIH influences the reproductive system

The Rufous-winged Sparrow

- Resident of the Sonoran desert (Fig 1)
- Timing of breeding varies annually and nesting is closely associated with irregular monsoon precipitation

Figure 1: A) Adult male Rufous-winged Sparrow. B) Geographical distribution

Question 1: What physiological and environmental stimuli control reproduction in the flexibly breeding Rufous-winged Sparrow?

Field Study

- Gonad diameter and plasma LH were measured in free-living male Rufous-winged Sparrows between February and October 2003 (Fig 2)
- Testis width is correlated with day length
- Plasma LH is correlated with precipitation, not photoperiod

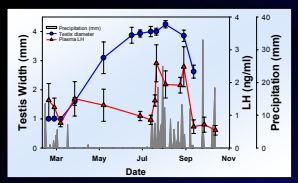

Figure 2: Testis width and plasma LH of free-living male Rufous-winged Sparrows. Points are mean +/- SE.

Captive Photostimulation

- Twenty-eight male sparrows were kept on eight hours of light per day (8L) for eleven weeks
- Sparrows (n=7/group) were transferred to 16L, 14L, 13L or 8L for eight weeks (Fig 3)
- 13L, 14L, and 16L exposure caused gonadal development
- 16L exposure significantly increased LH
- Photoperiod is the primary stimulus for testicular development
- Photoperiod is not the primary stimulus for increased plasma LH

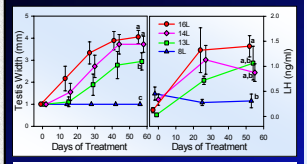

Figure 3: Testis width and plasma LH (mean +/- SE) of captive sparrows exposed to different photoperiods. Points not sharing the same letter on the last day of sampling are significantly different ($p<0.05$)

Question 2: What is the primary physiological stimulus for increased plasma LH in Rufous-winged Sparrows during the monsoon breeding period?

Hypothesis 1: Increased GnRH secretion increases plasma LH

Hypothesis 2: Decreased GnIH secretion increases plasma LH

Test of Question 2

- Adult male Rufous-winged Sparrows were field-sacrificed before (July 2; n=6) and during (July 29; n=6) the 2002 monsoon
- Testes were weighed, plasma was assayed for LH, and brains were removed and sectioned

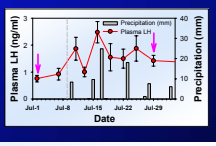

Figure 4: LH (mean +/- SE) of free-living sparrows from 2002. Arrows indicate sacrifice days.

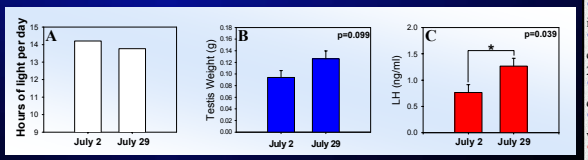

Figure 5: A) Photoperiod on July 2 and July 29, 2002. B) Testis weight and C) plasma LH in birds sacrificed on July 2 and July 29, 2002. Bars are mean +/- SE.

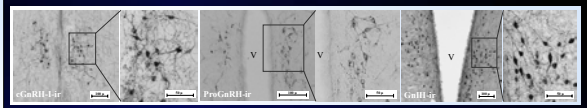

Figure 6: Hypothalamic staining for GnRH like immunoreactive (GnRH-li ir), ProGnRH-li ir and GnIH-li ir cells.

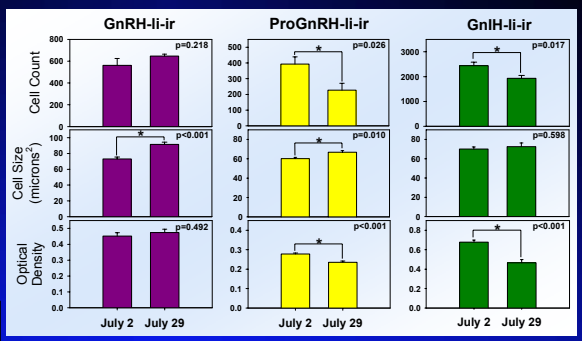

Figure 7: Cell count, cell size and optical density of GnRH-like immunoreactive (GnRH-li ir), ProGnRH-li ir and GnIH-li ir cells. Bars are mean +/- SE.

Results

- Day length declined between July 2 and 29 (Fig 5A)
- Testicular weight did not differ but plasma LH increased between July 2 and 29 (Fig 5B and 5C)
- Hypothalamic content of GnRH, ProGnRH, and GnIH were determined using immunocytochemistry (Fig 6)
- Cell numbers, cell sizes, and optical density of immunostained material were measured (Fig 7)
- GnRH cell count and optical density did not change, but cell size increased between July 2 and 29
- ProGnRH cell count and optical density decreased while cell size increased
- GnIH cell count and optical density decreased while cell size remained unchanged
- GnRH and ProGnRH data indicate a decrease in GnRH cell activity which is inconsistent with hypothesis 1
- GnIH data indicate a change in GnIH cell activity which is consistent with hypothesis 2

Conclusion

- Increased photoperiod is the primary stimulus for testicular development
- Plasma LH is primarily under the control of non-photoperiodic information
- There is presently no evidence that increased GnRH release stimulates LH secretion after the onset of monsoon rain
- Decreased GnIH release after the onset of monsoon rain may be responsible for increased LH

Proposed Model

- GnIH may play an important role in mediating the influence of non-photoperiodic information on the timing of reproduction (Fig 8)

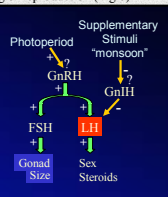

Figure 8: Model of how different types of information may influence the regulation of reproduction in male Rufous-winged Sparrows.