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Glucocorticoids and parental effort in tree swallows

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Glucocorticoids and parental effort in tree swallows (Tachycineta bicolor)

Mackenzie Prichard
Advised by: Dr. Creagh Breuner
Corticosterone (CORT)

- Function: stress response and metabolism
- CORT acts on tissues to help with coping with the stressful situation
  - mobilize glucose to cells
- Daily rhythms (the sleep/wake cycle)

**HPA Axis**

- Hypothalamus: In the brain
- Pituitary Gland: Next to brain
- Adrenal Gland: Above the kidney

Graph showing CORT levels:
- Baseline
- Normal Daily Spike
- Spike due to Stressor

Image credit: Reuters/John Javellana
HPA Axis

Hypothalamus
In the brain

Pituitary Gland
Next to brain

Adrenal Gland
Above the kidney

CORT
CORT and parental effort

Generally…
- CORT-Trade Off Hypothesis: increased CORT favors individual survival over reproduction thus decreasing parental effort

However…
- CORT-Adaptation Hypothesis: increased CORT associated with increased parental effort
CORT Trade-Off CORT-Adaptation

Ouyang et al. 2012
CORT Trade-Off  CORT-Adaptation

Ouyang et al. 2012

Crino et al. 2011
CORT Trade-Off

Ouyang et al. 2012

CORT-Adaptation

Crino et al. 2011
CORT Trade-Off  CORT-Adaptation

Ouyang et al. 2012

Bonier et al. 2009
CORT Trade-Off

CORT-Adaptation

Ouyang et al. 2012

Bonier et al. 2009

Crino et al. 2011

Ouyang et al. 2013
CORT Trade-Off

- Ouyang et al. 2012
- Crino et al. 2011

CORT-Adaptation

- Bonier et al. 2009
- Ouyang et al. 2013
My hypothesis

Moderate increases in CORT associated with increased metabolic demands of parenthood.

Extreme increases in CORT lead to trade-offs of reproductive effort for individual survival.

- Low CORT (Baseline)
- High CORT (Stressed Induced)

CORT Threshold
Methods and Field Site

• MPG North near Condon, MT in the Seeley-Swan valley
Methods and Field Site

• MPG North near Condon, MT in the Seeley-Swan valley
• Tree swallows
• Box nesting, easy to catch, well researched
• Measured in females
• Parental Effort: nest observations, nest videos, nestling growth, defense trials
• CORT (no data yet)

https://www.lib.utexas.edu/maps/montana.html
Methods and Field Site

• MPG North near Condon, MT in the Seeley-Swan valley

• Tree swallows
  • Box nesting, easy to catch, well researched

• Measured in females
  • Parental Effort
    • nest observations, nest videos, nestling growth
  • CORT
    • blood samples

https://www.lib.utexas.edu/maps/montana.html
Measuring Parental Effort

• **Nest Attendance: time on nest**
  • Visual observation

• **Feeding rates**
  • Videos

• **Nestling growth (K):**
  • Nestling measurements
Measuring CORT

In the field:

• 3 Blood samples taken from the alar vein
  • under three minutes
  • 10 minutes
  • 30 minutes

In the lab:

• Measure CORT concentration from blood samples with enzyme-immunoassay
Expectations

- moderate CORT levels there will be increased prevalence of these behaviors
- high CORT levels there will be a decrease in each of these behaviors
Expectations

Parental Effort

Graphs showing the relationship between Parental Effort and CORT levels:
- Left graph: Baseline CORT (ng/ml) vs. Parental Effort.
- Right graph: Maximum CORT (ng/ml) vs. Parental Effort.
Results

CORT vs Time Incubating

CORT vs Time Incubating
Results

CORT vs Time Incubating

- % Time in Nest Incubation vs Baseline CORT (ng/ml)
- % Time in Nest Incubation vs Maximum CORT (ng/ml)

Graph showing the relationship between CORT levels and time spent in nest incubation.
Results

CORT vs Time Incubating

% Time in Nest Incubation

Baseline CORT (ng/ml)

CORT vs Time Incubating

% Time in Nest Incubation

Maximum CORT (ng/ml)
Results

CORT vs Feed Rate

Nestling Feeding Rate per Hour

Baseline CORT (ng/ml)

CORT vs Feed Rate

Nestling Feeding Rate per Hour

Maximum CORT (ng/ml)
Results

CORT vs Feed Rate

Nestling Feeding Rate per Hour

Baseline CORT (ng/ml)

CORT vs Feed Rate

Nestling Feeding Rate per Hour

Maximum CORT (ng/ml)
Results

\[ P\text{-value} = 0.06 \]

\[ R^2 = 0.40 \]

\[ F = 4.74 \]
Results

CORT vs Growth Rate

- Mass Growth Rate (K)
  - Baseline CORT (ng/ml)

CORT vs Growth Rate

- Mass Growth Rate (K)
  - Maximum CORT (ng/ml)
Results

CORT vs Growth Rate

CORT vs Growth Rate

Baseline CORT (ng/ml)

Maximum CORT (ng/ml)
Results

CORT vs Growth Rate

\[ \text{P-value} = 0.19 \]
\[ R^2 = 0.20 \]
\[ F = 2.01 \]
Conclusions

• Moderate to weak support for the CORT-Trade-off hypothesis

• Relationships matched some predictions of CORT dose hypothesis

• Biggest probable source of error: small sample size, n=9
Why should we care?

• Organisms may experience elevated CORT for lots of reasons
  • Weather, food availability, exams…

• Understanding CORT helps us understand fitness

• Humans are influencing the environment more and more
  • Conservation
Thank you!!

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