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Avian Migratory Flight & Oxidative Stress: The Impact of Exercise on Erythrocytic Antioxidant Defense Systems

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Bohannon: Avian Migratory Flight & Oxidative Stress: The Impact of Exercise

Migratory Flight & Oxidative Stress

The Impact of Exercise on Erythrocytic Antioxidant Defense Systems



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Overview

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- Oxidative Damage
- Dietary Impact
- Migratory Flight
- Antioxidant Defense Systems
- Experimental Design
- Results

Oxidative Damage

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- ❧ Antioxidants critical
 - ❧ Neutralize oxidants

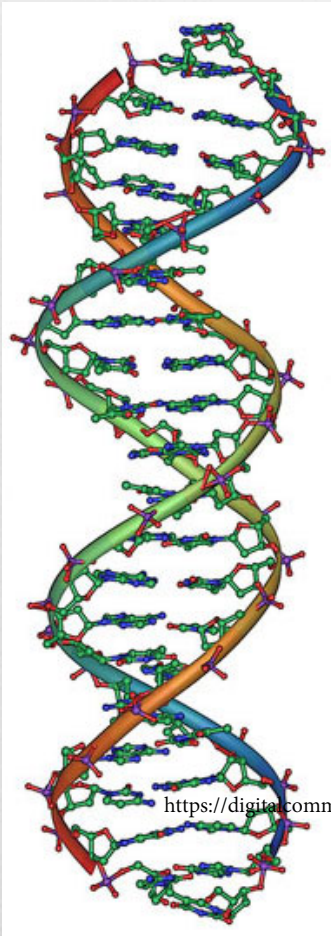
- ❧ Aerobic respiration
 - ❧ Efficient energy production mechanism
 - ❧ Creation of ROS (Hulbert et al. 2007)

- ❧ Reactive Oxygen Species (ROS)
 - ❧ Lead to damaged proteins, lipids & DNA in high amounts (Hulbert et al. 2007)



Oxidative Damage In

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- ∞ Linked to age-related disease
 - ∞ Alzheimer's, Parkinson's & Huntington's (Cui et al. 2011)
- ∞ Research supports development of preventative medicine and treatment options



Migratory Birds

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- ❧ Model organisms
 - ❧ Lifestyle promotes oxidative stress
- ❧ Endurance athletes
 - ❧ Migration not comparable to human physiological challenge (Guglielmo 2010)
- ❧ Increased physical demand requires increased metabolic activity



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Avian Nutrition

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- ❧ Primarily fatty acid oxidizers (Pierce et al., 2005)
 - ❧ 90% energy from fat (Guglielmo 2010)
- ❧ Birds alter diet to alter fatty acid composition
 - ❧ Prefer unsaturated fatty acids to saturated (Price 2010)
 - ❧ n-6 PUFA diets → enhanced exercise performance (Pierce et al. 2005)

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- ❧ PUFAs increase oxidative damage (Jenkinson et al. 1999)



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Endogenous Antioxidants

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- ❧ Erythrocytes regularly exposed and highly susceptible to oxidative damage (Pandey & Rizvi 2011)
- ❧ Equipped with cytoplasmic defense systems
 - ❧ Endogenous antioxidants
- ❧ Focus on GPx



Basic Experimental Design

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- ❧ Western Ontario University
- ❧ Divide subjects into 4 distinct dietary groups
 - ❧ Vary in antioxidant content and in PUFA content
- ❧ Simulate migration through flight training in wind tunnel
- ❧ Collect blood samples
- ❧ Assay samples to determine antioxidant concentration



Predictions

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- ❧ Exposure & reaction to oxidative stress
 - ❧ Vary based on dietary group & exercise
- ❧ GPx concentrations
 - ❧ Higher in increased PUFA diet
 - ❧ Lower in high antioxidant diet
 - ❧ Higher following physiological challenge

Study Species

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❧ European Starling (*Sturnus vulgaris*)

❧ Can travel 1,000-1,500km

❧ 60-80km/h (Linz et al. 2007)

❧ 100 birds total, 25 in each dietary group



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Diet Conditions

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- ❧ Imitates natural diet
 - ❧ 41% carb:13% protein:30% fat
 - ❧ 16:0, 18:1, 18:2
 - ❧ Anthocyanins
- ❧ 4 diet groups
 - ❧ 13% PUFA Low Antioxidant
 - ❧ 13% PUFA High Antioxidant
 - ❧ 32% PUFA Low Antioxidant
 - ❧ 32% PUFA High Antioxidant
- ❧ Allowed 1 month to acclimate

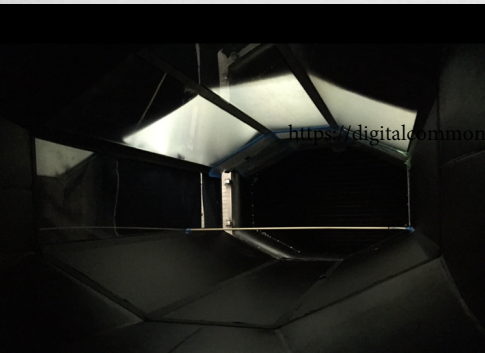
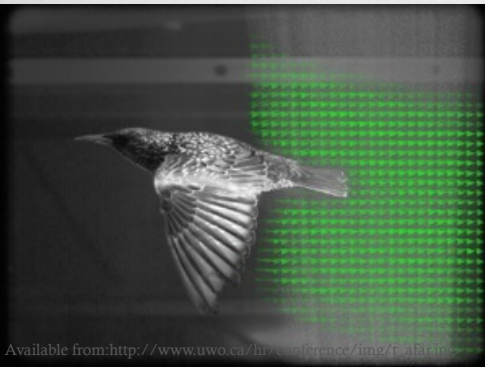


Flight Training

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- ∞ 15 birds from each diet trained
 - ∞ 10 serving as controls
- ∞ 5 flight cohorts in each diet → 20 total
 - ∞ 3 birds flown together
- ∞ Pre-training period
- ∞ 15-day flight period
 - ∞ Gradual increase of flight time
 - ∞ Leads into “long flight”
- ∞ EchoMRI
 - ∞ Before & after long flight



Physiological Challenge

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❧ The EchoMRI showed that the flight was a clear, physiological challenge

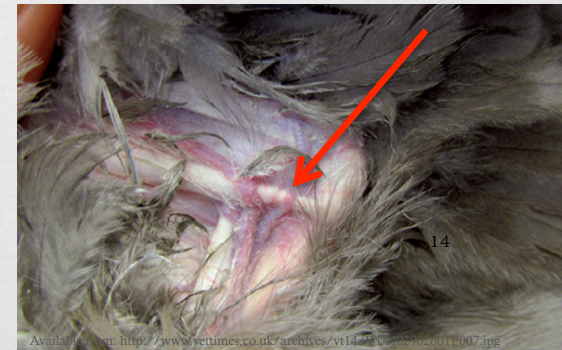
Average % of Fat Lost from Long Flight	
13% L	67.32059095
13% H	67.53449882
32% L	67.07951558
32% H	61.6473567

Sample Collection & Processing

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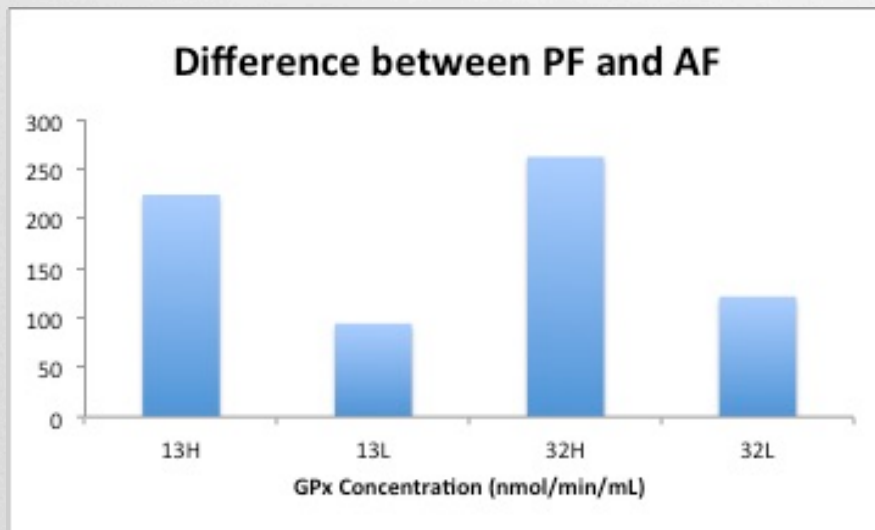


- ❧ Samples taken before & after longest flight (pre-flight & after-flight)
- ❧ Collection with heparinized tube
 - ❧ Erythrocytes separated from plasma
 - ❧ Frozen at -80°C
- ❧ Analysis of GPx with Cayman kit



Results

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- ∞ Increase in GPx among all diet groups
- ∞ Most dramatic increase in high antioxidant groups
- ∞ PUFAs had little perceived impact
 - ∞ Unexpected
- ∞ Possible interaction?
- ∞ Sample size

Acknowledgements

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- ❧ Barbara Pierce, PhD
- ❧ Scott McWilliams, PhD
- ❧ Chris Guglielmo, PhD
- ❧ Kristen DeMoranville
- ❧ Wales Carter
- ❧ Luke Douglas
<https://digitalcommons.sacredheart.edu/acadfest/2017/all/5>
- ❧ Maxwell Trudeau



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