

Symposium 1: Nutrition and Physical Activity

Adaptations for endurance exercise in migratory birds

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Background - Migratory birds perform some of the most phenomenal feats of endurance exercise in the animal world, making non-stop flights of up to 6,000 or even possibly 10,000 km. Birds combine extreme obesity with extreme physiological capacity (energy expenditure of >7 times BMR for 3-5 days). Adaptations associated with fuel deposition and use in long-distance migrants (mainly shorebirds, Charadriidae) are covered in this review.

Review - Migratory birds combine a variety of behavioural and physiological adaptations that enable extreme long-distance flight. Birds must deposit large fuel loads (sometimes doubling in mass; maximum recorded fat load 54%), quickly (daily mass increase rates of 5-15% day⁻¹ in captivity and 4% in the wild).^{1,2} The fuel composition must reflect immediate and upcoming demands: in addition to fat, up to a third of the mass increase can be lean tissue. Enlarged digestive organs aid fuelling, but may be partially broken down before departure³; increased exercise organs are needed for efficient flight while heavy. During flight, rapid energy supply is required, and migratory waders are able to move quickly to a fatty-acid derived energy source⁴, facilitated by underlying biochemical adaptations.^{4,5} While fatty acids provide the vast majority of the energy used during flight, protein breakdown provides 4-7% of the energy in long-distance migrants.⁶ Even this minimal level (as low as any inactive fasting animal) results in extensive breakdown of lean tissue from many organs during flight. Possible reasons for protein breakdown include generation of Citric Acid Intermediates, as a substrate for gluconeogenesis, unavoidable protein turnover during a high-energy turnover starvation period, and production of antioxidants. The impacts of the dramatically different body compositions before and after migration have not been studied well in the field, but impaired fuelling ability immediately after arrival is likely.⁷

Conclusions- Migratory birds are paradoxical from a human perspective, combining gluttony and obesity with unparalleled levels of sustained, high-energy, physical performance. While some of the mechanisms allowing this seeming contradiction have been discovered, much ecological, physiological and biochemical work is required before the variation in avian migratory strategies can be fully understood.

References

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