

Symposium 36 Energetics, physiology and biochemistry of bird flight

Introduction

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Although flight is the most characteristic and conspicuous feature of birds, its study under controlled conditions has been meager. Recently, however, major advances in facilities for performing such research have become available in the form of high quality wind tunnels. Using the large wind tunnel of the Birmingham/Bangor group in Britain, Charles Bishop and co-workers present data here on heart rate and rate of oxygen uptake in barnacle geese (*Branta leucopsis*) during flight. The long-term objective of this study is to make possible the use of heart rate as an indicator of metabolic rate in free-flying geese and other migrants. Marcel Klaassen has also used a tunnel in Lund, Sweden, to augment his findings here on the effect of size on energy and water use during migratory flight, together with problems associated with their modeling.

The three remaining papers were only presented orally. Herbert Biebach and Ulf Bauchinger discussed changes in the composition of the breast muscles in response to long-distance flights, making direct measure-

ments of energy expenditure, body mass and breast muscle performance in barn swallows (*Hirundo rustica*) and rosy starlings (*Sturnus roseus*) in the wind tunnel at Andechs, Germany. The two final papers reported on the flight physiology of the smallest of birds, the hummingbirds. Hummingbirds have the highest mass-specific rates of aerobic metabolism among vertebrates. Ingenious experiments and painstaking morphometric and biochemical studies have enabled determination of their power output and its biochemical basis. Robert Dudley, from Austin, Texas, addressed the ecological and evolutionary physiology of hovering in hummingbirds, including the relation of power output to body mass and altitude. In the final paper, Raul Suarez, from Santa Barbara, California, also discussed power output and the biochemical basis of hummingbird metabolism, demonstrating that flight in hummingbirds is at the very upper limits of performance. Abstracts of the last three papers are published in the Abstract volume of the Congress.