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SYMPOSIUM

Introduction to the Symposium: Environment, Energetics, and Fitness: A Symposium Honoring Donald W. Thomas

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Introduction

Resolving the link between an individual organism's environment, its energetics, and its fitness is crucial for understanding the persistence and performance of animals in various environments (Thomas et al. 2001; Careau et al. 2008). The ability of animals to respond and adjust to environmental challenges is the key concept of the Darwinian theory of natural selection. Fitness in turn, defined as the reproductive success of individuals, expresses their success in a given environment. Individual variability in the acquisition, expenditure, and conservation of energy mediates the link between environment and fitness through its association with life-history traits and performance. This organism–environment linkage has attracted substantial scientific attention over the past 20 years (Fig. 1) and was recently identified as one of the five grand challenges of organismal biology (Schwenk et al. 2009). Many new techniques and tools are available for use in addressing the growing number of questions related to how animals interact with their environment, how flexible they are in their interactions, and what limits their performance and adaptive capacity. All of this is leading to new, integrative approaches to longstanding questions about organism–environment interactions, with many of the most exciting approaches arising from the interweaving of field and laboratory methods (Costa and Sinervo 2003; Wikelski and Cooke 2006). The questions and the need for answers urgently increase with our growing awareness of the reality of global environmental change and its impacts on organisms.

This series of papers honors Professor Donald W. Thomas who died suddenly in May 2009 while doing field research in Corsica (Fig. 2). Don Thomas was recognized world-wide for his contributions to our understanding of the ecology and physiology of bats, rodents, and birds. As Don pointed out on his web site: "Although I have a slight bias towards bats, chipmunks, and blue tits in Corsica, I like to think that it is the question rather than the taxonomic group that drives research." His research focused mainly on physiology of thermoregulation, hibernation, and over-wintering strategies of bats and rodents, as well as the evolutionary and physiological ecology of breeding birds. Don was an exceptional empiricist who rightly thought that the marriage between the precision that can be obtained in laboratory-based measures and the reality of field-based studies allows better understanding of the strategies that animals have evolved to meet energetic challenges (Careau and Fenton 2009). Some of his most important contributions demonstrate how energetics serves as a mechanistic link between environmental variation and the fitness of endotherms (e.g., Thomas et al. 2001; Humphries et al. 2003; Careau et al. 2008). This link is an important and rapidly growing area of research in physiology and ecology, driven, in part, by recent successes in embedding field-based quantification of physiological variables into long-term field studies of

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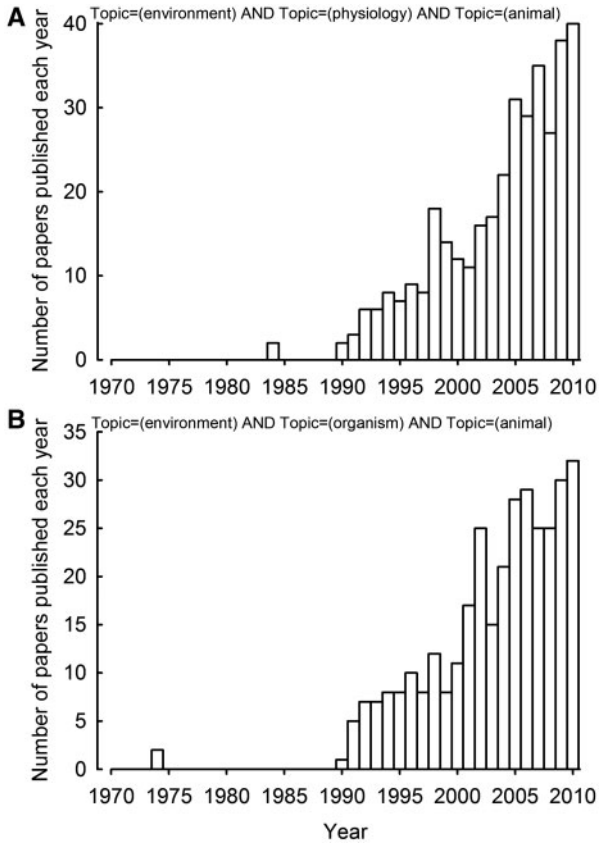

Fig. 1 Number of papers published between 1970 and 2010 and found in ISI Web of Knowledge using following topic criteria: environment and physiology and animal (**A**, $n = 361$) or environment and organism and animal (**B**, $n = 334$). Based on these criteria, there is a clear exponential growth in the number of papers published in the 40-year interval that we searched.

Fig. 2 Donald William Thomas (1953–2009) holding a blue tit (*Cyanistes caeruleus*) at his favorite field site in Pirio, Corsica. Beside his obvious smile and *bien-être*, note the capillary tube in his right hand used to collect blood required for the doubly-labeled water technique.

individual fitness and population dynamics (e.g., Blondel et al. 2006). Equally important is the search for mechanistic traits that may be used to predict populations' responses to environmental change (e.g., Humphries et al. 2002).

We selected "Environment, Energetics and Fitness" as the focus of this symposium because of the importance of Don Thomas' contribution to this subject and its growing importance to organismal biology. The interdisciplinary variety of contributions and international diversity of speakers reflect Don Thomas' contributions to the field of physiological ecology and his infectious enthusiasm for science and discovery that were exceptionally influential on young researchers. Presentations covered a wide range of topics on ecological physiology of endothermic animals, including ecological and physiological aspects of heterothermy in mammals and birds, the nutrition and energetics of migrating birds, as well as thermoregulation and evaporative water loss. A researcher attending the symposium, who had never met Don, indicated that by seeing the science that was presented and hearing the many references to Don's influence and friendship, he came away with a strong sense of Don's science, vision, and legacy. We hope the publications spawned by the symposium convey at least some of Don's influence on his peers and students.

Overview of papers

Geiser and Stawski (2011) analyze heterothermy in tropical and subtropical bats in relation to energetics, extinctions, and the evolution of endothermy, concluding that heterothermy is an ancestral trait in bats, which together with the ability to fly, could potentially lessen the extinction risk of chiropteran taxa. McKechnie and Mzilikazi (2011) review the diversity of heterothermy in Afrotropical mammals and birds, showing it to be more frequent and diverse than expected. The paper contains new insights as to how ecological correlates of heterothermy evolved. Willis et al. (2011) provide the first experimental tests of an hypothesis recently proffered by Cryan et al. (2010), suggesting that bat mortality associated with white-nose syndrome is a consequence of significantly increased evaporative water loss during hibernation. Aamidor et al. (2011) and Mizrahy et al. (2011) analyzed nutritional physiology and renewal of tissue in small migrating birds to show how refueling at migratory stopovers is achieved through behavior and food selection. Wojciechowski et al. (2011) expand the examination of stopover energetics of passerine birds by

highlighting the importance of conservation of energy and reduction of predation risk through heterothermy and huddling. Vézina et al. (2011) show that seasonal acclimatization in red knots, *Calidris canutus islandica*, includes programmed changes in mass and in thermogenic capacity. Korine et al. (2011) conclude that thermoregulatory side effects of ethanol consumption may prevent bats from eating overripe fruit in winter. Levy et al. (2011) reveal that torpor may not only reduce the expenditure of energy by spiny mice living in the Judean Desert but also contributes to the avoidance of interspecific competitors when resources of energy in the environment are limited. Humphries and Careau (2011) review evidence that activity in the cold is energetically cheap for endotherms of different body sizes and assess its relevance to metabolic ecology.

Collectively, these papers speak to the breadth of focus and approaches contributing to research in environment, energetics, and fitness. They also identify many opportunities for future elaboration, integration, and application. General curiosity about how animals work was the major impetus that drove Don Thomas' research interests. His ability to generate clear and compelling answers to scientific questions, and to communicate them with a special blend of *ardeur* and *joie de vivre*, led to the strength of his publications. In many cases, clear answers to interesting questions are translated into important and unexpected applications. For example, Don Thomas' research on the energetic and fitness consequences of phenological mismatches (Thomas et al. 2001) is being used to anticipate the impacts of climatic change on songbirds (Visser et al. 2004). Also, his studies of water loss and energy expenditure during hibernation have contributed to our understanding of the impacts of white-nose syndrome in bats (Willis et al. 2011). However, whether or not the application is immediately obvious, there is much to be learned and much to be gained through a basic focus on how animals work (Schmidt-Nielsen 1972). As organizers of this symposium, we thank the participants for honoring this important research tradition, by providing clear and compelling answers to so many interesting questions about how animals work at the interface of environment, energetics, and fitness.

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