correlational evidence that food limitation occurs in the late dry season of many (if not most) years. At a minimum, it seems to occur at least once per finch generation.

Furthermore, by obtaining morphological measurements from populations of *G. fortis* on Daphne Major over a series of years during which drought and feeding conditions varied, Grant and his students were able to document the differential survival of certain phenotypes and to relate the differences to ecological events. In this case, individuals with larger body size and greater bill depths survived better than smaller individuals. This was correlated with the presence of larger and harder seeds, which larger birds were shown to handle more efficiently. The differential survival of large phenotypes was shown to be further enhanced by females' choosing larger males when selecting a mate. Grant estimates that the combined effect of natural and sexual selection in this event resulted in a 4 to 5% shift in the direction of larger size in the population. Counterpressures on size and other characteristics are also considered, as are additional factors that influence evolutionary change in these species, such as sexual selection, hybridization, and genetic drift.

Grant concludes the book with a synthesis and his current view of the ecological forces and evolutionary processes that have led to the diversification of Darwin's finches. Although some of his views are clearly supported by data and experimentation, others still require verification. This is particularly so with respect to the generality of the findings. Grant's work thus far has concentrated on the more common species of ground finches (*Geospiza*), mainly on two or three islands. Since manipulative experiments cannot be conducted in the Galapagos, further long-term studies comparing population processes of the same and different species on different isands, as well as information on the other finch species, especially the tree finches and the warbler finch, will be necessary.

Likewise, studies of the relationship between finch morphology and behavior (functional morphology) are needed to substantiate claims made on largely circumstantial grounds. And, as Grant points out, the application of recently developed biochemical and genetic techniques might provide new ways of assessing the genetic affinities and relationships among the finch species and their possible ancestral stocks in Central or South America.

The most impressive feature of the current work, however, is the quantity and quality of the data and ideas that have been generated from intensive, well-designed, and relatively long field studies of natural populations. Population geneticists, evolutionists, ecologists, and indeed anyone interested in biology and the diversification of organisms will find interesting and provocative material in this book. They will also find the writing clear, the procedures and rationales of the analyses explicitly stated, and the photographs of the finches and their islands superb. This book is destined to become a classic in the field of ecology and evolution.

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Suspended Animation

Metabolic Arrest and the Control of Biological Time. PETER W. HOCHACHKA and MICHAEL GUPPY. Harvard University Press, Cambridge, MA, 1987. xvi, 227 pp., illus. $27.50.

A common fixture of science fiction is the possession of the ability to control biological time. In contrast to chronological time (clockwork), biological time is hypothesized to be more relative and amenable to slowing or arrest. Survival during space travel or profound longevity could theoretically result from slowing metabolic processes or entering a state in which metabolism is entirely suspended and life, by most definitions, ceases until arousal. This hopeful dream is typified for me by a slogan on a panel van in our neighborhood: "Life extension through cryonic suspension."

This book reminds us that such metabolic arrest is not fantasy but is rather a daily or seasonal feature of the lives of many animals. It is not impossible or even particularly unusual. Metabolic depression is a common strategy when animals encounter temporarily inhospitable environments, those with a lack of sufficient heat, oxygen, water, or usable energy. Resources are marshaled until better times return and normal life can resume. Examples of this depression can be found in nearly all groups of animals, for example during diving in birds and mammals, estivation in snails and lungfish, freezing in insects and frogs, and hibernation in rodents and turtles. Some animals—nematodes, tardigrades, brine shrimp cysts—can enter an ametabolic state, in which energy utilization and all other functional processes stop completely and animation is suspended.

This book is the story of these animals and a summary of our knowledge of their physiology and biochemistry. It is a good book and succeeds at several levels, both in its exploration of physiological diversity and in its examination of the underlying commonality of the mechanisms of metabolic depression. The authors assert that a common feature of metabolic slowdown in all these animals is the inactivation of transport channels in cell membranes. This "channel arrest hypothesis" recognizes that transport processes, particularly sodium-potassium exchange, are energetically expensive and represent a large fraction of the total energy expenditure of a cell. The temporary suspension of this transport would result in an immediate and substantial decline in energy demand. The suppression of other cell functions—aerobic and glycolytic metabolism, protein and RNA synthesis—is found more selectively and results in further energetic savings. The extrapolation of some or all of these functions to particular cases is sometimes quite conjectural, as the authors readily acknowledge. The value of their hypotheses will be seen in the widespread research that this book will surely provoke on such phenomena as hibernation, cryogenics, and anhydrobiosis. This is an excellent example of the vitality and utility of the field of comparative physiology.

While my overall assessment is very positive, the book is not without its faults. Its coverage of different animal groups is uneven. Some chapters are well-balanced discussions. Others are eclectic. The section on diving, for instance, discusses only the authors' own work on Weddell seals; that on anhydrobiosis concentrates almost exclusively on brine shrimp cysts. Though these are the best-studied examples, they are far from the only ones, and, as this book demonstrates elsewhere, much information can be obtained from diverse systems. The prose is often hard to interpret. Convoluted sentences are common, including one that is 82 words long (pp. 54–55), and difficult to follow. Technical terms are used freely, and an extensive background in biochemistry and physiology is assumed.

My only other reservation about this presentation is the complete enthusiasm with which the authors embrace metabolic slowdown or arrest. Its advantages, which are considerable, are discussed thoroughly. Its disadvantages are not. Its unspoken price is precisely the withdrawal from life that is otherwise praised. A hibernating, estivating, or frozen animal may survive, but it cannot simultaneously be fully alive. It cannot feed, behave, or, most important, reproduce. Its departure from normal metabolism is also a departure from the opportunities of normal life. It is not only biological time that is arrested; it is life itself.

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