BOOK REVIEWS

Comparative Oology

Egg Incubation. Its Effects on Embryonic Development in Birds and Reptiles. D. CHARLES DEEMING and MARK W. J. FERGUSON, Eds. Cambridge University Press, New York, 1992. xiv, 448 pp., illus. $195.

The egg of amniote vertebrates has been a key evolutionary innovation, allowing developing embryos to draw on a maternally provided package of micro- and macronutrients in the face of the hydric and temperature extremes that characterize terrestrial environments. With its precisely defined geometrical shape and its semipermeable shell with well-characterized physical properties, the egg is in many ways an ideal object for physiological inquiry. Fluxes of water and gases through the shell can be predicted from first principles of biophysics, and such predictions have been tested with elegant experiments and physiological measurements.

This volume provides an integrated perspective on amniote egg biology in a set of 27 review papers from diverse areas of biology. The volume is unique in the comparison it offers of avian and reptilian egg physiology. These two vertebrate classes are largely dichotomous in their strategies of egg incubation, reflecting divergence with respect both to presence or absence of parental care and to adult temperature regulation (endothermy in birds and ectothermy in reptiles).

Water and gas exchange are intimately related to temperature regulation. Temperature regulation of eggs can be effected by parental behaviors (as in most birds) or the eggs can be left to vagaries of the environment once a suitable oviposition site has been chosen (as in most reptiles). Endothermy permits birds to incubate eggs at relatively constant temperatures in spite of fluctuations in ambient temperature. With such temperature control, the flux and utilization of water in the embryo are quite predictable given a defined environmental regime. The avian egg begins with sufficient water to complete development, during which there is a net loss of water from the egg. The avian egg has a rigid shell with a defined size and number of pores through which water loss, as well as carbon dioxide and reciprocal oxygen exchange, is regulated. In contrast, most reptilian eggs require a net gain of water after they are laid, and a moist oviposition site becomes crucial for hatching success. However, the soil in and around the nest that provides the necessary water also dramatically limits gas exchange, and many reptilian eggs are endowed with a "parchment shell" that permits the rapid gas and water exchange necessary in the subsoil environment. There are exceptions to this pattern of differences, however. One example discussed in the book is the case of megapode birds, which bury their eggs in soil mounds, an environment very similar to that of the eggs of crocodilians and chelonians (turtles), and there are interesting parallels in the phenomena of gas exchange among these animals.

Most of us have encountered avian eggs in the natural environment, where they are in fact quite accessible. As is reflected in this volume, avian physiological ecologists have provided us with a wealth of studies on eggs in natural environments that allow interpretation of laboratory findings in ecological and evolutionary terms. In contrast, the inaccessibility of and difficulty of finding most reptilian nests, buried as they are below ground, has largely limited advances in the physiological ecology of reptilian eggs to the laboratory. For example, the temperature dependence of reptilian environmental sex determination has now been documented in many groups (crocodiles, turtles, geckoes), but there are only a handful of studies on the conditions in natural nests, and as yet no comprehensive studies on the ecological consequences of environmental sex determination. Interestingly, environmental sex determination, which is widespread in reptiles, is unknown in birds, in which all species for which data are available have chromosomal sex determination. This is not surprising given the more precise control of avian incubation environments.

There are other differences between bird and reptile eggs that are explored in this work, but the ultimate causes of these differences are not fully understood. Diapause during incubation, which is a state of embryonic "suspended animation," has evolved repeatedly in some groups of reptiles. Likewise, viviparity and ovoviparity, which both result in the birth of live young, are evolutionarily quite labile in reptiles. No birds exhibit either diapause or viviparity. Our understanding of these phenomena will depend critically on future studies of reptilian egg incubation in nature and of the hormonal factors leading to egg retention.

This book provides an authoritative summary of achievements in the physiological ecology of egg incubation of birds and reptiles, not only reviewing recent developments in this field but defining areas for inquiry. It is exactly what is required for advances in our understanding of the physiology and evolution of the amniote egg.

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An Appetite

Sodium Hunger. The Search for a Salty Taste. JAY SCHULKIN. Cambridge University Press, New York, 1992. xii, 192 pp., illus. $54.95.

The appetite for salt provides an excellent model for the study of motivated behavior because it is easy to induce and to quantify. The sensory stimulus is sodium, the sensory system is gustatory, and the key factors are hormones acting on the brain. In natural circumstances sodium appetite develops as a result of a nutritional deficiency or during pregnancy and lactation. In the laboratory, it is induced by creating a negative sodium balance. Jay Schulkin has provided a salient review of studies on salt appetite in this book. The five chapters that make up the core of the book cover salt-seeking behavior down to the possible neural circuits involved. Each chapter is flavored with behavior, hormones, gustation, physiology, and the central nervous system. The monograph is well illustrated and studded with chatty examples of other motivational systems to emphasize the generality of sodium appetite as a model.

Schulkin starts with the search for salt-seeking behavior, built upon Derek Denton's classic work, but despite the arresting picture on the cover of an elephant with its trunk deep in (presumably) salt-tasting soil, the book is not about the ecology of salt appetite. It is almost entirely about the laboratory studies that have been performed on rats. The innate hunger for sodium is clearly seen in the adrenalectomized rat. Without the adrenal gland the animal loses the sodium-retaining hormone, aldoste-

rone, and therefore develops a sodium hunger because it cannot retain sodium. However, as the story develops in the chapter on hormonal regulation of salt intake, aldosterone or the mineralocorticoid deoxycorticosterone increases salt ingestion when given alone. Since salt appetite occurs with or without mineralocorticoids, they alone cannot be the triggers of it. Angiotensin II, acting centrally, is another hormonal candidate for salt-appetite induction, particularly as angiotensin and mineralocorticoids are synergistic in their effect on salt ingestion. Sex steroid hormones are also implicated because females develop salt hunger during pregnancy. Within the brain the female "enhanced avidity for sodium" is hypothesized by the author to depend on the medial amygdala for its expression. Other hormones, including ACTH, glucocorticoids, and atrial natriuretic peptide, are considered here and there in the book but have been less well studied with respect to salt ingestion.

The review of brain circuitry underlying sodium hunger is mostly based on lesion studies. The most compelling of these are in decerebrated rats, those with the anterior third-ventricle lesions and those with bilateral amygdala damage. There is obviously much more detail to be worked out, and it remains for future studies to match hormone receptor distribution with greater precision in defining circuits.

This little book is a good introduction to the topic and a handy, up-to-date review. It will be useful for students interested in learning about the psychophysiology of motivation and for researchers looking for a highly palatable update on the behavioral search for the taste of salt.

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The Serpentine Problem

The Ecology of Areas with Serpentinized Rocks. A World View. B. A. ROBERTS and J. PROCTOR, Eds. Kluwer, Norwell, MA, 1991. x, 427 pp., illus. $229. Geobotany, 17.

The geological term *serpentine* correctly applies to a group of only three polymorphic minerals—lizardite, antigorite, and chrysotile—but the word has been used much more widely by geobotanists to include all ultramafic rocks with a significant serpentine content. Soils derived from such rocks have attracted the interests of pedologists and plant ecologists for more than a century because of their wide global occurrence (from the arctic to the tropics) and their very variable chemical and physical properties. Few generalizations about their chemical nature can be made other than that they are rich in ferromagnesian minerals and are of relatively low silica content; often they are also low in calcium (relative to magnesium) and major nutrients (such as nitrogen and phosphorus) and have high nickel, chromium, and cobalt contents. Such soils can support both sparse and closed vegetation, which may include both endemic species having very restricted distribution and widespread species. It is the interplay of soil chemistry (potential element deficiencies, imbalances, and excesses) and physical conditions that has dominated the thinking of plant ecologists in their attempts to explain the distribution of plants on and their adaptations to serpentine soils. For all these reasons the "serpentine problem" has become the focus of much ecological and evolutionary research.

All these issues are addressed in this compilation. As its title suggests, the book presents a global view of serpentine vegetation, with sections on North America (the United States and Canada), Europe (the British Isles, Portugal, Italy, the Balkans), the tropical Far East and Japan, Africa (Zimbabwe and South Africa) and Australasia (Western Australia and New Zealand). Although variable in scope, depth, and presentation, the 16 chapters provide good insight into serpentine vegetation on a regional scale. All are profusely illustrated and extensively referenced. Several are the first comprehensive accounts of serpentine vegetation for their areas (for example, sections on Newfoundland, Portugal, Japan, and New Zealand); others bring together much disparate information (on North America, the British Isles, and the tropical Far East). An introductory chapter on the geology of serpentinized rocks opens the discussions.

The strength of this work lies in its broad geographic coverage. There are, however, some serious omissions, notably South America, Cuba, the Middle East, and Turkey. A further weakness stems from the over-long gestation period of this book—it has taken more than six years to appear. As a result, several of the chapters are now somewhat out of date. Despite this, the book will become a standard reference for all those interested in soil-plant relationships and will provide a stimulus for further research in this aspect of biogeography and geobotany.

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Phasing Techniques

Direct Methods of Solving Crystal Structures. HENK SCHENK, Ed. Plenum, New York, 1992. x, 445 pp., illus. $115. NATO Advanced Study Institute series B, vol. 274. From an institute, Erice, Italy, April 1990.

In diffraction experiments the x-ray intensities of crystallographic reflections can be measured, but the phases of the amplitudes, which are necessary for complete determination of the underlying crystal structure, cannot be. This is the famous "phase problem" in x-ray crystallography, and for nearly half a century it was common dogma that this phase information could not be retrieved from the data and was lost forever. That all changed in 1947 when David Harker and John Kasper, working at the General Electric research laboratories in Schenectady, stumbled upon a mathematical relationship, known as Schwartz's inequality, in a textbook and recognized that it could be employed to determine the phases of small groups of reflections, provided their normalized diffraction amplitudes were sufficiently large. This discovery encouraged others to investigate further, culminating in 1985 when the Nobel Prize in Chemistry was awarded to Herbert Hauptman and Jerome Karle in recognition of their work in developing direct phasing techniques. Today it is fairly routine to use direct methods to determine the crystal structure of compounds containing as many as 50 to 100 carbon, nitrogen, and oxygen atoms, and researchers no longer have to introduce heavy atom markers to simplify the phasing process. At the present time, researchers are engaged in efforts to devise more powerful direct phasing techniques that would allow routine determination of larger "light-atom" structures, perhaps even small proteins.

The present volume is a collection of 47 papers from the most recent of a series of meetings on direct methods that began in the 1970s. The first quarter of the volume is devoted to introductory lectures on the subject; as a collection these chapters lack the coherence and polish that a single author could have imparted. Crystallographers who regularly use direct methods, however, will find the volume valuable for keeping abreast of the majority of more recent developments in this subject area. Indeed, some of the papers deal with procedures that were under development at the time of their presentation at the meeting. These include Sheldrick's phase-annealing procedure, the SAYTAN and SQUASH procedures developed by the York group, Hauptman's minimal function technique,