BOOK REVIEWS

Ceratopsians

The Horned Dinosaurs. A Natural History. PETER DODSON. Artwork by W. D. Barlowe and R. Walters. Princeton University Press, Princeton, NJ, 1996. xiv, 346 pp., illus., + plates. $35 or £23.

In the days of my childhood, which now appear as remote as the Mesozoic Era, it was inconceivable to approach the wonderful sculpted *Triceratops* standing majestically on the Smithsonian Mall without thinking immediately of Uncle Beazley, star of *The Enormous Egg*. What child didn't fantasize about hatching and raising his own pet dinosaur? And of the possibilities (*Tyrannosaurus*, a perennial favorite otherwise, might have turned on its owner at any minute), the stately *Triceratops*, with its protecting horns and a ready-made seat behind the great frill, fit the bill perfectly. Many of us who now study dinosaurs as adults never dreamed we'd grow up to do just that; some of us, including the author of this new book, always knew we would.

The ceratopsians, or horned dinosaurs, were Cretaceous herbivores known mostly for their great bony frills behind the head, their horns over eyes and nose, and their hooked upper beaks formed by a unique bone called the rostral. Like the duck-billed hadrosaurs, they had no teeth in front, but their cheek teeth were combined by the hundreds into a single beveled grinding and shearing surface in each quadrant of the jaw, which must have made them very effective vegetarians. The group includes not only the huge, spectacularly varied horned and frilled types; in fact, the first ceratopsians were small and probably mostly bipedal, with no horns and almost no frills at all. They seem to be most closely related to the dome-headed pachycephalosaurs, with whom they originated from generalized ornithopod dinosaur stock, probably in the Early Cretaceous.

Ceratopsians evolved into two major lineages: the centrosaurs, generally with shorter frills, large nose horns, and small eye horns (*Monoclonius*, *Styracosaurus*), and the chasmosaurs, who tended to sport larger frills, smaller nose horns, and larger eye horns (*Torosaurus*, *Pentaceratops*). Curiously, *Triceratops*, the most famous horned dinosaur, is somewhat anomalous: its horns securely pronounce it a chasmosaur, but it has a short frill that, unique among ceratopsians, is solid and thick, with no fenestrae. It was also the last known of the lineage, surviving to just below the Cretaceous-Tertiary boundary in Montana.

The horned dinosaurs are among the best-represented in the fossil record, with the number of known specimens per genus often ranging from the hundreds to the tens of thousands. It is perhaps surprising that no general work has ever been published about them, but the deficit is now redressed by Dodson's engaging, witty, and erudite new book. It is a labor of love by an admitted "ceratophile" (his term), an anatomist particularly skilled in biometrics, the quantification and analysis of variation that is so important in interpreting the diversity of fossil vertebrate remains in any kind of objective way. Dodson made his mark in the 1970s by determining that a gaggle of nine genera and 13 species of duck-billed dinosaurs could be reduced biometrically to two genera and three species, if one admitted the inevitability of juvenile specimens and the probability of sexual dimorphism among the lot. The same acumen is applied to this review of the horned dinosaurs, which are tackled here in the terms of their diversity and how we have come to know it. The historical development of each subgroup and genus is charted as new specimens were found, diagnoses changed, and names invented, combined, and often sunk. Along the way we are treated to a grand array of stories about early as well as more recent collectors, many of whom have often been overlooked. Dodson lays out the history, the evidence, and the conclusions (including his own) but always allows the reader plenty of room for judgment. The prose is graceful and never overly serious, and the footnoted asides are informative and amusing, so that even chapters on topics as dry as the necessary skeletal anatomy and principles of classification will be palatable to the non-specialist.

The issues in ceratopsian paleobiology are a microcosm of those for any extinct group. Over time, the initial enthusiasm for treating each new bone fragment as representing a new species waned, and attention focused less on splitting and more on grouping taxa as anatomy became better known and evolution became a guiding principle in taxonomy. The skeleton behind the ceratopsian head generally shows far less variability than the skull does, and after much soul-searching it has been generally accepted that the principal function of all this cranial ornamentation was for sexual display (though there is ample evidence of wounds inflicted in aggression). Such devotion of biologic energy to mating and territory implies a certain degree of sociality, supported also by mass graves of thousands of monospecific individuals who perished at once in a flood or other disaster (these are now known for several ceratopsian species). We now have growth series for several forms, and Dodson squarely advocates the view that sexual dimorphism, ontogeny, and normal populational variation account for most of the apparent diversity.

The book is strongest on anatomy and history. Less strong, perhaps, are the treatments of phylogeny, about which a great deal is now coming together, and of the distribution of these taxa through the rock column. Phylogeny and stratigraphy provide strong tests of each other's hypotheses, and it would be interesting to know to what degree the vertical distribution of ceratopsian lineages in the rocks matches their evolutionary patterns derived solely from anatomical features. In place of this, Dodson tests biometrically the cladistic hypotheses of character distributions and polarities on which current phylogenies are based, revealing broad agreement but not much new insight into evolutionary patterns. As Dodson notes, there is still much work to do on these wonderful creatures, and it is a pleasure to have his own substantial contributions summarized amid such a nice review and synthesis as this book.

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Contractile Mechanisms

Biochemistry of Smooth Muscle Contraction. MICHAEL BÁRÁNY, Ed. Academic Press, San Diego, 1996. xxvi, 418 pp., illus., + plates. $115 or £22.

The mechanism of muscle contraction has been studied extensively with skeletal muscle as a model for more than 40 years, following a number of critical findings: the identification of myosin as an adenosine triphosphatase by Engelhardt; the identification of actin-myosin as a contractile component by Szent-Györgyi; and the sliding-

Vignettes: Fiction and Nonfiction

We know . . . that little candles have flames nearly as big as large candles. How large were the flames of candles in Lilliput? And the more you think, the more questions you come up with: how large were the raindrops in Lilliput and Brobdingnag? Were the physical laws for water there different from the ones in our own world? And finally the physicists ask: how large were the atoms in those places? What kind of chemical reactions would they undergo with the atoms of Gullliver's body?

With these questions the stories falter.

—*Gerard 't Hooft*, in *In Search of the Ultimate Building Blocks* (Cambridge University Press)

The straightforward definitions and theorems of Euclidean geometry, conceived initially as exercises in thought, the mind companionably addressing itself, have a direct and thus an uncanny interpretation in the voluptuous and confusing world of the senses. A straight line *is* the shortest distance between two points. That the structure of the physical universe seems to have been composed with Fitzwater and Blutford's high-school textbook, *Welcome to Geometry*, firmly in mind is evidence that in general things are stranger than they seem.

—*David Berlinski*, in *A Tour of the Calculus* (Pantheon)

filament theory for muscle shortening proposed by A. F. Huxley, Hanson, and H. E. Huxley. Success in understanding the molecular mechanism of skeletal muscle contraction has largely been due to its unique characteristics. Its large cell size, as well as its highly ordered myofibril structure, has facilitated physiological and biophysical study, and the large quantity of protein involved in muscle contraction has facilitated functional analysis of protein components by biochemists. Smooth muscle has been studied for an equally long time, owing in part to its clinical importance, but the majority of the work has focused on the tissue level, and not until recently has there been molecular insight into the contractile mechanism. In the late 1970s, several research groups reported that in smooth muscle, unlike skeletal or cardiac muscle, actomyosin adenosine triphosphatase as well as contractility is strongly activated by myosin phosphorylation and that this reaction is catalyzed by Ca^{2+} and calmodulin-dependent protein kinase. This finding moved smooth muscle research into a new stage, focused on contraction at a molecular level. The phosphorylation theory for the activation of smooth muscle contraction is now established, and the role of Ca^{2+} as a primary intracellular messenger in the process is widely accepted. At the same time it is clear that the contractile response of smooth muscle is quite complex and that a number of other factors participate in its regulation. There remain some key unresolved issues. (i) Various protein kinases such as protein kinase C, calmodulin-dependent multifunctional protein kinases, MAP kinase, and tyrosine kinases might play roles in the signaling cascade, and their physiological function needs to be clarified. (ii) Thin-filament binding proteins such as caldesmon and calponin were found in the 1980s, but their physiological function is not yet understood. The regulatory or structural roles of these proteins need to be established. (iii) The phosphorylation theory predicts that smooth muscle contractile activity is determined by the extent of myosin phosphorylation. Therefore, the regulation of myosin light-chain kinase and phosphatase activities directly dictates the contractile activity. Although Ca^{2+} is the major factor that determines the myosin phosphorylation level, other factors also have an influence, presumably via modulation of the kinase and phosphatase. Understanding of the regulation of these enzymes will be critical. (iv) Intracellular Ca^{2+} concentration is regulated by numerous systems, including surface membrane as well as endoplasmic reticulum Ca^{2+} channels, Na/Ca exchanger, Ca^{2+} pumps, and mitochondria. Since Ca^{2+} is the primary second messenger for smooth muscle contraction, the homeostasis and regulation of intracellular Ca^{2+} have to be understood.

Biochemistry of Smooth Muscle Contraction addresses most of these questions in its 30 chapters. In the first section, current knowledge of several key contractile and regulatory proteins of smooth muscle is set forth in detail (13 proteins are selected and discussed). Two techniques (in vitro motility assay and cell permeabilization) that have contributed to recent progress in smooth muscle research are then introduced. This section is followed by chapters describing intracellular Ca^{2+} regulation and signal transduction. The coverage includes the nitric oxide–cyclic guanosine 5′-phosphate signaling system, one of the recent noteworthy topics in vascular smooth muscle physiology. In the last section, mechanics and energetics of smooth muscle contraction are described.

Each chapter contains up-to-date information, and perspective sections deal with key unanswered questions. The book provides comprehensive information on most of the important topics in this area. It is unfortunate that there is no treatment of small G proteins that may play a role in the regulation of myosin phosphorylation level in cells and no section on smooth muscle proliferation and differentiation, which would be interesting for clinically oriented researchers. However, the book makes a significant contribution to the field and will serve as a valuable reference both for investigators who have been working with smooth muscle and for those about to enter the field.

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Books Received

Ancient Egyptian Medicine. John F. Nunn. University of Oklahoma Press, Norman, 1996. 240 pp., illus. $39.95.

Brain Mapping. The Methods. Arthur W. Toga and John C. Mazziotta, Eds. Academic Press, San Diego, 1996. xiv, 471 pp., illus. $145.

Carnivore Behavior, Ecology, and Evolution. Vol. 2. John L. Gittleman, Ed. Comstock (Cornell University Press), Ithaca, NY, 1996. xii, 644 pp., illus. $85; paper, $37.50.

Dinosaurs of the East Coast. David B. Weishampel and Luther Young. Johns Hopkins University Press, Baltimore, 1996. xvi, 275 pp., illus. $35.95.

Encyclopedia of Earth Sciences. E. Julius Dasch, Ed. Macmillan, New York, 1996. Vol. 1, xlvi pp. + pp. 1–564, illus., + plates. Vol. 2, xii pp. + pp. 565–1273, illus., + plates. The set, $190; $165 until 31 Dec 1996.

Geology and Seismic Stratigraphy of the Antarctic Margin. Alan K. Cooper, Peter F. Barker, and Giuliano Brancolini, Eds. American Geophysical Union, Washington, DC, 1995. xiv, 303 pp., illus. + maps + CD-ROMs. $65; to AGU members, $45.50. Antarctic Research, vol. 68. Based on a symposium, Siena, Italy, Aug. 1994.

Introduction to Theoretical Organic Chemistry and Molecular Modeling. William B. Smith. VCH, New York, 1996. xii, 192 pp., illus. $59.95.

Low-Dimensional Semiconductors. Materials, Physics, Technology, Devices. M. J. Kelly. Oxford University Press, New York, 1995. xviii, 546 pp., illus. $120; paper, $60. Series on Semiconductor Science and Technology, 3.