Book Reviews

ANALYSIS OF VARIANCE AND COVARIANCE: HOW TO CHOOSE AND CONSTRUCT MODELS FOR THE LIFE SCIENCES. By C. Patrick Doncaster and Andrew J.H. Davey. New York, NY: Cambridge University Press. 2007. 288 pp. ISBN 978-0-521-68447-7. $52.99 (paper).

An abundance of texts that describe parametric statistical theory and methods are available, especially for the general linear model. It is uncommon, however, for these texts to provide both statistical mechanics and practical examples that not only are appropriate to biological lines of inquiry, but also serve as guidelines for developing experimental designs. Those books that perform these tasks are, on the whole, burdened by discussions on the breadth of statistical methods available, without the luxury of detailed consideration of any subset of those analytical models.

Doncaster and Davey's *Analysis of Variance and Covariance* is a rare example of a book that performs all of these functions while focusing on a particular family of statistical methods. Although their work will likely not eclipse the fundamental (though entirely mathematical) utility of Henry Scheffé's *The Analysis of Variance* (1959), Doncaster and Davey's book effectively fulfills its purpose: to provide a comparative framework by which biological researchers can decide which analyses best fit their hypothetical goals before designing studies and to demonstrate the breadth of ANOVA models for analyzing data. Rather than present these in an algebraically heavy format, the authors minimize the mathematics and center their discussions on concepts and models. This objective is efficiently facilitated by the use throughout of allocation tables, which provide visual representations of these models, thus giving the reader multiple formats to understand the research methods demonstrated in each section. Even though it is largely conceptual, the book is designed for readers already possessing a functional understanding of parametric statistics, namely the general linear model. In short, this is not an introductory text. However, advanced undergraduate students and certainly graduate students and practicing professionals will find it useful as a guide and reference for research design from an analytical perspective.

The book is roughly divided into three sections. First, the authors explain the general theory and assumptions behind analyses of variance and covariance and set the stage for the discussion of various models and experimental designs in the second section. These descriptions of models are subsequently explicated with practical biological examples laid out over seven chapters. Unsurprisingly, most of these examples (e.g., plant growth, barnacle population development) are not typical of hypotheses tested by biological anthropologists. Though some examples are directly applicable to anthropology, such as a study on captive lemur behavior (p 196), other examples may be readily extended to anthropological parallels. In the final section, comprising the last 30 pages, the authors discuss topics related to the methods and models presented in those seven central chapters, touching on factor comparison techniques and the relationship of analyses of variance to the development of research projects.

Those wishing to refresh themselves on the basic mechanics of calculating AN(C)OVAs will want to read through the "Introduction to analysis of variance," a chapter that is arguably independently functional as a review of the analysis of variance and covariance in graduate-level statistics courses. The consideration of nested, mixed, and split-plot model ANOVAs (p 21–29), while densely written, is a strength of this introduction section and reflects the focus of the following chapters. Indeed, very little space is devoted to descriptions of one-factor ANOVAs in favor of multiple-factor analyses.

It is noteworthy that the authors explicitly present the theory and calculations for AN(C)OVAs without specifying any statistical software package. Some readers may find this aspect of the book frustrating, as it requires one to look elsewhere for how to encode data and run analyses in the software of choice. However, it is refreshing to not have the limitation of software-specific examples. Without such discussion, the reader is forced to pay attention to the concepts and mechanics of calculating AN(C)OVAs. This prevents the rote mimicry of step-by-step use of software without comprehension of the underlying methodology or appropriateness of the employment of the statistics, what I term "shake-and-bake" statistics. Furthermore, as the authors state, the default use of computer packages "has a downside in their uncritical production of [AN(C)OVA] results" (p ix). Their approach elegantly sidesteps this problem.

Among the other strengths of this book is the treatment of experimental design by the authors. This is not limited to examples of how each analytical model is practically utilized but is extended at the beginning and end of the book with discussions of choosing appropriate experimental setups for use with AN(C)OVAs. In addition, Doncaster and Davey include a highly informative evaluation of alternative experimental models in light of statistical power. The authors also provide an excellent, although very brief, guide for presenting and interpreting AN(C)OVA results (p 260–263), as well as a "troubleshooting" dialogue (p 265–270), which together serve as a primer of "dos" and "do nots."

There are a few areas for improvement in the volume. It was surprising to find little discussion of planned or (unplanned) posthoc comparisons. The scant description of these methods, which neither details their merits nor compares their applications, is a striking oversight, as they—especially planned comparisons—are fundamental to hypothesis testing through ANOVAs. Likewise, no mention is made of nonparametric alternatives to the analyses presented. The authors, for instance, do not suggest the utility of Kruskal–Wallis tests in cases where parametric assumptions are violated. Also, even though Bayesian alternatives are beyond the scope of this volume, as they are often theoretically or practically inappropriate for the examples given, the mere existence of Bayesian methods is relegated to a single sentence at the end of the text (p 257). More discussion of all of these topics would be beneficial.

Generally, I recommend *Analysis of Variance and Covariance* for use as a guide and reference by advanced students and researchers in biological anthropology. As noted at the beginning of this review, works focusing on a limited set of statistics while considering methods for experimental design are uncommon. Doncaster and Davey provide an excellent resource that accomplishes both for a class of methods often employed throughout physical anthropology.

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The Human Fossil Record, Volume 3. Brain Endocasts: The Paleoneurological Evidence. By Ralph L. Holloway, Douglas C. Broadfield, and Michael S. Yuan. Hoboken, New Jersey: Wiley-Liss. 2004. 315 pp. ISBN 0-471-41823-4. $254.50 (hardcover).

Unfortunately for paleontology, brains do not preserve in the fossil record. Even if brains themselves fossilized, it would not be possible to examine their internal structure, essentially the "wiring" that reflects the specific neural functions that identify different species. The best that paleontologists can hope for is an endocast, a natural or artificial impression of the inside of the cranial vault. But an endocast is not a direct representation of the brain's external topography, because three layers of tissue separate the brain surface from the internal table of the cranial vault. Reading an endocast is like trying to decipher the surface of an object covered by a balloon and then placed in another water-filled balloon! Still, as the authors of this volume remind us, endocasts are the most direct evidence of ancestral brains available to science. From endocasts, scientists can get information on brain size, the general shape and morphology of the brain's external surface (e.g., asymmetries, relative development of regions, position of certain major gyri and sulci), and patterns of the meningeal-vessel impressions. A virtual treasure trove of information on these aspects of hominin endocasts is provided in this well designed, excellently produced volume.

Although, many prominent paleoanthropologists have studied endocasts of fossil hominins, no one has analyzed more specimens or dealt with the details of endocasts more systematically than Ralph Holloway, the senior author of this volume. Third in *The Human Fossil Record* series, *Brain Endocasts* follows the format of the other volumes, providing individual descriptions of 91 fossil hominin endocasts. For the majority of these, Holloway and colleagues provide illustrations (photographs, line drawings, or both), volumetric measurements, and the methodology used to obtain each (along with an assessment of the estimate's reliability), applicable metrics, and a discussion of the specimen's significance. In addition, there are summary tables of volumetric estimates and statistics for individual species and other groupings of fossil hominins in appendices. Simply, having the volumetric data available in a single source is a significant contribution of this volume.

However, Holloway and colleagues deviate from the other volumes in this series by moving beyond descriptions and providing some very useful and well considered interpretation of what these data can and cannot tell us about the brain in human evolution. They cogently present their perspectives on the major debates relating to hominin endocast studies (e.g., the location of the lunate sulcus in early hominins or the relative development of the frontal and prefrontal lobes in archaic human neocortices), but to their credit, they also discuss the uncertainties that are a part of these analyses. The majority of their interpretations, as laid out in Part 6, emphasize the mosaic nature of hominin brain evolution as it can be determined from endocasts. In other words, the various components of the recent hominin brain do not appear at the same time. Thus, the brain size increase so evident in hominin evolution is not an isometric process. For example, the reduction of the primary visual cortex and corresponding increase in the posterior parietal association cortex likely first appear with *Australopithecus afarensis*, while hominin-like development of Broca's cap and patterning of the left-occipital and right-frontal petalia are not apparent until about 2 million years ago. This pattern is found in specimens such as KNM-ER 1470 and in *Homo erectus*, but some purported early members of Homo (e.g., KNM-ER 1813) appear more australopithecine-like in endocast morphology. Holloway and colleagues note somewhat of a hiatus in endocasts that have been systematically studied from ca. 1.7 million years ago up until the appearance of Neandertals and their contemporaries. They elaborate on Holloway's previous assessment that Neandertal endocasts, when compared to those of modern humans, lack any convincing indicators of neurological primitiveness or absence of language abilities. It is important to note that this interpretation was made prior to the discovery that Neandertals possess the recent-human form of FOXP2, the so-called language gene, although this finding certainly supports the endocast analysis presented in this volume. Holloway and colleagues also provide an assessment of important human behavioral evolution in light of the patterns they see in the endocast data.

Although, I am sure that both Broadfield and Yuan contributed significantly to this volume's excellence (as does Grimaud-Hervé with her very useful consideration of endocranial vasculature), the fact is that this book is a clear reflection of the careful analytical and interpretive work that has characterized the five decades of Holloway's studies. Holloway and colleagues state at the outset that this volume is not a treatise on how the brain evolved. In fact, they assert that brain evolution can never be fully understood for the reasons noted at the beginning of this review. While that is likely true, Holloway and colleagues have given us an outstanding assessment of what we can glean through paleoneurology.

Given the volume's expense and specialized subject matter, I suspect it will find its way only into the libra-

ries of researchers with advanced interests in the human fossil record and the evolution of the brain. But for those with such interests and for the libraries of universities and museums that deal with such topics, this book is an absolute necessity. Not only does this volume provide for the first time a thorough compendium of known hominin endocasts, but also it does with clarity and attention to detail that will make it the standard for many years.

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HOMO ERECTUS: PLEISTOCENE EVIDENCE FROM THE MIDDLE AWASH, ETHIOPIA. Edited By W. Henry Gilbert and Berhane Asfaw. Berkeley: University of California Press. 2008. 480 pp. ISBN 978-0-520-25120-5. $75.00 (hardcover).

In this era of instant messaging, there is still something quite satisfying about a well made book printed on glossy paper and securely bound. Better still is a book that advances the field with descriptions of new material, thoughtful discussion, and an up-to-date bibliography. Such is the case with *Homo erectus: Pleistocene Evidence from the Middle Awash, Ethiopia*. The editors offer a comprehensive treatment of discoveries made from 1992 through 2002 in the Dakanihylo (Daka) Member of the Bouri Formation. Along with an account of the geology and geochronology of the study area, there are reports on various large fossil mammals, the Daka *Homo erectus* calvaria and postcranial remains, and the ecological setting in which the ancient animals and hominins evolved. In addition to the editors themselves, the contributors include the late F.C. Howell, to whom this and other monographs in the Middle Awash series are dedicated, and 15 specialists in paleoanthropology, vertebrate paleontology, radiometric dating, and stable isotope analysis.

Bouri Formation sediments were deposited along floodplains, channels, and lake margins. The Daka Member is sandwiched between the underlying Hata and overlying Herto Members and consists mainly of silt and sandstone layers. A pumice unit at the base of this member gives single-crystal $^{40}Ar/^{39}Ar$ dates averaging 1.043 ± 0.009 Ma, while pumice clasts collected high in the sections are dated to 0.966 ± 0.006 Ma. Thus the Daka sediments and their fossils are close to 1.0 Ma in age. A step trench at locality BOU-VP-19 provided the opportunity to take samples for carbon and oxygen isotopic composition. Soil organic and carbonate isotopic ratios suggest a flora made up mainly of C_4 plants growing in unshaded habitats. Considered along with paleosol geomorphology, these data indicate a warm, seasonally dry, wooded to open grassland environment.

The hominin cranium was discovered at locality BOU-VP-2 late in the 1997 field season. The investigators were able to transport their find to the National Museum in Addis Ababa, where further cleaning (accomplished in part with a porcupine quill, selected because it would not damage unprotected bone surfaces) revealed a remarkably well-preserved vault and base. This fine calvaria is described in detail. In their chapter on cranial anatomy, B. Asfaw, W.H. Gilbert, and G.D. Richards draw on the work of Franz Weidenreich and many subsequent authors, in an effort to incorporate a wide array of characters. Their account is explicitly comparative. There are numerous references to other Pleistocene specimens, particularly those referred to African and Asian *Homo erectus*. Such an approach requires careful effort, but in the end it is far more helpful than descriptions prepared without appropriate context. Black-and-white photographs of the Daka fossil itself are paired with CT images. In addition to the text and plates, there is a lengthy table giving virtually all (>200) of the standard ectocranial measurements and indices utilized in the current literature. Together with the chapter on tomographic analysis detailing the internal morphology and features of the endocast, the Daka descriptions constitute a valuable resource that will be consulted regularly by paleoanthropologists.

The Daka calvaria is sampled from a population living about 1.0 Ma. It is important to explore the evolutionary relationships of this group to others that are more or less contemporary in Africa and beyond, to determine how the lineage including Daka may have changed over time, and to outline a possible phylogeny of *Homo* in the Pleistocene. These topics are addressed in a separate chapter. Such questions are thorny ones, as there are many difficulties relating to the choice of "good" characters, construction of OTUs, and method of analysis. Indeed, most of the bony traits that anatomists depend on are hard to define, may not be homologous in different groups, and are probably not genetically or developmentally independent. Gilbert elects to carry out several cladistic analyses, not to generate cladograms that can be interpreted as evolutionary hypotheses, but rather to test assertions that have been advanced before about *H. erectus* and other species. A first analysis produces no clear separation of African from Far Eastern fossils. Also, the early East African hominins are not closer to advanced mid-Pleistocene *Homo* than is later *H. erectus* from Java. These findings are not consistent with the view that African *H. ergaster* and Asian *H. erectus* constitute distinct lineages with separate evolutionary histories. Other analyses lead to much the same result, and it is concluded that the nomen *H. erectus* should be applied to a large set of broadly similar crania from across the Old World.

The Daka hominins share anatomical features with both earlier African populations and later groups in Asia. It is increasingly difficult to identify characters such as vault thickening or expression of particular cranial superstructures that are limited to individual geographic provinces. Also, while the Daka evidence does not speak directly to this issue, local populations of *H. erectus* were probably quite sexually dimorphic. Vari-

ation between and within groups presents challenges for phylogenetic reconstruction. However, as suggested by the authors, it is reasonable to view *Homo erectus* as a widely dispersed, polytypic species within which there was some increase in brain size over time. The Daka fossils occupy an intermediate position within the lineage. This deme may be close in time to a later splitting event in which an African population gave rise to hominins that were clearly distinct from *H. erectus*. Indeed, such a specimen has been found in deposits at Bodo, also in the Middle Awash Valley.

Apart from their relevance to systematics, the Daka discoveries open a window onto the ancient East African landscape. Fossil assemblages include carnivores, cercopithecid monkeys, equids, giraffids, hippos, elephants, rhinos, suids, and numerous bovids. A large *Crocuta* (hyaenid) cranium is one of the best ever recovered from a Pleistocene locality. A new species of colobine, abundant equids, hippo remains found in association with stone tools, and a very fine sample of *Kolpochoerus* (a suid) all advance our understanding of African biogeography, biochronology, and paleoenvironment. However, it is the Daka bovid collection, 17 genera represented by hundreds of bones and teeth, that is most diverse taxonomically. Living bovids are relatively habitat specific. Tribal abundance comparisons show different patterns in closed and open environments. Despite the obvious difficulties of comparing modern assemblages with fossils ones, it is possible to draw general conclusions from the relative proportions of bovid taxa in the Daka Member. The large number of grazers points to open and grassy environments. It is likely that there were also gallery forests and wooded areas, with a perennial supply of water. When paired with an earlier monograph covering Middle Awash archaeology (De Heinzelin J. et al., eds. 2000. *The Acheulean and the Plio-Pleistocene Deposits of the Middle Awash Valley, Ethiopia* [Royal Museum of Central Africa, Tervuren, Belgium]. Ann Sci Geol 104), this book succeeds in presenting a remarkably detailed picture of *H. erectus* living on an ecologically rich East African savannah. As research continues in this remote but hugely productive segment of the African rift system, we can look forward to more discoveries that will fill out the story of human evolution.

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