

The Skull of *Australopithecus afarensis*

William H. Kimbel, Yoel Rak and Donald C. Johanson
with a chapter by Ralph L. Holloway and Michael S. Yuan

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In a brilliant integration of anatomical description and comparative analysis, William Kimbel, Yoel Rak, and Donald Johanson have produced nothing less than a masterpiece in *The Skull of Australopithecus afarensis*. In fact, it is difficult to find sufficient accolades for this impeccably organized study. The detailed, yet readable text is highly concise. More than 61 tables provide a wealth of raw data and over 117 illustrations including photographs, drawings, and various comparative diagrams and graphs generously illustrate the book from beginning to end. Among the figures are numerous ingenious comparative diagrams, which speak volumes and are clearly the means by which the authors have managed to achieve their monumental study in a mere 254 pages. The most complete *A. afarensis* skull, the AL 444-2 male, recovered at Hadar in 1992, forms the monograph's centerpiece. However, few craniofacial specimens from the *A. afarensis* sample escape consideration in this exhaustive study. Nor are the comparisons therein limited to *A. afarensis*. Kimbel *et al.* evaluate their findings within the broader context of Pliocene hominid (the authors use *hominin*) evolution through extensive comparisons with nearly all relevant Pliocene hominid specimens, as well as with a respectable sample of extant great apes and modern humans. The result, the culmination of many years of work by each author and clearly a labor of love, inspires confidence in their conclusions and unambiguously prioritizes the challenges we must address to further our understanding of this fascinating time in our Family's evolutionary history.

The first of six chapters sets the stage for the rest of the book by presenting an up-to-date synopsis of *A. afarensis*, from an historical account of its discovery and earlier interpretations to an explanation of the current controversies surrounding this pivotal mid-Pliocene taxon. Readers are provided with a summary of its geographical, temporal, geological, and paleontological contexts and a useful listing of all *A. afarensis* specimens recovered at Hadar between 1990 and 2001. From the outset, the authors emphasize the importance of the A.L. 444-2 skull and the significant morphological and temporal gaps this key specimen fills in the *A. afarensis* record. As they explain, the paucity of relatively complete craniofacial remains in the *A. afarensis* hypodigm before the discovery of A.L. 444-2 seriously hampered prior meaningful analysis of the sample's evolutionary significance. In addition, A.L. 444-2's recent date of approximately 3.0 mya has greatly extended the more recent end of the *A. afarensis* temporal range with the sample now spanning the intriguing interval between the earlier *Australopithecus anamensis* and *Ardipithecus ramidus* and the later *Australopithecus africanus*, *Australopithecus aethiopicus*, and *Australopithecus garhi*.

Chapter 2 introduces the reader to the A.L. 444-2 skull itself, starting with an accounting of its discovery and context in 3.0 ± 0.2 mya old sediments on the eastern edge of the Kada Hadar tributary of the Awash River, February 26, 1992. Its subsequent recovery, cleaning, and reconstruction are thoroughly

documented, with considerable emphasis placed upon its preservation and painstaking reassembly from over 50 fragments. The authors spare little detail in describing the fossil's original condition and postmortem deformation and fully disclose related difficulties with its reconstruction. Despite their inability to fully correct some of its postmortem plastic deformation, the overall result is a magnificent fossil providing a huge amount of previously unavailable metric and qualitative data.

Chapters 3, 4, and 5 comprise the comparative morphological study of A.L. 444-2 and the majority of the book. Chapter 3 examines the reconstructed skull as a whole and includes qualitative and metric anatomical descriptions of the fossil and numerous comparisons with relevant living and extinct taxa. While such anatomical description is prone to be notoriously dry, I was pleasantly surprised to find these comparisons well-explained in an easily readable style. The authors also avoid losing their readers in what could have been an overwhelming collection of metric data through the use of numerous innovative explanatory figures, among which many readers will recognize the work of Yoel Rak. Other valuable resources in this chapter are 28 lengthy metric tables and smaller compilations of metric data broken out of the text but not granted tabular status. This chapter alone includes 66 figures ranging from beautifully detailed drawings of A.L. 444-2 to various types of schematics. The only major anatomical complex not illustrated is the dural venous sinus system—a slightly surprising omission considering its well-documented differences among australopithecines and author William Kimbel's interest in its patterning.

Two guest authors, Ralph L. Holloway and Michael S. Yuan, present a first-class description and analysis of the A.L. 444-2 endocranial cast in Chapter 4. Their careful means of dealing with post-mortem distortions and of estimating endocast volume are discussed at length. Although the A.L. 444-2 endocast is rather poor in surface details, they have skillfully teased out a number of interesting observations. Perhaps the most fascinating of these describes the posterior endocast morphology as resembling robust taxa, and the anterior regions more closely resembling *A. africanus* and *Homo*, leading Holloway and Yuan to suggest that "a mosaic pattern of hominin brain evolution may have already been in place before 3ma" (p. 135). Consistent with other chapters, metric data are presented in an excellent series of tables. Unfortunately, the photographs in this chapter are not as crisp as elsewhere in the book and would have benefited from accompanying line drawings.

Chapter 5 is a meticulous, 73-page, bone-by-bone examination of the A.L. 444-2 skull. Here, using classic anatomical description at its finest, the authors thoughtfully examine the skull's composite parts. The text is richly supplemented by 21 tables, which offer extensive comparative metric data also depicted in numerous graphic representations including scattergrams, morphoclines, bivariate plots and more. In addition to examining individual bones, the authors also analyze regional complexes. For example, the bones forming the nasal cavity are studied as integral units and not simply as disassociated elements. Many of the more interesting aspects of A.L. 444-2's craniofacial morphology are documented and compared with other specimens photographically, with stereophotographs enhancing visualization in some cases. Both the maxillary and mandibular dentitions of A.L. 444-2 are also described in this chapter. However, it is the lucid reassessment of previous characterizations of the *A. afarensis* craniofacial complex woven skillfully into this superb analysis of the A.L. 444-2 skull that makes this my favorite chapter.

The Skull of Australopithecus afarensis ends with an engaging recapitulation and synthesis of the findings detailed in previous chapters. In light of A.L.444-2 and other new craniofacial remains the authors argue convincingly in favor of the taxonomic unity of *A. afarensis*, and justify the inclusion of Laetoli and Garusi with the Hadar material based on close scrutiny of temporal, geographic, and developmental variation within the overall sample. They conclude that the Laetoli *A. afarensis* sample is intermediate

morphologically as well as temporally between later *A. afarensis* at Hadar and earlier *A. anamensis*, although they avoid reaching any conclusions regarding the possible phylogenetic significance of this intermediacy. Finally, Chapter 6 concludes with a previously impossible 82-character cladistic analysis based on craniodental traits largely represented in the A.L. 444-2 specimen. As the authors point out, the resultant cladograms solidly place *A. afarensis* in a basal position compared with other Middle and Late Pliocene hominids. Interestingly, this detailed exercise was unable to clarify the phylogenetic relationships of *A. africanus* to other Pliocene taxa—a finding that Kimbel, Rak, and Johanson hint might very well support recent notions that more than one taxon is included in the *A. africanus* hypodigm.

Overall, the production is excellent, from the nearly flawless copyediting to the high quality of the materials and durable binding. The drawings and graphics are excellent, although details are difficult to visualize in some of the photographs as is often the case with fossil specimens of this condition. The authors note that their reconstruction of A.L. 444-2 involved the use of computerized tomography and the inclusion of some images would have been an interesting addition. Nevertheless, we are promised in the first chapter that the task of describing A.L. 444-2 is ongoing, so we may see such images in future publications. The 11-page index contains excellent cross-referencing of all specimens and taxa examined, an extremely useful feature that vastly simplifies what might otherwise be the cumbersome task of locating particular fossils in such an extensive comparative study. However, additional anatomical listings would have been helpful; I had to intensively examine the book to find 'vomer,' which was described in the text but not indexed.

As the authors point out on more than one occasion, previous descriptions of *A. afarensis* were undertaken without the benefit of good adult cranial remains, with the result that earlier interpretations were best viewed as tentative. The success of their ambitious undertaking to utilize A.L. 444-2 in remedying this situation is amply clear throughout the book. Considering that *The Skull of Australopithecus afarensis* is a definitive reference, sure to be an enduring classic, it is well worth the cost, and is a must for the library of any serious paleoanthropologist. At the book's outset, the authors state their intention ". . . to create a document of record, including description, measurement, and comparison of the first complete adult *A. afarensis* skull" (p. 10). With the publication of this distinguished, scholarly monograph, they have more than succeeded.