

ranked Shklovsky that his internal passport listed him as "Jew," not "Russian," especially since his education in the Soviet system had made him feel very much a full-fledged citizen of the country and he had served it well. He observes how many others suffered, sometimes much more seriously, from this pervasive anti-Semitism. Despite the extensive damage done to him by anti-Semitism, it is interesting that his condemnation of it, at least here, is limited—he seems to look upon anti-Semitism as one example among several of the weaknesses of some of the people in powerful positions in the Soviet Union.

Because of his contempt for pretense, Shklovsky loved to visit the West, where to him things were much closer to what they claimed to be. I remember a jolly walk with him on the first day of a meeting in Brighton, England. As though he had lived there all his life, he somehow knew how to lead us directly to his prime goal: a shoe store. He stood in front of the window and exalted at the shoes he saw; he knew they would be of a quality commensurate with their appearance, that he could buy them, and to him all was right with the world. In the book he describes a time when, by mistake, he was given a visa that allowed him to stay 12 days in Paris after a meeting. He had almost no money, but he was not

about to be denied those days in Paris; here you can find a charming lesson on how to live in Paris on \$1.40 a day and love every minute of it.

Nevertheless, Shklovsky's heart was deep in Russia. Although he knew he could have any number of glorious jobs in the West and could escape all the ill treatment he received in his own country, as far as we know he never even considered any of the many opportunities he had to leave Russia. In fact, if the subject was raised, he would not even talk about it. This was to the great benefit of the Soviet Union. He was an amazingly creative scientist. He started many important projects. He trained and motivated a large number of leading Soviet astronomers; indeed he worked hard to bring out the best in people. Recently we held a joint U.S.A.-U.S.S.R. scientific symposium that was attended by an impressive Soviet delegation. It was remarkable how many of those scientists had been students or colleagues of Shklovsky's. This book captures beautifully the essence of this unique and humane person, and how he came to be a person who could so influence his own and future eras.

FRANK D. DRAKE
Lick Observatory,
University of California,
Santa Cruz, CA 95064

***Homo habilis* in Detail**

Olduvai Gorge. Vol. 4, The Skulls, Endocasts and Teeth of *Homo habilis*. P. V. TOBIAS. Cambridge University Press, New York, 1991. Two volumes, boxed. xxxvi, 921 pp., illus., + plates. \$175.

Summer 1959 witnessed the discovery of what would prove to be two new, early species of extinct Hominidae from the oldest sediments exposed in the deepest reaches of Olduvai Gorge, northern Tanzania. The first, represented by a small jaw fragment with wisdom tooth (Olduvai Hominid 4), was utterly overshadowed by Mary Leakey's finding, shortly thereafter, of the marvelously preserved cranium (OH 5) that became the type of *Australopithecus boisei* (L. S. B. Leakey, 1959). However, beginning in late 1960 and repeatedly thereafter, further discoveries, largely from *in situ* excavations, eventuated in the recovery of additional hominid skull parts, some comparable to the initial fragment of 1959, sufficient to warrant recognition of a new species attributed to genus *Homo*, *H. habilis* (L. S. B. Leakey, P. V. Tobias, and J. R. Napier, 1964). In late 1968 the first largely complete, though much crushed, cranium with dentition (OH 24) was recovered, and subsequently (1971) it also was attributed to the species. In all as

MicroMath Scientific Software

"It is unworthy of excellent men to lose hours like slaves in the labor of calculation which could be relegated to anyone else if machines were used."

- Gottfried Wilhelm von Leibnitz (1646-1716)

"The operations of analysis are now capable of being executed by machinery... As soon as an analytical engine exists, it will necessarily guide the future course of science."

- Charles Babbage (1792-1871)

"All science as it grows toward perfection becomes mathematical in its ideas."

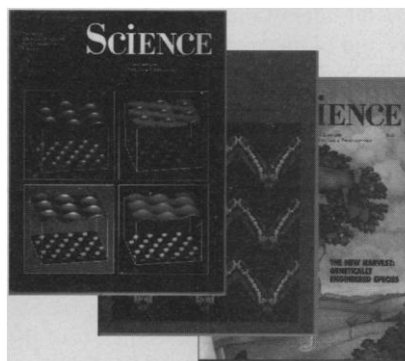
- Alfred North Whitehead (1861-1947)

"If you do much mathematical work you should be aware of MicroMath. Recommended."

- Jerry Pournelle, BYTE (Feb 1991)

**Call for your free catalog
1-800-942-6284 (MATH)**

Quotes above are from Isaac Asimov's *Book of Science and Nature Quotations*.
Weidenfeld & Nicolson, 1988 (with the exception of Pournelle).



ORDER ADDITIONAL COPIES OF ARTICLES YOU HAVE SEEN IN SCIENCE

For full details and prices, call the Science Reprint Service and ask for Corrine Harris at (202) 326-6527 or fax your request to (202) 682-0816. You may also write us at Science, 1333 H St., N.W., Washington, D.C. 20005.

Master Card and Visa accepted

many as two dozen individuals constitute the current Olduvai sample of this species, including (referred) postcranial elements and even diverse portions of a single individual's skeleton (OH 62, found 1986).

These volumes, constituting the fourth in the Olduvai series and again lavishly produced by Cambridge University Press, document these discoveries, comment on the ensuing, often heated debate regarding their systematic status and phylogenetic significance, and consider the current status of *H. habilis*. Since its formal recognition as a new taxon, Phillip Tobias has in over 50 publications examined the nature, validity, and evolutionary significance of this ancient human species. These exquisitely detailed volumes are the culmination of his efforts and constitute the definitive treatment of the Olduvai fossil sample.

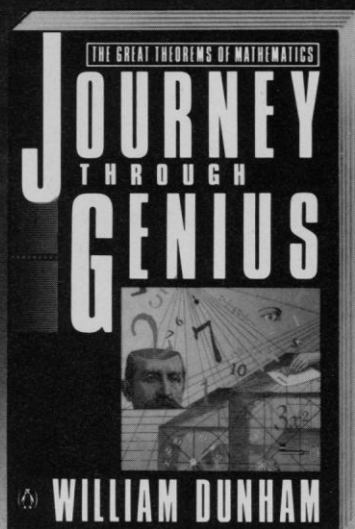
What sort of hominid was Olduvai's *Homo habilis*? It was of diminutive stature (a female individual perhaps a meter in height), weighed some 25 to 35 kilograms, and had disproportionately long upper and shortened (upper) lower limbs. Sexual dimorphism was apparently moderate to substantial (broadly chimp-like). A partial femur (OH 62) reveals some primitive (*Australopithecus*-like) features; but the (attributed) subadult leg bones (OH 35) and partial subadult foot skeleton (OH 8) reveal an

overall morphological pattern of human-like proportions and indicative of habitual upright stance and bipedal gait; the foot was essentially derived, not prehensile but plantigrade and propulsive, with adducted hallux, transverse and longitudinal arches, and close-packed tarsal elements, although lateral deviation of the heel was ill-expressed. Some bones of the manus (OH 7), mostly of a subadult and considered to represent the species because of their direct association with the type cranial parts, are more mosaic in morphological pattern: the digits exhibit strong flexor musculature, and the set of the thumb is indicative of some opposability if not full-power ("squeeze") grip capability. Cranial capacity is significantly greater (by some 10 standard deviations) than in *A. africanus*, the *Australopithecus* species generally accorded the closest proximity to *Homo* ancestry, and the endocranium exhibits diverse, particularly transverse, expansion of fronto-parietal and temporal areas, altered sulcal and gyral dispositions, discernible expressions of two "language-related" (Broca's, Wernicke's) motor areas, and elaborated ramifications and anastomoses of the meningeal vascular system. The cranial base exhibits, relative to *A. africanus*, altered disposition of the atlanto-occipital joint, shortened anterior segment, and realignment and altered morphologies of aspects of the tem-

poral bone, including the temporo-mandibular joint and the petrosal and mastoid areas. Calvarial vault bones are thinned and cranial tori are modest, though the supraorbital is salient; the brain case is elevated above the orbits and the frontal is domed; ectocranial superstructures are slight and realigned; and the occipital region reflects altered curvature, proportions, and attendant disposition of cranio-vertebral musculature. The facial skeleton is reduced ("gracilized") overall, although alveolar prognathism is substantial; the palate is reduced; and the form of the mid-face, including the cheek region and nasal aperture, is altered. Mandibular robusticity is reduced, as are heights of the corpus and symphysis, and the interbody space is enhanced. Cheek-tooth size is relatively reduced, particularly posteriorly, and some anterior cheek teeth are relatively elongated with narrowed crowns and modified occlusal patterns; enamel is thinned and exhibits retarded attrition, and there is a distinctive twisted or helicoidal pattern of dental wear. Upper central incisors are large, the laterals are small, and the canines are generally high-crowned. Hence, overall the cranio-dental morphology diverges in consistent and important ways from the *A. africanus* condition, often considered the best (better) ancestral model for *Homo*. There are, however, some linkages postcra-

THE ART OF SCIENCE

"I have never come across a book like Dunham's. It is mathematics presented as a series of works of art... mathematics by lightning flash."
—Isaac Asimov



NOW IN PAPERBACK

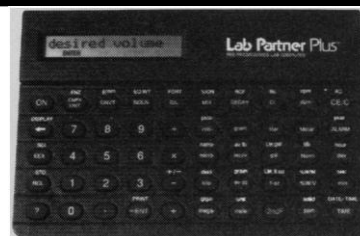
This ingenious look at twelve mathematical masterpieces—and the personalities behind them—proves that great mathematicians are just as creative, and often as eccentric, as great artists.

For the best in paperbacks, look for the PENGUIN



Circle No. 96 on Readers' Service Card

NEW LAB PARTNER PLUS™ IS THE PERFECT SOLUTION.



Free 10-Day Trial

Save time, money and chemicals with the infallible precision of *New Lab Partner Plus*. Lab Partner Plus contains powerful programs that allow you to make complicated conversions among different types of units with the touch of a button. And, for radiochemical users its incredible mixture program eliminates the guesswork of juggling volumes, masses and activities. So, don't settle for a partial solution, get the perfect solution **every time** with Lab Partner Plus. **Only \$279.95.** *Original Lab Partner™ still only \$199.95.*

For 10-day trial, more information or to order call 1-800-277-6045

Also available from you favorite distributor.

Circle No. 168 on Readers' Service Card



✱ **New Version 6.0** ✱ **Superb User-friendly Graphics Package** **for IBM PC/PS2 and Compatibles**

The latest release of Fig.P is even more powerful but retains the admired empathic Fig.P interface. There is a new spreadsheet data editor and lots more formats for acquiring data. Multi-figure production and batch output of figures is even easier. There is an integral notepad facility. Lots more predefined equations have been added together with statistical tests and area-under-peaks calculator. There are more output drivers and HPGL plotters can now print poster size. There is a completely new manual.

Fig.P retains its powerful graph/diagram drawing and labelling facilities with true WYSIWYG. Its fast operation and amazing control over all aspects of style are still there. Numerous data manipulations and transforms are available. Fig.P offers many types of curve fitting including a powerful equation plotter. Great output can be achieved on printers, laser printers, plotters, slidemakers etc and Fig.P can export to wordprocessors and DTP programs. It can store templates of usual figure styles. There is mouse support.

SEND FOR FREE DEMO

\$499



What Reviewers say about Fig.P

"The current version is a very powerful program with all the features which a user would like for custom design and formatting of graphs."

Biotechnology Software

"This versatility in figure design is where Fig.P really excels."

Journal of the American Medical Association

"Fig.P offers exceptional control over the production of figures."

Binary

"The combination of high quality graphics with good data handling and a non-linear curve-fitter makes a most useful tool."

Trends in Neurosciences

ALREADY BOUGHT THE WRONG PACKAGE?

If you bought a science graphics package costing more than \$300 and you want to change to Fig.P, enquire about our half-price deal.

BIOSOFT®

PO Box 10938, Ferguson, MO 63135. Tel(314) 524-8029 Fax(314) 524-8129

Europe: BIOSOFT, 22 Hills Road, Cambridge CB2 1JP, U.K. Tel +44 223 68622 Fax +44 223 312873

Circle No. 81 on Readers' Service Card

nially with the former taxon. There are similarly extensive and substantial divergences from either *Homo erectus* (s. str.) or its African antecedent, variously considered as the same or even a distinct, though (probably) ancestral taxon (*H. ergaster*).

At Olduvai the *H. habilis* deme occurred (in discrete horizons, often with associated vertebrates and artifacts) in sediments of an intermittently flooded, saline-alkaline lake margin with interbedded tephra in Bed I and to just above Lemuta Member aeolian-sorted tephra in (middle) Bed II. The time interval encompasses the eponymous Olduvai (N) geomagnetic subchron, here well dated radiometrically to 1.85 to 1.65 Ma, and the immediately reversed upper Matuyama (R) chron. Changes in environment, from more mesic (forested to wooded savanna) to more arid (substantial grassland) in Bed I and back to more mesic in (lower) Bed II, are consistently documented by sediments, isotopic geochemistry, palynology, and fossil vertebrates. Another hominid, *A. boisei*, is present, relatively uncommonly, penecontemporaneously within the basin during this interval (and later as well).

The other major occurrence of *H. habilis*, in eastern Africa, is in alluvio-deltaic and lake margin deposits of the Koobi Fora Formation, eastern Turkana basin (Kenya). There it is rather older, 1.9 to 1.88 Ma, although several specimens occur at 1.85 Ma; in the adjacent Omo basin (Ethiopia) it may extend still further back in time. Crania, mandibles, and dental elements, some assorted postcrania, and a fragmented skeleton (ER-3735) afford evidence critical toward fuller delineation of the species's overall structure and morphology. In the earlier time range *A. boisei* is very rare (four cranial parts), subsequently (1.85 to 1.65 Ma) increasing in abundance remarkably ($N =$ at least 34). Yet another hominid species, sometimes attributed to *H. habilis* (by various workers, including Tobias and previously myself) but now appropriately considered as a distinct taxon (*Homo* sp. nov. of B. A. Wood and others), occurs largely in the older time range. It differs significantly from *H. habilis* in cranio-gnathic-dental morphology, and evidently also in postcranial size and morphology, to judge from a diversity of such elements (unfortunately lacking direct skull-part associations). At the (presumed) end (1.85 Ma) of its documented span *H. habilis* is here penecontemporaneous with or succeeded by aforesaid *H. sp.* "aff. *erectus*" (= *H. ergaster*), as documented by at least seven cranio-gnathic specimens, between 1.85 and 1.65 Ma. Curiously, there is no concrete evidence for the latter species within the interval within which *H. habilis* occurs at Olduvai. The multiplicity of hom-

inid taxa, some persistent and some seemingly new appearances, documented in the reaches of the paleo-Turkana basin within this span of some 0.5 million years, has forced workers to reassess previous conceptions both of anagenesis and cladogenesis in respect to the origin (or origins) and phylogeny of genus *Homo*.

H. habilis is here considered one consequence (the other a "robust" *Australopithecus* lineage) of a major cladogenetic event, a moment of "explosive evolution," around 2.5 to 2.3 Ma, broadly coincident with an episode of significant global climatic change inducing cooler, drier conditions and attendant environmental circumstances in equatorial and adjacent lower latitudes; this was an interval, also, when both extinctions and "vigorous autochthonous bio-evolution characterized Africa in the dying eons of the Pliocene." The source (last common ancestor) of the splitting event is surmised to have been a "derived" morphotype of *A. africanus*, that is, a descendant of *A. africanus* and its forerunner, *A. afarensis*. The proleptic progenitor, postulated on the basis of a shared derived complex (synapomorphies) of cranial features found to co-occur in (subsequent) *A. boisei/robustus* and *H. habilis*, constitutes a projected link, although Tobias considers such a link might be represented even by the Taung child or be already in hand but insufficiently recognized among Omo-Shungura (Ethiopia) hominids of the appropriate geological age. *H. habilis* is recognized as "a very early maker of stone tools to a set and consistent pattern," a species whose "cultural achievements . . . imply a high degree of intelligent activity" and a "lifestyle of much greater complexity," such that "the transmission of such a culture would seem to have required speech and language," an evolutionary novelty substantiated perhaps "by the appearance on the endocasts of evidence that the cerebral bases for spoken language were already present." In sum, "*Homo habilis* was enabled by its cerebral revolution to attain a new mode of evolution, as an articulate, language-bound, culture-dependent hominid."

The author's perspective on the phylogenetic status of this species derives appropriately from overall morphological-structural-functional analysis, the species' range in geologic time, an appraisal of the fossil record of other ancient Hominidae, and behavioral inferences from archeological and vertebrate residues at some half-dozen Olduvai localities. Different perspectives lead other investigators to dissimilar interpretations. Such dissimilitude is reflected in a substantial and growing literature, a fair amount of which is not considered (cited) by the author (in part, at least, because these

volumes were delivered to press almost five years prior to actual publication).

Tobias's monumental effort, essentially directed toward documenting the biological nature of an extinct human species at the unique Olduvai locality, provides as well a perspicacious, sweeping perspective relative to many aspects of hominid evolution. These volumes thus not only are a lastingly invaluable documentary reference but set forth diverse aspects of a research program that will engage students of the evolution of humankind for decades to come.

F. CLARK HOWELL

Laboratory for Human Evolutionary Studies,
Department of Anthropology,
University of California,
Berkeley, CA 94720

Books Received

Brain Size and the Evolution of the Mind. Harry J. Jerison. American Museum of Natural History, New York, 1991. viii, 99 pp., illus. Paper, \$10. James Arthur Lectures on the Evolution of the Human Brain, 59. From a lecture, New York, 1989.

Coal Science 2. Harold H. Schobert, Keith D. Bartle, and Leo J. Lynch, Eds. American Chemical Society, Washington, DC, 1991. xiv, 337 pp., illus. \$77.95. ACS Symposium Series, 461. From a symposium, Miami Beach, FL, Sept. 1989.

Designing Intelligence. A Framework for Smart Systems. Steven H. Kim. Oxford University Press, New York, 1990. x, 273 pp., illus. \$39.95.

The Electrical Resistivity of Metals and Alloys. Paul L. Rossiter. Cambridge University Press, New York, 1991. xvi, 434 pp., illus. \$100; paper, \$37.50. Cambridge Solid State Science Series. Reprint, 1987 ed.

Flux Coordinates and Magnetic Field Structure. A Guide to a Fundamental Tool of Plasma Theory. Springer-Verlag, New York, 1991. xii, 241 pp., illus. \$98. Springer Series in Computational Physics.

Fossil Fuel Combustion. A Source Book. William Bartok and Adel F. Sarofim, Eds. Wiley, New York, 1991. xiv, 866 pp., illus. \$99.95. A Wiley-Interscience Publication.

Genital Papillomaviruses and Related Neoplasms. Christopher P. Crum and Gerard J. Nuovo. Raven, New York, 1991. x, 230 pp., illus. \$82.

Holographic Interferometry in Experimental Mechanics. Yu. I. Ostrovsky, V. P. Shchepinov, and V. V. Yakovlev. Springer-Verlag, New York, 1991. x, 248 pp., illus. \$69.50. Springer Series in Optical Sciences, 60.

Inner Earth. A Search for Anomalies. A Catalog of Geological Anomalies. William R. Corliss. Sourcebook Project, Glen Arm, MD, 1991. vi, 224 pp., illus. \$18.95. Catalog of Anomalies, vol. 11. Geology Series, vol. 4.

Long-Range Electron Transfer in Biology. P. Bertrand *et al.* Springer-Verlag, New York, 1991. viii, 233 pp., illus. \$98. Structure and Bonding, 75.

Medical Education, Accreditation and the Nation's Health. Reflections of an Atypical Dean. Andrew D. Hunt. Michigan State University Press, East Lansing, MI, 1991. x, 162 pp. \$20.

Numerical Modeling in Applied Physics and Astrophysics. Richard L. Bowers and James R. Wilson. Jones and Bartlett, Boston, 1991. xiv, 705 pp., illus. \$65.

Paysages Quaternaires de L'Afrique Centrale Atlantique. Raymond Lanfranchi and Dominique Schwartz. ORSTOM, Paris, 1991. 535 pp., illus. Paper, F 200.

Quantum Semiconductor Structures. Fundamentals and Applications. Claude Weisbuch and Borge Vinter. Academic Press, San Diego, CA, 1991. xii, 252 pp., illus. Paper, \$34.95.

River Projects and Conservation. A Manual for Holistic Appraisal. John L. Gardiner, Ed. Wiley, New York, 1991. xxxiv, 236 pp., illus. Spiral bound, \$125.

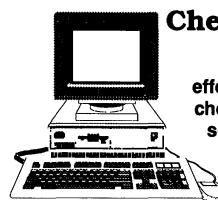
Seafood Safety. Committee on Evaluation of the Safety of Fishery Products, Institute of Medicine. Farid E. Ahmed, Ed. National Academy Press, Washington, DC, 1991. xvi, 432 pp., illus. \$49.95.

Chemistry Drawing Software

NEW by **SoftShell**
INTERNATIONAL

ChemWindow 2.0

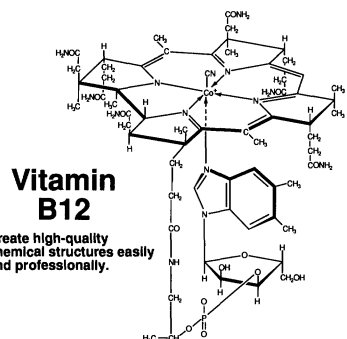
and
ChemWindow Classic



for the most
effective PC-based
chemistry drawing
software for both
large and small
DOS systems.

ChemIntosh

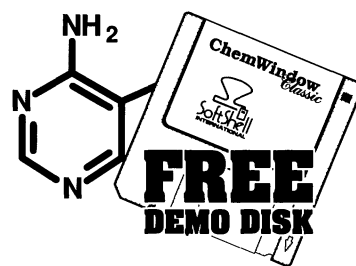
for the Macintosh
environment
provides a
quick and effective
way of
producing
high quality graphics.



Vitamin B12

Create high-quality
chemical structures easily
and professionally.

- User-defined Custom Tools
- Built-in Chemistry Scrapbook
- Multiple Drawing Styles
- Typeset-Quality Output
- Free Upgrades for 1 Year



To Order Call:
(303) 242-7502

Fax (303) 242-6469

SoftShell
INTERNATIONAL