

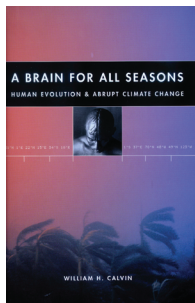
READINGS

BOOK REVIEWS

A BRAIN FOR ALL SEASONS: HUMAN EVOLUTION AND ABRUPT CLIMATE CHANGE

William H. Calvin, 2002, 341 pp., \$25.00, hardbound, University of Chicago Press, ISBN 0-226-09201-1

In *A Brain for All Seasons: Human Evolution and Abrupt Climate Change*, William Calvin argues that sudden climate flips catalyzed quantum leaps in human intelligence. Calvin, a theoretical neurobiologist, contends that famine and hominid population crashes following abrupt climate changes during the past 2.5



million years helped select for innovation, cooperation, and communication. Cold snaps, suddenly reversing rapid warming trends, presented surviving bands of hominids with drastically altered conditions in which to adapt. Collaboration, it appears, was as much a force as competition in shaping our evolution, and sudden environmental shifts may have provided the jolts.

There is growing interest in the role of multicentury droughts in the collapse of civilizations (Dalfes et al. 1994) and as drivers of large-scale human migrations (Nunez et al. 2002). While traveling from Darwin's home outside London to the Great Rift Valley of Africa and over the North Atlantic Ocean Current, Calvin integrates complex datasets drawn from ice cores, lake beds, and genetic analyses with conceptual frameworks depicting Earth's climate and orbital cycles. Calvin argues that the cold, dry, windy, dusty conditions following climate "whiplashes" led to widespread forest fires, altered landscapes, and transformed environmental challenges.

Following the population crashes, small bands of small-brained *Australopithecines* and later *Homo ergaster/erectus*—who formerly made a living off forest "services"—became dependent on hunting savanna-grazing mammals. This part is not new. But to hunt successfully, Calvin contends, hominids had to innovate (tools and hunting implements, the enigmatic "hand axes" and spears). They had to cooperate and even share the bounty with those not participating in the hunt (as surviving chimps still do today).

Most research on intelligence focuses on how synaptic connections and neural networks explain our abilities to plan, reflect, and (sometimes) self-correct. Mathematician John Nash developed a model for how mutually beneficial group decisions (reciprocal altruism) can flow from self-interest (Nasar 1998). But Calvin focuses on the pressures that helped mold the neural architecture out of the dynamic conversation among gene networks, proteins, and the environment.

Calvin draws heavily on the concept of punctuated equilibrium developed most prominently by Stephen Jay Gould. Steady stresses are one thing; intermittent, nonlinear perturbations favor greater variation and speciation. Calvin also leans on Jared Diamond's masterful work, *The Third Chimpanzee* (Diamond 1993), and makes use of island biogeography. Refugia and niches during climatic punctuations may have abetted evolution, and evolutionary pressures that spurred variance in peripheral populations would later penetrate to those at the center.

The first hominid skulls found—the Taung child (1924, by South African quarry workers), and in the Olduvai George (1959, by Louis Leakey)—were complemented by others exposed along the Great Rift Valley embankments and the "blisterlike uplift" of the African highlands. DNA dating suggests our chimp-bonobo ancestors began walking upright in wet woodlands some 5.8 million years ago (mya). Climatic and landscape changes over the subsequent 3 million years further encouraged knee and hip alterations. (Biologist Elizabeth Vrba is mentioned, though her pioneering work in this area is omitted.) While bipedalism allowed faster locomotion (e.g., to carry young, wade rivers, and cross open spaces), brain size did not change appreciably during this period. Then, ~2.5 mya things got more interesting. From that time to the present, brain size increased threefold and the neocortical surface (associated with reorganization) increased fourfold.

Around 3.1 mya plate tectonics closed off the Panama Isthmus. The detour in Atlantic Ocean currents intensified the Gulf Stream, culminating in the North Atlantic deep water (NADW) formation. The Gulf Stream brought warm water and more moisture to northern latitudes, paradoxically initiating the modern ice age (Shackleton et al. 1984). (This is Calvin's first example of warming leading to cooling, though not abruptly in this period.) Around 2.5 mya, tectonic plate movements also drove the Indian subcontinent up into Asia, and the emerging Himalayan pinnacles pierced the troposphere, shifting surface winds to suit the new contours.

Vostok ice core records (from Antarctica) extending back 420,000 years (Petit et al. 1999) reveal the seesawing between glacial periods of ~100,000 years (with polar caps covering ~1/3 of the land surface) and warm interglacials of ~10,000 years (with caps covering ~10% of the land). There were apparently many such cycles beginning 2.5 mya, and prior to 800,000 years ago interglacials may have interrupted glacial periods every 41,000 years (Berger et al. 1989).

Calvin focuses on the Younger Dryas, the cold reversal following rapid warming that occurred ~12,900 years ago toward the end of the Last Glacial Maximum (LGM). (Dryas, he explains, was a cold-loving tundra flower of the rose family, found unexpectedly in pollen records dated to that era as far south as Den-

mark.) Hundreds of reversals on a 1500-year (Dansgaard-Oeschger event) cycle, Calvin contends, created a bust-and-boom pulsation to hominid populations, as succeeding warm periods expanded grasslands and herds into previously arid regions. During the more hospitable stretches some survival skills would prove less useful; while the recurrence of harsh conditions 1500 years later might have up- or down-regulated previously encoded traits and abilities.

The long cycles, as Yugoslavian mathematician Milutin Milankovitch unraveled, reflect changes in insolation as a function of orbital shape and Earth's tilts, and the wobbles influenced by the gravitational pull of other planets.

High-resolution ice core records from the end of the LGM suggest that derivatives of change—increased rates of warming (or cooling) and heightened variability—may herald rapid climate change events (Mayewski and White 2002; National Academy of Sciences 2002). [John Nash's second great (unsolved) problem was to mathematically describe nonlinear, phase-state changes. Examining systemic-level characteristics of instability, on the other hand, might provide antecedent indicators of increased sensitivity and propensity to abrupt changes.]

So how stable is the climate today? Berger and Loutre (2002) calculate that Milankovitch harmonics indicate that, contrary to the cycles of the past 420,000

NEW PUBLICATIONS

ENVIRONMENTAL STRATIFIED FLOWS

Roger Grimshaw, Ed., 2002, 284 pp., \$135.00, hardbound, Kluwer Academic, ISBN 0-7923-7605-6

The dynamics of flows in density-stratified fluids are an important topic for scientific enquiry. Flows arise in many contexts, ranging from industrial settings to the oceanic and atmospheric environments. Both the ocean and atmosphere are characterized by the basic vertical density stratification, and this feature can affect the dynamics on all scales ranging from the microscale to the planetary scale. This volume provides a state-of-the-art account of stratified flows as they are relevant to the ocean and atmosphere, with a primary focus on mesoscale phenomena.

THE INTERNATIONAL YEARBOOK OF ENVIRONMENTAL AND RESOURCE ECONOMICS 2002/2003: A SURVEY OF CURRENT ISSUES

Tom Tietenberg and Henk Folmer, Eds., 2002, 448 pp., \$100.00, hardbound, Edward Elgar Publishing, ISBN 1-84376-213-7

This annual publication provides a cutting-edge survey of current research by the leading experts in the field of environmental and resource economics. It includes contributions on climate change policy, general equilibrium models in environmental and resource economics, progress and problems in the economics of sustainability, linking environmental ethics and environmental policy, and other topics.

AIR POLLUTION X

C. A. Brebbia and F. Martin-Duque, Eds., 2002, 840 pp., \$385.00, hardbound, WIT Press, ISBN 1-85312-916-X

This book contains most of the papers presented at the Tenth International Conference on the Modelling, Monitoring and Management of Air Pollution. Emphasis is placed on the development of experimental and computational techniques, which can be used as tools to aid the solution and understanding of practical air pollution problems, and on issues related to health effects, such as studies of aerosols and particles. Topics include air pollution modeling, air quality management, global and regional studies, monitoring and laboratory studies, remote sensing, and urban air pollution.

years, the relatively stable 10,000-year-old Holocene is not preprogrammed to end any time soon. But has the buildup of greenhouse gases in the atmosphere changed the equation?

Combined with the observed increased rate of warming and variability over the past quarter century (Houghton et al. 2001), accelerating retreat of montane glaciers and melting of part of Greenland's grounded ice through crevasses to the base may be the most tangible indications of instability. In 1961, oceanographer Henry Stommel warned of the potential danger of decreased salinity in the North Atlantic Ocean. The freshening occurring today is accompanied by a 20% decline in the last 50 years of the eastern branch of the NADW formation in the Greenland Sea (Hansen et al. 2001).

In *The Sea Around Us* (1952), Rachel Carson described the vast ocean current that constitutes a global thermostat, and Calvin properly acknowledges the salient work of geochemist Wally Broecker in deciphering thermohaline circulation—the grand conveyor belt that modulates climate and whose shifts appear to shepherd abrupt changes. Calvin's greatest concern is that, as ice melts and rainfall increases at high latitudes, we may be headed toward another cold reversal—soon. Will thermohaline circulation remain unstable for some time or might it suddenly shift south, as it did to initiate the Younger Dryas? And

would such a flip, fears Calvin, lead to a reorganization of the 6-cell atmospheric structure—Hadley, Ferrell, and polar cells in each hemisphere? Calvin notes that a cold reversal also appears in the record some 122,000 years ago in the middle of the warm Eemian (130,000–117,000 years ago), when there was as little (or perhaps less) continental ice as there is today!

One can take issue with the fine points of Calvin's eclectic and synthetic analysis. But Calvin—author or coauthor of 10 books (e.g., *The Cerebral Code*)—adopts a bold and compelling approach toward unraveling just how Earth's convulsive history helped shape the way we think, talk, organize ourselves, and question, observe, and analyze everything around us.

Calvin does question our use of resources and generation of wastes now altering atmospheric chemistry, physics, and biological systems (Houghton et al. 2001). Unfortunately, his prescriptions are not preventive. Calvin might have recommended a change in our energy diet and substantial incentives to jumpstart the energy transition. But Calvin resorts to heroic measures—such as blocking ice flows in North Atlantic passages to help maintain thermohaline circulation. While technological fixes are always tempting, they are fraught with unanticipated side effects and rarely constitute sustainable solutions to systemic level problems.

AIR POLLUTION MODELING AND ITS APPLICATION XV

Carlos Borrego and Guy Schayes, Eds., 2002, 544 pp., \$185.00, hardbound, Kluwer Academic, ISBN 0-306-47294-5

In 1969 the North Atlantic Treaty Organization (NATO) established the Committee on Challenges of Modern Society (CCMS), and air pollution has always been one of the major issues studied by this committee. This volume contains papers from the 25th NATO/CCMS International Technical Meeting on Air Pollution Modelling and Its Application. Main topics include the role of atmospheric models in air pollution policy and abatement strategies; integrated regional modeling; global and long-range transport; and regional air pollution and climate.

ENCYCLOPEDIA OF ATMOSPHERIC SCIENCES (SIX-VOLUME SET)

James R. Holton, John Pyle, and Judith A. Curry, Eds., 2002, \$1400.00, casebound, Academic Press, ISBN 0-12-227090-8

This is the first reference work to cover all aspects of the atmospheric sciences, including both theory and applications. Designed for the industrial and applied research market, it is written at a level that allows undergraduate students to understand the material. The scope of the work ranges from spectroscopy of atmospheric particles to weather prediction. It includes more than 350 articles and 1900 figures and photographs, with full color throughout.

EARTH UNDER SIEGE: FROM AIR POLLUTION TO GLOBAL CHANGE (SECOND EDITION)

Richard P. Turco, 2002, 530 pp., \$49.95, paperbound, Oxford University Press, ISBN 0-19-514274-8

This book examines one of the most important problems facing the modern age—air pollution. It provides a comprehensive description of the atmospheric environment, offering a basic understanding of how the physical environment surrounding us functions and how human activities are affecting it. This edition has been thoroughly revised and updated, incorporating many comments of previous readers in creating a concise new edition.

But I cannot truly fault Calvin for his desperate stab at interventions to restabilize the climate. This fascinating, well-written, highly entertaining, and convincing thesis provides a new perspective on human origins and demonstrates the value of integrative science in the evolution of new ideas and paradigms. Such integrative thinking might even contribute to a sudden shift in consciousness—and to the up-regulation of the cooperative and intelligent behavior that was so effectively expressed at other desperate times in not so distant eras.

—PAUL R. EPSTEIN

Paul R. Epstein, M.D., M.P.H., is associate director at the Center for Health and the Global Environment, Harvard Medical School. He served as a principal core author for the WHO/WMO/UNEP book Human Health and Climate Change (1996) and was a contributing author for the 1995 IPCC Second Assessment Report.

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