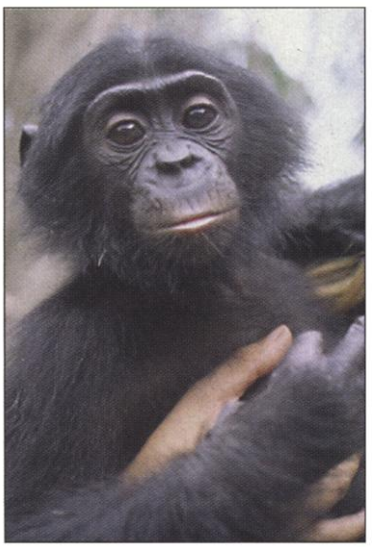
A group of more than 20 scientists urges the National Human Genome Research Institute to look toward the next step as the Human Genome Project (HGP) nears completion: "detailed analysis of one or more primate genomes is essential to full accomplishment of the overall goals of the HGP." The Living with a Star initiative proposed by NASA and the role planned for The Johns Hopkins University Applied Physics Laboratory in implementing the program if it is approved are discussed. And an idea that the sulfur isotope record from the Archean (around 3 billion years ago) could perhaps be explained by bacteria in the oceans that used molecular hydrogen instead of acetate for the reduction of sulfate is examined.

A Primate Genome Project Deserves High Priority

The initial goals of the Human Genome Project (HGP), to sequence the human genome and identify its constituent genes, are on the verge of being achieved. However, the scientific community recognizes that sequencing must be followed by understanding the manifold functions of human genes throughout the life-span, in health and in disease. In a *Science* interview (News Focus, 31 Mar., p. 2396), Francis Collins acknowledged this by saying, "Understanding what the sequence means will require us to make multiple comparisons....The arguments are quite strong for sequencing other mammals besides human and mouse...and for doing another primate."



Studying the primate genome promises to provide insight to understanding our own.

CREDIT: E. VAN KRUNKELSVEN AND D. DRAULANS

In our opinion, one or more primate genomes should receive the highest priority (*1*, *2*). An obvious candidate would be the chimpanzee genome, because it is more than 98% identical to the human genome (*3*). Because monkeys are much more appropriate for experimental purposes than apes, the genome of at least one of the commonly studied Old World primates should also be given high priority, for example, the rhesus macaque.

There are three fundamental reasons for analyzing primate genomes. First, we cannot fully understand human genome function until we have identified genetic features that underlie uniquely human anatomical, physiological, behavioral, and cognitive characteristics. To identify uniquely human aspects of gene structure and expression requires comparative data on related species. The mouse genome project will help, but analysis of rodent genomes can never tell us why we are not apes.

Second, there are compelling biomedical reasons for detailed comparisons with the chimpanzee genome (*4*). Several diseases differ in frequency and severity between chimpanzees and humans, including AIDS, Alzheimer's, cancer, and malaria. Understanding the genetic factors underlying these differences will help elucidate the etiology of such diseases and potentially increase our ability to control or cure them. There are also striking differences from human reproductive biology in apes (*4*), the genetic basis of which may help in understanding some major human reproductive disorders (*4*, *5*). Finally, the enormous differences in cognitive abilities between humans and apes must also have a fundamental genetic basis, notwithstanding the powerful influence that environmental factors have on the realization of genetically defined potential. Comparative data on the genetic factors that influence behavior and cognition will help elucidate normal brain functions as well as mental illness in humans.

Third, there is an urgent need to provide better protection for wild populations of primates, especially the great apes, and to optimize conditions under which captive apes are maintained. If the HGP officially embraces a primate genome project, public awareness of the close evolutionary relationship between humans and other primates will improve. An increase in ethically appropriate studies on basic aspects of ape anatomy, physiology, and development (*6*) might also be a likely outcome, which would favorably impact both research and conservation programs. Of course, as with the HGP, a primate genome project must be accompanied by careful consideration of all relevant ethical, legal, and social issues.

We conclude that detailed analysis of one or more primate genomes is essential to full accomplishment of the overall goals of the HGP. We hope that the National Human Genome Research Institute will begin such studies in the immediate future, while also exploring potential collaborations with biotechnology companies, who may be independently interested in comparative primate genomics (*7*). The recent announcement of a Japanese project to compare gene expression in chimpanzees and humans (*8*) suggests that an international strategic plan should be developed to minimize redundancy and maximize information that should become a globally available public resource.

Edwin H. McConkey
Department of Molecular, Cellular and Developmental Biology, University of Colorado, Boulder, CO 80309, USA. E-mail: mcconkey@stripe.colorado.edu

Ajit Varki
Department of Medicine, Glycobiology Research and Training Center, University of California, San Diego, La Jolla, CA 92093, USA. E-mail: avarki@ucsd.edu

Cosignatories: **John Allman**, California Institute of Technology; **Kurt Benirschke**, University of California, San Diego; **Francis Crick**, The Salk Institute; **Terrence W. Deacon**, Harvard Medical School; **Frans de Waal**, Emory University; **Achilles Dugaiczyk**, University of California, Riverside; **Pascal Gagneux**, University of California, San Diego; **Morris Goodman**, Wayne State University School of Medicine; **Lawrence I. Grossman**, Wayne State University School of Medicine; **Deborah Gumucio**, University of Michigan Medical School; **Thomas Insel**, Emory University; **Kenneth K. Kidd**, Yale University School of Medicine; **Mary-Claire King**, University of Washington; **Kenneth Krauter**, University of Colorado; **Raju Kucherlapati**, Albert Einstein College of Medicine; **Arno G. Motulsky**, University of Washington; **David Nelson**, Baylor College of Medicine; **Peter Oefner**, Stanford University; **George Palade**, University of California, San Diego; **Maryellen Ruvolo**, Harvard University; **Oliver A. Ryder**, Zoological Society of San Diego; **James Sikela**, University of Colorado Health Sciences Center; **Caro-Beth Stewart**, State University of New York, Albany; **Anne Stone**, University of New Mexico; **David Woodruff**, University of California, San Diego

References

1. E. H. McConkey and M. Goodman, *Trends Genet.* **13**, 350 (1997).
2. E. H. McConkey *et al.*, *Mol. Phylogenet. Evol.* **15**, 1 (2000).
3. M. King and A. C. Wilson, *Science* **188**, 107 (1975); C. G. Sibley and J. E. Ahlquist, *J. Mol. Evol.* **26**, 99 (1987); M. Ruvolo, *Mol. Biol. Evol.* **14**, 248 (1997).

4. A. Varki, *Genome Res.* **10**, 1065 (2000).
5. S. B. Eaton *et al., Q. Rev. Biol.* **69**, 353 (1994).
6. A. Varki *et al., Science* **282**, 239 (1998).
7. E. Pennisi, *Science* **288**, 2304 (2000).
8. R. Triendl, *Nature* **406**, 4 (2000).

NASA's Living with a Star Initiative

Andrew Lawler's News Focus article about NASA's Living With a Star (LWS) program ("Controversy flares up over NASA solar project," 28 July, p. 528) and its associated political turbulence is, on the whole, a balanced account of a complex and evolving situation. The importance of LWS science and the general enthusiasm of the solar-terrestrial community for this timely initiative are accurately conveyed. However, Lawler incorrectly quotes from my letter to the Goddard Space Flight Center ombudsman (*1*). What I wrote was, "If NASA expertise is bypassed to the extent stated in the CBD announcement [that is, the *Commerce Business Daily* announcement of the impending sole-source contract], the likelihood for success for any mission will be greatly compromised." I did not write, "'the likelihood of success...will be greatly compromised' if APL is given control over the iniative." I never expressed any doubts as to the competence of The Johns Hopkins Applied Physics Laboratory (APL), which has amply demonstrated its ability to build and manage successful space missions [for example, Advanced Composition Explorer (ACE) and Near Earth Asteroid Rendezvous (NEAR)] and would be a strong candidate in any competition for LWS missions.

Despite the side issues raised in the article, the solar physics community is solidly behind the LWS concept and is working hard to make this initiative a success. The officers and committee of the Solar Physics Division committee of the American Astronomical Society have recommended the following: (i) the processes of open competition, peer review, and community input normally used to plan, implement, and perform research with NASA missions should not be circumvented by a sole-source contract with any single institution (whether industry, government, or university); (ii) the collective expertise in managing sun-Earth missions that has been built up at Goddard Space Flight Center should not be abandoned; and (iii) for maximum accountability to the scientific community and the public, NASA should retain primary scientific and financial control over its missions.

Judith T. Karpen*
Naval Research Laboratory, Washington, DC 20375–5352, USA. E-mail: judy.karpen@nrl.navy.mil
*Chair of the Solar Physics Division, American Astronomical Society

References and Notes

1. The full text of my letter is available at http://www.gong.noao.edu/SolarNews/20000315.html

Lawler's article about NASA's proposed LWS initiative and related plan for a long-term partnership with APL contains several errors and some statements that might be easily misinterpreted. For example, the statement that the LWS initiative "has become mired in controversy that includes...questions about the propriety of a lucrative contract to manage it" is incorrect. NASA has never considered nor has APL requested the assignment of managerial control of the LWS program to APL. Responsibility for program authority, management, and direction has always resided and remains with NASA Headquarters. For program implementation, responsibility resides with NASA's Goddard Space Flight Center (GSFC). NASA Headquarters retains full responsibility, with no changes in any procedures, for selecting science investigations, instrumentation, science team participation, and mission data analysis. Science and flight instrumentation activities are based on peer-reviewed open competitions under the direct control of NASA Headquarters. Five months ago, NASA Headquarters highlighted these key roles and responsibilities in notices to the Sun Earth Connection (SEC) community (*1, 2*). (SEC is the NASA program office responsible for the LWS initiative.)

Concerning the sole-source contract and the plan for a new GSFC-APL partnership, the objective is to formalize the long-standing ties between the two institutions and to optimize an implementation strategy for LWS, based on two criteria: (i) low cost and (ii) mission success over a 12-year period of performance. NASA's *Commerce Business Daily* notice of intent to award a sole-source contract to APL states "APL...has heritage and infrastructure capability that is crucial to planning, development, and understanding of the SEC initiative" (*3*). The goal is to pool the resources and infrastructures of GSFC and APL for the betterment of the LWS initiative (*3, 4*). As an adjunct to the new partnership, in-house work at APL resulting from this contract would provide limited support to NASA of some "NASA-related essential capabilities" (these were listed in the *Commerce Business Daily* notice). The size of the new APL contract would amount to less than half of all LWS resources, and APL would continue its close partnerships with industry, which historically have included subcontracting 30 to 50% of spacecraft development activities and the competitive procurement of spacecraft (as was done recently for NASA's "FUSE" mission). All LWS spacecraft make/buy decisions would be subject to approval by NASA Headquarters (*1, 2, 4*).

We also take exception to Lawler's use of a quote by Judith Karpen, chair of the American Astronomical Society's solar physics division, that "the likelihood for success for any mission will be greatly compromised" to which Lawler added "if APL is given control over the initiative," which suggests that executing an APL contract would somehow harm or impair the LWS initiative. To the contrary, APL has an exceptional record of performance on space missions. Two examples are the NEAR Shoemaker mission, which is the first Discovery mission and the first spacecraft to orbit a small body, and the ACE, which is providing the first continuous, real-time space weather data. APL developed and launched NEAR Shoemaker at ~30% below NASA's cost ceiling and ACE at ~10% below the original cost estimate.

To conclude, NASA understands the formidable challenges presented by LWS and the need to enhance GSFC's resources, infrastructure, and implementation options to ensure that the LWS initiative is successful. It is imperative that the "case for LWS" be presented clearly and accurately so that the public, the space science and technology communities, and others will understand the purpose and benefits of the proposed GSFC-APL partnership.

Stamatios M. Krimigis*
John F. Appleby†
Space Department, The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723–6099, USA. E-mail: tom.krimigis@jhuapl.edu and john.appleby@jhuapl.edu
*Head, Space Department
†Program Development Manager, Space Department

References and Notes

1. G. L. Withbroe, *American Geophysical Union Space SPA Section Newsletter* (online) **7**, Issue 26 (2 Mar. 2000). Available at http://www-ssc.igpp.ucla.edu/spa/spanews.html
2. G. L. Withbroe, *SolarNews* (online) **2000**, No. 6 (16 Mar. 2000). Available at http://helios.tuc.noao.edu:80/SolarNews/
3. "Services Under the Sun Earth Connection Theme," *Commerce Business Daily Notice*, RFP5-00000-013 (16 Feb. 2000).
4. W. F. Townsend, letter to J. T. Karpen, Chair of the American Astronomical Society's Solar Physics Division (28 Mar. 2000).

Response

Krimigis and Appleby's discussion of NASA's proposed contract is welcome. However, it should be noted that Krimigis agreed to an interview only after stipulating that he would not discuss the details of the proposed APL contract. As to Karpen's concern, the story addressed APL's potential role in the new program, not its capabilities.

Andrew Lawler