Letter writers express concern that "difficulties" will complicate efforts to establish "a Great Ape Genome Project." A U.S. senator from Montana clarifies his record as a "strong supporter" of "scientific research and technology development in general." A group of letters discuss optimism and pessimism about world oil reserves. One writer predicts that "innovations could make oil uncompetitive even at low prices before it becomes unavailable even at high prices." And the history of Cope's Rule—"that there is a general tendency toward size increase in evolution"—is explored.

Chimp Research

Ann Gibbons's recent article "Which of our genes make us human?" (News Focus, 4 Sept., p. 1432) provides interesting insight into the genetics of human-chimpanzee differences. Gibbons writes that "small sequence differences [may] subtly change the expression of genes that regulate the timing of development," an idea elegantly articulated in 1975 by Mary-Claire King and Allan Wilson (*1*). In view of the potential that a developmental perspective holds for increasing our understanding of human evolution, biology, and disease, it is unfortunate that two difficulties will complicate attempts to pursue questions raised in this article. First, our knowledge of growth and development in chimpanzees is, at best, rudimentary. Studies of age-related changes in chimpanzee morphology are based on small data sets collected nearly half a century ago (*2*). Second, a 5-year moratorium on chimpanzee breeding has been recommended by the National Research Council (*3*). This is a sound and carefully considered decision, but a reduced population of juvenile chimpanzees may severely restrict opportunities for enhancing our understanding of developmental differences between humans and chimpanzees. Finally, it is crucial to emphasize that studies limited to adult morphologies and behaviors cannot provide a basis for the types of genetic inferences anticipated by Gibbons's sources. This potential can only be realized by integrated developmental protocols.

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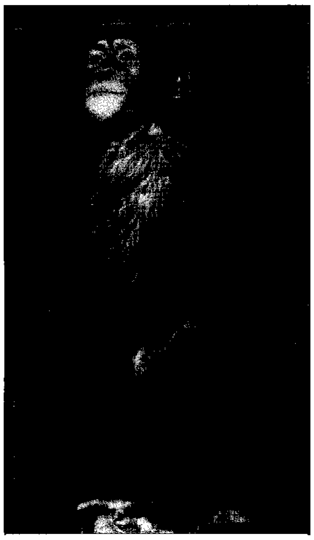

Pan troglodytes

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The increasingly apparent necessity to include analysis of multiple primate genomes, especially individuals of our closest relatives, the chimpanzees (*Pan troglodytes*), the bonobos or pygmy chimpanzees (*Pan paniscus*), and the gorillas (*Gorilla gorilla*) in comparisons with the human genome identifies a crucial need. Within the context of the Human Genome Project, the systematic effort to collect genetic samples from the diversity of human ethnic groups is expected to play an important role in developments in medicine and contribute to an increased understanding of anthropology and human evolution.

However, only extremely modest efforts are under way to conserve the genomic diversity among our closest evolutionary relatives. Furthermore, all great apes are endangered. The call for a Great Ape Genome Project must necessarily consider the establishment and use of such genetic resources in full compliance with the intent of the Convention on International Trade in Endangered Species (CITES), the U.S. Endangered Species Act, and the sovereignty issues raised by the Convention on Biological Diversity. We have recently amassed what may be the largest collection of DNA samples from great apes for use in comparative genomic studies through establishment of diploid fibroblast cell cultures and/or collections of high molecular DNA from 150 gorillas, 75 bonobos, and 25 chimpanzees. We recognize that our efforts still fall short of an ideal genomic resource collection from great apes for use in studies of human biology, medicine, and evolution, as well as for contributions to efforts to better understand and thereby conserve declining populations of great apes. Furthermore, without diligent efforts to protect dwindling wild populations of great apes from such threats as the bushmeat trade, the genetic diversity of great apes will be diminished and access increasingly improbable.

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Big Sky Science

I was disappointed in the article "Big bucks for big sky country" by Andrew Lawler (News Focus, 4 Sept., p. 1437). I am quite proud of Montana and the fine research our institutions are doing. We are succeeding by many measures, and we are undertaking research activities of importance to our state, our region, and, I believe, our nation. I will continue to work to see that our research opportunities in Montana expand. All participants in that endeavor should be congratulated, not criticized.

I am also disappointed that the article does not acknowledge that I have been a strong supporter not only of certain special projects but also of scientific research and technology development in general. I have served as the chairman of the Subcommittee on Science, Technology and Space of the Senate Commerce Committee, worked for National Science Foundation and NASA authorization bills that expand funding for science and research, cosponsored legislation to double fund civilian research, supported development of the Next Generation Internet, and worked on several technology development initiatives.

Additionally, I would be more than happy to claim the Long-Term Environmental Research language, but it was not mine. I have a deep respect and appreciation for the contributions of science and technology—for all Americans—and will continue to do my best in support of such initiatives.

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Is Oil Running Out?

Richard A. Kerr (News Focus, 21 Aug., p. 1128) draws attention to the newest round of gloomy prognostications by some geologists about the future of oil and, by extension, the future of prosperity. Kerr summarizes the views of both the pessimists and optimists. There are, nonetheless, some important omissions from the article that, when taken into account, make the case for an optimistic perspective much stronger than Kerr's account might suggest.

A central issue in this debate is the definition of recoverable oil reserves. In their *Scientific American* article referred to by Kerr, Colin Campbell and Jean Laherrère paraphrase the standard definitions of proved and probable reserves (*1*). A key element in these definitions is that reported estimates of reserves reflect judgments about what is recoverable, based on current oil prices and existing technology. This means that the areas under "Hubbert curves," the time profiles of oil production referred to in Kerr's article, are not fixed geological data subject only to geological measurement error. While estimates of ultimately recoverable reserves may be the subject of some political inflating in other countries, as Campbell and Laherrère assert, of equal or greater importance is the fact that when technologies advance or energy prices rise, the amount of estimated recoverable oil also rises. Concepts of reserves inherently are backward-looking and conservative (*2*). The same can be said of statistical extrapolations of past production in a Hubbert curve.

CREDIT: BRITISH PETROLEUM

Thus, optimists who assert that there are many years remaining before oil production peaks are simply and correctly asserting that changes in energy prices and technology can increase the recovery factor in old fields and increase the probability of discovering new, albeit smaller, economically viable fields (*3*). Pessimists seem to acknowledge that such behavioral and technological responses can matter a little, but that they ultimately cannot forestall a permanent slide into oil scarcity. More optimistic students of the issue reply that the race between physical scarcity on the one hand, and technological and economic adaptation on the other, is an empirical question. This is a question that a Hubbert curve analysis is inherently incapable of resolving. Oil is indeed depletable in this view, but the importance of its physical scarcity and the threat of its physical exhaustion is another matter.

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Kerr's geological description of oil depletion omits *demand*, which depends on efficient use and alternative supplies.

Natural gas is widespread, abundant, and climatically benign if wellhead-reformed with carbon dioxide (CO_2) reinjection (*1*), producing three profit streams—shipped H_2, enhanced CH_4 recovery, and sequestered CO_2. Combined-cycle CH_4-fired power stations dominate new generation, but are starting to be displaced by onsite co- and trigeneration, which deliver electricity about 2- to 10-fold more cheaply after crediting useful heat (*2*). Renewables are increasingly competitive, the fastest-growing energy source in Europe, and plausible sources of half the world's total energy by 2050 (*3*).

Progress is even greater in superefficient conversion and end-use. Ultralight hybrid-electric cars (*4*)—uncompromised and competitive—have multibillion-dollar private commitments, are coming quickly to market (*5*), and will ultimately save as much oil as the Organization of Petroleum Exporting Countries now sells. The most efficient will use H_2 fuel cells whose immediate commercialization, now feasible (*5*), can displace most if not all oil, coal, and nuclear power at a profit.

If oil became scarce, its rising price would speed these alternatives; yet most can beat even today's low and falling energy price. Many will be bought for other reasons—end-use efficiency's superior service quality, renewables' and fuel cells' distributed benefits (*6*). Most important, a decade ago, available end-use efficiency could have saved four-fifths of U.S. oil use at average costs of around \$2.50 per barrel (*7*). The scores of market failures that left most of these savings unbought are now becoming well understood—along with ways to turn each obstacle into a business opportunity (*8*).

Together, these technical and barrier-busting innovations could make oil uncompetitive even at low prices before it becomes unavailable even at high prices. Like uranium earlier, and coal increasingly, oil could become no longer worth extracting—good mainly for holding up the ground. Of course, this cornucopia is the manual model: you have to turn the crank. But many smart firms are already doing so (*9*).

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Kerr states, "Their [the pessimists'] case for the past being the best predictor of the future depends heavily on their success in predicting the oil production peak of the lower 48 states of the United States, the only major province whose oil production has already peaked." In fact, however, in addition to the lower 48 peak mentioned above, three other major provinces have peaked: total U.S. (lower 48 plus Alaska) in 1970; North America (the United States, Canada, and Mexico) in 1984, and the former Soviet Union in 1987.

Kerr also states, "If technology can greatly boost reserves, then the U.S. production curve should at least stabilize, while if the pessimists are right, it will soon resume its steep downward slope." The data show that the U.S. production trend has long since been on a steep downward slope. For example, from 1991 through 1997, it decreased every year, averaging minus 2% per year for that period.

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"Bow Tie" Correction

In our research article "High-power directional emission from microlasers with chaotic resonators" (C. Gmachl *et al.*, 5 June, p. 1556) (*1*), the upper limit for the stability-range of the "bow-tie"–shaped resonance was incorrectly given as $\varepsilon \approx 0.23$ instead of $\varepsilon \approx 0.18$, which is the correct value within the flattened-quadrupole model of the resonator. The value of $\varepsilon \approx 0.23$ is correct for the simple quadrupole parameterized in polar coordinates as $r(\phi) \propto [1 + \varepsilon \cdot \cos(2\phi)]$. We thank Anthony E. Siegman of Stanford University for pointing out this error.

Whether the bow-tie resonance has destabilized in the highest deformation