Letters

Technology Incentive Programs

The briefing on civilian R & D (News and Comment, 1 Aug., p. 360) refers to a report (*1*) prepared for the Joint Economic Committee of Congress by Robert Gilpin of Princeton University. According to the briefing, "The best way to encourage innovation is by 'demand-pull,' not 'technology-push': in other words by creating the market conditions that stimulate innovation rather than by creating new technology and hoping that a market will materialize for it. Most of the technology incentive programs run by the National Science Foundation and other agencies have in fact followed the technology-push strategy, which may be why they have not yet fulfilled the expectations of their creators."

This news account does not refer to a discussion in the Gilpin report (*1*, pp. 67, 71) of the Experimental Technology Incentives Program (ETIP) at the National Bureau of Standards. First, ETIP is the only technology incentive program now operating. The National Science Foundation program has been defunct for over a year, and there were no others. Second, in his report, Gilpin, in fact, praises ETIP for its "demand-pull" approach to innovation policies.

JORDAN D. LEWIS
Experimental Technology Incentives Program, National Bureau of Standards, Washington, D.C. 20234

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Fluorocarbons

The use of the word "fluorocarbons" (News and Comment, 27 June, p. 1286) to include such chlorine-containing compounds as the Freons is misleading. To condemn the entire class of fluorocarbons as a danger to the environment may block one of the most promising means of solving the stratospheric ozone problem.

Fluorocarbons are compounds of carbon and fluorine only. The suspect compounds are fluorocarbon chlorides. Fluorocarbons cannot generate chlorine upon radiation. Chlorine-free fluorocarbons can replace the Freons and other chlorine-containing compounds in aerosols and refrigerants with only a moderate increase in cost and minor adjustments of equipment.

The loose use of the word fluorocarbon may not mislead professional chemists, but if lawyers and politicians include the term in laws and regulations, the replacement of the suspect chlorine-containing compounds by chlorine-free fluorocarbons may be prevented.

JOSEPH H. SIMONS
Post Office Box 208, Marco Island, Florida 33937

Anthropocentrism and Evolution

As a biological anthropologist, I found W. H. Murdy's ideas on anthropocentrism (28 Mar., p. 1168) professionally relevant and personally stimulating. For the most part I concur with his views. His philosophical interpretation of anthropocentrism, grounded in evolutionary theory and ecological awareness, is basically the same rationale which I use to justify the pursuit of my own anthropocentric discipline—a rationale which I am probably more aware of than many anthropologists, since many of my data and conclusions derive from nonhuman populations. However, I find one fundamental part of his argument intellectually disturbing: his assertion that human survival is dependent on a belief in the human phenomenon within "a meaningful whole."

Murdy quotes Teilhard de Chardin (*1*) and Boulding (*2*) in support of the subjective idea "that we are essential elements of a meaningful whole and that our individual acts are vitally significant to the self-actualization of the process of human evolution itself and to the enhancement of value in the world." Perhaps Murdy is simply proposing the above as a critical item of faith, regardless of its verity—"critical" because he feels that such a belief "may be requisite to the future survival of the human species and its cultural values." However, Murdy seems to be propounding "the right thing [anthropocentrism] for the wrong reason" (*3*).

I, too, have an anthropocentric bias toward (but not necessarily "belief" in) the "value, meaningfulness, and creative potential of the human phenomenon," but my feelings can be explained in bioscientific terms without relying on the biomystical teleology of Teilhard de Chardin or others. In addition, I do not need to believe that the world or the universe has any ultimate meaning, at least in terms which I can ever comprehend (*4*) to understand why I am anthropocentric.

In the first place, it simply is not true, as Murdy states, that the "modus operandi of biological evolution" is "unbridled self-indulgence on the part of one generation without regard to future ones"—at least if this means that members of one generation do not invest time, effort, and, occasionally, their lives in enhancing the chances for survival (and, eventually, reproduction) of their offspring. Such parental investment is a basic form of kin selection, and even nonparental altruism may be explained in terms of natural selection (*5*). Populations which do not display some altruistic behavior (consciously or otherwise) toward at least some members of successive generations will probably become extinct.

Likewise, it is not really surprising that I am anthropocentric; both my culture and my genes (the products of very long periods of selection) have strongly predisposed me toward such an attitude. It is (or has been) a very adaptive attitude in most situations and, in evolutionary terms, that is what counts. However, it is not an attitude which necessarily reflects "meaningfulness" in the universe; nor must I accept a "belief" in such meaningfulness in order to accept my anthropocentrism. Beyond this, I am more than willing to accept the kind of anthropocentrism which Murdy advocates, even though our reasons for doing so may differ.

RON J. DARE
Department of Sociology and Anthropology, New Mexico State University, Las Cruces 88003

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1. P. Teilhard de Chardin, *The Future of Man* (Harper & Row, New York, 1964), p. 296.
2. K. E. Boulding, *The Meaning of the Twentieth Century* (Harper & Row, New York, 1965), p. 163.
3. N. R. Hanson, *Observation and Explanation: A Guide to Philosophy of Science* (Harper & Row, New York, 1971), p. ix.
4. G. S. Stent, *Science* **187**, 1052 (1975).
5. R. A. Fisher, *The Genetical Theory of Natural Selection* (Dover, New York, ed. 2, 19→ W. D. Hamilton, *J. Theor. Biol.* **7**, 1 (19→ *Nature (Lond.)* **228**, 1218 (1970); *Annu. Rev. Ecol. Syst.* **3**, 193 (1972); J. L. Brown, *Nature (Lond.)* **211**, 870 (1966); G. C. Williams, *Adaptation and Natural Selection* (Princeton Univ. Press, Princeton, N.J., 1966); R. L. Trivers, *Q. Rev. Biol.* **46**, 35 (1971); D. T. Campbell, *J. Soc. Issues* **28**, 21 (1972); P. J. Darlington, *Proc. Natl. Acad. Sci. U.S.A.* **69**, 293 (1972).

The only trouble with anthropocentrism, whether the old kind or Murdy's modern but indistinguishable version, is that it just isn't good enough. To dress the self-centeredness of the species in such lofty terms

as "belief in the value and creative potential of the human phenomenon" doesn't make it any better. If indeed man is the highest animal, may he not have the ability to transcend his anthropocentrism, or at least to mute it a bit? Deep religious experience seems to encourage such abnegation.

As a biologist interested in biological concepts, Murdy argues that the purpose of a species is to survive; therefore, we must be number one. Were he an ecologist, interested in more inclusive systems, Murdy might have argued (much more persuasively) that the purpose of a species is to keep its ecosystem running smoothly. The part must serve the whole, or else it is replaced.

Human survival can't be assured by anthropocentrism (look what it's doing to us today). But another Copernican revolution that locates the center of creativity and value in the magical system that encapsulates mankind just might work wonders for the species.

J. S. ROWE

Department of Plant Ecology, University of Saskatchewan, Saskatoon, Canada S7N 0W0

In his article Murdy describes the present human condition as a "knowledge crisis": we now possess sufficient knowledge, and therefore sufficient power, to have enormous impacts on the entire biosphere, but it is not clear that we have the wisdom (knowledge of how to use knowledge) to exercise our vast new powers wisely. At one point in his article, Murdy puts our present situation in a cosmic context. He writes: "The knowledge crisis is one that every cultural species on every inhabitable planet in the universe must surmount at a point in its evolution, or become extinct."

What an illuminating perspective on our time. It assumes, as most scientists today assume, that planets are a normal product of star-formation, that life will start up wherever the conditions are favorable and evolve over time toward higher levels of complexity and intelligence, and that the cumulative buildup of knowledge in a sufficiently intelligent cultural species will eventually lead to science and then to powerful science-based technologies. This cosmic perspective raises the following critical question: What usually happens when an intelligent species reaches the point where their technology becomes "planetary" in its reach and impact?

If our own planet is at all typical, we can see that the emergence of what might be called "planetary powers" has occurred almost instantaneously in terms of evolutionary time. In a mere century we have gone from clipper ships to spaceships, from the Pony Express to Telstar and Intelsat, from the town blacksmith to General Motors. The military career of Winston Churchill began with sword-wielding cavalry charges in the Battle of Omdurman and ended with Hiroshima.

We can also see, from our own experience, the initial consequences of crossing the evolutionary threshold to planetary power. When technology reduces a planet to a "communications point," suddenly all the species' subgroups are thrust into a new intensity of interaction that may be destabilizing. Cultures, ideologies, and religions collide in a tumult of movements for both synthesis and separatism; economic and political systems compete ferociously, even as they are pushed into increasing interdependence. And suddenly it becomes possible for the intelligent species to pollute its whole environment, to perturb the climate of its planet, to devastate its biosphere with radiation.

Because this knowledge crisis emerges so rapidly, it may well be that most intelligent species self-destruct or retrogress when they reach this critical point because they are not able to initiate a social transformation that is rapid enough and comprehensive enough to guide and constrain their new powers. It may be, then, that nature makes many starts but has few complete successes, so that just as the skies and waters of the earth are filled with migrating seeds, only a few of which survive, so the universe is full of evolving planets, but only a few of them will survive to develop their full potentials. Or, more optimistically, it may be that most intelligent species, when they cross the threshold of planetary power, are able to grasp the evolutionary significance of their knowledge crisis. Then, motivated by both fears of catastrophe and visions of the evolutionary possibilities ahead, many of them may find the inner resources to work out, in a very short time, the new ideas, values, and institutions to create a stable and cooperative "planetary civilization" in responsible control of its powers.

We simply do not know enough to estimate which of these outcomes is more likely in our own situation. We do know that it is perfectly reasonable to believe that it is this exact instant in history—the instant when a species first achieves planetary power but has no experience with managing that power—that is the most dangerous period in the whole evolution of our planet. Seeing all this, we know also that, if we are to survive, we must adapt our ideas and values and institutions in a very short time.

This is no era for small visions and modest plans. No matter how difficult the task, we must get those nuclear weapons out of existence; we must define and enforce planetary environmental standards; we must check our population growth worldwide; and we must solve all the other critical problems of conflict and cooperation that have so rapidly come upon us.

As Murdy says, it is by our understanding of the evolutionary significance of our time, our belief in the value and potential of the human phenomenon, and our ability to identify with the whole process of cosmic evolution of which we are participants that we can find the motivation to solve our crises, the patience to endure no matter how difficult the tasks, the vision and courage to create a new world. If the kind of cosmic evolutionary perspective that Murdy presents in his article could be grasped by a sufficient number of people, it would produce a mobilization of scientific talent and political leadership unprecedented in history, which is probably just what our survival requires.

If we are able to carry the evolution of life and mind forward on this planet, it will be precisely because the "knowledge crisis" of our time acted as an "evolutionary driver" for social transformation, pushing us faster than we have dared to dream possible toward a mature and cooperative planetary civilization that in retrospect would seem so inevitable that all previous history would be viewed as a prelude to it. Then the future would be open to possibilities that can only be attained by conscious, intelligent selection instead of natural selection. It would be a new state of evolution, a new state of matter. It is a prospect worth living for.

ROBERT L. OLSON

Center for Advanced Study, University of Illinois, Urbana 61801

The most fit individuals, in biological terms, are the best reproducers—those who make the greatest genetic contribution to the next generation. By the statement: "Unbridled self-indulgence on the part of one generation without regard to future ones is the modus operandi of biological evolution," I meant that individuals and populations seek to survive and to maximize their reproductive rate even when to do so may reduce the carrying capacity of the environment and thereby doom most of their descendants to starvation, disease, and premature death. The maximizing of biological fitness on the part of one generation may well involve investing time, effort, and occasionally their lives in enhancing the chances for survival of their offspring and may also involve what Dare refers to as altruistic behavior, provided it improves the reproductive success of individuals or their group. External

constraints such as limited resources, disease, and predation serve to limit the growth of populations. Mitigation of constraints, as in the case of man, results in a population explosion, which, if unchecked, is certain to visit global catastrophe on the species.

I agree with Dare that an anthropocentric bias can be explained in scientific terms. However, my claim that man occupies a special place in the biosphere because of his ability to influence his own evolution toward the enhancement of value in the world and that an anthropocentric belief in the value, meaningfulness, and creative potential of the human phenomenon may be a necessary motivation for action to solve our crises is no more verifiable by the present data of science than the claim of others who deny man unique importance and advocate the abnegation of anthropocentrism in order to preserve and enhance "nature's values." I regard both positions presently as items of faith.

Rowe in his letter asserts: "the purpose of a species is to keep its ecosystem running smoothly." I maintain that in order to survive as a biological species we must preserve our life support system, but in addition, in order to survive as an evolving cultural entity, we must seek to preserve and to enhance values unique to the human species.

W. H. MURDY

Department of Biology, Emory University, Atlanta, Georgia 30322

Radioactive Waste Disposal

Recently we have become aware of the difficulties of storing or disposing of radioactive wastes from the world's nuclear power stations. Possible methods of disposal include elimination by nuclear transformation or disposal in space, salt and other geologic formations, the ocean bed, and the major ice sheets, particularly that of East Antarctica (*1*).

This last suggestion was considered in May 1973, by the Glaciology Panel of the Committee on Polar Research of the National Academy of Sciences, and later by the committee itself, which then conveyed to the Scientific Committee on Antarctic Research (SCAR) of the International Council of Scientific Unions, and to the International Commission on Snow and Ice (ICSI), "the urgent need to investigate thoroughly the geophysical basis for, the implications of, and any scientific basis for such an ice sheet disposal scheme, so that its feasibility can be evaluated. . . ." In September 1974, SCAR agreed on the urgency of investigating the environmental