

The wind generators in place at the end of 10 years could be expected to go on producing for several more decades, at least, although they would already have been "paid for." More wind capacity could be added every year, using the money that would have been spent to finance the oil reserve.

The above is, of course, drastically simplified. However, the assumed and calculated numbers are reasonable. Wind has substantial environmental advantages as compared to oil. Perhaps we should be studying the replacement of at least a part of the oil reserve with wind generation capacity.

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#### References and Notes

1. Prices of large wind generators are not well defined at the present time; much depends on the scale of production and existing machines are all prototypes. Several studies sponsored by the Department of Energy have developed costs, based on present designs, in the \$500 per kilowatt range for rated wind speeds consistent with a plant capacity factor of 0.30.
2. Plant capacity factor is the factor by which the number of hours per year and the kilowatt rating of the generator must be multiplied to yield the number of kilowatt-hours generated in a year.
3. According to press reports (*Wall Street Journal*, 11 January 1979, p. 22) the cost of constructing facilities to store the oil seems likely to exceed \$3.50 per barrel.
4. If one considers that most of the crude petroleum is likely to be purchased at some future, higher price, the number \$15 per barrel is conservative.

#### Biological "Strategies"

The term "strategy" has become common currency among biologists of various persuasions from the molecular to the population level. We read of biochemical strategies exhibited by marine invertebrates and reproductive strategies of birds, not to speak of osmotic strategies in desert plants!

The term "strategy" implies that a rational choice has been made and has its origin in ancient military parlance. While I will concede that some higher mammals, such as a pride of hunting lions, may employ a decision-making process which borders on strategy, can you imagine a group of barnacles convening a meeting to decide on which set of isoenzymes to use so that their metabolism could become temperature-independent? The term is therefore semantically quite incorrect but, far more important, it is philosophically grossly misleading, as it implies that a process has occurred which is the very antithesis of the evolutionary concept of chance and necessity.

Let us therefore agree on the strategy

to expunge this nasty little word from our biological vocabulary and, while we are about it, let us also exclude its kid brother or congener the "trade-off principle," which is philosophically equally misleading.

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#### Carcinogen Report to the Public?

Luther J. Carter's article (News and Comment, 9 Feb., p. 525) on the amendment to the National Cancer Act requiring the Department of Health, Education, and Welfare (HEW) to issue a report each year on carcinogens suggests to me that, in addition to preparing this type of report, HEW should make a presentation to the general public concerning the dangers of various substances. This presentation could be sent to newspapers throughout this country, informing readers about what substances might increase their chances of contracting cancer. The report could also inform the public as to where these substances occur, that is, in gasoline, solvents, adhesives, paint, and so forth. With this knowledge the public would not only be aware of the dangerous substances but could carry out a surveillance action of its own, informing the proper regulatory agency of any possible overexposure to toxic substances. The reports should be in simple, nontechnical language; the use of brand names of particular products would be best, as it would put pressure on various companies to "clean up their act," so to speak.

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#### The Piltdown Hoax: Piltdown 2

The theory that Piltdown man was a joke, at least partially designed by W. J. Sollas (News and Comment, 8 Dec. 1978, p. 1062), does not fit the facts. Piltdown 1 and "associated fossils" were found over a number of years either by Charles Dawson or someone who was with Dawson at the time of the discoveries. The motivation appears to have been to prove that the eoliths were human-made by providing the maker, stone tools, and associated fossils for determining the age. The evidence pointing to Dawson has been carefully presented by

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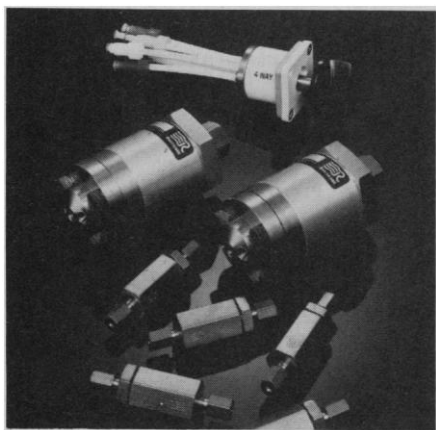
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Weiner (1) and recently evaluated by Krogman (2). The history surrounding the "discovery" of Piltdown 1 is vague, complex, and will probably never be completely understood.

The discovery of an anatomically modern braincase with an ape-like lower jaw set off a controversy that lasted until 1953, when all the supposed fossils and stone tools were shown to be fakes (1). If the forgery were just a joke that went too far, the matter, presumably, would have stopped after the discovery of Piltdown 1, but apparently the forger wanted to prove that the lower jaw and the skull belonged together. With this end in mind, Piltdown 2 was created. It consisted of a piece of frontal bone, a bit of occipital, and a lower molar tooth—just enough to suggest similarity with Piltdown 1 and to prove that the ape-like molar tooth belonged to a human with a high forehead and small browridge. The only person associated with Piltdown 2 was Dawson, who died shortly after the discovery; after his death no further stone tools or fossils were found. Clearly, Piltdown 2 was no joke but an attempt to end the controversy which gravely affected the importance of Piltdown 1.

Piltdown 2 had the desired effect and converted many scientists (3), or reinforced the opinions of others (4). The motivation behind 2 seems to have been the same as behind 1—to prove that a primitive form of human being had made the stone tools. The evidence suggests a serious attempt at fraud, not a joke or minor hoax. It must be remembered that at that time the eolith problem was one of the major issues in prehistory. Dawson had been involved in it, had faked tools (1), and, as Piltdown 1 failed to settle the issues, Piltdown 2 may well be regarded as a bold stroke to settle the matter beyond any reasonable doubt.

The argument that someone else with more anatomical knowledge must have been involved is very weak. Although it cannot be proved that someone else might have helped on Piltdown 1, the case is clear on 2. Further, if the forger had anatomical experience, the parts for Piltdown 1 would surely have been selected differently. To provide an ape-like jaw it was not necessary to find the simian shelf or the canine. Most of the body with the two molar teeth would have been quite enough. Further, if the jaw were to be associated with the skull, it was essential to remove the very distinctive human temporomandibular joint from the skull, not the condyle from the jaw. The joint is uniquely human, the condyle is much less distinctive, particularly if abraded a little (as was done to

the teeth). Dawson had been collecting stone tools, eoliths, and fossils for more than 20 years (1), so there seems to have been no necessity that anyone else be involved. That cannot, of course, be proved so many years later.

The great interest in Piltdown, both popular and scientific, was due, in part, to the belief that it was the first human fossil to be found in England. Smith Woodward's book is titled *The Earliest Englishman* (5)! But for the scientists, the discovery fitted the theory that, in human evolution, the brain had evolved earlier than the face, and that all previous discoveries were on side branches of the human evolutionary tree (6, 7). Weidenreich could not accept the "chimera" because it would not fit in with his view of human evolution (8). For Hooton, *Eoanthropus* was central to his theories (9). I think it was these implications of Piltdown that kept the controversies alive. For many years it was not possible to draw a scheme of human evolution without considering the Piltdown problem.

Sollas took a strong position favoring Piltdown, the association of the lower jaw and skull, and Smith Woodward's reconstruction (10). On the possibility that the jaw did not belong with the skull, he wrote, "The chances against this are, however, so overwhelming that the conjecture may be dismissed as unworthy of serious consideration" (10, p. 54). The canine was found after Sollas's book had been written, but it is described in a footnote (10, p. 55). Sollas commented that, "Thus, Dr. Smith Woodward's method receives an unexpected and triumphant vindication." In the second edition of *Ancient Hunters*, pages 51 to 57 are devoted to Piltdown, with no suggestion that there was anything suspicious about the finds.

A new theory suggests that Sollas was involved in a joke to discredit Smith Woodward, but the hoax became too successful to be revealed (11). Whatever Sollas's personal feelings about Smith Woodward may have been, what he published was strong support. The Piltdown finds were made over a period of several years, and each of the later ones was designed to answer the problems which had emerged in earlier reconstructions. The nasal bones helped in understanding the face. The canine tooth ended the problem of reconstructing the jaw. Piltdown 2 proved that skull and jaw went together. Is there any evidence that Sollas was involved in these "discoveries," which occurred over a period of more than four years?

If Sollas knew that Piltdown was not a

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genuine fossil, he knowingly published a most misleading account, allied himself with the forger, and silently watched the futile controversy for 25 years. These are serious charges to bring against a person who has been dead for more than 40 years. Surely Sollas should not be blamed unless there is more evidence than that he did not like Smith Woodward, had access to fossils, and was not pictured in a group of scientists studying Piltdown. I believe that what Sollas wrote is a far better guide to what he thought than the recently disclosed suspicions of a person who did not voice them until the critical actors in the drama had been dead for many, many years.

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## References and Notes

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2. W. M. Krogman, in *Biosocial Perspectives*, S. L. Washburn and E. R. McCown, Eds. (Benjamin/Cummings, Menlo Park, Calif., 1978), pp. 239-252.
3. H. F. Osborn, *Man Rises to Parnassus* (Princeton Univ. Press, Princeton, N.J., 1927). A very clear account of the Piltdown discoveries as they appeared to scientists in the 1920's is given on pp. 45-65. Osborn's doubts were removed by Piltdown 2.
4. E. A. Hooton, *Up From the Ape* (Macmillan, New York, 1931). Piltdown 2 "settled the case" for the association of the skull and jaw (p. 314).
5. A. Smith Woodward, *The Earliest Englishman* (Watts, London, 1948).
6. A. Keith, *The Antiquity of Man* (Lippincott, Philadelphia, 1929).
7. —, *New Discoveries Relating to the Antiquity of Man* (Williams and Norgate, London, 1931).
8. F. Weidenreich, *Apes, Giants, and Man* (Univ. of Chicago Press, Chicago, 1946). Weidenreich's chart (p. 30) clearly shows a wholly different arrangement of the fossils from that in Keith (7, p. 293).
9. E. A. Hooton, *Up From the Ape* (Macmillan, New York, rev. ed., 1946). Figure 61 on p. 413 shows the central position of *Eoanthropus*.
10. W. J. Sollas, *Ancient Hunters* (Macmillan, New York, ed. 2, 1915).
11. L. B. Halstead, *Nature (London)* **276**, 11 (1978).

## The Humanities and Science

I question Charles A. Lave's notion (Letters, 19 Jan., p. 224) of the humanists who "were the first to define 'education' long ago." As I understand the humanists of Western history, they did not limit themselves to arts and letters but sought to understand and codify all possible human experience and knowledge. Da Vinci and Newton are only two of the most obvious examples. These early humanists even understood how the drive to acquire knowledge of all things can lead to the illusion that we can control all things, as the enduring power of the legend of Faust shows us.

I strongly agree with Lave that we in the humanities need to know the issues debated in the sciences and have our

educated say on those issues—that is why I read *Science*. But the strong insistence that the scientists understand the issues in the humanities is based on a simple matter of scale. If I write a poem, it is unlikely to change the world for better or worse, regardless of the number of people who read it. But those in the physical and mechanical sciences have a great potential for changing the lives of a very great number of us, whether we choose to cooperate with them or not. Many lives have been saved by the invention and use of the Salk vaccine; many lives have been lost by the invention and use of nuclear weapons. Moral choices must always be made.

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Lave complains of anti-science discrimination by educational institutions, and by humanities departments in particular. I do not pretend to speak for institutions, but Lave and other readers might be interested to know that in the humanities few new topics have seemed more attractive in the last decade than science. Science's epistemology, ethics, social structure, psychology, rhetoric, and relations to current policy issues have been taken up by a broad spectrum of teacher-researchers in humanities (and social science) departments, including English departments like my own. Half a dozen new publications (for example, *Science, Technology & Human Values*) have appeared to display the fruits of this activity.

Also—and this is not untypical—members of my department are teaching advanced writing courses that take for their content the current debates over nuclear power and recombinant DNA research, two topics Lave implies are hopelessly beyond the range of humanities departments.

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## Reflections

There seems to be some confusion in the picture caption on page 15 of the 12 January issue (News and Comment) about the 13-inch *reflecting* telescope at Vassar. The ladies may be reflecting, but I am quite sure the telescope is refracting.

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