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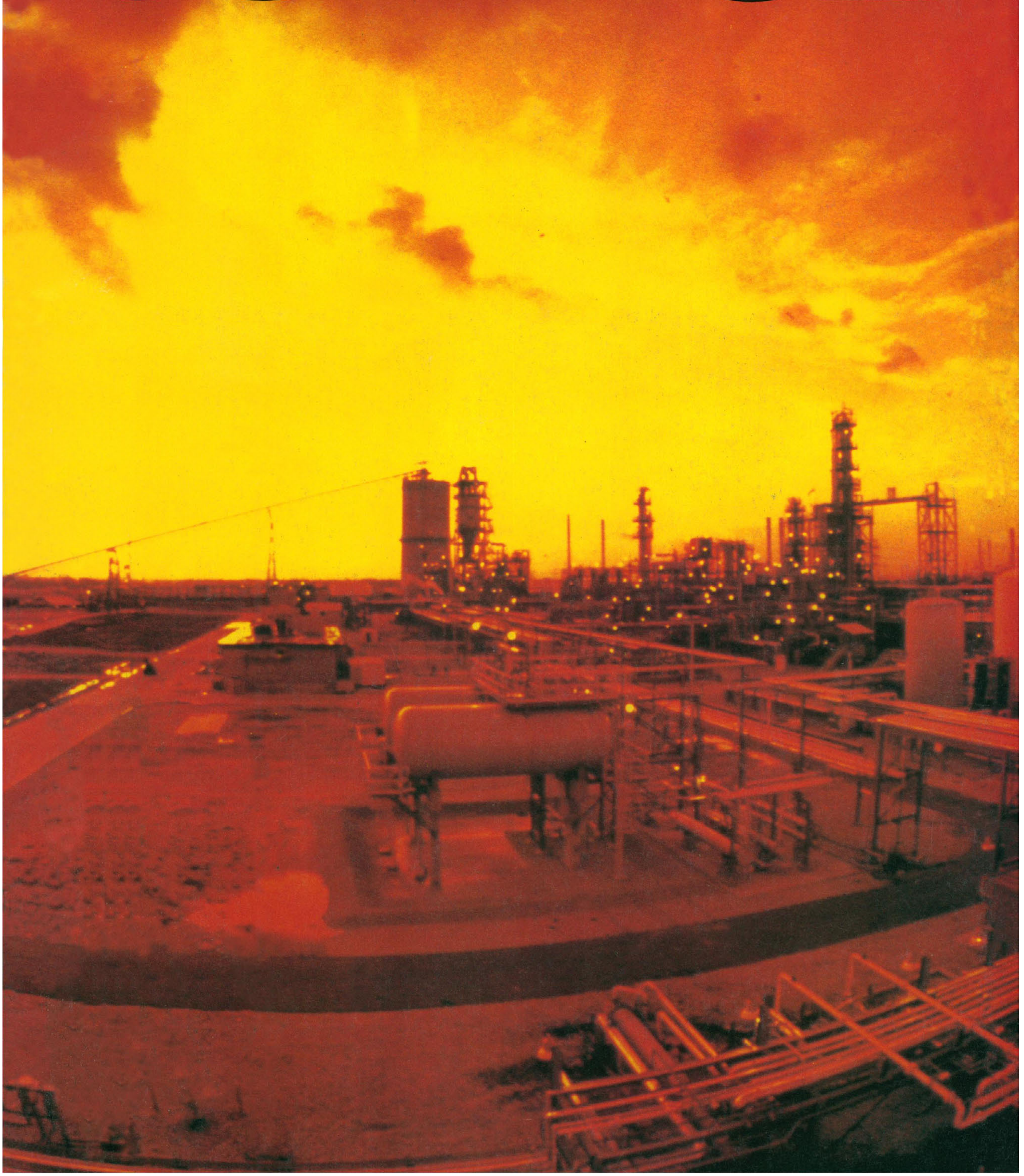

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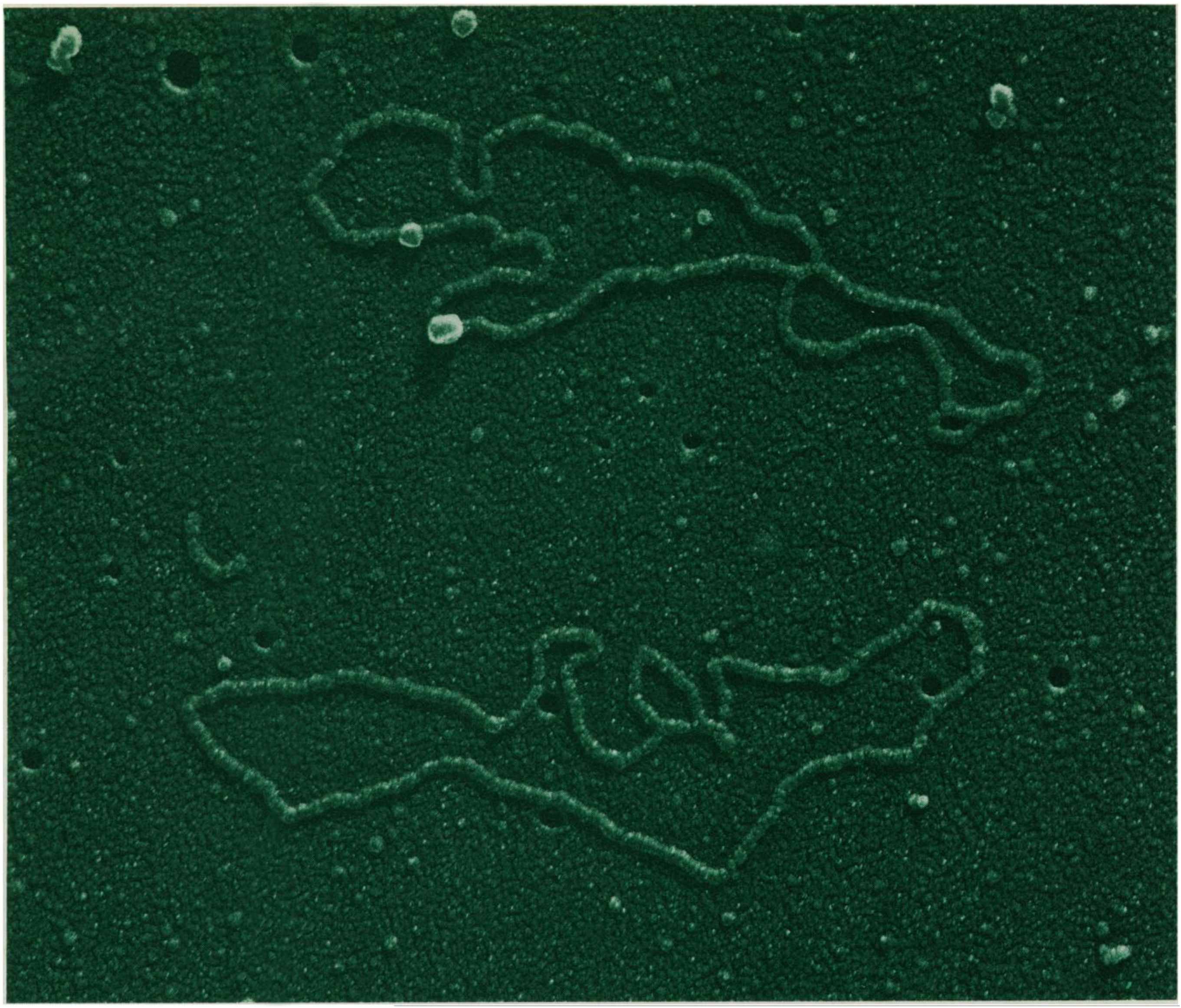

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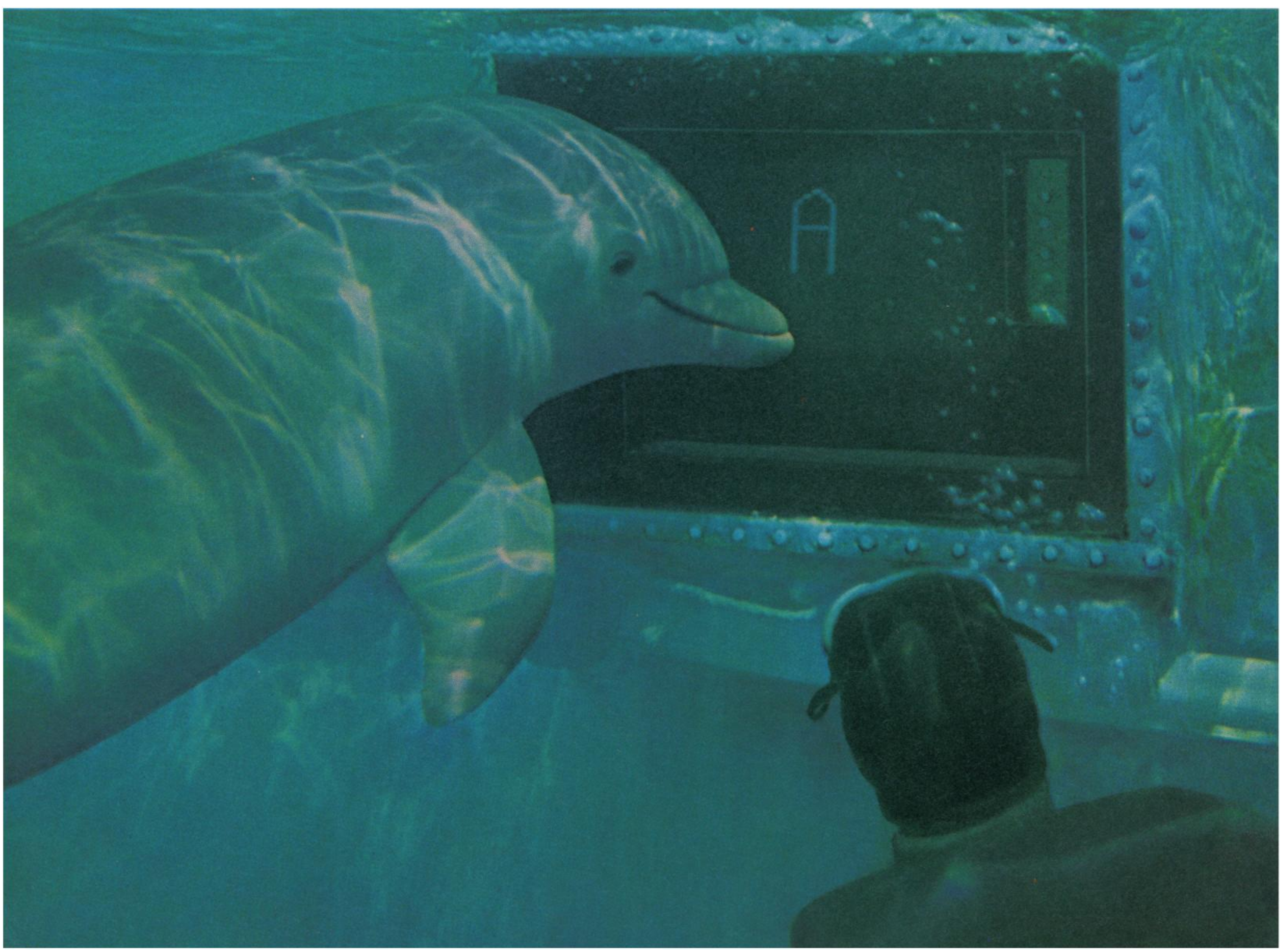

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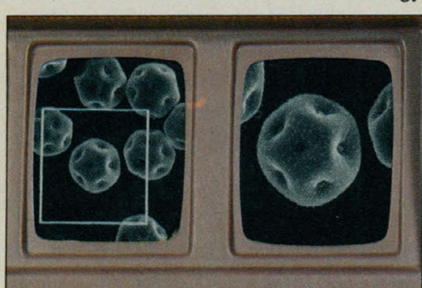

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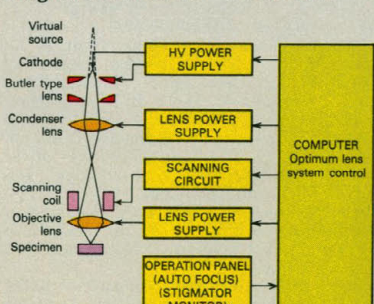

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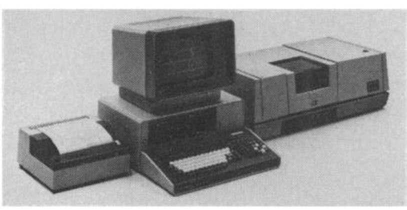

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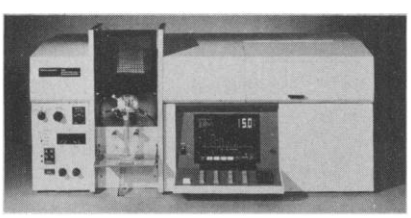

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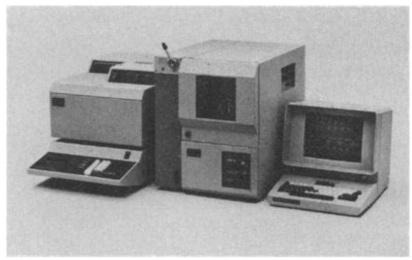

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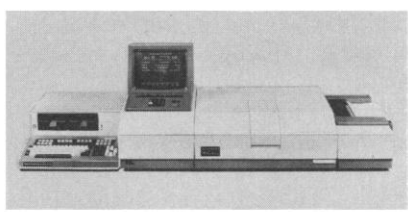

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Populations (Cambridge Univ. Press, London, 1980), pp. 30–33.
5. H. Leridon, *Aspects Biométriques de la Fecondité Humaine* (Presses Universitaires de France, Paris, 1973).
6. H. Caswell and A. Hastings, *Theoret. Popul. Biol.* **17**, 71 (1980).
7. K. M. Weiss, *Mem. Soc. Am. Archaeol.* **27**, 1 (1973).
8. L. C. Cole, *Q. Rev. Biol.* **29**, 103 (1954); R. C. Lewontin, in *The Genetics of Colonizing Species*, H. G. Baker and G. L. Stebbins, Eds. (Academic Press, New York, 1965); L. Demetrius, *Math. Biosci.* **4**, 129 (1969); D. B. Mertz, in *Statistical Ecology*, G. P. Patil, E. C. Pielou, W. E. Waters, Eds. (Pennsylvania State Univ. Press, State Park, 1971), vol. 2; T. W. Snell, *Oecologia* **32**, 119 (1978).
9. R. H. MacArthur and E. O. Wilson, *The Theory of Island Biogeography* (Princeton Univ. Press, Princeton, 1967), pp. 68–77.
10. M. Nag, *Yale Univ. Pub. Anthropol.* **66** (1963), pp. 169–172.
11. J. R. Napier and P. H. Napier, *A Handbook of Living Primates* (Academic Press, New York, 1967), p. 245; S. A. Asdell, *Patterns of Mammalian Reproduction* (Cornell Univ. Press, Ithaca, N.Y., 1964), pp. 166–170; A. S. Parkes, *Patterns of Sexuality and Reproduction* (Oxford Univ. Press, London, 1976), pp. 17–21; H. Charbonneux, in *Patterns and Determinants of Natural Fertility*, J. A. Menken and H. Leridon, Eds. (Ordina, Liege, Belgium, 1979).

Lovejoy traces human bipedal origins to a "demographic dilemma." We note the following problems with his scenario.

1) The chimpanzee interbirth interval and generational length utilized by Lovejoy are derived from studies at Gombe. However, this population was undergoing demographic changes associated with provisioning and epidemics of paralytic and respiratory diseases (*1*, table 9). Sugiyama and Koman (*2*) worked with a nonprovisioned group of chimpanzees and suggest an interbirth interval closer to 4 years, which allows a female to replace herself and a male in about 18 years. Thus, it seems unlikely that chimpanzees were forced to retreat into forested areas in the face of a demographic dilemma.

2) In his table 1, Lovejoy gives the "maximum life potential" of humans as 60, the age of sexual maturity as 15, and the interbirth interval as 2.5 years. However, most demographic models (*3*) use 15 and 45 as the age of sexual maturity and menopause, respectively. Use of the latter figure would greatly alter the reproductive values presented in Lovejoy's table 1. In equation 4, Lovejoy assumes that each taxon reproduces at a constant rate from age of sexual maturity to "maximum life potential." This assumption does not seem valid for humans (*3*) and may not be true for other primates (*4*). These considerations cast doubt on the reproductive values calculated by Lovejoy.

3) Lovejoy states that human females are continually sexually receptive; no scientific evidence demonstrates this, and studies (*5–6*) mentioned by Lovejoy indicate the contrary. Beach (*6*, pp. 354–355) writes, "No human female is 'constantly sexually receptive' (Any male who entertains this illusion must be a very old man with a short memory or a very young man due for a bitter disappointment)."

Where Lovejoy postulates concealed ovulation as a means of maintaining the pair-bond, Symons (*7*) suggests human females concealed ovulation to allow them to sneak copulations with males "fitter" than the mates with whom they were paired. Moreover, Symons argues that the human family is not a sexual but an economic union, a position supported by the fact that marriages in extant hunter-gatherer groups are alliances of families that extend social networks. Food-sharing in these networks is a partial insurance against future starvation (*8*).

4) In response to Lovejoy's argument that early hominids evolved dual parental care in order to increase reproductive output, it should be noted that *r*-selected species usually do not exhibit extended or extensive parental care. When offspring disperse and thus compete for first access to resources, selection favors low investment per offspring. It is only when offspring do not disperse and interact competitively for resources that selection favors large investment in the young (*9*). Thus, it seems unlikely that early hominids became biparental in order to increase *r*-selected traits.

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References

1. G. E. Teleki, E. Hunt, J. H. Pfiferling, *J. Hum. Evol.* **5**, 559 (1976).
2. Y. Sugiyama and J. Koman, *Primates* **20**, 323 (1979).
3. K. M. Weiss, *Demographic Models for Anthropology* (Memoir 27, Society for American Archaeology, Washington, D.C., 1973).
4. L. D. Wolfe and M. J. S. Noyes, *J. Mammal.* **62**, 698 (1981).
5. R. A. McChance, M. C. Luff, E. E. Widdowson, *J. Hyg.* **37**, 571 (1937); J. R. Udry and N. M. Morris, *Nature (London)* **220**, 593 (1968).
6. F. Beach, in *Advances in Behavioral Biology*, W. Montagna and W. A. Sadler, Eds. (Plenum, New York, 1974). pp. 333–365.
7. D. Symons, *The Evolution of Human Sexuality* (Oxford Univ. Press, Oxford, 1979).
8. R. B. Lee, *The !Kung San: Men, Women, and Work in a Foraging Society* (Cambridge Univ. Press, Cambridge, 1979).
9. R. R. Warner, in *Sociobiology: Beyond Nature/Nurture?*, G. W. Barlow and J. Silverbery, Eds. (AAAS Selected Symposium, Westview, Boulder, Colo., 1980). pp. 151–188.

Lovejoy proposes that human bipedalism arose as a consequence of natural selection on males: a male that was bipedal could carry more food to his mate and her offspring (and this would give the offspring an advantage over those from families in which the adult male was quadrupedal). A problem with this proposal is that the male could not be sure the offspring were his. By contrast, his mate, however promiscuous, would know her own offspring. Since males are never as sure of their paternity as females are of their maternity, selection on male behavior would be less efficient than selection on female behavior (*1*).

Therefore, it is important to give more consideration to the role of females in the origin of human bipedalism. One evolutionary model states that bipedalism arose because of the advantage it gave to females in the transport of infants (*2*). This model is appealing because it depends on the most important bond in mammalian groups, that of the mother and her dependent offspring. Upright walking, originally adaptive in infant transport, would confer the added ability to carry food and would contribute to infant care.

Although the material model states that, above all other considerations, human females would be selected for behavior associated with better infant care, they must still be both sexually attractive and sexually receptive at times if the species is to survive. Females who possess the ability to refuse unwanted sexual advances would be at an advantage, since they could provide environments for infant care away from the tense approaches of strange males. An obvious way for females to choose when and with whom they will mate is to conceal the outward signs of the estrous cycle.

In our maternal model, estrus is not concealed so as to prolong female sexual attraction. It is reduced and hidden in order to protect immature troop members, dependent for long periods of time on their mothers, from the constant social upheavals accompanying mating behaviors in those primates with prominent estrus. Its concealment is the ultimate expression of female choice. Mothers with these abilities are more likely to rear offspring who will survive preferentially the lengthy trials of troop socialization.

No particular mating pattern need result from the maternal model, in contrast to the paternal model, which is tied to an assumption of monogamy. Diversity in the organization of human societies today reflects precisely this point. We caution against interpreting the fossil record

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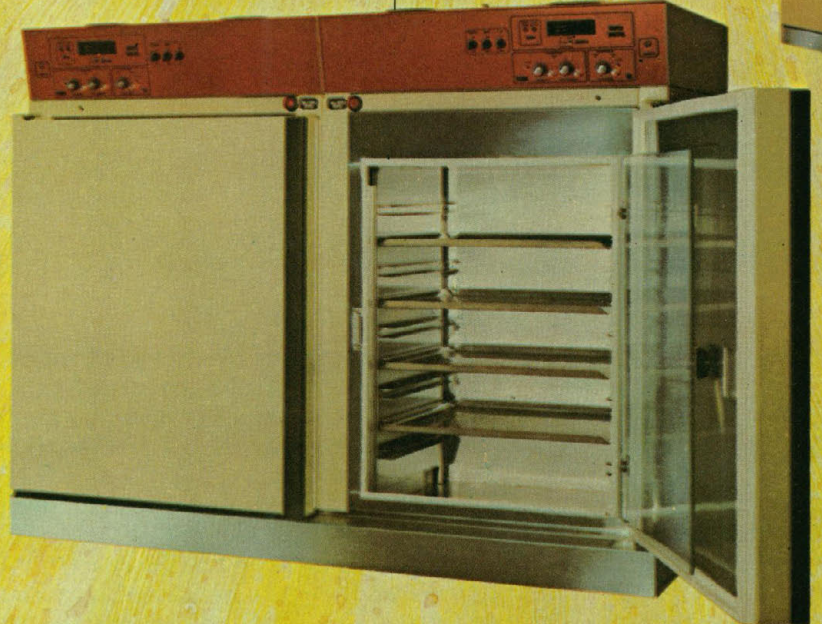

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SCIENCE

Energy for Western Europe

Intense concern about energy has abated in the United States, but in Western Europe it will continue for the foreseeable future. In the United States a combination of conservation, improved energy efficiency, and substitution of alternative sources of energy for oil has reduced imports markedly. A growing petroleum reserve provides a buffer against short-term interruptions of supplies. Europeans also have practiced conservation and attained increased energy efficiency, but in contrast to the United States their local resources of fossil fuels are tiny. There is practically no oil on the western portion of the continent. North Sea oil supplies only about one-fifth of the region's requirements. The remainder must be imported from countries that have repeatedly brandished the "oil weapon." The best coal deposits of Western Europe have been exhausted. West Germany obtains one-third of its energy from coal, but to achieve this must engage in a gigantic strip-mining process. Towns and villages are dismantled, and overburden as much as 200 meters thick is moved to get at lignite deposits.

In view of the uncertainties associated with supplies of oil and the difficulties, costs, and pollution associated with coal, the Europeans expanded their use of natural gas during the 1970's to the point where it amounted to about 200 billion cubic meters (bcm) or approximately 15 percent of total energy needs. Most of it is burned for residential heating. But reserves of natural gas in Western Europe are inadequate, and they are dropping. A major source is located at Groningen in the Netherlands. It supplies part of the needs of Belgium, France, Italy, and West Germany. Proved reserves at Groningen total 1600 bcm. Until recently this resource has been exploited at the rate of about 95 bcm per year. In practice the amount that can be produced drops with time; the Dutch estimate that they will be obtaining about 60 bcm in 1990. Exports will be sharply reduced. The North Sea is another source of natural gas. Gas from the British sector flows to the United Kingdom at an annual rate of about 32 bcm. Gas from the Norwegian sector (23 bcm) is sent south to the continent. Additional reserves, totaling about 1600 bcm, have been discovered in the Norwegian sector south of latitude 62°, but they are difficult to exploit. It is estimated that 12 to 14 years must elapse before the reserves could be used.

The other major supplier of natural gas to Western Europe is the Soviet Union. It has been delivering small quantities for roughly a decade and currently delivers about 25 bcm annually. The projected new pipeline would carry 28 bcm annually. Construction of facilities to bring Siberian gas to Western Europe will be a big project, but not a difficult one—5000 kilometers of large pipe and some compressor stations. Production capability is already in place. Soviet proved reserves are enormous (39,000 bcm), and much of the country has not been fully explored. In comparison, reserves in the United States are about 5600 bcm. The Russian reserves contain the energy equivalent of more than 200 billion barrels of oil, which in turn is more than the oil reserve of Saudi Arabia.*

Leaving ideology and national security aside, there is reason for cooperation between the Soviet Union and Western Europe. The former is rich in energy resources and wants high-technology imports. The latter needs natural gas and the jobs associated with producing goods. In contrast, the United States competes with Europe for both oil imports and sales of goods on the world market. In taking on an additional 28 bcm per year from the Soviet Union, the security of energy supplies of Western Europe is not much diminished beyond what it would be if more oil were imported instead. In contrast, were more coal supplied from the large, highly accessible reserves of the United States, and were practical gasification facilities in being, the hazards of an interruption of gas supplies might be minimized.

In dealing with its European allies, the United States should adopt a long-term view. In a few years, the current political issues may or may not be resolved. But the reality of the U.S.S.R. as a major producer of fossil energy will remain, as will the needs of Western Europe.—Philip H. Abelson

*Office of Technology Assessment, *Technology & Soviet Energy Availability*, November 1981.