

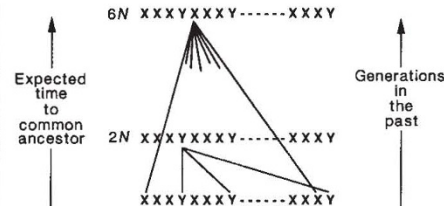
the amount of divergence that has occurred since humans entered New Guinea, Australia and the New World. Hence they estimated the time to a common ancestor as approximately 200,000 years, or 10,000 generations: note that this estimate does not depend on any assumptions about family size distribution, or absence of selection. But if we do assume no selection and a Poisson distribution, we can estimate that the human population contained, very approximately, 5,000 women. The number has of course fluctuated: the value of 5,000 should perhaps be taken as the geometric mean. Hence Eve, the woman who carried the ancestral mitochondrion, may have lived 200,000 years ago, but she had many female companions, and a like number of males, most of whom have contributed nuclear genes to the present population.

In principle, it should be possible to derive similar estimates from the Y chromosome, but this is proving difficult, because much of the DNA is highly repetitive, and the low copy number DNA is much more uniform than mtDNA, mainly because the mutation rate is higher in mitochondria. Ellis *et al.*² have tried to overcome this difficulty by sequencing 300 base pairs from the 'pseudoautosomal' region, adjacent to the boundary with the sex-specific region. This is the region where X and Y chromosomes have homologous sequences: although recombination does occur, it is rare, so that alleles now found only on the Y probably arose by mutation on the Y, and similarly for the X. Ellis *et al.* sequenced 57 Y and 60 X chromosomes, from ten human populations. They found seven variable sites: of these, four were polymorphic only on the X, one was polymorphic on both X and Y, and two were monomorphic for different bases on the X and Y. They conclude that the Y boundary region originates from an ancestor living more recently than does the X boundary region.

This conclusion is probably correct, although the numbers (five polymorphisms as opposed to one) are small. As the authors point out, this is to be expected on theoretical grounds (see figure). In a single generation, if there is a 1:1 sex ratio, there are three times as many X as Y chromosomes. Hence the expected time to a common ancestor is three times greater for the X, and the expected polymorphism is also greater. Their data on the distribution of haplotypes among X chromosomes suggest that this region of most human X chromosomes has descended from only two chromosomes with a long independent earlier history. This could prove to be of importance in elucidating patterns of migration.

In an independent study of the human Y chromosome (ref. 3), a low copy number region of the sex-specific Y was found to be polymorphic for five *TaqI* restriction

sites. The authors argue that, in a mammal, the presence of a *TaqI* site is likely to be primitive relative to its absence, because the CpG doublet is being eliminated in mammals (the *TaqI* endonuclease recognizes TCGA). If this is true, then the primitive allele can be recognized at each site. It is interesting that the chimpanzee has the primitive allele at four sites, and is polymorphic at the fifth. But this argument should be treated with caution. It is true that CpG is



Time to a common ancestor. The expected values, $2N$ and $6N$, have large standard errors. (X and Y are the female and male chromosomes; N is the number of males, and of females, in a single generation.)

rare in mammals because, due to methylation, it is readily lost by mutation. But if, as seems tenable, CpG has reached an equilibrium frequency, then loss and gain of such doublets will be equally common.

At present, the Y chromosome data are insufficient to make possible estimates of population size, or of the date and place of a common ancestor. Perhaps the most useful information provided by entities that are inherited without recombination concerns the history of past migrations: recombination destroys such information. The Y chromosome data agree with those on mitochondria in showing that most variation is present within racial groups. From this it would seem that most of the present variation was already present in an ancestral human population, before descendants of that population migrated world-wide. Cann *et al.*¹ suggest that Africa was the place of origin, essentially because, in their mitochondrial phylogeny, one main branch consists of Africans only. The Y chromosome data are compatible with an African origin, but as yet can provide only weak confirmation. In any case, if a value of 200,000 years (or even a value twice as great) is accepted for the ancestral mitochondrion, this would rule out the possibility that existing human populations are descended, in large part, from *Homo erectus* populations previously living in the same regions. □

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1. Cann, R.L., Stoneking, M. & Wilson, A.C. *Nature* **325**, 31–36 (1987).
2. Ellis, N. *et al.* *Nature* **344**, 663–665 (1990).
3. Lucotte, G. in *The Human Revolution* (eds Mellors, P. & Stringer, C.) 39–46 (Edinburgh University Press, 1989).

A perfect spy

ELECTRONIC surveillance is normally a hostile technology, used with ill intent against others. Daedalus, however, is developing a self-surveillance device as a consumer product. DREADCO's 'Little Brother' looks like a tiny tape recorder. But it is worn next to the skin, and functions more like an aircraft flight recorder, or the tachograph on a lorry.

Little Brother records many tracks of data simultaneously, such as time, location (deduced by the relative intensity of the local broadcasting transmitters) and instantaneous acceleration (activities like walking, running, driving, and so on, have very characteristic accelerational signatures). Further tracks record ambient sound and the wearer's own speech, and physiological data like his temperature and pulse. Modern digital coding can pack at least a month's worth of such data on one tape; so Little Brother, which continuously overwrites the same tape with new data, always holds exact details of the last month of the wearer's life. Any event which turns out to have been significant can be saved for examination.

The main advantage will be legal. In the present litigious climate, anybody may suddenly need to prove any detail of his life in court. Little Brother will be an unimpeachable witness. A single tape track is easily falsified. Two tracks together are far trickier (which is why a sound-and-vision recording is hard to edit). The dozen or so tracks on Little Brother's tape will be utterly unfakeable. The wearer will be able to prove where he was at any time, how he got there, what he said and what was said to him, even (from the pulse-rate record) how furious he was.

Little Brother will have a salutary social effect. Crimes like confidence trickery and false accusation, together with shady deals and malicious gossip of all kinds, will simply vanish. Vexatious litigation will cease, and most honest disputes will be cleared up out of court by comparing the adversaries' Little Brothers. Policemen, sociologists and coroners will have a new source of evidence!

Once most people have a Little Brother, those who fail to carry one will automatically attract suspicion. Unfaithful husbands, secret gamblers and alcoholics, and tax-evading moonlighters will find life increasingly difficult. Ultimately, by making secrecy impossible, Little Brother may also make it unnecessary. Society will cease to set impossible standards for its members, and will tolerate their weaknesses and failings. But till that happy day, Daedalus is fitting his creation with an emergency-erase facility. A wearer suddenly caught in a truly impossible situation can scrub the whole tape instantly. His Little Brother will never testify against him. David Jones