Commentary

Molecular slavery

Can the soul be cloned?

Every science has its own special dialectic, one that an uninitiated person can scarcely fathom. This makes it difficult for me to say why a matter that is controversial enough to flutter the leaves of the media-forest should have surfaced just now as a topic of discussion. The topic is an exciting one: it concerns the allegedly imminent breeding of a Superhuman. Along with possessing a host of other undesirable qualities, it is not clear whether this noble personage will also be immortal. We now live in a world of rabbits, a world which is quite incapable of giving rise to great deeds. That world is now to be replaced by a world of superlative geniuses. The very thought makes me want to stop up my ears.

I am not sure what could have prompted even philosophers to be drawn into the discussion. Has the Supersheep fanned their flames of inspiration, or did the least recommendable parts of "Zarathustra" pull it off? To be sure, some people have the talent for making a lot of noise even *in absentia*. My wife used to have a vivid term for them: "noise-making bellboys". There are many of these where I live, particularly because stridency is the first step towards becoming a celebrity. For instance, to be spoken of as a person of promise, one must first make a lot of promises. This applies with especial force to areas of biological research such as genetics and cell biology; and all the more so to the new trade of cloning.

Whoever chooses the cloning of human beings as a topic can be assured of a lot of attention. For all the talk concerning human cloning, though, nothing significant has happened so far. The reason has hardly anything to do with ethics; in any case, in the world of natural science ethics is now synonymous with finance. (As one of my old aphorisms had it: "Money is the life-breath of the devil".) One might find it convenient to say that research into the cloning of human beings has been slowed down for ethical reasons, but the fact remains that public funding for the purpose is not yet at hand. Later on, should everything have gone smoothly in the interim, the biotechnology industry is bound to monopolize the entire field. One day a patented human being will follow the famous Harvard mouse. This possibility confronts us with an interesting dichotomy: on the one hand, a glorious fulfilment of platonic dreams and on the other, an enslavement through molecules.

At the risk of re-stating the obvious, may I point out that brilliance, however one defines it, is hardly likely to be part of one's genetic endowment? A clone of Albert Einstein would more likely be a bad violinist than the discoverer of something as significant as the theory of relativity. Even if the latter, I doubt whether the outcome would be of much interest to anybody except psychiatrists and researchers interested in *idiots savants*. Who, therefore, is going to be the Original Daddy – to name him Father would be going too far – and provide us the material for the Superman clone? Might a suitable statistical agency situated in Hollywood help out? As I have said, the genetic engineers will not be ready for a long time to come. Still, philosophers are being asked to weave their web of words so as not to miss the great moment when it comes. To this end there is talk of a (modern) Codex of anthropological engineering.

Nobody knows what this Codex should represent because, in truth, nobody is sure of what he or she wants. In the past, in the Golden Age, a sense of dissatisfaction with what existed, the feeling that things could not go on as they had been going on, the feeling that something had to happen, was the forerunner of many great deeds. Here too, something may happen. All the same, the thought of letting a syndicate of philosophers and gene manipulators decide on the future of human beings seems absurd to me.

Anyone who takes this notion seriously is ignorant of the driving forces behind research in contemporary molecular biology. I assume that the philosophers of today are capable of thinking, even take great joy in thinking. But I doubt that this applies to most heads of scientific laboratories, though in some cases nostalgic memories may have survived. The reason for my saying so is that natural science has become a branch of the free-market economy and produces so-called knowledge in an industrial manner. Given that, it is hardly on the cards that a committee of inquiring philosophers and molecular biology-bosses could come up with something desirable.

I fear that if the molecular magicians who splash about in the dark waters of conception and reproduction were to be questioned about their goal, they would assert that it is the welfare of mankind. I do not know whether philosophers too would answer just as insincerely. But a similar query was posed and honestly answered long ago, in the beginning of the era of molecular biology. The famous Ciba Symposium "Man and his Future" (1963) demonstrated to researchers just how busily they were occupied with filling up a large number of Pandora's boxes. Here are ideas leading to two proposals that the bold dreamers of the future wished to see implemented (all names have been omitted):

"Do people have the right to have children at all? It would not be very difficult . . . for a government to put something into our food so that nobody could have children. Then possibly—and this is hypothetical—they could provide another chemical that would reverse the effect of the first, and only people licensed to bear children would be given this second chemical. This isn't so wild that we need not discuss it. Is it the general feeling that people do have the right to have children? This is taken for granted because it is part of Christian ethics, but in terms of humanist ethics I do not see why people should have the right to have children. I think that if we can get across to people the idea that their children are not entirely their own business and that it is not a private matter, it would be an enormous step forward".

"Clearly a gibbon is better preadapted than a man for life in a low gravitational field, such as that of a spaceship, an asteroid, or perhaps even the moon. A platyrhine with a prehensile tail is even more so. Gene grafting may make it possible to incorporate such features into the human stocks. The human legs and much of the pelvis are not wanted. Men who had lost their legs by accident or mutation would be specially qualified as astronauts. If a drug is discovered with an action like that of thalidomide, but on the leg rudiments only, not the arms, it may be useful to prepare the crew of the first spaceship. . . ."

And these were the cleverest and the best! They would give other answers today but their dreams would certainly not be more human. I am of the opinion that philosophy and modern science do not merge well, although in the ancient times the pre-Socratics could unite both. Of our natural sciences one can only say that they live on temporary finalities; indeed, it is doubtful if there is anything definite in them. (I do not consider Mathematics to be a natural science.) About philosophy I dare not say anything. At all events, my oxymoron will need to be defined in a manner which differs from that in the natural sciences.

I do not believe that the philosophically sanctioned breeding of paragons will contribute to calming the human soul. Can the soul itself be cloned? Molecular biologists would say no: "There is no such thing as the soul; we cannot grasp it; we cannot describe it; it does not have a defined chemical composition." Thus the puzzle of consciousness remains. All the miracles of reductionism shatter on it. And by the way – although this doesn't belong here – human destiny will never be cloned either.

Reference

Ciba Foundation Volume 1963 *Man and his Future* (ed.) Gordon Wolstenholme (London: J and A Churchill Ltd.)

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The smallest form of life yet?

Philippa Uwins and co-workers at the University of Queensland, Australia, may have discovered a previously unsuspected form of life (Uwins *et al* 1998). Because it is so much smaller than a microbe, the creature – if that is in fact what it is – has been christened 'nanobe'. Nanobes occur as filaments on rocks 3–5 km below the Australian seabed and, at 20 to 150 nm in diameter, are smaller than all known microorganisms (even mycoplasmas are about 300 nm). Except that they are so much more tiny, about one-thousandth the volume, their morphology resembles that of Actinomycetes and fungi. If the claim that nanobes are alive is true, this is an astonishing finding and makes one wonder how they might have evolved.

Evolution takes place whenever a chance change in the hereditary properties of a creature improves its efficiency of survival and reproduction. An obvious route to such improvement is to become bigger; a less obvious route is to become smaller (Bonner 1965). One of the most famous of the so-called trends displayed in evolution is that of an increasing body size as found in mammals and other groups [Cope's rule; however, as cautioned by Raup (1977), one should guard against the likelihood that in any given case the 'rule' may be an artefact of statistical analysis]. There are many advantages to an increase in size. One is that you can protect yourself better against changes in the physical environment – for example, retain heat better. Another is that you can make use of the economy provided by division of labour: different parts of a large plant or animal can become specialized to do different things. And you can prey on smaller creatures. In short, there is always 'room at the top'. Natural selection for size increase, complexity and division of labour can be mutually reinforcing (Bonner 1993), and it may only be the constraints imposed by the physics of bone and muscle that put a stop to evolutionary gigantism (Haldane 1927).

Curiously, though, most living creatures appear to be microbes; and among microbes, prokaryotes (including both the archaea and the eubacteria; see Whitman *et al* 1998). Considering that life on earth has been around for such a long time, this must mean that microbes are extremely successful at what they do. Thus it appears that there is 'room at the bottom' as well. What might its nature be? One obvious thing that small creatures can do is to grow rapidly. We take about 20 years to reproduce but bacteria need only 20 minutes; it takes much longer to build a large and complex body than a small and simple one (Bonner 1965). Secondly, being small means that you can parasitize something which is larger. Indeed, you can become such an efficient parasite that you lose all capacity to reproduce or metabolize on your own – a route that viruses have adopted, which is why we think of them as honorary living creatures. Dawkins (1990) has pushed this line of reasoning to an interesting limit. He concludes that large genomes are, in effect, made up of genes that parasitize on each other subject to the powerful constraint that they have to share the same vehicle for propagation.

But there is a problem with becoming ever smaller too. This time the difficulty does not have to do with physics – except in a trivial sense. The machinery needed for life is made up of huge aggregates of nucleotides and amino acids. These take up a lot of room inside a cell. What is the minimum amount of space the machinery requires? A lower limit might be set by the size of a single ribosome, say about 18 nm in each direction. If we add to this a molecule of DNA (or RNA) and many different kinds of proteins we might reach 50–100 nm. It is not clear how something could be significantly smaller than this and yet carry out reproduction and metabolism on its own. If nanobes are alive, how do they manage with such small bodies? Might it be that each nanobe contains only part of what it requires to carry on, with a collection of nanobes being the functional equivalent of a single living cell? If true, these nanobes display an unprecedented degree of cooperative social behaviour, with a degree of intimacy comparable to that between eukaryotic cells and the mitochondria that they house.

To get back to the question, Are these Lilliputians alive? They seem to grow spontaneously, contain DNA and are enriched in carbon, nitrogen and oxygen. That would seem to clinch the issue. But what sort of DNA? How is their DNA related to that of other, known microorganisms? In their original paper the Uwins group showed SEM images of the nanobe colonies that gave positive reactions to DNA stains and took care to guard against the possibility that contaminating microorganisms could account for the stain. One awaits supporting evidence (from work currently in the press) bearing on the existence and nature of nucleic acids within nanobe cells.

In 1996, NASA scientists reported the existence of what they thought were fossil nanobacteria in a Martian meteorite. (The material that formed the meteorite solidified on Mars 4·5 billion years ago, was shot into space by another meteorite that hit Mars, voyaged in space for 16 million years, fell in Antarctica about 13,000 years ago and was discovered in 1984.) That claim attracted a great deal of controversy and scepticism. Till today there have been no reports of anything like the Martian forms seen in fossils on Earth, which has (unfairly) added to the scepticism. Uwins's nanobes are roughly the same size as those nanobacteria but otherwise quite different.

To sum up, we still lack conclusive evidence for the occurrence of reproduction and metabolism in nanobes. Nor, assuming that they are living creatures, do we have a plausible hypothesis regarding their evolutionary antecedents. But, until we do, the possibilities for speculation remain fascinating.

References

Bonner J T 1965 *Size and cycle* (Princeton: Princeton University Press)
Bonner J T 1993 *Life cycles* (Princeton: Princeton University Press)
Dawkins R 1990 Parasites, Desiderata Lists and the Paradox of the Organism; *Parasitology* **100** S63–S73
Haldane J B S 1927 On being the right size; in *Possible Worlds and Other Essays* (London: Chatto and Windus)
Raup D M 1977 Stochastic models in evolutionary palaeontology; in *Patterns of evolution, as illustrated by the fossil record* (ed.) A Hallam (Amsterdam: Elsevier) pp 59–78
Uwins P J R, Webb R I and Taylor A P 1998 Novel nano-organisms from Australian sandstones; *Am. Mineral.* **83** 1541–1550
Whitman W B, Coleman D C and Wiebe W J 1998 Prokaryotes: The Unseen Majority; *Proc. Natl. Acad. Sci. USA* **95** 6578–6583

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