It’s supposed to be an unstoppable force of nature. But with most humans living long enough to pass on their genes, has our species’s evolution come to a halt? Here, two leading evolutionary biologists argue the case

Is Evolution

Yes

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What is the future going to be like? If you believe science fiction it is going to be a lot like today – tribes, empires, wars, with a little love interest on the way. However familiar their behaviour, though, the imagined heroes and villains of years to come tend to look quite different from us, with giant green skulls, massive brow ridges and tentacles.

Natural selection – the process that would drive such a transformation – ultimately results from inherited differences in the ability to reproduce. Once, it raged through most nations. In Shakespeare’s day two out of every three babies died before they were 21, and even in Darwin’s time almost half did.

Many of those deaths came from disease, starvation or violence – and there are inherited components in the ability to withstand all of them, whether it’s the blood type that gives resistance to smallpox, or the light skin that allows some people to synthesise vitamins missing from the diet.

Now, around 99 per cent of British babies, once they have survived the difficult first few months, survive until they are grown up – so that the differences that once fed Darwin’s mechanism have largely gone away. We do not need to know the details – how many perish from cholera, say – for the story to be clear.

Natural selection, like the driving test, is an examination with two papers. The first, the theory, is easy enough, but the practical is a lot harder. Staying alive today is straightforward, but finding a willing mate is more difficult. The range of success is wider, too, particularly for males. Each time a man has sex he makes enough sperm to fertilise every woman in Europe – in principle, he could have thousands of children.

Some still do remarkably well: Mohamed bin Laden, father of Osama, had 22 wives, and 53 children (and in the year of Osama’s birth he had six). His best known son had, at the last count, five wives and 22 sons and daughters.

And in the old days, sexual inequality could be even worse. Moulay Ismael of Morocco admitted to 688 children. There was, needless to say, more than one Mrs Moulay. As a result, around a hundred of his male fellow citizens must have had no wives, and no children at all. What did that mean for natural selection?

It meant there were great differences – great variation – in reproductive success. And any variation in the ability to attract a mate is raw material for selection. Now, that pattern has changed: variation in reproduction has all but disappeared. Most people have between zero and four offspring, with the Lotharios almost extinct.

If natural selection favours variation in the ability to stay alive and to have sex, then once that variation has gone it loses its power. Put the figures for survival and for reproduction together, and you get a statistic for the opportunity for natural selection. In the developed world, in the past few centuries, it has declined by around nine-tenths.

The result: for the time being at least (and keep your fingers crossed), there is no selection and evolution on the Darwin model is over.

In other words, if you are worried about what Utopia will be like, calm down; you are living in it now.

1865
Gregor Mendel shows that characteristics are inherited as discrete particles: each one of an offspring’s characteristics is not a ‘blend’ from its parents. It is not until 1900 that the particles are called genes.

1893
August Weismann proposes that acquired characteristics (any attribute that isn’t in your genes) cannot be inherited. So even if you chop a mouse’s tail off, its offspring will still have tails.

1910-1915
Thomas Hunt Morgan’s lab uses classical genetics to trace the history of mutations. They also discover that genes are located on chromosomes.
There are two things that must happen for human evolution to come to an end: one, everyone must be genetically identical, and two, the copying of DNA from one generation to the next must become absolutely flawless. The former is simply not the case, while the latter is physically impossible.

These conditions reflect the two engines that drive the appearance of anything new during the process of evolution. The first is the reshuffling of alleles (all the different possible forms of a gene). We human beings do this by using sex. Every child is the product of the random assortment of alleles from two individuals, producing a unique combination of alleles every time. This is a significant source of new variants and forms: the human race contains billions of people, and no two (with the exception of identical twins) have exactly the same arrangement of alleles. As long as the pool of parents vary, we will continue to produce children with unique attributes.

The second engine that keeps things fresh in the human gene pool is mutation. This is the change we see in the sequence of “letters”, called nucleotides, in DNA, and it is unavoidable. The most common mechanism is simply errors in copying. No machine can be immune to error, and that goes for the biological machinery of the cell, which is responsible for copying, one by one, each of the three billion letters in the human genome each time cells divide. And cells have to divide or we couldn’t produce populations of sperm and egg cells.

Our cells are actually very good at copying, only making one error in every 10 billion letters, which really is remarkably good. Imagine transcribing a million pages of text from one pile of papers to another. How many mistakes would you make? However, that still means a new mutation roughly once every three cell divisions, and since it takes several hundred cell divisions between birth and ejaculation to produce a sperm cell, that means each sperm contains hundreds of new mutations. Most of these are neutral in effect, since we can survive the many copying errors we accumulate, but it does mean that every single one of us is a mutant in the purest sense of the word.

In spite of this, one common argument for the end of human evolution is that we’ve loosened the constraints of natural selection with our technology and social support systems. That does not imply an end of evolution, though: selection is a conservative force that culls novelty, or reinforces the expansion of a few advantageous forms. What does that mean? That less selection allows greater amounts of genetic diversity in a population.

Not that we’ve actually eliminated selection, of course. All we have changed are the parameters, often in ways we take for granted. Perhaps we don’t have to outrun saber-toothed tigers anymore, but our offspring still have to overcome the hurdle of coping with the opposite sex in the big school dance, of acquiring skills that will get them a good job, of finding a mutually fertile mate sometime before they die. Selection can be a subtle force, and you cannot escape it.

Oh, and there is one other way we could see human evolution end: if we became extinct. Otherwise, evolution is a natural and unavoidable property of living, replicating systems, and it is absurd to talk of any living population as not evolving.

PZ Myers’s blog, Pharyngula, can be found at http://scienceblogs.com/pharyngula