

The Problem of Original Sin in an Evolutionary System

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Abstract

Catholic teaching on Original Sin requires a repudiation of polygenism for the origin of the human race which, *prima facie*, challenges scientific orthodoxy. However, a correct understanding depends on a definition of what constitutes a true human being, and what constitutes polygenism. If a particular random mutation equips a hominid with sufficient development for God to grant it a soul, and this hominid – ‘Adam’ – sins before begetting offspring, then the genetic inheritance of this ‘human’ capacity must inevitably be accompanied by the spiritual inheritance of Original Sin as it spreads through the hominid population. Therefore Catholic teaching is shown not to be in conflict with scientific orthodoxy. Alternative scenarios are also considered, and theological and moral consequences of this position are explored.

Introduction

One particular teaching of the Catholic Church seems to pose a crisis of conscience for any Catholic scientist who wishes to accept the prevailing scientific orthodoxy:^a the teaching against polygenism. This might *wrongly* be understood as a requirement to believe that all humans descend exclusively from one original couple, a belief which would have testable genetic consequences. Here, I intend to show that the Catholic position is in fact compatible with the most likely scientific hypothesis of human origin.

The Theological Position

In 1950, Pope Pius XII published his encyclical, *Humani Generis*, which allowed Catholics to consider evolution as a possible (but not favoured) hypothesis for the origin of the human body, while insisting that the spiritual part of a human person – the soul – is created immediately by God. He then declared:

37. When, however, there is question of another conjectural opinion, namely polygenism, the children of the Church by no means enjoy such liberty. For the faithful cannot embrace that opinion which maintains either that after Adam there existed on this earth true men who did not take their origin through natural generation from him as from the first parent of all or that Adam represents a certain number of first parents. Now it is in no way apparent how such an opinion can be reconciled with that which the sources of revealed truth and the documents of the Teaching Authority of the Church propose with regard to original sin, which proceeds from a sin actually committed by an individual Adam and which through generation is passed on to all and is in everyone as his own.

Scripture offers us at least three perspectives on the origin of the human race. Genesis 1:26-27 portrays the creation of a plural humanity (“Let them rule ... male and female he created them...”) whereas Genesis 2-3 depicts an original couple, Adam and Eve, who share responsibility for the Fall. St Paul’s soteriology (as seen, for example, in Romans 5:12-21) depends heavily on the idea of Christ the Second Adam who reverses the effects of the fall; Eve is not mentioned, and ideas of Mary as New Eve are only found in later (post-Biblical) theologizing.¹

Pius XII’s encyclical clearly takes the Pauline emphasis, relying on the idea of one individual ancestor, Adam, whose primordial sin taints all human beings through their common descent from him.^b All Catholics are bound by this document – part of the ordinary Magisterium – to presume that each and every living human being is a descendent of a particular individual, whom we call Adam. A loophole is left, however, in case the Magisterium itself should discover an alternative scenario for the origin of the human race which would nevertheless be consistent with what Scripture and past Magisterial pronouncements have taught about transmission of Adam’s sin.

The condition of Adam prior to the Fall may be called “original holiness” or “original justice”.² This was lost when Adam – a human being in perfect relationship with God – freely chose a course contrary to God’s will. Adam then entered a state of “original sin”, and it is axiomatic that this condition is inherited by every descendant of Adam.^c The condition can only be reversed through a special intervention by God.

In 1996, Pope John Paul II addressed the Pontifical Academy of Sciences³ on the question of evolution. He noted (§4) that since the publication of *Humani Generis*, there was a much stronger scientific consensus that evolution was the best available theory – although within the field of evolution there are various competing hypotheses.^d Human beings, with their intellectual powers and capacity for relationship with God, differ from all other animals; and since God wills their existence as such, and creates for each human an immortal soul, the emergence of these abilities of the human mind cannot be accounted for merely as a random or incidental consequence of evolution (§5).

John Paul II concludes that if human bodies came to exist through evolution, then although the process is one of physical, chemical and biological continuity, it includes a moment of ontological discontinuity (§6). This moment is not one which the empirical sciences can identify by their own methods,^e even though they may be able to gather experimental evidence for human beings living according to truly human values. He does not comment on Adam or Original Sin in this document, though he gave relevant catechesis during General Audiences in 1986.⁴

The theological position, then, requires a Catholic scientist to presume that all human beings, now and from the time of Adam himself, have Adam as a common ancestor. That this ancestor, ‘Adam’, is male is not explicitly stated by the documents, but is an implicit requirement of the Adam-Christ typology.

¹ *Catechism of the Catholic Church*, ¶ 411

² *Catechism of the Catholic Church*, ¶¶ 399-402

³ John Paul II, 22nd October 1996, “Magisterium Is Concerned with Question of Evolution For It Involves Conception of Man”, Message to Pontifical Academy of Sciences, sourced from <http://www.cin.org/jp2evolu.html> - published in **L'Osservatore Romano**, “Weekly Edition in English,” 30 October 1996

⁴ For a compilation, see <http://www.ewtn.com/library/PAPALDOC/JP2ORSIN.HTM>

The Scientific Position

What has science to say about the origin of the human race? This touches on a more general question, namely that of what constitutes the generation of a new species.⁵

It now seems beyond question that all animals on Earth are built of the same components: living cells, which grow according to a genetic code stored by the chemical DNA coiled up in their nuclei. When the code is changed by accident – a so-called random mutation – the behaviour of the cell changes to express the new code, provided that the mutated gene represents a possible chemical process. When the cell in question happens to be an embryo (or an egg or sperm destined to form a viable embryo) the change will affect every cell in the adult organism, including the sexual organs, which then propagate the change to its descendants.^f Changes which make it more likely for the animal to live long enough and healthily enough to reproduce, are more likely to get passed on to the next generation – this is ‘evolution by natural selection’. Over many generations, the advantageous gene spreads through the population until all the animals without this inheritance have died out.

So far this could describe the evolution of a particular single species. How many changes are required before you could fairly say that the population had become a new species? The answer is not clear; and perhaps the question unfairly tries to shoehorn a gradual process into a series of distinct categories. Although individual mutations are discrete events, they only (generally) produce small changes in the overall creature. A species becomes distinct as numerous small changes accumulate, making evolution a quasi-continuous process.^g

Now consider a population split in two by, say, a geographical barrier. The two groups eventually accumulate favoured mutations for their particular circumstances and so diverge. In the case of species which practice sexual reproduction, the loss of capacity to inter-breed and produce fertile offspring is taken as an indication of becoming separate species. Nevertheless, there is clearly a continuous process at work which makes it difficult to pinpoint a moment at which species A has suddenly become species B.

Next consider humans: anthropologists do not claim that we descend from today’s apes, but rather that we and they had a common ancestor. We and apes and chimpanzees are all classed as ‘primates’;⁶ it might be presumed that at some point in our history, a group of primates got separated from others of their species in an environment which favoured ground-dwelling over tree-dwelling, and in which the development of big brains (reasoning power and tool-making) aided survival to the extent needed to find or catch more food (big brains need a lot of energy to keep them going). Some sub-groups died out (e.g. Neanderthals); we, *Homo sapiens*, represent the one sub-group that survived.

Anthropology classifies different kinds of primates (hominids) in our ancestry as follows:⁷ *Australopithecus afarensis*, the first of our ancestors to walk upright, at 3.2 million years ago; it evolved into several species, including *Homo habilis*, whose particular adaptation was eating meat, and learning how to extract bone marrow with stone tools. Such a diet promotes brain growth. By 2 million years ago, *Homo ergaster* had probably lost most of its hair, begun to sweat,

⁵ See, e.g., J. Mallet, “Species, Concepts of”, preprint of article in in *Encyclopedia of Biodiversity*, ed. Simon A. Levin, Academic Press, New York. (2001) Volume 5: pp. 427-440, online at

<http://abacus.gene.ucl.ac.uk/jim/Sp/Species.html>; also B. Sellers, lecture notes on human evolution, “Evolution and Taxonomy”, Leeds University, online at http://www.leeds.ac.uk/chb/lectures/anth1_07.html

⁶ See e.g. B. Sellers, lecture notes on human evolution, “Primate Taxonomy”, Leeds University, online at http://www.leeds.ac.uk/chb/lectures/anth1_08.html

⁷ <http://www.bbc.co.uk/science/cavemen/chronology/> and links therefrom.

and developed a narrow pelvis more suited to upright walking. But this made childbirth difficult, and the birth of children with immature brains (allowing heads to be smaller at birth to pass safely through the pelvis) may have forced the development of the nuclear family as long-term childcare became essential.

By 500,000 years before the present, *Homo heidelbergensis* had a more developed brain and may have practiced burial rituals. The ice age 190,000 years ago forced those hominids in northern regions to evolve into Neanderthal Man, with a developed social structure and the physical capability for speech. The hominids who remained in, or returned to, Africa were reduced to a small population (perhaps as few as 10,000 individuals) by 100,000 years ago, yet this bottleneck population provides the immediate ancestors of *Homo sapiens*. It is a disputed question whether Neanderthals interbred with the ancestors of modern humans.

What happens if there is an evolutionary bottleneck and a single couple becomes isolated from a population, and they beget children who are forced to inbreed? Since a child inherits 50% of its genome from each parent, there is a great potential for diversity even in the offspring of a single couple. Humans have 23 pairs of chromosomes, so there are four-to-the-power-23, which is 70,368,744,177,664, ways of paring them up to produce a unique child – and this is without considering the shuffling of genes between chromosome pairs (recombination) which is a natural part of the process.

With so many combinations, it might seem odd that inbreeding is regarded as a problem. But it turns out that there are evolutionary advantages to carrying imperfect copies of genes on your chromosomes. As long as you inherit a good copy from one of your parents, the imperfect copy often doesn't do any harm. But if both of your parents have an imperfect copy, you have a one-in-four chance of getting a pair of imperfect chromosomes. Multiply by 22 chromosomes (excepting the X and Y sex chromosomes which behave differently), and on average you can expect to inherit five-and-a-half genetic disorders. Of course, this is over simplified (it assumes each chromosome carries one such gene, and in each case, both your parents have one imperfect copy) – but it shows how trouble could escalate.

If a single couple did produce an entire population, there would be two tell-tale genetic signs. All the males in the population would inherit the founding male's Y chromosome, and all the children of the original couple would have cell bodies with the same mitochondrial DNA (genetic material not part of the 23 chromosome pairs in the nucleus) as the founding female. Indeed, the appropriate one of these two markers would also occur in the case of a founding group with only one member of one gender, but more than one of the opposite sex. Since any changes in the mitochondrial DNA or Y chromosome would be due to mutations subsequent to the bottleneck, estimates of the mutation rate could even be used to date the founding parent(s).

Both of these markers have been searched for, and found, in the human genome. A common female ancestor, the so-called 'Mitochondrial Eve', has been dated to 143,000 years before the present day.^h The common male ancestor of today's men, however, lived only 59,000 years ago. Geographical dispersion indicates that both of these ancestors probably lived in Africa.⁸

We must be cautious about how we interpret these results. The existence of a common ancestor does not automatically mean that they were the only creature of that gender alive at the time. There may have been other women accompanying Mitochondrial Eve; their sons would breed with Eve's daughters and produce offspring with Eve's mitochondrial DNA. The other women would also produce daughters, but no humans alive today are descendents of these daughters

⁸ <http://news.bbc.co.uk/1/hi/sci/tech/999030.stm>

down the purely female line. Perhaps Eve's DNA gave her daughters the edge, or perhaps it is a random accident that her mitochondria prevailed. And similarly, other men could have been around at the time of 'Y Chromosome Adam'; any line of descent from them including a female would lose their Y chromosome. All we know for sure is that no direct male lines of sons survive from these fellow men.

What these gene lines do prove is that the genetic heritage of a particular individual can spread through the entire human population. They do not, however, give us a 'last possible date' for a common ancestor: remember that these two ancestors represent pure male and pure female descent lines. (They do give a last possible date for a bottleneck population with only one female or only one male.) It is easily possible for all humans to share a more recent common ancestor through lines of mixed gender (such as your mother's father's mother, etc.). Nor do they rule out common ancestors existing before Mitochondrial Eve, but in this case the evidence is hidden behind the bottleneck. Certainly a 'last possible date' for a common ancestor is required by the migration of different populations to remote parts of the world; the earliest major migration across an ocean seems to be that to Australia around 50,000 years ago.⁹

In all this biological detail, it is crucial to remember the technical meaning of a 'common ancestor'. A person has 2 parents, 4 grandparents, 8 great-grandparents, and so on, so that there are more than a million routes to your 20th generation of ancestors – most likely with particular individuals being related to you by multiple routes. As long as you and I have *one* individual in common somewhere in our genealogy, then we can claim to share a common ancestor. It is not necessary for the whole million to match!

Some Evolutionary Scenarios

As the current Pope noted in his 1996 address, there is a particular difficulty in associating the continuous process of evolutionary divergence sketched by science, with the theological requirement that there be a 'first human'.ⁱ Catholic doctrine claims that humans are discretely different from other animals, because of the presence of a spiritual component, the immortal soul. The soul's presence is not, however, empirically demonstrable.

If human bodies come into being through evolution according to the prevailing scientific orthodoxy, then at some point, God must decide that the time has come to bestow the first soul(s). Since John Paul II stated¹⁰ that an essential part of human nature^j includes the capacity for intellectual reasoning (including moral reasoning) and interpersonal relationships with other creatures and with God, then a brain capable of sustaining these functions would seem to be required. Therefore, we can plausibly argue for a threshold of sufficient brain-function which is achieved for the first time at some point in evolutionary history. We are required to hold that evolution was not a purely random process, insofar as God positively willed that creatures capable of bearing rational souls might come into existence.

⁹ <http://www.bbc.co.uk/science/cavemen/chronology/contentpage6.shtml>

¹⁰ John Paul II, 1996, *op. cit.*, §5.

Case 1: Polygenism

Suppose that we begin with a population of primates who have all achieved a certain level of brain capacity. Is God obliged to bestow a soul as soon as a brain with sufficient capacity has evolved, or may He wait? Suppose He waits for this mutation to spread through the population, and then one day bestows souls on the creatures, adult and children alike. This might be called the “Genesis 1” scenario, a plural creation of humans. With a numerous population, moral humans can breed without resorting to incest.

Now if one member – “Adam” – sins, other members of the population are not directly tainted. Even if the Fall has cosmic consequences, including death for all the unfallen humans, Original Sin is something explicitly inherited, not transmitted horizontally within a generation.

If those remaining in a state of original justice do not ostracise Adam, but permit him to marry (or if he rapes) then his spiritual inheritance can spread through the population. It could eventually become present in the whole population, especially if the consequent concupiscence confers some evolutionary advantage, or predisposes to rape, or if “perfect” members are forced to choose to mate with an offspring of Adam to avoid incest. In this way, the whole population becomes infected by Original Sin. Could the ‘sons of God’ and Nephilim of Genesis 6:1-4 be the members of the population not yet tainted by Original Sin in this scenario?

This case, however, is not compatible with Catholic doctrine. Pius XII insists that there can be no human beings after Adam’s fall other than those tainted by his inheritance. Allowing one member to fall and spread his spiritual inheritance through the population over several generations is not acceptable. Nor is positing that all the members of this original population fell, for Pius also insists on an individual, not collective, Adam.

Case 2: Adamic Monogenism

Imagine that, for the first time in primate history, a particular random mutation takes place (if it is random, since God’s providence underlies all creation). This produces a primate^k embryo which has the capacity to grow into a being with rational thought – an event which God has been waiting for from all eternity.¹ God immediately bestows on this embryo – Adam – an immortal soul.

Adam grows up among a population of primates who are, at a certain level, using tools and communicating socially. He learns from them to communicate, to interact socially, and to be a member of this community. But as he matures, he also becomes aware of a God who loves him, and allows him to have spiritual experiences. No other primate has these, because no other primate has a God-breathed spirit.

Perhaps through a direct revelation, or perhaps through an innate ‘natural law’,¹¹ Adam comes to know that some actions are against God’s will. Nevertheless, one day he chooses to break God’s law, and so irrevocably ruptures his perfect relationship with God. His spiritual state changes from Original Holiness to Original Sin.

In due course, Adam begets children. Of necessity he must interbreed with a primate who is biologically very similar to him, but ontologically profoundly different. Some of their offspring inherit Adam’s genes for higher brain capacity, and God is able to breathe into them, also,

¹¹ *Catechism of the Catholic Church*, ¶¶ 1954-1960

immortal souls. Along with their genetic inheritance, they receive a spiritual inheritance of Original Sin. Perhaps other offspring do not have this capacity. Does God give them souls, because they are Adam's heirs?^m If so, they too inherit Original Sin. Or does God withhold souls because they do not have the brain capacity? In this case, it makes no sense to speak of Original Sin. But the crucial consequence is that no primate can inherit Adam's mutation for advanced brain function without also receiving the spiritual heritage of Original Sin. And no primate who lacks Adam's genetic heritage has been given a soul – so these primates are not human beings.

Now, increased powers of thought may well bring an evolutionary advantage (and they obviously did, or we wouldn't be here now) – so Adam's mutation gradually spreads through the population. Eventually, a generation arrives where all members of this group of primates have inherited it: the whole group now consists of human beings with immortal souls, and the heritage of Original Sin. There is only one caveat: Adam's heritage must spread through the entire population before the same mutation happens randomly to the offspring of a pair of primates who have no Adamic ancestry. If this were to happen, and God was obliged to grant a soul, the offspring would not be tainted by Original Sin.

We seem to have satisfied Pius XII's prescription. All human beings – ensouled, rational primates – trace their ancestry to Adam. All inherit his Original Sin. Although, during the transition phase, there have been primates in the population without Original Sin, these have not inherited the capacity for rational thought: they are not humans – or, to use the dated language of *Humani Generis*, “true men”.

There is one problem in this scenario. Adam is forced to mate with a non-human primate. Does this constitute bestiality? Further, his offspring in early generations must choose between similar bestiality, or incest. Yet this, too, is not insuperable.

Why is bestiality wrong? The traditional approach invokes ‘Natural Law’, which declares that sexual relations between a human and an animal are wrong because they are unnatural; and a sign of that unnaturality is that they do not produce offspring. In this case, however, it is the most natural thing in the world for Adam to be attracted to, and mate with, a primate who is almost identical to him; and we can expect fruit of such a union. John Paul II stresses, after all, the material continuity which evolution requires between humans and their immediate forerunners.

An alternative approach to sexual morality is found in the personalistic philosophy expounded by the Polish Pope in his pre-pontifical tome *Love and Responsibility*,¹² which builds a philosophical system predicated on the existence of a human person as its highest good. In Adam's case, the only way he can produce another human person is to pass on his genes by mating with someone receptive to them, a female primate similar to himself in all ways but the crucial *capax dei*. Adam therefore preserves his dignity by mating with a ‘beast’ in order to beget human children;ⁿ whereas any present-day human who mated with a beast in preference to the myriad human partners available would defile human dignity. Further, the population of forerunner primates who would constitute dignified partners have died out over the generations after Adam, so the question of ‘legitimate bestiality’ cannot arise in the modern world. And having established the precedent, we could equally argue that the early generations of Adam's children, given the opportunity, would have found it more dignified to mate with ‘beasts’ than to commit incest.

¹² Karol Wojtyła, *Love and Responsibility*, trans. H. T. Willetts, 1994, Ignatius Press, San Francisco

Case 3: Evic Monogenism

The above scenario is not gender specific. The argument works identically if the first ensouled human is a woman – Eve. Theology clearly prefers a male Adam as the type of Christ, whose maleness is considered essential to Catholic ecclesiology and soteriology. Whether there are scientific grounds to prefer a male Adam depend on whether a mutation on the Y chromosome is particularly implicated in human evolution. At least one researcher suggests that this is in fact the case.¹³

Case 4: Digenism

What if we seek to realise the Genesis 2-3 scenario with both Adam and Eve? If we set aside the miraculous creation of Eve from Adam's flesh and posit that the first man and first woman both came to be by independent 'random' mutations (a man and woman cannot, of course, be twins from the same egg), we require a small miraculous intervention by God to make sure both mutations happen at the same time.

Adam and Eve can legitimately conceive children together, but their offspring are forced to conceive via their siblings or parents (incest) or via other primates in the local population (technically bestiality). All their descendents inherit original sin; not all of them necessarily inherit the advanced brain capacity. The argument then proceeds exactly as in the case of a single ancestor. Obviously an exclusive preference for incest would result in a highly inbred population, with genetic consequences; but this evolutionary scenario does not rule out the bestiality route.

Introducing an original couple rather than a single Adam (or Eve) requires special pleading, and solves only the problem of bestiality in the first generation without solving the subsequent incest/bestiality issue. Its only advantage is to make possible a solution with incest but no bestiality. Since we are not obliged to a literal reading of Genesis 2, and indeed St Paul and Pius XII direct us to the interpretation of Adam alone, this solution has no merit to recommend it.^o

Conclusion

It seems, then, that the Church's denial of polygenism is not the scientific stumbling block it would appear to be, *prima facie*. No-one is obliged to believe in an original couple from whom we all, exclusively, descend. We are obliged to believe that all humans share a common ancestor – but this is a finding which science itself has produced twice over, and is hardly more radical than saying that all humans share the genetic code for humans!

Theology requires a more clear-cut origin for *Homo sapiens* than the fuzzy species boundaries generally acknowledged in evolution. It may be significant that some scientists propose a distinct 'speciation event' for modern humans, and even more so that it concerns the Y chromosome promoting increased language capacity. We should be cautious, however, since Pope John Paul II has warned against trying to identify scientifically the identity of the first ensouled human.

Beyond the purview of science, we further claim that our earliest common ancestor was the original sinner, and his fault taints the spiritual status of all his offspring; *that* is a matter for faith alone.

¹³ <http://news.bbc.co.uk/1/hi/sci/tech/693744.stm> and **The Speciation of Modern *Homo sapiens*, J. Crow** Proceedings of the British Academy, Volume 106 <http://www.britac.ac.uk/pubs/cat/pba106.html>

Bibliography

(Web sites excluded, as full references given in the footnotes.)

Catechism of the Catholic Church

John Paul II, 22nd October 1996, “Magisterium Is Concerned with Question of Evolution For It Involves Conception of Man”, Message to Pontifical Academy of Sciences

Karol Wojtyla, *Love and Responsibility*, trans. H. T. Willetts, 1994, Ignatius Press, San Francisco
Pius XII, *Humani Generis*, 1950

^a The Catholic Church raises no objection to belief in the Big Bang as the most likely mechanism of origin of the universe, nor to evolution by natural selection as a plausible hypothesis for the current variety of plant and animal life on earth. Nor does the Magisterium impose a literal reading of cosmic consequences of the Fall which would demand that decay and animal death were absent from Earth prior to Adam’s sin.

^b Note that the Pauline position is not easy to reconcile with a literal reading of either of the Genesis accounts. Following the principle expounded in *Dei Verbum* 14-16 (Vatican II document, 1965), the correct interpretation of the Hebrew Bible is obtained in the light of the New Testament, so the Pauline theology is rightly preferred.

^c This is not the place to develop arguments about whether the automatic inheritance of original sin is just or not. We rely on God’s revelation to teach us what constitutes true justice, and the concept of spiritual inheritance may be noted (i) in Old Testament curses which touch children “unto the third generation” beyond the sinner, and (ii) in the empirical findings of those involved with prayer for deliverance (in particular in the categories of ‘intergenerational healing’ or ‘healing the family tree’) who sometimes report innocent children being plagued by oppressive spirits attracted by the sins of ancestors. Is it just that the child of a millionaire inherits more wealth than the child of a pauper? Furthermore, is it just that Christians may be redeemed from original sin through the death of Christ? If ‘justice’ makes redemption impossible, then Christianity itself is in trouble!

^d There is a controversy over the correct translation of the Pope’s message, delivered in French, which might be rendered evolution is ‘more than a hypothesis’, or ‘more than one hypothesis’. The Pope clearly refers to multiple hypotheses later on, but native French commentators on idiom and the official Italian text in *L’Osservatore Romano*, seem to favour ‘more than a hypothesis’. See <http://www.cin.org/users/james/files/whatsaid.htm>

^e I had intended to comment here that Pope John Paul II’s stance of “protecting” the moment of origin of human life as beyond the purview of science could be compared with his earlier protection of the moment of creation while endorsing cosmological studies up to the moment of the Big Bang, as noted by Stephen Hawking in *A Brief History of Time*. However, in trying to source this Papal statement, it seems that Hawking has misreported the Pope, who never made such a statement during the relevant address! See, e.g., <http://www.speroforum.com/a/4048/Hawking-misrepresents-Pope-John-Paul-II>

^f Incidentally, if the definition of a species rests on genetic make-up, and relevant changes must happen at the level of the egg, sperm, or single-celled embryo, then an age-old problem is solved: the egg (or at least, the *fertilised* egg) came before the chicken. (It was laid by a chicken-like bird which wasn’t quite a chicken as we would classify it.)

^g Another complicating factor, beyond the scope of our discussion here but often used as a critique of evolution by creationists, is the fact that the fossil record seems to show long periods of stability punctuated by short periods where many new species evolve.

^h You may recall hearing a news bulletin claiming that there were seven female ancestors. This in fact refers to patterns of migration to Europe, with seven different women all arriving in Europe during the last 45,000 years – daughters of the Mitochondrial Eve by a long stretch. See: <http://news.bbc.co.uk/1/hi/sci/tech/719376.stm>

ⁱ On the other hand, scientists with no theological interest in human nature seriously discuss the problem of ‘speciation’ and whether a particular event, namely one which promoted language abilities, marks the beginning of *Homo sapiens*: <http://www.britac.ac.uk/pubs/cat/pba106.html> (J. Crow, *op. cit.*). There is even a candidate for the gene responsible: it’s called FOXP2: *Current Biology*, Volume 17, Issue 21, 1908-1912, 6 November 2007. <http://www.cell.com/current-biology/abstract/S0960-9822%2807%2902065-9>

^j There is a deep philosophical question implicit here about ‘human nature’, and how it extends to particular individuals, especially if we adopt a genetic definition. What is it which is common to all human beings, which

makes them human? If we define 'human nature' in terms of a capacity for something, we humanize those individuals who never realise that capacity due to external circumstances ('nurture', or environment), but do we dehumanize those individuals who, through some genetic defect, do not have the capacity to achieve what most humans achieve?

^k Is being a primate essential for bearing the 'image of God'? Or if, say, dolphins had evolved sufficient brain-capacities making language and relationship possible (some would argue they have this already), would God have bestowed immortal souls upon them and Himself become a dolphin in Jesus Christ? This is not ruled out by holding that God willed the existence of rational man, as long as God's will is only that *some creature achieve rationality* rather than prescribing the exact design.

^l Could there have been individual primates before Adam with the genetic capacity for rational thought, who never realised that ability and so never Fell? Or do we insist that the first time this capacity was mutated into existence, it was realised? The theological identity of Adam as first human leans towards the latter, unless we want to argue for God withholding souls from the earlier embryos because of his foreknowledge that they won't realise their potential. But this would raise all sorts of difficulties about the human status of later embryos with diminished potential. So it seems more consistent to argue that once the genetic capacity for human nature is realised, God must bestow the soul.

^m This relates closely to the endnote above on human nature.

ⁿ Suppose some disaster wiped out all but one human being on Earth. Further suppose that this one human being has the technology and knowledge available to clone herself (or himself, the gender is irrelevant) – or indeed to create clones from the dead bodies of others. Would cloning under these circumstances be an insult to human dignity, or an appropriate course of action as the only way to create new human persons?

^o It may be wondered whether feminists will be dismayed at the banishment of Eve, or relieved at her exoneration from being the original sinner!