A conversation with Steve Jones (London)

"A Key To Everything"

Population geneticist and book author Steve Jones talks about explaining evolution to the public, updating Darwin, countering anti-evolutionism, the presumed end of human evolution... and about working on snails

Committed science writer: Steve Jones

Could I start by asking you about your scientific career?

Steve Jones: Such as it is! I did my degree and my Ph.D. at the University of Edinburgh. I was a postdoc at the University of Chicago with Richard Lewontin and I've been at UCL since the early 1970s. I have also travelled quite extensively.

Have you been working on evolutionary biology throughout?

Jones: Sure, on various different creatures.

Were you drawn to evolutionary biology or was it by accident that you got started on this research?

Jones: Well, most people's careers begin by chance. When I was younger I was always very keen on field biology, you know, going out on expeditions and that kind of stuff. As an undergraduate I did a small study of snail population genetics, which I thoroughly enjoyed, and I basically continued to do it for the next thirty years.

What are the main questions you have been addressing, looking at snails?

Jones: The first question is: why work with snails in the first place? What a mad thing to do! However, if you place yourself back in the mid-sixties, when I began the work, there were very few living systems in which you could actually go out and count gene frequencies. Now, of course, at least if you have the money, it is easy. You can do whatever you like with molecular biology, by doing some PCRs and looking at sequence divergence single nucleotide polymorphisms, etc. but in those days, there were very few systems where you had a straightforward situation for measuring diversity, where you could go out and count the allele frequencies.

The snail I worked on, from the genus *Cepaea*, had many people working on it because the frequency of alleles for shell pattern, the number of stripes on the shell, the presence or absence of stripes, the colour of the shell, etc. was variable within populations. The genetics was straightforward

and had been worked out. So, you could go out and try to infer, first of all, the less interesting question, which I think we more or less got straight, which is why do they vary in the frequency of, say, light-coloured shells, so strikingly across Europe and in different places within Europe, over a few kilometres? We did a lot of work on that but it's rather straightforward and, in some ways, dull. Of course, now you can work with DNA markers and do exactly the same kind of stuff looking at humans moving across the globe and the evolution of skin colour and so on. And that's fine, but it actually leaves unanswered the more difficult question at the centre of genetics, a question that remains largely unanswered, which is: why is there so much genetic diversity in the first place?

Why is there so much variation? Not just at the DNA level, which is now utterly spectacular when you start looking at SNPs and the HapMap (haplotype map of the human genome) and so on, but also at the protein and chromosomal levels? In fact, at every level you can think of within a particular species, there's a large quantity of diversity. Historically, when biologists find a new kind of diversity they immediately dismiss it as being unimportant. That happened, for example, with the blood groups – they were immediately assumed to be unimportant and utterly neutral. It happened with chromosomal variations in Drosophila, which were initially thought to be just the same. It happened mightily with protein polymorphisms in the 1960s and '70s when people started looking at these using gel electrophoresis. And, of course, it completely infests the world of DNA sequence variations where there is an almost automatic assumption that such diversity has no functional relevance.

One of the classic cases of this view was, in fact, the snail polymorphism. How could it matter what colour its shell is or what stripes it's got on its shell, etc.? It must be neutral. You can build all kinds of models, as people did, of the balance between migration and mutation based on that assumption of neutrality. Well, of course, that is complete nonsense! The pattern makes a great difference to individual fitness as manifest in geographical trends. But this still leaves the question: why, within a population in some nettle bed in southern England, say, most of the time, do you find twenty or thirty different morphs? If it's advantageous to be one particular phenotype, why aren't they all like that? Now, we know that one of the drivers behind the genetics of the snail populations is exposure to sunshine.

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They depend on the sun to stay alive. They're ectotherms. If they soak up too much solar energy, they die; if they soak up too little, they can't move around and eat. The colour of the shell has a dramatic effect; a dark-coloured shell soaks up much more sunshine than a light-coloured shell. So the question was: do light and dark-coloured shells vary in the population because

snails have experienced the sun in different ways? What I did was to invent a paint that fades at a measurable rate when exposed to the sun. You can spot thousands of snails with this paint, release them into the wild, or under semi-wild conditions and then, after a few months, recapture them to determine how long each individual has spent in the sun. And the answer is that there are big differences within a population, depending on genotype, in the amount of sun that individuals choose to experience. So, that may well be behind the polymorphism. It increases the niche breadth, I would say as an ecologist, of the population as a whole. In this way, they can fill more of the habitat. That's what the snail work basically ended up with.

In addition to working on snails and teaching at university, you have also developed a huge career as a public science communicator. What motivated you to get into this?

Jones: Oh, simple greed! Actually, I was kind of lucky. I've just been lecturing to a big audience of about 400 and I've always got a big buzz out of lecturing. I put a lot of effort into it. I've just been talking about F-coefficients and inbreeding, which is not the world's most thrilling subject but you can make it thrilling by giving human examples. I have always been quite good at explaining simple science (at least, what I think is simple) rather simply. I started doing this public understanding lark quite widely with schools. In the 1970s and '80s, I started giving talks in schools, and I still do; I went to three in the last week. Teachers just ask me to come and talk to their classes and I estimate that I've probably talked, face-to-face, to something like 150,000 school children over my career.

Then I started getting asked onto the radio. I did lots of that. It was a very good time to be a geneticist and a science populariser on genetics, we're talking now of the mid-1980s, when modern genetics was really beginning, when we were beginning to understand genetic diseases and all that hype about gene therapy (which of course took a long time to go anywhere). And people began to show interest in the obvious medically-relevant aspects of genetics. Then, in 1991, I was asked by the BBC to do the Reith Lectures, which was considered by some people the high point of BBC talk radio. In fact they tend to be given by academics, which means no mass audience. Bertrand Russell was the first, I was about the thirtieth.

I think that most people liked the lectures, not because I gave them but because I talked about a kind of genetics that the public had never really been exposed to before. That's to say, population genetics and evolution. Questions like: how different are human races? What's the story with eugenics? What's inbreeding? I did one about the genetics of the Jews and another, which still pops up now and again, the last one, on 'What can we say about the future of human evolution?'

I was then asked to write a book, which I did; it went under the Reith title, "The Language of the Genes". It's still in print and, I'm glad to say, I've sold many thousands of copies. Then I was called by BBC Television, who said they enjoyed the book and would I like to make a television series? So I did, although that was more of a mixed blessing for various reasons. But that's where it started and it hasn't really gone away since.

Steve Jones' research subject: Why is there so much shell variation in *Cepaea* snails?

150 years ago, Charles Darwin published his earth-shaking book, 'On the Origin of Species by Means of Natural Selection'. You have subsequently written an update of Darwin's book, 'Almost like a Whale – the Origin of Species Updated'. May I assume you think that 'The Origin of Species' should be compulsory reading for biologists?

Jones: I wouldn't say it's compulsory but it's highly advisable. Although I admit quite freely that I didn't read it myself until I was in my thirties. In many ways, that's the time to read it. I remember going on holiday many years ago to Greece with the lady who's now my wife. We both discovered that we hated lying on the beach and I happened to pick up a copy of 'The Origin of Species', thinking 'God, I should be reading this bloody book'. So there I was, read-

ing it on this Greek beach, when suddenly, I realised that we have the key to everything here!

If you follow Darwin's logic of 'The Origin', its "long argument", it is quite amazing to me how well it stands up – the order of the chapters, the structure of the arguments. Even given the extraordinarily incomplete information that Darwin had, for example, his lack of knowledge of genetics. If you read that book objectively, I would defy you to deny the truth of evolution! The guy wins game, set and match! And that's when the idea of updating the book really took hold. In fact, I then talked to a couple of friends Nick Barton, a mathematical geneticist, who was working with me here then, who is now in some institute in Austria, and Linda Partridge, who I was then working with on *Drosophila*; she has since become very distinguished in the genetics of aging and will shortly move to a part-time post in Germany. Anyway, we talked about writing a textbook based on 'The Origin of Species' because there was no good text on evolution – there are now two or three but there wasn't one at the time.

We started sketching it out but it soon became obvious that it would be a bit like Borges' famous map, which is as big as the country that it is mapping! It was clear that this book would have 28 volumes – you couldn't get it all into a single textbook. So we didn't do that. But the concept stayed around until I had the bright idea of updating 'The Origin' for the public, which I did.

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In fact, I've updated Darwin again since then, starting with 'Y: The Descent of Men' (an update of 'The Descent of Man, and Selection in relation to Sex'), which, in my view is a less successful book; then in 'Coral', I've updated his book on coral reefs ('The Structure and Distribution of Coral Reefs'). That book worked quite well and Darwin's book on coral reefs is brilliant!

I have just finished a book that will be out in January, called 'Darwin's Island'. This new book contains one chapter on each of his other books. Most non-biologists don't know that he actually wrote nineteen books altogether, on things as different as barnacles, self-fertilisation in plants, earthworms, the expressions of the emotions in man and other animals. Every single one of which, if you read them – and I have read them all, and some of them are rather a pain in the neck – every single one of which is, in its own way, a work of genius. Who knows that Darwin was the first to come up with the idea of a chemical messenger, a hormone, from his plant growth experiments? If he had never written 'The Origin', he would still be famous.

When you talk about evolution and what Darwin did, what are the main misconceptions you encounter among other scientists, for example, other biologists?

Jones: I think most biologists have got a pretty good handle on what he did. I often say Darwin basically invented the science of Biology. Before Darwin, there were plenty of good people out there, collecting fossils, or breeding plants and animals, exploring distant islands, identifying the creatures that lived on them. But nobody realised they were all doing the same thing. What they were doing, as 'The Origin' made clear, was studying "descent with modification" – Darwin's phrase for evolution. Molecular biology has made evolution even more central to a biologist's life than ever before, because you can go to some database and you can haul out your gene in *C. elegans,* say, and then you can find the equivalent in humans. That is an evolutionary statement!

In fact, molecular biology/genetics is really nothing more than what Darwin did, which is comparative anatomy. It just costs a lot more money; that's the only difference. We're really becoming, all of us, much more Darwinian than we ever were. Obviously, there are arguments within the biological community about the details but the fact is fairly universal – we all pretty much understand it.

However, the general public, I find, is incredibly confused. You have the idiots out there who are the fact-deniers, the ones who refuse to believe the evidence – as far as I'm concerned, they can get lost! If they won't accept plain facts, there's no point in talking to them. But there are others out there who simply don't know the arguments for evolution, including large numbers of biology teachers – that's one of the reasons I go to lots of teachers' conferences. In fact, I was talking to a teacher in a school yesterday who had done a survey of schoolchildren, asking them what aspects of school science teaching they found interesting or boring in biology, the topic that came bottom as the most boring was evolution, which to me is just amazing. How can that

be? It doesn't make any sense to me. Perhaps it's because if you ask teachers what they themselves know about evolution, they only know about the peppered moth, that's it, end of story! I think there is a need for professional biologists to educate teachers about the theory of evolution.

You've also written about human genetics and evolution. There have been some recent quotes from you predicting the end of human evolution.

Jones: That's suddenly come back to life! I've had lots of irritated e-mails and dozens of radio stations have been ringing me from around the world. It's actually from the last of my Reith lectures (back in 1991), which I happened to have repeated recently. Furthermore, Peter Myers, who writes the Pharyngula webpage, which incidentally is very good, has crapped all over me for being a complete idiot. But I'm not really – let's just look at what I'm saying. In fact, it is obvious. When most people talk about evolution, not necessarily people in the trade but most people out in the streets, they mean natural selection. And the question is: what opportunity is there for natural selection in modern developed human populations, now or in the immediate future? And it's clear that there isn't! It's a matter of simple demography.

I start my first year undergraduate lectures by asking the students to look at the person to their left and the person to their right and I say, fairly accurately, that two out of three of them will die for reasons connected to their genes – heart disease, cancer, diabetes; all have a strong inherited component (whatever that means). So they look a bit glum at that, then I say: Cheer up! If I had been giving this lecture in Shakespeare's time, two out of three of you would be dead already; in Darwin's time, one out of two of them would be dead. Nowadays, in Western Europe, 99% of babies that survive the first week live to be 21 years old. So all the childhood deaths, many of which were for genetic reasons, for example, in terms of resistance to infection, have gone. There's no longer any raw material for natural selection – there can't be any! You can add to that the fact that there's a much lower variance in male reproductive success – there's lots of evidence from Y chromosomes and from history that, historically, the pattern was for a few highly successful males with lots of female partners, which meant lots of unsuccessful males. Now, however, the pattern shows everybody has roughly the same number of partners and has roughly the same number of children. If you put those two figures together, you come up with a statistic called 'the opportunity for selection', which is widely talked about in the anthropological literature, which is where I dug it up, but rarely discussed by geneticists. It turns out that 'the opportunity for selection' in the developed countries has gone down by 90% compared to in the Congo, say, or compared to what it was in medieval England. There's no opportunity for natural selection – end of story. It's obvious! Nevertheless, I still get accused of being a fool; but I am talking about selection and not evolution – gene frequency change – in general.

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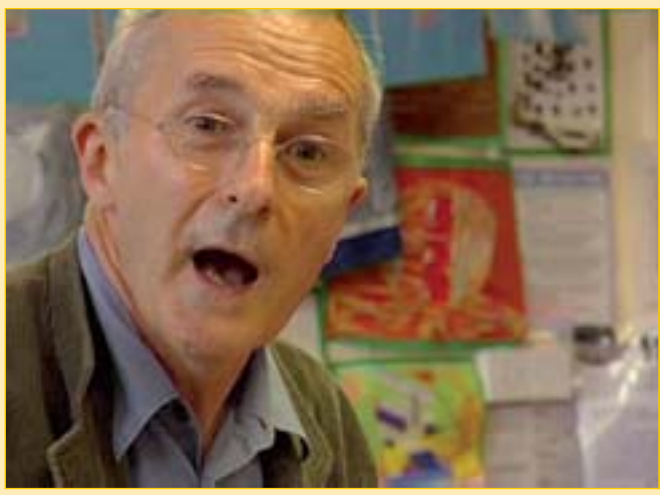
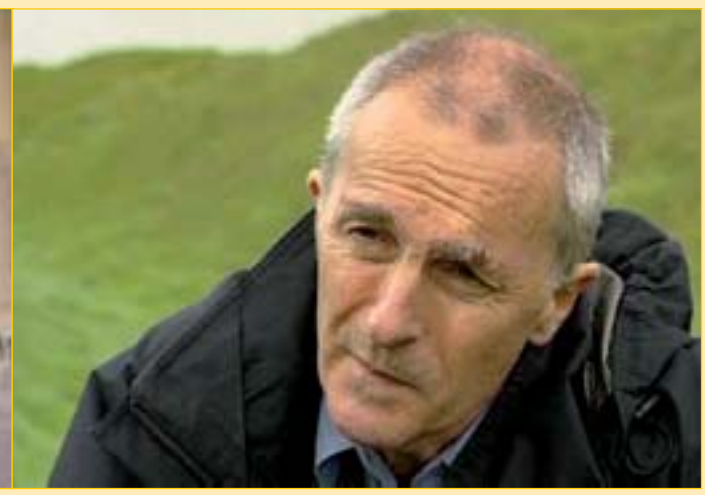
What do you think about the influence of humanity on the survival of the other species?

Jones: Obviously, we're destroying everything. There's no question of that. The last chapter of my 'Darwin's Island' book is kind of predictable, and it's depressing, because it's about what happened to Darwin's other islands – the Galapagos, of course, but there are also the Cape Verde Islands, St Helena and the other places he went. There will be nothing left of them within a century. And that's just the beginning of what's happening worldwide. It's been happening and it's accelerating, however, I'm not sure that it makes a big difference to the future of human evolution.

Do you think Social Darwinism and sociobiology could have contributed to the society that we have today?



Teaching at a primary school...



...and out in the field

Steve Jones,

evolutionary biologist and Professor of Genetics at University College, London, has become widely known to the general public through his public speaking engagements, his appearances on radio and television, as well as his regular newspaper column, 'View from the lab' in the UK's Daily Telegraph.

He has written popular science books examining aspects of human genetics and evolution, 'In the Blood: God, Genes and Destiny' and 'The Language of the Genes'. In 1999, with 'Almost Like a Whale: The Origin of Species Updated', he published the first of a series of books that re-examine and update Charles Darwin's scientific work, including 'Y: the Descent of Men', 'Coral', and 'Darwin's Island'.

Jones: Oh, well, that's all guff! As we all know, the term 'social Darwinism' was invented by Herbert Spencer before Darwin died. Darwin was always strongly against it. He had no interest in it because he didn't see it as a science. I think he was right. The example I always give is sociobiology – they're obsessed with sex. Sociobiology makes some extraordinarily precise predictions. For example, it predicts that old men will fancy young women. It also predicts that rich old men will have more sex with young women than poor old men and you can certainly make a sociobiological explanation of that. It's a bit obvious, perhaps, and I'm not sure we need professors of sociobiology to do it for us!

But the problem is, you can make a sociobiological explanation of anything you like. A good example is human sexual patterns. Generally speaking, the pattern when I was a kid in the 1940s and when my parents got married, was fundamentally one of strict monogamy. You only had sex when you got married and then you remained faithful. Go back a hundred years, back to Darwin's time, when there were tens of thousands of child prostitutes in London! What you had there was the appearance of monogamy with massive promiscuity behind the scenes. If you return to modern times, you find promiscuity but of a different kind – serial monogamy. People stay in one partnership for a while, that breaks off and they start up another one. I can give you a completely convincing and watertight sociobiological explanation for every one of those patterns of reproduction. In fact, this means that I can't give you a sociobiological explanation for any of them because you can make up any explanation to fit the facts, and that just isn't the way that science works. It's what I sometimes call 'arts faculty science' – the misunderstanding of the nature of science. You don't need *just* theories, although you do need *a* theory. As Darwin said: "I cannot work unless I have a theory". But a theory is no good without observations and tests! There are no tests in sociobiology.

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Do you feel there's a rise in anti-science behaviour and creationism at the moment?

Jones: Oh God, yes! For sure! I don't think it's anything to do with sociobiology. They're just deluded. But in Britain, yes, there's a massive, huge increase in creationism. In the last five to ten years, I'd say it's gone up five or six times. I always find it in every school I go to, often with Asian kids, but even with European kids. I don't think I've been to a school in the last five years where I haven't been attacked by a creationist!

Do you think this is due to a failing in the education system?

Jones: To a degree. It's overwhelmingly due to the increasing influence of Islam, which is understandable, given the number of Islamic children we have, many of whom are absolutely first-rate students. But they've been told that evolution is un-Islamic. I don't see the logic of that because the Koran really doesn't have a Garden of Eden myth. It's actually quite stark. It simply says: "Allah took the clay of the earth and moulded the form of a man", which, if you want, you could bolt onto one of the origin of life models and use as an evolutionary argument. But they've all taken what is fundamentally the born-again Christian view of evolution. The professional ignoramuses promote this idea of evolution as "only a theory", which lends them the argument: "You've got your theory and I've got mine, and we should teach them both". To which my response is: rubbish!! It would be like expecting me to teach that babies are brought by storks when I'm teaching genetics! Babies are not brought by storks – end of story!

To finish up, can I ask you what you consider to be the main currents in evolutionary biology at the moment? Where is it going as a science?

Jones: I think evolution is doing what it has always done but it is becoming much more complicated. There was a moment of simplicity in 1859 with 'The Origin of Species'. But what's really noticeable with 'The Origin' is that there were six editions of the book and every one of them is worse than the one before; every one is more complicated than its predecessor – the last edition is just a nightmare! In fact, with 'The Origin', Darwin, who was that rare breed, an honest scientist, was worried to death about the criticisms that had been made. He tried to cover himself but he didn't do it very well. However, it's clear that Life is a lot more complicated than it's painted in 'The Origin of Species' and its getting more complicated again. All I can say is: "Thank God for that!"

INTERVIEW: JEREMY GARWOOD