An Even Shorter History of Nearly Everything

Bill Bryson

30 September 2010

I am immensely honoured to be here. You know, this evening right now in my hometown of Des Moines, Iowa, people all across town are stopping whatever they are doing and saying: "What's that noise?"

And I can tell you right now it is the sound of Mrs. Smoltz, my high schools careers officer, spinning in her grave at the thought that Bill Bryson is standing in front of an audience at the Guildhall in London about to give a speech on behalf of Gresham College and the Royal Society. So thank you very much for letting me be here tonight.

I must begin with a couple of apologies. Apart from the obvious ones - that I am not a lecturer, that science is not my field, and that I have a pathological inability to gauge how long any speech I write will take to deliver -- this one could take 11 minutes or it could taken an hour and a quarter; there really is just no telling -- but apart from all that I have one big apology, which is that essentially I have given the wrong title for my speech.

If I may say so, I have had a really crazy year. First, this book (Seeing Further) came out and then in June a book of my own came out, which between them has meant dealing with publishers and publicists in Britain and America, and indeed in Australia, New Zealand, Canada, South Africa and elsewhere. As I hope you may have read in the papers, I have been engaged just lately with a really important initiiative through the Campaign to Protect Rural England to try to get a bottle deposit law reintroduced in the UK, and I have been proudly but peripherally involved with the Royal Society's 350th anniversary celebrations, along with rather a lot else.

So I have been a little distracted, frankly, and when Barbara Anderson, the kindly academic registrar of Gresham College, asked me what my topic for tonight would be, in a moment of total preoccupation, I said: "An Even Shorter History of Nearly Everything." Only much later -- in fact only in the last couple of weeks when I finally turned to the speech in earnest -- did it dawn on me that actually I am supposed to be talking about the long history and glorious achievements of the Royal Society.

So what I propose to do tonight is first talk about the Royal Society and what it has done and why it is important. Then, in case there is anyone here who has travelled down from Shetland to hear a lecture on A Short History of Nearly Everything, I will give a Really, Really Short History of Nearly Everything. They do actually fit together, after a fashion, I think. Or at least I hope so.

So first for the Royal Society. On a late afternoon in November, just shy of 350years ago, the Royal Society was founded at a location about 600 yards from where we are now.

The site today is occupied by the enormous building that was long called the NatWest Tower and is now called Tower 42 - though in my view doesn't get any more attractive however many times you change the name - but at the time it was the headquarters of Gresham College. We know that on that late wintry afternoon an audience of people gathered to hear a young and not yet famous Christopher Wren give a lecture on astronomy, and that afterwards 12 of those people, including Wren, retired to the rooms of one Laurence Rooke and there agreed to form a Society -- and for the first two years that that is all they called it: the Society -- to promote the accumulation and propagation of useful knowledge.

Rather ambitiously they set the enrolment fee at 10 shillings and the fee for attendance at the weekly meetings at one shilling. That's equivalent in modern terms to £500 to join and £50 to hear the lectures -- a lot of money. These guys were serious about what they were doing.

Nobody had ever done anything quite like this before, or would ever do it half as well again. It was truly a milestone event in human affairs. What they were doing really was founding modern science, and they seemed to know it.

The Royal Society (it became royal with the granting of a charter in 1662 by King Charles II -- a man who, incidentally, didn't ever pay a fee or attend a meeting) essentially established all the conventions of modern science. It invented the scientific journal and the process of peer review. It systematized experimentation. It made English the primary language of scientific discourse, in place of Latin -- though with one or two exceptions. Newton's Principia, notably, was published in Latin, probably because of its international significance, but even Newton wrote in English for his papers for the society onoptics and it is fair to say that the primacy of English as the language of science dates from the society's founding.

In addition, the society promoted -- indeed, insisted upon -- clarity of expression in place of high-flown rhetoric. and, even more unusually, encouraged the coinage of new terms used precisely. Among the words introduced to the world by the Royal Society in its early days, it seems, were cohesion, tension, elasticity, temperature and pharmacology.

From the outset, fellows of the Royal Society showed a tireless -- indeed, at times a breathtaking -- curiosity about almost everything. Nothing, it seems, was beneath their attention. Members discussed and considered woodland management, blood transfusion, architectural load bearing, the behaviour of gases, the development of the pocket watch, the thermal expansion of glass and much, much else. Before most people had ever tasted a potato, the Royal Society debated the practicality of making it a staple crop in Ireland (ironically, as a hedge against famine).

Their contribution to the world's good was immediate and dazzling. Two years after its formation, Christopher Merret, one of the founding fellows, whose expertise was actually in birds, demonstrated a method for fermenting wine twice over, endowing it with a pleasing effervescence. He had invented champagne. The next year John Aubrey contributed a paper on the ancient stone monuments at Avebury, in Wiltshire, and so effectively created archaeology.

They took their inspiration from everywhere. John Locke contributed a paper on the poisonous fish of the Bahamas. Edmond Halley, the great astronomer, happened upon figures for annual births and deaths in Breslau, Silesia, which fascinated him because they were so unusually complete. Most people would have treated these figures as an interesting diversion, but Halley realized that from them he could construct charts from which it was possible to work out the life expectancy of any person at any point in his existence. He could say that for someone aged 25 the chances of dying in the next year were 80 to 1 against, that someone who had reached the age of 30 could reasonably expect to live another 27 years, that the chances of a man of 40 living another seven years were 5½ to 1 in favour, and so on. He had, in short, produced the world's first actuarial tables, and, so made the life insurance industry possible.

Again and again the Royal Society demonstrated that it was an institution dedicated not just to understanding the world, but to changing it, improving it.

The names I have mentioned already in just the last minute or so are pretty telling: John Locke, John Aubrey, Edmond Halley, Isaac Newton, Christopher Wren and so on. Patently from the very beginning the Royal Society attracted the best minds. This combination of great minds and boundless curiosity is obviously a good formula for forming a learned society, but that alone has actually not been enough to sustain 350 years of continuous distinction at the highest level. For that, the Royal Society needed to do certain other things -- things that no other society had done before.

Three in particular stand out, I think.

First, from its earliest days, the Royal Society was truly international. Just three years after its founding it accepted its first foreign members, Christian Huygens and Samuel Sorbiere, and from its earliest days it was welcoming contributions from contributors like Marcello Malpighi in Italy and the great, eccentric microscopist Anton van Leeuwenhoek in the Netherlands. The result was that it became the central clearing house for scientific information for the world. It became a kind of early version of the World Wide Web.

In 1665, Henry Oldenburg, himself German born, launched the Society's first journal, which had the very full and very telling name Philosophical Transactions: Giving some Accompt of the Present Undertakings, Studies and Labours of the Ingenious in many Considerable Parts of the World. Nothing from the Society's early annals has more significance than those words 'ingenious' and 'many Considerable Parts of the World.' As they like to remind you at the Royal Society, it had a Foreign Secretary 100 years before the British government did.

Second the Royal Society has always elected people for their abilities rather than for their background or bearing. It was the first really important institution in the world, I believe, to be driven primarily by merit rather than considerations of breeding.

Third, and in many ways most extraordinary of all, the Royal Society has always had the most incredible knack for selecting people before they gave any particular hint of the greatness that would earn them their posterity. Edmond Halley was made a Fellow before he had finished at Oxford. Charles Darwin, elected in 1839 just three years after his youthful Beagle voyage, was not even known for his work on barnacles, much less on evolution when he became a fellow. William Henry Fox Talbot was elevated to fellowship long before he had the first vague inkling of giving the world photography. To the society, he was simply a promising young mathematician. It is extraordinary how many fellows of the Royal Society achieved their greatest distinction after becoming fellows. In consequence, the society didn't become a club of grand old men whose greatest achievements were behind them, but rather a place whose members were firmly and excitingly at the leading edge of scientific development.

It is these additional aspects, I would submit, that have truly made the Royal Society incomparable, enduring and important - indeed, important in ways beyond anything anyone could foresee or imagine, By way of illustration, let me cite three people, all fellows of the Royal Society -- whom I have come across completely by chance while researching other matters in the last year or so -- whose importance to the world could not have been the same without the existence of the Royal Society.

The first case study I offer is one of the great heroes of my own nation, Benjamin Franklin, who became a fellow of the Royal Society in 1756 -- nearly two decades before the political events that would make him famous to most of us.

It would be hard to think of anybody who better illustrates the wisdom of Royal Society policies than Franklin. He absolutely personified everything the Royal Society stood for. Like so many others of that busy age, he was into everything. He considered how and why water evaporates from puddles, the meanings of fossils, why rock strata are so often tilted and jumbled. He discovered and really quite brilliantly explained the Gulf Stream, and very nearly elucidated the germ theory of disease a century ahead of Pasteur. He made many practical inventions -- bifocals, for instance. Above all, he became a foremost authority on electricity at a time when electricity was one of the most exciting unknowns of science. Among much else, he created the world's first electric battery, coined the terms positive and negative in regard to electrical charge, and explained the properties and behaviour of electricity more thoroughly than anyone had before.

We are so familiar with Franklin's achievements that it is easy to forget that Franklin was a man who had practically no formal education, and came from what was then a provincial backwater. At the time he began his scientific experiments, he was a journeyman printer in a far-off colony who had a talent for coining amusing aphorisms, and that was about it. He needed the Royal Society to give him confidence and stature, and that it did. Without the Royal Society, the Benjamin Franklin who has come down through history could scarcely have existed.

Interestingly, by the way, the one scientific thing Franklin didn't do, it seems, was the one thing he is most famous for -- namely, flying a kite in a thunderstorm to prove that lightning was electrical. It is a story still lovingly repeated in every American schoolbook; I mentioned it myself in my introduction to Seeing Further and said that he reported the experiment to the Royal Society. It now appears that he didn't actually fly a kite into a thunderstorm and never exactly claimed to. His report to the Royal Society, in fact, merely described how such an experiment might be carried out. The idea, as you will remember, was that Franklin launched a kite during a thunderstorm, and that dangling from the string near his hands was a key in a glass jar. The kite attracted an electrical charge, which travelled down the string to the key and made it rattle in the jar. It was important for purposes of the experiment that Franklin and the key be under cover and dry, and so the kite was flown out a window.

The thing is, you can't fly a kite through a window. You just can't do it. It is nearly impossible to get it

launched and then if you did manage to get it launched it is nearly impossible to control and manoeuvre.

More to the point, if the string connecting the kite to the key did attract a bolt of lightning, anyone foolish enough to be grounded to it at the earth end would receive a positively enormous and very probably lethal jolt. The key in its jar wouldn't tinkle gaily, like a bell above a shop doorway, but would essentially explode like a stick of dynamite.

Since Franklin understood the physics of lightning well enough to invent the lightning rod, it is pretty nearly certain that he wouldn't have been rash enough to hold on to any length of string that was in danger of conducting an extremely robust charge of energy from a storm cloud to his body.

Now here's the thing. It was Franklin's standing as a scientist that made him greatly admired in France, and it was because of this admiration that the French were prepared to receive him as an important visitor and listen sympathetically to his appeal for financial support for the American cause during the American War of Independence. Without that support, the American colonies could never have sustained, and eventually prevailed in, a lengthy war.

So we may actually say that it is thanks to the Royal Society in some tangential but absolutely crucial sense that America gained its independence from Britain, for which I would like to say thank you.

Even more incidentally, it has also been said that when the new nation of America was debating what to call its chief executive, it was Franklin who suggested the term president, after the head of the royal society. So thank you again.

You really cannot exaggerate the importance of the Royal Society's policy of openness to people from all backgrounds and all countries. Foreigners gave a new and additional perspective that it could not otherwise have had. The reason Benjamin Franklin discerned the existence of the Gulf Stream was not simply because he was observant and had a scientific mind, but because he crossed the Atlantic Ocean repeatedly and was exposed to its effects again and again.

It isn't enough, in short, just to have great minds, but you have to have great minds at work in the right places. And that brings us to my second hero, whom I will mention much more briefly -- a man named Richard Carrington, who was English and lived from 1826 to 1875. Carrington was one of the great examples of being in the right place at the right time.

I came upon him entirely by chance while reading about an event of great commercial importance -- the discovery of oil in Pennsylvania by the man known to history as Colonel Edwin Drake (even though he wasn't a colonel but rather a failed railway conductor). The story, as you may recall, is that Drake and his business partners decided to drill for oil in Pennsylvania in 1859 and everyone thought them completely mad for drilling, but they persisted at great expense and eventually struck oil and in so doing laid the foundations for an industry that would utterly change the world.

It so happens that at the very time of this event, earth suffered a sudden great atmospheric disturbance of a type never before seen. Magnets and telegraph systems all over the world suddenly went haywire. Aurorae of unparallelled brilliance spread across the skies and became visible as far south as the Caribbean. The whole of earth's atmosphere was spectacularly disturbed.

The cause of this would have been a complete and worrisome mysterytery except that one man -- an amateur astronomer standing on Box Hill in Surrey -- happened to be the one person on Earth who was watching the sun at that moment. It was Richard Carrington.

Carrington was a devoted astronomer, who was unusual in that he spent more time looking at the Sun than at stars. He was particularly interested in sunspots. Carrington had real talent as an astronomer, but he had very limited chance to exercise his interest because he had to run the family business -- a big brewery called the Royal Brewery at Brentford in Middlesex.

So it was a rare treat for him to be able to get a day off. But on September 1, 1859, he did manage to get a day off and traveled out of London to Box Hill in Surrey, where he had a private observatory. While he was there on that day, an extraordinary event happened. The sun emitted a flare of really enormous proportions in an event now known to science as a coronal mass ejection. It was the biggest solar storm that has ever been recorded, and we know all about it simply because one person on earth -- an amateur astronomer on a hillside in Surrey -- happened to be watching the sun that day, and was able to report upon it..

Carrington became celebrated in astronomical circles and was elected a fellow of the Royal Society the following year. The rest of his story is not quite so happy, I am sorry to say. He grew increasingly deranged and argumentative and became famous for disrupting meetings of various astronomical societies. Quite late in life he married suddenly and unexpectedly a woman much younger than himself, but soon afterwards both he and his wife died in strange and mysterious circumstances. The suspicion has long been that he murdered her and then killed himself. On the plus side, he left £2,000 to the Royal Society.

I don't know quite what the moral of this is, so let me move swiftly on to my third example of unexpected ways in which the Royal Society makes the world a better place, and that is the wonderful case of the Reverend Thomas Bayes.

I first came across Thomas Bayes while looking for notable vicars for a book I was working on, and was recently published, called At Home, which is loosely about my own home, an old rectory in Norfolk. My house was built in 1851, and one of the things that was notable about country parsons in those days was that they were generally pretty well educated, pretty well off and had a lot of time on their hands, and so many of them did a number of extraordinary things.

If I may quote from my own book: [reading from book]

But perhaps the most extraordinary of all was Thomas Bayes, whom I liked so much that I included him not only in my own book, but also in my introduction to Seeing Further. Bayes was from Tunbridge Wells in Kent, and he was by all accounts a hopeless preacher, but a brilliant mathematician. At some point he devised a very complex mathematical equation that has come to be known as the Bayes theorem.

People who understand the theorem can use it to work out various probability distributions -- or inverse probabilities, as they are sometimes called. It is a way of arriving at statistical likelihoods based on partial information.

The remarkable feature of Bayes's theorem is that it had no practical applications in his own lifetime. You need computers, generally very powerful ones, to do the volume of calculations necessary to arrive at useful computations. So in Bayes's day it was simply an interesting but fundamentally pointless exercise.

Bayes evidently thought so little of his theorem that he didn't bother to publish it. It was a friend who sent it to the Royal Society two years after Bayes's death, where it was published in the society's Philosophical Transactions with the modest title of "An Essay Towards Solving a Problem in the Doctrine of Chances." In fact, it was a milestone in the history of mathematics. Today Bayes's theorem is used in countless ways -- in modelling climate change, in interpreting radiocarbon dates, in social policy, astrophysics, stock market analysis, weather forecasting and wherever else probability is an issue. And it exists today simply because nearly 250 years ago someone at the Royal Society decided it was worth preserving, just in case. I think that is the most marvellous thing.

My point in mentioning these three examples is that you can hardly delve anywhere, not just in the realms of science, but in any area of human endeavours and not find the Royal Society at the very heart of things.

Which raises a fourth extraordinary point about the Royal Society: it is still here. More than that, it is still here and it is still important. How many enterprises can you name that are still doing today what they were formed to do 350 years ago?

Today the Royal Society's interests remain an inspiration to recite. It provides 350 research fellowships and its grants support the work of 3,000 scientists all over the world. It bestows great numbers of medals and prizes, maintains an active programme of lectures and debates, and holds a beloved Summer Science Exhibition, which no one who appreciates science and can get to London should miss. It acts as the scientific conscience of the nation. It publishes seven journals, and an endless stream of papers. It remains emphatically international in its outlook, maintaining close links with 91 science academies around the world. As I said in my introduction, if we have an Earth worth living on a hundred years from now, the Royal Society will be one of the organizations our grandchildren will wish to thank.

It is impossible to list all the ways that the Royal Society has influenced the world, but you can get some idea by typing in "Royal Society" as a word search in the electronic version of the Dictionary of National Biography. That produces 218 pages of results -- 4,355 entries, nearly as many as for the Church of England (at 4,500) and considerably more than for the House of Commons (3,124) or House of Lords (2,503). It is more central to the life and history of Great Britain than most people realize.

If you removed from the historical record all that the Fellows of the Royal Society have done, there would be no photography, no internet, no bank holidays, no theory of evolution, no understanding of gravity, no lightning rods, no bifocals, no unravelling of DNA, no electronics industry, no Big Bang theory and literally uncountable hundreds and hundreds of thousands of vital things more.

It is impossible to exaggerate the importance of science to this country -- historically and currently. Chemistry alone is worth £50 billion a year to the British economy. The prestige value simply can't be measured. Britain has just one per cent of the world's people but produces, by one reckoning, 14% of the most frequently cited scientific papers. That is staggeringly disproportionate and ought to be a source of pride to every single person in the country.

And yet science seems to be under a relentless attack at the moment. Many of you will be familiar -- a few of you may even yet sting -- from an extraordinary attack by Simon Jenkins in the Guardian earlier this summer on science and its costs - he seemed to think that modern science was somehow a great scam -- and of course we are in the shadow of spending cuts which are expected to hit science and research hard.

I find that really disappointing. The glory of this country, the thing I admire more than any other, is that in a really small space you produce an amazing amount of wonderfulness -- in theatre, music, art, literature, science, and a great deal else. If you take away men's tennis and world cup football, you people are fantastic at almost everything. It would be a foolish tragedy to throw away any of that glorious, unpredictable abundance of creative activity in any of those fields, science not least, because we somehow feel compelled to punish ourselves for the excesses of bankers. I just don't get that.

You know, I am Chancellor at Durham University, and in that position I am often taken to visits to various departments. On one of my visits last year, they took me to the Engineering Department to see their new radio frequency anechoic chamber. They explained to me that essentially it is just a soundproof chamber. And I thought, well, how interesting can that be, and then I got there and saw it, and thought: Well, not very. Because it really was just a sound-proof chamber with foam baffles -- exactly like a radio broadcast booth, only slightly roomier It didn't look anything much at all. But what I learned is that in the hands of the amazingly dedicated, cerebrally super-charged people in Durham's engineering department, this dull chamber may one day perform miracles. By allowing people to control radio waves at ever finer resolutions, it could change the world in a hundred ways. It could provide a means to detect breast cancer so early that it never kills anyone again; or find people who are lost in the wilderness if they are carrying a mobile phone, even if it's switched off; or let firemen look through walls and see who is trapped inside burning buildings. And a lot more. And all this exciting potential was contained in one small corner of one department of one university, which is just one of 114 British universities all doing dedicated research -- and that's not to mention all the industrial and NHS and charitable research labs and so on, all of them doing interesting and exciting things, any one of which could fundamentally change the world.

The idea that any of that is expendable or surplus to requirements is simply bizarre.

Now hold that thought for a moment, please, while we shift quickly but I hope adroitly to our second topic: a really, really short history of nearly everything.

A few years ago, as you may know, I wrote a book called A Short History of Nearly Everything, which was my attempt to understand the world, and the universe around it, and how they both got to be the way they are - or (as I put it in the book) how we went from there being nothing at all to there being something and then how a little of that something eventually turned into us.

One of the things that particularly fascinated me was how scientists figure things out. How do they know where the continents were 300 million years ago, or how hot it is on the surface of the Sun, or what goes on at the heart of a gene, or what was happening in the universe in its first three minutes? How do they even know that the universe had a first three minutes and hasn't just been there forever? How does anybody ever figure these things out? And so the book became a kind of quest to find out not only what we know but how we know what we know.

And so for about four years, I did almost nothing but try to understand science and its achievements. I traveled to 11 countries on five continents, read lots and lots of books and journals and transcripts and monographs, and asked enormous amounts of dumb questions to incredibly kind and patient experts from a variety of disciplines from many of the world's leading institutions.

I didn't have any particular outcome in mind, no ax to grind or anything like that. I was just trying to pack an empty mind with as much interesting information as it could hold. But in doing the book, I found myself

being drawn again and again to certain inescapable, elemental, but really quite important conclusions about the universe we live in and our part in it, including four really remarkable facts. I think they may be the four most remarkable facts there are.

So here, without ado, they are - the four most remarkable facts I know.

First, you exist. You're alive. That's really quite a marvelous thing to be able to say, when you think about it?For you to be here now, trillions and trillions of drifting atoms had somehow to come together to make you. In the history of the universe atoms have never got together in quite this way before and they never will again.

These atoms came to earth from all over. They could be anything. But for some reason they have decided for a few tens of years to be you. That's pretty extraordinary, if you ask me.

Why atoms do this is a puzzle. Being you is not a gratifying experience for the atom. An atom doesn't even know you are there. It doesn't even know that it is there. Atoms are mindless particles, after all. They don't know a thing.

Yet somehow for the length of your existence, these tiny devoted particles will engage in all the delicate, cooperative efforts necessary to keep you humming, to make you you, to give you form and shape and let you enjoy the rare and supremely agreeable condition known as life.

This is really hard to explain because there is nothing special about the atoms that make you. A human being, or any other living thing, is an assortment of almost embarrassingly mundane components - some carbon, hydrogen, oxygen and nitrogen, a little calcium, a dash of sulfur, a sprinkling of other very common chemicals. This is the same stuff you would find in a pile of dirt. The only thing special about the atoms that make you is that they make you. That is of course the miracle of life.

But having obliging atoms is only part of the good fortune that got you here. You've also been incredibly lucky genealogically, ancestrally. Statistically speaking, you shouldn't be here. None of us should. Survival on earth is surprisingly hard work. It is a curious fact of our existence that we come from a planet that is very good at producing life but even better at extinguishing it. Of all the billions of species of organism that have sprung up on earth in its long, productive history, 99.99 per cent are no longer here. They are gone - gone forever. The remarkable fact is that the normal condition for a species on earth is to be extinct.

The average species on this planet lasts for only about four million years. If you wish to last longer, as we most assuredly do, then you must continually recreate yourself. You must be prepared to change everything that defines you - shape, size, color, physiology, diet, metabolism, everything - and to do so repeatedly, in the right sequence at precisely the right historical moments. For us to be here now, it has been necessary for our ancestors to make all kinds of wholesale adjustments -- all of them random, none of them inevitable or even necessarily logical, but every one of them necessary to get us here today.

But even that's not enough. You've also got nearly four billion years of reproductive good fortune behind you as an individual. Consider the fact that for you to be here now Every one of your ancestors since the dawn of time has been attractive enough to find a mate, robust enough to reproduce, and sufficiently blessed by fate and circumstance to live long enough to do so. Not one of your forebears in nearly 4 billion years them on either side was squashed, devoured, stranded, starved, stuck fast, pipped by a more glamorous suitor, spurned or otherwise deflected from its life's quest of delivering a tiny charge of genetic material to the right partner at the right moment to perpetuate the only possible sequence of hereditary combinations that could result - eventually, astoundingly and all too briefly - in you.

I don't wish to belabor the point, but life is a damned lucky thing. Your existence is a miracle, and you shouldn't let a day pass that you don't rejoice in having it.

Which brings me to my second amazing fact. Life doesn't happen anywhere else in the universe, as far as we know. Now that really is odd, The atoms that so freely and congenially clump together to form living things on earth seem entirely disinclined to do it elsewhere.

Of course the evidence isn't all in yet. So far astronomers have found only a few dozen or so planets beyond our own solar system, out of the ten billion trillion or so that are thought to exist, so we can hardly claim to have searched every corner of the universe, but it is certainly the case that the only life that has turned up so far - and very possibly ever will - is found on this one single unprepossessing blue planet in a nameless solar system two thirds of the way out from the center of the milky way.

That's not much in a great big universe - particularly when you consider that all the life on that small blue

planet is found almost exclusively in a frail wisp of water and atmosphere around the surface. If you imagine the Earth shrunk down to the size of a standard desk top globe, then the atmosphere is only about the thickness of a couple of coats of varnish.

And the part of that atmosphere that supports life - the biosphere, as it is known -- is only a small part of that. Most of the earth is too cold or dry or lofty and thin-aired for most types of life. Humans - even with the advantage of clothing and shelter -- can manage to live on only about 12 percent of Earth's landscape. Other animals are restricted further still. In consequence, most of earth's life is confined to an exceedingly - indeed an unnervingly -- modest range. Just 1.4 percent of earth's land area contains more than half its biodiversity. I can't think of a better reason than that to be worried about global warming.

Which brings me to my third amazing fact - that we live on a planet that we don't really know. There may be no other detectable life in the universe, but there is such an abundance of it here on our own planet that we don't actually know how much there is. We don't even remotely know. I find that quite amazing. Even more amazing, we don't even know what we know. No one has ever managed to collate the total number of known living things on the planet. Most estimates for the number of named species of things on earth usually fix on a figure .of about one a half million, but that's really only a guess. As for the number of unnamed, yet-to-be-identified species of living things, we are even more clueless. It may be tens of millions, it may be hundreds of millions. But according to one extraordinary estimate perhaps as much as 97 per cent of all that lives on the earth and in the seas is still to be discovered.

And so to my fourth amazing fact - the last one I will burden you with here, I promise - namely, that all life comes from a single moment of creation.

Some 3.8 billion years ago, in some bubbling mud pot or deep ocean vent, some little bag of chemicals twitched and became animate and then, miraculously, reproduced itself. Everything that lives now on earth, or ever has lived, descends from that moment. We are all built from a single original blueprint. I don't believe there is a more important or remarkable fact in the natural world - indeed any world -- than that.

Since life arose, Earth has produced - or so it is thought - some 30 billion different species of creature, which is a much, much larger number than it sounds. If you imagine that I projected slides of all those creatures on a screen behind me at the rate of one a second, it would take nearly a thousand years to get through them all. Earth has produced a lot of life in its time.

Out of all that number, only one species of thing has been smart enough and sensitive enough to reflect upon its place in the universe, to manipulate the environment to make it more productive and secure, to look beyond its own immediate needs and to work out strategies for improving its lot. And only one - the same one, alas -- has been reckless enough or foolish enough to trifle with the air it breathes, bulldoze its forests and jungles, dynamite its coral reefs, drive to extinction creatures on land, sea, and in the air. We are in the uncanny position of being simultaneously life's best hope and its worst nightmare simultaneously.

It is a mystery to me why is it so hard for us as beings to see how vulnerable we are, to appreciate that we have all the water we are ever going to get, the only air we're going to breathe. We are not going to find new oceans teeming with life or some back-up Amazonia that we have somehow till now overlooked. We have all we are ever going to have. This is all there is. There is nowhere else to go.

The most brilliant and thoughtful naturalist of our generation, Edward O. Wilson -- who is, it goes without saying, a Fellow of the Royal Society -- put it better and more succinctly than anyone ever has. In his classic work The Diversity of Life he wrote: 'One planet, one experiment.' It really is as simple as that.

We are moving into a world that is very uncertain and very scary. Every problem we have will be solved by science or it won't be solved at all.

This really is no time for cutting.

Oh, and there's just one other thing that I learned about life while researching my book. It doesn't last very long, I'm afraid. Even a good full human life goes on for only about 650,000 hours. So there really isn't a moment to be lost. I don't know about you, but with that in mind, I'm really going to enjoy a drink in a minute.

Thank you for listening so patiently and thank you for having me here tonight.