Standing on the Shoulders of Giants or Keeping it in the Family

Standing on the shoulders of giants is a phrase that has long held a fascination for me: it is a constant reminder of how much we owe to pioneers of the past, and among them I would, of course, include Erasmus Darwin. The first recorded use of the phrase is that of Bernard of Chartres, in the C.12th., who said "We can see further not by virtue of the sharpness our sight, but because we are carried high, raised up"[1]. There have always been generally accepted candidates for the role of 'giant', particularly in classical antiquity. A more modern candidate is the C.17th. Isaac Newton, who is recorded as saying "If I have seen further it is by standing on shoulders of giants". Whilst it may be difficult to decide, and agree, who the giants are, in the bicentenary year of his birth, and 150 years after the publication of the Origin, Charles Darwin is certainly being so treated. (I was lucky enough to attend the International Darwin Seminar, in Cambridge, in July, and this left us in little doubt about his status.) As the consummate expositor of the theory of natural selection, CD started an enormous movement in biological and other fields of thinking. The titles of some of the subjects covered shows this:

From Genomes to the Diversity of Life
Adaptation, variation or extinction: how can there be theology after Darwin
Darwin and .. the development of self-conscious emotions
The growth of child development studies
Learning as an evolutionary search engine.

My eye was even caught the other day by an article in the Sunday Times Magazine, which suggested a link between Darwinism and racism, genocide and psychopathic behaviour in mass murder. The claim was made that Pekka-Eric Auvinen, a Finn, who shot his teacher and seven fellow students, claimed to be a 'social Darwinist', and to be assisting the process of natural selection by survival of the fittest, by getting rid of the weak! CD would surely be mortified to hear of this! After all just think of the picture we have of him, as a benign, far-sighted grandfather figure. However, as one lecturer put it[2] this is largely as a result of the pictures and cartoons, which flowed into circulation at the end of the C.19th. Of course, there can be no doubting his enormous contribution, but what really made him a giant, and whose, if anybody's, shoulders did he stand on? The first consideration, perhaps, is that he managed to publish his views at the right time.

The stimulus of Wallace:

Although he would, eventually, have got round to it, the stimulus, to his publication of the rather rushed *Origin of Species*, came from receiving a paper from Wallace, in which he discovered that Wallace had hit on the very idea on which he was working. Darwin sent the paper to Lyell, and Lyell and Hooker inserted it, with an earlier (1844) essay by CD and a letter sent, in '57 to Asa Gray, on the subject, into the agenda of the meeting of the Linnaean Society on 1 July 1858. The papers, later published by the Society[3], apparently caused little stir, though Darwin was extremely apprehensive. Wallace was delighted with their publication, and, apparently, far less worried about their reception.

Alfred Wallace was the eighth of nine children (Charles Darwin, of course, was fifth of six and Erasmus Darwin, his Grandfather, last of seven), and born in 1823, 14 years after CD. On leaving school, he took up land surveying, with his eldest brother. Working in this field, rather in the same way as it had William Smith, famed for his geological map, Wallace got interested in what he saw around him, and trained himself to identify plants. He also became an avid reader, scouring through the *Encyclopedia Brittanica,* and discovering Malthus, Hutton, Lyell and, significantly, *The Vestiges of Creation* and Darwin's *Journal* from the voyage of the Beagle. All of these set him thinking, particularly *The Vestiges,* in which the, then, anonymous author spoke of the transmutation and the gradual, simple to complex, development of species, relegating God to being the ultimate designer of the process. In due course, he gave up the surveying and turned to teaching in Leicester, coming under the influence of Walter Bates (1825-92, Batesian

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[1] Attributed to Bernard of Chartres in *John of Salisbury, Metalogion* (1159) Book 111, ch.4

[2] Professor Ludmilla Jordanova, *The impact of images of Darwin*

[3] As- *On the Tendency of Species to form varieties* and *On the perpetuation of Varieties of Species by means of Natural Selection.*

mimicry), who inspired him to become a Beetle collector. In 1848, Wallace suggested to Bates an expedition to the Amazon. He had already been drawn to the evolutionary idea and wrote to Bates that he "would like to take some one family to study thoroughly- principally with a view to the theory of the origin of species. By that means I am strongly of the opinion that some definite results might be arrived at". He was 25, with little formal education, interested in evolution and looking for the key to the means whereby organisms develop into different species. They collected independently, and Wallace lost all his specimens, comprising thousands of insects and hundreds of bird skins, on the voyage home.

Undeterred by his loss, Wallace then set out for the Malay Archipelago. He visited many islands and collected many thousands of insects, 7,500 shells, 8050 bird skins, and 410 mammals and reptiles. Several 1000 were new to science, and they included, for example the exotic Rajah Brook Birdwing (Trogonoptera brookiana). One of the notable aspects of his work was the collection of multiple specimens through which he explored the variability of species, noting the considerable variation among individuals, which he surmised might provide the differential material upon which selection works. In 1855, he wrote an influential paper on his researches, *Sarwak Law*, which included the words "every species has come into existence coincident both in time and space with a pre-existing closely allied species".[4] It was the receipt of this, which prompted Lyell to suggest to Darwin that he should get on with his writing. Charles did not react and it was Wallace's further paper that was the real stimulus. Wallace went on to study the distribution of species and defined what later became known as the 'Wallace Line', between Bali and Lombok, Borneo and Salawei, which differentiated the many Asian and Australasian species. For example, whereas there are 177 spp of bird and 225 mammals in Asia, but there are 241 birds and only 79 mammals in Australia and, of course, no indigenous mammals in NZ! His work led to him being known as the 'Father of Biogeography'. More importantly, recalling how Lyell suggested species seemed to be linked through strata, Wallace concluded "every species has come into existence coincident both in space and time with a pre-existing closely allied species". It was this that really aroused Darwin. Wallace did not suggest a mechanism, but he did conclude that his findings were more fitting of 'evolution than creation'.

Wallace's is a remarkable story, full of parallels with Darwin's, though Charles, of course, moved way beyond Wallace in his culling of examples, which backed his thesis, both from other writers and from his own researches and experiments. Alfred Wallace was a gracious man, as one may judge from his ready sharing of his significant paper, and he gave Darwin all the credit.

Darwin, then, stole a march on Wallace, recognising that their work had coincided, but having amassed far more understanding of the concept of species development through natural selection, and a remarkable array of experimental, observed and published ideas to substantiate the theory. Wallace was never going to be seen as a 'giant' even if the Wallace website claims that he was 'the world's most famous scientist' at the time of his death in 1913. However, Wallace is important since he stimulated Charles Darwin into action and also reminds us, secondly, that Charles benefitted a great deal from the fact that evolution was a considerable talking point.

Evolution was a talking point:

The idea of evolution, even if not called that, had been around for a long time. Giants of the past had suggested it. Aristotle, for example, (348-322) talked about the development of life, and of higher species from lower, Indeed, The Revd Robert Murray[5], even suggests that Aristotle's view of the development of life led to the correct interpretation of the Mosaic account of the creation, and that his view was accepted by St Augustine. "If, he says, the teaching of the African doctor, in this respect at least had remained the teaching of the Church, the triumph of the theory of evolution might have been anticipated by fourteen centuries! More recently, Erasmus Darwin had written about it in the late C18th. and Lamarck had not only spoken of it but also, tentatively, suggested a mechanism. However, the writer who really opened it up for the C.19th. , and made it a talking point, was the author of *The Vestiges of Creation*, an anonymous on publication, revealed in the 1880s to be Robert Chambers.

[4] Sources: David Quammen *Alfred Wallace is the forgotten evolutionist,* article in National geographic, Dec.2008 and the Wallace website.

[5] In *Science and Scientists in the C.19th*., p .109 in 1925 edition

Robert Chambers was born in 1802, born, as was his brother William, with six digits on each limb. Although not having an extensive education, like Wallace, he was interested in books from an early age, in particular pouring over the *Encyclopedia Brittanica*, which he found on his father's shelves. At 16, his brother having become a bookseller's apprentice, and then set himself up in publishing, Robert joined him and started writing. Eventually they would publish the *Chambers Journal* and superintend the publication of *Chambers Encyclopedia, 1859-68*. Around 1830, Robert became interested in Geology (interesting how many found Geology a formative discipline), becoming a fellow of the Geological Society in 1849. His studies and reflections led him to publish *Ancient Sea Margins* in 1848, but, more importantly, *Vestiges of Creation* in 1844. The book was anonymous, till 1883, because, his friend Alexander Ireland reveals in the first attributed edition (12th. published in 1884), he felt that to 'escape strife at the expense of losing any honour that may arise from my work, is to me a most advantageous exchange, since I really do feel, with respect to a theme so august, that to entertain a thought of self-glorification would be inexpressibly contemptible'.[6] This is his worthy rationalisation, Ireland suggests, of the realisation that he was largely unknown in the fields of scientific research, his conclusions could easily cause an uproar amongst the uninformed public, the theory might have a better chance of a hearing if it stood on its own and he should not put his brother's publishing business at risk. (They had a rule that their publications should as far as possible not get mixed up with debateable questions in politics and theology.) His thesis was that there had been the progressive transmutation of species governed by God given laws. In arguing for this view, Chambers refers to the earlier work of Lamarck, though he is critical of his ideas.

Jean Baptiste Lamarck (1744-1826) started out as a soldier, but, retiring in 1766, he then turned to medical studies for a time, before turning to science, as we would now call it, and studying Botany, in which he had become interested through visits to the Jardin du Roi, founded in Paris in 1646 and then under Bernard de Jussieu. He also became an authority on Invertebrates. In 1800, he propounded the first comprehensive theory of evolution in a lecture, developing his ideas, later, in books published between 1801 and 1822[7]. Animals, he argued, were formed by an ongoing process of spontaneous generation and developed from simple to more complex forms through the inheritance of acquired characteristics, which were the result of adapting to local environments. Chambers, in the first edition of *Vestiges*, described this theory as 'so inadequate that we can only place it among the follies of the wise' but in the latest revised edition, published in 1860, he is more measured. "M. Lamarck, he writes, suggested that the gradation of animals depended upon some general law which it was important for us to discover. So far he was right; but the theory he consequently formed with regard to the causes of the varieties of animated being, was so far from being adequate to account for the facts, that he has scarcely a single adherent."[8]
Lamarck not well received perhaps largely because of his espousal of 'spontaneous generation'. Chambers was more circumspect and talked of God given laws. The anonymous *Vestiges* was acclaimed by many, especially Unitarians and Quakers, though it angered Sedgwick, the Geologist, and Chambers was denounced, after giving a later paper, by Bishop Wilberforce. Both, however, kept the topic of evolution alive, paving the way for Darwin, the giant who was to come, though they can hardly be thought to have made him the giant- he did not stand on their shoulders! A better candidate is, of course, Lyell. If Wallace stimulated him to publish at the right time for fame, and Lamarck and Chambers paved to way for his work to be well received, then it was the influence of others, which made a substantial, giant-building contribution, because, as *The origin* shows, he read and consulted widely, and Lyell must take pride of place.

The influence of others:
Charles Lyell (1797-1875) built on the work of Hutton and developed the theory of Uniformitarianism, which dispensed with the current views of Neptunist and Catastrophist alike, and paved the way for Darwin's evolutionary ideas. Indeed, Charles took volume I of Lyell's *Principles of Geology* on the Beagle, receiving vol.2 in South America. Lyell grew up in the new Forest. Given an interest in nature by his father, who was a botanist, he was, also, greatly influenced from reading Blakewell's 'Introduction to Geology' in 1816, and further engaged by geology when

[6] Letter to George Combe, written by Mrs Chambers, and quoted by Alexander Ireland in the Introduction to the twelfth edition, which credited the authorship to Chambers.

[7] 1801- *Systeme des animaux sans vertebrae* .. 1815-22 –*Histoire naturelle des animaux sans vertebrae* ...

[8] *Vestiges of the Natural History of Creation,* last revised edition, 1860, p.232

he attended lectures by Buckland, whilst studying Law at Cambridge. Buckland, of course, was a Catastrophist, believing in a series of inundations to explain the various levels of marine fossils, and thus retaining his hold on the biblical record! Leaving the Law in 1827, Lyell took the Chair of Geology in London and published the *Principles of Geology* between 1830 and 1833, arguing that they key to the past lay in the observation of the present. The present processes of denudation and rock formation were, he suggested, part of a continuous process, from the beginning of time. Importantly for our study, he recognised the significance of homologous structures of successive fossil species, but did not rush to the conclusion that evolution had taken place, favouring rather the idea of natural development from 'centres of dispersion'. Indeed, Lyell was very critical of Lamarck's view of progressive development, in volume II of the *Principles*, and explicitly rejected evolution, He was mainly deterred by the transmutation of species, which he thought undermined the creative activity of God. In a letter to William Whewell, he says "To assume that the evidence of the beginning and the end of so vast a scheme lies within the reach of our philosophical experience, or even of our speculations, appears to us inconsistent with a just estimate of the relations which subsist between the finite powers of man and the attributes of the infinite and eternal being."[9] He also felt that Lamarck lacked any real evidence for his suggestions, writing "I devoured Lamarck, he says in a letter to his friend and surgeon, Mantell, and his theories delighted me more than any novel I ever read, and much in the same way, for they address themselves to the imagination, at least of geologists, who know the mighty inferences which would be deducible were they established by observations."[10]

Whilst it remained a puzzle to CD and many of his colleagues and friends that CL did not espouse the cause of evolution, the reason lay, quite clearly, in his need for scientific verification. In the event, it was probably in reaction to a publication by Agassiz (1807-1873), who argued for successive special creations of distinctive species, that led Lyell to admit that he was now drawn more towards the views of Lamarck, and ultimately to acknowledge Darwin's work. Bunbury writes "He does not look on it (Darwin's theory) as proved and does not therefore express himself on it with the same confidence as Darwin, Huxley and some of the others, but it is very clear which way he leans." It was not until the 1860s and the tenth edition of his work that he acknowledged that his mind had changed. "thus going against his old creed" and removing man from his exalted position, and God from his interventionist creative activity.

Lyell quite a giant in his own way since he revolutionised the science of geology, however he did not entirely break with tradition in the way that his ideas merited, setting out to preserve the interventionist creativity of God. Charles Darwin had studied Geology with Adam Sedgwick, used Lyell's work extensively during the time on the Beagle and refers to him in the *Origin.* He faithfully recorded rock formations on the Beagle. He would not, surely, have reached the conclusions he did without his extensive knowledge of geology provided in large part by Lyell, who had also influenced Chambers.

So, stimulated by Wallace, whose observations led him to postulate the same theory of progressive development, Darwin published *The Origin* at a time when the idea of evolution was commonly discussed and thought on. This was largely due to Chambers, who certainly broke new ground in presenting evolutionary theory in a popular way, and to the work of Lamarck. Important though this makes him in the story of evolution and in the making of the Giant, Charles, Robert Chambers owed a great deal to many others and particularly Lyell, as did Darwin himself. Charles' had an immense capacity for reading and sharing ideas with others, which contributed to his growing conviction about evolutionary development and his explanation of the process behind it. However, all these advances had been made by people who had an immense capacity for observation and reflection. Where did this come from in Charles Darwin? We must look, fourthly, at his education.

An alternative education:
Darwin was educated at Cambridge and Edinburgh. From an early age, he was destined for medicine, as was his brother Erasmus and their father Robert, who practised in Shrewsbury. Charles followed his brother to Shrewsbury

[9] Lyell, K 1881 *Life and Letters of Charles Lyell,* vol.1, p.168

[10] Op.cit. vol.2, p.5

College, where he seems not to have enjoyed the rigour of public school life under Butler, hated the staple fare of the Classics, and took much more delight in collecting and naming plants and fossils, and setting up a chemical lab, at home, with brother Erasmus. He left at 16 and was apprenticed to his father, going round with him on his medical rounds. Erasmus wanted Charles to join him to study in Cambridge, but he went to Edinburgh, as had his father and grandfather before him, being joined by Erasmus for his first year. Edinburgh was a well equipped university and, significantly, a haven for Dissenters, since there was no pressure for students to subscribe to the 39 Articles. Charles was one of 900 medical students, but certainly not one of their best! He was very critical of the lectures in Anatomy of Alexander Monro 111 and of Dr Andrew Duncan on Medicines. He disliked the clinical work on the wards, and preferred, as one might expect, Dr Hope on Chemistry. He also chose to go and learn the art of taxidermy from a freed slave, Charles Waterton. Significantly, at home, in the vacations, he walked the Shropshire hills with Gilbert White's book, observing birds and, prompted by his father, read his Grandfather's *Zoonomia.*

He lost interest in his studies in the second year, but went to societies and lectures, mixing with radical thinkers and debating such subjects as science and religion. It was also then that he took to walking on the beaches, collecting, and came under the influence of Robert Grant. Grant had withdrawn from medicine and taken up marine biology. Grant was an uncompromising evolutionist, following both Lamarck and St Hilaire, and seeing the naturalist's job as exploring the causes of evolutionary change. The young Darwin impressed Grant greatly and Charles even made significant contributions to his researches. (For example, Charles identified the fact that black bodies in Oyster shells were the eggs of the Skate Leech.) Grant was fascinated by the development of homologous organs in divers animals, and noted the progressive sequence of fossil forms as indicative of developing organisms, and so evidence of evolution.[11]
It would be strange if he did not refer to Zoonomia, as he worked with the author's Grandson. Indeed, Charles, himself, records that he, not only, read Zoonomia, but also, "listened in astonishment (to a lecture on evolution by Dr Robert Grant at Edinburgh), and as far as I can judge, without any affect on my mind. I had previously read the *Zoonomia (1794)* of my grandfather in which similar views are maintained, but without producing any effect on me. Nevertheless it is probable that the hearing rather early in life such views maintained and praised may have favoured my upholding them under a different form in my *Origin of Species.* At this time I admired greatly the *Zoonomia* ...[12]
It was in Edinburgh that he, also, learnt about the work of Augustin de Candolle (1778-1838) and his system of classification, and noted his idea about the war between the species. He also came across Thomas Malthus (1786-1824) and his work on population, which led him to write later "I happened to read Malthus on Population. It at once struck me that under these circumstances favourable variations would be preserved, and unfavourable ones be destroyed. The result of this would be the formation of new species."[13]

Charles left Edinburgh in April '27, without a degree, but greatly influenced by those he met and walked with, and with whom he observed and collected. He was well along the path, which led to his seminal work on evolution. Although this was not the beginning of the making of a giant, as we shall see, it was an important part of his life, preparing him for what happened in Cambridge when he walked with Henslow. Cambridge was an enormous contrast with Edinburgh. A stricter regime, more conservative, with a large number reading the classics and training for the priesthood, but Charles, luckily came under the influence of his cousin William Fox, at Christ's College and Adam Sedgwick, the Woodwardian Professor of Geology, who was the Senior Proctor in charge of discipline. Whilst Charles avoided him in this role, the great geologist would take him under his wing for the study of rocks and minerals. Charles was, also, able to indulge his passion for beetle collection, very common to students in those days, and he vied with Fox over finds. He also worked met and worked with Jenyns, who is, perhaps, lesser known.

Leonard Jenyns (1800-1893) began studying natural history when he was 12. He went to school at Eton, where he copied out Gilbert White's *Natural History of Selbourne*, met Joseph Banks and left for St John's College, Cambridge in 1818, just ahead of Darwin. There he came to the attention of John Henslow, and worked with him in natural

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11 The term was first used in 1826

12 Charles Darwin, *Autobiography* (ed. N.Barlow) 1958 p.49

13 Op. Cit., p.120- on reading Malthus in 1838, according to R D Keynes in *Charles Darwin's Beagle Diary.*

history. Jenyns took his degree in 1822, became a Fellow of the Linnean Society and of the Cambridge Philosophical Society and with Henslow set up that Society's Museum. In May 1823, he was ordained Deacon and worked in Norfolk. His natural history interest continued, he was an avid insect collector and published several papers. His diary for 1831 has a very interesting entry. He was offered the post of naturalist with Fitzroy on the Beagle, but, he records, declined it because of his parish work, and he notes that it was offered to CD "the grandson of the celebrated Erasmus Darwin, author of The Botanic Garden". So here is another, and less well-known contributor to the making of our giant! Jenyns went on to become a member of the Geological Society, published several more papers on various topics and books on the vertebrates, 1835. Notable was the lecture he gave in Cheltenham, in 1856, on 'the variation of species', of which CD obtained a copy. However, we must return to Henslow for although all these experiences at Edinburgh and Cambridge built up Darwin's potential to be the giant he became, arguably, the most important 'giant-building' experience came from his work with Henslow.

John Henslow (1796-1861) was influenced by an art teacher at school, became an ardent butterfly collector abd collected marine specimens in Devon, some of which he presented to the British Museum, where he was Assistant Keeper in the school holidays. When he was 18, he entered St John's College Cambridge, graduating in Maths four years later, and continuing his studies in natural history. He also met Adam Sedgwick, the geologist, who recognised his skill in museum work and took him, in 1819, on a tour of the Isle of Wight. In the same year Henslow took students on field trips to the Isle of Man, became a Demonstrator in Chemistry, helped found the Cambridge Philosophical Society and became a member of the Geological Society. 1820 saw him in Anglesey, to which he returned the following year, with students. In the same year (1821) he read his first paper to the CPS, on Anglesey, a paper published in 1822,[14] and published an article on the Isle of Man.[15]

More directly influential on CD, however, was Henslow's work on the limitation of species. Species had of course been defined by John Ray, the C.17th naturalist, but Henslow, who had moved from being Professor of Mineralogy, to being Professor of Botany (1825), was working on variability by a process he referred to as collation. He amassed a great number of variable forms of different species, gathered by himself and an army of collectors, which even included Charles Darwin and set out to discover the limitations of species. He looked also at hybridisation and concluded that fertile hybrids were variations, but infertile should be deemed new species. He also recognised that manipulation of the environment could alter heredity, and was fascinated by 'monstrosities', speculating that if 'we could understand monstrosity then we could understand the fundamental process of development'[16]. At the same time, he revolutionised the teaching of botany and moved the small 'physic garden', at Christ's, for which he was responsible, to found the Botanic Garden of Cambridge. It was into this arena that Darwin came, and Henslow's's lectures were the only ones, which he seriously attended.

Henslow's study of species peaked in the years '29-'31, the years in which Charles attended his lectures, and John Parker, the present Professor of Botany, and responsible for the Botanic Garden, who has done extensive work on Henslow, claims that it was Darwin's exposure to Henslow 's thinking that was crucial for his understanding and acceptance of evolution. Exposed to Henslow's lectures, illustrated by fine and detailed drawings, and backed by detailed practical work, Charles would also have observed the remarkable way in which Henslow did his collation, noting the place and details of each specimen in his Herbarium. He would imitate his methods on the Beagle, though not with so much attention, and still relying on his friend and mentor to work with the specimens he sent home. Later he would repeat Henslow's own experiments with Primula plants, which had led his mentor to describe the pin and thrum-eyed froms, vital to cross fertilisation.

Henslow will have recognised fertile ground, worth cultivating, in his young student, who became a close friend, and it is small wonder that he nominated him for the Beagle. There is however one further avenue to explore in this 'making of a giant', the fifth- his family background and, in particular, the influence of his Grandfather, Erasmus.

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[14] Transactions, Cambridge Philosophical Society

[15] Transactions , Geological Society of London

[16] Cited by Professor Parker in *The Cambridge Years: Henslow's Legacy, Darwin's Inheritance.*

A family affair:
Erasmus Darwin lived a century earlier than his more famous Grandson, Charles Darwin. He was born in Elston, in Nottinghamshire, in 1731, went to school in Chesterfield for nine years, before studying (1750-53) in Cambridge, and then at the Medical School in Edinburgh. He finally graduated from St John's College, Cambridge in 1755, and started medical practice in Nottingham. However, after a few months, he moved to Lichfield (1756). Here, in Darwin House, on Beacon Street, having married Mary Howard, known as Polly, he lived and worked as a Physician, for 25 years, before moving back to Derbyshire with his second wife, Elizabeth, the widow of Colonel Pole, in 1781.

Erasmus was the leading Physician of his day. He had a far-reaching and lucrative/successful practice, earning £1000 a year, by the late '60s, perhaps as much as £100,000 today. The King asked him to become his Physician, but he refused, preferring to stay in Lichfield caring for rich and poor alike. Accomplished medic as he undoubtedly was, there was much more to Erasmus Darwin. He had an inquiring mind and an entrepreneurial spirit. He excelled in many fields, especially science and technology; he gave valued advice to many- on canals to Josiah Wedgwood -on tiles to Sir Harry Harpur of Calke Abbey; and he even entered business, speculating in developing mills at Wychnor and Alrewas. He was also a good poet. He had written poetry as a child and student, and woo'd both his wives using it. Later he would write his great scientific books in poetic form: poetry, which was admired by Coleridge, who called him 'the foremost literary mind in Europe'.

It was in the late '50s and '60s, that Darwin began to gather round him a fascinating group of eminent thinkers. Early on, the group included the American Scientist and Politician, Benjamin Franklin, who became a mentor for him, John Whitehurst the clockmaker and Geologist, and Brindley of canal fame. Later, stimulated by the arrival of Dr Small, from the USA, many more were added, men like Wedgwood, the Potter, Watt, working away at steam, and Priestley, the exciting Chemist. It was this growing circle, which became the Lunar Society, whose experiments and inventions influenced the Industrial Revolution. Erasmus was a leading light- inventing a turning mechanism for carriages, a spoked and sprung wheel for better stability en route, and a horizontal windmill for grinding materials in Josiah Wedgwood's pottery. He explained elementary gas laws, photosynthesis and Artesian wells. His was altogether a most impressive mind and he could well be called 'Britain's answer to Leonardo da Vinci'!

It is however his work in the Natural Sciences, which was ground-breaking and paralleled the work of his more famous Grandson, Charles. The story begins with his interest in Geology. His Father was credited with finding, in 1718, what we now know to be a Dinosaur fossil, which he presented to the Royal Society (via Wm.Stukeley). Whether this influence persisted or not, we cannot know, but early in the '60s, he became involved with Josiah Wedgwood in the building of the Grand Union Canal, (ED even advised JW on routes, tributaries and tariffs. He had a commercial eye!) and, in 1767, Wedgwood sent Darwin a box of fossils found in the Harecastle Tunnel. In a letter of response, Erasmus says some were relatively familiar, others were not, and he hints at evolutionary ideas by jokingly comparing some of them to the bones of a Patagonian Ox![17] It was his perplexity in trying to understand the fossils, we may assume, which sowed the seeds of evolutionary theory in his mind for, by 1770, he had come up with the idea of evolution, seeing fossils as evidence of earlier, and generally, less complex, forms of life. It was at this time that he began to use a family crest of three shells with the motto 'e conchis omnia' (everything from shells). Canon Seward at the Cathedral objected (of course!) and he had to remove it from public sight on his carriage, but it remained his bookplate. Although Darwin seems then to have hit on evolution, as we now call it, by 1770, he delayed publishing his ideas, fearing that so bold an assertion would lead to ridicule, or worse, and affect his medical practice. He suggested in a letter, of 1775, that such a publication should be posthumous, when it could do him no harm![18] However, it would be strange if talk of these ideas did not feature in the meetings of the Lunar Society, and we may be sure that Erasmus

[17] *The Collected Letters of Erasmus Darwin,* ed. D. King-Hele, 67.2

[18] Op. cit. 75.6

would have shared his puzzlement over the presence of unrecognisable and, probably, extinct marine animals and tropical style ferns in different layers of rock in the centre of England!

However, we see his ideas developing, through sharing with men like John Whitehurst., the oldest member of the Lunar Society, who worked on the geology of Derbyshire, only just over the border.

John Whitehurst in was born in Congleton in 1713. A Clockmaker, inventor and scientist, he was, like many of his time, aware of the knowledge acquired through mining and the building of canals, and, by his own careful observation, made a substantial contribution to the growing science of geology. He described the fossils of sea creatures now extinct, speculated as to the formation and age of the earth, and believed that many rocks were formed through volcanic action bursting through growing layers of sedimentary rocks formed before the great flood. Significantly, by his own admission, he had great problems reconciling geology and his faith. His most important publication *An Inquiry into the Original State and Formation of the Earth* (1778) put forward his views, being careful not to offend in Part I, but in Part II he gave a far more scientific documentation of the Derbyshire rocks, establishing the successive strata of the Carboniferous. He describes Millstone Grit, for example, as volcanic in origin and coal as formed from vegetation. Josiah Wedgwood[19] was perplexed by the differences between the two parts of the book. "I own myself astonished beyond measure, he says in a letter to Thomas Bentley, at the laboured and repeated accounts to bring in and justify the mosaic account beyond all rhyme and reason". One further contemporary influential naturalist should be mentioned ED corresponded with and read the books of Le Comte de Buffon[20].
George Leclerc (1707-88) was admired by Erasmus Darwin, and said by his Grandson, Charles, who also admired Lamarck's work, to be the first modern author to 'treat evolution in a scientific spirit'. Buffon suggested that the spread of species from what he termed 'centres of dispersion' could mean that similar environments could support different and distinct species, considered the possibility of a common ancestry for humans and apes, and dated the earth, which he saw as spanning seven epochs, at 75,000 years, a figure based on the rate at which iron cooled. He insisted that, in spite of these observations, he was not an atheist, but he did, explicitly, deny that the flood had occurred. By the end of C.18th., criticism of the established Christian biblical tradition had thus been voiced, but the hypotheses advanced could be said to lack scientific rigour.

So much for Darwin's Geology, but it is clear that his study of living fauna and flora will, also, have moved him to greater conviction about evolution, and a reassessment of the role of God in creation. Although The C.19th. was the period of extensive plant collection, this had begun some time before. Men like John Ray (1627-1705), and several on the Continent, were collecting species of both fauna and flora. Joseph Banks (1743-1821) reputedly persuaded the King, George III, to support voyages to new lands so that he could indulge his passion for Botany, and he published Linnaean descriptions of the plants of Labrador and Newfoundland. He went to the South Pacific, and found 800 new species in Australia, between 1768 and '71, the time when Erasmus Darwin was establishing his extensive Botanic Garden in Lichfield, a garden about which we know very little, but which may well have contained species from overseas. Whilst Erasmus Darwin would have learnt from these great collectors, we know that he was, also, aware of the work of Linnaeus. Indeed, he would go on to translate Linnaeus, who systematised plants, showing their relationship through their reproductive parts.
(The point about all this is that studying plants across the world in this way also raises acute questions about their origin. I experienced this recently in Costa Rica, where I found a small pink Mimosa, known as the tracker plant in Malaysia. How did this come to be in two such different areas? I also recently came across a series of botanical paintings by two Conyers (Matilda and Henrietta, from Essex) dating from 1752 and 1769, which show the sort of plant species that may have puzzled ED. There is one, a Bindweed, which is different from our Calystegia (pinky bracteoles, for example) and has on it a Caribbean bug!

On the fauna side, he observed and recorded variation in animal life was fascinated by monstrosities, and speculated as to their significance for the Survival of the Fittest and the development of the species. He spoke about this in *Zoonomia,* published in 1794, and, eventually, made public his conclusion that spontaneous generation had begun a

[19] Cited in *The Lunar Men* by Jenny Uglow, 2002, p.301 note 20 not ED!

[20] Op. cit. 75.4

process of development through reproduction, when *The Temple of Nature* came out, posthumously, in 1803. In *Zoonomia,* Erasmus observed that all living creatures struggle to reproduce, and in some species, the male creature had to fight to win his mate. He concluded 'The final cause of this contest among the males seems to be, that the strongest and most active animal should propagate the species, which should thence become improved'. Further, in the struggle to survive, Erasmus observed that all living creatures have to eat, and that the various types of birds have developed different beaks, and so they do not have to compete for food, and he writes:
'Some birds have acquired harder beaks to crack nuts, as the Parrot
... Others for the softer seeds of flowers, or the buds of trees, as the finches.'
He also saw that each has its own way of escaping or hiding.
'Some have acquired wings instead of legs, as the smaller birds ... Others great swiftness of foot, as the Hare. Others have acquired hard shells, as the Tortoise ...'[21]

He makes the point clear in the preface to the book:
'The great CREATOR of all things has infinitely diversified the works of his hands, but has at the same time stamped a certain similitude on the features of nature, that demonstrates to us, that the whole is one family of the parent.'[22]

It was these ideas, concluded from recorded observations, many years before his Grandson, Charles Darwin, published the *Origin of Species*, that Charles would have met in reading *Zoonomia,* and who is to say that he did not also read *The Temple of Nature,* in which he wrote:

'Organic life beneath the shoreless waves
Was born and nurs'd in ocean's pearly caves.
First forms minute, unseen by spheric glass,
Move on the muds, or pierce the watery mass;
These, as successive generations bloom,
New powers acquire, and larger limbs assume;
Whence countless groups of vegetation spring,
And breathing realms of fin, and feet and wing.[23]

So, his studies in fossils, and of the living fauna and flora, led him, eventually, to publish his conclusion that spontaneous generation had begun a process of development of more complex species, through reproduction and the struggle to survive. It was evolution in embryo!

Darwin was by this time well known. His books had been translated into other languages, and the poetry in which they were written was much admired. Hence Coleridge's reaction. But, now, the honeymoon did not persist, because the idea of development through evolution, and the acceptance of the concept of extinct species, challenged the current view of creation. Significantly, however, Darwin did not dispense with a 'creator God', but, in *Temple of Nature*, spoke of "God the First Cause!- in this terrene abode."[24], and in a footnote refers to Paul saying to the Athenians, on the Areopagus "In Him we live, and move, and have our being" (Acts 17.28). In his biography of his grandfather, Charles Darwin cites an ode written by Erasmus, which ridicules Atheism.[25] "Dull Atheist, he says, could a giddy dance of atoms, lawlessly hurled, construct so wonderful, so wise, so harmonised a world?" There can be little doubt that, for all his scientific rigour and challenging conclusions about the process of life, he retains a living faith in a

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[21] Erasmus Darwin, *Zoonomia,* 1794, Canto 1, lines 507-13

[22] Op cit. Preface, p.vii

[23] *Temple of Nature,* 2003 edn., Canto 1, line 295

[24] Ibid, line 223, compare the opening lines of canto 1: By firm immutable immortal laws

impress'd on nature by the GREAT FIRST CAUSE.

[25] *Charles Darwin's The life of Erasmus Darwin,* edited by Desmond King-Hele, 2002, p.62

creator God. In a long footnote, in the *Temple of Nature,*[26] having cited others, who had, also, spoken of progressive development, he writes:

> Perhaps all the productions of nature are in their progress to greater perfection! an idea countenanced by modern discoveries and deductions concerning the progressive formation of the solid parts of the terraqueous globe, and consonant to the dignity of the creator of all things.

So it is reasonable to conclude that this ground breaking scientist had moved English thinking forward in science but also adapted the religious doctrinal tradition, at any rate to his own satisfaction- no mean achievement! For my money he was a real giant!

Staffordshire and Erasmus Darwin made a substantial contribution on the evolution front, during the C.18th. and the battle lines were drawn between science and the bible, but Darwin's direct influence on C.19th evolutionary thinking was negligible, because he fell from favour. However he may have had more impact than we imagine and he has been given credit for. We have already seen that Charles is fairly dismissive of his Grandfather's influence, however, in the full edition of his biography of his Grandfather, he pays far more tribute to the way in which he feels he was influenced by the great man.[27] The biography was published in 1879, but, interestingly enough, the edition was 116% shorter than the original draft, recently published by Desmond King-Hele. This was because his daughter edited it, and cut out several passages, some of which reflected well on Erasmus, and, she may have thought, would detract from Charles' glory! In the biography, Charles writes about the family heritage, recording that three sons survived from the five children his Grandfather had with Polly. Charles, who died from infection dissecting in Edinburgh, was a collector and experimented with machines. He was also a poet and keen on science. Erasmus, a Lawyer like his Grandfather and Uncles, drowned at 40. Like his father, he wrote poetry. He also collected coins and was keen on statistics. Erasmus' other surviving son, Robert became a Doctor in Shrewsbury. Although his son, Charles, records hat he was not much of a scientist, it is known that he believed in evolution, and retained the use of his father's bookplate 'e conchis omnia'. He then goes on in ne of the expurgated passages:

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As we have been considering how much or how little the same tastes and dispositions prevail in the same family, I may be permitted to add that from my earliest days I had the strongest desire to collect objects of natural history; and this was certainly innate or spontaneous, being probably inherited from my grandfather. Some of my sons have inherited the same innate taste for science.[28]

We have already remarked on his grudging admission that reading Zoonomia may have influenced him [29], and in a further expurgated passage, he pays handsome tribute to his Grandfather:

I have now given as faithful an account as I could of the character of my grandfather. His energy was unbounded. In his day he was esteemed as a poet. As a physician, he was eminent in the noble art of alleviating human suffering. He was in advance of his time in urging sanitary arrangements and in inculcating temperance. He was opposed to any restraint of the insane, excepting as far as was absolutely necessary. H strongly advised a tender system of education. With the prophetic spirit, he anticipated many new and now admitted scientific truths, as well as some mechanical inventions. He seems to have been the first man who urged the use of phosphate of lime in agriculture, which has proved of such great importance to the country. He was highly benevolent, and retained the friendship of many distinguished men during his whole life. He strongly insisted on humanity to the lower animals. He earnestly admired philanthropy, and abhorred slavery. But he was unorthodox; and as soon as the grave closed over him he was grossly

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[26] Op. cit., footnote to line 122

[27] *Charles Darwin 's The Life of Erasmus Darwin, 1887*, edited by Desmond King-Hele, 2003

[28] P.16

[29] Above- p.

and often calumniated. Such was the state of Christian feeling in this country at the beginning of the present century; we may at least hope that nothing of the kind now prevails.[30]

Prevail it did, in a way, and still does today, but certainly Charles published at a much easier time that his Grandfather. Erasmus not only came up with the idea of evolution and published it, he foresaw the problems which would flow from his questioning of the biblical tradition and countered it in his writing.
There can be little doubt that Charles was a giant, and we may have seen some of the influences that made him a giant in Biology, but surely the most important was the family influence of his grandfather- a bit of a giant in his own day! Talk about keeping it in the family!

Finally, I am prompted to ask whether the current approach to the teaching of biological subjects in schools, and the media based culture of our own day, encourage and give enough time to pure observation and reflection, which was surely the groundwork of all those whom we have looked at and certainly of the man himself, Charles Darwin- and no less of his Grandfather Erasmus.

[30] Op.cit p.88-9, the biography was published in 1879.

Appendix: How Erasmus Darwin worked out his idea of 'evolution'.

After the promulgation of his family motto (e conchis omnia), in 1770, Erasmus Darwin continued to work towards a hypothesis of progressive development of the species, through reproduction and the struggle to survive. Using experiment and observation, the sharing of material with others, and reflection with speculation, Darwin, eventually, arrived at a very interesting account of 'evolution', in *Zoonomia*, published in 1794, and a book which we know his Grandson, Charles, read [31].

In the course of his argument, he dares to be critical as well as appreciative of the work of others; to break with tradition, biblical and scientific, and yet to maintain his conviction that God, the Prime Mover, lies behind creation. Thus, for example, although he clearly abandons the biblical account of creation in Genesis, he nevertheless quotes the story of the Jacob's sheep[32] and, explicitly, defines the area of expertise of the scientist and of the Church and revelation.[33] Among those cited in the passage under review, below, are: Gilbert White, also read by his Grandson, Charles, and his friend Leonard Jenyns[34], the observations of Osbeck, a disciple of Linnaeus, on the Frigate Pelican, Linnaeus himself, Buffon, whose books, we know[35], he owned, Haller, Dr Haighton's experiments on rabbits, and Capt Hunter's observations in NSW. Many of these are cited ,in support of his thesis concerning generation and its value for the development of new species and their struggle to survive, in Section XXXIX (vol.6 of this edition of *Zoonomia*).

Erasmus begins by drawing a parallel between Dr Hartley's opinion (sic) that our immortal part acquires certain habits of action or sentiment, which continue to a further state of existence, and applies this to the generation of new animals, which partake of the form and propensities of the parent. The 'embryon' is, he says, not a new animal, but, secreted from blood, is reactive and endued with 'habits or propensities' peculiar to the parent, which lead to it becoming very similar to the parent. This, he then surmises, absorbs nutrients, from the fluid of the nidus (female contribution) and oxygen, through vessels which grow in their response to the desire for food. He acknowledges that the process of generation is still involved in impenetrable obscurity, but, as he explores development, in a manner suggesting close observation of nature, he concludes that the male contribution to the embryon dominates, though not, as some say, as an 'animalicule', for development is not by distension, but by the accretion of new parts. "I suppose the primordium or rudiment of the embryon consists of a living filament, as a muscular fibre"[36]. This forms a ring and then a tube, and 'irritability' of the new extended embryon forms the organs of the body, connected with 'thirst, lust or other sensations, and becomes a developing form, the vessels of the jaw producing teeth as the fingers produce nail, like a Tadpole acquiring legs. The composition of the female nidus fluids, in which all this happens, is crucial. How else could changes occur; a mule (hybrid) be formed, or monstrosities result, except through the female influence and aberrations in the fluids? So, he concludes, all animals have a similar origin, from a single filament, the 'differences in forms arising from different contributions and sensibilities'. And so, as Linnaeus has suggested for the vegetable world, "those animals and vegetable mules (sic) which could continue their species have done so, and become the

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[31] Quotes and references from *Zoonomia or The laws of Organic Life,* reproduction of 3rd edition, edited by Martin Priestmann (2004)

[32] P.267, ref. Genesis 30 and 31

[33] He cites, for example, St Paul in 1 Cor.XV and goes on "I leave the consideration of the immortal .. to those who treat of revelation", *Zoonomia,* vol.5*,* XIV.1, p.148

[34] See pp.5 and 6 above.

[35] P.8 above

[36] P.221

species of today, and those which could not have perished, according to the observation of Aristotle" he adds.[37] This accounts for the similarity between species, which Capt. Hunter has observed, in NSW, in species of Kangaroo and fish. Interestingly, he suggests that volition comes later in the developing embryon, and can then affect development (in a manner which appears Lamarckian?). \next, he cites David Hume, suggesting that "the world itself might have been generated rather than created; that is it might have been gradually produced from very small beginnings, increasing by the activity of its inherent principles rather than by a sudden evolution of the whole almighty fiat". Wow! He almost exclaims, "What a magnificent idea of the infinite power of THE GREAT ARCHITECT! THE CAUSE OF CAUSES!! PARENT OF PARENTS! ENS ENTIUM!"[38]
In support of this theory of development of the adult, similar to its parent, but capable of differences which would explain new species, he then cites several facts and examples from nature:

- The abundance of seeds and the spawn of fish suggests that "by a wise superfluity of provision, she (nature) has ensured their continuance". (XXXIX 2.2, p.210)
- Mr Koelreuter's experiments with two species of Nicotiana, which have shown that the male form dominates over the female. (p.214)
- Linnaeus, saying- "in respect of the vegetable world, it is not impossible but the great variety of species of animals, which now tenant the earth, may have had their origin from the mixture of a few natural orders". (pp.230-1)
- The changes in developing butterflies and frogs
- Changes observed, and possible, in reproduction
- Changes induced by 'accidental or artificial cultivation' animals, for example in horses and dogs.
- Monstrous births, which can be propagated (four claws in chickens, six fingers in humans).
- Homologous structures developing from a 'similar living filament'.
- Changes in animals which are, in part, produced by their own exertions (their desires and aversions such as hunger, security and lust, as cited above), which are then transmitted to a future generation. Some are reproduced in plants he says, citing Osbeck on plants which conceal their honey.

So, he concludes, that perhaps over "millions of ages before the commencement of the history of mankind ... all warm-blooded animals have arisen from one living filament, which THE GREAT FIRST CAUSE endued with animality, with the power of acquiring new parts ... and possessing the faculty to improve by its own inherent activity, and of delivering down those improvements by generation to its posterity, world without end."[39]

Small wonder that, writing an appreciation of Erasmus Darwin, in 1879[40], Ernst Kraus assessing Erasmus Darwin's contribution to science, associates ED with Lamarck, but sees him as being the first to establish a 'complete system of the theory of evolution'. However, he sees ED as establishing the hypothesis and theories 'out of his fancy, even though they are supported by a very considerable knowledge of nature', rather than, as did later scientists, and especially CD, 'demonstrating them by an enormous number of facts, carrying such a degree of probability as to satisfy those most capable of judging' However, by the time of his death Erasmus was able to write, in the posthumously published *Temple of Nature,*

> Organic Life beneath the shoreless waves ... as cited above.
> And breathing realms of fin, and feet, and wing.

And, of course, he prefaces the earlier *Zoonomia,* with the clear words:

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[37] P.231

[38] P.247

[39] P.240

[40] Included in *Charles Darwin's The Life of Erasmus Darwin,* p.149

"The great CREATOR of all things has infinitely diversified the works of his hands, but has at the same time stamped a certain similitude on the features of nature, that demonstrates to us, that *the whole is one family of one parent.*" Surely this is a fine theory of evolution in the making?!