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'Almighty God! What a wonderful discovery!': Did Charles Darwin really believe life came from space?☆

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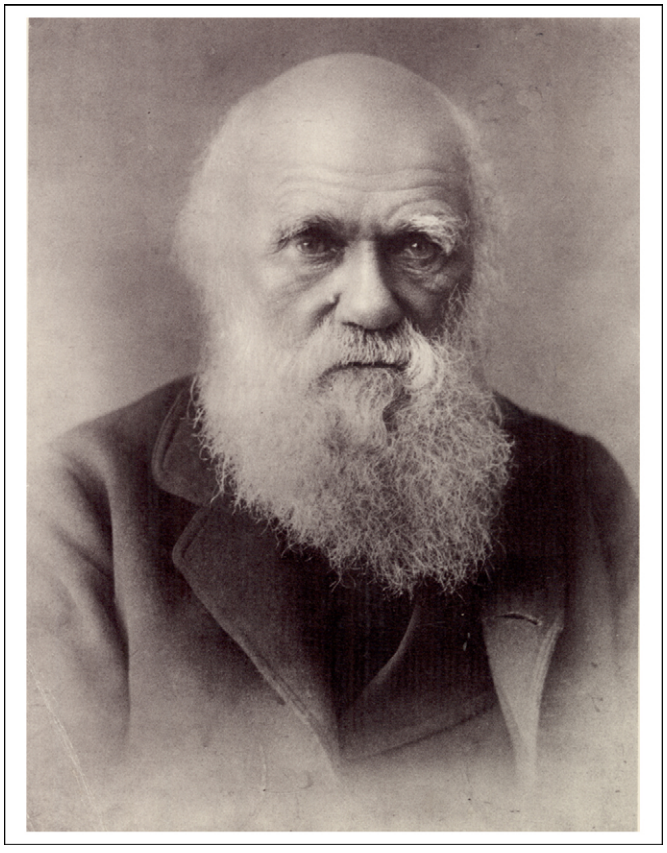
In the August 1881 issue of the New York magazine *Science* there is a long overlooked article entitled 'Mr. Darwin on Dr. Hahn's discovery of fossil organisms in meteorites'. *Science* was founded the preceding year by journalist John Michels with financial backing of Thomas Edison. Struggling to find a place in the popular science market, the illustrated weekly magazine was only published until March 1882. The current journal of the same name is a later incarnation. The article contains some extraordinary quotations from a lost Darwin letter or letters and, even more surprisingly, spoken words attributed to Darwin upon viewing meteorite specimens. The passage reads:

> Not content with the mere presentation of his work, Dr. Hahn visited the veteran zoologist [Darwin] and brought his preparations to him for inspection.
>
> No sooner had Mr. Darwin peered through the microscope on one of the finest specimens when he started up from his seat and exclaimed:
>
> "Almighty God! What a wonderful discovery! Wonderful!"
>
> And after a pause of silent reflection he added:
>
> "Now reaches life down!"

The latter remark no doubt refers to the proof furnished by Dr. Hahn's discovery that organisms can reach our planet from celestial space. It is an acknowledgment of the relief Mr. Darwin must have felt in not being forced to a belief in a primeval "*generatio equivoca*" [spontaneous generation].[1]

Could this be true? Did Darwin really leap out of his chair? Did he believe life on Earth came from outer space?



To understand the context of this mysterious claim we first need to go back 20 years before Darwin's purported leap to the work of professor of physics at the University of Glasgow, William Thomson (1824–1907), later Lord Kelvin.[2] Following his earlier work estimating the age of the Sun, Thomson set out to estimate the age of the Earth using mathematical physics. Assuming that the Earth had begun as a sphere of molten rock, Thomson estimated how long it would take to cool to its current temperatures. He thereby estimated the age of the Earth as only 20–400 million years old. (The age of the Earth is now estimated at 4500 million years.) Although geologists of the day had little idea of the exact age of the Earth, this estimate was vastly less than what they concluded from the study of the Earth itself. One of those who had studied the Earth was of course Darwin whose earlier scientific career was largely geological.[3] His appreciation of the age of the Earth was

☆ I am grateful to Joachim Seng of the Freies Deutsches Hochstift; the Darwin Correspondence Project for sharing details of Darwin's unpublished correspondence and particularly Samantha Evans for revealing a crucial mistake about Hahn's last letter; Adam Perkins of the Cambridge University Library Manuscript Room was extremely helpful; Janet Browne, Gordon Chancellor and J. David Archibald and two anonymous referees gave helpful comments on earlier versions of this essay. Tori Reeve provided access to Otto Hahn's books now at Down House. I am grateful to the Syndics of Cambridge University Library for permission to quote from unpublished manuscripts in the Darwin Archive at Cambridge University Library.

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[1] The whole article, with new editorial notes, is reproduced in John van Wyhe ed., *The Complete Work of Charles Darwin Online* (http://darwin-online.org.uk/content/frameset?itemID=F1929&viewtype=text&pageseq=1) and John van Wyhe ed., *Charles Darwin's Shorter publications 1829–1883* (Cambridge U. Press, 2009): 449.

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[2] Joe D. Burchfield, *Lord Kelvin and the age of the Earth* (London: Macmillan, 1975).

[3] See for example Sandra Herbert, *Charles Darwin, geologist* (Ithaca, NY; London: Cornell U. Press).

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certainly not second-hand or borrowed simply from the writings of the great Scottish geologist Charles Lyell. Not unintentionally, Thomson's 1862 estimate therefore appeared to challenge Darwin's *Origin of species* (1859) which built on the universal belief (amongst geologists) that the Earth was extremely ancient. Yet Thomson seemed to show that the Earth was too young for life to have originated here. According to his estimate there was insufficient time for the molten globe to cool enough for life to have slowly evolved to its present state of complexity according to the gradual process of descent with modification and natural selection as proposed by Darwin and Wallace and most thoroughly elaborated and widely known from Darwin's *Origin of species*.[4]

A solution to this apparent impasse was proposed but the German physician Hermann Eberhard Richter in 1865. Building on previous suggestions that life on Earth came from elsewhere Richter proposed a 'cosmozoa' concept. 'We regard the existence of organic life in the Universe as eternal. Life has always been there; it has always propagated itself in the shape of living organisms, from cells and from individuals composed of cells.'[5] Hence the small bodies that might pass between and through the atmospheres of different heavenly bodies, such as meteors, could be the origin of life on Earth and that this 'supplies the capstone to Darwin's daring edifice'. Rather than needing to slowly originate here, life on Earth could have been kick started by the delivery of pre-existing life forms.

Around the same time John William Dawson (1820–1899), professor of geology, Principal of McGill University, and one of the foremost geologists in Canada, together with geologist William Edwin Logan (1798–1875), announced the discovery of a putative microscopic fossil organism they called *Eozoön canadense* or the 'dawn animal of Canada' at the 1864 meeting of the British Association for the Advancement of Science. An insightful article by Juliana Adelman, *Endeavour* vol. 31 No. 3 (2007), discusses the controversies over *Eozoön* and its place in late nineteenth-century struggles over scientific credibility in the face of ever increasing popular science publishing. *Eozoön* was believed to be a gigantic foraminiferan that once lived on the bottom of the sea. Its discovery appeared to show that the oldest known strata of rocks ever found on Earth, which were long thought to contain no evidence of life, and indeed to pre-date the existence of life, were actually full of the remains of living things. Thus *Eozoön* would be by far the oldest living thing ever found on Earth, and indeed in a stroke greatly extended the depth of the geological record and the evidence for the antiquity of life on Earth. The senior geologist Charles Lyell even devoted part of his presidential address to the Association to *Eozoön*.[6]

Eozoön intrigued Darwin who mentioned it in the tenth chapter of the fourth edition of *Origin of species* (1866) 'On the Imperfection of the Geological Record' to show that gaps in the palaeontological record were being filled: '...within the last year the great discovery of the Eozoon in the Laurentian formation of Canada has been made; and after reading Dr. Carpenter's description of this remarkable fossil, it is impossible to feel any doubt regarding its organic nature.'[7] However 3 years later, in the 5th edition of the *Origin of species* the end of this sentence was modified to 'it is scarcely possible to doubt regarding its organic nature' and by the 6th edition of 1872 it been softened to 'the existence of the Eozoon ... is generally admitted'.

It is at this point that the mysterious Otto Hahn, who supposedly made the elderly Darwin leap out of his chair, enters the story. Otto Hahn (1828–1904), was a lawyer, author, and amateur petrologist in Reutlingen, Baden-Württemberg, in the newly united (1871) Germany.[8] (Hahn should not be confused with his more famous namesake, the radiochemist and Nobel laureate Otto Hahn (1879–1968), no relation.) He was also an active Swedenborgian (Swedenborg believed and published on the plurality of worlds.) Hahn gave up his legal career in order to

[4] C. Darwin and A.R. Wallace, "On the tendency of species to form varieties; and on the perpetuation of varieties and species by natural means of selection", *Journal of the Proceedings of the Linnean Society of London. Zoology* 3 (1858): 46–50. All of Darwin's publications cited here, and several of those by Otto Hahn, are freely available on *Darwin Online* (http://darwin-online.org.uk/).

[5] H.E. Richter, "Zur Darwinschen Lehre", *Schmidt's Jahrbücher der in- und ausländischen gesammten Medicin* 126 (1865): 243–253.

[6] *Report of the thirty-fourth meeting of the British Association for the Advancement of Science; held at Bath in September 1864* (London: John Murray, 1865): lx–lxxv.

[7] C. Darwin, *On the origin of species* (London: John Murray, 1866): 371.

[8] On Hahn see Eberhard Zwink, "Otto Hahn (1828–1904). Stationen auf dem Lebensweg eines Hahn-/Paulus-Nachkommen: Der swedenborgische Einfluß des Großvaters Karl Heinrich Ernst Paulus und Otto Hahns Bestrebungen im Bruderhaus Gustav Werners in Reutlingen", In *Beschreibung zu Beiträge zur Geschichte des Württembergischen Pietismus. Festschrift für Gerhard Schäfer zum 75. Geburtstag am 2. Juni 1998 und Martin Brecht zum 65. Geburtstag am 6. März 1997*. 24 (1998): 328–353.

pursue his social and scientific reformist interests. He sought a place to pursue a new free religion. Hahn first came to public notice during the *Eozoön* controversies with the publication of an article in 1876: 'Is there such a thing as Eozoon canadense? A microgeological investigation'. In this article Hahn argued that *Eozoön* was not a fossil but instead natural features of the rocks. He found that certain characteristics of foraminifera were absent from the Canadian limestones which should be present if the microscopic shapes were the remains of foraminifera. Hahn's polite and measured contribution came to the notice of the international community when it was translated into English by W.S. Dallas (one of Darwin's translators) in the *Annals and magazine of natural history*.[9] Hahn later responded to criticism in an 1878 paper.[10] The inorganic nature of *Eozoön* was not fully established until the 1890s.[11] For his work on *Eozoön* Hahn was awarded a doctorate from the University of Tübingen. In 1878–9 Hahn visited Canada as an emigration agent of the Canadian government. During his stay he collected rock samples from the Archaean limestones of western Canada with Dawson. Although Hahn was sceptical of the organic nature of *Eozoön* he clearly felt the rocks were worth further investigation.

In 1879 Hahn returned to Germany only to see two of his five children die of whooping cough. Undaunted he leapt into his studies of the samples brought from his now beloved Canada. He cut thin slices of the rocks and then ground them down to semi-transparency so that light could pass through the sample and make it possible to examine them under a microscope. By June Hahn was writing Dawson that the canal systems of *Eozoön* were in fact sea algae and that Hahn named these new plants *Eophyllum canadense* (dawn plant of Canada).[12] Hahn publicly announced *Eophyllum* in a paper in 1880.[13] The promises of the new world opened up to Hahn new evidence of a new origin of life on Earth. It seemed only fitting that the earliest life form should be a plant rather than a more complex animal.

It was the further investigation of the Canadian samples that led Hahn to the startling conclusions published in his book *Die Urzelle* or 'the primordial cell' in the same year.[14] In *Die Urzelle* Hahn claimed that he found microscopic plant fossils in rocks such as granite, gneiss, serpentine, talc, sandstone and basalt. These included metamorphic rocks, which have undergone melting and twisting and it was universally accepted that fossils were not and could not be found in such rocks. Indeed Hahn seemed to find fossils everywhere he looked. This led him to the breathtaking conclusion that many kinds of rocks were in fact entirely composed of the fossilized remains of living things.

Hahn also believed he found amongst these microscopic Ur-forests the first animal and named it after the Reichskanzler *Titanus bismarcki*. All this suggested a new and more ancient dawn for the advent of life. Hahn thought his findings would create a new foundation for the theory of evolution. Around the same time a number of other theorists, particularly in Germany, began publishing speculations about the possibility of life reaching Earth on meteorites.[15] Hahn and other meteor theorists before him waxed lyrical about the revolutionary nature of their discoveries. They believed that the sciences had seen such a number of great revolutions, most recently perhaps the theory of evolution, and that it was only fitting that theirs should count amongst them. This may account for some of the enormous enthusiasm expressed by advocates of theories of extraterrestrial life at the time. But then it is also not unusual for advocates of highly ambitious fringe beliefs, such as phrenology, to be both enthusiastic and uncritical.[16] Hahn sent copies of the book to the British Museum, the Paris Academy, and Charles Darwin.[17] By this time Darwin, one of the greatest living names in science, was routinely sent works by ambitious authors seeking support or encouragement. Hahn sent *Die Urzelle* together with a letter, written in German, dated 1 September 1879.[18] Hahn did not shy away from suggesting that Darwin and his English colleagues promote the discovery.

Perhaps inspired by the renewed suggestions of other theorists at the time, Hahn next turned to the microscopic examination of sections of stony meteorites. Whereas other theorists speculated that living things might travel on interplanetary bodies, Hahn used his experience identifying purported fossil plants in ancient rocks to look for evidence of fossilized organisms in meteorites. This resulted in what became his most celebrated and controversial work: *Die meteorite (chondrite) und ihre organismen* (The chondrite meteorites and their organisms [chondrite meteorites are stony, as opposed to metallic, meteorites]). In this work, perhaps the first to contain photomicrographs of meteorites, Hahn not only claimed to have discovered microscopic fossils of sponges, corals and crinoids within extraterrestrial meteorites, but that these were in fact the true origin of life on Earth. Life may have begun in space as early as the formation of the solar system amongst the primeval liquid masses from which the solar system had since condensed. The book was richly illustrated with 32 high-quality photomicrographs of the structures Hahn identified with his microscope.

[9] O. Hahn, "Is there such a thing as Eozoon canadense? A microgeological investigation", *Annals and magazine of natural history* 17 (1876): 265–282.

[10] O. Hahn, "Gibt es ein Eozoon canadense? Erwiderung auf Dr. C.W. Gümbels und Dr. Carpenters Entgegnung in Reutlingen", *Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg (Württembergische naturwissenschaftliche Jahreshefte)* 34 (1878): 155–177.

[11] See Charles F. O'Brien, "Eozoön Canadense "The Dawn Animal of Canada", *Isis* 61, No. 2. (1970): 206–223.

[12] Hahn to Dawson 18 June 1879, McGill University Archives, M.G. 1022, C. 7.

[13] O. Hahn, "Eophyllum canadense aus dem Serpentinkalk des Laurentian-Gneises von Canada", Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg (Württembergische naturwissenschaftliche Jahreshefte) 36 (1880): 71–74.

[14] O. Hahn, Die Urzelle. Nebst dem Beweis, dass Granit, Gneiss, Serpentin, Talk, gewisse Sandsteine, auch Basalt, endlich Meteorstein und Meteoreisen aus Pflanzen bestehen: die Entwicklungslehre durch Thatsachen neu begründet; mit 30 lithographirten Tafeln (Tübingen: Verlag der Laupp'schen Buchhandlung, 1879).

[15] Michael J. Crowe, The extraterrestrial life debate: 1750–1900; the idea of a plurality of worlds from Kant to Lowell (Cambridge; London; New York: Cambridge U. Press, 1986): 405.

[16] J. van Wyhe, *Phrenology and the origins of Victorian scientific naturalism* (Aldershot: Ashgate, 2004).

[17] Hahn to Volger 28 December 1880, Freies Deutsches Hochstift, Nachlass Otto Volger, 19704.

[18] Darwin Archive, Cambridge University Library, DAR 166: 82. *Darwin Correspondence Project Online Database* (http://www.darwinproject.ac.uk/).

On 16 December 1880 Hahn sent Darwin a letter together with his new book. This time writing in English, Hahn thanked Darwin for his 4 November 1879 letter (now lost).[19] Hahn assured Darwin that the work was being well received and that it offered not only the key to the beginning of life on Earth but, as so much of the solid material of the solar system was purported to consist of the remains of living beings, the beginnings of the Earth itself.

Initially it appeared that Hahn's work might gain support from the scientific community. The German zoologist David Friedrich Weinland published enthusiastic reports on Hahn's microscopic preparations. Weinland exclaimed, 'we can actually see with our own eyes the remains of living beings from another celestial body.'[20] Weinland later sent a copy of his book to Darwin, where it too remains at Down House.[21] An even more exuberant report of Hahn's new book appeared in *Science* in June 1881 by an American physician and medical writer, George W. Rachel, who, judging from his other published articles, believed readily in outlandish theories (including using water as a combustible fuel).[22] Rachel described Hahn as 'This successful amateur, for such he was before he succeeded in gaining his present reputation by his participation in the debate on the '*Eozoon canadense*,' and then resigned his government position to pursue this peculiar line of research at his leisure – this 'Gerichts-Referendarius, a D.' I have not found these biographical details in any other discussion of Hahn, and this may prove relevant to unravelling part of the mystery of the origin of the 'Almighty God!' statement in *Science*. Rachel concluded that 'It may be safely claimed that Dr. Hahn's book will prove to be one of the most important contributions to natural science of the present time.'[23]

In August 1881 another article by Rachel appeared in *Science*, the piece with which this story begins. In addition to the words attributed to Darwin already quoted above, Rachel included fragments of a Darwin letter to Hahn upon receipt of *Die meteorite*:

> "...It seems to be very difficult to doubt that your photographs exhibit organic structure..."
>
> and
>
> "..your discovery is certainly one of the most important."

Can these words be genuine? They sound suspiciously like words pulled out of context, and removed from Darwin's characteristic qualifying statements. Nevertheless they do sound like Darwin. They could be from Darwin's lost 4 November 1879 letter, or a subsequent letter on receipt of the second book. In fact, a transcription of Darwin's 20 December 1880 reply upon receiving *Die Meteorite* survives in the Darwin Archive at Cambridge University Library.[24] In this letter Darwin wrote 'If you succeed in convincing several judges as trustworthy as Professor Quenstedt, you will certainly have made one of the most remarkable discoveries ever recorded.' The wording is not identical.

However, just eight days after the date of Darwin's letter, Hahn wrote to his colleague, another German lawyer–geologist, Otto Volger on 28 December 1880, in which Hahn paraphrased Darwin's response to the receipt of *Die Meteorite*: 'Zugleich sprach sich Darwin aus: es sei eine der wichtigsten Erklaerungen, welche je gemacht worden seien' [At the same time Darwin pronounced: it is one of the most important elucidations ever made.][25] This paraphrase by Hahn, or one like it in a letter to another correspondent could be the source for the truncated lines in *Science*. They may have passed through translation into German and back into English, which could account for their variance from Darwin's wording.

How Rachel could have come by Hahn's letter from Darwin, or a quotation from it, is unclear. His periodical contributions suggest that Rachel had strong connections with German medical circles and so may have corresponded with Hahn or someone who knew him. The apparently unique biographical details about Hahn in the June 1881 article in *Science* suggest that Rachel had some access to information from Hahn; personal communication between the two is certainly possible.

In the same month as the August article in *Science* another article appeared in Germany that carried the same Darwin quotations. It was a positive review essay of Hahn's *Die Meteorite* by the German geographer and philosopher of technology Ernst Kapp (1808–1896).[26] Kapp described Hahn's work as 'one of the greatest discoveries of all times'. This article carried almost identical quotations (in English) as *Science* including the 'Almighty God!' exclamation. A comparison of the two seems to suggest that the article in *Science* could have been the source for Kapp's article and not vice versa because part of Kapp's English quotation is truncated and translated into German outside the quotation marks as compared to the Rachel article. There were several reprintings of these Darwin quotations in subsequent months.[27]

[19] Darwin Archive, Cambridge University Library, DAR 166: 83. See *Darwin Correspondence Project Online Database* (http://www.darwinproject.ac.uk/) 12917.

[20] David Friedrich Weinland, "Korallen in Meteorsteinen", *Das Ausland* 54 (17 April 1881): 301–3, 301. Quoted in Michael J. Crowe, *op cit.*, p. 405.

[21] David F. Weinland, *Über die in Meteoriten entdeckter Thierreste* (Esslingen: G. Fröhner, 1882).

[22] Rachel, "Fossil organisms in meteorites", *Science* 2, No. 50. (11 June 1881): 275–277.

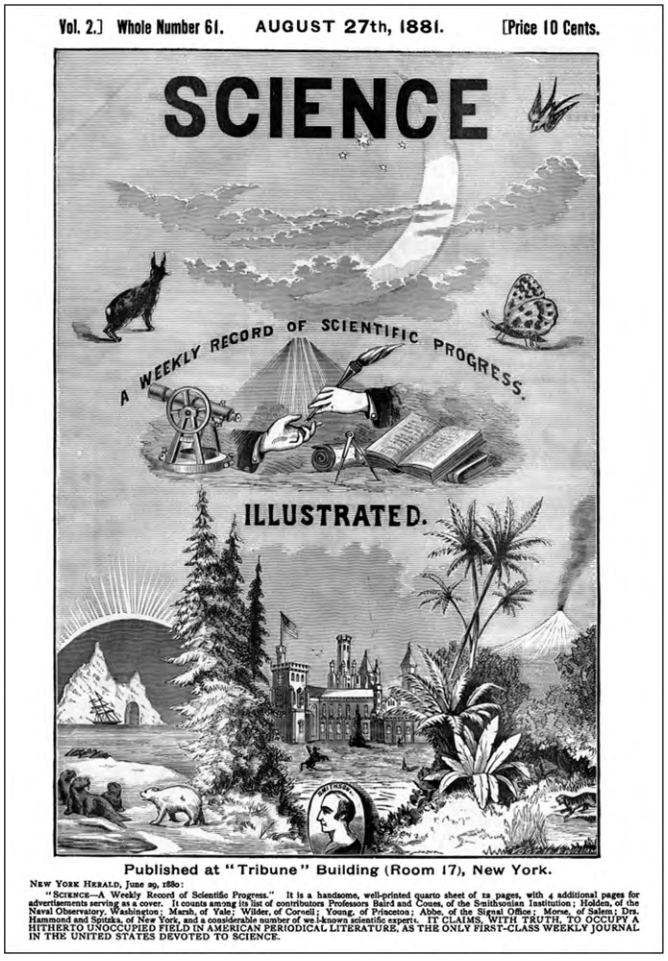
[23] Op cit., p. 277.

[24] Darwin Archive, Cambridge University Library, DAR 251: 3334, *Darwin Correspondence Project Online Database* (http://www.darwinproject.ac.uk/) 12929f.

[25] Hahn to Volger 28 December 1880, Freies Deutsches Hochstift, Nachlass Otto Volger, 19704.

[26] Ernst Kapp, "Zur neuen Weltanschauung", *Jahrbuch der illustrierten deutschen Monatshefte* 50 (1881): 626–650, p. 627.

[27] See for example: *The microscope: and its relation to medicine and pharmacy* 1, no. 4 (October 1881): 114; *The student's journal* X, No. 117, No. 9 (September 1881): 6.


Vol. 2.] Whole Number 61. AUGUST 27th, 1881. [Price 10 Cents.

SCIENCE

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

ILLUSTRATED.

Published at "Tribune" Building (Room 17), New York.

NEW YORK HERALD, June 29, 1880:

"SCIENCE—A Weekly Record of Scientific Progress." It is a handsome, well-printed quarto sheet of 12 pages, with 4 additional pages for advertisements serving as a cover. It counts among its list of contributors Professors Baird and Coues, of the Smithsonian Institution; Holden, of the Naval Observatory, Washington; Marsh, of Yale; Wilder, of Cornell; Young, of Princeton; Abbe, of the Signal Office; Morse, of Salem; Drs. Hammond and Spitzka, of New York, and a considerable number of well-known scientific experts. IT CLAIMS, WITH TRUTH, TO OCCUPY A HITHERTO UNOCCUPIED FIELD IN AMERICAN PERIODICAL LITERATURE, AS THE ONLY FIRST-CLASS WEEKLY JOURNAL IN THE UNITED STATES DEVOTED TO SCIENCE.

Rachel's article also claimed that Friedrich August Quenstedt (1809–89), professor of mineralogy and geology at the University of Tübingen, was convinced by Hahn's specimens – as Hahn told Darwin. Rachel concluded that Hahn's discoveries made the 'Richter-Thomson hypothesis' of the origin of life on the Earth a tangible reality.[28] This was a reference to the views of Richter and Thomson, outlined above, that living cells must be the only source for subsequent living cells (thus contradicting theories of spontaneous generation) and that these might travel from planet to planet inside meteorites or comets.

Hahn's claims were first mentioned in *Science* in May 1881. The editor, John Michels, wrote that the magazine could not endorse Hahn's claims after Professor Robert Parr Whitfield, superintendent of fossils and minerals in the American Museum of Natural History, examined some of Hahn's specimens. Whitfield eventually attributed Hahn's beliefs 'to a too sanguine temperament, and an 'imagination which bodies forth the form of things unknown.'[29] Perhaps Rachel hoped that Hahn's interpretation would enjoy wider support if Darwin's apparent endorsement were known. It seems not to have worked. In a December 1881 editorial Michels wrote that he examined microscopic sections from one of the same meteorites as Hahn. Michel reported that at low power magnification a structure resembling a shell was apparent, but that at higher magnification clear organic structure disappeared. Michels declared he would withhold judgement on the case until further evidence could be provided.[30]

Hahn's claims were also discussed in the *Journal of the Royal Microscopical Society*, *The American Naturalist* and the *English Mechanic*. The German-born Swiss naturalist Carl Vogt refuted Hahn's claims in a memoir presented to the French Academy of Sciences.[31] The American chemist Ferdinand Gerhard Weichman argued that the structures Hahn detected were formed by the cooling of the meteorites.[32] However Michels found Wiechman's paper worthless as the latter was said to be 'destitute of the elements of the knowledge necessary for the work he has undertaken.'[33] It seems most experts were not convinced by the superficial resemblances between Hahn's photomicrographs and fossilized organisms, despite the brief notoriety his claims enjoyed.[34]

After 1882 Hahn seems to have published no more on fossils or meteorites, instead devoting his publications to an eclectic mix of German economic protectionism, railways, women's rights, philosophy of consciousness, plays, church reform, and particularly emigration. By the mid-1880s the mere appearance of 'Hahnian heresy' was enough to give pause to other researchers of the microscopic structure of meteorites.[35] In July 1888 Hahn and his family emigrated to Toronto, Canada. In an 1889 autobiographical periodical entry, Hahn barely mentioned his meteorite and fossil publications, as if he no longer wished to be remembered for that part of his literary output.[36] Hahn died in 1904 while on a trip back to Germany.

The origin of life for Darwin

If Darwin did not believe life came from outer space, then were did he think it came from? Although Darwin's *Origin of species* is still widely believed by many to refer to the origin of life, this was not a question the book addressed. His book was instead about where existing species come from. The short answer is that they are genealogically descended in an unbroken reproductive series from earlier species. But what *did* Darwin think about the origin of life? In the *Origin of species* he wrote 'I should infer from analogy that probably all the organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed.'[37] Although a few years later in 1863 Darwin wrote to his friend the botanist Joseph Dalton Hooker: 'I have long

[28] H.E. Richter, "Zur Darwinschen Lehre", *Schmidt's Jahrbücher der in- und ausländischen gesammten Medicin* 126 (1865): 243–253; W. Thomson, *Presidential address to the British Society for the Advancement of Science, Edinburgh meeting* ([London: British Association], 1871).

[29] J. Michels, *Science* (14 May 1881): 217.

[30] J. Michels, *Science* (December 1881): 605.

[31] See Carl Vogt, *Les prétendus organismes des météorites* (Genève: Imprimerie centrale genevoise, 1882); reported in *The American naturalist* (June 1882): 533–534.

[32] Annals of the New York academy of science ii (1882): 289.

[33] *Science* 1, No. 18 (June 1883): 521.

[34] See or example U.B. Marvin, "The meteorite of Ensisheim – 1492 to 199", *Meteoritics* 27 (March 1992): 28–72.

[35] "Hahn'schen Ketzerei", Friedrich Rolle, *Die hypothetischen Organismen-Reste in Meteoriten* (Wiesbaden: Bergmann, 1884): 2.

[36] O. Hahn, "Hahn, Dr. Otto", Jahresberichte des Württembergischen Vereins für Handelsgeographie und Förderung deutscher Interessen im Ausland: 7. und 8. Jahresbericht Stuttgart. 7/8 (1889): 106–109.

[37] C. Darwin, *On the origin of species* (London: John Murray, 1859): 484.

regretted that I truckled to public opinion and used Pentateuchal term of creation, by which I really meant 'appeared' by some wholly unknown process. – It is mere rubbish thinking, at present, of origin of life; one might as well think of origin of matter.'[38] Yet despite these cautious protestations we can clearly glean from his occasional references to the origin(s) of life that Darwin believed that life arose by purely natural causes as simple micro-organisms in an aquatic environment on Earth.[39]

In an 1859 letter Darwin explained to Lyell 'The parent monad-form might perfectly well survive unaltered & fitted for its simple conditions, whilst the offspring of this very monad might become fitted for more complex conditions. The one primordial prototype of all living and extinct creatures may it is possible be now alive!'[40] Darwin later wrote to Thomas Henry Huxley 'we know nothing as yet [of] how life originates.'[41] Similar to his private statements in letters, is his often overlooked response to an anonymous critical review of *Origin of species* (in fact written by the anatomist Richard Owen as Darwin suspected), 'Your reviewer sneers with justice at my use of the 'Pentateuchal terms,' 'of one primordial form into which life was first breathed': in a purely scientific work I ought perhaps not to have used such terms; but they well serve to confess that our ignorance is as profound on the origin of life as on the origin of force or matter.'[42] In the 3rd edition of *Origin of species* (1861) Darwin added the remark 'science as yet throws no light on the far higher problem of the essence or origin of life'.[43]

Darwin's statements in the six editions of the *Origin of species* are probably better known than his other writings,[44] so it might be more enlightening to examine his (comparatively) lesser known writings. In his 1868 book *Variation of animals and plants under domestication* he addressed the topic, though still retaining the term 'created':

> As the first origin of life on this earth, as well as the continued life of each individual, is at present quite beyond the scope of science, I do not wish to lay much stress on the greater simplicity of the view of a few forms, or of only one form, having been originally created, instead of innumerable miraculous creations having been necessary at innumerable periods; though this more simple view accords well with Maupertuis's philosophical axiom 'of least action.'...all living creatures have descended from a single prototype.[45]

In the second edition of 1875 this became:

> In considering how far the theory of natural selection may be extended, —that is, in determining from how many progenitors the inhabitants of the world have descended,—we may conclude that at least all the members of the same class have descended from a single ancestor. A number of organic beings are included in the same class, because they present, independently of their habits of life, the same fundamental type of structure, and because they graduate into each other. Moreover, members of the same class can in most cases be shown to be closely alike at an early embryonic age. These facts can be explained on the belief of their descent from a common form; therefore it may be safely admitted that all the members of the same class are descended from one progenitor. But as the members of quite distinct classes have something in common in structure and much in common in constitution, analogy would lead us one step further, and to infer as probable that all living creatures are descended from a single prototype.[46]

It is important to note, however, that Darwin's phrase 'primordial form' did not always mean the earliest living organism. In an 1868 article he wrote: 'Finally, although we may feel confident that *Primula veris*, *vulgaris*, and *elatior* as well as the other species of the genus, are all descended, from some primordial form, yet, from the facts which have been given, we may conclude that they are now as fixed in character as are very many other forms which are universally ranked as species.'[47] Here 'primordial form' referred to the common ancestor of a particular group – this is very far removed from the earliest of all living things – yet this use is consistent since Darwin believed that the earliest living thing was the common ancestor for all succeeding groups.

But perhaps most revealing of all is an oft quoted 1871 letter to Hooker:

> It is often said that all the conditions for the first production of a living organism are now present, which could ever have been present. But if (and oh! what a big if!) we could conceive some warm little pond, with all sorts of ammonia and phosphoric salts, light, heat, electricity, &c., present, that a protéine compound was chemically formed ready to undergo still more complex changes, at the present day such matter would be instantly devoured or absorbed,

[38] Darwin to J.D. Hooker [29 March 1863] *The Correspondence of Charles Darwin* (Cambridge U. Press), v. 11: 278.

[39] On Darwin's ideas on origins of life see J. Farley, The spontaneous generation controversy: from Descartes to Oparin (Johns Hopkins University Press, Baltimore, 1977), and James Strick, Sparks of Life: Darwinism and the Victorian Debates over Spontaneous generation (Cambridge, MA: Harvard U. Press, 2000).

[40] Darwin to Lyell 11 October [1859] *The Correspondence of Charles Darwin* (Cambridge U. Press), v. 7: 344.

[41] *The Correspondence of Charles Darwin* (Cambridge U. Press), v. 7: 421.

[42] C. Darwin, "The doctrine of heterogeny and the modification of species", *Athenaeum* No. 1852 (18 April 1863): 554-555, p. 554.

[43] C. Darwin, *On the origin of species* (London: John Murray, 1861): 514 and subsequent editions.

[44] Compare the passage that began in the first edition of *Origin of species* as 'Therefore I should infer from analogy that probably all the organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed.', p. 484 with 2nd edition p. 484, 3rd edn p. 519, 4^{-} edn is identical to the 3rd, 5th edn p. 573; 6th p. 425.

[45] C. Darwin, The variation of animals and plants under domestication (London: John Murray, 1868), v. 1: 12–13.

[46] C. Darwin, The variation of animals and plants under domestication (London: John Murray, 1875), v. 1: 13.

[47] C. Darwin, "On the specific difference between Primula veris, Brit. Fl. (var. officinalis, of Linn.), P. vulgaris, Brit. Fl. (var. acaulis, Linn.) and P. elatior, Jacq.; and on the hybrid nature of the common Oxlip. With supplementary remarks on naturally-produced hybrids in the genus Verbascum", *Journal of the Linnean Society of London (Botany)* 10 (1868): 437–454. p. 541. This passage also appeared in C. Darwin, *The different forms of flowers on plants of the same species* (London: John Murray, 1877): 73.

> which would not have been the case before living creatures were formed.[48]

James Strick has shown how Darwin's remark followed Thomas Henry Huxley's address against spontaneous generation to the British Association for Advancement of Science in 1870.[49] Strick observed that it was an important political consideration for Darwin to remain vague enough to allow some of his readers to retain their belief in divine creation for the beginning of life. His main goal was, after all, to convince his contemporaries of organic change over time via descent with modification, and primarily through natural selection. Insisting on a purely natural origin of life as well would make the theory of evolution appear too unorthodox for many of his readers.

Even to the end of his life Darwin maintained that there was no evidence to support spontaneous generation.

> Though no evidence worth anything has as yet, in my opinion, been advanced in favour of a living being, being developed from inorganic matter, yet I cannot avoid believing the possibility of this will be proved some day in accordance with the law of continuity. I remember the time, above fifty years ago, when it was said that no substance found in a living plant or animal could be produced without the aid of vital forces. As far as external form is concerned, *Eozoon* shows how difficult it is to distinguish between organised and inorganised bodies. If it is ever found that life can originate on this world, the vital phenomena will come under some general law of nature.[50]

Given the consistency of Darwin's statements on the origin of life, the claim that he believed in an extraterrestrial origin seem extremely implausible.

Did Hahn meet Darwin?

But did Otto Hahn actually visit Darwin at his home Down House in Kent? Perhaps. Hahn was paid by the Canadian government to act as an emigration agent, the reason for his 1878 visit to Canada. He received $700 per year to advertize and pay a secretary.[51] He wrote pamphlets and helped encourage emigration. In 1881 he and a delegation of three other Germans travelled to Canada.[52] Hahn may have visited Darwin en route to Canada.

Evidence has recently been found at the Darwin Archive at Cambridge University Library in a previously mis-catalogued 1889 letter from Hahn to Darwin's son George, then Plumian professor of astronomy and experimental physics at Cambridge.[53] Hahn, writing after Darwin's death, was responding to recent publications by George and Norman Lockyer on comets and meteorites which failed to notice Hahn's contributions. Hahn tried again to suggest his findings were rendered more plausible and respectable, despite the drubbing they received from the international scientific community, because they convinced the elderly Darwin. To do this Hahn provided a complete transcription of Darwin's December 1880 letter (cited above). Hahn added:

> in the January of 1881 I saw your father at his residence in Down and laid before him the thin slices of some Chondrites When he looked upon the figure in plate 1. (afterwards called Hahnia) he jumped up of his chair exclaiming: "Almighty God what wonderful discovery: now reaches the life down." Very, very organic! And at the close of our meeting he expressed convinced himself of the organic structure of the Chondrite enclosures.[54]

It seems unlikely that Hahn would lie about such a visit to a member of Darwin's own family. The words attributed to Darwin do not sound genuine. Certainly 'almighty God!' was not a phrase Darwin used in his letters or other writings. Hahn's imperfect English may explain the unusual closing phrase: 'now reaches life down' or 'now reaches the life down'. This is clearly not normal English usage and a search of Google Books does not reveal that they are quotations from an earlier writer. Instead they probably stem from Hahn's recollections, or, less charitably, invention, in German, which he inexactly translated into English. He may have meant to say something like 'so life reached Earth'. Hence if Darwin really did speak to Hahn, it is conceivable that he might have repeated his earlier statement that, *if confirmed*, Hahn's work would be a 'wonderful discovery'. No other evidence for the meeting has been found in the Stadtsarchiv Reutlingen, Germany, in the Darwin Archive or in the Darwin correspondence.

The books Hahn sent to Darwin still survive at Down House. There is no sign that Darwin read or took any interest in them. In 1908 both books were part of the Darwin Library donated by the family to the Botany School at the University of Cambridge. *Die Urzelle* was mentioned by Francis Darwin's introduction as: 'Another book containing statements not generally received is Otto Hahn's *Die Urzelle*, in which the fossil remains of plants are described and figured as occurring in granite and similar improbable localities.'[55]

[48] Darwin to Hooker 1 February [1871], F. Darwin ed., *The Life and Letters of Charles Darwin* (London: John Murray, 1887), v. 3: 18; original in the Darwin Archive, Cambridge University Library, DAR 94: 188–89. See Janet Browne, *Charles Darwin: The power of place. volume II of a biography* (London, Jonathan Cape, 2002): 393–395.

[49] James E. Strick, "Darwin and the origin of life: public versus private science", *Endeavour* 33, Issue 4 (December 2009): 148–151.

[50] Darwin to Daniel Mackintosh 28 February 1882 in F. Darwin & A.C. Seward eds. *More Letters of Charles Darwin* (London: John Murray, 1903), v. 2: 170–1.

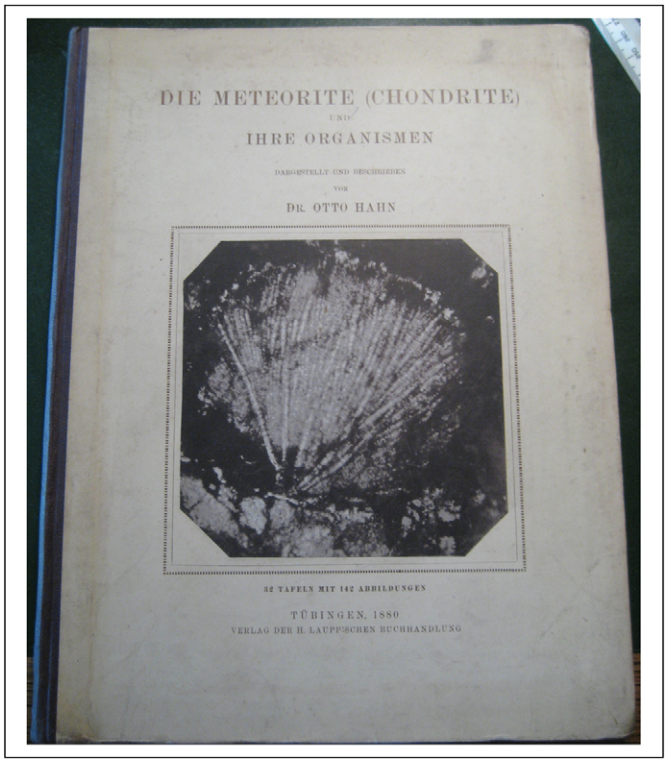
[51] Journals of the House of Commons of the Dominion of Canada from the 9th December, 1880, to the 21st March, 1881 ... being the 3rd session of the 4th Parliament of Canada, session 1880–1881, p. 59.

[52] O. Hahn, *Canada: die Berichte der vier deutschen Delegirten über ihre Reise nach Canada im Herbst 1881* (Reutlingen: Eduard Schauwecker, 1882). See Angelika E. Sauer, "The Unbounded German Nation: Dr. Otto Hahn and German Emigration to Canada in the 1870s and 1880s", *Canadian Ethnic Studies* 39 no. 1–2 (2007): 129–144.

[53] For this I am grateful to Samantha Evans and Adam Perkins.

[54] Hahn to G.H. Darwin 4 April 1889, Darwin Archive, Cambridge University Library, DAR 251: 3334, *Darwin Correspondence Project Online Database* (http://www.darwinproject.ac.uk/) 12929f.

[55] H.W. Rutherford, Catalogue of the library of Charles Darwin now in the Botany School, Cambridge (Cambridge: Cambridge U. Press, 1908): xii–xiii.



Rachel's August 1881 article in *Science* that claimed Darwin leapt out of his seat also caught the eye of professor of geology at University College London, Thomas George Bonney (1833–1923). Bonney wrote to Darwin's son Francis:

> To turn to quite another matter may I ask you a question which I hope you will not think impertinent—An American publication called 'Science' states that your Father on being shown by a certain Dr. Hahn a series of microscopic slides of what the latter believes to be organic structures in meteorites &c (they are nothing of the kind…) exclaimed 'Almighty God what a wonderful discovery wonderful' After a pause of silent reflection he added 'Now reaches life down'— I don't believe his story—but should like to be able to apply to in a print the epithet 'apocryphal' in a review of a kindred subject which I am writing. Do you think I may do so?[56]

Unfortunately the reply to this letter, by Charles Darwin himself, seems to be lost. However a second letter from Bonney in reply survives in the Darwin Archive at Cambridge University Library. In this letter, dated 5 February 1882 (just two months before Darwin's death), Bonney wrote:

> My dear Sir
>
> I am greatly obliged to you for the trouble which you have taken in writing to me on the subject of the statement in Science. Either Dr. Hahn or the writer of that paragraph, is as I suspect, a person of vivid imagination and inaccurate habits—I disbelieved it when I read it from a priori reasons, but in contradicting a statement one likes to have something better than one's own conception of the possible or impossible in another person—I saw a few of Dr. Hahn's slides but did not look at many because I saw enough to perceive it would be a waste of time, as he clearly could not distinguish between mineral and organic structures.[57]

And Bonney may well have said so in print. An anonymous book review, possibly by Bonney, of King and Rowney's *An old chapter of the geological record* (1882) contains a footnote mentioning the August 1881 *Science* article and the 'Almighty God!' quotation followed by the statement: 'A story so circumstantial one would think must needs be true; but we have the best authority for characterizing it as simply fabulous. 'Having 'the best authority' was practically Victorian code meaning it was first-hand information.[58] So, thanks to Bonney, we can be reasonably sure that Darwin did not believe Hahn that life on Earth came from outer space.

Conclusion

The story of Darwin crying out 'almighty God!' and accepting the extraterrestrial origin of life is a scientific legend that did not succeed in becoming widely known. A legend that does not spread can tell us almost as much about the public understanding of science as those that do because they might serve as counterfactual examples to speculative questions such as, what if the story of Newton's apple had not succeeded in becoming widely known? Or the legend of Darwin's deathbed conversion?[59] Just as James Moore found that, although the story of Darwin's deathbed conversion was legendary, the story was not simply one of an outright falsehood from beginning to end. In fact the lady who claimed to have spoken to Darwin may indeed have been at Down as some, though not all, of her descriptions of the house and grounds were correct. Similarly, given his international travel in 1881, and his claim to Darwin's own son that he visited Down House, Hahn may have visited Darwin. Nevertheless Darwin's belief in the purported fossils and the statements attributed to him seem extremely uncharacteristic and unlikely.

The causes behind the origination of a scientific legend are usually quite different from the conditions needed to allow one to spread, and furthermore the conditions required to sustain one over any length of time. Why should anyone bother to repeat a particular story about science? This story certainly had what it took to spread at first – merely from its extreme claim about a

[56] T.G. Bonney to Francis Darwin [January? 1882], Darwin Archive, Cambridge University Library, DAR 160: 247. See *Darwin Correspondence Project Online Database* (http://www.darwinproject.ac.uk/) 13591.

[57] T.G. Bonney to Darwin 5 February 1882, Darwin Archive, Cambridge University Library, DAR 160: 246, 248. See *Darwin Correspondence Project Online Database* (http://www.darwinproject.ac.uk/) 13663.

[58] [T.G. Bonney?], "Notices respecting new books. An old chapter of the geological record with a new interpretation, or rock metamorphism (especially the methylosed kind), and its resultant imitations of organisms: with an introduction, giving an annotated history of the controversy on the so-called Eozoon canadense…" by King and Rowney", *Philosophical magazine* (1882): 217–222, p. 218.

[59] James Moore, *The Darwin legend* (Grand Rapids, Michigan: Baker Books, 1994).

famous scientist[60] – it was published in a respectable popular science magazine and repeated internationally in more than a score of periodicals and books. It spread somewhat, but without a more substantial number of extraterrestrial life advocates, or others whose views would stand to gain from such a revelation at the time, this legend did not enjoy the conditions needed to sustain and further propagate it. Whereas the Darwin deathbed conversion legend met a creationist audience whose beliefs were flattered and reinforced by it. Unfortunately for Hahn's 'almighty God!' story, the extraterrestrial origin of life hypothesis had view advocates and they tended not to be high status figures in the scientific community of the day. Against this unfavourable backdrop, the story that one great name in science endorsed his claims was not nearly enough. Hence this legend soon lapsed and was forgotten. It just did not have the right stuff.

[60] Indeed when I read a paper of this title at the British Society for the History of Science annual conference in Oxford in 2008, the Society was seeking to generate more popular and media interest in its conferences. The abstract and title of my paper was one of those selected for a press release to journalists. The media interest in the extreme sounding claim of Darwin believing life came from outer space still managed to generate short-term media interest. The BBC sent a chauffeur driven car to Oxford at 5AM and whisked me off to London's Broadcasting House to appear on BBC1 Breakfast TV, BBC Radio 4 Today Programme and BBC Radio 5 Live Breakfast.