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Neptunism and Transformism: Robert Jameson and other Evolutionary Theorists in Early Nineteenth-Century Scotland

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Abstract. This paper sheds new light on the prevalence of evolutionary ideas in Scotland in the early nineteenth century and explores the connections between the espousal of evolutionary theories and adherence to the directional history of the earth proposed by Abraham Gottlob Werner and his Scottish disciples. A possible connection between Wernerian geology and theories of the transmutation of species in Edinburgh in the period when Charles Darwin was a medical student in the city was suggested in an important 1991 paper by James Secord. This study aims to deepen our knowledge of this important episode in the history of evolutionary ideas and explore the relationship between these geological and evolutionary discourses. To do this it focuses on the circle of natural historians around Robert Jameson, Wernerian geologist and professor of natural history at the University of Edinburgh from 1804 to 1854. From the evidence gathered here there emerges a clear confirmation that the Wernerian model of geohistory facilitated the acceptance of evolutionary explanations of the history of life in early nineteenth-century Scotland. As Edinburgh was at this time the most important center of medical education in the English-speaking world, this almost certainly influenced the reception and development of evolutionary ideas in the decades that followed.

Keywords: Evolution, Transformism, Neptunism, University of Edinburgh, Robert Jameson, Charles Darwin

Introduction

It has long been suggested that the transcendental anatomy taught in the Edinburgh extra-mural schools in the 1820s and early 1830s played an important role in paving the way for the acceptance of evolutionary

ideas by many Edinburgh-educated thinkers in the decades that followed (see, for example, Desmond, 1989; Rehbock, 1983). In this paper I will argue that the Wernerian geology taught by Robert Jameson (1774–1854), the University of Edinburgh's professor of natural history from 1804 to 1854, may also have played a significant role in suggesting evolutionary explanations for the history and diversity of life on earth to his students. Some of the most well-known of Jameson's students and associates who came to accept a transformist interpretation of the history of life were Robert Grant (1793–1874), Robert Knox (1791–1862), Ami Boué (1794–1881), Hewett Cottrell Watson (1804–1881) and, most famously, Charles Darwin (1809–1882). In this paper I will suggest how Jameson's teaching and the influence of the natural history circle around him may have nudged these individuals towards transformist solutions to one of the great questions of nineteenth-century biology.

By most accounts Jameson was an energetic and diligent professor. According to the report of the Scottish Universities Commission of 1826 he lectured to his students five days a week for the five months of his course and also made "it a practice to converse with them an hour before the Lecture, and very frequently after the Lecture." (Scottish Universities Commission (1826), 1830, p. 47). In addition, the report of the Commission notes that he took them on regular field excursions. As a result, Jameson's lectures were popular and well attended. As Robert Christison (1797–1882), who was a student of Jameson in 1816, later testified, his:

> lectures were numerously attended in spite of a dry manner, and although attendance on Natural History was not enforced for any University honour or for any profession. The popularity of his subject, his earnestness as a lecturer, his enthusiasm as an investigator, and the great museum he had collected for illustrating his teaching, were together the causes of his success. (Quoted in Ashworth, 1935, p. 100).

Jameson therefore had ample opportunity to promote his views both through formal lectures and in more informal settings. Among his students were many of the key figures who were to shape debates on the transmutation of species in the decades leading up to the publication of the *Origin of Species* and beyond. As Edward Forbes (1815–1854) was to say in his inaugural address as Jameson's successor in the chair of natural history at Edinburgh, "The value of a professorial worth should chiefly be estimated by the number of his disciples. A large share of the best naturalists of the day received their first instruction from Professor

Jameson.'' (Forbes, 1854, p. 4). It would therefore seem highly likely that many of the leading figures in natural history in the nineteenth century would have been influenced by the progressivist and transformist ideas discussed in the Edinburgh natural history circles around Jameson.

In an important paper on the ''Edinburgh Lamarckians'' published in 1991 James Secord questioned earlier attributions of an anonymous transformist article entitled ''Observations on the Nature and Importance of Geology'' which was published in the *Edinburgh New Philosophical Journal* in 1826 (Anon, 1826). Earlier accounts of the article had assumed that Robert Grant was the author of the piece (see, for example, Eiseley, 1958; Desmond, 1989).[1] As the article praised the transformist theories of Jean-Baptiste Lamarck (1744–1829), who Grant is known to have admired, it is easy to see why his authorship seemed likely.[2] The fact that in the mid-1820s Grant was also a member of the natural history circle around Robert Jameson, who was the editor of the journal as well as Edinburgh's professor of natural history, also added plausibility to the argument. Secord suggested instead that Jameson, was a much more convincing candidate, both in regard to the style and the content of the article. If this attribution is correct, it would seem that Jameson was both a neptunist geologist and a transformist, a combination that might appear unlikely in the light of some conventional interpretations of the history of science. As Secord remarked, that ''Jameson could be simultaneously a neptunist, a gradualist, and a transmutationist shows how completely our current picture of the acceptance of evolution needs to be overhauled. It is not only in questions of attribution that we have taken too much for granted'' (Secord, 1991).

As Rachel Laudan has demonstrated, the neptunian theory of the earth of Abraham Gottlob Werner (1749–1817) ''dominated geology until the late 1820s'' (Laudan, 1993, p. 87). That Jameson was the leading British advocate of Werner's theory had been well known to historians of geology; however, that he may also have been a transformist was perhaps a more surprising claim. The apparent incongruity between neptunism and transformism stemmed from prevalent models

[1] Desmond later accepted Secord's attribution of the paper to Jameson in Desmond and Parker, 2006, p. 206.

[2] I will be using the terms 'transmutation of species' or 'transformism' henceforth in this paper to distinguish these older theories from Darwinian evolution, from which they vary significantly. The term 'evolution' was current in the 1820s, but was generally used with reference to foetal development, and was often associated with preformationist theories of generation.

of the histories of geology and evolutionary thought that Secord threw into question in his paper. These interpreted transmutationism as an essentially progressive phenomenon, pointing forwards towards the triumph of evolutionism in the second half of the nineteenth century, while neptunism was perceived as a geological creed which had had its day by the mid-1820s, when Jameson had become one of its last defenders in Britain.

The contention that there may have been a link between theories of neptunism and transformism in the early nineteenth century receives striking confirmation in the writings of one of Jameson's contemporaries in Edinburgh, the geologist and minister of the Free Church of Scotland John Fleming (1785–1857). The close relationship between the two doctrines was quite clear in Fleming's mind when he wrote his inaugural lecture as professor of natural history at the newly founded New College in Edinburgh in 1850. In this lecture, Fleming unleashed a tirade against the theory of the earth espoused by Werner and his Edinburgh disciples in the following words:

> Subsequent to the rise of this Scottish geology of Hutton, the German geology of Werner was introduced, and for a while appeared to triumph. This system, equally indifferent to the truths of palaeontology, and outraging all philosophy by the extravagance of its assumptions, paved the way for those reveries of progressive development with which of late years we have been inundated. (Fleming, 1851, p. 216)

The catalyst for this outburst seems to have been the publication a few years before of Jameson's "laudatory" reviews of Robert Chambers' anonymously published transformist magnum opus, the *Vestiges of the Natural History of Creation* (1844) and its sequel, *Explanations: A Sequel to "Vestiges of the Natural History of Creation"* (1845), in the "new publications section" of the *Edinburgh New Philosophical Journal*. Jameson had this to say of *Vestiges*: "Although we do not agree with the ingenious author of this interesting volume in several of his speculations, yet we can safely recommend it to the attention of our readers" ([Jameson], 1845, p. 186). The following year he reviewed *Explanations*, noting that "These explanations sufficiently prove that the author has met with great effect the arguments of its distinguished opponents." ([Jameson], 1846, p. 400). While perhaps not meriting the term "laudatory", Jameson's reviews at the very least indicate that he maintained an open mind towards the "development hypothesis" that Chambers expounded in *Vestiges* and which Fleming referred to dis-

missively as ''reveries of progressive development''. That Jameson considered *Explanations* to have effectively answered the arguments of the critics of *Vestiges* must have been particularly galling to Fleming, as these critics included Fleming himself, as well as and his friend and fellow evangelical David Brewster (1781–1868), who has written a blistering review of *Vestiges* for the *North British Review* ([Brewster], 1845). Fleming roundly condemned Chambers' book in the strongest possible terms later in his inaugural lecture and it seems that in his mind there was no doubt regarding the links between the scandalous theory of universal progress outlined in that work and the developmental vision of the history of the earth advanced by the Wernerians earlier in the century. In this paper I intend to follow up this intriguing suggestion and examine to what extent directional theories of the earth of the kind developed by Werner may have helped to pave the way for the acceptance of a developmental model of the history of life in the early decades of the nineteenth century.

Robert Jameson and Wernerian Geology in Edinburgh

Jameson, the professor of natural history at the University of Edinburgh whom Fleming castigated for both his positive review of *Vestiges* and espousal of neptunist geology in his inaugural lecture, probably first became acquainted with Werner's theories through Charles Anderson, the translator of Werner's *Theory of the Formation of Veins*, whom he got to know while he was working as an assistant to the surgeon John Cheyne as a young man in Leith (Jameson, 1854, p. 6). In 1792 and 1793 Jameson attended the lectures of the University of Edinburgh's professor of natural history, John Walker (1731–1803), whose friendship and patronage were later to shape Jameson's career. Jameson made a trip to Ireland in 1793 where his interest in Werner's theory of the earth and rejection of the rival theory proposed by James Hutton (1726–1797) were encouraged by the Irish geologist Richard Kirwan (1733–1812), who pointed out to him ''several strong fails [sic] against the Huttonian theory'' (quoted in Sweet, 1967, p. 110). By 1796 Jameson had fully embraced Werner's neptunian theory of the earth, as can be seen in two papers which he read to the Royal Medical Society of Edinburgh in that year in which he expressed an uncompromisingly neptunist view of the history of the earth (Sweet and Waterson, 1967). In 1800 Jameson travelled to Freiberg, where Werner taught at the Mining Academy, to study with the master himself.

On his return to Scotland, and following the death of his friend and mentor, John Walker, Jameson was appointed professor of natural history at the University of Edinburgh in 1804. This put him in a strong position to promote his views to generations of students over the five decades for which he was to hold the chair. In 1808 he founded the Wernerian Natural History Society, named in honor of his master. From 1819 he edited the *Edinburgh Philosophical Journal*, first with the natural philosopher and scientific journalist David Brewster, and then alone after 1824. From 1826 he was the sole editor of the successor to the *Edinburgh Philosophical Journal*, the *Edinburgh New Philosophical Journal*. This was to provide an important forum for the dissemination of progressivist theories of geology and transformist theories of the history of life. Before we are in a position to examine the relationship between theories of the earth and of the history of life, we will need to cast a quick glance at the fundamental differences between the Wernerian vision of the history of the earth and the rival Huttonian system.

The situation in geology at the beginning of the nineteenth century has been accurately summarized by Martin Rudwick, who has noted that the theories prevalent at the time could be classified into "those that postulated an earth in steady state or cyclic equilibrium and those who saw the earth's temporal development in directional terms" (Rudwick, 2005, p. 173). The theory of Werner belongs firmly in the latter camp, while Hutton's is an extreme example of the former. While Werner's theory interpreted the geological record as showing a clear pattern of progressive change over time, Hutton's theory was radically ahistorical, centered on a uniformitarian model of the history of the earth. For Hutton the earth's history was an endlessly repeated cycle of uplift and erosion with, as he famously put it, "no vestige of a beginning, – no prospect of an end" (Hutton, 1788, p. 304). But for religious considerations, there would have been no reason to assume that this unchanging natural order was not eternal. Despite Hutton's importance for the later development of geology, directional models were dominant in the early nineteenth century to the extent that Rudwick refers to theories of the type espoused by Werner as the "standard model" for the period. So what was the nature of the Wernerian directional model of earth history? To illustrate his theory I will be drawing largely on the writings of Jameson, his most important British disciple and one of the principal subjects of this paper.

Neptunist geotheory was based on the premise that sea levels had been falling continuously throughout geological history. The nature of the Biblical Deluge, much debated by geologists in this period, did not,

however, present particular problems for Werner and his followers. Apparently anxious to take into account historical evidence for the Deluge, Werner argued that the retreat of the ocean was not necessarily an absolutely continuous process, but that the geological record provided evidence that a temporary resurgence of the waters had taken place (Laudan, 1993, p. 90). In the earliest times he believed that there had existed a universal ocean, very different in chemical composition from the ones that exist today. The spherical form of the earth was taken as evidence of its original fluidity (Jameson, 1808, p. 73). From this primordial ocean the oldest rocks had been deposited by chemical precipitation. The rocks of the earliest, ''primitive'', period in the earth's history were crystalline in character, as might be expected from their process of formation.[3] Obviously crystalline rocks such as granite and gneiss would fall into this category. During the ''transition'' and ''floetz'' periods the waters receded and the first land appeared. While chemically precipitated rocks, such as limestone, continued to be formed, erosion of the land masses also contributed mechanically deposited strata, such as sandstone. Gradually the balance shifted, and the recent ''alluvial'' strata were almost entirely deposited mechanically rather than chemically, the most recent ones being largely unconsolidated. As might be expected from their order of deposition from a receding universal ocean, the most ancient, crystalline rocks were to be found in high mountain ranges, while the youngest, alluvial, rocks were found in low lying areas of the globe. Several different explanations for the recession of the ocean were put forward by neptunist thinkers; the one favored by Jameson was that the excess water had been lost to space over the millennia (Jameson, 1808, p. 77).

As can be seen from the surviving notes from his lectures, this was essentially the model of earth history that Jameson taught his students until at least the mid-1830s.[4] Generally, it is the recession of the oceans and gradual but profound change in their chemical composition that Jameson saw as driving the directional change that he observed in the geological record. However, there are some indications that he also considered the possibility that global temperatures had declined over time, a doctrine often associated with George-Louis Leclerc, Comte de Buffon (1707–1788), who saw the cooling of the earth from an original

[3] The terminology to describe the different periods changed over time and according to the author. I have here used the terminology to be found in the table between pages 95 and 96 of Jameson, 1808.

[4] See, for example, the very full account of the neptunian theory in the set of notes taken in Jameson's lectures by D.B. Ramsay (Jameson, 1835/1836).

molten state as the primary motor for change. The section of the natural history syllabus that covered botany for the 1826 session included ''Deductions illustrative of Gradual Change in the Heat of the Earth, and of Alteration in Climate, as disclosed by the facts in the Physical and Geographical Distribution of Fossil and Living Plants'' (Jameson, 1826, p. 11). In his lectures Jameson gave a little more detail regarding the direction and effects of climatic change; in a set of lecture notes from 1830 he suggested that in the geological past ''the climate was very different from what it is at present and that at the time Britain was calculated to produce plants and animals requiring a much more considerable temperature then the Island possesses at present'' (Jameson, 1830, f.5). In a fragmentary note found among Jameson's paper we also find the following note in Jameson's hand that suggests he saw a diminution in temperature over geological time as likely and compatible with a broadly neptunian picture of earth history:

> 7 [owing?] to the diminution of temperature the expanded state of water becoming less the quantity of the atmospheric vapor & height of water diminishes 8 the Transition rocks the next down from them conglomerate, charcoal & their organic remains intimate the existence of mechanical action & of such a temp as to allow of the growth of organic bodies all of which appear to have been marine (Jameson, n.d. (a)).

The evidence quoted above also hints at the consequence of directional change in the conditions on the earth's surface for the history of life, and it is to this subject that I turn in the next section of this paper.

Progressive Visions of the History of Life in Edinburgh and Beyond

By the early decades of the nineteenth century it could no longer be ignored that the fossil record appeared to follow a strong trend towards greater complexity in the remains of living creatures found in the rocks, with the major groups of living things making their appearance in a clearly defined order. The progressive nature of the fossil record was becoming generally accepted among geologists in this period and, as Martin Rudwick has chronicled, by the early decades of the nineteenth century there had developed a general consensus among geologists that the history of life was progressive (Rudwick, 2008, p. 49). In a set of notes from Jameson's lectures, which are undated but not earlier than

1826, as they contain a reference to a paper published that year, we find the following outline of the fossil record:

> In the oldest strata [of the Transition] we find the lowest species of vegetables & animals, as marine plants and zoophytes, which were therefore first called into existence. … Floetz rocks are less crystallized than transition rock, but contain a greater variety of organic remains. Indeed there appears to be a regular & consistent distribution of organic beings through the rocks of this class from the very low species of the earliest strata to the more perfect animals of the newest strata, immediately adjoining the alluvial formation. (Jameson, n.d. (b), f.255).

For Jameson, the directional history of life revealed by the fossil record was directly related to the directional changes in the physical environment of the earth's surface. In his *Elements of Geognosy* (1808) Jameson wrote that

> As the water diminished, it appears to have become gradually more fitted for the support of animals and vegetables, as we find them increasing in number, variety and perfection, and approaching more to the nature of those in the present seas, the lower the level of the outgoings of the strata, or, what is the same thing, the lower the level of the water. The same gradual increase of organic beings appears to have taken place on the dry land. (Jameson, 1808, p. 82).[5]

In the first decade of the century a student of Jameson named J. Ogilvy wrote a dissertation "On the Huttonian and Neptunian Theories of the Earth" for the Royal Medical Society of Edinburgh, which appears in the Society's dissertation book for 1806–1807. This essay demonstrates that Jameson had already made some converts among the student body to his neptunian geology and its connection with a progressive vision of the history of life with his "masterly statement of the Wernerian theory" in his first few years as professor (Ogilvy, 1806–1807, f.238). In his dissertation Ogilvy remarked that

> Another general observation of the same philosopher [Werner] beautifully confirming his opinion, – is the constantly increasing frequency of the relicts of the animal and vegetable kingdoms, as we descend from the Transition to the rocks of most recent formation; and, at the same time, he sagaciously remarked, that, in

[5] It is worth noting that Fleming quotes part of this passage in his 1850 inaugural lecture as proof of Jameson's adherence to transformism.

> making this descent, these vestiges point out individuals of these kingdoms with which be become the more familiar as we approach the most modern formations. (Ogilvy, 1806–1807, f.238).

We have already seen that in later decades John Fleming became a harsh critic of both Werner and Jameson, as well as a resolute opponent of transformism. However, Fleming's views had changed radically between the 1820s and 1850. His earlier writings show that in the early decades of the century Fleming had held geological views not very different from those of Jameson and he had been a founding member of the Wernerian Society in 1808. In his great work on *The Philosophy of Zoology* (1822) he wrote that

> From the period, therefore, at which petrifactions appear in the oldest rocks, to the newest formed strata, the remains of the more perfect animals increase in number and variety; and it is equally certain, that the newest formed petrifactions bear a nearer resemblance to the existing races, than those which occur in the ancient strata. (Fleming, 1822, vol. 2, p. 97).

Fleming believed, as did Jameson, that these changes were caused by physical changes in the environment of the surface of the globe. Like Jameson, he believed that the area of dry land had increased over time, although he considered that this had been achieved by the filling in of lakes and seas by the products of erosion rather than by a net loss of water. He also believed that one result of these changes was the gradual modification of the climate, making the difference in temperature between summer and winter more extreme. Although he may have differed from Jameson about the details of the mechanism of progressive change, he expressed its consequences in a similar manner:

> A variety of changes have taken place in succession, giving to the earth its present character, and fitting it for the residence of its present inhabitants. And if the same system of change continues to operate, (and it must do while gravitation prevails,) the earth may become an unfit dwelling for the present tribes, and revolutions may take place, as extensive as those which living beings have already experienced. (Fleming, 1822, vol. 2, p. 104).

The *Edinburgh New Philosophical Journal*, edited by Jameson, provided a forum for like-minded geologists, not just from Edinburgh or Great Britain, but from across Europe and beyond, to exchange their findings and opinions. It included a significant number of papers that dealt with the history of the earth. The following three examples will give a flavor

of the kind of articles dealing with the progressive history of life on earth that Jameson published. The first appeared in 1826 and was entitled ''Geological Observations''. Its author was Ami Boué, an Austrian Wernerian geologist, former student of Jameson in Edinburgh and member of the Wernerian Natural History Society. After noting that ''the farther we penetrate into the crust of the earth, the more simplicity do we observe in the vegetable and animal productions'', he speculated that this was due to a greater equality of temperature across the globe before concluding that as ''the zones and climates gradually became established, the vegetables and animals became diversified.'' (Boué, 1826, p. 90). In the following year Jens Esmark (1762–1839), the Danish-Norwegian Wernerian mineralogist, published a piece in which he speculated that the earth might have been devoid of life for several thousand years after the creation, and that ''organisation did not begin till this long period was completed, which the earth required to the full development of its own constitution; that, after it began, it proceeded by successive steps from the less to the more perfect formations, ending with man as the head of the whole.'' (Esmark, 1826, pp. 120–121). We are presented by Esmark with a model in which the appearance of life was made possible by changes in the physical environment, changes which then continued to act, gradually promoting an increase in the complexity of living things. Jameson was clearly favorably impressed by Esmark's article, as he discussed this ''very ingenious paper'' approvingly and at some length in one of his lectures, a set of notes for which survives in Edinburgh University Library (Jameson, n.d. (b), ff.236–238). A similar paper was published anonymously in 1830. Here again we find the same gradual, progressive history of life as we have seen in the preceding papers. The anonymous author remarks that

> It is, notwithstanding, always of much importance to be able to look into the facts already established, and to observe that the gradual development of organic bodies in the animal and vegetable kingdom has followed precisely the same progress. While the simplest organized kinds of both kingdoms first appear, we also find repeated throughout the same gradations, as regards the gradual appearance and increase of the most perfectly organized beings in the strata of the earth's crust. (Anon, 1830, p. 127).

These articles demonstrate how Jameson's journal provided a space for broadly Wernerian geologists to present their ideas on the relationship between the history of the earth and the history of life. It is evident from them that the link between a progressive history of the earth and a

progressive history of life was clearly a commonplace of the geological circles around Jameson. But did any of these thinkers ever speculate regarding the process responsible for the progressive change evident in the fossil record and make the leap to a transformist interpretation of this pattern? This is the question I will be addressing next.

Neptunian Geology and Transformism

In a footnote to the introduction to his *System of Mineralogy* (1804), Robert Jameson had laid out the main problems of natural history as he saw them as the nineteenth century began. For Jameson, the most important questions included: ''Were all animals and plants originally created as we at present find them, or have they by degrees assumed the specific forms they now possess? Are certain species become extinct? In what order and whither have they migrated? What change has climate produced?'' (Jameson, 1804, pp. xix–xx). Right at the very beginning of his career as professor of natural history at the University of Edinburgh, Jameson was already raising important questions regarding the history of life on earth. First among these questions was that of the transmutation of species. If James Secord was correct in his attribution of the paper ''Observations on the Nature and Importance of Geology'' to Jameson himself, by 1826 Jameson he had found an answer to his question. As Secord has noted, ''For the author of the 'Observations,' this progression of life is best explained through transmutation. Lamarck's theory is the logical consequence of Werner's.'' (Secord, 1991, p. 9).

The attribution of ''Observations'' to Jameson is not, however, absolutely secure, and Pietro Corsi has suggested that the author of the article may in fact have been Ami Boué (Corsi, 2011, p. 17). Most of the arguments in favor of Jameson would hold equally well for Boué, who had attended Jameson's classes when he was a medical student in Edinburgh between 1814 and 1817 and, like Jameson, to whom he still referred in his autobiography many decades later as ''mon maître'', was a Wernerian geologist (Boué, 1876, p. ii). In any case, the article shows every sign of having been written by a Wernerian, down to the characteristic terminology that is used throughout. That the author was steeped in Wernerian geological theory is evident from the vocabulary he used to discuss his subject. Whoever wrote it, the article certainly makes the connection between Wernerian geology and transformism quite explicit. The anonymous author comments at some length on the

progressive nature of the fossil record, before going on to link this to the transformist theories of Lamarck. According to the author, the "doctrine of petrifactions, even in its present imperfect condition, furnishes us with accounts that seem in favour of Mr Lamarck's hypothesis." (Anon, 1826, p. 297). The article notes the presence in the rocks of colder parts of the globe of fossils of species only found today in hot climates, indicating "a great change in the temperature of their former situations" (Anon, 1826, p. 299). If this is so, the author maintains, it raises an important question about the effect that such changes have on living things. The changes that can be observed to have been wrought on domesticated plants and animals by modifying their environment help to provide an answer:

> But are these forms as immutable as some distinguished naturalists maintain; or do not our domestic animals and our cultivated or artificial plants prove the contrary? If these, by change of situation, of climate, of nourishment, and by every other circumstance that operates upon them, can change their relations, it is probable that many fossil species to which no originals can be found, may not be extinct, but have gradually passed into others. (Anon, 1826, p. 298).

This passage, which contains unmistakable echoes of the theories of the French comparative anatomist and transformist Étienne Geoffroy Saint-Hilaire (1772–1844), makes clear that the author considers that directional change in the physical environment of living things is the ultimate cause of the transmutation of species, rather than an innate tendency to increase in complexity as proposed by Lamarck. Directional change in the surface of the globe, of the kind which is integral to the Wernerian model of the history of the earth, is therefore put at the center of this theory of transmutation.

Even if there is some doubt as to the attribution of the anonymous 'Observations' to Jameson, there is significant evidence from other sources to suggest that he was sympathetic to a transformist interpretation of the history of life. In the preface to the fifth edition of Cuvier's *Theory of the Earth* he wrote of "Geology, which discloses to us the history of the first origin of organic beings, and traces their gradual development from the monade to man himself" (Cuvier, 1827, p. vi). These words would appear to express a fundamentally transformist interpretation of the fossil record. In an appendix 'On the universal deluge' published the same edition the *Theory of the Earth* Jameson went on to add the following telling observation: 'like the formation of

the rocks, we observe a succession of organic formations, the later always descending from the earlier, down to the present inhabitants of the earth, and to the last created being who was to have dominion over them.' (Cuvier, 1827, p. 431). These passages would clearly seem to indicate that Jameson interpreted the succession of fossil forms found in the geological record in genealogical terms rather than as a series of progressive but separate creations.

The 'Observations' was not the only article that proposed a transformist interpretation of the history of life against the background of a directional theory of the earth to be published in the *Edinburgh New Philosophical Journal* during the 1820s. The following year, Jameson's journal published an article entitled ''Of the changes which life has experienced on the globe''. This has received less attention than the 1826 article discussed above, although it has been suggested by Adrian Desmond that it might have been by Grant (Desmond, 1989). While Grant is certainly a possible candidate as the author, there is no concrete information that would allow authorship to be confidently assigned. It was unlikely to be by Jameson, as the references to the important role of volcanism and ''the original igneous state of the earth'' would be incompatible with his orthodox Wernerian views on the original aqueous state of the globe (Anon, 1827, p. 299). This would not, perhaps, necessarily entirely rule out Boué, who himself admitted he was not as zealous a Wernerian as Jameson.[6] The article opens with a reference to the important role of fossils as evidence of ''the history and successive changes of the various races that existed before the present'' (Anon, 1827, p. 298). The author then goes on to establish two types of causes at work in the natural world. The first and most important act gradually but inexorably: ''The differences which vegetables and animals exhibit at the present day, according to the various climates or situations in which they occur, have been gradually established under the predominating influence of a small number of natural causes, and constitute at length the order of distribution which life now presents at the surface of the earth.'' (Anon, 1827, pp. 298–299). He then proceeds to establish the nature of these causes:

> These gradual variations in the temperature, the lowering of the general level of the seas, the equally successive and gradual diminution of the energy of volcanic phenomena arising from the original igneous state of the earth, as well as the strength and power of atmospheric phenomena, and of the tides – such were the reg-

[6] In an appendix to his autobiography he admitted that in 1820 he was 'extremely plutonist in comparison to my master Professor Jameson' (Boué, 1876, p. ii).

> ular, general, and continued natural causes of the modifications which life has undergone … (Anon, 1827, p. 299).

The author then calls the fossil record as a witness to "the successive and gradual change which we have pointed out." (Anon, 1827, p. 300). The second and less significant type of cause to which the author then turns consists of "the irregular, and more or less violent and perturbing secondary causes of the partial vicissitudes experienced by animal and vegetable life." (Anon, 1827, pp. 299–300). This model of double causation is reminiscent of that of Lamarck, whose theory included both a continuously acting innate tendency towards progressive change and a secondary mechanism that depended on the effects of unpredictable environmental changes, which disrupted the simple pattern of development that would otherwise have prevailed. It differs radically from Lamarck, however, over the nature of the primary cause of transmutation, which is attributed to the effect of directional environmental change rather than an innate tendency of living things to become more perfect even in a constant environment. In this the anonymous author seems more inclined towards a Wernerian view of the history of the earth than Lamarck, who in geology was essentially a uniformitarian (Burkhardt, 1977, p. 111). Finally, the author expresses his overwhelming confidence in the correctness of his theory and appeals to its compatibility with natural law as confirmation: "Our theory, which is founded on all the facts that have been established, cannot but prevail over the systems hitherto established, for it is in harmony with the natural laws of order and permanency which rule the universe" (Anon, 1827, pp. 300–301).

The only transformist articles published in the *Edinburgh New Philosophical Journal* in the 1820s which appeared under their author's name were by Robert Grant. Grant was principally an invertebrate zoologist, and most of his published papers in this period dealt with marine invertebrates. It is well known and has been thoroughly documented by a number of scholars that Grant was one of the most significant transformist thinkers in Britain in the 1820s and 1830s (see in particular Desmond, 1984; Secord, 1991). At the time he wrote the articles he was resident in Edinburgh and was a leading figure in natural history circles in the city. As noted above, he had been a student of Jameson and there is some evidence in these articles that he adhered to an essentially Wernerian view of the history of the earth and saw the transmutation of species as occurring in the context of an earth undergoing gradual, directional change. He published a series of 16 papers between 1825 and 1827 in the *Edinburgh Philosophical Journal*

and its successor the *Edinburgh New Philosophical Journal*. These papers mostly dealt with aspects of the biology of the invertebrate animals he had collected from the Firth of Forth. However, two of them contain explicitly transformist themes. It is in a paper published in 1826 ''On the structure and nature of the Spongilla friabilis'' that we find the first statement in print of Grant's transformist views. Towards the end of the article, he speculated regarding the relationship between the freshwater sponge *Spongilla* and the more complex marine sponges:

> From this greater simplicity of structure and internal texture, we are forced to consider it as more ancient than marine sponges, and most probably their original parent; and, as its descendants have greatly improved their organization, during many changes that have taken place in the composition of the ocean, while the spongilla, living constantly in the same unaltered medium, has retained its primitive simplicity, it is highly probable that the vast abyss, in which the spongilla originated and left its progeny, was fresh, and has gradually become saline, by the materials brought to it by rivers, like the salt lakes of Persia and Siberia. (Grant 1826a, pp. 283–284).

Grant here gave a concrete example of the principle expounded by Geoffroy Saint-Hilaire in his ''Organisation des gavials'' that when the ''physical and chemical agents'' to which an organism is exposed remain the same, so does the development of the organism, but when conditions change, the development of the organism exposed to these new conditions will be modified by them, provided the change is not so great as to kill it (Geoffroy Saint-Hilaire, 1825, pp. 151–152). Grant then went on to give his evidence for the alleged primitive character of this freshwater sponge, based on the siliceous nature of its skeleton, noting that ''its aptness for secreting silica, and the abundance of that earth in its skeleton, show the period of its creation to have been nearly synchronous with that of the siliceous or primitive rocks.'' (Grant, 1826a, p. 284). The implication here is that these primitive creatures first came into being in an ocean rich in silica, which was in the process of precipitating out to form the crystalline primitive rocks. Wernerians had long been aware that silica was soluble only in hot basic liquids, of the kind they imagined constituted the primordial ocean (Laudan, 1993, p. 181). The silicate rocks would therefore be the first to precipitate out as the ocean cooled and its chemical composition changed over time. Grant's clear espousal of this model is strong evidence that his trans-

formist views were integrated with a fundamentally Wernerian model of earth history.

Later the same year Grant repeated his views on the evolution of sponges in a paper on the structure of siliceous sponges published in the first number of the *Edinburgh New Philosophical Journal*. Here Grant suggested a family tree of sponges based on the form of the spicula which make up the skeletons of many species. He traced the development of the spicula from the simple forms found in freshwater sponges through three stages of increasing complexity, first to forms where "the unnecessary and probably hurtful embedded point has been removed" and finally to the most complex jointed speculum (Grant, 1826b, p. 350). Grant relates these changes directly to function, as he considered that the more advanced forms were better suited for defending the sponge against predators, as "at the time of its formation, animalicules of larger magnitude swarmed in the heated ocean" (Grant, 1826b, p. 350). Here Grant also made it clear that he believed that the oceans of earlier epochs had been hotter than at present and that the earth had consequently experienced progressive cooling during its geological history. Although there is strong evidence that Grant admired the theories of Lamarck, his belief that directional change in the physical environment played a role in driving the transmutation of species brought him closer both to Wernerian geology and to the theories of Geoffroy Saint-Hilaire. We know that Grant was an enthusiastic disciple of Geoffroy's views on unity of form in comparative anatomy and had got to know him well during his trips to Paris in the 1820s (Desmond, 1989, p. 56). Unlike Lamarck, whose views on geology were essentially uniformitarian, Geoffroy believed that there had been a gradual but profound change in the composition of the atmosphere over geological time, and that this was the motor for the transmutation of species (Geoffroy Saint-Hilaire, 1831, p. 79).

In 1829 Jameson published an anonymous report in the *Edinburgh New Philosophical Journal* of a memoir read by Geoffroy before the French Academy of Sciences and published in the *Mémoires du Muséum d'Histoire Naturelle* the previous year (Anon, 1829b, pp. 154–155).[7] This report was attributed to Grant by Desmond in a 1984 paper (Desmond, 1984, pp. 201–202). However, Pietro Corsi has recently demonstrated beyond doubt that the paper is in fact a direct translation of an anonymous article which appeared earlier the same year in the French newspaper *Le Globe*.[8] The article gives a detailed account of Geoffroy's

[7] The paper on which this article was based was Geoffroy Saint-Hilaire (1828).

[8] Pietro Corsi, personal communication. For the original article, see Anon, 1829a, pp. 207–208.

transformist theories and supports his belief that changes in the composition of the atmosphere drove the transmutation of species. The content of this paper was clearly of great interest to Jameson, as on 25 April 1829 he ''gave an account of the doctrines of Geoffroy St Hilaire on the analogy between extinct animals and those now living'' to the Wernerian Society, although sadly no record of exactly what Jameson had to say about Geoffroy's ideas has survived to enlighten us as to the opinions he expressed on that occasion (Wernerian Natural History Society, 1808–1858, vol. 1, f. 297). However, from the brief description of the talk from the minutes quoted above it seems almost certain that his paper focused principally on Geoffroy's transformist theories, which would surely have been congenial to Jameson, based on what we know about his own views. Given the coincidence of dates between Jameson's paper to the Wernerian Society and the publication of ''Of the continuity of the animal kingdom'' in his journal, which appeared in the April–June 1829 number, it seems highly probable that the paper he gave was largely based on that article.

We have seen above that Ami Boué wrote an article on the progressive nature of the history of life and its relationship with the Wernerian model of the history of the earth which appeared in the *Edinburgh New Philosophical Journal* in 1826. While the picture of the history of life presented in this article is open to a transformist interpretation, it stops short of making any explicitly transformist claims. However, as Goulven Laurent has demonstrated, there is significant later evidence from other sources that Boué was indeed a transformist and an admirer of the theories of Lamarck and Geoffroy (Laurent, 1993). His credentials as a transformist are left in little doubt by a ''résumé of the progress of geological sciences during the year 1833'' he wrote for the *Bulletin de la Société Geologique de France*. In this work he stated that:

> The naturalist who restricts the circle of his ideas to the short duration of his life will necessarily be directed to the ancient idea of the species as a being *sui generis* formed once for all time, which must perpetuate itself as such, at least as long as the present laws of nature remain in effect. The authority of scholastic writings and the most ancient legislators also corroborate this opinion, engraved in the memory from the most tender infancy. On the other hand, in examining the whole scale of creations, living as well as fossil, in ignoring individual instances in order to see the whole, set in motion by a subtle material that is disseminated everywhere, one easily

> arrives with the Lamarcks, the Geoffroys, and other great naturalists, at an entirely different conclusion. (Boué, 1834, pp. 113–114).[9]

It has recently come to light that another of Jameson's students, Henry H. Cheek (1807–1833), who studied medicine at Edinburgh between 1826 and 1832, also openly espoused transformist views (Jenkins, 2015). While Cheek was bitterly critical of Jameson's teaching as professor of natural history, the opinions he expressed in his writings on transformism are very much in harmony with the ideas we have seen were current in the circle around Jameson. In a key paper he published in 1830 in the *Edinburgh Journal of Natural and Geographical Science*, a journal he himself edited between 1829 and 1831, Cheek outlined his transformist ideas, concluding that "Adaptation of the law by which organized bodies change with the variation of the conditions of existence; and separation of the functions of relation, and concentration of the vital functions, seems to be the mode of perfection." (Cheek, 1830, p. 65). His wording might be rather obscure, as is the case with much of his writing, but the suggestion that changes in the 'conditions of existence' are the driving force for the transmutation of species is clear. Cheek's ideas seem to derive more from the theories of Geoffroy St Hilaire, whose theories he vociferously defended in his journal, than from Wernerian geology. Nonetheless, they do go to show how commonplace the idea that the transmutation of species was linked to directional environmental change of the kind that was integral the Wernerian model was in the Edinburgh of the late 1820s and early 1830s.

It would therefore appear that there is significant evidence that transformist ideas were widely discussed and relatively uncontroversial in Edinburgh natural history circles, at least up until the early 1830s, and that they were closely linked to directional, broadly Wernerian theories of the earth. However, evidence for transformist opinions in Edinburgh becomes scantier from the early 1830s onwards. The next section will make some suggestions as to why this might have been.

[9] The original French text reads : 'Le naturaliste qui restreint le cercle de ses idées à la courte durée de sa vie, sera nécessairement porté à l'idée ancienne que l'espèce est un être *sui generis* formé une fois pour toutes, et devant se perpétuer tel, aussi long-temps du moins que dureront les lois actuelles de la nature. L'autorité des écrits scolastiques et des législateurs les plus anciens vient encore corroborer cette opinion gravée dans la mémoire de la plus tendre enfance. D'un autre côté, en parcourant toute l'échelle des créations, tant vivantes que fossiles, et en négligeant les individualités pour ne voir qu'un tout mis en mouvement par une matière subtile disséminée partout, on arrive aisément avec les Lamarck, les Geoffroy, et autres grands naturalistes, à une tout autre conclusion.'

The Eclipse of Transformism in Edinburgh

After 1832 open advocacy of progressive, gradualist visions of the history of life become increasingly rare in Edinburgh natural history circles.[10] Wernerian geology itself found few defenders after the mid-1820s, and Robert Jameson, the high priest of neptunism, became an increasingly isolated figure among geologists. Cuvierian catastrophism, championed in England by such figures as William Buckland, William Conybeare and Adam Sedgewick, for a time carried all before it. Buckland, for example, in his Bridgewater Treatise, suggested that the history of life on earth had been punctuated by "revolutions and catastrophes, long antecedent to the creation of the human race" that were apparent in the geological record (Buckland, 1836, vol. 1, p. 130). In his *Discourse on the Studies of the University* Sedgwick also asserted that "our globe has been subject to vast physical revolutions" (Sedgwick, 1834, pp. 25–26). Sedgwick went on to make clear that the creatures of the new creations that followed these revolutions showed a radical discontinuity with previous forms, and "though formed on the same plan, and bearing the same marks of wise contrivance, oftentimes [are] as unlike those creatures which preceded them, as if they had been matured in a different portion of the universe and cast upon the earth by the collision of another planet." (Sedgwick, 1834, p. 30).

Catastrophism, implying as it did a more or less complete turnover of flora and fauna at the time of each catastrophe, was fundamentally incompatible with the picture of the gradual development of life driven by environmental change that Wernerian geology had suggested to many earlier geologists. Ironically, Jameson had done much to promote catastrophist ideas as the editor of successive editions of Cuvier's *Theory of the Earth*, for which he also provided extensive notes. However, the picture of the history of the earth presented in the *Theory of the Earth* may not have seemed to Jameson to challenge the Wernerian picture of gradual, progressive change in living things, as Cuvier himself admitted that marine organisms had undergone transmutations brought about by changes in the properties of the medium in which they lived. There is a striking statement of this in Jameson's translation for the fifth edition of the *Theory of the Earth* (1827), where, closely following the original French text, it is noted that: "There has, therefore, been a succession of variations in the economy of organic nature, which has been occasioned by those of the fluid in which the animals lived, or

[10] A late reference to progressive development from 1836 is to be found in Cunningham, 1838, p. 9.

which at least corresponded with them; and these variations have gradually conducted the classes of aquatic animals to their present state'' (Cuvier, 1827, p. 14).[11] Despite this, the majority of British geologists interpreted the obvious, radical discontinuities in the fossil record as evidence that an entire world of living things had been swept away and replaced with a new creation. Hugh Miller, one of the leading Scottish advocates of discontinuity the history of life, was to write that ''The curtain drops at his command over one scene of existence full of wisdom and beauty – it rises again, and all is glorious, wise and beautiful as before, and all is new.'' (Miller, 1841, p. 102).

As the quotation above makes clear, it was not just Miller's catastrophist views on the history of life that led him to reject any slow transformation of life over geological time, but also the evangelical faith that underlay them. Miller was utterly opposed to the idea of gradual, progressive development, which he saw as denying God's power to create new species by supernatural intervention. In his *Old Red Sandstone* he asserted that:

> There is no progression. If fish rose into reptiles, it must have been by sudden transformation; – it must have been as if a man who had stood still for half a life-time should bestir himself all at once, and take seven leagues at a stride. There is no getting rid of miracle in the case (Miller, 1841, pp. 44–45).

The Evangelical Party within the Church of Scotland included many prominent scientists and natural historians among its ranks, including John Fleming and David Brewster as well as Miller. Some of these Evangelical figures, such as Fleming and Brewster, had been close associates of Jameson. Brewster co-edited the *Edinburgh Philosophical Journal* with Jameson until he broke with him in 1824 to found his own journal, the *Edinburgh Journal of Science*. Its increasing militancy in the decades before their definitive split with the Established Church to form the Free Church of Scotland in the Disruption of 1843 had a profound influence on cultural developments in the period, not least in natural history (Baxter, 1993). In the two decades leading up to the publication of *Vestiges of the Natural History of Creation* in 1844 attacks against transformism from Edinburgh natural historians came almost exclusively from among the ranks of the Evangelicals and their allies, and

[11] The original French text reads: 'Il y a donc eu dans la nature une succession de variations que ont été occasionnées par celles du liquide dans lequel les animaux vivaient ou que du moins leur ont correspondu ; et ces variations ont conduit par degrés les classes des animaux aquatiques à leur état actuel' (Cuvier, 1825, p. 14).

even after the publication of that book led to more widespread condemnation of transformist ideas they very much led the charge in Scotland. A very early Evangelical response to Lamarckian transformism comes from the pages of the *Memoirs of the Wernerian Society*. This took the form of a paper by the Evangelical minister James Grierson (1791–1875), given to the Society in February 1824. Here Grierson rejects Lamarckian transformist theories "which, if they do not evince much power of observation, or great accuracy of deduction, certainly shew no deficiency in power of fancy." (Grierson, 1823–1824, p. 404). The dismissal of transformism as mere fanciful speculation was to be a principal mode of attack for the Evangelical opponents of transmutation.

Although John Fleming seems to have supported a progressive history of life on earth in his *Philosophy of Zoology* of 1822, by 1829 he was completely denying any evidence for the progressive appearance of the different orders of animals in a review of J.E. Bichino's *Systems and Methods in Natural History* (1827), published in the *Quarterly Review*. He claimed that the fossil record did not after all present a picture of progressive development, but that in fact the remains of "zoophytes and mollusca, along with the bones of *vertebrated animals*, and the stems of *dicotyledonous plants*" could all be found in rocks from every geological epoch where there was evidence of life ([Fleming], 1829, p. 321). The main focus of his attack, however, was on Lamarckian transformism, asking why God could not have created "Man directly, as easily as a Monas" ([Fleming], 1829, p. 320). Fleming's later estrangement from Jameson and rejection of Wernerian geology and the progressive view of the history of life raises many questions, although it certainly bore some relation to his religious beliefs. Fleming was a deeply religious man and a minister of the Evangelical Party of the Church of Scotland, and after the Disruption of 1843, of the Free Church of Scotland. Like many Evangelicals with scientific interests he was horrified by the use made of geological and biological theories in the *Vestiges of the Natural History of Creation*, which he saw as an appalling assault on the principles of true religion.[12] Based on the testimony of his inaugural address quoted above, he had clearly come to believe that the dangerous "development hypothesis" outlined in that book had its roots in the Wernerian geology favored by Jameson and his associates, including Fleming himself in his younger days. Fleming's personal relationship with Jameson may also have deteriorated over the years. Jameson was a complex and

[12] For a masterly account of the reactions of the Scottish Evangelicals to *Vestiges*, see Secord (2000, pp. 261–296).

difficult character, who succeeded in alienating many of those he had dealings with during his long career through his high-handed manner and arbitrary behavior. Fleming's later estrangement from Jameson is quite evident in a quotation found in John Duns' memoir of Fleming, only published in 1859 after the deaths of both men, where Fleming is quoted as describing Jameson as "irregular, cold, and distant" (Duns, 1859, p. xl). Whatever the reasons, Fleming in later years became one of the most implacable enemies of transformism and progressivism in British geology. By the early 1830s, the rise of catastrophist geology, the evidence for discontinuity in the fossil record and the concerted opposition of influential Evangelical natural historians would seem to have made gradualist, developmental theories of the history of life on earth appear increasingly untenable and support for such theories, at least in public, died away.

Conclusion

We have seen that there was a significant circle of figures promoting progressivist and transformist theories of the history of life associated with the Edinburgh natural history circle around Robert Jameson, Edinburgh's professor of natural history, in the early decades of the nineteenth century. Of those we have concrete evidence for, Grant and Jameson himself were resident in the city, while Boué had left Edinburgh for France after graduating, although it seems he continued to keep in touch with Jameson and his circle. Cheek, while not part of Jameson's circle and deeply critical of the professor himself, shared many of their opinions. There are likely to have been others, some represented perhaps by the anonymous articles in the *Edinburgh New Philosophical Journal*, but it is impossible to identify these with certainty. We have also seen that these transformists generally accepted a directional model of the history of the earth rooted in Wernerian neptunist geology and saw the gradually changing environment as a primary motor for the transmutation of species. In addition, we know there existed a wider circle of other Wernerians among Jameson's associates and correspondents who accepted a relationship between a directional history of the earth and a progressive history of life that must surely have strongly suggested a transformist interpretation, although they may not have made the final leap to accepting transformism themselves; in the 1820s these probably included John Fleming in Edinburgh and Jens Esmark in Norway.

Grant, who was certainly a committed transformist, is sometimes portrayed as a radical figure on the margins of mainstream natural history circles (see in particular Desmond, 1989). This seems to have been very far from the case in the Edinburgh of the 1820s, where he appears to have maintained cordial relations with many of the key figures in scientific and natural history circles, including Jameson and Fleming, who were both very much establishment figures in their different ways. Grant seems to have been a particular friend of Fleming, who even named a newly discovered species of sponge *Grantia* in his honor (Fleming, 1828, p. 524). Both Jameson and Fleming supported Grant's successful application for the post of professor of comparative anatomy at University College London in 1827, as did a number of other key figures from the Edinburgh medical and scientific establishment ([Wakley], 1850, p. 690). Grant provides a shining example of how an openly transformist thinker could be fully integrated into the network of patronage and friendship that existed in Edinburgh natural history circles in the 1820s. His ability to publish articles in a respected journal openly avowing his transformist views surely must lead us to question any interpretation of him as a radical outsider at that time, even if, as Desmond has suggested, his situation in London after his move there in 1827 may have been very different (Desmond, 1984).

Charles Darwin, who was a medical student at Edinburgh between 1825 and 1827, had no time for Jameson's Wernerian geology (Darwin, 2002, p. 26).[13] It has been suggested by a number of scholars that the development of Darwin's evolutionary theory may have been more deeply influenced by the transformist ideas he must have encountered in Edinburgh that has conventionally been accepted, or than Darwin himself was prepared to admit (see, for example, Secord, 1991; Hodge, 2014). However, while he may have been influenced by the ideas he would have heard discussed by Grant and some of his student contemporaries, Jameson's Wernerian geology does not seem to have been among the influences pushing him towards his theory of evolution. Although he attended Jameson's lectures during his second year in Edinburgh, Darwin seems not to have got much out of them (Ashworth, 1935, pp. 99–100). He much later described Edinburgh's professor of natural history in a letter to J. D. Hooker as "that old, brown, dry stick Jameson" (Darwin, 1985–, vol. 5, p. 195). In his posthumously published autobiography he went on to claim of Jameson's "incredibly dull" lectures that "The sole effect they produced on me was the

[13] An old, but still valuable account of Darwin's studies at Edinburgh can be found in Ashworth (1935).

determination never as long as I lived to read a book on Geology or in any way study the science.'' (Darwin, 2002, pp. 25–26). It is therefore perhaps not surprising that he does not appear to have made the connection between a directional history of the earth and the transmutation of species that some of his older contemporaries undoubtedly did. He was certainly exposed to transformist ideas in Edinburgh, as it is well known that while he was there he had a short-lived but close friendship with Robert Grant, with whom he used to go on long invertebrate-collecting trips along the Firth of Forth. Darwin famously noted in his autobiography that Grant ''burst forth in admiration of Lamarck and his views on evolution'' one day while they were on a collecting trip together, although Darwin denied that this had any significant effect on his own thinking (Darwin, 2002, p. 24). When he did come to formulate his own theory of evolution, it was to grow not from a directional model of geohistory, but from the, to all appearances, less fertile ground of Charles Lyell's uniformitarian geology, a model of earth history that had been developed in part as a refutation of Lamarckian transformism (see, for example, Rudwick, 2008). However, Darwin's rejection of Wernerian geology does not rule out the possibility that some germs of his own theory of evolution may not have been planted during his years in Edinburgh.

Unlike the Darwinian theory of evolution, with its roots in Lyell's essentially unchanging, uniformitarian vision of the earth, which would have been entirely congenial to Jameson's Huttonian enemies in the early decades of the nineteenth century, the transformists of the Edinburgh of the 1820s drew inspiration from a progressive, directional model of the history of the earth associated with Werner and his Edinburgh followers. Corsi has pointed out that Geoffroy Saint-Hilaire's model of transformism, unlike Lamarck's ''had the additional virtue of being formulated in the context of a geological hypothesis linking the vast, progressive changes in environmental conditions to a parallel development of living forms.'' (Corsi, 1988, p. 215). It was just such a fertile soil that Wernerian geology provided for transformism in Edinburgh in the early decades of the nineteenth century. This should perhaps come as no surprise, for, as Corsi has demonstrated, a number of European thinkers, notably Jean-Claude Delaméthrie (1743–1817), made similar connections (see, for example, Corsi, 2012). Indeed, it seems that Lamarck may have been somewhat unusual among transformists in the early nineteenth century in espousing a uniformitarian geology.

In this paper I have tried to show how directional theories of the history of the earth, inspired principally by the work of Werner, opened up the possibility of a transformist solution to the problem of the progressive nature of the fossil record for a generation of Scottish geologists and natural historians. These figures seem to have largely belonged to a circle around Robert Jameson, the professor of natural history at the University of Edinburgh and Werner's most important British disciple. Jameson, who was clearly sympathetic to transformist ideas himself, taught a number of these figures as professor of natural history at Edinburgh, provided a forum for them to air their ideas through his editorship of the *Edinburgh New Philosophical Journal* and his presidency of the Wernerian Natural History Society, and also acted as an important patron to some of his younger colleagues. This circle of transformist and progressivist natural historians seems to have emerged in first decades of the century before losing coherence after around 1830. The eclipse of neptunist theories of the earth and the ascendancy of catastrophist models less congenial to transformist interpretations of the history of life doubtless go some way to explain this phenomenon, while other social, religious and political factors, such as the growing Evangelical reaction against transformism, certainly also must have played a role. Because the transformist theories of Lamarck and Chambers did not rely on environmental change to drive transmutation the decline of Wernerian geology did not lead to the complete disappearance of transformism from debates on the natural world, and geologists such as Lyell still found it worthwhile to refute them. However, critics found it relatively easy to dismiss Lamarck's theory as a fanciful, speculative system, and it did not seem to have had many adherents in elite natural history circles after the early 1830s, while Chambers' development hypothesis met an almost universally hostile reception from expert critics on its publication in 1844. Another generation would pass before transformist ideas would once again be taken seriously by British scientists and natural historians. And when that happened they would re-emerge in a very different context. Nonetheless, the speculations regarding the history of life that took place among Robert Jameson's students and in the pages of the *Edinburgh New Philosophical Journal* were surely not entirely without consequence. At a time when Edinburgh was the leading center of medical education in the English-speaking world the exposure of a generation of Edinburgh students to a gradualist, progressive vision of the history of life, fully compatible with the transmutation of species, must surely have colored their reception of

evolutionary ideas when they again bubbled to the surface in the succeeding decades.

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