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Edward Hitchcock's Pre-Darwinian (1840) "Tree of Life"

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Abstract. The "tree of life" iconography, representing the history of life, dates from at least the latter half of the 18th century, but evolution as the mechanism providing this bifurcating history of life did not appear until the early 19th century. There was also a shift from the straight line, scala naturae view of change in nature to a more bifurcating or tree-like view. Throughout the 19th century authors presented tree-like diagrams, some regarding the Deity as the mechanism of change while others argued for evolution. Straight-line or anagenetic evolution and bifurcating or cladogenetic evolution are known in biology today, but are often misrepresented in popular culture, especially with anagenesis being confounded with scala naturae. Although well known in the mid 19th century, the geologist Edward Hitchcock has been forgotten as an early, if not the first author to publish a paleontologically based "tree of life" beginning in 1840 in the first edition of his popular general geology text *Elementary Geology*. At least 31 editions were published and those between 1840 and 1859 had this "paleontological chart" showing two trees, one for fossil and living plants and another for animals set within a context of geological time. Although the chart did not vary in later editions, the text explaining the chart did change to reflect newer ideas in paleontology and geology. Whereas Lamarck, Chambers, Bronn, Darwin, and Haeckel saw some form of transmutation as the mechanism that created their "trees of life," Hitchcock, like his contemporaries Agassiz and Miller, who also produced "trees of life," saw a deity as the agent of change. Through each edition of his book Hitchcock denounced the newer transmutationist hypotheses of Lamarck, then Chambers, and finally Darwin in an 1860 edition that no longer presented his tree-like "paleontological chart."

Keywords: L. Agassiz, H. Bronn, R. Chambers, creationism, G. Cuvier, C. Darwin, E. Geoffroy Saint-Hilaire, S. Gould, E. Haeckel, E. Hitchcock, J. Lamarck, H. Miller, P. Pallas, phylogeny, scala naturae, "tree of life"

Introduction

The American geologist and third President of Amherst College (1845–1854), Edward Hitchcock (1763–1864), is best known among scientists for his pioneering work on fossil trackways in the Connecticut River Valley.[1] His large collection of trackways, which includes those of dinosaurs, is housed at the Pratt Museum of Amherst College, Massachusetts. These were described in scientific papers as well as in his popular text *Elementary Geology* published as sole author between 1840 and 1859, and with his geologist son Charles H. (1836–1919) between 1860 and 1870.[2]

Elementary Geology was very influential in its day and was perhaps the best summary of Hitchcock's views. Hitchcock's geological views certainly were not biblically literal, because the English geologist Charles Lyell's (1797–1875) uniformitarianism was beginning to find a place in Hitchcock's thinking, but Hitchcock still argued that catastrophism was an important agent in shaping the earth's crust.[3]

What appears to have been lost to the history of science is that in the sole authored editions between 1840 and 1859, Hitchcock published a branching diagram of both the animal and plant kingdoms that he referred to as a tree. Also, it was set within a geologic context showing what was then known for fossils of some groups. This appears to be the

[1] Padian and Olsen, (1989), pp. 231–235.

[2] I examined 13 variants of the text of *Elementary Geology*. Four of these were original texts (1841, 2nd ed.; 1847, new ed.; 1847, 8th ed.; 1852, 8th ed.), which all preserved the foldout paleontological chart at the front of the text. I was also able to observe three of four of these same texts as pdfs, as well as six additional pdf variants (1840, 1st ed.; 1842, 3rd ed.; 1844, 3rd ed.; 1845, 3rd ed.; 1855, 25th ed.; 1856, 30th ed.), all copies of the original text. None of the pdf versions included the chart but all have a description of the chart indicating that originally it accompanied or at least was intended to accompany the text. Three additional pdf variants (1860, 31st new ed.; 1862, new ed.; 1866, new ed.) were co-authored with Edward Hitchcock's son Charles, but none have any indication that the chart was present in the bound volume. None of the three variants co-authored with Charles indicates an edition on the cover page, other than being a "new edition." All three have a "preface to the thirty-first edition" by Edward Hitchcock dated June 1, 1860. All variants except the 1840, 1st edition have an "introductory notice" by the English theologian-geologist John Pye Smith (1774–1851), although those editions coauthored with Charles do not indicate this on the title page. Not all editions and variants of *Elementary Geology* were viewed, but based on hard copies and pdfs that were viewed, and library records for the Library of Congress and Amherst College, it appears that the 1859, 30th edition was the last solely authored by Edward Hitchcock; the 1860, 31st new edition was the first with his son Charles; and the 1870, 32nd new edition may have been the last printing.

[3] Lawrence, 1972, pp. 30–31.

earliest such figure, but as I will discuss, it is clear that Hitchcock did not intend his diagram to support the hypothesis of evolution, which was controversial at the time.

Early Biological "Tree of Life" Iconography

Tree imagery is widespread in human culture, being used to represent a diversity of conceptualizations. As a general vehicle to show history in a Western tradition, however, it may well date to the Calabrian mystic Joachim of Floris (1135–1202). His view was of three ages of the father, son, and the Holy Spirit. While decidedly religious, what was of importance was his image of this history as a tree with overlapping ages. It arguably helped shape our modern conception of history.[4]

Our quite common iconography of the family tree dates from the late Renaissance, when noble families in Europe had their pedigrees drawn as genealogical trees. When and how this iconography was borrowed to show the history of life or "tree of life," is not certain but a likely candidate is the German/Russian naturalist Peter Simon Pallas (1741–1811) who suggested a systematic arrangement of all organisms in the image of a tree in his *Elenchus Zoophytorum* in 1766.[5] Pallas did not provide a diagram or describe a mechanism, but his intent is very clear.

> But the system of organic bodies is best of all represented by an image of a tree which immediately from the root would lead forth out of the most simple plants and animals a double, variously contiguous animal and vegetable trunk; the first of which would proceed from mollusks to fishes, with a large side branch of insects sent out between these, hence to amphibians and at the farthest tip it would sustain the quadrupeds, but below the quadrupeds it would put forth birds as an equally large side branch.[6]

[4] Cook, 1988, pp. 28–30, 124.

[5] Hestmark, 2000, p. 911.

[6] Pallas, 1766, pp. 23–24, "At omnium optime Arboris imagine adumbraretur Corporum organicorum Systema, quae a radice statim, e simplicissimis plantis atque animalibus duplicem, varie contiguum proferat truncum, Animalem & Vegetabilem; Quorum prior, per Mollusca pergat ad Pisces, emisso magno inter haec Insectorum laterali ramo, hinc ad Amphibia; & extremo cacumine Quadrupedia sustineret, Aves vero pro laterali pariter magno ramo infra Quadrupedia exsereret." English translation by E. N. Genovese.

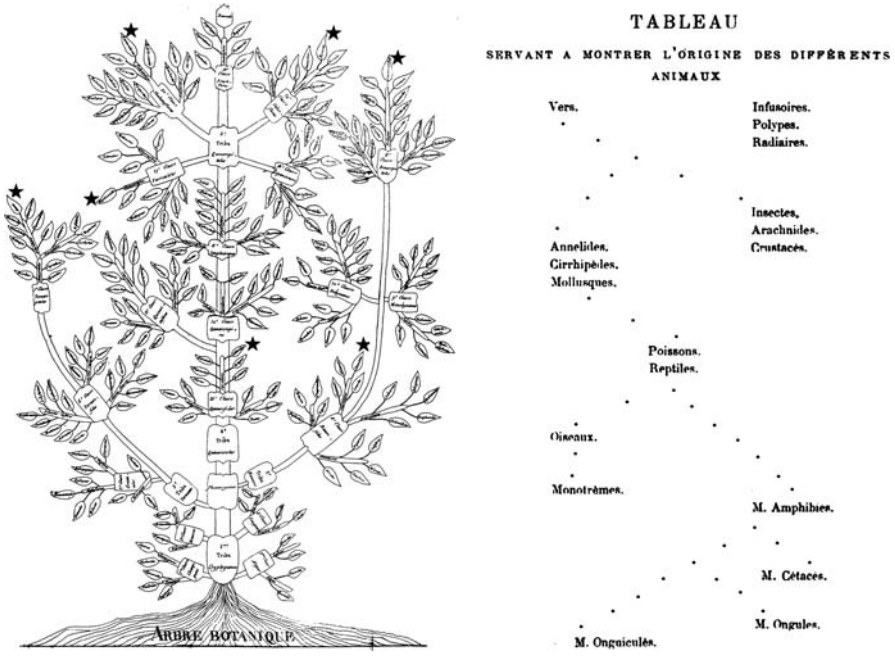

Figure 1. Left, Augier's 1801 Arbre botanique (see Stevens, 1983). Right, Lamarck's 1809 branching diagram of animals for which he argued evolutionary change was the cause. His dots have been slightly embellished so that they might show better.

The earliest known published tree of which I am aware showing relationships of organisms is that of the obscure French botanist Augustin Augier who in 1801 published a quite detailed tree-like diagram replete with leaves depicting his views of the natural relationships between members of the plant kingdom (Figure 1). Augier does refer to the Creator and from what can be determined he did not accept an evolutionary mechanism for his tree. Earlier he had accepted the idea of a scala naturae but the nature of the plants he studied did not allow such a linear series, thus pointing him to a tree-like figure.[7]

[7] Stevens, 1983, pp. 203, 208–210. Stevens, 1993, 206 translates the following from Augier, 1801, p. 2, "A figure like a genealogical tree appears to be the most proper to grasp the order and gradation of the series or branches which form classes or families. This figure, which I call a botanical tree, shows the agreements which the different series of plants maintain amongst each other, although detaching themselves from the trunk; just as a genealogical tree shows the order in which different branches of the same family came from the stem to which they owe their origin."

Early in his career, the French naturalist and evolutionist Jean-Baptiste Lamarck (1744–1829) was an advocate of a scala naturae or single series view of the history of life, but he later accepted that branching had occurred.[8] Hence, in 1809 he published the first known branching diagram of animals that explicitly argued for evolution as the cause of the splitting (Figure 1).[9] Lamarck's diagram can fairly be called the first evolutionary "tree of life" because it marries a branching diagram with evolution as the mechanism creating the branching.[10] Although Lamarck's sketchy, evolutionarily based, tree-like diagram is somewhat unusual in that it opens downwards, it is nevertheless clear what Lamarck was showing. In the discussion preceding the diagram he hypothesizes that the loss of the hind limbs and pelvis in cetaceans and the similar trend in seals are a result of disuse, one of his themes for the cause of evolution.

> If it is considered that, in the seals where the pelvis still exists, this pelvis is impoverished, narrowed and without hip projections; it will be felt that the poor use of the posterior feet of these animals must be the cause, and that if this use entirely ceased, the hind feet and even the pelvis could at the end disappear… The following chart will be able to facilitate the intelligence of what I have just

[8] One reviewer raised an interesting query, namely whether Lamarck's branching diagram is showing common descent or whether its is better viewed as a "branched scala naturae, with new organisms being forever created at the root by spontaneous generation, and then ascending up the branches independently of one another."

Appel, 1980, p. 310 noted, "Lamarck's two-factor theory of evolution also allowed for branching in the animal series. If the first factor – the inherent tendency of matter to develop increasing perfection – acted alone, the animals would indeed form a perfect series. However, the second factor, the adaptive power of the environment acting upon animals through their needs, led to anomalies or branches in the series."

In his essay included in a 1984 translation of *Zoological Philosophy*, Burkhardt (1980) addressed Lamarck's view of the pattern of evolution. Burkhardt noted that by 1802, Lamarck indicated that because of environmental influences, animal species could not be arranged linearly, but rather formed "lateral bifurcations" (p. xxiv) and further that by 1815 Lamarck viewed a single line of increasing complexity as untenable (xxxiii).

It would appear that by at least 1809 when *Zoological Philosophy* was published that Lamarck allowed if not strongly supported repeated spontaneous generations leading to more than one ramifying histories. Thus it would also seem correct to say that his 1809 diagram does represent a bifurcating tree, but he may well have had more than one such tree in mind.

[9] Lamarck, 1809, figure on p. 463.

[10] Voss, 1952, p. 17.

> exposed. It will be seen there that, in my opinion, the animal scale starts at least with two particular branches, and that, in the course of its extent, some branches appear to finish in certain places.[11]

An evolutionist contemporary of Lamarck, the French naturalist Etienne Geoffroy Saint-Hilaire (1772–1884), argued a major role for paleontology in elucidating evolution. This put Geoffroy Saint-Hilaire at odds with the great French naturalist George Cuvier (1769–1832), both for his evolutionary views and for his trespassing in Cuvier's paleontological sandbox.[12] Yet, unlike Lamarck, Geoffroy Saint-Hilaire never presented his views as a tree-like figure even though his evolutionary intent was clear in such work as that on marine reptiles. For example, although he erroneously mixed what we know today to be distantly related groups of aquatic reptiles,[13] his paleontologically based evolutionary intent was clear.

> If the alleged crocodiles of Caen and Honfleur contained in similar earth, those of the Jurassic formation, with the plesiosaurus, would not be in the order of times, as well as by degrees of their organic composition, a ring of junction which would attach without interruption these very-old inhabitants of the earth to the reptiles currently alive and known under the name of gavials.[14]

After Lamarck in the middle third of the 19th century, various authors utilized variants of the "tree of life" iconography, some who like Lamarck

[11] Lamarck, 1809, p. 462, "Si l'on considère que, dans les phoques où le bassin existe encore, ce bassin est appauvri, resserré et sans saillie sur les hanches; on sentira que le médiocre emploi des pieds postérieurs de ces animaux en doit être la cause, et que si cet emploi cessait entièrement, les pieds de derrière et le bassin même pourraient à la fin disparoître. …Le tableau suivant pourra faciliter l'intelligence de ce que je viens d'exposer. On y verra que, dans mon opinion, l'echelle animale commence au moins par deux branches particulières, et que, dans le cours de son étendue, quelques rameaux paroissent la terminer en certains endroits."

[12] Bourdier, 1969, pp. 44–51.

[13] Desmond, 1979, p. 230, footnote 31.

[14] Geoffroy Saint-Hilaire, 1833, p. 4, "Si les prétendus crocodiles de Caen et de Honfleur renfermés dans de semblables terrains, ceux de la formation jurassique, avec les plesiosaurus, ne seraient point dans l'ordre des temps, aussi bien que par les dégrés de leur composition organique, un anneau de jonction qui rattacherait sans interruption ces très-anciens habitants de la terre aux reptiles actuellement vivants et connus sous le nom de gavials?"

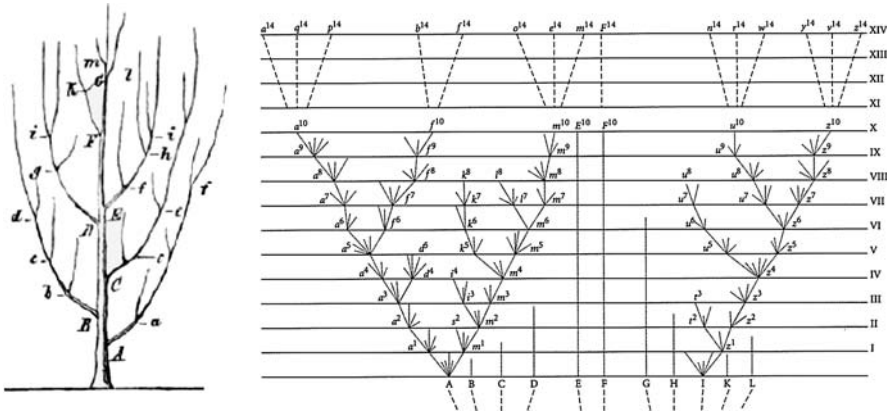

Figure 2. Left, the hypothetical phylogenetic tree of Bronn (1858). Right, hypothetical phylogenetic tree and only figure in Darwin 1859.

argued for some evolutionary force.[15] Others did not accept evolution as the mechanism for change that they saw in the fossil record, but rather argued it was God who caused the observed change. These persons will be discussed more thoroughly later but for contextual purposes they are noted here. The best known is the Swiss-American scientist Louis Agassiz (1807–1873). Lesser known are Edward Hitchcock, the subject of this paper, and the Scottish geologist Hugh Miller (1802–1856). As will be discussed, all three published what they likened to trees, but it was Hitchcock who appears to have been the earliest to do so in 1840.

The next commonly recognized tree-like diagram purporting to show evolutionary history after Lamarck is that of the German paleontologist Heinrich Georg Bronn (1800–1862), who employed a tree analogy in 1858 in which he used a very wispy tree-like figure labeled with letters (Figure 2),[16] not unlike Darwin's labeling of his more stick-like hypothetical phylogeny in *Origin of Species* in 1859.

[15] Barsanti, 1992, p. 92 mentions that Chambers (1844, p. 212), along with Carpenter (1841, p. 197), Wallace (1856, p. 205), as well as Darwin (1859, between pp. 116–117) provided "natural" trees that included the fourth dimension (of time). I agree that the simple stick figures of Carpenter and Chambers can be said to be tree-like and are directional. These authors, however, describe these diagrams as showing ontogenetic (using current terminology) stages through which major vertebrates groups were thought to pass, rather than describing these as akin to 'trees of life.' Wallace's diagram is a network rather than a tree and thus is not clearly delineating descent. Of course Darwin's is a hypothetical phylogeny.

[16] Bronn, 1858. The figure first appeared on p. 481 in 1858 in the German version Untersuchungen über die Entwicklungs-Gesetze der organischen Welt während der Bildungszeit unserer Erd-Oberfläche and again on p. 900 in 1861 in the French version Essai d'une résponse a la question de prix proposée en 1850.

Bronn seems to have been most concerned with addressing the idea that although there was a trend toward perfection, less perfect forms kept branching even after more perfected forms had appeared ("… but the twig ***c*** of the first branch develops only after the twig ***b*** of the second…").[17] While certainly not a creationist, Bronn was less accepting of Darwin's natural selection as the mechanism for species changes in particular, or any mechanism in general to explain the pattern of change he saw in the history of life.[18]

The fold-out (and only) diagram showing a branching scheme for two hypothetical lineages and the stasis of another nine in Charles R. Darwin's (1809–1882) *Origin of Species* (1859)[19] appears to be only the third such published diagram after Lamarck (1809)[20] and Bronn (1858)[21] to argue that this pattern is the result of evolution; specifically, for Darwin, natural selection was the chief but not the only cause (Figure 2). We now know that Darwin had been thinking of such branching diagrams well before the publication of *Origin of Species* in 1859.[22]

One of the best-known and oft-repeated figures comes from Darwin's Notebook B[23] in which he used letters on a branching stick figure, certainly a precursor of the sole figure in *Origin of Species* in 1859 (Figure 3A). He does not mention the use of a tree analogy here, but a few pages earlier he noted, "The tree of life should perhaps be called the coral of life, base of branches dead; so that passages cannot be seen."[24] This is accompanied by a three-way branching diagram whose upper parts are solid lines and whose lower parts are dotted lines, presumably as an analogy to coral (Figure 3B).[25] This is followed on the same page

[17] Bronn, 1861, p. 899 ("…mais le rameau ***c*** de la première branche ne se développe qu'après le rameau ***b*** de la seconde…").

[18] Gliboff, 2007, pp. 286–291; Williams and Ebach, 2008, p. 42.

[19] Darwin, 1859, figure inserted between pp. 116 and 117.

[20] See footnote 7.

[21] See footnote 12.

[22] O'Hara, 1996, p. 82.

[23] Darwin, 1837–38, pp. 36–37; de Beer, 1960, p. 46; Gruber, 1978, p. 129.

[24] Darwin, 1837–38, p. 25, de Beer, 1960, p. 44, Gruber, 1978, p. 128.

[25] Darwin, 1837–38, p. 26; de Beer, 1960, p. 44, Gruber, 1978, p. 128, 126, makes the reasonable suggestion that this three-way branching diagram is described earlier on pp. [23–24]by Darwin, "Would there not be a triple branching in the tree of life owing to three elements air, land & water, & the endeavour of each one typical class to extend his domain into the other domains, and subdivision three more, double arrangement. – if each main stem of the tree is adapted for these three elements, there will be certainly points of affinity in each branch."

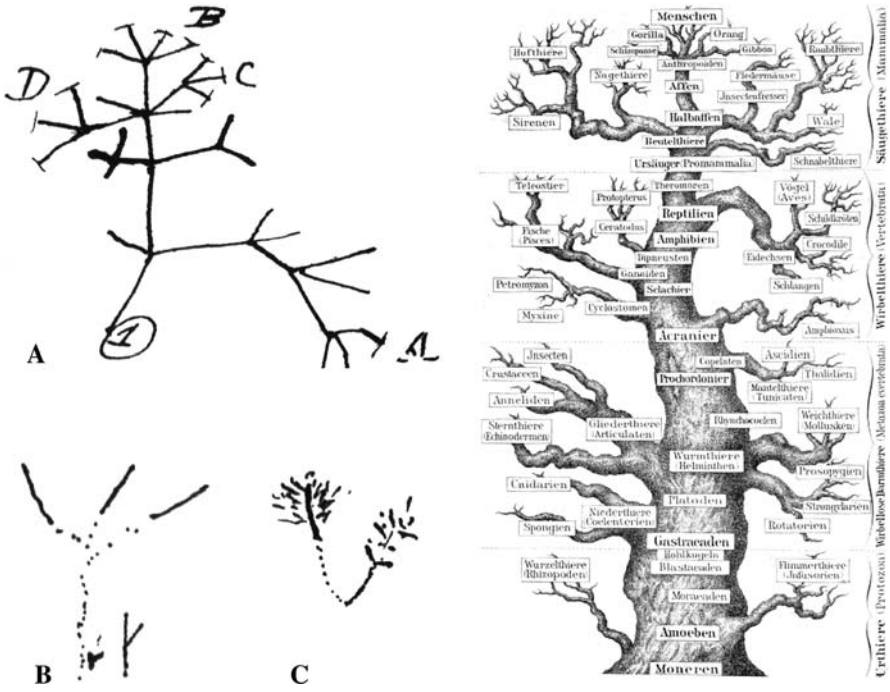

Figure 3. Left, phylogenetic diagrams from Darwin's Notebook B (1837–1838) (Redrawn after http://darwin-online.org.uk/manuscripts.html). (A) A branching stick figure. (B) A "coral of life" phylogenetic analogy presumably showing the dead portion by dotted lines and the living portion by solid lines. (C) Another, bushier version possibly representing birds on the left and fishes on the right. Right, Haeckel's (1874, plate XII) *Stammbaum des Menschen* (pedigree of man).

by a slightly bushier version (Figure 3C) about which he appears to say, "Is it thus fish can be traced right down to simple organization. – birds – not?" One can surmise that the branch on the left (Figure 3C) with the longer dotted line represents the bird clade about which very little was known at the time versus the right branch that has a solid line down to the bifurcation point, probably representing the much better fossil history of fishes. Somewhat unfortunately, the less accurate tree analogy prevailed over his coral analogy. Darwin's use of "perhaps" in his statement that "[t]he tree of life should perhaps be called the coral of life" suggests that he was aware that the "tree of life" was already a recognized icon and thus his coral analogy would not supplant it.

Being well aware of Lamarck's work, it is possible that Darwin was also familiar with Lamarck's 1809 "diagram showing the origin of the

various animals''[26] that joined the iconography of a branching diagram with the concept of evolution. This is suggested by the fact that Darwin discusses the aquatic adaptations of mammals recognized by Lamarck (as well as others),[27] which Lamarck had discussed a few pages before his diagram.

The German biologist and evolutionist Ernst Haeckel (1834–1919) was the first to exploit fully the tree analogy beginning in 1866 with numerous branching trees as well as branching stick diagrams, both showing actual taxa.[28] Haeckel's representations had been influenced by Bronn. Bronn also made the first German translation of *Origin of Species* (1859) in 1860, which Haeckel began to read in the summer of 1860.[29] Haeckel was a consummate artist and unlike tree representations before and after, some of his have a quite gothically gnarled, mysterious, and even grotesque appearance (Figure 3).[30]

It was Haeckel in 1866 who coined the term ''phylogeny'' as ''tribal history'' or ''paleontological history of evolution,'' or more precisely ''phylogeny includes palaeontology and genealogy'' with the best evidence of genealogy being paleontology.[31] Benoit Dayrat has pointed out that our sense of a phylogeny, as a genealogical tree is not the sense that Haeckel intended for the term. According to Dayrat, Haeckel referred to trees that he drew as ''Stammbaum,'' which means a ''genealogical tree'' or ''pedigree'' whereas in Haeckel's usage ''phylogeny'' was a succession of morphological types, which harked back to the older idea of scala naturae.[32] This is not the case today; a phylogeny may represent a branching sequence of morphological types, but it now refers more

[26] Lamarck, 1809, ''tableau servant à montrer l'origine des différens animaux'' on p. 463.

[27] Darwin, 1859, pp. 427–428.

[28] Williams and Ebach, 2008, pp. 38–39.

[29] Oppenheimer, 1987, p. 123; Richards, 2004, p. 121.

[30] Breidbach, 2006. The entire book is devoted to the scientific art of Haeckel.

[31] Williams and Ebach, 2008, p. 49 stated, ''Haeckel coined the word ''phylogeny'' (Haeckel, 1866, I, p. 57; II, p. 301: ''Generelle phylogenie oder Allegemeine Entwickelungsgeschichte der organischen Stämme'') for what he later described as the ''tribal history, or 'palaeontological history of evolution''', adding for precision, ''Phylogeny includes palaeontology and genealogy'' (Haeckel, 1874 …).'' Reif (1983. p. 7) claimed that the German paleontologist Franz Martin Hilgendorf's (1839–1904) ''collection [of the snail *Planorbis*] contains the oldest phylogenetic tree, which is known so far.'' Hilgendorf's published the phylogeny in 1866, but as Reif showed, the materials for Hilgendorf's unpublished 1863 dissertation indicate a fossil based phylogeny. While I do not agree that this is the earliest phylogeny (Lamarck, 1809 is), it may well be the earliest one based on the fossil record.

[32] Dayrat, 2003, pp. 515, 525–526.

broadly to the evolutionary history of any set of populations or taxa and can be built from molecules, morphology, or both.[33]

Popular Conceptions and Current Biological "Tree of Life" Iconography

In addition to considerable scholarly work on "tree of life" iconography, it has also found it way into popular culture, notably in both print and video advertisements. Along with this iconography have come some profound misunderstandings by the general public of how evolution operates. This was a favorite topic of the late American paleontologist Stephen Jay Gould.[34] He drew a sharp contrast between showing the history of life as a ladder, great chain of being, or scala naturae versus some sort of botanical analogy such as a tree or bush.

The term anagenesis is sometimes unfairly given as a proxy for scala naturae.[35] It is unfair in the sense that whereas the scala naturae from the time of Lamarck and before was intended to represent all life from inanimate matter at the base to humans at its upper reaches, it most often was not evolutionary in intent. Anagenesis is most often used now in paleontology to trace the evolutionary history of a series of fossil species in a limited area that change but do not appear to divide into multiple lineages. The concept of anagenesis, however, can lead to oversimplification. For example, the series of anagenetic changes that formerly were used to represent horse evolution was known to be an oversimplification even early in its inception.[36]

Similarly, the Pulitzer Prize-winning, Russian-born American nature artist Rudolf Zallinger (1919–1995) created the linear depiction of human evolution for the 1965 popular book on human evolution by the American anthropologist F. Clark Howell (1925–2007) (Figure 4).[37] Although it was not intended to do so, this iconography has helped perpetuate the misrepresentation of evolution as a straight-line process

[33] I have attempted to be consistent in using "tree of life" or tree-like diagram in a general sense for any branching figure showing the history of life, whereas I follow the general intent of Haeckel (1866) in referring to a branching diagram based on evolutionary change as a "phylogeny." Thus I regard the published branching diagrams of Lamarck (1809), Bronn (1858 and 1861), Darwin (1859), and Haeckel (1866) to be phylogenies, whereas those of Hitchcock (1840) and Agassiz (1844) are not. All are "trees of life."

[34] Gould, 1989, pp. 27–45; 1991, pp. 168–181; 1993, pp. 427–438.

[35] Campbell and Hodos, 1991, pp. 211–214.

[36] See Gould, 1991, pp. 168–181.

[37] Howell, 1965, pp. 41–45.

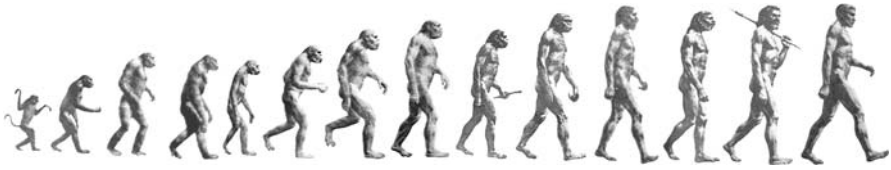

Figure 4. Modified rendition after Zallinger's linear depiction of human evolution for the 1965 popular book on human evolution by Howell that unfortunately perpetuates the scala naturae view of evolution.

or ladder that has been rightly condemned, but still, it persists in advertising.[38] Nevertheless, there are much shorter intervals of times (tens of thousands rather than tens of millions of years) over which given species in a small region appear to show anagenetic or directional change without splitting into lineages. Thus, whereas anagenesis is very likely to be a process limited in time and space, it nonetheless has support from a number of case studies in limited geographic regions.[39]

Cladogenesis (clade birth), often represented by a tree or branching diagram, is clearly the dominant mode of speciation simply by the fact that clades must split to form additional taxa. There are of course many instances especially in plants or microorganisms where hybridization joins or even reticulates clades. The tree or bush analogy is the most common way of showing such relationships.

Today, emphasis has shifted from paleontological to genetic evidence for phylogeny. Hence, a not untypical definition is: "phylogenetic tree (or phylogeny): a graphical representation of evolutionary genetic history."[40] Of course at the time of Darwin and before, nothing was known of genetics, but the pattern of descent begged for an explanation. That explanation for the tree pattern need not have been evolution, and except for Lamarck's, 1809 "tableau" (diagram) and probably Bronn's, 1858 tree, the mechanism for change in pre-Darwinian trees was certainly some form of multiple creations by a deity. This is certainly the case for Hitchcock's "Paleontological Chart" first published in 1840.

Hitchcock's *Elementary Geology* and Anti-Evolutionary Views

Edward Hitchcock staunchly believed and argued that evolution could not be the mechanism for change that he saw in the fossil record.

[38] Gould, 1989, pp. 29–35.

[39] Rose and Bown, 1993, pp. 299–330 discuss the recognition of anagenetic lineages in Eocene primates.

[40] Avise, 2007, p. 5.

He certainly was neither a six-day, literal creationist, nor a theistic evolutionist as we shall see, but rather saw God's direct hand as the agent for change over geologic time. Unlike Lyell, Hitchcock saw progression in the fossil record, which affected the way he represented it.[41]

> *Inference 14* It appears that every successive general change, that has taken place on the earth's surface has been an improvement of its condition.
> *Proof* Animals and plants of a higher organization have been multiplied with every change, until at last the earth was prepared for the existing races; the most generally perfect of all with man at their head.

Hitchcock's attacks on evolution in *Elementary Geology* changed over time, as each new proponent emerged, starting with Lamarck in the 1840 edition. Although he saw progress in species over geologic time, he also argued that all major groups had been present early in earth history.[42]

THE HYPOTHESIS OF TRANSMUTATION OF ANIMALS

> *Inference 1* From the preceding table we learn that all the important classes of animals and plants are represented in the different formations.
> *Inference 2* Hence we learn that the hypothesis of Lamark is without foundation, which supposes there has been a transmutation of species from less to more perfect, since the beginning of organic life on the globe: that man, for instance, began his race as a *monad*, (a particle of matter endowed with vitality,) and was converted into several animals successively; the ourang outang being his last condition – before he became man.

Although it could be in a later edition of *Elementary Geology*, that of 1856 is the latest in which I could locate this response to Lamarck. It is not in the 1860 edition.

The next transmutation threat came in the form of the English publisher Robert Chambers' (1802–1871) then anonymous *Vestiges of Creation*, first published in 1844. Hitchcock's first response to *Vestiges* was his inaugural address as president of Amherst College in 1845

[41] Hitchcock, 1840, p. 161.
[42] Hitchcock, 1840, p. 91.

(Lawrence, 1972).[43] The first scientific rebuttal came in the 1847 edition of *Elementary Geology*.[44] This is that quote, taken from the 8th edition (1852).[45]

> … no plants have been found below the upper part of the Silurian rocks; yet it seems certain that they must have existed as early as animals. It is also true, that no vertebral animals have been found in the lower Silurian group. Hence a late anonymous writer very strenuously maintains the doctrine of the creation and gradual development of animals by law, without any special creating agency on the part of the Deity. *Vestiges of the Natural History of the Creation and a Sequel to the Same: New York 1844 and 1846*. But the facts in the case show us merely that the different animals and plants were introduced at the periods best adapted to their existence, and not that they were gradually developed from monads. In the whole records of geology, there is not a single fact to make such a metamorphosis probable; but on the other hand, a multitude of facts to show that the Deity introduced the different races just at the right time. That he did this according to certain laws though not by their inherent force, – for laws have no such force – may be admitted; as may be done in respect to all his operations: but this does not prove them any the less special or miraculous.

He does not dispute that species are introduced at different intervals of time in geologic history. He argues, however, that the geologic record shows no godless gradual change or metamorphosis. Rather, the facts show that these introductions of various species were by the Deity at just the right time.

By the 25th edition (1855) he has added a fuller discussion under two headings ''Hypothesis of creation and development by Law'' followed by ''Supposed Geological Proof of the hypothesis.''[46] By ''law'' in the first heading he certainly means what he calls ''natural law,'' which argues that the origin of the universe (cosmogony), the origin of life (zoogony), and the improvement of life forms (zoonomy) occurred

[43] Lawrence, 1972, pp. 32–33, ''Hitchcock's first response the [sic] *Vestiges* was contained in his inaugural address as president of Amherst College. The main theme of the address was its title, *The Highest Use of Learning*.''

[44] Lawrence, 1972, p. 32.

[45] Hitchcock, 1852, p. 168.

[46] Hitchcock, 1855, ''Hypothesis of creation and development by Law'' (pp. 333–334) followed by ''Supposed Geological Proof of the hypothesis'' (pp. 334–335).

"without any special Divine Interposition."[47] He continues that this can be adopted by those arguing for atheism or by those such as the author of Vestiges that see this as God's law.[48]

> The proposed object of these latter works [referring to *Vestiges*] is to prove that the whole revelation of the works of God, presented to our senses and reason, is a system based 'on what we are compelled, for want of a better term, to call *law*." But if the views are adopted, they virtually annihilate the doctrines of miraculous and special Providence and of prayer.

He has explicitly rejected not only atheistic evolution, but theistic evolution as well. Under "Supposed Geological Proof of the hypothesis" he clearly gives his position, probably best summarized in these two quotes: "The gradual introduction of higher races is perfectly explained by the changing condition of the earth which being adapted for more perfect races Divine Wisdom introduced them"[49] and "But so immeasurably is man raised by his moral and intellectual faculties above the animals next below him in rank that the idea of his gradual evolution from them is absurd."[50] Interestingly, Hitchcock uses the phrase "gradual evolution" as we would today. He, of course, is no theistic evolutionist.

By the 31st edition in 1860 with his son Charles, no mention is made of *Vestiges*, although certainly in reference to it there is a discussion dealing with "creation by laws" versus Hitchcock's "special Divine creating power" for the appearance of new species.[51] Mention of Lamarck is also gone, but because of an editorial error the index gives the following entry, "Lamarck's hypothesis of transmutation of species, 270."[52] But on page 270 it is Darwin that has now taken the helm of the transmutationists.[53]

> "We find in the history of fishes," says Pictet, "many arguments against the hypothesis of the transition of species from one into the other. The Teleosteans could not have had their origin in the fishes which existed before the cretaceous epoch, and it is impossible to derive the Placoids and Ganoids from the Teleosteans. The connection of faunas, as Agassiz has said, is not material, but resides in

[47] Hitchcock, 1855, pp. 333–334.
[48] Hitchcock, 1855, p. 334.
[49] See footnote 47.
[50] Hitchcock, 1855, pp. 334–335.
[51] Hitchcock and Hitchcock, 1860, pp. 373–374.
[52] Hitchcock and Hitchcock, 1860, p. 425.
[53] Hitchcock and Hitchcock, 1860, p. 270.

> the thought of the Creator.'' It is well to take heed to the opinions of such masters in science, when so many, with Darwin at their head, are inclined to adopt the doctrine of gradual transmutation in species.

An 1866 edition of *Elementary Geology*, published two years after Hitchcock's death, carries the same material as that of the 1860 edition. Until the end, Hitchcock maintained his anti-evolutionary stand.

Hitchcock discussed his anti-evolutionary ideas in many other venues in addition to *Elementary Geology*, most notably in what has been called his masterwork, *Religion of Geology*, first published in 1851. This was a different sort of book from *Elementary Geology*. While *Elementary Geology* had many illustrations and was filled with geological facts, *Religion of Geology* had but one illustration, a hand-colored frontispiece ''section of the earth's crust.''

As Lawrence noted, ''Hitchcock's stated motive for this, his *magnum opus*, was to combat those atheists who were disparaging science's role in natural theology by using it against revelation.''[54] *Religion of Geology* was quite typical natural theology of the time. In this volume Hitchcock tried to reconcile geology with scripture; as Lawrence noted, for Hitchcock, the Bible does not ''attempt to use the precise and accurate description of science. In the same vein, science did not attempt to teach the moral truths contained in Scripture. Yet, the two subjects did occasionally intertwine, as in the case of Genesis.''[55]

Hitchcock was not so biblically literal that the flood story needed to explain all geology (there was deep geological time) but there were catastrophes, and a modified creation story in which multiple creations were acceptable. As in *Elementary Geology* both Lamarck's (and his contemporaries') and Chamber's (referred to as Vestiges because of the author's then anonymity) attempts at introducing transmutation as an explanation for change seen in the fossil record was roundly assailed by Hitchcock. Darwin does not escape Hitchcock's commentary. In 1863, just a year before his death, Hitchcock wrote an article in which he includes a refutation of Darwin's theory of natural selection, aptly titled ''The Law of Nature's Constancy Subordinate to the Higher Law of Change.''[56]

[54] Lawrence, 1972, p. 33.

[55] See footnote 53.

[56] Lawrence, 1972, p. 34.

Hitchcock's *Elementary Geology* and his "Paleontological Chart"

Although Hitchcock maintained a staunch anti-transmutationist stance throughout his life, he was clearly comfortable using iconography to show the history of life that today we would clearly label as a Haeckelian phylogeny or tree. This at first seems incongruous but can be explained once his iconography is explored.

Figure 5 shows the foldout diagram from the 8th edition (1852) titled "Paleontological Chart" that measures 34 cm by 41 cm in the original. I have been able to observe original texts for four variants of this work. In all cases it is hand water-colored, folded into four parts, and attached after flyleaves at the front of the volume. Other than slight color variations, all four examples I have observed appear to be otherwise identical.[57]

Later in Hitchcock's text an explanation titled "Palaeontological Chart" is given. Unlike the chart, the explanation was updated in later editions. The 1840 text is here reproduced in its entirety.[58] Spellings, punctuation, and capitalizations are those of Hitchcock. Differences other than spellings, capitalizations, and italicizations between the 1840 edition and the 1856 edition[59] (the latest I was able to observe with the chart) are boldface for the 1840 edition followed by the 1856 text in brackets (including additions to the text).

> In order to bring under the eye a sketch of the vertical range of the different tribes of animals and plants, that have appeared on the globe from the earliest times, the Chart which faces the title page, has been constructed. The whole surface is divided into seven strips, to represent Geological Periods: viz the lowest, the *Gray-wacke* [Silurian] Period: the next, the carboniferous Period: the next, the Saliferous Period: the next, the Oolitic Period: the next, the Cretaceous Period: the next, the Tertiary Period: and the highest, the Historic Period, or that now passing. The animals and plants are represented by two trees, having a basis or roots of *primary* [hypozoic] rocks, and rising and expanding through the different periods, and showing the commencement, developement, ramification, and in some cases the extinction, of the most important tribes. The comparative abundance or paucity of the different families, is shown by the greater or less space occupied by

[57] See footnote 29.

[58] Hitchcock, 1840, pp. 99–100.

[59] The explanation of the "Palaeontological Chart" appears on pp. 118–119 in the 1856 edition.

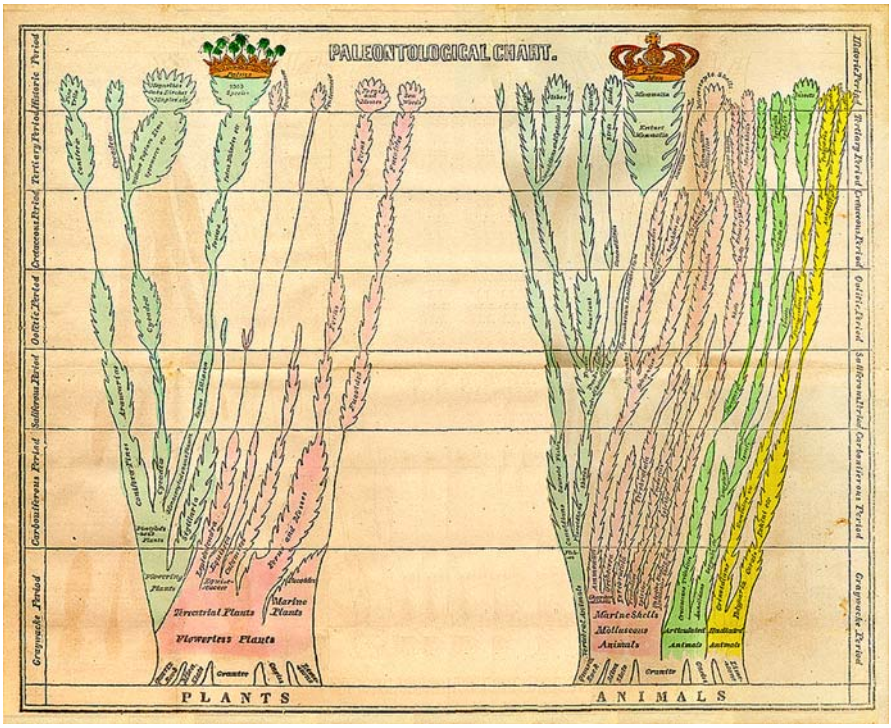

Figure 5. The foldout diagram titled "Paleontological Chart" from the 8th edition (1852) of Hitchcock's *Elementary Geology*. The diagram first appeared in the 1st edition (1840). The original is hand colored. Names of plant and animal groups are drawn on the diagram with geological time on the vertical axis.

them upon the chart; although there can of course be no great exactness in such representations. The numerous short branches, exhibited along the sides of the different families, are meant to designate the species, which almost universally become all extinct at the conclusion of each period. Hence the branches are contracted in passing from one period into another, and then again expand, to show that the type of the genera and orders alone survive. Where a tribe, after having been developed during one period, disappears entirely during the next or several succeeding periods, but at length reappears; a mere line is drawn across the space where it is wanting.

While this chart shows that all the great classes of animals and Plants existed from the earliest times, it will also show the gradual expansion and increase of the more perfect groups. The vertebral animals, for instance, commence with a few fishes; whose number

increases upward: but no traces of other animals of this class appear, till we rise to the Saliferous Group, when we meet with the tracks of cheirotheria, tortoises, and birds [and one mammal]. But not till we reach the oolitic period, do we meet with *the bones of the mammalia* [mammalia]; and then only *two species of marsupialia* [the four species]. No more of this class appear till we reach the tertiary strata, where they are developed in great numbers, approaching nearer and nearer to the present races on the globe as we ascend, until, in the Historic Period, the existing races, ten times more numerous, complete the series with MAN at their head, as the CROWN of the whole; or as the poet expresses it, "the diapason closes full in man."

In like manner if we look at that part of the Chart which shows the developement of the vegetable world, we shall see that in the lowest rocks, the flowering plants are very few, and consist mostly of Coniferce and Cycadeae: links as it were, between the flowering and the flowerless plants. It is not till we ascend to the Tertiary Period, that the willows, elms, sycamores, and other species that form the forests of the temperate zone, appear. *But lower down in the series, a few monocotyledonous plants are seen, such as lilies and palms; which, however, do not seem to have been greatly multiplied till we reach the Tertiary Period. Still more fully developed do we find them in the Historic Period; where 1,000 species of PALMS, – the CROWN of the vegetable world, have been found.* [Monycotyledonous plants are found through the whole series, appearing in great force in the coal formation; and among existing species they are developed in great abundance, not less than 1,000 species of Palms, – the CROWN of the vegetable world – having been described.]

To refer to another example of a somewhat different character: take the Saurian animals, which began to appear during the Saliferous Period. In the next period above, or the Oolitic, their developement is very great; so that they seem to have been the rulers of the animal creation. But above this Period, they gradually decrease, until among existing animals all their representatives, except the crocodile and the alligator, are on a most diminutive scale. [Take another example from the animals. The Saurian Reptiles began to appear in the Carboniferous period: and they continued to be developed in greater numbers through the Permian, Triassic and Liassic periods, and reached their greatest expansion in the Oolite. But above that

formation their numbers and size decreased, and at present their representatives on the globe, with the exception of the crocodile and the alligator, are mere pygmies].

A similar example among plants exists in – the lycopodiaceae; which during the carboniferous period, formed trees from 40 to 60 feet high. But above that period, they rarely appear; and their only remaining representatives on earth at the present time, are obscure plants a few inches in height.

Much more information of this sort may be obtained by a few moments inspection of this chart; which will prevent the necessity of details. As this however is the first effort that has been made to give such a representation of the leading facts in Palaeontology, I shall expect that defects and imperfections will be discovered in it.*

*Since the above was in type, I have received the *Lethaea Geognostica* of Professor Bronn. published at Stuttgart in 1837 and 1838, where I find a chart constructed on essentially the same principles. The wonder with me is, not that I have been anticipated, but that no simple a plan to exhibit the leading facts of paleontology, has not been employed by writers in the English language.

Four of the geological "periods" in Hitchcock's diagram are no longer used – the primary corresponds to the pre-Cambrian or Proterozoic Era, the Graywacke spans the Cambrian through Silurian periods, the Saliferous is the Triassic Period, and the Oolitic, depending upon the source, represents the middle and latter part or the entirety of the Jurassic Period.[60] Between the 1840 and 1856 editions, Hitchcock replaces primary with hypozoic and Graywacke with Silurian. Hypozoic is a Lyellian term for the Proterozoic that is also no longer in use. Basically, Hitchcock shows what was then known of what we today call the Paleozoic, Mesozoic, and Cenozoic eras, roughly the first 550 million years for which the vast majority of life is known.

Of the biological terms mentioned in the description, only cheirotheria (chirotheria in the 1856 edition) is totally unfamiliar to most current readers. Because of his reference to tracks, Hitchcock certainly means *Cheirotherium* or *Chirotherium* ("hand beast") trackways that were known from Europe and North America, including those he described from Triassic deposits of the Connecticut River valley, some of which are

[60] Hans-Dieter Sues, personal communication, 2008.

now considered to be Early Jurassic in age. His reference was certainly not to Cheirotheria proposed four years later in *Vestiges of Creation* by the (at the time) anonymous author Robert Chambers for bats "from the sole character which is universal amongst them, their possessing hands, and with a regard to that pre-eminent qualification for grasping which has been ascribed to them – an analogy to the perching habit of the typical order of birds, which is worthy of particular notice."[61]

On the chart (in all editions) Hitchcock shows "Tracks of Cheirotheria" at the base of the branch leading to Mammalia. In a table in the 1840 edition Hitchcock indicates, "Chirotheria allied to Marsupialia."[62] In the 1856 edition on the equivalent table Hitchcock indicates "Chirotheria or gigantic Batrachians (*Labyrinthodon*)."[64] *Chirotherium* was considered mammalian by most nineteenth-century authors with the notable exception of Lyell and the English paleontologist Richard Owen (1804–1892) who related it to labyrinthodonts.[63] As it turns out, the tracks almost certainly belong to a reptile and the supposed thumb is actually the smallest, digit five.[65]

The reference to "one mammal" from the Saliferous (Triassic) in the 1856 edition description of the chart almost certainly pertains to teeth of what was named *Microlestes* in 1847 (now referred to as the haramyiid *Thomasia*, a stem group to mammals), as Hitchcock showed "*Mammalia*: Microlestes antiquus" as coming from the "Trias" in a table in the same edition.[66] The indication of four unnamed mammal species for the Oolitic Period in the above description of the chart in the 1856 edition almost certainly refers to the four species that he notes but does not list for the Lias and Oolitic (together equaling the current Jurassic Period) in another table elsewhere in the 1856 edition.[67] These are not named and he provides names for only two species of mammals for the same period of time in another table in the 1856 edition.[68]

One of the major changes between 1840 and 1856 pertains to plants. In the 1856 version monocotyledonous plants are found earlier and in greater abundance, especially beginning with what we call the Carboniferous Period. Although there are abundant plants in these coal measures, these

[61] Chambers, 1844, p. 267.
[62] Hitchcock, 1840, p. 93.
[64] Hitchcock, 1856, p. 113.
[63] Hans-Dieter Sues, personal communication, 2008.
[65] Sarjeant, 1990, p. 299; Davidson, 2008, pp.55–63
[66] Hitchcock, 1856, Table on p. 113.
[67] Hitchcock, 1856, Table on pp. 108–109.
[68] Hitchcock, 1856, Table on p. 113.

were misidentifications, because it is now known that angiosperms (including monocots) are not found until the Cretaceous Period.

A second major change pertains to saurian animals, which today usually refers to what we commonly call reptiles (minus turtles). Throughout much of the nineteenth century this pertained to both reptiles and amphibians. The major change between the 1840 and 1856 editions is the statement that these animals are now found in the older Carboniferous Period rather than the Saliferous (Triassic) Period. The indication of Chelonia (turtles) from the earlier Devonian Period is incorrect.

Reading the description of the paleontological chart without any other context, one is struck by the clear tree iconography seemingly describing evolutionary change, "The animals and plants are represented by two trees, having a basis or roots … rising and expanding through the different periods …showing the commencement, developement [sic], ramification, and in some cases the extinction, of the most important tribes … the numerous short branches, exhibited along the sides of the different families, are meant to designate the species …"

Even though we are tempted to treat this chart as a Haeckelian phylogeny, two major points in or derived from the text show that this interpretation is wrong. First and most important, as discussed earlier, Hitchcock believed that God created life, but he did not do this over only six days a few thousand years ago; rather, he repeatedly created life over a very long span of geological time. Thus, the phrasing that to us seems to be describing evolution is meant by Hitchcock to represent a deity's creative forces.

Second, Hitchcock indicated in the footnote to his paleontological chart that the German paleontologist Heinrich Bronn anticipated him in his 1837–38 *Lethaea Geognostica*. Based upon Hitchcock's comment that Bronn has produced "a chart constructed on essentially the same principles" one would expect to find a tree-like diagram as in Hitchcock. This is most definitely not the case (Figure 6). Bronn's figure is titled a "sequence of the stratified formations and their members and distribution of the organic remains therein."[69]

Like Hitchcock's chart, Bronn's figure shows deep geological time, many lines representing many different groups known by fossils, and even some variation in line thickness to indicate relative taxonomic abundance. What Bronn's diagram does not show is any hint of a tree-like or branching diagram. His lines are unswervingly straight with some change in thickness from bottom to top to indicate an increase in

[69] Bronn, 1837–1838, table at the end of volume two, titled "Reihenfolge der Schichtgebirge und ihrer Glieder und Verbreitung der organischen Ueberbleibsel darin."

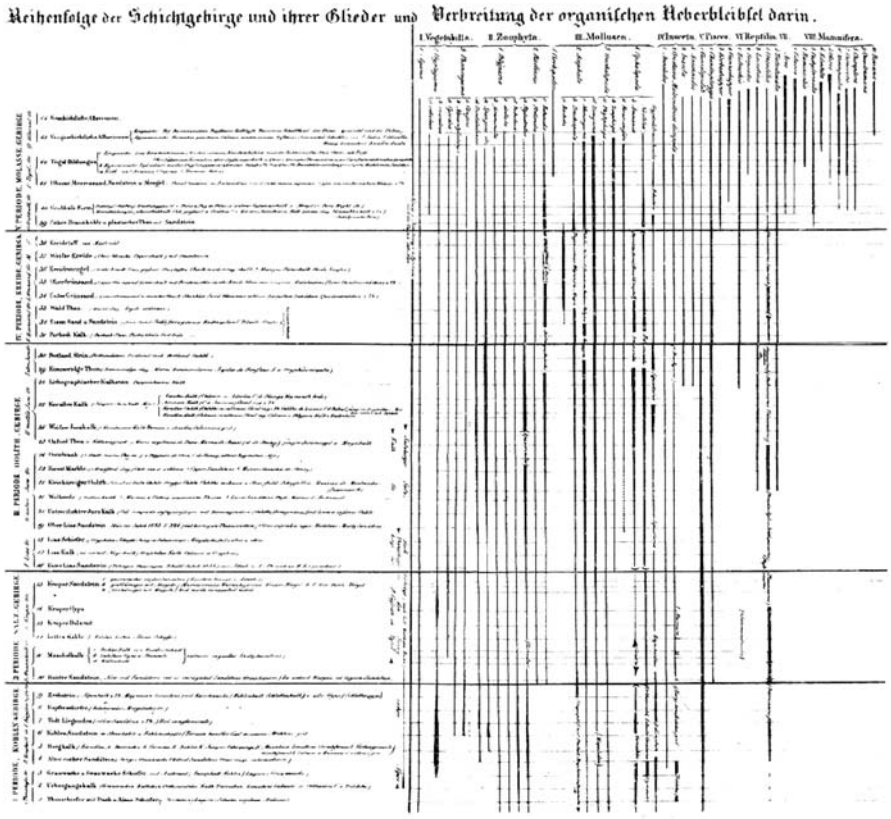

Figure 6. The large foldout diagram from Bronn's *Lethaea Geognostica* (1837–1838) showing geological time on the vertical axis (to the left) and major groups at the top represented by many numerous vertical lines. Note that the lines do not converge or meet although some thicken.

the number of species. What he has produced is what today paleontologists call a fossil range chart that conveys when fossil taxa existed, not how they are related, except in a very general way by how they are grouped on the diagram. That Hitchcock did not see much difference between his and Bronn's 1838 figure indicates that Hitchcock did not realize that his connecting of the branches within his figure held any particular significance beyond what Bronn's unconnected lines showed.

Another set of what we would call fossil range charts were published in 1857 by the Scottish geologist Hugh Miller (1802–1856) in his *Testimony of the Rocks*. There are three such diagrams – one for plants, another for animals, and another specifically for fishes (Figure 7).[70]

[70] Miller, 1857, one for plants, p. 40; another for animals, p. 45, and another specifically for fishes, p. 93.

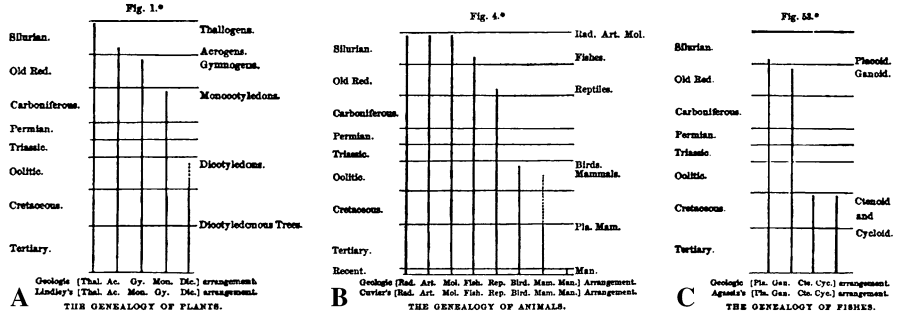

Figure 7. Three diagrams from Miller's 1857 *Testimony of the Rocks* that the author called genealogies. (A) Plants. (B) Animals. (C) Fishes. Geological time is on the vertical axis.

As with Hitchcock's and Bronn's diagrams, geological time is shown; but unlike for the diagrams of these authors, geologic time goes from oldest at the top to youngest at the bottom. Miller's fossil range charts are much simpler than those of Bronn and do not thicken or thin to show variations in species richness. Given that he has presented us with simple, straight lines for each major group it comes as a surprise that he calls each of the three diagrams a genealogy. For us, the only way in which such diagrams could be construed as a genealogy is if we restrict the term to each line representing the history of a particular group rather than any sense of connection of the groups. Miller's view of genealogy is to some degree revealed in the following quote discussing his "genealogy of animals."[71]

> The numerous tables of stone which compose the leaves of this first and earliest of the geologic volumes [referring to Silurian rocks] correspond in their contents with that concluding volume of Cuvier's great work in which he deals with the mollusca, articulata, and radiata; with, however, this difference, that the three great divisions instead of occurring in a continuous series, are ranged, like the terrestrial herbs and trees, in parallel columns. The chain of animal being on its first appearance is, if I may so express myself, a threefold chain; – a fact nicely correspondent with the further fact, that we cannot in the present creation range *serially*, as either higher or lower in the scale, at least two of these divisions, – the mollusca and articulata.

[71] Miller, 1857, pp. 45–46.

Unlike Cuvier, who according to Miller serially arranged molluscs, articulates, and radiates, Miller places them as three separate chains in the "chain of animal being" in his genealogy. In addition we also are provided yet another tree metaphor that it is quite different from that usually encountered. Instead of the whole of the diagram being tree like, the metaphor is for each of the groups to be a tree standing along with the others in neat rows.

Hitchcock's diagram more resembles a bush than a tree, with many of the branches emanating from near the base, each with spines representing species ("numerous short branches, exhibited along the sides of the different families, are meant to designate the species"). This is quite reminiscent of a plant in southwestern North America called an ocotillo. This shape is in keeping with his view that all major groups are known from near the beginning although some branching does occur higher in the tree. Both the plant and animal trees are astride five kinds of rock – quartz rock, mica schist, granite, gneiss, and limestone (primary or hypozoic). The plant tree has an internal structure composed of only one basal group, "Flowerless Plants" whereas the internal structure of the animal tree has four major groups. The four major parts in the animal tree are vertebrate animals, marine molluscous animals, articulated animals, and radiated animals. Although he does not acknowledge it, these are clearly the four embranchments of Cuvier.[72]

Hitchcock had clearly accepted the views of Cuvier that life does not represent a single scala naturae or great chain but rather a series of branches, and that these branches do not form a common bauplan resulting from evolution.[73] Further, Hitchcock was not alone in showing the history of life as a tree yet rejecting that transmutation was the cause. In the first volume of his monographic study of fossil fish the Swiss-American scientist Louis Agassiz (1807–1873) presented a tree-like figure for fishes (Figure 8).[74] Although he began this study in 1833, all indications are that this diagram did not appear until the completed version was published in 1844.[75] He called his figure a table that he described as "the family trees on the trunk of which will be registered the oldest kinds, while the branches will bear the names of the more

[72] Cuvier, 1812 and 1817.

[73] Rudwick, 1997, pp. 253–254.

[74] Agassiz, 1844, pp. 170–171.

[75] Brown, 1890, p. xxv.

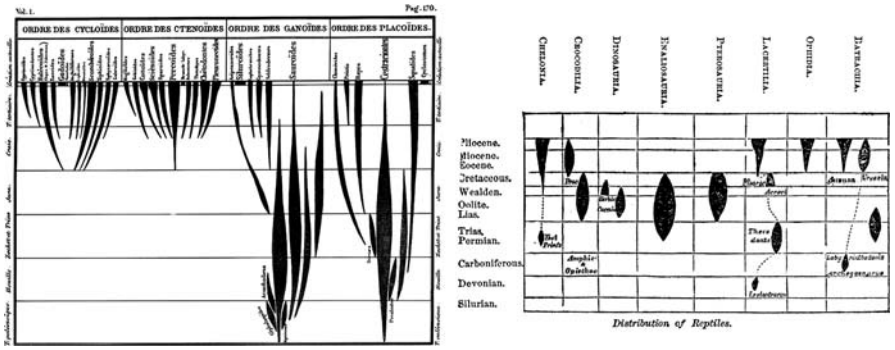

Figure 8. Left, a diagram of fish relationships from Agassiz (1844). Note that most of the spindle-like parts of the diagram converge but do not touch. Geological time is on the vertical axis. Right, Hitchcock and Hitchcock's 1860 spindle diagram, purportedly by Owen, showing the "Distribution of Reptiles" (amphibians are included) from the Silurian to Recent.

recent types.'[76] He continues that based on these principles, he has constructed[77]

> "… the attached diagram, which represents the history of the development of the class of fish through all the geological formations and which expresses at the same time the degrees of affinity between the various families. … Finally the convergence of all these vertical lines indicates the affinity of families with the principal stock of each kind. I however did not bind the side branches to the principal trunks because I have the conviction that they do not descend the ones from the others by way of direct procreation or successive transformation, but that they are materially independent one from the other, though forming integral part of a systematic unit, whose connection can be sought only in the creative intelligence of its author.

[76] Agassiz, 1844, p. 170, "des arbres généalogiques sur le tronc desquels seront inscrits les genres les plus anciens, tandis que les branches porteront les noms des types plus récents."

[77] Agassiz, 1844, p. 170, "…le tableau ci-joint, qui représente l'histoire du développement de la classe des poissons à travers toutes les formations géologiques et qui exprime en même temps les degrés d'affinité qu'ont entr'elles des différentes familles. … Enfin la convergeance de toutes ces lignes verticales indiquée l'affinité des familles avec la souche principale de chaque ordre. Je n'ai cependant pas lié les rameaux latéraux aux troncs principaux parce que j'ai la conviction qu'ils ne descendent pas les uns des autres par voie de procréation directe ou de transformation successive, mais qu'ils sont matériellement indépendants les uns des autres, quoique formant partie intégrante d'un ensemble systématique, dont la liaison ne peut être cherchée que dans l'intelligence créatrice de son auteur."

The ''the creative intelligence of its author'' certainly refers to a creative deity and the nearly but not quite joined branches hark back to Cuvier, yet Agassiz does indicate that ''the convergence of all these vertical lines'' indicates a relationship of form. This is essentially Hitchcock's argument four years earlier in his book and its included tree, although Agassiz was more explicit in stating that his tree comes from a deity rather than via transmutation. Further, as is clear in the above quote and as Gould pointed out, in Agassiz's tree the branches converge toward an archetype – the ''trunk'' in the center of each group of fishes – but they intentionally never touch.[78] Like Hitchcock's tree, that of Agassiz shows the waxing and waning of particular groups by changing the thickness of the line representing a particular group. These lines in Agassiz are more symmetrically and smoothly drawn creating what is called a spindle diagram, which is still common in some phylogenies drawn today.

Probably more by a matter of degree, Agassiz does appear to be more willing than Hitchcock to accept that not all major branches of animals stretch back to the beginning.[79]

> Two orders [fishes] of the class appear alone as of the first times of development of the life on the surface of the globe; [they] appear there simultaneously with representatives of all the classes of animals without vertebrae, while they are for a long time the only types of vertebrate animals which exist.

Gould is incorrect that Agassiz was the ''lone holdout against Darwin to the death.''[80] Although Hitchcock is less well known today for his anti-evolution ideas and died nine years before Agassiz, he was almost equally well known at the time for his creationism. In referring to why Agassiz did not accept evolution even though his diagram cried out to us for such an explanation, Gould says that ''… such a feeling only represents the chauvinism of later knowledge imposed upon a fundamentally different worldview.''[81] I concur.

By at least the 1860 edition with his son Charles, the paleontological chart is gone along with any mention of it in the text. We do not know

[78] Gould, 1993, p. 432.

[79] Agassiz, 1844, p. 171, ''Deux ordres [poissons] de la classe apparaissent seuls dès les premiers temps du développement de la vie à la surface du globe; il y apparaissent simultanément avec des représentants de toutes les classes d'animaux sans vertèbres, tandis qu'ils sont pendant longtemps les seuls types d'animaux vertébrés qui existent.''

[80] Gould, 1993, p. 432.

[81] See footnote 71.

why this the case, but we might surmise that either the authors thought that it had outlived its utility after 22 years or maybe with the appearance of *Origin of Species* in 1859, the authors no longer wished to use an iconography that had been usurped by the emerging transmutation school of thought.

The form of and comments concerning a figure occurring in the 1860 and later editions of *Elementary Geology* support the latter supposition (Figure 8). The figure, purportedly by Owen, is a spindle diagram showing the ''Distribution of Reptiles'' (amphibians are included) from the Silurian to Recent.[82] The spindles are boxed in columns showing no hint of bending towards one another, unlike the suggestion of relationship seen in Agassiz's 1844 converging spindle diagram of fishes. Further, the ''Paleontological Chart'' from 1840 to 1856 claimed to show the ''commencement, developement [sic], ramification, and extinction of taxa,''[83] whereas the 1860 reptilian figure now claimed to show the ''commencement, expansion, diminution, and extinction''[84] of taxa. Gone are evolutionarily tinged words ''development and ramification'' to be replaced by the more neutral descriptors ''expansion and diminution.'' Intentional or not, the iconography of evolution had been expunged by the last editions of *Elementary Geology*.

Conclusion

''Tree of life'' iconography is today associated with the concept of Haeckel's ''phylogeny,'' which marries evolution (the mechanism) with the genealogy of life (the pattern). Although it is somewhat foreign to us, before and after evolution (or transmutation) became the accepted theory for changes in the genealogy of life, a number of 19th century scientists such as Agassiz, Hitchcock, and Miller claimed the continued intercessions of God as the mechanism for change. Interestingly, all three included paleontological as well as geological information in their ''trees of life.'' Whereas today we would not accept Miller's straight-line figures as ''trees of life,'' those of Agassiz and Hitchcock do use this iconography. Hitchcock's 1840 ''tree of life'' is the earliest version known to me that incorporates paleontological and geological information, even though God was viewed as the mechanism creating this pattern. That of Agassiz followed in 1844. Both Hitchcock and Agassiz

[82] Hitchcock and Hitchcock, 1860, fig. 410, p. 365.

[83] Hitchcock, 1840, pp. 99–100.

[84] Hitchcock and Hitchcock, 1860, p. 365.

were well-known 19th century anti-evolutionists all their lives, never accepted that evolution had occurred let alone accepting Darwin's evolutionary mechanism of natural selection.

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This paper began as a chance discovery of the 8th edition (1852) of Hitchcock's *Elementary Geology* at Wahrenbrock's Book House, San Diego some 10 years ago. It was a shock to see in this volume a foldout showing the "tree of life" in a geological and paleontological context fully seven years before Darwin's *Origin of Species*, nine years before Bronn's "tree of life," 14 years before Haeckel's coining of the word phylogeny and publication of his well-known phylogenies. Work on this project first started as a talk for the Zamorano Club, Los Angeles in 2002, and then an expanded version for the Darwin Day Celebration, National Museum of Ireland, Dublin, 2008. Various help and information from the following people is gratefully acknowledged: Gloria E. Bader, E. Nicholas Genovese, Hans-Dieter Sues, and David J. Ward. I thank Paul Farber, E. Nicholas Genovese, Curtis Johnson, Kevin Padian, Hans-Dieter Sues, and three anonymous reviewers for reading and providing comments that improved the manuscript. The California State University at Long Beach Library, the Princeton University Library, the San Diego State University Library, and the University of California Los Angeles Library, are thanked for access to print materials in their care. The Google® book search engine, The Complete Work of Charles Darwin Online©, and Kurt Stüber's Online Library are thanked for access to electronic materials in their care.

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