ELECTIVE AFFINITIES: SCIENCE, CERTAINTY AND FREEDOM IN GOETHE, HENRY ADAMS AND THOMAS PYNCHON

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We hear a good deal these days about scientific illiteracy, a phrase usually taken to mean not that scientists are illiterate - whatever one may think about that - but that the rest of the public is ignorant of science. Doubtless it is true that many of the subtleties of science have escaped any number of us, and I may say that that is just as true of scientists as it is of non-scientists. But it is also true that, ever since the ideas of natural science became part of general intellectual discourse, say around the time of Galileo, every thinking person has beenwell aware of at least some of the matter of science. In the particular case of those thinking persons who were also literary artists, we have, in the form of the texts they produced, records of their thought. If properly understood, these records ought to show how the artists have introjected and transformed scientific ideas. Such an understanding, one may hope, should illuminate both the cultural importance of scientific ideas and the process of literary creation.

In an encounter between a literary artist and the natural science of his time, it is to be expected that some scientific ideas will exercise a greater attraction than others upon the literary imagination. There is, in my view, one complex of scientific themes which has appealed with particular strength to three writers at disparate points in scientific history: to Johann Wolfgang von Goethe in the early 19th century, to Henry Adams in the early 20th century and to Thomas Pynchon at the present time.

Each of these writers has produced a text which relies on the metaphorical power of the conflict between AFFINITY, the forces which act in the physical world between the microscopic particles of substance so as to generate the structure, the form, we see in ourselves and other physical objects, and what I will refer to as ELECTION, the process which works in the physical world to produce change, or flux, the alterations over the course of time we see in ourselves and other objects. All three writers, in thinking about structure and flux in the physical world, about affinity and election, were additionally taken by a feature of both practical and fundamental concern in science: the problem of the HIDDEN VARIABLE. The term refers to the universal presence of hidden, uncontrolled conditions which influence the observations on which scientific ideas are based. The certainty that hidden variables are present means that all scientific ideas will change in time: just as there is structure in the edifice of scientific thought at any one point, so there is flux, and the form of scientific thought will surely change.

At least a part of the metaphorical power of these concepts derives from their mirroring of the concepts of CERTAINTY and FREEDOM in human affairs. Insofar as human affairs and relationships are structured, they lend certainty, security, predictabilty and peace of mind, but there is a necessary absence of freedom or election. On the other hand, when there is flux and change, there is great freedom and latitude for election, but there is also an absence of certainty, there is insecurity, unpredictability and unrest. The problem of the hidden variable presents us with a similarly irresolvable conflict in the use of scientific concepts as guides for life in the world. What science, as an operational technique for the generation of human knowledge, gives us are models, which are maps of the world and instructions for dealing with it. The use of these maps requires certainty, reliability, confidence in their correctness. But the very modus operandi of science makes it certain that the maps will be revised, that there are hidden variables present, that the freedom in the world, the insecurity, is greater than we know.

Goethe's "Elective Affinities"

In 1809, Goethe published a novel, called in German "Die Wahlverwandtschaften" and in English "Elective Affinities," which is quite explicit about its use of the metaphor of the chemical forces involved in the structure and the transformations of substances. In an advertisement which Goethe anonymously prepared for his publisher's use, he said that "the author's incessant studies in physics suggested the title to him..." In the course of the novel, several of the characters enjoy a long, detailed conversation about elective affinities in chemistry and their allegorical equivalents in human affairs. The discussion relies heavily on the double meaning of the German technical terminology: for example, "Verwandtschaft" means "affinity" both in the chemical sense and in the sense of family relationships; the word "Scheidung" means both chemical separation, as when a chemist resolves a mixture into its components, and marital separation or divorce. The title of the novel itself is in fact the German title of a famous chemical monograph of 1775, written by the Swedish chemist Torbern Bergman.

In the story, Goethe explores human affinities, and the election among them, in a specific case. A baron, Eduard, and his baroness, Charlotte, invite two guests to join them on their country estate. The guests are the Captain, an old Army friend of the baron, temporarily fallen on hard times, and Ottilie, Charlotte's orphaned niece who is having some difficulty in her boarding school. Ottilie is enchanting beyond measure, every adolescent boy's dream, and the dream of every man in whom the adolescent boy lives on. This is precisely the category of Eduard; his passion blooms, is returned by Ottilie, and they are soon locked in a chaste, but otherwise unrestrained attachment. Rather to their own surprise, the dignified Charlotte and the stolid Captain also fall in love with each other. The plot then assumes an operatic complexity, with the main points being that the child of Eduard and Charlotte drowns while in the care of Ottilie, the stricken Ottilie starves herself to death, and Eduard expires of grief. The novel ends with the future situation of the Captain and Charlotte unresolved. Thus the development of the affinities among the four characters is played out completely, but the resolution - in chemical terms, the completion of the reaction - is not accomplished.

Much of the argument of the novel is devoted to the medium through which human affinity is expressed, the mechanics of its development and maintenance. Foremost among Goethe's concerns here is the power of the imagination (Einbildungskraft), which allows an affinity once established to be continued even when its objects are at a great distance (as when Eduard leaves Ottilie to go to the wars), and which provides equally for an election between affinities, as when Charlotte contrasts mentally her affection for the Captain with an image of herself repeating her marriage vows and chooses the course of conventional morality. There is even an ascription of truly horrific power to the imagination: Eduard and Charlotte conceive a child after their new affinities have formed, so that during the act of love Eduard thinks of Ottilie and Charlotte of the Captain. The child is born with the eyes of Ottilie and the build of the Captain, rather than the features of his parents.

Thus Goethe seems to consider human affinities and their election in comparison with their chemical analogs, and to suggest that the power of the imagination is vital as a mechanism in human affinity. But the novel stops short and fails to bring matters to a final resolution. To understand this, it is necessary to bring in two new facts.

First, Goethe was deliberately mysterious about the intended interpretation of the novel, advising his friends to read it several times, indicating he himself might not be certain about what the novel "had become," writing to his friend Zelter, "I am persuaded that the veil, transparent yet opaque, will not prevent you from seeing beyond to the truly intended form."

Second, the chemical theory of Bergman from which the novel appears to proceed was, by the early 1800's, completely outdated. Bergman, in his treatise of 1775, had summarized his view of elective affinities among chemical substances in 64 pictorial schemes of original design, employing a very effective set of chemical symbols derived from alchemical usage. Ten of these schemes involved the symbol for phlogiston, and indeed Bergman's monograph was the brilliant culmination of phlogistonic chemistry. Although the mongraph failed in its effort to find a universal table of relative affinities, valid under all experimental conditions, it did provide an excellent summary of chemical observations up to the 1770's, interpreted on the phlogiston theory. Almost at the moment of publication, however, Bergman's treatise and all other phlogistonic literature were rendered impotent in the eyes of most contemporary chemists by a discovery which drew aside a "veil, transparent yet opaque" and exhibited a hidden variable which undercut the concept of phlogiston. This was the discovery by Scheele, Priestley, and Lavoisier that the air contained a new substance -

oxygen - and that this substance could form chemical combinations.

The concept of phlogiston had arisen from a very reasonable interpretation of experiments in which heat, often produced by the focussed rays of the sun, effected the conversion of certain metals such as iron into powdery, obviously non-metallic substances known at that time as "calces" of the metals. Two assumptions, unstated and largely unrecognized, formed the veil which concealed reality. The heat was assumed to drive out, to dissolve affinity, to destroy a combination, as it had so often seemed to do. And the air, always present and apparently never involved in chemical changes, was assumed to be innocuous. The material driven out was called "phlogiston" and calces were believed to be simply the metal deprived of phlogiston: "dephlogisticated" metals.

The discovery of oxygen removed the veil. Heat, far from driving out what now emerged as the mythical phlogiston, effected the combination of iron and oxygen: the calx of iron we now know as iron oxide. The fact that phlogistonic chemistry had successfully used the erroneous concept in rationalizing a great variety of observations now lent only more force to the scorn to which it was treated by the advocates of Lavoisier's "new chemistry."

With these points in mind, we may profitably return to Goethe's version of "Elective Affinities:" an experiment of sorts in which four persons are driven by passions or affinities beyond their comprehension or control into attachments they cannot resist but for the most part do not wish. The medium by which their affinities are generated, maintained and resisted is the power of the human imagination. Goethe warns us that the intention of his novel is beyond a veil, and he employs a chemical metaphor of peculiar appeal and power but which, as he knows, has fallen victim in the view of scientists to the hidden variable. And finally, the experiment is incomplete: the affinities and elections are unresolved at the end of the story.

The parable here is not, I believe, a likeness merely between the attractions and combinations in human life and those in the microscopic world of chemical substance, but rather between the depths of understanding in the two realms of the rules and laws, the forces that govern these attractions and combinations. If there are such rules and laws, physical principles that universally dictate attractions and combinations, then whether we speak of microscopic reality or human affairs, reliability and predictability are possible. Since affinities will be guided by these principles and elections determined, a knowledge of the principles gives certainty; but it also removes freedom. If such principles do not exist, freedom is perfect and election unlimited but certainty and security are gone. If the principles exist, can we learn them? For the microscopic world, Bergman sought and failed to find them, and further, the entire theoretical apparatus upon which his search depended had emerged as fallacious, built upon the apparent and not the real. In the world of human affinities and elections, we may see hints, perhaps involving the power of imagination, but the essential certainty of the hidden variable, the certainty of uncertainty, will leave us as impotent as phlogistonic chemistry. Security and predictability, the clarity of the final resolution are not to be; yet neither is freedom perfect, for beyond the veil we cannot know what "dark, passionate necessity" - Goethe's words - may govern our actions.

Henry Adams and "The Rule of Phase Applied to History"

Exactly one hundred years after the publication of "Elective Affinities," Henry Adams, 71 years old in 1909, looked back at a century in which science and technology had worked an incredible transformation in human life. The changes were uncongenial for him; he was disturbed by the conversion of order into chaos, of certainty and reliability into unpredictabilty, as the modern age had advanced. In 1909, he tried his hand at bringing scientific certainty to the apparently chaotic progress of history. He wanted to look beyond the veil for a physical law that would restore some predictability.

The result, an essay entitled "The Rule of Phase Applied to History," is on first reading a most unimpressive effort. In Adams's defense, one must note that he did not write the essay for publication. It appeared only after his death in a collection of his essays, edited by his brother Brooks Adams and entitled by the latter, with ill-advised alliteration, "The Degradation of the Democratic Dogma." On the other hand, in my view, a close reading reveals more to this paper than is initially visible.

In looking about for scientific principles possibly applicable to history, Adams had been attracted to the field of thermodynamics. Thermodynamics contained at the close of the 19th century two of the great laws which govern the structure and interconversion of substances, and from these Adams's fellow New Englander Josiah Willard Gibbs (1839-1903) had deduced a useful technical guidepost known as the Phase Rule or, as Adams has it, the "Rule of Phase."

It is not certain where Adams came across the Phase Rule. The least likely hypothesis is that he read Gibbs's 140-page paper, "The Equilibrium of Heterogeneous Substances," in the 1875 volume of the Transactions of the

Connecticut Academy of Science; the mathematical austerity of this paper insulated it for around ten years from even chemists and physicists. There is a reasonable probability that he read a book by Alexander Findlay, published in 1904, entitled "The Phase Rule and its Applications," and having the stated ambition of providing an "exposition ... made entirely non-mathematical..."

The word "phase," as used in thermodynamics, refers most commonly to the states of matter: solid, liquid and gas. But in the title of Findlay's text, it may have caught Adams's attention because, in his search for order in history, he had been working through the writings of Auguste Comte (1798-1857). Comte had suggested a passage of human thought during history through three successive stages, which he called "phases:" the theological phase, the metaphysical phase, and the positive or scientific phase. In Adams's mind, an equation of these two concepts formed, and from this identification of two disparate technical terms, his essay developed.

The trigger which loosed him somewhat recklessly along the path the essay takes seems to have been a graph he drew: a plot of the annual coal production of Great Britain during the 19th century against the year. The curve of coal production rises slowly in the early years, and then ever more steeply as industrial use grows exponentially. This curve Adams must have compared to the curve in Figure 1 of Findlay's "Phase Rule," where the pressure of the water vapor in equilibrium with liquid water is plotted against the temperature. The visual appearance of the two curves is very similar, and every doubt was swept from Adams's mind: "The curve resembles that of the vaporization of water. The resemblance is too close to be disregarded, for nature loves the logarithm and perpetually recurs to her inverse square."

All scruples gone, Adams equates the passage of ice into liquid water and liquid into vapor with the historical passage of human thought from a solid, religious phase into a "mechanical" phase, where the principles of Newtonian mechanics furnish the principal medium of thought, at about the year 1600 AD; in 1900, a further transformation to the "electrical" phase, with an "ethereal" phase and perhaps others to follow. In the electrical phase, human thought will be dominated by Clerk Maxwell's principles of electricity and magnetism, and in the ethereal phase by pure mathematics.

Adams feels he has established closely enough an interval of 300 years for the Mechanical Phase (1600-1900), and proceeds by "the old, familiar law of squares" to calculate the time intervals for the Religious Phase (300^2 years, thus reaching back from 1600 to 88,400 BC, the period during which "fetish force" governed human thought), the Electrical Phase ($300^{1/2}$ or about 17 years, therefore 1900-1917) and the Ethereal Phase ($17^{1/2}$ or around 4 years). The Rule of Phase would then "bring Thought to the limit of its possibilities by the year 1921. It may well be!"

The temptation is great to dismiss all this as the idiosyncratic ramble of a vague and aged imagination. This would be a mistake, for there is more here than one might think.

First, there is in fact a close and accurate analogy between changes in the organization of human cultures - Adams's changes of historical phase - and changes in the states of matter. Both tend to occur precipitously: water melts just at zero degrees Celsius; social revolution can occur over a few years after centuries of stability. Thermodynamicists call phase changes like the melting of ice "cooperative" because the fission of the first bonds holding an ice crystal intact tends to weaken the remaining structure, leading to an acceleration of the destruction of the crystal. Similarly, the first stages of social revolution weaken the remaining structure of society and promote further, more rapid change.

Again, the melting of a crystal is said to be "driven" by the increased freedom of the liquid molecules, compared to the security and certainty in the bound and rigid state of the crystal (that is, the entropy of the liquid compensates for the loss of enthalpic binding in the crystal). In the historical phases over which Adams looked back, he could see a similar gain in freedom or election in the new phase as the rigidity or high affinity of the preceding phase was lost.

Yet again, the idea that the interval over which a phase would continue to exist should decrease progressively contains a clear thermodynamic analogy, although the "old, familiar law of squares" is nonsense. A succession of material phases would be expected to exist over progressively smaller temperature intervals because the loss of affinity at each phase change, and the corresponding increase in motion of the molecules, in a sense "prepares" the substance for the next phase change. In the history of human affairs, each loosening of restraints and increase in freedom renders more facile the acceptance of further change.

Finally, Adams suspected, or perhaps greatly hoped, that there was a "veil, transparent yet opaque" which made the disorder and deterioration he saw in history only apparent, that there was a hidden variable which would restore mathematical certitude to seemingly chaotic change. He sought it through the metaphoric power of affinity and election.

Thomas Pynchon: "Gravity's Rainbow"

Thomas Pynchon's novel of 1973 is 760 pages long, and so difficult to get through that one critic wrote an article "On Trying to Read 'Gravity's

Rainbow'." Edward Mendelson, who considers Pynchon the greatest living writer in the English-speaking world, places "Gravity's Rainbow," along with six of the masterpieces of European and American literature, in the genre of "encyclopedic narrative." An encyclopedic narrative, according to Mendelson, attempts "to render the full range of knowledge and beliefs of a national culture, while identifying the ideological perspectives from which that culture shapes and interprets its knowledge." As is therefore to be expected of the encyclopedic narrative of 20th-century American culture, scientific and technical metaphor take a major role.

Before excavating and examining this metaphor, however, it is useful to clarify a feature of "Gravity's Rainbow" which helps in the apprecia-tion, or at least the toleration, of some of its most repulsive, turgid and tedious passages. In its essence, the novel recounts the mental life of a young American intelligence officer during the final year of World War II. When the V-2 ballistic-missile bombardment of London by the Germans begins in September 1944, the officer is assigned to anti-V-2 defense. He becomes an expert in all aspects of the V-2 and, as the war ends and the occupation of Germany begins, he is sent into the chaos of the defeated country to participate in the salvage of missiles, parts and missile scientists for later use by the U.S. For many readers, this plot synopsis will be unrec-ognizable. This is because Pynchon has equipped his hero with an all-day, all-night, four-alarm, one-man undergraduate bull-session which runs non-stop on the wide screen of his consciousness. Thus the medium through which the hero's mental life comes to the reader is the undergraduate bull-session lampoon, the off-hand, allusion-filled, obscene, scatological, repulsive, hilarious hyper-fantasy, at the absolute pit-bottom of bad taste and and the outer, shaggy-dog limit of tiresome length.

Any student or one-time student, who has sat through the night to dawn, in the company of friends, afloat in beer or wine, regaling and being regaled with bull-session lampoons, will instantly recognize Byron the Bulb, on the run from the world-wide electrical cartel; Dr. Laszlo Jampf, sometime Pavlovian psychologist, sometime chemist and inventor of the erectile polymer Imipolex-G; the sinister Nazi rocket-commander Weissmann; the egregiously American Major Marvy; or the comic-book hero Rakete-Mensch, or Rocketman. Indeed the bull-session lampoon is the perfect medium for the American encyclopedia, because it is the late-20th-century version of that profoundly American form of humor, the frontier tall tale. Pynchon's Oberst Enzian, commander of the Black rocket troops of the Wehrmacht, trekking through occupied Germany in search of a mythical rocket, is the lineal descendent of Black Harris. It was Black who cossed the Black Hills in fifty feet of snow while it rained fire, and discovered the petrified (or putrified) forest, where with a single shot he brought down a petrified bird in mid-song. Once the mental lampoons of Pynchon's hero, who is either named Tyrone Slothrop or gives himself that name in his mental bull-session, are seen for what they are, the nature of "Gravity's Rainbow" emerges with greater facility.

The rainbow of gravity is the trajectory of the V-2 missile, rising from Holland or Germany and arching in a promise of destruction by fire to its target in London. The rocket rose steeply from its launch site, driven by the full power of the chemical destruction of its 19,310 pounds of main propellant. In its combustion chambers, ethanol was destroyed by furious combination with the liquid form of that same oxygen which concealed the reality beyond the veil from the phlogistonic chemists. The energy of affinity, converted to the vast freedom of the gaseous products, drove the rocket upward, while simultaneously its internal guidance mechanism delicately calculated the ideal moment for cessation of thrust, so that its impact upon its target would be as certain and exact, the destruction as sure and precise as possible. At the calculated moment for thrust cut-off ("Brennschluss" to the Germans, "all-burnt" to the British) the integrating accelerometer stopped the flow of propellant, and the fate of the rocket was transferred to the gravitational field of the Earth. Its path of flight became parabolic, although the variations of air speed and Mach number along its trajectory revealed the hidden richness beneath the apparent simplicity of the trajectory. At the moment of impact, the descending missile moved at twice the speed of sound so that it approached its victims in total silence, and the scream of its approach was heard only by the survivors after the 2,150-pound warhead had done its destruction. This awful character, seeming to reverse the order of cause and effect, fascinates the hero Slothrop.

In Pynchon's V-2 meditations, the moment of "Brennschluss" returns again and again: it is one of the many occurrences in "Gravity's Rainbow" of an interface, a point of division. At thrust cut-off, the physical principles which dominate the rocket's history are altered and there is that ultramicroscopic moment of absolute freedom when the thrust has left off, but gravity has not yet taken control. This is the idea of a dividing point, line or surface at which transfer occurs, a place where all rules are off and freedom is perfect.

Or is the freedom as perfect as it seems? Pynchon's "Zone," chaotic Germany at the moment of transition between defeated state and occupied area, is a point of division but as Rocketman repeatedly learns, paranoia is well-advised. The vast networks of the tale-spinning lampoonist stretch and cover and entangle: nothing is as it seems, hidden variables are every-where, beyond every veil are infinitely more veils, one must not only be paranoid, but "paranoid enough."

The points of transition (between black and white, life and death, inside and outside, positive and negative, known and unknown, earthly and unearthly...) assume this dominance because it is just there that stasis becomes flux, that structure becomes change. The title of Pynchon's first novel, "V.," perhaps not by accident, draws in pictorial symbol the curve of binding energy, the energy well in which the bound particle is locked. At the bottom of the well, the transition of the V from downward to upward thrust, is perfect certainty, but also perfect bondage. The rainbow of gravity draws in pictorial symbol the energy curve of change, the passage through a maximum of energy which marks the transition from one V to another V, one structure to another structure (from V-1 to V-2). As the miminum of the V marks perfect certainty, the maximum of the rainbow marks perfect freedom but also perfect insecurity.

And always there is the hidden variable, the necessity of paranoia. During the 20th century, the hidden variables of relativity and quantum theory have emerged from beyond the veil. Particularly the quantum theory and its universal guarantee of uncertainty pervade "Gravity's Rainbow." Where once we could find at the minimum of the binding curve that perfect certainty and perfect bondage, that too has now been lost; the very fabric of matter sacrifices structure to flux. Even at the absolute zero, the "zero point" where motion should cease and all things be exact and final, the principle we owe to Werner Heisenberg (1901- 198x) assures us that nature permits no such certainty. Freedom is forced upon us, affinity is never absolute, election is always possible, and indeed required.

And thus it is that the mythical rocket that every bull-session phantom of the "Zone" is seeking, the rocket of vast range and destructive proportions, driven into the future and guided by a mechanized, objectified human being, is known as the "00000," revealingly pronounced by the German-speaking Herero members of the Schwarzkommando as "Fuenffachnullpunkt:" the five-fold zero-point. This device, this mechanism, sought through unimaginable travail by so many, carries in the end only the message of the zero point, of fundamental uncertainty, of freedom enforced.

Another contribution of the quantum theory and the theory of relativity to 20th-century thought has been the final stage in accomplishing the conversion of our maps of the world to pure mathematical form, as in the Ethereal Phase that Henry Adams anticipated. Slothrop frequently considers the implications of this affinity between scientific thought and mathematics for our freedom in the use of scientific world-maps. As he travels from the rocket base at Peenemuende, Slothrop is led by the stair-step roof-line of a North German building to consider the description of the rocket's flight, of gravity's rainbow, in terms of the differential calculus. The calculus breaks up the course of the rocket, as it moves both upward from the Earth and horizontally toward London, and later downward toward the Earth and horizontally toward London, into minute successive steps, first up then on. Slothrop calls this mathematical description of the smooth and beautiful trajectory "the pornography of motion." As the act of love is analyzed pornographically into vulgar mechanical steps so the rocket flight is reduced to crude mechanics in differential calculus. Yet on second thoughts - always the paranoia of the hidden variable - the integral calculus restores the beauty, and in fact passes beyond the actual trajectory (which is not smooth and beautiful motion, of course, but the irregular passage of a real physical object) to produce an ideal description more beautiful than reality. The real trajectory is thus an interface, a state of transition rich in freedom, between the bondage of analysis, the pornography of the differential calculus, and the bondage of synthesis, the ideality of the integral calculus. The mathematical description of nature, it is suggested, binds us in certainty, away from the freedom of reality.

The Red Thread

In the "Elective Affinities," one of Goethe's many charming devices is the diary kept by Ottilie, in which she records observations and epigrams, many of which have become proverbial for Germans. In his introduction to the diary, Goethe provides another image which has become proverbial - a "winged word," as the Germans, following Homer, call such phrases - the image of the red thread.

The English Navy, Goethe tells us, had all its ropes manufactured each with a single red thread, twisted so intimately among the fibers of the rope, throughout its length from beginning to end, so that the red thread could be removed only by complete destruction of the rope. Even the shortest section of a rope of the Royal Navy could therefore be identified instantly by the red thread, always present and always visible. The "red thread" has come to mean, in the German and Scandinavian languages, a subtle but vital theme, always present and always visible, which runs inexorably through a body of thought.

In this examination of texts of Goethe from 1809, of Henry Adams from 1909 and of Thomas Pynchon from 1973, we have, I think, never lost the red thread. The theme of affinity, certainty and binding, of election, freedom and flux, and of the hidden variable that lies beyond the veil, rendering certainty and freedom equally illusory, pervades the texts.

Variations on the theme have come with the times. The growth of thermodynamics and the precise rendering of affinity and flux in the language of enthalpy and entropy gave Henry Adams's phase rule of history a form that would have been been incomprehensible to Goethe but which, because of further change, seems quaint and eccentric to us today. Quantum uncertainty and the absolute reign of mathematical science as official epistemology give a character to Pynchon that is at once stark and ornately repellent, varying between the pornography of analysis and the ideality of synthesis.

But always there is the red thread. It shows the power of this metaphor of affinity and election, uncertainty and flux and of the conflicting promise of science, of a reliable mapmaker with a continual revision underway, that has run among the strands of our culture for two centuries.