

SWEDENBORG AND HIS SCIENTIFIC REVIEWERS*

XXXIV

Opera Philosophica et Mineralia

Nova Acta Eruditorum (Continued)

He then passes on to the generation and origin of finites. He holds that they are generated by a motion and fluxion such as is conceived of by geometricians [§24]. Of course, he must necessarily say this, since he makes the element a mathematical point. But, hurrying our pace, let us go on with our author.

3. For the explanation of this matter, he sets forth a philosophical reasoning concerning the first finite, that is to say, the simple finite, and its origin from points (I, iii). To the author “simple finite” and “first substantial” are synonymous terms. [§1] No finite can come into being save by motion among the points [§2] if we are to believe our author. The motion of the points among themselves, and their state, must needs be similar to pure motion, or to the internal state in the point, and therefore is likewise spiral [§4]. The author therefore gives the following definition of the simple finite, namely, *that it is the first entity or simple finite existing from the motion of the points among themselves, and thus is the first substantial of all finites* [§5]. He then further explains that it is geometrical and limited; that it fills space, but the smallest possible space; that it is endowed with figure, though in least limits, etc. [§8–9]; furthermore, that this finite possesses the same active force as the point, so that it can produce finites more compounded; that it enjoys internal motion, in like manner as the point [§14–15]; and other statements of the same nature. He then endeavors to set up a geometric reasoning, as he calls it, concerning the figure and motion of points when generating the first and least finite [§19 *seq.*]

4. Then comes a philosophical inquiry concerning the second finite; and the mode in which this seems to have taken its rise successively from the finite of the simple;¹¹¹ also a general treatment concerning its coexistent, which the author calls the active of the first finite, and the mode in

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which this also has taken its rise geometrically from the same origin, that is, from the first and simple finite (I, iv). The following is a definition of this second finite: *It is the second finite entity, existing from the motion of the simple finites among themselves; and thus is the second substantial of all finites* [§6]. From this the author, as in the preceding chapters, draws a number of conclusions. In the present case he exerts himself to tread with greater particularity and more fully concerning his geometry of spirals generated by motion [§18 *seq.*] and the inquiring reader should peruse the whole of this treatment.

5. This chapter is *a special inquiry respecting the active of the first finite, its origin from the first simple finite, its motion, figure, state and the other attributes and modifications which it possesses*. The author contends that this active is the active which constitutes our sun; and that it forms elementary particles¹¹² (I, v). The active of the first substantial is nothing but the motion of one substantial running out into circles whereby a surface is formed [§1]. The remaining points under this heading, as well as other additional points, can be seen by the reader in the book itself. For the statements are all so abstruse, and are constructed with such laborious subtlety that we judge it to be hardly possible to give any summary of them, but what would offend our readers with its tiresome obscurity. At the end of this chapter, however, some statements are made concerning the active of the point, a conception of which is obtained by analogy with the active of the substantial.

Having accomplished this, the author passes on to his mechanics and to the actual world.

6. Therefore, he treats *of the first and most universal element of the universe, or of the first elementary particle, which is composed of finites and actives; of its motion, figure, attributes, and modes; likewise of its origin and composition from the second finite and the active of the first; and that this element constitutes the solar and stellar vortices* (I, vi). He inserts *a geometrical treatise on the figure, and a mechanical treatise on the situation and motion of the Parts of a compound*¹¹³ *both in finites and in actives and elementaries* (I, vi *ad fin.*).

7. This chapter treats of the actives of the second and third finites (I, vii). To the author the active of the second, that is, of the second substantial, is nothing more than the second finite set at liberty and thus become

active. So the active of the third is the same as the third finite set at liberty [§3 *seq.*].

8. He then proceeds to discuss the third finite or substantial (I, viii). In respect to its origin, and the figure, situation, motion, etc., of its parts, this finite is entirely similar to the preceding substantials, and also to the point. It consists purely of second finites; it has taken its rise from the first elementary particle under the highest pressure, and this near the great active or solar space; and from these finites, of which we now speak, can arise new elementary particles.

9. The author then passes on to *the second element of the world, or to the second element, that is, the second elementary particle composed of third finites, and the actives of second and first*. He treats of its motion, figure, attributes, and modes, and endeavors to show *that this element, together with the former element, constitutes the solar vortex, and principally contributes to the phenomena seen in connection with the magnet* (I, ix).

10. To the above is added a doctrine concerning the existence of the sun, and the formation of the solar vortex (I, x).

The second Part of the *Principia* is entirely filled with an explanation of the magnet and its forces. The author strives to demonstrate that the force of the magnet comes from the motion of the first and second or magnetic element, from which two, are formed the solar vortices, and likewise the vortices of the planets. He states that the magnetism of the magnetic element consists in effluvia which are of such a nature that they must move around their axis; and, being moved in a gyre or spiral, they actuate this subtle element; that, in consequence of these gyrations, little vortices arise and the colligation of these vortices from one of the poles of the magnet or sphere to the other; that thus magnetism is created and its conjunctive force, whenever similar effluvia surrounding a given body are brought together. The magnet itself, in respect to its interior texture, consists in the rectilinear or regular situation of such parts from the one pole to the other; hence, by mechanical necessity there is formed extrinsically a sphere colligated with the two axes. The effluvia, or the above mentioned parts, are purely ferrous, iron can be made magnetic provided that its inner parts, by the friction of a magnet, are brought into a rectilinear or other regular situation. Magnetic declination arises from the situation of the same particles of the first and second elements, i.e., of that

element from which are formed the vortices around the sun and the earth; and the magnet with its sphere can be directed into the same situation as that of aforementioned particles; which particles, because at the same time they form a vortex around the earth, must needs be flexed into a spiral situation from one Pole of the ecliptic to the other; whence arise anomalies.

For the rest, one sees in this second Part a remarkable wealth of magnetic experiments, including those made by the author himself and those quoted from the best authorities; likewise a table of the declination of the magnetic needle, at London and Paris, constructed by calculation for various years, and also at the Cape of Good Hope, Rome, and elsewhere [II, xxvi *seq.*] The author has inserted here the map or magnetic table made by Halley in 1700, including the magnetic inclinations observed by Pound. The same table is used by Musschenbroek both in his dissertation *On the Magnet*, and in his *Elements of Physics*.

The third and last Part of Volume I sets before the eyes (1) A comparison of the starry heaven with the magnetic sphere. (2) The diversity of worlds. (3) A reasoning concerning the fourth finite and its rise from the second elementary particle. (4) The universal chaos of the sun and planets, and its separation into planets and satellites. (5) The ether or third element of the world. (6) The fifth finite. (7) The air or the fourth element of the world. (8) Fire, or the actives of the fourth and fifth finites, and the actives that follow. (9) Water, or the purely material finite. (10) Water vapor or the fifth element of the world. (11) The vortex around the earth, and the progression of the earth from the sun to the circle of its present orbit. (12) The Paradise of the earth, and the first man.

For the sake of the purpose we have in view, let us give a taste of just a few of the contents of these parts, those, namely, that are easier to understand.

In chapter I §7, the author says that *our solar vortex is not in the axis of the sphere but near that axis where there is a signal curve or inflexion*. Furthermore he says (§8), that *the common axis of the sphere, that is, of the starry heaven, is that galaxy where is found the greatest massing of stars; that along the galaxy all the vortices in their situation and their rectilinear series cohere together in respect to their poles; that they are likewise more intimately colligated by spirals of sharper curvature; that the other solar or stellar vortices then proceed from that*

axis, and are variously inflected, but that nevertheless all refer themselves to that axis.

In §11 he says *that in the finite universe there may be innumerable such spheres or starry heavens; that they can be colligated exactly as are the spheres of two magnets; and that the whole visible heaven is perhaps a mere speck in relation to the whole universe.*

In chapter vi, he declares that the fifth finite, which is similar in every way to the preceding finites, has its origin *wherever there is an abundance of finites of the fourth kind, and in the place where the fourth finites can somewhat unfold and can mutually finite each other; Hence, that they arise about the surface of the earth, at some distance from the sun, where the pressure of the vortical elements is not so great as in the neighborhood of the sun.*

In chapter vii, he says that *air consists superficially of fourth¹¹⁴ finites, and that within are enclosed first elements and likewise second; thus it is exactly similar to ether, differing from it only in degrees and dimension.*

In chapter viii, he endeavors to demonstrate that actives of the fourth finite create elementary fire; and actives of the fifth finite, or fifth finites when made active, create common or atmospheric fire.

In chapter ix, he says that the particle of water is similar to a compressed air particle wherein is left nothing elementary, yielding, or elastic; *but that it is hard, and consists of contiguous spherules formed within some larger spherule; and that the particle of water is not a finite which can actuate itself, like all the preceding finites, but is a purely material finite; consequently, that water is not an elementary particle, etc.*

In chapter x, he teaches concerning vapors that *they are formed on the surface of water, and this from the motion of the interfluent ether particles; and that when formed, vapor encloses within it a small volume of ether, and, on the outside, is pressed by the ether and likewise by the air; thus, that its surface is equilibrated by forces without and within, and preserves the spherical shape whatsoever be the degree of its compression, etc.*

According to the author, the earth underwent innumerable changes before coming to its present state. First, when it commenced to depart from the sun, it made its axillary rotation and its gyral course with greater celerity than afterwards when it receded to an ever greater distance from the sun [XI, 2]. Therefore, the changes it has undergone in its progress

from the sun to its present orbit, are as many in number as have been the circles or spirals which it measured out, and the degrees of celerity which it experienced, in its annual and diurnal circumvolution [XII, 2]. The author therefore concludes that in its state when gyrating more swiftly around its own axis and around the sun, making its days and years somewhat shorter, it enjoyed a kind of perpetual spring; *and that without this, seeds could not have been created nor could plants and animals of any kind have come into being* [ibid., §3]. That formerly the earth had shorter days and years, is, he thinks, borne witness to, by the ages of the first men, ages which extended to eight or nine hundred years. The antediluvians, if they came upon our times, would wonder at a spring that is so short and at winters and summers that are so long, and would complain of the long drawn out year and that they themselves grow old before fulfilling their years, etc.

But time does not allow of our giving further extracts from this first volume; nor does the fulfilling of our purpose permit it. It is enough that we have given some idea of this system so as to enable the reader to judge concerning it for himself. So far as possible, we have used the author's own words, and if he should, nevertheless, find some gaps and some statements which are not in agreement with his opinions, we trust that he will readily pardon us; for he himself will probably be aware that a first reading of his philosophy, and a cursory one at that, would be hardly sufficient for the perceiving of all the subtleties with which it is abundantly filled, or for constructing them into an epitome. Let us hasten on then to what remains, and briefly lay it before our readers.

The second and third volumes set forth the author's mineralogical works. We quote the complete title of the second: *The Subterranean or Mineral Kingdom. Concerning Iron, and the ways of smelting iron which are in use in different parts of Europe; and concerning the conversion of crude iron into steel; concerning iron ore and its proving; likewise concerning chemical preparations and experiments with iron and its vitriol*, etc. Thus, from the very title it can be seen what the author has undertaken to treat of in this Part of his work, for here he deals solely with iron. It is his intention, however, to treat successively of the other metals in the same way, including also salts and different kinds of stones; and thus to run through the whole of the mineral kingdom [Preface].

Whatever the metal, whether iron or any other, its treatment is distributed into three Classes; the first Class being taken up with the processes and smelting methods in use in various parts of Europe; the second with the processes of smelting ores, that is, with proving processes, by which an ore or metal is submitted to examination at a small hearth, or in proof-furnaces; and the third with a recital of chemical processes, and with experiments on the metal by solutions, crystallizations, precipitations, etc.

As concerns the first Class in the work before us, the author there occupies himself in telling of the better known modes of smelting used in Europe, describing with the greatest fullness those that are in use in the Kingdom of Sweden, since of these he has a deeper and riper knowledge. Thus, in chapter I, he tells of the mode used in many places in Sweden, of hardening, smelting, and roasting iron ore; and he adds a very complete description of the smelting furnace and of all the parts of which it consists. The process of smelting and casting is described with such great fullness, and all the particulars are related in so living a way, that in our opinion hardly a single circumstance or observation has escaped the author's attention. These descriptions occupy by far the greater part of chapter I of the first Class.

Toward the end of the chapter comes a particular enumeration of all the smelting furnaces and iron works in Sweden. We deem that it will not be displeasing to the reader if, in order to show how great an amount of iron wealth Sweden cherishes in her bosom, we give the number of these. In the province of Kopparsberg there are 79 smelting furnaces for iron, and 47 iron works. In Westmanland, 57 smelting furnaces, 78 iron works. In the Province of Örebro, 157 smelting furnaces, 165 iron works. In Uppland and Roslag, 24 smelting furnaces, in iron works. In Gästrikland and Hälsingland, 6 main smelting furnaces with many smaller ones, and 54 iron works. In Södermanland, 2 main smelting furnaces, 23 iron works. In Östergötland, 17 furnaces, 24 iron works. Of these iron works many have from three to ten hearths.

The chapter ends with mention of the fact that in 1726, native silver was found in a mine, exclusively of iron, in Nordmark in the Province of Värmland.

The second chapter deals with iron works and hearths, the smelting of crude iron, and its resmelting, and likewise with its extensibility under the

hammer. In the Kingdom of Sweden, two principal methods are used in the smelting of crude iron and rendering it malleable and pure, the one being called the German method, and the other the French. The author treats of both these processes, using equal care in both cases, and describing all the instruments pertaining to each.

The third chapter is concerning bog ore and its roasting and preparation in Sweden, especially in Ångermanland and Dalarne. The fourth chapter treats of the lake or river ore found in Sweden, and of the smelting thereof into iron. The fifth chapter concerns the Swedish iron, called *Osmund*,¹¹⁵ and of its preparation. The sixth chapter, of the mode of hardening, smelting, and roasting the iron ore or Dannemora in Roslag; the seventh, of the iron works and hearths in Roslag, and of the smelting and re-roasting of crude iron, and also of its extensibility under the hammer.

Chapters 8 to 14 tell of the modes of smelting and roasting iron used in various countries and particularly in France, Italy, England, and Russia. The author also adds a geographic map showing the mines and iron and copper works in Siberia. The fifteenth chapter presents Norwegian furnaces and iron works. The sixteenth to the twentieth, deal with the modes of roasting iron which prevail in various countries of Germany, in Silesia, Styria, Carinthia, etc.

The twenty-first chapter concerns the treatment of iron ore according to Agricola. The twenty-second tells of an attempt to smelt iron by faggots, and also combustible earth mixed with charcoal. Chapters 23 to 26 describe the mode of converting crude iron directly into hard steel by means of re-roasting it at an iron hearth, as is done in different places. These chapters also treat of the art of softening iron. The author does not here explain how iron that has already been forged is to be converted into steel, since this has been dealt with by the illustrious de Reaumur who gave a fine treatment on the subject in his treatise on *The Art of Converting Forged Iron into Steel*. Then follow certain attempts and miscellaneous experiments concerned with the softening of iron, its melting, roasting, etc. And finally, in the 27th chapter, are set forth some methods for dividing and cutting iron into thin bars and rods and of broadening these between cylinders. In this way, the first Class is brought to an end.

As we have already observed, the second Class contains the various methods used for proving iron ore and iron stone, such as by the magnet,

in a crucible, etc.; the methods used for exploring the quality of crude iron, and likewise of wrought iron, where some passages from Reaumur are quoted; the signs of the change of iron into steel; the difference of character between steel and iron, etc. In the seventh chapter, hematites and schist are given a special treatment.

The third and last Class, which, as we have stated, tells of chemical preparations, treats of (1) iron or steel filings; (2) aperient, and (3) astringent crocus of iron or steel; (4) the preparation of this crocus for the use of glassmakers; (5) the preparation of vitriolized sweet crocus; (6) crocus prepared with antimony; (7) sudorific crocus; (8) the regulus Martialis or steel; (9) the aperient and (10) the Ludovician and Cydoniate tincture of Mars. There are also, a number of other chapters all taken from the best known chemical writers whose names are faithfully recorded by our author. So much for the second volume.

The complete title of the third volume is: *The Subterranean or Mineral Kingdom. Concerning Copper and Bronze, and the modes of smelting copper as used in various parts of Europe; its separation from silver; its conversion into bronze and other metals of various kinds; the calamine stone; zinc; copper ore and its proving. Likewise concerning chemical preparations, and experiments made with copper, etc.* Thus it is clear without further examination that this volume is arranged in exactly the same way as the preceding.

In chapter 1 of the first Class, the author explains at some length the mode of drying, smelting, and purifying the copper ore of Fahlun—the most celebrated and ancient of all Swedish mines, into whose origin the author thinks in vain to inquire, seeing that its age exceeds many centuries and perhaps a thousand years.¹¹⁶

The second chapter tells of certain attempts made by several men, among whom the author mentions Kunckel, to improve and renovate the art of smelting as used at Fahlun. These many attempts, however, were found to be unfortunate. Not even Kunckel could earn the reward of 500,000 imperial thalers offered him by King Charles XI if he fulfilled his promises.

Chapters 3 to 8 treat of the precipitation of copper by iron, and the examples of this precipitation, both in Sweden and elsewhere; also the modes used in different parts of Sweden for drying and smelting copper ore; after which, in Chapter 10¹¹⁷ are given the processes of smelting used

in Norway. Chapter 11¹¹⁸ tells of the copper ores of Siberia. Chapters 12¹¹⁹ to 31 treat of the processes used in almost all the countries of Europe where copper is obtained. Added to these chapters are essays on the smelting of copper, quoted from various authors.

The author then passes on to the separation of silver from copper in various countries, and from various authors (chaps. 32–42). In chapters 43 to 53, he discourses at length concerning bronze and its preparation; also concerning the calamine stone of Aix la Chapelle, England, Goslar, and other places; the mode of converting copper into bronze as used in Sweden, England, etc.; the casting of statues, printers types, bells, cannons, and the mixture of metals for use in mirrors; brass and Prince Rupert's metal.¹²⁰ An appendix is added on zinc, white or silver colored metal and its preparation, and on the way to silver copper, or paint it with a silver color. All this is to be seen in the first Class.

The second Class presents modes whereby to prove copper ores and copper stone. Chapter 1 treats of the different kinds of copper ore, the author running through them as they are found in all parts of the known world. Chapter 2 treats of the provings of copper ore, namely, of the crucibles and furnaces, and the menstrua, which serve in the proving of copper; concerning a way of proving copper ores which melt easily, or with difficulty, which are poor, etc. The third chapter treats of the proving of copper by the touchstone; chapter 4, of the proving of copper or its ore for silver; also of metals that are impure, arsenical, antimonial; of metals used for bells, etc.; and of the preparation of proving needles. There is much else of the same kind which can hardly be enumerated.

Finally, the third Class sets forth various chemical preparations made with copper and bronze, and also experiments, to wit: The preparation of verdigris or green bronze (chap. 1); the various modes of preparing ultramarine or cerulean (chap. 2); burned bronze (chap. 3); the preparation of the crocus of Venus (chap. 4); vitriol and the crystals of Venus (chap. 5); the tincture of Venus (chap. 6); the spirits of Venus (chap. 7) the oil of Venus (chap. 8); the sulphur of Venus (chap. 9) the flowers of Venus (chap. 10). Divers other chemical preparations from copper, such as the mercury of copper, the regulus of Venus, Zwelfer's alcahest, the quintessence of Venus, etc. (chap. 11). Chapter 12 contains various observations on copper, gathered here and there, as regards its specific weight, its increase in

weight by means of a flame, its solution by different acids, etc. And so the third Class also is brought to a close.

Let us further note, from the Preface to this volume, the author's statement that at various places in Lapland, especially in the northern regions between latitudes 66–70°, are seen veins of copper, and also of silver, of considerable power and richness. In the same Preface, moreover, the reader will find something which is pleasant to know concerning the Norwegian mines in Königsberg where native silver is sometimes mined (*Act. Erud.*, August, 1737, pp. 342–56).

Neue Zeitungen

The above review was noted in the *Neue Zeitungen* for Aug. 1, 1737, p. 544.

*Traité sur l'Acier*¹²¹

Natural steel is much less known in this kingdom, though it is much used and is manufactured here; but for the greater part of our requirements, it is of a very mediocre quality. The best must always be imported from foreign countries. I do not know of any French book which gives instructions as to the manner of making it. M. Emanuel Swedenborg, Assessor in the Swedish College of Mines, has given the details respecting this process in a Latin book printed at Dresden, 1734, in which these details constitute a very small part of three volumes in folio. As the books published in Germany are known in France, only by a small number of scholars, I made up my mind to translate what the Swedish author says about the art of converting crude or cast iron into steel, and to put it at the end of the little treatise I am giving out.¹²²

On the occasion of M. de Hircheim's discovery,¹²³ a dispute arose, which for a long time was harmful to the success of his undertaking. He used the term "steel ore," and many persons to whom he announced his discovery doubted its reality, on the ground that there is no such thing as steel ore. It is true that there is no steel ore, if what is meant is a steel which comes ready made from the earth; . . . but it is also true that there are steel ores if one means simply the distinguishing of an iron ore suitable for conversion into steel from another ore suitable for conversion into wrought iron. It is in this sense that the Germans understand it, and I do not see

why this should be repugnant to the French. Therefore, like M. Swedenborg, whenever occasion requires I shall use the term “steel vein” or “steel ore.”

What we call “cast iron” is called by the Swedish author “crude iron.” In the translation of his work, I shall retain this term; but in my own dissertation, I shall use the term “cast iron” which well expresses the iron ore after its first smelting (*ibid.*, *ad fin.*).

M. Swedenborg observes that artificial steel is inferior to natural steel because it cannot often be put back into the fire without losing its quality of steel. This is a considerable disadvantage; for there are many instruments which frequently require to be put back into the fire, such as burins, chasing tools, chisels for cutting files, the files themselves, in a word, all instruments that lose their temper while in operation (p. 17).

There are quick ways whereby to recognize the value of a steel, but they are not those used by workmen. M. Swedenborg tells of several ways which will be found in the chapter containing his observations. They are, however, only approximately good, and are by no means infallible (p. 24).

To show how little the statements of travelers [as to the processes of making steel used in Africa, India, China, and Japan] can be relied on, I will only relate what M. Swedenborg says of them on the authority of certain travelers: They contend that the Japanese, having made forged iron into bars, place the latter in marshes and let them lie there as long as necessary for the rust to consume them in part. They then take them out and forge them anew. They then place them in a salt marsh for eight or ten years until a new rusting has again in large part destroyed them. According to what is told us, what remains is the steel of which they make all their instruments.

This process is so contrary to all fixed ideas as to the nature of steel, that it can be passed by as a fable, or as an illusion of some travelers, who (and this is very common) having seen a marsh ore such as can be seen in Dalecarlia have taken the iron thence procured to be an iron that has already been placed there.

What is reported of the methods used in Celebes, an island near Batavia, is very probable. It is said that by treating iron and then cooling it in water, they come to make steel of a very excellent quality; and that the nature of the water contributes to its fine temper. The traveler who reported this has certainly omitted the treating by a hammer; but taking this

for granted, then their method of making natural steel is the same as that used in Europe. As to what they say of its temper, experience justifies us in believing that these people might be deceived, and might attribute to the quality of certain waters what is nothing but the effect of a varying degree of coldness in this liquid. For one knows that the goodness of the temper, whether greater or less, depends on nothing more or less than the coldness of the water, and the heat in the iron. In general, the hotter the iron and the colder the water, the better the temper (pp. 27–29).

Natural steel, or steel from cast iron, is made in several provinces in France . . . ; but because they have never succeeded in making as good natural steel as that coming from Germany, many persons have believed that the Germans had a mysterious secret process. The description which I shall give, of the mode in which it is made in Alsace, and the description given by M. Swedenborg, will reduce this so-called secret to the class of the simplest and most natural effects (p. 30).

Nature has so well predestined certain ores to become steel, rather than others, that in some manufactures in France where natural steel is made, there is found in the same smelting an assemblage of two ores which are well distinguished; they keep separated in the same bloc. There are others where, as will be seen in M. Swedenborg, in the smelting the steel floats over the iron; this kind is of the best for making excellent steel at a very low price, but unfortunately it yields only a small quantity (p. 31).

If one compares the description which I shall give of the method employed in Alsace for transforming cast iron into steel, with those given by M. Swedenborg, and all M. Swedenborg's methods with each other, he will find many processes very remarkable by reason of their varieties (p. 36).

I have not undertaken to make a literal and servile translation of M. Swedenborg's entire chapter on the methods of converting crude iron into steel as used in many places in Germany, Sweden, and elsewhere. That would be highly unprofitable for the present volume. My design has been no other than to give to the inquirer some idea of the chief processes whereby one can make natural steel, which is so common and so useful in all the arts. I have selected from the book which I translate, only that which is able to instruct the whole world and which pertains to my plan. I have passed by many things which are matters of indifference, and others

which are nothing but the customs of the workmen. Those who want to know this art in greater detail, can have recourse to the original which deserves a place in all good libraries (*Avertissement* to the translation).

Note. The above notice constitutes the first appearance of Swedenborg's name in French literature. As already stated, this French translation was retranslated from French into Swedish, and published as *Utdrag af några Herr Asses. Swedenborgs Annärkningar om Ståhl ofwersätte från Fransöskatt*. Stockholm, 1753.

Anders Celsius¹²⁴

It is well known that here in Europe the declination or variation of the magnetic needle changes so slowly in a year that, for example, in Paris and London it increases hardly 1 minute of a degree a month, or 2 seconds a day. Consequently, the variation of the compass from day to day can be regarded as almost nil. Still, in the year 1682, Father Tachart, wishing to find the magnetic variation for the King of Siam, was the very first, so far as is known to me, to discover that the magnetic needle undergoes a daily change which is much greater than this slow movement would give us to suppose. Later, in the year 1722, Herr Graham, the celebrated mechanic and watchmaker in London, noted with much industry that the magnetic needle not only changed its declination daily but also from hour to hour. And since I have noticed that some natural philosophers, and particularly Herr Assessor Swedenborg in his philosophical work on the Magnet, bring the result of this experiment into doubt, and assert that it has come from some fault or carelessness in the observation,¹²⁵ I thought it would be worth while to set up new experiments here in Sweden. For this purpose, and at the suggestion of Herr Graham, I had an accurate compass ordered from the London instrument maker Siffon, which I will describe together with the care used in these observations, in order that everyone may be in a position to judge concerning their accuracy.

The compass needle is of prismatic shape, 1 foot and 1/2 line long, 1/2 line broad, and 1/3 line thick. In the middle of the needle is a holding knob of brass which moves on a brass pin with the least possible friction. At the south end of the needle, a small piece of brass can be moved to and fro for the purpose of setting the needle horizontal. The box is of wood

with a brass piece having at either end a circular arc of 40 degrees, so raised that the needle stands on the same level as the arc, on which latter are marked, with a fine line, divisions for every five minutes. Between these divisions, however, there is so much space that, with a convex glass, one can distinguish divisions into fifths or for every minute. Close to these divisions, and having a little play, points the needle with a fine edge which is ground perpendicular to the horizon. The box is well covered with a glass plate, so that, when one comes to make observations, neither air nor wind can get at the needle to move it from its right position.

Since in the present case it is required only to learn the difference in the variations from one hour to the other, I set the compass on a table in my room, at some degree indifferently, without setting it in accordance with the meridian; and I am sure that, during the time I made the observations, it remained there entirely undisturbed. When making the observations, I had no key or iron with me. All the iron which might be here and there in the room, as for instance, in the window and door, remained unmoved at the same distance from the needle, and therefore would have constantly the same influence. Afterwards, and especially when the first variation was noted, I also several times drew the needle away from its position, with a key, and held it steady in the position in which it stood at the first observation; but when the key was taken away, I found it always went back again to the same point. The same thing happened when the needle swung off during the observation when I stamped assiduously on the floor. Thus I am sure that the observed movement of the needle is a true property of the magnet.

I have already made a great number of observations with this compass, but I now adduce as proof only the following, made during 2 days, namely:

1740 April 30	8	A.M.	the needle pointed to	29 minutes
	9			24
	10			25
	11			35
	12			47
	2	P.M.		50
	3			51

	4.30	50
	5	49
	6	47
	6.45	47
	10.45	43
May 1	8 A.M.	36
	10.15	38
	11	39
	12.30 P.M.	45
	9	42

From this it clearly appears that the magnetic needle changes its position from one hour to the other, sometimes as much as 10 minutes, and, in 6 hours, to as much as 27 minutes; furthermore, that from the one day to the next at the same time, it does not stand in the same place, but the difference may sometimes be as great as 7 minutes, etc. I have not yet noticed that cold, warmth, the different weight of the air, wind, etc., have any relation to this variation; but it will be a pleasure to me, to continue with this matter, and to communicate with the Academy at another time if I can find any sure law in this movement (*Kong. Sw. Vetenskaps Acad. Handl.*, April–June, pp. 297–99).

Note. Celsius reported further observations in a paper *On the variation of the magnetic needle or its deviation from the north, as observed at Upsala*, which was read before the Academy on August 23, 1740, and was printed in its Transactions, from which we extract the following:

[After speaking of the variations hitherto observed in the declination of the magnet, and of the necessity for navigation, that these variations shall be accurately known, Celsius continues:] One can well imagine that philosophers, who are usually impatient of waiting for a long extended experience, have already offered to explain the cause of these marvelous properties of the magnetic needle. And the most probable guesses on this subject amount to this, namely, that they represent our globe as a great magnet having its two poles, one in the north and the other in the south, which move very slowly around the earth's true axillary poles, at a certain

distance, and so cause the difference in the direction of the magnetic needle; or, that within the earth, like a kernel, lies another great magnetic globe which, at a certain depth and distance, has the same centre as the earth's poles, so that this magnetic globe, by the motion of its poles, directs the magnetic needle on the earth above it; or, that both these causes exist at the same time, since the earth's external outline or shell, like the inner magnetic globe, has two poles in the north and two in the south.

Therefore, if one knew with accuracy the true position of these magnetic poles, whether they be above the earth or within it, and likewise their slow progress, then one would be able to work out the magnetic declination at any given time for all places of which the longitude and latitude were known. On the other hand, when by observation he had found the declination of the magnetic needle, one at sea could find the much desired longitude as well as the latitude, especially if he received assistance from the inclination of the magnetic needle, or its depression below the horizontal line. On this matter, God willing, I shall have the honor of communicating my observations to the Academy at another time.

But since we have not a sufficient store of experiments carried on all round the earth to enable us as yet to find the situation of these magnetic poles geometrically, especially in these northern places, therefore it would be desirable that the declination of the magnetic needle be carefully noted here in Sweden—at sea by those who travel in the Baltic, and also to the Levant and the East Indies, and on land by the surveyors in the provinces who, for that matter, need to know the declination of the magnet if they are to join up their charts true to the quarters.

Therefore, on the 28 July last, between 3 and 4 P.M., and in clear and warm weather, I observed the declination of the magnetic needle here in Upsala, with the same compass as that which I previously described in these Transactions, using therewith every possible precaution. First, by means of a well-set astronomical clock, I made a meridian line, 6 ells long, which I am sure would not be wrong up to a few seconds of time; and in order to avoid the neighborhood of any iron, I did this in my garden in the open air. Moreover, during the observation I had no iron tool on my person, such as keys, shoe buckles, etc. Along the meridian line I stretched a fine thread, and the compass was so placed under it that the thread stood exactly over the degree 0 on the division of the two brass arcs. When the

thread was taken away, the magnetic needle lay on its pin, and the whole was covered with a glass. I then observed the needle declined

Westerly from the north	8° 53''
Attracted from its position by a key, the needle then stood at ...	8° 50''
When the compass was moved and again set under the thread, the needle showed	8° 45''
Moved with a key	8° 47''
When the compass was moved and then again placed under the thread	8° 50''
The mean of all this is	8° 49''

The latter figure is the true westerly declination of the needle in this locality.

Since Herr Assessor Swedenborg has shown how one can find a priori the declination of the magnetic needle for any given place,¹²⁶ therefore at my request Magister Hiorter,¹²⁷ using the 28 operations in accordance with this theory, calculated the declination of the magnetic needle for Upsala at the present time:

In Upsala	17° 2.5''
which thus shows an error of	8° 13.5''
In like manner he found that the declination in Tornea on April 17, 1736 should be	12° 22''
yet that which I observed then was	5° 5''
showing an error of	7° 17''

From which it is sufficiently apparent that the Herr Assessor's theory would require some further improvement (*Handlingar*, July–Sept., 1740, pp. 384–88).

Note. The above two articles by Celsius were included in the German translation of the Transactions of the Swedish Academy of Sciences, published in Hamburg, 1749. The articles were also translated into Latin and published in *Analecta Transalpina*, Venice, 1, 1762, 63–65, pp. 80–2. This marks the first mention of Swedenborg's name in

Italian publications. On November 26, 1740, soon after the publication of Celsiusus' observations, Linnaeus nominated Swedenborg for membership in the Academy of Sciences. He was unanimously elected on December 10, and took his seat on January 8, 1741. Swedenborg then handed in his reply to Celsiusus' strictures,¹²⁸ and this was read before the Academy on January 14, neither Swedenborg nor Celsiusus being present.

He commences with some observations on why it is so difficult to make an exact observation of the needle's declination, illustrating his remarks by showing from Professor Celsiusus' first article, that the variation may be as much as 27 minutes in 6 hours; and he maintains that the magnet does not make "such irregular jumps forwards and backwards," otherwise, the earth would "vibrate in its balance and so be threatened with falling out of its equilibrium."

After some remarks on reasoning a priori and a posteriori, Swedenborg then considers the two objections raised against the latter reasoning, namely, that (1) there is not yet a sufficient store of facts, and (2) it is doubtful whether a theory will be of any advantage. In connection with the latter objection, he remarks that a true theory of the needle's declination would solve the problem of finding the longitude at sea.

He then thanks Professor Celsiusus for the calculation of the declination at Upsala according to his theory, for "in order to stand, a calculation grounded on theory must be proved by experience." After this he submits in detail his own mathematical computation of the declination at Upsala, showing the result as $8^{\circ} 52''$ as compared with the observed declination of $8^{\circ} 49''$, being a difference of only 3 seconds. He offers to make the same calculations for Tornea as soon as he is told the latitude and longitude of that place.

After the hearing of this reply, the Academy resolved that the President, Count Höpken should communicate it to Professor Celsiusus with a request for his opinion. The latter's reply was read before the Academy on January 25, and at the President's request, was sent to Swedenborg.¹²⁹

Celsius

Since Herr Swedenborg has now been pleased to himself calculate according to his theory, the declination of the magnetic needle in Upsala, and has found it to be tolerably close to my own observation, when yet, guided by Herr Magister Hjorter's calculation, I gave the error as $8^{\circ} 13.5''$, therefore I examined Herr Magister Hjorter's calculation and found it to be in accordance with the Herr Assessor's rules and examples as laid down in his philosophical work. On the other hand, I observed that the Herr Assessor's own calculation agrees with my observation by accident seeing that it is quite faulty, especially in view of the fact that he takes the latitude of Upsala instead of its complement or equatorial elevation. I have also the honor of herewith sending to the Academy of Sciences Herr Magister Hjorter's calculations for the meridian of Upsala, together with the errors found in Herr Assessor Swedenborg's calculations; from which the Academy of Sciences can clearly see that the difference as shown does not consist of any mistake in Magister Hjorter's calculations, but in the theory itself.

This seems the less remarkable, in that Herr Assessor Swedenborg was as yet unable to obtain a sufficient number of experiments, both as to the declination of the magnet and as to its inclination, instituted with all possible care around the whole globe, to enable him to be in a position to make a perfect theory which would not need to be improved and changed, in consequence of later observations. Dr. Halley,¹³⁰ more than any other man I believe, has applied his profound mind to a theory concerning the declination of the magnet which the learned are now seeking further to develop, but he does not yet think himself able to determine geometrically the situation of the magnetic pole on the earth. Meanwhile, and mostly from his own experiments made during his voyages, he has empirically drawn curved lines representing the declinations of the magnet on the largest oceans of the world, and has had the good fortune to see them all more and more confirmed by later experiments. And noting that Herr Assessor Swedenborg's theory was entirely different from Dr. Halley's, I was so much the more anxious to see how the former would correspond to my own observations in Tornea and Upsala, especially when I saw that the calculations were in such close agreement with the declinations of the magnet observed in London and Paris.

Otherwise, since Herr Assessor Swedenborg is still pleased to make the same objection to the hourly change in the declination of the magnetic needle as previously, in his philosophical work,¹³¹ he made against Muschenbroek's and Graham's observations, I have not felt like refraining from uttering my humble thoughts thereon.

The observation of the declination of the magnet with such nicety that one is absolutely sure of having the right magnitude in degrees and minutes, is held by me also to be a very difficult and delicate matter; so that the factors brought forward by the Herr Assessor may render observations faulty, if they are not obviated as far as possible. In observations of the hourly variation of the magnetic needle at one and the same place, these causes have the less place, since in this case one looks only for the differences of the declination, without troubling as to the absolute magnitude of the vibration. Therefore, in this case the placing of the needle in accordance with the correct meridian, does not matter, provided only that one marks one definite degree;¹³² nor does it matter whether the whole arc is not so exactly divided, provided only one half degree is approximately accurate; nor if some iron stuff lies imbedded in the window frames, the door, the wall, or in the earth, since these would merely make the absolute quantity of the declination incorrect, but, since they operate all the time at the same distance with the same force, they cannot cause any error in the difference. Nor can any draft in the room, or any play of the weather, at all change the direction of the needle, when the compass is well covered with a glass; and so forth. Moreover, for this reason Herr Graham used two magnetic needles set at some distance from each other, and he found that they registered about the same magnitude in this hourly variation. Nor can the friction of the needle on its pivot be at all able to give rise to any change in this respect; for both Herr Graham and I myself have proved that, when the needle was at its greatest or least change for the day, if one then drew it from its position with a key, and by this means held it stationary in a position other than that which it held earlier in the day, then, as soon as the key was taken away, the needle went back to its former position.

From this, it would seem one can clearly infer, that this hourly variation of the magnetic needle does not arise from any fault in the observation, however this may be demanded by some given hypothesis; but that

its cause is still unknown to us, and is worthy of being sought out by many experiments.

Meanwhile, on the basis of more than a thousand observations, Herr Graham has found that this variation can be ascribed neither to heat nor cold, clear weather nor cloudy, stormy nor calm, nor to any difference in the height of the barometer; which also is in harmony with my observations here in Upsala. And he thinks he is justified in concluding that the greatest variation in increase takes place between 12 and 4 P.M., and the least at 6 or 7 P.M.; on which matter I shall further communicate my experiments when I acquire more experience in this matter.

Note. Three documents by Hjorter were enclosed in the above communication:

(1) "A calculation of the magnetic declination for the year 1740, at Upsala, made according to the rules of the Noble Herr Assessor Swedenborg. The latitude of the northern place is $59^{\circ} 52''$, the complement whereof is $30^{\circ} 8''$. The longitude east from London is $17^{\circ} 30''$." The result gives the declination at Upsala as $W 17^{\circ} 2.5''$ being $8^{\circ} 13.5''$ greater than the observed declination.

(2) "A calculation of the magnetic declination at Tornea in the year 1737, computed according to the rules given by the Noble Herr Assessor Swedenborg. The latitude of the northern place is $65^{\circ} 50''$, whose complement is $24^{\circ} 10''$. The longitude east of London is $20^{\circ} 30''$." This shows the declination at Tornea to be $12^{\circ} 22''$ being $7^{\circ} 17''$ more than the observed declination.

(3) "The mistakes in well-born Herr Assessor Swedenborg's calculation, handed in to the Academy, of the declination of the magnetic needle in Upsala in the year 1740, in connection with the principles, rules, and examples given in his philosophical work." The main point in this paper was that Swedenborg put the height of the pole at Upsala as $59^{\circ} 50''$ instead of $59^{\circ} 52''$; and the longitude as 15° east of London instead of $17.5''$; these and some other errors had of course been multiplied in his calculation.

After Swedenborg had been given the loan of Celsius' paper, he returned it to the Academy, probably accompanying it with a short

answer.¹³³ In this, he states that he had received the latitude of Upsala from Flamstead in 1710; and that his error in one case was due to an error in Vlac's Logarithmic tables. He also found "at first glance" that there were some errors in the calculation he had handed in.

At the meeting, Celsius' paper (and probably also Swedenborg's reply) "was referred to the Mathematical Section to go through it and transmit to the Academy its opinion concerning it."

This is the last word concerning the Celsius-Swedenborg controversy, of which we have any record.¹³⁴

Cromwell Mortimer, M.D.¹³⁵

For the sake of such as understand Latin, we must not pass by that magnificent and laborious work of EMANUEL SWEDENBORGIUS, entitled, *Principia Rerum Naturalium, sive novorunt Tentaminum Phaenomena Mundi Elementarii philosophice explicandi*. Dresdae and Lipsiae 1734, in 3 tom. in Folio; in the 2nd and 3rd tome of which he hath given the best Accounts, not only of the methods and newest improvements in metallick works in all places beyond the seas, but particularly of those in England, and our Colonies in America; with Draughts of the furnaces and instruments employed. It is to be wished we had extracts of this work in English. So industrious are the Swedes in improving themselves in the Art of Metallurgy, that they send young gentlemen yearly to travel, not only all over England but all over Europe, to learn everything new in regard to mines; while we in England sit still at home, and seldom go beyond a County or two; though, if more diligent search was to be made by persons of skill, there is great reason to believe that Nature hath enriched these our Isles with as great subterranean treasures, even the Virgin Silver of Potosi not excepted, as any other spot of the same extent (Appendix, pp. 453–54).

Commentarium Literarium

The calamine stone or fossil Cadmia is asserted by Boecler to be devoid of metal. On the other hand, in his work on Copper and Bronze, P. 341 seq., Swedenborg teaches that fossil cadmia, especially that of England and also the cadmia of the furnaces of Goslar, partakes of lead. With him also agrees Henckel in his *Pyrolologia* (*Com. Lit.* May 31, 1741, p. 172).

Johan Gotschalk Wallerius¹³⁶

Emanuel Swedenborg, Assessor in the College of Mines of his Royal Majesty and the Kingdom of Sweden, has published *Miscellaneous Observations in respect to Natural Things*, Leipzig, 1722, in which work, though scattered here and there, something is said about some kinds of stones and petrification. Besides this, however, there was published by him *The Subterranean or Mineral Kingdom, on Iron*, Dresden and Leipzig, 1734; and *The Subterranean or Mineral Kingdom, on Copper*, *ibid.*, 1734, specially treating of Swedish and foreign mines, and introducing all smelting operations and smelting; it also touches somewhat on ores and stones (*Miner. Pref.*).

Julius Bernard Von Rohr¹³⁷

In this class [of books on the Origin of Natural Things] comes also Swedenborg's *Principles of Natural Things or of New Attempts to Explain the Phenomena of the Elementary World, philosophically*; with copperplates and a rational, godly, and natural knowledge of the four elements, and of the creations arising therefrom, as to how these perform their operations magnetically; and how to discover all sicknesses as to their causes; and also, how to cure them magnetically both inwardly and outwardly, by the highest medicine created by God¹³⁸ (*Phys. Bibl.*, 2 On the Elements, p. 90).

In the second and third volumes of his philosophical and mineralogical works, Emanuel Swedenborg, who has been mentioned by us at different times, gives evidence of profound learning. He grounds himself on mechanism, and draws powerfully on the experiments which he has made (*ibid.*, 11 On the Mineral Kingdom, p. 367).

We also find a complete account of copper and bronze in Swedenborg's *Subterranean or Mineral Kingdom* in the volume on Copper and Bronze, which not many years ago he communicated to the world in folio with a large number of copperplates (*ibid.*, p. 403).

Courtivron and Bouchu¹³⁹

It is iron that we shall endeavor to examine—a substance, in appearance so rough, but in reality so subtle, so necessary, so deserving of being known, and so capable of rendering us an infinitude of services. It has seemed appropriate to give some information in regard to the comparison

and examination of different mines and their methods of working. In order to multiply sources of information on this subject, we have given a translation of Swedenborg's treatise on Iron, and to this treatise we shall refer for a number of details which otherwise we should have been obliged to give in the course of our own exposition. The printers having willingly consented to print this translation of Swedenborg in a type¹⁴⁰ which will lower the price of the work so as to bring it within the reach of workmen whose enlightened experience will become more useful to the public. This work (from which we have omitted all that the Swede borrows from M. de Reaumur¹⁴¹), together with the latter's work on Steel and Cast Iron, will serve as a commentary on our own treatise (p. 2).

The ore of *Dannemore* in *Roslag* must be assigned to this class (ore of black laminated iron). This ore is so abundant, says Swedenborg, that it suffices, each year, to keep several furnaces working. It excels all other ores, both for its purity and for its richness. The iron which it yields is not brittle, whether cold or hot. It is very suitable for the making of many instruments. It supplies the finest steel and the most suitable for the making of files. It is, therefore, much sought after in Europe and India, where it sells at a higher price than all others. This iron appears to be entirely composed of threads and scales interlaced with each other.

The ore is very heavy and is of the color of iron or lead, resembling the iron which comes from it. Like steel, it is composed of fine grains; but mingled therewith are very delicate threads, limestone, and quartz, which traverse it in every direction like veins or arteries. The grains of iron are so well mingled with these fibers that the result presents a kind of leaden color, and a certain whiteness which blends the black of the iron into whiteness, and a result of which is that the ore melts very easily; for it carries its flux within itself.

Pieces of this ore have a black and smooth surface covered with a small membrane of hornstone; there are also pieces covered with green asbestos, regularly divisible according to their plane (p. 11).

To these propositions we may oppose what Swedenborg tells us at the end of his observations on the German and French furnaces: "In the German furnaces (he says), they call for a crude iron which is tenacious, and, in fracture, is of a gray color; in French, they desire an iron which is

cruder, brittle, and the fracture of which shines with little grains and bright dots; for with iron of this kind the melting is done with more difficulty. Raw iron which is tenacious and which has been well recooked in the furnace, not only resists the fire a longer time, but when it is converted into iron the residue is not so considerable as that of the white and brittle castings" (Sect. II, p. 77).

To make these various processes clearer, we deem it best to speak of them from the following different points of view: open molding, molding in earth, molding in sand, molding in shells. There is reason to be surprised at the silence of Swedenborg on this work. He has only indicated a few places where these kinds of merchandise are made. Was he afraid of instructing us? What might lead us to believe this, is the eagerness with which he has seized on the work of M. de Reaumer (*ibid.*, p. 79).

Correction of Swedenborg's treatise on Iron, in the fourth section of *Fourneaux a Fer*, p. 183: In the fourth section of *l'Art de Forges*, in the translation of Swedenborg's treatise on Iron, is found an analysis of the waters of Passy. At the end of this analysis he says: *No salt has been found in these waters, no vitriol, no nitre; for the rest, it is demonstrated that these waters contain a little iron and considerable gypsum, and that they are of little use.* This is not correct. The excellent analyses of these waters which have been made since the first edition of Swedenborg's work have shown the presence of many medicinal salts; and daily experience has furnished multitudinous proof as to the usefulness of these waters in the case of many ills. The Academy having noted this error, has judged it proper to advertise the public concerning it (Sect. IV, note on back of title page).

The translation of the work of M. Swedenborg, which constitutes the fourth Section of *l'Art des Forges*, is given for the purpose of comparing the works in Sweden with those in France. This foreign scientist, who has written several works on Metallurgy, is employed by the Swedish government in the Iron and Copper Manufactories of that kingdom, there to introduce the enlightened views which his knowledge has given him. After M. Bouchu had made his translation of M. Swedenborg's Treatise on Iron, it had been thought that after the work of this foreigner had been divested of all that he had borrowed from M. de Reaumer on the subject of steel and cast iron, it might be possible to distribute it among the various sections of *l'Art des Forges*, in the form of notes; but, considering that it

would be embarrassing for everyone and that it would be difficult for simple workmen to search among scattered notes for processes which will instruct them, it has been decided, in accordance with the translator's desire, to publish the work in the form in which it now appears, printing it in the same type that would have been used in the notes and corrections, of which we spoke in another place. The translator has kept the same plates and figures as those used in M. Swedenborg's book; and the draftsman, in order to lessen the number of the plates, has merely made some changes in the arrangement of the figures on each plate, without changing anything in the figures themselves. The same letters are used, and the figures have been numbered as they are in the original. All that has been necessary, in order to arrange them in fewer plates, was to move two or three figures from one plate to another; and this arrangement has been preferred to the inconvenience of making a more expensive work by the use of a greater number of plates (*ibid.*, Avertissement).

*Göttingische Anzeigen van Gelehrten Sachen*¹⁴²

Paris. There has been published here *Art des Forges et Fourneaux* by MM. Courtivron and Bouchu. . . . The fourth section consists of 196 pages with 8 copperplates. It contains a translation of the Swedenborgian work on Iron, together with the plates, slightly changed (*Gött. Anzeig.*, Sept. 29, 1763, p. 952).

Henning Calvör¹⁴³

In Swedenborg's *Regnum Subterraneum*, or Mineral Kingdom, in the volume on Copper and Bronze, page 200, is a ground plan of a Swedish Puckwerk¹⁴⁴ drawn to correct scale and with the Latin names of the parts, except that the drawing lacks the trough (I) over the water wheel, and the runlet (o) which enters into this trough, together with the little ore-channel (P) and the little runlets (ee).¹⁴⁵

John Christian Cuno¹⁴⁶

That Herr Swedenborg is a philosopher, and indeed a philosopher of the first magnitude, cannot be denied him; and were there no other proof of this, then the three folio volumes *Principia Rerum Naturalium sive Novorum Tentaminum Phaenomena mundi elementaris philosophice explicandi. Cum figuris aeneis*, [these would be sufficient]. In the whole history of philosophy, I

have learned to bring him into comparison with none of the learned except the great physician and chemist Theophrastus Paracelsus. I have already gone through his philosophical works to some little extent, and I will say no more about them, in order not to become all too diffuse. I leave his philosophy in its place, but then also he must not offend against the Holy Scriptures. He concludes his first volume with the words of the great philosopher, von Wolf : “One must therefore leave full freedom to him who philosophizes in the philosophic style, and in doing this one apprehends no danger for religion, for virtue and for the common welfare.”

I accept this statement by the late Herr von Wolf without hesitation, but I submit the thought as to whether it is not a great offence when the description of creation by our philosopher is quite other than that given by Moses, from whose description, howsoever short and simple it sounds, the English physician and philosopher Dickinson, as a mere philosopher, demonstrates the divine mission of Moses. Moses says, all that was created was created in six days; our philosopher uses a time the length of which he himself does not know ere our earth reached its completion. And how will he prove that in its commencement our earth had its situation much nearer the sun? and that therefore its course and consequently its years, were much shorter? The 900 years of life which Moses ascribes to Methuselah, Herr Swedenborg says, amount to not much more than 100 years. For my own part, I hold fast to the belief that our earth has still the same position in our solar system, and the same course, which the Almighty Creator appointed it from the beginning; and I see not the least impossibility in the statement that before the flood men could live several hundred years. One who has but little knowledge, and who will reflect, will understand that our earth is no longer the same as it was before the flood. I do not wonder, therefore, when this same Moses though he was born less than 800 years after the flood and attributes to the patriarchs before the flood a life of such wondrous length, yet, even in his own day, ascribed to men a space of life no longer than 70 years, and if he reaches an older age, than 80 years (Ps. 90:10). This, however, I say only in passing, since I have already expressed myself circumstantially on this subject elsewhere (Biedermann,¹⁴⁷ I, Pt. 3 Discourse).

What Herr Swedenborg says in chapter XII concerning the earthly paradise and the first man, has as little place in a philosophical work,

methinks, as his assertion, in agreement with Wolff, that religion has no danger to fear therefrom (*Aufzeich*, pp. 157–60).

Professor John Beckman

At the general meeting of the Royal Academy of Science of Göttingen on July 6 last [1771], Herr Professor John Beckman read a paper on "The Reduction of fossils or petrified objects to the natural classes of their prototypes." He stated . . . That among all recorded ornitholiths there is not one which is not subject to doubt. The skeleton of a four footed animal found on slate near Glucksbrunn, and pictured by Swedenborg, is probably a seal [*Allmänna Tidn.*, October 14, 1771, p. 263].

Note. The picture referred to is Plate II in the work on Copper, where it is mentioned on page 168. The fossil was dug up in 1733, and Swedenborg first saw it in August of that year, at the house of Councillor of Mines Trier in Dresden (*Doc. Conc. Swedenborg*, II, 72). Three days later he left for Leipzig, where in January, 1735, he received from Trier a drawing, which he caused to be engraved for inclusion in the work he was then publishing (*Op. Quaed.*, 1, 324). In that work he describes it as some kind of sea animal or amphibian, and as the most perfect and complete of all fossils of animals or fishes that he had ever seen.

(*To be Continued*)

ENDNOTES

111. This is a mistake for "simple finite."
112. The reviewer should have said "first elementary particles."
113. This should read "of the parts and of the compound."
114. This should be "fifth."
115. A superior kind of iron formerly peculiar to Sweden.
116. The original charter which is still preserved by the owners of the Fahlun Mine is dated 1284.
117. This should be "9."
118. This should be "10."
119. This should be "11."

120. A kind of brass.

121. *Traité sur L'Acier ou l'art de convertir le fer de fonte en acier* (a treatise on Steel, or the art of converting cast iron into steel). Strasburg, 1737. As noted above, a French translation of a portion of Swedenborg's work on Iron was incorporated in this anonymous work of 115 pages, sm. 8vo. We now give some extracts from the work itself.

122. In the work thus "given out" it constitutes pages 63–115.

123. Five or six years previously, M. de Hirchem, a Strasburg burgomaster, had discovered in Alsace an iron ore suitable for making a steel equal to any imported from Germany.

124. Anders Celsius was professor of astronomy at Upsala University and one of the earliest members (June, 1739) of the Swedish Royal Academy. The paper of which the text is a translation is entitled "Notes on the hourly changes in the variation of the magnet." It was read before the Academy on May 14, 1740, and published in the Transactions of the Society for that year. It made the beginning of what was known as "the Swedenborg and Celsius polemic."

125. The reference is to p. 273 of the *Principia* (II, xiv), where Swedenborg suggests a possibility of inaccuracy in the reported observations of the declination of the magnetic needle, due to the neighborhood of iron, wind, or even the breath, defect in the needle or in its poise or horizontal position, etc.

126. This refers to *Principia*, p. 318 seq. (II, xv) where Swedenborg explains theoretically a method of calculating the declination of the magnetic needle in different places and at different times. In chapter xvi he presents the method itself, which involves 28 mathematical processes. This he follows by actual calculations of the declination at London, Paris (from 1610–1780), Rome, Uranienburg, etc. Then, so far as possible, he compares the calculated declinations with those actually observed and finds a close agreement. This comparison is introduced by the words: "I am not so vain as to dare to give out theoretical figures unless experience gives her sanction and consent. Unless the latter imparts her light to theory, theory will only produce blindness and lead the mind astray" §xxiii).

127. Lecturer on astronomy at Upsala University and assistant to Professor Celsius.

128. An English translation of this reply may be seen in *Documents Concerning Swedenborg*, 1, 568–77.

129. Neither Swedenborg's first answer nor Celsius' reply, nor any of the subsequent papers in this polemic were ever published; but they are all preserved in the Library of the Royal Academy of Sciences, Stockholm

130. In his reply, which Celsius here answers, Swedenborg had referred to Dr. Halley's chart of magnetic declinations over the whole world as showing the regularity of the needle's declination. He had included this chart in his own treatment on the magnet.

131. *Principia*, II, xiv, 9.

132. Here, and in what follows, Celsius takes up the various circumstances adduced by Swedenborg in his *Principia*, II, xiv, I seq., as contributing to errors in magnetic observations.

133. This answer is marked "Read Feb. 1, 1741," but since the next meeting after January 31 was February 7, in the Minutes of which no mention is made of this polemic, the date is perhaps an error for "Jan. 31."

134. For a better understanding of this controversy, and especially of Swedenborg's position, see the very thorough study of the subject contributed by Professor R. W. Brown to the *New Philosophy* for October, 1924, pp. 307–8.

135. In John Andrew Cramer's *Elements of the Art of Assaying Metals*. Translated from the Latin; with an Appendix containing a list of the chief authors who have published works in English upon minerals and metals. London, 1741. The notes to this volume, and also the list of authors, were supplied by Dr. Cromwell Mortimer, Secretary of the Royal Philosophical Society.

136. In his *Mineralogia*, Stockholm, 1747.

137. In *Physikalische Bibliothek*, Leipzig, 1754.

138. It is quite evident that von Rohr was entirely ignorant of the contents of Swedenborg's *Principia*.

139. In *Art des Forges et Fourneaux à Fer* (The Art of Foundries and Furnaces for Iron) by the Marquis de Courtivron, and M. Bouchu, correspondent of the Royal Academy of Sciences. Royal folio. Paris, 1762. This work was published by the Royal Academy of Sciences of Paris. In it Swedenborg is frequently referred to as an authority on iron; in the text we quote two or three of these references.

140. The translation of Swedenborg is printed in a type very slightly smaller than the rest of *Art des Forges* except de Reaumur's treatise; but like the latter, it is put in double column unled. It fills 196 pages, and is accompanied by 9 copperplates; de Reaumur's treatise fills 124 pages.

141. The whole of Swedenborg's work on Iron is included in this translation except two pages containing names of Swedish furnaces, three pages quoted from the alchemists; and forty-six pages on steel quoted from de Reaumur. Of Swedenborg's 36 plates, 25 are reproduced here and 11 in connection with de Reaumur's work. The plates are somewhat diminished, 25 plates being made into 9 (in Royal folio). Sometimes the plates are slightly altered and improved.

142. *Göttingische Anzeigen von Gelehrten Sachen unter der Aufsicht der Königl. Gesellschaft der Wissenschaften* (The Göttingen Advertiser of learned matters; under the superintendence of the Royal Society of Sciences).

143. In *Acta, Historico-Chronologico-Mechanica circa metallurgiam in Hercynia. Superiori* (Historical Chronological and mechanical facts in relation to Metallurgy in Upper Hercynia); von Henning Calvör, Braunschweig, 1763.

144. A machine for crushing ore; it was worked by a water wheel.

145. The figure referred to is Calvör's ground-plan of a puckwerk, which he thus compares with Swedenborg's.

146. In his *Lebensbeschreibung* (Autobiography) part of which was published in *Aufzeichnungen eines Amsterdamer Bürgers über Swedenborg* (Notes on Swedenborg by an Amsterdam Citizen), Hannover, 1858. These notes were written by Cuno in 1770, when he was in daily intercourse with Swedenborg.

147. Biedermann was the title of a moral romance written by Cuno about 1763 or 1764. Whether it was published or not, is not known. (See *Aufzeichnungen*, p. 27.)

