

# SWEDENBORG THE SCIENTIST

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## Contents

CHIEF SCIENTIFIC WORKS.....	2
EMANUEL SWEDENBORG* .....	3
HE DEFINES HIS SCIENTIFIC PERIOD.....	3
THE MAGNITUDE OF THE TASK.....	3
THE PRESENT PURPOSE .....	3
WRONG METHODS OF APPROACH.....	4
THE RIGHT METHOD .....	4
SWEDENBORG'S ACADEMIC CAREER.....	4

CHOICE OF A SCIENTIFIC CAREER.....	4
SWEDENBORG'S FIRST FOREIGN TOUR.....	5
SOME PRACTICAL RESULTS .....	5
SWEDENBORG'S LOVE OF USE .....	5
SWEDENBORG AS INVENTOR.....	6
SWEDENBORG AS MATHEMATICIAN AND ASTRONOMER.....	6
SWEDENBORG DECLINES PROFESSORSHIP.....	7
SWEDENBORG AS EDITOR.....	7
SWEDENBORG' S OFFICIAL APPOINTMENT .....	8
SWEDENBORG AS CIVIL ENGINEER .....	8
SWEDENBORG AS GEOLOGIST .....	8
SWEDENBORG AND COSMOLOGY .....	9
SWEDENBORG AS CHEMIST .....	10
SWEDENBORG THE METALLURGIST.....	11
SWEDENBORG AS ANATOMIST AND PHYSIOLOGIST.....	13
THE UNFAILING QUEST .....	15

## CHIEF SCIENTIFIC WORKS

1716-1718. *Daedalus Hyperboreus* (Northern Daedalus).

1718. *Regel-Konsten* (Algebra).

*Forsole At finna Ostra och Westra Lengden igen igenom Manan* (To find the Longitude, 1747).

1721. *Prodromus Principiorum Rerum Naturalium*, 1911

(Principles of Chemistry, 1847).

1722. *Miscellanea Observata*, Partes I—IV (Miscellaneous Observations, Part I—IV, 1847).

1734. *Opera Philosophica et Mineralia*.

Vol. I. *Principia Rerum. Naturalium*, 1908 (The Principia, 1845 and 1912).

Vol II. *Regnum Minerale : de Ferro* (on Iron).

Vol III. *Regnum Minerale : de Cupro* (on Copper).

1740. *Oeconomia Regni Animalis*, 2 Vols. (Economy of the Animal Kingdom, 1845).

1744. *Regnum Animale*.

Pars Prima : *De Visceribus Abdominis*.

(The Animal Kingdom, Vol. I. 1843.) Pars Secunda : *De Visceribus Thoracis*.

(The Animal Kingdom, Vol. II. 1844.)

1745. Pars Tertia: *De Cute, Sensu Tactus*, etc.

## POSTHUMOUS

1729. *Principia Rerum Naturalium*, 1908. (Lesser Principia, 1912.)

1740. *De Cerebro, Cerebello*, etc. (The Brain, Vol. I.1882. Vol. II. 1887.)

*De Fibra*, etc. 1847. (The Fibre, 1918.)

1742. *Psychologia Rationalis*. 1849. (Rational Psychology. 1887. )

1743. *Anatomia Corporis: De perioste*o, etc. 1849.

*Anatomia Corporis: De Generatione*, etc. 1849.

(Generative Organs. 1852.)

1744. *De sensu communi*, etc. 1848. (The Five Senses. 1914.)

## EMANUEL SWEDENBORG\*

EMANUEL SWEDENBORG, who was born in Stockholm in 1688 and died in London in 1772, is generally known as a seer and theologian; as a man who in later life made extraordinary claims to unique spiritual experience. But it is not generally known that he was then at the very acme of a scientific career that had placed him in the forefront of his generation and had brought him into direct and intimate relations with royalty, statesmen, the literati, the scientists and philosophers of Europe. Nor is it generally known that he was elected in 1729 a Member of the Royal Society of Sciences at Upsala, a corresponding Member of the Imperial Academy of Sciences, St. Petersburg, in 1734, and in 1740, on the motion of Carl Linnaeus, the great naturalist, a Member of the Royal Academy of Sciences in Stockholm, which had then just been incorporated. The same august body had a medal struck in Swedenborg's honour in 1852 both in bronze and in silver. And when the Swedish Church in London was to be demolished where Swedenborg's remains were interred, these were, by decree of the Swedish Diet, transferred in 1908 with National honours and deposited in a granite sarcophagus in the National Cathedral at Upsala.

*\* For convenience I have called him Swedenborg throughout. His family name was Swedberg, but in 1719 when the family was ennobled, the name was changed to Swedenborg, from Sweden, the name of the family homestead near Fahlun.*

## HE DEFINES HIS SCIENTIFIC PERIOD

Reverently looking back in 1766 over his long life, Swedenborg discerned the leading of Divine Providence throughout the years, and recognized that all his varied efforts and studies had really contributed towards making him more fit for the high office of "Servant of the Lord Jesus Christ." "I was introduced by the Lord into the natural sciences and thus prepared; and indeed from the year 1710 to 1744, when heaven was opened to me" (Documents No. 232, Vol. II, p. 257).

## THE MAGNITUDE OF THE TASK

To pass in review these preparatory 34 years, to assess the place and value of some 37 scientific works large or small, to determine how much of this output is to be attributed to his predecessors, and what specifically is his own, how far Swedenborg was limited by the age and environment in which he lived, and what exactly is Swedenborg's place and power in the lineage of Science, these are some of the topics one would fain discuss, in simple justice to a great pioneer in many fields. But this would necessitate a bulky volume and long years of patient research, whereas we must confine ourselves to the merest sketch of a great theme.

## THE PRESENT PURPOSE

At the outset let it be clearly understood what we propose to do. The subject is "Swedenborg the Scientist." And natural science is taken to be: the accurate observation and classification of facts and the recognition of their sequence and relative significance; or as Prof. T. H. Huxley defines it: "the knowledge of the laws of Nature obtained by Observation, Experiment and Reasoning." Our task therefore is twofold: (1) to attempt to state briefly, yet with accuracy, the facts regarding this period of Swedenborg's life, and (2) to attempt to estimate in some measure his actual achievement.

## WRONG METHODS OF APPROACH

Unfortunately, as Dr. Garth Wilkinson long ago pointed out, there are "mistaken notions respecting the scientific labours of Swedenborg. Sometimes they were regarded merely as the successful prize essays of one who afterwards distinguished himself in another field, and therefore of no direct value, though betokening the greatness of the future career, and the possibility at least of the glorious issue. Sometimes, on the other hand, there was a certain exhaustive and impossible universality attributed to them, as though the whole future of the sciences were summed up in Swedenborg; as though he had anticipated everything; knew everything; had reaped the last harvest of truth from the plains of nature; had left no room for discoveries, but only for commentators; and was to rule the furthest coming time with a more than Aristotelian sway. The first of these opinions was immeasurably less than the truth. The second opinion, as immeasurably exceeds the fact, and could not be long maintained by any mind at the present hour, unless under the influence of a wild generosity of superstition." (*Popular Sketch of Swedenborg's Philosophical Works*, pp. 9-10.)

## THE RIGHT METHOD

Single-eyed for the truth, and without bias due to fear or favour, we must pursue our investigations and, in a truly scientific spirit, seek for just appraisal of all the evidence. Any other method would be unworthy of him who could write: "I am resolved to be contrary to no one, but simply to fix my attention upon data and facts, and to follow where I see the truth, or the cause supported by experience and reason", (*Economy*, Vol. I, p. 449). And elsewhere he says: "What need is there for words? Let the thing speak for itself. If what I say be true, why should I be eager to defend it? Surely truth can defend itself. If what I have said be false, it would be a degrading and silly task to defend it" (*Principia*, Vol. II, p. 366). In a like mood of philosophic calm then, let us pursue our theme.

## SWEDENBORG'S ACADEMIC CAREER

At the early age of eleven Swedenborg attended Upsala University, and from June 1699 until June 1709 followed the usual graduation course, closing his University career with a Classical thesis as usage required. For part of this period he lived under the paternal roof, his father being Professor and later, Dean of the University, but on the latter's preferment to the bishopric of Skara in 1702, the young student remained in Upsala and probably went to live with his elder sister Anna, when she, in 1703, married Eric Benzelius, the Librarian of the University. Between the two young men a close, affectionate and enduring friendship was established, although Benzelius was some thirteen years the senior.

## CHOICE OF A SCIENTIFIC CAREER

On both sides, Swedenborg came of mining ancestry. Members of his family and near relatives were miners, or associated with that industry, or with the Board of Mines, which had oversight of the mineral resources of the country. His own inclination and genius were eminently practical, and when his own predilection coincided with the advice of his brother-in-law, a scientific career was inevitable. Thus, he writes to Benzelius (Document 36, Vol. I, p. 200): "I have always desired to turn to some practical use, and also to perfect myself more in the studies which I selected with your advice and approval". And he mentions particularly mathematics, physics and natural history, a choice worthy of note.

Possibly two other factors contributed to that choice: (1) the tense scientific and philosophic sphere which prevailed in his *Alma Mater* owing to the recent Aristotelian-Cartesian controversy, and which ended in the younger rival ousting the age-dominant Aristotelianism, and (2) Swedenborg's brief stay in the year 1710 as privileged assistant and guest of Christopher Polhem,\* mathematician, physicist, inventor and civil engineer, "the great Swedish Archimedes"; an association which ripened into mutual respect, friendship and close collaboration in following years.

\* Christopher Polhammar, as the name is spelt in *Daedalus*, Parts I and II, traced his ancestors to Hungary, where they were called von Polheim, and so for a time he signed himself Polheirner (see Document 63, Vol. I, p. 266), but when ennobled in 1717, he signed himself Polhem (see *Daedalus*, Pt. VI).

## SWEDENBORG'S FIRST FOREIGN TOUR

In accordance with custom, but still more for advantages of advanced study, Swedenborg must needs go abroad. Entrusted with numerous commissions for the purchase of books and scientific instruments for his University and its staff: and urged particularly to note the type and construction of astronomical instruments, the method of using them and the results obtained, this young man of 22 left his own country in September 1710. He spent two years in England, six months in Holland, a longer period in France, and thence travelling via Hamburg he came to Pomerania and settled for over 12 months, first at Rostock, and later at Griefswalde, the little seaside University town, returning home in April 1715, having been away four years.

## SOME PRACTICAL RESULTS

Whilst in his quiet Pomeranian retreat, he had time to gather and complete his notes on various mechanical and scientific projects and inventions, a list of which he gives in a letter to Eric Benzelius, dated 8 September, 1714 (see Document 46, Vol. I, pp. 230-I). They were as follows:

- (1) The plan of a submarine.
- (2) The construction of a new siphon.
- (3) A method of raising weights by means of water.
- (4) Sluices (or locks) so constructed that where there is no fall of water, ships and cargo can be raised to any height.
- (5) A machine, fire driven, for throwing water.
- (6) A drawbridge.
- (7) Machines for condensing and exhausting air.
- (8) Air guns.
- (9) A universal musical instrument by which the unskilled may play any kind of music written in score.
- (10) A mechanical method of shade drawing by means of fire.
- (11) A water clock which indicates not only the hours but also the movements of the heavenly bodies.
- (12) A carriage with all sorts of mechanism worked by the movement of the horses. Also a flying machine.
- (13) A new method of ascertaining the desires and affections of the minds of men by analysis.
- (14) New methods of constructing cords and springs.

The letter continues: "These are my mechanical inventions which were heretofore lying scattered on pieces of paper, but nearly all of which are now brought into order, so that when opportunity offers, they may be published.

To all these there is added an algebraic and a numerical calculation, from which the proportions, motion, times and all the properties which they ought to possess, are deduced. . . . O how I wish, my beloved friend and brother, that I could submit all these to your own eyes, and to those of Prof. Elfvius. But as I cannot show you the actual machines, I will at least, in a short time, forward you the drawings, with which I am daily occupied. . . . I have now a very great desire to return home to Sweden, and to take in hand all Polhammar's inventions, make drawings and furnish descriptions of them, and also to test them by physics, mechanics, hydrostatics and hydraulics, and like-wise by the algebraic calculus; I should prefer to publish them in Sweden, rather than in any other place; and in this manner to make a beginning among us of a Society for Learning and Science, for which we have such an excellent foundation in Polhammar's inventions. I wish mine could serve the same purpose."

## SWEDENBORG'S LOVE OF USE

This practical bent, this love of being useful comes out incidentally, yet clearly, in the record of these early years. Wherever he was, he never failed to seize every opportunity of adding to his practical efficiency and to his

knowledge of useful arts. Thus he learnt bookbinding whilst the binder was busy with his father's books. During his travels he changed his lodgings from time to time that perchance thereby he might pick up from the craftsmen with whom he lodged somewhat of their craft. He learnt thus watch-making, cabinet-making and the making of mathematical and scientific instruments, and whilst in Holland and at the suggestion of Prof. Elfvius (Document 42, Vol. I, p. 215), he devoted himself to the art of grinding lenses. Here also is an instance of his versatility and determination. It is recorded that, commissioned to purchase globes for his University, when he found the price asked and the dangers of transit a matter of difficulty, he tried to purchase the engraved sheets separately that they might be mounted in Sweden. But when the maker refused to sell these he promptly devoted himself to learning the art of engraving that he might prepare the sheets himself (Document 43, Vol. I, p. 217).

## SWEDENBORG AS INVENTOR

One of his rules of life drafted for his own guidance was "to be as universally useful as possible", and certainly nothing was too homely or insignificant to escape his study and invention, if thereby he could add to the sum total of knowledge, or to human comfort or promote the welfare of his own land. In the *Daedalus* of 1716 he gives particulars of a Conveyor for minerals; suggestions for a flying machine; describes ear trumpets and speaking tubes for the benefit of the readers. He issued in 1719 *Proposals for the Regulation of Coinage and Measures* in accordance with the Decimal system, to remove the anomalies of and facilitate trade. In 1721 he published *A new Mode of discovering the power of vessels by the application of mechanical principles*, which is really an early form of the present-day nautical tank for testing the stability of ships' models. In his *Miscellaneous Observations* of 1722 he deals with: The improvement of Stoves in Sweden, A new construction of Fireplace, treats of Draught Furnaces, of the Causes of Smoky Chimneys, and describes the first efficient Mercurial Air Pump. And in his *Observations and Discoveries respecting Iron and Fire* he gives full descriptions of Slow Combustion Stoves, the principle of which was patented in this country by Dr. Arnott and in America by Dr. Orr, more than a century later. Further, in 1763 Swedenborg sent to the Royal Academy of Sciences, Stockholm, a Memoir *On inlaid work in marble, for tables and for ornamental purposes generally*.

## SWEDENBORG AS MATHEMATICIAN AND ASTRONOMER

During his foreign travels he made an intensive study of pure and applied Mathematics and kept in touch with the leading mathematicians and astronomers wherever he went. As early as 1710 he wrote, "I study Newton daily". As we shall see later, whatever apparatus he described he always sought to give quantity and measurement and to explain the geometry or numerical law relating thereto. In 1712 he writes, "With regard to astronomy, I have made such progress in it, as to have discovered much which I think will be useful in its study. Although in the beginning it made my brain ache, yet long speculations are now no longer difficult to me." He mentions a new method of finding the terrestrial longitude (of which we shall hear later), which he hopes to submit to the Royal Society, and states: "I have also discovered many new methods for observing the planets, the moon and the stars. . . . I am now busy working my way through algebra and the higher geometry, and I intend to make such progress in it as to be able in time to continue Polhammar's discoveries." As the outcome of these studies, we find Swedenborg in 1718, publishing *Regel-Konsten* (or *The Art of Reckoning*), the first work ever printed in Swedish on Algebra. Though a small 8vo of 136 pages, it yet is remarkable for its compression, comprehensiveness and practical applications. It was reviewed at length in the *Acta Literaria Sueciae* and in *Neue Zeitungen von Gelehrten Sachen*, from the latter of which we select two paragraphs (see *New Philosophy*, 1929, p. 34). "This work has been well received by book lovers; indeed, it contains more good things than one would expect in so small a number of sheets. The author seems to have been born for the promotion of mathematics, he being the first man in Sweden to propound the elements of algebra; and not only has he done this in a distinctive method, which is extremely easy and is suitable for all beginners, but, by examples sought out from all possible subjects, he has also shown the great use of this excellent art, especially in mechanics; and all this in good intelligible Swedish, including very happy translations even of the technical terms." "The work consists of seven books—the last three books, on factoring and differential and integral calculus are not yet printed. Each book consists of three Parts. In the first Part are contained principles, namely, definitions and theorems which the author has taken from the whole of mathematics, geometry and more especially from the

mixed branches of learning and his own experience; in the second, the rules of algebra are handled in an excellent way, according to the method of modern scholars; and in the third, this science is applied to the solution of well-known problems of divers sorts."

In the same year, 1718, he also published in Swedish: *Attempt to find the East and West Longitude by means of the Moon*. It is evident that, during his residence in England, he heard of the imperative need of a satisfactory solution of this problem, and he eagerly entered upon the task. The topic is discussed in his letters. He gave an outline of his theory to various literati in the course of his travels. He adverts to the subject in a brief paper in the *Daedalus*, Pt. IV, and now he publishes it in a small pamphlet of 42 pp. with a Preface addressed to Edmund Halley, the Savillian Professor of Astronomy at Oxford and later Astronomer-Royal. In 1721 this appeared in a Latin form and extended to 31 pages; which again was reprinted in 1727, was rewritten in 1754 (57 pp.) and finally appeared in 1766 in 4to. This latter edition was submitted to the Committee of adjudication, who referred it to the Astronomer-Royal, Maskelyne and, on technical grounds, was by him turned down. The two learned journals previously mentioned gave extended notices of the contents of the work but failed to offer any serious criticism, but when the 1721 edition appeared it was the subject of criticism from Prof. Conrad Quenzel, the holder of the chair of Mathematics at Lund. A vigorous reply was given in the author's absence by a friend (E. J. Burman).

But no estimate of Swedenborg as Astronomer can be made which overlooks the evidence of erudition, penetration and research, to be found in the third Part of his *Principia* of 1734, to be mentioned later. Here all his work in this domain comes to fruition. Effectively to summarize this is all but impossible, and we refer the reader to the work itself. But perhaps, as stimulus thereto, we may quote the words of Prof. F. W. Very, of the Astrophysical Observatory, Westwood, Mass., U.S.A.: "The great master-principles of the work loom large as mountain peaks . . . and excite in me a feeling of profound respect and admiration for Swedenborg as a Scientist. His hypotheses may have to be modified so as to be scarcely recognizable. Some of them must be abandoned entirely; but nothing can dim the glory of this magnificent dash into the unknown. It will stand alongside of the sublime poem of Lucretius, which no one accepts as a true picture of the cosmos, but which will remain as one of the monuments of a heroic struggle of the philosophic intellect to reach freedom."

## SWEDENBORG DECLINES PROFESSORSHIP

It was doubtless due to the publication of Swedenborg's early and varied works, and his obvious erudition and ability that when Prof. Elfvius died in 1718, he was approached as to becoming successor at Upsala to the Chair of Astronomy; but he definitely waived it aside (see Document 77, Vol. I, p. 293). Again, in 1724, when Prof. Nils Celsius died, Swedenborg as definitely declined the Chair of Mathematics at Upsala, on the sufficient plea that he already had a practical calling, that he had no gift for teaching, and had, as his brother-in-law knew, a slight impediment in his speech (see Document 101, Vol. 1, p. 337). Yet one cannot help thinking that Swedenborg's practical genius was repelled by the thought of life-long occupation with merely abstract things. Perhaps we may see somewhat into his real state of mind in a brief and intimate passage in one of his letters to Benzelius (Document 61, Vol. I, p. 263). "It is a fatality with mathematicians that they remain mostly in theory. I have thought it would be a profitable thing if to ten mathematicians there was added one thoroughly practical man by whom the others could be led to market; in which case the one man would gain more renown, and be of more use than all the ten together."

## SWEDENBORG AS EDITOR

When Swedenborg returned from abroad in 1715, he for a time went to Brunsbo, near Skara, his paternal home, and paid visits to Benzelius and Polhammar. He visited Kinnekulle, the isolated and beautiful mountain on the shore of Lake Venner, to find a site for a private observatory. But most of his time was spent in intensive scientific study and with preparations for the issue, at his own expense, of an illustrated journal in Swedish, devoted entirely to scientific subjects. It was the first ever issued in that war-distracted country. It was entitled *Daedalus Hyperboreus*, and dealt with "Mathematical and Physical Experiments and Observations". When issued it consisted of two or three sheets in 4to with copperplate engravings to each number. It extended to six numbers issued at irregular intervals from 1716 to 1718. Throughout it was eminently practical and consisted mainly of

descriptions of Polhem's and Swedenborg's inventions and devices, with some few speculative papers, and one or two others by Profs. L. Roberg and J. Vallerius. Its first number was dedicated to King Charles XII, and that monarch became deeply interested in the venture, and discussed some of its topics with the Editor. So intimately was its genesis associated with Upsala and the interests of the scientific reformers there, that its six parts have been officially recognized as the real precursor of the *Acta Literaria Sueciae*, the official organ of the Royal Society of Sciences of Upsala, the first learned Society to be established in Sweden. Through this effort, though so short lived, the ardency and determination of Swedenborg, the diversity of his scientific interests, his practical bent, inventive genius and sheer capacity, brought him into prominence and placed him in the forefront of the scientists of his own country, and led to an opening such as his talents deserved.

## SWEDENBORG' S OFFICIAL APPOINTMENT

On the recommendation of Polhammar, in December 1716, Charles XII appointed Swedenborg to the Board of Mines. As there was no present vacancy, he was made Assessor Extraordinarius. This unusual procedure did not pass without adverse comment and jealousy, but this Swedenborg ignored, and devoted himself with zeal to his new duties and to those studies that were immediately related thereto. The appointment was at first an honorary one, and it was stipulated that he should be free to attend upon and assist Polhammar in all his mechanical and engineering works. Swedenborg's full appointment as Assessor came in June 1724; and he continued in that office for a further twenty-three years. He was then offered the high position of Councillor, but instead requested that he might retire on half pay. This request was granted and in July 1747 he took formal farewell of his colleagues and at the same time, practically, of the scientific world.

We must now give some few notes of his achievements during those twenty-nine and a half years.

## SWEDENBORG AS CIVIL ENGINEER

As Polhammar's assistant, Swedenborg, from 1716 onward, took an active part in the construction of the naval docks at Carlsrona and the early stages of the great Gota canal (connecting the Baltic with the North Sea), including the constructing of special locks and sluices to circumvent the falls and rapids in the neighbourhood of Trollhatta, Carlsgraf and Motala. Arising out of these experiences we find Swedenborg publishing (1) *Information concerning Docks, Canal-locks and Saltworks, 1719* ; and in 1721 (2) *A New Mechanical plan of constructing Docks; whereby vessels may be repaired in harbours that are not reached by the tides; and (3) A new construction of Dam or Mole for arresting the course of rivers and torrents; with a contrivance whereby it becomes firm and fixed in proportion as the oncoming body of water is large and impetuous: the work being less expensive and more durable than that in present use.* Alas! for the fixity of their dam, for the one they had built at Trollhatta to protect their works was destroyed by floating timber in 1755.

In July 1718 Swedenborg was able to perform a signal service to his King, Charles XII. That restless son of Mars, was seeking to subdue Frederickshall, a Norwegian border fortress. The Dano-English fleet was supporting Norway, operating through the Swinesund and in the Iddefjord, and was able to ensure supplies and add considerably to the defence. Polhem planned and Swedenborg executed a scheme whereby by means of brushwood and rollers, there were conveyed over rough, hilly and often marshy ground, two galleys, a sloop and several large boats from Stromstad in the Iddefjord, a distance of some 17 miles, and thus changed completely the aspect of the campaign (Document No. 197, Vol. I, p. 555).

## SWEDENBORG AS GEOLOGIST

Geology is essentially a modern science, and although Xenophanes of Colophon (500 B.C.) interpreted rightly the fossil fish remains found near Syracuse as evidence that those parts of the earth had at one time been covered by the sea, yet the Aristotelian idea that fossils were expressions of the earth's plastic force that had failed to come to the surface, was what dominated the ages. Leonardo da Vinci, in the 15th century, is a glorious exception. But the demonstration of the true nature of fossils was reserved for Prof. Steno, a Dane (1669); and the idea of the strata in which they occur being of different ages with a definite succession in time, arose out of the labours of the German, Prof. A. G. Werner (1750-1817) and Wm. Smith (1769-1839), the English surveyor.



In the 18th century the prevailing ideas were those of Aristotle, or else those associated with the Biblical doctrine of Noah's flood. Geology practically did not exist, and theory ran wild.

Swedenborg, even before his appointment to the Board of Mines, had begun to interest himself in geological subjects. His ever alert mind noted, after a visit to Westergyllen in 1716, the possible use as a black dye of a particular soil found there. He reports also a white clay which might be exploited for making pottery and tobacco-pipes (Document: No. 60). About the same time he wrote a brief paper entitled *Observations on Mussels, Snails, etc., in limestone and slate*. He gave drawings of identifiable fossils in the pages of *Daedalus*; and even before this had secured and sent to Upsala University "the bones of a giant", really the skeleton of an extinct species of whale.

In the *Miscellaneous Observations*, 8vo, 230 pp., published in 1722, the whole of Part I and much of Part IV are devoted to geological subjects. It is obvious from the preface of Vol. II of his great *Opera Philosophica et Mineralia* (in three vols., folio, published in 1734) that he regarded these volumes merely as an instalment and that later he intended "to traverse the whole mineral kingdom". In Vol. III there are splendid plates, in part redrawn from other publications, illustrating the types of life once existent on the globe; a fossil reptile, fish, invertebrates and plant remains. "Swedenborg was the first Swede who described plant fossils and interpreted them in a manner satisfactory for those times," says Prof. A. G. Nathorst, the great paleobotanist. And from Swedenborg's numerous papers and publications we find that he rightly interpreted pot-holes, stalactites, made note of erratics, and the direction of "osar" or kames, although attributing them to the action of the sea, which had formerly, he judged, been at a much higher level. On this latter subject he published, in 1719, a small pamphlet of 16 pages, extended to 40 in the second edition of the same year. In the words of Baron Berzelius, he "was the first who called attention in a printed work to a rise of the Swedish coast. In 1719 he published a little work entitled *Respecting the great Depth of Water and the Strong Tides in the Primeval World; Proofs from Sweden*. In a dedication to the Queen, he congratulated her on ruling over a land which is constantly enlarged at the expense of the sea". Swedenborg turned once more to this topic in his *Principles of Chemistry*, of 1721, and definitely broke away from the current interpretation of all being signs of a universal deluge, by bringing forward evidence from the Scandinavian peninsula extending to Lapland and the shores of the Baltic, to prove a great difference of sea level in former times. Nor must we overlook his acute observations regarding the origin of mineral veins, the possibility of their detection above ground, the differences in strata, and the absence of all fossils in trap rocks; the successive shells of oxidation in rocks through the percolation of water, the origin of dendritic structures, the causes of hot springs, of vitrification as due to rapid cooling of molten matter, etc., etc.

As Prof Nathorst says: "One immediately notices in studying Swedenborg's geological writings that an investigating nature of the highest rank is in question, which on a solid foundation and with sharp powers of observation noticed everything, even what was apparently insignificant, in order to draw conclusions from it, and which, when possible, endeavoured to control the correctness of the same by experiment. The wealth of observations which he collected from various parts of Europe is astonishing, and he did this at a comparatively early age." "Swedenborg's contributions in the field of geology are of such a significance and sweep, that they alone would have been sufficient to have secured him a respected scientific name" (*Geologica et Epistolae*, 1907, p. xlix).

## SWEDENBORG AND COSMOLOGY

At the end of the year 1718 Swedenborg published in Swedish a small work of some 40 pages, "*On the Motion and Position of the Earth and Planets*, in which are some conclusive proofs that the earth's course decreased in rapidity, being now slower than heretofore, making winter and summer, days and nights, longer in respect to time than formerly". It is a work curiously indicative of the period; and the "conclusive proofs" are drawn from the letter of Scripture, the voice of tradition, ancient and contemporary authors, with others of a more definitely scientific character. But it is intensely interesting, as shewing how Swedenborg's mind at this early date, and on such slender grounds, arrived tentatively at the conclusion which, in our own day, has received mathematical demonstration at the hand of Prof G. H. Darwin, F.R.S. He did not however assign any cause of the decrease; that was reserved for Prof. Darwin.

But in 1734 Swedenborg in his *Principia* takes up cosmological problems and deals in a most fascinating way with the whole question of the origin of solar and stellar systems, illustrating his theories with a series of diagrams that prove he had perfectly clear conceptions, and was the real begetter of the Nebular Hypothesis and other related theories hitherto regarded as essentially modern, and the credit for which has been given to others. Whilst undoubtedly influenced by the prevailing Cartesian conception of the universe, he yet strikes out in original fashion and, from the first mathematical or natural point deemed to be one of pure motion, through a series of Finites and Elementaries he builds up his universe of suns and systems. And how essentially modern his conception! "How many myriads of heavens may there not be! how many myriads of mundane systems! . . . In a word, we might say, that infant heavens and earths were successively coming into existence as the others declined in age, grew hoary with years, and fell into decay." But to follow the thesis in detail is impossible here: we content ourselves with the following excellent passage written by Prof. Svante Arrhenius, "If we briefly summarize the ideas which were first given expression to by Swedenborg, and afterwards, although usually in a much modified form—consciously or unconsciously—taken up by other authors in cosmology, we find them to be the following:

The planets of our solar system originate from the solar matter—taken up by Buffon, Kant, Laplace and others.

The earth and other planets have gradually removed themselves from the sun and received a gradually lengthened time of revolution, a view again expressed by G. H. Darwin.

The earth's time of revolution, that is to say, the day's length, has been gradually increased—a view again expressed by G. H. Darwin.

The suns are arranged around the Milky Way —taken up by Wright, Kant and Lambert.

There are still greater systems, in which the Milky Ways are arranged—taken up by Lambert." *Cosmologica*, 1908, p. xxx.

Some first form of the Nebular Hypothesis is to be found in Descartes' *Principia* of 1644, but it differs essentially from that of Swedenborg, who published his *Principia* in 1734. Buffon followed in 1749 with his version. Wright followed with his *New Hypothesis of the Universe* in 1750. Kant, who had read Swedenborg, published his *Natural History of the Heavens* in 1755, whilst Laplace, who is usually credited with the theory and who published his *System of the World* in 1796, openly acknowledges his indebtedness to Buffon. Now Buffon's own copy of Swedenborg's *Principia* (with autograph on title page and date 1736) was sold by Bohn the publisher, and is now in the possession of the American Swedenborg Printing and Publishing Society of New York. Thus the affiliation in essentials, of all forms of the theory (except Descartes who preceded him, and of Wright who published 16 years after Swedenborg) is fairly sure. Yet outstanding as is Swedenborg's ability, bold as is his speculation, he retains still the unruffled calm of the true philosopher and, amidst it all, confesses, "In this therefore consists our highest wisdom, that we know how small is the extent of our knowledge."

## SWEDENBORG AS CHEMIST

As soon as Swedenborg was freed from the mechanical tasks assigned him by Charles XII we find him devoting himself with zeal to special studies relating to his official duties. Thus in 1720 he writes to his brother-in-law: "I am at present engaged in examining all the chemistry contained in the treasury of the Sudeman Library, which belongs now to Hesselius; for I have proposed to myself to examine thoroughly everything that concerns fire and metals, *a primis incunabulis usque ad maturitatem* according to the plan of the memorandum which has been already communicated to you. I take the chemical experiments of Boyle, Reucher, Hjarne, Simons and others, and trace out nature to its least things, instituting comparisons with geometry and mechanics. I am also encouraged every day by new discoveries as to the nature of these subtle substances, and as I am beginning to see that experience in an uninterrupted series seems to be inclined to agree therewith, I am becoming more and more confirmed in my ideas." On looking over the sale catalogue of Swedenborg's books we find he had himself also a large number of the then most up-to-date works on chemistry, physics, mineralogy and metallurgy. But the letter continues with naïve and characteristically practical frankness: "It seems to me that the immense number of experiments that have been made affords a good ground for building upon; and that the toil and

expenses incurred by others may be turned to use by working up with the head what they have collected with their hands. Many deductions may thus be made, which will be of use in chemistry, metallurgy, and in determining the nature of fire and other things." (Document 93, Vol. I, pp. 325-6.)

Alas ! for Swedenborg's decision to forego in the least degree independent experimental research. For chemistry was only just emerging out of alchemy; the composition of air and water, and the nature of heat and fire, were as yet unknown. All metals were regarded as compounds of salt, sulphur and mercury; and from a supposed primal substance, "by distillation, sublimation, rectification, circulation, filtration, commixtion, digestion, precipitation or crystallization might be educed any substance". This then, is the background of Swedenborg's work published in 8vo in 1721 entitled: *Specimens of a work on the Principles of Natural Philosophy comprising New Attempts to Explain the Phenomena of Chemistry and Physics by Geometry*. In the opening address to the Reader, the following illuminating passage occurs: "What are Physics and Chemistry? What is their nature, if not a peculiar mechanism? What is there new in nature, which is not geometrical. What is the variety of experiments, but a variety of position, figure, weight and motion, in particles?"

Since, then, we have several thousand experiments, indicating the nature of the various metals, salts and elements; and since these bodies entirely consist of groups of particles, varying in their shapes and positions; in which again, there is a certain geometrical arrangement, we have grounds for concluding that these subjects may at last be demonstrated. To this end, I have collected experiments from the best authorities, as Boyle, my own countryman Hjarne, Boerhaave, Lemmer, and others, which I have added to and partly repeated; I have also applied geometry to the investigation of causes, and have at length formed principles in accordance with the data. It is for the reader to judge of what I have done, and may it meet with his approbation." The Specimens consist of Parts VIII—XIV and XXV, with some other matters drawn from the larger projected work in part prepared, but which never appeared.

The initial assumption that in the geometrical relations of particles we have the complete explanation of all the properties of natural substances and of the phenomena of the physical realm, of course cannot be maintained; and the work in bulk is entirely obsolete, as for instance Swedenborg's theory that water was the primeval matter, and that "by the enormous pressure in the deepest parts it was disintegrated and formed saline, stony, argillaceous and other substances," or, as he declared later, "in a single drop of water is latent the whole Elementary world, both visible and invisible" (*Principia I*, p. xcvi).

But the work has interest because of the collection of empirical data gathered from contemporary authors dealing with chemistry. It has interest because of Swedenborg's grappling with the problems of molecular physics and the genesis of the varieties of matter. The theory is a purely geometrical one. He enumerates particles of six kinds increasing in size in a tenfold ratio; and particles of the sixth kind form water. But in working out his theory he investigated the possible arrangements in space of similar round particles, and so formed what are known as "space lattices" of the various polyhedral figures. In this respect, perhaps unknown to Swedenborg, he had had one predecessor, Robert Hooke, who in 1665 tried similarly to explain octahedral solid figures by the varying arrangements of piles of shot.

It is doubtless in reference to these space lattices that Van t'Hoff, in his introduction to the *Arrangement of Atoms in Space*, translated by Eileart, says that "they embody the germs of the modern science of crystallography". In this limited sense also, M. Dumas declares, "It is then, to him we are indebted for the first idea of making cubes, tetrahedrons, pyramids and the different crystalline forms, by grouping the spheres". But the foundations of the science of crystallography were truly laid by the investigations of Rome de l'Isle, the Abbe Hauy, Victor von Lang and Nevil Story Maskelyne of a later day.

## SWEDENBORG THE METALLURGIST

Throughout the thirty years that Swedenborg held the position of Assessor of the Board of Mines he devoted himself with zeal to his duties and to those studies which would add to his efficiency. For this end he made numerous journeys at home and abroad, inspecting mines, smelting works, foundries, rolling mills, salt works, vitriol plants, etc., and taking note of all extant processes in the production and manufacture of the various metals from the ore to the finished article. In 1717 we find him giving *Information concerning Tinware of*

*Stjernesund, its use and the Method of Tinning*, the works being owned by Polhem. Then in 1721 we have his *Principles of Chemistry* already discussed, Part XXV of which consists of The Theory of Lead. This discusses not only its possible geometry but also summarises the known facts in relation to that metal, its ores, its extraction, its properties and uses. There is also a series of Experiments on Silver and Mercury. Contemporaneous with this is Swedenborg's *New Observations and Discoveries concerning Iron and Fire* already referred to. Actually it consists of "data collected from the workmen of a large iron furnace, shewing also the construction of the furnace". From time to time he seeks, by petition to the Monarch or to the Board, to secure better methods in Working Copper, or in the Mining of Copper and Iron, or seeks to extend the production of Iron, and urges the establishing of Salt and Iron Works and Rolling Mills.

In 1722 he issued a prospectus of a large work then in preparation which was to cover some 1,200 pages in quarto, and entitled *De Genuina Metallorum Tractatione*, dealing with the indigenous or local methods in the treatment of metals. His experience implemented his own previous saying: "I clearly see that long plans are like long roofs, apt to tumble in". The scheme was too ambitious and had to be dropped. Part of the material gathered was incorporated in some of the works already mentioned, part still remains in manuscript, and part appears in his monumental work, *Opera Philosophica et Mineralia*. This was published in 1734 in three volumes folio of over 1,400 pages and illustrated with 146 copper plates. It was issued under royal patronage, the whole cost being generously defrayed by the Duke of Brunswick-Luneburg.

The *Philosophica* is definitive in the old sense of the word in "Natural Philosophy," and Swedenborg gives his own definition of what exactly he means: "By Philosophy is here understood the knowledge of the mechanism of our world, or of whatever in the world is subject to the laws of geometry; or which it is possible to unfold to view by experience assisted by geometry and reason".

The first volume is entitled: *The Principia; or The First Principles of Natural things, being New Attempts towards a philosophical explanation of the Elementary World*. Swedenborg had in 1729 drafted what is known as The Lesser Principia, which traverses somewhat the same ground, but this he never printed, and it is interesting, as shewing how long his mind had pondered over and grappled with these great problems. We have already made some slight references to this above-named major work. It deals with the origin and development of the universe in its least and its greatest magnitudes. It includes a large section devoted to the phenomena of Magnetism, based on the experiments of Musschenbroek and the diligent study of Gilbert, Kircher and other authorities; then Swedenborg gives his own masterly deductions therefrom. In its cosmology, as already shewn, it is the undoubted progenitor of many modern theories. In its derivation of the whole universe from points of pure motion or mere centres of energy, it most marvellously anticipates the science of today. But personal study alone will give any adequate conception of its contents, its logical coherence and its imaginative sweep. For its times, it is a master work of wondrous power.

The second and third volumes of this sumptuous work deal with *The Subterranean or Mineral Kingdom* and specifically with Iron and with *Copper*. Each treatise has a threefold division of subject matter; the first covering the various methods of treating the ore and smelting the metal, the second giving the varying methods of assaying, and the third covering the several chemical processes and experiments involved. The different types of furnace, the machinery, the very tools and the necessary apparatus are all described and figured. And where Swedenborg could not gain the requisite personal experience, he gives copious extracts from standard authors. In this way he traverses the principal mining areas of Europe, describes their processes and discloses their secret arts. The full titles of the volumes are as follows: *Concerning Iron, and the Methods of smelting it as used in various parts of Europe; also the method of converting crude iron into steel; of the occurrence of iron and its assaying, and likewise of chemical preparations and experiments made with iron and its vitriol*. From this work the chapter on the conversion of iron into steel was reprinted in Strasburg in 1737, and the whole of Section I was translated into French, and included by M. Boucher in his *Description des Arts et Metiers*, in 1762.

The third volume treats *Of Copper and Brass, also the methods of smelting copper in use in various parts of Europe; further of its separation from silver, its conversion into brass, and into alloys of different kinds; of the mineral Calamine; of Zinc; of the occurrence of copper, and its assaying; likewise of chemical preparations and experiments made with copper*. Concerning this volume an excellent and useful notice and summary will be

found in The New Church Magazine (1937), Vol. LVI, pp. 237-240, by Mr. B. Fullman, B.Sc., A.I.C., and to this the reader is referred.

These volumes were recognized at once as standard works of reference, and received the highest commendation in the scientific press. Undoubtedly they proved the keenest devotion to his calling of this Swedish Assessor and did much to transform and develop the industries of his own country. As Prof. Schleiden declared: "We should never be able to finish if we should attempt to enumerate all the improvements which Swedenborg introduced in the working of the mines of his native country, and it would be impossible to say how great were his merits in promoting the industry and the arts of Sweden". (Quoted *Vie de Swedenborg*, p. 40, by M. Matter.)

## SWEDENBORG AS ANATOMIST AND PHYSIOLOGIST

We now pass to the last great department of Swedenborg's scientific study and achievement: viz., that in the realm of human anatomy. One of his papers in the *Daedalus* 1718 (Part VI) bears the title: *Arguments showing that our vital force consists mostly of little vibrations, that is, tremulations*. It is something to marvel at that this conception should be broached thus early, and incidentally, should include such an illustration as the following, which might have been regarded as original at a much later date: "It frequently happens that a person falls into the thought of another person, that he perceives what another is doing and thinking, that is, that his membrane trembles from the tremulation of the other person's cerebral membranes, just as one string is affected by another, if they are tuned in the same key".

On 3rd November, 1719, he wrote to E. Benzelius "I have written a little anatomy of our vital forces, which, I maintain, consist of tremulations; for this purpose I have made myself thoroughly acquainted with the anatomy of the nerves and the membranes, and I have proved the harmony which exists between that and the interesting geometry of tremulations. . . . The day before yesterday I handed them in to the Royal Medical College" (Document 85, Vol. I, p. 310). Unfortunately, that MS. has been lost, but a copy in part, sent to his brother-in-law, proves that it is an expansion into a small treatise of the above subject. The title and treatment are noteworthy.

In 1722 we find included in the *Miscellaneous Observations* a short paper asserting that "The Blood circulates through the Capillaries more easily than through the Trunks of the Arteries", proving that physiology still had its claim with Swedenborg. But in the same year as the *Opera Philosophica et Mineralia* appeared, i.e. in 1734, Swedenborg also published *Outlines of a Philosophical Argument on the Infinite, and the Final Cause of Creation, and on the Intercourse between the Soul and the Body*, but as the Argument is entirely philosophic it is beyond our province; yet it is surely significant, for it shows how Swedenborg at this time was not merely interested in the body but also in the soul, and was seeking to trace the connection between the two.

From this time on we find in increasing numbers among his MSS. notes on anatomical subjects and extracts from the works of the old anatomists, and brief papers on such topics as The Way to a Knowledge of the Soul, etc. But Swedenborg was never content with mere book knowledge. According to Frederick von Walden he studied anatomy for a time at Amsterdam, and John Augustus Tulk left it on record that Swedenborg studied under Boerhaave, professor at Leyden, and that he had Monro, the reputed discoverer of the foramen of Monro, as his fellow student in that University.

The outcome of these researches was the issue in 1740—1 of two volumes in 4to, 597 pp., entitled: *The Economy of the Animal Kingdom, considered Anatomically, Physically, and Philosophically*. Swedenborg is here investigating the *Animate Kingdom* or the Kingdom of the Soul. In Part I he deals with the Blood, the Arteries, the Veins and the Heart, with an Introduction to Rational Psychology. In *Part II* he discourses on the motion of the Brain, of the Cortical Substance and of The Human Soul. His method is first to assemble all the related anatomical facts gathered from all sources and then to give his own clear, incisive and cogent induction, first as to general principles and then in detail. The treatment throughout is that of a wonderfully penetrative, logical and ever alert mind, from whose observation nothing can escape detection. The theme is sustained throughout with eloquence and dignity. Swedenborg the scientist stands out supreme. To gauge the spirit of the man as a dispassionate investigator, take this passage from his Introduction, §§. 17 and 18: "In the experimental knowledge of anatomy our way has been pointed out by men of the greatest and most cultivated talents; such

as, Eustachius, Malpighi, Ruysch, Leeuwenhoek, Harvey, Morgagni, Vieussens, Lancisi, Winslow, Ridley, Boerhaave, Wepfer, Heister, Steno, Valsalva, Duverney, Nuck, Bartholin, Bidloo, and Verheyen; whose discoveries, far from consisting of fallacies, vague and empty speculations, will for ever continue to be of practical use to posterity.

" Assisted by the studies and elaborate writings of these illustrious men, and fortified by their authority, I have resolved to commence and complete my design: that is to say, to open some part of those things which it is generally supposed that nature has involved in obscurity. Here and there I have taken the liberty to throw in the results of my own experience; but this only sparingly, for, on deeply considering the matter, I deemed it best to make use of the facts supplied by others. Indeed there are some that seem born for experimental observation, and endowed with a sharper insight than others, as if they possessed naturally a finer acumen; such are, Eustachius, Ruysch, Leeuwenhoek, Lancisi, etc. There are others, again, who enjoy a natural faculty for contemplating facts already discovered, and eliciting their causes. Both are peculiar gifts and are seldom united in the same person. Besides I found, when intently occupied in exploring the secrets of the human body, that as soon as I discovered anything that had not been observed before, I began (seduced probably by self-love) to grow blind to the most acute lucubrations and researches of others, and to originate the whole series of inductive arguments from my particular discovery alone; and consequently to be incapacitated to view and comprehend, as accurately as the subject required, the idea of universals in individuals, and of individuals under universals. Nay, when I essayed to form principles from these discoveries, I thought I could detect in various other phenomena much to confirm their truth, although in reality they were fairly susceptible of no construction of the kind. I therefore laid aside my instruments, and restraining my desire for making observations, determined rather to rely on the researches of others than to trust to my own." With such a dispassionate, truth-loving guide one cannot go far wrong in the investigation of the problem and the quest, to determine "the essence and nature of the soul, its influx into the body, and the reciprocal action of the body" which is the avowed purpose of these volumes.

A period of some four years passed, devoted to intensive anatomical study, and we find Swedenborg publishing at the Hague, in 1744, *The Animal Kingdom, considered Anatomically, Physically and Philosophically*, in two volumes, totalling some 732 pages in 4to. *Part I* treats of The Viscera of the Abdomen, or the Organs of the Inferior Region, and *Part II* covers The Viscera of the Thorax, or the Organs of the Superior Region. The following year, *Part III*, 171 pp., was printed in London, and treated of The Skin, the Sense of Touch and of Taste and of Organic Form generally. This closes the list of Swedenborg's scientific publications.

But he left a mass of close on 3,000 pages in 4to and folio, dealing with anatomical and psychological matters, and from these posthumous papers the following have been translated and printed: *The Five Senses*, viii + 380 pp., 8vo; *The Generative Organs*, x + 327 pp., 8vo; *Posthumous Tracts*, iv + 149 pp., 8vo; *The Brain*, Vol. I; The Cerebrum and its parts, xxxviii 794 pp., 8vo; Vol. II: The Pituitary Gland, Cerebellum and Medulla Oblongata, xvi + 645 pp. and two further volumes are in part prepared. *The Economy of the Animal Kingdom, Transaction III*, xxii + 385 pp., 8vo, treats of the Medullary Fibre of the Brain and the Nerve Fibre of the Body; The Arachnoid Tunic and Diseases of the Fibre; and *The Soul or Rational Psychology*, xxvi ± 388 pp., 8vo.

Anatomists and physiologists who have looked into these various volumes, have been astonished to find buried away therein proofs that as Prof. Gustaf Retzius, the President, declared before the Congress of Anatomists held at Heidelberg in 1903, "Emanuel Swedenborg was not only a great expert in the knowledge of the brain according to the standard of his time, but in fundamental questions he was far in advance of his contemporaries . . . he was not only a learned anatomist and skilled observer but he was also a deep and critical anatomical thinker". And Dr. Max Neuburger, Professor of the History of Medicine at Vienna, declared in London, 1910: "The crown of Swedenborg's physiological achievements is formed by his views of the functions of the brain, especially of the cortex cerebri.

Swedenborg defended the respiratory movements of the brain and the existence of the liquor cerebro spinalis; he was the first to assign definitively the higher psychological functions and the perception of the senses to the grey substance of the brain; he taught in harmony with modern science that the various motor functions have each their special localisation in the cortex cerebri, and so forth.

I have given only the results of a few of his physiological researches, but these are already sufficient to enable us to judge of the importance of his whole work. . . . The deficiencies, the mistakes, the incomplete proofs, are the defects of Swedenborg's time, but the ideas, the prophetic anticipations, reach forward victoriously to the threshold of our own age; they constitute the distinctive mental property of Swedenborg, and their truth has been wonderfully confirmed by the most modern science."

Stimulated by the enquiries of scientists abroad and by independent investigators at home, at last, in 1902, The Royal Academy of Sciences in Stockholm appointed a Committee of five from its own members, under the chairmanship of Prof. Gustaf Retzius, to examine these manuscripts of Swedenborg. Later it was decided to print them under the auspices of the Academy. Under the able direction of this committee, and with Mr. A. H. Stroh as transcriber and editor, a complete and definitive edition was projected. But the untimely deaths of editor and chairman caused the project to lapse when only the following had been issued:

- I. *Geologica et Epistolae*. (1907) lii + 344 pp., 4to.
- II. *Cosmologica*. (1908) xxxvi + 373 pp., 4to.
- III. *Miscellanea de Naturalibus*. (1911) xxxviii + 328 pp., 4to.

## THE UNFAILING QUEST

But the question will be asked why did Swedenborg in 1745 thus cease publication of his anatomical and physiological studies, when he had already so much prepared, had made such laborious researches, and achieved such outstanding results? Surely it was because with him the quest of truth was the master-passion of his soul; and in the scale of values that outweighed all the rest. As he protested in the *Economy*, Part II, No. 218: "Of what consequence is it to me that I should persuade anyone to embrace my opinions? Let his own reason persuade him. I do not undertake this work for the sake of honour or emolument; both of which I shun rather than seek, because they disquiet the mind, and because I am content with my lot: but for the sake of the truth, which alone is immortal, and has its portion in the most perfect order of nature."

Swedenborg had become completely absorbed in the quest for the soul, to know its nature and its destiny. And in the *Animal Kingdom*, §19, he confesses: "Not very long since, I published the *Economy of the Animal Kingdom*, a work divided into distinct treatises, but treating only of the blood, the arteries and the heart, and of the motion of the brain, and the cortical substance thereof: and before traversing the whole field in detail, I made a rapid passage to the soul, and put forth a prodromus respecting it. But on considering the matter more deeply, I found that I had directed my course thither both too hastily and too fast,—after having explored the blood only and its peculiar organs: I took the step, impelled by an ardent desire for knowledge. But as the soul acts in the supreme and innermost things, and does not come forth until all her swathings have been successively unfolded, I am, therefore, determined to allow myself no respite, until I have run through the whole field to the very goal—until I have traversed the universal animate kingdom to the soul. Thus I hope, that by bending my course inwards continually, I shall open all the doors that lead to her, and at length contemplate the soul herself: by the divine permission."

And so he renewed his investigations, piled Pelion upon Ossa; all to no effect. Gradually his meditations and researches convinced him it was a hopeless task. Strange psychological experiences which now became his lot, made him realize that he was upon the wrong track, that indeed "that which is born of the flesh is flesh, and that which is born of the Spirit is spirit"; that the soul after all is a substantial form organized not out of material substances but out of spiritual substances; that these are radically discrete from matter; that, as Paul said, "If there is a natural body there is also a spiritual body"; and that therefore it must abide in its own spiritual realm. Swedenborg had ever been a loyal truth-seeker: had ever sought to penetrate into its inner realm. When, therefore, his new experiences opened his eyes to a new wonder world and gave promise of a real solution of life's enigmas and of unravelling the problem of human destiny, Swedenborg with prayer and deep devotion and still deeper humility, gave himself up to the task, and from a Scientist became a Seer. He resigned his post as Assessor, refused all honours, and devoted himself wholeheartedly to his new function and use. Of course, there were those who hinted of him, as had been said of his Master, "He hath a devil and is mad". But in wisdom and

benevolence and unruffled calm he went his way, the same rational investigator of evidence, the same dispassionate searcher after truth. He wrote his experiences, expounded the Word, published his theological works (for the greater part anonymously), and when, towards the end, he put his name to a title page, he added in all lowliness, what, after all, is his greatest honour and his greatest claim: "Emanuel Swedenborg, Servant of the Lord Jesus Christ."

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