

SWEDENBORG AND HIS SCIENTIFIC REVIEWERS*

Miscellaneous Observations, Parts I-III¹⁶⁷

Frederich Christopher Oetinger¹⁶⁸

In his *Miscellaneous Observations*, p. 117,¹⁶⁹ in which work are found none but right sound observations, Swedenborg says that if a spurious metal is to be changed to gold, this metal must first be brought back to its original materia, to wit, salt.¹⁷⁰ The salt or crystallization of silver has one figure, that of iron another, that of lead another, etc. Moreover, their solutions have an entirely different taste. The taste of mercury is very 'astringent and biting, that of silver very bitter; other 'metals taste sweet and others again sour; all of which arises from the differences in the figure of their particles. Now it would be unnatural, nay, and against all mechanics, all contiguity, if, by means of some subtle materia the figure of the particles, their taste, weight, color, ductibility, were so suddenly to be changed, and this into something entirely different. Moreover, no metal has such large particles as gold; and the interstices between gold particles must be larger than those between water particles. The diameter of a gold particle must be ten times greater than that of a water particle, since warm water placed in a gold vessel can be forced through the pores of the gold by pressure.

All these mechanical causes, however, prove nothing. As regards the last statement above, it shows that gold has inwardly a yielding penetrable form, and that, for the most part, it partakes of an entity that is penetrable, and can be changed into all manner of forms. As to Swedenborg's first statement, it is not necessary that transmutation take place in so mechanical a way by contiguity. Transmutation is effected by a flashing decussation which is implanted by God in the first entity,¹⁷¹ as seen in the glitter of gold when refined, and in the force of electricity. Electricity shows quite clearly that it is a penetrable entity which penetrates all things at once and without contiguity, and which is not bound by the law of contiguity. From

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this one sees that Herr Swedenborg holds transmutation to be impossible merely from reasoning and not from experiment. For the rest, I think that his reflections on the elements could be used to make much in Jacob Böhme understandable (*Irrd. u. Himm. Phil.*, I, pp. 16, 17).

Miscellaneous Observations, Part IV

Christian Wolff¹⁷²

The Law of numbers as we have given it, is received among all nations, so far as we know, and since we have been accustomed to it from our first childhood it seems to be of indisputable necessity. Nevertheless, not only has Erhard Weigelius in his *Arithmetica Tetractyca* shown the possibility of going no further than 4 in our numbering, but, besides this, the illustrious Leibnitz, in *Historie de l'Academie Royale des Sciences* for 1703, has invented a binary arithmetic which uses only two signs, 1 and 0, and which is suitable for investigating the properties of numbers. Of this system, M. Dangicourt, in *Miscellanea Berolinensia*, p. 336, has given some specimen in relation to arithmetical progressions. . . . And according to Emanuel Swedenborg in his *Miscellaneous Observations*, Part IV, p. 1 *seq.*, Charles XII, King of Sweden, invented a sexagenary calculus furnished with new characters and new denominational numbers. The decadic arithmetic now universally used, undoubtedly owes its origin to the ten fingers; for we use the fingers in counting, so long as we have little skill in computation (*Elem. Math.* I, § 46).

Note. This is the only specific reference to Swedenborg contained in Wolff's works. The latter's *Theologia Naturalis* (1736), however, seems to contain a veiled reference. At any rate, this was so supposed by Swedenborg himself, who, in his *Journal of Travels*, writes under date of July 20, 1736, that on that day he saw Wolff's *Theologia Naturalis*, "where, without mentioning my name, he seems to refer to me." In Wolff's thick volume of nearly 1,100 pages, it is difficult to determine the specific passage here referred to; it is probable, however, that it occurs in the section on Creation, which would naturally have a peculiar interest for the author who two years previously had published his *Principia*. More specifically the reference is perhaps to § 787,

p. 771, where Wolff refutes the hypothesis that God first produced a chaos, and created the world by reducing this chaos into order.

XXXV

The Infinite

Prodromus Philosophiae Ratiocinantis *De Infinito et Causa Finali Creationis*, deque Mechanismo Operationis Animae et Corporis. Dresd. and Leipz. 1734, 8 vo, pp. 270.

Acta Eruditorium

A Forerunner of a *Reasoning Philosophy concerning the Infinite, and the final cause of creation*; and concerning the mechanism of the operation of the Soul and Body. By Emanuel Swedenborg, Assessor of the College of Mines of his sacred and royal Majesty of Sweden. Dresden and Leipzig, at the expense of Frederick Hekel, 1734, 8vo, 17 sheets.

This book is dedicated to the venerable Eric Benzelius, Bishop of East Gothland, a relative of the very illustrious author, the latter venerating in this kinsman his high merits, his deeds of kindness, and the harmony that exists between them.

In the Preface, the author meets the objections of those who dread metaphysical inquiries, cloaked as they are with a harsh style. He sets the end of human reason in the perception of things revealed and things created; and this reason is given us as an aid to the knowing and worshipping of God. From this he gathers, that revealed mysteries considered in themselves are not contrary to human reason.

He then turns to the subject-matter of his book. He holds that there is no regarding of the infinite in comparison with the finite (I: I³).¹⁷³ He denies that there is such a thing as a quantity in finitely small (I: I⁴). *Infinitude of time* is taken by the author as eternity (I: I⁷). This kind of eternity is usually affirmed of things created, but never of God. That is to say, the infinite is contained both in the idea that denies and in the opinion that affirms. Metaphysics and an affirming opinion dictate that the infinite is that which is endowed with all possible perfections.

The author calls that *infinite* which cannot be finited by any cause, but is in the cause of itself (I: iii⁵). Furthermore, he proves from the storehouse

of reason, both *a priori* and *a posteriori*, that an Infinite of this kind exists, and that it is God.

The cause of evil is to be derived from the finite and its limitations, not from the infinite (I: v¹). The motion of the infinite is illustrated by a theory concerning the least things and the greatest that exist in the world. The medulla oblongata is said to be the fount of all the sensations and the senses, both subtle and gross (I: v⁷). All the parts of the human body, nay, and of the world, tend to their own common end, which none but an infinite Intellect is able to know and establish. Infinite substance is said to be something which one cannot understand as to what it is, or what its nature, but which yet one must acknowledge. And finally, the author adds that human souls tacitly consent that God exists and that he is infinite (I: v⁸).

Philosophers, whose idol is nature, confound finite and determinate forces with forces that are infinite and insuperable; and they think, moreover, that the event or issue is expected by God before he decrees the mode of direction or government; that is to say, philosophers of this class set up in the infinite something of the imperfect and finite (I: vi, vii), and fall into the fount of anthropomorphism¹⁷⁴ from whence have emanated idolatries and the hylotheism¹⁷⁵ of Aristotle and others (I: viii¹).

The author shows by infinitesimal calculus that the algebraic infinite has a likeness with the finite; but not so the metaphysical infinite. The former, comparatively, is nothing, but the latter is not nothing (I: viii²).

It is then shown that there is a nexus in the world, and that the infinitude of the Creator shows forth from the final cause of creation (I: x); that the ultimate effect had indeed been broken by the sins of men but was repaired by the only begotten Son of God (I: xiv²). If we may be allowed to add some warning here, the incautious will take these statements to mean that all men are to be blessed in Christ because they had each been blessed in the state of perfection. Some will object that those who are ignorant of the Messiah will also be blessed. The author foresees the shaft, and he meets the objection in these words: *Whoso has faith in the Infinite, does not exclude from faith the Only-begotten. He makes no distinction because he cannot. . . . Hence, if such persons simply include in God all that which is infinite, and likewise, those things of which they have no knowledge; and since in faith itself*

there is something divine; therefore, in that faith the one infinite cannot be separated from the other (I: xiv⁴).

The author also affirms that God is worshipped by things inanimate, in that these tend to the obtaining of the end of creation in the ultimate effect (I: xv).

He shows in a very solid way that the human soul is finite and is bound by rules (II : i²). The degrees of spiritual perfections in finite substances can certainly be estimated, and, by means of bodies, they put forth effects which are determined mechanically. From this, the accomplished author draws the conclusion that the rules, to which finite spirits are subject, are mechanical (II: i³). He likewise teaches that the finite cannot be conceived of except as an extense (ibid., 4). If the reference is to parts, and degrees within the dynamic parts, this will be freely granted by all. Furthermore, he adds that the soul is not purely simple, for absolute simplicity is proper to God alone (ibid.⁶); and he further teaches that the soul, though subject to mechanical and geometrical rules, is nevertheless immortal, but *by the grace of God* (II: iii¹⁷⁶). We add that the grace of God cannot have regard to the souls of the wicked and that thus, according to this doctrine, they would be mortal. But the author goes on to contend that it is naturally impossible for the soul to die; and he proves this from the fact that the soul perpetually partakes of the final cause which God willed to attain by means of the world (II : ii⁸). His calling the soul *the subtlest part of our body*, will seem to many a somewhat hard matter.

He contends, moreover, that among things finite no nexus can exist without a natural contiguity (II : iv¹); nor can any mutation of limits and state be thought of, without motion. Elements operate upon the animal substances (II: iv⁷), acting in man by delicate membranes receptive of geometric rules. He adds that *the soul is the center of the most subtle motions, which act by means of a contiguous tremor*¹⁷⁷ (ibid. 11).

He puts *the seat of the soul in a place within the brain where the membranes are more and more attenuated* (II: iv¹²). The souls of brutes are elementary souls which do not consist of those *actives* which constitute the actuality of reason (ibid., 16). He makes *life* to consist in *the preparation of the soul for an ever living state after the death of its body* (ibid. 17).

He concludes by giving praise to the Christian philosopher, when the latter, from the light of the soul and of the body, renders the soul more happy.

We have performed the office of reviewer, not of judge, leaving to the reader, a more accurate judgment of this Specimen and, to the author congratulations. We shall await further fruits of his highly refined mind which so greatly excels in its fitness for lofty subjects. We laud the endeavor to explain the commerce of soul and body by means of *physical influx*, and, like the author, we prefer not to disdain to consult the distinguished works of those leading writers, Bülfinger and Hollmann. (*Act. Erud.*, Dec. 1735, pp. 556–59.)

Neue Zeitungen von Gelehrten Sachen

The December number of the *Nova Acta Eruditorum* contains the following: . . .

8. Eman. Swedenborgii S. R. M., Suec. Collegii Metallici Assess. Prodrumus philosophiae ratiocinantis *de Infinito et causa finali creationis; deque mechanismo operationis animae et corporis*. Dresd. et Lips. ap. Frid. Heckel. 1734, 8, 17, sheets (*Neue Zeit.*. Jan. 12, 1736, p 32).

Julius Bernard von Rohr¹⁷⁸

The learned Swede, Emanuel Swedenborg, in his *Prodrumus of Philosophy, reasoning concerning the Infinite and the final cause of creation and concerning the mechanism of the operation of the soul and body* (1734, 8vo) treats of eternity, infinity, contingency, of nature and the creation of the world; and he shows how, by means of Nature, we shall be led to a knowledge of the Creator and preserver of all things. In many places he states propositions in common with Herr Councillor Wolff; in some, however, he departs from Wolff and introduces his own thoughts. I have the misfortune, in common with many others, that we do not understand him (*Phys. Bibl.*, 4 On Heaven and Hell, p. 140).

Friederich Christopher Oetinger¹⁷⁹

As concerns the soul of man in the body, Swedenborg, since he can find nothing which does not act according to mechanical rules, and since he conceives that there can be no finite without extension, believes that the

soul could not be a pure simple; but that, attached to the soul's activity, there must by all means be a passive; and thus that the soul also must act according to mechanical rules [II, i, 3–5, 7]. On other grounds, the soul is indeed immortal, and likewise is coordinated with a contiguous natural, that is to say, the motion of the one must ever be from the other, until finally it reaches the motion in the soul. *He believes that there is a subtler world within the grosser; a world which also has its elements, seeing that we behold so many phenomena which can be ascribed neither to the air nor to the ether nor yet to the magnet* [II, ii, 3–4]; and in their progression, these subtle elements can have as much celerity in a moment as the grosser elements have in a longer time¹⁸⁰ [II, iv, 7]. There is a nexus of motions as there is a nexus of things, or a nexus of modes as there is a nexus of substances [II, iv, 1].

He states therefore that the membranes must receive these motions of all the elements; that there are grosser and subtler membranes each having its own peculiar tension; that the grosser membranes are held tense by the enclosed fluids or elements; that the most highly fluid or moving element causes the membranes to harmonize in their expansion; that the motions which have been received can be spread forth uniformly, and propagated; that the rules of motion in elements are like the rules of motion in membranes and in human organs; and finally that the soul is the center of all such motions [II, iv, 8–11]. She is not equally in all parts of the body but where the membranes become most subtle, there will the soul be formed and become accustomed to the motion of the membranes.

The brain is clothed in every part with membranes. The most general parts are loosely clothed by the dura meninx; the particular parts by the pia meninx; which dips down into the deep passages of the brain and proceeds into the spine and covers the nerves, but finally becomes invisible to the anatomical eye. In the brain the pia meninx or pia mater with its blood vessels runs off into ramifications and goes to the cortical substance, then into the medullary, and finally to the cerebellum and the whole of the medulla oblongata. Everywhere we see traces of the ramification of the membrane, and since almost the whole brain is filled with similar substances, and also the cerebellum and the spine, therefore Swedenborg concludes that the soul resides in the cortical and medullary substance, where these delicate skins form a nexus between part and part, covering

each part, above, around and within. The cortical substance is closely bound to the meninges, being at least two lines in thickness, and creeping about in the manner of a serpent; it also enters into the brain itself, though in the cerebellum the ramifications are still more abundant, as likewise in the pineal gland, the continuation whereof is medullary. The medulla oblongata, which is situated under the two brains, is likewise ash colored and also medullary. The medullary substance is not devoid of the soul, for it appears to be composed of fibers and tubules and is mingled with arteries. From this it can be concluded that the soul is in all places where the spreading membranes become smaller and smaller, and where they have their fixed origin [II, iv, 12 (xiii)].

He says finally that the soul is the last term of all the intermediate motions; yet there is nothing passive therein, nothing elementary; but in the center is the purely active. If, however, the action of the soul be conceived of apart from membranes, then one could not predicate any determined place in respect to it. The active in its vicinity, however, cannot remain without space and without membranes. The soul itself is indeed the most active in the center, yet it must be surrounded by something finite or passive (II, iv, 13, 15) (*Irrdische and Himml. Phil.* I, pp. 9–12).

XXXVI

Economy of the Animal Kingdom I

Oeconomia Regni Animalis in Transactiones divisa. Part I, De Sanguine, ejus Arteriis, Venis et Corde, London and Amster., 1740; 4to, pp. 396.

Note. This volume was published anonymously. It is referred to in a letter by Swedenborg, dated September 16, 1745 (five months after the Lord had appeared to him in London), where, after referring to the fact that his correspondent had found pleasure in reading *Worship and Love of God*, he says he will send him two works “On the Heart” which deal with the mind and the soul. He then adds: “The copies thereof which I have, are given freely for the service of those who possess understanding and have a disposition to take pleasure in such matters” (*Op. Quaed.*, I, 337–38).

Neue Zeitungen von Gelehrten Sachen

London. In this city and at the bookshop of Franc. Changuion in Amsterdam has been put on sale: *Oeconomia Regni Animalis*, in transactiones divisa; quarum haec prima de sanguine, ejus arteriis, venis et corde agit; anatomice, physice et philosophice perlustrata. Cui accedit introductio ad Psychologiam Rationalem. 4to. 4 alphabets and 4 sheets, with one copper-plate.

In this first treatise on the *Economy of the Animal Kingdom*, all that the unnamed author has been able to say concerning the blood, the arteries and veins, and the heart is comprised in seven chapters. The first deals with the composition and genuine essence of the blood; the second, with the arteries and veins, their tunics and the circulation of the blood; the third, with the formation of a chick in an egg and the rudiments of the arteries and veins and of the heart; the fourth, with the circulation of the blood in an unborn fetus, the oval hole, the moderating arterial canal¹⁸¹ of the heart in the untimely born and in children; the fifth, with the heart of a sea-tortoise; the sixth, with the peculiar arteries and veins and all the other vessels which encompass the heart; the seventh, with the motion of the heart in an adult man.

The author's method of handling his material is, that in each chapter, in place of an introduction, he gives first the experiences of learned men, following closely their own words. From these he draws some general principles; and these he afterwards confirms and further develops one by one by means of the experience which he has laid down as his foundation.

In the appended Introduction to Psychology, he shows himself not satisfied either with the philosophical system of Physical influx, or with Occasional Causes, or with Pre-established Harmony, but makes for himself a new system which he calls Co-established Harmony. The System seems somewhat medical, and so far as we have been able to see, it consists in this, namely, that all things proceed in certain series from the highest to the lowest, and according to certain degrees from the most perfect to the most imperfect; and that at the same time they are all in harmony one with another, and the one is determined by the other. The simple substance of every series rules in that whole individual series. From it flows all that one sees to be determined in such series. From it by order of succession, when

intermediates form the connecting links, are derived compound substances [n. 594–97]. By the determination of these, more compounded substances are formed which are *mediatory* and *subdetermining*, from whence arise the substantial and proper series which make the whole and bind it together [n. 598, 600]. It is also through determining substances, by the medium of the subdeterminant means, that one thing is so perpetually connected with another that whatever part in this series is unconnected, does not belong to the series. Herein consist Co-established Harmonies [n. 601].

The more distinctly the simpler substances discriminate themselves from the compound substances, and the better the substances of a single degree discriminate themselves from their associates while yet their essence and properties remain, the more complete is the constability [n. 602–4].

The most simple and unique substance in the animal kingdom is the spirituous fluid, which, from the first, has been most perfectly determined by the aura of the world [n. 634]. From this results such an essence that it is able to be the formative substance of its body; a substance in which is the life and the soul, which is the first exciting cause of those things that are present in the whole series [n. 636–37] (*Neue Zeit.*, August 4, 1740, p. 553–55).

*Zuverlässige Nachrichten*¹⁸²

Oeconomia Regni Animalis, that is, The Structure and Organization of the Animal Kingdom; divided into separate treatises; of which this, the first, deals with the Blood, Arteries, Veins, and Heart, etc.; to which is added an Introduction to a Rational Knowledge of the Soul. London and Amsterdam, 1740; large 4to; 2 alphabets and 4 sheets, with 1 copperplate.

For this volume we have to thank the industry of the famous Swedish philosopher, Herr Swedenborg. Although he does not wish to set his name to the work, nevertheless, by other works, he has already earned such a reputation for learning, and has made his ideas on philosophy so well known, that from the nature of the work itself one can easily guess its author. His purpose in this work is a commendable one, namely, to lay before the eyes of the student of natural science, assembled in a single work, the most noteworthy and excellent new discoveries and observations of what is new in respect to the structure of the human body and the

manifold composition of its parts—discoveries and observations which are scattered about in many different books to which not everyone can obtain access, or here and there in learned journals. The store of such observations, which we now possess, is uncountable; but they are not all of equal worth, and many of them are of no service whatever in bringing out that solid system of medical art which has been so long desired, and so long sought for. Moreover, it is only a few who possess these riches and are thus in a position to give a helping hand by the careful selection and wise choice of such things as shall be useful for the advancement of medical science; and still fewer have the necessary experience and insight to make such choice according to their desire. Bearing these considerations in mind, one can easily see that one is under greater obligations to the famous author for the work he has done, than would be the case if one should rashly imagine that this work were a mere compilation of things which one already finds in other books. The learned Herr Swedenborg has not let the matter rest at a number of experiments and experiences, told in a dry way; but he makes genuine use of these, and imparts a wealth of instruction concerning the noble truths which follow from them. He does indeed frequently present these as nothing more than conjectures; but to the learned reader it is well enough known how great a distinction must be made between the opinions of the ordinary physician and the opinions, which, from modesty, they call conjectural—of men who are solidly experienced in the structure of the human body.

This first treatise of the author consists of eight chapters. In the first, an inquiry is made as to the particles of which the blood is composed, and as to their nature. In the second, the author deals with the arteries and veins, and more especially with their canals and the circulation of the blood therein. In the third, he shows how the chick is formed in the egg, and how the arteries and veins first arise near the heart. In the fourth, he treats of the circulation of the blood in a child and also in the mother's body, of the oval hole, and the special arterial tube¹⁸³ in the heart of the unborn or very young child; in the fifth, of the heart of the sea-turtle; in the sixth, of the veins and arteries peculiar to the heart, and of other vessels of the heart; in the seventh, of the motion of the heart in the adult; and in the eighth, the author will give an Introduction to a fuller knowledge of the soul and its operations.

He lays down the position that one can never easily find the truth, in the absence of experience; and that it is through this alone, that one must penetrate into the causes of things [n. 10, 11]. Still, one must make a distinction between general experience, and the particular experience obtained merely by a single man [n. 12, 13]. The latter can beget only obscure and partial notions which, in time, if they come to greater maturity, may perhaps lay down a good foundation for the most excellent truths [n. 14]. It is only when one admits into his deliberations all that is offered by the medical art, natural science, a knowledge of the structure of the human body, etc., that he has at hand a sufficient store of means, to bring to light the most hidden truths.

With this in mind, the author, in the present work, proceeds in an entirely new way in his use of the experiences which he cites from the most famous and skillful authors (especially authors of modern times), being minded to base his rational inductions on these alone. And though, here and there, he sometimes adds a few of his own experiences, this occurs but rarely; for after looking into the matter more closely, he considers it preferable to make use only of borrowed goods. There are some men who, as though born thereto, have the ability to institute experiments in a skillful way, and in these to extend their sight further than the skill of other men can reach. Possessed of such natural gifts, were Eustachius, Leeuwenhoeck, Ruysch, Lancisi, and others. Other men, on the contrary, are more skillful in deducing new truths from the experiments made by others, and in discovering the causes thereof which have been concealed by nature. Both these faculties are special gifts, and one seldom or never finds them united in a single man. Moreover, the author has experienced in himself, that when he had used all diligence, specially devoted to a more accurate knowledge of the human body, and had noted some things which others had overlooked, then, to him—perhaps from some unconscious self-love—the discoveries and opinions of other learned men, even when they concerned the selfsame things, appeared entirely obscure; and then he exerted himself to connect with his new discoveries, all other things that had previously been known to him, and to drag these in with some force. But, without his marking it, by this pernicious self-love, such a course would gradually have led away from the right and only path whereby to search for the truth. From these discoveries of his, he formed

for himself general principles, and he thought that if he used these in other and separate connections, he would find a remarkable harmony; but yet he himself afterwards perceived that actually this was not the case. For this reason, he made the resolution to lay entirely aside his own experience; to leave untouched the stock of costly instruments which he had procured for this purpose; and to use that which other learned men, whom he here mentions by name, had discovered before him, rather than to trust himself to the dangerous snares of self-love [n. 18]. Such are his reflections on these experiences, and on the way in which he, as a natural philosopher, should use them.

Since in this work he now intends to present an entirely new system of philosophy, therefore, before speaking of the matters contained therein, we consider ourselves bound to impart some further information with respect to his opinion as to how he would have this system ordered. Since he everywhere speaks of various unlimited¹⁸⁴ series of things, their degrees, connections, and manifold species, we ourselves found it very hard to obtain an insight into his thoughts, until in the last chapter of this first Part, we came across some further explanation. This we will impart to the reader at once, before proceeding further.

In the doctrine of these series and degrees of things, he sees a guidepost pointing to the way which nature ever observes in all things, whether standing the one under the other, or situated one after the other, and to which she holds herself bound as by immutable law. These series comprise all existing things, whether standing one under the other, or side by side, either at the same time, or, one after the other.¹⁸⁵ Degrees, on the other hand, are a particular kind of series, where several different things are set either under each other or side by side [n. 581–83]. In the world, therefore, there are a great many series, these being both more general and less general; under these are many other series; and each of these has its own established and proper series. Thus there is nothing in the world that either does not itself constitute a particular series, or does not have its own definite and appointed place in some certain series.¹⁸⁶ Consequently, the whole science of natural things depends on one's having a clear and distinct notion of all these degrees and their series, and likewise of how they stand side by side or one under the other¹⁸⁷ [n. 584–87].

The most universal series of all, is the whole world under which are comprised manifold other series; for which reason the celebrated Herr Wolff describes the world as being a series of finite things connected together, wherein are found many standing side by side, and many following one after the other. The author divides all existing series in the whole world into three higher and three lower. The former embrace the bodies that exist above the earth; the latter those that are found upon the earth or within it. To the former belong all forms of that matter which fills the boundless space wherein flow all the heavenly bodies, the fire of the sun, and the different kinds of fine atmospheres which can penetrate into other bodies, according to the nature of their particles. The lower series, which are found on or within the earth, are the so-called three kingdoms, the animal, vegetable, and mineral. Under the mineral kingdom again are many other species, minerals properly so called, stones, salts, fluid or solid marl,¹⁸⁸ etc. [n. 584]. In the vegetable kingdom, great pains have been taken in modern times to reduce this kingdom to fixed genera and species, and thus, in this case, to determine the true series to which they belong.

All these series of things on the earth follow each other in a known time and order. The first is the mineral kingdom or the earth itself, as being the common mother of all things. The vegetable kingdom has its origin from the minerals that lie in the earth; and, moreover, whenever it will come forth or be born anew, it is in the earth, as in a true womb, that it lays its seeds. The animal kingdom follows last, because the animal, when born, and if it is to endure, requires that the previously existing world and all belonging thereto, shall be ready at hand. The last and most perfect in this whole series is man, who can be regarded as a summary of all the perfections in the world, or, as the saying is, as a little world [n. 584].

Under this general series in the world, the author conceives of innumerable other series, for he regards each single thing¹⁸⁹ as being a particular series. Thus, all the parts and members of each single animal, the brain, the intestines, the stomach, the kidneys, the womb, etc., are in their turn particular series. The liver is a large gland wherein are contained innumerable smaller glands of the same kind; and these likewise define a particular and definite series [n. 585].

In the search into nature, one rightly begins with those individual¹⁹⁰ things in which are perceived many other and contingent things and

qualities. Now, although these individual things are of such manifold sorts, yet there is only one substance which is such that all the others proceed from it. On this as being the principle of all natural things, the Most High has impressed the commencements of every individual substance. One finds a single individual substance in every series; but this substance has its origin in the first individual substance of the world. Thus, each of the three kingdoms of nature, the animal kingdom, the vegetable kingdom, and the mineral kingdom, has its own primary individual substance, which some philosophers call elements, nomads, primitive substances, simple substances, etc. [n. 589–92].

This first, simple, and individual substance of each series, rules in all the several members of the series; and from it and its substance comes all that is found in every single member of such series as essential to it. Each member is itself determined by definite things outside itself; and, in the whole series, one member is always so connected with another, that without such connection they would not belong to a definite series, much less to this series rather than to some other. This the author calls “Co-established Harmony” [n. 594–601].

In the author's opinion, the most perfect and noblest System is that which is constituted by all the bodies of the world¹⁹¹ put together; a system wherein one individual thing is so situated under another or by its side that all are in a definite connection, and in a mutual dependence one on the other. Hence, necessarily, the simple things must feel and sensate that which goes on in those that are more compounded [n. 608]. For this reason, the provident Author of nature has provided every individual being with certain sensitive members, whereby that being can sensate all the external changes which affect the series, and can also give notice thereof to other things which stand in the same series with itself. The outer skin in which every such body is enveloped, feels almost every impression made by external bodies. The tongue perceives the form of innumerable small and hard bodies floating in fluids. The nose perceives the still finer bodies of the same sort, which float in the air. The ear will be informed by a quivering motion arising in the air, and the eye, by that different kind of motion which arises in the finest atmosphere. And, according to their nature, so also the first individual substances in every series retain their own qualities, contingent things, powers, etc., and these in like manner are

then connected with the qualities, contingent things, powers, etc., of other individual things, both in this series and in others [n. 609].

Now since all compounded things in every series consist of certain unities, therefore, the author would have us know, that by these unities he does not mean the so-called monads of Mortis, nor the homoeomerae¹⁹² of Anaxagoras, nor the atoms of Epicurus, Democritus, Leucippus, nor even the so-called elements of later philosophers; for all these are simple, and will not allow of being broken up; but he means merely the unities of a given kind of individual substance. Thus, in the animal kingdom, we find three fluid bodies, the one originating from the other, namely, the red blood, the middle blood, and an extremely fine fluid essence. Each of these fluid bodies has its own certain and definite first unit. In like manner, the blood vessels, the fibrils of the nerves and of the little muscles, the pores in the glands and the vesicles of the latter, etc.; all have their definite unities. In the vegetable and mineral kingdoms, all earths, stones, salts, waters, oils, sulphurs, etc., have their unities, and there are unities also in the very air that surrounds the earth [n. 629].

The simplest and one only individual substance of the animal kingdom is that fluid body of utmost fineness which, by its connection with a subtle world-atmosphere, is determined into such a substance that it can form a body wherein is soul and life, and which, therefore, can be the foundation of all else that stands in a series with it [n. 634–37].

Seeing that the author himself remarks that very few will have an insight into what he wishes to express by his universal world-atmosphere, therefore he does not shirk the trouble of communicating further explanation concerning it. He calls it the form of all the forces of the whole created world-system; a form to which one can attribute in the greatest perfection the properties of the lower kinds of atmospheres; as, that it occupies space; is fluid; has an expansive force,¹⁹³ etc. But as to whether the other particular sorts¹⁹⁴ of the finest fluid body in the human body were produced by means of certain limitations of that world-atmosphere, thus enabling them to constitute the first and most perfect series of the whole animal kingdom, this cannot be seen, save as in a mirror by an accurate knowledge of their effects. For if the understanding cannot reach to the things that are above it, then from the lowest step of the series lying before it, it must mount ever higher, step by step. First, it must take into consideration the facts of

experience, as to how the lowest atmosphere operates in a living body, and must advance ever onwards, and consider how the finer atmosphere flows into it; then from this, by sure rational conclusions, it finally brings to light the operations of the highest atmosphere.

The author determines on four kinds of this atmosphere which ever becomes ever finer and finer. He shows their different operations in a living body, and how, from the operation of the first kind, one can obtain an ever better insight into the operations that follow. The oldest philosophers have already given their counsel that one must pursue this road in the investigation of nature; that one cannot obtain insight into higher things except, as in a mirror, by reflecting upon and giving consideration to their various effects. The Chaldean, Egyptian, Greek, and Latin philosophers maintained that there are many kinds of heavens, by which they meant nothing else than the fluid body surrounding our globe. Mercury Trismegistus, Plato, Iamblicus, and Alcinous taught that each of these heavens was animated by a soul of its own. Origen ascribed to them an inclination to virtue or vice. Aristotle did indeed attribute to them a life but yet he said that the soul dwelling within them was without understanding [n. 635]. The author avows that he is in complete unity of opinion with the last-named philosopher; and from what we have adduced above, it is clear that by his so-called world-atmosphere he means nothing else than what Aristotle called the Form of Things.

He further teaches that if one would discover the true causes of the operations in the bodies of animals, he must diligently observe those things in the highest series which are the analogues of those in the lowest series. For in like manner as one elevates himself from inferior and particular things to things universal, so also there is no other way to fathom the nature of the human soul than first to acquire a knowledge of what precedes in animals of a lower sort. For this reason he counsels the learned that for all universal things they should work out a certain mathematical philosophy by the help whereof, just as in the case of infinite quantities in ordinary algebra, one can represent by mere signs that which does not allow of being expressed by words. On the basis of this, he entertains the hope that with the help of this philosophy one may unlock the hidden mysteries of nature and so may behold them¹⁹⁵ [n. 648–51].

In connection with this subject, the author, by various digressions, undertakes to discuss the relation in which body and soul stand to each other, and to express his opinion concerning the ideas held by other philosophers. We justly hesitate to enter into the far-reaching deductions which he brings up for this purpose; and so can give our readers no further information than that he utterly rejects both the Cartesian doctrine concerning causes which afford to the motions of the body merely an occasion, and also the doctrine of pre-established harmony; and in their place he would introduce a doctrine which he calls “Co-established Harmony” [n. 649].

His manner of writing concerning this his new discovery, is so obscure that we cannot get at any of his thoughts except with trouble; nor have we any confidence in our ability to make them so clear to another that he might be helped by our information. Moreover, we entertain the hope that it will not be a hardship to our reader if, for a few pages, we detain him with a presentation of these profound principles of natural philosophy, so far removed from the senses, as the author has framed them. This is unavoidably necessary if we are to be understood in the extracts which we intend to give from this and the following part of the work before us.

As concerns the author’s method of presenting his doctrine, we have simply to remark that he sets forth the necessary experiences from the writings of the best natural scientists, physicians, and others who have investigated the structure of the human body, from these he draws some universal principles which he calls Inductions; and then follow various appended explanations of the latter [n. 28].

In his first dissertation he inquires into the nature of the blood in the human body, first adducing, and this in their own words, what Leeuwenhoeck, Boerhaave, Malpighi, and Verheyen have written on this subject. He presents the blood as a fluid body of the utmost purity, which, when found in the red blood as the principal part thereof, and as that from which it receives its living force, he calls the Vital Spirit [n. 37]. In addition to the latter, one also finds in the blood various kinds of salts. Hence the author holds himself justified in regarding the blood as a compound liquor which, in the animal kingdom, stands in place of the soul [n. 43–46].

Surrounding the red blood flows another watery fluid with which must be associated all those corporeal particles from which the blood is to

be compounded [n. 47–48]. By this nutritive serum enclosed in water are brought to it all kinds of salts, oils and spirits. With the aid of the lungs, the air brings in nitrous and other volatile particles that float therein. The finest atmosphere supplies particles still more volatile. For without all this provision, the blood cannot carry out in the human body all that to which it is appointed [n. 49–57].

In this way the smallest particles of the body, being particles of almost every kind, are brought together in the blood and are there commingled. Therefore, the blood is like a storehouse and treasure chamber, from which all the constituent parts of the entire animal kingdom, both fluid and solid, will be nourished and sustained; for there is nothing in the whole human body which has not first been in the blood [n. 58–59].

The essence of the blood makes the blood in itself, and also the fine volatile juice and even the particles that are carried in water, to possess the most perfect force of expansibility. It flows together, with great ease as soon as no obstacle is present; and it takes on, without resistance, any outward form that one desires to give it¹⁹⁶ [n. 100–102].

The author illustrates his idea concerning the essence of the blood by the addition of various statements. In these moreover, he answers some difficult questions, namely: How it came about that, although the blood must necessarily nourish the body, yet many men maintain life for a considerable time without food or drink? [n. 55, 58]. Why, according to the experiments of Lancisi and Boyle, the blood, under the bell-jar of an air-pump, emits bubbles and almost begins to seethe? and yet Leeuwenhoek expressly relates that, in the case of blood caught fresh from its vein, one can get no air from it by means of the air-pump, though one can, from blood which has stood for some hours [n. 113]. Why blood is heavy? [n. 114]. Why it is that in the whole of nature there is nothing simpler and more perfect than an air-globule?¹⁹⁷ [n. 115], etc.; and, in particular, he makes various new divisions of the liquors flowing in the human body, and also assigns to them certain names of his own [n. 104].

Among other things in this chapter, he states that natural philosophers have not yet sufficiently defined the circulation of the blood in the human body. For in his opinion the movement and circulation of all the fluids in the human body are much more general than the course of the blood in the arteries and veins; and this movement goes on from the

smallest fibers to the large vessels, and from the latter back again to the former. This, according to his statement, has not yet been observed by those who have hitherto investigated the structure of the body and the motion of the fluids that flow therein [n. 38].

In the next chapter he treats of the veins and arteries, but principally of their channels and of the circulation of the blood. We pass by the experiences of Verheyen, Lancisi, Vieussens, Malpighi, Leeuwenhoeck, and Boerhaave, which he has committed to print from their own writings and in their own words; which he places at the beginning of the chapter; and from which he infers the well known truth, that the blood is urged from the left heart-chamber through the arteries into the veins, and from the latter pours back into the right heart-chamber, and, passing onwards through the lungs, comes again into the left heart-chamber [n. 132].

Now, just as in the preceding chapter three kinds of blood were determined on, so the channels wherein the blood runs are also of three kinds. In the channels wherein runs the red blood are found all the other kinds of channels joined together, the one always covering over the land; and it is of these channels that the channel as a whole is composed [n. 136, 143]. The purer and finer blood flows in fewer and more simple channels, while the vital spirit or the most delicate fluid runs in a single channel which is in no way composed of several combined channels [n. 144–45].

These three sorts of channels are thus: first, blood vessels commonly so called; second, vessels wherein is no blood in the ordinary sense of the word; and lastly, the vessels of the nerves.

As according with this division, the circulation of the blood itself is also of three sorts. The circulation of the red blood is the least universal; the course of the pure blood is more universal; and the circulation of the vital spirit is wholly universal [n. 146–48].

While the red blood is passing over from its own vessels into vessels of another sort, the purer blood will be separated from it; for, at the entrance to the mouth of these vessels the former lays aside the minute saline, urinous and sulphurous particles which had been mingled with the red blood. When it enters into the channels of the first sort, or into the finest little vessels, this newly prepared blood will be still further purified and rendered more perfect [n. 149–501].

From the latter vessels it proceeds onwards, and returns to the vessels of the second and third kind; so that it will be again compounded and commingled, just as previously it had been separated. Herein properly consists the universal circulation of the blood, whereby all parts in the whole human body will be irrigated, renovated, nourished, and maintained in life [n. 151, 154].

Both the blood and the vessels wherein it runs, are of three kinds, as we just now stated; and thus one sees that the greater vessels, which are meshings and assemblages of vessels, are also of three kinds. The glands which take up the different kinds of fluids that have been separated from the blood, or which also carry off from the latter its useless parts, are either compound or simple, and there are still others which are simple in a higher degree than the latter; that is, they are either glands properly so called, or vesicles, or minute pores [n. 163].

Of the particles which have been separated or cast off in the last and smallest arteries, some go back into the veins through the glands, and again become mingled with the blood [n. 165].

The motion of these fluid parts goes on in their vessels in a short time, imperceptible to the senses, in the same way that waves progress in a body of water; thus the channels must be pressed at every point of the vessel through which the blood progresses; and consequently, must be elevated; from this comes the so-called pulse [n. 166].

After a wave of this kind has received its first impulse from the heart, the movement goes outwards through all the arteries even to their end; so that its velocity is continually accelerated. And in this way the fluid body from the larger vessels can enter un-hindered into the smaller, wherein it is resolved, and can proceed therein [n. 173–74]. But the velocity of the fluid body is greater in vessels of the second kind than in those of the first; and in the small vessels it is almost infinitely greater than in those of the second kind. For in these small vessels the motion comes not only¹⁹⁸ from the impulse which has been given them by the heart of the human body, but the push becomes increased by the impulse of innumerable small quasi hearts which are found in the brain at the extremity of each of these vessels [n. 176–77].

In order that the circulation of the fluids may be the more easily maintained and promoted onwards, there is of necessity a general pres-

sure, or rather an equilibrium of this pressure, throughout all the arteries. In building the human body, nature has attained this end, in that she has covered the arteries, all the way from the heart to the finest capillaries, with a coat of the same character as the muscles; in which coat, innumerable rings are enmeshed for the promotion of this motion [n. 182]. Nay, she has also clothed these canals with a second and inner coat whereby the above mentioned rings are the more firmly drawn together and put on the stretch [n. 187].

In the veins, no characteristic circulation has been observed such as is observed in the arteries; but they become filled and then emptied by a mere pressure which has no definite direction, and which is exercised upwards and downwards and also to all sides [n. 190]. The inflowing blood is received and absorbed by the innumerable little mouths of the veins, though no certain and definite time for this influx can be observed. It then advances ever onwards into the large vessels, until it empties into the left ventricle [n. 198].

If one more closely considers the true nature of the circulation of the blood, the structure of the vessels, and the properties of the blood itself, as previously explained, one can acquire a fundamental conception as to how Nature proceeds in the motion which she makes in the human body. It is necessary: (1) That suitable fluids and minute particles be conveyed to the blood; (2) that these be well commingled, (3) and combined with those already present; (4) then again separated; (5) and the useless parts completely put aside, and (6) either be cast out, or be absorbed anew by the glands to the end that they may be improved. (7) Finally, every blood globule must itself be dissolved, and then be again united with particles that are suitable to it [n. 199]. The conveyance of the new particles, the commingling and combining of them with each other, is effected in the veins; whereas the arteries, on the other hand, divide the blood, separate its parts, and reject some of them. But the blood is especially divided directly before the mouths, when it is passing from one vessel into the other [201–2].

And the more thoroughly the blood, while flowing into the arteries, is separated from these water-carried particles, the more natural and perfect is its motion in its circulation [203].

From the above principles, which the author has laid down for the elucidation of the circulation of the blood in the human body, it is enough to conclude that he has so ordered his exposition, as to find everywhere those endless series which he has introduced into philosophy, and their harmony with each other, which, in subjoined appendices he is at much pains to show in detail. Using the style of exposition that is dear to him, he also discusses many other weighty matters such as the quantity of blood in the body of a healthy man, and especially the velocity of its motion [n. 237], particularly since some scientists cannot agree as to whether the blood has a greater velocity in the great arteries near the heart than in the least capillaries in which it finally becomes lost, etc.

In view of the fact that the blood, compounded from different particles, and which he represents as the most excellent mixture among all fluid bodies in the world, encloses in its substance so many other kinds of bodies, therefore, viewing the vessels wherein it flows, and also the many different kinds of tunics of which these vessels are composed; viewing likewise the fact that the blood itself is separated, combined, and perfected in so many places; he marvels at the remarkable harmony which is seen to exist among these natural things. This leads him to wish that someone with experience in the structure of the human body and with a clever head would elaborate a special work on Co-Established and Re-established Harmony [n. 155]. Indeed, so far as one can gather from his words, we are given not a little hope that he himself is minded to undertake such a work (*Zuverlässige Nachr.*, no. 17, June, 1741, pp. 337–62).

Neue Zeitungen von Gelehrten Sachen

The above review was noted in *Neue Zeitungen von Gelehrten Sachen* for June 22, 1741, P. 448.

*Bibliothèque Raisonnée*¹⁹⁹

Oeconomia Regni Animalis in Transactiones divisa, quarum haec prima de Sanguine, ejus Arteriis, Venis, et Corde agit, Anatomice, Physice, et Philosophice perlustrata. Cui accedit Introductio ad Psychologiam rationalem.

That is to say:

Economy of the Animal Kingdom divided into Transactions. This first Transaction treats of the Blood, Arteries, Veins, and Heart, according to the principles of Anatomy, Physics, and Philosophy. There is added an Introduction to rational psychology. In 4to, pp. 388 not counting the Table of Chapters and the Index. This work has been printed at the expense of the anonymous Author. It is sold in London and in Amsterdam, at Francois Changuion's, 1740.

There are so many works on the matters treated of in this volume that I am not surprised that the Bookseller, ignorant of its value, did not want to risk printing it at his own expense. Most doctors and, above all, most professors in any of the Faculties, would think their reputation to be injured if they did not offer their lessons or the fruit of their studies to the public. They would think themselves to have assigned over-narrow limits to their glory, did they not transmit that glory to posterity in the form of the public monuments they erect to it.

The book, the title of which I have just given, certainly deserves to be read. I do not know whether or not the anonymous author is one of these disinterested men who toil and sweat, only to communicate to others the fruit of their labors. May I be permitted, however, to remind the reader, of the incontestable truth, which concerns medicine equally as theology, that the more we study this mysterious science, the more we speak of it and write about it, the less clearly do we understand it. One cannot say anything about it that is able to satisfy unprejudiced reason. Medicine—that grand art which I call conjectural, in spite of all those who call it science—is to be regarded in about the same way. Speak of it, reason about it, as much as you please, it is none the less obscure; and in practice it becomes even more uncertain. Physicians, I think, would provide better for the public good if they applied themselves mainly to learning the *materia medica*, and to working upon it with zeal and exactness, that so they might become acquainted with the salutary remedies it contains. Such blissful labors would be much more advantageous to the public than a theory, the doubtful application of which, often poorly satisfies the expectation of the physician and the hopes of the patient. In this, experience is far superior to science. It is better to recover health by a judicious test than to lose one's life from extremely well reasoned principles.

The work before us, however, is as good as all others of this kind, though it contains only a theoretical knowledge of the principles of life and health. It consists of a single Article which the author calls a "*Transaction*." It is a sort of Introduction which treats of the Blood, the Arteries, the veins, and the Heart.

Following the steps of a great number of scholars who have preceded him, the author commences by admitting (n. 1, 2²⁰⁰) that the good or bad condition of an animal depends upon the nature, constitution, determination, circulation, and abundance of the blood. Like the others, he admits that this vital fluid contains salts of every kind, volatile and fixed, such as oils, spirits, waters; in a word, all that can be produced by the mineral, vegetable, and animal kingdoms. It does even more; for, the author says, *it appropriates all that the air of the atmosphere contains in its globules. It is for this reason* (he adds) *that while passing through the lungs, it frequently presents itself to the air in order to enrich itself (ut inde locupletetur)* [n. 3].

It seems to me that all the physicists will not admit this principle. No one doubts that the air is the reservoir of the corpuscles which become detached from all bodies, both the harmful and poisonous, and the harmless and salutary. But no one will admit that the animal seeks to appropriate the one kind or the other indifferently. Such is not the purpose of Nature. Nature has an unconquerable inclination to remove from herself all that may destroy her. Now the atmosphere is only too often impregnated with arsenical, acrid, poisonous, and harmful corpuscles; and these little bodies are certainly not fit to enrich Nature; they can but make her the poorer. If the blood, therefore, presents itself to this unhealthy air, it is not for the purpose of drawing from it, nor of receiving, what it contains; but, being forced by the inviolable rules of mechanics to present itself to the air, it is unfortunately so exposed as to appropriate from it that which impoverishes as well as that which may enrich it. Hence the common contagions—epidemic diseases, which, making the blood too thin or too thick, destroy the animal of which it is the soul and motory. I ascribe this inaccuracy on the author's part, however, to his undoubted purpose of avoiding prolixity; though, writing many lines to express truth would not be prolixity, and expressing error in two words is already too much prolixity.

After establishing the necessity of anatomical experiments, and especially of particular experiments preferably to general ones, in order properly to make known the economy of the animal kingdom, the author quotes (n. 17) the most weighty authors (at least those to his taste) whose observations and experiments will always be respected and followed by posterity. He quotes Eustachius, Malpighi, Ruysch, Leeuwenhoek, Harvey, Morgagni, Vieussens, Lancisi, Winslow, Ridley, Boerhaave, Wepfer, Heister, Steno, Valsalva, du Verney, Nuck, Bartholin, Bidloo, and Verheyen. With these clear-sighted guides, he opens for himself a very obscure pathway which he intends gloriously to follow to the end. Nevertheless, he speaks of himself with great diffidence and much modesty. He even thinks with Seneca, that many might have become wise had they not thought themselves already such.

The above preamble concludes with the distribution of the work. The author divides it into eight Paragraphs which is the name he gives to the chapters; and he declares that, without further preliminaries, he will at once begin with the experiments of the great men whom he takes as guides, and will draw from their opinions the *Inductions* which naturally spring therefrom. So *that* (he says), *adhering chiefly to experience, it is this alone that will speak in the present work. All that I have to say will flow from it naturally* [n. 28].

The first Chapter or Paragraph treats of the composition and essence of the blood. Before entering upon this subject, the author sets forth the experiments of Leeuwenhoek, Lancisi, Malpighi, Verheyen, etc., using their own words. Nothing new is learned from this. The authority of the learned Boerhaave is the only one that might give pleasure to the reader, and this induces me to translate the whole passage:

In the veins of a corpse (*says this great man*), a fluid blood is seen which does not coagulate for a long time, while in the heart and arteries it coagulates in a short while. This liquid, which in a living man everywhere appears equally red when seen under the microscope, is nothing but a multitude of red globules which swim in a subtle and transparent water. So that each of these globules is red because it is composed of six smaller globules which, when separated, have nearly the character of a yellowish and transparent water and are of various colors. To what point these

globules can be divided is a difficult matter to conceive of. No one doubts that, of all the humors in the viscera, arteries, and veins, which are nourished and cherished by health, that which we call the red blood is the grossest. After this comes a yellowish serosity which coagulates when heated. Then comes that milky humor, etc. (n. 31).

The author then enters upon a particular discussion of the properties and use of the blood, and he concludes that this fluid is the seminary, the parent and the nourisher of all the solid, soft, and fluid parts. *For* (he adds), *nothing exists in the body which did not preexist in the blood* [n. 59].

After this analysis of the blood, he makes a short synthesis, asking himself two questions. First: What is the volume of the blood? and second: What is its consistency or thickness? He answers the first question by saying that the volume of this liquid is pure, mixed homogeneous, mixed heterogeneous [n. 104]. To answer the second question, he assumes that the consistency of this vital humor holds a middle place between the volume of the fluid and the mass of the solid; and he decides that the consistency or thickness of the blood, like its volume, must be considered under three states. It may be pure, mixed homogeneous or mixed heterogeneous [n. 106]. He would also have it, that it is this humor, in whatever state considered, which gives rise to the almost infinite variety that is found in the liquids and solids of the animal kingdom [n. 115].

In the second Paragraph of the work, we read concerning the systems of several authors in respect to the arteries and veins, their tunics, and the circulation of the blood. But little difference is found here, though it appears that there is some difference in the experiments which the authors assert they have made on various animals and on dead and living bodies. After citing a long passage from *Verheyen* concerning the tunics of the arteries and veins, he sets forth *Verheyen's* opinion on the circulation of the blood, and quotes the experiments which he uses as proofs. He again cites the opinion of *Leeuwenhoek*²⁰¹ who endeavors to prove that the blood circulates no faster in the large vessels than in the small [n. 116].

One sees by the observations of the latter author on the movement of the blood in an eel, that this humor circulates with so much rapidity that, whether going or returning, it runs over a space of 280 inches or 24 feet in one hour. From this, *Leeuwenhoek* concludes that in the human body the

blood goes and returns, from the heart to the feet and from the feet to the heart, twice in an hour; and that in the same space of time, it goes from the heart to the extremities of the fingers four times, and to the extremity of the head eight times; and finally, that the whole blood of a man runs over the whole human body fourteen times in an hour.

Bidloo also is quoted on the tunics of the veins, and especially on the exterior tunic of the arteries, and on their valves and muscles [n. 117]. One sees also *Morgagni* opposing *Manget* on the figure of the Tube of the arteries, the latter claiming that it has the figure of a cylinder, and the former that its figure is that of a cone, according to the opinions of *Vallisneri*, *Santorini*, and *Bernard Zendrin* [n. 119].

Heister is then quoted on the subject of the number of the arteries. This learned man is praised, with much reason, for acknowledging only two, the pulmonary and the aorta or Great Artery, of which all the others are merely ramifications; and although he thinks they have the figure of a cone, he nevertheless admits that towards their extremities the branches take the figure of a cylinder. He attaches much importance to *Eustachius'* 25th figure, that is to say, the figure of the Eustachian valve; but he refuses him the honor of its discovery, insisting that *Cheselden*²⁰² was the first to have had a knowledge of it. In the opinion of the learned *Heister*, *Winslow* has given a better description of it than any of his predecessors. He calls it, however, the valve of *Eustachius* because, undoubtedly, this name is generally accepted; he assigns to it a use which *Lancisi* and several others had not observed. The last named author contents himself with making it serve as a hindrance, so that the blood, coming, down with too great impetuosity from the jugulars through the upper vena cava, shall not encounter and run against the blood which goes up through the lower vena cava. But besides the use of the valve thus imagined by *Lancisi*, *Winslow*²⁰³ finds another which is just as well reasoned; namely, that in new-born children, in whom this valve can be seen very plainly, it prevents the blood from returning from the upper vena cava into the lower [n. 120].

On this subject, the author reports the opinion of *Boerhaave*, and I think I may give pleasure to those who have not the writings of this eminent professor at hand, by inserting his opinion here:

The red humor, which is called blood (*says this eminent man*, n. 126) and which is distributed to almost all the parts of the living body, is found in a healthy man in vessels proper to it, such as the arteries and veins, or in certain reservoirs intermediate between these two kinds of vessels. Such intermediate reservoirs are the venous sinuses of the heart, of the liver, of the dura mater, of the auricles [and ventricles] of the heart and of [the loculi in] the male and female genital parts, and perhaps even of the spleen.

One sees in effect, that the arteries are canals of a conical figure, oblique, branching, furnished with no valves except in the heart, and the branches of which have different origins. Frequently they rise at acute angles toward their elevation, and seldom at right angles, as in the case of the intercostals, etc. They have five coats. The exterior coat is thin and nervous on its outer surface; but its inner surface is made into a very thick network composed of arterial vessels drawn from the coronary arteries, together with veins. The second coat is cellular, thin, readily expansible on the dilatation of its cells, which latter, distilling an oily and fatty liquid through its muscular fibers, perpetually keeps them in alternate contraction and dilatation. The third, which is glandular, might possibly be a part of the second. It contains fatty offshoots which extend to the fourth coat. The latter is muscular. It is made up of highly compact annular fibers, thickened by the union of stratified surfaces, which can be separated into several leaves. These fibers have great elasticity. Finally, the fifth coat is interior, thin, membranous, appearing to have long and contractile fibers. . . . The veins, almost similar to arteries in disposition and figure, are larger and perhaps more numerous. . . . All the arteries which are in the body, join, so to speak, with the trunk of the aorta which springs from the left side of the heart; and those which are used for the construction of the lungs, spring from the pulmonary artery which originates from the right side of the heart. As to the veins, they all have the same relation to the vena cava as the arteries to the aorta, etc.

Various calculations (*Boerhaave adds*²⁰⁴) have been made in order to determine the quantity of blood contained in a living animal. Some authors find that there are 25 pounds in man; some give him only 10; others are satisfied with 8. However, hemorrhages through the nostrils

have been seen when 48 pounds of blood have been lost in three days, and up to 75 pounds in twelve days. This is attested to by the *Acta Lipsiensia*.²⁰⁵

Some physicians (*finally says Boerhaave*) doubt the possibility of the revulsion and derivation of the blood, a practice established by the Ancients. The former consists in drawing off, by blood-letting, from a viscus or from any part of the body, the blood which causes the inflammation. The latter is supposed to be done by determining the blood to take a road different from the one that leads it to the afflicted part [n. 126]

Boerhaave does not say what he himself thinks of this; and this silence would seem to warrant the accepted practice of opening the vein in cases where revulsion and derivation are necessary for the relief of the patient.

In consequence of the principles and experiences he has set forth in this second chapter, the author establishes his opinion concerning the circulation of the blood, and concerning the solid parts which, by their various movements, contribute to it. He treats of this matter with as much method as eloquence. His conclusions, which I call Aphorisms, are just and generally accepted. Every physician can adopt them without fear of making any error.

Meanwhile, in his Induction, the author goes on to develop in a clear and mechanistic fashion the system of the circulation, and the effects that it produces in the body of the animal. He explains in the most satisfactory manner how, and by what artifice of nature, secretion is made by the arteries from which the arterial blood flows into the veins [n. 221 seq.]; he shows that it is from the arteries and their blood that the body draws its force and life [n. 231]; that the smallest vessels considered as a whole contain much more blood than their trunk, and that several reasons prove this truth [n. 234]; that in the inflammation of the parts, there is no better remedy than to open the vein in order to effect the revulsion and derivation of the blood [n. 235]; that one cannot easily determine the quantity of red blood contained in the body of the animal [n. 237]; why the arterial blood differs so considerably from the venous [n. 238]. Finally, he concludes that there is nothing so perfect in the world as man, although, if he abuses the faculties which Nature gives him to maintain himself in a good and salutary condition, he is the most imperfect of all animals [n. 239].

Chapter III, which treats of the formation of the chick in the egg, and of the origin of the arteries, veins, and heart, contains passages from several authors who have made various experiments on this matter. Bellini (n. 241) reasons in a more general way and not so exactly as Malpighi (n. 242). The latter gives more details concerning the development of the organic parts of the chick. He gives the times, the hours, and, so to speak, the moments, when the successive alterations take place. One would think that he had observed the operations of nature by catching her in the act. I know not whether such circumstantial details of so hidden an operation should not be suspected. The same judgment also, in my opinion, may be given with respect to what is said on this matter by *Lancisi* (n. 248). *Harvey* (n. 246) is a little more reserved. He is satisfied with showing the difference which he has found between the development of the fetus and that of the chick.

In his Induction, the author, after establishing the difference which in this matter, exists between the perfect and imperfect animals—those which are formed in the womb and those which develop in an egg—concludes and proves (n. 248) that at the time when the embryo is formed in the bosom of a woman, as well as in the formation of the chick in the egg, nature operates most distinctly. This thesis is followed by several others, as a principle by its consequences. The author goes on to say that there exists a certain substance or formative force which continues the woof of the animal from the first moment of its life to the last [n. 253]. Finally he decides that this substance or formative force is nothing else than the soul [n. 270]. But is not this an explanation of an obscure proposition by one that is less clear? In the remainder of his Induction, however, the author reasons concerning this inexplicable phenomenon in a plausible manner, by supposing principles, which, from the fact that they are received, are not the more sensible. The chief principle is, that the brain, heart, and lungs are the causes and principles of the motion of the animal [n. 279]. In order to clarify the matter, it would be necessary to decide which of these three is the first principle of the movement.

Paragraph IV treats of the circulation of the blood in the *fetus* before birth; of the oval foramen or egg; and of the arterial canal of the heart of the embryo and of the duly organized child. *Verheyen* (n. 316) is quoted at great length, on the difference between the circulation of the blood in the

fetus and in the adult. He explains the various ways by the organic mechanism. The opinion of *Lower* (n. 317) is related with much precision. This eminent man proves clearly that since respiration cannot be carried on freely in the fetus, all the blood which will not necessarily pass through the lungs is compelled to follow the pathway of the other viscera or canals. From this he concludes that a large part of the blood, being expelled from the right ventricle of the heart, passes through the arterial canal, where, being mingled with the rest of the blood, it is distributed into the whole body.

Following this, *Harvey* (n. 318) explains the system of circulation in a few words. *Needham*, *Munnick*, *Mery*, *Morgagni*, and *Fantoni* each contribute their grain of salt; and after reading and meditating upon all that they say, with much emphasis, one is neither more learned nor more satisfied. The viscera and canals in which the great mystery of the circulation of the blood takes place are so obscure and tortuous that the most alert and piercing eye does not see sufficiently well to get a correct idea of this mechanism, the knowledge of which Nature has reserved to herself.

The Induction that follows, embraces the three changes which take place in the circulation of the red blood in an egg which has been brooded and is ready to hatch. The first takes place when the heart or salient point, through certain branches, impels the blood toward the brain. The second, when the aorta extends itself in the region of the abdomen or lower belly [n. 326 *seq.*]. The third, after birth or exclusion from the egg; for the blood is then impelled from the superior vena cava and at the same time from the inferior, into the right ventricle of the heart; and after passing through the lungs, it flows into the left ventricle of this viscus, from which it is afterwards driven into the aorta to supply the brain with the quantity it needs [n. 345].

The author ends his Induction by a kind of Corollary [n. 359 *seq.*], in which he ventures on a dissertation concerning the circulation of the pure and white blood, and this in spite of the difficulty he had previously experienced in explaining this subject. His reasonings are in harmony with the mechanism accepted by the learned. No new discovery is found here, which can derogate from the opinions established in the Faculties and in the writings of individual doctors.

In Paragraph V, where the author treats of the sea turtle, he claims that the heart of this amphibious animal shows the use of the oval foramen and the arterial tube better than any other heart [n. 372]. In favor of his opinion, he cites only the experiment which *Morgagni* with a certain number of friends, once made in Venice on a sea turtle weighing thirty-six pounds [n. 373].

The author's Induction turns entirely on consequences which he draws from the mechanism of the sea turtle, as compared with animals, not excepting man, in the state of the embryo, of the fetus, of the child, and of the adult. He concludes with the remark, that a sea turtle whose head has been cut off, yet continues to live for some weeks [n. 385]. As to this, he cites *Caldesi*, who asserts that when its head has been separated from its body, this amphibian carries its shell equally as well as before, for fifteen days. It is a fact; experience proves it.

Paragraph VI, which treats of the arteries and veins peculiar to the heart, and of its coronary vessels, contains little more than a long passage from *Lancisi*²⁰⁶ [n. 387]. After this author, he quotes *Lower*, *Winslow*, *Ruysch*, *Morgagni*, *Verheyen*, and *Vieussens*, and among them one finds the learned *Boerhaave*, whose opinion he reports (n. 390). In accordance with the authority of these great men, the author, in his Induction, judges that the coronary vessels of each class, arterial or venous, spring from the heart and not from the beginning of the aorta [n. 399]; and he brings forward, at great length, proofs of this statement founded on his principles. He also contends that all these vessels depend solely on the action of the heart, which is not only the provider but also the mover of its own blood [n. 418]. Whence it follows (he adds), that since the blood of the coronaries flows from this source, therefore the superficial vessels commonly called the coronaries perform their diastole when the heart performs its systole; just as the superficial vessels of the auricles perform their diastole when the auricles themselves perform their systole [n. 423]. This doctrine gives rise to the distinction which he makes of these vessels into *refundent*, *retorquent*, *anticipant*, *transferent*, and *retroferent* [n.432]. These barbarous terms must make the reader feel that it is no less difficult to conceive these things than to explain them. Be that as it may, the author, omitting to reason about the *Coronid*, dwells at length upon the disposition of the blood in the heart. He

ends his Induction by decisively concluding that the action of the heart is effected from within to without, and the action of the brain from without to within, that is to say, that the brain concentrates all its forces upon itself, while the heart, on the other hand, communicates its forces to the other parts of the body [n. 459].

The subject of Paragraph VII is the motion of the adult heart. The author gives a long extract from the writings of the learned *Boerhaave*, in which the nature, construction, and motion of the heart are very clearly explained, provided the principles, which are assumed, are certain. Here we see the whole mechanism of this viscus, founded on the most exact experiments—experiments by the most weighty physicists and physicians, which are reported in their own language. So scrupulous has the author been, that, lest he be accused of inaccuracy, he has copied them word for word.

These are the foundations of his Induction, in which he concludes that the efficient causes of the motion of the heart are remote. They are, he says, the lungs, the cerebrum, the medullas oblongata and spinalis, and the cerebellum [n. 548]. We read here concerning the manner in which these influence the motion of the heart; and since they are only the remote causes, the author contends that even if any of these parts ceased to act, the heart would nevertheless move for a longer or shorter time according as the nervous fibers could preserve their strength [n. 571]. He asserts that in order to understand this mechanism, it is necessary to know what is the cause of the action of nerves in general, of the intercostal nerve and the par vagum in particular, of the great cardiac plexus, and in particular of the nerves of the heart dependent thereon [n. 471 seq.].

This doctrine, which the author sets forth with much erudition, naturally ensues, he says, from the following principles: That there is nothing living in the body save the spirituous fluid; that for this fluid to live, it is necessary that it reside in a fiber which determines it; that the simple motor fibers act in the same manner as the compound motor fibers; that by means of their fluid the simple fibers can act upon the compound fibers and their fluid; and finally, that the smaller arteries depend more immediately on the nervous fibers, and consequently, on the brain, than the larger [n. 503]. From this doctrine, he infers that the proximate cause of the heart's diastole is the continuous pressure and action of the blood of the

vena cava in the right auricle; and the proximate cause of its systole is the extension of the nervous fibers, so that the nervous fiber yields when the blood acts, and when the fiber is inaction, the nervous fiber²⁰⁷ yields in its turn [n. 512].

The rational arguments which this author makes in treating of these matters are as solid as they are profound. Here one finds the doctrine of the Ancients united with that of the Moderns. The experiences of the one and of the other are set forth to be seen at a single glance. All that is said in this work, and all that is cited, is said and cited with much discernment. Good taste is evidenced throughout. Nothing is clearer, nothing more familiar, than the author's expressions. The experiments he relates are as convincing as though they concerned a mechanism which could be seen and judged by the eyes. But both the microcosm and the macrocosm are equally beyond the reach of the human mind. I mean, that the little world, which is man, is a mechanical whole, no less inscrutable than the vast universe.

This author, whose writings reveal neither his name nor his quality, ends his work with Paragraph VIII wherein he gives an Introduction to Rational Psychology. He makes this science to consist in the knowledge of the nature and essence of the soul, and of the manner in which it flows into the operations of the body [n. 579]. His efforts would be worthy of praise, and his memory precious to posterity, if he could bring some feeble ray of light on so obscure a chaos, which none has thus far been able to unfold. But the darkness is too great for us to expect to see it dissipated. One may say that this phenomenon is carried on in an inaccessible place, and that he who would insist on penetrating thither would thereby risk being dazzled and even losing his sight.

Our anonymous author is, however, worthy of praise for having dared to open for himself a career so extraordinary. In *magnis tentasse sat est*.²⁰⁸ He submits that to attain to so elevated an object, even though it is within ourselves, we must mount up to it by the same steps or degrees as Nature uses in the production of her effects. It is for this reason that he here undertakes to explain that doctrine of series and degrees, which he mentions in the preceding Paragraphs [ibid]. He speaks rightly; for the human mind that busies itself in the research of causes by the analysis of their effects, can never find these save in the subordination of things and in

the arrangement of these subordinates [ibid.]. Therefore, the influx of the soul into the operations of the body can be explained only by the doctrine of Physical Action or of Occasional Causes; and if these two means do not succeed, a third offers itself of which one must needs make use, namely, the harmony of all the organs and of all the parts of the human body [ibid.]. A fine subject of contemplation for those speculative minds which live on ideas; but very wearisome for those which yield only to evidence.

After establishing his principles with all possible solidity, the author presents the details of those degrees of which he has spoken. In the nine points into which his Introduction is divided, he goes over them all. There, one sees a method short and easy for beginnings. The rational arguments which the author makes, the experiments he quotes, the consequences he draws, are worthy of the meditations of the most finished expert in the theory of physics and anatomy. I say *physics* and not *metaphysics* because in the present work the author treats only of the soul in its relation to the operations of the body, without troubling himself about the fact that it is an immaterial being.

I dare say that this work is as singular in its synthesis as it is in the analysis it makes, of the noble and essential parts of the human body. The authors quoted are weighty and respectable; the experiments set forth have a verisimilitude and perhaps a character of truth that satisfies the mind; the rhetoric and style of the author cannot but please the judicious and men of good taste, who love the solidity of the subject and the purity, the clearness and the beauty of the diction.

The work seems to promise us a continuation. The “First” Transaction, as we read on the Title-page, promises us other Transactions. We hope they will be as useful and pleasant to the learned as is this first. Men could not with reason refuse to applaud it (*Bibliothèque Rais.* vol. xxvii, 1741, Oct.-Dec., pp. 411–433).

(To be Continued)

ENDNOTES

167. This should have appeared earlier in the present work.

168. In his *Swedenborg und Anderer Irrdische and Himmlische Philosophie*, volume 1, 1765. This review is interpolated by Oetinger in his review of Swedenborg's *Principia*.

169. In the English translation, page 75, "Reasons shewing the impossibility of transmuting metals, especially into gold."

170. Swedenborg says nothing about "salt" in this connection. He merely observes that every metal is composed of particles of a form peculiar to itself, as seen when it is crystallized; therefore these forms must first be destroyed and changed to others before there can be any transmutation. Oetinger identifies crystals with salts.

171. Oetinger is here referring to the mystic doctrine of creation by the "decussation of the seven spirits," propounded by Jacob Böhme of whom he was a follower.

172. In, his *Elementa Matheseos Universae* (Elements of the whole of Mathematics), vol. I, Geneva, 1732.

173. The reviewer's references are to the pages of the original; these we have changed to references to the Parts, Chapters, and marginated paragraphs, which latter we have numbered.

174. By this term, the reviewer means the worship of men as gods. See *Infinite*, I: viii¹.

175. The doctrine that matter or the universe is God.

176. [Note by the Reviewer:] This was the opinion of Andreas Rüdiger whom the author frequently follows.

177. [Note by the Reviewer:] If we mistake not, according to this, thoughts are the effects of motive forces inseated in nerves and their fibrils; and, this dogma being granted, then matter can think, and bodies are capable of reasoning. Thus the soul is a compound substance, and is naturally dissolved and destroyed, despite anything that may be specially objected to this, or that may be advanced against it, on the ground of the final cause of creation. The *Influxionists* have here clear consequences which by their principle of a physical union, they are compelled to admit. But see Humphrey Ditton's Appendix to *The Truth of the Christian Religion Demonstrated from the Resurrection of Jesus Christ*.

178. In *Physikalische Bibleothek*, Leipzig, 1754.

179. This review is interpolated by Oetinger, in his review of the *Principia*. It concerns only the second chapter of the *Infinite*, On the Mechanism of the Operation of Soul and Body.

180. [Note by the reviewer:] The reader will here notice the basis of his heavenly philosophy.

181. That is, the ductus arteriosus.

182. *Zuverlässige Nachrichten von dem gegenwärtigen Zustande, Veränderung und Wachsthum der Wissenschaften* (Authentic News concerning the present state, change, and growth of the sciences). This monthly journal was published in Leipzig from 1740–57 in direct continuation of the *Deutsche Acta Eruditorum*, under the same editorship, by the same publisher, and with the same high standard of scholarship.

183. The ductus arteriosus.

184. *Unendliche* (infinite, boundless). Probably the reviewer means "continuous."

185. That is, in successive or simultaneous order.

186. [Note by the reviewer:] We hope the reader will not blame us if he finds this explanation obscure. Had it fallen to us to express the author's theories, then, with other philosophers, we should have said that all things in the world stand side by side or one after the other, in a certain order of space and time; that each unending series of things is determined by a certain property which one must necessarily perceive in each member, if it belongs rather to this series than to any other, etc.

187. This is the reviewer's translation of the words *subordinatio* and *co-ordinato*.

188. The reviewer appears to have understood Swedenborg's *plures species . . . terrarum, liquidorum, etc.*, to mean "many kinds of liquid earths,"—which he then identifies with marl.

189. [Note by the reviewer:] Herr Privy Councillor Wolff has made use of these series, especially in his so-called metaphysics; but his conception was not so much that each thing is a definite series in the world, but rather that all single things are taken as members of particular series. The author, on the other hand, makes a particular series out of each member. Experience must decide whether, with this conception, he will accomplish the great things in natural philosophy which he designs.

190. *Selbständig*, which we here translate *individual*, means *self-dependent, independent, individual, absolute, substantial*. The reviewer uses it (in conjunction with *thing*) as the translation of *substantia*; but this latter word he also translates as *wesen* (which we render *substance*). *Wesen* means *being, entity, substance, matter, essence, etc.* Again he translates *substantia* as *selbständig wesen* rendered by us *individual substance*.

191. The reviewer has understood Swedenborg's words *systema corporeum* to mean a system composed of "all the bodies in the world," whereas what is meant is "the corporeal system," i.e., the animal body.

192. The homogeneity of the elements or first principles.

193. This is the reviewer's interpretation of Swedenborg's "has elasticity."

194. *Obaber die andern besondern arten, etc.* Possibly, there is a *lapsus calami* here. Swedenborg's words are: But as to whether the individual parts of the spirituous fluid were formed by the determination of that aura, etc.

195. [Note by the reviewer:] He here appeals to the great philosopher Herr Wolff, who likewise hoped that keen minds would undertake the working out of a science wherein should be contained the general principles of the knowledge of all finite things; a science which not only would be of good service in mathematics but could likewise be used in many ways by philosophers. So far as we can see, however, the science proposed by Herr Wolff is far from being the same as that which is desired by the author. At least, Herr Wolff, unlike the author, does not give it as a key to open all the mysteries of the many movements of the body in nature.

196. The reviewer has here given a somewhat loose interpretation of Swedenborg's words.

197. This is a slip for *blood-globule*.

198. The "only" is an addition by the reviewer.

199. *Bibliothèque Raisonnée des Ouvrages des Savans de l'Europe* (A Methodical Bibliotheque of the works of the learned in Europe). A Quarterly periodical published in Amsterdam from 1728–1778. Next to the *Journal des Scavans*, it was the most influential of all the literary journals published in French.

200. In the original review, the references are to the pages of the Latin edition. As a matter of convenience to the student, we have changed these to references to paragraph numbers.

201. The citation from Leeuwenhoek is part of the extract from Verheyen.

202. All that Heister states is that Cheselden was the first to *describe* the Eustachian valve. The first *delineation* of this valve was made by Eustachius who died in 1570. Eustachius' plates, however, were not published until 1714, whereas Cheselden's description of the valve was published in 1713. See Heister's *Anatomy*, nota 69.

203. The French text has *Eustachius*, but this is undoubtedly a misprint.

204. This and the following paragraph, while apparently quoted from Boerhaave, are actually from Schurig's *Haematologia*.

205. *Acta Eruditorum*, 1688, p. 205. In the course of a review of a learned journal, the *Acta Eruditorum* here notes the case of a young man of 25 years old, who lost 75 lbs. of blood in *ten* days by nose bleeding. He was eventually restored to health.

206. The reviewer is mistaken in this, for the citations from Lancisi constitute less than one half of the anatomical citations.

207. This is manifestly an error for "the blood."

208. In great undertakings, it is enough to have tried.