

## POLHEM'S PHILOSOPHY

Several manuscripts in Swedenborg's handwriting, formerly regarded as Swedenborg's own productions and so listed in Hyde's *Bibliography* (1906), have since been found to have originated with Christopher Polhem. Thus the text in Mathematics (Hyde XXIII) referred to in Swedenborg's letter of February 14, 1716, was printed in part at Upsala in 1716, anonymously except for the phrase, "delivered by C. P." Swedenborg probably had revised the treatise. An incomplete draft of the whole proposed book was found among Polhem's manuscripts.

The "Dialogue between Mechanics and Chemistry on the Essence of Nature," attributed to Swedenborg (Hyde L), is also found in Polhem's handwriting. (See *Opera Quaedam* III, pp. xxxv, xxxvi, and 245ff.) And the little treatise on "The Causes of Things" (Hyde XXXVII) seems from internal evidence to have been one of Polhem's proposed contributions to the *Daedalus Hyperboreus*, rewritten by Swedenborg as editor.

For the final determination of the authorship of such treatises, and in general to judge of what influence the famous Polhem might have had on the youthful mind of his assistant, it is necessary to probe into Polhem's many-sided activities and his less publicized views and attitudes regarding both science and religion. It is also of special interest to note Polhem's more private views since Swedenborg later tells of meeting him in the spiritual world, and finding his thought still immersed in mechanics and physics. Polhem's inwardly materialistic thinking led him to the denial of God and to the thought that "the life in man and beast is something mechanical" (SD 4722, 6049, 6071).

In *Christopher Polhem*, a memorial of the Swedish Society of Technology (Stockholm 1911.), several specialists contribute articles towards a biography of this pioneer in mechanics. Samuel E. Bring is the main contributor. We submit below a translation of extracts from one of his chapters, entitled "Polhem and our first Society of Learning."

The society in question was the "Collegium Curiosorum" which was formed in 1710 through the initiative of Eric Benzelius, the learned librarian of the University of Upsala. Some nine members met for a year more or less regularly to discuss new advances

in mathematics and physics and in practical economics and mechanics. And as corresponding members the society counted, foremostly, Polhem, and, it seems, also Swedenborg. In 1719 the society was revived as the "Bokwetts Gille" or Swedish Literary Society, which was in turn transformed into the Royal Society of Letters and Science (1728).

After noting that the epoch-making discovery of Newton that the law of gravitation depended on the attraction of bodies had not gained any following in Sweden, being regarded by Pehr Elvius, the professor of astronomy, as "a pure abstraction," Bring opines that it seems to have been through Polhem, and later through Swedenborg, that Newton's theory had received a more general publicity. In Sweden the old theory was accepted, that the weight of bodies was caused solely by the pressure of the ether. Not until April, 1712, had Polhem gone through Newton's *Principia*, although it had been published in 1687; and he found it difficult and obscure, and felt that the author was showing off his learning rather than making others learned. Polhem's position toward the problem is best shown from the closing paragraphs of his own "A Short Explanation of Newton's centripeta et centrifuga" which he sent to Elvius in 1712, and which Bring quotes:

"Now since fixed matter, of which the planets consist, can in no wise be as light as ether, it follows consequently, clearly and indisputably, that all planets must be hollow and full of fire, which is as much lighter than ether as ether is lighter than fixed matter, and as a hollow lead bullet can float in water, so the earth and the planets [can float] in the air without any gravity.

"But whether the earth is driven by its own natural impetus, which is not contrary to mechanics when there is no weight, or whether it follows the streaming ether around it as in a whirlpool of water, or whether it is driven by the inward fire which has a communication with the fire whirling about the sun, or else a lesser one around some great planet—that I leave for the learned to surmise. I for my part regard the last as the safest, since all the rules of motion are thus best preserved, as also a better opportunity to prove polar motion, since otherwise, where no resisting medium is present, all motion is infinite and without proportion."

The rest of the chapter (from page 63 to page 80) now follows, as translated from the Swedish by Hugo Lj. Odhner:

*Extracts from Bring's "Christopher Polhem"*

Whether at a later time Polhem possibly accepted Newton's doctrine of gravitation is not known to me. Perhaps he, like Swedenborg, received the doctrine itself but denied action at a distance?

Besides these purely physical speculations, Polhem was occupied, in his correspondence with the members of the Collegium Curiosorum, even with practical physical problems. With Harald and Johan Wallerius, of whom the first was a great lover of music and the musical director of the university, he exchanges thoughts about music and the influence of temperature upon the clavier.<sup>1</sup> A greater musical work is also extant, "Concerning the Musical Staff," probably composed in the autumn of 1710 or early in the spring of 1711. In this Polhem invented a new theory for the division of the twelve intervals of the octave, "so that all the semitones are alike; all the whole tones, thirds, fourths, and fifths, etc., would be alike, and thus an octave would be divided into three complete thirds." Harald Wallerius showed the absurdity of this equal division, and some years later Johan Cahman, "the reformer of organ-building in Sweden," came to the same result.<sup>2</sup>

With Benzelius, Polhem exchanged letters about a new method to measure the speed of light and about other experiments in physics; with J. Wallerius concerning different kinds of motions and their laws.

With these physico-mechanical expositions of Polhem his cosmological ponderings stand in the closest connection. But since these have as yet been examined not at all,<sup>3</sup> I dare enter into them only to a little extent. Only so much can be said, that in this matter, as in much else, Polhem was a predecessor to Swedenborg, who, from him, received the initiament of many of his theories. Would not Polhem's cosmological thoughts and essays deserve to be drawn into the light as well as Swedenborg's?

<sup>1</sup> Undated letter to H. Wallerius, probably from the close of 1710. Letter to J. Wallerius, March 6, 1711.

<sup>2</sup> Codex no. 12, Library of the Diocese of Linköping. Contains also Wallerius' notes and Cahman's letter of April 15, 1732, to Benzelius.

<sup>3</sup> The only one to my knowledge who has touched on Polhem's views of natural philosophy, is the President of the Chancery Department, Fredrik Wilhelm von Ehrenheim, in his "Essays in General Physics"; D. 1 (1822), pp. 226-227. (S.E.B.)

When one sees the following purely modern statement, it is almost as if one heard a sougning of the hypothesis of the "evolution of worlds." Polhem wrote to Benzelius on the 19th of November, 1710, as follows: "If I dared to express my own thought, it should not appear unlikely that the earth was first a sun, and then, after many hundreds of thousands of years, gradually became what she is; for, from eternity allows enough time and space, although everything goes slowly from our point of view. When we regard the four infinities of time and space, the center and concept of which is God Himself, we find Him very much greater as to His essence than simple people can have any idea of." That the earth did not have its present form and appearance at its origin was clear to Polhem; but he assumed that mountains originated through earthquakes. For proof he cited, among other things, that in Switzerland he had seen two mountains far from each other, the configuration of which clearly showed that they had once been joined together. And the sedimentary slate in the mountains in Hartz, which corresponds on either side of the valleys, proved also that these mountains arose through earthquake; "yes, the slate itself arises under water on the sea bottom by the clay falling into the turbid water, and this is so much the more conclusive, as is shown by the enclosed forms and figures of fishes, with many other things which are too lengthy to recount and besides are likely known."

Polhem regarded earthquakes to have been caused by a "causal subterranean operation of the four elements, fire, air, water and earth." The globe of the earth consisted inmosty of fire—the so-called central fire—then of a vault of pumice about fifty miles thick,<sup>4</sup> and then of an equally great layer of water, earth, and various kinds of rock; in this great cavities occurred, filled with air heated from the central fire. "Now, since these caverns continually labor to augment themselves because of the inflowing and expulsion (*afstagande*) of sulphur, salt, and other minerals, which continues until an opening is produced for water to flow in when the enclosed air must be expelled in proportion as water flows in; but since the expulsion is not so easy, it meets with obstacles in other places higher up, either in the earth itself, or else in some cavities most highly compressed, until it finally receives a pressure (*luft*) sufficient to expel itself. As it so happens the earth is then not still more solid, an earthquake occurs."

<sup>4</sup> A Swedish mile is about 10 Km, or 6.64 English miles. (H.L.O.)

Polhem develops his view about the origin of the earth more fully in a letter to Benzelius dated November 26, 1710,<sup>5</sup> in which he at the same time proposes some "Rules for making gold according to a mechanical demonstration." In this letter he says, among other things: "It seems from all circumstances that the earth and the planets have had their origin in this manner, that they first passed for suns but after long ages have imbibed so much *materia fixa* from other perished planets that a crust developed about them, over which first air, and later water, began to increase." After the water has become so deep that it, through its weight, has compressed the liquid mass into a solid form, the first coagulation occurred in localities where the crust was thinnest. And when matter increased still more, it began to push up in some places at which a number of concavities were formed at the same time, through the cold water which streamed thither and the warm water which streamed forth. Thereupon "steam began to rise like a fermenting dough, now rising up into high mountains, now sinking into deep valleys." The nethermost mountain crusts, in process of time, were crushed asunder, and through the great movement were turned into "round boulders, sand, etc., by wearing against each other."

It does not behoove me to place this explanation of Polhem's, as to the formation of the world, into its right place among cosmogonic ideas, in the absence of theories about it; but I feel that I cannot omit, for the sake of his memory, to cite from the work of a well-known Swedenborg student<sup>6</sup> some lines about the fundamentals of Swedenborg's cosmology, according to the *Principia*, which is regarded as Swedenborg's epoch-making work. "These incipient suns come into a whirling motion and exert a strong pressure upon the surrounding sphere of 'finites'; thus are formed the first elementaries and some higher degrees of substances. The sun at last becomes covered by a crust consisting of fourth finites, and because the crust is crowded together upon the equator of the sun (caused by the increasing gyration of the sun) the crust then breaks into greater and smaller masses, which sail away from the

<sup>5</sup> Also: "Förklaring på det förra bihanget," by Benzelius, considers this to refer to the letter of Nov. 26; but it may possibly refer to that of Sept., 1712.

<sup>6</sup> Stroh, *Grunddragen af Swedenborgs lif*, 1908, p. 50-51.

sun and form planets <sup>7</sup> and moons. Finally, after the lower degrees of matter are formed, air, water, salt, metals, and soil, are created; and at last are created planets, animals, and man. The creative power in nature is God, and the means is motion." Surely this is the same theory, although it has been developed and been made more profound by the pupil.

In another kindred subject Swedenborg also builds upon Polhem. The latter says, in a posthumous work "Concerning Animal Spirits," <sup>8</sup> that "not only man's body but even also brute creatures, yea, everything growing upon the ground, are full of an infinite lot of small living particles or grains, the figure and size of which cannot be described, unless one gives them the bare name of motion, and that in such a manner and order as their space and habit have brought about." This infinite motion could, however, be nothing except God Himself. As later Swedenborg, so also Polhem divided the particles into six different kinds which he (Polhem) called: elementary, vital, vegetative; and three mineral: salt, sulphur, and mercury, "of which all terrestrial bodies are composed." <sup>9</sup> These animal spirits Polhem regarded ("through human reason and mechanical principles") to have had their origin from the bottom of the sea and the central fire "which produce all fixed matter, yea, life and living." <sup>10</sup> The figure of the particles he supposes to have been round, since this is "most convenient for motion." In the work "on Habit and Nature," <sup>11</sup> where he first presented the theory, he develops this thought more fully, and speaks about the different position, figure, weight, and motion of the particles in air, water, and other "terrestrial matter." Both these works were written in the autumn of 1710, while Swedenborg's *Prodromus Principiorum*,

<sup>7</sup> Polhem once mentions seven planets (cf. Bring, p. 95) and Swedenborg uses the same number in his diagram in the *Principia* and in his poetical description of creation in WL.G. See also NEW CHURCH LIFE, 1946, p. 153. (H.L.O.)

<sup>8</sup> Manuscript: *Filosofi*. Royal Library. "Animal spirits," it says in another place, "is the name for the infinitely small lives which are in nature, without which no life and living could exist in beast and cattle, yea, not in plants and trees."

<sup>9</sup> Discourse concerning the form and figure of spaces and on matter in general. Manuscript in rescript. *Teknologi*. R.L.

<sup>10</sup> Letter to Benzelius, dated December 17, 1710.

<sup>11</sup> Manuscript in copy. *Teknologi*. Roy. Lib. Compare letter to Benzelius dated December 31, 1710.

which treats of precisely the same subject, was not published until 1721.<sup>12</sup>

In another work, "Thoughts about the Essence of Spirits,"<sup>13</sup> Polhem accounts for the influence of motion on the senses, thoughts, and cerebral activity of man. To explain sympathy and antipathy and many other things in nature, which otherwise might be regarded as supernatural, would be extremely difficult, "so far as one did not accept as a premise this principle, that thought, as well as the outward senses, possesses its respective matter." And even as waves of sound can penetrate through a wall and "sight through the hardest diamond," so nothing could hinder the free passage of thought. Therefore two good friends could also become aware of each other at a distance of many miles, especially children and parents, wife and husband, "so that when the one experienced some sorrow, anguish of death, yea, also, great joy, and at the same time thinks of his absent friend," the latter would notice it, yet without knowing whence it comes. Dreams, in fact, are nothing else than this fine thought-matter put into motion. That during sleep one does not dream continuously and the same thing, depends on the perceptions of the outward senses. Dreams about the misfortune and welfare of others are nothing else than the movement between them of the thought-matter.

Polhem's modern conception of the origin of the cosmos was, of course, diametrically opposed to the traditional idea as presented in the first book of Moses, which no one at that time dared or could question. But, like Newton, Polhem believed in a personal God, who had revealed Himself before man in creation. "To question the words of Moses, which were dictated by the Holy Spirit, does not behooe any Christian, still less to doubt the very words of Christ." The Mosaic theory of creation ought, however, not to be taken literally, but rather as a parable. "That the earth was created from nothing is in so far correct as one generally says that the air is nothing, and still more that which is subtler, to wit, something which our gross sense cannot observe; but in reference to God Himself it was certainly at least infinite matter, which He then made into a finite (*finitum*)." Contrary to the biblical concept, he propounded several critical observations. Since light

<sup>12</sup> Stroh, *op. cit.*, p. 45.

<sup>13</sup> Manuscript. *Filosofi*. Royal Library.

existed before the sun shone in the sky, the sun and the fixed stars must at least have existed beforehand. Likewise it would be difficult to conceive how days and nights could have existed before the sun and moon were created.<sup>14</sup> "For it is to be noted," he writes in an earlier letter of November 6th, "that the whole of nature hangs together like the links in one chain, so that none can do without the other if anything shall be produced."

Perhaps Moses had meant with his story only "the origin of his own people, and had taken a little region for the whole world, as also occurred in the time of the apostles. Besides, one cannot notice in any place that anyone at that time had the knowledge of geography or of the character of the world beyond his own boundaries. If God created everything good, the question comes, whence come the many worthless things, like mountains, bogs, morasses, etc., unless through the alteration of the earth?—for instance, various kinds of useless worms and animals, plants, and so on." Naturally there was some meaning in the Mosaic story of creation. This, according to Polhem's view, had been composed in order that men might know: "1) Who their God was. 2) His omnipotence. 3) Their origin from Him. 4) How highly He loved obedience and docility. 5) The punishments that were caused by disobedience." On this account the history should "be held in high valuation as an article of faith," since it was easily comprehensible to the people and was effective of more than what "the most could otherwise accomplish with their elaborate eloquence." Men would have found it difficult to believe in a God if they did not have at least a history concerning Him. "On this account it is best to preach to the peasants that God has ears and eyes through which He hears and sees their evil doings, and that there is a hell burning with sulphur by which He punishes; for the kingdom of heaven they are less concerned about." It would have been of very great interest to see how Benzelius viewed these heretical propositions and expositions. So far as is known to me, no direct reply is extant, nor are there any marginal annotations made by Benzelius on the copies of these letters of Polhem. The learned librarian (Benzelius) was indeed a pioneer within the spiritual Kultur of Sweden, but he was not so far ahead of his time that he had freed himself from the spiritual points of view of his age. His theological point of view was, on the contrary, at

<sup>14</sup> Letters to Benzelius, November 19 and 26, 1710.

least since he became bishop, marked by a fixed and definite orthodox conception. It is therefore likely that he could have done nothing else than to regard Polhem's pronouncements as heresy and as scorn of the authority of the Bible. And if Polhem had openly declared his doctrines, the authorities would certainly have laid upon him a severely punishing hand. Therefore he also begs Benzelius that "these and other such discourses may not go forth in Swedish among simple folk, although the essence of God is hidden from us in many more respects." And as an apology for his daring opinions, he concludes the letter with a request for pardon for his free speech. "Great reverence and praise of God has therefore not decreased with me, but on the contrary has assumed a higher value in as far as His miraculous work can never fully be searched out; although I have steeped my brain in the subject."

Polhem, however, seems again to have expounded his critical views of the Bible, for in November, 1712, he writes to Benzelius: "That the last *materia* did not prove particularly pleasing I am not surprised at, especially since it had indeed been sketched out in haste and with too coarse a brush, as also *ultra crepidam*.<sup>15</sup> But I shall be delighted to accommodate myself to your pleasure and enjoyment, Mr. Librarian." He cites as the cause of his procedure that he has noticed a great many young priests to have been so ignorant in such things "that they make their pulpit a joke before the peasants by such discourses, and by such behavior outside of the same," which must necessarily lead to "barbarism." Instead, the physico-mathematical science should be, like all other sciences, a firm support for "the whole structure of religion," and first of all for the history of creation which is "valuable as the foundation to everything." Polhem now declares that his first explanation truly had been somewhat clumsy, but that "there is not the least conflict between the words of Moses and the properties of nature, if only one may permit some reasonable rules, without which men would be like the dumb beasts, which is not required by this history." It is possible that Polhem's little essay concerning "The History of Creation according to Natural Modes," which Benzelius refers to the time preceding this letter, was, instead, a consequence of it, since Polhem in this essay has considerably modified his former views in the direction of fidelity to the Bible. However this may be, he declares that, by reason of the spirit within

<sup>15</sup> "Ne sutor supra (ultra) crepidam," i.e., "Shoemaker, stick to your last."

two questions propounded by Benzelius, he would take them to heart and no further engage himself in any Biblical criticism.

In another purely theological question, however, he sided wholly<sup>16</sup> with Benzelius. The German religious fanatic, Johan Conrad Dippel, was visiting in Stockholm for some years in the 1720's, and published there his doctrines, which were constituted of a mixture of pietism, mysticism and astrology. On the part of the Swedish priesthood a violent polemic was directed against "Dippelianism," and Benzelius, at the Diet of 1728, was one of those who most actively contributed to his expulsion from Sweden. Polhem, indeed, did not openly partake in the contest, but he left two essays on the subject: "Thoughts concerning the Philosophy of Dippel," and "Spectacles for Mr. Dippel" (the latter incomplete).<sup>17</sup> In these essays he takes sharp issue with Dippel's point of view and doctrines, and therewith lists the differences between worldly wisdom and spiritual wisdom (philosophy and theology) as follows: "that the former contains three kinds of knowledge, namely, mathematical, physical, and moral; so also the latter contains likewise three kinds of knowledge, namely, revelation, miracles, and the will of God according to which people ought to live." The difference between philosophy and theology he gives in another passage,<sup>18</sup> as follows: "As soon as philosophy stops reasoning about everything, but simply believes what theology tells, then it is not philosophy, but a pure theology, the difference in which consists in this, that the one requires childlike faith, and the other reason and experience; as, for instance, when one shall believe that the iron floats, then it is theology; but if one says that it sinks, then it is philosophy." The propositions of Dippel might indeed "come under consideration among farmers and common laboring folk, but never with any learned man of sound reason. For how extravagant and absurd is it not in this age to cast such reflections upon the old Aristotelian philosophy, that the new philosophy should thus be despised." That he has gained so great a following was due to the fact that he founded his doctrines upon "spooks and occult qualities" and not upon the fundamental experiments of mathematics and mechanics. "Truly," writes Pol-

<sup>16</sup> See SD 5962, 3485, 3486, and NEW CHURCH LIFE, 1911, pp. 654-662.

<sup>17</sup> Manuscript. *Filosofi*. Royal Library.

<sup>18</sup> Thoughts concerning the Origin of the World. Manuscript. *Filosofi*. Royal Library.

hem in 'Thoughts concerning the Philosophy of Dippel,' "if I were as learned and practiced in eloquence as Dippel, and had as little shame as he of bespotting learned and honest men, I would so besmear him as he besmears others; but now I rejoice that fate has deprived me of such a talent."

In the already cited collection of letters from Polhem to members of the Collegium Curiosorum, there are only a few from the year 1711, and these refer vaguely to the activity or work in this society of research. But from the preserved minutes, recently edited,<sup>19</sup> one may discover a number of tasks which prove Polhem's importance, even for the sessions of 1711. At the sessions in January the discussions chiefly revolved about a large work from his pen bearing the title: "General Domestic Construction, Moveable as for instance Mills, as well as fixed like that of Houses; with Mathematical, Mechanical, and Physical Notes, Rules, and Proportions; collected and published by the Collegium Curiosorum of Upsala, for use and service to our Dear Fatherland."<sup>20</sup> Observations concerning it were made by the members, which perhaps may seem to us somewhat peculiar, for instance; "Whether it were better to cut out the walls for the stoves or not; the latter seems better but somewhat more dangerous on account of fire," or, "Under what condition one can and ought to use stoves which have their opening in one room but the chimney pipe in another"; "What use one may make of balconies." But it testifies unquestionably of a more practical view, when it is pointed out in one note, that in pile-work it is of value to know the soil, whether it be clay, moor, or bog, even as another of Polhem's "building notes" brought forth an observation of the value of the English custom of polishing and grinding the tile which was placed about doors and windows, "which makes for a beautiful distinction from the rest and a proper appearance." Undoubtedly Polhem originated the reflections concerning barley, malt, and brewing, which were topics of discussion on the 10th of April.

At this meeting also was read Polhem's program for a scientific expedition to Lappland.<sup>21</sup> This was left for the examination of

<sup>19</sup> The Bicentennial Publication of the Royal Academy of Sciences in Upsala. 1910, pp. 57-67, compare pp. 15-17.

<sup>20</sup> Codex E. 3. Library of the Diocese of Linköping.

<sup>21</sup> "List of Some Experiments which need to be performed in the Mountains and Valleys of Lappland." Dated Stjarnsund, April 15 (1), 1711.

Lars Roberg, professor of anatomy and practical medicine, who was also a member of the Collegium Curiosorum; and it was discussed at the meeting of May 8th. This program was very comprehensive and took up twenty different points in all. First and foremostly one should make a lot of physical observations and mensurations upon the highest mountaintops and in the valleys to discover the height of the atmosphere, the resistance and weight of the air by means of pendula and a cannon-ball; the speed of sound waves, "what time elapses between the firing of a gun and the report at the longest known distance; as well as what difference of time occurs when the sound of the shot is heard from a height, and contrariwise from a depth"; the difference of effectiveness of powder in high and low terrain; whether the sun seems bigger than usual in clear weather when the barometer is high. Further, it was planned to make a computation of latitude and longitude (Sw. *gradmätning*) at as high a degree of latitude as possible, and compare the results with those received from France in order to discover whether the surface of the earth nearer to the pole has the same proportion. Besides these undertakings, the expedition should take account of all plants and animals living on the highest mountains, and bring home samples of the former to submit them to chemical analysis as to "what they may contain of salt and sulphur," and institute an examination of what charcoal might be the best.

In the program that was composed, various alterations were made by members of the Collegium Curiosorum. Some points were omitted, others were enlarged. At least some observations were carried out according to Polhem's program by the expedition which departed for Lappland in 1711, and in which, among others, Henric, the younger brother of Benzelius, participated.<sup>22</sup>

At the June meeting were read some essays by Polhem on *Motu et Resistentia Mediorum*, about projectiles and curves, about the vibrations of pendula and the resistance of the air, about equal speed in rising and falling.<sup>23</sup>

*Codex Bf 31.* Library of the Diocese of Linköping. In Latin in *Acta Literaria*, 1 (1720-24), pp. 285-289.

<sup>22</sup> Bicentennial Publication of the Royal Academy of Sciences in Upsala. 1910, p. 16.

<sup>23</sup> The first of these essays may be found in Codex N. 13. Library of the Diocese of Linköping.

(To be concluded)