



Joan Baptista van Helmont

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JOAN BAPTISTA VAN HELMONT.

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Life and Character.

JOAN BAPTISTA VAN HELMONT was born in Brussels in 1577¹ or 1580², and died 30 December, 1644, either in Brussels or Vilvorde (near Brussels). He was descended from a noble and ancient family: his mother was Marie de Stassert, and he belonged to the family of Mérode through his wife, Margaret Van Ranst. His father died in 1580, and Joan Baptista was the youngest child.

He studied arts at Louvain until 1594 but took no degree, since he considered academic honours a mere vanity. He then went to the Jesuits' School at Louvain, recently founded in spite of the prohibition of the King, the University and Pope Clement VIII, where he studied the Qabbalah under Martin Del Rio, who expounded his celebrated *Disquisitiones magicarum*³. Still dissatisfied, van Helmont turned to the mystics, and studied the works of Thomas à Kempis (1379–1471) and Johann Tauler (1290–1361), both of whom wrote "On the Imitation of Jesus Christ". He then took up medicine and read the works of Hippocrates, Galen, Avicenna and a great number of modern authors, from which he says he "noted all that seemed certain and incontrovertible but was dismayed on reading my notes to find that the pains I had bestowed and the years I had spent were altogether fruitless"⁴.

¹ His own statement: *Ortus medicinae*, Amsterdam, 1652, p. 14.

² 12 Jan. 1579 (Old Style), 1580 (New Style); birth register of St. Gudula, Brussels, quoted by A. J. J. Vandeveldt, "Helmontiana, I–III", *Koninklijke Vlaamsche Academie voor Taal-en Letterkunde, Verslagen en Mededeelingen*, 1929, 453, 716.

³ Louvain, 1599.

⁴ Van Helmont, *Ortus medicinae*, 1652, p. 14 f.: *Studia Authoris*,

He says he gave away to students books worth 200 crowns but wished afterwards that he had burnt them ⁵. He had visions, in one of which he saw his own soul in the form of a resplendent crystal ⁶, and he regarded all science and wisdom as a gift of God ⁷. He took the degree of M.D. at Louvain in 1609 ⁸ after ten years of study and travel, in which he visited the Alps, Switzerland, Italy, Spain, France and England (1604–5) ⁹.

D'Elmotte says he was admitted to the Rosicrucian order in Bavaria, but gives no authority ¹⁰. Among other lucrative offers he declined one from the Emperor Rudolph II at Vienna. In 1609 he married Margaret Van Ranst, and he says: "God has given me a pious and noble wife. I retired with her to Vilvorde and there for seven years I dedicated myself to pyrotechny [*i. e.*, Chemistry] and to the relief of the poor" ¹¹. Boerhaave ¹² says he was told that Helmont was "wholly taken up in chemical operations night and day" and that "he was scarce known in his neighbourhood; that he did not apply himself to practice; nor scarce ever stirr'd out of doors". He was a very influential and highly respected man, with a great reputation, although Boyle ¹³, who constantly quotes Helmont as an authority, remarks that he was "an author more considerable for his experiments than many learned men are pleased to think him". Helmont's harsh although deserved criticism of the conventional medicine of his time made him many enemies and retarded the general acceptance of his views.

Van Helmont was proud of his claim to be called a chemist, and calls himself (*e. g.*, in the introduction to his *De lithiasi*) "Philosophus per ignem". He represents the transition from alchemy to chemistry. Van Helmont made a careful study of the chemical as well as the medical writings of Paracelsus (which he later found full of errors) and carried out a large number of chemical experiments in his house at Vilvorde. He loved his apparatus, and tells us of a beautiful receiver which he thought he had spoiled through neglect: a vessel "exceeding great, clear, Crystalline and precious . . . easily capable of containing three Gallons . . . I sequestred from the long snout of an Alembick", and

⁵ *Ib.*, p. 837.

⁶ *Ib.*, p. 565: *Imago Dei*.

⁷ *Ib.*, p. 8, *Promissa Authoris*.

⁸ *Ib.*, p. 11.

⁹ *Astra necessitant*, § 48; *Ignotus hydrops*, § 11; *De lithiasi*, cap. 2: *Ortus*, 1652, pp. 103, 408, 667.

¹⁰ W. Rommelaere, "Etudes sur J. B. van Helmont", *Mémoires des concours et des savants étrangers publ. par l'Académie Royale de Médecine de Belgique*, Brussels, 1866, 6, 281–541; 301.

¹¹ *Tumulus Pestis: Ortus*, 1652, p. 835.

¹² *New Method of Chemistry*, transl. Shaw and Chambers, 4°, London, 1727, p. 31 f.

¹³ *Sceptical Chymist*, 1680, p. 112.

“ was grieved that a Glass so precious was stained about so sordid a matter ”. The stain put him in train of an important truth, and was easily removed by acid, so that “ those things which I judged I had committed through my own carelessness I knew had come to pass by divine Goodnesse so disposing it ”¹⁴.

Autobiographical details and a notice by his son Francis Mercurius are given in Helmont's works¹⁵, and there are several studies of his life and works¹⁶.

With their wide scope, critical attitude, varied interests, and intimate blending of the practical and mystical, the writings of van Helmont as printed convey the impression of a complex personality and, in fact, all shades of opinion are represented in the various appreciations of their author. I shall permit myself to give an independent opinion on those

¹⁴ Van Helmont, *Oriatrike, or Physick Refined*, London, 1662, p. 847.

¹⁵ *Ortus medicinæ*, 1652, *Præfatio*; *Studia authoris*, p. 14 f.; *Tumulus pestis*, p. 834.

¹⁶ Boerhaave, *New Method of Chemistry*, trans. by Shaw and Chambers, 1727, p. 30 f.; N. F. J. Eloy, *Dictionnaire historique de la médecine ancienne et moderne*, 2 vols., Liège, 1755, ii, p. 20; *ib.*, 4 vols., 4°, Mons, 1778, ii, p. 478; Wiegleb, *Geschichte der Chemie*, 1792, p. 200—very unfavourable; Sprengel, *Histoire de la médecine*, Paris, 1815, v, p. 22 f.; Gmelin, *Geschichte der Chemie*, Göttingen, 1797, i, pp. 524–55, summary of chemical contributions; *P. d'Elmotte, *Essai philosophique et critique sur . . . van Helmont*, Brussels, 1817; J. E. Dezeimeris, *Dictionnaire historique de la médecine ancienne et moderne*, 4 vols., Paris, 1828–39, iii (1836), p. 99; J. J. Loos, *J. B. van Helmont*, 12°, Heidelberg, 1807; *H. Masson, *Essai sur la vie et les ouvrages de van Helmont*, Brussels, 1857; T. A. Rixner and T. Siber, *Leben und Lehrmeinungen berühmter Physiker am Ende des XVI und am Anfange des XVII Jahrhunderts, als Beyträge zur Geschichte der Physiologie*, 7 vols., Sulzbach, 1826, vii (Helmont); J. A. Mandon, “J. B. van Helmont, sa Biographie, Histoire critique de ses œuvres, etc.”, *Mémoires des concours et des savants étrangers publ. par l'Académie Royale de Médecine de Belgique*, Brussels, 1866, 6, 553–739; P. A. Cap, “Notice biographique sur J. B. van Helmont”, *Journal de Pharmacie*, Antwerp, 1852, 8, 265, 319; Melsens, “Note historique sur J. B. van Helmont à propos de la définition et de la théorie de la flamme,” *Mém. couronnés et autres mémoires publ. par l'Acad. Roy.*, 8°, Brussels, 1875, 24, 1 f.—omits to mention Aristotle and Albertus Magnus; *Nouvelle Biographie Universelle* (NBU), xxiii, p. 853, and bibliography; British Museum MS. Sloane 617, ff. 142–151, life by F. M. van Helmont; some treatises by the latter, translated by Dr. D. Foote, are in Sloane 530 (Alchemical Enquiries) and Sloane 3984, ff. 151–2 (Chymical Processes); R. O. Moon, *Proc. Roy. Soc. Med.*, 1931, Sect. Hist. of Med., 25, 23; F. Strunz, *J. B. van Helmont*, Leipzig and Vienna, 1907; H. S. and M. L. Redgrove, *J. B. van Helmont*, 1922; Walden, “Von Iatrochemie zur organischen Chemie”, *Z. angew. Chem.*, 1927, 40, 1; Delacré, “Le rôle de Van Helmont dans l'histoire des sciences”, *Rev. gén. des Sciences*, 1924, 35, 703; Prescott, *Archiv für Geschichte der Mathematik, der Naturwissenschaften und der Technik*, Leipzig, 1929, 12, 70 f.; W. Pagel, “Helmont, Leibnitz, Stahl”, *Archiv für Geschichte der Medizin*, Leipzig, 1931, 24, 19–59; *ib.*, *Jo. Bapt. van Helmont, Einführung in die philosophische Medizin des Barock*, Berlin, 1930; G. de Mengel, *J. Alchemical Soc.*, 1913, 1, 49; Sir M. Foster, *Lectures on the History of Physiology*, Cambridge, 1901, p. 128 f.; Bibliography of essays on the life and works of Helmont in **Gazette médicale de Paris*, 1868, 457; *J. M. Caillaud, *Mémoire sur Jean Baptiste van Helmont et ses écrits*, Bordeaux, 1819; *F. Giesecke, *Die Mystik Joh. Bapt. van Helmont*, Dissert. Erlangen, 1908, Starred references I have been unable to see,

parts of his writings which are of chemical interest. Some parts of van Helmont's works show the credulity we should expect in his time. He tells a story of a church tower at Leyden having been struck by lightning in 1554 and disappearing entirely into the ground, where it was afterwards found complete by digging¹⁷; he asserts that he and many others were cured of diseases by taking oil into which a stone had been dipped by an Irishman, Butler, imprisoned at Vilvorde¹⁸; and he gives a very circumstantial account of the transmutation of nearly 2000 times its weight of mercury into gold by means of a quarter of a grain of the philosopher's stone given him by a stranger¹⁹. This was a heavy red powder glittering like powdered glass and smelling of saffron; it was enclosed in wax and projected on the mercury heated to the melting-point of lead, when the metal grew thick and, on raising the fire, melted into pure gold. Helmont did not believe that the philosopher's stone was also the elixir of life, as Paracelsus assumed. He gives directions for preparing a powerful elixir by dissolving cedar wood in the alkahest and distilling off an oil, of which a drop given in wine cures serious illnesses in a few hours²⁰. He says that by means of the alkahest of Paracelsus he had converted vegetables or oak charcoal into water²¹. He calls the alkahest *ignis aqua*, and it was probably nitric acid. In some of the examples which he gives of converting bodies into water, he neutralizes acids with chalk and distills off water. Schmieder²² gives a derivation of the name alkahest from $al + \kappa\alpha\nu\sigma\tau\acute{\eta}\varsigma$, a Greek-Arabic word. J. le Pelletier²³ after a long dissertation on the nature of the alkahest, and extracts from Ripley, Philalethes and Starkey, leaves the matter where he found it. The idea probably came originally from the water of Styx, which could be kept only in an ass's hoof, whereas the alkahest should dissolve any vessel in which it is put and gradually bore its way to the centre of the earth, so that Kunckel²⁴ said the name should be "Alles Lügen est"²⁵.

¹⁷ *Meteoron Anomalum, Ortus*, 1652, p. 74.

¹⁸ *Butler, Ortus*, 1652, p. 466; on Butler see Lenglet du Fresnoy, *Histoire de la philosophie hermetique*, Paris, 1742, i, p. 398.

¹⁹ *Demonstratur thesis*, § 58; *Vita æterna*; *Arbor vitæ*; *Ortus*, 1652, pp. 534, 590, 630.

²⁰ *Arbor vitæ*; *Ortus*, 1652, p. 633.

²¹ *Complexionum atque misionum*, § 29; *Ignota actio regiminis*, § 11; *Arbor vitæ*; *Ortus*, 1652, pp. 88, 265, 635.

²² *Geschichte der Alchemie*, Halle, 1832, p. 86.

²³ *L'Alkaest ou le dissolvant universel de van Helmont. Revelé dans plusieurs Traitez qui en découvrent le Secret*, Rouen, 1704; cf. Kopp, *Geschichte der Chemie*, ii, p. 241.

²⁴ *Laboratorium Chymicum*, Hamburg and Leipzig, 1716, p. 506.

²⁵ O. Tachenius, **Epistola de famoso liquore Alkaest*, 4°, Venice 1655; *ib.*, *Echo ad Vindicias Chirosophi. In que de liquore Alcæist, Paracelsi et Helmontij Veterum vestigia perquiruntur*, 4°, Venice, 1656; Boerhaave, *New Method of Chemistry*, transl. by Shaw and Chambers, 4°, London, 1727, p. 362.

An unknown contemporary says Helmont was pious, learned and famous. He was called usually to patients who were abandoned by other physicians as incurable, and they were never long in his hands, since on the second or third day they were either dead or cured ²⁶.

Van Helmont believed in spontaneous generation: he asserts that full-grown mice are produced in three weeks from wheat in a glass stopped with dirty linen, and that scorpions are formed from the herb basil crushed in a cavity between two bricks, but he also gives some good observations in natural history which seemed to support the theory ²⁷, which was accepted as late as last century.

He made extensive use of sympathetic remedies and the usual "Dreckapotheke" of his period, prescribing the most disgusting remedies even for his own illnesses ²⁸. His remedy from toads (Zenexton) ²⁹ was used as an amulet against plague ³⁰. He taught that plants are produced from a primordial juice called Leffas, and metals and minerals are generated in the earth from a whitish-green paste (*Saponis liquidi*) called Bur ³¹.

Cap ³² regarded Helmont as much superior to Paracelsus in learning, patience and logic, and above all in the nobility and elevation of his character, and Moon ³³ gives an expert appreciation of his medical views: "fanciful explanations in medicine, as in other things, are often stimulating and fertilizing and are perhaps better than none at all". In chemistry van Helmont was certainly very considerably superior to Paracelsus, both in theory and experiment. Thomson ³⁴ says that Helmont, "notwithstanding his attachment to the fanatical opinions" of his time, overturned "a vast number of errors, both theoretical and practical". Although he "has been frequently placed on the same level with Paracelsus, and treated like him with contempt", his merits were very much greater: "his erudition was great, his understanding excellent, and his industry indefatigable" ³⁴. The recent attempts to prove the great dependence of Helmont on Paracelsus have gone too far, and are

²⁶ Rixner and Siber, *op. cit.*, vii, p. 243.

²⁷ *Imago Fermenti*, § 9; *Demonstratur thesis*, § 97 f.; *Ortus*, 1652, pp. 92, 542 f.

²⁸ E. g., *Pleura furens*, § 35; *Ortus*, 1652, p. 322; *sumsi cervi genitale carptum . . . mox bibi drachmam cruoris hircini*.

²⁹ *Tumulus pestis*, *ib.*, p. 879; the name is due to Paracelsus.

³⁰ Cf. C. H. La Wall, *Four Thousand Years of Pharmacy*, 1927.

³¹ *Elementa*, § 13; *Magnum oportet*; *Ortus*, 1652, pp. 43, 127; Cap, *op. cit.*, thought Bur was synonymous with "affinity".

³² *Op. cit.*, p. 325.

³³ *Op. cit.*, p. 28.

³⁴ *History of Chemistry*, i, p. 192.

often too vaguely expressed³⁵. Delacre³⁶ more correctly emphasizes the great change in philosophic outlook between Paracelsus and Helmont. Helmont thought³⁷ young men should be taught in their three and seven years in the universities, not the pagan philosophy of Aristotle, but Mathematics, Geography, Political Economy, Natural History and Mineralogy, and especially practical Chemistry—"to know and separate the first principles of bodies . . . their fixedness, volatility, separation, life, death, transformations, alteration, weakness, corruption, transplanting, solution, coagulation, resolution and new operations . . . not by naked discourse but by handicraft demonstration of the fire . . . by distilling, moistening, drying, calcining, resolving, as Nature works".

He wrote a treatise³⁸ on the therapeutic properties of animal magnetism which he published only after being urged to do so by Jesuits. This at once brought him in contact with the Inquisition, which considered his case for thirteen years. He was a good Catholic, and offered to have the book burned if condemned. In 1634 he was sent to a Franciscan prison in Brussels, but after the intervention of powerful friends—including, it is said, Marie de Medici, he was released after a few weeks and confined to his own house, which he was not allowed to leave without a dispensation of the Archbishop of Malines. The gentle and pious Brotherhood was thus balked of a second Roger Bacon, but the treatment of van Helmont was by no means mild: when the plague broke out, his family refused to leave without him, and as a result two of his sons died. He appears to have been left alone by his persecutors after 1638. Some of his papers were confiscated and were unknown until they were found and published by C. Broeckx³⁹.

His *Supplementum de Spadanis fontibus* (on Spa water) in six chapters, published at Liège (Leodii) in 1624⁴⁰, criticized a work of Henri de Heer (or Heers), a Liège physician, published at Liège in 1614 (*Spadacrene, Hoc est Fons Spadanus*, 8°, Leodii, 1614; *Les Fontaines de Spa*, 8°, Liège, 1616) and made him some medical enemies. In 1642 he published

³⁵ *E. g.*, Pagel, *J. B. van Helmont*, 1930, p. 41: views of Helmont can be found in Paracelsus "in höchst sublimierter Form und als Niederschlag intuitiver Ganzheitsschau"; *ib.*, *A. Med.*, 1931, 34, 19 f.: Helmont's complex "Faust-like" personality was influenced by the Qabbalah and Campanella.

³⁶ *Rev. gén. des Sciences*, 1924, 34, 704.

³⁷ *Physica Aristotelis et Galeni ignara, Ortus*, 1652, p. 40.

³⁸ **De magnetica vulnerum naturalis et legitima curatione*, Paris, 1621, Liège, 1624; reprinted in *Ortus medicinæ*, Amsterdam, 1648, p. 746, and later editions.

³⁹ *Interrogatoires du docteur J. B. van Helmont sur le magnétisme animal*, Antwerp, 1856; *ib.*, *Documents pour servir à l'histoire de la bibliographie médicale Belge*, 1858; *ib.*, *Prodrome de l'histoire de la faculté de médecine de l'ancien Université de Louvain depuis son origine jusqu'à son suppression*, 1865; Rommelaire, *op. cit.*

⁴⁰ I have not seen the original issue: Hoefler says it was published at Cologne; Reprinted in *Ortus medicinæ*, 1648, p. 685 f.

his important work on fevers⁴¹, which was reprinted in 1644 with three new tracts, one on the stone (*De Lithiasi*), one on the plague (*De Peste*) and one criticising the theories of Galen (*De humoribus Galeni*), as *Opuscula medica inaudita*⁴².

Works.

Shortly before his death van Helmont gave his papers, which he had thought of burning, to his son Francis Mercurius (1614–1699), who had studied and practised medicine, but led an irregular life among gipsies⁴³, charging him to publish them all, even the crude and incorrect. The result was the work, containing parts previously published separately, entitled *Ortus medicinæ*, or the “Origins of Medicine”, dedicated to Jehova (“Verbo ineffabili”), the first edition of which appeared in 1648 and the last in 1707⁴⁴.

Boerhaave⁴⁵, who calls van Helmont “the greatest and most experienced of all the chemists that have yet appeared”, says the Venice and German editions contain “morsels not in the fashion of the author”, but it is a mistake to say that the later editions are very different from the first, of 1648. The English translation⁴⁶ is by John Chandler, of Merton Hall, Oxford.

⁴¹ *Febrium doctrina inaudita*, 12°, Antwerp, 1642; *French transl. by Bauda, 8°, Paris, 1653.

⁴² Cologne, 8°; reprinted as a supplement to *Ortus medicinæ*, 1648, and later editions; G. A. Mercklein, *Lindenius renovatus, sive J. A. van der Linden de scriptis medicis libri duo . . . continuati . . . et purgati*, 4°, Norimbergæ, 1686, p. 528; A. J. J. Vandeveld, “Helmontiana”, *Koninklijke Vlaamsche Academie voor Taal-en Letterkunde*, Ledeberg-Gent, 1929, 857.

⁴³ NBU, xxiii, p. 864; M. J. Nicolson, *Conway Letters*, 1930, pp. 84 f., 309 f.; Vandeveld, *op. cit.*

⁴⁴ *Ortus medicinæ, Id est, initia physicæ inaudita. Progressus medicinæ novus, in morborum ultionem, ad vitam longam. Authore Joanne Baptista van Helmont, Toparchä in Merode, Royenborch, Oorschot, Pellines, etc.*, 4°, Elzevir, Amsterdam, without index, 1648; 2 ed., fol., Venice, 1651, with index by Tachenius; 3 ed., 4°, Elzevir, Amsterdam, 1652, with index—this is usually considered the best edition, and all references are to it unless otherwise stated; later eds. are: fol., Lyons, 1655 and 1667; 4°, *Opera omnia additis de novo Tractatibus aliquot posthumis ejusdem Authoris . . . antehac non in lucem editis*, Francofurti, Sumptibus Johannis Justi Erythropili. Typis Johannis Phillippi Andreae, 1682; *ib.*, Francofurti, Apud Hier. Christ. Paulli, ex Bibliopolio Hafniense, 1707; these editions (all in my possession) appear to be the only ones ever published in Latin, those quoted by Ferguson, *Bibliotheca Chemica*, 1906, i, p. 381, being mostly imaginary.

⁴⁵ *New Method of Chemistry*, transl. by Shaw, 1741, p. 45; cf. T. L. Davis, *J. Chem. Educ.*, 1928, 5, 678.

⁴⁶ *Oriatrike or Physick Refined . . .*, 4°, London, 1662; reissued with new t.p. and prelim. matter as *Works, containing his most excellent Philosophy, Physick, Chirurgery, Anatomy . . .*, 1664, 2 vols.

The French translation⁴⁷ by Jean le Conte is incomplete; the German translation⁴⁸ is by Knorr von Rosenroth with the assistance of F. M. van Helmont: Rixner and Siber⁴⁹ say that the translator compared the Latin and Flemish texts, and his version is literal but obscure. Three treatises (*Of the magnetic cure of wounds*; *The nativity of tartar in wine*; and *The Image of God in man*) were translated by Walter Charleton (1619–1707; physician to Charles I) and published in 1650 as *A Ternary of Paradoxes*⁵⁰.

An interesting work of van Helmont's is that written in Flemish: *Dageraad oft Nieuwe Opkomst der Geneeskunst, in verborgen grondt-regelen der Natuere* ("Dawn of the revival of medicine and the concealed fundamental rules of nature"), *Nooyt in't licht gesien, en van den Autheur selve in't Nederduyts beschreven*⁵¹. The 1660 edition is sometimes called, incorrectly, a Dutch translation of the *Ortus medicinæ*. Rixner and Siber say the manuscript was given by van Helmont to his daughter, from whom it was obtained by a friend who had it printed. An edition of Leyden, 4°, 1615, has been reported. The first mention I have found is in Rixner and Siber⁵² with the title as *Dagereat ef the nieuwe Opkonst der Gennees-Konst in verborgen Grond-Regulen des Nature*, Leiden, 1615, 4°: they also mention (p. 27) an Antwerp edition of the Latin works which seems imaginary. Dezeimeris⁵³ quotes the title as above with a reference to Rixner and Siber. In the *Catalogue des livres* of Dezeimeris' library⁵⁴, the only work of van Helmont mentioned is the French translation of the *Ortus* by le Conte. Boerhaave⁵⁵ quotes an "Aurora medicinæ Belgice edita", but gives no date, hence he probably means the 1659 edition; the 1615 edition is also mentioned by Rommelaere⁵⁶ and Broeckx⁵⁷: none of these authors appears to have seen the book,

⁴⁷ *Oevvres . . . traittant des Principes de Medicin et Physique, pour la Guérison assurée des Maladies*, 4°, Lyon, 1670, and 1671.

⁴⁸ *Aufgang der Artzney-Kunst*, Sultzbach, fol., 1683.

⁴⁹ *Op. cit.*

⁵⁰ London, 4°, 144 pp., dedicated to Viscount Brouncker.

⁵¹ T'Amsterdam by Jan Jacobsz. Schipper, 4°, 1659, 404 pp.—the edition seen and quoted; *Tot Rotterdam by Joannes Narranus, 4°, 1660, also quoted by Vandeveldde, who says the two editions are identical except for spelling variants: the book is exceedingly rare.

⁵² 1826, vii, p. 25.

⁵³ *Dictionnaire hist. de la méd.*, 1836, iii, p. 101.

⁵⁴ Paris, 1852.

⁵⁵ *Elementa Chemiæ*, Leyden, 1732, ii, p. 527.

⁵⁶ *Op. cit.*, pp. 307, 327; also by A. Le Roy, *Biographie Nationale de Belgique*, 1880–83, vii, p. 919: "il est assez curieux de noter que celle de Rotterdam (1660) présente le livre comme inédit"; also by Strunz, 1907, p. 5.

⁵⁷ *Essai sur l'histoire de la médecine Belge avant le XIX siècle*, Antwerp, 1837, p. 85 f.

which probably does not exist⁵⁸ since no one claims to have seen a copy.

The title-page of the German translation of the *Ortus medicinæ* states that the text is completed from the Flemish edition ("mit Beyfügung dessen was in der Ersten auf Niederländisch gedruckten Edition, genant Die Morgen-Röthe, mehr, oder auch anders, als in der Lateinischen")⁵⁹. The *Dageraed* contains fundamental ideas which are expanded in the *Ortus medicinæ*, including the criticism of Galenical medicine, and the ideas of *gas* and *blas* but not the important treatise *Complexionum atque mistionum elementalium*, etc. The Flemish text is said by Rommelaere to be clearer than the Latin in the *Ortus medicinæ*, but it is less detailed. The editions of 1659 and 1660 contain, in the second part, treatises on the plague which were probably written late in the author's life.

A list of some of the treatises contained in the 1659 and 1660 editions is given below. I have also indicated in the later discussions what is to be found on the subject in the *Dageraed* :—

1. Van tijdt, duringe, oft weringe, p. 1 ;
2. Van reden, en verstandt, p. 16 ;
3. Van de ziele, en beeldt Godts, p. 30 ;
4. D'oorsaecken der naturelijke dingen, p. 37 ;
5. Van den inwendigen werck-meester der saden [Archeus], p. 43 ;
6. Van verscheyde teeringen des lijfs, p. 48 ;
7. Wat tarter zy by Paracelso, p. 51 ;
8. Hoe alle zaet, by middel van eenigen heve, uytwerckt alle . . . afgemaelt wesen, p. 53 ;
9. Van de Elementen, p. 61 ;
10. Der Elementen en Meteorē rechte kennisse, p. 83 (including "Gas-maeckinge", p. 92) ;
11. Dat de leere van Blas en Gas tot nut streckt, p. 106 ;
12. Oorsaecken om den Tarter te vinden, p. 119 ;
13. Den grooten oporet . . . , p. 126 ;
14. Naerder bediet des middel-levens, p. 130 ;
15. De geboorte des Wijn-steens, p. 140 ;
16. Dat'er geenē tarter en is in onse Spijsen . . . , p. 144 ;
17. Tarter en is niet in den dranck, p. 156 ;

Van de drie eerste beginselen aller lichaemen, p. 164 (on the three principles) ; . . . De steenwordinge des bergh-wercks, p. 199 ; De winden der menschen, p. 206 (*De flatibus*) ; De steenwordinge in ons, p. 219 ; Oorsaecken van de duelech de Ouden van ons verscheyden, p. 238 ; Genesinge des duelechs, p. 253. The second part contains the treatises on plague (*De Pest*) in 19 parts, including Genesinge der pest, p. 376.

The Chemical Work of van Helmont.

An important feature of van Helmont's chemical work is its quantitative character : he made extensive use of the balance, expressed

⁵⁸ Delacre, *Revue gén. des sciences*, 1924, 35, 703 ; A. J. J. Vandevelde, "Helmontiana I-III", *Koninklijke Vlaamsche Academie voor Taal-en Letterkunde*, Ledeberg-Gent, 1929, 453, 715, 857, gives reasons why the book as it was published in 1659 could not have appeared in 1615, *e. g.*, dates after this occur in the text.

⁵⁹ From an actual copy.

clearly the law of indestructibility of matter, and emphasized that metals when dissolved in acids are not destroyed but can be recovered again by suitable means. He also realized that when one metal precipitates another from a solution of a salt, there is no transmutation as Paracelsus thought⁶⁰. Helmont says that Paracelsus taught that "although a metal is destroyed ten thousand times, it will always rise again more perfect by its destruction"⁶¹. When silver is dissolved in *aqua fortis* (*chrysulca*), it is not destroyed but is concealed in the clear liquid as salt is contained in a solution in water and can be recovered (*permanet tamen in pristina sui essentia*)⁶². When gold is distilled seven times with sal ammoniac, antimony and mercury sublimate, it is converted into a red oil, but this is easily reduced again into its former weight and body (*in pristinum auri pondus et corpus*)⁶³. Dissolved copper is precipitated by iron, which takes its place (*putatus est ferrum in æs mutare, delusionem scilicet viri metallarii vix agnoscentes; eo quod ferri absumit locum, æris succedentes atomi, explerent*), and copper similarly precipitates silver⁶⁴. Nothing is made of nothing, therefore weight is made of another body of equal weight in which there is only an apparent transmutation of the matter (*ut materiæ sit transmutatio*)⁶⁵. When mercury is boiled with oil of vitriol it forms a white precipitate like snow (*præcipitatus albus nivis instar*) which on washing with water turns yellow, and on revivification gives the same weight of mercury⁶⁶. He describes the preparation of blue vitriol by concentrating mine-water; by lixiviating roasted pyrites exposed to air; by throwing sulphur on melted copper and putting the mass (cuprous sulphide) in rain-water; and by boiling copper plates with oil of vitriol, when a black mass is obtained which is dissolved to a blue solution in water. Contrary to the statements of Isaac Hollandus, George Agricola and "other moderns" (*i. e.*, Paracelsus), copper vitriol yields little or no acid on distillation, but when common (iron) vitriol is distilled by a strong fire in a coated glass retort it yields

⁶⁰ Delacre, *Revue gén. des sciences*, 1924, 35, 704.

⁶¹ *Tria prima chymicorum principia*, § 59; *Ortus*, 1652, p. 331—"in vexatione præfata": the reference is probably to the vague statement: "destructio bonum perficit", in the preface to Paracelsus's *Cælum philosophorum sive liber vexationum*, *Opera*, Geneva, 1658, ii, p. 120.

⁶² *Terra*, § 14; *Progymnasma meteori*, § 17; *Ignota actio regiminis*, § 11; *De febribus*, cap. viii; *Ortus*, 1652, pp. 45, 57, 265, 765.

⁶³ *Progymnasma meteori*, § 6; *De lithiasi*, cap. iv, § 9, cap. viii, § 10; *Ortus*, 1652, pp. 55, 678, 706; *Dageraed*, 1659, p. 86.

⁶⁴ *Supplementum de Spadaniis fontibus, paradoxum tertium*, § 14, *paradoxum quintum*, § 11; *Opera*, 1652, pp. 550, 554; cf. Kircher, *Mundus subterraneus*, Amsterdam, 1668, i, p. 319, Paracelsus an impostor: *ib.*, 1665, ii, pp. 185, 223, report from Hungary.

⁶⁵ *Progymnasma meteori*, § 18; *Ortus*, 1652, p. 57.

⁶⁶ *De lithiasi*, cap. iv, § 13; *Ortus*, 1652, p. 679.

a very acid oil (*oleum acidissimum*) of vitriol⁶⁷—a clear distinction between copper and iron vitriols, not made by Paracelsus.

Views on the Elements.

Van Helmont's criticism of prevailing views on the elements is contained especially in the treatise entitled *Complexionum atque mistionum elementalium figmentum*. ("The fiction of elementary complexions and mixtures"), the summary of which, given at the head, is very suggestive⁶⁸ :—

(1) Why earth does not seem to be a primary element. (2) Fire is neither an element nor a substance. (3) All visible things are formed of water only. (4) Why the place of the air, called the middle region, is cold. (5) What the three chemical principles may be. (6) Some bodies are not reducible into the three principles (*tria prima*). (7) The inconsistency of Paracelsus. (8) The errors of the chemists. (9) Demonstration of the reduction of the three principles into the water of a cloud. (10) The volatile salt of simple bodies is fixed by melting (*colliquationem*). (11) The three principles are not pre-existent but are formed in separation, and indeed a new body (*et quidem nova creatura*). (12) The oil of things is only water, the seed of the compound body being abstracted (*ablato concreti semine*). (13) The same is true of charcoal. (14) What gas sylvestre of things is (*quid gas sylvestre rerum*). (15) Why gas is generated in the grape (*uva*). (16) Gas of wines. (17) Why many grapes spoil. (18) Gas of must is not spirit of wine (*spiritum vini*). (19) Opinion of Paracelsus erroneous. (20) Twofold (*duplex*) sulphur in tin, which is why it is light. (21) Gunpowder proves gas. (22) Some things change themselves into gas. (23) Incompatibility of some things melted together. (24) Gas, materially, is not earth or air (27) An experiment with alkahest. (28) Gas is wholly from the element of water. (29) Proof by an experiment with charcoal. (30) By experiment (*per mechanicam*) every vegetable is wholly and materially made from water only. (31) So a stone is wholly water. (32) Fish and everything unctuous are wholly of water. (33) Every smoke (*fuligo*) is solely water. (34) All sulphurs are reduced into smoke and gas and these into water. (35) Why fire cannot produce air from water. (36) Ashes and glass are wholly water. (37) Gas of salts is only insipid water. (38) Gas of fruits is only water. (39) Commentaries of the schools on exhalations. (40) Physics is obscure without chemistry (*Physica in tenebris absque Pyrotechnia*). (41) The vital spirit is materially gas of water. (42) Sweat before death is not sweat but the dregs of a liquid (*liquamen liquoris*). (43) We are easily killed by endemic gas.

Van Helmont's views on the elements are important⁶⁹. He rejects the theory of the four elements and three principles as taught by

⁶⁷ *Supplementum de Spadamis fontibus*, paradox iii, § 12 f.; *De lithiasi*, cap. viii § 11 f.; *Ortus*, 1652, pp. 550 f., 706.

⁶⁸ *Ortus*, 1652, p. 84 f.

⁶⁹ Cf. Delacre, *Rev. gén. des sciences*, 1924, 35, 704.

Paracelsus, and the "heathen" theory of a primary matter of Aristotle⁷⁰. Neither of the two primary elements (air and water) is convertible into the other⁷¹ and an element cannot be reduced to a simpler state⁷². Van Helmont proceeds to show that the other two so-called elements, viz., fire and earth, do not deserve the title, since fire is not a form of matter at all, and earth can be formed from water.

Gas.

Van Helmont says that flame, which is only burning smoke (*non est nisi accensa fuligo*)⁷³, perishes at once in a closed vessel, and charcoal may be heated continuously in a closed vessel without wasting. Yet if 62 lb. of oak charcoal contain 1 lb. of ashes, the remaining 61 lb. are "wild spirit" (*spiritus silvester*) which cannot escape from the shut vessel. (These ideas contain the germ of Stahl's theory of combustion.) "I call this spirit, hitherto unknown, by the new name of gas, which can neither be retained in vessels nor reduced to a visible form, unless the seed is first extinguished" (*Hunc spiritum, incognitum hactenus, novo nomine Gas voco, qui nec vasis cogi, nec in corpus visibile reduci, nisi extincto prius semine, potest*). The last part of this famous definition he explains by saying that the gas of flame is not yet water (the fundamental element) because, "although the fire has consumed the seminal forces of the burning body, yet some primitive fermentive differentiations of the body remain (*primæ fermentales aliquot concreti notæ*) which being at last consumed and extinguished, the gas returns to the element of water (*redit istud Gas in elementum aquæ*)"⁷⁴. Flame is ignited smoke and smoke is gas (1. *Imprimus indubium est, quin flamma sit fumus ascensus*. 2. *Quod fumus sit corpus Gas*)⁷⁵. Van Helmont⁷⁶ describes an experiment of burning a candle in air in a cupping-glass over water, when the water rises and the flame goes out: the suction is caused by consumption of part of the air. "There is in the air something that is less than a body, which fills up the vacuities in the air and is wholly annihilated by fire." The contraction is due to the pressing together

⁷⁰ *Causæ et initia naturalium*; *Ortus*, 1652, p. 26.

⁷¹ *Complex. atque mist. element.*, § 1; *Ortus*, 1652, p. 85.

⁷² *Progymnasma meteor.*, § 5; *Ortus*, 1652, p. 55.

⁷³ Although Van Helmont is usually credited with this definition, *e. g.*, by Roscoe and Schorlemmer, *Treatise on Chemistry*, 1905, i, p. 811, it is due to Aristotle: *De cælo*, iii, 4; *De gen. et corr.*, ii, 4; *Meteor.*, iv, 9, who also frequently uses the word *φλογιστά*. Kopp, *Beiträge*, iii, p. 84, incorrectly attributes the definition of flame to Albertus Magnus: see Partington, *Nature*, 1935, 135, 916.

⁷⁴ *Complex. atque mist. element.*, § 14; *Formarum ortus*, § 31; *De lithiasi*, cap. iii, § 13; *Ortus*, 1652, pp. 86, 111, 670.

⁷⁵ *Vacuum naturæ*, § 7; *Ortus*, 1652, p. 68.

⁷⁶ *Vacuum naturæ*, § 8; *Ortus*, 1652, p. 68.

of the empty spaces in the air by the smoke from the burning candle, the air having been "created to be a receptacle of exhalations". The air in mines, saturated with exhalations from minerals, extinguishes a flame. All this shows, he says, that a vacuum, which Aristotle thought impossible, is "something quite ordinary" (*aliquid valde ordinarium*). The vacuities of the air, he supposed, are normally filled by *magnale*, which is not light but a special form (*forma quædam assistens aeri*); on heating the air, the matter is really condensed, but the *magnale* in the pores is extended.

The name *gas sylvester* (*sylvestris*, "of the wood") is given to the "wild spirit", "untameable gas", which breaks vessels and escapes into the air (*vasis incoercibile, foras in aëra prorumpit*). If nitric acid is poured on sal ammoniac in a glass vessel which is closed by cement or by melting the glass, a gas is produced which bursts the vessel: "the vessel is filled with plentiful exhalation (yet an invisible one) and however it may be feigned to be stronger than iron, yet it straightway dangerously leapeth asunder into broken pieces"⁷⁷. The Flemish text⁷⁸ says: "Gas veel subtijlder is dan eenigen damp", and it is interesting that in describing the experiment (*De winden der menschen*, p. 216 f.) he uses the word "wind", not gas: "In het [glass] maecken das Konincks-waeters komt'er uyt het wercken beyder geesten, te weten des salpeters, en van het zout armoniac, eenen onsielijcken windt, die oock in de koude van selfs werckende, geboren wordt, en niet tot sienelijck waeter off stoffe en mach gebrocht, noch gehouden worden, hoe groot het vat zy." This explosive property explains the effects of gunpowder (*historiam enim Gas exprimit proxime pulvis tormentarius*⁷⁹). The name gas is almost certainly derived by van Helmont from the Greek word *chaos* (*non longe a Chao veterum secretum*)⁸⁰. Juncker's derivation⁸¹ from *Gäscht*, "froth", and a favourite derivation from *Geist* (spirit), are incorrect⁸². The Flemish text⁸³ has: *Gas-maeckinge: uyt het water eenen gas (dat is eenen griexschen water-chaos)*.

Paracelsus⁸⁴ uses the name *chaos* for the "element air", but there is no indication that he had any idea of the existence of separate gases,

⁷⁷ *Complex. atque mist. element. figmentum*, § 37; *Ortus*, 1652, p. 89; *Oriatrike*, 1662, p. 96.

⁷⁸ *Dageraed*, 1659, p. 90.

⁷⁹ *Complexionum*, etc., § 21; *Ortus*, 1652, p. 87.

⁸⁰ *Progymnasma meteori*, § 28; *Ortus*, 1652, p. 59.

⁸¹ *Conspectus chemiæ*, Halle, 1730, i, p. 365.

⁸² Lippmann, "Zur Geschichte des Namens Gas", *Abhandlungen und Vorträge*, Leipzig, 1913, ii, p. 360 f.; cf. Kirkby, *Chem. and Ind.*, 1923, 42, 325.

⁸³ *Dageraed*, 1659, p. 92.

⁸⁴ Lippmann, *Abh.*, ii, p. 360 f.; Stillman, *Paracelsus*, 1920, p. 102 f.; Strunz, *J. B. van Helmont*, 1907, p. 30.

and the statement⁸⁵ that he used the name *spiritus sylvestris* for the gas evolved in fermentation, effervescence and combustion, I have been unable to confirm. The statement that Paracelsus describes the production of hydrogen from metals and acids is completely mistaken⁸⁶. Paracelsus seems to have regarded air as formed from water and fire⁸⁷.

Van Helmont also deals with gas in his treatise *De flatibus*⁸⁸ in which he speaks of *gas ventosum*, *gas pingue*, *gas siccum*, *gas fuliginosum sive endemicum*, *gas sylvester* (*sive incoërcibile, quod in corpus cogi non potest visibile*), *gas sulphureum*, *gas wxæ*, *gas vini*, *gas musti*, *gas flammeum*, etc., some of which are really the same. He was the first clearly to realize the production of gas in various chemical processes⁸⁹. In Spa water, which had been said to contain all manner of dissolved substances, he observed only a little iron vitriol (it really contains ferrous bicarbonate) and *gas sylvester*, on the escape of which in bubbles it deposits an ochry sediment⁹⁰. The common assertion that the name "gas" was not used after van Helmont until it was revived by Macquer⁹¹ is incorrect, since the name appears repeatedly in earlier authors, such as Becher⁹². It seems to have been intentionally avoided by English authors after Boyle (who speaks of "air"). Van Helmont says more than once that he was the "inventor" of gas (*halitum illum Gas vocavi*) which Paracelsus was ignorant of (*ignoravit . . . quidditatem Gas, meum scil. inventum*)⁹³, and there is no doubt that Paracelsus had no such ideas on gases as he. Van Helmont definitely distinguishes gases from condensable vapours and from air, and from one another⁹⁴. He says that gas is composed

⁸⁵ Bergman, *Essays*, Edinburgh, 1791, iii, p. 155; Gmelin, *Geschichte der Chemie*, i, p. 217; Escher, Ersch-Gruber, *Encyclopädie*, 1838, [iii] xi, p. 293.

⁸⁶ Stillman, *Story of Early Chemistry*, 1924, p. 357 f.; Dobbin, *Isis*, 1933, 19, 262; already in Kopp, *Beiträge*, iii, p. 241.

⁸⁷ Dorn, *Congeries Paracelsicæ*, Frankfurt, 1581; Manget, *Bibliotheca Chemica Curiosa*, Geneva, 1702, ii, p. 426.

⁸⁸ *Ortus*, 1652, p. 335 f.

⁸⁹ Delaere, *Rev. gén. des sciences*, 1924, 35, 707.

⁹⁰ *Supplementum de Spadanis fontibus*, paradox. iv; *De lithiasi*, cap. iv, §§ 5, 7: *bullas atque silvestre Gas excitant, ac tandem se vasi affigunt*; *Ortus*, 1652, pp. 551, 677.

⁹¹ *Dictionnaire de Chymie*, 2 ed., Paris, 1778, ii, p. 240 f., art. Gas; Lavoisier uses the name "gaz".

⁹² Lippman, *op. cit.*

⁹³ *Progymnasma meteorî*, § 27; *Gas aquæ*, § 1; *Ortus*, 1652, pp. 58, 59: *Gas et Blas nova quidem sunt nomina, à me introducta, eo quod illorum cognitio veteribus fuerit ignota*. Brucker, *Historia critica philosophiæ*, Leipzig, 1743, IV, i, p. 721, says: *qualia sunt Gas et Blas ejus, quibus tamen inventionibus mire gaudet, licet nec perspicuitatem gignant, nec solidi quid dicant, nec distinctam notionem faciant*.

⁹⁴ *Progymn. meteorî*, § 29; *Ortus*, 1652, p. 59—*Sat mihi interim sciri, quod Gas, vapore, fuligine, et stillatis oleositatibus, longe sit subtilius, quamquam multoties aëre adhuc densius; De Lithiasi; Explicatio aliquot verborum artis*, preceding the preface in the 1648 ed.: *Gas est spiritus non coagulabilis*.

of invisible atoms which can come together by intense cold and condense to minute liquid drops (*atomi Gas, ob nimiam exiguitatem invisibiles, . . . frigoris excessum, in minimas rursus guttulas concidunt*)⁹⁵.

It is usually asserted⁹⁶ that van Helmont confused various kinds of gas together, so that it is necessary to point out : (1) that he sometimes uses the name *gas sylvester* as a general name for gas and sometimes for one particular gas (as one of a group), and (2) that he realized clearly that there were gases with different properties. He speaks of gas in a number of treatises⁹⁷, mentioning :—(i) The poisonous gas, extinguishing a candle flame, which collects in mines and in the Grotto del Cane (pp. 70, 78, 90, 126, 863 ; *in crypta Canis*), *i. e.*, carbon dioxide. (ii) The *gas carbonum* formed by burning charcoal and other combustibles (pp. 86, 88, 90, 111, 329 f., 490, 868), which is usually carbon dioxide but sometimes carbon monoxide, since van Helmont says he was himself once nearly poisoned at the age of 65 by the fumes of burning charcoal (pp. 242, 720) and gives the symptoms of carbon monoxide poisoning. (iii) The gas forming in cellars, especially from fermenting wine (carbon dioxide). Grapes can be dried to raisins if the skin remains whole, but if the skin is broken they ferment and evolve *gas sylvester*, which makes them appear to boil and is contained in wines which have been closed up in casks before the fermentation is ended and makes them effervescent (*vina furiosa reddit*). Since the fresh grape on distillation is reduced by art to elementary water, but gives rise to gas in presence of a ferment, it follows that gas itself is water (pp. 87, 89, 90, 126, 343, 490). (iv) Gas formed by effervescence of sulphuric acid and salt of tartar (p. 768), or distilled vinegar and calcium carbonate (carbon dioxide) (p. 343 : *acetum stillatitium, dum lapides cancrorum solvit . . . eructatur spiritus sylvester* : crab's eyes was a form of calcium carbonate)⁹⁸. (v) A poisonous red gas formed when aqua fortis (*chrysulca*) acts on metals such as silver (pp. 343, 490 : *chrysulca argentum, eructatur spiritus sylvester*). The *Dageraed* (1659, p. 216) also mentions this red gas : *maer soo het sterck-waeter koper oft silver eet, soo maeckt hen een selven rooden*

⁹⁵ *Blas meteoron*, § 11 ; *Ortus*, 1652, p. 66.

⁹⁶ Thomson, *History of Chemistry*, i, p. 185 ; Kopp, *Beiträge*, iii, p. 155 ; Delacre, *Revue gén. des sciences*, 1924, 35, 706 ; but cf. Hoefler, *Hist. de la Chimie*, 1869, ii, p. 140.

⁹⁷ The page references in the text are to the *Ortus*, 1652, the treatises corresponding being : 60, *Gas aquæ* ; 70, *Vacuum naturæ* ; 78, *Terræ tremor* ; 86–90, *Complexionum*, etc. ; 91–94, *Imago fermenti* ; 111, *Formarum ortus* ; 126, *Magnum oportet* ; 146–151, *Blas humanum* ; 155, *Endemica* ; 242, *Jus duumviratus* ; 323, *Pleura furens* ; 336–43, *De flatibus* ; 349, *Catarrhi deliramenta* ; 416, *Ignotus hydrops* ; 490, *De inspiratio* ; 550, *Supplement. de Spadanis font.* ; 621, *In sole tabernaculum* ; 677, *De lithiasi*, c. iv ; 720, *De lithiasi*, c. ix ; 768, *De febribus*, c. ix ; 863–888, *Tumulus pestis*.

⁹⁸ Lemery, *Traité universel des drogues simples*, 1698, p. 141 : *oculus cancri, pierre d'écrevisse*.

roock, die nu wint ist. The *Explicatio aliquot verborum artis*, preceding the preface in the 1644 edition of *De lithiasi*, has: "Gas, qualis è fermentante vino; itemque ruber ille, qui chrysulca operante, eructatur," etc. This was nitric oxide, which Juncker⁹⁹ still called *gas sylvester*. (vi) The gas evolved from aqua fortis and sal ammoniac in the cold (p. 343: chlorine and nitrosyl chloride). (vii) The gas evolved in bubbles from Spa water, which then deposits an ochry sediment (p. 679: carbon dioxide). (viii) The gas evolved in eructations (*gas sylvester; gas ventosum*), *i. e.*, carbon dioxide, sharply distinguished from inflammable intestinal gas (pp. 94, 341, 349), *i. e.* (ix) *Gas pingue*, which is inflammable, is evolved in putrefaction, and is contained in intestinal gas which he (as did Albertus Magnus, see ref.⁷³) knew was inflammable (p. 341: *ructus sive flatus originalis in stomacho . . . extinguant flammam candelæ. Stercoreus autem flatus, qui in ultimis formatur intestinis, atque per anum erumpit, transmissus per flammam candelæ, transvolando accenditur, ac flammam diversicolore, Iridis instar exprimit*) (hydrogen, methane, with fetid impurities). (x) A gas, different from (ix), which inflates the tympanum (? in gas gangrene) (pp. 341, 416). (xi) A combustible gas (*gas pingue, siccum, fuliginosum, endemicum*) formed on dry distillation of organic matter (p. 336) (a mixture of hydrogen, methane and carbon monoxide). (xii) A sulphurous gas (*gas sulfuris; sal acidum, i. e.*, sulphur dioxide) which flies off from burning sulphur, which is a material wholly fatty and combustible (*totum sit pingue et φλογοστον*): this gas when formed in a vessel filled with air extinguishes a candle-flame: it can be condensed in a bell-jar into a juice (*per campanam in succum cogitur*; sulphuric acid) (pp. 550, 888: the word φλογοστον is given in both places; it also occurs in the Flemish *Dageraed*, p. 378: *Dit is't het welck wy levende swavel noemen, en φλογοστον uyt den swavel-plaets getrocken*). (xiii) A *gas sylvester* from fused saltpetre and charcoal (carbon dioxide) (p. 343). Van Helmont missed the oxygen from heated saltpetre, although he says (p. 87) that when saltpetre is strongly heated it gives off a little acid water and leaves salt of tartar (really potassium nitrite or oxide). (xiv) Gunpowder when inflamed evolves gas which bursts vessels, yet the charcoal, sulphur and saltpetre when heated separately do not explode: the detonation of the mixture is due to a mutual antipathy by which they try to destroy one another (*ergo illa apposita se mutuo in gas convertunt, per destructionem*) (p. 87). (xv) An ethereal or vital gas (*gas æthereum ac vitale*), a kind of vital spirit of a gaseous nature (*spiritum vitæ nostræ materialem de natura gas esse*), which is the reason why other gases act so swiftly and powerfully on the body; this is a preservative balsam, formed in the blood in the heart

⁹⁹ *Conspectus Chemiæ*, Halle, 1730, i, p. 569.

and not inspired from the outer air. From the arterial blood no dregs or filth are expelled, smoky vapours being wanting where there is no adustion; but venous blood in wasting itself by the guidance of heat produces a gas, as water does a vapour, and this gas is subsequently of necessity expelled (pp. 89, 146, 149, 155 f.).

In respiration, the air mingles in the lungs with the venous blood, which would otherwise coagulate; it mingles with the sulphur of the blood, and exhales together with watery vapour in an unperceivable gas (*per gas insensibile transpiratum*, p. 151). Van Helmont criticizes Galen for teaching that the object of respiration is refrigeration¹⁰⁰, and says its purpose is to maintain animal heat, by a ferment in the left ventricle of the heart changing the arterial blood into a vital spirit (*vita humana est lux formalis*). The friction together of saline and sulphurous particles in the blood, caused by the beating of the heart, produces heat and a "formal" light in the blood¹⁰¹.

The Element Water.

In his treatise "On the causes and beginnings of natural things"¹⁰² van Helmont criticizes the teachings of Aristotle, and in the contents he has the following propositions: "(13) *Tria Paracelsi corporum initia non habere naturam causerum.* (22) *Chimicorum principia non habere vim principiandi.*" Van Helmont still occasionally makes use of the three principles of Paracelsus, as when he says that water contains salt, sulphur and mercury, but this is only "to meet the weakness of our understanding" (*ut intelligendi imbecillitati nostræ*)¹⁰³. He says the three principles ("borrowed from Basil Valentine") are not in bodies actually nor are they separated unchanged by fire¹⁰⁴: mercury is a simple actually existing body, not a constituent of things¹⁰⁵. Metals can combine only with themselves without losing their lustre¹⁰⁶. Van Helmont asserts that the true elements are air and water (*duo dixi primitiva elementa, aërem et aquam*), and points out that water, with heaven and earth, was formed on the first day in the account of Creation in Genesis¹⁰⁷. He describes the famous "Tree Experiment" to prove that "all vegetables proceed out of the element of water only"¹⁰⁸:—

¹⁰⁰ Unjustly according to Adams, *Paulus Aegineta*, 1844, i, p. 214.

¹⁰¹ *Blas humanum; In sole tabernaculum; Ortus*, 1652, pp. 147, 621; cf. Willis.

¹⁰² *Causæ et initia naturalium; Ortus*, 1652, p. 26 f.

¹⁰³ *Gas aquæ*, § 8; *Ortus*, 1652, p. 60.

¹⁰⁴ *Imago fermenti*, § 7; *Tria prima; Ortus*, 1652, pp. 91, 323.

¹⁰⁵ *De lithiasi*, cap. iii, § 17; *Ortus*, 1652, p. 671.

¹⁰⁶ *Arbor vitæ; Ortus*, 1652, p. 630.

¹⁰⁷ *Elementa; Complexionum etc.*; *Ortus*, 1652, pp. 43 f., 85 f.

¹⁰⁸ *Complexionum, etc.*, § 30; *Ortus*, 1652, p. 88; the passage is quoted from the English translation, 1662, p. 109.

“ I took an Earthen Vessel, in which I put 200 pounds of Earth that had been dried in a Furnace, which I moistened with Rain-water, and I implanted therein the Trunk or Stem of a Willow Tree, weighing five pounds ; and at length, five years being finished, the Tree sprung from thence, did weigh 169 pounds, and about three ounces : But I moistened the Earthen Vessel with Rain-water, or distilled water (always when there was need) and it was large, and implanted into the Earth, and lest the dust that flew about should be co-mingled with the Earth, I covered the lip or mouth of the Vessel, with an Iron plate covered with Tin (*lamina ferrea, stanno obducta*), and easily passable with many holes. I computed not the weight of the leaves that fell off in the four Automnes. At length, I again dried the Earth of the Vessel, and there were found the same 200 pounds, wanting about two ounces. Therefore 164 pounds of Wood, Barks, and Roots, arose out of water onely.” The conclusion is mainly correct, since the tree is largely water (about 50 per cent. of fresh willow wood is free water), but it is an irony of fate that van Helmont did not know the part played by the carbon dioxide in the air, since, as has been shown, he was the first to realize the existence of this gas, to which he gave a special name. In the idea, but apparently not in the performance of this famous experiment, van Helmont had been anticipated by a century and a half in a work of Nicolaus of Cusa.

The Cardinal Nicolaus Krypts of Cusa (1401–1464), born at Cusa (Kues) on the Moselle, was a mystic and a Lullist ; although in some respects in advance of the science of his time, his importance has been exaggerated by German authors¹⁰⁹. The only part of his works of interest to us is the one written in 1450 at Fabriano, with the title : *Idiotæ, dialogus IIII*¹¹⁰. In an interesting chapter *de staticis experimentis* he anticipates van Helmont’s tree experiment but does not seem actually to have performed it¹¹¹ : *Si quis positis centum libris terræ in potu testaceo, colligeret succesive, ex herbis, aut seminibus, in terram iactis, prius ponderatis, centum libras, et iterum terram ponderaret : in pauco, ipsam in pondere reperiret diminutam. Ex quo haberet, collectas herbas pondus*

¹⁰⁹ *D. Nicolai de Cusa Cardinalis, vtriusque Iuris Doctoris, in omnique Philosophia incomparabilis viri, Opera*, 3 vols., with continuous pagination, pp. 1176, Basle, 1565, ex officina Henricipetrina—good index ; Thorndike, *Science and thought in the 15th cent.*, New York, 1929, p. 133 f. ; *ib.*, *History of Magic*, 1934, iv, p. 387 f.—unfavourable ; Stones, *Isis*, 1928, 10, 446 ; *ib.*, 1934, 20, 457 ; *ib.*, 1935, 21, 562.

¹¹⁰ *Opera*, 1656, pp. 172–180 ; English transl., 12°, London, 1650, *The Idiot in four books. The first and second of Wisdom. The third of the Minde. The fourth of Statick experiments, or experiments of the Ballance* ; and by Viets,**Annals of Medical History*, 1922, 4, 115–35, q. by Thorndike, *Magic*, iv, p. 389 ; Pagel, *Archiv für Gesch. der Med.*, 1931, 24, 42 ; Prescott, *Archiv für Gesch. der Math., der Naturwiss. und der Technik*, 1929, 12, 70.

¹¹¹ *Opera*, 1565, p. 176.

ex aqua potius habere. Aquæ igitur in terra ingrossatæ, terrestreitate attraxerunt, et operante Sole in herbam, sunt condensatæ. Si herbæ illæ incinerentur, nonne per coniecturam, ex ponderum omnium diversitate, attingeres, quantum terræ plus centum libris experires, et illud aquam attulisse manifestum est. Conuertuntur enim elementa, unum in aliud per partes, uti experimur uitro in niue posito, aerem in uitro in aquam condensari, quam in uitro fluidam reperimus.

“ There is a saying that no pure element is to be given, how is this prov'd by the Ballance ? *Id.* If a man should put an hundred weight of earth into a great earthen pot, and should then take some Herbs, and Seeds, & weigh them, and then plant and sow them in that pot, and then should let them grow there so long, untill hee had successively by little and little, gotten an hundred weight of them, hee would finde the earth but very little diminished, when he came to weigh it again, by which he might gather, that all the aforesaid herbs, had their weight from the water. . . . If those Herbs be then burn't to ashes, mayest not thou guesse by the diversity of weights of all ; How much earth thou foundest more then the hundred weight, and then conclude that the water brought us all that ? ”

Van Helmont's theory (*doctrinam illam de aqua omnium rerum principis*) was severely criticized by Morhof, who says the tree experiment is unconvincing (*nikil plane probat*)¹¹². Although Prescott accuses van Helmont of plagiarising Cusa's experiment, Pagel does not think he did so intentionally.

As further proofs of his thesis, van Helmont says that spirit of wine carefully dephlegmated (dehydrated) with salt of tartar gives only water on combustion, and that fish are nourished and their fatty matter produced from the water in which they swim¹¹³. He establishes links between materials to prove that they are formed from water ; for example, since wood was shown to be formed from water in the tree experiment, all the products obtained from wood, such as charcoal and ash, must also consist of water. If gold is to be formed from water, this will involve a compression to one-sixteenth the volume, which is quite possible to Nature, although water has no pores. Grain by fermentation is converted into beer, which still leaves a solid residue on evaporation. But beer can undergo a further fermentation, becoming sour and consuming its dregs, and finally it returns of its own accord into water¹¹⁴.

Van Helmont sharply criticizes the theory of the four elements¹¹⁵. Earth is not an element, but is formed from water. For if sand is fused

¹¹² *Polyhistor*, 4 ed., Lübeck, 1747, ii, p. 210.

¹¹³ *Progymnasma meteorii ; Complexionum, etc. ; Ortus*, 1652, pp. 57, 58, 86.

¹¹⁴ *Imago fermenti*, § 2 ; *Ortus*, 1652, p. 91 ; vinegar, in fact, loses its acidity by attack of organisms.

¹¹⁵ *Elementa ; Ortus*, 1652, p. 42 f. : *elementorum doctrina, in medendo, impertinens tota*,

with excess of alkali it forms a glass. If this glass is exposed to the air, it liquefies to water (*resolvi in aquam*), and if sufficient *aqua fortis* is added to saturate the alkali (*quantum saturando alcali sufficit*), the sand settles out again of the same weight as was used to make the glass ¹¹⁶. Fire, which is clearly distinguished from light ¹¹⁷, is not an element, cannot form a material constituent of bodies (*nec materialiter corporibus commiscetur*), and is "a positive death of things, a singular creature, second to no other", which can pierce glass ¹¹⁸. Air cannot be condensed to water (*aërem et aquam esse corpora impermutabilia*), as is proved by the experiment with the air-gun (*in canna ferrea . . . instar sclopeti*), in which compressed air remains elastic and can propel a ball through a board ¹¹⁹.

An air thermoscope described and shown in a figure consists of two glass bulbs, separated by a U-shaped tube with a long and a short leg, and containing sulphuric acid coloured with roses. The upper bulb is closed and contains air, the lower bulb communicates with the atmosphere by a small hole. The instrument was used to measure the temperature of the body ¹²⁰. Van Helmont gives a scale of temperatures with fifteen "fixed points", instead of the usual four of the alchemists: the greatest cold, melting ice (? , *aqua nondum glaciata*), well-water, gentle lukewarm, human body temperature, feverish temperature, May sun, distillatory, boiling (water), subliming sulphur, melting pyrites, dark red heat, bright red heat, reverberatory with bellows. He points out that touch is an uncertain guide near body temperature ¹²¹.

On the Stone.

Of all Helmont's works, that on urinary calculi (*De Lithiasi*) is said by Boerhaave ¹²² to be "incomparable, and the best", and it also contains the greatest number of chemical experiments, which must have occupied him for a long period of time. He criticizes Paracelsus's theory of tartar, gives a fairly accurate description of the formation of tartar in wine-casks, and says tartar is not contained in food and does not cause the disease of the stone ¹²³. In his *De Lithiasi*, in nine chapters, he says the stone, called *duelech* by Paracelsus, is not tartar, since it does not

¹¹⁶ *Terra*, § 16; *De lithiasi*, cap. iii, § 28; *Ortus*, 1652, pp. 46, 672: the use of the term "saturation" is noteworthy.

¹¹⁷ *Formarum ortus*, § 22; *Ortus*, 1652, p. 108.

¹¹⁸ *Terra*, § 1; *Formarum ortus*, § 31; *Ortus*, 1652, pp. 44, 111.

¹¹⁹ *Aër*, §§ 3, 11; *Supplement. de Spadamis font.*, ii, § 10 f.; *Ortus*, 1652, pp. 50 f., 548.

¹²⁰ *Aër*, § 12; *Humidum radicale*; *Ortus*, 1652, pp. 52, 574.

¹²¹ *Calor efficienter*, § 35; *Ortus*, 1652, p. 165.

¹²² Boerhaave, *op. cit.*, transl. Shaw, 1741, i, p. 45.

¹²³ *Tartari historia*; *Tartari vini historia*; *Inventio tartari, in morbis temeraria*; *Alimenta tartari insontia*; *Tartarum non in potu*; *Ortus*, 1652, p. 186 f.

dissolve in boiling water. Although urine is clear when voided, even if it has been retained for several hours, it soon deposits a sandy sediment or crust if allowed to stand in a vessel. By mixing spirit of urine (ammonium carbonate solution) with spirit of wine he observed the formation of a white precipitate (*ambo simul in offam albam coagulata sunt*), afterwards called *offa Helmontii* ¹²⁴. He discusses a number of ways in which solid concretions and coagulations are formed in nature and concludes that they are all different from the formation of *duelech*. This is deposited from urine in the bladder by the concurrence of three things: the spirit of urine, spirit of wine (*aqua vitæ*), and a corrupting ferment from the kidneys ¹²⁵. This conclusion is faulty, since spirit of wine does not occur in the body, and the spirit of urine which he used, containing ammonium carbonate, does not occur in fresh urine. Van Helmont isolated from urine two fixed salts, one of them common salt, which he asserted was that taken with the food, and another of different crystalline form—probably microcosmic salt ¹²⁶.

For the volatile ammonium salt (ammonium carbonate) van Helmont uses the names *spiritus urinæ*, *sal volatile* (also for ammonium chloride in soot), *spiritus lotii*, etc. ¹²⁷. A spirit can be distilled from blood which cannot be distinguished by smell or taste from spirit of urine, but cures epilepsy, which spirit of urine does not ¹²⁸.

By distilling a calculus (*duelech*) van Helmont obtained a fetid spirit of urine, yellow crystals, and an oil like that from dried urine; a black unsavoury earth remained ¹²⁹.

Ferments.

Van Helmont's theory of ferments is very original and interesting. He says the name of ferment was unknown before, except for the leaven used for making bread, whereas there is no change or transmutation brought about by the sleeping affinity of matter except by the work of the ferment (*nulla in rebus fiat vicissitudo, aut transmutatio, per somnium appetitum hyles: sed duntaxat solius fermenti opera*). The two

¹²⁴ *De lithiasi*, iii; *Ortus*, 1652, p. 668; in the Flemish text, 1659, p. 243, the passage reads: *ick goot dit leste waeter, dat over den helm was gekomen, in een fleschjen met den besten brande-wijn, die op eenen oogenblick in een schoon wit vluchtigh sout worde verkeert, niet min, als den geest des wijns, oft der pisse*.

¹²⁵ *De lithiasi*, cap. iii, v f.; *Ortus*, 1652, pp. 669, 683 f.: *Rommelaere, op. cit.*, p. 448, who says spirit of urine = uric acid.

¹²⁶ *De lithiasi*, cap. iii, § 19—man as the microcosm is also mentioned; *Sextuplex digestio alimentum humani*, § 58; *Ortus*, 1652, pp. 177, 671.

¹²⁷ *Complexionum, etc.*, § 37; *De lithiasi*, cap. iii; *Ortus*, 1652, pp. 89, 669 f., 675, etc.

¹²⁸ *Aura vitalis*; *Ortus*, 1652, p. 577; cf. Boyle.

¹²⁹ *De lithiasi*, cap. v, § 9; *Ortus*, 1652, p. 684: a very interesting chemical experiment.

chief beginnings of bodies (*prima initia*) are water and ferment or seminal origin (*fermentum sive initium seminale*); the ferment is an indwelling formative energy, "hardly 1/8200 part of a body", which disposes (*disponit*) the material of water so that a seed is produced and life (*vita*), and the mass develops into a stone, metal, plant or animal¹³⁰. These ideas, and that of the Archeus, are derived from Seton (or Sendivogius)¹³¹ (*juxta Chymicorum Cosmopolitam*).

Helmont's theory of the Archeus¹³² is a modification of Paracelsus's¹³³, and is a peculiar vitalism¹³⁴. He uses the "new name *Blas*" to designate the principle of movement of the stars (*Blas motivum stellarum est virtus pulsiva, ratione itineris, per loca et secundum aspectus*), which pours its influences on the earth¹³⁵. The Archeus or efficient cause (the name Archeus is used by Basil Valentine¹³⁶) causes matter to develop from within to certain forms: "the seed is a substance in which the Archeus is already contained, a spiritual gas containing in it a ferment, the image of the thing, and moreover a dispositive knowledge of things to be done. . . . One thing is not changed into another without a ferment and a seed." The ferment pre-exists in the seed, which is developed by it, and this contains also a second ferment of the seed, the product of the first. The ferment exhales an odour, which attracts the generating spirit of the Archeus. This spirit (*aura vitalis*) creates bodies after its own Idea: it disappears only at the instant of death to produce a new creation of the body, which then enters for the second time into fermentation. Seed is not indispensable for generation: animals produced when the Archeus acts on a suitable ferment are as perfect as those produced from eggs.

The Stoic theory of Seminal Reasons (*rationes seminales*) was perhaps borrowed by van Helmont from St. Augustine¹³⁷. The latter taught that God deposited in matter a hidden treasure of active forces or seminal reasons or principles (*rationes seminales*), which, by successive germination

¹³⁰ *Causæ et initia naturalium; Complexionum atque mistionum, etc.; Imago fermenti imprægnat massam semine; Tractatus de morbis; Ortus*, 1652, pp. 86 f., 90 f., 428 f.

¹³¹ *Novum lumen chemicum*, in Albineus, *Bibliotheca chemica contracta*, Geneva, 1652, I f.; Becher's ideas are also very similar.

¹³² Martin Heer, *Introductio in Archivum Archei vitale et fermentali viri magnifici Johannes Baptistæ van Helmont, Philosophi per ignem*, 4°, Laubæ, 1703; *Helmont disguised*, by J[as.] T[hompson], 16°, London 1657.

¹³³ Strunz, *Paracelsus*, 1903, p. 18.

¹³⁴ Cf. Pagel, *op. cit.*; Sprengel, *Hist. de la médecine*, 1815, v, p. 22 f.; Rixner-Siber, *op. cit.*, vii, p. 125 f.; A. Lemoine, *Le vitalisme et animisme de Stahl*, Paris, 1864.

¹³⁵ *Blas meteoron; Ortus*, 1652, p. 65 f.; *Blas humanum; ib.*, p. 143 f.; *Causæ; Archeus faber; Imago fermenti; Magnum oportet; Ortus*, 1652, pp. 30, 33, 91, 120 f.

¹³⁶ Heer, *Introductio in Archivum Archei*, p. 56.

¹³⁷ Prescott, *op. cit.*

in the matrix of matter as occasion presented (*acceptis opportunitatibus*), produced each a different species of corporeal being¹³⁸.

Van Helmont taught that there are specific ferments and *archææ* in the stomach, the liver, and other parts of the body, which bring about digestions and other physiological changes (*in aliis locis continuo aliis fermentis*)¹³⁹. His ideas on ferments, although naturally rather crude and undeveloped, were in the right direction and in many ways resemble the modern theory of enzymes¹⁴⁰. The acid of the gastric juice is necessary for digestion, but an excess of acid causes discomfort and illness, since it cannot be neutralized into salt by the alkali of the gall in the duodenum (*aciditatem sui in salem commutat*)¹⁴¹. The pylorus, opening and closing under the influence of the Archeus, regulates the transfer of chyme (*cremor*) from the stomach to the duodenum¹⁴². Van Helmont compared the interactions of various juices in the organs with chemical reactions between liquids outside the body. He showed by experiment that salt can pass with water through a bladder, and explains how the digested food (chyle) can pass through the walls of the intestines into the veins¹⁴³; he does not know of the lacteals, discovered by Aselli of Cremona in 1622, but first published in 1627. He distinguished six fermentations of the food in passing through the body. The stomach and spleen, acting under the direction of the Archeus, constitute a *duumvirate* and cannot act separately¹⁴⁴. They produce an acid liquor (which van Helmont said had been tasted in the saliva of birds) which carries out the first digestion. The mass passes through the pylorus into the duodenum, where it is neutralized by the gall (*fel*) of the gall-bladder, a vital balsam different from the excrementitious biliary principle in the mass of the blood, and this is the second digestion. The third digestion takes place in the mesentery, to which the gall-bladder sends the prepared fluid. The fourth digestion occurs in the heart, where the red blood becomes more yellow by the addition of vital spirit; the fifth digestion consists in the conversion of arterial blood into vital spirit, and occurs mainly in the brain; and the sixth digestion consists in the elaboration of the nutritive principle

¹³⁸ De Wulf, *History of Mediæval Philosophy*, 1909, p. 93.

¹³⁹ *Imago fermenti*, § 23; *Sextuplex digestio alimenti humani*; *Aura vitalis*; *Ortus*, 1652, pp. 93, 167, 577.

¹⁴⁰ Brucker, *Historia critica philosophiæ*, Leipzig, 1743, IV, i, p. 715; Sir M. Foster, *Lectures on the History of Physiology*, Cambridge, 1901, p. 135; W. M. Bayliss, *Principles of General Physiology*, 1915, p. 307; Partington, *Everyday Chemistry*, 1929, pp. 508, 551, 555.

¹⁴¹ *Sextuplex digestio etc.*, § 56; *Ortus*, 1652, p. 176.

¹⁴² *Pylorus rector*; *Ortus*, 1652, p. 180.

¹⁴³ *Sextuplex digestio*, § 48; *Ortus*, 1652, p. 174—an early experiment on osmosis.

¹⁴⁴ *Ignota actio regiminis*; *Ortus*, 1652, p. 273.

in each separate member from the blood, by a separate ferment. There are, thus, six digestions: the number seven is chosen by Nature for a state of repose¹⁴⁵. The seat of the Archeus is in the stomach, as Helmont proved by an experiment¹⁴⁶. He took aconite (*Napellus*) and felt himself thinking in the stomach, not in the head, an experiment he could not repeat. Diseases are caused by the Archeus in the stomach sending acid ferments or juices to various parts of the body¹⁴⁷. Van Helmont's theory of the connection between fermentation and digestion was soon replaced by other less accurate views. The Iatro-mathematical school as represented by J. A. Borelli (1608–1679) regarded digestion as mere trituration, and estimated the force exerted by the walls of the stomach as 1350 pounds¹⁴⁸. The chief antagonist of van Helmont's views was Archibald Pitcairn (1652–1713), who objected that if digestion were effected by a ferment, this should also dissolve the walls of the stomach¹⁴⁹.

Miscellaneous Chemical Observations.

In addition to the important chemical ideas and observations described above, a large number of others of considerable interest occur in the works of van Helmont. He was well acquainted with sulphuric acid both from the distillation of vitriol and by burning sulphur under a bell. He describes the preparation of nitric acid by distilling equal parts of saltpetre (*salispetræ*), vitriol and alum, first dried and then mixed together¹⁵⁰, and apparently knew that it converted sulphur into sulphuric acid (*salispetræ spiritus elevat sulfur humidum et embryonatum vitrioli*)¹⁵¹. He mentions aqua regia, made from nitric acid and sal ammoniac, and the gas (chlorine and nitrosyl chloride) evolved from it¹⁵². He describes the distillation of spirit of sea-salt (*spiritus salis marini*), *i. e.*, hydrochloric acid, from salt and dried potter's clay¹⁵³. Quicklime contains a two-fold alkaline salt, one lixivial and the other acid, as may be perceived by the taste (*in calce viva est duplex sal alcalizatium. Unum quidem lixiviale, et alterum acidum*); by the action of

¹⁴⁵ *Sextuplex digestio alimenti humani*; *Ortus*, 1652, p. 166 f. I have made use of the summaries of Sprengel, and of Thomson on the subject; see also Pagel, *J. B. van Helmont*, 1930, p. 115.

¹⁴⁶ *Demens idea*; *Ortus*, 1652, p. 222.

¹⁴⁷ *A sede animæ ad morbos*; *Ortus*, 1652, 234 f.; *De febris*, cap. ix; *Ortus*, p. 767; details in Sprengel and Thomson.

¹⁴⁸ Sprengel, *Hist. de la médecine*, 1815, v, p. 142.

¹⁴⁹ Sprengel, *op. cit.*, p. 123. Pitcairn was the teacher of Boerhaave.

¹⁵⁰ *Complexionum etc.*, §§ 33, 37; *Ortus*, 1652, p. 89.

¹⁵¹ *Potestas medicaminum*, § 65; *Ortus*, 1652, p. 387.

¹⁵² *Complexionum*, § 37; *Ortus*, 1652, p. 89, etc.

¹⁵³ *Butler*; *De lithiasi*, cap. vii, § 28; *Ortus*, 1652, pp. 475, 702.

water these salts become hot, as when acid spirit of vitriol is poured upon salt of tartar¹⁵⁴. Fixed alkali is not present (as such) in plants but is produced by combustion (*alkali fixum in vegetabilibus non præ-exstitisse: fixari vero cremando*)¹⁵⁵. Alkali neutralizes all acidity (*quatenus alkali quodvis omnem aciditatem, quam attingit, perimit*)¹⁵⁶. Van Helmont uses the name *sal salsum* for a neutral salt¹⁵⁷. When strong spirit of vitriol is poured on salt of tartar, heat is produced, and when sugar of lead is calcined the residue takes fire when exposed to the air—van Helmont thought because the alkali in it took up moisture from the air¹⁵⁸.

The volatile red oil obtained by repeatedly distilling sulphur (with ammonia?) was probably ammonium sulphide¹⁵⁹, usually credited to Boyle.

In the Flemish text van Helmont describes the solution of precipitated silver chloride (apparently containing a little copper) in the spirit (ammonia) distilled from urine: *ick stelde hem op kalck van silver gemaect door't scheydt-waeter, en met zeesout nedergeslaegen, en seer nauw afgesoet, door veel warme waeteren, en ten lesten gedrooght. Ick saghen den voorschreven pis-geest met kleynder lauwhyght hemels-blaeuw worden*¹⁶⁰.

Van Helmont rejected the old Galenical pharmacopœia and used many mineral remedies, following Paracelsus¹⁶¹. He gives a list of the *arcana* of Paracelsus, including antimony and mercury compounds (*corallatum Paracelsi, arcanum corallinum, mercurius præcipitatus, mercurius diaphoreticus, corallatum dulci mercurii diaphoretici, præcipitatus diaphoreticus*), the latter probably including red oxide of mercury and Turpeth mineral (basic sulphate), which he used in venereal cases, gout, fevers, dropsy, and many other diseases. He says, however, that potable gold is useless, and he considered with Paracelsus that arsenic compounds, however prepared, were unsuitable for internal use¹⁶².

Arsenic gives a salt fixed in the fire [potassium arsenate] when fused with saltpetre (*sal-petræ et arsenicum, ambo volatilia, per colliquationem, fixantur*)¹⁶³. The three colours of the rainbow [red, yellow and blue] are those of the three sulphurs in burnt minerals (*trium sulfurum in mineralibus concrematis*)¹⁶⁴.

¹⁵⁴ *De febribus*, cap. ix; *Ortus*, 1652, p. 768.

¹⁵⁵ *Tria prima*, etc.; *Ortus*, 1652, p. 329.

¹⁵⁶ *Blas humanum*, § 53, *Ortus*, 1652, p. 153.

¹⁵⁷ *Sextuplex digestio*, § 27; *Ortus*, 1652, p. 170.

¹⁵⁸ *De febribus*, cap. ix; *Ortus*, 1652, p. 768.

¹⁵⁹ *Quædam imperfectoria*; *Ortus*, 1652, p. 458.

¹⁶⁰ *Dageraed*, 1659, p. 242; the passage is not in the Latin edition.

¹⁶¹ *Pharmacopolium ac dispensatorium modernum*; *Ortus*, 1652, pp. 366 f., 556.

¹⁶² *Ortus*, 1652, pp. 134, 151, 248, 315, 375, 384, 416 f., 455, 498, etc.

¹⁶³ *Complexionum etc.*, § 10; *Ortus*, 1652, p. 86.

¹⁶⁴ *Meteoron anomalum*; *Ortus*, 1652, p. 72—flame colours.

What van Helmont calls Aroph¹⁶⁵ has been identified with ferric ammonium chloride. He prescribed burnt sponge (containing iodine) for goitre¹⁶⁶. He says that wine is strengthened by freezing out the water¹⁶⁷, that the common people distil spirit (*aqua vitæ*) from beer, mead, fruits, grains, etc., as well as from wine, and that a sweet oil, different from the spirit, can be separated from wine¹⁶⁸.

Conclusions.

When we review the work of van Helmont, we cannot deny that he represents the transition from alchemy to chemistry, and is a worthy predecessor of Boyle, who studied him carefully and adopted many of his ideas. That he was "a great chemist, undoubtedly the greatest prior to Lavoisier"¹⁶⁹ is an over-statement which van Helmont himself would, if he could look back over the period between his experiments at Vilvorde and the work of the great Frenchman, be the first to correct.

I have to thank Dr. Douglas McKie for very generously placing at my disposal reprints of the three articles by Vandavelde and some notes on the *Dageraed*: I had then completed my study of the latter work but was able to compare my account with that of Dr. McKie.

¹⁶⁵ *Supplement. de Spadanis font., paradox. numero criticum*, § 53; *Ortus*, 1652, p. 560.

¹⁶⁶ *Tartarus non in potu*, § 15; *Ortus*, 1652, p. 205.

¹⁶⁷ *Tartari vini historia*, § 3 f.; *Ortus*, 1652, p. 188; in Paracelsus.

¹⁶⁸ *Aura vitalis: Arbor vitæ*; *Ortus*, 1652, pp. 576, 633.

¹⁶⁹ J. Campbell Brown, *History of Chemistry*, 1913, p. 202.