William Harvey: some neglected aspects of medical history / by Walter Pagel.

Reprinted from the Journal of the Warburg and Courtauld Institutes.
Vol. 7. 1944.

WILLIAM HARVEY: SOME NEGLECTED ASPECTS OF MEDICAL HISTORY

By Walter Pagel

The medical historian endeavours to trace the stepping stones which lead up to the modern point of view; to sketch a line of steady progress taking us up to the climax of present-day science and medicine. He extracts "correct" and "still valuable" data and facts from their original setting which may appear to him utterly "useless" and unscientific. It is well known that the discovery of the flow of blood from the right heart through the pulmonary artery and the lungs, into the left heart (as against fictitious pores in the ventricular septum)[1] occurs in a religious tract which sets out a unitarian point of view and is entitled: *Restitution of Christianity* (1553). The historian will not dare waste his time or trespass on the patience of his readers with its actual contents. Three hundred years before Servetus, the author of this book, an Arab, Nafis, had anticipated his discovery. Nafis may have arrived at it in a legitimate way, that is, by anatomical observation and reasoning as to factual evidence. We are not quite clear about this point.[2] At all events the record of the discovery is deeply embedded in lengthy arguments as to the correct interpretation of certain passages of Galen whose voluminous works formed the Bible of mediaeval medicine. Here again the setting is unscientific and apparently devoid of interest for the modern observer. We may also recall from the history of science the famous case of Kepler's laws which are found in a book with the title: *The Mystery of the Kosmos* (1596), and later in his *Harmony of the World* (1619). Both title and contents of these works betray the desire of a Platonic theologian and metaphysician who believed in "planet-Souls" to retrace the process and rationale of divine creation—an attempt which in Kepler's case largely employs scientific observation and in particular mathematical reasoning. As an old interpreter of Kepler's *Theology and Religion* says: "Deum ille in totius universi contemplatione, ut ipsius verbis utamur, manibus quasi palpavit et observationes siderum saepissime ad pias meditationes transtulit."[3] The results only, not the work as a whole, attract the attention of the present-day historian of science and his audience of scientists. Yet, it remains to be seen how far the true historian can afford to ignore the original setting in which the discoverer presented new knowledge. Historical truth may be endangered by the usual construction of a line of progress based on the selection of material from the modern point of view.

Modern physiology may be said to begin with Harvey's discovery of the blood circulation (published 1628). Harvey proved his point scientifically, by empirical observation and reasoning, and presented it in terms of quantitative consideration; in other words, he proceeded on lines

[1] We have no right to call this the "discovery of the lesser circulation," as Max Neuburger (*Archiv f. Geschichte d. Medizin*, XXIII, p. 7) has conclusively shown in 1930. For the early pre-Harveyan anatomists, though demonstrating the correct anatomical pathways available for the passage of blood through the lungs, did not recognize that it is the *whole* blood that passes through in the unit of time. Without knowledge of the greater there was no knowledge of the lesser circulation. Harvey thus remains the discoverer of both. Similarly Curtis wrote in 1915: "Those who so speak (sc. as though Colombo etc. were in some sort sharers in the discovery of circulation) fail to note the difference between blood and *the* blood. Although Columbus girded at Galen and corrected him, Columbus' pulmonary transit of a fraction of the blood, by curing more than one defect of the Galenic doctrine strengthened the erroneous Galenic physiology of the blood movement." (J. G. Curtis, *Harvey's views on the use of the circulation of the blood*, New York, 1915, p. 38.) Cf. also G. Sarton, *Isis* XXXV, 1944, p. 186.

[2] On this question cf. O. Temkin, "Was Servetus influenced by Ibn an-Nafis?" *Bullet. History of Medicine*, VIII, 1940, p. 731, where the main references concerning Nafis can be found. Temkin concludes that Servetus differed in two main points from Nafis which supports the suggestion that he was not influenced by him.

[3] C. F. Staeudlin, *Narratio de Joannis Kepleri theologia et religione*, Gottingae, 1793. Reprinted in: Pott-Ruperti, *Sylloge Commentationum Theologicarum*, Helmstadii, 1800, p. 141. Staeudlin refers to Epist. CCCLVIII where Kepler writes: "Nihil est, quod scrupulosius examinem quodque adeo scire desiderem, si forte Deum, quem in totius universi contemplatione manibus veluti palpo, intra me ipsum etiam invenire possim;" also to: De Cometis, L. III: "Cometa a Deo inter sidera eum in finem exhibetur, ut sit testimonium universis et singulis mortalitatis suae, utque admoneantur, decretum esse Deo, brevi bonam generis humani partem promiscuae conditionis, quacunque fati lege, ex hoc mundo transferre. . . . Monere itaque caelestem praeconem, ut pro se quilibet Deo reconcilietur, migrationi se paret, terrena ista negotia, rem, studia, liberos et similia sic componat, uti optat a discessu suo constituta et composita observari. His monitis si in commune pareatur, tunc et quem mors rapuerit, is feliciter migrabit . . . et qui longius supervixerit, cometam aliquem in praeclaros usus adhibuerit . . . nec sese ab Astrologo adeo feliciter delusos unquam indignabuntur."

similar to those of a modern physiologist. Yet it should be noted that blood circulation was only *one* idea in a world of ideas cherished by Harvey, the Aristotelian thinker and natural philosopher. It is *the* idea which made him immortal, yet the very fact that it had its place in a philosophy makes it appear different from a modern discovery.

In Harvey's time there grew up a strong opposition to Aristotle whose natural philosophy had governed the oriental and occidental mind for many centuries. It was felt to be inimical to scientific progress as it tended to subordinate observation to reasoning and insisted upon fitting it into the narrow framework of logical theories and categories. It is this feeling which actuated Bacon in formulating his principles and paving the way for the establishment of "inductive science." But the School of Padua to which Harvey belonged vigorously upheld the Aristotelian tradition. In Aristotle's world it was the heart which formed the centre of the living being and therefore deserved the main attention of the natural philosopher. It is hardly due to accident that the great masters of cardio-vascular anatomy such as Realdo Colombo (1516-59) and Fabricius of Acquapendente (1537-1619) were typical exponents of the Aristotelian School of Padua and at the same time the immediate predecessors of Harvey and his discovery. Cesalpino (1518-1603), who came even nearer to it than did Colombo was the latter's pupil and one of the greatest Aristotelian philosophers of his time. His correct estimation of the pulmonary artery as a "vas publicum" and not a "private" vessel for the nutrition of the lung parenchyma, his knowledge of the blood content of the left auricle and of the flow of blood from the heart through the lungs back to the heart, and above all his insight into the centripetal direction of the blood flow in the veins and the centrifugal flow in the arteries[2]—all these corrections of the wrong, but then ruling opinions of Galen, corrections that foreshadowed Harvey's discovery, are to be found in a book: *Questions concerning Peripatetic Philosophy* (1571), and it is significant that the great physiologist Haller (1708-77) said of Cesalpino that his concentration on the heart and abandonment of the central position held by the liver enabled him to achieve his progress in physiology, in other words that this was due to his adherence to the doctrines of Aristotle as against those of Galen. It was Aristotle who not only made the heart the origin and "principle" of the blood and the vessels, but also devoted much thinking to the logical demonstration that the circular movement is the noblest of all forms of movement and that the circular motion of the heaven forms the pattern to which motions of "sublunary" bodies, especially the microcosm of living organisms aspire. The circular motion is perfect, Aristotle said, because there is no other form of motion opposed as contrary to it (as upward and downward motion are the contraries of one another),[3] it is the only motion which is continuous,[4] it is a very great marvel for it is made up of contraries which are present together, namely motion and rest, the concave and convex, its moving simul-

[1] For the detail compare Charles Singer, *The discovery of the circulation of blood*, London, 1928. Also Sir Humphrey Rolleston, "Harvey's Predecessors and Contemporaries," *Annals of Medicine*, X, 1928, p. 323; Sir M. Foster, *Lectures on the History of Physiology*, Cambridge, 1901; Robert Willis, *William Harvey*, London, 1878; J. J. Izquierdo, *Harvey iniciador del metodo experimental*, Mexico, 1936.

[2] This has been rightly emphasized by Sir Michael Foster, *op. cit.*, p. 35. It is an important point in judging Cesalpino's actual merits and shortcomings which are not always given with the desirable clarity. I, therefore, quote what he says: ". . . nec ullum imminet periculum, ne transumptio fiat ex arteriis in cor: motus enim fit ex venis in cor caliditate alimentum trahente, simul autem ex corde in arterias, quia hac solum patet iter propter membranarum positionem: idem enim motus utraque oscula aperit venae scilicet in cor, cordis autem in arterias. Positae autem sunt hoc modo membranae, ne unquam contingeret contrarium motum fieri, quod accidere posset in vehementibus animi perturbationibus, aut aliis causis a quibus sanguinis retractio fit ad cor: obsistunt enim huic motui membranae. Nam si hae hoc modo conditae non essent, ignis cordis vel leui causa extingueretur. Si enim motus fieret contrarius, simile esset ac si flamma compingeretur deorsum ad alimentum, quod cum minime sit praeparatum, aut copiosius quam oportet, ignem suffocat . . ." *Quaestionum Peripateticarum*, Lib. V, cap. 3. Venetiis, apud Juntas, 1593, fols. 123-123'. French Transl. by Maurice Dorolle. Paris, Alcan. 1929, p. 219 ff.

Cesalpino's arguments are part and parcel of his defence of Aristotelian doctrines versus Galen and partly based on correct observation. It is a "mixture of tradition and experience, a mixture of rationalism and observation" which he presents (Dorolle, *op. cit.*, p. 87). It is thus that he still believes in the "spirits" conveyed by the arteries to the tissues and in the openings in the veins by which the tissues draw substances necessary for growth, and that he remains *ignorant* of the fact that *all* blood passes through veins and arteries in the direction which he had described so correctly, in other words that it *circulates*.

[3] Aristotle, *De Caelo*, I, 4; 270b 32 (translated by J. L. Stocks, Oxford, 1922).

[4] Aristotle, *De Generatione et Corruptione*, II, 10; 336b 38 (translated by H. H. Joachim, Oxford, 1922).

taneously to a forward and backward position.[1] No such speculations can be found in Harvey's treatises. Nevertheless his adherence to Aristotle and Aristotelian ways of thinking and observing is easy to recognize, particularly in his work on embryology and in his comparative-anatomical methods. For Aristotle may be rightly called the founder of embryology and comparative anatomy, and Harvey's master Fabricius a worthy follower of Aristotle on these lines. Harvey makes no secret of his adherence to Aristotelianism: "The authority of Aristotle has always such weight with me that I never think of differing from him inconsiderately."[2] It is the sovereignty of the heart, its independence of the brain in sense and motion, its supremacy in being "the first part which exists, its containing blood, life, sensation, motion, before either the brain or the liver were in being,"[3] in other words the main tenets of Aristotle's physiology which Harvey feels he has proved. He concludes: "The heart, like the prince in a kingdom, in whose hands lie the chief and highest authority, rules over all; it is the original and foundation from which all power is derived, on which all power depends in the animal body."[4] The stroke of genius by which Harvey welded the multitude of his observations and arguments into the concept of blood circulation, he describes himself as follows: "I began to think whether there might not be *a motion as it were in a circle*. Now this I afterwards found to be true; . . . which motion we may be allowed to call circular, in the same way as Aristotle says that the air and the rain emulate the circular motion of the superior bodies; for the moist earth, warmed by the sun evaporates; the vapors drawn upwards are condensed, and descending in the form of rain, moisten the earth again; and by this arrangement are generations of living things produced; and in like manner too are tempests and meteors engendered by the circular motion, and by the approach and recession of the sun. And so in all likelihood, does it come to pass in the body, through the motion of the blood; the various parts are nourished, cherished, quickened by the warmer more perfect vaporous spirituous, and, as I may say, alimentive blood; which, on the contrary, in contact with these parts becomes cooled, coagulated, and, so to speak, effete; whence it returns to its sovereign the heart, as if to its source, or to the inmost home of the body, there to recover its state of excellence or perfection. Here it resumes its due fluidity and receives an infusion of natural heat—powerful, fervid, a kind of treasury of life, and is impregnated with spirits, and it might be said with balsam; and thence it is again dispersed; and all this depends on the motion and the action of the heart. The heart, consequently, is the beginning of life; the sun of the microcosm, even as the sun in his turn might well be designated as the heart of the world; for it is the heart . . . which . . . is indeed the foundation of life, the source of all action."[5] Here, the circulation of the blood is visualized as the microcosmic copy of a general cosmological pattern and principle. It no longer remains a discovery of scientific detail, but obtains a position in a view of the world which is based on two main tenets of Aristotle: the excellence of the circular motion and the parallelism of the macrocosm and microcosm, that is, the universe and the living organism. We need not, therefore, be surprised that the first approval of Harvey's discovery came from the mystic Robert Fludd (1574-1637) who called Harvey his "friend, colleague and compatriot well versed not only in anatomy but also the deepest mysteries of philosophy," and his theory a demonstration that the spirit of life retains an impression both of the planetary system and of the zodiac.[6] In other words he regarded the genuine Aristotelian idea of the "fountain of life" in the living body imitating the circular movement of the "common parent and producer" in

[1] Aristotle, *Mechanica*, 847b 18 (translated E. S. Forster, Oxford, 1913).

[2] Harvey, *On Generation*, Exercise XI; *Works*, translated by R. Willis, London (Sydenham Society), 1847, p. 207.

[3] *Anatom. Disquisit., On the Motion of the Heart and Blood in Animals*, Cap. XVII; *Works, ed. cit.*, p. 83. Also in *Second Disquisit. to John Riolan jr.; ibid.*, p. 137.

[4] *Motion of Heart, ibid.*, p. 83.

[5] *Motion of the Heart*, Cap. VIII, *Ibid.*, p. 46. On the supreme rôle of the sun as "the common parent and producer or at all events the immediate and universal instrument of the Creator in the work of reproduction," and his agreement with the Aristotelian pattern of this doctrine (*De Generatione et Corruptione*, II, 10, 336b 8), see Harvey, *On Generation*, L, *Works, ed. cit.*, p. 367. It is of special interest that the passage from Aristotle quoted by Harvey occurs in the same chapter in which Aristotle illustrates circular motion (as the cause of perpetuity of coming-to-be) by the transformation of water into air, air into fire, and fire back into water—a completion of a circle because of the water reverting to itself—(*op. cit.*, 337a). This passage was referred to by Harvey in the text of "Motion of the Heart," VIII, *ed. cit.*, p. 46, as quoted above.

[6] The present writer was the first to draw attention to Fludd with reference to Harvey's discovery: see W. Pagel, "Religious Motives in the Medical Biology of the XVIIth Century," *Bulletin, Johns Hopkins Institute of the History of Medicine*, Baltimore, 1935, III, p. 277.

the bigger world of the universe, the sun, as an essential requisite of Harvey's work. It should be borne in mind that at this time Harvey was widely disbelieved and attacked by the exponents of "scientific" and professional medicine, as then understood.

In his first book, that on blood circulation (1628), Harvey had already shown an inclination to regard the blood as the original part formed and therefore the source of life. He says[1] that there are "obscure palpitations" inherent in blood and spirit, that the first thing formed is a pulsating drop of blood which is the origin of the auricles of the heart, and that the heart proper, i.e. the ventricles, does not develop until later[2]—a view which is not advanced as being at variance with that of Aristotle, and we have mentioned how he extols the heart in the true Aristotelian tradition.[3] But in his later work—that on Generation (1651)—he expresses a disagreement with Aristotle, and definitely places the heart second in dignity to the blood. Referring to the authority of the Pentateuch he says, the blood is the residence of life, "because in it life and the soul first show themselves and last become extinct."[4] And "I maintain against Aristotle that the blood is the prime part that is engendered, and the heart the mere organ destined for its circulation."[5] In Aristotle's contention the "primary nutritive soul" must be located in the heart, for this governs the region which is intermediate between that where food enters and that where excrement is discharged. It is also the starting point of the veins in sanguineous animals, while the blood constitutes the nutriment from which the organs of the animal are directly formed.[6] Warmth is the essence of life (a point with which Harvey fully agrees), but the source of this warmth according to Aristotle[7] is the heart. Genesis from seeds always starts in the middle, as seen in plants; likewise in sanguineous animals the heart is the first organ developed.[8] It has supreme control as the origin of the veins, of the blood, i.e. the final nutriment from which the members are formed, of the sensitive and nutritive soul; it is the common sensorium.[9]

It should be emphasized that it was not a materialistic tendency by which Harvey was actuated in according the blood a position of primary importance, in the sense that "it constitutes the vital principle itself." This is the wording of Willis' translation.[10] A more accurate version would probably be: "In it the vital principal inheres."[11] That such a materialistic twist was really intended by Harvey is hardly possible, as it is at variance with his many other utterances as quoted below. If it were so it would be antagonistic to Aristotle's conception of the vital principle, the Anima, which is the "prote entelecheia," the "Eidos," that is the "first grade of actuality," the "form" of a natural body (e.g. the eye) having life (e.g. vision) potentially within it, in other words something functional, the plan of form and function, but not something material such as the heart, let alone something dependent on it such as the blood.[12] It is more than doubtful whether Harvey

[1] *Works, ed. cit.*, p. 29.

[2] *Ibid.*, p. 30.

[3] See above.

[4] *On Generation*, LI, *Works, ed. cit.*, p. 376. Although it has hardly any bearing upon this discussion of Harvey's point of view it may be added that the Pentateuch has both versions. In Leviticus XVII. v. 11, we read: "ki nephesh habassar baddam hi," "for the life of the flesh is *in* the blood"; but in verse 14: "ki nephesh chol bassar," "for it *is the* life of all flesh," and it continues: "Damo b'naphsho hu," "the blood of it is for the life thereof" (Luther: "Denn des Leibes Leben ist *in* diesem Blut, solange es lebet," and a little later in the same verse also: "Denn des Leibes Leben ist *in* seinem Blut," although the text says again: "ki nephesh chol bassar damo hi," "for the life of all flesh is the blood thereof"). In commenting on "Damo b-naphsho hu" Rashi says—the soul (i.e. the vital spirit) is suspended in it ("sche-hanephesh th' lujah bo"), the sense obviously being of both occurring in the same place. And on Deuteronomy xii, 23: the prohibition of eating blood is because it is regarded as the living part of an animal. On the biblical ideas of "Soul and Blood" see the comprehensive account by F. Delitzsch, *System der biblischen Psychologie*, 2nd ed., Leipzig, 1861, p. 238 ff.; also H. Leisegang, *Der Heilige Geist. Wesen und Werden der mystisch-intuitiven Erkenntnis in der Philosophie und Religion der Griechen*. Leipzig and Berlin, 1919, I, i, p. 94.

[5] *Ibid.*, p. 374.

[6] *De Respiratione*, XIV; *Parva Nat.*, 474b (translated by G. R. T. Ross, Oxford, 1908).

[7] *De Iuvent. et Senect., Parva Nat.*, 469b.

[8] See above.

[9] *Ibid.*, 469a; see also *De part. animal.*, III, 665b; *De Somno et Vigil*, 456a.

[10] *On Generation, Works, ed. cit.*, p. 376.

[11] The Latin text runs as follows: "in eo (namely: sanguine) primum calor animalis innascitur, spiritus vitalis ingeneratur et anima ipsa consistit." Lewis and Short's Latin-English dictionary gives as meanings of *consistere*, to place oneself anywhere, to stand still, take a position. It also gives to subsist, be, exist, as among the meanings of the word—that is the sense in which it has been taken by Willis. It might be argued in favour of this interpretation that it says a little later: "Fabricus well reminds us that however distinct are the artist and the instruments in things made by art, in the works of nature they are still conjoined and one. In like manner are the vital principle and its instrument immediately conjoined."

[12] See *De Anima*, II, 1, 412a ff. (translated by J. A. Smith, Oxford, 1931) and for the rejection of the theory that the soul is the blood, *ibid.*, I, 2, 405b.

really meant to identify "Soul" with "Blood." In most places he speaks of life residing, revealing itself and the soul *in* the blood where there are "the lares and penates of life enshrined" and "the vital principle itself *has its seat*."[1] Rather than the embodiment of the soul, the blood appears to be, according to Harvey, its vector, in the same way as Van Helmont regarded "Gas" as the vector of specificity, and the "Gas" in the blood as the vector of Life.[2] This, however, is not meant in the sense of Scaliger and Fernelius who believed that the vital principle ("soul"), i.e. "heat" and "spirits" are *added* to the blood which, by itself, cannot display any activity superior to that of its elemental constituents. It is, in the present author's opinion, because of its materialistic implications that Harvey deprecates such view. In the same way he militates against the elemental faculties being held responsible for the excellence of the blood. Just as there exists in the semen, says Harvey, something which makes it generative and exceeds the powers of the elements in building an animal, there dwells in the blood some power which acts beyond the power of elements, its chief function being nutrition and preservation of the parts of the body. It is a nature and indeed a "soul" inherent *in* the blood, neither a fire, nor something that takes its origin from fire or from an astral element.[3] Harvey is sceptical towards the rôle of the elements and indeed to their existence in the sense of the ancient and contemporary doctrines, thereby closely following the vitalistic argument as advanced by Van Helmont[4] and later taken up, on the strength of further empirical (chemical) findings by Boyle. "The so called elements are not prior to those things that are engendered, but rather are subsequent thereto; they are remainders rather than principles. Neither Aristotle himself nor any one else has ever demonstrated the separate existence of the elements in the nature of things, or that they were the principles of bodies which consist of parts similar to one another."[5]

If, then, blood and "soul" are identical, the latter, however, being neither the product of the elemental constitution of the blood nor of something "ethereal" ("heat," "spirit" or "astral body") added to it, "soul" can mean nothing but the natural function inherent in blood which acts as the material substratum necessary for the appropriate effects to be obtained in physical life. Only as far as the blood displays a certain function ("virtues and powers") i.e. not blood substance by itself, but blood flowing in its proper channels, can it be called "spirituous" or "celestial."[6]

As Joseph Needham has pointed out, Harvey's leanings were vitalistic and "he argues against both those who wished to deduce generation from properties of bodies (like Digby) and the Atomists (like Highmore)."[7] In other words, his views were anti-materialistic in the true Aristotelian tradition. Harvey says: "It is a common mistake with those who pursue philosophical studies in these times, to seek for the cause of diversity of parts in diversity of the matter whence they arise. Thus medical men assert that the several parts of the body are both engendered and nourished by diverse matters, either the blood or the seminal fluid. . . . Nor do they err less who, with Democritus, compose all things of atoms; or with Empedocles of elements. As if *generation* were nothing more than a separation, or aggregation or disposition of things. It is not indeed to be denied that when one thing is to be produced from another all these are necessary, but generation itself is different from them all. I find Aristotle to be of this opinion; and it is my intention, by and by, to teach that out of the same albumen (which all allow to be uniform, not composed of diverse parts) all the parts of the chick, bones, nails, feathers, flesh, etc., are produced and nourished. Moreover, they who philosophize in this way, assign a material cause (for generation), and deduce the causes of natural things either from the elements concurring spontaneously or accidentally, or from atoms variously arranged; they do not attain to that which is first in the operations of nature and in the generation and nutrition of animals; viz., they do not recognize that efficient cause and divinity of nature which works at all times with consummate art, and providence and wisdom, and ever for a certain purpose, and to some good end; they derogate from the honour of the Divine Architect, who has

[1] *On Generation, loc. cit.*, p. 376.

[2] W. Pagel, "Religious and Philosophical Aspects of Van Helmont's Science and Medicine," *Bulletin, John Hopkins Institute of the History of Medicine*, Baltimore, 1944, Supplement No. 2, p. 20; also: *Id.*, "J. B. Van Helmont," *Nature*, CLIII, 1944, p. 675 and *Brit. Med. J.*, I, 1945, p. 59.

[3] *On Generation, ed. cit.*, LXXI, pp. 505-507.

[4] W. Pagel, *op. cit.*, 1944, p. 3 ff.

[5] *On Generation, ed. cit.*, LXXII, p. 517.

[6] *On Generation, ed. cit.*, LXXI, pp. 507 and 510.

[7] Joseph Needham, *History of Embryology*, Cambridge, 1934, p. 120.

not contrived the shell for the defence of the egg with less of skill and of foresight than he has composed all the other parts of the egg of the same matter, and produced it under the influence of the same formative faculty."[1]

It is thus that Harvey establishes the immateriality of the vital principle in the sense of Aristotle, against the crude materialistic and pseudo-idealistic ("animistic") theories of his time.

A further point which may be mentioned in this connexion is Harvey's denial of the entry of air into the blood, the "concoction" of the latter in the lungs and the diversity of arterial and venous blood in quality. As Curtis[2] has shown, the transit of the blood through the lungs was no essential requisite for the discovery of circulation. But apart from that it is tempting to suggest that Harvey's ulterior motive for his denial of the above points was the tendency to remove all reasons for a materialistic derivation of the vital function of the blood from air entering it.

To divest the "Vital Principle" from all such materialistic notions is clearly the aim of Aristotle's treatise "On the Soul"—in spite of the "life giving" qualities which the philosopher attributed to the "psychical" or "generative" heat of the sun and animals elsewhere in his writings.[3] Harvey's adherence to the Aristotelian interpretation of the "Soul" as something functional, which he located in the blood, seemed thus to be the result of his philosophical conviction rather than the fruit of despair to which "the lifelong thinker upon the meaning of the circulation" (Curtis)[4] was driven by his ignorance of the oxygenation of the blood. We agree, however, with Curtis that Harvey saw both circulation and "the prodigious history of generation" in the same light and, as the present author would add, as the fundamental microcosmic cycles which determined the position of the smaller world of the organism in the macrocosmos of the celestial bodies.

It was this philosophical view which, to Harvey, consummated the ultimate meaning of these biological processes. Boyle tells us that Harvey was led to his discovery by the reflection "that so provident a cause as nature had not so plac'd many valves without design,"[5] that is without a consideration of the final causes in the true Aristotelian sense—for it was Aristotle who had said that: "Nature, like Mind, always does whatever it does for the sake of something, which something is its end."[6] But, to Harvey, adherence to Aristotelian philosophy did not mean subjection of empiricism to reasoning, for he refers to Aristotle's advice: "Faith is to be given to reason if the matters demonstrated agree with those that are perceived by the senses; when the things have been thoroughly scrutinized, then are the senses to be trusted rather than the reason."[7] Moreover, he says against those who had attacked him for having refuted the authority of Galen: "The facts cognizable by the senses wait upon no opinions, and the works of nature bow to no antiquity; for indeed there is nothing either more ancient or of higher authority than nature."[8]

To sum up: I am not concerned with the question whether Harvey's general attitude was "reactionary" or "progressive,"[9] for the tremendous progress achieved by his discovery needs no discussion. But I endeavour to show that only a process of abstraction from a world of 17th century ideas will take it to the level of modern physiological research and that this abstractionendangers

[1] *On Generation*, Exerc. XI, *Works, ed. cit.*, pp. 206-7.

[2] J. G. Curtis, *op. cit.*, pp. 38-53.

[3] *De gener. anim.* 762a 18-24 as against *De Anima* 416a 9-18.

[4] *Op. cit.*, p. 152.

[5] Pagel, *Religious Motives*, etc., p. 309.

[6] Aristotle, *De Anima*, II, 4, 415b (Smith's translation).

[7] Aristotle, *De Generatione Animal.*, III, 10. Harvey, *Second disquisition to Riolan, Works, ed. cit.*, p. 131; and Introduction to *De Generatione, ibid.*, p. 158.

[8] *Second Disquisition on Circulation to J. Riolan jr., Works, ed. cit.*, p. 123. See also in *On Generation, ibid.*, p. 332 (Exerc. XLIV): Fabricius went astray in seeking a certain part of the egg as the matrix of the chick, "mainly, as it seems, that he might not be found in contradiction with Aristotle's definition of an egg . . . And so it happens to all, who forsaking the light, which the frequent dissection of bodies, and familiar converse with nature supplies, expect that they are to understand from conjecture, and arguments founded on probabilities, or the authority of writers, the things or the facts which they ought themselves to behold with their own eyes, to perceive with their proper senses . . . They who philosophize in this way, by tradition, if I may so say, know no better than the books they keep by them."

[9] G. H. Lewis, *Aristotle. A chapter from the History of Science*, London, 1864; T. H. Huxley, *Errors attributed to Aristotle.* "Science and Culture," 1881, p. 180; H. Cassirer, *Aristot. Schrift "Von der Seele,"* Tübingen, 1932, may be consulted with reference to Aristotle's achievements as compared with modern science, and Joseph Needham (*op. cit.*, p. 128 ff.) with reference to Harvey as embryologist.—R. Willis in *William Harvey*, London, 1878, as well as E. Radl, *Geschichte der biologischen Theorien in der Neuzeit*, 2nd edition, Leipzig and Berlin, 1913, I, p. 134 ff., mention the Aristotelian bias particularly of Harvey's embryology.—By far the best and most comprehensive synoptic comparison of Aristotle and Harvey was given by Curtis, *op. cit.*, throughout.

the historical understanding of this chapter in the history of medicine. I mean by "historical understanding" an attempt at evolving a medical theory or discovery from the world of ideas cherished by its author and his period without regard to their scientific or non-scientific character and value. Instead of separation such an attempt will demand reconstruction of all the elements underlying the process of "invention,"—scientific, philosophical, religious and other contemporary trends of thought[1]—re-statement of scientific results in their original setting, examination of the "savant" in all the aspects which he presents[2] and the influence which these had on each other. In thus following neglected ways of medical historiography our aim is to outline spheres of ideas centred around the individual scientific worker rather than to construct lines of progress based on a dismemberment of these spheres.[3]

It may be objected, however, that such spheres do not really exist, that non-scientific sentiments are not and never have been of any significance for a scientific worker and that where they appear they are not meant seriously but are merely figures of speech, poetical arabesques adorning a dry scientific text or an old-fashioned clumsy language, a cloak in which the ancient author had to present his knowledge in a then customary way. In Harvey's case, with which we are chiefly concerned here, such criticism is obviously false. His book on *The Motion of the Heart and Blood* is famous for its small size, for its conciseness, its clear language, its logical structure in which fact follows on fact, argument on argument, proof on proof. Yet Harvey himself thought it worth while to devote a few of its precious pages to Aristotelian philosophy.

* * *

The intimate blending of scientific detail with philosophy and religion is even more obvious in another naturalist of the early 17th century, Harvey's contemporary, J. B. Van Helmont (1579-1644). In almost all his treatises we find so many non-scientific elements that they must be regarded as essential and cannot be ignored when the story of his discoveries in science is related.

We are told that Van Helmont discovered "gas." This is perfectly true. Van Helmont was the first to distinguish air and water vapour on the one hand from "gas," notably carbondioxyde and the other "gases" which he had isolated, on the other. But it is not the whole truth. The discovery of

[1] A masterly appreciation of Harvey's position in the history of European thought has been given by H. E. Sigerist in *Archiv f. Kulturgeschichte*, XIX, 1928, p. 158; also in *Man and Medicine*, New York, 1932. Here Harvey is seen as the typical exponent of the spirit of the Baroque period, which dissolved the strictly linear and finite, i.e. "static," forms in which the Renaissance had represented things into the perspective of things infinitely moveable, "dynamic," and consequently created Physiology, whereas Anatomy emerges as a typical product of the Renaissance spirit.

[2] One of these aspects is the "psychology" of the thinker and his views, as Jago Galdston has shown in a recent paper on Descartes and Modern Psychiatric Thought (*Isis*, XXXV, 1944, p. 118).

[3] It is only on these lines that, in the present author's opinion, the question of the "precursor" can be answered. It is perfectly true that Dutrochet was the precursor of Schwann in that he established the Cell-Theory 15 years before the latter, using the same means of histological investigation and reasoning, as A. R. Rich has shown in a brilliant paper. ("The place of R. J. H. Dutrochet in the Development of the Cell-Theory," *Bullet. J. Hopkins Hosp.*, 1926, XXXIX, p. 330.) Both Dutrochet and Schwann originate in the same "sphere of ideas," in the same cultural background. It is open to doubt, however, whether, for example, Henricus Langenstein, a late 14th century scholastic, can claim to be the "precursor" of Van Helmont. As Lynn Thorndike pointed out, it was Langenstein who stated that the exhalations from water are aqueous, those from earth are nothing but earth, and those from putrefying corpses are merely flesh in a "subtiliated" condition—in other words he recognized different kinds of "subtiliated" matter, and the question arises whether this can be compared or even identified with Van Helmont's contention that "Gas" represents a "*specific*" object in a volatile condition and should be distinguished from common water vapour or air. As D. B. Durand shows, however, "a very considerable portion of the "advanced" notions of Henry of Hesse (Langenstein), and for that matter of Oresme and others of this group are the direct outgrowth of subtle speculative elaboration of the Aristotelian text ("Magic and Experimental Science. The Achievement of Lynn Thorndike," *Isis*, 1941, XXXIII, 691; see here the references to Thorndike's book and the relevant passage from Langenstein). Langenstein's achievements are derived from his hermeneutic and scholastic activities, Van Helmont's discovery of "Gas" is partly a product of experimental-scientific work of a 17th century author who admittedly was stimulated by religious ideas, but decidedly deprecated scholastic argumentation and the authority of Aristotle or anybody else. He was partly actuated by non-scientific ideas and motives, but these were fundamentally different from those of Langenstein and his time (see the following chapter in the present paper). With regard to Paracelsus as a "precursor" of modern Science and Medicine compare A. Koyré, "Paracelse," *Revue d'Histoire et de Philos. religieuses*, 1933, XIII, pp. 46 and 145 ff.

"gas" as a physico-chemical, i.e. scientific entity is partly a product of Van Helmont's quite unscientific idea of detecting the divine spark implanted in things when created, their "seed" containing the plan of form and function, their "time-table" of development towards a destined end, something "spiritual," yet of finest corporality which could not be apprehended unless its coarse material cover was removed. The "spagyric" art of chemistry, the "Philosophy by Fire," that is the employment of combustion, seemed to Van Helmont the most promising method to attain his end. He found that charcoal, heated in a closed vessel, will never substantially disappear, but will be almost completely transformed into a "wild spirit"—called "wild" because it cannot be held in an open vessel and solidified. Van Helmont felt that this is a new entity for which he had to coin a new term—"gas." He argued that each organized body in nature (i.e. everything that is not insipid water or air) contains "its" gas, a spirit, under normal conditions, "concrete" or "coagulated like a solid body" and thereby kept dormant. The whole body, however, may become volatile, and reveal its gaseous nature, when it has combined with an appropriate "ferment" such as can be seen in fermenting grapes when left lying about with their skin damaged. If the skin is intact, however, and the ferment thus prevented from access, they simply dry up without liberation of "their" gas. Gas is, therefore, to Van Helmont, unlike water vapour and air, no common volatile medium of which all things partake, but something specific, it is the material vector of specificity, such as the "life-spirit" in our blood, a vital principal present in all things, in organic beings more easily perceptible than in inorganic objects. Van Helmont set out to search for the divine spark in beings and discovered a scientific, a chemical entity.

That it is not simply 17th century style and language which account for the philosophical and religious aspects of the authors discussed, is also shown by the fact that other contemporary savants do not present any such aspects, to cite only the two examples of Galileo and Santorio.

A further objection which may be raised is that nowadays, work in the laboratory, the approach to scientific ideas and choice of problems will be unaffected by non-scientific considerations, such as strong adherence to Catholicism which hardly influenced the scientific work of such people as Theodor Schwann (1810-82) or Louis Pasteur (1822-95). But the situation of the modern scientist substantially differs from that in which the earlier scientists found themselves. Then, there were no university departments, no laboratories in which professors and their staff of specially trained assistants devoted time and public means to specialized and well-defined scientific tasks. Science, then, was rather in the hands of individuals, wealthy noblemen such as Van Helmont and Boyle, of adventurers, or of men like Paracelsus (1493-1541) and his followers, mostly vagrant doctors and alchemists, or of clergymen such as formed the nucleus of the Royal Society,[1] with the result that

[1] "Pious Science" is the subject of an essay by Joseph Glanvill (1636-1680), chaplain to Charles the Second, friend of Robert Boyle and zealous advocate of the Royal Society, entitled: "The usefulness of Philosophy (i.e. science) to Theology" (1671, reprinted in *Essays in several important subjects in Philosophy and Religion*, London, 1676). It sets out to prove: (1) That God is to be praised for His works; (2) That His works are to be studied by those that would praise Him for them; (3) That the study of Nature and God's Works is very serviceable to Religion; (4) That the Ministers and Professors of Religion ought not to discourage, but promote the knowledge of Nature, and the Works of its Author. For "acquaintance with nature assists Religion against its greatest Enemies which are Atheism, Sadducism, Superstition, Enthusiasm, and the Humour of Disputing" (p. 6). Thus the magnifying glass will discover more beauty and uniformity of contrivance in the natural objects than is seen with the naked eye, and also their perfection as against the "Flaws, Deformities and Imperfections" which it will uncover "in our most elegant Mechanicks . . . so that if any are so brutish as not to acknowledge him up on the view of the mere external frame of the Universe they must yet fall down before the evidence when Philosophy hath opened the Cabinet, and led them into the Jewel-house and shewn them the surprising variety that is there." And against the mystic believers in miracles: "I say, If we know no further than occult Qualities, Elements, Heavenly Influences and Forms, we shall never be able to disprove a Mechanick Atheist" (i.e. pretenders to the Mechanick Principles, viz. those of mere Matter and Motion), "but the more we understand of the Laws of Matter and Motion, the more shall we discern the necessity of a wise mind to order the blind and insensible Matter, and to direct the original Motions; without the conduct of which, the Universe could have been nothing but a mighty chaos, and mishapen Mass of everlasting Confusions and Disorders" (p. 8). Science ("Philosophy") will decide what "a spirit is; and whether there be spirits, or not," whether these (namely angels and souls) are only a finer sort of matter or a different kind of beings. Science concludes from "divers operations in our own Souls" that there is a sort of beings which are not matter or body, "viz. Beings self-motive, penetrable and indivisible; Attributes directly contrary to those of Matter which is impenetrable, divisible and void of Self-motion." "Now by stating the Nature, and proving the existence of Spirits, a very considerable service is done to Religion: For hereby our notion of the adorable Deity is freed from all

"Philosophia Naturalis," Nature in all its aspects, scientific, theological, metaphysical, cosmology in the widest sense, was the early scientist's concern. This can be seen not only in the two examples given, but in many others of whom Francis Glisson (1597-1677), Robert Boyle (1627-91) and John Ray (1628-1705) may be cited. As far as depth of philosophical thinking and insight into theoretical biology are concerned, Glisson is superior to his contemporaries. His idea of forces immanent in matter and of living beings constituting units with physical and psychic aspects not essentially different from each other, does away with the concept of inert matter as opposed to "Soul" or "Thinking" which act *on* the former in a way which has never been explainable in a biologically satisfactory manner. Van Helmont's concept of "Gas" implied a recognition of the immanence of force in "organized" matter, but still retained the idea of an inert universal menstruum which he called "Water." Glisson, abolishing the concept of inert matter altogether, thus stands between Van Helmont and Leibniz who developed Glisson's concept into "Monadology."[1] It is hardly accidental that Glisson who emphasized the immanence of force in matter introduced the concept of "Irritability" into biology, i.e., the notion of vital response inherent in tissues, particularly fibres. It was Glisson who consequently discovered the action of sphincters and the rhythmic impulses therein.

It is worthy of note that Glisson, like Harvey, was deeply influenced by Aristotelian philosophy and based many of his deductions on the work of the Neo-Aristotelian schoolman, Suarez.

No religious motives and concerns are recognizable in Glisson and Harvey, the Aristotelian philosophers and naturalists. Such motives are prominent in Van Helmont's as well as Boyle's and Ray's views, with the difference, however, that the shallow deistic views of "design in nature" as expounded by the latter are easier to separate from their scientific work than are the "pneumatic" and "emanatistic," neo-platonic trends in Van Helmont's thought.[2]

There is, therefore, no need to "excuse" Harvey's Aristotelianism as the spirit of his time and his school, or to blame him for having introduced unscientific elements in that he followed Aristotle not only in his "correct" but also in his speculative ways. Nor is it true that Harvey was "in reality" a mechanistic thinker who for traditional or domestic reasons endeavoured to attain an outward

material grossness, in which way those must conceive him, that acknowledge nothing but Body in the World" (p. 9). This illustrates the significance which Van Helmont's discovery of Gas must have had for wide circles of contemporary society beyond those of actual scientists. It may be added, however, that Glanvill's dualistic tendencies are quite different from the much deeper philosophical insight which Van Helmont possessed. Glanvill declares himself satisfied with the deistic version given to the "Corpuscularian Hypothesis" by its "late restorers" who "hate and despise the wicked and absurd doctrine . . . of the World's being made by a fortuitous concurrence of atoms . . . : and this those of Epicurus his Elder School taught. . . . But thus far they think the Atomical Philosophy reasonable, viz. as it teacheth, That the Operations of Nature are performed by subtile streams of minute Bodies; and not by I know not what imaginary Qualities and Forms; They think, That the various Motions and Figures of the parts of Matter, are enough for all the Phænomena, and all the varieties which with relation to our senses we call such, and such Qualities. But then they suppose, and teach, That God created Matter, and is the supreme Order of its Motions, by which all those Diversities are made: And hereby Piety, and the Faith of Providence is secured" (p. 33). This obviously alludes to the deistic view as expounded by Boyle.

[1] The present writer endeavours to pursue the conceptual line leading from Helmont, Glisson and Leibniz to such modern scientific entities as cellular biology and cellular pathology, and their forerunners in the "romantic" Natural Philosophy of the early 19th century. (W. Pagel, "The speculative background to modern Pathology; Jahn, Virchow and the Philosophy of Pathology," *Bulletin, Johns Hopkins Institute of the History of Medicine*, XVIII, 1945, p. 1. On Glisson as "precursor" of Leibniz see: H. Marion, *Franciscus Glissonius quid de natura substantiae s. vita naturae senserit et utrum Leibnitio de natura substantiae cogitanti quidquam contulerit.* Thèse. Paris, G. Baillière, 1880. It was V. Cousin who first asserted some dependence of Leibniz on Glisson. The present author hopes to resume the question at a later date.

[2] On Van Helmont see W. Pagel, *Religious and Philosophical Aspects.* On the religious views of Boyle see particularly George Wilson, *Robert Boyle*; reprinted in *Religio Chemici. Essays.* London and Cambridge, 1862, p. 165 ff. Wilson says (*op. cit.*, p. 248): "Boyle . . . was a Christian philosopher. Foolish as this world is, it contains many philosophers; wicked as it is, it contains many Christians; but not many Christian philosophers. Boyle was one of the few who, from time to time, are granted to us by a kind providence to make us wiser and better. He was not a Christian on the Sundays, and a philosopher on the week days; a Christian over his prayer-book, and a philosopher over his air-pump . . . He studied Nature, not as a veil hung between man and God, but as the works of Him, without whom 'was not anything made that was made'. . . ." See also: L. T. More, *The Life and Works of the Honourable Robert Boyle*, Oxford, 1944, pp. 136-188; also W. Pagel, *Religious Motives* (1935), p. 305 ff. On Ray see his work, *The Wisdom of God manifested in the works of the creation*, London, 1691; see also Radl, *op. cit.*, p. 163, on "Epigonenbiologie."

reconciliation of his views with Aristotle's vitalism. We have seen that Harvey rejected materialistic ideas notably that of generation being a process of separation, aggregation and disposition of things in the atomistic sense. Harvey says, it is his aim to demonstrate that out of the same uniform albumen all the parts of the chick including its bones are formed, without a material cause such as the arrangement of atoms or the properties of bodies as due to spontaneous or accidental concurrence of elements. We have collected evidence against the assumption that Harvey regarded the blood itself as constituting the vital principle. His idea that the semen acts like a "contagium" and not by contributing organic material is in conformity with his vitalistic trends of thought, although in this point they are at variance with the much more materialistic theory of Aristotle. We have, therefore, no reason to doubt that they are genuine, for they are consistent in themselves, they are stated repeatedly and with particular emphasis and thus represent the purport of Harvey's embryology just as much as the first introduction of the scientific element, namely time-series of empirical observations, the element which is usually given as the original and genuine feature of his work. It is true that the emergence of science and the consideration of the quantitative relationship between things as introduced by Harvey marks out the spirit of the Baroque-period and its "dynamism." Not science or mechanistic thinking pure and simple, however, but science associated with and developing from non-scientific views of the world characterize this period.

PRINTED IN ENGLAND BY
EBENEZER BAYLIS AND SON, LTD., THE TRINITY PRESS,
WORCESTER, AND LONDON