

# MICHAEL SERVETUS

## HIS IMPORTANCE IN THE HISTORY OF MEDICINE

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The twenty-seventh of October 1953 was the four hundredth anniversary of the martyrdom of Michael Servetus in Geneva. It is therefore natural that there should recently have been a revival of interest in the life and works of this great Renaissance figure, if indeed this interest can ever be said to have died. Two American scholars have honoured the occasion by producing books which are of the greatest value to those who wish to study Servetus. Professor C. D. O'Malley of Stanford University has published an annotated translation of Servetus' geographical, medical and astrological writings. This translation is superior to any that has so far appeared, particularly in the faithfulness with which he has reproduced the meaning of the original Latin for the modern reader. Professor John F. Fulton of Yale has published a distinguished monograph on the life and death of Servetus. To it has been added a detailed and authoritative bibliography of Servetus' works by Miss Madeline E. Stanton, Librarian at Yale Medical Library, together with a census of known copies of these rare volumes.

This is not the place to repeat the details of Servetus' career. The aim of this article is to draw attention to and discuss the importance of his statements about the vascular system, widely celebrated as the earliest deviation from Galenic physiology. The few pages in which they are found, for which Servetus holds an honoured place in the history of the development of anatomical and physiological knowledge in the Renaissance, occur as an integral part of a theological work entitled *Christianismi Restitutio* and published in 1553, which led to his execution for heresy that same year. These statements about the heart and lungs apparently attracted no attention for about 140 years

and were certainly unknown to Harvey when he published his discovery of the circulation of the blood in 1628. It has been suggested that Servetus' statements nevertheless indirectly influenced Harvey since they were known to—but not acknowledged by—Realdus Columbus, one of the writers whom Harvey quotes.

Since the re-discovery of Servetus' work a constant succession of medical historians have commented on the strange physiological interlude in what is otherwise a wholly theological work. So efficiently did the ecclesiastical authorities destroy the volume which they considered heretical that only three copies are known with certainty to have survived. It is thus not surprising that garbled and incorrect versions of what Servetus wrote were current for many years. Those interested in medical history therefore owe a great debt to the two American scholars already mentioned—O'Malley for his scrupulously accurate translation of Servetus' work and Fulton for his admirable essay and bibliography, which includes a facsimile reproduction of the two pages containing the essential part of Servetus' description of the heart and lungs, taken from the original 1553 edition. With such assistance, first-hand study of early writers is made possible for those who are remote from the original sources and—sad commentary on learning in this age—so often deficient in Latin.

### THE BELIEFS OF GALEN

In order to appreciate Servetus' contribution it is necessary to rehearse what was generally believed in the sixteenth century to have been Galen's teaching about the movement of the blood. These beliefs were so strongly supported by ecclesiastical authority as to

constitute dogma, deviation from which was heresy. It must be noted that what was understood in the sixteenth century to be the teaching of Galen (who lived in the second century A.D.) was not necessarily what he actually wrote. Prendergast (1928) has shown by a careful and detailed study of surviving texts that Galen recorded, in different parts of his voluminous writings, different and sometimes contradictory statements about the movement of the blood. But in the Middle Ages his teaching was generally taken to have been along the following lines:

To Galen there were three important organs in the body, viz. the liver, the heart and the brain. Each of these was associated with a system of conduits, the liver with the veins, the heart with the arteries and the brain with the nerves (which were believed to be hollow). In each system of tubes there was found a different substance or fluid, charged with a specific *pneuma* or spirit. In the system of veins the venous blood containing 'natural spirit' was manufactured by the liver from the products of digestion of food in the gut. This ebbed and flowed to and from all parts of the body, according to the specific needs of each part. The right side of the heart was part of this system and the venous blood entered the *vena arteriosa* (i.e. the pulmonary artery) and was cleansed of impurities in the lungs by the process of respiration. The second system of vessels, the arteries, contained a different sort of blood charged with 'vital spirit'. This was manufactured in the left ventricle from venous blood which had been changed in some mysterious way during its passage from the right to the left ventricle *through the invisible channels which perforated the ventricular septum of the heart*. This changed blood was combined in the left ventricle with air brought to the left side of the heart by the *arteria venosa* (i.e. pulmonary vein). Arterial blood was distributed, again by ebb-and-flow movements, to all parts of the body. In the brain a third type of *pneuma*—'animal spirit'—was created and distributed to the body by nerves (believed to be hollow).

In the abbreviated account given above no mention has been made of the detailed functions of the three *pneumata*. It must be admitted that, if Galen's premises are accepted, his concept is ingenious and self-consistent, including and explaining all the facts known to him about the functions of the body. From a modern standpoint the system may appear somewhat grotesque, but then we have the advantage that William Harvey discovered and taught the circulation of the blood over three hundred years ago: Apart from the error inherent in the ebb-and-flow concept of blood movement, Galen made two errors (from a modern point of view) in his account of the blood (or rather the two kinds of blood) and its movements. The first error is quantitative and has been clearly expressed by Franklin (1949). According to the Galenic system only as much blood would move from the right to the left ventricle as is used up by the tissues at the periphery of the arterial system. Franklin stated that over a period this would roughly equal the amount of venous blood manufactured from the products of digestion by the liver. Now this equation is perhaps somewhat simplified, since it ignores the quantity of venous blood which might, according to Galen's ideas

be consumed by the tissues at the periphery of the venous system. However, it does make it quite clear that the *amount* of blood transferred from right to left ventricle would be relatively small and the rate of flow correspondingly slow. The second error in Galen's system is the famous anatomical one: there are no passages, visible or invisible, through the ventricular septum of the heart. The influence of Servetus' work in correcting these two errors will be discussed below.

#### SERVETUS' CONTRIBUTION

Having described the framework of physiological ideas current in Servetus' times, let us turn to Servetus himself. In the celebrated passage of the *Christianismi Restitutio* (pp. 168-173), Servetus begins by describing how the divine spirit is a breath of air which God breathed into Adam's nostrils at the Creation and which He gives to every man who breathes. This is supported by numerous quotations from the Bible and from classical authorities. From the outset he thus focuses attention on the process of respiration and therefore on the lungs. Next he deals with the question of the three spirits (natural, vital and animal). There are not three spirits but rather one divine spirit, he writes. Yet he allows that this exists in three forms in the three systems, so that he does not in effect contradict this aspect of the Galenic system. Next follows further discussion of the Creation of Adam, during which he draws attention to the presence of an artery and a vein in the umbilical cord of the foetus. He philosophizes on this point, showing how artery and vein 'are always joined in us'. The next involved and—to modern minds—obscure passage ends with the statement that the 'divine spirit is in the blood', rather than in the walls of the heart, the brain or the liver. Bainton (1951) explains the attraction which the idea of the soul residing in the moving blood would have had for Servetus.

The next three paragraphs are those on which Servetus' fame in medical history depends. They deal with the creation of 'vital spirit', which is distributed by the arteries from the left side of the heart. After some phrases describing the qualities of this spirit, he writes:

'It is generated in the lungs from a mixture of inspired air with elaborated, subtle blood which the right ventricle of the heart communicates to the left.'

This is the general statement; he then proceeds to the details. The exact order of the following statements seems important, and they are therefore quoted in full:

'However, this communication is made not through the middle wall of the heart, as is commonly believed, but by a very ingenious arrangement the subtle blood is urged forward by a long course through the lungs; it is elaborated by the lungs, becomes reddish-yellow and is poured from the pulmonary artery into the pulmonary vein. Then in the pulmonary vein it is mixed with inspired air and through expiration it is cleansed of its sooty vapors. Thus finally the whole mixture, suitably prepared for the production of the vital spirit, is drawn onward from the left ventricle of the heart by diastole.'

It can be seen how Servetus visualizes the blood being *first* elaborated by the lungs, becoming reddish-yellow—evidently changing in some mysterious way—and *then* passing to the pulmonary vein where it is mixed with the inspired air. The reference at the end of the passage



to diastole as the process by which the blood proceeds from the left ventricle reflects the belief that diastole was the active process of the heart and arteries; this belief was first corrected by Harvey.

Servetus next gives the reasons which led him to this new conception. First he remarks on the 'different conjunctions and the communication of the pulmonary artery with the pulmonary vein in the lungs'. By conjunctions it is fair to assume that he referred to the numerous branches of the pulmonary artery and veins which are found lying together. The communication between them he could not, of course, observe, but they had been postulated by Galen and were in any case necessary to his 'long course through the lungs'. Second, he considers that the great size of the pulmonary artery indicates that it does more than simply nourish the lungs. Moreover (as Galen had shown) in the embryo the blood avoids the lungs, which must therefore be 'nourished from elsewhere'. Consequently when blood enters the lungs at the time of birth it must be 'for another purpose', i.e. not only to nourish the lungs. This observation was sound and a true advance on the views of Galen. It was, as can be seen, an anatomical observation. Third, Servetus reiterates the belief that the change in the blood and the mixture of air and blood do not take place in the heart, but in the lungs—this because he considers the left ventricle to be too small for the purpose—nor does the ventricular septum possess the 'vessels and mechanisms' necessary for the elaboration of the vital spirit, 'although something may possibly sweat through'. This last reservation indicates that Servetus could not completely free himself from Galenic doctrine on this point.

The vital spirit, elaborated in the way described, according to Servetus is 'transfused from the left ventricle of the heart into the arteries of the whole body . . .'. Fulton (1953) interprets this passage to indicate that Servetus had some idea of the greater circulation. However, without further evidence, it does not seem necessary to infer that by these phrases he meant anything more than was implicit in the Galenic distribution of vital spirit through the arteries, despite the fact that he does not specifically mention the ebb and flow of blood in them. Some support is lent to this simpler explanation by the context of the passage. The next two pages of Servetus' book are concerned only with the creation of 'animal spirit' from 'vital spirit' in the brain and its distribution to the sense organs of the body by way of the nerves; there is no suggestion of a *return* of the blood from the periphery, which, after all, is the *sine qua non* of a circulation. The remainder of the passage in Servetus' book which O'Malley translates is not of importance to the present discussion, being concerned with the functions and disorders of the brain and the situation of the soul.

#### THE NATURE OF HIS CONTRIBUTION

It is a remarkable fact that, despite 250 years of discussion, commentators are by no means agreed on the significance and importance of Servetus' contribution. A recent example of disagreement may be found in Trueta (1954), who challenges O'Malley's (1953) opinion that the basis of Servetus' conception is to be found in Galen's

writings. If that were so, Trueta argues, why had not others noticed this passage of Galen's before? Surely the explanation is that those who believed in the short septal route from the right to the left ventricle had no need to consider an alternative. As to whether Galen was of any assistance, Harvey is an eloquent witness, for in the seventh chapter of *De Motu Cordis* he quotes Galen at length in support of his views on the existence of the pulmonary circuit.

Trueta (1948, 1954) and Fulton (1953) roundly describe Servetus as having discovered the pulmonary circulation. (Both authors are aware of the Arabian manuscript by Ibn an-Nafis (c. 1210-1288) discovered 30 years ago, which contained a clear description of the pulmonary transit of blood, repeated several times. But there is good reason to believe that Servetus had no knowledge of the Persian writer who had preceded him by three centuries).

Bainton (1951) is slightly less certain, and mentions some of the objections to the statement that Servetus discovered the pulmonary circulation; he uses the word 'transit' rather than 'circulation' in the title of his paper.

O'Malley (1953) points out that in view of what may be found in Galen and in Vesalius' famous first edition of the *Fabrica*, which was published in 1543, no great originality was displayed by Servetus. On the other hand O'Malley refers to the famous passage as 'the first printed account of the circulation of the blood through the lungs'.

Izquierdo (1937), who according to Bainton followed the views of Max Neuburger, placed an even greater restriction on Servetus' contribution, contending that nobody who held Galen's views on the origin and distribution of blood in the veins could have grasped the idea of the circulation of the blood through the lungs.

Franklin (1949) has expressed similar views, laying stress on the quantitative aspect of the question, which, in his opinion, disallows the use of the word circulation (in its modern sense) before Harvey's time.

Can one judge between these views? It is my belief that if Servetus' account is considered in the context of sixteenth-century Galenic doctrine, it is possible to decide how far and in what direction Servetus deviated from Galen's teaching. This, after all, is the crucial decision; on it must depend any assessment of Servetus' achievement in the development of knowledge about the functions of the vascular system.

The first obstacle to such an assessment is the fragmentary nature of Servetus' account. Clearly Servetus had no intention of describing the mechanism of the body except in so far as it concerned the movement of the divine spirit through the body after it had been inspired as air. As O'Malley has expressed it, Servetus was more interested in tracing the movements of the spirit in the body than in the movement of the blood in which it was contained. Nevertheless, it is clear that the general plan of Servetus' account follows Galenic teaching closely, which is not surprising, since Servetus was in other matters a strict disciple of Galen. His vital spirit is elaborated in two stages as in the Galenic system, first as a change in the qualities of the blood as it passes from right to left ventricle (but taking place in the lungs rather than in the septum); second when the changed blood is mixed with air (in the pulmonary vein rather than in the left ventricle). There is no evidence on which to base an opinion that Servetus had any intention of challenging the quantitative basis of Galen's system. In fact, the closeness with which he follows that system indicates that, from our modern standpoint, he followed Galen into the same quantitative error as has been described above.

On the other hand, Servetus clearly contradicts the Galenic belief that blood flowed through the ventricular septum. Whether he or Vesalius deserves credit for first questioning this famous error, does not seem to me to be as important as the fact that Servetus drew the logical conclusion from his observation, thus emancipating himself from this part of Galenic doctrine in a manner which Vesalius quite failed to do. The genius of Servetus is that he brought together this observation about the septum with another on the great size of the pulmonary artery and so arrived at the central importance of the lungs. The fact that he was attracted to this conclusion by his theological position and that he could have no real understanding of the functions of the lungs only makes it the more remarkable that he should have got so far. Again it does not seem to me very important whether or not Servetus could have gathered his ideas from Galen; the role he describes for the lungs is vastly different from anything Galen had in mind.

It is therefore with no intention of decrying Servetus that I suggest that his achievement should be regarded as more anatomical than physiological. Certainly he drew from his accurate anatomical observations functional conclusions; but the functions he was concerned with were strictly Galenic. The fact that his conclusions seem so aptly to fit the modern knowledge of the circulation is to a large extent an accident. Galen's system required movement of some blood from the venous to the arterial system. If the septal route from the right ventricle did not exist, what alternative was there to its passage through the lungs? It is my belief that it is this accident

which has misled those who now claim that Servetus described the pulmonary circulation.

Such an assertion is altogether too sweeping. Of the opinions quoted above those of Izquierdo and Franklin would seem to me best supported by the facts. On the other hand, these writers have perhaps underestimated Servetus' anatomical achievement. To deny Servetus any of the credit which belongs to William Harvey is not to diminish his fame as one of the earliest who dared question any part of the Galenic doctrine.

Servetus' life and martyrdom can be seen as an assertion of the right of men to proclaim the truth as they see it, an assertion for which, in that intolerant age, he paid the supreme penalty. His contribution to medical thought was but a small part of his life's work. Nevertheless, were it his only claim to fame, it would be sufficient. Coming at the time it did, it established his right to be remembered as one of the pioneers who began the process of freeing medicine from the baneful influence of the Dark Ages.

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