

I. *An Anatomical Description of the Heart of Land Tortoises from America.* By Mr. Paul Bussiere, Surgeon, F. R. S.

IN the Description that I give of the Heart of these Animals, I have in no wise any design to criticise upon what Mr. *Mery* hath published in the Memoirs of the Royal Academy of Sciences, *Anno* 1703. but leave it to the Determination of the Publick. I never was a friend to Disputation, it contributing oftentimes more to intangle the Subjects that are treated, than to explain the Veracity of the Facts that are searched after; and I had entirely abandoned this, which hath been some Years between Mr. *Mery* and myself, concerning the Use of the *Valves*, which cover the *Foramen Ovale* in the Heart of an Human *Fœtus*, if Mr. *Mery* had not pretended to maintain his Opinion by the comparison of the pretended *Valves*, which he imagines to be in the Heart of the Land Tortoises of *America*, (apparently that he hath invented them himself) in the pretended *Ventricles* of the Heart of that Animal; and if at the same time three Commissaries of Reputation deputed by that Academy, had not given an Authentick Approbation to what is advanced by that Anatomist. This sort of Authority might impose on the Publick, the greatest part whereof believe every thing upon such testimony, and the others remain in suspense for want of the necessary means to inform themselves of the truth; the Land Tortoises of *America* being very rare in *Europe*, and the greatest part of Anatomists wanting either the Means or Conveniencies to get them. I
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have then Reason to hope, that those who concern themselves in these Matters, will not disapprove the Care I have taken to have some brought from *America*; and to let them know the Structure of the Heart of this Animal, which, of all that might have been chosen, is the most proper to convince Mr. *Mery* of his mistake, and confirm the use of the *Valve* of the *Foramen Ovale* in the Heart of an Human *Fœtus*, establish'd first by Dr. *Harvey*, and confirmed and demonstrated by all Anatomists since his time. The Structure of the Heart of this Animal being very simple, and the use of the double *Valve*, which covers the two *Foramina* of the *Auricle*, in the *Sole Ventricle* of the Heart, so plain and so manifest, that 'tis not possible to mistake, as it will be acknowledg'd by the Description of its Parts and its principal Vessels. I dissected three successively of the five I received from *Jamaica* in *September* last, being yet alive, in the Presence of Dr. *Sloane*, Dr. *Sylvestre*, Mr. *Pujolas*, and Mr. *Lafage*, an able Surgeon of *London*; all being ocular Witnesses of what I assert. The other two being dead by that time, I caus'd their Hearts to be taken out entire; one of which I sent to be dissected in *Paris*, and I kept the other to satisfy the Curiosity of those who will see it.

A Description of the Heart of a Land Tortoise of America.

The Heart in this Animal is situated in the *anterior* part of the capacity that maketh the *Abdomen*, separated from all the other *Viscera* by a large *Pericardium*, which encloseth it. This *Pericardium* is fastned by its *superior* part to the Spine of the Back, by the *anterior* to the Muscles of the Neck; which is the cause that the Heart moveth forward when the Animal putteth forth his Head out of the Shell, and backward when he

he draws it in: By the *Inferior* part it adheres to the *Peritoneum*, which is fastned to the lower Shell; so that by all these Ligaments the *Pericardium* is kept distended sufficiently, that the Heart hath an entire liberty in it.

In this *Pericardium* there is found a good quantity of a very clear and transparent Water, which hath the same use there, as that which is found in the *Pericardium* of other Animals.

'Tis in the middle of this *Pericardium* that the Heart is suspended; to wit, at its *Basis* by the Arteries, and at its *Inferior* part by a little Tendon, or a very thin Ligament, which from the Point or Cone of the Heart, ascendeth to insert it self to that part of the *Pericardium* which adheres to the Back.

This little Ligament is very remarkable in this, that by its means the Point of the Heart is suspended on the Level of its *Basis*; without which 'tis visible that the Point of the Heart would fall lower, and bend the Vessels of the *Basis*, which might have interrupted the free Circulation of the Blood, and by consequence would have endanger'd the Life of the Animal.

The *Pericardium* being opened, the Heart appeareth as if it was standing by itself, being only fix'd to the Arteries which go out of it (supposing the Animal turned upon its Back) its *Auricles* being separated and hid under its *Basis* and Arteries, towards the Back of the Animal; which is very different from the Sea Tortoises, where the *Auricles* are situated on the Right and Left Angle of its *Basis*, by which way they push the Blood into the Heart.

The Figure of the Heart of this Animal is almost lenticular; making nevertheless three obtuse Angles, two on the *Basis*, one to the Right, and the other to the Left; the third is at the *Inferior* part, where the little Tendon, which suspendeth the Heart on the Level of its *Basis*, is inserted.

If this Animal be opened alive, you have the satisfaction to see the Circulation of the Blood, by reason of the transparency of the Membranes of the Veins, and the Alternative Motions, or Dilatations of the Heart and Auricles, and the Arteries and Veins, which are very slow in this Animal.

From the *Basis* of the Heart pass out four great Arteries, that appear distinctly separated one from the other; whereas in that of the Sea Tortoise, these Arteries are involved, for the length of an Inch, in a *capsula* common to them all, which maketh them to appear as if they were but one Trunk. If these four Arteries be entirely cut, the Heart is no more suspended, but by the conjunction of the two *muscular Conduits* of the *Auricles*, which pierce the Heart in its *posterior* part, towards the middle of the Heart, on the Left side; by which the Blood runneth from the Auricles into the *Ventricle* of the Heart.

These Arteries being thus divided, and the Heart turned over, the *Auricles* appear lying transversely against the Back, in the capacity of the *Pericardium*: They make but one continued fleshy Body, a little extended, about two thirds inclining to the Left side. 'Tis in this Body that the Cavities of the *Auricles* are separated the one from the other, by a *muscular Septum*, situated Internally to that Place, which appears contracted Externally. These *Auricles* make a *muscular* Production about six Lines long, which uniteth them to the Heart, towards the middle and left of its backside. This Production is composed of two Conduits, separated only from one another by the Extension of the *Septum*, which divideth the two *Auricles*: It is by these two Conduits that the Blood floweth from the Auricles into the Heart. The Body of these *Auricles* hath no adherence to the *Pericardium*, nor any support but that of the Veins, which end in it; for if you divide these

Veins, the Heart and *Auricles* comes out of the Body; and then if you suspend the Heart by the *Auricles*, they resemble two Funnels joyned together, the little end of which opens into the *Ventricle* of the Heart, to pour the Blood into it: And 'tis in this manner we are to conceive them, in the Natural Situation of the Animal.

After having thus considered the External Parts of the Heart and its *Auricles*, we are to proceed to the Examination of the inside of both of them. In order to that, it must be opened at its Inferior Surface, (supposing the Animal turned upon its Back) because all the Orifices of either the Arteries and Veins, and their *Valves*, are in the opposite side: Therefore a Probe may be introduced through one of the Arteries into the Heart, and it opened upon it; after that, you cut all this side round about the Inferior Circumference, from one Angle to the other, and then turn over all that part which is cut on the *Basis* of the Heart: For then it is easy to remark and view all the Internal Parts of an Heart, and observe that there is but one sole *Ventricle*, which comprehends the whole extent of the Heart, and is as uniform and plain as either of the *Ventricles* of the Human Heart, or of any other Animal whatsoever; and that it is impossible to remark any kind of *Septum*, either Musculous or Membranous, that might make any Division or *Cellule* in this *Ventricle*: And 'tis very surprizing, that the Anatomists of the Royal Academy of *Paris* have shewn, the one three, and the other four *Ventricles*, in the Heart of a Land Tortoise of *America*. I confess this Difficulty is to me and the Gentlemen who have seen them dissected, a Mystery, which these Anatomists and their Approvers will discover to us when they shall think fit.

After having considered the extent of the Cavity of the Heart, there remain two things to be examined. The first is, that in its back-part there are five Holes or Orifices, two whereof are on the Left Side: These are the Orifices of the two Funnels of the *Auricles*: They are covered by a large *Valve* lying flat upon them, supported in its middle by the Prolongation of the *Septum*, which divides the *Auricles*, in such a manner, that half of it covers the Orifice of the Right *Auricle*, and the other half that of the Left; so that this *Valve* resembles two folding Doors of a Porch, which have the same support, and whereof one opens or shuts to the Right, and the other to the Left. It is visible, that this *Valve* permits the Entrance of the Blood into the *Ventricle* of the Heart, but opposes its return into the *Auricles*, because this Blood being once in the Heart, presses by its own weight upon this double *Valve*, and keeps it close and flat upon these Orifices: Which confirms perfectly well the Office of the *Valve*, which is in the *Foramen Ovale* in the Heart of an Human *Fœtus*, the Disposition being entirely the same. The other three Holes lying on the Right side of the *Ventricle* of the Heart, are the Orifices of the four Arteries which come out of the *Basis*: Of these three Holes, that which is the most Left is the Orifice of the Pulmonary Artery; that which is the highest, is the Orifice of the *Aorta sinistra descendens*; and that which is the most to the Right side, is common to the *Arteria Aorta dextra*, and to the *superior Aorta*. Each of these Orifices is furnished with two Semilunary *Valves*, which permit the Blood to pass without difficulty from the *Ventricle* of the Heart into the Arteries, but hinder its return into the Heart. 'Tis a pure Illusion, to place these Holes in different *Ventricles*; they are all in one and the same Cavity; so that the Blood enters into this only Cavity, by the two Holes which are on the Left

Side, and goes out of this same *Ventricle*, by the three Holes which are on the Right Side.

The second thing remarkable in this *Ventricle* is the Fibres of the Heart. They are of two sorts; some are External, disposed under the common Membrane in several Plans, very small, but obliquely circular, extending from the *Basis*, but particularly about the Arteries, which serve them instead of Tendons or Points of support, towards the Inferior Circumference of the Heart: The other Musculous Fibres which compose the Heart, are in the manner of several Columns, as those of the Human Heart; they are situated Internally in both sides, lying obliquely from the Right, where their Tendons are about the Arteries, to the Left; which demonstrates that their action is from the Left to the Right Side, where the Orifices of the Arteries lye open, to let the Blood pass out.

It has been said before, that the two *Auricles* of the Heart of the Land Tortoise of *America*, make Externally but one continued Body; but that it has Internally two Cavities, separated from one another by a Musculous *Septum*. This *Septum* separates them so exactly, that there is not the least Communication of the one with the other; so that the Blood of either *Auricle* does not mix with that of the other, but in the *Ventricle* of the Heart. The Right *Auricle* is as big again as the Left; all the Blood of the Animal (that of the Lungs excepted) passing through it to go into the Heart; the Left *Auricle* receiving only the Blood which cometh from the Lungs, the Pulmonary Veins being very small. The Internal Part, of the *Auricles* are furnished with little Musculous Columns, but particularly at their Extremities, situated in such a manner, that it is visible their action tends to push the Blood against the *Septum*, where the Conduits, which convey it into the Heart, are situated.

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There is in the bottom of the Right Auricle an oblong Orifice, by which the Blood cometh into its Cavity from the great Reservoir of the Veins, situated on the back-part of the Heart. This Orifice is furnished with two Semilunar oblong *Valves*, disposed in such manner, that when the Auricle is relaxed, the Blood enters its Cavity, but when contracted, they shut close to hinder the Blood from returning into the Veins: The Orifice of the Funnel, or the Conduit into the Heart, is to be seen against the *Septum*. The Left Auricle hath exactly the same Structure as the Right: 'Tis in the bottom of this Auricle, that the Orifice, common to the two Pulmonary Veins, is to be observed, furnished with two Semilunar *Valves*; and against the *Septum* to the Right, that the Funnel or Conduit into the Heart is situated, joining with the Funnel of the Right Auricle. These two Conduits are separated from one another by the continuation of the *Septum*, which divides the Auricles to the very *Ventricle* of the Heart, and is as a support to the middle of the double *Valve* which covers their Orifices in the Heart.

Of the Vessels of the Heart.

IT has been said before, that from the *Basis* of the Heart of the Land Tortoise of *America*, there goes out four great Arteries. Of these, the first which presents itself, (the Tortoise being turned upon his Back) is the Pulmonary Artery: It is more on the Left Side than the others, and is much bigger for the space of an Inch; then it divides itself into two Branches, the most apparent whereof cometh from the Right Side of its Trunk, and turns itself over towards the Left Side, accompanying the *Aorta inferior sinistra*, till it hath pierced the *Pericardium*; after that it unites with the Left Branch of the *Trachea Arteria*, which it accompanies through

through all the Extent of the Left Lobe of the Lungs. The other Pulmonary Branch going out of the Left side of its Trunk, turns itself over immediately cross upon the other Arteries, from the Right to the Left, to joyn the *Aorta Inferior dextra*, till it has pierced the *Pericardium*, where it joyns to the Right Branch of the *Trachea Arteria*, which it accompanies through the whole extent of the Right Lobe of the Lungs.

One thing seems to me very remarkable in this Pulmonary Artery; it is this, that though its Trunk, in going out of the Heart, hath more than twice the Diameter of the *Arteria Aorta sinistra*, yet the two Branches which it sends to the Lungs, have not either of them one third of the Diameter of the *Aorta sinistra*. In the Arteries, which I have fill'd with Wax, the Trunk of the Pulmonary Artery hath between seven and eight Lines Diameter; the *Aorta sinistra* four and a half; and the Pulmonary Branches, after having pierced the *Pericardium*, have not either of them but one Line and a half Diameter: Nevertheless this Artery doth not produce any other Branch; all the Blood, which enters from the Heart into its Trunk, is carried into the two Lobes of the Lungs, and no where else. The reason of such disproportion I cannot guess; but this is matter of Fact, since it is the same in all: Nevertheless, if I may be permitted to conjecture, it seems to me that it may be attributed to the alteration that happens to the Branches of the *Trachea Arteria*, when the Tortoise stretcheth forth his Head out of the Shell; for these Pulmonary Branches making an half Circle before they joyn with the *Trachea Arteria*, when the Animals Head is drawn in, the Extension which happens to the Branches of the *Trachea Arteria* when the Animal goes out of the Shell, turns these half Circles into sharp Angles; inso-much, that thereby the Passage of the Blood is somewhat Interrupted, and consequently the Blood, which
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passes continually from the Heart into the Trunk, not being capable to return back, because of its Valves, must out of necessity dilate this Trunk more than the other Arteries, in which the Blood passes in an equal Passage.

And that which persuades me that there doth not go into the Lungs of this Animal, more Blood than that quantity which the Pulmonary Branches can admit by their small Diameter, and not the quantity which the Diameter of their Trunk could furnish, is, that the Pulmonary Veins, which bring back all the Blood of the Lungs into the Left Auricle of the Heart, have not either of them entirely two Lines Diameter, which is very proportionable to the bigness of the two Pulmonary Branches of the Arteries.

The second Artery which goes out from the *Basis* of the Heart, is that which I call *Aorta sinistra*: It ascends, as it comes out of the Heart, together with the Left Pulmonary, till they have pierced the *Pericardium*; after which it makes a large turning, without any support, towards the Left Side, which gives it the liberty to extend itself when the Animal stretches out of its Shell, and to refold itself when it retires into it; after that, this Artery descends against the Back, where it gives some small Branches to the *Medulla Spinalis*; after that, it returns through the Lungs into the *Abdomen*, and it is here that it produceth a considerable Branch, which divides into two, of which one is distributed to the Liver, the Stomach, and the Intestines, and the other turning towards the Right in the middle of the *Abdomen*, unites to the *Aorta dextra*; so that these two Arteries are but one and the same Branch divided into two. This same *Aorta sinistra* continues afterwards to the lower Belly, to be distributed to the Kidneys, Thighs, and the Parts that are below. This Left *Aorta* is much longer than the Right, because of the great
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Circle it makes when it cometh out of the Heart, to accommodate itself to the motions of the Animal, and to make room for its Head, which is placed under this Artery in the Left Side, when he draws it into his Shell : And 'tis for that reason that the Left Branch of the *Trachea Arteria* is longer than the Right. This Artery is also bigger than the Right *Aorta*, because that it furnisheth a greater number of Parts with Blood. It hath a distinct Orifice into the Ventricle of the Heart, and hath not the least Communication with the Pulmonary Arteries, neither in the Heart nor in any other Part. This does not resemble at all to the *Ductus Arteriosus*, or, as a certain Modern is pleas'd to call it, the Canal of Communication, in the Heart of an Human *Fœtus*.

The third Artery going out from the *Basis* of the Heart of this Animal, is that which I call *Aorta descendens dextra* : After having pierced the *Pericardium* it sinks towards the Back; then returning through the Lungs into the *Abdomen*, where it receives the Branch of the *Aorta sinistra*, it is distributed to the Right Kidney, Thighs, Bladder, and Parts of Generation : So that I call these two Arteries, *Arteriæ Aortæ descendentes*, because they distribute the Blood to all the Inferior Parts of this Animal, the same as the *Aorta descendens* doth in all other Animals.

The fourth Artery going out from the Heart, is the *Aorta ascendens*. It hath an Orifice in the Ventricle of the Heart, common with the *Aorta descendens dextra* : It appears in part under the *Aorta sinistra* coming out of the Heart, and ascendeth in a stroit Line till it hath pierced the *Pericardium*; after which it divideth into three principal Branches, whereof the two lateral go to the fore Legs, and make the Carotid; the third ascends all along the *Trachea Arteria* towards the *Larynx*, and gives Branches to all the Parts of the Neck.

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The Disposition of the Arteries which go out of the Heart being examined, there remains only the Veins which bring the Blood into it from all the Parts of the Animal: But first one must observe, that there is no Veins which terminate in the Heart; for all the Veins open themselves into the Auricles, which are, as hath been said, separated from the Heart.

There are two ways to show these Veins without Dissection: The first is to fill them with Wax, by Syringing it into them by their Orifices in the Auricles; for if one syringeth by the oblong Orifice in the *Auricula dextra*, all the Veins of the Body (except those of the Lungs) will be entirely fill'd; and afterward by Syringing into the Oval Orifice in the *Auricula sinistra*, the two Veins of the Lungs will be full at once thro' the whole extent of *Trachea Arteria* in the Lungs.

The other way is to wait till the Animal is expired; because the Heart losing insensibly its Vigour, (it beating for the space of 24 hours,) it has not then the force to discharge itself of the Blood which comes from all Parts into these Veins, which then grow very turgid by the coagulated Blood collected in them: Then you need only to turn over the Heart towards the Neck, cutting only the little Cororary Vein which comes out of the Substance of the Heart, for to observe all the great Veins without Dissection; because they all come and end in a common Reservatory, situated across in the capacity of the *Pericardium*, joining to the Auricles. And here one may observe a great Vein, or an Irregular Reservatory: In the Tortoises I have dissected of 18 and 20 Inches long, this Reservatory was 10 Inches broad, and 18 Inches long. In this Reservatory the two Axillary Veins which come from the upper Parts of the Body, joyn one another, after having pierced the *Pericardium*, one on the Right side, and the other on the Left. From the Inferior Parts there joyn two large Veins, one

on the Right side, and the other on the Left of the Inferior Part of this Reservatory ; the first whereof is made up of all the Branches which come out of the Right Lobe of the Liver, which is very big ; and the other consists not only of the Veins of the Left Lobe of the Liver, but also of a Vein which supplies the place of the *Vena Cava*, and which I call the *Vena Intestinalis*, because after it has received all the Veins of the Inferior Parts of the Animal, it runs all along the Intestines, from which it receives the Veins ; and being arrived at the *Pylorus*, it passes cross the Left Lobe of the Liver, and terminates in the common Reservatory.

Besides these four great Veins, there are three, and sometimes but two, coming from the middle part of the Liver, which are inserted into the bottom of the Reservatory ; as also the little Coronary Vein from the Heart.

All these Veins being thus re-united in one common place, this Reservatory terminates upwards in a Conduit, which is inserted into the Posterior Part of the Right Auricle, and opens into its cavity by an oblong Orifice, furnished with two long Semilunar Valves, which permit the Blood of the Reservatory to enter into the Auricles, but hinder its returning from the Auricles into the Reservatory.

A little above the Reservatory, under the Left Auricle, the two Pulmonary Veins are seen : The Left, after having entered the *Pericardium*, is hid under the Axillary Vein, and does not separate itself from it but a little above the Auricles ; from thence it bends to go and insert itself into the Posterior Part of the Auricles. The Right Pulmonary Vein follows after the same manner the Right Axillary, which it quits after it has entered the *Pericardium*, to traverse almost all the length of the Reservatory, and meet the Left Pulmonary about two Lines distance from the Auricles. These two Veins thus united,

ted, open themselves in the Posterior Part of the *Auricula sinistra*, by a common Oval Orifice furnished with two Semilunar Valves; by which means they pour into this Auricle all the Blood that comes from the Lungs to the Heart.

By all that has been observed concerning the Structure of the Heart of the Land Tortoise of *America*, and the Disposition of both its Auricles and Vessels, how extraordinary soever it may appear, it is impossible to find out the least thing which may injure the Opinion of *Dr. Harvey*, and all other Anatomists, about the manner that the Blood Circulates in the Heart of an Human *Fœtus*, and the use of the Valve which is at the *Foramen Ovale*; which is, to permit the Blood to pass from the Right Auricle through this Hole into the Left, and to hinder the Blood's passing from the Left Auricle by this Hole into the Right. And I add further, that amongst all the known Animals, one could not chuse one whose Heart may be more proper to confirm this Opinion, than the Land Tortoise of *America*, by reason of the simplicity of its Structure, and of the plain and distinct manner in which all the Parts appear. Therefore there is room to hope, that if *Mr. Mery* would give himself the trouble to examine a second time the Structure of the Heart of this Animal, with that Honesty and Candour he would make us believe he has, he will acknowledge his Mistake and Errors: But if after that, he persists still in his Opinion, I have done with him; and shall leave him to enjoy peaceably the agreeable satisfaction he takes in his Opinion, and shall not trouble my self any farther, to convince him, or his Followers of their Error.

Explication of the Figures.

T A B. I.

Fig. 1. a. a. a. *The Heart.*

b. b. b. *Its Auricles.*

c. *The Trunk of the Pulmonary Artery.*

d. *The Arteria Aorta descendens sinistra.*

E. *The Arteria Aorta superior.*

H. *The Arteria Aorta descendens dextra.*

F. *The Ligament that suspendeth the Cone of the Heart in the Pericardium.*

G. G. G. G. G. *The Pericardium opened.*

Fig. 2. a. a. a. *The Heart opened to show the Parts of its Ventricles.*

b. *The double Valve covering the Orifices of the Ductus's from the Auricles.*

c. *The Orifice of the Right Auricle i.*

d. *That of the Left H.*

e. *The Orifice of the Arteria Pulmonalis K.*

f. *That of the Aorta sinistra L.*

g. *The Orifice common to both the Arteria Aorta dextra M. and the Aorta superior N.*

Fig. 3. a. a. a. *The Auricles.*

b. *The Right Auricle.*

c. *The Left Auricle.*

d. d. *The Musculous Septum that divides the Cavities of the Auricles:*

E: *The Orifice of the Reservoir of the Veins.*

F. *The Orifice of the Pulmonary Veins.*

g. g. *The*

- g. g. *The large Parts of the Funnels.*
- H. *The Musculous Ductus of the Funnels.*
- i. i. *The Reservoir of the Veins.*
- K. *The Left Axillary Vein.*
- L. *The Right Axillary Vein.*
- M. *The great Intestinal Vein.*
- N. *The great Hepatic Vein.*
- o. o. *Two small Hepatic Veins.*
- P. *The Right Pulmonary Vein.*
- q. *The Left Pulmonary Vein.*

Fig. 4. a. *The Heart of the Tortoise.*

- b. *The Trunk of the Arteria Pulmonalis.*
- c. c. c. &. *The Branches of the Arteria Pulmonalis, accompanying the Bronchia in the Lungs.*
- d. d. d. d. *The Arteria Aorta descendens sinistra.*
- e. e. e. e. *Arteria Aorta descendens dextra.*
- f. f. *One Branch of the Aorta sinistra, which communicates with the Aorta dextra.*
- g. g. *Arteria Intestinalis.*
- h. *Arteria Aorta superior, or ascendens.*
- i. *The Ligament that suspends the Heart.*
- K. *The Trachea Arteria.*
- L. L. L. L. &c. *The two Branches of the Trachea Arteria going to the Lungs.*

Fig: 1^a.

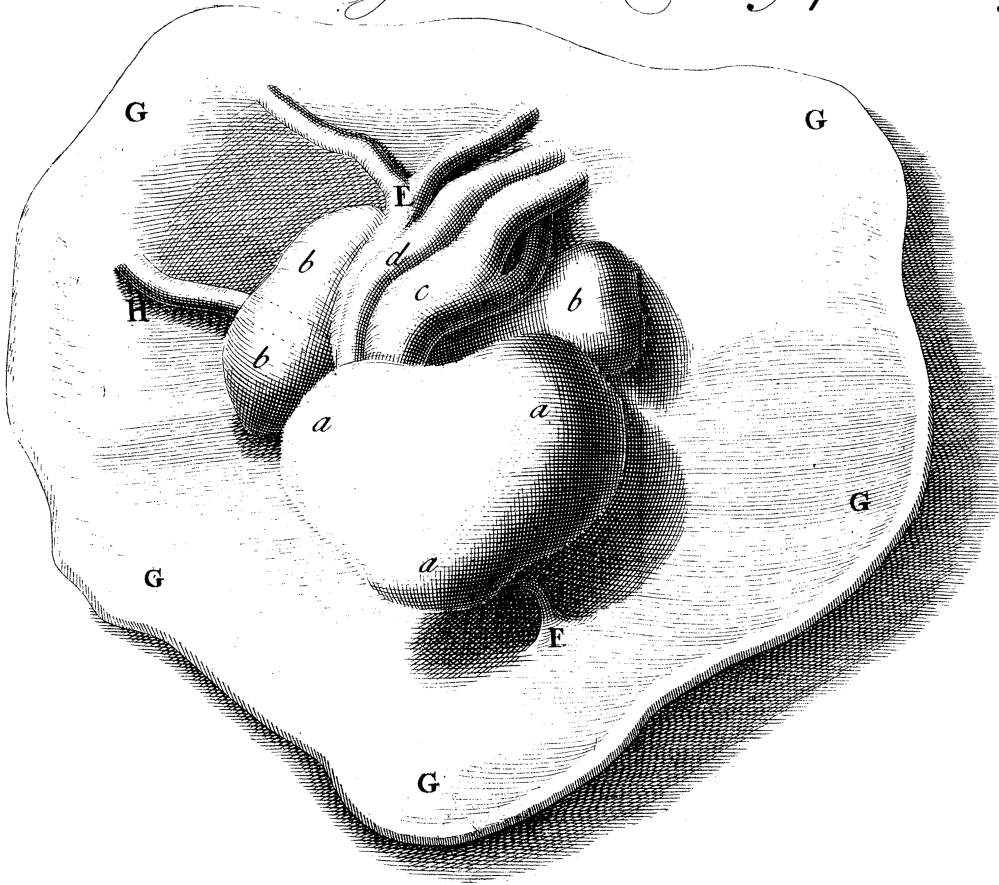
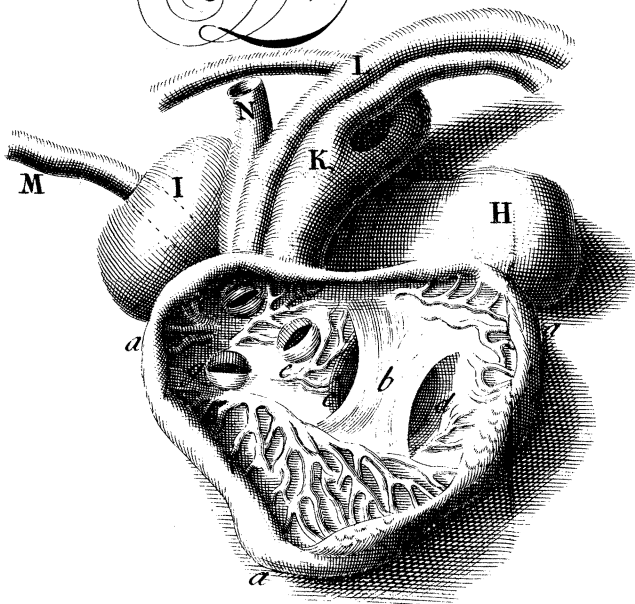


Fig: 2^a.



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Fig: 3^a.

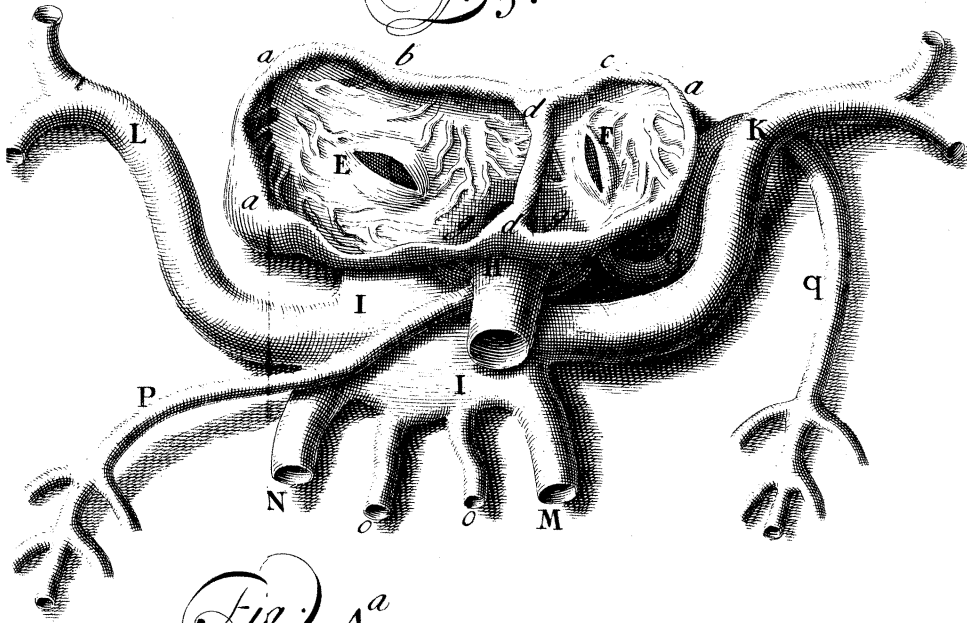
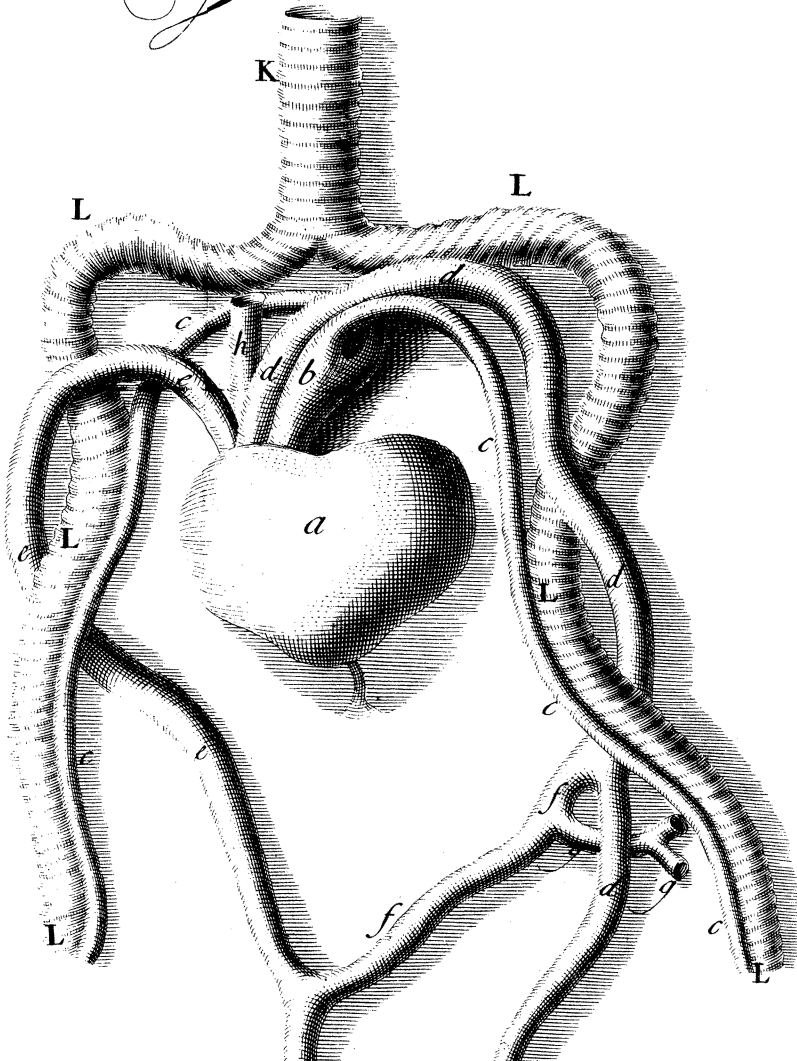
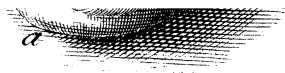
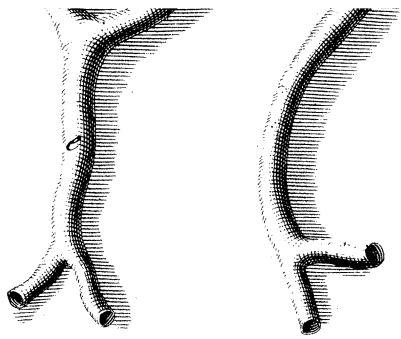


Fig: 4^a.







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Fig. 1^a.

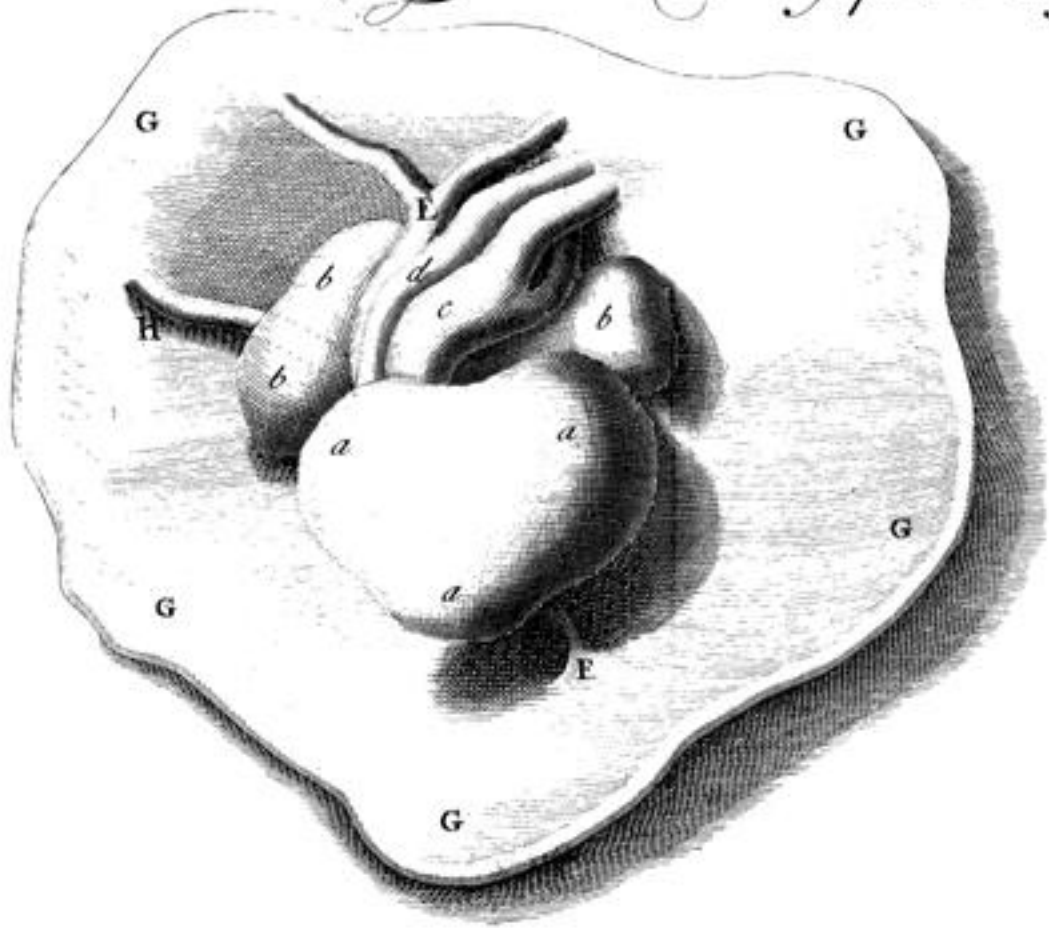


Fig. 3^a.

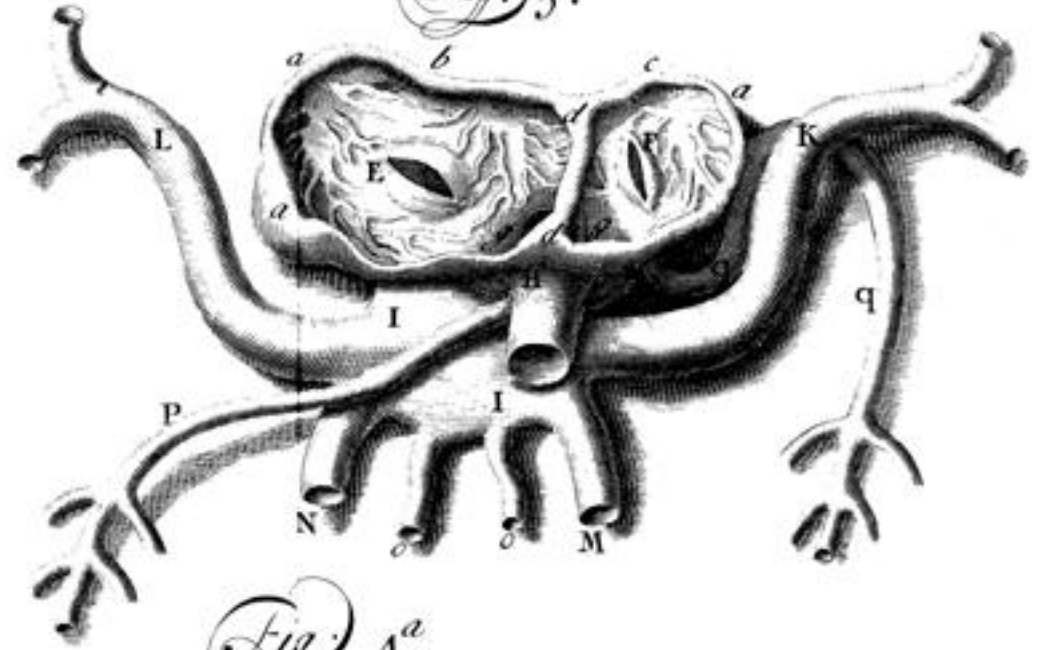


Fig. 4^a.

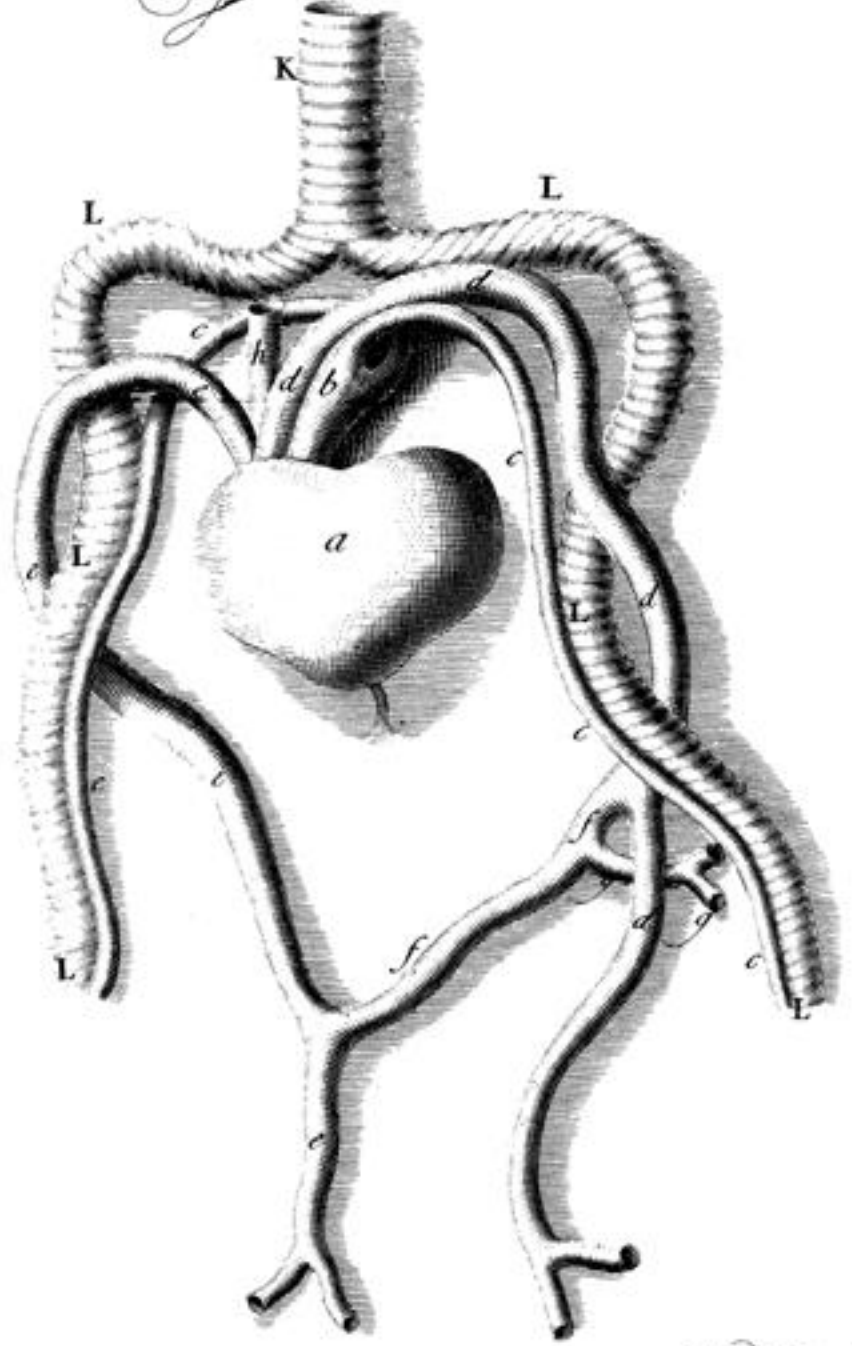


Fig. 2^a.

