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XXIV. *An Account of some peculiar Advantages in the Structure of the Asperæ Arteriæ, or Wind Pipes, of several Birds, and in the Land-Tortoise.*

Read June 9, 1766. **H**AVING, in my former discourse, given an account of some particular phenomena, in amphibious animals, which rendered them more happy and perfect in their animal œconomy towards their preservation; I shall now lay before this learned Society, certain advantages in some birds, towards assisting them in the acquisition of their food, which they seek for in the water; and some of these swim upon the water and dive down occasionally; others only wade into the water, in shallow places, as far as their long legs will carry them, without touching the water with their feathers, in search of their nourishment.

The natural history of four of them is very well set forth by authors; the other two are not mentioned that I know of, but barely by their names; and, although the author has not described them, yet he knew the structures of their asperæ arteriæ, and was a person who made many observations in natural history, of whom I shall speak in his turn.

These birds are; the wild swan, colum, feras, crane, Indian cock, demoiselle.

The structure of the wind-pipe of all these is so singular and so little known, that I thought a proper notice of the subject would be agreeable to the Society, and very fit to be recorded together in the Transactions, if it be approved of (and will be a suitable sequel to those considerations upon amphibious animals); which I shall illustrate with drawings, to render their description the more intelligible.

The wild swan is somewhat smaller than the tame one; this inhabits fresh rivers in land, while the wild one always resorts great lakes and arms of the sea. These are two distinct species, the river swan, and the sea or wild swan; and yet it has been suggested, that the latter might become as tame and familiar as the others, if they were brought up young: and hence they were supposed to be the same. But this wonderful structure of the *aspera arteria* shews that they are different, for the river swan has it not; although a very modern author, who is certainly as well versed in natural history as any one whatever, has these remarkable words; “ All the writers on birds; says he, “ have described the swan: they have called it *cygnus domesticus*, and *cygnus feras*, distinguishing it in “ its wild and familiar state into two species, but this “ is idle and unnecessary: the bird is wholly the “ same in both.”

It will be seen, however, by the description of the part mentioned, they cannot be the same species; for, besides this formation of the pipe, Mr. Edwards shews their heads to be very different also.

In the general run of birds, the *aspera arteria* is nearly strait; that is, having no plications, but descending directly from the epiglottis into the cavity of the  
body

body to lye upon the sternum, and terminating in the lungs; whereas, in these birds, which are the subjects of this discourse, they have certain turnings within the sternum or breast-bone, and run back again to double up into the thorax: which elongates them to double the length of those in other birds of equal, nay of greater magnitude, than the birds that have them.

In the wild swan, the wind-pipe runs down from its upper extremity under the epiglottis, in company with the oesophagus, till it comes within about four or five inches of the last vertebra of the neck; here the pipe quits the oesophagus, (which keeps its course to the intestines) and makes a convex curve forward between the ossa jugalia, in a circular sweep, till it enters into a hole formed through a strong membrane in the center between the insertions of the ossa jugalia into the sternum under the breast; and, in that circular sweep, is covered closely by the skin, so, that, in that place, a very slight blow would destroy the bird.

This hole is the beginning of a theca or cavity in the keel of the sternum, in which the pipe passes on to the end, and then returns back, forming a loop which is circular; and, passing out by another hole through the same strong membrane, makes another circular sweep within, and parallel to the exterior one, and then rises in that round direction, till it enters the cavity of the thorax, and is divided into two branchiæ, which terminate in the lungs.

When one views this structure, it is impossible to avoid being surprized at the wonderful formation of this part, especially too if we attend to the noble  
contri-

contrivance for securing these circular volutions of the pipe, from compressing one another, or from bending into angles; for, if this was the case, their long and free respiration could not be maintained, and the end, for which the pipe is so formed, would not be answered. An explanation of this contrivance will be necessary in this place: there is a strong membrane, which arises from all the clavicle, and is inserted all along the jugal bone on each side, very stiff like a drum; and as the aspera arteria makes its anterior volutions between the latter, (for the posterour turning is that loop within the keel of the sternum described,) it was necessary that the pipe should be supported by a stay in each circular sweep, to prevent the impediments just mentioned. Accordingly there are three strong transverse ligamentous membranes, running from one jugal drum to the other; over the outer of which, the pipe goes into the keel of the sternum through the under hole, and, in its return, rides over two others in a circular direction in its way to the thorax. These are the stays, which prevent its doubling back in an angle, in these two volutions; and in that within the theca, there was no need of such a fulcrum, being secured in its bed from any external pressure.

This wild swan was brought alive from Philadelphia, but died soon after its arrival; and I assisted in the dissection, and made these drawings from the prepared parts. I find no mention of this structure of the aspera arteria in the wild swan\*, but originally in

\* Mr. Edwards found it in the swan he describes. See his *History of Birds*.

Bartholin, who took delight in comparative anatomy, from whom Blafius has taken it.

It is difficult to say what may be the real use of this kind of wind-pipe in the several birds that have it, if it be not to procure them a longer retention of inspired air, (while they seek their food where they are obliged to remain some time immersed in water,) than if the pipe was strait, as in geese, ducks, and such like; for these and the river swan often dive down to feed, yet it is always in shallow places, and their continuance under water is very short; whereas the wild swan dwells upon and seeks his food in great lakes, and arms of the sea; and dives into deeper waters, and consequently requires a power of continuing longer without respiration than the others.

Poets and natural historians in great numbers have asserted that these birds sing very harmoniously; and this gave occasion to a friend of mine, to whom I shewed these drawings, to surmise that this structure might be of use to them in singing; but I never found any one who would say they ever heard either wild or river swans sing: and therefore I doubt it much. But, if they do sing, the length of the pipe contributes nothing towards it; it is the glottis, which forms the voice, and modulates it, whether the pipe be long or short: besides, none of the song, or speaking-birds, have any flexion in their pipes, that we are acquainted with.

The crane is the next I shall take occasion to mention, which has such a turning of the aspera arteria in the keel of the sternum; but the volution of this bird is round within the bone, and may be compared to that of a French-horn; whereas that of the wild swan

swan is strait within the bone, and may be compared to a trumpet; yet the entrance of this into the sternum, and its exit, and its passage into the cavity of the thorax, are similar to those of the swan.

This is a bird who cannot go upon the water, being no more capable of swimming than a common cock or hen. His feathers will not admit of it; and, having no webs to his toes, it is unable to swim. It is somewhat surprising that not one of the tribes which are similar to the crane, such as the herons, storks, bitterns, &c. has any such structure of the *aspera arteria*; and yet they all feed upon fish or water insects. We are, however, to consider, that the heron chiefly haunts brooks, springs, and the narrow heads of rivers, where he seeks his food, and finds it with ease: but the crane is under a necessity of immersing its head, and remains a considerable space in that situation upon strands and marshes: it is also a bird of congress; for, at certain seasons, a multitude of cranes flock together and rise upon the wing to a great height in the air, being birds of passage, and they are by many authors said to travel from most parts of Scythia to Egypt, where, for a certain season, they remain about the Nile, and the great lakes of that country. Perhaps this elongation of the windpipe in them may be also of use, in their great flight through various degrees of rarified or condensed air, in the variety of climates through which they pass.

The Indian cock, *Gallus Indicus* of Aldrovand and Longalius, and *Gallus Persicus* of Johnston, the Mutu Poranga of Margrave, is not the Coq d'Inde, or Turkey cock, but by the last author ranged among the pheasant tribe; this bird has a plication of the *aspera*

arteria, but not so considerable as either of the fore-mentioned, swan or crane: for it descends in a strait line, along with the oesophagus, to the middle of the jugal bone, without and above the thorax, where it is spread and fastened on each side. Then, turning backwards, being somewhat flat, it makes a fold upward to about an inch and half high, and there being made fast again, by a strong membrane, it doubles down and passes into the thorax, terminating by two bronchia in the lungs: and where it is fastened and folded, that is, in the flat parts, it is triple the circumference of any other part of the pipe. This bird and another of the same species were dissected by the Royal Academy of Sciences, and this structure of the pipe appeared in both; for which it is difficult to assign a reason in any of the pheasant kinds, if it be not to retain inspired air longer than ordinary upon some occasions, though they are not frequenters of rivers or marshy grounds; which one might reasonably suggest from the great capacity in the plicated parts of the wind-pipe.

The next I shall mention is the *Grus Numidica*, Numidian crane, or Demoiselle.

This bird has also a plication in the wind-pipe, which was likewise dissected by the Academy of Sciences, in whose account the natural history of it may be seen; and a true description and figure of it from the life, by Mr. Edwards, in his Natural history of birds. I confine myself only to the configuration of this part, in as many animals as I can find endowed with such a structure, in order to collect them and lay them here in view: and shall hereafter make farther researches and dissections, in such as I may reasonably suppose

suppose to have a different formation from the common standard of a strait wind-pipe.

In this bird, being of the crane kind, the pipe runs down in company with the oesophagus, to about a foot in length, and then turns outwards and forwards, as it does in the swan and crane, and enters into the keel of the sternum, which, like the others, forms a bony box for its reception, through a ligamentous hole for about three inches: then it returns upwards, and a round turn into the thorax terminating in bronchia and lungs.

Now, in the Indian cock mentioned, the plication is made above the sternum, in a roomy part between the jugal bones; whereas, in the others mentioned, the plication is within the keel of the sternum.

The other birds I find any account of, having the aspera arteria folded, are only two, and of these our information is very short.

In Dr. Fryers's account of India and Persia, where he treats of his description of Surat and his journey into Duccan, page 119, I find the following passage: " Fish, oysters, soles, and Indian  
 " mackerel, the river yields very good; and the pools  
 " and lakes store of wild fowl; particularly brand  
 " geese, colum, and serafs, a species of the former;  
 " in the cold weather, they, shunning the northern  
 " rigid blasts, come yearly hither from mount Cauca-  
 " sus; what is worth taking notice of, is their aspera  
 " arteria wound up in a case on both sides their breast-  
 " bone, in manner of a trumpet, such as our waits  
 " use: when it is single, it is a serafs; when double,  
 " it is a colum, making a greater noise than a



“ bittern, being heard a great while before they can  
 “ be seen, flying in armies in the air.”

From this passage, it is plain our author had examined the interior parts of this colum and serafs, and that they are different species of the same genus. We can only, however, endeavour to find what this genus is; and, by what we have heard of the crane, it is not improbable that they are of that kind. The crane, by every author, is said to take long flights in vast multitudes; and to make a great noise in the air. The colum and serafs are said to come to the rivers and lakes about Surat or Duccan from Caucasus, flying in armies, and making so great a noise, that they are heard a great while before they are seen. Again, by his short account, we may easily learn, that they are not the crane that is described in this paper, because the colum has a volution of the wind-pipe on both sides of the keel of the sternum, the crane but one; and I suppose, from the likenefs of the serafs to the colum, he says, that the former is a species of the latter; nor can we have room to suggest that these birds are of the wild goose kind; because he mentions the brand geese first, without taking the least notice of their aspera arteria; and confines the rest of the paragraph to the other two, calling the one a species of the other.

These are all the birds that have hitherto come to my notice, having this remarkable flexion in the aspera arteria; it now only remains to mention farther that of the land tortoise, which I bring in here on account of a similar formation of that organ in him.

Having never dissected a land tortoise myself, I must have recourse to those that have; and accordingly I  
 find

find its parts examined by a celebrated physician of his time, Velchius, from whom Blasius has taken it, and by the Academy of Sciences. Blasius has, however, made the anatomical distribution of its parts and their explanation; from whom I shall take the figure in a somewhat larger scale, for its better illustration; and although this last author quotes Severinus and Coiterus as dissectors of the tortoise, as well as Velchius, yet this latter only mentions the wind-pipe.

In Blasius's figure, this pipe, for a few inches from the epiglottis, is single, but soon divides into two; and as it descends in company with the oesophagus, it forms a folded ring outwards on each side, and turns down again to enter the lungs: so that the animal has the advantage of a double aspera arteria, with a volution in each: which shews that this provision is intended to contain a greater portion of air than ordinary while he is under ground in winter.

The tortoise dissected by the Academy of Sciences, was a large land tortoise from the coast of Coromandel; in which was found a bifid wind-pipe; each branch is said to be six inches long, but no mention is made of the volutions in this land tortoise; which, one would think, being so remarkable a variety from the common standard, ought not to escape the notice of such able anatomists. Yet it was found, by several experiments, that respiration was very slow and unequal in this animal, as well as in the camelion; the Academicians observed several tortoises for a long time together, and have taken notice, that they sometimes cast forth a cold breath through the nostrils, but that is by long intervals and without order; and that the camelion is  
some-

sometimes half a day without one's being able to discern in him any motion for the respiration.

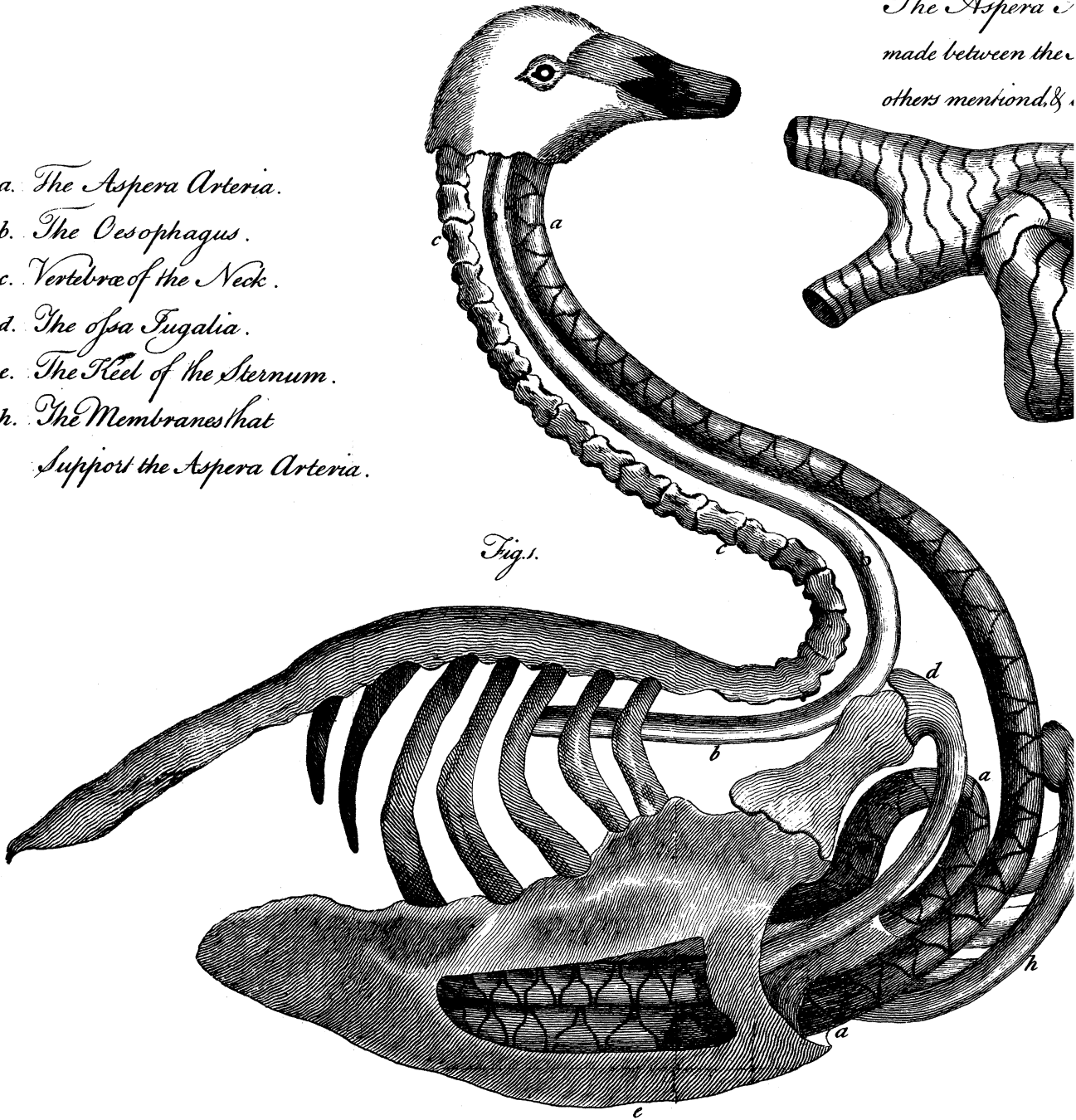
From this it is easily seen, that they can retain inspired air a long time : and the Academicians therefore think, that the principal use of the lungs in tortoises, is to render themselves specifically lighter or heavier in the water, by their inflation and compression at will, as fishes do by their swimming bladders ; indeed such a power of long inspiration seems to be as necessary in the land tortoise as in that of the sea ; because, in many countries where they breed, they are known to go into the ground and lye concealed for several months ; and it is well known, that several species of land tortoises go into ponds or canals in gardens, where they are kept, and remain long under water at pleasure. Of this my worthy friend Mr. Collinson had instances in his gardens at his country seat : and I saw two land tortoises in the bottom of a circular canal, in the gardens of the Palais Royal in Paris several times, which were very large ones, and remained under water many hours together.

The ingenious Academicians, however, in order to verify their sentiments, that one principal use of the lungs in a tortoise is to render them capable of remaining at any depth in the water at will, made the following experiment : they locked up a living tortoise in a vessel of water intirely full ; on which there was a cover exactly fastened with wax, from which there went a glass pipe : the vessel being full, so as to make the water appear at the bottom of the glass pipe ; they observed the water did sometimes ascend into the pipe, and that it sometimes descended. Now this could be done only by the augmentation and diminution

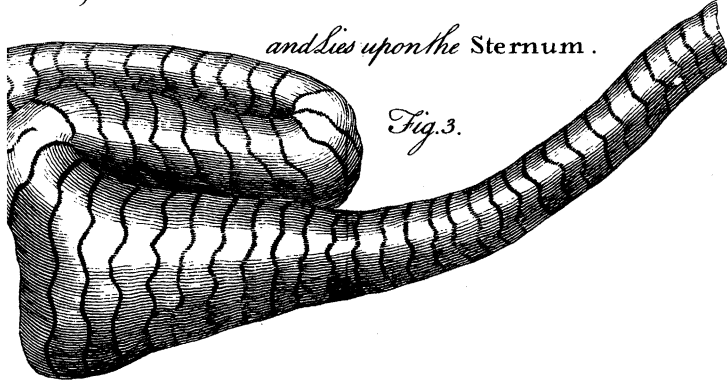
The Aspera  
made between the  
others mentiond, &c.

- a. The Aspera Arteria.
- b. The Oesophagus.
- c. Vertebrae of the Neck.
- d. The Ossa Jugalia.
- e. The Keel of the Sternum.
- h. The Membranes that  
Support the Aspera Arteria.

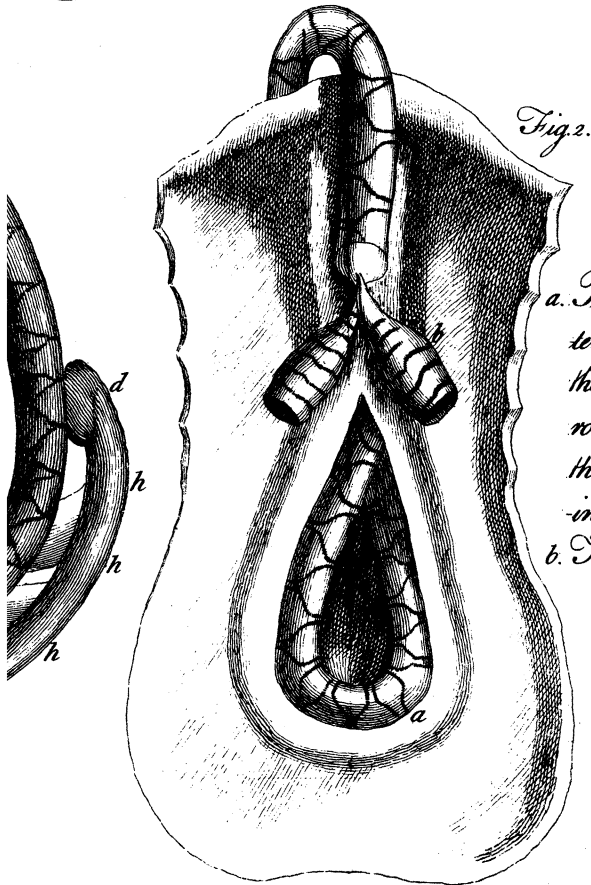
Fig. 1.



*vera Arteria of the Indian Cook. this Plication is  
in the Jugal Bones & not in the Breast Bone, as are the  
found, & then the End, with the Bronchia, enters the Thorax  
and lies upon the Sternum.*



*Fig. 3.*

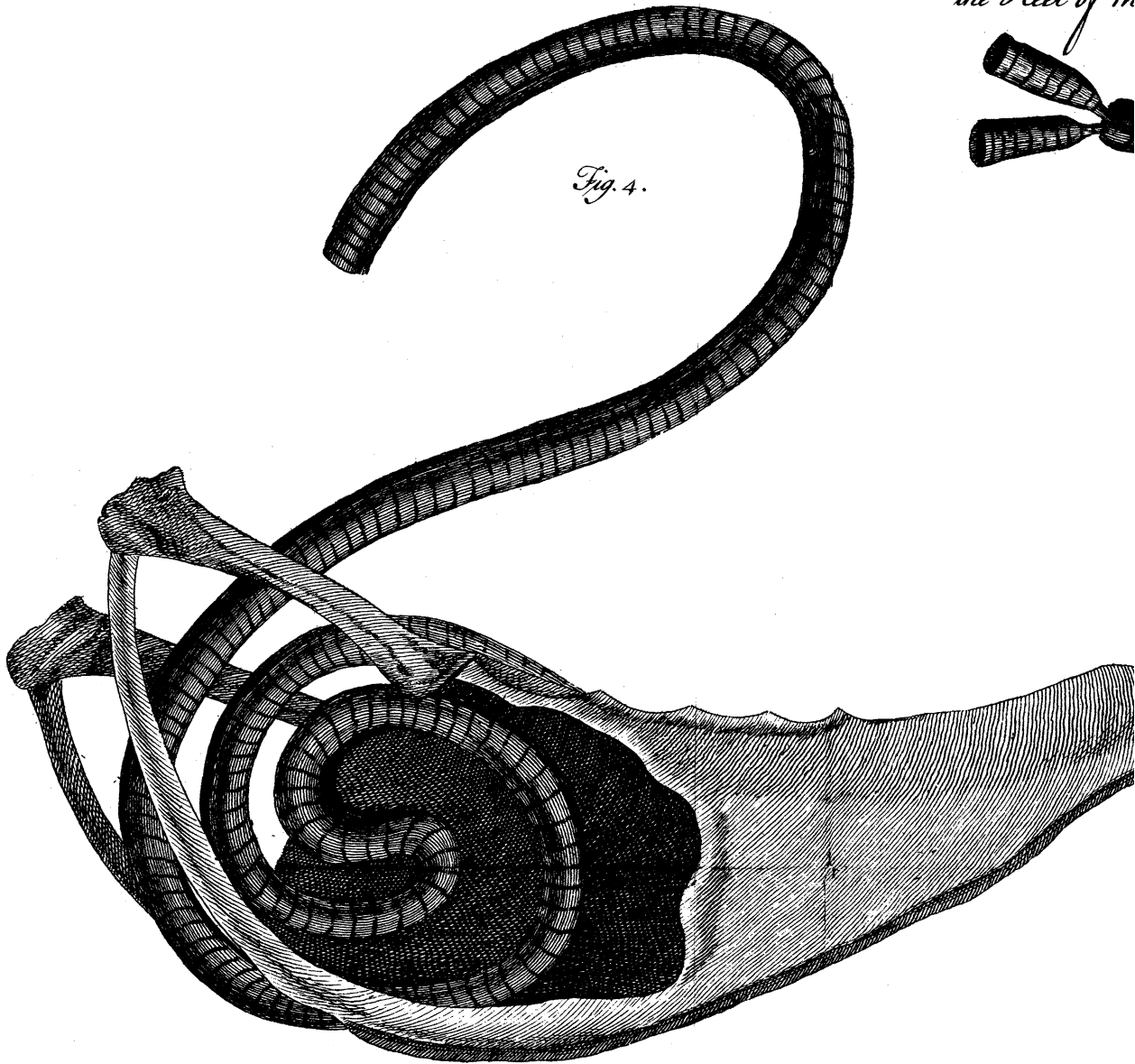


*Fig. 2.*

*a. The Aspera Ar-  
teria passing in  
the Theca, doubling  
round to lie upon  
the Sternum, End-  
ing in  
b. The Bronchia.*

*The Course of the Aspera Arteria in the Crane.*

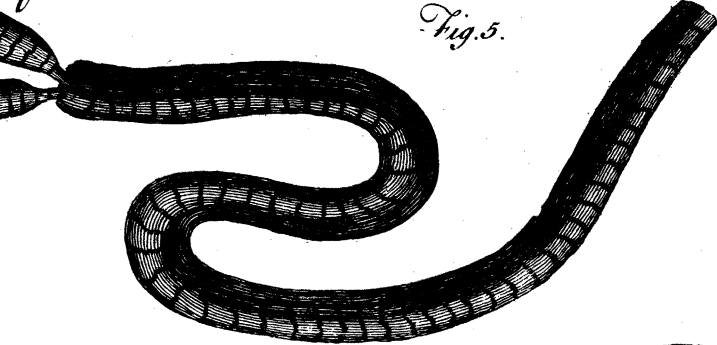
*The Aspera  
or Demoiselle  
the Keel of the*



*Fig. 4.*

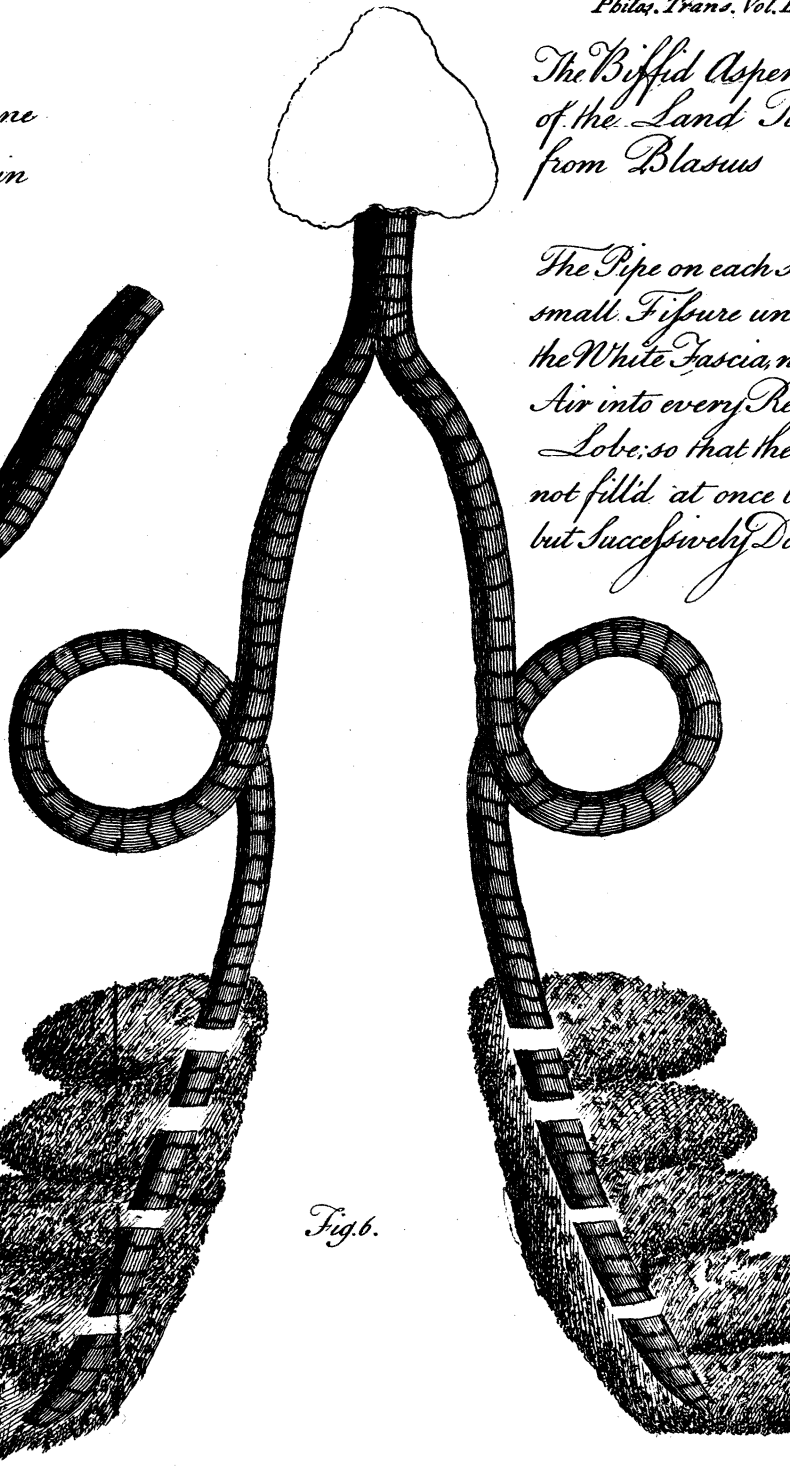
*Arteria of the Numidian Crane  
noiselle. This Plication is made within  
of the Sternum.*

*Fig. 5.*



*The Puffed Aspes  
of the Land  
from Blasius*

*The Pipe on each  
small Fisure in  
the White Fascia,  
Air into every Re-  
Lobe; so that the  
not fill'd at once  
but successively De-*



*Fig. 6.*

*Aspera Arteria  
and Tortoise  
sus*

each Side has a  
ure under each of  
Vascia, which admits  
ery Respective  
that the Lobes are  
t once by Inspiration  
vely Downwards.





nution of the bulk of the tortoise; and it is probable that when the tortoise endeavoured to sink to the bottom, the water fell in the pipe, because the animal lessened its bulk by the contraction of its muscles; and that the water rose by the slackening of the muscles, which, ceasing to compress the lungs, permitted it to return to its first size, and rendered the whole body of the tortoise lighter. I have, in many kinds of fish, dissected their swimming bladders, and found that in great and small these are vested with a strong muscular membrane, which they are capable of contracting and dilating at will, whereby they are able to compress or expand the column of air within very considerably; this bears some analogy to the detrusor muscle of the human urinary bladder, in contracting itself for the expulsion of the urine.

**TAB. X. Fig. 1.** Represents the situation and inclosure of the aspera arteria of the wild swan, in a lateral view.

2. A view of the same, with its progress within the thorax upon the sternum.

3. The aspera arteria of the Indian cock.

**Tab. XI. Fig. 4.** A lateral view of the aspera arteria of a crane, as situated in the cavity formed in the sternum.

5. Shews the flexion of the aspera arteria of the Numidian crane.

6. The bifid aspera arteria of the land tortoise.

The Aspera Arteria of the Indian Cock, this Plication is made between the Jugal Bones & not in the Breast Bone, as are the others mentiond, & then the End, with the Bronchia, enters the Thorax and lies upon the Sternum.

- a. The Aspera Arteria.
- b. The Oesophagus.
- c. Vertebrae of the Neck.
- d. The ossa Jugalia.
- e. The Keel of the Sternum.
- h. The Membranes that Support the Aspera Arteria.

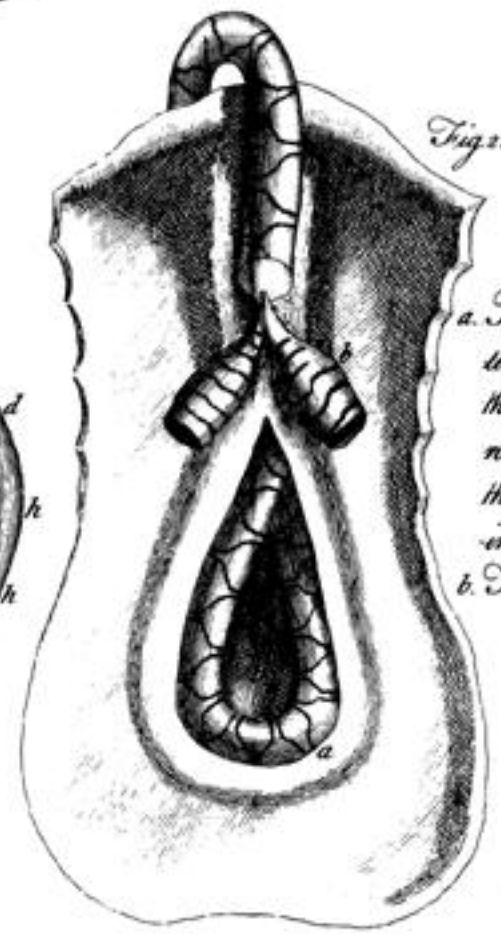
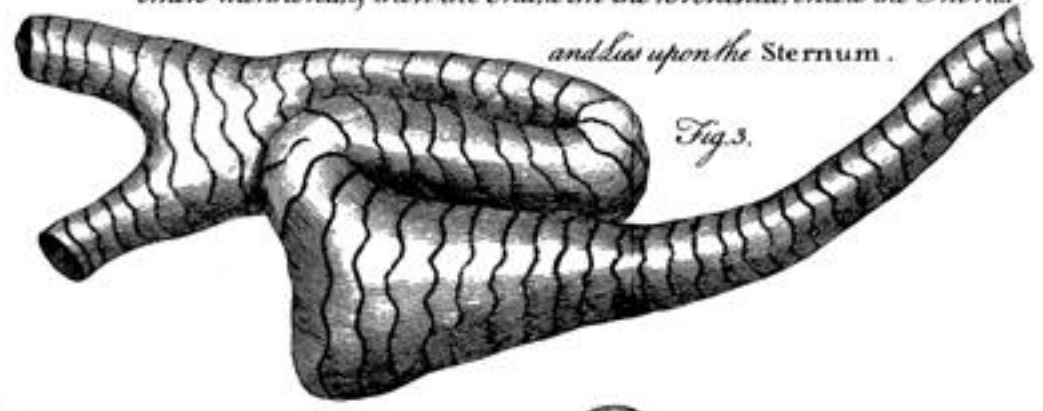
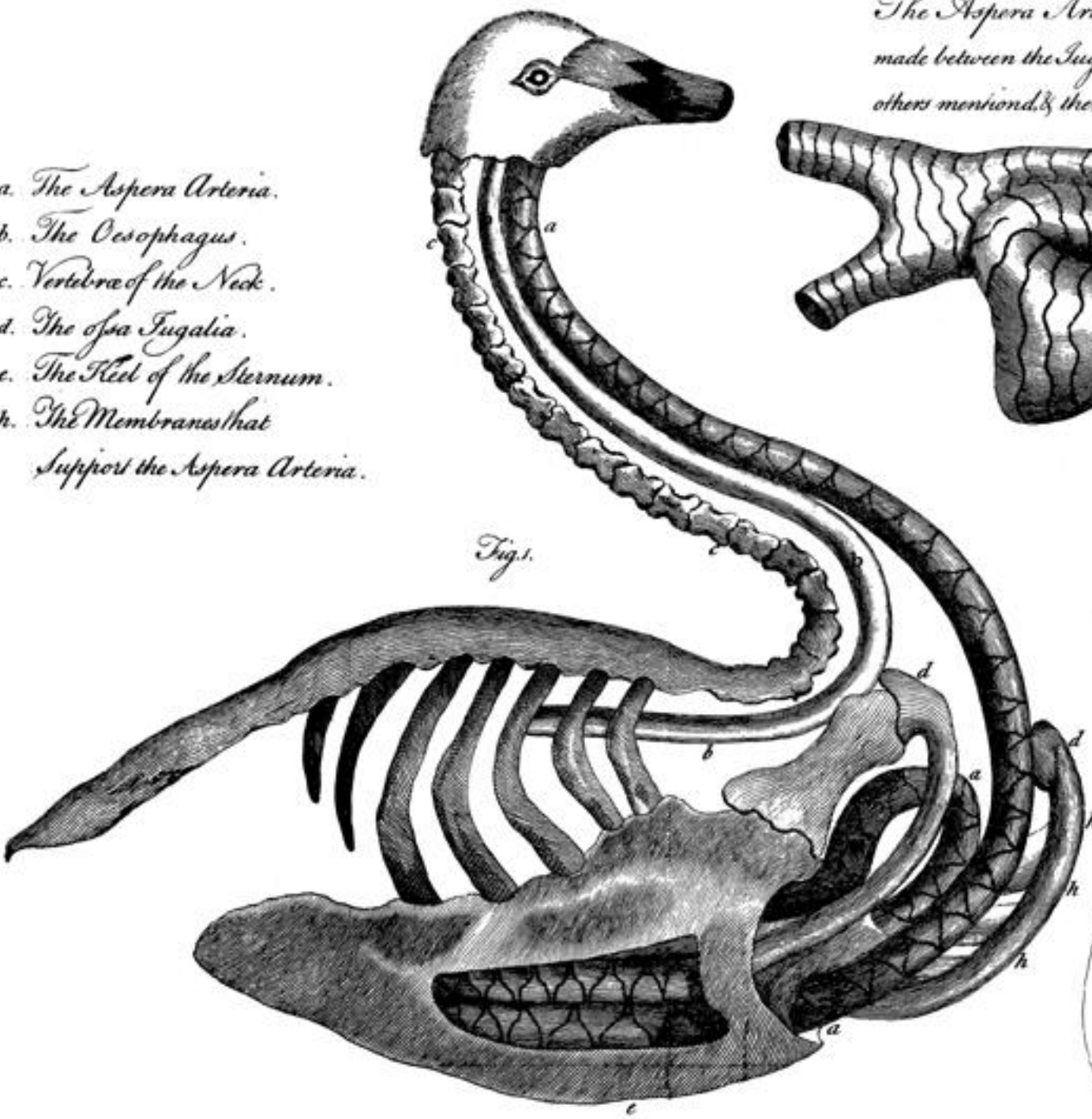


Fig. 2.  
 a. The Aspera Arteria passing in the Theca, doubling round to lie upon the Sternum, Ending in  
 b. The Bronchia.

The Course of the Aspera Arteria in the Crane.

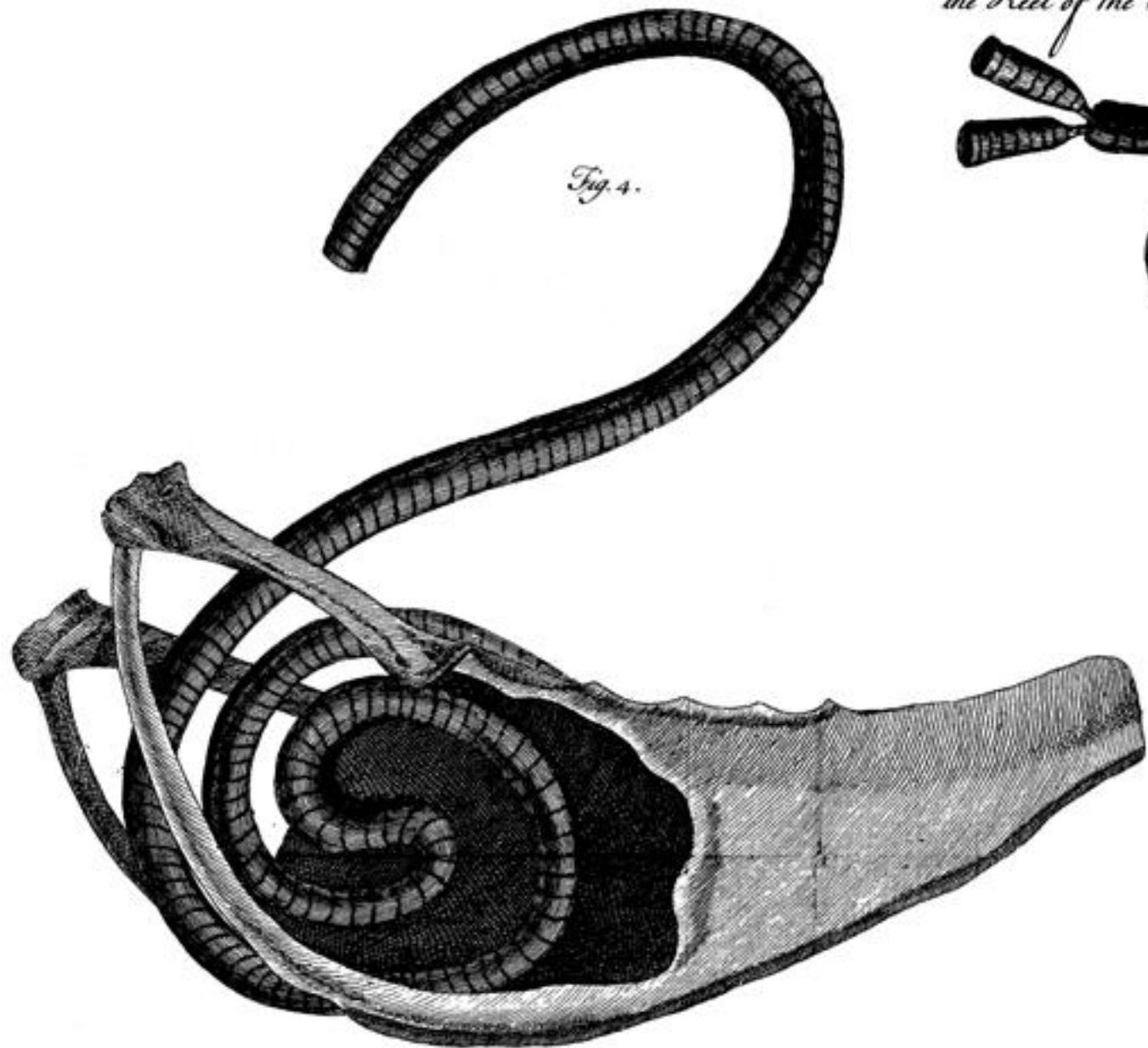


Fig. 4.

The Aspera Arteria of the Numidian Crane or Demofelle. This Plication is made within the Keel of the Sternum.

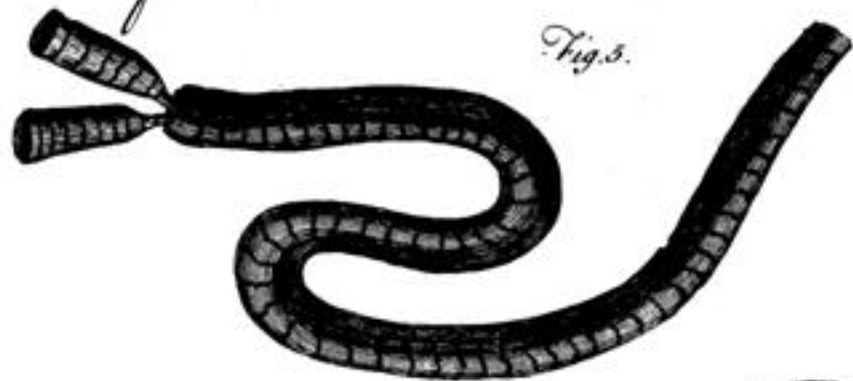


Fig. 5.

The Bifid Aspera Arteria of the Land Tortoise from Blasius

The Pipe on each Side has a small Fisure under each of the White Fascia which admits Air into every Respective Lobe: so that the Lobes are not fill'd at once by Inspiration, but Successively Downwards.

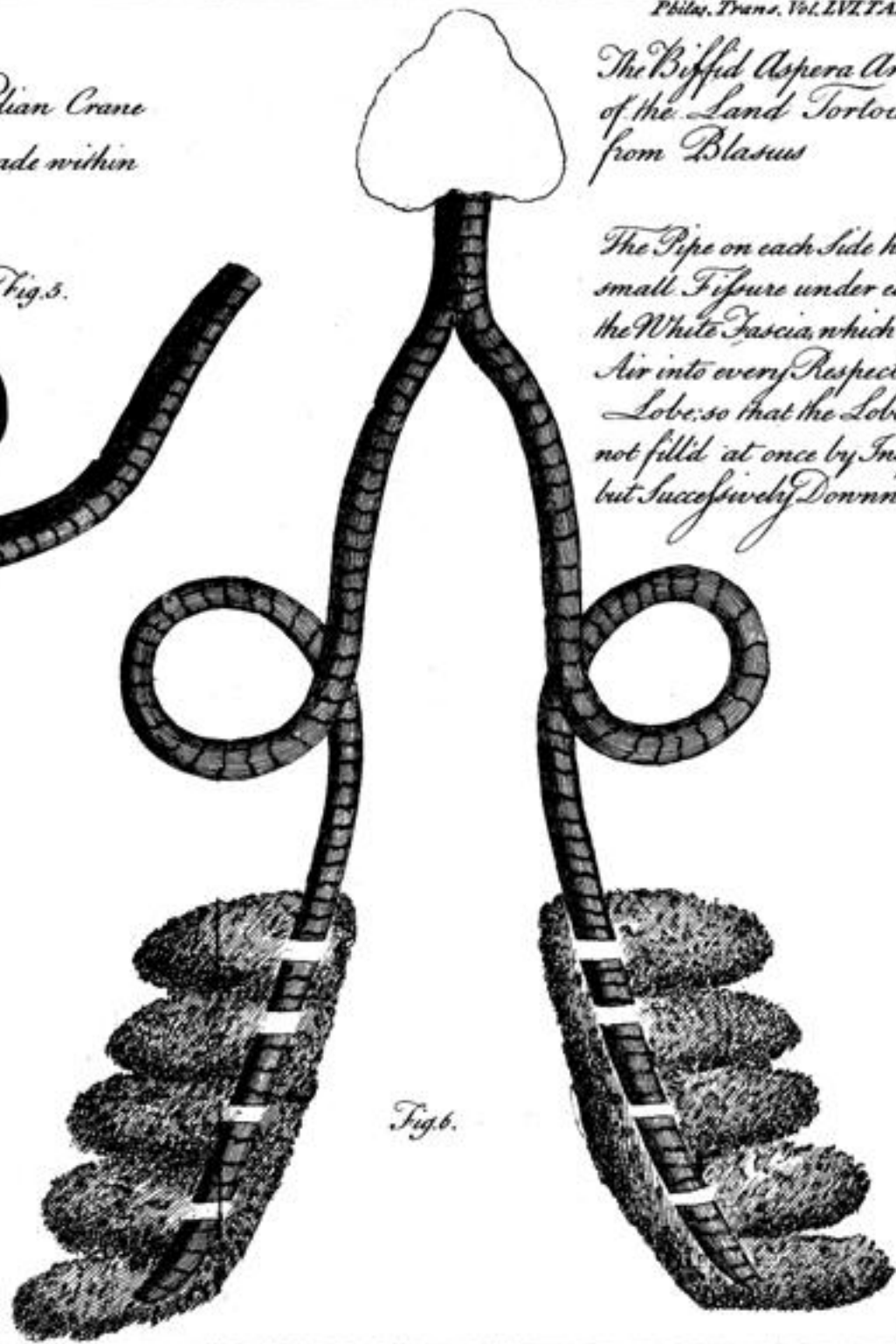


Fig. 6.