IV. *A Description of the Anatomy of the* Ornithorhynchus paradoxus. *By* Everard Home, *Esq. F. R. S.*

Read December 17, 1801.

THE subjects from which the following description is taken, were sent from New South Wales, to Sir JOSEPH BANKS, who very obligingly submitted them to my examination.

These were two specimens preserved in spirit; one male, the other female. The male was rather larger than the female, and in every respect a much stronger animal; they had both arrived at their full growth, or nearly so, as the epiphyses were completely united to the bodies of the bones, which is not the case in growing animals.

The natural history of this animal is at present very little known. Governor HUNTER, who has lately returned from New South Wales, where he had opportunities of seeing them alive, has favoured me with the following particulars respecting them.

The Ornithorhynchus is only found in the fresh-water lakes, of which there are many in the interior parts of the country, some three quarters of a mile long, and several hundred yards broad. This animal does not swim upon the surface of the water, but comes up occasionally to breathe, which it does in the same manner as the turtle. The natives sit upon the banks, with small wooden spears, and watch them every time they come to the surface, till they get a proper opportunity of striking

them. This they do with much dexterity; and frequently succeed in catching them in this way.

Governor HUNTER saw a native watch one for above an hour before he attempted to spear it, which he did through the neck and fore leg: when on shore, it used its claws with so much force, that they were obliged to confine it between two pieces of board, while they were cutting off the barbs of the spear, to disengage it. When let loose, it ran upon the ground with as much activity as a land tortoise; which is faster than the structure of its fore feet would have led us to believe. It inhabits the banks of the lakes, and is supposed to feed in the muddy places which surround them; but the particular kind of food on which it subsists, is not known.

Description of the external Appearances.

The male is $17\frac{1}{2}$ inches in length, from the point of the bill to the extremity of the tail. The bill is $2\frac{1}{4}$ inches long; and the tail, measuring from the anus, $4\frac{1}{2}$ inches.

The body of the animal is compressed, and nearly of the same general thickness throughout, except at the shoulders, where it is rather smaller. The circumference of the body is 11 inches. There is no fat deposited between the skin and the muscles.

The female measures in length $16\frac{1}{4}$ inches, and in circumference 11 inches. The size of the body is rendered proportionally larger than that of the male, by a quantity of fat lying every where under the skin.

The male is of a very dark brown colour, on the back, legs, bill, and tail; the under surface of the neck and belly is of a silver gray. In the female, the colour of the belly is lighter.

The hair is made up of two kinds; a very fine thick fur, $\frac{1}{2}$ of an inch long, and a very uncommon kind of hair, $\frac{3}{4}$ of an inch long; the portion next the root has the common appearance of hair, but, for $\frac{1}{4}$ of an inch towards the point, it becomes flat, giving it some faint resemblance to very fine feathers: this portion has a gloss upon it; and, when the hair is dry, the different reflections from the edges and surfaces of these longer hairs, give the whole a very uncommon appearance. The fur and hair upon the belly, is longer than that upon the back.

Externally there is no appearance of the organs of generation, in either sex; the orifice of the anus being a common opening to the rectum and prepuce in the male, and to the rectum and vagina in the female.

There is no appearance, that could be detected, of nipples; although the skin on the belly of the female was examined with the utmost accuracy for that purpose.

The head is rather compressed. The bill, which projects beyond the mouth, in its appearance resembles that of the duck; but is in its structure more like that of the spoonbill, the middle part being composed of bone, as in that bird; it has a very strong cuticular covering.

In the upper portion of the bill, the lip extends for half an inch anteriorly, and laterally, beyond the bony part, and is thick and fleshy. The upper surface of the bill is uniformly smooth, and does not terminate where the hair begins, but is continued on for $\frac{3}{4}$ of an inch, forming a cuticular flap, which lies loose upon the hair. In the dried specimens that have been brought to Europe, the flap has been contracted in drying, and stands

up perpendicularly; this, however, is now ascertained not to be its natural situation.

The under surface of the upper half of the bill is also smooth; but has two hard ridges of a horny nature, an inch long and $\frac{1}{10}$ of an inch broad, situated longitudinally, one on each side of the middle line of the bill.

The lower portion of the bill is much smaller than the upper; and, when opposed to it, the lip of the upper extends beyond it for the whole of its breadth. The edges of the lip of this lower portion have deep serræ, in a transverse direction, like those in the duck's bill, but they are entirely confined to the fleshy lip; and, immediately within these serrated edges are grooves, lined with a horny substance, which receive, in the closed state of the bill, the ridges of the upper portion above described. There is also a cuticular flap extended upon the hair, as in the upper portion of the bill.

The nostrils are two orifices, very close to each other, near the end of the bill; the upper lip projecting $\frac{3}{4}$ of an inch beyond them.

The eyes are very small; they are situated more upon the upper part of the head than is usual, and are directly behind the loose edge of the cuticular flap belonging to the bill. The eyelids are circular orifices, concealed in the hair; and in the male are with difficulty discovered, but in the female there is a tuft of lighter hair, which marks their situation.

The external ears are two oval slits, directly behind the eyes, and much larger than the orifices of the eyelids.

The teeth, if they can be so called, are all grinders; they are four in number, situated in the posterior part of the mouth,

one on each side of the upper and under jaw, and have broad flattened crowns. In the smaller specimens before examined, each of these large teeth appeared to be made up of two smaller ones, distinct from each other. The animal, therefore, most probably sheds its teeth as it increases in size. They differ from common teeth very materially, having neither enamel nor bone, but being composed of a horny substance only embedded in the gum, to which they are connected by an irregular surface, in the place of fangs. When cut through, which is readily done by a knife, the internal structure is fibrous, like nail; the direction of the fibres is from the crown downwards.

This structure is similar to that of the horny crust which lines the gizzard in birds.

Between the cheek and the jaw, on each side of the mouth, there is a pouch, as in the monkey tribe, lined with a cuticle. When laid open, it is $1\frac{1}{2}$ inch long, and the same in breadth. In the female, it contained a concreted substance, the size of a very small nut, one in each pouch: this, when examined in the microscope, was made up of very small portions of broken crystals.

Besides these grinding teeth, there are two small pointed horny teeth upon the projecting part of the posterior portion of the tongue, the points of which are directed forwards, seemingly to prevent the food from being pushed into the fauces during the process of mastication. This circumstance, of small teeth on the tongue, is, I believe, peculiar to this animal, not being met with in other quadrupeds. In the tongue of the flamingo there is a row of short teeth on each side, but in no other bird that I have seen. The teeth are represented in the annexed drawing.

The fore legs are short, and the feet webbed; the length of

the leg and foot, to the end of the web, is about three inches. On each foot there are five toes, united together by the web, which is very broad, and is continued beyond the points of the toes, for nearly an inch. On each toe there is a rounded straight nail, which lies loose upon the membrane forming the web. The palms of the feet are covered with a strong cuticle; and there is a small prominence at the heel.

The hind legs are nearly of the same length as the fore legs, but stronger. Each leg has five toes, with curved claws; these are webbed, but the web does not extend beyond the points of the toes. The four outer toes are at equal distances from each other; but the inner one is at a much greater distance from the one next it. The under surface of the foot is defended by a strong cuticular covering.

In the male, just at the setting on of the heel, there is a strong crooked spur, $\frac{1}{2}$ an inch long, with a sharp point, which has a joint between it and the foot, and is capable of motion in two directions. When the point of it is brought close to the leg, the spur is almost completely concealed among the hair; when directed outwards, it projects considerably, and is very conspicuous. It is probably by means of these spurs or hooks, that the female is kept from withdrawing herself in the act of copulation; since they are very conveniently placed for laying hold of her body on that particular occasion. The female has no spur of this kind.

The tail, in its general shape, is very similar to that of the beaver. The hair upon its upper surface is long and strong; it has a coarse appearance. The under surface, if superficially examined, appears to have no hair; but, when more closely inspected, is found to be covered with short straggling hairs.

Description of the internal Parts.

The panniculus carnosus, which lies immediately under the skin, and extends over the greatest part of the body, is exceedingly strong.

The tongue is two inches long; it lies in the hollow between the two jaws, but does not project any way into the bill, being confined to its situation, except a very small portion at the tip. It is smallest at the point, and becomes larger towards the root; the posterior portion becomes very large, and rises considerably higher than the rest, forming a projection, on the anterior part of which are the two small teeth already mentioned. The tongue is covered with short cuticular papillæ, the points of which are directed backwards.

The velum pendulum of the palate is very broad. The glottis is uncommonly narrow; and the epiglottis proportionally small. The rings of the trachea are broad for their size; they do not meet behind, but nearly so. The tongue and epiglottis are represented in Plate II. Fig. 2.

In the structure of the bones of the chest, there are some peculiarities which deserve notice.

The ribs are sixteen in number: the six superior are united to the sternum, which is narrow and very moveable; the other ten terminate anteriorly in broad, flattened, oval, bony plates, which overlap each other in the contracted state of the chest, and are united together by a very elastic ligamentous substance, which admits of their being pulled to some distance; so that the capacity of the chest can undergo a very unusual degree of change.

The ribs are not connected to the sternum by their cartilages, as in other quadrupeds, but by bone; the cartilaginous portion

being only about an inch long, and situated at some distance from the sternum, between two portions of rib, forming a kind of joint at that part. There is no ensiform cartilage.

On the upper end of the sternum is a bone an inch long, which at its upper part has two processes that answer the purpose of clavicles, and unite with the upper part of the scapulæ, keeping them at a proper distance. The scapulæ have a very unusual shape: the posterior part is more like the imperfect scapula in the bird; and the flat part is situated with one edge under the bone, immediately above the sternum. The other edge forms the glenoid cavity, for the articulation of the os humeri; so that the fore legs have their connection with the trunk more forward than in other quadrupeds; and the scapula itself is much more firmly confined to its situation.

This bone above the sternum, with the anterior part of the two scapulæ, forms a bony covering of some strength, under which pass the great blood-vessels of the neck, secured from compression.

The appearance of the ribs, sternum, and other bones, is represented in Plate III.

The heart is situated in the middle line of the chest, its apex pointing to the sternum, and is inclosed in a strong pericardium: it is made up of two auricles and two ventricles. The foramen ovale between the auricles was closed, nor was there any communication between the ventricles. The right auricle is very large, and has two ascending venæ cavæ; that to the left winding round the basis of the heart, and forming the subclavian and jugular vein of that side, after giving off the vena azygos. This is similar to the kangaroo, beaver, otter, and many other animals. The aorta and other arteries are small.

The lungs are large in size, corresponding to the capacity of the chest. On the right side there are two lobes; there is a small azygos lobe under the heart; and in the left side only one. Instead of a portion of the lungs being above the heart, as in other animals, the heart may be said to be above the lungs; for they only embrace its sides, and do not surround its upper surface, but extend downwards, into the more moveable part of the cavity of the chest.

The diaphragm is very broad, and every where towards the circumference is muscular, having only a small central portion, which is tendinous, immediately under the heart.

The œsophagus is extremely small, more particularly at its origin behind the larynx, where the fauces terminate in it.

The stomach is a membranous bag, of an oval form, into which the œsophagus can hardly be said to enter, being rather continued along one end of the oval, till it forms the duodenum; so that the stomach appears to be a lateral dilatation of a canal, which is the œsophagus where the dilatation is formed, and becomes the duodenum immediately afterwards, at which part the coats are thickened, forming the valve of the pylorus.

The stomach is smaller than in most other animals; in this respect it is like the true stomach of birds. In the collapsed state it is only $1\frac{1}{2}$ inch long, and $\frac{3}{4}$ of an inch broad. This is exactly double the size of one of the pouches in the cheek.

The duodenum makes a turn in the right side of the abdomen; then crosses the spine, and becomes a loose intestine. The small intestines are strung upon a loose, broad, transparent mesentery. The origin of the colon is only to be distinguished by a small lateral appendage, $1\frac{1}{2}$ inch long, and $\frac{1}{4}$ of an inch in diameter, going off from the side of the intestine, which is not

altered in its size at this part. This process corresponds to the cæcum: it is unlike the cæcum in quadrupeds, but resembles that in birds, only is much smaller, and in general they have two; but the bittern and heron have only one. From this part, the colon passes up the left side, fixed to its situation by being attached to the omentum; then goes across the body, and becomes rectum, which gradually increases in size, and is very capacious before it terminates at the anus.

The small intestines are four feet four inches long. The colon and rectum are one foot four inches long.

The rectum opens externally at the root of the tail, $1\frac{1}{2}$ inch below the pelvis. On each side of the anus is a large solid body, about the size of the testicle, which proves to be a gland, whose ducts open by several orifices into the rectum. In the female, the same glands are met with, but of a much smaller size.

The mesentery is free from fat; nor are there any fatty appendages, or longitudinal bands, on the colon. The mesenteric glands are of the size of millet-seeds; they are numerous, and scattered over the mesentery. The lacteals are small.

The internal surface of the stomach is uniformly smooth. The duodenum has valvulæ conniventes, which are transverse: these are not met with in the jejunum and ilium; but in them the internal membrane is studded over with glands. There is no appearance whatever of valve at the beginning of the colon; but there are ten dotted lines, which run in a longitudinal direction, at equal distances from one another, and have their origin at the orifice of the cæcum: these dots, upon a close inspection, prove to be the projecting orifices of ducts belonging to the glands of the intestine. The cavity of the small cæcum is very cellular, as is shown in Plate II. Fig. 3.

The omentum is a thin transparent membrane, without any fat in it, originating from the side of the stomach next the duodenum, and also from that intestine anteriorly: on the left side it hangs loose, and the spleen is connected to it; but, on the right, after it reaches the colon, it surrounds that gut, and returns to the spine; so that, although the colon is confined by the omentum, there is no part of that membranous bag projecting beyond it.

The liver is composed of four lobes, besides the small lobe or lobulus Spigelii. The gall-bladder is in the usual situation, and of the common size. The cystic and hepatic ducts unite into one, and are joined by the pancreatic duct before their termination in the duodenum, which is about an inch from the pylorus.

The pancreas is spread upon the great and little omentum, as in the sea-otter, and is made up of small parts, in a very similar manner.

The spleen consists of two very long slender bodies, united together at one end for the length of half an inch: one of these portions is six inches, the other four inches long.

The kidnies are conglobate, and lie in the usual situation. The capsulæ renales are rather small. The ureters are pellucid and small.

The urinary bladder is not situated in the pelvis, but just above it, in the cavity of the abdomen, and is attached to the peritonæum lining the abdominal muscles.

The skull is rather flattened upon the upper surface: its cavity is capacious; and there is a bony process projecting from the cranium, in the place of the falx of the dura mater. This, I believe, is not the case in any other quadruped: it is met with

in some birds in a less degree, as in the parrot and the spoon-bill; which last bird, in the structure of its beak, bears some analogy to this animal. The tentorium is entirely membranous.

The brain was not in a state to admit of its structure being accurately examined; but it appears to be made up of the same parts as those of quadrupeds in general.

The olfactory nerves are small, and so are the optic nerves; but the fifth pair, which supplies the muscles of the face, are uncommonly large. We should be led, from this circumstance, to believe that the sensibility of the different parts of the bill is very great, and therefore that it answers the purpose of a hand, and is capable of nice discrimination in its feeling.*

The eye is very small, and is nearly spherical: the globe is about $\frac{1}{4}$ of an inch in diameter; the cornea $\frac{3}{16}$ of an inch in diameter. There is a membrana nictitans; and the eyelid is very loose upon the eyeball; it is probably capable of great dilatation and contraction.

The organ of smell, in its construction resembles that of other quadrupeds, and may be said to consist of two turbinated bones in each nostril; that next the bill is the largest, and has the long axis in the direction of the nostril; its external surface is very irregular. The posterior one is shorter, projects further into the nostril, and is situated transversely, with respect to the nostril. As the external openings of the nose are at the end of the bill, there is a canal of an unusual length for the air to pass through, before it is applied to the immediate organ, unless there is an extension of the branches of the olfactory nerve upon the linings of the cavity, so as to make it a part of it. The external

* The same observations were made by Professor BLUMENBACH, of Gottingen, who first dissected these nerves.

opening of the ear is at a great distance from the organ; and there is a cartilaginous canal, the size of a crow-quill, winding round the side of the head, upon the outside of the temporal muscle, leading to the orifice in the temporal bone.

The membrana tympani is larger than in other quadrupeds of the same size: it is of an oval form; and the central part is drawn in, making its external surface concave. It has only two bones; one passing directly from the membrane towards the foramen ovale, upon which there is a second bone, imperfectly resembling the stapes, having a flat surface of a circular form upon the orifice, and a small neck, by which it is united to the other bone.

This structure of the bones is less perfect or complex than in other quadrupeds; so that the organ altogether bears a greater resemblance to that of the bird.

The organs of generation in this animal have several peculiarities of a very extraordinary nature.

The male organs do not appear externally; so that the distinguishing mark of the sex is the spur on the hind leg.

The testicles are situated in the cavity of the abdomen, immediately below the kidneys: they are large for the size of the animal. The epididymis is connected to the body of the testicle by a broad membrane, which admits of its lying very loose.

The penis in this animal does not, as in other quadrupeds, give passage to the urine. It is entirely appropriated to the purpose of conveying the semen; and a distinct canal conducts the urine into the rectum, by an opening about an inch from the external orifice of the intestine. The gut, at this part, is defended from the acrimony of the urine, by the mucus secreted by two glands already described, which probably for this reason

are very large in the male, but small in the female. The opening of the meatus urinarius, and the orifices of the glands, are represented in Plate IV.

The penis is short and small in its relaxed state; and its body does not appear capable of being very much enlarged when erected. The prepuce is a fold of the internal membrane of the verge of the anus, as in the bird; and the penis, when retracted, is entirely concealed.

The glans penis is double; one glans having its extremity directed to the right, the other to the left; and, as they supply two distinct cavities with semen, they may be considered as two penises. This is an approach to the bird, many of which have two. Each glans has, at its extremity, pointed conical papillæ, surrounding a central depression. In one glans, the papillæ are five in number, in the other four. When the urethra is laid open from the bladder into the rectum, about half an inch from its termination it communicates with the proper urethra of the penis, which afterwards divides into two, one going to each glans, in the centre of which is a cavity communicating directly with the papillæ, the points of which are pervious, forming the orifices by which the semen is evacuated.

The vasa deferentia open into the membranous part of the urethra, before it comes to the root of the penis.

Not being aware of so extraordinary a structure, and the parts not being in a perfect state of preservation, they were too much injured by dissection before it was discovered, to admit of their being prepared by injection. The appearance of these parts is delineated in Plate IV.

There was no appearance of vesiculæ seminales.

The female organs open into the rectum, as in the bird. Just

within the anus there is a valvular projection, between the rectum and vagina, which appears to be the proper termination of the rectum. This also is similar to the bird.

There was no appearance of clitoris, that could be observed.

The vagina is $1\frac{1}{2}$ inch long: its internal membrane is rugous; the rugæ being in a longitudinal direction. At the end of the vagina, instead of an os tincæ, as in other quadrupeds, is the meatus urinarius; on each side of which is an opening leading into a cavity, resembling the horn of the uterus in the quadruped, only thinner in its coats. Each of these cavities terminates in a fallopian tube, which opens into the capsule of an ovarium.

The ovaria are very small: they were not in a very perfect state of preservation, but bore a general resemblance to those of other quadrupeds.

This structure of the female organs is unlike any thing hitherto met with in quadrupeds; since, in all of them that I have examined, there is the body of the uterus, from which the horns go off, as appendages. The opossum differs from all other animals in the structure of these parts, but has a perfectly formed uterus; nor can I suppose it wanting in any of the class Mammalia.

This animal having no nipples, and no regularly formed uterus, led me to examine the female organs in birds, to see if there was any analogy between the oviducts in any of that class, and the two membranous uteri of this animal; but none could be observed; nor would it be easy to explain how an egg could lie in the vagina, to receive its shell, as the urine from the bladder must pass directly over it. Finding they had no resemblance to the oviducts in birds, I was led to compare them with the uteri of those lizards which form an egg, that is afterwards deposited in

a cavity corresponding to the uterus of other animals, where it is hatched; which lizards may therefore be called ovi-viviparous; and I find a very close resemblance between them. In these lizards there are two uteri, that open into one common canal or vagina, which is extremely short; and the meatus urinarius is situated between these openings. The coats of these uteri are thinner than those of the uteri of quadrupeds of the same size.

In the ovi-viviparous dog-fish, the internal organs of the female have a very similar structure. There is therefore every reason to believe, that this animal also is ovi-viviparous in its mode of generation.

EXPLANATION OF THE DRAWINGS.

See PLATES II. III. and IV.

PLATE II.

Fig. 1. Represents the hind leg of the male, in order to shew the situation and appearance of the spur.

Fig. 2. Represents the tongue, in its natural situation; and shows its relative position to the grinding teeth, and the lower portion of the bill; also the two pointed teeth upon the tongue itself.

On the outside of the jaw, on each side, are the pouches for the food.

The glottis, epiglottis, and œsophagus, are represented of the natural size.

Fig. 3. The loculated cæcum, with a portion of the ilium and colon.

PLATE III.

Represents the bones of the chest and pelvis, in their relative

situation, to show the uncommon shape of the scapulæ, which are not connected with the chest, but with a bone placed above the sternum, the upper part of which answers the purpose of clavicles; the anterior part of each scapula passes under this bone laterally, forming with it a bony case for this part of the neck.

Another peculiarity is, the cartilages of the ribs not being placed next the sternum, but between two portions of the rib. The false ribs have their cartilages terminated by thin bony scales, which slide on one another in the motions of the chest.

The pelvis is unusually small, and has the two moveable bones, attached to the os pubis, which are met with in the kangaroo.

a a a. The bone which corresponds to the clavicles in other animals.

b b b. The left scapula.

c c c. The bony scales along the margin of the chest.

d d d. The cartilages of the true ribs.

e e. The moveable bones of the pelvis.

Plate IV.

Fig. 1. Represents the penis in a relaxed state, but drawn out to its full extent, with its relative situation to the rectum and testicles, which are contained in the cavity of the abdomen.

a a. The bodies of the testicles.

b b. The epididymis.

c. The urinary bladder.

d d. The rectum.

e e. Two glands, whose ducts enter the rectum by a number of small orifices.

f. The body of the penis, whose external covering is a continuation of the lining of the lower part of the rectum.

gg. The double glans: at the point of the right one are five conical papillæ, and at the point of the left only four, which are open at their extremities; through these orifices the semen passes.

h. The opening of the urethra into the rectum.

Fig. 2. A view of the uteri and vagina.

aa. The vestibulum, common to the rectum and vagina.

bb. The cut edges of the rectum; the gut being dissected off to expose the vagina.

c. The vagina.

d. The meatus urinarius.

e. The bladder.

ff. The orifices leading to the uteri.

gg. The two uteri.

hh. The fallopian tubes.

ii. The ovaria, enclosed in the capsules.

Fig. 1.

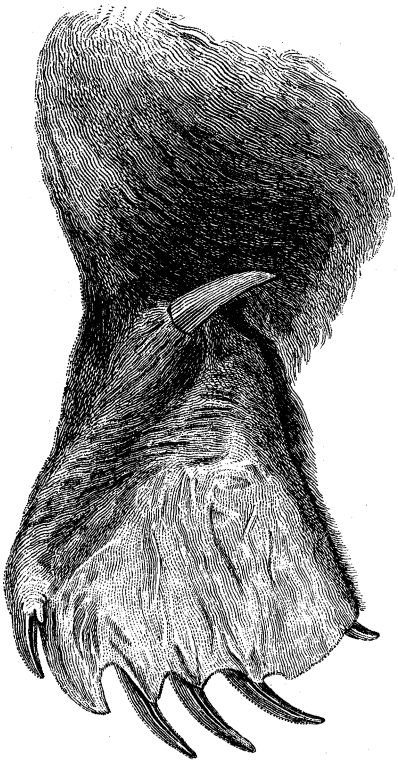


Fig. 2.

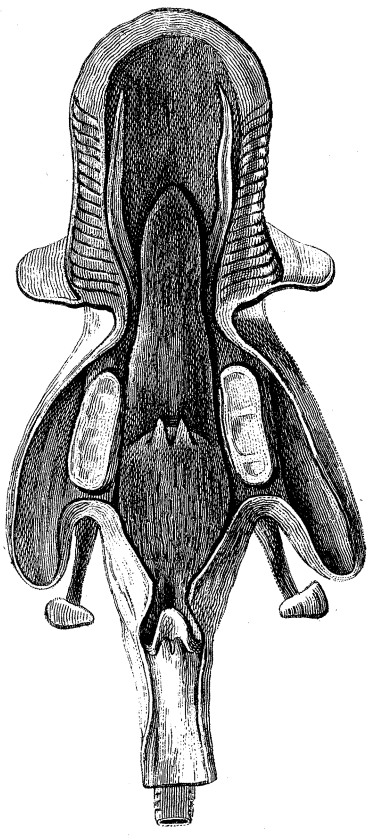
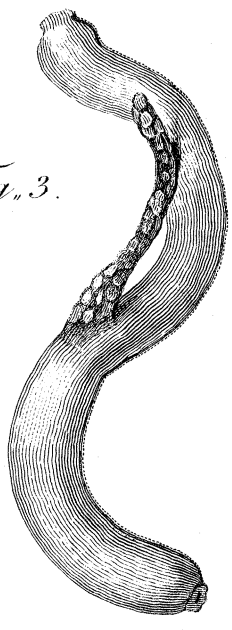


Fig. 3.



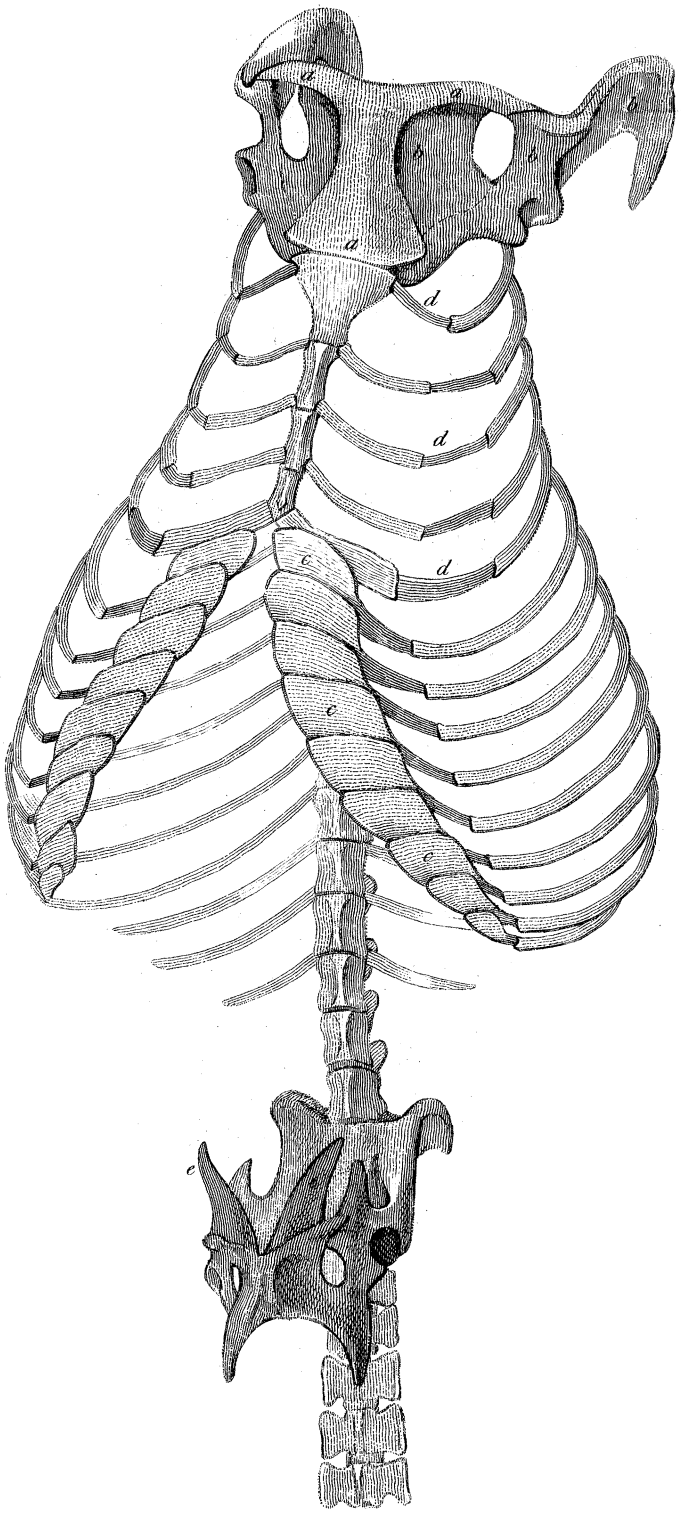

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Fig. 1.

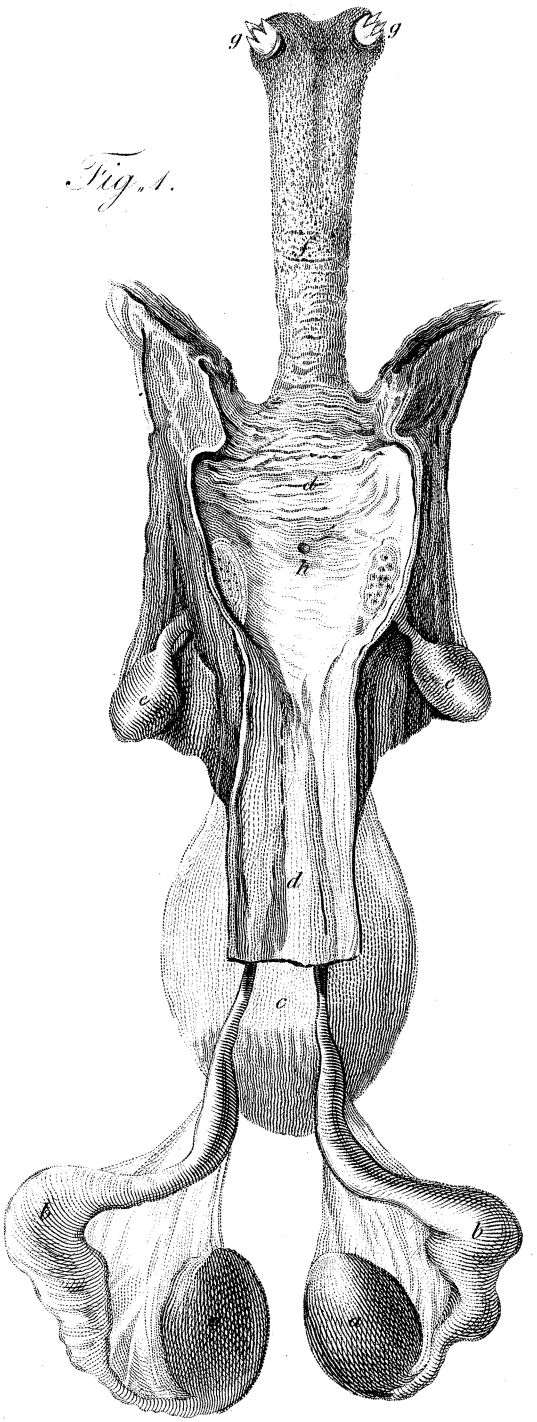

Fig. 2.