III. *On the Anatomy of the Indian Rhinoceros* (Rh. unicornis, *L.*).

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Part I.

Introduction. External characters. Position of Viscera.

THE very rare opportunity of investigating the internal structure of the Rhinoceros, which the death of the fine male specimen of the Indian species, *Rhinoceros unicornis*, L., at the Menagerie of the Zoological Society, has afforded, enables me to submit to the Society the following details of its anatomy.

I may premise, as a requisite point of comparison with the dimensions and weight of some of the viscera, that the animal, which was full-grown and had lived in the menagerie fifteen years, measured thirteen feet and a half from the end of the muzzle to the root of the tail, and thirteen feet in its greatest circumference: its total weight was upwards of two tons[1].

The animal had begun to show a loss of appetite in July 1849, when it was supposed to be under the influence of the rut: the more decided symptoms of ailment first manifested themselves about a week before its death, when it was observed to make occasional efforts, as if to vomit, followed by the escape of a bloody and frothy mucus and fluid from the mouth and also from the nose. It died on the evening of the 19th of November 1849. Subjoined are the symptoms noted in the Head-Keeper's Minute-book[2].

After the removal of the integuments and some dissection of the muscles, the abdominal and thoracic viscera were exposed by the detachment of all the ribs of the left side; when it was found that the seventh rib had been fractured at the bend near the vertebral end: a kind of false joint had been formed between the broken portions. One

[1] Mr. Miller, the Superintendent, has transmitted to me a record which shows that the Rhinoceros, when received at the Gardens, 20th September 1834, weighed 1½ ton: there was no means of weighing the entire animal after its death: but an approximation was made by weighing separately the limbs, the trunk, detached masses of flesh, the hide, &c., which allowed the total weight to be estimated at about 5000 lbs. avoirdupois.

[2] "1849, November 12th. Rhinoceros vomited slimy mucus.

14th.	ditto	ditto, with blood.		
15th.	ditto	ditto	ditto.	
16th.	ditto	ditto	ditto, and from the nostrils.	
17th.	ditto	ditto	ditto	ditto.
18th.	ditto	ditto	ditto	ditto.
19th.	ditto	ditto	ditto	ditto."

of these had wounded the left lung, and the inflammation, which had caused extensive adhesion of the back part of the lung to the pleura costalis, had also extended into the pulmonary substance, and along the bronchial tubes into the trachea. The surface of the part of the left lung near the wound was extensively emphysematous; and the inflamed bronchial tubes were loaded with bloody frothy serum and mucus. The supposed attempts at vomiting were doubtless efforts to disembarrass the windpipe of the successive accumulations of this fluid; and the death of the animal is to be ascribed to the injury and disease of the left lung consequent on the fracture.

The other morbid appearances were of minor moment: a portion of the right lung was the seat of Hydatids, of the genus *Echinococcus*. The parent cysts were of various sizes from the diameter of two inches to that of half an inch; two or three being successively included in one another. The uncinated vermicules floating freely in the fluid of the parent cysts were $\frac{1}{1000}$th of an inch in diameter, and in countless numbers. They will be more particularly described by Mr. Quekett in the Appendix to this paper; in which also will be given the particulars of the morbid state of the gastric follicles in the digesting portion of the stomach, as observed by the microscope: to this state may be attributed the failure of appetite which first drew attention to the declining health of this rare and valuable quadruped.

The calcareous matter which was discovered in the gastric follicles would probably have laid the basis of a gastric or intestinal calculus, if the animal had lived; but the apparently healthily digested condition of a considerable proportion of the contents of the stomach showed that the state of the secreting apparatus could only be remotely connected with the last fatal symptoms. The liver was less firm than usual; but this might be due to the rapidity with which the large pachyderms pass into a state of chemical decomposition after death. There is a striking difference in that respect in different mammalia; the Ruminants resist the decomposing forces longer than the Pachyderms, as I have experienced in dissecting the Giraffe and the Aurochs; and the resistance is more remarkable in some other orders. On dissecting the two-toed Sloth in moderately warm weather, I was surprised at the length of time in which it kept sweet. Martin, in his 'History of the British Colonies,' observes of the Sea Cow (*Manatus americanus*), "Its flesh is white and delicate, resembling veal in appearance and taste, and it will keep good several weeks, even in the hot climate of which it is a native, when other meat will not resist putrefaction for as many days." The Elephant and the Tapir which I have dissected at the Society's Gardens rapidly passed, like the Rhinoceros, into an offensive state of decomposition.

The bodies of the 5th, 6th and 7th dorsal vertebræ were anchylosed together along their under part, from which an exostosis of apparently old growth projected into the base of the mediastinum, forming there an obtuse rounded tumour of about two inches vertical thickness and twelve inches in circumference. The neural arches and spines of these vertebræ showed no fracture or disease, and as there had not been any symptom

of paralysis, further damage to the skeleton for the purpose of examining the spinal marrow at that part was not deemed expedient.

Our able and active Secretary has reminded me, that at the time when the large male Elephant was exhibited along with the Rhinoceros in a contiguous paddock, the latter used to submit to be poked on the back by the Elephant, who could lift his head over the palings and press down with his tusks upon the thick hide of the Rhinoceros; and that the Rhinoceros has been observed to have been thus forced down until his belly touched the ground. Now although this procedure did not actually fracture the spines or neural arches so pressed upon, it most probably strained the ligaments beneath the bodies of the same vertebræ, and produced the ossific inflammation which led to the anchylosis and tumour discovered on dissection. One cannot, however, attribute to this old injury the immediate cause of the animal's rapidly fatal malady. It may have led to the fracture of the rib articulating to the anchylosed parts, through the suppression of that degree of elastic yielding, which the interspace of the vertebræ in their ordinarily moveable state would have afforded. The animal, in lying down, usually fell heavily on its side, and the rib had probably become fractured on one of these occasions by 'contre-coup.'

The external form and characters of the present specimen of Indian Rhinoceros agreed with the full and often-repeated descriptions which have been already published; especially with that excellent one by Daubenton in Buffon's 'Histoire Naturelle,' 4to, tom. xi. p. 198, and with the description, illustrated by two fine and accurate figures, by F. Cuvier in the 'Histoire Naturelle des Mammifères,' fol., fasc. xiii. 1820, p. 2. The only point which appears to have escaped these and other good observers, is the orifice behind each carpus and tarsus, which forms the termination of the duct of a pretty large subdermal glandular pouch.

In the male *Rhinoceros unicornis*, in a state of nature, the horn, when the animal has attained the length of nine feet eight inches, is, according to Mr. Hodgson, the learned and accomplished Resident at Nepal, five inches in height. In the Society's specimen, the horn, owing to the habit which the animal had acquired of rubbing and beating it against the woodwork of its den, had never been permitted to grow beyond eight inches in height; but its base measured nine inches in transverse breadth, eleven inches in antero-posterior extent, and twenty-six inches in circumference. It was distant

	Inches.
From the inner canthus of the eye	4
From the end of the upper lip	7
From the occipital ridge	22

In a female Rhinoceros of the same species which died in a travelling menagerie in January 1838[1], and was purchased by the Royal College of Surgeons, the horn was a mere

[1] This animal was found dead in its den after a night during which the thermometer had fallen 10° below

callous protuberance, scarcely an inch in height and only four inches across the base, although the animal was nine feet in length and the same in its greatest circumference. This difference indicates that the epidermal production in question varies in its proportions in the male and female, making a sexual distinction analogous to that which may be observed in the antlers of the Reindeer, the false antlers of the Giraffe, and in some other Ruminants in which horns are present in both sexes[1].

Since, as Daubenton well demonstrated, and as has been amply confirmed and elucidated by later observers, the horn of the Rhinoceros is an unvascular production, an agglutination of fibres like bristles, unsupported by any osseous core, the question early suggested itself to me, how the relative position of the epidermal conglomerate to the eye and the end of the muzzle was preserved during the progressive growth of the head, and I have carefully watched the progress of the horn in the male animal here described from its first reception into the Society's Menagerie. During the whole of the period of the animal's growth, the back part of the horn was that which alone exhibited natural decay; the fibres there being ragged and broken, while the new fibres were added at the sides and chiefly in front. Thus the horn kept pace, as to its relative position, with the progressive elongation of the jaws during the acquisition of the permanent teeth, by a process analogous to that by which the adductor muscle of the oyster maintains the same relative position to the hinge and outlet of the shell during the whole period of the shell's growth. This partial or local decay and renovation became less conspicuous after the Rhinoceros had attained its full size, and in the long and large horns of aged individuals the whole circumference presents the same smooth and polished surface: whence it may be concluded that when the skull, and especially the upper jaw of the Rhinoceros have attained their full size, the horn receives additional matter along the whole extent of the base, and increases more rapidly in length than in the immature animal.

The glandular orifices at the back part of each foot to which I have alluded, are situated about three inches above the callous sole in the fore-feet and about two and a half inches above the sole in the hind-feet: they are concealed from cursory observation in the middle of the transverse fold that runs parallel to the interspace between the carpus and metacarpus, and between the tarsus and metatarsus. The orifice is analogous to that which opens on the fore part of the foot between the digits in the Sheep and some other Ruminants. The gland itself (Pl. IX. fig. 1) in the Rhinoceros is of a compressed ovate figure, measuring one and a half inch in length and one inch in breadth. The thickness of the glandular parietes (*Ib.* fig. 2) varies from two to three lines. These parietes consist of a compact congeries of follicles, surrounded externally

the freezing point: it had previously exhibited no signs of disease, and had been carried about and exhibited upwards of a year.

[1] In the female *Rhinoceros Simus* the anterior horn is longer and more slender than in the male: in other two-horned species I am not at present aware of any sexual distinction in these weapons.

by a muscular and tendinous coat: the diameter of the excretory orifice (*Ib.* fig. 3) is about eight lines when fully expanded.

The anus is dilatable to a great extent, corresponding to the large masses in which the fæces are discharged; and the Rhinoceros presents, in the size of this aperture, the opposite extreme to the Giraffe and the Nilghau.

A deep groove formed by two thick and prominent parallel folds extends from below the anus along the median line of the perinæum, gradually widening, to the back part of the base of the preputial or pendulous part of the penis. In the ordinary retracted state of this organ, the distance from the anus to the preputial orifice is two feet ten inches: the length of the thick, wrinkled, tegumentary prepuce (Pl. IX. fig. 4), within which the long glans is commonly retracted and concealed, is about nine inches; its basal circumference measures one foot six inches; on each side of this part there is a hemispheroid warty prominence (*Ib. a*). When the animal stales, the glans is protruded downwards with a curve backwards (*Ib.* fig. 5), and the urine is ejected between the hind-legs in a succession of jerks. I never saw it issue in a continuous stream. Under sexual excitement the penis is much further protruded and drawn forwards in a straight line (*Ib.* fig. 6). The singular form of the glans will be subsequently described.

In the female Indian Rhinoceros, the vagina and the preputium clitoridis open on the external surface by two separate, narrow, vertically elongated orifices, each being, in the individual of nine feet long—the subject of the remarks on this sex in the present Memoir, about two inches in length: the vulva (*Ib.* fig. 7, *vu*) is immediately above the clitoris (*Ib.* fig. 8, *c*), *i.e.* nearer the anus. The extent of the perinæum between the anus and vulva was four and a half inches.

The nipples (*Ib.* fig. 8, *m*, *m*) were two in number and inguinal; they were situated fourteen inches in advance of the vulva, and two and a half inches apart from one another. They were subcompressed, obtusely rounded at the extremity, and about two inches in length: about a dozen lactiferous ducts opened upon the somewhat flattened summit of each nipple.

The integument on the middle line of the abdomen, along which it was divided in the operation of skinning, presented a general thickness of three-fourths of an inch. where it was cut on the inner side of the extremities, it was about one-fourth of an inch in thickness. It was connected to the abdominal parietes by a loose cellular tissue, and by a closer subcutaneous tissue to most of the other parts of the body; but the parts to which the stiff and ponderous hide most firmly adhered were the spinous processes of the posterior lumbar and sacral vertebræ, and the anterior extremities of the iliac bones, at which places the corium was blended with the periosteum, and was remarkably thin. The hide adhered over the jugal bones to a kind of moveable fibro-cartilage; and its attachment along the median line of the fore part of the head was so firm as to require, especially beneath the horn, the use of a chisel in order to separate it from the skull.

But, besides its attachment to subcutaneous cellular tissue, fasciæ, elastic tissue, fibro-cartilages and periosteum, the hide is connected with parts which are destined for its motions and adjustment upon the body. So far from the *panniculus carnosus* being absent, it is developed in certain parts to an extraordinary thickness; and it became obvious, on contemplating these muscles, that one use of the permanent folds in the hide of this thick-skinned species of Rhinoceros, is to afford, like the processes of bones, a firmer insertion to the aponeuroses of the cutaneous muscles than a plane surface of integument could possibly have done. A sheet of *panniculus carnosus* situated on each side of the thoracic or scapular region sends its fascia into the interstice of the fold in front of the anterior extremities, the skin being bent upon itself, as it were, to grasp this fascia. Similar portions of *panniculus carnosus* send their aponeuroses into the posterior folds of the skin. But the most remarkable portions of the cutaneous muscular system are two, which arise, broad and thick, one on each side of the anterior part of the abdomen from the superficial fascia covering that part, and, passing backwards, terminate in aponeurotic sheets which are inserted into the fasciæ covering the patellæ and knee-joint. As the patellæ are higher than the abdomen, in the erect position of the animal, the preceding muscles would seem to be developed chiefly to afford additional support to the bulky abdomen, the weight of which is thus in part transferred immediately to the hinder extremities; and these the muscles in question must also tend to draw forwards during progressive motion.

The dense but highly elastic 'fascia superficialis', spread over the peripheral surface of the abdominal muscles upon their pubic and hypochondrial regions, increases in thickness as it passes over the abdominal rings, and invests the spermatic chord with a thick sheath, which becomes thinner where it expands upon the 'tunica vaginalis testis.' Each testis was situated out of the abdomen, but pretty close to the external abdominal ring, without, however, causing any protuberance in the thick integument: and there is no scrotum or outward indication of the essential glands of the male organs.

In the female the superficial fascia covering the external abdominal rings descended upon and surrounded the mammary glands; which occupy a corresponding position to that of the testes in the male[1]. On the internal or central surface of the mammary glands was situated a plexus of large veins: the arteries supplying them were a branch from the superficial femoral and branches of an artery answering to the cremasteric artery in the male, which passed with the 'ligamentum teres uteri' through each abdominal ring.

The sole of each foot was occupied by a thick cushion of elastic tissue, not adipose chiefly, as in Man, but of a whiter, gelatinous and ligamentous texture, resembling the morbid tissue called 'albuminous carcinoma.' The difference between the thick epidermal layer covering the sole, and that sheathing the fore part of each of the three

[1] This correspondence is accompanied by a similarity in the development and functions of the cremaster muscle in the two sexes of the Marsupial quadrupeds.

toes, is more marked than in the Horse: the hoofs proper, or homologues of the nails, are firmly attached to the periosteum of the ungual phalanges by fine vertical laminæ interlocking with corresponding vascular laminæ of the thickened periosteum.

Before entering on the subject of the visceral anatomy of the *Rhinoceros unicornis*, I may premise that some general details on this subject will be found in a paper by Dr. James Parsons in the Philosophical Transactions for 1743, on the occasion of the death of the Rhinoceros sent by the Chief of the Hon. E. I. Company from Patna to London in the year 1739: I possess an impression of a scarce print of the animal published in London in that year.

A second Rhinoceros of the same species, which was exhibited and died in London in 1800, was dissected by Honoratus Leigh Thomas, Esq., who has given an account of his observations on that occasion in a paper printed in the Philosophical Transactions for 1801. Mr. William Bell had previously contributed to the Philosophical Transactions for 1793, some interesting remarks on the anatomy of the Sumatran two-horned Rhinoceros, then for the first time described.

In the one-horned Indian specimens dissected by me, the peritoneal membrane was thick and much stronger than in the human subject: the cellular tissue connecting the external surface of this serous membrane to the adjacent structures is condensed into an aponeurotic firmness where it is attached to the serous coat, the free surface of which presents an opake, whitish appearance. In the female Rhinoceros I exposed the abdominal viscera by laying open the cavity along the middle line of the ventral surface, and turning aside the flaps of its yielding soft parietes. Not the least trace of epiploon was observable when the cavity of the abdomen was thus exposed; but the viscera which presented themselves were in immediate contact with the sustaining parietes. A single but enormous fold of the colon, not less than two feet in breadth, formed more than one half of the exposed surface of the abdominal viscera: it passed obliquely across the middle of the cavity, from the right hypochondriac to the left hypogastric or iliac region; immediately below this was a smaller fold of colon[1] running parallel with the preceding; below this was a second fold; and, occupying the right iliac region, a part of the smooth parietes of the cæcum appeared: a portion of the liver and the stomach were obscurely visible in the epigastric and hypochondriac regions, and below these were seen a few coils of the small intestine.

The colon was not displaced without considerable difficulty, owing to the weight of its contents, and the strength of the duplicatures of the peritoneum attaching it to the spine and contiguous parts. Behind and above the great oblique folds of colon lay a short, thin and corrugated epiploon, devoid of fat; and behind and below them were several coils of the small intestines: the spleen and kidneys were also brought into

[1] It is to these enormous folds of the colon that the great size of the abdomen is due, and not to the cæcum, which is not proportionally so large as in the Horse.

view, together with the large cæcum, appearing like a second stomach, occupying the right iliac and lumbar regions.

In the male Rhinoceros the thoracic and abdominal viscera were exposed by the successive detachment of the ribs of the left side, together with the soft walls of the same side of the thorax and abdomen. The diaphragm separating these two cavities extended from about the seventeenth dorsal vertebra obliquely downwards and forwards, curving, as it approached the ventral parietes, more rapidly towards them; its diameter following this course being four feet six inches. The length of the abdominal cavity was seven feet; its depth or antero-posterior diameter three feet six inches. The length of the thoracic cavity near the spine was three feet six inches; its depth at the most prominent part of the convex diaphragm was two feet; its size, contrasted in this view with that of the enormous abdomen, seemed disproportionately small.

The viscera of the abdomen which presented themselves, enumerated from the diaphragm backwards, were the free curved border and part of the upper convex surface of the left lobe of the liver, partly overlapping the stomach, of which about two-thirds of the greater or cardiac portion were visible. The lower free border of the spleen extended from below all the visible part of the great curvature of the stomach; and the thin, fatless, shrivelled epiploon was continued from beneath the spleen upon the upper part of the base of the great fold of the colon above mentioned. This enormous fold slipped forwards as soon as the supporting walls of the abdomen were removed, and exposed the large coils of the left descending portion of the colon continued from it, and below and ventrad of these were exposed some of the coils of the small intestine. A part of the left kidney protruding at the angle between the cardiac end of the stomach and the commencement of the descending colon, was covered by a duplicature of peritoneum extending from its ventral surface to the contiguous end of the spleen.

The dorsal border of the left lobe of the liver was attached by a similar duplicature, forming a strong 'ligamentum triangulare' to the contiguous part of the diaphragm. The length of the great fold of the colon taken in a straight line as it lay first exposed was six feet six inches: some idea of its capacity may be formed from the fact that the portion of the fold next the cæcum could easily contain a man, with ample room for him to turn about in it. But the dimensions of the alimentary canal and its several parts will be subsequently given.

Part II.

Digestive Organs. Abdominal Viscera.

The Mouth.—The substance of both the lower and upper lip was composed of cellular and subligamentous tissue permeated in all directions by muscular fibres, and resembling in section the 'corpus cavernosum penis' in the Horse: the skin covering this substance is very thin and vascular in the upper lip. These muscular fibres, which are homologous with the decussating fibres in the proboscis of the Elephant, presented the striated characteristic of the voluntary muscular fibre under the microscope.

The seventh pair of nerves, which was lost principally in the muscles and the above-described contractile tissue of the upper lip, was of large size.

In the male Rhinoceros the tongue measured two feet three inches from the epiglottis to the tip, and seven and a half inches across its broad anterior part: the depth or thickness of the tongue is four inches, at its root. In the female Rhinoceros the tongue measured nineteen inches in length from the epiglottis to the tip. This organ is broad and flat, slightly expanded at its anterior extremity, and becoming narrower and deeper as it extends backwards: there is a small protuberance on the upper surface opposite the posterior grinders, divided by a longitudinal depression: the large fossulate papillæ of the dorsum are principally collected in a group of ten to twelve on each of these risings: the epithelium is disposed on the anterior part of the tongue in a number of very fine close-set pointed papillæ, resembling short hairs: behind the papillæ the epithelium is condensed into a thick callous stratum, which gradually becomes thinner where it covers the posterior glandular part of the tongue. There are no retroverted cuticular processes, as in the Ruminants. There is a lytta beneath the anterior flattened part of the tongue.

A reticulate structure at the sides of the soft palate, having muciparous follicles in the interspaces of the meshes, and many subcompressed conical processes of various lengths, represents the tonsils (Pl. X. *t*, *t*, *t*): the arches of the palate, or 'isthmus faucium,' form on each side a thin sharp fold, which descends obliquely along the sides of the pharynx and terminates insensibly near the sides of the glottis. The soft palate consists of a stratum of muciparous follicles one-third of an inch thick, placed vertically between two layers of mucous membrane; their blind extremities being in contact with the whitish dense membrane lining the nasal or air-passage, their orifices terminating on the soft red and vascular membrane at the roof of the mouth. The constrictors of the pharynx formed at the anterior margin of that canal a thick rounded edge.

The pointed apex of the triangular epiglottis (*Ib. e*) curves forward above the base of the tongue, to which the epiglottis is attached by a pair of strong 'glosso-epiglottidei' muscles.

The alimentary canal.—The œsophagus extends pretty straight from the pharynx to the stomach, with an uniform diameter, in its passive or contracted state, of three inches: its total length was five feet. It extends about six inches into the abdomen

after piercing the diaphragm, and terminates at the cardiac orifice about one foot five inches from the left extremity of the stomach. This organ (Pl. XI. figs. 1 & 2) presented the ordinary form of the simple stomach: it was moderately distended with food; with a large obtuse cardiac end, expanding to the cardiac orifice (fig. 2, *c*), opposite to which it presented the greatest circumference; thence contracting to near the pylorus (*ib. p*), on the cardiac side of which the stomach presented its smallest circumference; and then expanding into a blind end, of a hemispheric form, beyond the pylorus. The length of the stomach in a straight line was four feet; its diameter from the cardia to the opposite part of the great curvature was one foot ten inches. The small curvature between the cardia and pylorus was one foot nine inches. There was a glistening aponeurotic sheet (*ib. a*) upon the anterior and posterior surfaces of the contracted pyloric end of the stomach.

A sheet of white thick epithelium spreads from the cardia over the inner surface of the cardiac portion of the stomach, about one foot four inches along the lesser curvature, and along the greater curvature to the extent shown in figure 2, *e*. This epithelial layer is one line thick, smooth, or with very fine rugæ on its inner surface, and terminating by a well-defined border, near which it is perforated by numerous orifices of mucous follicles (*Ib.* fig. 4). The rest of the inner surface of the stomach presents the usual vascular structure, with the more minute orifices of the secerning follicles of the gastric juice. There is no crescentic fold or valve at the cardia, as in the Horse: nor is there any valvular protuberance on the gastric side of the pylorus, as in the Cow and most other Ruminants: the thickened rim of the pylorus was slightly produced into the duodenum.

In the female Rhinoceros the stomach presented the same simple elongated form as in the male, corresponding with the description of its external form given by Cuvier (after Vicq. d'Azyr?)[1]. Its total length in a straight line was thirty-two inches, and the distance from the cardia to the left extremity was fourteen inches. It was distended with a mass of coarsely divided hay mixed with oats. The whole of the cardiac extremity, excepting at one small spot, was lined with a smooth compact layer of thickened epithelium, like that in the male: it extended along the upper or smaller curvature of the stomach half-way between the cardia and the pylorus; its greatest extent from the left end of the stomach being twenty-two inches. The boundary-line between this and the glandular or mucous coat of the stomach was even, but as abrupt and well-marked as in the Horse. The epidermis was very easily detached, and in some places had separated spontaneously, as does the thick epithelial lining of a gizzard soon after death, and it is probable that such spontaneous separation of the cuticle in the Rhinoceros dissected by Mr. Thomas may have induced the belief that it was wanting in that animal[2]. The

[1] Leçons d'Anat. Comp. iii. (1805) p. 392.

[2] "The stomach upon its inside was in every part covered by a secreting surface; whereas in the Horse it is partly cuticular."—*Philos. Trans.* 1801, p. 147.

Indian species agrees, however, in the twofold nature of the lining membrane of the stomach, with the Sumatran two-horned Rhinoceros described by Mr. William Bell[1]. About the middle of the cuticular surface of the stomach of the female there was a small irregular patch of glandular membrane: this was proved to be an original formation, and not an appearance due to a partial separation of the cuticle, by detaching the surrounding cuticular lining and comparing the patch in question with the denuded surface. It is probably, however, but an individual variety, as it was not repeated in the male. The surface of the digestive membrane covering the pyloric moiety of the stomach was even, not broken by rugæ, and it presented the same peculiar smooth, almost polished, appearance which characterizes the peculiar glandular membrane lining the second cavity of the stomach of the Porpoise.

The cardia did not present the semi-spiral valve observable in the Horse. The globular pyloric extremity is suddenly bent upon the rest of the stomach, so as to appear partly separated from it by the entering fold. A thick circular lip projects from the pylorus into the duodenum. The outer layer of the muscular tunic, *a*, is one-fourth the thickness of the inner layer, *b*, and becomes thinner over the pyloric end of the stomach. The nervous or vasculo-cellular tunic, *c*, begins to increase in thickness near the termination of the thick epithelium, *d*, in relation to the increased vascular action required by the functions of the glandular layer, *e*: the relative thickness of this layer is shown in the section, figure 3, *e'*.

The contents of the duodenum were of a greenish black colour and almost fluid consistency: only very few small portions of the vegetable substances appeared in the tract of the small intestines, but the cæcum and colon were tensely distended with a magma of substances like those in the stomach, but of somewhat softer consistence, as if in a further stage of digestion.

	Female.	Male.
The length of the small intestines was . . .	50 feet.	65 feet.
The circumference of the duodenum	8 inches.	10 inches.
The circumference of jejunum	6 inches.	8 inches.
The circumference of ileum	7 inches.	9 inches.

The lining membrane of the duodenum, at the beginning of that gut, was puckered up into small irregular rugæ; the flattened triangular processes, as described and figured by Mr. Thomas, began to make their appearance about six inches from the pylorus (Pl. XII. fig. 1); in the jejunum three or four of the processes are often supported on a common base (*Ib.* fig. 2); as they approach the ileum they begin to lose breadth, and gain in length, until they assume the appearance, near the end of the ileum, of vermiform processes, like tags of worsted, from two-thirds of an inch to an inch in length (*Ib.* fig. 3). Peyer's glands appeared scattered here and there; a very conspicuous reticular patch was situated close to the end of the ileum.

[1] Philos. Trans. 1793. Cuvier does not describe the inner surface of stomach.

The small intestines have nearly the same disposition as in the Horse; they are suspended by a short mesentery, in which the anastomosing arteries form only one series of arches. The mucous membrane of the ileum projects in the form of a circular fold within the cæcum; but it seems inefficient as a valve for preventing regurgitation of at least fluid matters from the large intestines. The length of the cæcum (Pl. XIII. *cæ*) from this orifice to its blind extremity in the male Rhinoceros was three feet, and its greatest circumference was four and a half feet. In the female Rhinoceros the length of the cæcum was two feet; its circumference two feet six inches; these proportions to the colon and the rest of the intestinal canal being rather less than in the Horse. The anterior surface of the cæcum is traversed longitudinally by a fibrous band, four inches broad, upon which it is slightly sacculated: a second band appears, nearer the colon. Its lining membrane was puckered up into innumerable irregular small transverse rugæ, which appear, however, to be but temporary foldings of the mucous membrane, and are easily obliterated when this is stretched. The colon for the first four feet of its extent was puckered up upon three longitudinal bands into sacculi, each about five inches long: it was suddenly bent upon itself at this part, forming the long and large fold (*Ib.* *co*^{l}, *co*^{l}), the two parts of the fold being very closely connected to each other; it there became dilated into the very wide portion which formed the most prominent object on laying open the abdomen; the beginning of this dilated portion is also closely adherent by its posterior surface to the opposite surface of the beginning of the cæcum. The circumference of this dilated part of the colon (which if permanent, and not due to accidental accumulation of alimentary matter, might be regarded as representing a second cæcum or reservoir,) is five feet: beyond this fold the colon becomes gradually narrower, its smallest circumference being twenty inches, where it passes into the rectum, which forms several short convolutions before its termination.

	Female.	Male.
The entire length of the colon was . . .	19 feet.	25 feet.
The entire length of the rectum	3 feet.	5 feet.

The total length of the intestinal canal, including the cæcum, was in the female seventy-three feet; in the male ninety-six feet, or eight times the length of the entire animal.

The circumference of the rectum was ten inches in the female, and sixteen inches in the male; but it widens towards the anus. The masses in which the fæces are discharged from the immense receptacles formed by the large intestine, are greater than in the Elephant, and are softer and more amorphous.

The longitudinal muscular fibres of the rectum were developed into such powerful fasciculi as to lead me to suspect some change of tissue; but on examining the fibre microscopically, it presented the same absence of aggregation of the ultimate fibres into striated bundles, as in the higher tract of the intestines. The contrast between these

fibres in the rectum and those of the external sphincter was well-marked, the latter presenting the striated character of true voluntary muscles.

The herbivorous Mammalia differ from the carnivorous more in the character of their large intestines than of their small intestines. The less putrefactive nature of their food renders it susceptible of a longer retention in the body; and the receptacular and saccular character of the large intestines seems especially designed to retard the course of the alimentary substances. An observation made by the celebrated Surgeon Dupuytren, throws light upon the final purpose of this detention of the food of the Herbivora: he noticed in a patient who had an artificial anus near the end of the small intestines, that the vegetable parts of the food thence ejected were undigested. Dr. Beaumont also observed that the vegetable substances underwent much less change than the animal substances in the stomach of the man (Alexis) with the fistulous opening into the stomach. That organ in the artiodactyles (Peccari, Hippopotamus, and Ruminants) is rendered specially complex for overcoming the difficulty, and the cæcum and colon are comparatively small: but in the perissodactyles (Horse, Tapir, Rhinoceros) the more simple stomach is compensated by the increased capacity and complexity of the large intestines. The subdivided stomach in the Sloths is in some respects, as *e. g.* the glandular appendage, and vascular secerning surface of the paunch, more complex than that of Ruminants: and here accordingly we find the cæcum absent and the colon undefined. These facts should be kept in mind by the Physiologist when he draws from Comparative Anatomy in support of inferences as to the special function of the cæcum in completing the digestion of vegetable food. The Dormouse and other hybernating Rodents are far from being the sole exceptions to the presence of a proportionally large cæcum in the Herbivora: a large cæcum is rather the exception than the rule in the vegetable feeders. It is only found in those Herbivora, in which, through the necessity of a correlation with other circumstances than that of the nature of the food, the stomach retains the simple form and moderate size of that of the carnivorous or mixed feeding mammals. Comparative Anatomy significantly warns us against ascribing a special or exclusive importance to any particular dilatation of the alimentary canal. It plainly demonstrates that neither a complex stomach nor a large cæcum are essential to the digestion of vegetable food: but it teaches that a capacious and complex alimentary canal is essential for that purpose, at least in the Mammalia. Either a highly-developed and concentrated glandular apparatus must be added to the stomach, as in the Dormouse, Wombat and Beaver; or the stomach must be amplified, subdivided or sacculated, as in the Ruminants and herbivorous Marsupials; or both complexities must be combined, as in the Sloths, Dugongs and Manatees; or, if a simple condition of stomach is retained, it must be compensated by a large sacculated colon and cæcum.

Digestive glands.—The liver presented the dark colour noticed by Mr. Thomas in his dissection of the Rhinoceros. In the female specimen which I examined, its texture was as firm as in the Horse, and its weight was 21 lbs. avoirdupois. In the older and

larger male its texture was softer and more grumous; and it weighed 44 lbs. avoirdupois. With respect to its form, I did not find an agreement either with the statement of Mr. Thomas[1] or the description in the second edition of the 'Leçons d'Anatomie Comparée,' iv. p. 464 (1836). In both specimens of Rhinoceros the liver was divided into fewer lobes than ordinary, taking the Mammalia generally, yet had a right lobe in addition to the principal bifid lobe and the left lobe, the two latter only being assigned to it by Cuvier. The form of the gland is flattened, as in the hoofed animals generally; its greatest thickness was not more than six inches in the male. Its longest or transverse diameter measured in the female twenty-seven inches, and the length or antero-posterior diameter of the middle lobe seventeen inches. Three great hepatic veins join the inferior cava just below the diaphragm. The strong serous tunic of the liver was beautifully marked by arborescent vessels of a white colour. The 'ligamentum rotundum' and corresponding fold of peritoneum entered as usual into the notch dividing the middle lobe, which might be compared to the cystic lobe in the quadrupeds which possess a gall-bladder. This appendage, however, as in Mr. Thomas's dissection[2], was wanting, as it is also in the other perissodactyle or odd-toed Pachyderms; *e. g.* the Hyrax, the Tapir, the Elephant, and the Horse. In these, as in the Rhinoceros, the absence of the gall-bladder seems to be dependent on the small size of the stomach as compared with the quantity of food taken, to the consequent frequency of feeding, and to the rapid and probably unintermitting transit of the gastric contents through the small intestines to the enormous cæcal and colonic receptacles where digestion and animalization are finally completed[3]. The great biliary duct is formed in the portal fissure by the union of six or seven branches from the lobes of the liver: its diameter is half an inch; it terminates in the duodenum six inches from the pylorus.

The *pancreas* resembles that of the Horse and Tapir: its principal duct (Pl. XIV. fig. 1, *h*) enters the intestine close to the biliary duct (*Ib. a*), communicating therewith in the oblique course between the tunics: the duct of the smaller portion of the pancreas (*Ib. h*) terminates about two inches from the large and protuberant common opening of the preceding ducts, but at the same distance from the pylorus.

The *spleen* is an elongated, subtrihedral, flattened body, lodged in the duplicatures of the short omentum. It weighed 5 lbs. in the male, and 3 lbs. in the female Rhinoceros: in the latter its length was two feet six inches; its greatest breadth one foot; its smallest breadth six inches: in the male it measured three feet six inches in length, one foot four inches in breadth: it resembles in structure that of the Horse.

Kidneys.—The weight of these two glands was about 8 lbs. in the female and 11 lbs. in the male Rhinoceros. In both they had the same situation in the abdomen as in the Horse. They were lobulated, and the extent of subdivision was intermediate between

[1] "It was divided into several lobes."—*Tom. cit.* [2] See also Cuvier, *loc. cit.* iv. p. 549.

[3] See the excellent remarks by Mr. Youatt in his work on 'The Horse,' 8vo, 1831, p. 212. In the Hog the cæcum is comparatively small.

that which respectively characterizes the kidneys of the Ox and Bear; the average size of the component lobules being two inches[1]. In the female, the kidneys did not resemble each other in form. That on the left side was flattened and semi-ovate, ten inches long, six and a half inches broad, and two inches thick. The right kidney was subtriangular (Pl. XIV. fig. 2), presenting a flattened surface to the broadly expanded ribs on which it rested, and having on the opposite or anterior side two flattened surfaces meeting at an obtuse angle: this kidney was eight and a half inches long, seven and a half inches broad in the female. In the male the kidneys were more symmetrical: the right measured eleven inches in length and seven inches in breadth. The great vein, the artery, and the ureter had the usual relative position near the pelvis of the kidney; the vein being anterior, and the ureter descending behind the artery: this duct presented a diameter of half an inch.

The ureter (*Ib.* fig. 3, *u*) having penetrated the substance of the gland for the extent of an inch, divides into two branches (*Ib. p, p*) at right angles to the trunk: one branch ascends, the other descends, and both together form a long canal which may be called the 'pelvis' of the kidney. Into this canal the common trunks (*Ib. t*) of the radiating 'tubuli uriniferi,' from the several lobes, open without forming any valvular protuberance or 'mammilla.' There is the same facility, therefore, for injecting the 'tubuli' as in the Horse or Tapir.

A white injection of size and flake-white was thrown into the ureter, and forced into the tubuli uriniferi by pressing the injection onwards towards the kidney, and thus alternately emptying the ureter by the finger and thumb, and filling the ureter from the syringe: the tubuli uriniferi were injected as far as the superficies of the gland; and the injection was continued until a few specks of extravasation appeared; but not any portion of injection returned either by the artery or vein.

In the right kidney the tubuli uriniferi were filled, with similar success, and afterwards the emulgent artery was injected with red size injection; this returned by the vein, but did not penetrate any of the branches of the ureter. The tubuli uriniferi form loops at the periphery of the kidney, returning into the cortical substance.

The ureters, which preserve a diameter of about half an inch through their whole course, penetrate the urinary bladder, in the male (at *u*, *u*, Pl. XVI.), a little way above the fundus of the 'vesiculæ seminales,' where they are about six inches apart, but they converge in their oblique course through the thick muscular coat of the bladder. In the female they are more closely approximated at their terminations, which, in the young animal I dissected, were only half an inch apart, and about one line in diameter: their orifices were six inches from the commencement of the urethra. This short tube opened into the urogenital canal (Pl. XVIII. fig. 1, *u*) five inches from the vulva.

[1] The Rhinoceros examined by Mr. Thomas had not attained its third year, which led that gentleman to conjecture that the lobulated structure might be lost as the animal advanced in life (*loc. cit.* p. 148); but the persistence of this structure to the ninth year, in the female, and to the fifteenth year, in the male animal dissected by me, proves that to be a permanent condition of the renal organ in the Rhinoceros, as in some other Mammalia, which is a common fœtal peculiarity in Man.

Suprarenal glands.—These bodies, like the kidneys, differed from each other in form; they were elongated and nearly cylindrical. The right had one extremity bent at a right angle: its length in the female Rhinoceros was three and a half inches; its breadth across the bent extremity two inches: the left was simply elongated, three and a half inches long, one and a half broad and one inch thick. In section they presented an external greyish-yellow fibrous cortex, from one-fourth to one-third of an inch thick, enclosing a fleshy-coloured substance, in the middle of which there was a semilunar portion of the grey fibrous matter: there was no trace of a central cavity. Both suprarenal bodies adhered closely to the contiguous large veins.

The urinary bladder presented nothing remarkable except a very distinct pit or cicatrix, surrounded by a double concentric fold of membrane (Pl. XIV. fig. 4, *a*), where the duct of the allantois originally communicated with the cavity.

Part III.

Thoracic Viscera.

The thoracic viscera presented much the same relative position as in the Horse; the lungs becoming narrow and elongated at the contracted anterior part of the thorax: the distance between the pericardium and the diaphragm was relatively less than in the Horse.

The heart weighed 28 lbs. avoirdupois. The length of the undistended ventricular part was one foot one inch; the breadth of the ventricles was one foot three inches. The pericardium was of great strength. The heart presented the short, obtuse form which characterises it in the Elephant and Tapir.

The superior precaval vena cava receives the right or common vena azygos close to its termination at the upper part of the right auricle: two inches above this it receives the right vertebral vein, which is about half an inch in diameter; two inches above this it is formed by the junction of the left subclavian with the right subclavian vein. At the concavity of the great vein formed by this junction, which concavity crosses the fore part of the aortic arch, the bronchial veins and some small pericardial veins enter the superior cava. The upper part of the superior cava receives the two large jugular veins close together, so that a proper 'vena innominata' can scarcely be said to be formed. The left vena azygos, which is formed by the union of a few superior intercostal veins of the same side, terminates in the left subclavian vein, which receives separately the left vertebral vein from the neck. The right or principal azygos receives the intercostal veins of both sides as far forwards as its entry into the precaval vein; the Rhinoceros in this structure agreeing with the Horse.

The coronary vein receives only a small pericardial vein, which descends along the back of the left auricle, before it terminates with the inferior cava, at the base of the right auricle.

There was no trace of a valve at the orifices, either of the inferior cava or coronary vein; the latter easily admitted the end of the fore-finger. In the right ventricle, the tricuspid valve presented the following attachments:—its strong chordæ tendineæ were distributed to three obtuse and transversely oblong columnæ carneæ, one rising from the external or moveable wall, a second from the septum, and a third smaller one from the anterior interspace between the fixed and moveable wall: the tendons diverged from each column to the two contiguous moieties of the divisions of the tricuspid valve; a provision which ensures the simultaneous action and the outstretching of these three membranous processes. There were besides two smaller columns placed opposite to each other, one on the free and the other on the fixed wall of the ventricle; they were connected together by a single strong tendon passing across the ventricular cavity from the apex of one to that of the other.

The mitral and semilunar valves offered nothing unusual.

The aorta, after giving off two coronaries, each of which freely admitted the fore-finger, ascended and divided at the summit of its arch into the descending aorta and a smaller trunk supplying the head and anterior extremities. The vessels immediately derived from the ascending division were the two internal thoracics[1], the brachials, and the common trunk of the two carotids.

Each lung was divided into a small upper and a large lower lobe; the right lung gave off in addition a transversely elongated narrow azygos lobe. The superior lobe of each lung was characterized by numerous deep marginal notches, which gave it an appendiculated character. The lining membrane of the branches of the bronchiæ presented very strongly marked longitudinal rugæ; that of the trachea was similarly disposed. After reflecting the pleura from the surface of the lung, a thin extensible stratum of condensed cellular tissue continuous with the interlobular cellular tissue could alone be perceived. Between the pleuræ and the parietes of the chest was much elastic tissue.

The cartilaginous hoops of the trachea are stout and close-set; they meet posteriorly, but their extremities do not coalesce; their number was 31. The diameter of the windpipe is two inches and a half, being not greater than that of the Lion.

The larynx consists of the thyroid (Pl. XV. *th*), cricoid (*Ib. c*), and arytenoid (*Ib. a*) cartilages, of the epiglottis (*Ib. e*), and of a small sesamoid fibro-cartilage (*Ib.* fig. 1, *k*) developed in the commissure of the 'arytenoidei transversi' and 'obliqui,' here blended together; but there is no trace of the cartilages of Santorin or Wrisberg. The wings of the thyroid cartilage meet at a slightly obtuse angle, contrary to their usual disposition in the Hog tribe and Ruminants: there is no notch at the upper margin of the anterior median line; but there is a considerable triangular vacancy below, filled

[1] The intercostal spaces above or anterior to the heart, are numerous in proportion to the narrowness of the chest, which obliges the heart to be placed nearer the diaphragm; and the internal thoracics, which are of insignificant size in Man, are there largely developed in order to supply those intercostal spaces, which, from the position of the heart, cannot receive their arteries directly from the trunk of the aorta.

up by dense elastic and aponeurotic membrane, to which yielding walls of the larynx some of the fibres of the thyreo-arytenoidei muscles adhere. The arytenoid cartilages are relatively of large size; their base extends half-way across the aperture of the larynx, and from the anterior extremities of these produced bases, the upper (Pl. XV. fig. 1, *u*) and lower (*Ib.* *v*) 'chordæ vocales' extend forwards to the thyroid cartilage and base of the epiglottis. Only the anterior half, therefore, of the 'rima glottidis' is bounded by vibratile vocalizing material, and the ordinary feeble bleat of the Rhinoceros (like that of a calf) is what might be expected to be produced by such a structure.

On each side, between the upper and lower chordæ vocales there is the opening of a large sacculus laryngis, which communicates anteriorly with a crescentic fossa under the base of the epiglottis. A fold of membrane (Pls. X. & XV. *l*) extends on each side from a small fibro-cartilage (*f*), at the inner or under side of the base of the epiglottis, downwards, inwards, and forwards to the anterior termination of the chordæ vocales, *u* and *v*: these oblique folds form the inner or posterior walls of the anterior fossæ of the sacculi laryngis.

The anterior or superior labia (Pl. XV. fig. 2, *m*) of the glottis form two broad, thick, slightly everted folds of mucous membrane.

In the mass of muscles (Pl. XV. fig. 2, *o*, *o*) attached to and passing between the arytenoid cartilages, there are developed about twelve tendons which radiate to be inserted into the central sesamoid cartilage before mentioned.

The epiglottis (Pls. X. & XV. *e*, *e*) is of a triangular figure, with the pointed apex curved forwards, and having strong glosso-epiglottidei muscles attached to it.

The thyroid gland consisted of two elongate, subtriangular lobes extending from the sides of the larynx to the fourth tracheal ring; diminishing as they descend and united by a very thin and narrow strip continued between their inferior extremities, obliquely across the front of the trachea. The structure of this body is more distinctly lobular than is usually seen; a small compact yellow glandular body was attached to the thyroid at the point where the veins emerge.

Part IV.

Generative Organs.

Male organs.—The cremaster is a very powerful muscle, and consists of coarse carneous fasciculi in two flattened masses, one crossing the other obliquely as they escape with the spermatic chord beneath the arch of the abdominal ring. A cluster of lymphatic glands with much tough elastic cellular tissue fill up the rest of the ring. The cremaster at this part measures one inch and a half in breadth and half an inch in thickness.

The external inguinal position of the testis in close contact with the abdominal rings, has already been described. The tunica vaginalis communicated freely with the peritoneal cavity. Each testis presented an oval figure, seven inches in length, four inches and a half in breadth, and four inches in thickness. It is surrounded by a strong and thick 'tunica albuginea.' On making a section into the gland along the line of attachment of the epididymis, the 'corpus Highmorianum' was exposed, in the form of a moderately thick white band, continued from the end of the gland where the efferent vessels pass out to form the 'caput epididymidis,' along the whole longitudinal axis of the gland. From this almost ligamentous band or centre of the cellular framework of the gland, the septal layers diverge to all parts of the external tunic of the testicle, forming the compartments in which the lobes of aggregated 'tubuli seminiferi' are lodged. The branches of the spermatic artery, on penetrating the tunica albuginea, pass directly to the corpus Highmorianum, and their ramifications diverge thence, supported by the radiating septa, and form a rich network upon the inner or vascular layer of the capsule of the testis.

The vas deferens enters the inguinal canal surrounded by the vessels and especially by the plexiform veins of the spermatic chord, and on entering the abdomen is received in a peritoneal fold and is conducted to the side and then to the back part of the urinary bladder, passing between the bladder and the ureter: having got to the inner side of the termination of the ureter, the vasa deferentia (Pl. XVI. fig. 1, *vd*, *vd*) descend straight, slightly converging, to the middle of the back part of the prostate: they penetrate that gland, together with the ducts of the vesiculæ seminales, lying to the inner side of these; and, communicating with them, the common duct on each side finally terminates by a minute pore (Pl. XVII. fig. 4) upon the crucial verumontanum. The vasa deferentia are thickened to about thrice their ordinary diameter in the last three inches of their course; but their canal or area is not proportionally dilated; it is, on the contrary, rather contracted, by the thickness of the cellulo-glandular parietes to which the enlargement of the duct is due.

The vesicular glands or 'vesiculæ seminales' (Pl. XVI. fig. 1, *vs*, *vs*) present an elongate subcompressed pyriform shape, eight inches in length, and three inches and a half across the broadest part of the fundus. They have a lobulated exterior, and a structure very similar to that of the same bodies in Man.

The prostate (*Ib. pr*, *pr*) is much less compact than in Man and more resembles that of many Rodents, being composed of an aggregate of long slender cæcal tubes with glandular walls, converging to the ducts of the vesiculæ and vasa deferentia, and opening by numerous minute apertures on the verumontanum (Pl. XVII. fig. 4). The breadth of the prostate is six inches; its antero-posterior extent four inches: it does not quite surround the beginning of the urethra, but is closely applied to the back and sides of that canal.

The muscular or membranous part of the urethra, *m*, extends about three inches from the prostate before it joins the bulbous and cavernous portions, close to which are

situated two large subcompressed oval Cowperian glands (*Ib.*, *c*, *c*). Each of these measures three inches and a half by two inches and a half. The structure of the corpus cavernosum resembles that of the Horse.

The great plexus of veins above the dorsum penis near its root, was enveloped in a mass of elastic tissue, like the 'dartos' of the human scrotum.

The fleshy part of the 'levatores penis' (Pl. XVII. *ll*) measures fourteen inches in length, five inches across their basal origin, and between one and two inches in thickness. Their oblique origin is extended over the space of one foot from the ento-pelvic part of the pubis down to the ischium. The tendinous part of the muscle commences where the pubic portion joins the ischial portion of the muscle at the inner and under border of the fleshy part: it is half an inch thick at its commencement, but expands as it extends along the muscle, the fleshy fasciculi of which are inserted into the tendon in an obliquely converging, or semi-penniform manner. As the tendon augments in breadth, it diminishes in thickness, converging towards its fellow, which it meets and joins two inches before the anterior termination of the fleshy portion. The two united flattened tendons beyond are gradually converted into a round chord of ligamentous substance an inch in diameter. This chord (*Ib. l'*) glides through a strong, slightly elastic aponeurotic sheath along the median groove of the dorsum penis; it is connected with the inner surface of the sheath by a highly elastic cellular tissue; the chord maintains its ropelike character along the basal third of the glans (*Ib. l''*), then subsides, expanding laterally, and is finally lost upon the firm capsule of the glans. There is no 'os penis.'

The nerves of the dorsum penis, the arteries, and trunks of two large plexuses of veins, pass beneath the bridge formed by the confluence of the tendinous and muscular parts of the 'levatores penis' and between the two suspensory ligaments of the penis. These ligaments are an inch in breadth, and one-third of an inch in thickness at their origin from the ischio-pubic arch a little in advance of the ligamentous attachments of the crura corporis cavernosi.

The total length of the undistended penis is three feet nine inches; the circumference of the prepuce is one foot five inches.

The external and constantly exposed firmer tegumentary part of the prepuce has been already described, and is figured in Pl. IX. fig. 4.

The substance of the large reflected preputial fold of softer integument (Pl. IX. fig. 5, and Pl. XVII. fig. 1, *pr*) is from half an inch to two-thirds of an inch in thickness, and consists of a moderately compact cellular corium, with a delicate epiderm, minutely rugose in the transverse direction, and perforate or punctate with the pores of the mucous follicles which are very regularly dispersed at intervals of about a quarter of an inch.

The glans penis (*Ib. ib. gl*) is a long and slender subcompressed cone with a truncate apex; it measured in its flaccid undistended state, one foot in length: the prepuce is reflected upon its base at the same transverse or circular line, and there is no frænum. The apex (Pl. IX. figs. 5 & 6, and Pl. XVII. figs. 1, 2 & 3, *a*) is not simple, but resembles

a mushroom on a thick peduncle (fig. 3, *p*) projecting from an excavation (*Ib.* *e*, *e*) at the end of the glans with a thin wall or border, like a second prepuce; but this is of the same structure as the rest of the firm surface of the glans

On each side of the base of the glans, and rather towards its under part, there is a longitudinal thick oblong ridge or lobe (Pl. IX. figs. 5 & 6, and Pl. XVII. fig. 1, *r*, *r*), three inches and a half in length, and eight lines in basal thickness: the thick rounded free border of each lobe inclines downwards.

Mucous follicles similar to those on the under surface of the prepuce extend from the attachment of that fold along one half of the interspace of the lateral lobes. The depth of the preputial fold is least on the dorsal side of the glans. On each side of the base of the glans, near the dorsum, the follicles extend along a space of two inches from the root of the prepuce, but do not occur on the middle line. A narrow ridge commences in the median space of the 'dorsum glandis,' which increases in height as it advances forwards, and then subsides two inches from the border of the terminal or apical fossa. The projecting border of this fossa (Pl. XVII. figs. 2 & 3, *e*, *e*) describes a compressed oval, and is attached to the pedunculated appendage (*Ib.* *p*, *a*) by a process, like a frænum (*Ib.* fig. 3, *f*, *f*), continued upon the middle line of both the upper and under surfaces of the thick peduncle (*Ib.* *p*): the fossa between this peduncle and the free external border is not less than two inches in depth on each side; the upper or dorsal border of the fold is three times the breadth of the under one. The stem *p* of the terminal expanded discoid appendage *a* is subcompressed with an oval section, one inch in long diameter, where it supports the terminal disc two-thirds of an inch across. The disc *a* is ovate, one inch eight lines long by one inch across its broader inferior part, where it extends farthest from the supporting stem. The urethra (*Ib.* *u*) is perforated in the middle line of the terminal disc between its middle and upper third.

The lateral lobes (*Ib.* fig. 1, *r*, *r*) consist chiefly of erectile tissue; and all the parts of this singularly complex glans are much altered in size, and somewhat also in shape, during erection (see Pl. IX. figs. 4, 5 & 6).

Female Organs.—The ovaria are included within a large peritoneal sac (Pl. XVII. *o*, *p*) communicating with the general abdominal cavity by an opening which is three inches wide. They are compact, oblong, flattened bodies, with a smooth surface, as might be expected from the immature age of the animal. The left ovarium measured three inches and a half in length, by two inches and a half in breadth: the right was somewhat smaller. The external capsule of the ovarium is stout and unyielding, and the serous covering has the appearance of being strengthened by tendinous lines, one of which runs in a curved direction across the anterior part of the ovary, having other shorter lines diverging from it. The stroma ovarii is also dense. Three ovisacs or Graafian vesicles were dissected out of each ovarium: of these one was an inch in diameter, with very dense thick dark-coloured parietes; the rest had a diameter of two-thirds of an inch, with thinner coats. Their contents were examined with great

care under the microscope, but the granular layer was evidently broken up by decomposition, and the ovulum was invisible. The animal had been dead a fortnight.

The Fallopian tubes or oviducts commence by wide orifices having a richly fimbriated margin (Pl. XVII. *f*,*f*); their diameter at the expanded end equals two-thirds of an inch, but gradually diminishes in size as the tube passes in a slightly tortuous course along the parietes of the ovarian capsule towards the uterus; just before they enter the cornu uteri their diameter does not exceed one-third of a line; they terminate in the extremity of the cornu upon a valvular protuberance about the size of a pea, which is divided into four or five processes (*Ib. p*). The inner surface of the oviduct is augmented by short irregular longitudinal folds or processes of the lining membrane. Each oviduct is fourteen inches in length.

The cornua uteri (*Ib. u'*, *u*) are each seventeen inches in length, and uniformly about an inch in diameter; their area is occupied by close-set longitudinal folds of the lining membrane, about a quarter of an inch in breadth, and having a wavy irregular free margin. There is no appearance of processes for the attachment of cotyledons. Where the cornua join the body of the uterus, the crenation or scalloping of the longitudinal folds becomes shorter and deeper. The length of the common uterus (*Ib. c u*) is about one and a half inch. The surface of its lining membrane is smooth, and presented, when first exposed, a leaden hue. The place of the 'os tincæ' is occupied by a complex and remarkable structure, which will be described as it was traced from the vagina towards the uterus.

A large transverse semilunar fold (*Ib. f*,*f*) projects from the upper and lateral parts of the vagina; the upper and broadest part of the fold is one inch; it gradually diminishes as it descends on each side, and the cresses are lost about four inches from the vaginal orifice, and about an inch and a half from the middle line of the lower surface. About an inch above this fold, or nearer the uterus, a second and smaller fold is formed, which also descends from the upper and lateral walls of the vagina, but passes across in an oblique direction. Then follow in quick succession a series of shorter, but equally broad semilunar folds (*Ib. f'*, *f'*), which become alternate in their relative position as they approach the uterus, so as to cause the vagina to assume a spiral course not very unlike the disposition of the intestine in the Shark. As these valvular folds also assume a thicker, softer, and more vascular texture as they approach the uterus, it is by no means easy to determine where the vagina ends or the uterus begins. Measuring from the thickest fold which most resembles an os tincæ, the common uterine cavity does not exceed two inches in length: and in this short extent, compared with the cornua, the Rhinoceros resembles the Elephant.

The form, size, and relative positions of the vulval and preputial orifices have been already described. The length of the common or urogenital canal (*Ib. v*, *ug*) was four inches; its diameter about three inches. On each side, and about one inch and a half from the external outlet, were situated the apertures of the Malpighian or mucous

canals (*Ib. m, m*). The diameter of the orifice was about a line, but as the canals passed inwards in the parietes of the urogenital passage, they widened to the diameter of from two to three lines. At about three inches, distance from their outlet they branched off into two or three smaller divisions, from which a glairy mucus could be expressed, and these again subdivided and terminated in blind secerning cæca applied to the outside of the commencement of the vagina. The orifice by which the vagina (*v*) communicates with the uro-genital canal is small in proportion to the width of that canal, and its area is diminished by several short oblique longitudinal folds, whose free edges project into it: the whole of this contracted orifice may be regarded as a form of hymen, beyond which the vagina rapidly dilates in the wide canal represented at *v, v*, Pl. XVIII.

Part V.

Nervous System.

Of this part of the Anatomy of the Rhinoceros the opportunities for making observations were limited to the structure of the Brain and the Eye.

The brain of the full-grown male (Pl. XIX. XX. & XXI.) weighed, when deprived of its membranes, 1 lb. 14½ oz. avoirdupois, its proportion to that of the entire body being as 1 to 164.

An upper view of the natural size is given in Pl. XIX. fig. 1, a side view in fig. 2, and a base view in Pl. XX.

The cerebral hemispheres present a subdepressed semioval form, broader behind, and narrower in front than in the Horse, and presenting fewer and larger convolutions. Their disposition resembles that in the larger hoofed mammalia generally; converging from behind forwards as far as the anterior third of the cerebrum, and thence diverging as they extend forwards, but in a minor degree than in the Horse or Ox.

In the view of the base of the brain (Pl. XX.), the large external crura *p*, and internal crura *q*, of the rhinencephalon or olfactory ganglia, 1, 1, are shown, together with the protuberance *r*, which lies between the two crura. The chiasma of the optic nerves is shown at 2, 2; the infundibular base of the hypophysis cerebri at *k*; the single mass representing the corpora candicantia at *l*; the crura cerebri at *i*, and the third pair of nerves at 3, 3. The obtuse apices of the 'protuberantiæ natiformes,' *o*, are less broad than in the Ox, and more resemble the shape of the same parts in the Horse.

The cerebellum shows the small lobes, called 'flocci,' at *h*; and the inferior convolutions at *g*. The olivary tracts make a very slight prominence at *d*; the pyramidal bodies are better defined, but are crossed by some superficial transverse fibres near the pores *f*: and the 'corpora trapezoidea,' *e*, are defined. The inferior 'vermiform process' of the cerebellum is more regular and better defined than the superior one: it is shown at *v*, fig. 4, Pl. XXII.

The relative longitudinal extent of the great commissure or 'corpus callosum' is shown at *s*, *s*, in the view of the vertical section of the brain of the female Rhinoceros given in Pl. XXII. fig. 1. A septum lucidum, *q*, of moderate extent, connects the under surface of the anterior half of the corpus callosum with the fornix: in the same section the optic thalami are seen at *o*; the 'plexus choroides' at *p*; and the mass of the quadrigeminal bodies at *k*. The arrangement of the grey and white matter in the lobes and lobules of the cerebellum, forming the 'arbor vitæ,' *a*, is also shown: this is less complex than in the Horse.

The lateral ventricle is laid open by the removal of its outer wall to show the size and shape of the great hippocampus at *n*, fig. 2, Pl. XXII.; and in the same figure are shown the 'plexus choroides' *p*, passing through the 'foramen Monroianum' *m*, beneath the crura of the fornix and the outer lamina of the septum lucidum, *q*. The left lateral ventricle is laid open from above to show the proportions of the 'corpus striatum' *f*, with the hippocampus *i*, and the intervening part of the fornix, covering the optic thalamus *h*, together with the 'plexus choroides' *p*. In Pl. XXI. the corpus callosum *s*, *s*, has been bisected and the hemispheres divaricated to show the forms and proportions of the bigeminal bodies; of which the posterior pair *b* are broader but shorter than the anterior ones *a*. The pineal gland is shown at *n*; the optic thalamus at *h*; the 'plexus choroides' at *p*; and the 'corpus striatum' at *f*.

The commencing decomposition of the inner substance of the brain prevented the better definition of some of the other parts of this organ.

The common anastomotic trunk of the basilar or vertebral arteries, after traversing the median line of the pons, gives off a pair of arteries at right angles, which cross the crura cerebri between the pons and the third pair of nerves: a second pair of transverse branches is sent off just anterior to the former, and receive the anastomosing longitudinal branches from the ento-carotids which complete the circle of Willis. From the ento-carotid parts of the circle, a branch is given off to the interspace between the middle and anterior lobes of the cerebrum, where it divides into three or four branches.

The eyeballs are of small comparative size; each measured in antero-posterior diameter one inch five lines, and in transverse diameter one inch three lines. Some dark-brown pigment lies under the conjunctiva for the extent of about a line from the circumference of the cornea: the same kind of pigment is also deposited upon the outside of the nictitating eyelid, and over a great part of the inner surface of the same part, covered of course by a reflection of the conjunctiva. The trunks of the venæ vorticosæ perforate the sclerotica half-way between the entry of the optic nerve and the edge of the cornea. I injected one of these veins with mercury, which immediately returned by vessels perforating the sclerotica near the optic nerve. The disposition of the venæ vorticosæ, with the flocculent but somewhat firm connecting tissue of their radiating branches, presented that structure which most nearly resembled the figures given by Mr. Thomas of the parts he describes as "processes having a muscular

appearance, with the fibres running forwards in a radiated direction[1]." There are no fibres accompanying the radiated branches of the veins, showing the striated character of voluntary muscle under the microscope. Mr. Thomas found that "the ciliary processes were affixed to the crystalline lens;" but on removing the anterior part of the sclerotica, whilst the eye was suspended in spirit, both the vitreous humour and the lens rolled out; and the capsule of the lens showed no particular mark of the insertion or fixation of the ciliary processes; their impressions, in remains of pigmental matter, were perceptible on the anterior part of the canal of Petit. The transverse diameter of the lens was six lines, the antero-posterior diameter four lines. Mr. Thomas also states that "the pigment was confined to the inside of the choroid[2]." But in both Rhinoceroses dissected by me, I found on the outside of the chorion much loose cellular tissue, with dark pigment: this coloured flocculent tissue concealed at first the venæ vorticosæ, even when injected. The sclerotica is one line thick at the back part of the eyeball; and is thinnest near the middle of the ball, becoming thicker towards the cornea, which is two lines thick. The choroid adheres pretty strongly to the back part of the sclerotic, around the entry of the optic nerve, both by the entering vessels and by the tenacity of its outer flocculent coat, especially where the vessels penetrate the sclerotica. There is no tapetum lucidum. The lower eyelid has a special depressor muscle.

DESCRIPTION OF THE PLATES.

All the parts are of the natural size except when otherwise expressed.

PLATE IX.

Fig. 1. Metacarpal gland.
Fig. 2. Metatarsal gland, laid open.
Fig. 3. Excretory orifice of the gland.
Fig. 4. External prepuce during the ordinary retracted state of penis (one-sixth natural size).
Fig. 5. Penis as protruded when this retromingent quadruped stales (one-sixth natural size).
Fig. 6. Glans penis, or the portion uncovered by the prepuce, when the organ is in a state of erection (one-sixth natural size).
Fig. 7. External parts of generation in the female (two-thirds natural size).
Fig. 8. The two teats.

PLATE X.

Fig. 1. Right tonsil, epiglottis, and back part of larynx.

[1] Philosophical Transactions, 1801, p. 150. pl. 10. figs. 1, 2, 3.
[2] Ib. p. 150.

Fig. 2. Inner surface of left side of the larynx laid open; a part of the accessory fold of membrane *l*, and of the lower 'vocal chord' *v*, of the right side are preserved and turned forwards: *f*, accessory fibro-cartilage; *u*, upper 'vocal chord'; *th*, thyroid cartilage; *cr*, cricoid cartilage; *tr*, first tracheal ring; *e*, epiglottis.

PLATE XI.

Fig. 1. Outer surface of the stomach, with the serous tunic partially reflected to show the two decussating muscular layers (one-eighth natural size).

Fig. 2. Inner surface of the stomach (one-eighth natural size).

Fig. 3. Section of the coats of the stomach at the junction of the epithelial with the gastro-mucous linings.

Fig. 4. A portion of the inner surface of the stomach, showing the follicular structure at the termination of the cardiac epithelium.

PLATE XII.

Fig. 1. Portion of the inner surface of the beginning of the jejunum.

Fig. 2. Portion of the inner surface at the end of the jejunum.

Fig. 3. Portion of the inner surface near the end of the ileum.

PLATE XIII.

The cæcum, colon, and beginning of the rectum (one-tenth natural size).

PLATE XIV.

Fig. 1. The inner surface of the duodenum, showing the terminal orifices of the biliary and pancreatic ducts.

Fig. 2. The inner surface of the fundus vesicæ, showing the allantoic or urachal cicatrix.

Fig. 3. Outside view of the right kidney (one-third natural size).

Fig. 4. View of a portion of the pelvis of the kidney, with the beginning of the ureter.

PLATE XV.

Fig. 1. Back view of the larynx, showing, *th*, thyroid cartilage; *c*, cricoid cartilage; *a a*, arytenoid cartilages; *e*, epiglottis; *d*, *crico-arytenoidei* muscles, the

left reflected; *o*, the right *arytenoideus*, reflected; *e*, *thyro-cricoideus*; *c*, articular tubercle, with a synovial surface for the joint with the base of the arytenoid cartilage.

Fig. 2. Back view of the larynx, showing in addition to the foregoing,—*k*, the commissural cartilage of the *arytenoidei* muscles *o o*; *g*, the right *thyro-arytenoideus*; *m*, the superior labia of the glottis; *n*, the upper 'chorda vocalis'; *v*, the lower 'chorda vocalis' bounding the entry of the laryngeal sac; *f*, the fibro-cartilage giving attachment to the epiglottideal fold of membrane *l*, which bounds the upper part of the suprachordal sacculus.

PLATE XVI.

The urinary bladder, vasa deferentia, vesicular, prostatic, and Cowperian glands (one-fifth natural size). The letters are explained in the text.

PLATE XVII.

Fig. 1. Muscles of the penis: *c*, crura penis; *pr*, reflected prepuce; *gl gl*, glans penis; *r*, lateral lobes of glans; *a*, terminal appendage of glans; *l l*, carneous mass of *levatores penis*; *l'* beginning, and *l''* insertion of the common tendon of the *levatores*, which runs along the 'dorsum penis'; *t t*, retractores penis.

Fig. 2. Front view of terminal fossa, and appendage of the glans penis: *u*, the orifice of the urethra.

Fig. 3. Oblique view of the same parts, showing, *e e*, the borders of the fossa; *p*, the peduncle of *a*, the discoid appendage; *f f*, its upper and lower frœna; *u*, urethral orifice.

Fig. 4. Part of the 'cervix vesicæ' showing the common orifices, into which bristles are inserted, of the vasa deferentia and vesicular glands, upon the crucial verumontanum; and the smaller excretory pores of the prostatic lobes.

PLATE XVIII.

The female organs of generation (one-fifth natural size): *op*, ovarian capsules; *f*, fimbriæ of oviduct; *p*, valvular papilla on which the oviduct terminates in the uterus; *u' u*, cornua uteri, the left laid open; a probe is passed through the coats of the right cornu to show the place of confluence of the cornua with the 'corpus uteri'; *f f'*, valvular folds of 'cervix uteri' and 'fundus

vaginæ'; (the complex glans penis has, probably, relation to this structure;) *v v*, vagina; *u*, the urethra, beyond the hymeneal constriction dividing the vagina from the uro-genital canal; *m m*, Malpighian canals, the left laid open—bristles are inserted into both; *vu*, vulva and clitoris.

PLATE XIX.

Brain of the male Rhinoceros.

PLATE XX

Base of the brain of the male Rhinoceros.

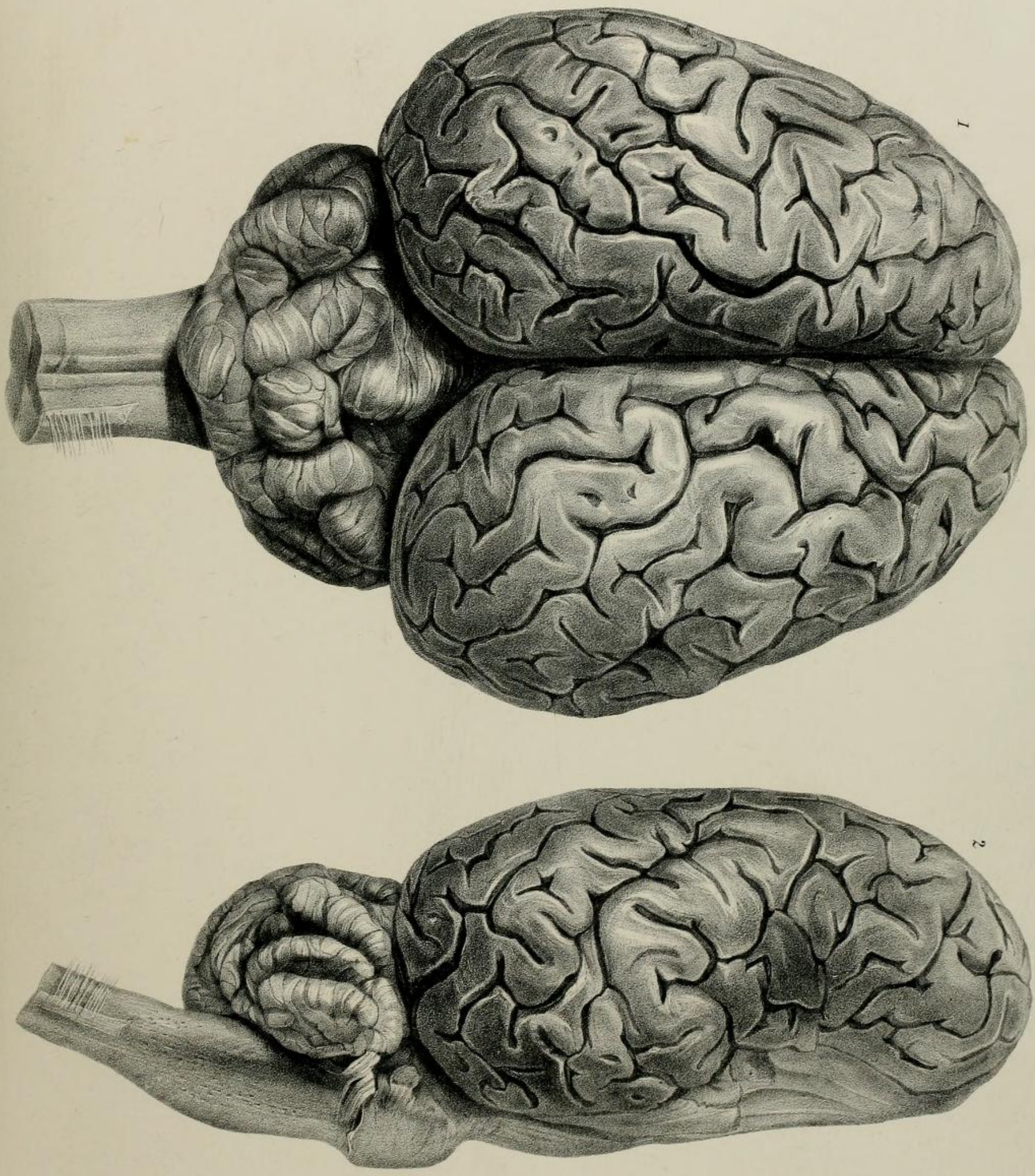
PLATE XXI.

Dissection of the brain of the male Rhinoceros.

PLATE XXII.

Dissections of the brain of the female Rhinoceros. The letters are explained in the text.

Trans. Zool. Soc. Vol. 4, p. 58, pl. 19.



From Nature on Stone by J. Erxleben.

Day & Son, Lith.rs to The Queen.

Rhinoceros Indicus.

Trans. Zool. Soc. Vol. 4. p. 58. pl. 20.

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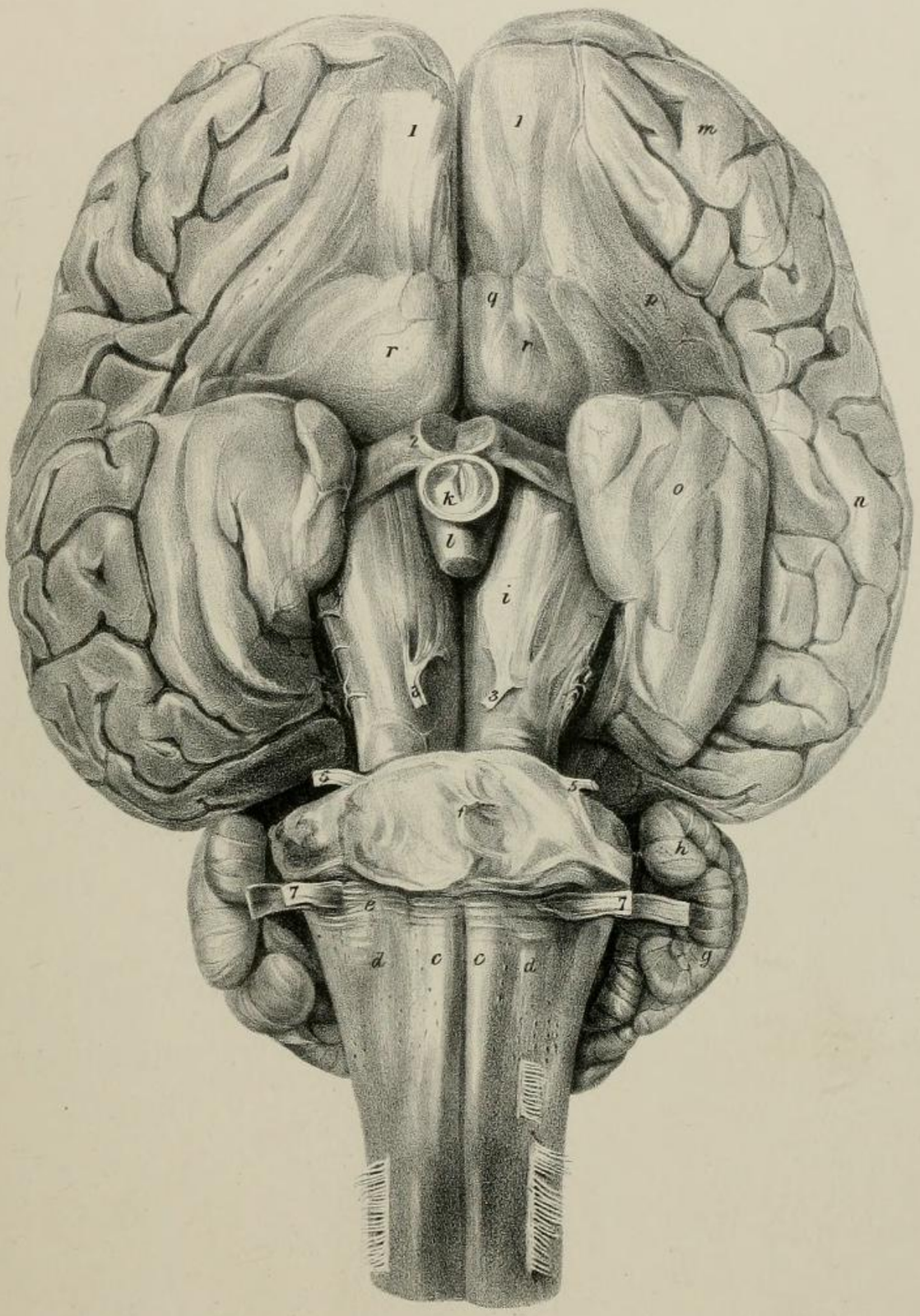

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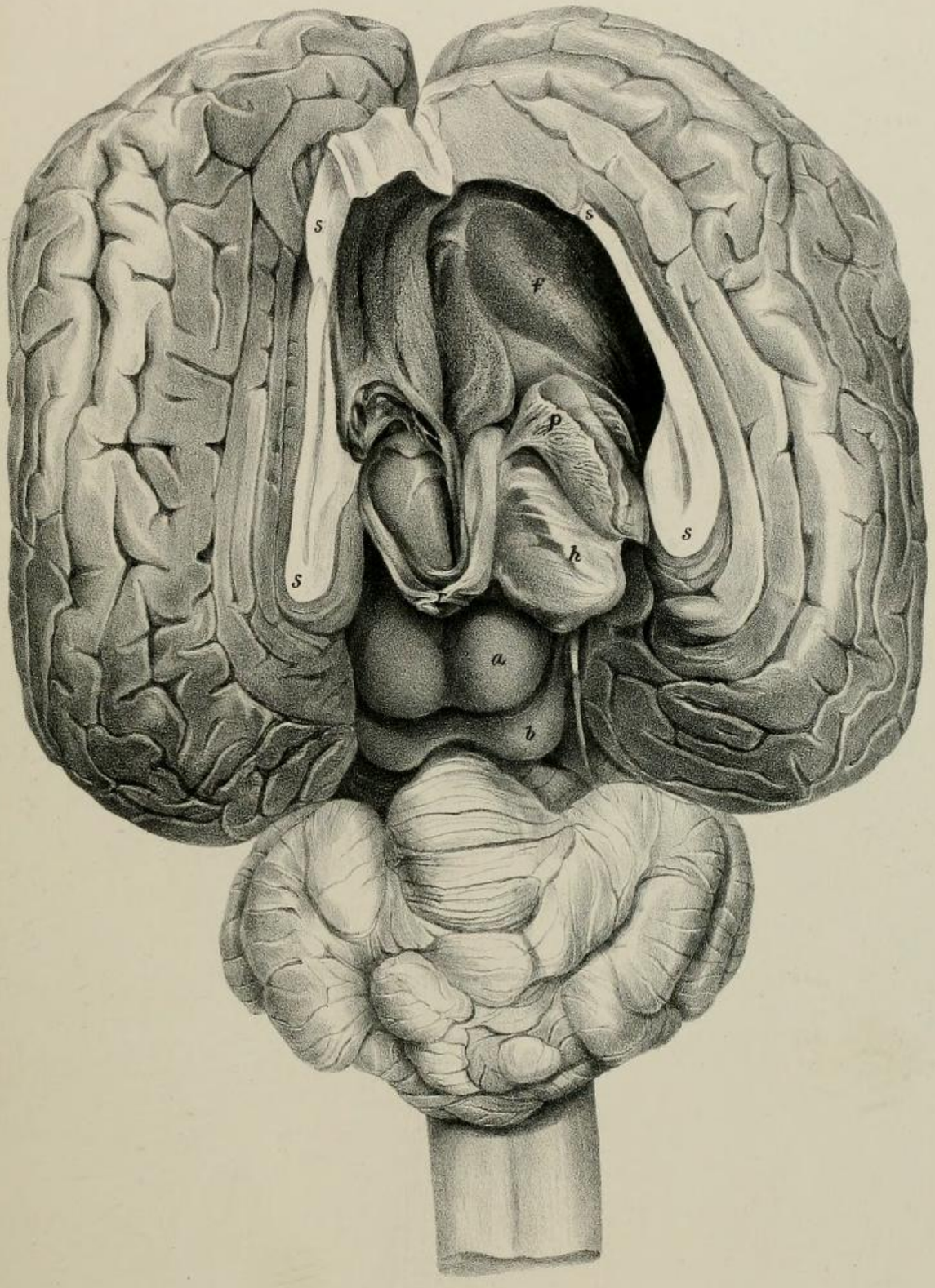

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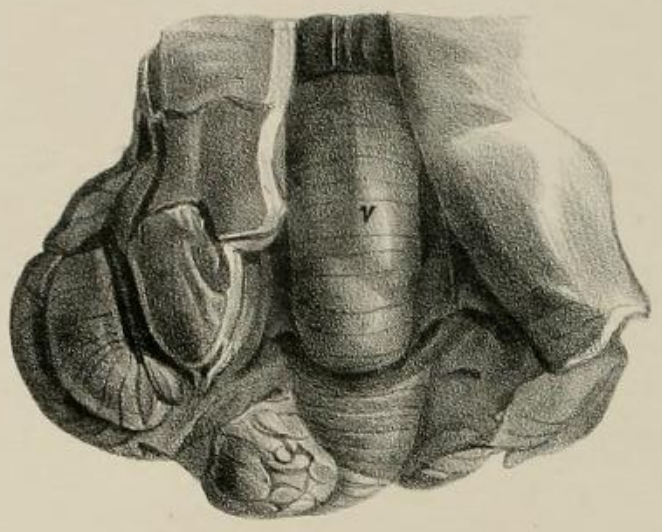

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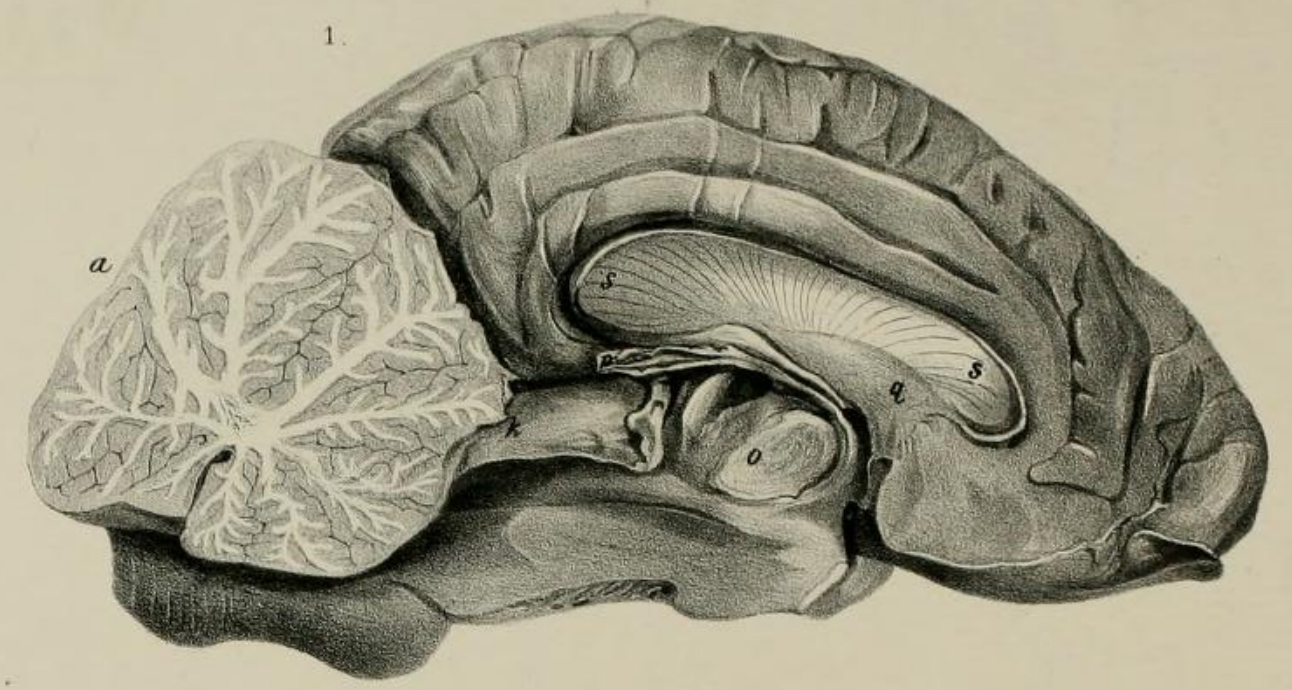

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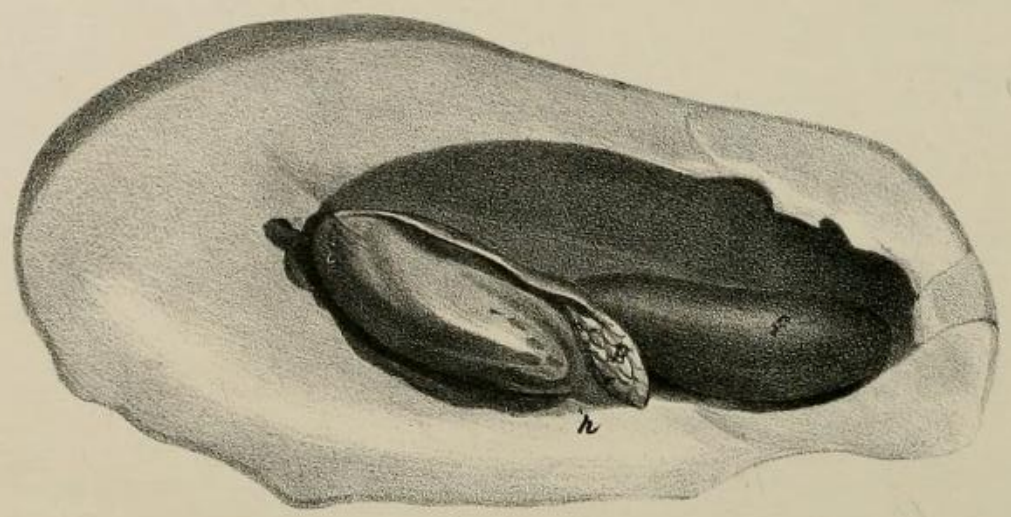

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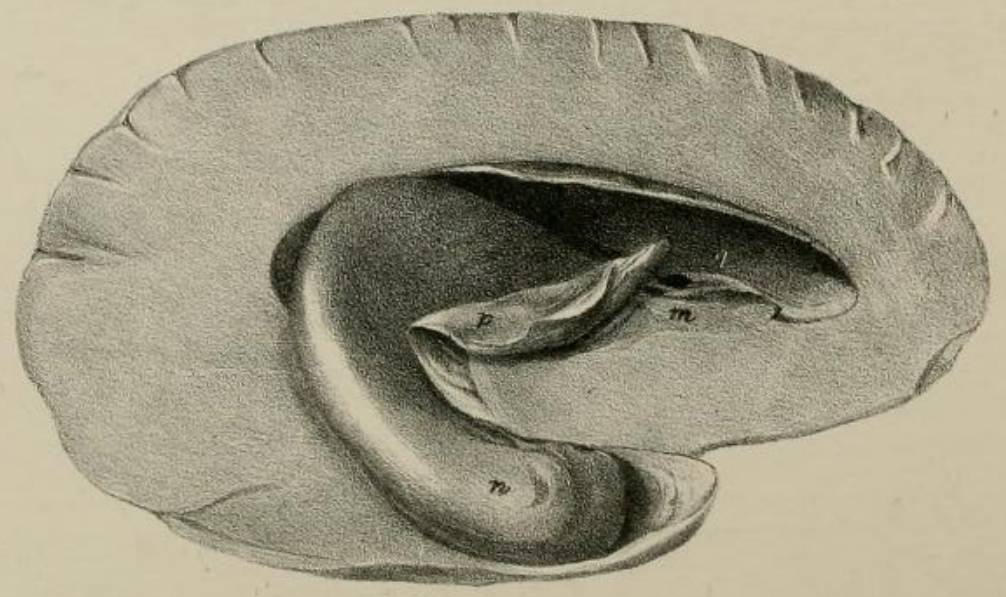

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