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THE COLLECTED
SCIENTIFIC PAPERS

OF THE LATE

ALFRED HENRY GARROD, M.A., F.R.S.,

FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE; FULLERIAN PROFESSOR OF PHYSIOLOGY
AT THE ROYAL INSTITUTION; PROFESSOR OF COMPARATIVE ANATOMY IN KING'S
COLLEGE, LONDON; PROSECTOR TO THE ZOOLOGICAL SOCIETY OF LONDON.

EDITED,

WITH A BIOGRAPHICAL MEMOIR OF THE AUTHOR,

BY

W. A. FORBES, B.A.,

FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE; PROSECTOR TO THE ZOOLOGICAL SOCIETY OF LONDON.

LONDON:

R. H. PORTER: 6, TENTERDEN STREET, W.

1881.

5890
26/11/89



22. ON THE VISCERAL ANATOMY OF THE SUMATRAN RHINOCEROS (*CERATORHINUS SUMATRENSIS*).*

Page 92. THE death on September 21st, 1872, of the only English specimen of the Sumatran Rhinoceros has afforded me an opportunity of determining many points in its anatomy previously unknown; and Professor Owen's excellent memoir on *Rhinoceros indicus*, in the fourth volume of the Society's "Transactions," has made it possible to compare the details of structure in the two species.

The differences in the shape of the stomach, and the character of the mucous membrane of the small intestine, together with the peculiarities of the skin, including the presence of a second horn, the absence of a gland behind the foot, and the smallness of the folds, which cannot accurately be termed shields, appear to me quite to justify the separation, into a distinct genus, of the Sumatran Rhinoceros from its Indian ally, as has been done by Dr. Gray from a study of its osteology only.

The specimen upon which these observations are based is said to have been captured in Malacca:† it is an aged female: its skin is of a dark slate-colour, and is covered thinly with black hairs, which are more than an inch long, situated mostly on the middle line of the back and on the outer sides of the limbs. Its length from the tip of the nose to the base of the tail is $96\frac{1}{2}$ inches. The tail is 22 inches long; from its base to the transverse shoulder-fold is 44 inches; and from the latter to the occipital crest is 22 inches. The ears are lined, and not fringed (as are those of the *Ceratorhinus lasiotis*) with black hairs. No traces could be found at the back of the feet of the glands described by Professor Owen in the Indian Rhinoceros.

The skull, the only part of the skeleton which I have examined, is $21\frac{7}{8}$ inches from the tip of the nasal bones to the middle of the occipital crest, following its longitudinal direction. From one lachrymal tubercle over the head to that of the opposite side is 8 inches. The conjoined nasal bones in their broadest part are $6\frac{3}{8}$ inches across from their lower margins over the insertion of the anterior horn.

The lower incisors and the first premolars are lost; Professor

* "Proceedings of the Zoological Society," 1873, pp. 92-104. Read, Jan. 21, 1873.

† See for an account of its history Mr. Selater's notes, "Proceedings of the Zoological Society," 1872, p. 494.

Flower informs me that a specimen in the Museum at Brussels has also lost its lower incisors. The premaxillary bones are ankylosed to the maxillaries, a condition I have not found in any other specimen, and which is probably dependent on the loss of the lower cutting-teeth.

Including the present one, I have seen eight skulls of Asiatic two-horned Rhinoceroses (*Ceratorhinus*)—four in the College of Surgeons' Museum, two in the British Museum, and one at the Museum at Cambridge. The present specimen agrees very closely with that at the last-named place, and with No. 1461 *a*, adult, from Pegu, in the British Museum. It being that of an aged individual, comparison with most of the others referred to is more difficult, as they are nearly all immature. The skeleton mounted at the College of Surgeons, No. 2933, obtained by Sir S. Raffles from Sumatra, is aged also; but there are points in which it differs materially from the present specimen. It is of slighter build, and the nasal bones are narrower. Page 93.

A much larger skull, not quite adult, in the Museum of the College of Surgeons, No. 2935, stated to be that of a "male Sumatran Rhinoceros," and presented by Sir S. Raffles, is evidently from a larger animal, and agrees also with *Ceratorhinus lasiotis* in being proportionately broader in the parietal regions. In this skull also the posterior of the submental foramina is situated in front of the second premolar, while in all the others (except No. 2936, R.C.S., which is young, but peculiarly massive) it is situated, when present, behind that tooth.

Subjoined is a table giving a few of the measurements in the skulls above referred to:—

	No. 2935, R. C. S.	Zool. Soc. specimen.	No. 1461 <i>a</i> , B. Mus.	No. 2933, R. C. S.	Cam- bridge specimen.
	in.	in.	in.	in.	in.
Length of skull from tip of nasals to middle of occipital crest.....	23	21·875	21·925	21·25	22·125
Breadth across nasal bones	5·25	6·375	—	4·75	6·75
Length of 2nd upper molar at base	2	1·775	1·7	1·6	
Length of 1st upper molar at base	1·75	1·5	1·375	1·35	
Length of 4th upper premolar at base	1·6	1·25	1·255	1·225	

The following is an account of the various features of the viscera that were observed in the Sumatran Rhinoceros.

Alimentary Canal.—The palate, which is covered with a smooth epithelium, is marked by conspicuous transverse angular ridges. There are eleven of these on each side; and they are not continuous anteriorly across the middle line, but the prominences of one side are carried on as the fossæ on the other. The posterior ridges are continuous from one side to the other; and they, instead of being transverse, as are those in front, are arranged in the form of a V, the concavity of the V being directed forwards. On the soft palate, which is $4\frac{3}{4}$ inches long, these ridges disappear. The palate is narrow, as can be readily seen by an inspection of the skull; anteriorly its breadth is $2\frac{3}{4}$ inches, and posteriorly $3\frac{1}{2}$ inches, gradually increasing from before backwards.

In no part of the alimentary canal, except on the surface of the tongue, were there any papillæ visible to the naked eye.

The *cheeks* form pads on either side, composed of areolar and muscular tissue, which project into the cavity of the mouth. These pads are shaped like prominent blunted triangles, with their apices directed

Fig. 1.



Tongue of *C. sumatrensis* (superior surface).
p, soft palate, embracing the root of the tongue *epig*, epiglottis.

forwards; they are $3\frac{1}{2}$ inches deep behind, where they are lost on the fauces, and they are about 9 inches long. The epithelium covering them is nearly smooth, and is very thick.

The *tongue* is elongate, and in shape much like that of the Ruminants, being thin from above downwards in front, and deep behind, with a somewhat sudden transition from one to the other. From the apex to the posterior of the circumvallate papillæ is 15 inches, and from the epiglottis to the same papillæ is $2\frac{3}{4}$ inches. In the middle of the anterior thin portion the breadth is $2\frac{3}{4}$ inches, and in the middle of the posterior moiety it is $4\frac{1}{2}$ inches.

There are many circumvallate papillæ, 33 on one side and 26 on the other, forming two clusters, separated by a smooth median longitudinal line. Each cluster is triangular in shape; and the two acute-angled triangles they form lie side by side and have their apices directed backwards. The individual papillæ which go to form them are largest posteriorly, reaching a diameter of $\frac{1}{8}$ inch; anteriorly they get smaller, and cease by becoming more and more scattered. The rest of the tongue is covered uniformly with filiform papillæ, among which no fungiformes are to be seen. Page 95.

The soft palate runs downwards as well as backwards; and its posterior portion, as Professor Flower specially pointed out to me, so closely embraces the base of the tongue that, except when in the act of swallowing, the epiglottis always projects quite into the posterior narial chamber, as in the horse and many other animals. The anterior portion of the soft palate is $\frac{3}{4}$ inch thick, and very glandular. A collection of glands of considerable size on each side of the fauces are the only representatives of the tonsils.

The *salivary glands* present the usual characters. The *parotid* is much the largest. It weighs 1 lb. 1 oz., and is of an irregular semi-lunar shape, the concavity embracing the superior portion of the angle of the jaw; it is mostly situated between the body of the masseter and the posterior insertion of the sterno-mastoid muscle. It lies almost entirely below the level of the zygoma, sending up a small portion into the interval between it and the external auditory meatus. Its duct, which is 14 inches long, commences at the inferior angle of the gland, and, as in the Ungulata generally, runs round the lower margin of insertion of the masseter muscle, and up along its anterior border till it pierces the buccinator, to terminate by a simple orifice in the well-marked fossa between the cheek-pad described above and the superior gum, in a line with the interval between the first and second upper true molar teeth.

The *submaxillary* gland weighs $2\frac{1}{2}$ oz., and is irregularly cubical in shape. It is situated just under the angle of the jaw, covered by the digastric muscle. The duct is $13\frac{1}{2}$ inches long; anteriorly it is

closely bound to the inner surface of the sublingual gland; and it opens far forwards, close to the frænum of the tongue, on either side of it.

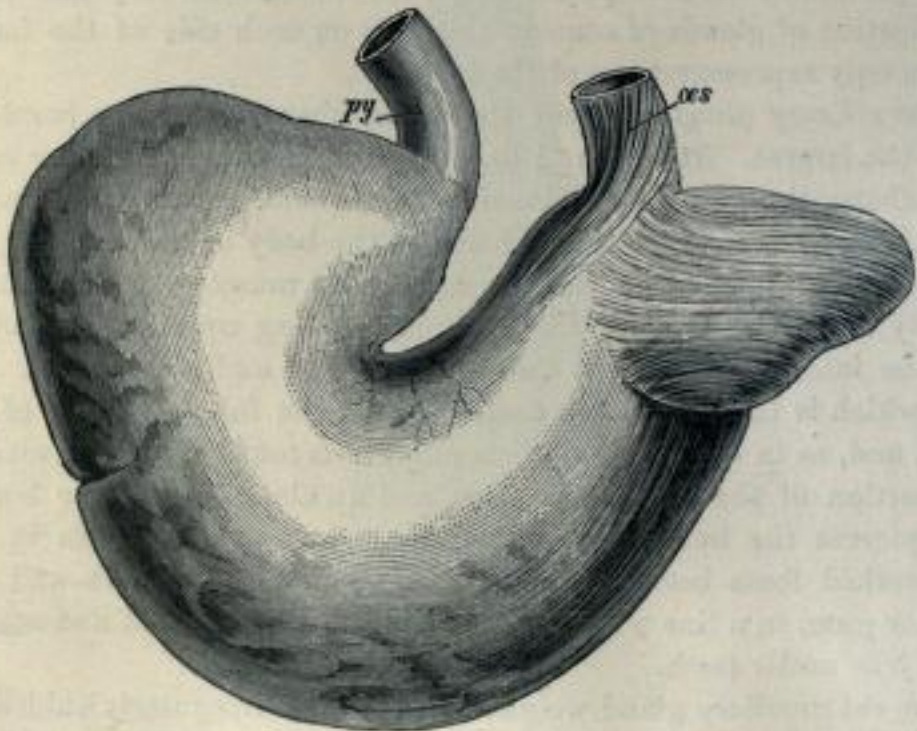
The *sublingual* gland weighs 2 oz., and is composed of several small portions which open separately, almost in one straight line, about half an inch apart, below the sides of the tongue, and parallel with the ramus of the jaw. The whole gland is about 6 inches long and 1 inch deep.

The *œsophagus* is thick and muscular, not of large calibre; it has the mucous membrane but loosely connected with the muscular parietes, and arranged in bold longitudinal folds.

The *stomach* is of a very different shape from that of the Indian Rhinoceros as figured and described by Professor Owen, and in most respects resembles that of the horse. It forms a broad tube much bent upon itself, with the cardiac and pyloric orifices approximated, and a deep and narrow interval between them, in which the main vessels and nerves run, and across which the peritoneum extends. There is no definite constriction between the cardiac and pyloric portions of the viscus; but there is a peculiar diverticulum from the outer portion of the cardiac extremity, of a subconical form, in which the base of the cone is the attached end. The whole organ is therefore somewhat globose, with the above-mentioned cardiac cæcum projecting to the left side.

Page 96.

Fig. 2.

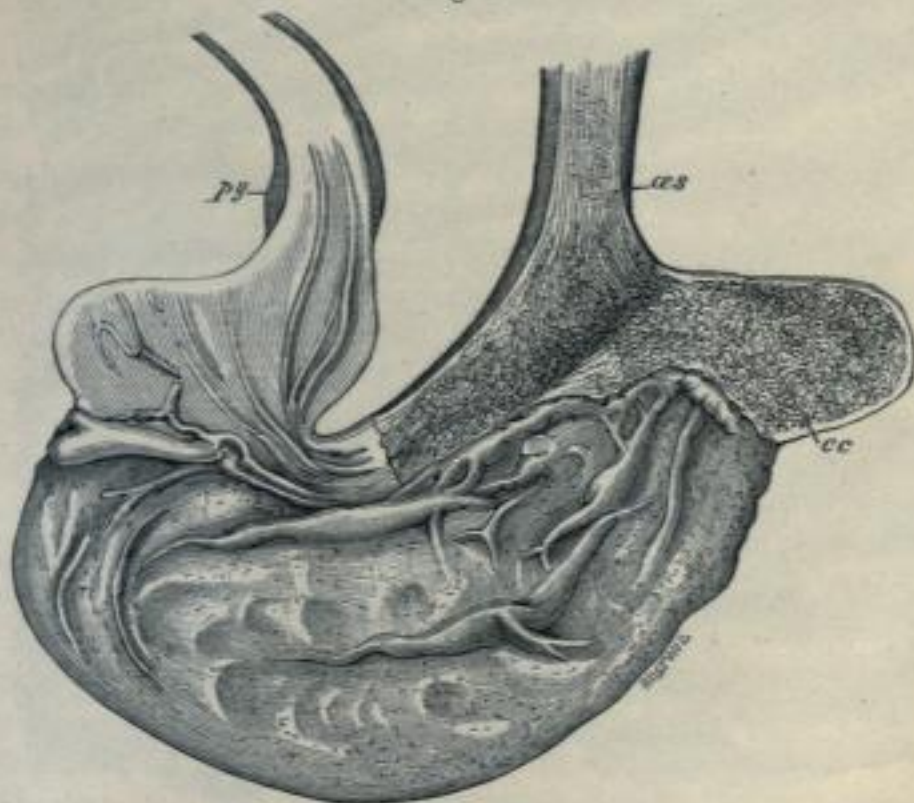


Stomach of *C. sumatrensis* (inferior or parietal surface).
œs, termination of œsophagus; *py*, commencing duodenum, just beyond pylorus.

With regard to the size of the stomach, the greater curvature is 62 inches in length, and the lesser 6 inches; the greatest breadth from side to side, including the cardiac diverticulum, is 26 inches; the greatest depth is 18 inches; and the length of the diverticulum is 11 inches, whilst it is $5\frac{1}{4}$ inches in diameter. The diameter of the undistended œsophagus where it enters the stomach is 2 inches, and of the commencing duodenum $1\frac{1}{2}$ inch. There is not a trace of enlargement of the duodenum at its pyloric end, like the considerable dilatation in the Indian species. A large portion of the pyloric portion of the stomach is situated beyond, or to the right of, the pylorus itself; but it is only a direct continuation of the cavity of the viscus, and hardly forms a true *cul-de-sac*. The great omentum, which does not cover the intestines, is of considerable size; it contains no fat, and is not in any way attached to the colon, but runs up, behind the stomach, free to the vertebral column.

The interior of the stomach presents a similar condition to that found in the Tapir and Horse, the mucous membrane being of entirely different characters in the cardiac and pyloric portions. That in the cardiac end, and in its diverticulum, is much plicated in all directions, and has a white opaque appearance; while the pyloric portion is covered with a thick and apparently smooth mucous membrane of the ordinary colour. The line of junction of these two portions is abrupt; Page 97.

Fig. 3.



Stomach of *C. sumatrensis* (inner surface).
cs, œsophagus; *py*, pylorus; *cc*, cardiac cul-de-sac.

and its position can be best understood from the accompanying drawing, in which it is seen that the corrugated white opaque epithelium only covers about one-fourth of the whole cavity—namely, the margins of the œsophagus for about an inch, and the diverticulum, from which it extends to the right, and backwards for a short distance. The walls of the stomach are nearly uniform in thickness, being a little more muscular at the cardiac extremity and along the lesser curvature than elsewhere. When the organ is fully distended the diverticulum becomes less conspicuous, the direction of its superficial fibres being from its base to its apex. The pyloric muscular ring is strong and nearly an inch thick, projecting into the tube.

The small intestine is 36 ft. long, and of a nearly uniform circumference of 6 inches, reaching 7 inches in the duodenum. For the first six inches after the pylorus the mucous membrane is smooth and simple, much like that in the pyloric portion of the stomach. The seventh and eighth inches present irregular folds, which immediately give place to a perfectly uniform series of thin, continuous (or nearly continuous), transverse foldings, just like the *valvulae conniventes* of the human

Fig. 4.



Mucous membrane of the small intestine, natural size, showing the *valvulae conniventes*.

small intestine. There are nineteen of these folds in each six inches of the intestine; and they continue unchanged to within half an inch of the ileo-cæcal valve, where they cease. Their great number (over 1,300), extreme simplicity, and uniformity is very striking; they project nearly $\frac{1}{4}$ inch into the intestine. Many are continuous right round the tube; but where two approach one another, as is frequently the case, an intermediate one frequently ceases after having made nearly a complete circle. A few are to be seen extending for only about an inch; but most are either that size or considerably longer. There are no traces of any triangular or cylindrical papillæ the whole length of the intestine. Page 98.

The bile and pancreatic ducts open on a papilla situated a foot from the pylorus, among the valvulæ conniventes, on the mesenteric border of the gut. This papilla is conical and rounded, projecting half an inch, with a single orifice at its apex. There is a second smaller orifice for a duct two inches further on, between two of the valvulæ and on one side of the main one.

No Peyer's patches could be found; and in their usual situation there was no irregularity of the valvulæ conniventes.

The ileo-cæcal valve does not project to any extent into the colon; but where the small intestine ceases, on the border of the ileo-cæcal orifice which is nearest the caput cæci, there are two closely approximated globose, apparently glandular masses, about the size of Tangerine oranges, situated in the walls of the intestine. Page 99.

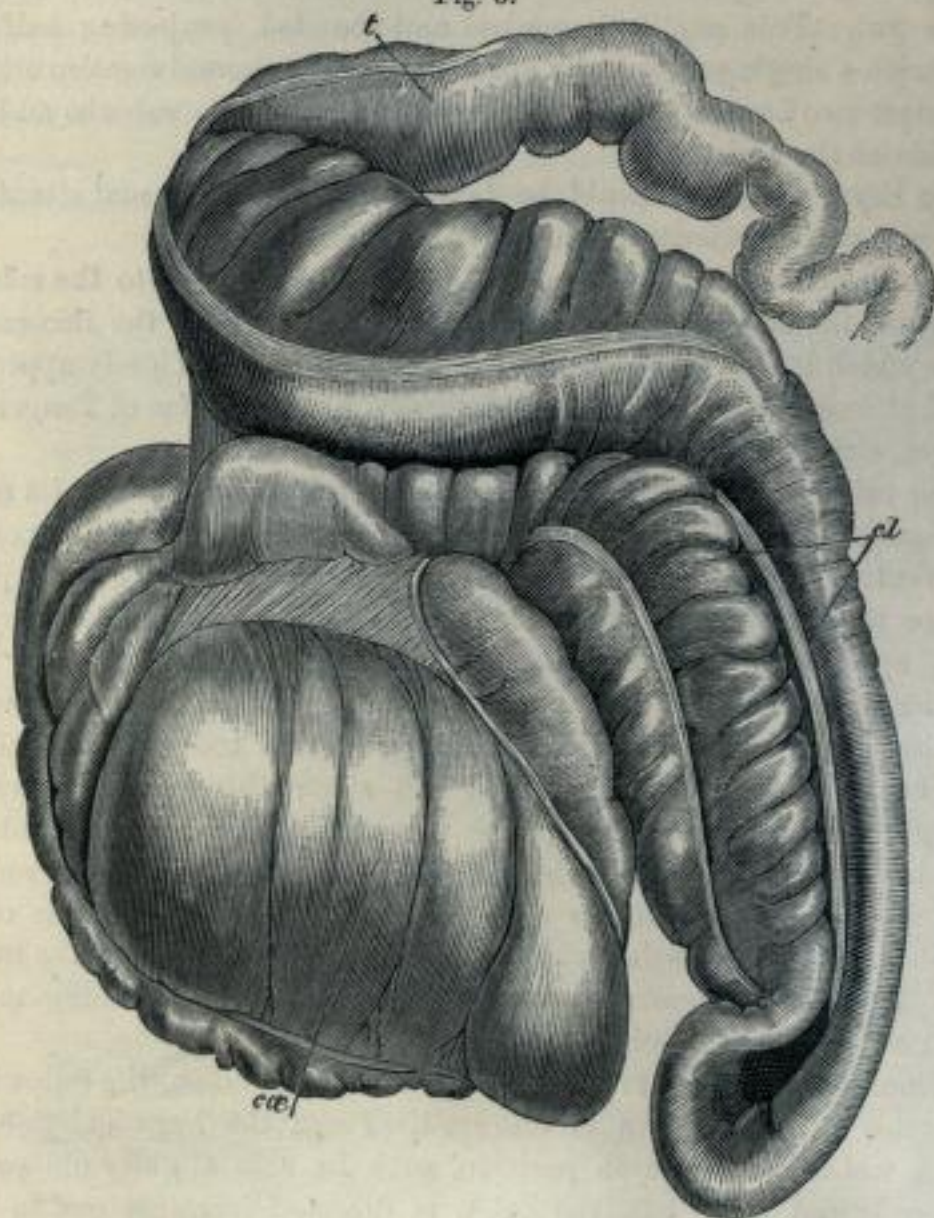
The *colon* presents features of great interest, and agrees in its convolutions with the Indian Rhinoceros. When the abdomen is opened by a ventral longitudinal and transverse incision, the posterior portion, or the hypogastric region, is seen to be occupied entirely by a large, apparently globose viscus, which is the ventral wall of the cæcum: anteriorly to this, in the umbilical region, is seen a very capacious and sacculated tube, running nearly transversely and a little backwards as it tends to the left side; this is the posterior moiety of the enormous loop of the first part of the colon (ascending colon in man). Further forward, in the epigastric region, and somewhat covered by the ribs, is seen another transverse, but less considerable, sacculated tube, which is the anterior moiety of the same loop. There is no omentum covering these viscera. Nothing more can be seen without moving these parts. Page 100.

When the intestines are removed from the abdomen, the following disposition of the viscera is observed. From the huge subglobose cæcum, which is median in position, with its axis slightly obliquely backwards and to the left, the colon is directed forwards and to the right; but it almost immediately gives rise to the very considerable colic loop, which is directed first transversely to the left, and con- Page 101.

tinues on obliquely backwards, the anterior returning portion of which returns to the right hypochondriac region, where its mesentery is very incomplete, and it is firmly bound down to the adjacent parietes. The transverse colon, running from this point, is situated quite above the colic loop, and is also bound down at the left hypochondrium as at the right. The third part of the colon (the descending in man) is very sinuous in its course; it ends by a very simple sigmoid flexure, and is continued on as the capacious rectum.

The *cæcum* is 3 feet long, and of nearly the same diameter; it is pyriform in shape, and much like that of the Tapir, the blind end being the narrower. It is traversed by three long longitudinal bands, between which it is folded in large sacculi. The colon springs from

Fig. 5.



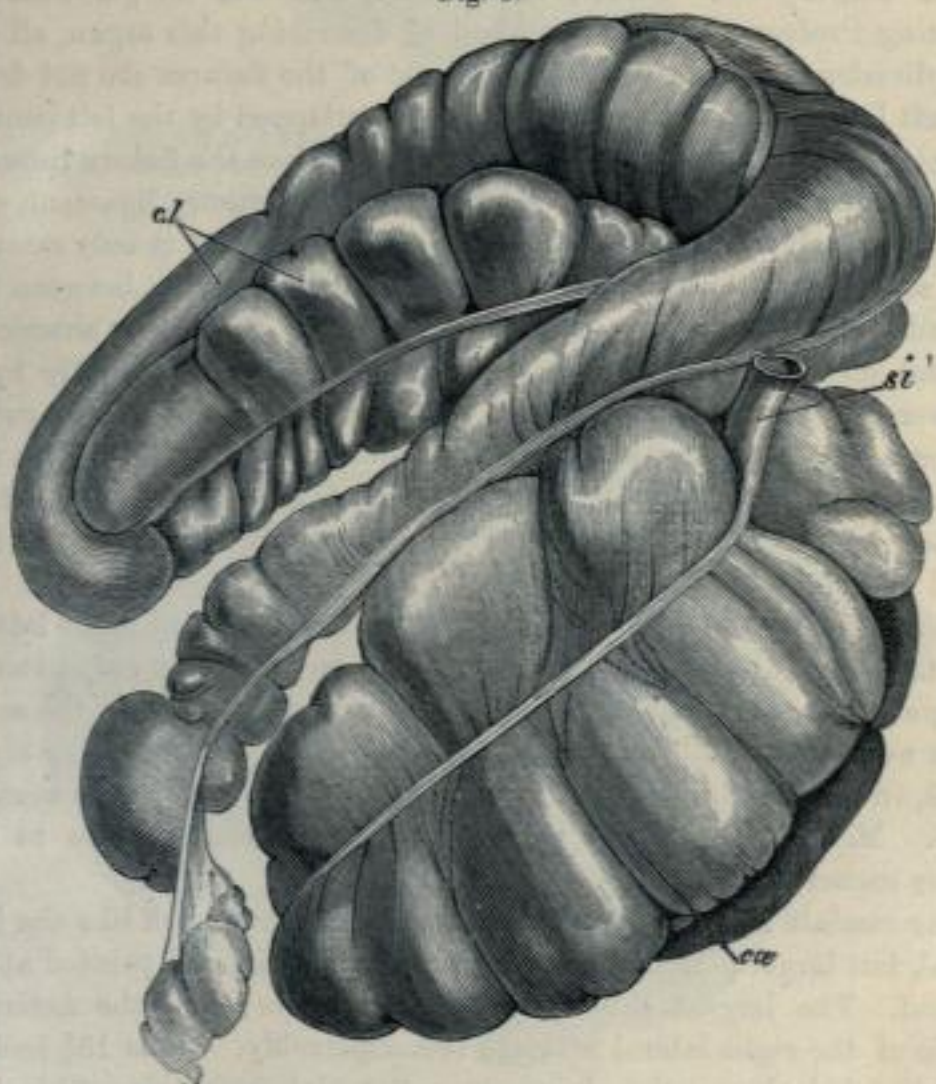
Inferior view of the colon of *C. sumatrensis*.
cæ, cæcum; *c.l.*, colic loop; *t.*, transverse colon, placed above the colic loop to show it more clearly.

the anterior end of the cæcum, and immediately makes a short sigmoid curve to the right. Its interior is lined with a smooth, simple, irregularly plicated epithelium, the folds of which are quite removed when the organ is distended.

From the ileo-cæcal valve to the anus is 16 feet; and in its broadest part the colon is 39 inches in circumference. It is peculiar that, as in the Horse and also in the Tapir, the tube is of very different diameters in its different parts, the bend of the colic loop being very narrow in comparison with its main parts.

The proximal $\frac{2}{3}$ of the colic loop is sacculated, and, at its middle, 13 inches in diameter; but at its bend, where it is situated in the left iliac fossa, it is much smaller, being only $6\frac{1}{2}$ inches across, and not the least sacculated. It continues thus uniform on its surface, and gradually dilating for about $2\frac{1}{2}$ feet till in the epigastric region it again becomes sacculated and very capacious, reaching a diameter of

Fig. 6.



Superior view of the colon of *C. sumatrensis*.
si, small intestine; *ca*, cæcum; *c.l.*, colic loop, with the transverse colon between it and the cæcum.

16½ inches. From this point it rapidly reduces in the transverse colon, remaining somewhat sacculated, with only one longitudinal band, which is at the mesenteric border, till at the sigmoid flexure the diameter is 6½ inches. The colic loop is just 5 feet long. There are no regular folds of the mucous membrane of the large intestine, but many minor ones, which disappear when the tube is distended. The rectum is nearly 7 inches in diameter.

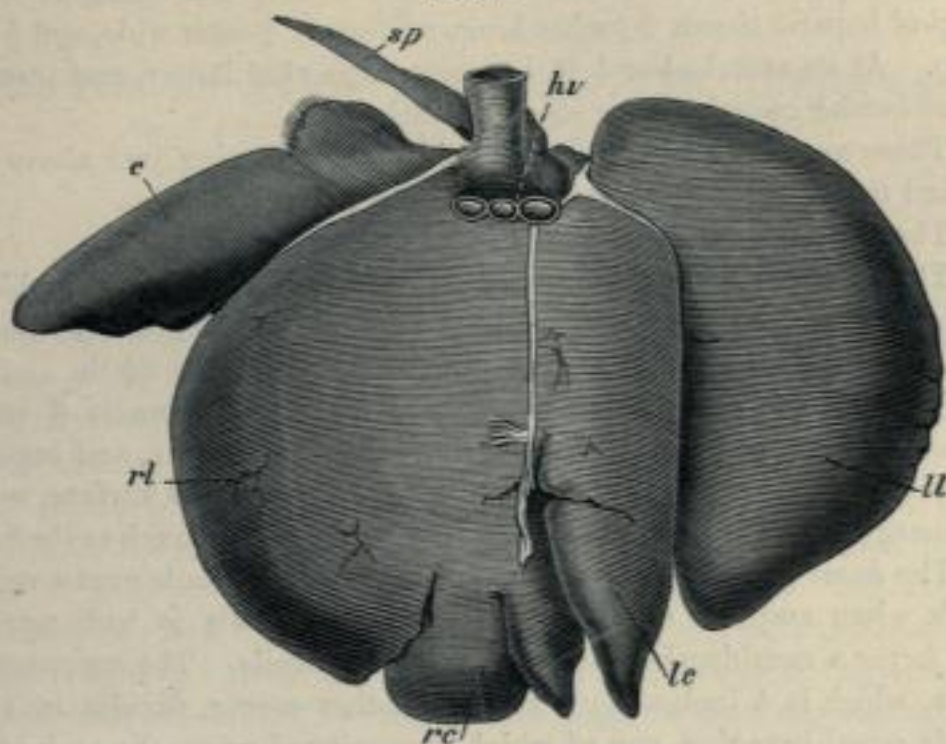
This arrangement of the colon is different from that of the Horse in that the portion corresponding to the ascending colon is longer in the latter. In the Horse and Tapir the colic loop is formed from the transverse colon, in this Rhinoceros more from the right hypochondriac angle of that viscus. In the direction of the cæcum, namely backwards and to the left, the Rhinoceros agrees with the Tapir and differs entirely from the Horse.

The *liver* is not large, considering the size of the animal. It weighs slightly over 15 lb., is flattened, and has no gall-bladder. Adopting Professor Flower's method of describing this organ, all the main divisions are indicated, though most of the fissures are not deep. The left lateral lobe is the largest, and is overlapped by the left central
 Page 103. along its median border. On the anterior surface the fissure between the two extends upwards to the left lateral suspensory ligament, and therefore nearly through its whole surface; posteriorly it only extends up to about two thirds the distance. The median suture, between the left and right central lobes, extends halfway up the organ anteriorly and not quite so far posteriorly, where it is stopped abruptly by a transverse bridge of hepatic tissue. The left central lobe is triangular, prismatic, and elongate, coming to a point below on a level with the general contour-line. One flat surface of this prism, the largest, is directed forwards; and the other two are wedged between the left lateral and right central lobes.

The right central lobe is less differentiated from the right lateral than those just described are from one another, the fissure only extending upwards a short distance; and it is itself cleft to nearly the same extent near the middle of its truncated inferior border. The right lateral, the lobe second in size, is suboval and simple, with the margin entire. Mesially it slightly overlaps the right central lobe at its inferior corner.

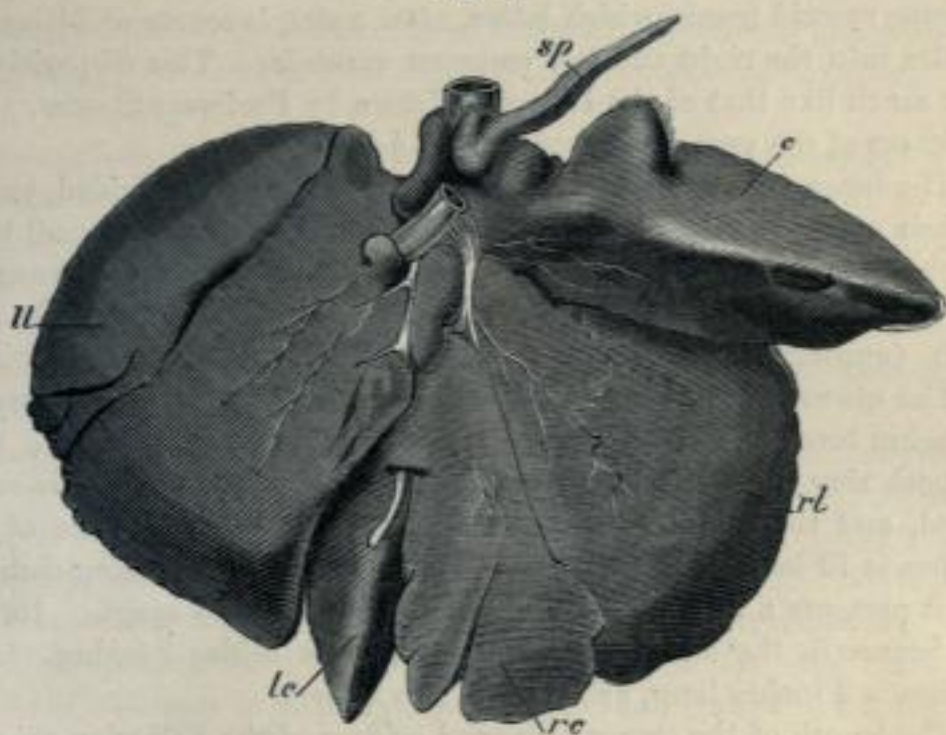
The caudate is a very considerable lobe, shaped much like the left central, but larger; it is elongate, ovate, prismatic, and pointed at its free end. The largest side is directed forwards; and the external margin of the right lateral overlaps it considerably. It is 15½ inches long, the whole liver, when lying on a flat slab, measuring 22 inches across, and 14 inches from above downwards. In no part does it measure more than 3½ inches from before backwards.

Fig. 7.



Anterior or diaphragmatic surface of liver of *C. sumatrensis*.
 rc, right central lobe; rl, right lateral; lc, left central lobe; ll, left lateral;
 c, caudate lobe; sp, Spigelian lobe; hv, hepatic veins.

Fig. 8.



Posterior or abdominal surface of liver of *C. sumatrensis*.
 rc, right central lobe; rl, right lateral; lc, left central lobe; ll, left lateral;
 c, caudate lobe; sp, Spigelian lobe.

The Spigelian lobe is most peculiar, mainly consisting of a thin strip of hepatic tissue, 8 inches long, uniformly $\frac{3}{4}$ inch wide, and $\frac{1}{4}$ inch deep. At its attached end it becomes somewhat larger, and presents a free border superiorly for about an inch.

There are three large hepatic veins, which spring just above and behind this lobe, on their way to the vena cava.

The *pancreas* is irregular, not large nor concentrated.

The *spleen* is very thin and flat; it forms an elongated oblong, rounded at one end and squared at the other. Its length is 25 inches, and breadth 8 inches. It is slaty in colour, and weighs $2\frac{3}{4}$ lb.

The *kidneys* are flattened and oval in form. One is 6 inches broad by 2 inches long. They are nearly equal in size, and together weigh 10 lb. The hilum is linear, and on the inferior surface, not at the margin. They are lobulated externally, but not so much as the Seals.

The *heart* presents no peculiar features. The whole organ weighs 10 lb. when emptied of clots. The annulus ovalis is well marked, and forms a considerable fold over the fossa ovalis. The commencing aorta, which is 4 inches long and $3\frac{1}{2}$ inches across, divides into two nearly equal branches, one of which is continued on as the arch of the aorta, with a diameter of 1.85 inch; the other gives off the vessels to the head in the following manner. Immediately after the main division of the vessel into two parts, the innominate gives off the left subclavian, which, again, is much divided up. The innominate then, 3 inches above its origin, divides into the right subclavian and the common carotid trunk, which latter, after a simple course of $2\frac{1}{2}$ inches, divides into the right and left common carotids. This disposition is very much like that of the Llama as drawn by Professor Owen. The thickness of the ventricular septum is $1\frac{1}{2}$ inch.

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The *lungs* are extremely simple, coniform, and undivided, except at their apices, where, as in many animals, they send down small lobes which overlap the auricles of the heart. They are nearly equal in size, being 25 inches long by 15 deep and 5 broad. They weigh each $9\frac{1}{2}$ lb. (uncongested).

The *uterus* is two-horned. The corpus uteri is $3\frac{1}{2}$ inches long by $2\frac{1}{2}$ inches broad; the cornua are $16\frac{1}{2}$ inches, by 2 inches broad; they are both very distinctly longitudinally plicated. The os uteri is much folded, and the orifice is quite small; from it to the orifice of the urethra is 12 inches. The vagina is lined with a squamous epithelium, and it presents a few transverse folds about 3 inches apart. Its circumference in the middle is 15 inches, at its orifice 9 inches. The urethra is 2 inches long, and admits two fingers.

The length of the elongate fringed orifices of the Fallopian tubes is 5 inches.

The clitoris and vulva are similar to those of the Indian species.