**On the Abdominal Viscera of *Cercopithecus fuliginosus* and
Lagothrix humboldti. By O. Charnock Bradley,
M.B. (With Three Plates.)**

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The anatomy of the primates is responsible for a very considerable volume of contributions to morphological literature. But, quite naturally, those forms which have the closest affinity to man have been more extensively and more carefully observed than those occupying a lower position in the zoological scale. And, further, the most painstaking and accurate work has been done in connection with organs which are very specially modified in man, such, for example, as those of the nervous system. This is perfectly consistent with the desire to obtain any light, and from any source, which will facilitate the unravelling of the many problems of human structure. Moreover, the soft and flaccid viscera do not lend themselves to accurate observation so readily as do the more solid organs which retain their shape after their removal from the body. So it comes to pass that, up to quite recent times, the abdominal viscera, and more especially the hollow organs of the abdomen, such as the stomach and the intestines, have only received scant attention; or, if they have been more carefully examined, the descriptions as given prior to the introduction of modern methods cannot be held as absolutely satisfactory, because of the change of shape and disposition resulting from the removal of their natural support, to wit, the abdominal walls.

The method of hardening the whole body by the injection of some kind of chemical substance in solution has caused, and is still causing, an almost complete revision of those chapters in the text-books of human anatomy which deal with the softer viscera. That similar methods, when sufficiently commonly employed, will produce like revolutions in comparative anatomy, can scarcely be doubted. And in no order of mammals are such methods likely to

lead to greater results than in primates: an order containing a large collection of animals of very diverse form, the classification of which, except on the broader lines, is none too firmly established. Any contribution to our knowledge of the anatomy of the lemurs, monkeys, and apes should be welcomed by the zoologist as well as by the morphologist. And the more precise and detailed it is possible to make the description, the more welcome it should be.

It was, therefore, with much gratification that I recently received two monkeys not too long dead for the hardening of the entire body to be undertaken with the prospect of satisfactory results. It was felt that the fact that one of them belonged to the Cebidæ and the other to the Cercopithecidæ would permit of an interesting comparison of a New World with an Old World form.

Both animals were full-grown males: the one, a *Cercocebus fuliginosus* (sooty mangabey); the other a *Lagothrix humboldti* (Humboldt's woolly monkey). They were both injected with a 10 per cent. solution of formol through the femoral artery; and in both the hardening was very satisfactory. So far only the abdominal viscera have been examined, with results as set forth in the following pages.

It may be here stated that in both animals the stomach and intestines were practically empty; therefore a comparison can be more easily made than would have been possible had these viscera been loaded with ingesta in the one, and empty in the other.

Cercocebus fuliginosus.

Œsophagus.—It is barely possible to speak of an abdominal portion of the œsophagus, for it enters the stomach immediately after it becomes free from the diaphragm. In its course through the diaphragm it forms a gentle curve in a dorsal direction, and so its junction with the stomach comes to be in the form of a fairly open angle (Pl. I. fig. 1).

Stomach.—This organ has a form of considerable interest, inasmuch as it can be divided into two parts, whose boundary is marked on the surface by the entrance of the œsophagus on the one side and by a constriction on the other (Pl. I. fig. 1). These two portions may be designated, for the sake of convenience, the

saccular and the tubular parts of the stomach: these terms giving some idea of their form. The saccular portion lies dorsal to and to the left of the entrance of the œsophagus: its greatest diameter is 57 mm. The comparative narrowness of the tubular part is best indicated by saying that its greatest diameter is only 20 mm. It is placed ventral to and to the right of the œsophageal opening, and is abruptly bent upon itself at no great distance from the pylorus. As far as this bend it is only slightly curved, and passes in an oblique direction ventralwards and a little to the right. The abruptness of the bend causes the pyloric portion of the stomach to take a direction towards the vertebral column, and brings the pylorus within a comparatively short distance from the œsophagus. Not very far removed from the pylorus a constriction is noticed on the surface of the stomach; this marking off a slight dilatation adjacent to the pylorus (Pl. I. fig. 1 p.c.). The position of the pylorus itself is indicated to the eye by a very conspicuous constriction, and to the touch by a thickening of the wall.

Owing to the degree of approximation of the œsophagus and pylorus, the difference, in extent, of the two curvatures is considerable. The greater curvature is, at first, directed dorsally; then it turns round to the left and finally to the right. This curvature is indented by a deep notch which marks the point of junction of the saccular with the tubular portion. The lesser curvature looks towards the vertebral column; is confined to the tubular part; and is most acute where the sudden change in direction of this portion of the stomach takes place.

The "hepatic" surface looks almost entirely cephalwards. Though this surface may be called "hepatic" for convenience, it should be stated that the greater part of the saccular portion is not in contact with the liver, but with the diaphragm. The line (xxxxxx) in Pl. I. fig. 1 shows the extent to which the stomach contacts the liver.

Although the arrangement of the peritoneum will be described later, the gastric attachment of the great omentum may be mentioned here. The tubular portion has the omentum attached to its greater curvature, but in the saccular part the line of reflection of the omentum crosses the caudal surface of the stomach obliquely.

When the stomach is opened it is found that there is a decided difference in the character of the walls in the two portions. In the saccular part the wall is much thinner than in the tubular segment, and the mucous membrane is all but completely smooth. The tubular portion, on the other hand, has thick walls, and the mucous membrane, in addition to being thick, is arranged in a number of well-marked folds which run longitudinally. The change in the character of the mucous membrane is abrupt, the line of demarcation joining the entrance of the œsophagus to the notch in the greater curvature which is seen on the surface. The manner in which the pylorus opens into the duodenum is an exaggeration of the condition as figured in some text-books on human anatomy, and is perhaps most easily described by saying that it reminds one of the way in which the os uteri projects into the vagina.

The peculiarity in the form of the stomach of *Cercocebus*, as just described, is of some interest since it affords an example of the tri-partite condition of the stomach of primates in general. Although some attention had been directed to the subject by Wurmb (1) and Otto (2), the compound character of the stomach in monkeys was first really investigated by Owen (3) in such genera as *Semnopithecus*, *Nasalis*, and *Colobus*. Owen described the stomach in these monkeys as being divided into two parts which, he suggested, probably play different rôles in the process of digestion. Martin (4) also mentioned a like condition in *Semnopithecus nasalis*; and it finally became a recognised characteristic of the group to which these various monkeys belong. Later writers showed that other primates also possessed a stomach divisible into two portions, although the external features of the division were not so strongly marked as in *Semnopithecus*. Huxley (5), for example, described the stomach of the orang and gibbon as being considerably elongated, and having its cardiac extremity rounded and its pyloric portion tubular and curved. Flower (6) asserted that in the chimpanzee and orang there is a much elongated, recurved pyloric portion marked off from the rest of the stomach by a constriction. Sandifort (7) had earlier figured the stomach of the orang as having the pyloric portion separated from the main cavity by a narrow construction. From

the observations of these writers, as well as of others, it came to be recognised that the stomach in many, if not all, primates was of a compound nature. This conception of a bi-partite primate stomach has now given place to one in which the viscus is held to consist of three parts; and there seems little reason to doubt that in all primates, with the possible exception of the lemurs, a tri-partite stomach exists. The Lemuroidea in this, as in other anatomical details, appear to stand somewhat apart from the Anthropeidea; though there may be indications of a compound stomach even in this group, for Patten (8), describing the abdominal viscera of *Lemur varius* examined after hardening *in situ*, speaks of the organ as being ovoid, but with a pylorus of considerable length and bent sharply on the fundus.

Additional evidence has been recently afforded in a paper by Keith and Wood Jones (9). These observers have re-examined the stomach of *Semnopithecus*, and assert that it consists of three sharply differentiated and highly specialised compartments, which are already demarcated before birth. These three chambers are a fundus (saccular in form), a body, and a pyloric part, the two latter being tubular. The pyloric part is further subdivided into an antrum pylori and a pyloric canal. This condition was also found to obtain in the stomachs of Anthropoids, and also, to a lesser degree, in that of lower forms (especially in *Myctetes*). Further interest attaches to the short paper by these writers from their observations on the development of the fundus of the human stomach. In man, they say, the fundus does not develop as a general expansion of the gastric part of the fore-gut, but in the form of a localised out-growth or diverticulum from the cardiac end of the greater curvature of the stomach. This diverticulum appears to be best marked in human foetuses of the 3rd or 4th month. This discovery, combined with the recognition by human anatomists of a pyloric canal, brings the stomach of man well in line with that of the other primates, and so tends to establish more firmly the tri-partite nature of the primate stomach.

In the stomach of *Cercopithecus* there can be little doubt as to the identity of the saccular portion with the fundus of *Semnopithecus*, etc.

Nor is it difficult to conceive that the slight dilatation close to the

pylorus represents the pyloric canal. But there is no distinction between a body and a pyloric antrum such as is shown in *Semnopithecus*. With the evidence at our disposal we can only conclude, provisionally, that in *Cercocetus* these two portions are undifferentiated to the naked eye, and that they form the major part of the tubular segment. It is to be regretted that the animal had been dead for some little time before it came into my possession. Had it been possible to make reliable microscopic sections of the different parts of the stomach, much more definite conclusions could have been arrived at. Sections have been made, but, on examination, it is found that post-mortem changes are too extensive to permit of any statement being made which would be of any value.

Small Intestine.—As previously stated, the pylorus points towards the dorsum of the animal. From it the duodenum passes in a curved direction caudalwards, the concavity of the curve looking ventralwards and towards the pelvis. This part of the duodenum inclines (but not markedly so) towards the left, and so it arrives in the mesial plane of the body, where there is an abrupt bend ventralwards and cephalwards. The second part of the duodenum is short and inclined to the left. The duodenum, as here described, is recognised as that part of the small intestine that is without a mesentery. Its total length is about 90 mm. On opening it the common opening of the bile and pancreatic ducts is found at a distance of 75 mm. from the pylorus, *i.e.*, these canals open into the first part of the duodenum as here described.

The remainder of the small intestine is located almost entirely to the left of the mesial plane, and measures some 286 cm. in length when freed from its mesentery and laid out straight on a table. When the abdomen is first opened and the great omentum has been removed, only a little of the terminal part of the ileum is visible; the rest of the small intestine being hidden by the colon and the mesocolon (Pl. I. fig. 2). The calibre of the tube is fairly uniform. There are no valvulae conniventes, and Peyer's patches are extremely difficult to recognise.

Cæcum.—This is a short curved tube, of considerable diameter, whose apex is blunt and points to the left, and is, therefore, not

the most caudal part of the cæcum. The cæcum is free, having neither a mesentery nor any other form of peritoneal reflection. There is no vermiform appendix. Owing to some degree of lateral flattening, the cæcum may be described as having two surfaces and two curvatures. The greater curvature is mainly dorsal in position, but is also inclined slightly to the right. Traced from the commencement of the colon, it runs caudalwards for a little distance, then turns ventralwards and to the left to end at the apex. The lesser curvature is only very slightly concave. It is directed ventrally and looks a little towards the left. Measured from the apex to the entrance of the ileum, this curvature is only 30 mm. in length. The surfaces of the cæcum are lateral and mesial. The former is in contact with the abdominal wall, and looks somewhat ventralwards. The mesial surface is smaller in extent than the lateral, and is concave. It is applied to the last part of the colon (Pl. I. fig. 2 and Pl. II. fig. 3).

On opening the cæcum it is found that its walls are of considerable thickness. The ileo-cæcal (or ileo-colic) orifice is in the form of a rounded opening surrounded by a thick and prominent circular fold of mucous membrane, which, in the hardened condition at any rate, does not give the impression that it could act as a very efficient valve. On a level with the opening there is a ridge (*Fræna* of human anatomists) running across the dorsal part of the tube, but absent ventrally. Corresponding to the position of the fræna, there is a furrow on the surface (*frænal furrow* of Struthers (10)), which thus supplies a clear line of demarcation between the cæcum and the colon.

Colon.—The colon is a tube of considerable length and of complicated arrangement. In none of the abdominal viscera is the value of hardening the body as a whole more clearly demonstrated than here. For, had the colon been of natural softness, its disposition could not have been so easily studied with any hope of arriving at a reliable conclusion. Since it is disposed in a manner very similar to the condition found in man, the first part may be called the *ascending colon*, though this is not a strictly accurate term as applied to an organ in a pronograde animal. It runs straight cephalwards for a short distance, and then makes a wide curve in a ventral direction and to the left, to terminate in

a sharp bend by which it is continued into the next part of the colon. This curve is in contact with the right lateral lobe of the liver. In calibre the ascending colon is, at first, about equal to the cæcum ; but it narrows slightly as it passes onwards.

The succeeding parts of the colon are so ordered that there is no possibility of receiving assistance from the terms used in human anatomy. It seems convenient, on the other hand, to give the various parts a literal designation, without in any way endeavouring to compare them with the parts of the human colon. When the colon has formed the sharp hepatic flexure above mentioned, there follows a part which we may refer to as A (Pl. I. fig. 2), running towards the pelvis, ventral to the ascending colon and to the right of the mesial plane. After a course of about 65 mm. a sigmoid curve is formed by the intestine turning abruptly over to the left and, at the same time, inclining dorsalwards ; and then as suddenly bending towards the pelvis. This double curve brings the colon almost into the middle line of the abdomen, and takes place a little above the level of the termination of the ileum. The next stretch of intestine we will call B. It is about 140 mm. long, and passes almost straight caudalwards to the entrance to the pelvis. Here there is another sudden change of direction. This time the bend is dorsalwards and to the left, and leads to a length of colon marked C in the figures. A certain portion of C can be seen without any disturbance of the small intestine ; but this part of the intestinal canal must be removed before the further course of the colon is visible. C is found to run cephalwards, and in contact with the wall of the abdomen on the left side, for a distance of 130 mm. ; then there is a series of twists which results in the production of a piece of intestine which may be said to resemble a horse-shoe in form. The curves, etc., are as follows :—C ends by turning abruptly cephalwards, so that the next short segment of the colon lies dorsal to C. Then there is a turn ventrally and somewhat to the right, and the colon again becomes visible as the animal is lying on its back. Finally there is a turn directed cephalwards and to the left (Pl. II. fig. 4).

After this series of twists comes a short, narrow part of the colon which runs cephalwards and obliquely to the right to gain the mesial plane of the body, where there is a final sudden turn at

which the part indicated as D in the figures begins. D passes almost straight caudalwards to the entrance to the pelvis, where it is continued by the rectum. This last piece of the colon is approximately in the mesial plane.

Examined as a whole, the large intestine is seen to have a very variable calibre. The cæcum is the widest part, and might almost be called saccular. As previously stated, the ascending colon is, at first, almost as wide as the cæcum; but later it narrows slightly. At the bend between the ascending colon and A there is a sudden reduction of calibre. A and B are of approximately the same width; but where B ends and C begins there is a sudden increase in size, so that C is nearly as wide as the ascending colon. The second part of the horse-shoe-like piece of the colon is somewhat narrower than the part immediately preceding it; and the part marked + in Pl. II. fig. 4 is even narrower than A and B. D, on the other hand, is again wide, there being practically no difference between the diameters of C and D. This is the variation which was found in the particular *Cercocebus* dissected; but in what measure it may be due to different parts of the intestine having been distended with gas during the process of hardening, I do not feel in a position to say. In any case, the large calibre of the cæcum and ascending colon does not appear accounted for as the result of gaseous distension. There does not seem to be any reason to doubt that these parts of the large intestine have retained their natural size.

In all parts of the cæcum and colon three longitudinal bands are found, one of the three being always along the line of attachment of the meso-colon where this exists. Owing to the numerous turns, these bands have no constant arrangement in the greater part of the colon; but in the cæcum and ascending colon they are disposed as follows:—One runs along the left side of both cæcum and ascending colon. Another passes along the lesser curvature of the ascending colon. At the entrance of the ileum into the cæcum it splits to become united again on the other side of the ileum, and to be continued to the apex of the cæcum. The third band courses along the greater curvature of the ascending colon, and obliquely across the lateral surface of the cæcum to its apex. All three bands end at the apex of the cæcum.

The degree of sacculation is very variable in different parts of the large intestine. The cæcum has no sacculations, but they are well marked in the ascending colon, and in A and B (especially in the initial part of B), and in the narrow piece of colon marked + (Pl. II. fig. 4). Sacculations are very faintly indicated, and few in number, in C and D.

Pancreas.—A lengthy description of the pancreas of *Cercopithecus* is not necessary, for it bears a remarkably strong resemblance, both in form and position, to the organ as described in the average text-book on human anatomy. Its head is in contact with the entire length of the duodenum. The rest of it crosses the middle line to come into relation with the cephalic part of the ventral surface of the left kidney; the blunt tail touching the spleen.

Liver.—It is regrettable that, though a considerable volume of work has been done on the surface anatomy of the mammalian liver, there should still be some lack of uniformity in the methods of description employed by various writers in their discussion of the lobes, etc., of the liver of the particular animals upon which their attention has been bestowed. No doubt this is due to the slow-dying notion that the human liver should be taken as the type. That the liver of man has been considerably modified in the evolution of the erect attitude has been deduced from comparative anatomy by various authors. Keith (11), for example, has averred that the consolidation and absence of fissures in man and the anthropoid apes is the result of the upright posture. In anthropoids, with an erect position during locomotion, the dorsal mesentery, says Keith, has acquired all the complicated attachment seen in man, with the result that the viscera are more firmly and extensively fixed to the dorsal wall of the abdomen than obtains in pronogrades. This more extensive fixation of the liver to the dorsal abdominal wall is accompanied by the disappearance of deep fissures in the liver. This writer also points out that the change in form of the thorax and abdomen in anthropoids has had an effect upon the form of the liver. Ruge goes even further than Keith, and, after showing that the trunk of all primates has undergone a change in form (12), states that the remodelling of the liver of primates depends upon a change in the entire trunk, accompanied by an alteration in form of the diaphragm, which has

gradually become flatter and flatter and of increased span because of the widening of the trunk. The bearer of a lobed liver, he goes on to say, has considerable mobility of the trunk, whereas an unlobed liver belongs to an animal with a plumper bodily formation (13).

Evidence, therefore, goes to show that the human liver is the most modified in the primate series, and, for this reason, cannot logically be employed as the type with which the livers of other animals should be compared. As long ago as 1835, Duvernoy (14) found a difficulty in comparing different mammalian livers with the human organ. He sought to overcome the difficulty by assuming that the liver of man was formed of one lobe only (*lobe principal*) with a rudimentary right lobule, that of Spigelius. In other mammals he supposed that additional lobes were added to the "principal lobe." This hypothesis was obviously untenable. Rolleston (15) suggested that the average mammalian liver consisted of three lobes—suspensory, right, and left—to the middle of which the suspensory ligament is attached. The suspensory lobe Rolleston described as being very commonly trifid, the dividing lines of its component parts being the position of the suspensory ligament and of the gall-bladder. The recognition, as an independent component of the liver, of what has come to be known as the caudate lobe, is also due to Rolleston. He described it as the "right kidney lobule." Owen (16), writing a few years later, agreed in the main with Rolleston, and criticised Duvernoy's views in saying that "fissures, rather than lobes, are added to the liver of quadrupeds."

Since subsequent workers have found very little to alter in it, Flower's conception of the arrangement of the lobes of the liver (6 and 17) forms one of the most valuable contributions to the subject. He considered the liver as primarily divided by the umbilical vein into two segments, right and left. In the majority of mammals each segment is further divided by a fissure—the right and left lateral fissures. In such a case the lobes lying on each side of the umbilical fissure are known as the right and left central lobes, and those beyond the lateral fissures as the right and left lateral lobes. Rex (18), writing in 1888, confirmed

Flower's divisions and merely offered a different nomenclature, in

which the only improvement upon that of Flower appears to be the substitution of the term *lobus omentalis* for "Spigelian lobe." It must be admitted that the former name affords some idea of the relationship of this portion of the liver, which "Spigelian" does not. The latest investigation upon the subject is that of Ruge (13), and here again no radical alteration of Flower's views is attempted, except the desire to consider the Spigelian and caudate lobes as merely parts of one lobe (*lobus venæ cavæ*) and not as independent entities. Undoubtedly there is much reason for such a combination; for the caudate and Spigelian lobes are certainly connected with each other by liver substance crossing the ventral face of the vena cava. It seems desirable, therefore, to call them *lobules*, the component part of a *caval lobe*.

The views of Cantlie (19), regarding the division of the liver, not having received acceptance at the hands of anatomists, there appears to be no reason for declining the universal adoption of the divisions of Flower, with such slight modifications as the observations of Rex and Ruge have suggested. In the descriptions of the liver of *Cercocebus* and *Lagothrix* the nomenclature as indicated in the following table will be employed. The fissure by which the caval lobe is separated from the right lateral lobe might be known as the *right dorso-lateral fissure* if a special name is required:—

Caval Lobe (*lobus venæ cavæ*, Ruge):

Omental Lobule (*lobulus omentalis*, Rex, modified; Spigelian lobe).

Caudate Lobule (*lobulus caudatus*; caudate lobe).

Right Dorso-Lateral Fissure (*incisura interlobaris dorso-lateralis dexter*).

Right Lateral Lobe (*lobus lateralis dexter*, Ruge).

Right Lateral Fissure (*incisura interlobaris lateralis dexter*, Ruge).

Right Central Lobe (*lobus centralis dexter*, Ruge).

Umbilical Fissure (*fossa sagittalis sinistra*, Ruge).

Left Central Lobe (*lobus centralis sinister*, Ruge).

Left Lateral Fissure (*incisura interlobaris lateralis sinistra*, Ruge).

Left Lateral Lobe (*lobus lateralis sinister*, Ruge).

The liver of *Cercocebus* appears to be of relatively large size, that part of it which lies to the right of the mesial plane being decidedly larger than that on the left. On first opening the abdomen, the central lobes are seen to project beyond the limits of the thoracic wall. The measurements of the liver are as follows:—

Greatest transverse diameter	=	110 mm.
„ dorso-ventral „	=	105 mm.
„ cephalo-caudal „	=	95 mm.

Taken as a whole, it may be described as having three surfaces. The *cephalic surface* is the smallest of the three, and is in the form of a triangle whose apex points ventrally. Its convexity is most marked in a transverse direction. An examination of fig. 1 shows the lines along which the peritoneum is reflected; in connection with which it is interesting to notice the large size of the bare area as compared with *Lagothrix*. The *visceral surface*, concave in all directions, looks dorsalwards as well as towards the pelvis. Its relations are shown in fig. 2. The third surface may be called *ventro-lateral*, since it is really a combination of a ventral and two lateral surfaces. It is not clearly defined from the cephalic surface, and the two might have been described together as the diaphragmatic surface; but this was not considered advisable, as the two surfaces look in different directions. The ventro-lateral surface is markedly convex in a transverse direction this convexity being most pronounced ventrally. A little to the left of the line of attachment of the falciform ligament, there is a shallow wide groove which extends for a short distance on to the cephalic surface. It seems likely that this is produced by some projecting border of lung; but, the thorax not having been opened as yet, this is only a conjecture.

All the fissures and lobes of the typical liver are present in *Cercocebus*. The *umbilical fissure* is very well marked, crossing the visceral surface from the portal fissure to the margo acutus, and being continued on the ventro-lateral surface almost as far as the boundary of the cephalic surface. The *left lateral* is the most complete of all the fissures, entirely isolating the left lateral lobe from the bulk of the liver (figs. 1 and 2). The *right lateral fissure* stands next in order of completeness. Beginning at the

portal fissure, it crosses the visceral surface, cuts the margo acutus, and is continued across the ventro-lateral surface as far as to the boundary of the cephalic surface. When the lobes of the liver are undisturbed, the cystic fossa appears to coincide with a part of the right lateral fissure; but in reality the gall-bladder is supported by the customary lobe—the right central. There is a fissure—or rather a groove with sharp borders—passing from the left side of the cystic fossa to the umbilical fissure. It cannot be seen so long as the parts are allowed to remain in their natural

FIG. 1.

positions, because of the overlapping of the right central by the left central lobe. Attention would not have been called to this fissure were it not that some interest is connected with it owing to certain observations by Thomson (20). In the course of his inquiry into the morphological significance of certain fissures in the liver of man, Thomson found a fissure (which he marks "f" in his figures) passing "from the left edge of the fossa for the gall-bladder for a short distance towards the umbilical fissure," *i.e.*, in a position corresponding to the one just mentioned as occurring in *Cercocebus*. In the human subject, apparently, the fissure is

very inconstant, it being encountered in three out of twenty-four foetal livers, and in two out of nine adult organs. Whether there is any very important morphological significance attached to this fissure is not very clear; but we shall see later that it is possibly represented in *Lagothrix*.

The only lobe of the liver of *Cercocebus* that seems to require special description is the caval (*lobus venæ cavae*, Ruge). For the others it will suffice to say that the left lateral is the most independent, and the right lateral the most voluminous. The

FIG. 2.

omental lobule (Spigelian lobe) of the caval lobe is largely developed, and consists of two closely connected portions—a dorsal and a ventral. The dorsal part can be seen when the liver is viewed from the cephalic aspect, and is remarkable for having a pointed projection jutting out towards the right (figs. 1 and 2). The ventral portion of the omental lobule (tuber papillare) is tongue-shaped, comparatively free, and, when the viscera are in their natural position, in contact with the lesser curvature of the stomach. It is marked off from the dorsal portion by two

slight notches. The caudate lobule (caudate lobe) has the form of an irregular three-sided pyramid, two of whose surfaces are concave—one for the right kidney, the other for the duodenum. The third surface is convex and in contact with the right lateral lobe. The apex of the caudate lobule is pointed, and falls short of reaching as far as the border of the right lateral lobe. The bridge of hepatic substance spanning the ventral surface of the vena cava, and joining the omental and caudate lobules, is rather thin, but decidedly conspicuous.

From the above description it will be seen that the liver of *Cercocebus* does not depart in any essential point from the mammalian type as laid down by Flower.

Spleen (Pl. III. fig. 5).—The spleen of *Cercocebus* is remarkable in that, in all essentials, it approximates in form to what Cunningham (21) was the first to show is the true configuration of the human organ. Prior to the appearance of Cunningham's paper, His' model had been taken as representing the arrangement of the surfaces on the human spleen; these surfaces agreeing with the *superficies gastrica*, *superficies renalis*, and *superficies phrenica* as indicated in Luschka's (22) description. Cunningham, from observations made upon organs hardened *in situ*, showed that a fourth surface must be added—a "basal surface" or *superficies basalis*. This revolution in the conception of the form of the human spleen is of some importance in the present connection, for we find writers describing the spleen of the apes and monkeys as resembling that of man, inasmuch as there are three surfaces (*cf.* Symington on the "Viscera of a Chimpanzee" (23)). Such a description doubtless arose from two causes—the then accepted notion of the form of the human spleen, and the fact that the viscera of the lower primates had not been hardened *in situ*. That the spleens of the various primates described do resemble that of man is no doubt correct, but the "basal surface" was overlooked in the descriptions. In the paper referred to, Cunningham says that the spleen of the chimpanzee and orang, among anthropoids, is tetrahedral in form; and that in certain of the Cercopithecidae (bonnet monkey and baboon) the same shape obtains. It was, therefore, interesting to find in *Cercocebus* a spleen so clearly resembling that of man. Its diaphragmatic surface is, as was to be expected, the most ex-

tensive and convex. The gastric surface comes next in point of extent, and is markedly concave. It looks cephalwards and, to a less degree, towards the mesial plane. The renal surface, also concave, has not so great a superficial area as has the gastric surface. It looks caudalwards and towards the mesial plane. The basal surface (Cunningham) is the smallest of the four, and is irregularly convex. It is in contact with the small intestine. Of the angles, that forming the apex of the organ is the most acute. The *anterior* (ventral) *basal angle* (Cunningham) is rather rounded; and the *internal* (mesial) *basal angle* (Cunningham) is very poorly developed. The comparative bluntness of the ventral basal angle is of some interest, because Cunningham states that, in the human subject, it appears to be more strongly marked in the foetus than in the adult; and in the figure of the spleen of *Macacus sinicus* which accompanies his paper it is decidedly sharper than in *Cercocebus*.

Of the borders the *margo intermedius* (Luschka) is the least well defined; only at the apex is it sharp and definite. The *margo obtusus* (Luschka) is much more definite. The *margo crenatus* (Luschka)* is convex, and by far the sharpest of the three. The term "crenatus," as applied to it, is only justified by the presence of one notch close to the apex. Comparative freedom from notches appears to be a characteristic of the spleen of anthropoids; and it would appear that some of the primates lower than the Simiidae also share in this peculiarity; though there is evidently much variation in closely allied genera. Parsons (24), for instance, gives a figure of the spleen of *Cercopithecus callitrichus* in which there are three notches. Cunningham's illustration (*Macacus sinicus*), on the other hand, shows no definite notches. The present specimen from *Cercocebus*, therefore, stands in an intermediate position.

The question of the morphological significance of splenic notches is one which does not appear to have been satisfactorily answered as yet. Parsons (24) has directed some attention to the subject, and inclines to the view "that the notches are mere crummings of

* These terms are used, not because they apply in *Cercocebus*, or, indeed, in mammals in general, but because of a reluctance to employ names other than those familiar to the human anatomist.

the spleen due to its growth and to pressure of the surrounding viscera." He further states it as his impression "that the presence of a large vessel makes the spleen less inclined to bulge at that point and, combined with pressure, determines the site of the future notch." This may be so, but one cannot forget that there are variations, both in number and depth, of the notches in spleens taken from the same species of animal, which do not appear to be explained on this view. The spleen of the horse and dog are not generally notched; yet I have seen indentations (certainly not deep, but as certainly definite), in both animals, when the spleen was not larger than usual, nor was there any pathological change. It appears to me that any explanation of the causation of splenic notches must interpret the origin of the abnormal forms of spleen such as have been discussed by Haberer (25). The notches may be continued to such a depth that the spleen is truly lobulated. Fürst (26) has quite recently described a case in the human subject where there were five separate and approximately equal lobes, which collectively reproduced the form of the normal organ. And Helly (27) only a few weeks ago reported upon a human spleen composed of two distinct parts, which, before they were separated, made up a spleen of normal form and size. Each of these parts, it should be noted, was deeply notched; so that there were five lobes in each segment. It seems not too much to ask that an explanation of the normal notches should also account for the exuberance of the indentations in the above-mentioned and similar cases; and that it should also take some cognisance of those accessory spleens which are occasionally so numerous, Albrecht (28) having found a very large number in one case. Fürst thinks that comparative anatomy can throw some light upon these anomalies; and also, we may suppose, upon the normal condition of which the abnormalities appear to be merely excesses. We may certainly expect that any satisfactory answer as to the meaning of the notches in the mammalian spleen will be given by comparative anatomy and embryology combined. The question has been gone into thus fully here because of the difference between the spleen of *Cercocebus* and that of *Lagothrix*, to be presently described.

Kidneys.—The kidneys differ from each other very largely with

regard to position ; the left being much nearer the pelvis than the right. Perhaps this dissimilarity may be best denoted by saying that the caudal extremity of the right lies 45 mm. nearer the head than the corresponding end of the left (fig. 3). The dimensions of

FIG. 3.

the two organs are also different, as is shown in the following table :—

	<i>Right kidney.</i>	<i>Left kidney.</i>
Length . . .	60 mm.	58 mm.
Breadth . . .	37 "	40 "
Thickness . . .	27 "	25 "

The *left kidney* has a flattened dorsal surface, its convexity being only very slight. Its ventral surface is very convex, especially along a line beginning close to the cephalic extremity and running along the surface about its middle to terminate some little distance from the caudal end. The result of the presence of

this blunt ridge is that the ventral surface has three slopes—mesial, lateral, and caudal in position. The mesial and caudal slopes and the caudal part of the lateral slope are in contact with the colon. The remainder of the lateral slope is related to the spleen and pancreas (fig. 3). The lateral (convex) border is comparatively narrow; the mesial border is more rounded. The caudal extremity of this kidney is much larger than the cephalic, which is flattened for the adrenal body.

The *right kidney* is more convex on its dorsal surface than the left; and along this surface is a blunt ridge passing from one end to the other. The ventral surface is very convex, especially in its cephalic half; the rest being more flattened. So much of the lateral border as is in contact with the liver is thick and rounded; but caudal to this the border is much sharper. The mesial border is both straighter and narrower than the corresponding border of the other kidney. There is no great disparity in the size of the two extremities, as is the case in the left kidney. The cephalic end is blunt, rounded, and thick; the caudal end being rounded transversely, but flattened dorso-ventrally.

Adrenals.—There is some dissimilarity in the shape of the two adrenals; but the unlikeness is not nearly so notable as we shall see obtains in *Lagothrix*. The right adrenal fits into an interval circumscribed by the caudate lobule and the right lateral lobe of the liver and the right kidney. It is conical in form, with a concave base—applied to the kidney—and a bluntly pointed apex. The left adrenal is flattened in a dorso-ventral direction. Its apex is much blunter than that of the right, and its base is flat to accommodate itself to the flattened cephalic extremity of the left kidney.

Lagothrix humboldti.

Œsophagus.—As in *Cercocetus*, there is practically no abdominal part of the Œsophagus.

Stomach.—In its external form the stomach of *Lagothrix* is somewhat simpler than that of *Cercocetus*, inasmuch as there is no sharp division into a saccular fundus and a tubular body and pyloric portion. At the same time there is a curious, somewhat saccular diverticulum dorsal to and to the left of the entrance

of the œsophagus, which reminds one very much of the condition of the fundus of the human stomach at the third month of foetal life as figured by Keith and Wood Jones (9); but here it is bent caudalwards and almost at a right angle upon the rest of the stomach. It is a little less in diameter than the immediately adjoining part of the stomach, and is bluntly pointed. Its internal characters also separate it from the rest of the stomach, and ally it with the saccular fundus of *Cercocebus*; for its walls are comparatively thin and smooth, whereas in the major part of the stomach there are conspicuous longitudinal folds of mucous membrane which end abruptly at the entrance to the appendage in much the same manner as did the similar folds in the Old World monkey. It is not without reason, therefore, that one may look upon it as homologous with the fundus of the stomach of *Cercocebus*, and consequently of man. As in *Cercocebus*, here also a microscopic examination would have been of great interest, had it been possible to make one.

The pyloric portion of the stomach, though bent upon itself, does not change its direction so suddenly as in the other monkey dissected; and the constriction, which may possibly demarcate a pyloric canal, is about 40 mm. from the pylorus, and is not very distinct. The pylorus projects into the duodenum, but to a lesser degree than in *Cercocebus*.

Small Intestine.—As in *Cercocebus*, so in *Lagothrix* the duodenum can be divided into two parts; the first of which runs almost straight caudalwards, just to the right of the mesial plane, until it reaches almost to a level with the caudal extremity of the right kidney, and nearly to a level with the opening of the ileum into the cæcum. This portion of the duodenum is about 70 mm. long, and at its termination the intestine turns sharply upon itself and to the left. The second part is shorter than the first, being scarcely 50 mm. in length. It runs cephalwards to the left of the first part; and lies immediately to the left of the mesial plane. It ends by making a fairly sharp turn in a ventral direction, and so becomes continuous with the jejunum. Here, as in *Cercocebus* that part of the small intestine which has no mesentery has been called duodenum; as soon as a mesentery appears the jejunum has been taken to commence.

Measured along the inside of the tube, the common opening of the bile and pancreatic ducts is found to occur 75 mm. from the pylorus, that is, into the second part of the duodenum. Unlike the condition in *Cercocebus*, the jejunum and ileum are exposed as soon as the abdomen is first opened; there being not even the great omentum covering them. Before they are disturbed, they lie in the form of a triangular mass of coils immediately caudal to the transverse colon; the base of the triangle is on the right side (Pl. III. fig. 6). The greater bulk of the small intestine is therefore to the right of the mesial plane.

When the intestine is opened seventeen very prominent Peyer's patches can be counted; but valvulæ conniventes are absent.

Cæcum.—In no part of the intestinal canal is the difference between *Cercocebus* and *Lagothrix* more marked than in the cæcum. In *Lagothrix* it is in the form of a wide bent tube, some 120 mm. in length, which forms a prominent object when the abdominal wall is first removed. It lies immediately caudal to the triangular mass of small intestine, and may be said to form one of the sides of the triangle. Traced from the termination of the ileum, there is first a short portion directed obliquely caudalwards. Upon this the main part of the cæcum is bent at an acute angle, and runs obliquely cephalwards and to the left until it almost reaches the left abdominal wall. The terminal 50 mm. or so is abruptly recurved upon the main portion of the cæcum, and so it comes to lie dorsal and slightly caudal to it. This apical recurvature is permanent, that is, the two pieces of the cæcum are bound together by the peritoneum passing from one to the other.*

In no part of the cæcum are there even faint indications of sacculations; nor is there, in spite of its great length and considerable volume, any attempt at the formation of a mesocæcum, so that it is free to make certain excursions from the position in which it is seen in the specimen at present described. Its lesser curvature is dorsal in position, and the bend of the recurved apical segment is merely an exaggeration of it.

The ileo-cæcal opening is oval in outline, with its long axis

* This apical recurvature is apparently common in those Celidæ which have a long cæcum. It is present in *Ateles* and *Nyctipithecus*; but in *Cebus*, where the cæcum is short and simple, it does not obtain.

transverse to the long axis of the gut. The two segments of the valve are about equal in development, and the fræna are very conspicuous and run round the entire circumference of the intestine. Corresponding to the fræna is a marked frænal furrow on the outside of the tube which also completes a circle (Pl. III. fig. 6, *a*). There is therefore, both internally and externally, very clear indication of the limits of the cæcum and the colon. A short distance caudal to the ileo-cæcal opening there is another fold of mucous membrane (in the position marked *b* in Pl. III. fig. 6), which is confined to the lesser curvature, and whose presence makes the cæcum appear to be divided into two compartments, a lesser to the right, and a greater to the left of the fold. The question is probably in no wise worth raising, but one is led to ask if, by any possibility, this fold can in any way be considered as representing that semilunar fold of mucous membrane which was long ago described by Gerlach (29) as guarding the entrance to the vermiform appendix in man. I am aware that Berry (30) and other anatomists are of opinion that Gerlach's valve is inconstant and of no importance. It is perhaps carrying surmise too far, but the large size of the cæcum in *Lagothrix*, and its relatively small dimensions in the higher primates, leads to the thought of the possibility, at least, that the greater part of the cæcum here represents the vermiform appendix of man, and that the limit of such a representative may be indicated by this particular fold of mucous membrane. That the fold occurs where there is a kink in the intestine would remove any possibility of its having a morphological significance were its dimensions entirely accounted for by the kink; which they are not. Possibly further investigation will either explain the meaning of the fold, or show that its occurrence is purely accidental.

Colon.—The colon of *Lagothrix* is arranged so much like that of man that the terms in use in human anatomy may very well be employed in its description. The *ascending colon* is a wide tube with a diameter equal to that of the cæcum. In its progress cephalwards to the liver, it forms a gentle curve whose convexity looks to the right (*i.e.*, it follows the concavity of the abdominal wall). At the same time there is another less marked curve, the concavity of which looks ventralwards. The actual lesser curvature

of the ascending colon, to which the mesocolon is attached, is mesial in position. There are several sacculations on this part of the large intestine, but none of them is well marked.

The *hepatic flexure* is fairly abrupt, the intestine turning first towards the mesial plane, and then ventralwards. The *transverse colon* is a little longer, but somewhat narrower, than the ascending colon, its length being 100 mm. as against 80 mm. for the initial part of the colon. It is in the form of a U-shaped tube: or perhaps it would be better to say that it is V-shaped, with the angle of the V rounded off and forming the most ventral part of this portion of the intestine. The greater curvature being directed ventralwards and inclining a little towards the pelvis, the most pronounced part of the bend is visible, caudal to the liver, as soon as the abdomen is opened (Pl. III. fig. 6, TC). The concavity of the transverse colon is in contact with the lesser curvature of the stomach. The sacculations on this length of the intestine are only very faint. The *splenic flexure* occupies a position a little more caudal than that of the hepatic flexure, and it is not so abrupt as the previous bend of the colon. It is lodged in the angle formed by the spleen and the stomach. The *descending colon* is curved in a manner similar to that of the ascending colon. It is narrower than the part immediately preceding it, especially in its more caudal part; and its sacculations are well marked. In the formation of the *sigmoid flexure* the colon alters its direction in the following manner. It first runs ventralwards and to the right. Having arrived just to the right of the mesial plane, it turns cephalwards and towards the dorsum of the body. Then there is a sudden swerve to the left, leading to the last part of the flexure, which runs caudalwards to the entrance to the pelvis, dorsal to the first.

On the ascending colon there are three, not very distinct, longitudinal bands. One of these is placed along the greater curvature, and, therefore, lies to the right, *i.e.*, it is lateral in position. The second is ventral, and the third is dorsal. None of these bands can be followed on to the cæcum; but they can all be traced for variable distances on to the other parts of the colon. Of the three, the lateral band passes for the greatest distance. It is continued along the transverse and descending colon, and only fails at the last turn of the sigmoid flexure. The ventral band can be

followed as far as the commencement of the sigmoid flexure, but on the descending colon it is far from being distinct. The dorsal band of the ascending colon is found to disappear at the splenic flexure, and so is the shortest of the three.

Liver.—It is a matter for regret that the liver of this animal is pathologically enlarged; and, consequently, that some of its special features may have been modified or exaggerated. But the enlargement does not appear to have been great; nor has it produced any distortion. It appears to have been perfectly uniform. This last fact leads one to suppose that a normal liver of *Lagothrix* would show the same characteristics, but possibly in a lesser degree. The enlargement, no doubt, accounts, in a measure, for the considerable area of liver which is visible on first removing the wall of the abdomen. But this circumstance is, I think, largely contributed to by the flatness of the arch of the diaphragm as compared with that of *Cercocebus*. There is a much greater volume of liver to the right of the falciform ligament than to its left.

The measurements of this liver are as follows:—

Greatest transverse diameter	= 104 mm.
„ dorso-ventral „	= 75 „
„ cephalo-caudal „	= 100 „

The actual figures are not of so much interest as is the relation between the transverse and dorso-ventral diameters, and the comparison of this relation with that of the same two diameters in *Cercocebus*. In *Lagothrix* the transverse measurement is much greater than the dorso-ventral. In *Cercocebus* the difference is not nearly so great—it only amounts to 5 mm. Since the liver in both animals stretches right across the abdomen, its measurements give us some idea (not absolutely accurate, no doubt, but still suggestive) of the form of the cephalic part of the abdomen. It is, therefore, evident that in *Lagothrix*, though a New World monkey, the abdomen resembles that of man in shape more closely than does the same cavity in *Cercocebus*; in spite of the fact that the latter animal is placed higher in the zoological scale (*cf.* the outlines given in figs. 1 and 4). This point is not here strongly insisted upon, because it may be objected that the dimensions of the liver do not necessarily afford an absolutely safe guide to the

form of the abdomen; but it was thought desirable to call attention to it as relating to the observations of Keith (11) and Ruge (13) on the change which has taken place in the form of the trunk, and the alteration of the ratio of its various diameters, in primates.

The same three surfaces as were distinguished in the liver of *Cercocebus* are to be made out in *Lagothrix*. It is a matter of some importance to notice that the area, devoid of a peritoneal investment, is much smaller in *Lagothrix* than in *Cercocebus* (cf. figs. 1 and 4). Whether the particular specimen of *Cercocebus* which I examined has an unusually large bare area or not, I

FIG. 4.

cannot say. But the point is of moment in view of Keith's statement (11) regarding the comparative straightness of the line of attachment of the dorsal mesentery to the liver of pronograde monkeys, and its relation to the presence of well-defined lobes in these animals.

All the fissures of the liver (with the exception of the umbilical) are much more complete than in *Cercocebus*, and this may be associated with the difference in the lines of reflection of the peritoneum to which attention has just been directed. Both right and left lateral fissures reach the neighbourhood of the vena cava on the cephalic surface (fig. 4), and to the portal fissure on

the visceral surface. The umbilical fissure extends across the visceral surface from the region of the portal fissure, cuts the margo acutus, and passes for a short distance on to the ventro-lateral surface. Because of the extensive overlapping of the right central by the left central lobe, the gall-bladder appears to lie in a part of the umbilical fissure.

There is a linear indentation—it can scarcely be called a fissure in the usual acceptance of the term—crossing the right central lobe from the cystic fossa to the right lateral fissure; and a

FIG. 5.

corresponding indentation, at the same level, cutting the surface of the left central lobe from the umbilical fissure to the left lateral fissure. Perhaps these may be considered as homologous with the groove in the liver of *Cercocebus*, which has been already compared with Thomson's fissure "f" (20). The fact that these grooves are present in a position corresponding to the angle formed by the cephalic and ventro-lateral surfaces, may possibly account for their presence. They may be due to the curving of the liver upon itself. If so, their morphologic status is only subsidiary.

Because of the greater completeness of the fissures, all the lobes

of the liver of *Lagothrix* are more distinct than those of *Cercocebus*. The right lateral lobe is the largest; the central lobes, taken together, come next in point of size; the left lateral lobe is comparatively small (figs. 4 and 5). The most striking feature is the form and development of the caval lobe. Its omental lobule is not in any way remarkable. It resembles the same lobule in *Cercocebus*, except that there is no distinction into a dorsal and a ventral part, and there is no pointed projection. It has a tongue-shaped tuber papillare which is in relation to the lesser curvature of the stomach. It is to the caudate lobule that the liver of *Lagothrix* largely owes its peculiarity of form. This is so large that it extends for some distance beyond the margin of the right lateral lobe, and is extensively related with the diaphragm. A considerable area of it is visible when the liver is viewed from the cephalic aspect (figs. 4 and 5); and it is in cases such as this that a special term is required to designate the fissure between the caval and right lateral lobes. The name of *right dorso-lateral fissure* has been suggested in an earlier part of this paper. It is probable that the large size of the caudate lobule is in some degree due to the pathological change which has affected the whole organ; but there seems no reason for thinking that under normal conditions the lobule would not be relatively very large. The bridge of liver substance, crossing the vena cava ventrally and uniting the omental and caudate lobules, is thick and very evident.

Spleen.—At the first glance, the spleen of *Lagothrix* appears so different from that of *Cercocebus*, that a recognition of four surfaces seems to offer a task of great difficulty. It is very much elongated and flattened (Pl. III. fig. 7), and reminds one of the spleen as seen in many Carnivora. It is closely applied to the parietes of the abdomen, and is, therefore, curved in conformity with the curve of the abdominal wall. And, having its dorsal extremity close to the vertebral column, the curve is extremely pronounced in the region of the apex. Tracing its curve from the apex, the spleen first runs dorsalwards; then it forms a short sweep to the left; after which the major part of the organ runs ventralwards with a certain amount of inclination towards the pelvis. The most ventral angle is exposed on opening the abdomen.*

* The spleen struck one as being of larger size than was to be expected.

A more careful examination reveals the tetrahedral shape; the only surface which is in any way ill-defined is the basal. The phrenic surface (*superficies phrenica*) is by far the most extensive, almost equalling in area the combined gastric and renal surfaces, because of the flatness of the whole spleen. Strictly speaking, the term "phrenic" does not apply to the most ventral part of the surface, since it is in relation to the abdominal wall, and not to the diaphragm. The gastric surface (*superficies gastrica*) is deeply concave, and, in point of area, comes next to the phrenic surface. The renal surface (*superficies renalis*) is also very concave. Except where it is separated from the phrenic surface, the basal surface (*superficies basalis*) has no definite boundaries; but it may be distinguished from the adjacent gastric and renal surfaces by its irregularly convex character. It is related to the splenic flexure of the colon.

The margo intermedius is very obtuse, and has the hilum running along it. Both the margo crenatus and the margo obtusus are thin and sharp. The former carries two notches; the latter, one (Pl. III. fig. 7). It seems highly probable that in all mammals, crenations, when they do occur, are more likely to be found on thin borders than on thick ones. And this apparently applies also to those cases where notches appear in spleens usually free from them. In an earlier paragraph it has been stated that notches are now and then observed on the spleen of the horse. When this is the case, the notches are invariably on the thinnest border—that corresponding to the margo obtusus of man. So far as memory serves, I should say that notches on the spleen of the dog occur indifferently on either of the two thin borders, as they do in this particular specimen of *Lagothrix*.

The apex of the spleen of *Lagothrix* is obtuse. The only other angle which is at all distinct is the anterior (ventral) basal angle. The internal (mesial) basal angle is indistinguishable, and its position can only be determined upon by observing the point of junction of the gastric, renal, and basal surfaces.

It is possible that the pathological change in the liver may have "told back" upon the spleen, and so have produced some increase in size from venous engorgement, though this was not suggested to the naked eye. Microscopic sections were not made.

Kidneys.—The kidneys are placed at approximately the same level; the caudal extremity of the left being only about 5 mm. nearer the pelvis than the same extremity of the right. It seems not unreasonable to account for the more caudal position of the right kidney of *Lagothrix*, as compared with *Cercocebus*, as being due to the large size of the caudate lobule of the liver. The dimensions of the kidneys are as follows:—

	Right Kidney.	Left Kidney.
Length . . .	71 mm.	65 mm.
Breadth . . .	35 „	34 „
Thickness . . .	25 „	25 „

The kidneys of *Lagothrix* being not unlike those of *Cercocebus* in form, it will suffice to point out in what particulars they mostly differ from the same structures in the latter animal. The left is not so broad, but it is decidedly longer, and its extremities are almost alike. The right is also slightly longer and a little narrower than in *Cercocebus*. So that it will be seen that the two kidneys in *Lagothrix* resemble each other very closely in form, and both have a shape not unlike that of the right kidney of *Cercocebus*.

Adrenals.—The right adrenal has an extraordinary shape. It is much elongated, and fits into a cranny formed by the caudate lobule of the liver, the vena cava, and the diaphragm. (See its surface of contact with the liver shown in fig. 5.) It may again be asked if the large size of the caudate lobule is a factor in the production of this curious feature. The left adrenal only differs from that of *Cercocebus* in being somewhat less flattened in a dorso-ventral direction. It is not placed quite on the extreme cephalic extremity of the kidney, but rather more mesially than in *Cercocebus*.

Comparison of the Length of the Intestine with the Length of the Body.

Noë (31) has recently suggested the substitution of another method for the time-honoured plan of comparing the length of the intestine with the length of the body. He compares the length of the intestine, measured from the pylorus to the anus, with the *weight* of the body, and so obtains a “coefficient” expressed in metres per kilogramme. His observations were conducted with a view to contradicting the classical assertion that the character of

the food governs the intestinal length, and with a desire to show that the weight of the body is of primary importance in this connection. And certainly his tables show that, as the weight of the body increases, the "coefficient" diminishes, independently of the kind of animal. But still more recently (at the beginning of the present year) Lapique (32) has pointed out objections to Noë's method, and shown that the older practice is more satisfactory. Therefore the classic plan will be followed here.

In *Cercocebus* the measurements of the intestine are as follows :—

Duodenum . . .	=	90 mm.
Jejunum and Ileum	=	2860 „
Cæcum . . .	=	50 „
Colon . . .	=	850 „
* Rectum . . .	=	110 „
		<hr/>
		3960 mm.

The length of the body, measured in a straight line from the vertex of the head to the root of the tail, = 600 mm.

$$600 : 3960 :: 1 : 6.6$$

That is, the length of the intestine is 6.6 times the length of the body.

In *Lagothrix* the length of the intestine is :—

Duodenum . . .	=	120 mm.
Jejunum and Ileum	=	1820 „
Cæcum . . .	=	120 „
Colon . . .	=	410 „
* Rectum . . .	=	65 „
		<hr/>
		2535 mm.

The length of the body, measured as in *Cercocebus*, is 500 mm.

$$500 : 2535 :: 1 : 5.07$$

The length of the intestine is, therefore, about five times the length of the body.

* The length of the rectum was obtained by measuring, with calipers, the distance from the pelvic inlet to the anus. This was done because it was desired to leave the pelvic viscera undisturbed. There seems little reason to doubt that this method gives results sufficiently accurate for the present purposes of comparison. In both *Lagothrix* and *Cercocebus* the rectum, so far as can be seen, runs straight between the two points from which the measurements were taken.

In both animals the ratio is well within the extremes which have been noted in various primates. For, so far as can be gathered from different papers on the anatomy of different primates, the intestinal length varies from four to eight times the body length. It is difficult to compare the figures of the different writers, because the length of the body is not always measured in the same way. It would be infinitely better if some fixed method were adopted; and it seems more rational to take the length of the trunk without the inclusion of the limbs, which are capable of different degrees of straightening in various species.

Arrangement of the Peritoneum.

In bodies hardened by the injection of formol the arrangement of the peritoneum is much more easily followed than in those examined in the natural condition. Bearing in mind the fact that the peritoneum is not infrequently differently disposed in animals with close zoological affinities, and finding that Klaatsch (33), in his extensive memoir, does not devote much space to either the Cebidæ or the Cercopithecidæ, a very careful examination of *Cercocetus* and *Lagothrix* was made. And the result was found to justify the trouble taken, since certain particulars of much interest were revealed.

The arrangement of the peritoneum in *Cercocetus* will be described first. The great omentum is exceedingly well developed in this animal. It covers the whole intestinal mass very loosely, extending even for a short distance into the pelvis. There is no difficulty in resolving it into a dorsal and a ventral layer until one arrives at a sagittal plane a little to the right of the duodenum. To the right of this plane two layers cannot be distinguished. On the left side of the abdomen, its margin is free until the spleen is reached. Here the usual attachment is observed. But on the right side of the abdomen there is a line of attachment to the dorsal abdominal wall, to the right of the ascending colon, extending caudalwards almost as far as the iliac fossa. Here, as just said, the two layers of the omentum cannot be demonstrated. When this line of attachment is traced cephalwards, it divides into two immediately to the right of the duodenum, and in the

vicinity of the hepatic flexure of the colon. That is to say, the dorsal and ventral layers of the omentum separate at this point. The ventral layer has its line of attachment crossing the duodenum obliquely to gain the greater curvature of the stomach, along which it is continued as far as the notch separating the saccular fundus from the tubular body. Then, as stated in an early part of this paper, it forsakes the curvature and crosses the caudal surface of the fundus obliquely, to ultimately reach the spleen. The dorsal layer of the omentum soon becomes confounded with the mesocolon, as will be explained later.

There is nothing remarkable about the gastro-hepatic omentum. The duodenum has no trace of mesentery, its fixation being very complete. The mesentery has a narrow root on a level with the termination of the duodenum. When it is traced to the termination of the ileum, it is found to become attached along the lesser curvature of the ascending colon as far as the hepatic flexure, where it is continuous with the mesocolon. Except for a small triangular fold of peritoneum which joins its lesser curvature to the ileum, the cæcum is entirely surrounded by peritoneum. The ascending colon has no mesocolon; its dorsal surface being nearly entirely devoid of peritoneal investment, as it is in man. The arrangement of the peritoneum with regard to this part of the colon will perhaps be best understood from an examination of the diagram given in fig. 6. All the other parts of the colon have a very well developed mesocolon; this being especially the case in connection with those parts which have been earlier referred to as A and B. It is easier to trace the parietal line of attachment of the mesocolon from the point where it is continuous with the mesorectum. If this is done, the line is found to be at first in the mesial plane. Then, passing cephalwards, it deviates to the left, and so comes to cross the ventral surface of the left kidney. Then it turns over towards the right, and a union of the mesocolon and the dorsal layer of the great omentum begins. This union is very slight on the left side of the abdomen; but it becomes gradually greater as the two structures are followed to the right. At the hepatic flexure the two abruptly separate; the mesocolon to become continuous with the mesentery which is attached to the lesser curvature of the ascending colon; the dorsal layer

of the great omentum to become blended with the ventral layer.

From the above it will be seen that, though there is some approximation to the condition as found in man, both mesentery and mesocolon have retained much of their primitive disposition. The attachment of the great omentum along the right side of the dorsal abdominal wall appears to be altogether peculiar.

In *Lagothrix* the condition of affairs is not so involved as it is

FIG. 6.

in *Cercocebus*. At the same time it is important to notice that, comparatively low though *Lagothrix* is among primates, the human arrangement is approximated in connection with the ascending colon. In this animal the great omentum is very short, and presents little of interest, except that it practically does not exist in connection with the extreme right of the stomach. What little there is of it is tucked up into the interval circumscribed by the stomach, the spleen, and the splenic flexure of the colon ; so that,

when the abdomen is opened, there is nothing hiding the intestines (Pl. III. fig. 6). The duodenum is as devoid of mesentery, and as firmly fixed to the abdominal parietes, as it is in *Cercocebus*. This is apparently an advance upon the state in the other Cebidæ; for Klaatsch states that the duodenum of *Mycetes* is more firmly fixed than in *Cebus*; and in *Lagothrix* it is evident that it is even more adherent than in *Mycetes*.

The mesentery has a narrow root, as in *Cercocebus*, and does not present any notable feature. As already stated, the cæcum is completely covered by peritoneum. The ascending colon, the hepatic flexure, and the right part of the transverse colon have only an exceedingly rudimentary mesocolon; the peritoneum being reflected from their dorsal face on to the duodenum and the greater curvature of the stomach. The left part of the transverse colon, the descending colon, and the sigmoid flexure have a long mesocolon, especially the sigmoid flexure. The line of attachment of the mesocolon to the dorsal wall of the abdomen is a little to the left of the mesial plane. It runs in an oblique direction, becoming gradually nearer to the mesial plane as it is followed towards the pelvis, and finally reaches that plane at the termination of the colon.

It is evident that the arrangement of the peritoneum is very variable in the Cebidæ. I have examined *Cebus capucinus*, *Ateles ater*, and *Nyctipithecus trivirgatus*, and in all of them I find certain differences in the degree of fixation of the duodenum, the amount of blending of the mesocolon and the great omentum, and the development of the mesocolon in connection with the ascending colon. It seems undoubted that, as Klaatsch asserts, more than one type of arrangement obtains among the members of the family; and that *Mycetes*, *Ateles*, and *Lagothrix* follow a different line from that instanced in *Cebus*.

EXPLANATION OF FIGURES.

Pl. I. fig. 1. *Cercocebus fuliginosus*.—Stomach as seen from the cephalic aspect. F., fundus; O., œsophagus; p.c., pyloric canal; p., pylorus; g.o., line of attachment of the great omentum; g.h.o. line of attachment of the gastro-hepatic omentum. All above the xxxxx line (in the fig.) is not in contact with the liver.

Pl. I. fig. 2. *Cercocebus fuliginosus*.—To show the viscera exposed when the abdomen is opened and the great omentum removed. L., liver; A, B, C, and D, parts of the colon referred to by these letters in the text; Il., ileum; Cæ., cæcum; l.g., lymphatic gland. The mesocolon—to the right of the figure—covers the small intestine.

Pl. II. fig. 3. *Cercocebus fuliginosus*.—The abdominal viscera exposed by removal of parts A and B of the colon and the greater part of the mesocolon. A.C., ascending colon; S.I. small intestine. Other letters as in Pl. I. fig. 2.

Pl. II. fig. 4. *Cercocebus fuliginosus*.—Parts C and D of the colon and their connections as seen from the ventral aspect. The dotted line shows the course of the curves not visible from this point of view. †, a narrow part of the colon referred to in the text.

Pl. III. fig. 5. *Cercocebus fuliginosus*.—Spleen. s.g., superficies gastrica; s.r., superficies renalis; s.b., superficies basalis; a.b.a., anterior (ventral) basal angle; i.b.a., internal (mesial) basal angle; h., hilum; pan., area for pancreas.

Pl. III. fig. 6. *Lagothrix humboldti*.—The abdominal viscera as exposed on removal of the walls of the abdomen. L., liver; f.l., falciform ligament; T.C., transverse colon; Sp., spleen; S.I., small intestine; A.C., ascending colon; a, frænal furrow (position of ileo-cæcal orifice); b, position of mucous fold in cæcum referred to in the text; D.C., descending colon; Cæ., cæcum; s.f., sigmoid flexure; u.b., urinary bladder.

Pl. III. fig. 7. *Lagothrix humboldti*.—Spleen. The same lettering is used as in Pl. III. fig. 5, with the addition of s.p., superficies phrenica.

Fig. 1. *Cercocebus fuliginosus*.—Cephalic view of the liver.

Fig. 2. *Cercocebus fuliginosus*.—Visceral surface of the liver. Letters common to figs. 1 and 2:—R.C., right central lobe; L.C., left central lobe; L.L., left lateral lobe; R.L., right lateral lobe; om. lob., omental lobule; caud. lob., caudate lobule; u.f., umbilical fissure; r.l.f., right lateral fissure; l.l.f., left lateral fissure; v.c., vena cava; fal. lig., falciform ligament; pan., area for pancreas; rt. ad., area for right adrenal; rt. kid., area for right kidney; duod., area for duodenum; pyl., position of the pylorus; s., area for the stomach.

The gall-bladder and the portal fissure are shown in solid black.

The dotted area has no peritoneal covering.

The surface of the right lateral lobe, not accounted for in fig. 2, is related to the ascending colon. The visceral surface of the

FIG. 2.
Abdominal Viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*.—Plate I.

FIG. 1.
Abdominal Viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*.—Plate I.

Prof. O. CHARNOCK BRADLEY.

FIG. 4.

FIG. 3.

Abdominal Viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*.—Plate II.

Prof. O. CHARNOCK BRADLEY.

FIG. 6.
Abdominal Viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*.—Plate III.

FIG. 5.

FIG. 7.
Abdominal Viscera of *Cercocebus fuliginosus* and *Lagothrix humboldti*.—Plate III.

right central, left central, and left lateral lobes, not in contact with the stomach, is related to the small intestine.

Fig. 3. *Cercocebus fuliginosus*.—Outlines of the kidneys to show their relative position in the abdomen. Liv., area for liver; pan., area for pancreas; Duo., area for duodenum; A.C., area for the ascending colon; Sp., area for spleen; Col., area for colon; R. Adr. and L. Adr., outlines of the right and left adrenals.

Fig. 4. *Lagothrix humboldti*.—Outline of liver as seen from the cephalic aspect.

Fig. 5. *Lagothrix humboldti*.—Outline of the liver as seen from the visceral surface.

The same lettering is used as in figs. 1 and 2, with the addition of:—*p.*, line of attachment of peritoneum; *r. d-l.f.*, right dorso-lateral fissure.

The colon is related to that part of the visceral surface not accounted for in fig. 5.

Fig. 6. *Cercocebus fuliginosus*.—Diagrammatic transverse section through the abdomen to illustrate the arrangement of the peritoneum.

A., part of the colon referred to as A in the text; A.C., ascending colon; S.I., small intestine; R.K., right kidney; L.K., left kidney; 1, great omentum; 2, mesocolon; 3, mesentery.

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