CONTRIBUTIONS TO OUR KNOWLEDGE OF THE ANATOMY OF LEMUROIDEA

Part VI. Digestive System of Loris lydekkerianus

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Introduction

Comparative anatomists have contributed much to our knowledge of the anatomy of the digestive system of Lemurs. Hunter's observations on the subject, though of a general nature, are valuable. Owen has given an admirable account of the alimentary system of the Lemurs from the view-point of comparative anatomy. Whilst Beddard and Mitchell have mainly confined their attention to the form and blood supply of the alimentary canal, Wood Jones and Le Gros Clark have studied the structural features of the digestive tract as part of a wider problem, namely, the affinity of Lemurs to other primates. However, there is a paucity of information about the anatomy of the Prosimian Loris lydekkerianus, an inhabitant of the Southern India. In this communication we propose to offer an account of the digestive system of Loris lydekkerianus. Although this communication is chiefly confined to a description of the gastro-intestinal tract, a brief account of the external features of the mouth region is included. The following description is based on the dissection of four formalin preserved specimens.

External Features of the Mouth Region

The head of Loris lydekkerianus is more or less spherical, but the short snout protrudes anteriorly and inclines antero-posteriorly giving it a slightly drawn out appearance. The head and face are covered with soft hair. The hairy coat on the head and circum-orbital region is black; the upper part of the nasal bridge between the orbits, the lateral aspect of the snout and the ventral aspect of the lower jaw are covered by soft white hair; the circum-oral region is covered sparsely with short white hair. A few hair on the upper lip tend to be slightly longer. There is a row of well-developed vibrissae on either side of the lateral aspect of the nose about 7-8 mm. behind

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the anterior openings of the nares. In *Loris*, the upper lip does not bear any vibrissae.

The openings of the anterior nares, each of which has the shape of an inverted comma, are placed on the most anterior part of the snout and are 6 mm. apart. Between them is a shallow depression which extends upward to the nose for a short distance; a groove from the centre of the depression continues downward to the upper lip. It may be noted that the rhinarium is relatively limited, for the skin over the depression and over a narrow strip around the nostrils is smooth and devoid of hair, and this region has been observed to be moist in the living animal.

The gape of the mouth in *Loris* is large. The angle of the mouth very nearly reaches the vertical plane passing through the lateral angle of the eye. The lips appear to be moderately muscular. The red margin of the lower lip is well seen whereas that of the upper lip becomes visible only on slightly evertting the lip. The vertical grooves on the lower lip give it a striated appearance in preserved specimens; these grooves which are prominent towards the angle of the mouth, are absent for a distance of about 5 mm. on either side of the middle line of the lip.

The upper lip is bifid at its margin which fuses with the gum in the mid-line so that this part of the vestibule stops short on either side. The external surface of the upper lip is as noted above marked by a median deep groove in continuation of which is the stout frenulum, binding the lip to the underlying gum. The skin on the upper half of the groove and on an area about a millimetre on either side of it, is hairless and forms the labial part of the rhinarium, whereas that on the lower half of the groove is covered with very fine hair. Whereas in the Lemuroidea the primitive mammalian type of rhinarium persists, in *Loris lydekkerianus* the maxillary processes from which the lateral hairy parts of the upper lip are formed have met each other about the free margin of the lip and the median nasal process representing the labial part of the rhinarium has sunk into a deep groove as in *Galago* (Le Gros Clark62). With this partial labial contribution the rhinarium in this animal may be said to be regressive. Thus it may be stated that *Loris lydekkerianus* is more primitive than *Tarsius*7 in which there is no labial contribution to the rhinarium.

**Oral Cavity**

The following structures, namely, the teeth, the tongue, the palate and the fauces with tonsil are described under this heading. The salivary glands which pour their secretion into the mouth are described along with the other larger glands associated with the digestive tract.
The Teeth

It is not proposed in this paper to describe in detail the dental characters. The dental formula in *Loris* is as follows:

I. C. PM. M.
2, 1, 3, 3

The teeth, especially the incisors, however, are in the form of a comb and are adapted to hair combing function as pointed out amongst many others by Geoffroy and Cuvier, and Gregory.

The Tongue

The tongue (Fig. 1) is a tapering muscular structure and in the formalin preserved specimens, the dorsal surface of the tongue shows the impressions of the palatal ridges. It is nearly 3 cm. long and 1 cm. wide at the level of the anterior pillars of the fauces.

A shallow median groove runs antero-posteriorly on the dorsum of the tongue (Fig. 1 A). Numerous papillae cover the dorsal surface. The nature and density of distribution of different types of papillae vary in the oral and pharyngeal regions of the tongue. On the oral part short filiform papillae are most numerous while fungiform papillae are fewer; the latter are uniformly distributed among the filiform papillae all over the dorsum of the oral part. The dorsum of the pharyngeal part which forms the posterior fourth of the tongue is relatively smooth; fungiform papillae are few in number and are confined to the anterior portion of the pharyngeal part; the filiform papillae, though limited in number, are taller, more robust and are confined to the lateral aspect of the dorsal surface; few small nodular
elevations are seen in the central part of the dorsum of the pharyngeal part of the tongue. The circumvallate papillae are only three in number and are situated at the junctional zone between the pharyngeal and oral parts. These are arranged in the form of the letter V whose apex points posteriorly. These papillae, which are large in size measuring about one mm. in diameter, are slightly elevated above the general surface and are, as usual, surrounded by a trench. Neither a Sulcus terminalis nor a foramen cæcum is present. Posteriorly a well-developed median glosso-epiglottic fold connects the tongue with the anterior surface of the epiglottis.

The smooth inferior surface of the tongue is traversed by a median groove. The frenulum linguae, arising from the posterior part of the median groove, attaches the tongue to the sub-lingua; and anteriorly, the tongue is free from attachment to the extent of one centimetre. The lytta of the tongue is absent in Loris.

The sub-lingua (Figs. 1 B and 2) which is a tongue-shaped structure is well developed in Loris; it is hard in consistency as it contains a plate of

![Diagram](image)

Fig. 2. Diagrammatic representation of the tongue, sub-lingua and frenel lamella. Fr. L., Frenel lamella; S. L., Sub-lingua; T., Tongue.

hyaline cartilage. It measures one centimetre in length and 0.7 centimetre in width. The apex and the anterior half of the lateral borders, are serrated; at the apex the serrations are so deep and the denticles are so prominent as to give rise to a comb-like appearance. This feature, as stated by Wood Jones and others, is associated with the peculiar specialisation of the lower anterior teeth and is “an expression of its use as a rake for cleaning these toilet teeth” after the hair-combing operation is over. The upper surface of the sub-lingua is traversed by a longitudinal ridge in continuation of the attachment of the frenel linguae; and on the under-surface there is a well-developed ridge which forms the lytta of the sub-lingua as in Nycticebus; but the lytta differs from that of Potto in not being bifurcated posteriorly. The frenel lamella (Fig. 2) which is attached to the under-surface of the sub-lingua posteriorly, is a soft triangular structure. It extends posteriorly as far as the posterior border of the last molar tooth and anteriorly reaches the level of the second premolar. Its apex and anterior half of the lateral border are slightly serrated. The anterior 1/3 of the
frenal lamella is split in the mid-line, on either side of the cleft in the frenal lamellar tissue, which is traversed by the terminal part of the duct of the submaxillary gland.

The important anatomical features of the lingual region of *Loris lydekkerianus* are as follows:—

1. It is only the dorsum of the tongue that is papillated; filiform papillae are short, and more numerous anteriorly whilst they are fewer but more robust posteriorly; fungiform papillae are practically confined to the anterior region; the circumvallate papillae are three in number and are arranged in the form of a "V".

2. The lateral organs and lytta of the tongue are absent.

3. The sub-lingua is denticulated with a lytta on its under-surface and contains hyaline cartilage in its substance.

4. A frenal lamella with a serrated border is present.

Thus it can be stated that these features of *Loris lydekkerianus* conform to the conditions obtaining in *Loris gracilis*, *Nyctecebus*, *Potto* and *Galago* and differ from those in *Tarsius* and other *Lemurs*.10a

*The Palate*

In formalin-preserved specimens the palate is 3 cm. long and 1 cm. wide in its broadest part. It is somewhat oval in shape being broad in the middle and narrow both anteriorly and posteriorly. The hard palate (Fig. 3)

![Fig. 3. Diagram of the hard and soft palate. (On the posterior border of the soft palate the semifused nodule, described in the text, can be seen.)](image)

is about 2 cm. long. On its most anterior part just behind the alveolar margin can be seen two tiny openings of the naso-palatine ducts, one on either side of the middle line. The hard palate is traversed by seven transverse ridges which run in an arched manner from one alveolar margin to
the other; the convexity of the arches is always directed anteriorly. The anterior three arches are complete, whilst the posterior ones are made up of bilaterally placed halves which meet in the median line. These palatal ridges are almost invariably present in all mammals excepting some of the higher anthropoids and man but they are varied in number and form. They are present in *Tarsius*; in the Chimpanzee there are eleven arches and none of them forms a complete arch; in Aye Aye, of the seven arches present, the anterior three are complete and the posterior four arches incomplete. *Potto* has five arches and *Galago* possesses eight to nine. As suggested by Owen the palatal ridges when present serve to produce a roughness and aid the tongue in retaining the food in the mouth.

The posterior part known as soft palate is musculo-membranous and measures about one cm. antero-posteriorly. The anterior two-thirds of the soft palate is thicker than the posterior third. The soft palate ends posteriorly in a rounded arched border whose concavity is directed posteriorly. In two of the specimens, at the middle of the border, two discrete nodular swellings were noticed (Fig. 3); in one of them not only were these nodules fused but they were projected posteriorly, dividing the posterior border into two concave arches and thus giving rise to a condition nearly resembling that of the human subject. Owen records that "the uvula is represented in the Aye Aye and some other Lumuridae by a median longitudinal ridge arising from the back of the soft palate close to its margin but not projecting so as to divide the fauces into two arches. The same author remarks that the latter type of soft palate and uvula begins to appear in Platyrhines and Baboons, and in the apes it assumes almost the proportion of the human soft palate.

The nature of the soft palate has been elucidated recently by Wood Jones: According to him the soft palate is a partition between the nasal cavity and the pharynx, allowing communication between these by nasopharyngeal hiatus and its concave posterior border fits to the anterior surface of epiglottis; this border contains in its substance glandular tissue. With the development of constant vocalisation the nasopalatine hiatus becomes bigger and concomitantly the glandular substance aggregates in the middle line to form the uvula, which apparently is not associated with vocal function. In *Loris lydekkerianus* the presence of nodular swellings in the centre of the posterior border of the soft palate in two out of the four specimens examined, and the projection posteriorly of a semifused nodule in one of them suggest a tendency for the formation of an incipient uvula with a bilateral concave border of the soft palate. This curious feature is difficult to explain in view of the fact that there is no constant vocalisation in this animal.
The Fauces

The anterior and posterior pillars of the fauces enclose between them the tonsillar fossa (Fig. 4). The anterior pillar is well marked whereas the posterior one is not so well defined and appears as a slight vertical elevation. The tonsil which is an oval body, measuring $3 \text{ mm.} \times 1.5 \text{ mm.} \times 1 \text{ mm.}$, lies in this fossa with its longitudinal axis directed antero-posteriorly. Above the tonsil is a well-defined supra-tonsillar fossa.

The Pharynx

As a direct continuation of the fauces, the pharynx forms a structure shaped like an inverted funnel. Its walls are fibro-muscular, with an internal lining of smooth mucous membrane. The presence of a pharyngeal tonsil could not be made out in our dissections. The internal openings of the Eustachian tube are situated in the posterior part of the nares (nasopharynx) at the junction of the lateral wall and the roof.

The Oesophagus

The oesophagus commencing as a continuation of the pharynx at the level of the cricoid cartilage, courses through the neck and thorax; then passing through the oesophageal hiatus of the diaphragm, it becomes continuous with the stomach, after an intra-abdominal course of about 6-7 mm. The course of the oesophagus is not straight; in the neck it is to the right, and in the upper part of thorax to the left, of the median line; from the level of the fourth dorsal vertebra it keeps to the sagittal plane. It is surrounded by areolar tissue which binds it to the adjacent structures. Dorsal to the oesophagus lies the vertebral column covered by soft structures; the other
relations differ in different parts of the oesophagus and they are as follows:—In the neck, whilst the trachea is on its ventral aspect, the sympathetic trunk, the carotid artery, the vagus and recurrent laryngeal nerves and the lobe of the thyroid gland lie on the lateral aspect of the oesophagus. In the proximal part of the thorax, the trachea continues to remain ventral to the oesophagus; the left common carotid artery, left vagus nerve and subclavian artery lie on the left side of the oesophagus; on its right side are the innominate artery, right vagus, right subclavian artery and a little distally, the azygos vein. In the distal part of the thorax, ventral to the oesophagus is the pericardium; the vagi covered by the parietal pleura form its lateral relations. In the abdomen the oesophagus lies in a deep groove formed by the left and Spigelian lobes of the liver.

In the formalin-preserved specimens, the mucous membrane of the oesophagus is smooth in its proximal part but is thrown into four or five longitudinal folds in its distal portion.

The Stomach

On opening the abdomen, only a small portion of the gastric surface is seen (Fig. 5), the rest remaining covered by the large lobes of the liver as

![Diagrammatic representation of the viscera as seen on opening the abdomen. (The limbs of the colic loop are slightly pulled apart to show the peritoneal bands between them.) L., Liver; St., Stomach; Sp., Spleen; Om., Greater omentum; C.L., Colic loop; S.L., Small intestine; Bl., Urinary bladder.](image)

in the case of Tarsius⁷ but unlike Nycticebus malainus¹¹ where the stomach is completely hidden by the liver.

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The stomach of *Loris* is a saccular organ with a curved longitudinal axis. It possesses the cardiac and pyloric orifices, the cranial and caudal surfaces and the lesser and greater curvatures.

Both the cardiac and pyloric orifices are situated about the same level; as the cardiac orifice is to the left of the median plane and the pyloric is in the median plane the major portion of the stomach lies in the epigastric and left hypochondric regions.

At the cardio-oesophageal junction while the right border of the oesophagus becomes continuous with the lesser curvature without any well defined demarcation, the left border of the oesophagus forms an angle with the greater curvature of the stomach.

The lesser curvature is very short and measures only 12–14 mm. and as the pyloric and cardiac openings are separated by a short interval of about 8–10 mm. it has a U shape. The curvature winds round and fits to the groove on the Spigelian lobe of the liver. To this curvature is attached the gastro-hepatic ligament or lesser omentum.

The greater curvature is rather long measuring about 70–72 mm. This border gives attachment from right to left to the greater omentum, gastro-splenic ligament and to the mesogastrium.

The cranial surface is in relation with the caudal surface of the left and central lobes of the liver which is hollowed out to receive the stomach. A narrow strip of cranial surface adjacent to greater curvature is covered by the spleen. It is only a small portion of this surface that lies between left and right lobes of the liver that comes into relation with the ventral abdominal wall.

The relations of the caudal surface of the stomach to the other abdominal viscera is very nearly similar to the conditions obtaining in man: the splenic lobe of the pancreas is in intimate relation with this surface; the small and large intestines and to a small extent the left kidney are related to this surface.

The usual three divisions, namely, the fundus, body and pylorus can be distinguished in the stomach of *Loris* and these divisions are indicated on the external surface by the faint sulcus angularis and sulcus intermedius. The fundus is well defined and is to the left of the cardiac orifice; its mucous membrane is usually smooth. The body is the largest portion of the organ and its mucous membrane is thrown into longitudinal rugæ when the organ is empty; the pylorus is short and narrow; the longitudinal rugæ of the pyloric mucous membrane is more prominent than those of the
body. The pyloric sphincter is well developed. The pylorus does not project like a knob into the duodenum as it does in man.

The Small Intestine

The small intestine consists of three divisions, namely, duodenum, jejunum and ileum.

Duodenum.—The duodenum in *Loris* (Fig. 6) like that of *Nycticebus* does not possess the characteristic ‘C’ shape seen in the case of man and Chimpanzee. Beginning at the termination of pylorus, at about the level of the last dorsal or first lumbar vertebra, the duodenum passes to the right and dorsally only for a short distance of about 5 mm. forming the first part of the duodenum. It then abruptly turns caudalwards to become the second part, which runs a straight course, at the end of which it turns almost at a right angle to pass to the left forming the third or horizontal part of the duodenum. The second and the third parts measure 3.5 and 1.2 to 1.4 cm. respectively. Usually the duodeno-jejunal junction is marked externally by a flexure; in one of the specimens it was marked by a constriction of the gut. With a diameter of about 6–7 mm. the duodenum possesses a larger calibre than that of the rest of the small intestine whose diameter rarely exceeds 4–5 mm., a feature frequently met with in the Primates.11

The first part of the duodenum is in relation with the right surface of the Spigelian lobe of the liver and gives attachment to the right lateral
part of the gastro-hepatic ligament. The second part of the duodenum is in relation laterally with the right lobe of the liver whose surface is grooved to accommodate the duodenum and medially with the duodenal lobe of the pancreas; ventrally it is covered by the colic loop. The flexure between the second and third part comes into relation with the ventral surface of the right kidney. The junction of the horizontal and descending lobe of the pancreas abuts against the flexure between the first and second part of duodenum. The third part crosses the median plane from right to left; dorsal to the third part lies the terminal portion of the duodenal lobe of the pancreas.

The duodenum has a complete investment of peritoneum and possesses a narrow mesentery, mesoduodenum, as in the case of Tarsius. This is a primitive mammalian character absent in anthropoids where usually the duodenum is firmly anchored to the posterior abdominal wall as a sequel to the rotation of the gut.

The internal surface of the duodenum is lined by mucous membrane thrown into villi which are tall and close set. Even to the naked eye the change in the nature of the mucous membrane at the pyloro-duodenal junction is obvious on account of these tall villi on the duodenal side. The duct formed by the union of the common bile duct and the pancreatic duct opens on the summit of a papilla which is situated about 7-8 mm., from the pyloroduodenal junction (Fig. 7). Usually the papilla is hidden in the midst of tall villi.

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**Fig. 7.** Diagram to show the duodenal papilla of the common bile duct. D., Duodenum; D.P., Duodenal papilla; C.B.D., Common bile duct; Py., Pylorus.

*The Jejunum and Ileum.*—The jejunum and ileum, in Loris, together measure about 35 cm. There is no external indication to demarcate the junction between these two regions as in the case of the human subject. Commencing as a continuation of the duodenum, at the left of the sagittal plane, the small intestine is freely suspended from the dorsal abdominal wall by the mesentery. There are in all six loops as in Tarsius and Nycticebus malainus; but the ladder-like arrangement of these coils seen in Tarsius is absent in Loris which resembles in this respect, Nycticebus malainus. In the formation of these coils though the gut crosses and recrosses the median line, yet the greater part of the small intestine lies in
the left half of the abdominal cavity. The terminal part of the ileum (Fig. 8) forms a straight tube which passes from the left part of the abdomen to the right and cranialwards, behind the other coils of small intestine, to join the colon. The position of the ileo-cæcal junction in *Loris* (Fig. 8) being near the duodenum,—a primitive mammalian disposition,—differs from that of the higher primates in which it tends to move away from the duodenum towards the right iliac region.

The small intestine is completely invested by peritoneum. Its calibre is fairly uniform and its diameter is 4–5 mm. The mucous membrane observed under a lens, is seen to be clothed with villi.

*The Large Intestine.*—The large intestine in *Loris* consists of a blind pouch, the cæcum, a colon proper which terminates in a straight portion, and the rectum.

The cæcum (Fig. 8) is capacious and is about 5–5 cm. long. Commencing as a dilated pouch at the ilio-colic junction it becomes somewhat sacculated as it passes caudalwards; its calibre becomes reduced towards the distal blind-extremity. It joins the ilio-colic junction slightly obliquely. At the cæco-colic junction the lumen becomes narrow and the mucous membrane is thrown on either side into a crescentic fold so that the circular lumen is narrowed into a slit-like aperture (Fig. 9). When empty the mucous membrane of the cæcum forms transverse folds. Often the cæcum is loaded with nematode worms. A triangular mesentery (Fig. 8) attaches the cæcum to the terminal part of ileum as in the case of other lower mammals. There is no tinea-coli in cæcum, nor is there a vermiciform appendix.
The colon in Loris retains the primitive mammalian character; the anatomical divisions of the colon, viz., the ascending, transverse and descending parts, characteristic of the anthropoid apes and the human subject, are not differentiated in Loris lydekkerianus. From the ileo-colic junction, the colon first proceeds straight cranialwards and then abruptly bends anteriorly to pass caudalwards for about 3 cm.; then it curves to the left and passes cranialwards keeping parallel to the previous segment and thus forms the characteristic ‘U’ shaped colic loop (Fig. 8). After the formation of the loop the large intestine with a broad bend proceeds straight caudalwards, keeping slightly to the left of the median line, until it opens externally. For a varying distance from its commencement the colon has a narrow calibre, but before it bends to form the colic loop its diameter becomes nearly double. The first or the ascending part has a narrow mesocolon; the limbs of the colic loop are straight and are attached to each other by peritoneal bands (Fig. 5); the loop as a whole is attached by a narrow peritoneal band to the dorsal mesentery of the rectum. The terminal straight portion, the rectum, possesses a somewhat broader mesentery. The total length of the colon is about 22 cm. The colon is not sacculated due to the absence of tinea-coli and there are no appendices epiploicae.

The colic loop noted above corresponds to ansa coli dextra, since it occurs on the distal limb of the pendant loop and also as it is to the right of the highest point reached by the colon. The loop is straight and of wider calibre; and thus differs from the spiral colic loop of Nycticebus malainus. In both these animals the ansa coli sinistra is absent.

A glance at the table given below, shows that the ansa coli dextra is a

<table>
<thead>
<tr>
<th>Species</th>
<th>Ansa coli dextra</th>
<th>Ansa coli sinistra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiromys</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Indris</td>
<td>Present</td>
<td>&quot;</td>
</tr>
<tr>
<td>Galago garnetti</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Perodicticus</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>Lemur Mongoz</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Nycticebus malainus</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Loris lydekkerianus</td>
<td>Present</td>
<td>Absent</td>
</tr>
<tr>
<td>Chiropotes</td>
<td>Absent</td>
<td>Present (Mitchell), Absent (Le Gros Clark)</td>
</tr>
<tr>
<td>Microcebus</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Tarsius spectrum</td>
<td>Absent</td>
<td>Absent</td>
</tr>
</tbody>
</table>
constant feature in the Prosimiae excepting in Chirogaleus, Microcebus, and Tarsius whilst the ansa coli sinistra is not so constant.

It may not be out of place to note here that there does not seem to be any constancy with regard to the size and form of the ansa coli dextra in prosimiae: Beddard\(^3\) describes the ansa coli to be "straight in Chiromys and Lemur and spirally twisted in Galago, Loris, Nycticebus, Indris and probably Perodicticus" whilst Mitchell\(^4\) states that "in Chiromys the loop is narrow and straight and in Lemur it tends to be spirally twisted" and further adds that "in Lemur the loop tends to be wider and more irregular and that spiral twisting varies considerably in extent". Harrower\(^1\) describes a spiral loop of the colon (what corresponds to ansa coli dextra) in Nycticebus malainus. From the statements noted above it becomes clear that the form and size of ansa coli dextra do not yield information of much value.

On opening the colon (Fig. 9), it is seen that the ileum joins the colon a little above the cæco-colic junction. The ileum projects into the lumen of the colon in a knob-like manner. The ileum is much reduced at this opening which may be either an oval or slit-like aperture; but there are no frenula connecting the knob with the lateral wall of the colon and is unlike the condition in man. The mucous membrane of the proximal part of the colon is thrown into transverse folds whereas that of the rest of the colon is smooth. At the recto-anal junction the mucous membrane is raised into longitudinal folds (Fig. 10), which resemble the rectal columns of the human subject. These are only 5 mm. in length.

![Diagram of the interior of the ileo-cæco-colic junctional region.](image)

- C., Cæcum ; C.C.Sp., Crescentic fold of mucous membrane between cæcum and colon ; Co., Colon ; I.C.V., Knob-like projection of ileum into colon ; IL., Ileum.
Fig. 10. Figure showing the longitudinal folds of the mucous membrane at the recto-anal junction.

In the following table the measurements of different anatomical divisions of the alimentary canal in some primates are given and these measurements are correlated with their respective stem heights:

<table>
<thead>
<tr>
<th>Primate</th>
<th>Stem Height</th>
<th>Length of small Intestine</th>
<th>Length of large Intestine</th>
<th>Length of Cæcum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Man</td>
<td>About 86 cm.</td>
<td>600 cm. ×7</td>
<td>150 cm. ×1.7</td>
<td>6 cm.</td>
</tr>
<tr>
<td>Chimpanzee</td>
<td>57.5 cm.</td>
<td>360 cm. ×6</td>
<td>133.75 cm. ×2.3</td>
<td>7.5 cm.</td>
</tr>
<tr>
<td><em>Loris lydekkerianus</em></td>
<td>24.75 cm.</td>
<td>40.5 cm. ×1.7</td>
<td>22 cm. ×0.9</td>
<td>5.5 cm.</td>
</tr>
<tr>
<td>Aye Aye</td>
<td>34.75 cm.</td>
<td>103.25 cm. ×3</td>
<td>55 cm. ×1.5</td>
<td>6.75 cm.</td>
</tr>
<tr>
<td><em>Nycticebus mahanus</em></td>
<td>30.0 cm.</td>
<td>46 cm. ×1.5</td>
<td>42 cm. ×1.5</td>
<td>5.5 cm.</td>
</tr>
</tbody>
</table>

From the above table it becomes clear that the small intestine which represents the main absorptive surface in the alimentary canal, is relatively shorter in Prosimiae than in Simiae; and the lengths of the large intestine in both these groups do not differ much.

The Large Glands associated with the Digestive System

Salivary Glands.—There are three paired glands: the parotid, the sub-maxillary and the sub-lingual.

The parotid gland (Fig. 11) is situated on the posterior aspect of the face, below and in front of the ear. The gland is surrounded by a capsule which is tough near its upper part. It possesses four surfaces; a craniodorsal in relation to the auditory tube; an antero-medial surface in contact with the masseter muscle; a caudal surface in relation to the submaxillary gland and a lateral surface forming the base of the pyramid. The base is roughly quadrilateral and is covered by platysma and deep fascia.
Fig. 11. Figure to show the parotid gland with its duct. (Some of the vessels and nerves on the face have been omitted for the sake of clearness.) P.G., Parotid gland; S.M.G., Sub-maxillary gland; St. D., Stenson's duct.

Apical portion of the gland lies deep and is directed medially. The distance from apex to base is 6-7 mm. From about the middle of the anterior border of the base, the duct of the parotid gland (Fig. 11) emerges, after crossing the lateral surface of the masseter muscle runs straight anteriorly along the upper border of the orbicularis oris muscle and pierces the substance of the cheek obliquely to open into the vestibule about the level of the second upper premolar tooth. There is no papilla at the opening of the duct into the vestibule. The duct measures about 2.5 cm. long.

The submaxillary gland (Fig. 12) is situated at the angle of the mandible partly under cover of its ramus. As in other Lemuridae, it is smaller than the parotid gland, and somewhat globular in shape. Its relations with the other structures are as follows: its superficial aspect is covered,
by platysma and cervical fascia; anteriorly it is in relation with the interramii muscles; posteriorly the gland is separated from the parotid by fascia; and laterally the submaxillary is in relation with the ramus of the mandible. The duct emerging from the deeply situated part of the gland passes anteriorly under cover of the hyoglossus muscle to reach the posterior pole of the sub-lingual gland; in its further course it lies at the angle between the dorso-medial and dorso-lateral surfaces of the sub-lingual gland and finally opens on the frenal lamella about a millimetre behind its apex. The duct is about 2·6 cm. long.

The sub-lingual gland (Fig. 12) is an elongated structure and measures 1·5 cm. by 0·5 cm. It lies beneath the mucous membrane of the floor of the mouth, medial to the body of the mandible and covered ventrally by interramii muscles. It is triangular in section and has a dorso-median, a dorso-lateral and a ventral surface. The duct of the submaxillary runs in relation to the angle between the dorso-medial and dorso-lateral surface.

The Liver.—The liver of *Loris lydekkerianus* is a large multilobulated organ occupying the epigastric and both the hypochondric regions (Fig. 8). It occupies greater part of the cranial portion of the abdominal cavity. Its weight is about 6·5 grammes in an animal weighing 300·0 grammes. It has a complete investment of peritoneum. The liver possesses two surfaces, a cranial, in contact with the diaphragm and a caudal one, in relation to abdominal viscera. The liver of *Loris lydekkerianus* is very nearly completely divided into many lobules (Fig. 6). One can recognise in the liver of this animal three primary subdivisions, the central, right and left lobes; each of these is further subdivided into secondary lobes by fissures passing into the liver substance.

The central lobe is separated from the left and right lobes by deep and complete fissures. The umbilical fissure passing through the ventral half of this lobe divides into a smaller left and a bigger right part; the alciform ligament lodges itself in this fissure and attaches the cranial surface of the central lobe to the ventral abdominal wall. The right part of the central lobe is traversed by an incomplete fissure, known as cystic fissure which penetrates the liver substance to varying extent in different specimens; but in no specimen is it very extensive. On the caudal surface of this lobe, in continuation of the cystic fissure is a fossa for the lodgement of the gall-bladder and still more dorsally the fossa gives way to a sulcus in which the cystic duct runs.

The left lobe is by far the largest of the liver lobes. Its cranial surface is in contact with the diaphragm and the caudal surface is hollowed, as noted
above, to receive the fundus of the stomach. The border between these two surfaces is rounded and its ventral part is in relation with the Spigelian lobe and the dorsal part contains the oesophageal groove. The anterior margin is crossed by a small fissure. To the dorsal aspect of the cranial surface the left triangular ligament is attached.

The right lobe is slightly smaller than the left lobe. A deep lateral fissure divides the right lobe into two portions, namely, the superior lobe which lies adjacent to the central lobe and the caudate lobe which forms the caudal end of the right lobe. The caudal surface of the superior lobe is grooved to lodge the first and second part of the duodenum. The caudate lobe is more or less pyramidal and is drawn out towards the caudal aspect. The tail end of the caudate lobe is hollowed to receive the right supra-renal body and part of the cranial pole of the right kidney; slightly medially the inferior vena cava enters the caudate lobe and becomes completely surrounded by liver tissue. From the left posterior angle of the caudate lobe is given off the Spigelian lobe (also known as papillary process, which is connected to the main right lobe) by means of a slender process of liver tissue known as caudate process. The cranial surface of the right lobe is attached to the diaphragm by the right triangular ligament.

The Spigelian lobe is pyramidal in shape and has three free surfaces. The left lateral surface is grooved to receive the rounded medial border of the left lobe; the dorsal surface is grooved to receive the abdominal part of the oesophagus; the caudal surface bears two impressions. The left impression comes in contact with the ventral surface of the stomach in the vicinity of lesser curvature and the right impression is in relation with the pyloro-duodenal junction. The rounded border between the caudal and the dorsal surfaces exactly fits into the lesser curvature of the stomach.

The porta hepatis lies ventral to the Spigelian lobe and gives attachment to the gastrohepatic ligament. At the porta the hepatic artery and portal vein enter the liver and the cystic duct joins the hepatic duct to form the common bile duct.

From the description of the liver of Nycticebus given by Harrower it is obvious that the liver of Loris lydekkerianus resembles that of Nycticebus malaimus in its multilobulated condition and in the interrelationship of the lobules; the one notable difference is, whereas the cystic fossa in the Nycticebus opens on the diaphragmatic surface of the liver it does not do so in Loris.
The gall-bladder (Fig. 13) occupies the cystic fossa of the central lobe. Generally only a part of the fundus of the gall-bladder is visible on the caudal aspect of the liver; in one of the specimens the gall-bladder was very nearly completely covered by the adjacent quadrate lobe and a part of the lobe had to be dissected out to bring the bladder into view. In none of the specimens dissected did the fundus of the bladder reach the ventral border of the liver. As in the case of man the gall-bladder is a pear-shaped organ with its fundus projecting towards the ventral aspect. A narrow neck joins the body of the bladder to the cystic duct. The deeper surface of the gall-bladder is invariably attached to the fossa by a small mesentery. When the viscus is empty it measures 7 mm. by 5 mm.; the cystic duct is about 6–7 mm. long.

The duct system (Fig. 13) was traced by partial dissection of the hepatic tissue, and was observed to be as follows: the ducts of the left lobe and quadrate lobe join together; the united duct after a short intra-hepatic course of about 4 mm. is joined by the ducts coming from (1) the papillary process, (2) caudate lobe and (3) from that part of the central lobe which is to the right of the cystic fossa. This common trunk is joined by a duct arising in the hepatic tissue of the central lobe lying to the left of the cystic fossa and about 3 mm. away by another duct from the cranial portion of the right lobe; and the cystic duct unites with the common trunk to give rise to the common bile duct.
The common bile duct leaves the portal fissure and enters the lesser omentum where it is in company with the portal vein and the hepatic artery. After a course of about 12–13 mm. the common bile duct being joined by the main pancreatic duct very nearly at right angles, pierces the medial wall of the duodenum obliquely about 7–8 mm. from the pyloro-duodenal junction (within the proximal one-third of the second part of the duodenum) to open on the summit of the duodenal "papilla."

The Pancreas.—The pancreas of Loris (Figs. 14 & 15) is neither so compact as that of the human subject nor so diffuse as that of the lower mammals, such as rabbit. It consists of two main lobes, a transverse or splenic lobe and a duodenal lobe.

The splenic lobe is more compact than the other. It is about 4·5 cm. long and extends from the pyloro-duodenal junction to the middle of the hilum of the spleen. Though to the naked eye it appears flat, it is really triangular in section. It is completely invested by peritoneum being enclosed within the posterior two layers of the greater omentum. The left lateral one-third of the splenic lobe lies against the spleen and the medial two-thirds is in relation with the caudal surface of the stomach.

The duodenal lobe of the pancreas is flat and consists of two parts, a smaller part, in close contact with the mesial concave border and a larger part separated from the former by a short interval. The larger part of the duodenal lobe is about 3 cm. long; beginning at the pyloro-duodenal junction it remains dorsal to the second and third parts of the duodenum and extends a little beyond the duodenum. Curiously enough, in Nycticebus malaiensis the presence of the duodenal lobe which is generally found in all mammals has not been mentioned by Harrower.
The duct of the splenic lobe of the pancreas (Fig. 15) commencing at the tip of the lobe, passes horizontally from left to right through the gland substance gaining in size due to accession of smaller ducts. It is accompanied by the principal vein of the pancreas. Corresponding to the two subdivisions of the duodenal lobe of the pancreas there are two ducts. These join together to form a single duct which after a short course unites with the duct of the splenic lobe to form the main pancreatic duct. The main duct after traversing 1–2 mm. joins the common bile duct almost at right angles as noted above.

The Peritoneum.—The arrangement of the peritoneum in Loris is very simple and recalls the conditions in Tarsius. The diagram representing peritoneal attachment in Lemur coronatus represents the conditions in Loris.

The peritoneum in Loris forms a complete covering to the abdominal cavity and to most of the abdominal organs, and a partial covering only to a few of the organs of the abdominal viscera, like kidneys, adrenals and urinary bladder. It is attached to the dorsal abdominal wall in the middle line from œsophageal hiatus in the diaphragm to the pelvic floor. From this median attachment it spreads on the one hand in either direction to form the parietal peritoneum and the other to form the investment of various organs, and to form the peritoneal ligaments and mesentery by which the viscera get bound to each other or get suspended directly or indirectly from the abdominal wall.

There are two peritoneal sacs, the lesser and the greater communicating with each other through the epiploic foramen. The epiploic foramen is a
relatively large slit-like aperture measuring 1 cm. in its longitudinal axis; and its boundaries are formed ventrally by gastro-hepatic ligament, caudally by cavo-duodenal ligament and dorsally by the caudate lobe of the liver.

The greater omentum, though an apron-like structure, is furled to a great extent, unlike in *Tarsius*, higher anthropoids and the human subject, where it forms a covering to the abdominal viscera. It measures about 4·5 cm. in transverse direction and about 3·4 cm. cranio-caudally when it is fully unfurled. It is a transparent structure and is not loaded with fat.

Its anterior and posterior layers are not adherent. The anterior two layers are attached, cranially to the greater curvature of the stomach up to the pyloroduodenal junction laterally to the hilum of the spleen on the left to form the gastrolineal ligament, and to the right limb of the colic loop on the right side. The posterior two layers are attached on the left to the hilum of the spleen and on the right to the left limb of the colic loop.

After enclosing the splenic lobe of the pancreas these get themselves attached to the rectum. The anterior and the posterior layers are continuous with each other along the whole length of their caudal border, whilst laterally they are continuous only where they are not attached to the various viscera noted above.

The lesser omentum is a double layer of peritoneum stretching across the interval between the stomach and liver. Cranially it is attached to the porta hepatis and caudally to the lesser curvature of stomach; and the right border is free. Between its layers near the free margin, the portal vein, hepatic artery and common bile duct are enclosed.

The liver is suspended as it were, in the abdominal cavity by three peritoneal ligaments. The attachment of the left triangular ligament to the liver extends for about 1·5 cm. whereas that of the right triangular ligament for only 0·5 cm. The falciform ligament is well marked and serves to attach the liver to the ventral abdominal wall. There is no "bare area" of the liver as in *Nycticebus malayanus*.

The Spleen

The spleen of *Loris lydekkerianus* is situated in the left hypo-chondrium. The semilunar-shaped organ, though appearing flat, is really triangular in section. It measures about 3·5 cm. in length and 7 to 9 cm. in its broadest part. Though loosely suspended between the layers of the greater omentum, the spleen lies in contact with the left half of the greater curvature of the stomach and its cranial part bends over the fundus in a hook-like
manner. It possesses a parietal and a visceral surface. The parietal surface is convex and comes into relation with diaphragm and lateral abdominal wall. The visceral surface is divided into a cranial and a caudal part by a ridge running along its entire extent; the cranial part is concave and is applied to that portion of the gastric surface which is adjacent and ventral to the greater curvature; the caudal part is in relation with the left suprarenal gland, kidney, tail of the pancreas, the colon and the coils of small intestine. The ridge, comparable to the hilum of the spleen, gives attachment to the gastro-splenic ligament and the posterior two layers of the greater omentum. The splenic artery, while giving off branches of supply to the spleen, runs in company with the splenic vein between the two layers of the gastroplenic ligament; in this part of its course it is situated parallel to and at a little distance from the ridge on the visceral surface. The spleen of Loris lydekkerianus in its shape, situation and attachments, presents all the lemurine characteristics; but it differs from that of Nycticebus malaiicus in one fact, namely, whilst the spleen of the former does not bear any relation to the liver, that of the latter does bear an intimate relationship.

Mesentery of the intestines.—The dorsal mesentery as already mentioned is primitive in its arrangement and is attached on the one hand to the dorsal wall of the abdomen and on the other to the abdominal part of the oesophagus, part of the greater curvature of the stomach and to the rectum.

The mesentery of the small intestine is a fan-shaped structure with a narrow dorsal attachment and an expanded ventral border by which it is attached to the whole extent of the small intestines. The root of the mesentery does not arise directly from the dorsal abdominal wall but as a diverticulum from the right surface of the dorsal mesentery at about the level of the second lumbar vertebra. It is interesting to note that in Loris the dorsal attachment of the mesentery is only one centimetre in extent, unlike the extensive attachment found in animals which have assumed an erect posture.

The following peritoneal bands are found in Loris lydekkerianus:

(i) Peritoneal bands connect the two limbs of the colic loop ventrally and in addition each limb has a narrow mesentery which fuses with its fellow and the fused band is attached to the mesentery of the small intestine;

(ii) The caudal part of mesoduodenum passes over to the inferior vena cava, forming the cavoduodenal ligament;

(iii) a peritoneal band binds the duodeno-jejunal junction to the proximal part of the rectum;
(iv) a peritoneal band binds the ileo-cæcal junction to the duodenum;
(v) the cæcum is provided with a mesentery of its own which attaches
the whole length of the cæcum to the terminal part of the ileum; in the
middle of this mesentery a main vessel runs distributing its branches both
to the cæcum and ileum.

Summary

(1) The rhinarium persists but the labial contribution is limited.
(2) The upper lip is bifid and is bound to the gum by a stout frenulum.
(3) The number and arrangement of the circumvallate papillæ and the robust
filiform papillæ on the pharyngeal part of the tongue, conform to the condi-
tions found in other Lemurs. (4) The well-developed sub-lingua shows
lemurine specialisation and possesses a tyutta. It contains a plate of hyaline
cartilage in its substance. (5) The posterior border of the soft palate shows
certain peculiar features connected with the incipient formation of an uvula.
(6) The oesophagus has a definite intra-abdominal course. (7) The du-
denum is completely invested by peritoneum and possesses a meso-duodenum.
(8) The small intestine is relatively short; and the ileo-cæcal junction is
placed near the duodenum. (9) The large intestine with a colic loop
occurring on the distal limb of the pendant loop is of primitive mammalian
type. (10) Whilst there is a long capacious cæcum there is no vermiform
appendix. (11) The parotid gland is flat as in other lemurs. (12) The liver
is multilobular and is without a bare area. (13) The pancreas is not compact.
(14) The arrangement of the peritoneum is primitive.

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