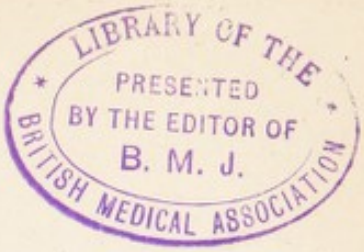
The gastro-intestinal tract in monotremes and marsupials / by William Colin MacKenzie.

The Comparative Anatomy of Australian Mammals

PART I.

THE GASTRO-INTESTINAL TRACT IN MONOTREMES & MARSUPIALS

MACKENZIE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THE GASTRO-INTESTINAL TRACT IN MONOTREMES AND MARSUPIALS.

BY

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Illustrated with 59 Original Figures.

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All proceeds from the sale of this work will be devoted to the advancement of Medical Research in the Commonwealth of Australia.

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A

CORRECTION.

On page 10, the fourth line should read, "but not showing histologically." This correction is important. Although macroscopically the large stomach of Echidna appears to conform to that of higher mammals, yet microscopically its lining shows, like the Platypus, a stratified epithelial character surmounted in addition by a keratinous layer. At the pyloric region in both monotremes the presence of a mucous secreting alveolar type of gland is noted with cells of a low columnar type.

INTRODUCTION.

A study of the fauna of the Australian Commonwealth offers a unique opportunity in aiding the solution of many important biological questions, and especially those pertaining to the gastro-intestine. The two monotremes and the various marsupials represent the selected results of a struggle with forces that have been operating through many ages. As the survival results among the marsupials are in many ways so diverse, we have a distinct advantage in being able to institute comparisons among animals limited to the same order. Furthermore, during the last century these animals—lowest on the mammalian scale—were suddenly brought into contact with modern man. We are unfortunately now witnessing final phases in the struggle and their biological significances. Amongst the Marsupials we have on one side the Koala, a purely eucalyptus-leaf feeder, with a caecum which may reach the great length of 244 cm., and on the other the Tasmanian Devil (Dasyurus Sarcophilus), purely carnivorous, which has evolved a simple intestinal tube swung on a single mesentery, with no apparent differentiation between the large and small intestines. Both these are rapidly becoming extinct—the former in spite of a rigid protection. Between these varieties we have the True Phalanger (Trichosurus), more adaptable as regards diet than the Koala, and hence still numerous in different parts of the continent, and the allied varieties of the Macropodidae—viz., wallaby, the selected and more adaptable variety, whose caecum may resemble that of the human foetus, and be only 5 cm. long, and the kangaroo, whose caecum—much more capacious—varies from 30-40 cm. In addition, we have Phascolomys (wombat), the selected marsupial, living on a nutritious

diet of vegetable matter, whose abdominal contents resemble those of man, and who shares with him, the higher anthropoids, and the Echidna, the possession of a true vermiform appendix.

With such diversity of intestinal type limited to a single order, one might have imagined that these animals would have formed the basis of the numerous investigations now being conducted all over the world on the functions of the human stomach and intestine. Surely before the large intestine was condemned as a " useless organ " some consideration might have been given to the intestinal experiments amongst the marsupials, and especially to the structural relations of the gastro-intestine in the Carnivorous Marsupials. For the study of intestinal muscle tone, one could not imagine a more hopeful field than the intestinal tracts of Echidna, Wombat, and Koala. Yet it is extremely doubtful if a single X-ray examination has ever been made of even the marsupial stomach. This work, though structural, has been written from the point of view of function. Every illustration has been designed with the idea of throwing some light on the structure and function of the human gastro-intestine. A further work on similar lines, dealing with the Liver, Spleen, Gall Bladder, and Panacres, is now in the press. In the author's opinion, researches on comparative anatomy should have some direct bearing on the structural and functional anatomy of the human frame; otherwise they are of only academic interest. The visceral histology of Monotremes and Marsupials has been completed by William Owen and myself, and will be published at a later date. The complete histology of the Gastro-Intestinal Tracts in Monotremes and Marsupials is now available at the writer's private laboratories in Melbourne for students wishing to undertake researches on the subject.

It is lamentable that in a rich country like Australia —the only country where these fast disappearing relics of man's past are to be found—there is not a solitary

Research Institute devoted to the carrying out of functional and structural investigations on the Monotremes and Marsupials. Here in the Australian Commonwealth research is carried on in the teeth of numerous difficulties, and everything has to be paid out of the investigator's pocket. How one envies the scientists in the United States, where money and buildings are always forthcoming, irrespective of immediate results. Some papers dealing with the Gastro-Intestines* have already been published by the writer, and these have been, to a certain extent embodied in the present publication.

In conclusion, the writer wishes to thank the President and Council of the Royal College of Surgeons, London, and Professor Arthur Keith, of the Hunterian Museum, for facilities accorded him whilst conducting researches at the Hunterian Laboratories; also Professor Wood Jones, of the London University, and Professor J. P. Hill, of University College, for their help on numerous occasions; his cousin, Major Charles Mackay, R.A.M.C., for assistance in the preparation of many hundreds of dissections during the past six years; Mr. William Owen, for his untiring and valuable co-operation in connection with the histology; Miss Esther Paterson and Mr. Victor Cobb, of Melbourne, and Mr. W. Finerty, of London, for the excellent illustrations; Mr. Le Souef, F.Z.S., Director of the Melbourne Zoological Gardens, for valuable advice and assistance; also Mr. E. Hill, of the Goulburn Valley.

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LIST OF ILLUSTRATIONS.

CONTENTS.

MONOTREMATA.

MARSUPIALIA.

THE GASTRO-INTESTINAL TRACT OF PLATYPUS (ORNITHORHYNCHUS ANATINUS).

The Oesophagus dilating slightly near the Diaphragm, may be traced into the abdomen for a distance of 1-1.25 cm.

The Stomach of the Platypus presents a somewhat primitive type, and might almost be regarded as a dilatation of the oesophagus, giving rise to a membranous sac. It is directed down and to the left, forming practically a right angle with the commencement of the duodenum. It is lined by stratified epithelium and has a lesser omentum attached above and a well developed great omentum attached below, extending along the great curvature and duodenum as far to the right as the entrance of the common duct. The body and great right process of spleen are suspended on the great omentum, while the lesser left process of spleen is suspended on the lienomesocolic fold (left lateral), which is continuous above with the great omentum and below with the mesocolon of the left or distal colon. Owing to this relationship the spleen—left portion of pancreas—stomach—distal colon—with portion of the ascending duodenum near the flexure can be raised off the left kidney in one piece. I have met with the stomach in a female only 2.5 cm. long and a breadth of 1.25 cm. On the other hand, it may reach 6 cm. long and 2-3 cm. wide. Owing to the close approximation of the oesophageal and pyloric orifices the lesser curvature is small and may be only .6 cm. in extent.

General View of Gastro-Intestinal Tract in Platypus.

S Stomach, K Oesophagus, P Pylorus, D Duodenum with Duct entrance, E Duod-Intest. Flexure, T Small Intestines, C Caecum with Mesentery, R Right or Proximal Colon, L Left or Distal Colon.

The Pylorus is well defined, having a hard knobby feel. It measures about .8 cm. long and presents on its interior longitudinal folds. The common bile duct receives the pancreatic duct about 2-2.5 cm. before its termination and finally opens into the duodenum about 2.5 cm. from the pyloric knob.

The Duodenum.—From the pyloric knob the duodenum passes nearly vertically down with a slight inclination to the right for a distance of about 2.5 cm. to where the common bile duct enters. It then curves out for a distance of about 6-7 cm. nearly horizontally to the right side. It then descends with an inclination to the right for about 5 cm. It then passes inwards and upwards to the left in front of the lower pole of the right kidney for about 5 cm., reaching the mid line and forming a distinct bend — the duodeno-intestinal flexure — from which it is continued on to the small intestine. The duodeno-intestinal flexure lies to the left of the root of the mesentery. In this last part of duodenum a transverse and ascending portion may be distinguished, although the latter may or may not be well developed. We have then a well defined duodenal loop swung on a mesoduodenum so that it can be raised freely off the dorsal abdominal wall. The greatest width of the mesoduodenum or duodenal mesentery equals 5 cm. The distal 3 cm. of duodenum (*i.e.*, really ascending duodenum) is connected to the mesocolon of the left or distal colon by a fold—the right lateral or duodenal fold. This is free below, and between the upper extremity which is usually well defined, the root of the mesentery, and the duodeno-intestinal flexure a pocket is found. This is the primary Duodenal Fossa. It and it alone is traceable throughout the Mammalia.

STOMACH, DUODENUM, AND DUCTS IN PLATYPUS.

S Stomach (external and internal views), M Gland on interior of commencing Duodenum, P Pylorus, K Oesophagus, D Duodenum, H Gall Bladder, L Hepatic Ducts, E Mesoduodenum with Pancreatic Tissue, C Common Bile Duct joined below by the Pancreatic Duct (A).

Small Intestine. — From the duodeno-intestinal flexure there is a mobile loop of intestine swung on the common mesentery, the width of which may equal 9-10 cm. This portion includes the small intestine from the flexure to caecum, 120 cm. long—the caecum—and proximal colon. On examining the interior of the intestine from the pyloric end this is seen to present a curious arrangement—the mucous membrane being raised into a series of fine wavy transverse folds which diminish in number and prominence as the caecum is approached, finally terminating abruptly about 25 cm. from that structure. After that the mucous membrane presents a smoother appearance, some very fine longitudinal folds being seen running on to the large intestine. The circumference of the small gut is greater than that of Echidna and may reach 3 cm.

Caecum.—This structure denotes macroscopically the distinction between the large and small intestine, which is not so evident as in Echidna. It is situated about 30-45 cm. from the Cloaca and is 3 cm. long, with a distinct mesentery passing to the intestine on the side proximal to the stomach. In all cases examined it was found to be free, with a well defined lumen continued to its termination. A typical section shows a well-defined circular, but narrower longitudinal muscular layer. In the submucous layer several nodules of lymphoid tissue are seen. The mucous layer shows long convoluted tubular glands lined by cubical cells.

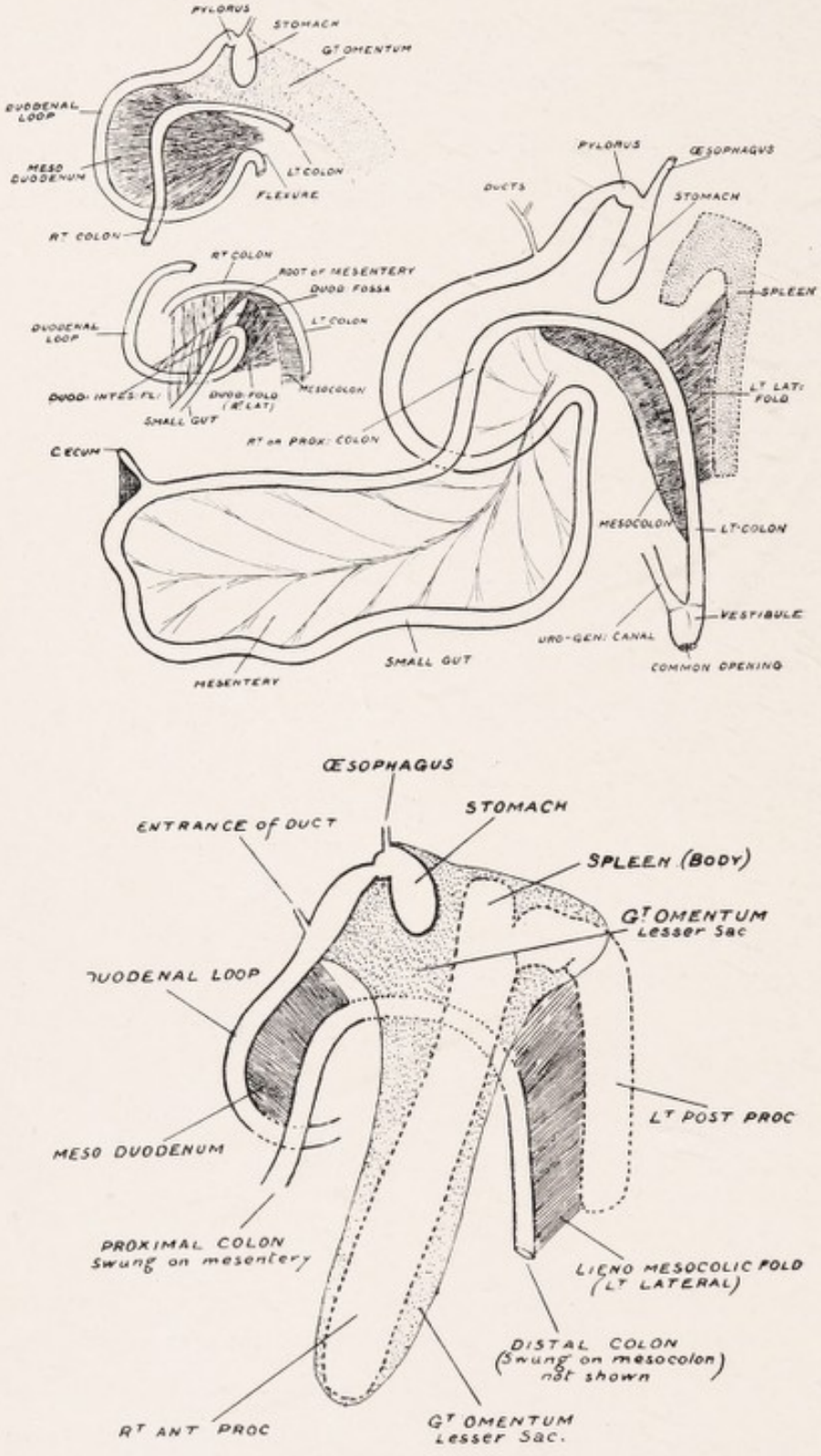
Colon.—Opposite the right extremity of the lesser omentum, *i.e.*, about the level of the common duct entrance and right commencement of the great omentum, a distinct peritoneal puckering is noted corresponding to the least mobile portion of the colon. This marks the separation of the colon into two portions—

Caecal Region, Platypus (External and Internal Views). S Small Intestine, E Large Intestine, C Caecum, M Common Mesentery.

(a) Right colon swung with the small intestine on the general mesentery, and about 17 cm. long.

(b) Left colon 22 cm. long passing to the Vestibule. This portion is swung freely on its own mesocolon, which is traced back to the dorsal wall between the Psoas muscles, and has a greatest width of 5 cm.

(a) *Right or Proximal Colon.*—This portion is at first swung on the mesentery and crossing the transverse duodenum it passes up ventral to the mesoduodenum for about 6 cm. For the first 2.5 cm. of this portion, *i.e.*, up to the middle of the descending duodenum, the mesentery is usually free, although in one specimen where the mesentery in this area was becoming bound I have seen three adhesions bands between the duodenum and the colon. About the middle of the duodenum a distinct band of adhesion between the two intestines is found, and for a distance of 1.5 cm. the mesentery is bound down to the mesoduodenum. Then on to its termination the mesentery and the right colon are tacked on to the mesoduodenum, but the two intestines are never in apposition, the nearest approach being 2 cm. At its termination—corresponding really to the junction of the mesocolon and mesentery with a distinct "tucking in" effect—the right colon is nearer the duodenum than elsewhere, and traces of a band—the mesial band—may be present from the colon to the duodenum. This represents the most fixed part of the colon tract. We may also see fine bands from the back of the mesentery to the duodenum. Thus Nature gives us a hint in a lowly mammal of future evolution. We have our primary mesial band fixation. Then by peritoneal adhesions colon and mesentery are tacked on to the mesoduodenum — the tacking down spreading from above downwards. The result is a broad-



PERITONEAL RELATIONS OF GASTRO-INTESTINAL TRACT IN PLATYPUS.

ening of mesenteric attachment so essential for the erect position.

(b) *Left Distal or Primitive Colon.*—Swung on its own mesentery or mesocolon, this portion of the gut passes almost vertically down in the mid line to the pelvis between the two Psoas muscles. The great omentum is in contact with the mesocolon for the first 2 cm., but it is important to note that neither the mesocolon nor left colon is included in the lesser sac. As before stated, attached on the right of the mesocolon is the duodenal or right lateral fold, and on the left side we have the lieno-mesocolic fold (left lateral), which supports pancreatic tissue, and the left smaller process of the spleen. As the body and the right process of the spleen are in the lesser sac this process forms a connection between the great omentum and the mesentery of the left distal colon — the mesocolon. The bowel, after entering the Pelvis, terminates by a sphincteric opening on the dorsal aspect of the commencement of the common Vestibule, into which also opens the uro-genital Canal, and on each side of the termination a prominence is to be noted on which we see the orifices of follicles secreting sebaceous matter. In the Monotremes there is a single opening or Cloaca for the Genito-Urinary and Intestinal Systems.

THE GASTRO-INTESTINE OF ECHIDNA

(ECHIDNA ACULEATA).

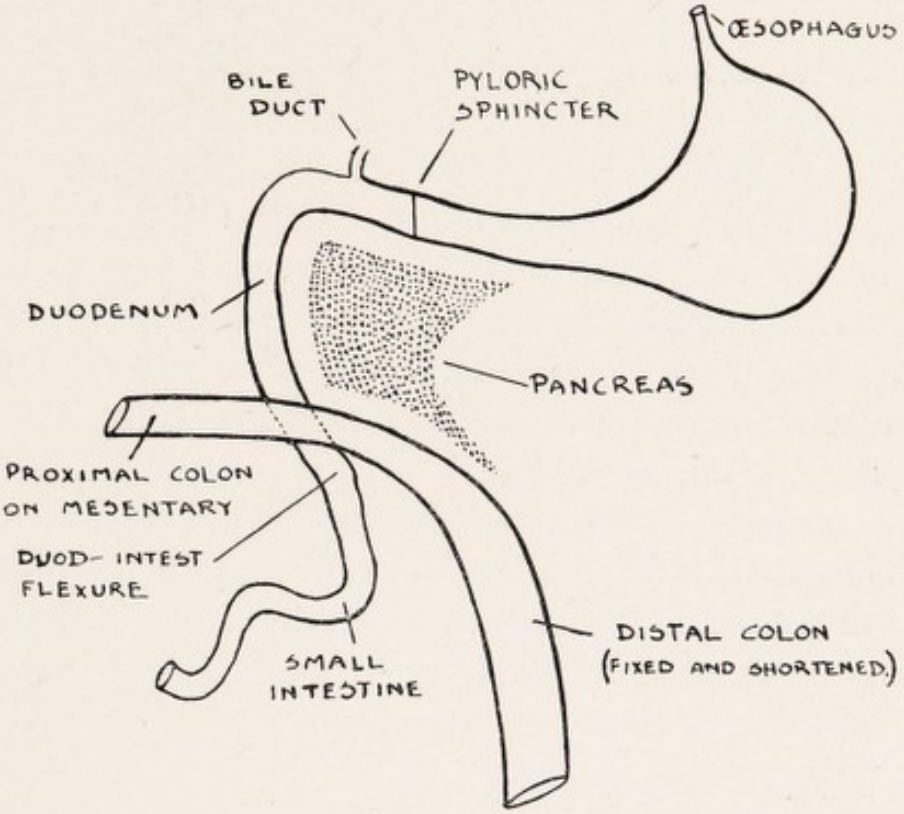
Whilst in the Platypus the Stomach can be regarded as a specialized epithelial diverticulum lying in the left hypochondrium, in the Echidna it is a much larger structure, showing histologically the Mammalian glandular character. It is placed in the left hypochondriac and epigastric regions, and the termination of the pylorus usually corresponds to the ventral mesial plane. It is somewhat rounded in shape, with the pylorus coming off abruptly from it. The length varies from 6 cm. in a female to 10 cm. in a male, and with the greatest breadth when empty of 4.5 cm. to 8.5 cm. Thus we see there is not such a marked difference between length and breadth. To the lesser curvature the gastro-hepatic omentum is attached, behind which we find the spigelian lobe of the liver. The length between oesophagus and pylorus varies from 4-7 cm. To the greater curvature is attached a well developed usually fatty great omentum, in relation with which we have the body and ventral right process of the spleen. The greater curvature measures from 10 cm. in a female to 16 cm. in a male specimen. We frequently see a small pouch to the left of the oesophagus, reminding one of the pouches seen in Macropodidae. I have seen a second pouch developed on the great curvature in a large male Echidna. Though usually obliquely placed the stomach may occupy an almost vertical direction. The fundus of the stomach is usually attached to

STOMACH AND LIVER IN ECHIDNA.

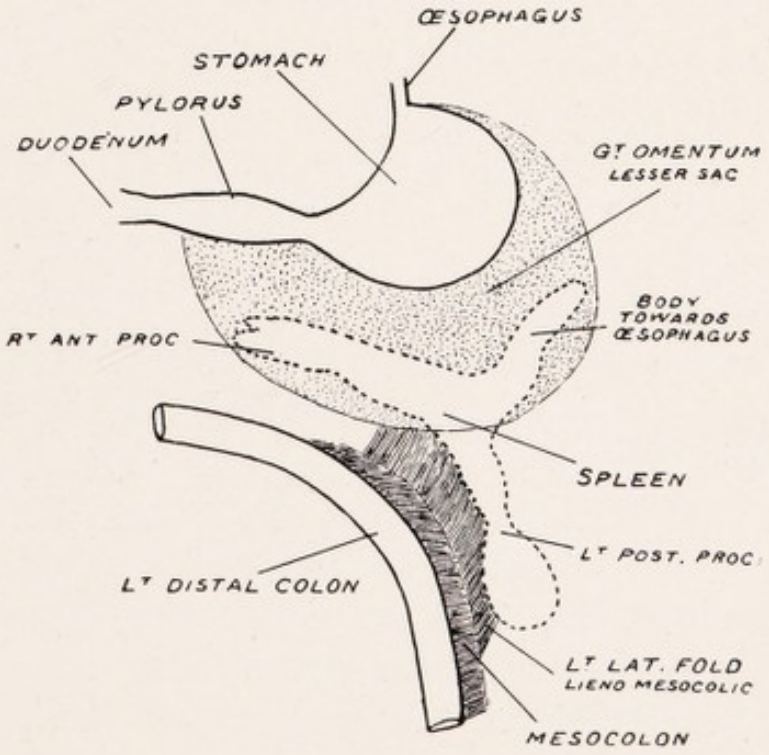
H Gall Bladder with Common and Pancreatic Ducts, L Left Lobe Liver, M Mesial (Cystic) lobe of Liver, R Right lobe Liver, C Caudate lobe Liver, S Stomach, P Pancreas, A Lesser Omentum, E Rigid Pylorus (Sphincter), D Duodenum, O Great Omentum, B Portions of Small Intestine, F Right Proximal Colon, T Distal Colon.

the diaphragm. The pyloric sphincter of this Monotreme is characteristic, and is unlike that of the Platypus or any of the Marsupials. It is a firm elongated structure, which may be of uniform circumference or taper slightly at the duodenal end. It begins and terminates abruptly. It varies in length from 2.5 cm. in a female to 4 cm. in a male, and its circumference in a large male reached 3.5 cm. On examining the interior of the stomach in the region of the fundus and great curvature the mucous membrane is seen to be raised into transverse folds, giving this portion a coarse rugous character. Along the lesser curve the folds are not so well defined, and run in a longitudinal direction. Towards the pylorus all the folds assume a longitudinal direction. The mucous membrane at the commencement of the pylorus has a spicular character, giving this part a somewhat horny feel. The mucous of the pyloric sphincter is markedly rugous, due to the presence of 7-8 longitudinal folds which stop abruptly at the commencement of the duodenum, where the mucous membrane has a finer spongy granular character.

Duodenum.—There is a well-defined duodenal loop which, however, is not so constant in character as in the Platypus. We recognise three portions—a first or ascending portion, descending, and a terminal or transverse portion. Owing to the dorsal fixation of the pancreas, there is less mobility of the duodenal loop, though it can be raised off the liver and right kidney. The first part of the duodenum varies from 2.5-5 cm. long, and passes from the pylorus to the visceral surfaces of the right cystic and right lateral lobes of the liver. It may pass almost horizontally, inclining, however, slightly upwards, or pass up and to the right, or it may be somewhat bent upon itself, passing first down and to the right and then up and to the right.



Stomach and Duodenum in Echidna.



Peritoneal Relations of Stomach, Spleen and Left Colon in Echidna.

The descending duodenum is 3-3.5 cm. long, and passes down ventral to the lobus caudatus and right kidney. It then inclines inwards and to the left for 1.5 cm. behind the commencement of the mesentery and proximal colon to the duodeno-intestinal flexure, where it is continued on as small intestine. The flexure is fixed dorsally about the root of the mesentery and the pancreas. The important point is that compared with the Platypus there is little more than a "tucking in" of the termination of the descending duodenum, reminding one of the condition in the Virginian Opossum. As showing the variability of this region in the Echidna, in a large male the first part of the duodenum passed out, downwards, and outwards to the right again, ventral to but free from liver, with a total length of 6 cm. It then descended in front of but free from caudate lobe of the liver and right kidney for 3 cm., and inwards ventral to the inferior vena cava for 1.25 cm. The included pancreas was fixed dorsally however, the upper part being attached to the caudate lobe. A membranous band may be traced from the flexure to the mesocolon of the distal colon, with a small fossa between this and the root of the mesentery. This is in contrast to the Platypus, in which we have a well-defined duodenal fold and fossa. The rule, however, is that there is no duodenal fold or fossa in Echidna. The bile duct enters the duodenum 1.75-3 cm. from the elongated rigid pylorus.

The Small Intestine extends from the duodeno-jejunal flexure to the appendicular region. It is thrown into a series of loops and is mobile, being suspended like the proximal colon on the common mesentery, the width of which equals 8-10 cm. It measures 225-240 cm. Compared with the Platypus, there is a well marked definition at the appendicular region between the large and small intestines, and internally we can distinguish what

Professor Keith refers to as caecal colon, into which the small gut, and what I regard as a vermiform appendage (when patent), separately open. The mucous membrane of the duodenum and small gut is not coarse like the colon, but has a finely granular character. The circumference of the small intestine is for the most part uniform and varies from 1.5 to 2.75 cm. There is frequently a slight increase, both at its commencement and termination.

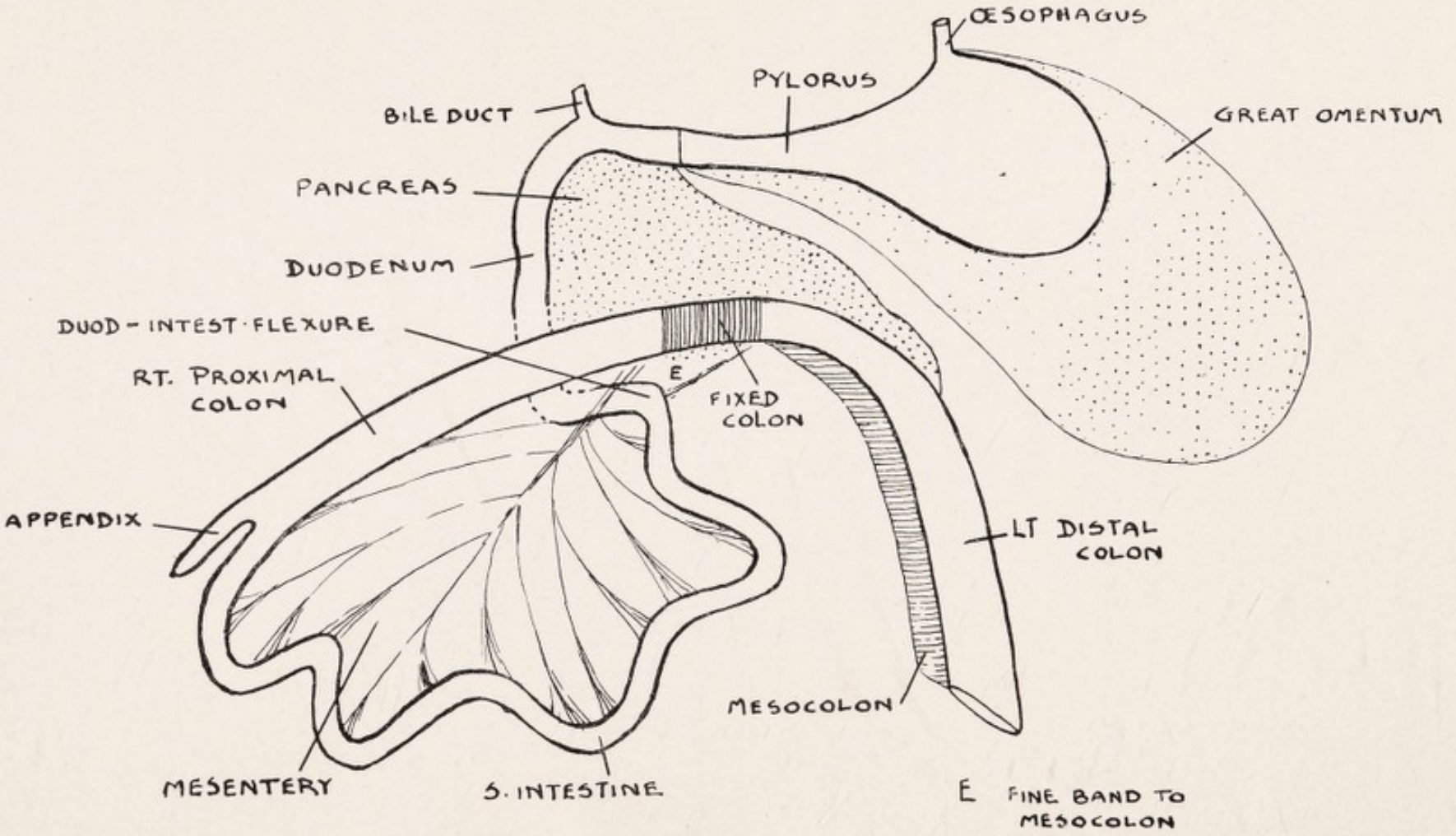
Vermiform Appendage.—This lies 30-60 cm. from the termination of the large gut at the dorsum of the commencement of the Vestibule. Its length varies from 1.5 to 3.5 cm., but, compared with the caecum of the Platypus, a great feature is variability as regards length, freedom, mesentery and lumen. In 35 per cent. the lumen is incomplete, and the appendage could not be distended by compression of the intestinal content. A trace of mesentery may be noted at the root of the appendix, but all specimens examined by me but one, which was free, were adherent to the wall of the termination of the small intestine, as in the Wombat, this varying from an adherency at the commencement up to half the length. In the specimen illustrated, which was 1.5 cm. long and devoid of mesentery, fully two-fifths are incorporated with small gut, the remainder being only a slender rigid stem without lumen. In one specimen the appendage was the seat of an inflammatory change, to which the omentum was adherent, this giving us a hint, low down in the Mammalian scale, as to a function of this structure. The examination of a typical histological section shows the muscle coats to be relatively small, though the inner circular is the larger, but the submucous tissue is largely replaced by lymphoid tissue. This latter displaces also a considerable amount of the mucous layers, in the glands of which columnar goblet cells are seen. The intestine on either

Ileo-Caecal Region in Echidna (External and Internal Views).
S Small Intestine, E Large Intestine, C Partly adherent Appendix.
The dotted areas are glandular.

side is typical large and small mammalian gut, the appendix having the character of the large gut. The orifice of the appendix is slightly raised, and about it we see a series of small glandular openings, in addition to several small collections on both the large and small intestines in this region.

Proximal Colon.—The colon is fixed dorsally, about the root of the mesentery-pancreas- and duodeno-intestinal flexure, for a distance of 1.5-3 cm. Occasionally the lumen is narrower. No mesial fold is present, but fixation begins opposite the pylorus. The proximal or right colon extends from the appendix to this fixed area. Like the small intestine and appendix, it is swung on the common mesentery, the width of which may reach 10 cm., narrowing, however, at the commencement of the small intestine and towards the fixed colon. It varies from 30-35 cm. long, and lies ventral to the lower part of the descending duodenum, off which it can be raised. Both the proximal and distal colons are frequently distended with dark, gritty, faecal material. The circumference of the proximal colon varies from 4-5 cm. The fixed colon marks then the distinction between proximal and distal colon, and corresponds to the junction of the common mesentery and mesocolon.

Distal Colon.—This extends from the fixed colon to the pelvis, and is continued to the dorsal part of the commencement of the Vestibule as the Rectum, which is immobile and descends at the back of the Pelvis. The total length from above the duodeno-intestinal flexure to vestibule varies from 13 cm. in a large male specimen, with the distal colon fixed dorsally to 28 cm. in a specimen with the distal colon movable. The degree of mobility of the distal colon varies; in one specimen it formed a freely mobile omega loop, with its convexity to the left. The mesocolon, on which it was swung, had a width of 5 cm.,



THE GASTRO-INTESTINAL TRACT IN ECHIDNA.

and it was attached to the dorsal wall running mesially between the two kidneys for 4 cm. In relation to the left aspect of the mesocolon was the lieno-mesocolic fold supporting the left dorsal process of spleen, ending in the nummular process, which was 1.5 cm. from the mesocolon. This left splenic process was outside the lesser sac. In two other male specimens there was less mobility. No omega loop was present, the colon passing almost vertically down between the two kidneys, and the width of the mesocolon in one was 2.25 cm., and in the other 2 cm. In the large male specimen mentioned above, whose distal colon and rectum measured only 13 cm., the distal colon was fixed dorsally—there being no mesocolon—and descended on the left of the mid-line ventral to the inner side of the left kidney. In this specimen the testes were also fixed dorsally, and in close relation to the left dorsal aspect were found the kidney and colon above, and between the colon and left testes below was the lower nummular process of the spleen also fixed to the colon. In the Echidna usually the body and right ventral process of the spleen are in the lesser sac, *i.e.*, on the great omentum and the left dorsal process on the lieno-mesocolic fold, *i.e.*, outside the lesser sac. Sometimes the body and both processes of the spleen are in the lesser sac, which dips down on the left of the colon, the terminal nummular-like process connected to the left process by a thin fibrous strand being, however, outside the lesser sac. The pancreas curving along the upper edge of the distal colon is not included in the lesser sac. The circumference of the distal colon varies. It equals about 3.5 cm., increasing, however, as the Pelvis is approached, where it may reach 8 cm. In a female specimen the proximal colon was 15 cm. in length, and the distal, 11 cm., describing an almost vertical course to the pelvis with a width of mesocolon of only 1.5 cm. The circumference of this proximal

colon was 2 cm., and at the pelvis the circumference was 5 cm. The mucous membrane of the colon has a coarse rugous character, owing to the presence of transverse and longitudinal folds. I have seen the terminal 6 cm. of the small gut also rugous, but not so markedly. In one specimen, where the appendix though free was devoid of mesentery and measured 2.5 cm. long, at a distance of 12 cm. proximal to this, a small diverticulum, 1 cm. long, was noted simulating a second caecum.

SUSPENSORY PERITONEAL FOLDS IN MONOTREMES AND MARSUPIALS.

In a study of peritoneum of the members of the two orders Monotremata and Marsupialia, three primary folds are noted which are traced in varying degree throughout the Mammalia, and play an important part in the fixation of intestine, spleen and pancreas, which is co-adjusted to the erect posture. These are:—

1. *Mesial Fold,* well marked in Koala, and connecting the colon to the pyloric region. This corresponds to the separation of the colon into right proximal, or mesenteric, and left, distal, primary, or mesocolic colon. As showing its connection with the ventral mesentery, in the Chameleon this fold is noted crossing the pylorus to be continuous with the gastro-hepatic omentum or ventral mesogaster. There is also evidence of this in Macropodidae and Cheiroptera.

2. *Left Lateral* (lieno-mesocolic fold).—This is well seen in the Platypus. It passes from the shorter left posterior process of the spleen to the left aspect of the mesocolon of the left colon. On this fold is suspended the left, frequently the greater, part of the pancreas.

3. *Right Lateral* (duodeno-mesocolic or duodenal fold).—This is well developed in Koala and the common Phalanger. Where we have a definite duodenal loop developed, this fold passes from the ascending duodenum to the right aspect of the mesocolon. Where the loop is not developed, the right fine extremity of the fold corresponds to the termination of the duodenum, *i.e.*, a part

defined by an inequality of growth between the mesoduodenum and the common mesentery, as is well shown in the Tasmanian Devil. Between the duodeno-intestinal flexure, root of mesentery, and the upper margin of the fold is the primary duodenal fossa, which can be demonstrated through the Mammalia up to Platyrrhini.

1. *Mesial Fold.*—From the selection point of view, this fold is of prime importance in colon development. Proximity of the colon to the pylorus is associated with colon development to the right, *i.e.*, on the mesentery. Failure of this proximity, *i.e.*, poor development or absence of the band, is associated with small development of colon to the right. The extremes in Marsupialia are the Koala and the Carnivorous Dasyures, and throughout the Mammalia varying intermediate grades are seen. The right colon—like the mesial hepatic lobe—is the experimental colon. Here we find large and small cæca-appendices—coils—and loops. The somewhat complicated right colon of Rodents is simplified in the Lemuroidea, and the human type appears in the Platyrrhines. In the Tasmanian Devil there is no development of the colon on the mesentery, but at the junction of the small intestine and the colon (left, mesocolic) some direct branches are traced from the right vagus to the gut. Furthermore, there is evidence in Mammalia of a direct branch or branches of the right vagus to the colon on the right of the pyloric relation, *i.e.*, corresponding to the division into right and left colons. It is interesting to note, as seen in Lemuroidea, Platyrrhines, Catarrhines, and great Anthropoids, that the fixation of the right colon, *i.e.*, shortening and dorsal fixation of its common mesentery, takes place from above downwards, *i.e.*, begins at the mesial attachment.

The selection sequences from the "human" point of view would be expressed as follows:—

(1) Presence of a Mesial Fold causing approximation of the commencement of the left, distal, or mesocolic colon to the pyloric region.

(2) Associated with this a good development of colon to right, on the common mesentery.

(3) The coils and loops seen in Rodentia and Lemuroidea are used as Nature's means for shortening the colon.

(4) Definite shortening and simplification precede fixation essential for the erect attitude.

(5) Fixation dorsally of the right colon, and so increase of the base of Mesentery commences from the Mesial Fold, *i.e.*, above downwards.

2. *Left Lateral Fold.*—The importance of this fold is in connection with the fixation of the colon in the splenic region. My explanation of its origin is that it is a *pari-passu* development with the spleen and the great omentum (*cf.* platypus), the spleen originally having, as in certain Reptilia, lain obliquely in dorsal mesogaster and mesocolon. In others the spleen involves mesogaster only, and such a spleen would not be associated with the development of this process, as in Koala. On this process diffuses the left part of the pancreas (below the level of the lesser sac). For selection purposes it would not be advantageous for the pancreas to be included in the lesser sac. It would not then easily conform to the abdominal law of dorsal fixation of solids. As evolution proceeds, the upper part of the great omentum (gastro-splenic) shortens inclining spleen dorsally. Pancreas also approaches the dorsum, and the result is shortening of the fold and adhesion to the kidney (lieno-renal), first to the lower pole, then the upper. The fold was originally free of kidney and dorsal wall. Thus we have proximal the spleen, pancreas, colon, kidney, and adrenal, and grades are seen in Platypus, Opossum, Wombat, and Anthro-

poids. The fixation of the left colon is now further aided by secondary inclusion of the gut and its mesocolon—between pylorus and spleen—by the great omentum; and grades of this can be seen in Kangaroo, Platyrrhines, Catarrhines, and Anthropoids Thus the mesial band is of further importance, as this inclusion begins on the right, and it is noticeable also that the fixation of the "descending" colon begins at the splenic region and extends downwards.

3. *Duodenal or Right Lateral Fold.*—The important question in connection with this fold is what part does it take—if any—in producing duodenal shape? If we regard this band and the so-called Treitz's fold as producing shape, then we assume that they dominate function. The peculiar shape of the duodenum is the result of function force, not traction force. Shape is response to a need. In the Chameleon we have evidence of duodenal shape. At this early period the duodenum becomes defined as a distinct intestinal segment. There is a distinct tucking in, representing loop commencement. Yet no membrane is present traceable to the mesocolon, so that the point of view of a band between the two acting as a traction force is out of the question. At this early period there is an inequality of growth—a failure to develop of the dorsal mesentery for the commencement as compared with that for the rest of the small intestine. Apart from gut specialisation, this inequality of growth is influenced also by growth of pancreas, spleen, and great omentum. The result of this inequality of development in the dorsal mesentery is to produce a loop or bend in the intestines at the junction of the mesenteries, *i.e.*, mesoduodenum and common mesentery. Owing to the presence of the mesial fold, *i.e.*, the pyloric relation of the beginning of the left colon, the mesentery of the small intestine is *ab initio* ventral to the mesoduodenum, and further development of

the duodenum would be to the left and dorsal to the common mesentery. As is seen throughout the Mammalia, this development does take place, and the result is an adhesion between the duodenum and the mesocolon of the left or primitive colon. From this adhesion the duodenal fold so characteristic of the Mammalia up to the Platyrrhini develops. Pancreatic development is only a minor factor in helping duodenal shape. Futhermore, throughout the Mammalia the junction of the duodenum and small intestine is an important nerve-control area receiving direct branches from the right vagus, and also mixed branches of the vagus and sympathetic; and one sees the advantage of the position of the flexure in Man, since it lies dorsally near the origin of the superior mesenteric vessels. Mechanical factors probably play a part in its good development in Koala, where we have a large right colon and caecum swung on the mesentery and supported at the pylorus. A minor and later function of the duodenal loop would be to form good attachment in the looping and fixing of the right colon. So far I have failed to find evidence of nerve-carrying function of this band, and only in the Bandicoot, where it is continuous with the left lateral fold in front of colon, is there a suggestion that the band is not adaptive but ancestral. It can be stated that the nearer we approach the single Mesentery type seen in the Tasmanian Devil and Ant-eater the less defined becomes the duodenal fold. In the latter it is absent, and in the comparatively simple gut of the Virginian Opossum, by dividing the elongate lax mesial fold and stretching the duodenal fold we get practically the primitive condition of the Ant-eater.

To sum up, duodenal shape is a response to function, and its specialisation is associated with the entrance of a direct vagal branch or branches at its termination. This entrance is a constant. The site of duct entrance is not,

as is shown throughout the Marsupials; but it is always proximal to the vagus relation. The fold is not an ancestral peritoneal fold, but a secondary one and result of adhesion (Zygosis). It is seen throughout the Mammalia up to Platyrrhini, is the "primary" duodenal fold, and is associated with the "primary" duodenal fossa. With the dorsal fixation of the duodenum from peritoneal adhesions, associated with fixation of right colon and its mesentery, and especially pancreas, neither fossa nor fold is seen in Catarrhini nor Orang.

From the comparative point of view the human-gut segments can be regarded as follows:—

1. Duodenum, pyloric sphincter to duodenal-jejunum flexure, where we have direct vagal control.

2. Small Intestine. Duodenal-jejunum flexure to termination of ileum, where we have the valve and also vagus and vago-sympathetic control.

3. From ileo-caecal valve to large gut, opposite the pyloric region of the stomach, practically corresponding to the entrance of direct vagal branches, is right, proximal, or mesenteric colon. This includes caecum, appendix, "ascending colon" and "hepatic flexure."

4. Colon to the left of that, *i.e.*, from pylorus to pelvis, is left, distal, or mesocolic colon. This includes "transverse colon," "splenic flexure," "descending colon," and "sigmoid" (iliac and pelvic colons).

My researches have failed to discover throughout the mammalia up to great anthropoids the presence of the so-called Jackson's membrane, Lane's band, and Treitz's band. So that in my opinion these can be regarded as adaptive bands—associated in Man with the erect posture.

THE GASTRO-INTESTINE IN MACROPUS (KANGAROOS AND WALLABIES).

Although the *Oesophagus* in the Koala and Wombat terminates in the Stomach almost as soon as it has pierced the diaphragm, in the Kangaroo, on the contrary, it traverses the abdomen for a distance of 10-12 cm. before reaching the stomach. Its termination lies 12-15 cm. from the left or *cul-de-sac* extremity of the stomach, and from the pylorus, *i.e.,* the length of the lesser curvature the distance is about 35-45 cm. When we open the abdomen ventrally the abdominal oesophagus is not seen, being hidden by the left portion of the stomach at the dorso-inner part of which it is found. It lies in the lesser sac behind the lesser omentum with the lobus spigelii, lying in a groove on the left surface of the latter.

Stomach.—After a feeding, the stomach is found to occupy almost every area of the abdominal cavity. The left extremity is usually bifid, presenting two somewhat rounded *cul-de-sacs,* but in smaller varieties, as the Wallaby, only a single one is noted. From the lower epigastric, or the mid-abdominal region, the stomach is traced up and to the left to the left hypochondrium, descends through the left lumbar region, to the left iliac region, then forming a loop or bend, it is traced up to the right hypochondrium, and passes down and back on the right of the spine to terminate in the duodenum. When seen *in situ,* the stomach may be described as a V-shaped structure, consisting of a large left and smaller right

STOMACH OF KANGAROO.

M Abdominal Oesophagus, S Spleen, E Non-sacculated Lesser Curve, H Common Bile Duct, D Duodenum.

portion. The left division consists of two portions, owing to the curving down and to right of the left or cardiac extremity, with its single or double *cul-de-sacs.* Similarly two portions of the right division may be recognised, owing to the fact that the non-sacculated pyloric portion curves downwards to terminate in the pylorus. Compared with other members of the Marsupial order, the stomach of the Macropod is relatively enormous in size, and no doubt the V-shape is an accommodation effect. Sacculation is a characteristic feature of the organ due to the presence of three longitudinal muscle bands, about .5 cm. wide; one of these, the least distinct, is traced along the greater curvature of the stomach at the attachment of the greater omentum, and the other two are traced, one on the dorsal and the other on the ventral surfaces from the base of the ventral *cul-de-sac* on the left extremity. The portion between these two latter bands constitutes the lesser curvature area, and is non-sacculated. These bands are not continued to the right extremity of the organ, and usually end at the junction of the upper and middle thirds of the right portion, with the result that the bend or upper extremity of the right gastric division is free from sacculation. This portion may be regarded as the pyloric portion of the stomach, and is related to the visceral surfaces of the right mesial and right lateral lobes of the liver, while the summit of the left division is related to the visceral surface of the left lateral lobe. In Macropus Gig. the stomach may reach a total length of 100 cm. In a Macropus Gig. measured *in situ,* the inner portion of the left division of the stomach (with the *cul-de-sacs*), measured 12 cm., and was connected to the body by a fold of peritoneum, which included the dorsal *cul-de-sac,* the ventral *cul-de-sac* being free. The remaining part of the left division, *i.e.,* from the summit to the apex or bend

STOMACH OF KANGAROO.

M Abdominal Oesophagus, A Bifid Cardiac extremity, S Spleen, E Smooth Lesser Curvature, P Pyloric Sphincter, D Duodenum, H Common Bile Duct.

(corresponding to the right limitation of the spleen) measured 35 cm. From here to the top of the right division measured 17 cm., of which the proximal 12 was sacculated, and the distal 5 cm. non-sacculated. From the summit of the right division to the pylorus, also non-sacculated, was 7 cm. The right pyloric or non-sacculated portion of the stomach is usually separated by a constriction or depression externally from the sacculated part, and where the greatest circumference of the non-sacculated portion was 17 cm., that of the sacculated was 26 cm., the measurement in a young Wallaby being respectively 7.5 cm. and 15 cm. In the latter specimen, the non-sacculated portion (including the right portion of the left division, 6 cm.) measured 35 cm., and the non-sacculated portion 10 cm. In a large Wallaby I found the right part of the left division forming a narrow dependent *cul-de-sac,* about 13 cm. long and free, except at its upper portion. A simple division of the stomach then is into two portions, *viz.,* a left, larger, cardiac sacculated portion, and a smaller, right, non-sacculated portion. The former consists of the two portions of the left division, including the oesophageal orifice and *cul-de-sacs,* and the lower two-thirds of the ascending portion of the right division (when seen *in situ*) ; and the latter would include the remainder of the stomach as far as the pyloric sphincter. Attached along the greater curvature is the great or gastro-colic omentum, and to the lesser curvature the lesser or gastro-hepatic omentum, whose left limitation is the oesophagus. Owing to the length of the oesophagus, and consequently of the lesser omentum, the stomach of the Macropod is laxer than that of the other Marsupials. The pyloric sphincter or knob, which is related to the visceral surface of the lower part of the right hepatic lobe, measures 4.5 cm. long, with a circumference of 8-9 cm. The walls may equal .5 cm. in thick-

STOMACH IN SITU, KANGAROO.

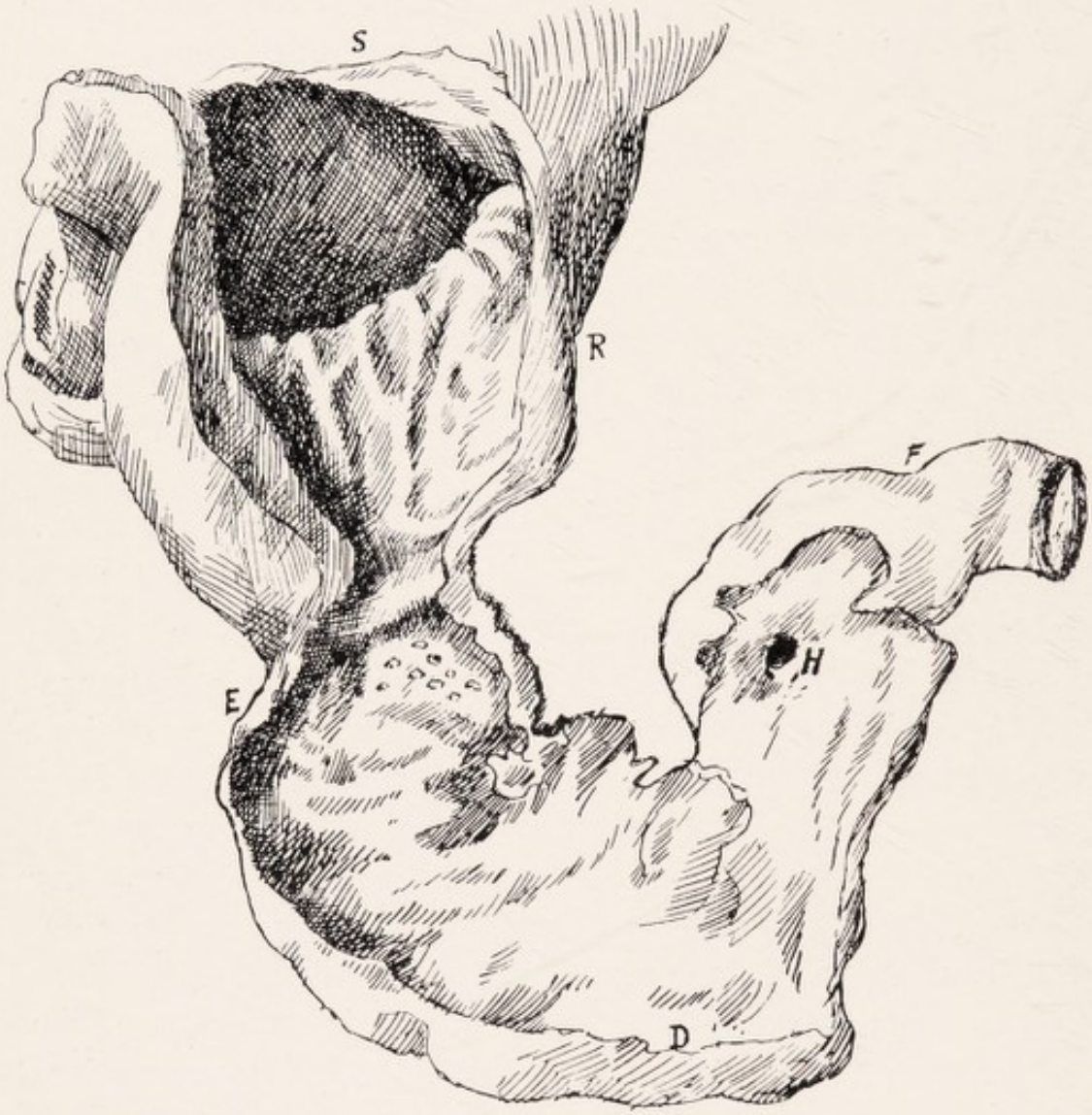
H Heart and Lungs, D Diaphragm, L Liver, S Stomach, C Caecum, T Small Intestine, E Ileo-Caecal junction, A Attached Colon.

ness. The interior of this portion is rugous, due to the presence of irregular longitudinal folds. On opening the stomach, three distinct areas of mucous membrane may be defined. Around the oesophageal opening the lining membrane is seen to be of a coarse, rugous character. It is epithelial and continuous with that of the gullet. This is mainly confined to the non-sacculated lesser curvature region, extending dorsally and ventrally between the dorsal and ventral longitudinal muscle bands, though not absolutely limited by these. Neither dorsally nor ventrally does it reach the greater curvature below. To the left of the oesophagus, it extends to the dorsal, but not to the ventral pouch or *cul-de-sac*. Occasionally I have seen an insulated epithelial patch on the left sacculated portion of the stomach. To the right of the oesophagus in Macropus Gig. it extends for about 7-8 cm., and usually ends abruptly and often with a defined ridge. Its termination practically corresponds to the commencement of the pyloric or non-sacculated portion of the stomach. The mucous membrane of the sacculated portion of the stomach, though smooth, is characterised by the presence of folds and sacculation. This is a glandular secreting area. The right or pyloric non-sacculated portion has its mucous lining smoother than that of the rest of the stomach, though Owen says it may be finely corrugated. It is glandular, and is characterised by the presence of a rounded patch, 2.5-3 cm. across, paler than the rest, smooth, but firm. This corresponds to the summit of the right division of the stomach, and here peptic glands are found. In connection with the lining membrane of the sacculated portion of the stomach lymphoid elevations are noted. These are not found in the pyloric or non-sacculated portion.

DUODENUM IN MACROPUS.

S Right extremity of Stomach, R Pyloric Sphincter, E Dilated commencement of Duodenum, D Duodenum, F Duod-Intest. Flexure, P Pancreas, H Bile Duct.

Duodenum.—This forms a somewhat V-shaped loop, ventral to the right psoas, liver, and kidney, so that a descending and ascending portion may be recognised. It is dilated for 1 cm. at its commencement, and the interior of this portion has an irregular rugous appearance, owing to the presence of glandular projections. Either the ascending or descending portion may be the longer, though occasionally in the Wallaby the two stems may be about equal in length. In the Kangaroo the descending stem varies from 5.5-8 cm., and the ascending pole 7-9 cm. The circumference of the ascending is less than that of the descending stem, and in a Kangaroo the width of the descending stem, collapsed, was 1.75 cm., and that of the ascending 1 cm. In a young Wallaby, the descending stem of the duodeum was 3.5 cm. long, and that of the ascending 6 cm. In a Tasmanian Wallaby, the measurements were 4.5 cm. and 6 cm. In a large adult Wallaby I found the dilatation of the commencement of the duodenum was more marked than in the Kangaroo, and was nearly three times the circumference of the rest. There was a tendency to twist at the loop, so that the ascending stem passed ventral to the descending stem. The descending limb measured 6 cm., and the ascending 8 cm. The pipe stemmed common bile duct enters the ascending duodenum about its middle. The opening is characterised by a slight papillary elevation, and is guarded by a sphincter. It lies in Macropus Gig. about 12-14 cm. from the pyloric sphincter, and about 7-10 cm. in Macropus Ualab. It may terminate close to the duod-intest flexure, and in a large Kangaroo I found it only 1.5 cm. distant. The ascending duodenum does not cross the mid-line. The duod-intest. flexure lies ventral to the dorsal wall, and is somewhat fixed. It lies behind the stomach, and is best seen by raising that organ. Though practically on a similar ventradorsal



Interior of Duodenal Region in Kangaroo.

S Right Extremity of Stomach, R Pyloric Sphincter, E Dilated commencement of Duodenum with Glands, D Duodenum, F Duod-Intest. Flexure, H Entrance of Common Bile Duct.

plane to the "fixed" colon, it lies 5 cm. dorsal to it. The duodenal loop is free—being provided with a mesoduodenum, and can be raised from the right psoas and kidney. It is not so mobile in the Wallaby as in the Kangaroo. Ventral to the lower part of the loop we have the right or proximal colon, and the root of the mesentery, and in relation to the meso-duodenum, within the loop, the right portion of the pancreas is noted. There is a well defined duodenal or right lateral fold connecting the ascending duodenum and the mesocolon of the left or distal colon. It is narrow above, but wider or more oblique below, where its width may reach 3 cm., and it may extend caudally almost to the pelvis. The finger can be passed behind the lower margin of the fold. Between the duod-intest flexure, the root of the mesentery and the upper part of the fold is a small but well defined duodenal fossa.

Small Intestine.—This is extensive and bunched into convolutions. It is swung on the latively narrow common mesentery, the greatest width of which varies from 16-18 cm. This Intestine may reach 600 cm. in length, and it has a somewhat uniform circumference of 4-5 cm. At its termination it lies obliquely parallel with the caecum before entering the large gut. In a Tasmanian Wallaby, I found the distal half greater in circumference than the proximal, and darker in colour.

Caecum.—The macropod has a well defined caecum much larger, however, in the Kangaroo than in the Wallaby. The caecum in the Kangaroo varies from 25-35 cm. in length, and the circumference when moderately distended is 8-10 cm. In the Wallaby the caecum varies from 7-12 cm. long, and the average maximum circumference is about 7 cm. Great variability is the characteristic feature of the caecal region of the Wallaby however. Thus I have seen the caecum resembling in character

CAECAL REGION IN KANGAROO AND YOUNG HAND-FED WALLABY.
C Caecum, M Mesentery of Caecum, E Ileo-Caecal junction, K Large Intestine, B Lymphatic Gland.

that of the human foetus. It measured 4.3 cm. long; the width of the proximal third was 1.25 cm., and of the distal two-thirds only .6 cm. In another the width was 3 cm., and length 5 cm. In two others the length was about 11 cm., but while the width of one at the tip and base were 2 cm. and 3 cm. respectively, in the other the measurements were 1.5 at the base and at the extremity 2.5 cm. The caecum is provided with a special mesentery, which extends between it and the lower border of the termination of the ileum in the Wallaby rarely extending to the end of the caecum, but in the Kangaroo traceable, though greatly narrowed, to the extremity. In a Kangaroo, however, I have seen its only trace for the distal 7 cm. was a fine shred of membrane. I have seen the terminal 2 cm. in both the Kangaroo and Wallaby devoid of mesentery and quite free. In two Wallabies, whose caecal length was 10 cm., the mesentery extended 3.75 cm. along the ileum and 3.75 along the caecum. In a typical specimen from a Kangaroo measuring 26 cm. long the greatest width of the mesentery between the caecum and ileum was 6.5 cm. It was traceable to the end of the caecum, though greatly narrowed. Its attachment to the ileum was only 9 cm., and its free edge was concave. In a specimen of Macropus major, three faint longitudinal bands were detected on the caecum, but approaching the ileo-caecal junction only two were present, which were continued on to the colon — one for 12 cm., and the other for about 40 cm. It is not usual to trace these bands to the distal or left colon. They are subject to great variation, and on a Wallaby's caecum 10 cm. long no bands were detected. Three distinct types of ileo-caecal orifice may be met with. It may be a transverse slit 1.5 cm. long, guarded by two lips or valves (proximal and distal), which coalesce at each

CAECAL REGION IN WALLABY AND KANGAROO.

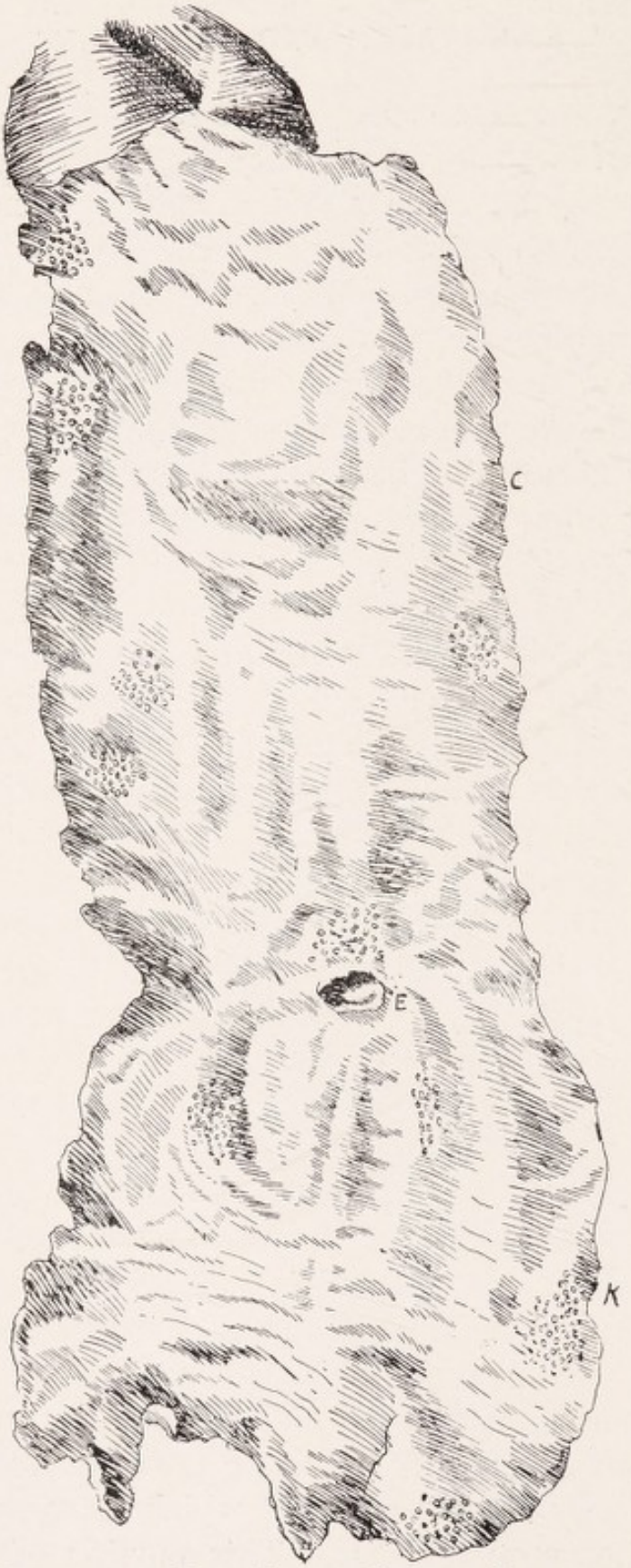
C Caecum, E Ileo-Caecal junction, K Large Intestine.

INTERIOR OF ILEO-CAECAL REGION, WALLABY.

C Caecum, K Large Intestine. E Ileo-Caecal Valve showing Retinacula.

extremity, and are continued as distinct retinacula for a short distance round the lumen. On the other hand, the aperture may be more rounded, the edges not being so defined, and no retinacula present; or we may have, as was present in an adult female Wallaby, a somewhat rounded sphincteric projection into the large gut of .5 cm., with ill-defined retinacula resembling somewhat the orifice in Koala. In macropus, vessels on a fine fold may be traced across the dorsal aspect of the termination of the ileum from the common mesentery to the mesentery of the caecum.

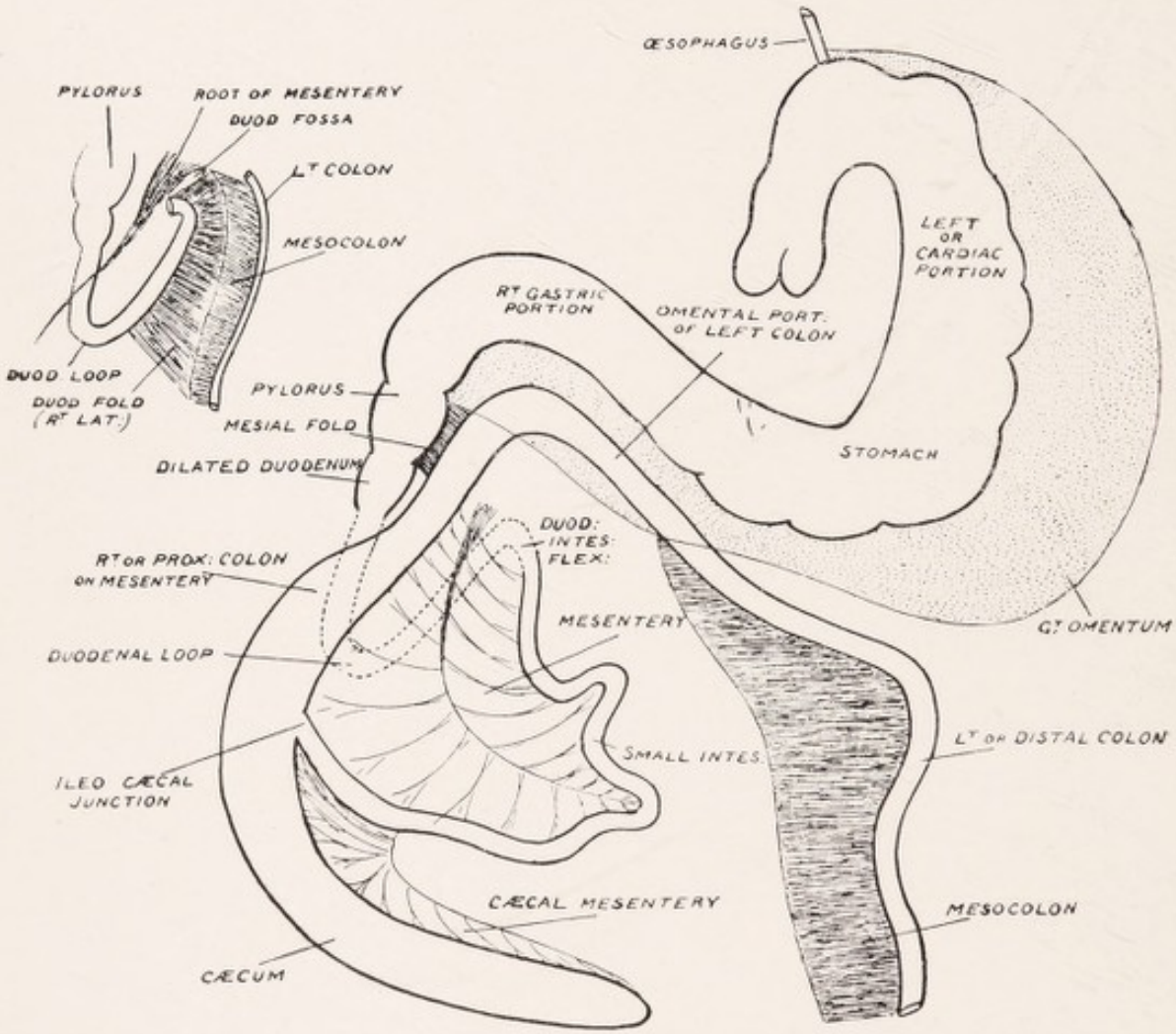
Colon.—The important feature of the colon, whose total length may reach 200 cm. in Macrop Gig. is its binding down, *i.e.*, relative fixidity, at the pyloric region and adjacent great curvature of the stomach, the arrangement of which is at first difficult to understand. The pyloric sphincter indicates the separation of the colon into two portions, *viz.*, right proximal, short, but wide mesenteric colon, and the left, distal, or mesocolic colon. It is interesting to note the presence of a band 2-2.5 cm. broad, which passes across the thickened pyloric sphincter of the stomach from the right of the lesser to the right of the greater omentum. This band, though adherent slightly to the pylorus, forms a continuity between the colon at the pylorus, and the lesser omentum. It is analogous to folds seen in the chameleon and in the bat (Cheiroptera), and is part of the ventral mesogaster. In a male adult Kangaroo, ascending from the ileo-caecal valve, which was proximal to the lower part of duodenal loop, the first 4 cm. of right or proximal colon was mobile, being swung on the common mesentery, the transverse measurement of which between colon and small gut was only 10 cm. This portion of colon lay ventral to the duodenal loop, from which it could be raised. It was closely applied at the pylorus, and the



INTERIOR OF ILEO-CAECAL REGION, KANGAROO.

C Caecum, K Large Intestine, E Ileo-Caecal Valve.
Note patches of Lymphoid Glandular Tissue.

distance between may be only 1.5 cm. This was followed by a comparatively fixed portion of colon (proximal portion of distal or left colon), 13-15 cm. long, really on the mesocolon, but closely related to the greater curvature of the stomach, owing to the fact that it and its mesocolon have been included in the great omentum. This is the contrast to the Koala, and obviously is associated with the erect attitude of the macropod. The relationship is to the greater curvature of the right division of the stomach, *i.e.*, non-sacculated, and portion of the sacculated parts, but I have never seen it extending in the Kangaroo to the left as far as the apex of the V, though almost reaching that part in an adult Wallaby. On the right, *i.e.*, near the pyloric sphincter, the distance between the colon and the great curve was 2 cm., on the left 7 cm., and between the two 3 cm. The colon is nearer the great curve in Wallaby than in Kangaroo. In this specimen the separation of mesocolon from great omentum was gradual. In another kangaroo the whole attachment, *i.e.*, inclusion by great omentum, equalled 20 cm., and of this 12 cm. was related to the great curve of the non-sacculated portion of the stomach. In another the distance between colon and great curvature on the right was 3.5 cm., and on the left 4.5 cm., *i.e.*, nearly uniform all along, so that the separation of mesocolon from great omentum was more rapid. Thus we see there is a closer attachment of the colon on the right than on the left. In the male Kangaroo described above, the width of the right colon when empty was 2 cm.—1.5 at the greater curvature—and on the mesocolon 1 cm. In another the width of the right colon when collapsed was 7 cm., and the left colon only 3 cm. Thus we see that the right colon is wide and the left comparatively narrow. In the Kangaroo whose caecum was 35 cm. long the right free colon was 10 cm. long, and width 5 cm., the attachment at pylorus



The Gastro-Intestinal Tract and Peritoneal Relations in Kangaroo.

and great curve was 17 cm., and the greatest width 2.5 cm., while the width of the left colon was 2.5 cm. In another 22 cm. of left colon was included in the lesser sac. In a series of Wallabies I found the measurements were as follows:—

Right Free Colon on Mesentery .	6	cm., width	4.5	cm.
„ „ .	10	cm., „	4.5	cm.
„ „ .	4.5	cm., „	4	cm.
Attached Colon at Great Curve .	14	cm., „	2.5	cm.
„ „ .	14	cm., „	2.25	cm.
„ „	11	cm., „	2.75	cm.

The width of the left mesocolic colon was about 1 cm.

In a Tasmanian Wallaby, while the length of the right free colon was 8 cm. and width 3.75 cm., the width at the attachment was only 1.75 cm., and 10 cm. from the pyloric sphincter scybala were noted in the colon. The lesser sac, *i.e.*, great omentum, extends on the right to the pyloric sphincter. We frequently see a peritoneal adhesion or band from the dextral margin of the right free colon to the descending duodenum, even as far as its lower third; and in a foetus I have seen a peritoneal band connecting the right colon to the whole of the descending duodenal. Here Nature gives us an indication of her method of dorsal fixation of the colon. The mesentery, though shortened, is not dorsally fixed, *i.e.*, the base or dorsal attachment is not lengthened, and further, the mesoduodenum is present.

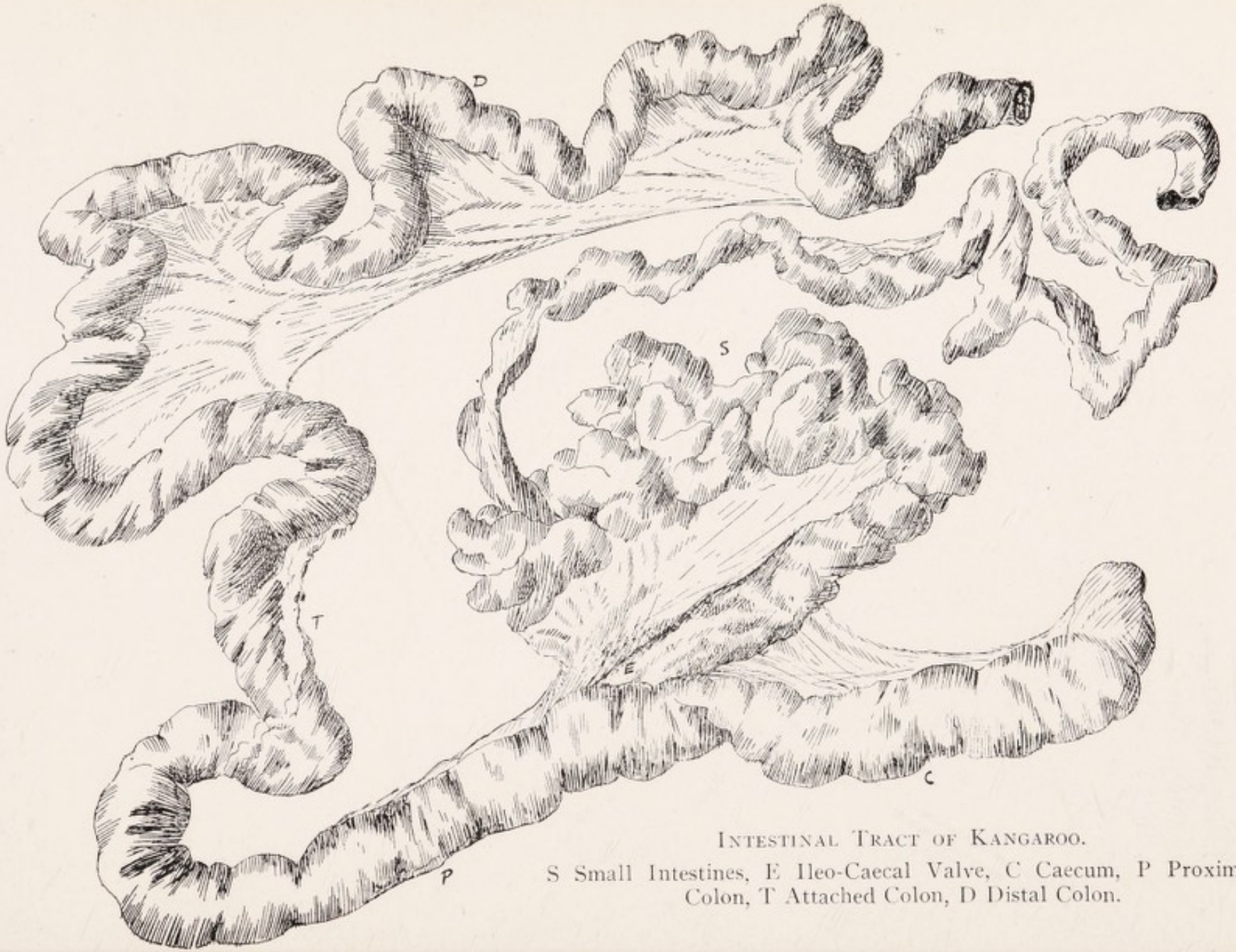
Left Colon.—This begins at the pyloric sphincter, and, as state above, is at first included in the lesser sac, *i.e.*, great omentum. Leaving the great omentum, it is seen to be swung freely on the mesocolon, the greatest width of which may equal 7-12 cm. This is attached dorsally for about 10 cm. between the two psoas muscles and the kidneys, and gradually disappears into the pelvis. The colon is looped, and measures in the Kan-

Relation of Colon and Stomach in Kangaroo.

S Stomach, P Pyloric Sphincter covered by Ventral Fold, N Duodenum, S Small Intestine, C Caecum, E Ileo-Caecal junction, P1 Proximal Colon, M Great Omentum, D Distal Colon.

garoo 80-100 cm., and in the Wallaby about 46 cm. As showing the method of inclusion of distal colon by the great omentum, a peritoneal band may be noted passing from the left of this structure to the commencement of the distal colon swung on the mesocolon. Soft scybalous formation may be noted near the commencement of the distal colon swung free on the mesocolon. The gut is finally traced into the pelvis, passing not laterally, as in Koala and Wombat, but mesially, and is more mobile than is the case in those Marsupials. The rectum or pelvic portion has its proper sphincteric termination, surrounded with the genital outlet, by the common sphincter. *The Large Intestine may be thus summed up.* There is a well defined freely mobile caecum. This is followed by a mobile wide but short right or proximal colon swung on the mesentery extending as far as the pylorus, to which the colon is closely applied, and frequently connected by a band or bands to the descending duodenum The left or distal colon begins at the pyloric sphincter. It is narrower, though longer than the proximal portion, and at first is related to the great curve of the stomach, being with its mesocolon included in the lesser sac, *i.e.*, great omentum. Leaving the omentum, it is traced into the pelvis, being looped and swung freely on a mesocolon.

Interior of the Large Intestine.—In the Kangaroo the mucous membrane in both the caecum and colon is comparatively smooth, presenting a fine network, and patches of lymphoid follicles are met with in the ileo-caecal region, both in colon and caecum. In the Wallaby well defined raised longitudinal folds are met with in the interior of the caecum. Around the ileo-caecal orifice the mucous membrane is smoother, but in the colon longitudinal folds are again seen, though at the stomach attachment the folds, though still giving a marked rugous character, may be more transverse. Lymphoid patches



INTESTINAL TRACT OF KANGAROO.

S Small Intestines, E Ileo-Caecal Valve, C Caecum, P Proximal Colon, T Attached Colon, D Distal Colon.

are met with, especially near the ileo-caecal junction, and more markedly in the Kangaroo than the Wallaby.

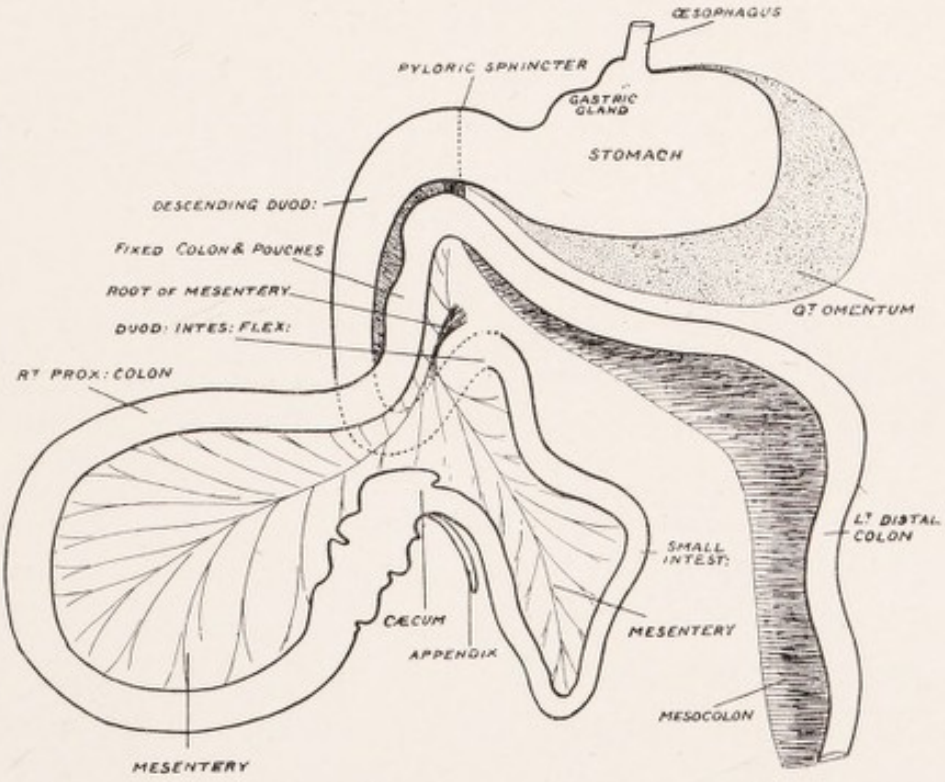
The contents of the caecum are usually in Macropus Gig. of a green pultaceous character. These become less fluid as we proceed along the colon. Soft scybala are met with just beyond the left of the omental relationship, which become firmer as we approach the pelvis.

THE GASTRO-INTESTINE OF THE WOMBAT (PHASCOLOMYS).

The Stomach of the Wombat may be described as a somewhat oval structure lying obliquely in the epigastric and left hypochondriac regions, and the oesophagus terminates almost immediately on passing through the diaphragm. After a feeding the stomach becomes more rotund and extends to the right hypochondrium as well. When collapsed the greatest length equals 12-15 cm. and width 7-8 cm. In an old male Wombat shot when feeding the lateral measurement was 20 cm., and greatest width 12 cm. The lesser curvature is shorter in the Wombat than in the Koala, and even in a large male may not measure more than 3-4 cm., whilst the great curve may reach 27 cm. The distance of the oesophageal orifice from the cardiac extremity is about 5 cm. Along the lesser curvature is attached the lesser omentum, and dependent from the great curvature is a well defined great omentum. On the dextral side of the oesophageal orifice, and extending along the lesser curvature, there may be felt externally a thickening denoting the position of the gastric gland characteristic also of the stomach of Koala and the Beaver. On examining the interior of the stomach this gland is seen to be slightly raised above the mucous membrane, and is larger than in the Koala. About 24 orifices are noted, and at the bottom of the main pits smaller openings are seen. It measures 3-4 cm. long, and 1.5 cm. at widest part. Its pyloric extremity is narrower than the cardiac. The fundus or left portion of stomach is com-

THE STOMACH IN WOMBAT.

E Oesophageal Orifice, K Gastric Gland, P Pyloric Sphincter, D Duodenum.



THE GASTRO-INTESTINAL TRACT AND PERITONEAL RELATIONS IN WOMBAT.

paratively thin walled, whilst the dextral portion is firmer and the wall thicker, especially the narrow pyloric portion. On examining the interior of the stomach the mucous membrane of the cardiac extremity is smooth, but the remainder is markedly rugous owing to the presence of longitudinal and transverse ridges. In the small right or pyloric portion, usually defined by an external depression or constriction, the rugous honeycombed condition of the body takes on the character of parallel ridges, and the wall may equal .5 cm. in thickness. This is succeeded by the thinner walled duodenum, the thickness of which may be only 1 mm. The pyloric valve is well defined, and when the pyloric region is opened and the walls divaricated, it forms a projection above the commencement of the duodenum of about 3 mm. There is not that distinction into the right ascending or pyloric portion of the stomach and the left cardiac portion seen, *e.g.*, in Koala and Tasmanian Devil, and in one specimen where the lateral measurement was 14 cm. and width 8 cm., the right narrow pyloric portion was only 2 cm. long and 2 cm. across. In some cases, so marked is the rugous character of the interior, that the gastric gland is scarcely discernible.

Duodenum.—There is a well-defined duodenal loop, and four portions, as in the human duodenum, may be recognized, viz.:—

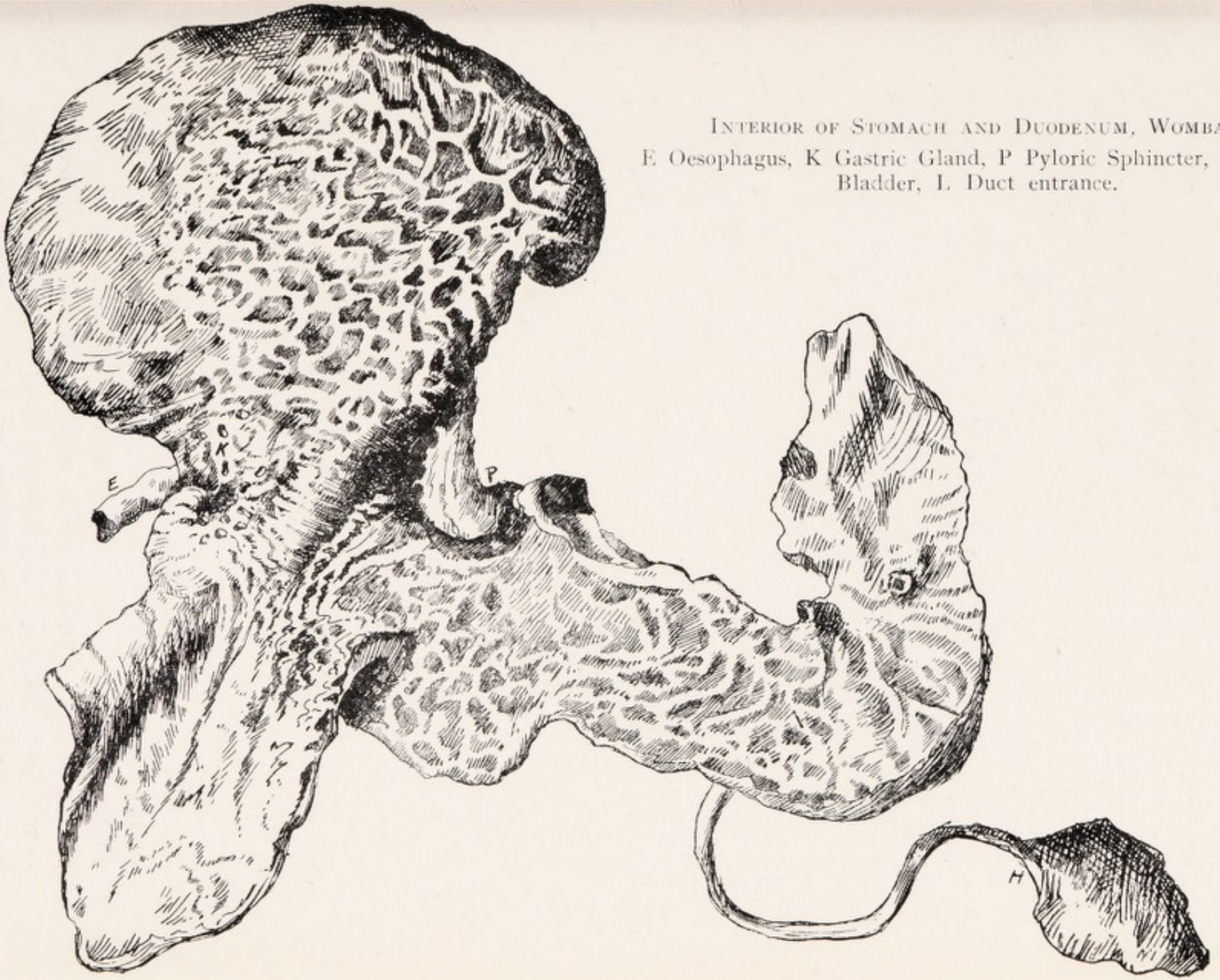
First slightly dilated, directed down and out for 2-3 cm.

Second or descending, 9-12 cm.

Third or transverse, 1.5 cm.

Fourth or ascending, 3 cm.

It lies ventral to the right lobe of the liver and right kidney, off which it may be raised. Owing to the dorsal fixation of the pancreas, which fills the loop, the duodenum presents little independent mobility, being less

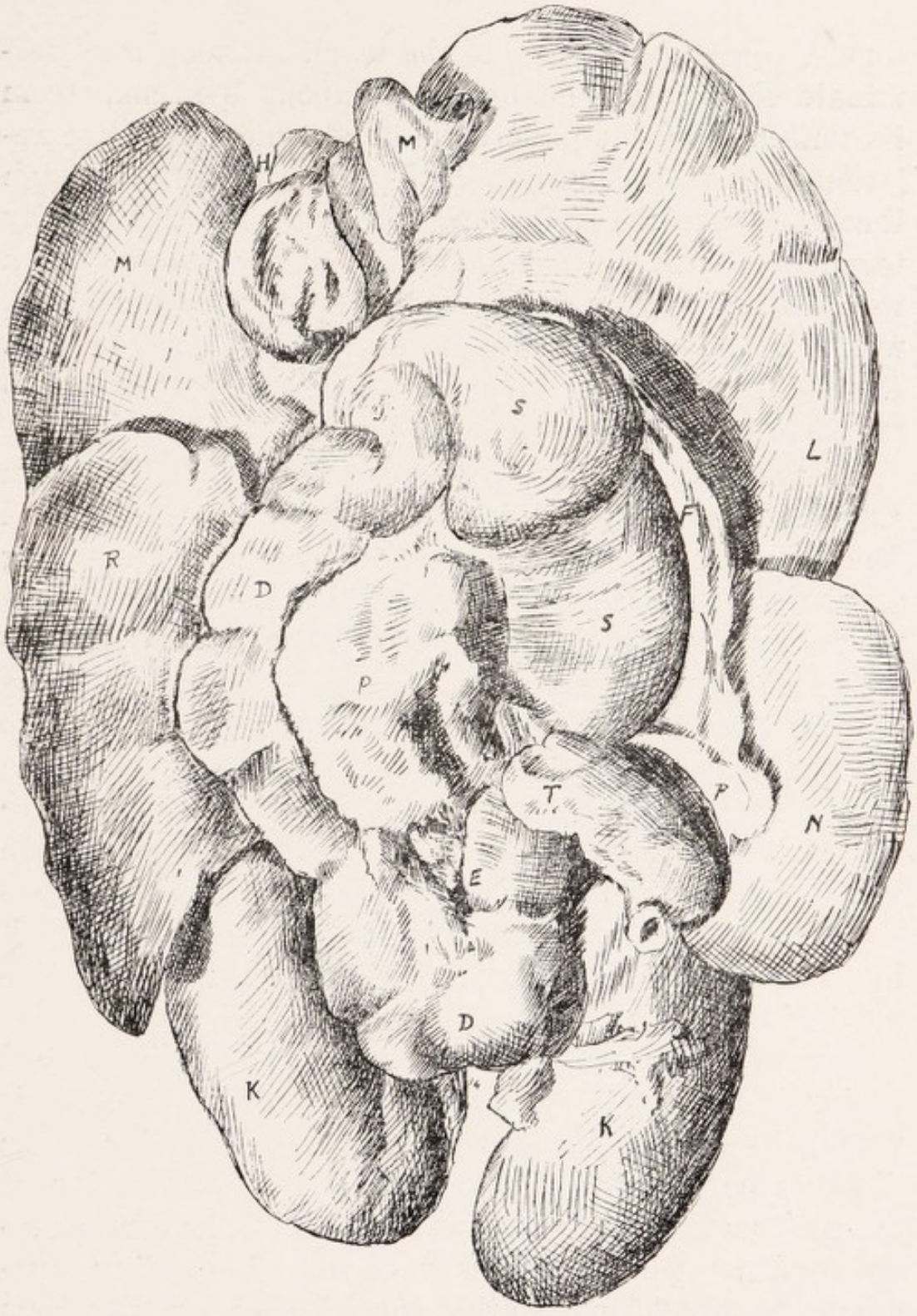


INTERIOR OF STOMACH AND DUODENUM, WOMBAT.

E Oesophagus, K Gastric Gland, P Pyloric Sphincter, H Gall Bladder, L Duct entrance.

mobile than in other Marsupials—*i.e.,* it has a shorter mesoduodenum, although I have not met any case of actual adhesion of the descending duodenum to the liver or the kidney, as in Echidna. The lower portion of the loop is free, and the bend corresponds to the lower pole of the kidneys. The ascending duodenum passes up, and the left of the mid-line to the duod-intest. flexure, where it is continued on to the small intestine. In relation with this portion, there is a right lateral or duodenal fold connecting it to the dorsal abdominal wall ventral to the left psoas minor and near to the attachment of the mesocolon of the left or distal colon. This fold is transverse above, and equals .5-1 cm. in width, while below the lower free margin is 2-2.5 cm. in width, and more oblique; but it rarely extends below the inferior pole of the left kidney. Between the upper part of the fold — the root of the mesentery — and the duodeno-intestinal flexure a small pocket is noted—primary duodenal fossa. In one specimen with the duodenum more fixed dorsally no duodenal fold could be demonstrated. There may be no defined first portion of the duodenum, and instead of a third of transverse portion the two stems—descending and ascending—may form an angle which occasionally is acute. The lining membrane of the duodenum is coarse rugous resembling somewhat that of the stomach. This is traceable as far as the duct entrances. After that the inner membrane takes on a finely striated character.

The Common Bile Duct is traced on the right of the gastro-hepatic omentum ventral with the portal vein, to the inf. v. cava. It passes behind the pylorus and commencement of the duodenum and descends in the substance of the pancreas, from which it has to be dissected —within the duodenal loop—to finally terminate in the ascending limb of the duodenum lying nearer to the



RELATIONS OF STOMACH AND DUODENUM IN WOMBAT.

S Stomach, D Duodenum, E Termination Bile Duct. T Duod-Intest. Flexure, F Great Omentum, P Pancreas, K Kidneys, N Spleen, H Gall Bladder, M Mesial lobe Liver, R Right lobe Liver, L Left lobe Liver.

duod-intest. flexure than to the bend. It may even terminate close to the flexure. At about 3-4 cm., from its termination, the pancreatic duct comes into close relation with it, becoming adherent to its wall, although it can be separated right down to the intestine. It finally terminates with the common duct at the summit of a well defined papilla in the interior of the duodenum, which lies about 14-16 cm. from the pyloric sphincter. From this papilla a probe may be passed directly into the common or pancreatic duct.

Small Intestines.—This varies from 130-170 cm. in length. I have met with it 300 cm. long in a "recent" old female specimen, and it may be even longer. It is swung on the common mesentery, the width of which at its widest part reaches 15-17 cm., and is thrown into a series of loops, though not so markedly as in Macropus. The interior presents a finely rugous character owing to the presence of fine transverse striations. As we approach the ileo-caecal valve the mucous membrane becomes more rugous in character, the wall more rigid, and two or more well defined peyers patches are to be noted. The circumference varies from 5-6 cm. At its termination the small intestine usually forms a right angle with the commencement of the large intestine.

Ileo-Caecal Region and Appendix.—The ileo-caecal region is adjacent to the root of the mesentery, and it may be regarded as a fixed part of the intestine. The distance between this region and the attached colon at the pylorus is 6 cm., while between it and the commencement of the colon attachment to the descending duodenum is only 2.5 cm., so that tucked close together form above downwards we have descending duodenum, attached colon, root of mesentery, duod-intest. flexure to the left and dorsal, then the ileo-caecal region. This association I regard as being dominated by the right

vagus nerve, and it is interesting to note that I have been able to trace a direct branch of the vagus to this region. The commencement of the colon is firm walled and characterised by a puckering, producing irregular sacculation and depression. Occasionally the presence of longitudinal bands may be noted, but the sacculation I regard as dependent on the above relation. The intestinal tract of this Marsupial, like that of the Anthropoid Ape and Man, is characterized by the presence of a true vermiform appendage, which has, however, reached a more retrogressive stage than either. An average length would be 4.5 cm.

The classical description of the human appendix by Sir Frederick Treves still forms the basis for classification. He recognised four types. (a) Infantile, with muscle bands equi-distant; (b) caecum, more quadrilateral, appendix appearing between two bulging sacculi; (c) apex turned to the left and dorsally, the base of the appendix being brought nearer the ileo-caecal valve; (d) sacculus to the right relatively large, while that to the left has disappeared—the root of the appendix appearing to spring almost from the ileo-caecal junction. No anatomist has ever suggested that the relatively large size of the right sacculus was the result of some reversion to a more bulky diet. These four variations become intelligible—not mere statements of fact—if we recognize that each represents a co-ordinated sequence of the other; each is part of a co-ordinate scheme in the evolution of the appendix and no one variation can be regarded as the type.

In 1902 Dr. Lomberg advanced the opinion that if the Wombat's appendix were a true vermiform appendage—*i.e.*, the reduced blind end of a caecum—it ought to have opened into the caecum of which it was a part; "as it does not, but opens with a quite independent opening

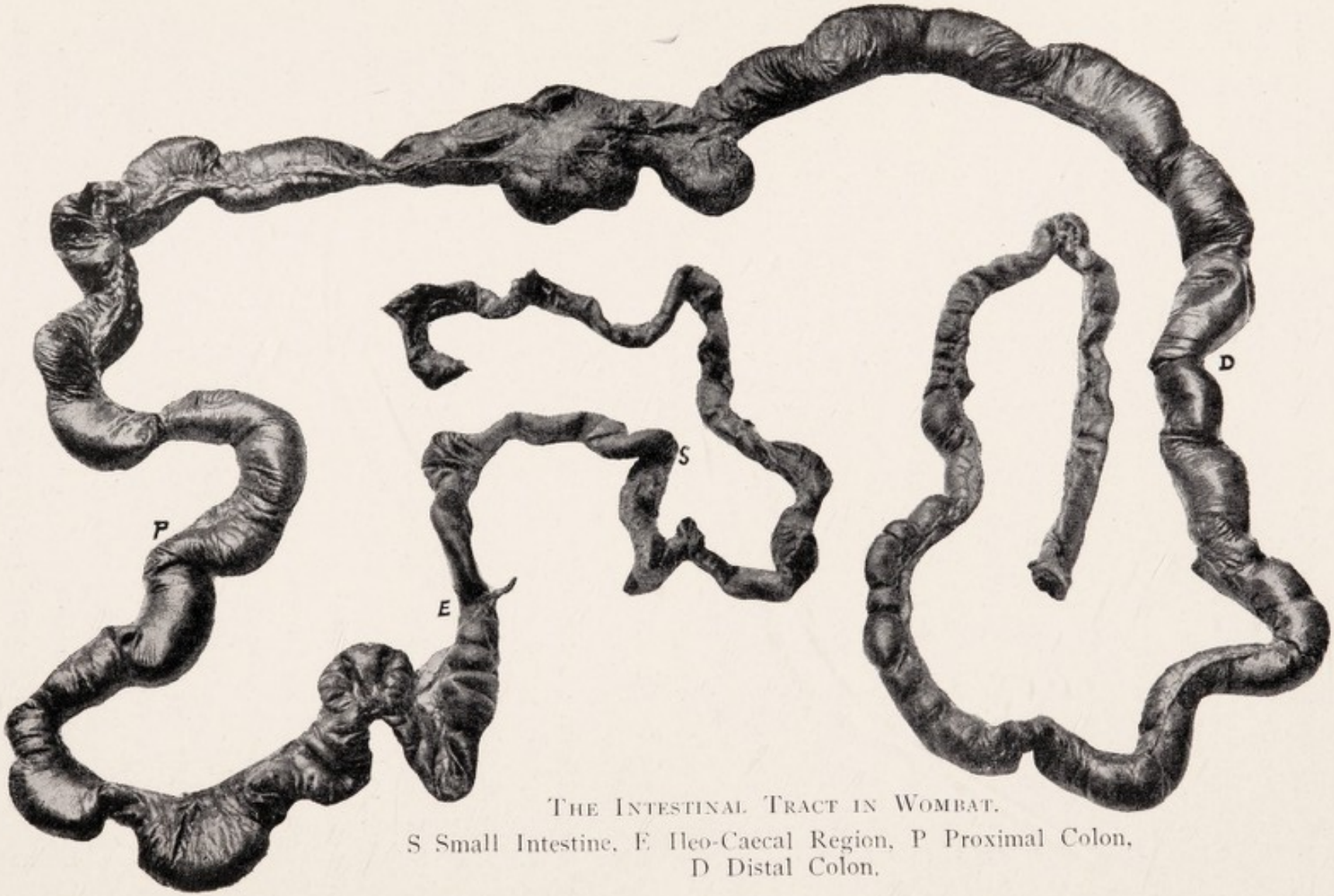
Types of Vermiform Appendage in Wombat (Phascolomys Mitchelli).
E Termination of Ileum, C Caecum.

of its own near that of the ileum," he judged that the so-called processus vermiformis of the Wombat represents a rudiment of the whole caecum, since it acquires a similar situation, opening into the colon in relation with the ileo-caecal valve. A new caecum becomes formed behind the caecum, the result of a bulge of the colon owing to food alterations—*viz.*, reversion to a more bulky diet. Apparently Lonnberg's material was limited, as he tells us, when discussing the colic sacculi, that he had worked on two animals, and further, his description might equally apply to the fourth variety of the human caecum in which, according to Deaver, the internal sacculus has disappeared entirely, and the base of the appendix is attached to the caecum dorsal to the receding angle between the ileum and the caecum, the opening being sometimes in relation with the ileo-caecal valve. Furthermore, we have no evidence that food alterations presumably recent have occurred. A reference to two specimens showing a mesentery in which the lumen of the appendix is patent, indicates the rotation taking place, and shows the base of the appendix corresponding to the true apex of the caecum. In a specimen where the internal opening, which was not within the lips of the ileo-caecal valve, has closed, and the appendix is adherent to the ileum, not only has the left sacculus disappeared, but the right has atrophied almost up to the level of the ileum. The average human caecum, *i.e.*, one approaching the fourth type, has a depth of about 6 cm. In the case of a young Orang-Utang, in the Hunterian Museum, the depth of the caecum is 2.5 cm. and the width 4.5 cm. This approaches the fourth type—the termination of the ileum running obliquely through the intestinal wall being in juxtaposition to the appendicular orifice. An examination of a series of twelve Victorian Wombats showed that the caecal depth varied from 1 to 1.5 cm. In two cases it

was only 0.5 cm., and in one case was actually on the ileal level. In a latifrons, with a well-defined lumen, mesentery, and appendix the pouch was 3 cm. deep, and in another (Mitchelli), with the appendix obviously the apex of the caecum, the depth equalled 4 cm. and the width 5 cm. The lumen of the appendicular canal was incomplete in 64 per cent. of specimens. After the twentieth year, 32 per cent. of human appendices are obliterated. The approximation of the base of the appendix towards the ileo-caecal valve is quite in accordance with the evolutionary trend of that organ. Lomberg believes such a movement took place. Yet he would not admit of the classification of the Wombat with Man and Ape, because he believes a new caecum has been formed, the result of supposed diet alteration. To favour that view from the examination of a large number of specimens I have failed to find evidence that, apart from the formation of a new caecum, even the right external sacculus has enlarged. On the contrary, there is abundant evidence of atrophy. Owen's generalisation, that "the caecum in the Wombat is extremely short but wide; it is remarkable for being provided with a vermiform appendage" must be still accepted. By a study of the vermiform appendix in the Wombat Nature offers us the clue to the mode of disappearance of that structure in Man, since we can trace it from the fourth human type to complete disappearance. It may be found as in Phascolomys latifrons quite independent of the ileum with a well defined mesentery, or the mesentery may be only partial, and the base be in relation with the termination of the ileum, or the mesentery be altogether absent and the appendix finally becomes incorporated into the wall of the ileum, and the various grades of this may be seen; and in one specimen no appendix was present—the only structure being a firm knob on a shred of mesentery. In none of the specimens

I have examined was there evidence of any inflammation. Thus a complete co-ordinated sequence in Man and the Wombat from the foetal or infantile type of caecum to one showing complete disappearance of the appendix is clearly demonstrated. Glandular patches are noted in the ileo-caecal region on both the large and small intestinal aspects. Two varieties of the ileo-caecal valve may be noted. If we open the ileo-caecal region from the colic side and examine the interior with the mesentric edge of the gut dependent, *i.e.*, the appendicular edge of the ileum uppermost, the ileal orifice is seen to be slit-like and formed by two well defined musculo-glandular folds. These may project from the surface for a distance of 1-1.25 cm., but this is less marked towards the mesenteric edge of the gut. The slit-like interval may measure 2 cm., and at the upper part where the development of folds is most marked is the depression corresponding to the orifice of the appendix when the lumen is partially, or completely patent. A distinct septum exists between the orifice of the appendix and that of the ileum. The arrangement is comparable to that of the human female external genitalia—the appendicular orifice corresponding to the urethra and the lower to that of the vagina. In one specimen I found the valve was a tongue-like process, somewhat curved at the free extremity placed between the ileum and caecum. From the attached to free edge equalled 1.5 cm., and laterally well defined fraenulae were noted. In this specimen, though there was a partial appendicular canal, the opening was non-patent.

Proximal or Right Colon.—This portion of large intestine extends from the caecum to the attachment at the pylorus (mesial fold). It is attached to the first and descending portions of the duodenum, and its proximal 5 cm. may be regarded as fixed like the ileo-caecal region. Apart from these "fixed" portions, the proximal colon



THE INTESTINAL TRACT IN WOMBAT.
S Small Intestine, E Ileo-Caecal Region, P Proximal Colon,
D Distal Colon.

is freely mobile and swung like the small intestine on the common mesentery. It measures in an adult about 175-220 cm. For about the first 25 cm. the wall is firm, rigid, and irregularly sacculated, and the mucous membrane is rugous, due to the presence of fine transverse folds. The lining membrane of the greater part of the proximal colon is, however, smooth. The average circumference of this portion may reach 10 cm., and the greatest width of the mesentery may reach 22 cm. Towards its termination the right colon passes ventral to the loop of the duodenum, pancreas, and mesoduodenum, and becomes closely applied to the descending and first portion of the duodenum, as well as to the pylorus. The length of this attached portion of the colon varies from 12-15 cm. The attachment is usually so close to the duodenum that no membrane can be detected between the two; but sometimes a slight interval may be noted. It is interesting to note the presence of one, usually two, pouches on the colon at this attachment. These I regard as mechanical and not functional in origin. The circumference of the intestine here may reach 20 cm., and the pouches measure in greatest length 6 cm., and in greatest width 5 cm. Occasionally a contracted portion may be met with before the pouches are reached. Frequently, however, the circumference of the colon is increased on each side of the pouches so that a greatly enlarged portion may be noted reaching nearly 30 cm., in length.

Left or Distal Colon. — This extends from the pylorus to the pelvis, and is continued as rectum along the left wall of the pelvis to its termination. It measures, including rectum, about 230-300 cm., and apart from the rectal portion, which is closely related to the left pelvic wall, is swung freely on the mesocolon or colic mesentery, the greatest width of which may equal 25 cm.,

so that it is laxer than the proximal colon; the dorsal length of the mesocolon is about 15 cm. For its proximal two-fifths the circumference, like that of the right colon, equals about 10 cm., while the circumference of the remaining portion, which is more uniform and firmer walled, with the mucous membrane more rugous, only equals 2 cm. Scybala are noted 70 to 90 cm. from the termination, though I have seen these much nearer the pyloric attachment. The anal termination of the Intestine has its own sphincter, but this, as well as genital outlet, is surrounded by the common sphincter. It thus conforms to the usual Marsupial character, which is really Monotrematous. A noted exception is the Tasmanian Devil.

THE GASTRO-INTESTINAL TRACT IN KOALA (PHASCOLARCTUS CINEREUS).

The Oesophagus in both the Wombat and Koala does not traverse the abdomen as in Macropus, where it often reaches 4-5 inches in length.

The Stomach might be described as an elongated oval body, and occupies *in situ* a somewhat oblique position in the epigastric and left hypochrondriac region, the pyloric extremity looking ventrally, and the cardiac extremity being placed dorsally. The greater curvature having attached the great omentum and spleen looks ventrally, and the lesser curvature, to which the lesser or gastro-splenic omentum is attached, lies hidden dorsally. When distended after a feeding, the stomach is more rounded in shape and occupies a more horizontal position. On removal of a stomach that has been fixed by formalin, the organ is seen to present a somewhat looped shape, the left stem of the loop, which is directed down, and to the right being the larger of the two, and containing the fundus or cardiac extremity, the oesophageal opening, and conglomerate gland—the right or pyloric portion directed up and to the right being more vertical, shorter, and narrower. In an average formalin hardened specimen the circumference of the left stem equalled 15 cm., and the right 8 cm., and in the same specimen the greatest length of the stomach was 16 cm. and the breadth 6 cm.; the greater curvature measuring 23 cm., and the lesser curvature 6 cm. In a specimen examined shortly after

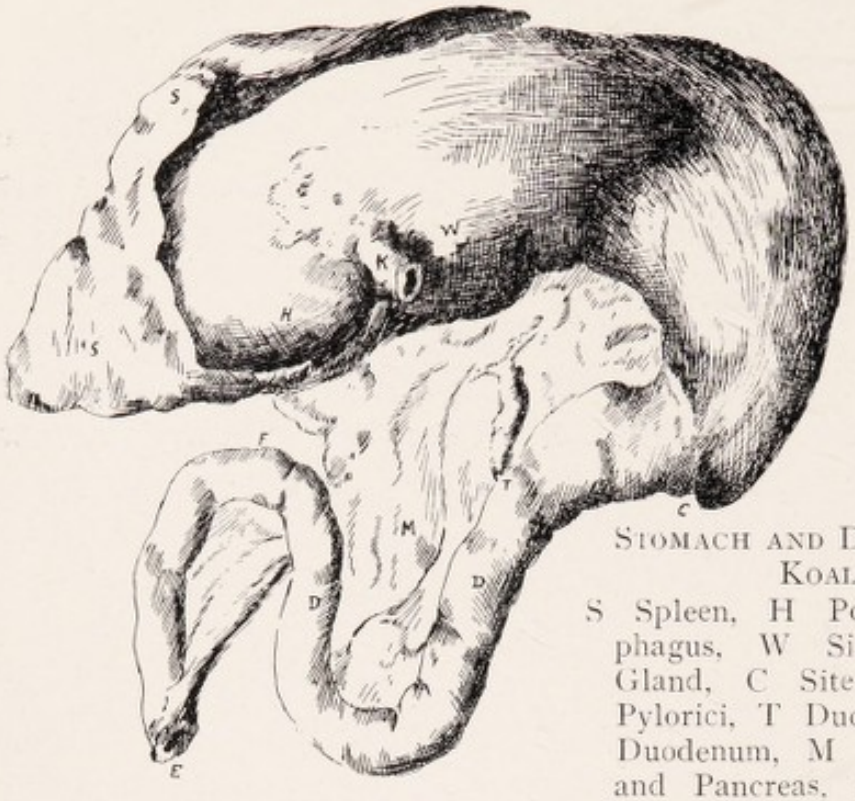
STOMACH AND DUODENUM IN KOALA.

S Spleen, K Oesophagus, H Pouch, W Site of Gastric Gland, R Site of fold on interior between Pyloric and Cardiac portion, C Position of Sphincter Pylorici, D Duodenum, T Terminations of Ducts, M Pancreatic Tissue and Mesoduodenum, F Duod-Intest. Flexure, E Portion of Small Intestine.

a feeding, the greater curvature was 30 cm., and the greatest breadth 11 cm.; and the circumference of the left stem was 23 cm. The oesophageal orifice usually lies 3-4 cm. from the left or cardiac extremity.

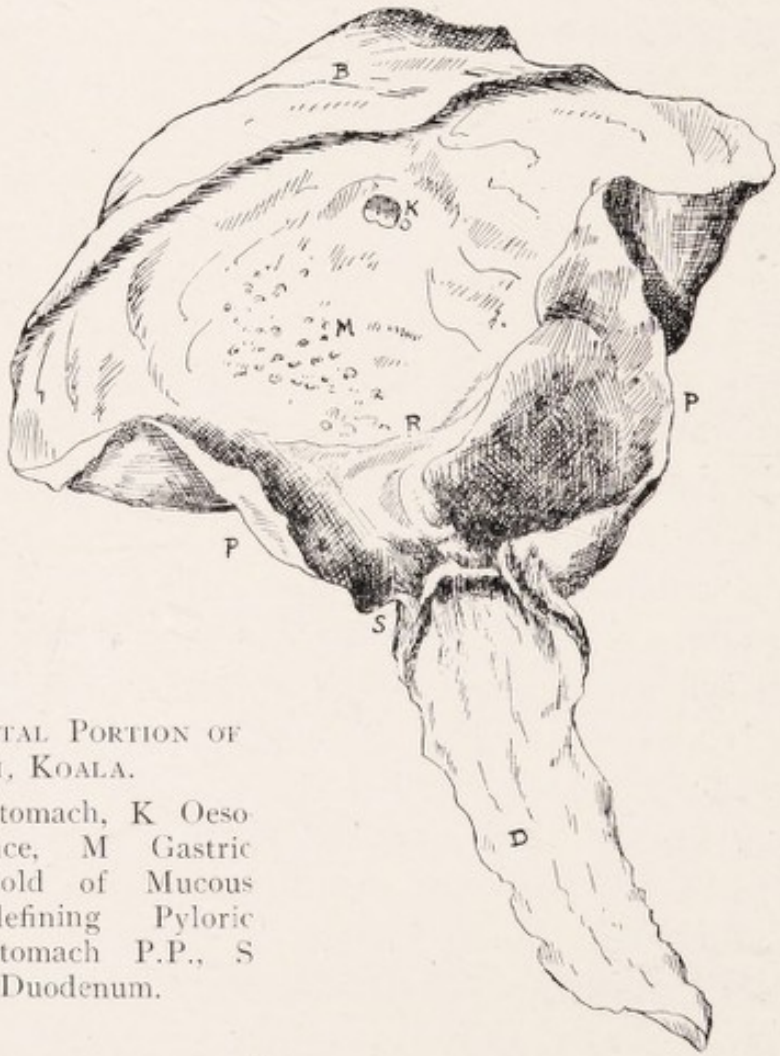
In a young specimen the lesser stem was 4 cm. long, and the larger left 10 cm. In an adult, where the left stem equalled 17 cm. and right 5 cm., the latter pole was narrow with a rigid scirrhus-like feel. In two adults the right stem in one was 6 cm. long, and left 13; and in another the right was 6, with a circumference of 10 cm., and the left was 17 cm., with a circumference of 25 cm. In this Marsupial, whose diet consists solely of Eucalyptus leaves, it is to be expected that great varieties in shape and size will be met with depending on the time elapsing after feeding. A peritoneal fold is noted to the left of the lobus spigelli, more developed in some specimens than in others, attached below to the stomach in the lesser curvature region, above to the left lobe of the liver, and dorsally to the lesser omentum, with which it forms practically a right angle. This fold corresponds externally to the junctions of the large left cardiac stem and the smaller right pyloric stem. To the left of the oesophageal orifice a pouch may be noted reminding one of the pouches seen in Macropodidae, the stomach of the Kangaroo being provided with two, while in the Wallaby a single pouch only is met with.

The Stomach of the Koala, like that of the Wombat, is characterized by the presence of a glandular structure—gastric gland—which forms a more distinct prominence externally than that of Phascolomys, and lies along the lesser curvature to the right of the oesophageal orifice, but nearer that opening than the pyloric orifice. It measures 3 cm. long and 2.5 cm. wide. On opening the stomach the gland is seen to be more defined from the surrounding mucous membrane than in the case of the



STOMACH AND DUODENUM IN KOALA.

S Spleen, H Pouch, K Oesophagus, W Site of Gastric Gland, C Site of Sphincter Pylorici, T Duct entrances, D Duodenum, M Mesoduodenum and Pancreas, F Duod-Intest. Flexure, E Small Intestine.



INTERIOR OF DISTAL PORTION OF STOMACH, KOALA.

B Fundus of Stomach, K Oesophageal Orifice, M Gastric Gland, R Fold of Mucous Membrane defining Pyloric portion of Stomach P.P., S Sphincter, D Duodenum.

Wombat, and the openings number 20-25. It is important to note that the simple chronic ulcer in the human stomach is met with about that situation. On the left of the oesophageal orifice corresponding to the fundus the mucous membrane presents a raised rugous appearance due to the presence of distinct folds of membrane. The remainder of the mucous membrane of the stomach presents a slightly roughened appearance and feel, due to the presence of fine longitudinal folds, which usually terminate at a distinct transverse fold of mucous membrane extending across the stomach, which serves to distinguish the left cardiac stem from the right pyloric, where the mucous membrane is smooth in character.

About 3-4 cm. from the pyloric opening the mucous membrane begins to thicken, finally terminating in a distinct pyloric ring .15 cm. broad.

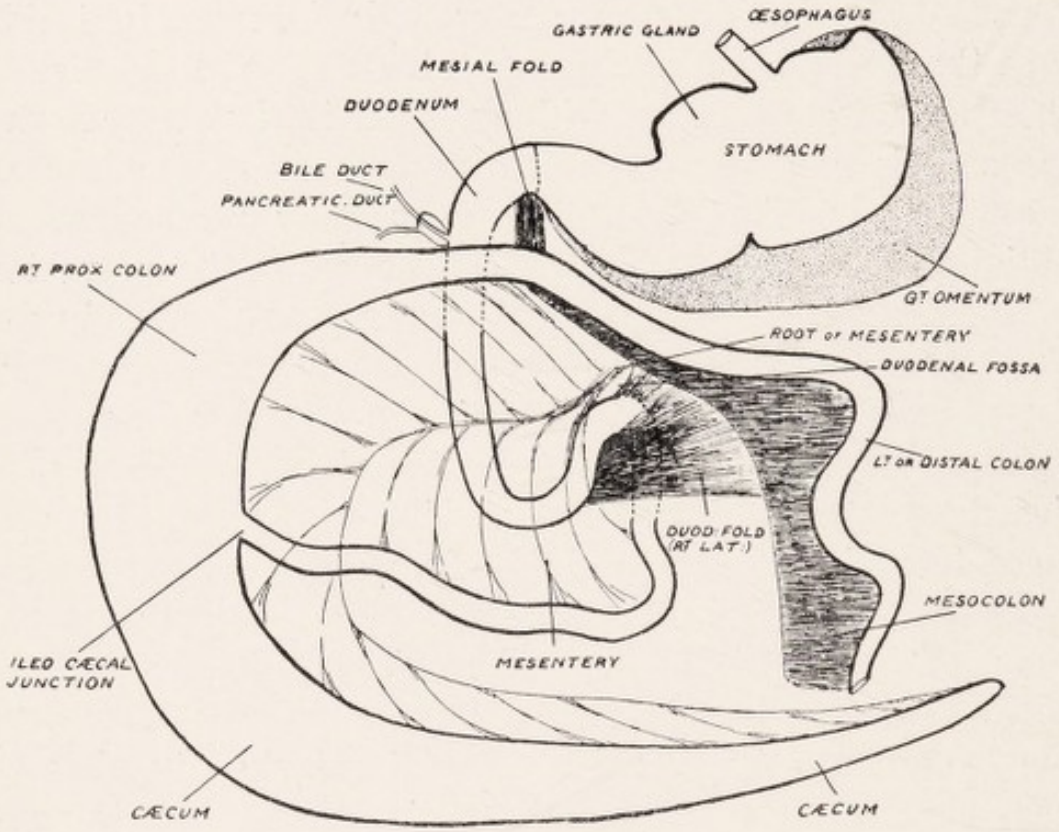
Duodenum. — This forms in Koala an almost V-shaped loop, the proximal or descending arm of the loop being longer than the distal or ascending arm. In a recent specimen the proximal stem measured 15 cm., and the distal 8 cm., and in a formalin one the proximal was 6.5 cm., and the distal 3 cm. In a young specimen the descending stem measured 6 and the ascending 4 cm. The common bile duct and pancreatic duct open independently into the descending stem 4-5 cm. from the pyloric sphincter. For its last 2 cm. the pancreatic duct dilates into a sac 1 cm. across. Dorsal to this lies the common duct in close relation to the sac wall. On reaching the wall of the duodenum the pancreatic dilatation narrows and runs like the bile duct obliquely through the gut wall. They open separately into the interior, a septum being between the two. These openings may be noted at the summit of a papillary projection, or this may be absent and the openings only detected after the passage of fine probes. The duodenal loop is swung on a narrow meso-

INTERNAL VIEW OF STOMACH, KOALA.

K Oesophageal termination, B Fundus, M Orifices of Gland, F Body of Stomach, R Fold separation Pyloric portion from body of Stomach, P Pyloric portion, S Sphincter, D Dilated commencement of Duodenum.

duodenum, the whole being freely mobile and able to be raised off the liver and right kidney. For the first 2-3 cm. the duodenum is dilated, and in some specimens almost merits the designation of a first or transverse duodenum. The width of this portion may equal 3 cm., the remainder of the duodenum having a somewhat uniform width of about 1.6 cm. The descending stem passes ventral to the liver and upper two-thirds of the right kidney, though in a young specimen it extended 2 cm. below the inferior pole of the kidney. At its lower part the mesenteric root passes ventrally, and at the upper part the colon. The ascending stem may be somewhat obliquely placed so as to give the duodenum the character of an omega loop, though this is never so marked as in the Wombat. This stem rarely crosses the mid line, and forms with the small intestine a distinct loop—the duodeno-intestinal flexure. To the right of this flexure lies the root of the mesentery. There is a well defined right lateral or duodenal fold—free below—and running from the dorsum of the ascending duodenum to the mesocolon of the right colon. The primary duodenal fossa between the duodeno-intestinal flexure—root of the mesentery—and upper part of the fold is marked in phascolarctus. The mucous membrane is smooth, and in contrast to the roughened interior of the duodenum in phascolomys, though occasionally a slightly rugous character may be noted in the vicinity of the entrance of the common and pancreatic ducts.

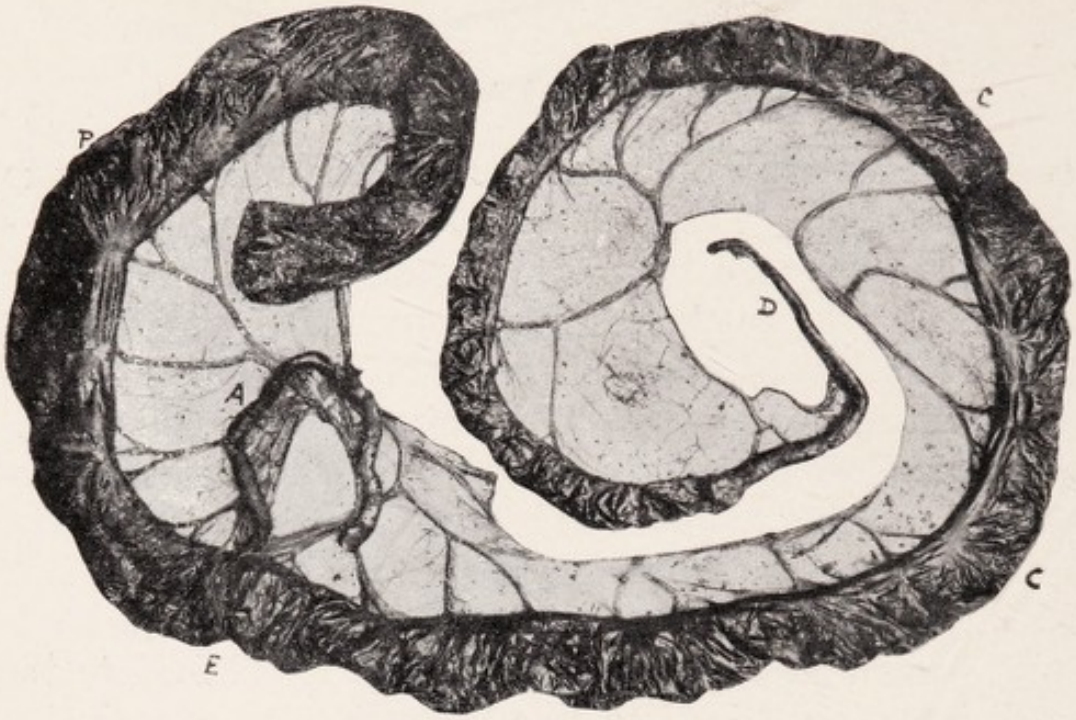
The Small Intestine varies from 180-250 cm., and is of a generally uniform character throughout, measuring, like the main part of the duodenum, about 1.6 cm. across. Speaking generally, in a formalin kept specimen the small gut has a somewhat rigid feel, especially the distal portion, and compared with the colon, has a bunched up insignificant appearance conveying the impression that



The Gastro-Intestinal Tract and Peritoneal Relations in Koala.

its main function would be to convey the food quickly to the caecum and colon, where the chief digestion takes place, as evidenced by the fact that we may see in the caecum Eucalyptus leaves in a comparatively undigested state. The mucous membrane of the small gut is for the most part smooth, but on approaching the caecum is somewhat roughened owing to the presence of fine transverse ridges becoming longitudinal near its termination. The termination of the ileum or small intestine projects into the large gut for about .3 to .6 cm., and an effectual valvular obstruction is offered to the return of food to the small intestine at the ileo-caecal junction. On each side of the ileo-caecal orifice two glandular patches are noticed —subdivided into fossae—which measure 3-4 cm. long and 1.75 cm. across. The small intestine, like the caecum and proximal colon, is swung on the common mesentery.

The Caecum. — In the Koala we meet with the greatest instance of caecal development in the Mammalia. the organ reaching the great length of 180-240 cm. (6-8 feet). Externally it presents no muscular bands, but in the interior the mucous membrane is raised into 10-12 longitudinal folds. At its commencement the circumference may reach 15 cm., and at the middle 10 cm. It usually tapers gradually to the blind termination, and a well-defined lumen exists to the tip. In many cases the caecum terminates more abruptly, so as to give the extremity a vermiform character. These probably represent types in which the caecum is undergoing retrogressive changes. The caecum, like the small intestine and right or proximal colon, is swung on the mesentery. This may be regarded as the common mesentery, since it has a single root of origin; nevertheless, owing to the lengthy caecum and the prolongation of the mesentery along it three distinct portions may be recognized, *viz.*, one for caecum, and one for the proximal colon (continuous), and



CAECUM OF KOALA.

C Caecum, D Appendicular-like termination, A Termination of Small Intestine, E Ileo-Caecal junction, P Proximal Colon.

INTERIOR OF ILEO-CAECAL REGION, KOALA.

K Portion of Caecum, M Portion of Colon, F Glandular Fossae, V Ileo-Caecal Valve, P Termination of Ileum.

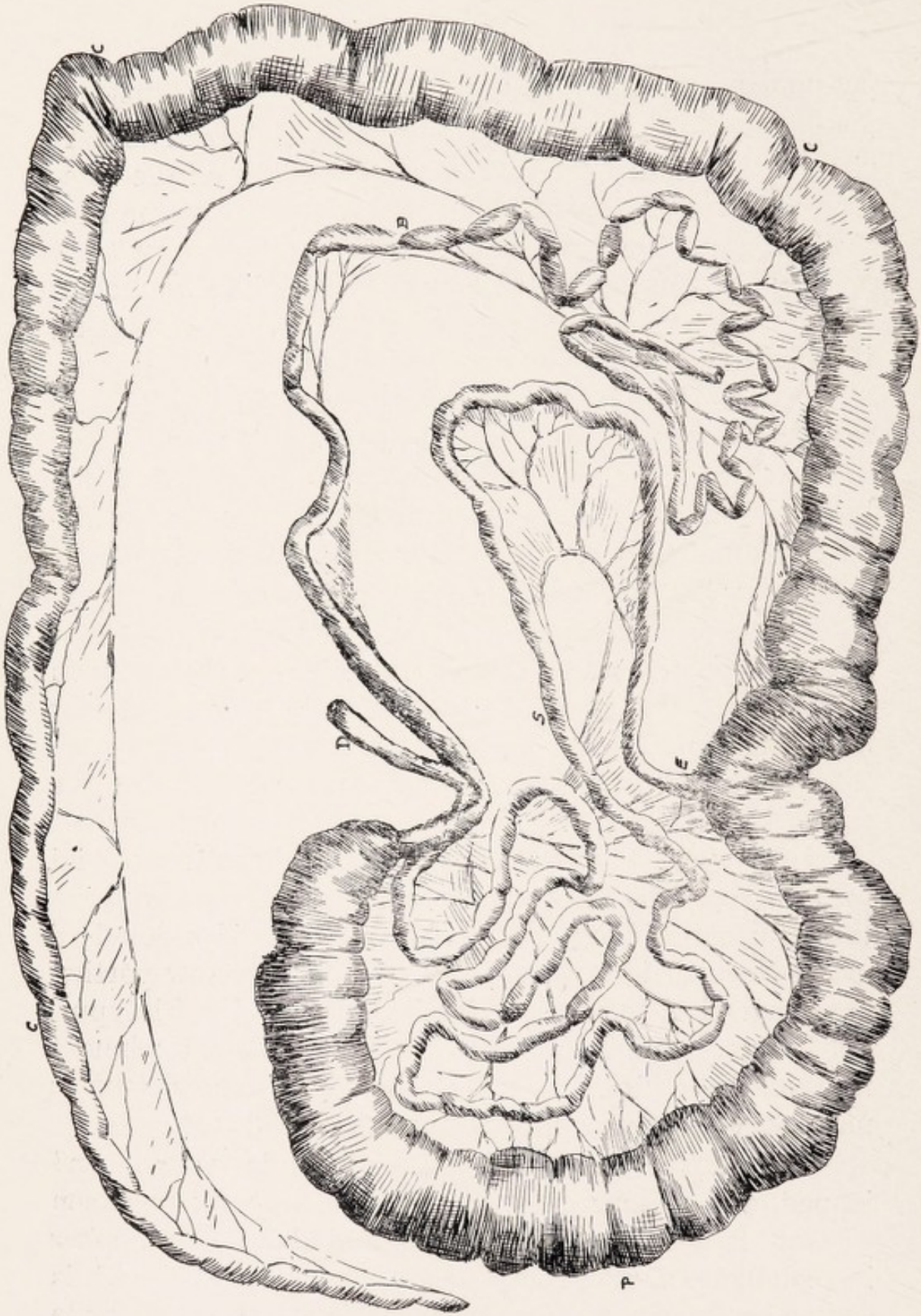
another for the small intestine, which joins the others at a right angle, as is evidenced by raising the terminal portion of the small gut. The greatest width of the common mesentery equals 22-30 cm., while that for small intestine equals 10 cm. wide, and in a young specimen 7 cm.

At the termination of the small intestine two mesenteric fossae are to be noted—one along the upper margin, ileo-colic, and another at the lower margin, the ileo-caecal.

Colon.—The large intestine or colon is suspended to the pyloric and commencing duodenal region by a tough fibrous band—the mesial fold—1.5 cm. long and 1 cm. broad. Thus we have a distinction into a left narrow distal colon and a shorter but wider right proximal colon.

(a) *Right Proximal Colon.*—This measures in an adult 150 cm., and in a young specimen 67 cm., and it is swung with caecum and small intestine on the common mesentery. Its greatest circumference may equal that of caecum, *viz.*, 15 cm., but this narrows as we approach the pylorus, where the gut becomes firmer and harder, the circumference only reaching 5-7 cm. The mesentery of the narrow colon immediately to the right of the mesial fold is short, and only measures in width 4 cm., while at the adjacent wider portion of colon the width equals 8 cm. Nevertheless, the mesentery of this narrow portion is not attached to the mesoduodenum as in the Platypus, but is free, being traceable to the root. The attachment is suggested owing to the fact that the duodenal loop is narrow, thus narrowing also the mesoduodenum.

(b) *Left or Distal Colon.* — This is narrow and looped, and measures 210 cm., and in a young specimen 87 cm. It is the primitive colon, and about 20 cm. after its commencement scybala begin to be noticed. It is swung on its own mesocolon, which is attached along the dorsal abdominal wall, mesial to the kidneys, between the psoas minor muscles, and the width of which in a young



Intestinal Tract of Koala.

D Portion of Duodenum, S Small Intestines, E Ileo-Caecal junction, C Caecum, P Proximal or right Colon, B Distal or left Colon showing Scybala.

specimen equalled 10 cm., and in an adult it may reach 20 cm. It has a somewhat uniform width of about 4 cm., becoming still further narrow as the pelvis is approached, when the gut assumes a more vertical character, and becomes the rectum, inclining in its descent to the right pelvic wall. The longitudinal folds noticed in the caecum are traceable into the colon, becoming finer and closer as the bowel narrows about the pylorus. The left colon at its commencement somewhat abruptly roughens owing to the presence of coarse, knotty longitudinal ridges, which become less distinct as the scybalous region is reached, when the mucous membrane as a rule becomes smooth in character. As in the case of the monotremes at the termination of the rectum, a sphincter is present, and sebaceous follicles are to be noted. Nevertheless, although the vestibule is not present, we have really a common outlet for genito-urinary and intestinal tracts guarded by a sphincter externus. An exception is the Tasmanian Devil, in which the separation of genito-urinary from intestinal termination is more complete.

Great Omentum.—This is traced along the great curvature of the stomach to the commencement of the duodenum on the right. It does not include on the right either the colon or mesocolon, and on its left extremity we see the spleen and left portion of the pancreas. Neither the spleen nor the left of the omentum are connected to the mesocolon, *i.e.*, there is no left lateral or lieno-mesocolic fold from the left process of the spleen to the mesocolon, as in other Marsupials—the distal colon, spleen, and kidney being distinct.

RELATION OF COLON TO STOMACH AND DUODENUM, KOALA.

S Stomach with Spleen on Great Curvature, L Oesophageal termination, D Site of Gastric Gland, P Sphincter, R Duodenum, E Small Intestines, M Proximal Colon showing narrowing at A, N Distal Colon, K Free Mesentery of Proximal or right Colon. The thickened portion on left is Mesial Fold.

PARTS SEEN ON REMOVAL OF VENTRAL ABDOMINAL AND THORACIC WALLS, KOALA.

A Heart and Lungs, D Level of Diaphragm, B Liver, K Caecum with appendicular termination lying behind O.

The remaining Intestine seen, except the small area E (Small Gut) consists of Colon.

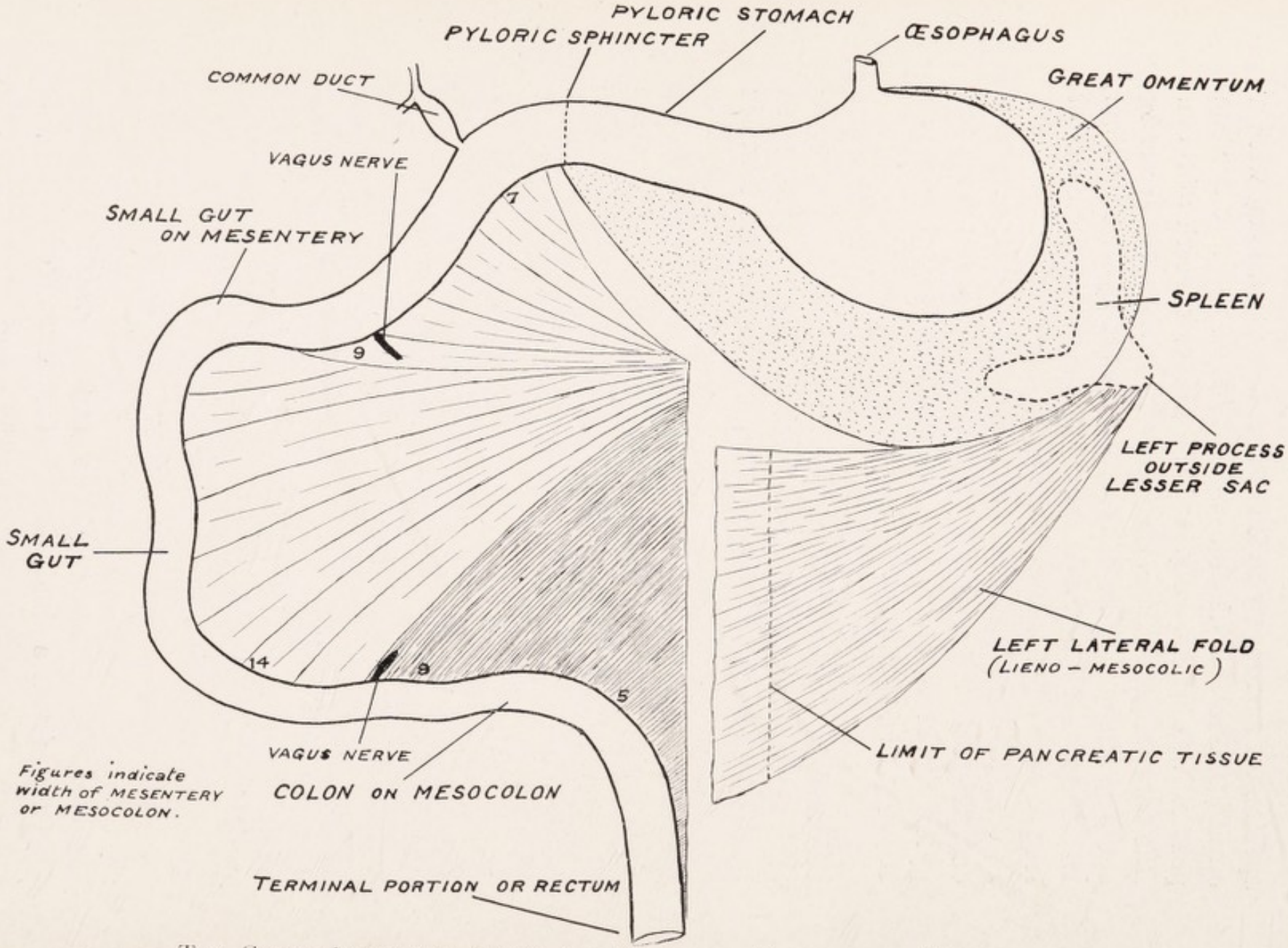
THE GASTRO-INTESTINE OF TASMANIAN DEVIL (SARCOPHILUS URSINUS).

Stomach.—The stomach, even when moderately distended, may be traced across the midline from the right to the left hypochondrium. It consists of two portions, *viz.*, a large rounded left or cardiac portion, and a smaller, narrower, somewhat rigid tube-like pyloric portion, which at first, owing to the external constriction defining the two portions, might be mistaken for the first portion of the duodenum. Along the lesser curvature we have attached the gastro-hepatic or lesser omentum, in the right of which we have the common bile duct and some pancreatic tissue, and along the great curvature is the great omentum, 12-15 cm. long, suspended on which we have the body and anterior or ventral process of the spleen. It is interesting to note that the entrance to the lesser sac (Foramen Winslowii), behind the right of the lesser omentum, is well defined, admitting easily the forefinger. When removed for examination, the stomach is seen to be somewhat flask-shaped. As in Koala and Phascolomys, the oesophagus does not traverse the abdomen as it does in Macropus. It opens into the large left portion. The stomach can be regarded as characteristic of the Marsupial Carnivora, and resembles that seen in Placental Carnivora, *e.g.*, dog and cat, although these differ by having a short caecum and a better definition of large and small intestines. In an undistended female

specimen the right pyloric portion was 5 cm. long, with a circumference of 7.5 cm., while that of the left cardiac portion was 12 cm. long, and the greatest width of 9 cm. The oesophageal orifice lay 6 cm. from the left extremity and 3 cm. from the commencement of the pyloric portion. In a large male specimen shot whilst feeding, the greatest length of the cardiac portion equalled 20 cm., and width 12 cm., while the pyloric portion was 7 cm. long. The oesophageal orifice in this specimen was 4 cm. from the pyloric portion and 15 cm. from the left or fundic extremity, *i.e.,* the big distension was to the left.

On opening the stomach in the female specimen above referred to the mucous membrane presented an appearance resembling that of the Wombat. The fundus showed an irregular rugous appearance, and from here towards the pylorus 10-12 longitudinal raised folds of mucous membrane could be traced, which became fewer and less distinct in the pyloric portion, and ceased abruptly at the sphincter. No distinct fold defining the pyloric portion of the stomach from the body as in Koala can be demonstrated, but here the mucous membrane becomes more markedly rugous in character, and transverse strictions are noted. No gastric gland is present as in Koala and the Phascolomyidae. In the large male specimen above referred to the stomach was hardened *in situ,* and owing to the distension with food the wall was thin, with a consequent obliteration to a great extent of the rugous character seen in the undistended specimen. A definite pyloric ring about .4 cm. wide denotes the junction of the stomach and intestine.

Intestine.—From the pylorus to the rectum the Intestinal Tube varies in length from 135 cm. in a female specimen to 210 cm. in a large male. This is suspended apparently on a single dorsal mesentery, and there is no obvious distinction between duodenum and small and



THE GASTRO-INTESTINAL TRACT AND PERITONEAL RELATIONS IN TASMANIAN DEVIL.

large intestines, as in other Marsupials. This general description demands, however, various qualifications. In an intestinal canal measuring 157 cm. long from pylorus to termination, the base of the mesentery running along the dorsal abdominal wall between the two kidneys measured 7 cm. This base, on examination, however, was found to consist of two parts—(a) an upper part 1.5 cm. long, really the root of the mesentery, with the entrance of the sup. mesenteric artery, and corresponding to "duodenum" and small gut, whose length equalled 135 cm.: (b) a lower part 5 cm. long, really the attachment of the mesocolon for the remaining 22 cm., which is large intestine.

Right Lateral or Duodenal Fold.—Though Owen described 60 years ago a duodenal curve, not, however, tied to the spine at its termination, there is no definition of a duodenum now. The termination of a fold is noticed, however, at what may be regarded as the end of the duodenum, on its under surface, *viz.*, 10 cm. from the pylorus corresponding also to a branch of the vagus nerve. The base of the fold, which is well defined, runs along the mesocolon near its attachment, and disappears in the pelvis. It is traceable as a fine film to the point 10 cm. from the pylorus, although the last 2 cm. may have to be stretched to be detected. If the duodenum were looped this fold would form part of the boundary of a duodenal fossa, the attachment being at the flexure, as can be demonstrated artificially. There is no mesial fold bringing the colon into relation with the pyloric region as in, *e.g.*, Man and Koala, the minimum interval in an adult being about 18 cm.

Left Lateral Fold (*Lieno-Mesocolic*). — This is a well-defined, somewhat triangular-shaped fold attached above to the great omentum and small left process of spleen, which is outside the lesser sac. Below it appears

to be attached to the mesocolon of the colon, but on closer examination is traced to the peritoneum of the dorsal abdominal wall to the left of the base of the mesocolon, about .75 cm. of peritoneum intervening. It disappears below in the pelvis, and measures nearly 10 cm. in greatest length. The greater part of pancreatic tissue is found in relation with the fold and the lesser process of spleen, though it never extends on the fold nearer to the dorsal abdominal wall than 2 cm. Pancreatic tissue is found in the great omentum and about the root of the mesentery; but to the right of the latter, and in the region of the intestine about the entrance of the common bile duct, it is not as a rule found.

Bile and Pancreatic Ducts.—The length of the common bile duct is 9 cm. It descends in the right of the lesser omentum and becomes surrounded by pancreatic tissue. It opens into the intestine 3 cm. beyond the pyloric sphincter. The portion of gut between the duct entrance and pyloric sphincter is dilated, and here Brunner's glands are found, and its wall has a firmer feel than that of the intestine immediately beyond the duct, although it is interesting to note the great vascularity of this (latter) portion. The common duct terminates by an easily defined pin-hole opening. I have not found it associated with a papillary projection. The pancreatic duct joins it 5 cm. from its termination. After the entrance of the pancreatic duct, the common duct dilates, and the circumference of the last 3 cm. is about double that above the entrance.

Vagus Nerve.—If the right vagus be traced from the oesophagus behind the left lateral fold a branch is seen —well defined—passing across the mesentery to the gut, where the right lateral fold terminates, *i.e.*, about 10 cm. from pyloric sphincter. If we divide the superior mesenteric artery, a branch also well defined is seen pass-

ing to the commencement of the large intestine, *i.e.*, at the beginning of the attachment to intestine of the mesocolon. The remainder of the termination of the vagus runs with the trunk of the sup. mesenteric artery joining the mesenteric plexus of the sympathetic.

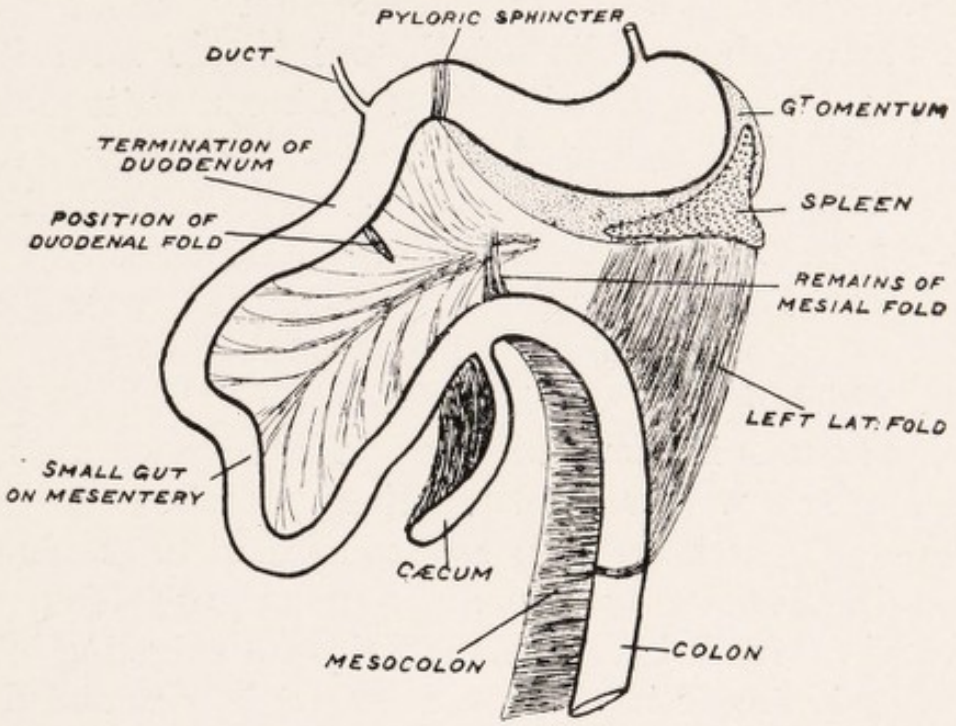
The intestine measures about 6 cm. in circumference at the commencement, becoming narrowed as we approach the pelvis, where its circumference only equals 3.5 cm. In the large male specimen referred to the circumference was 10 cm. at beginning, and only 1.25 cm. near the pelvis (termination). Two pairs of lymphoid patches were noted 98 cm. from the pylorus, *i.e.*, towards the termination of the gut. In contrast to the stomach the mucous membrane for the first 14 cm. is smooth in character. Thereafter, with the exception of a smooth portion 5 cm. long situated 25 cm. from the pylorus, the mucous membrane resembles that of the stomach, being rough and rugous, owing to the presence of raised longitudinal folds interspersed with transverse ones. This character, however, is scarcely marked as the pelvis is reached.

Passing into the pelvis, the gut descends vertically, and a more marked distinction between the intestinal and the genito-urinary terminations is noted, as compared with others of the marsupials. In the female we note anteriorally a well-defined vulval projection, and in the male we see the development of an external penis.

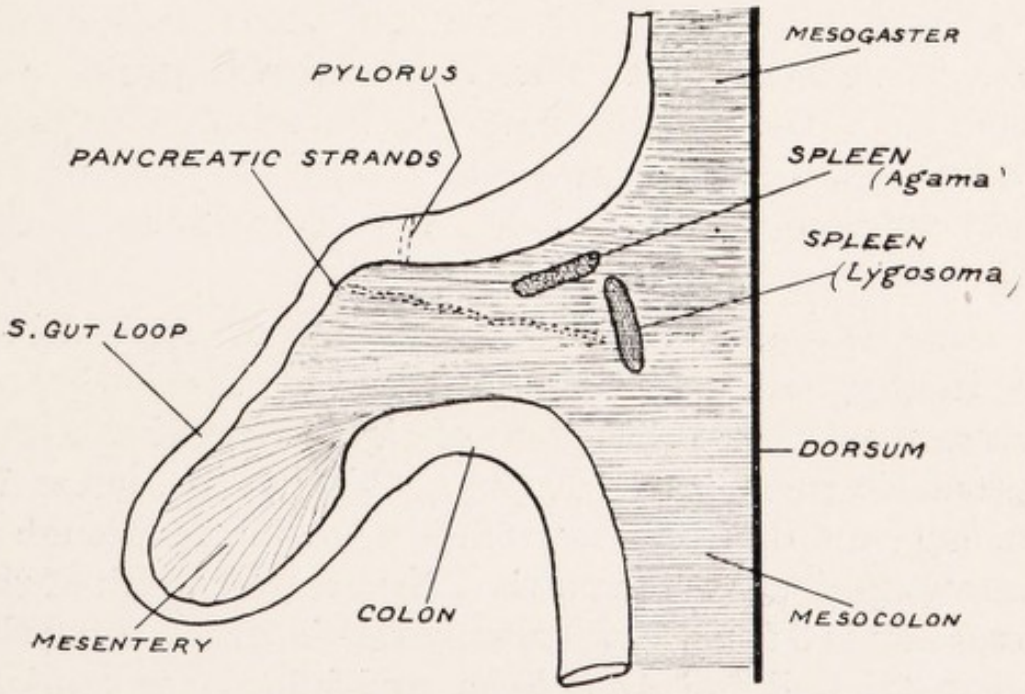
THE GASTRO-INTESTINE OF BANDICOOT (PERAMELIDAE).

The Stomach is an oval body presenting a large left or cardiac portion and smaller right or pyloric portion, though the angle between these two is not so marked as in Koala or Wombat. It measured in an adult laterally 4.5 cm., and greatest width was 3 cm. The oesophagus opened 1 cm. from the left extremity. The lesser curvature measured 1.75 cm., and greater 7.5 cm. To the lesser curve was attached the gastro-hepatic omentum, but the great omentum on the left side did not extend along the whole length of the curvature. On the interior the greater part is coarse, and rugous, but the right or pyloric portion is smoother. As we approach the pyloric sphincter the wall thickens, and may equal .4 cm. The length of the pyloric sphincter is about .3 cm.

Small Intestine.—There is no defined duodenal loop, and the arrangement of the small gut resembles that of the Carnivorous dasyures. The duodenum is defined as a portion extending 2.5 cm. from the pylorus, whose mesentery (mesoduodenum) is narrowed compared with that beyond it. The greatest width of the mesoduodenum is about 1.75 cm., while that of the mesentery equals 7 cm. The common duct opens into this portion 1.5 cm. from the pyloric sphincter. Apart from the shortened mesentery we have defining the termination of this short duodenal portion, a band—right lateral or duodenal—



THE GASTRO-INTESTINAL TRACT OF BANDICOOT (Peramelidae).



THE PRIMITIVE GASTRO-INTESTINE IN AGAMA AND LYGOSOMA (Reptilia).

running dorsal to the common mesentery, about 5 cm. long, narrow above at its attachment to the mesenteric edge of the gut, broadening below to 1 cm. at its attachment to the right aspect of mesocolon, and finally becoming continuous ventral to the colon before it enters the pelvis, with the left lateral or lieno-mesocolic fold. The result is that a pouch is formed between the ventral wall of the gut dorsally and the junction of the two folds ventrally, which is traceable into the pelvis. The width of the duodenoum is about 1.25 cm. The common duct entrance is by a well marked papillary prominence. The common bile duct, from its commencement to the duodenal papilla, is about 3 cm. long. It passes with the portal vein and artery between the caudate and spigelian lobes, and then is traced in the lesser omentum surrounded by pancreatic tissue to its termination. About 1 cm. from the termination of the common duct I noticed three fine pancreatic ducts converging and entering it. One of these was larger than the rest, and was traced to the left. The common duct, after their entrance, was dilated somewhat. The remaining part of the small intestine is swung on the common mesentery, and has a uniform width when collapsed of about 1 cm. It measures 25 cm. long.

Large Intestine.—This is swung on the mesocolon, *i.e.*, is all primitive—distal—or left colon, there being no development on the mesentery of right — proximal — or mesenteric colon, as in Koala. This gut measures 14 cm. long, and the greatest width is nearly 2 cm., though it narrows as it enters the pelvis. The greatest width of the mesocolon is 3.5 cm., and dorsally this is traced along the abdominal wall for about 5 cm. and internal to the left kidney. On entering the pelvis the large intestine is continued on as rectum, becoming fixed along the dorsal wall of the pelvis, and finally terminates by an opening

common to it and the genito-urinary apparatus externally, so that it is really as, in the case of other Marsupials, monotrematous. The colon is characterized by the presence at its commencement of a curved caecum 5.5 cm. long, with a greatest width of 1 cm. Its extremity is rounded and not narrowed and appendicular, as we see in Koala and Opossums. It is usually narrowed at its commencement, and is connected to the termination of the small intestine by a well defined mesentery 1.25 cm. wide, which, though extending to the extremity of the caecum, only reaches 1 cm. along the small intestine, so that its free edge is concave. The distance between the pylorus and the ileo-colic junction, which are practically in the same mesial plane, is about 5 cm. At the ileo-colic junction, a well-defined mesial band is noted, which is traced as far as the root of the mesentery, but not up the pylorus. There is a well defined sphincter at the junction of the large and small intestine. The caecum enters the colon .5 cm. from this sphincter by a somewhat rounded opening. The interior of the caecum is finely rugous. The large intestine has its interior roughened owing to the presence of coarse striations.

THE GASTRO-INTESTINAL TRACT OF TRUE PHALANGERS.

1. *Trichosurus*, or common phalanger.

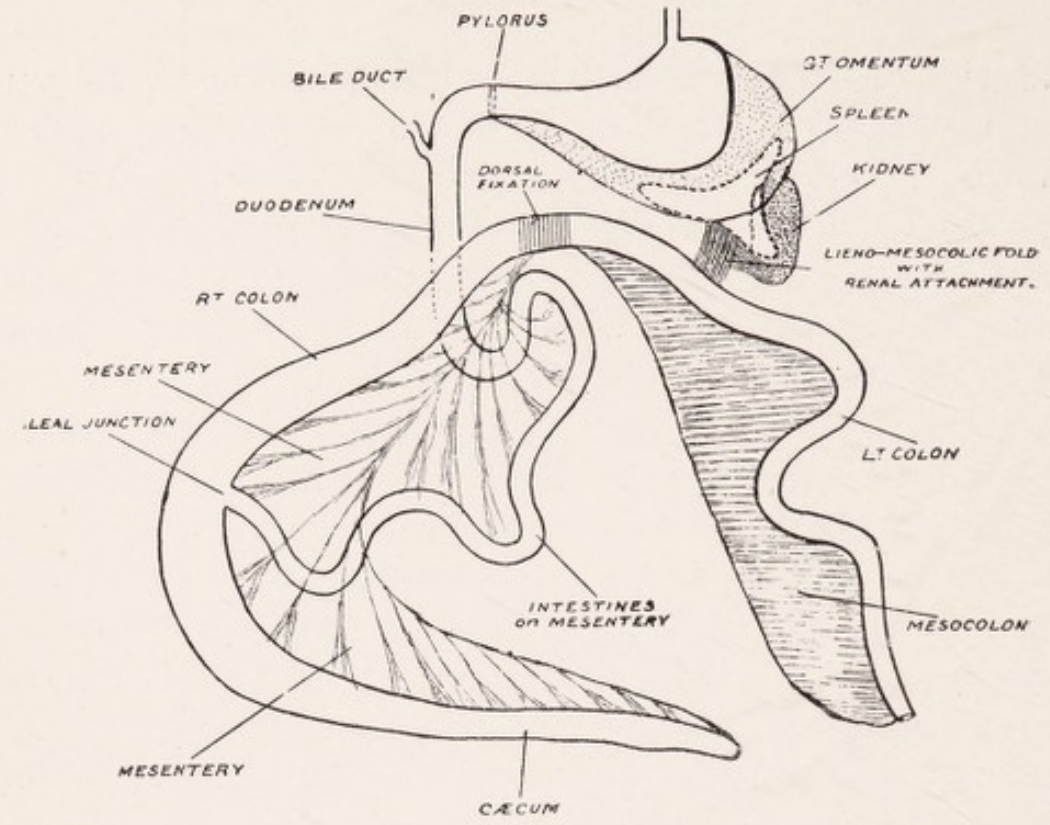
The Oesophagus traverses the abdomen for about 1.75 cm. before terminating in the stomach.

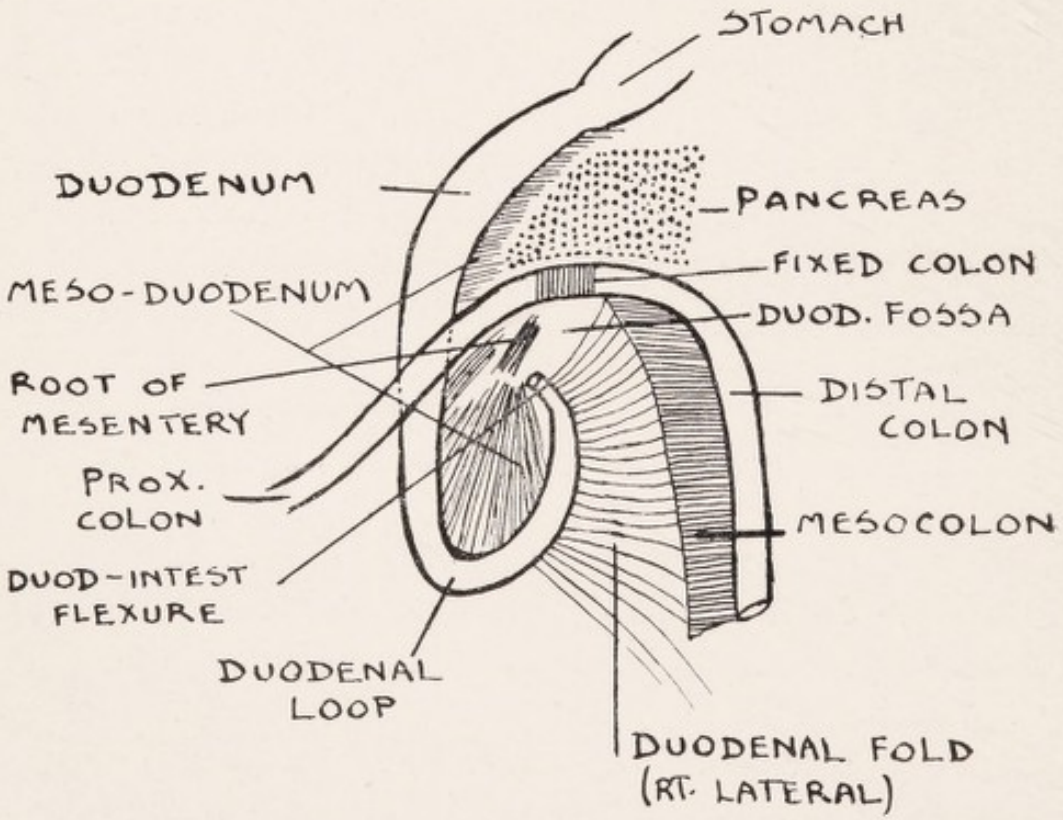
The Stomach, when distended, is somewhat oval-shaped, and is situated not only in the epigastric and left hypochondriac region, but encroaches on the right hypochondrium as well. It measures 11 cm. in its greatest length and 5 cm. in greatest width, and may be regarded like the Koala as consisting of two portions—a left larger vertical portion directed down and to the right, and a right smaller horizontal one, directed up and to the right. The oesophagus enters about 2-2.5 cm. from the pyloric opening, and the fundus, or left extremity, lies about 4 cm. to the left. The great curvature measures 17 cm., and dependent from it we have the great omentum, with the body and anterior right process of the spleen. Between the liver and the lesser curvature we have the lesser omentum, on the right of which we find the common bile duct with portal vein and hepatic artery as in the human type. The left portion of the Stomach measures 7.5 cm. long, and greatest width 5 cm., while the right smaller portion measures 3.5 cm. and greatest width 2.75 cm. On opening the interior of the stomach a well defined raised fold of mucous membrane is seen, as in the Koala, defining the smaller or pyloric portion, which has when hardened a cylindrical character. Longitudinal and transverse rugae are seen in the

interior of the large portion, which terminate at the projecting fold. The mucous membrane of the greater portion is, however, smoother in character, but approaching the orifice the wall thickens, giving on palpation a firm knobby feel as in the Platypus. The pyloric sphincter measures about .3 cm. wide. There is no gastric gland as in the Koala and Wombat.

Duodenum.—At its commencement the duodenum is dilated, though not so markedly as in Koala. This portion varies from 1-1.5 cm. long, and in some specimens is directed up and to the right, being succeeded by a transverse portion 2 cm. long, passing in front of the right kidney, so that a first portion of the duodenum can be described apart from the two stems. In one specimen this first portion passed obliquely down and to right for 3.5 cm. before reaching the descending stem.

As a rule, in addition to the dilated commencement, we distinguish a duodenal loop formed by two stems or limbs, *viz.*, a descending one passing in front of the right kidney and psoas for 10 cm., and a shorter ascending one 4 cm. long, passing up and to the left to the duod-intest. flexure, where it is continued on as the small intestine. The lower part of the loop almost reaches to the pelvis, and in a female was only distant 2 cm. from the right ovary. As the mesoduodenum—*i.e.*, the dorsal mesentery investing the duodenum—is present, there is mobility of the duodenal loop, so that it can be raised with the proximal colon crossing it off the psoas muscle and right kidney. From the ascending limb of the duodenum we have a fold — the right lateral or duodenal fold—which transverse above is traceable to the mesocolon of the left or distal colon, and oblique below is prolonged downwards by the side of the dorsal attachment of the mesocolon, into the pelvis, and in the female may become continuous with the right broad ligament.





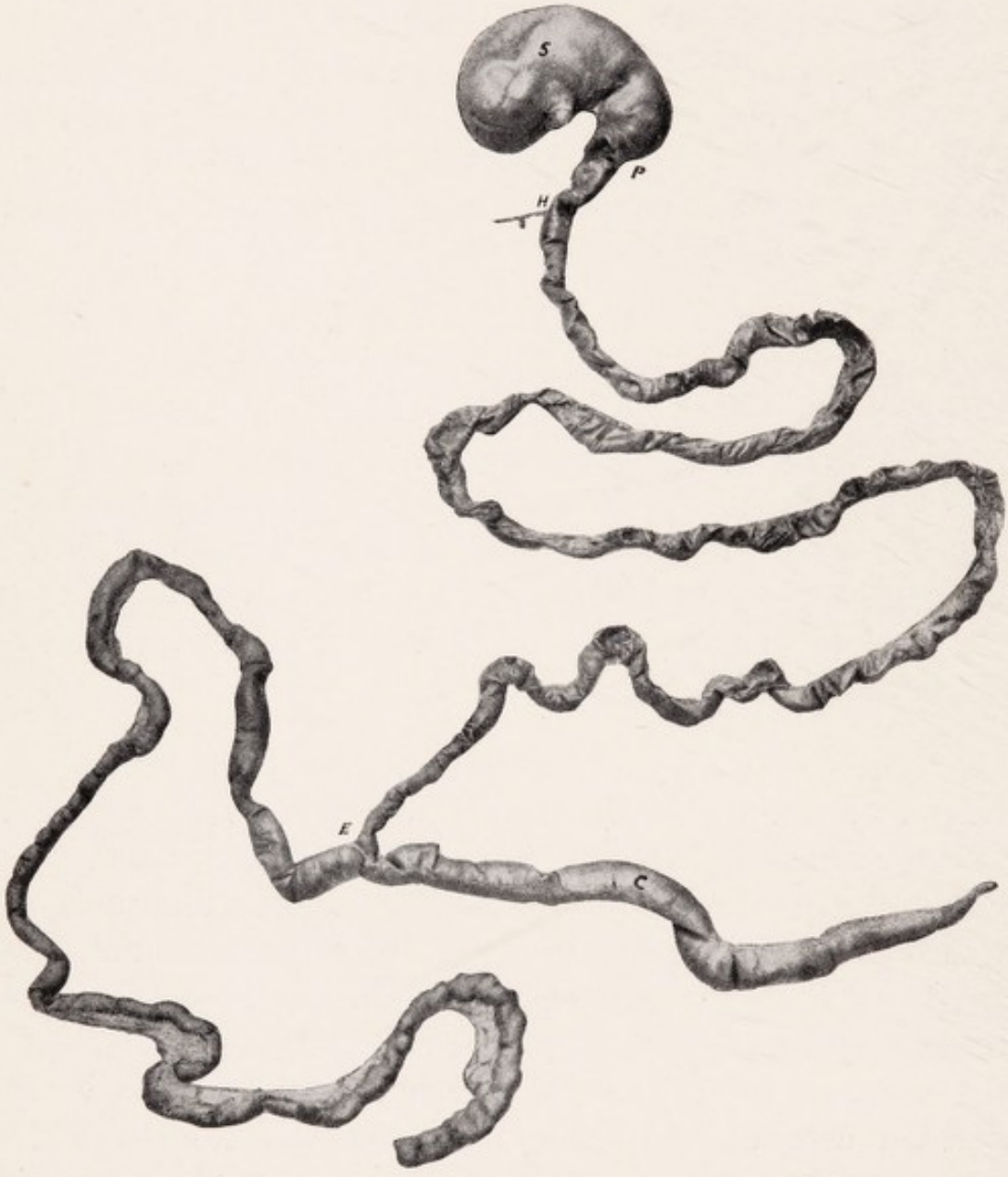
THE GASTRO-INTESTINAL TRACT AND PERITONEAL RELATIONS IN TRICHOSURUS.

The greatest width of the duodenal fold equals 2.5 cm.

Between the upper part of the duodenal fold — root of the mesentery — and duod-intest. flexure lies the primitive duodenal fossa. As the ascending duodenum does not rotate as in some of the Mammalia, the duodenal fold is attached to the dorsal aspect of the gut, *i.e.*, in line with the mesoduodenum, and not ventrally, as in cases where it has undergone rotation.

The common bile duct, which receives the pancreatic duct about 2 cm. before its termination, opens into the descending limb of the duodenum 5 cm. from the pyloric opening. The duod-intest. flexure, which forms the lower boundary of the duodenal fossa, is in close relation with the fixed portion of the colon, lying, however, on a plane caudal and dorsal to it. On its right is the root of the mesentery. It is a relatively immobile portion of the intestine.

Small Intestine.—This is continued from the duod-intest. flexure to the ileo-caecal junction. It is bunched and measures 130-150 cm. in length, with an almost uniform circumference of 3 cm. The dorsal mesentery, on which it is swung, is narrow at its commencement, but reaches 12 cm. in its greatest width. As in Koala, this mesentery joins at a right angle what may be regarded as the common mesentery for the proximal or right colon and the caecum. At the termination of the small intestine there is a fine fold—ileo-caecal—from the edge of the ileum to the mesentery of the caecum, and a well marked ileo-caecal fossa is present, into which the thumb can be inserted. The mucous membrane of this portion of intestine presents a finely granular rugous character, especially at its commencement and termination. As in Koala, the termination of the small intes-



General View of Gastro-Intestinal Tract, Trichosurus.
Stomach, P. Pyloric Sphincter, H Entrance of Common Duct,
E Ileo-Caecal Junction, C Caecum.

tine (ileum) forms a projection into the large gut for .3 cm., and in this way an efficient valve is produced.

Caecum.—This is relatively large, and measures 45-55 cm. Its termination may be abruptly pointed, presenting practically an appendicular end or the calibre of the bowel may be gradually continued on to a cone-shaped end. Even in the former the lumen is continued to the termination. It is suspended like the small intestine and right or proximal colon on the common mesentery, and the portion for the caecum has a greatest width of 5 cm. The distal 5-6 cm. of caecum is devoid of mesentery. No longitudinal muscle bands are present externally, and the longitudinal plaits or folds seen in the caecum of Koala are absent; but instead we notice fine transverse ridges more marked as the termination of the caecum is approached.

The circumference of the caecum may reach 7-9 cm.

Colon.—As in the Koala, we recognize a right or proximal colon swung on the common mesentery, with the caecum and small gut, and a left distal colon swung on the mesocolon—the primitive colon.

The Right Proximal Colon extends from the ileo-caecal valve to the region of the root of the mesentery, and measures 25 cm. It is mobile, and its lumen is practically continuous in size with that of the caecum. It crosses, with the mesentery and commencement of the small intestine, the descending limb of the duodenum at its lower third sometimes about the middle. As we approach the root of the mesentery the gut is seen to narrow, and becomes closely bound down for a limited extent (1 cm.) to the mesoduodenum and pancreas, but in addition for 3 cm. before the fixed area is reached the colon may, as in the case of the Platypus, be related by peritoneal adhesions to the descending duodenum and mesoduodenum. Occasionally a fine process (mesial

band) may be traced from the fixed colon to the pyloric region across the pancreas, the distance between the two being about 3 cm. The greatest width of the mesentery for the proximal colon equals 11 cm.

Left or Distal Colon.—The area of attached colon corresponds to the commencement of duodenum above—root of mesentery — and the duod-intest. flexure. Thence onwards it becomes freely mobile, being swung on the mesocolon, and descends to the pelvis. This, the left or distal colon, is thrown usually into loops, and measures 90-100 cm. long.

The mesocolon, which runs dorsally along the dorsal abdominal wall between the two psoas muscles, is only 7 cm. long, and although narrowing as it enters the pelvis, has an almost uniform width of about 9 cm. The distal colon is usually pale and tube-like, and though narrower in circumference than the right colon, yet as we approach the pelvis it becomes darker and the lumen enlarged so that a circumference of 2 cm. is succeeded by one of 4.5 cm. At the commencement of the colon, close to the ileo-caecal valve, two lymphoid patches are noted. Throughout its course the mucous membrane of the colon presents fine transverse and longitudinal ridges. On entering the pelvis, the gut becomes vertical and less mobile. A more marked distinction is noted, as in the case of the Tasmanian Devil, between the Intestinal and Genito-Urinary terminations than is found in Wombat, Koala, or Kangaroo.

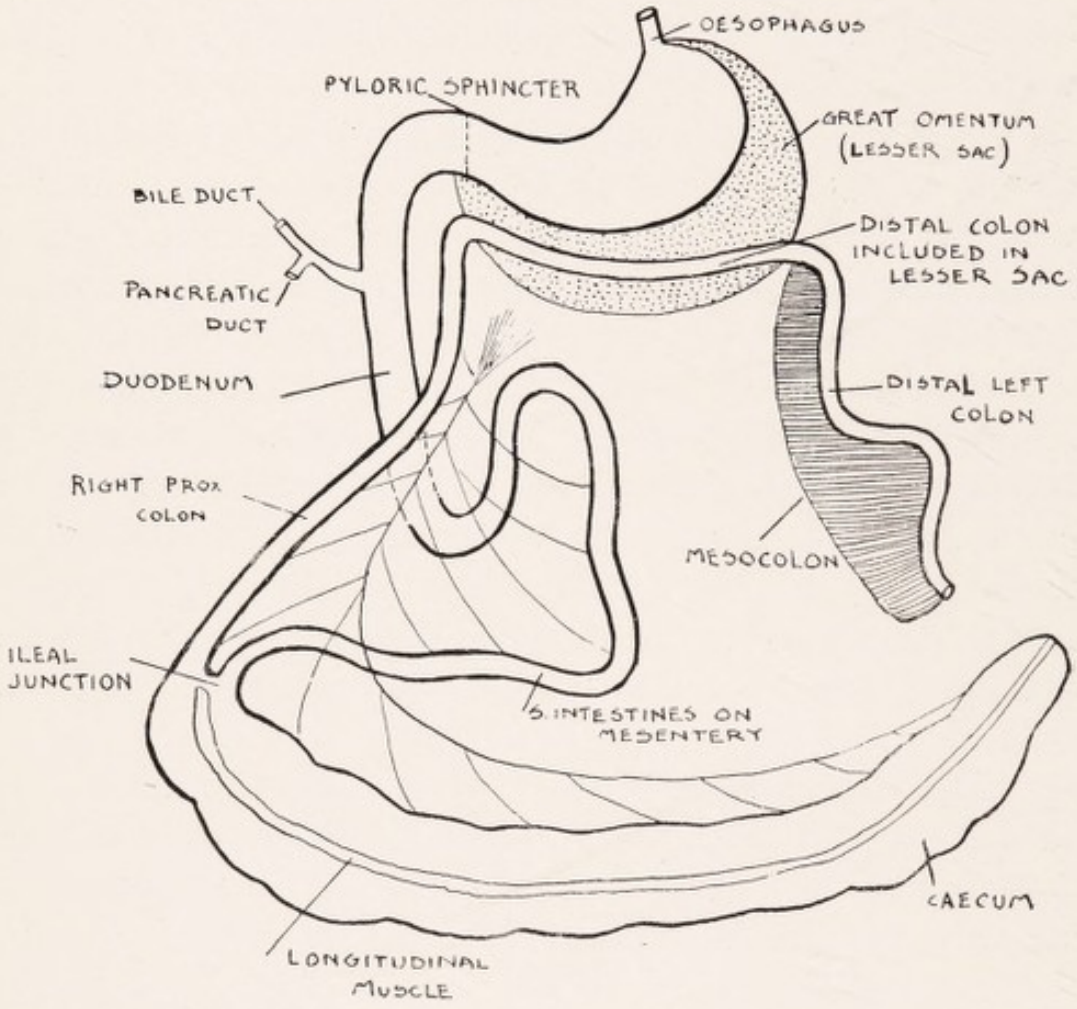
Great Omentum.—This is well developed, and is attached above to the great curvature of the stomach and commencement of the duodenum; below it reaches the mesocolon of the left distal colon, but does not include the colon. On the left it gradually recedes from the mesocolon. In relation to the great omentum we have the body and anterior or ventral right process of the

spleen. Attached to the left dorsal process, which is outside the lesser sac, we have the lieno-mesocolic fold, which is attached below to the kidney, but not as in the case of the Monotremes, Macropus, and Phascolomys, extending dorsally to the mesocolon.

2. *Pseudochirus, or Common Ring-tailed Phalanger.*—The following are the important points for comparison with Trichosurus:—

Caecum.—The outstanding feature of the Intestinal Tract of Pseudochirus is the relatively large caecum, which I have always found distended with faeces. The large intestine from the ileo-caecal junction onwards looks in comparison like a narrow pipe stemmed tube. The length is about 33 cm., and at the middle the circumference may reach 8-9 cm. Though narrowest at the termination, we see no tapering as in Trichosurus. Two longitudinal bands .3 cm. wide are noted running the whole length of the caecum, and as a result it is thrown into a series of puckers and convolutions. There is a well defined mesentery 3 cm. wide, which terminates 1.5 cm. from the end.

Right Proximal Colon.—This extends from the ileo-caecal valve to the dilated commencement of the duodenum, and for the first 6 cm. is swung on the common mesentery with the caecum and small intestine, and these can all be raised off the duodenal loop and meso-duodenum. Crossing the lower part of the descending pole of the duodenum, the colon passes up more or less parellel to it, being separated by an interval of about 1.5 cm. till the dilated commencement is reached. Just a little below the middle of the descending pole this ascending right colon and its mesentery become connected to the mesoduodenum and the descending pole by peritoneal adhesions, and at the commencement of this part a loop may be found in the colon.



The Gastro-Intestinal Tract and Peritoneal Relations in Pseudochirus.

Left Distal Colon.—At its commencement the distal colon comes into relation with the lesser sac, being included by the great omentum, and forms an arch from right to left following practically the greater curve of the stomach as far to the left as the extremity of the right process of the spleen. This portion measures 8-10 cm. It is then continued into the pelvis, being swung on the mesocolon, off which above and to the left the great omentum gradually recedes. The mesocolon has a maximum width of 7 cm., and is attached dorsally along the mid line between the two psoas muscles. The total length of distal colon equals 54 cm. So slender may this portion of the gut be that I have known its circumference only to equal .75 cm. Owing to the shortness of the attachment of the mesocolon compared with the length of the colon this portion is thrown into a series of loops.

The Small Intestine.—This is not usually so long as in Trichosurus, and at its termination is seen to run parallel with the commencement of the colon. An ileo-caecal pocket is present.

Duodenum.—Though dilated at its commencement, it consists of a descending pole 7 cm., and ascending pole 2.5 cm.

The Duodenal Loop, though free, is not so mobile as in Trichosurus, and from the descending limb a fine membrane is traced to the right kidney. The right lateral or duodenal fold is not as developed as in Trichosurus, and the lower oblique portion only passes a short distance along the dorsal wall. The lower part of the loop lies 1.75 cm. below the caudal pole of the right kidney, so that it does not extend as low distally as in Trichosurus.

THE GASTRO-INTESTINE OF AMERICAN OPOSSUM (DIDELPHYS MARSUPIALIS).

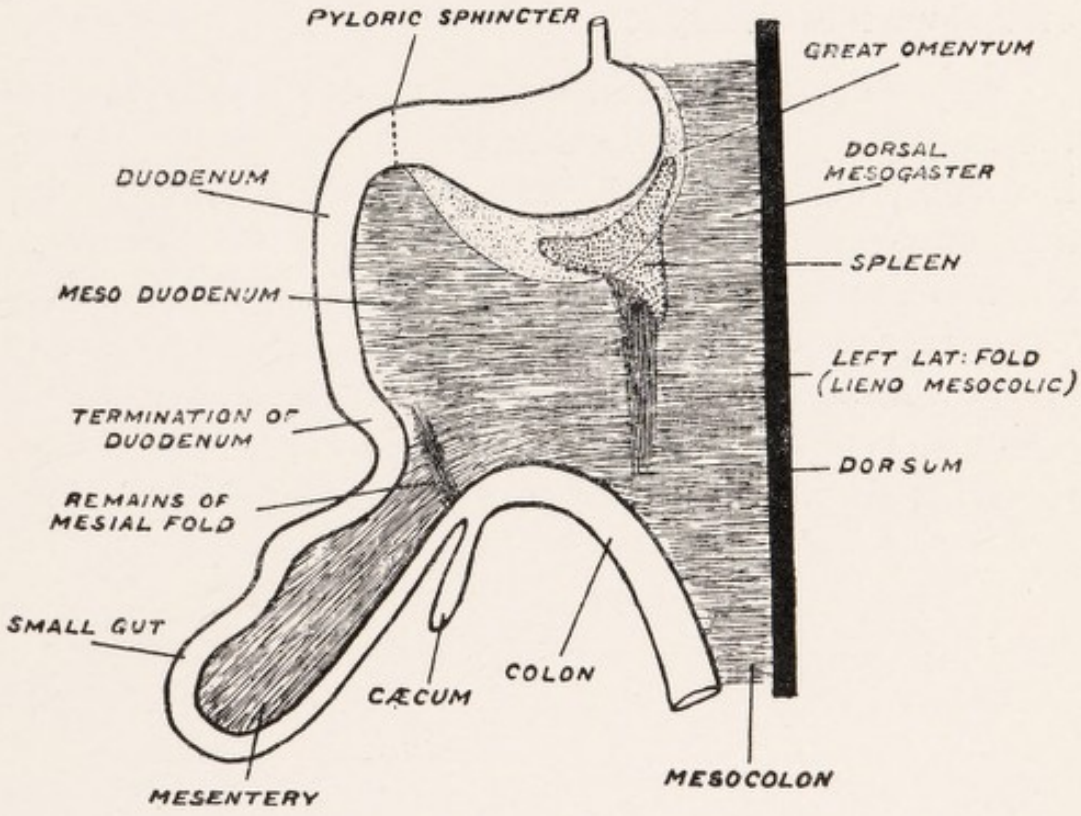
As there are striking differences in the Anatomy of the Intestine between the Australian and American Opossums, a description of the latter becomes essential.

(1) In this animal, though a Marsupial, the peritoneal arrangement is more primitive than in the Platypus, and we do not see the well defined differentiation of the dorsal mesentery into mesoduodenum, mesentery, and mesocolon of the Monotremes, There is, however, the typical mammalian stomach, which has rotated to the right.

(2) There is a great omentum supporting the body and right anterior process of the spleen, while the left splenic process is suspended on the lieno-mesocolic fold, This is free from the kidney, although attached in the common Australian Opossum. In this connection, it is interesting to note that both kidneys have a mesonephron.

(3) A mesial fold is seen passing from the commencement of the colon to the mesoduodenum about the termination of the duodenum, so that there is no approximation of colon to the pyloric region.

(4) Duodenum.—There is a descending duodenum with a "tucking in" at its termination. In some specimens the "tucking in" may be so developed as to produce a duodenal loop, but we never see the duodenal development as in Monotremes or Australian Marsupials. From the dorsal aspect of the tucked-in part is a band—the



PLAN OF GASTRO-INTESTINE, AMERICAN OPOSSUM.

duodenal or right lateral—passing to the right aspect of the mesocolon. The earliest trace of a duodenal fossa between it—intestine—and mesentery—is seen.

(5) Although thre is a narrow tubular caecum 2 cm. long, there is only about 1 cm. of colon, proximal to the mesial fold, *i.e.*, swung on mesentery. As in the Tasmanian Devil, we have a short primitive colon swung on its own mesocolon.

(6) The small intestine is seen to form a loop on the mesentery, which is defined as the result of the inequality of its growth compared with the mesogaster and mesocolon. Thus we see that in the American Opossum we have not the specialisation of intestine met with in the Monotreme. If we divide or stretch the mesial and duodenal folds we can produce what corresponds to a simple reptilian condition—as seen, *e.g.*, in Agama—of an intestinal loop swung on a dorsal mesentery.

ABRIDGED INDEX.

O.

P.

R.

S.

V.