THE ARTERIAL SUPPLY OF THE DIGESTIVE AND REPRODUCTIVE TRACTS OF THE SHEEP

by

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INTRODUCTION

In the textbooks of the anatomy of the domestic animals (Chauveau, 1889; Martin und Schauder, 1935; Ellenberger und Baum, 1943; Nickel et al., 1961) little has been described about the anatomy of the sheep. The reader is always referred to the anatomy of the ox. Sieber (1903) described the abdominal and pelvic arteries of the ruminants. Mader (1907) described briefly the blood supply of the penis of the sheep. Kattauer (1926) made a study of the size of the aorta and its important branches in the sheep. Klages (1931) studied the vessels of the liver of the sheep. May (1955) described the anatomy of the sheep, exclusive of the anatomy of the neck and head. Günther (1958) made a thorough study of the vascularization of the caruncula of the uterus of the sheep, while Hamid Hegazi (1958) studied the vascularization of the heart in the ox, sheep and goat. Rustamov and Polyakov (1958) described the arterial blood supply to the stomach of the Karakul sheep and Rustamov (1958) studied the arterial blood supply to the udder in the Karakul sheep. In his inaugural dissertation Happich (1961) described the blood supply of the digestive tract of the sheep.

The different origin of the sheep in comparison with that of the ox (Lush, 1945) and because of relatively few references available today in the literature, the writer was encouraged to undertake a macroscopic anatomical study of the arterial blood supply of the digestive and the reproductive tracts of the sheep.

It is hoped that this study may act as a contribution to the

literature, thus providing a better understanding of the anatomy of the ruminants in general.

REVIEW OF LITERATURE

A study of the literature pertaining to the arterial supply of the digestive and the reproductive tracts in the ruminants is reviewed according to the following categories: the arterial supply of the stomach, including the liver, spleen and the pancreas; the intestine; the male and the female genital tracts.

The following abbreviations are used: A. = Arteria (artery); Aa. = Arteriae (arteries); V. = Vena (vein); Tr. = Truncus.

The Arterial Supply of the Digestive Tract

The arterial supply of the stomach

The arterial supply of the ruminant stomach, including the liver, spleen and pancreas and the cranial part of the duodenum, according to Chauveau (1889), Sieber (1903), Martin und Schauder (1935), Ellenberger und Baum (1943), Sisson and Grossman (1953), comes from the A. coeliaca. It is agreed that it arises from the ventral wall of the Aorta abdominalis, between the crura of the diaphragm. In the goat, Scupin (1960) found that the origin is located at the level of the last thoracic vertebra, but Otto (1961) stated that the location is between the first and the second lumbar vertebra. In the sheep Happich (1961) found the same location as Scupin reported.

According to Sieber (1903), Martin und Schauder (1935), Ellenberger und Baum (1943) and Sisson and Grossman (1953), the A. coeliaca is 12 cm long in the bovine and 4 to 4.5 cm in the sheep and goat (Sieber, 1903). McLeod (1958) observed a variation of 7.5 cm to 12.5 cm in the bovine,

depending on the size of the animal, while Scupin (1960) found in the goat an average of 6 cm. Happich (1961) states that in the sheep an average of 4 cm is common.

Most authors observed that the A. coeliaca and the A. mesenterica cranialis may occasionally originate from one common trunk, which arises from the abdominal aorta. Sieber (1903) and Kattauer (1926) called it Truncus coeliacomesentericus. In 113 specimens of the ox Kádár (1926) found a percentage of 4.42%. Of the 113 specimens, 80% were males and of this figure 4.2% exhibited a common trunk. Kattauer (1926) found that 20% of the specimens he examined showed this variation. Franzke (1958) reported a case of the presence of the common trunk in the sheep. Scupin (1960) and Happich (1961), however, did not find a single case of this variation in the goats and sheep respectively that they examined.

Sieber (1903) stated that the diameter of the Truncus coeliacomesentericus varies between 17 to 23 mm in the ox; in the goat it is 1.5 cm long and 18 mm in diameter. Kattauer (1926) said that in the ox it is 10 to 30 mm long.

According to Yoshikawa et al. (1956), in general the A. coeliaca divides into three chief branches as the A. hepatica, A. lienalis and A. gastrica sinistra. Due to the enormous development of the proventriculi of the ruminant stomach, the Aa. ruminalis dextra et sinistra develop to a considerable extent, so as to supply the right and the left side of the rumen.

Although the A. coeliaca is a visceral vessel it gives off, as its first branches, the parietal vessels, the Aa. phrenicae, which supply the

diaphragm (Sieber, 1903; Ellenberger und Baum, 1943; May, 1955; Scupin, 1960; Otto, 1961; Happich, 1961). May (1955) called this branch the phrenico-abdominal artery. The Aa. phrenicae, according to most authors, consist of two arteries: A. phrenica caudalis dorsalis and A. phrenica caudalis ventralis. Happich (1961), however, stated that the A. phrenica caudalis ventralis in most of his specimens is absent. According to Sieber (1903) and Scupin (1960) A. phrenica caudalis dorsalis arises from the A. coeliaca, passes in a cranio-ventral direction and divides into two arteries, which course to the diaphragm. Each artery enters the corresponding crus diaphragm and anastomoses with the respective ventral caudal phrenic arteries. According to Scupin (1960) the A. phrenica caudalis dorsalis gives off a right and left ramus for the dorsal part of the crus diaphragm, which anastomoses with the ventral twigs of the first lumbar artery; after 4 cm it divides into Rami dexter et sinister, which enter the right and left crura of the diaphragm respectively to form anastomosis with the ventral twigs of the first lumbar artery; after 4 cm it divides into the Rami dexter et sinister, which enter the right and left crura of the diaphragm respectively to form anastomosis with the Ramus proximalis and A. phrenica caudalis ventralis; the latter arises from A. reticularis.

It is agreed that the arterial supply of the liver comes from the A. hepatica. In the ox its diameter is 8 mm, in the sheep and goat 4 to 5 mm (Sieber, 1903). According to Rustamow and Polyakow (1958) the diameter of the A. hepatica in the Karakul sheep is 3 to 4 mm. In the goat it is 8 cm long (Scupin, 1960). According to Sieber (1903) A. hepatica

gives off the following branches: Rami pancreatici for the pancreas; branches to the left lobe and the quadrate lobe and to the right and the caudate lobe of the liver; A. cystica which passes along the cystic duct and ramifies in the gall bladder; the continuing vessel divides into the A. gastroduodenalis and the A. gastrica dextra. Habel (1955) and May (1955) called the arteries to the liver the dorsal and ventral branches; the latter gives off the A. gastrica dextra. The A. gastroduodenalis divides into the A. gastroepiploica dextra, which runs toward the beginning of the duodenum, supplies it and continues along the pyloric of the abomasum, sends branches to it and to the greater omentum, and anastomoses with the A. gastrica sinistra, and the A. pancreaticoduodenalis, which supplies the pancreas and duodenum.

It is observed that in the ruminant the A. lienalis arises by a common trunk with A. ruminalis dexter. The common trunk is 2 cm long (Happich, 1961). Occasionally it comes off from the A. coeliaca (Sieber, 1903; May, 1955), or by a common trunk with A. ruminalis sinistra (Martin und Schauder, 1935; Ellenberger und Baum, 1943; Sisson and Grossman, 1953). Scupin found in the goat two cases and Happich (1961) found four cases in the sheep, where the A. lienalis was double at its origin.

The arterial supply of the right wall, the blind sacks and the left wall of the rumen comes from A. ruminalis dextra. It was mentioned above that this artery generally arises with A. lienalis; occasionally, however, it may arise from A. ruminalis sinistra (Martin und Schauder, 1935). Yoshikawa et al. (1956), however, did not observe this type of branching in the goat. In the ox the artery is 8 cm long and the diameter is

12 mm (Sieber, 1903). In general it is agreed that the A. ruminalis dextra along its course gives off the following branches: Rami pancreatici and the Aa. epiploici; Rami dorsales, whose most cranial branch anastomoses with branches from A. reticularis, for the right dorsal surface of the rumen; Rami ventrales, for the right ventral surface of the rumen, which form anastomoses with branches from A. ruminalis sinistra; Aa. coronariae dextra dorsalis et sinistra. Arriving on the left wall it gives off the Aa. coronaria sinistra dorsalis et ventralis. In the ox the A. ruminalis dextra terminates on the left wall of the rumen as Ramus longitudinalis, which forms anastomosis on the one hand with the Aa. coronariae, on the other with A. ruminalis sinistra. In the goat the Ramus longitudinalis is absent (Sieber, 1903; Scupin, 1960).

According to most authors, the arterial supply of the left wall of the rumen comes from the A. ruminalis sinistra. However, Sisson and Grossman (1953) and Yoshikawa et al. (1956) limit the area supplied by A. ruminalis sinistra only to the cranial left half of the rumen. According to Sieber (1903), Montané et Bourdelle (1917), Martin und Schauder (1935), Ellenberger und Baum (1943), Sisson and Grossman (1953) and McLeod (1958) A. ruminalis sinistra arises from A. coeliaca. In the sheep, May (1955) stated that it usually comes from A. gastrica sinistra. Yoshikawa et al. (1956) found that A. ruminalis arises from A. coeliaca or has a common trunk with A. gastrica sinistra. In one case, however, he found that it has a common trunk with A. hepatica. In the ox it is 8 mm in diameter, in the sheep and goat 3 to 5 mm (Sieber, 1903). Happich (1961) found two cases in which the A. ruminalis sinistra arises

from a common trunk of the A. lienalis and the A. ruminalis dextra.

The A. ruminalis sinistra which is located to the right of the rumen, passes toward the transverse groove of the rumen, hence, it turns around the cranial groove to the left longitudinal groove of the rumen. After passing caudally approximately two-thirds of the length of the groove it obliquely ascends as Ramus ascendens to the dorsal surface of the rumen, where it anastomoses with branches of A. reticularis and Ramus longitudinalis of A. ruminalis dextra (Sieber, 1903). Scupin (1960) in the goat and Happich (1961) in the sheep found that A. ruminalis sinistra divides into Ramus ascendens and Ramus descendens on the left surface of the rumen, where branches anastomose with those of A. ruminalis dextra and A. reticularis.

It is generally accepted that the reticulum obtains its arterial supply from the A. reticularis. According to Scupin (1960) in the goat and Happich (1961) in the sheep, the Ramus dorsalis of the A. gastrica sinistra gives off, 2 to 3 cm from its origin, a branch, which they call the A. reticularis accesoria. It supplies the right cranial wall of the reticulum. In the ox it is 6 mm in diameter (Sieber, 1903). May (1955) also mentioned this branch, although he did not give it any particular name. Sieber (1903), Scupin (1960) and Happich (1961) found that the A. reticularis gives off the A. oesophagica caudalis, which supplies the cardia and anastomoses with the A. oesophagica cranialis, a branch from the Truncus bronchooesophageus. A second branch, the A. phrenica caudalis ventralis, is given off 3 cm from the origin of the A. reticularis (Scupin, 1960). Happich (1961) did not find this artery in the sheep.

All authors agreed that the A. reticularis arises from the A. gastrica sinistra, occasionally it comes off the A. ruminalis dextra (May, 1955). Yoshikawa et al. (1956) found a case in which an anastomosing branch exists between the A. ruminalis dextra and the A. reticularis. The terminal branches of the A. reticularis, according to the authors, form anastomosis with the branches of the A. gastrica sinistra or the A. ruminalis sinistra.

The continuing branch of the A. coeliaca, according to the authors, is called the A. gastrica sinistra. Because of its supply to the omasum and abomasum it is also called the omaso-abomasal artery (May, 1955; Habel, 1955; McLeod, 1958). According to Sieber (1903) its diameter is 10 to 14 mm in the ox, and 4 to 6 mm in the sheep and goat. After a course of 12 cm (Sieber, 1903) or 10 to 12 cm (Sisson and Grossman, 1953) it divides into two branches, dorsal and ventral (Sisson and Grossman, 1953; May, 1955; Yoshikawa et al., 1956; McLeod, 1958; Dobberstein and Koch, 1958; Scupin, 1960). Yoshikawa et al. (1956) considered the former as the A. gastrica sinistra in a narrow sense, which supplies not only the omasum, but also the abomasum. The vessel was observed to anastomose with the A. gastrica dextra by the authors. As it has been mentioned before, the dorsal branch gives off the A. reticularis accesoria. The ventral branch, which becomes the A. gastroepiploica sinistra is in the ox 6 to 7 mm in diameter (Sieber, 1903). It passes to the lesser curvature of the omasum, continues on the greater curvature of the abomasum to anastomose with the A. gastroepiploica dextra. It was observed that the A. gastroepiploica sinistra gives off a branch which curves around the front of

the neck of the abomasum to communicate with the A. reticularis (Sieber, 1903; Sisson and Grossman, 1953; May, 1955; Scupin, 1960). According to Scupin (1960) in opposition to the findings of Sieber (1903) in the ox, the abomasum of the goat does not receive its main supply from the A. gastrica dextra and the A. gastroepiploica dextra, but from the A. gastrica sinistra and the A. gastroepiploica sinistra just at the border of the rumen and the abomasum.

The arterial supply of the intestine

The arterial supply of the intestine of the ruminalis is from three sources, namely, the A. mesenterica cranialis and the A. mesenterica caudalis and the A. rectalis (haemorrhoidalis) caudalis. The former supplies the duodenum, as far as it is not supplied by the A. pancreaticoduodenalis of the A. coeliaca, and the colon, except its descending part, which is supplied by the A. mesenterica caudalis.

The A. mesenterica cranialis arises from the abdominal aorta caudal to the A. coeliaca. Variations may occur in the origin of this vessel. Most of the authors observed that this artery may arise by a common trunk with the A. coeliaca. Scupin (1960) and Happich (1961) found in the goat and in the sheep respectively a distance of 1 cm between the A. coeliaca and the A. mesenterica cranialis. According to Sieber (1903) and Martin and Schauder (1935) the A. mesenterica cranialis of the ox is 17 to 20 mm in diameter and about 10 cm long. In the goat, Scupin (1960) found that it is 12 cm long. In the sheep it is 8 to 9 cm long (Happich, 1961). In the ox, Kádár (1926) stated that the A. mesenterica cranialis has an average diameter of 15 mm, while in the sheep Kattauer (1926) found an average

of 10.15 mm in diameter. Zimmermann (1926) gave the following internal diameters for this artery, namely, in the ox, 3.8 to 8.2 mm, and 2.6 to 4.5 mm in the sheep.

The A. mesenterica cranialis, according to Chauveau (1889), divides into two branches, an anterior branch for the small intestine and a posterior branch for the large intestine. The following branches are given by most of the authors: Rami pancreatici, A. colica media, A. ileocaecocolica, and the Ramus collateralis, the latter vessel being only present in the ox. The continuing vessel is called the Truncus intestinalis, which in the ox has a diameter of 12 mm at its origin (Sieber, 1903).

The A. mesenterica caudalis, according to Sieber (1903), arises in the region of the sixth lumbar vertebra and divides into the A. colica sinistra, which supplies the colon descendens and the A. rectalis cranialis to the last part of the colon descendens.

According to Happich (1961) the A. rectalis caudalis, a branch of the A. urethrogenitalis, supplies the ampulla of the rectum and the anus.

The Arterial Supply of the Reproductive Tract

It is agreed that the main supply of the male and female reproductive tract comes from two arteries. The first, the A. spermatica interna (Sieber, 1903; Martin und Schauder, 1938; Ellenberger und Baum, 1943; May, 1955; Dobberstein and Koch, 1958) supplies the testicles and the ovaries respectively. Some authors call this artery the utero-ovarian in the female (Sisson and Grossman, 1953; Habel, 1955; McLeod, 1958). The second, the visceral branches of the A. hypogastrica or the A. iliaca interna, supplies the tubular genital tract.

The arterial supply of the male genital tract

According to Sieber (1903) the A. spermatica interna of the bull arises from the ventral wall of the abdominal aorta and is about 3 mm thick. It descends through the inguinal canal in the plica vasculosa, becomes very convoluted, and upon arriving between the testicle and epidydimis the convolutions decrease. The vessel then passes to the ventral part of the testicles. It gives off coiled terminal branches which run in a cranial direction. Anastomoses occur with branches from the A. deferentialis, (Sieber, 1903). Branches of the A. pudenda externa contribute to the supply of the scrotum (Martin und Schauder, 1938).

The A. iliaca interna supplies with its branches: the A. umbilicalis, the A. urethrogenitalis, and the A. pudenda interna, the genital tract. According to Sieber (1903) the A. iliaca interna of the ox is 16 mm in diameter, that of the sheep and the goat 6 mm. Kádár (1926) found in the ox that it has a diameter of 17 mm and in the sheep Kattauer (1926) found an average of 8.05 mm for the right and 8.26 mm for the left artery. Zimmermann (1926) gave an average of 5.7 mm for the internal diameter of the ox and 2.6 mm in the sheep.

According to Sieber (1903), the A. umbilicalis of the animal at birth is three times the size of the A. iliaca interna. In the adult animal he found that the size of the A. umbilicalis is 0.6 to 2 cm in the ox, 8 mm in the goat, and 8 to 10 mm in the sheep. In the adult male its size is at the utmost 7 mm, while in the female it reaches a size of 2 cm.

In the male the A. umbilicalis, according to most authors, gives off: (a) A.uretericafor the ureters; (b) A. deferentialis, which is 2 to

3 mm in diameter. It supplies the ductus deferens and some small twigs go to the epidydimis to form anastomoses with branches of the A. spermatica interna; (c) the A. vesicalis superior (cranialis), according to Sieber (1903), is in the ox 2 to 4 mm in diameter and in the sheep it is 1 to 3 mm in diameter. It sends diverging branches to the vertex of the bladder, forming polygonal areas with its corresponding fellow. Branches are given off to the lateral wall of the bladder, which anastomose with the A. vesicalis inferior (caudalis).

The A. urethrogenitalis is, according to Sieber (1903), 4 to 5 mm in diameter in the ox and 2 to 3 mm in the sheep. In the ox it is given off 20 to 30 cm posterior to the A. glutea cranialis. It gives off the A. vesicalis caudalis, which supplies the caudal part of the bladder and the accessory genital glands. The branches of the A. vesicalis caudalis form a network on the bladder similar to the network formed by the A. vesicalis cranialis (Sieber, 1903).

The A. pudenda interna, which is well developed in the male, is the continuation of the A. hypogastrica and forms the main supply to the penis. After giving off the A. rectalis caudalis, the A. perinei, and the A. bulbourethralis, it divides into the A. profunda penis and the A. dorsalis penis (Sisson and Grossman, 1953). The A. dorsalis penis passes on the dorsal surface of the penis and terminates in the glans penis (Dobberstein and Koch, 1958).

The arterial supply of the female genital tract, including the mammary glands

The female reproductive tract consists of the ovaries, the fallopian tube, the uterus, the vagina and the vulva. The ovaries receive their blood supply from the A. spermatica interna (Sieber, 1903), Martin und Schauder (1938) and some other authors called the vessel the utero-ovarian artery (Sisson and Grossman, 1953; McLeod, 1958). All agree that this artery supplies with its branches the ovaries and the cranial part of the uterus. Sieber (1903) called these branches the Ramus uterinus and the Ramus ovaricus.

The main supply of the uterus comes from the A. umbilicalis through its branch the A. uterina media. According to Sieber (1903) this vessel is 12 to 15 mm in diameter in the ox and in the sheep and goat it is 3 to 5 mm. It extensively ramifies in the uterus and anastomoses in the cranial region of the uterus with branches of the Rami uterini of the A. spermatica interna and in the caudal region with the A. uterina caudalis. In some cases the A. uterina media gives off the caudal branch of the A. ureterica.

The urethrogenitalis or the A. vesico-uterina (Sieber, 1903) arises as in the male from the A. iliaca interna. According to him it is 5 to 6 mm in diameter in the ox and in the sheep it is 3 to 4 mm. It gives off the A. rectalis caudalis, the A. vesicalis interior (caudalis) for the caudal part of the bladder and its terminal vessel becomes the A. uterina caudalis. This vessel enters the vagina to send twigs caudally as well as cranially. It also anastomoses with twigs from the A. uterina

media.

According to Ellenberger und Baum (1943) the mammary glands in the cow are represented by two mammar complex, while in the sheep and goat they are represented by one mammar complex.

It is agreed that the arterial supply of the mammary glands comes from the A. pudendalis externa. This artery passes through the inguinal canal, leaves the external inguinal orifice and divides into the A. subcutaneus abdominalis and the A. mammaria. The artery of the udder of the cow has been well described by many authors (Emmerson, 1940; Ellenberger und Baum, 1943; El Hagri, 1945; Swett, 1949; Ziegler and Mosimann, 1960). Rustamov (1958) described the arterial supply of the mammary glands in the Karakul sheep and Otto (1961) discussed the arterial supply of the mammary glands of the goat.

MATERIALS AND METHODS

In this study, fifteen sheep were used, consisting of ten ewes and five rams. Five ewes were dissected in part by the students in the classes of gross anatomy (Specimens No. 11 through 15) and the remainder (Specimen No. 1 through 10) were done by the author. The breed was of a Southdown cross. Their ages varied from four to eight years and their weight ranged from eighty to one hundred and twenty lbs. in the female, and one hundred thirty to one hundred eighty lbs.in the male.

The specimens which were dissected by the author were prepared according to the following procedure (see table 1). For three to four days feed was withheld from the animals. After the age and weights were determined, the animals were given general anaesthesia with either Chloral hydrate Magnesium sulfate solution or Equithesin. Injection of an anticoagulant, Chlorazol Fast Pink B solution* (2 grams in 4000 cc of .85 per cent sodium chloride solution) was carried out for the purpose of preventing the blood from clotting during the exsanguination. The A. carotis sinistra was dissected and the animals were bled by means of their own heart action. To prolong this heart action in order to exsanguinate as much blood as possible, an .85 per cent saline solution was introduced through the V. jugularis externa.

Preinjection perfusions with acetic acid, 1 per cent sodium citrate, 4 per cent sodium nitrite and sodium chloride solutions were used. Baker (1946) found that 5 per cent acetic acid solution prevents tissue

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*Manufactured by the Allied Chemical and Dye Corporation, 40 Rector Street, New York 6, New York.

contraction and does not fix protein, thus leaving the tissue pliable.

This characteristic gives a better opportunity for the injection material to fill the smallest vessels. Christensen (1953) used as perfusion fluid, 1 per cent sodium citrate, followed by 4 per cent sodium nitrite, in order to relax the smooth muscles of the arterioles and dilate the lumen. Since cementex was used, which is a latex compound, it was necessary to flush the vessels with a saline solution to prevent clotting of the latex which would occur if it contacted the acetic acid.

Perfusion and injection of the arteries was accomplished by air pressure with a special outfit (see Fig. 1). This outfit consisted of two five-gallon bottles (one for the injection material and the other for the perfusion solutions and the embalming fluid), an open mercury manometer, plastic tubes, glass tubes, and rubber stoppers for the bottles. A valve was attached to the manometer to control the air pressure. Air is obtained from a compressor. The manometer was connected with the bottles via a Y-tube on one side and with the air inlet on the other.

Before injection took place into the A. carotis sinistra in some of the specimens an attempt was made to bypass the heart and lung (see table 1). By opening the left thoracic wall between the third and the fourth rib the origin of the aorta was clamped at its base before the bifurcation into the common brachio cephalic trunk and thoracic aorta by a hemostatic forcep. This procedure allowed more material to fill the vessels revealing more anastomotic branches.

Injection material used for the arteries was red cementex*, a latex

*Manufactured by the Cementex Company, New York 3, New York.

compound. Hill (1937) found that 2 per cent ammonia water will increase the sliding ability of latex. Besides this ability, ammonia water has the ability to prevent clotting of the latex for a certain period of time. Based on this characteristic, the cementex was diluted with 2 per cent ammonia water in a ratio of 4:1.

After flushing the arteries with saline solution, cementex was injected under a pressure of 120 mm Hg. In specimens in which the heart and lung were not bypassed, more cementex was used (see table 1). To preserve the specimens, regular embalming fluid of the Department of Anatomy and Histology, College of Veterinary Medicine, Iowa State University, was injected into the V. jugularis externa. The formula of the embalming fluid is as follows:

Isopropyl alcohol	60%
Formaldehyde 40%	4%
Phenol (melted)	6%
Corn syrup (diluted 50-50 in water)	5%
Water	25%

The amounts of perfusion fluid, cementex, and embalming fluid used are listed in table 1.

RESULTS

The Arterial Supply of the Digestive Tract

The stomach, including the liver, spleen and pancreas

The stomach of the ruminants shows distinct differences in structure compared to other domestic animals. According to Nickel et al. (1961) it consists of three fore-stomachs, the proventriculi: rumen, reticulum and omasum; and a fourth part: the abomasum. These four parts are arranged in such a way that the rumen lies largely to the left side of the median plane, the reticulum cranial to it and the omasum lies to the right of the median line. The abomasum is located on the ventral wall of the abdomen covered in part by the omasum and the rumen. Thus, because of the considerable extent of development of the stomach, additional blood supply is brought to it.

All the measurements given in the following results represent averages as listed in tables 2, 3, 4, and 5. The outside diameter and the length of the individual arteries are measured. The diameter is taken at the origin, and the length is measured from the origin of the vessel until the first branch or a bifurcation occurs. The average measurements are given in the ewe in tables 2 and 6 and for the ram in tables 3 and 7.

The numbers in parenthesis after the individual arteries refer to figure 2, except where otherwise indicated.

A. coeliaca (1) This artery arises from the ventral wall of the abdominal aorta on the level with the space between the last thoracic and the first lumbar vertebra, between the crura diaphragmatica. It is 4.0 cm long and its outside diameter is 9.6 mm in the ewe, and in the ram

its length is 4.6 cm and its diameter is 11.0 mm. It passes in a cranio-ventral direction, between the anterior part of the rumen and the cranial part of the pancreas, and to the right of the crus of the diaphragm and the posterior cava.

It is observed that in five cases the A. coeliaca may arise by a common trunk with the A. mesenterica cranialis (see Figs. 4/2 and 5/2). The author calls this common trunk the Truncus coeliacomesentericus, concordant to Sieber (1903). In the ewe it is a 1.9 cm long vessel with a diameter of 10.9 mm in specimen No. 1. In the ram the measurements are 3.5 cm and 11.2 mm respectively.

The A. coeliaca supplies with its branches the diaphragm, the stomach, the greater omentum, the liver, the spleen, pancreas and the cranial part of the duodenum.

The following branches arise from the A. coeliaca:

1. A. phrenica caudalis dorsalis (2) This artery arises 2.0 to 2.5 cm from the origin of the A. coeliaca and passes in a cranial direction. After 1 to 2 cm it gives off: Rami proximales dextra et sinistra (3) for the right and the left dorsal portion of the diaphragm respectively. The continuing vessel courses in a ventral direction, divides into two branches, Rami distales dextra et sinistra (4, 5) for the right and left distal part of the diaphragm respectively. The Rami distales give off twigs (5') to the esophagus.

2. Rami pancreatici (7) These branches, 2 to 4 in number, arise by a common vessel (6) with the A. epiploica, from the caudal wall of the A. coeliaca. It enters the left lobe of the pancreas where it

ramifies extensively. The Rami pancreatici may arise separately.

3. A. epiploica (8) This artery, which comes off either separately or with the Rami pancreatici from the A. coeliaca, supplies the greater omentum. It passes between the two layers of the greater omentum in a caudal direction and gives off twigs ventralward, which anastomose with the Rami epiploici (43).

4. A. hepatica (9) This artery arises from the A. coeliaca and passes to the right toward the visceral surface of the liver. On the right side it is bordered by the posterior cava. In the ewe this vessel is 7.8 cm long and 3.8 mm in diameter, while in the ram the sizes are 8.0 and 3.3 mm respectively. The A. hepatica gives off the following branches:

A. cystica (10) This vessel supplies with its branches the gall bladder, the caudate process and the right lobe of the liver. Close to its origin, twigs are given off to the porta hepatis and the portal lymph nodes. After 1 to 1.5 cm the A. cystica divides into two branches. The first branch, Ramus caudatis et partis dextra hepatis (11), passes to the caudate process and the right lobe of the liver, supplying both lobes respectively. The second (12) courses toward the bile duct, which it follows sending twigs to it to terminate in the gall bladder.

A. gastroduodenalis (13) This vessel leaves the hepatic artery a few cm after the A. cystica. It passes in the lesser omentum toward the duodenum, and after arriving at the latter, it divides into two vessels: the A. pancreaticoduodenalis cranialis (15) and the A. gastroepiploica dextra (16, 40). The former passes in a caudal direction along the dorsal

side of the duodenum descendens. Branches are given off to this part of the duodenum, and close to its origin, to the pancreas. At the flexura caudalis of the duodenum it anastomoses with the A. pancreaticoduodenalis caudalis of the A. mesenterica cranialis. The A. gastroepiploica dextra runs in a caudoventral direction, parallel to the duodenum on a distance of 2 cm of the abomasum and follows the greater curvature of the abomasum. This distance becomes larger at the first half of the abomasum, (4 to 5 cm) and after that it runs very close to the greater curvature. This vessel gives 4 to 5 small branches to the pylorus (39), the abomasum (39'), and sends fine branches to the greater omentum (43). Finally, it anastomoses with the R. ventralis (32) of the A. gastrica sinistra.

A. gastrica dextra (14) This vessel leaves the hepatic artery 3 cm after the A. gastroduodenalis. It passes parallel to the duodenum, in the hepatoduodenal ligament toward the pylorus of the abomasum. A small branch is given off to the duodenum descendens, where it forms an anastomosis with the Ramus duodenalis of the A. gastroduodenalis. After giving off this branch, the A. gastrica dextra closely follows the lesser curvature of the abomasum and anastomoses with the Ramus dorsalis of the A. gastrica sinistra. Along its course the A. gastrica dextra gives off branches to the pylorus and the abomasum, Rami abomasici (42). The latter forms anastomosis with its fellow (39, 39'), branches from the A. gastroepiploica dextra. It is also observed that the A. gastrica dextra gives off twigs to the lesser omentum (41).

The continuing vessel (17) of the A. hepatica passes as the Ramus partis sinistra hepatis along the Incisura Interlobularis and here it

divides into several branches. One branch enters into the pars intermedia infraportalis, while another supplies the pars sinistra hepatis.

5. The A. lienalis and the A. ruminalis dextra arise by a common trunk, Truncus lienoruminalis (18), from the A. coeliaca. In the ewe this trunk is 2.0 cm long and 4.4 mm in diameter and in the ram it is 2.1cm long and 4.5 mm in diameter. It passes in a dextrocaudal direction and divides into the:

A. lienalis (19), which is 4.0 cm long and presents a diameter of 3.7 mm in the ewe; in the ram it is 5.8 cm long and 3.2 mm in diameter. This artery passes dorsal to the left along the dorsal surface of the rumen where it divides into a Ramus cranialis and a Ramus caudalis. The former is the largest and supplies the cranial third of the spleen. It gives off a Ramus intermedius, which ramifies in the middle third of the organ. The Ramus caudalis supplies the caudal third part of the spleen.

It is observed that in specimen No. 2 the A. lienalis is double, while in specimen No. 7 this artery divides into three vessels. In five cases (see Fig. 5) the Truncus lienoruminalis gives off the A. ruminalis sinistra.

A. ruminalis dextra (20) leaves the parent vessels in a caudoventral direction toward the right longitudinal groove. In the ewe it is 43.4 cm long and 3.9 mm in diameter, and in the ram it is 49.7 cm long and 3.7 mm in diameter. It then runs in the groove, reaching the caudal transverse groove to run parallel to the left longitudinal groove on the left surface of the rumen.

In its course the A. ruminalis dextra gives off:

Rami dorsales (21), 4 to 5 in number, which pass in a caudodorsal direction, and 5 to 8 Rami ventrales, which pass in a caudoventral direction (24). These branches ramify in the dorsal and the ventral wall of the rumen respectively.

A. coronaria dextra ventralis (23) leaves the A. ruminalis dextra in a ventral direction in the right ventral coronary groove. In its course it gives off the Rami craniales (26) and the Rami caudales (25) in a cranial and a caudal direction respectively. These branches ramify in the right ventral wall of the rumen.

A. coronaria dextra dorsalis (22) This artery is quite small and ramifies in the right dorsal blind sac of the rumen.

A. coronaria sinistra ventralis (Fig. 3/8) It is given off by the A. ruminalis dextra after the latter passes the caudal transverse groove. It passes in a cranioventral direction and gives off the Rami craniales (10) and the Rami caudales (11) which ramify in the caudoventral region of the rumen.

A. coronaria sinistra dorsalis (Fig. 3/9) courses in a craniodorsal direction and ramifies in the left part of the dorsal blind sac.

6. The common trunk of the A. ruminalis sinistra and the A. reticularis, which the author calls the Truncus reticuloruminalis (27) comes off from the A. coeliaca and passes ventrally toward the cranial transverse groove of the rumen. In the ewe it is 4.0 cm long and 4.3 mm in diameter, while in the ram it is 2.2 cm long and 4.3 mm in diameter. In five cases (see Fig. 5) it is observed that the A. ruminalis sinistra comes off from the Truncus lienoruminalis and in these cases the A.

reticularis then comes off from the A. gastrica sinistra.

A. ruminalis sinistra (29; Fig. 3/4) leaves the parent vessel in a ventral direction, bounded on the left by the pancreas and the portal vein coursing toward the Sulcus transversalis cranialis. In the ewe it is 33.8 cm long and 3.8 mm in diameter, and in the ram it is 34.8 cm and 3.7 mm in diameter. On the right surface of the rumen it gives off branches (30) which ramify in the cranial ruminal sac. It then turns to the left side of the rumen and divides into two branches: the Ramus ascendens (Fig. 3/4') and the Ramus descendens (Fig. 3/6). Ramus ascendens first passes in a caudodorsal direction to ascend dorsally in the left longitudinal groove. Three to five strong branches, Rami craniales (5) are given off to supply the left dorsal region of the rumen. Two to three branches, Rami caudales (7), pass to the left wall of the rumen. Anastomosis with branches of the Aa. coronaria sinistra are observed. Ramus descendens ramifies in the cranial part of the left ventral sack of the rumen.

A. reticularis (Fig. 3/1) comes off from the trunk with the A. ruminalis sinistra, except in five cases as described above. In the ewe it is 4.7 cm long and 2.5 mm in diameter, while in the ram the measurements are 4.5 cm and 2.4 mm. It passes craniodorsal and to the left of the rumen, caudal to the cardia in the reticuloruminal fold, where it descends to cranioventral. Two cm from its origin it gives off the A. oesophagica caudalis (Fig. 3/2), which ramifies in the cardia and the esophagus. Anastomosis with the A. oesophagica cranialis of the Truncus bronchoesophageus are not found. Furthermore, it gives off branches to the rumen, Rami ruminales, which vascularize the craniodorsal and the

caudodorsal wall of the rumen respectively. Finally the A. reticularis ramifies in the cranial wall of the reticulum. An A. phrenica caudalis ventralis is not observed.

7. A. gastrica sinistra (31) Measured to the bifurcation in the ewe this artery is 4.4 cm long and 4.6 cm in the ram. The diameter in the ewe is 5.6 mm and in the ram 5.9 mm. It passes in a ventral direction, slightly cranial where it divides at the transition of the reticulumomasum into two branches, the Ramus dorsalis and the Ramus ventralis.

Ramus dorsalis (33) passes along the greater curvature of the omasum towards the transition of the omasumabomasum, where it extensively ramifies in this area. The main vessel (38) follows the lesser curvature of the abomasum and joins the A. gastroepiploica dextra. Shortly after its origin it gives off a branch, which passes in a cranioventral direction to the omasum and the reticulum. The author calls this branch the A. reticularis accessoria (37). After 4 to 5 cm this branch gives off a branch, which passes toward the rumen and ramifies in the right wall of the rumen, to form anastomosis with the other ruminal branches of the Ramus dorsalis and the Ramus gastrici of the A. gastroepiploica sinistra. A few centimeters thereafter a branch comes off which passes in a left and ventral direction, to supply the right cranial wall of the reticulum and anastomose with branches of the A. reticularis, Rami reticularis of the A. gastrica sinistra.

The Ramus dorsalis gives off branches, Rami omasici (34) to the omasum. In its course along the convex border of the omasum 10 to 15 small branches arise to supply the reticular lymph nodes. At the transition

omasum-abomasum 4 to 5 branches (38') are given off, which ramify in this area. One branch follows the lesser curvature of the abomasum and joins the A. gastroepiploica dextra.

Ramus ventralis (32) passes in a ventral direction toward the transition of the omasum-abomasum. It follows the reticulo-omasal groove, to give off branches to the reticulum, Rami reticulares (36) and to the omasum, Rami omasici (35). Smaller branches go off to the reticulo-abomasal lymph node which lies dorsal and ventral in the reticulo-ruminal groove. The continuing vessel of the Ramus ventralis, the A. gastroepiploica sinistra (32'), runs in the greater omentum, first to the left, later on at a distance of 1 cm from the greater curvature of the abomasum. In its course it gives off branches (39') to the abomasum, and forms anastomosis with the branches from the Ramus dorsalis of the A. gastrica sinistra. Besides this, numerous branches, Rami epiploici (43), are given off to the greater omentum, which join with the branches of the A. epiploica and the A. pancreaticoepiploica.

The intestinal tract

The arteries which supply the intestine are the A. mesenterica cranialis, the A. mesenterica caudalis and intestinal branches of the A. iliaca interna.

The same procedure of measuring the arteries to the stomach is used for the intestinal arteries. The average diameter in the ewe is given in table 6 and for the ram in table 7; the average length for the ewe in table 4 and for the ram in table 5.

The numbers in parenthesis after the individual arteries refer to

figure 6, except where otherwise indicated.

A. mesenterica cranialis (1) This artery arises from the Aorta abdominalis just behind the A. coeliaca. In the ewe it is 8.5 cm long and the diameter is 9.5 mm. In the ram the measurements are 8.9 cm long and 10.6 mm in diameter. As has been described, the A. mesenterica cranialis may arise by a common trunk with the A. coeliaca (see Figs. 4 and 5). The artery passes in a ventral direction between the pancreas and the posterior cava, caudal to the colon transversum and crosses the last part of the colon spiralis. It then divides into two trunki: the Truncus jejunalis (18) and the Truncus ileocaecocolicus (7). The following branches of the A. mesenterica cranialis were dissected and are described as follows:

1. Rami pancreatici arise in a variable number from the A. mesenterica cranialis. They ramify extensively in the pancreas. One or two branches pass to the greater omentum.

2. A. pancreatica magna (2) arises from the caudal wall of the A. mesenterica cranialis. It passes in a caudal direction and after 1 to 2 cm it divides into several branches. Most of the branches ramify in the pancreas. Two to three branches go to the greater omentum as Rami epiploici.

3. A. pancreaticoepiploica (3) arises from the parent vessel 1 cm dorsal from the A. pancreatica magna. Crossing the portal vein it turns caudally and to the right toward the right lobe of the pancreas. Here it ramifies in the pancreas with 2 to 3 branches going to the greater omentum.

4. A. pancreaticoduodenalis caudalis (4) leaves the A. mesenterica cranialis in a left and caudal direction 6 cm from its origin of the Aorta abdominalis. In two specimens it arises from the first A. jejunalis. It then passes to the left, turns caudally and runs parallel to the duodenum descendens. Branches are given off to this part of the duodenum. Along its course pancreatic branches are given off. At the flexura caudalis of the duodenum the A. pancreaticoduodenalis caudalis joins the A. pancreaticoduodenalis cranialis.

5. A. colica media (5) arises 6 to 8 cm distal from the origin of the A. mesenterica cranialis and passes in a cranial direction. In the ewe the diameter is 1.4 mm and in the ram it is 1.3 mm. It divides into 3 to 5 branches. Two to three branches pass in a right and ventral direction to supply the Ansa distalis of the colon ascendens. One to two vessels supply the beginning and the middle part of the colon transversum. A fifth vessel passes in a left and caudal direction to follow the colon descendens, to supply it and form anastomosis with the A. colica sinistra, a branch of the A. mesenterica caudalis. In two specimens the A. colica media arises from the Truncus ileocaecocolicus. In 5 specimens the A. colica media gives off pancreatic branches.

6. Truncus ileocaecocolicus (7) one of the terminal branches of the A. mesenterica cranialis, in the ewe 3.6 mm in diameter and 1.9 cm long, in the ram 3.8 mm in diameter and 2.5 cm long, passes in a caudal direction and divides into the A. ileocaecocolica and the Truncus ileocaecalis and the Truncus colicus. In two specimens the A. colica media arises from the Truncus ileocaecalis. In addition, branches are given

off to the Ansa distalis of the colon descendens. Pancreatic branches are also observed.

Truncus colicus (8), 3.3 mm in diameter in both sexes, arises from the ventral wall of the Truncus ileocaecocolicus and passes toward the Ansa centralis of the Colon spiralis. In three sheep it had a double origin, in two others four came off, and the remainder showed a single vessel (Fig. 6). This trunk supplies with its branches, the Rami colici (9), the centrifugal and the centripetal coils of the colon, except the last part, which receives its blood supply from the Aa. jejunales. Connections among the Rami colici are observed and in two cases anastomosis with the Truncus jejunalis on the one hand, and with the A. ileocaecocolica on the other are observed. Twigs arise from the Rami colici to the colic lymph nodes.

A. ileocaecocolica (10) arises from the Truncus ileocaecocolicus after the Truncus colicus. It passes in a ventral direction and supplies the Ansa proximalis of the colon ascendens, the caecum and the ileum. The following branches are dissected:

Rami ansae proximalis (11, 12), 3 to 4 in number, arise from the dorsal surface of the parent vessel. They pass in a dorsal direction and terminate in the Ansa proximalis of the Colon ascendens. Anastomosis with the terminal branches of the Truncus colicus, especially of the first branch were observed.

At the end of the ileum the A. ileocaecocolica gives off a branch, the Ramus ilecus (13). It follows the ileum and gives off branches to it. The Ramus ilecus terminates then at the middle of the ileum.

The A. ileocaecalis (14) forms the continuation of the A. ileocaecolica. In the ewe it is 2.5 mm in diameter and 18.8 cm long, while in the ram the sizes are 2.6 mm and 20.9 cm. It passes caudoventrally in the ileocaecal ligament toward the apex of the caecum, at the same distance from the ileum and the caecum. At the free edge of the ligament it continues in the caudal part of the mesentery of the jejunum and forms an anastomosis with the terminal branches of the Truncus jejunalis. The A. ileocaecalis sends branches to the caecum, Rami caecales (15), 10 to 15 in number, at regular distance of 1 cm. These branches divide into two, a right and a left one, before they terminate in the caecum. The right and the left vessels join each other at the dorsal region of the caecum. Twigs are given off from the ileocaecalis to the caecal lymph glands. Rami ileci (16) leave at variable distances of 1 to 5 cm from the A. ileocaecale and ramify in the ileum. The terminal branch of the Rami ileci joins the Ramus ilecus of the A. ileocaecoclica, the Ramus anastomoticus (17). They pass in a caudoventral direction, left to the ileum to join the terminal branch of the Truncus intestinalis.

7. Truncus intestinalis (18) is the continuing vessel of the A. mesenterica cranialis. In the ewe it is 44.3 cm long and in the ram it is 53.0 cm. It passes in the cranial mesentery in a curved course. The following branches of the A. mesenterica cranialis were dissected:

Aa. jejunales (19) The number of the Aa. jejunales varied in the individual animals, namely 18 to 24 vessels. The distance between one vessel and the other varies from 0.5 to 4 cm. The proximal branches arise closer to each other. The Aa. jejunales pass in a direction parallel to

the jejunum. They are 4 to 5 cm long and divide into two branches, before they enter the jejunum. These branches join each other, forming an arcade (20). At several places a second arcade (21) is formed. From the first or second arcade the Rami jejunales enter the jejunum. These rami form anastomosis with each other. Twigs to the jejunal lymph nodes come off from the Aa. jejunalis. Besides this the Aa. jejunales give off branches to the last part of the centrifugal colon, the Rami colici, (22). Anastomosis of these rami with branches of the A. colica media are observed.

Rami ileci (23) pass toward the ileum which they supply. Branches go off to the ileal lymph nodes. A branch continues to pass in a dorsal direction and anastomoses with the Ramus ilecus of the A. ileocaecalis.

A. mesenterica caudalis (24) This vessel arises at the level of the fifth lumbar vertebra from the ventral wall of the Aorta abdominalis. In the ewe it is 8 cm long and the diameter is 3.1 mm, while in the ram the measurements are 9.1 cm and 3.8 mm. Passing in a ventral direction in the caudal mesentery toward the colon descendens, it soon divides into two branches, the A. colica sinistra and the A. rectalis cranialis.

1. A. colica sinistra (25) passes cranially in the mesentery of the colon descendens. It gives off 3 to 4 branches to both sides of this part of the colon. Connections between the right and the left branches were observed. The most cranial branch forms an anastomosis with a branch of the A. colica media.

2. A. rectalis cranialis (26) passes in a caudal direction in the mesorectum toward the anus. Along its course it gives off branches

to both sides of the rectum, where they ramify into caudal and cranial branches. These cranial and caudal directed arteries form anastomosis with each other. The cranial branch of the A. rectalis cranialis joins the most caudal branch of the A. colica sinistra. At the end of the rectum the A. rectalis cranialis divides into 2 to 3 branches, which pass ventral to the ampulla and form an anastomosis with branches of the A. rectalis caudalis.

Intestinal branches from the A. iliaca interna. A branch from the A. iliaca interna, namely the A. urethrogenitalis, supplies the rectum. In the ram the A. urethrogenitalis gives off the A. vesicalis caudalis (Fig. 11/16) and a Ramus muscularis (Fig. 11/16'), while in the ewe it gives off the A. uterina caudalis and the A. rectalis caudalis, which gives off the A. vesicalis caudalis and the A. perinei. The vessel concerned is the A. rectalis caudalis and the discussion of the other vessels will be described in more detail in the portion on the arterial supply of the reproductive tract.

In the ewe the A. rectalis caudalis (Fig. 8/23) passes in a caudal direction and supplies the caudal third and ventral part of the ampulla of the rectum. Along its course it gives off the A. vesicalis caudalis and the A. perinei. It then passes dorsally to ramify in the dorsal sphincter muscle of the anus. Anastomotic branches exist between these branches and the branches of the A. rectalis cranialis.

In the ram the A. rectalis caudalis (Fig. 11/18) arises from the dorsal face of the A. pudenda interna. It passes caudally and ramifies in the ampulla of the rectum and the anus.

The Arterial Supply of the Reproductive Tract

The reproductive tract of the ewe, including the mammary glands

The reproductive tract of the ewe includes the ovaries, fallopian tubes, uterus, vagina and vulva. Since the mammary glands are physiologically associated with the reproductive tract, an anatomical description of the arterial supply to them will also be given.

The arterial supply of the reproductive tract is derived from two sources, namely from the A. spermatica interna, to the ovaries, and the visceral branches of the A. iliaca interna, to the tubular genital tract. The mammary glands are supplied by a branch of the A. pudenda externa.

The same procedure of measuring the arteries to the stomach and the intestine is used for the arteries to the reproductive tract. The average diameter in the ewe is given in table 8 and for the ram in table 9; the average length in table 10 for the ewe and in table 11 for the ram.

The number in parenthesis after the individual arteries refers to figure 8 in the ewe and figure 11 in the ram except where otherwise indicated.

A. spermatica interna (5) This vessel arises from the lateral wall of the abdominal aorta, at the level of the fourth lumbar vertebra, 3 to 4 cm in front of the bifurcation of the aorta. It is 15.2 cm long and its diameter is 3.1 mm. It is seen in the broad ligament of the uterus, accompanied by its satelite vein. Soon it divides into two rami, the Ramus ovaricus and the Ramus uterinus.

1. Ramus ovaricus (15) passes with a tortuous route in the mesovarium toward the ovary. It divides into many branches, which enter the

ovary. In two ewes branches to the fallopian tubes were observed.

2. Ramus uterinus (14) passes in the meso-metrium (broad ligament) of the uterus in a caudal direction and divides into branches, which form arcades, similar to that of the Aa. jejunales. From these arcades, Rami uterini are given off, which enter the horn of the uterus.

The A. iliaca interna (3) arises as one of the terminal branches of the Aorta abdominalis, between the fifth and the sixth lumbar vertebra. It passes caudally and slightly ventral to give off parietal and visceral branches. The latter furnishes the arterial blood supply of the tubular genital tract.

The following branches of the A. iliaca interna to the genital tract were dissected:

1. A. umbilicalis (7), 11.9 cm long and 2.7 mm in diameter, leaves the A. iliaca interna 4 to 5 cm from the latter's origin. It passes in a ventral direction toward the vertex of the bladder and terminates as the lateral umbilical ligament. The first part of the A. umbilicalis, which still remains open, gives off:

A. ureterica (8) passes toward the ureter. Upon arriving it divides into a cranial (9) and a caudal (10) directed branch. They follow the ureter and give off branches to it. In specimen No. 4 these branches arise separately from the A. umbilicalis. Anastomosis with branches of the A. renalis or the A. suprarenalis were not observed.

A. uterina media (11) arises from the cranioventral surface of the A. umbilicalis, 3 to 4 cm from the latter's origin. It is 12.4 cm long (measured to the bifurcation before it enters the uterus) and its outside

diameter is 3.5 mm. It then passes in the meso-metrium in a caudoventral direction to the middle part of the uterus and divides into two branches, Ramus cranialis (13) and Ramus caudalis (12). The Ramus caudalis enters the uterine wall and gives off small branches, Rami uterini (16). The Ramus cranialis divides into Rami uterini (16'), which divides into smaller rami, which enter into the cranial part of the horn of the uterus. Rami uterini of the caudal and the cranial branches anastomose with each other, and anteriorly anastomoses with the Ramus uterinus of the A. spermatica interna and posteriorly with the branches of the A. uterina caudalis.

2. A. urethrogenitalis (19) arises from the ventral wall of the A. iliaca interna, 4 to 5 cm after the origin of the A. umbilicalis. It is 3.4 cm long and 1.0 mm in diameter. It passes in a ventral direction to give off the A. rectalis caudalis (23) (see page 33). The continuing vessel of the A. urethrogenitalis continues as the A. uterina caudalis (20) to the wall of the vagina where it divides into cranial (21) and caudal (22) branches. The former enters the vaginal wall to anastomose with the A. uterina media, and the latter courses caudally in the wall of the vagina.

3. A. pudenda interna (25) This artery forms the continuation of the A. iliaca interna after the A. urethrogenitalis is given off. It is 8.9 cm long and its diameter is 1.3 mm. It passes in a caudal direction and forms the A. clitoridis (26). In specimen No. 15 the A. uterina caudalis gives off the A. clitoridis. A branch of the latter anastomoses with a branch of the A. pudenda externa (27).

The arterial supply to the mammary glands (see Fig. 9)

The arterial blood supply of the mammary glands is derived from the A pudenda externa (18), which comes off from the Truncus pudendoepigastricus (16). The latter arises from the A. profunda femoris (15) which, in turn, arises from the A. iliaca externa (2). The Truncus pudendoepigastricus divides into two vessels: the A. pudenda externa (18) and the A. epigastrica caudalis profundus (17). The A. pudenda externa passes ventrally, enters the inguinal canal and appears at the external inguinal orifice. It then runs ventrally and gives off along its course a branch to the supramammary lymph nodes. A second branch is given off to the caudal part of the mammary gland (21). This vessel can be compared with the A. mammary caudalis of the cow. The A. pudenda externa turns cranially and continues as the A. mammaria (22) and the A. epigastrica caudalis superficialis (22'). The A. mammaria passes in the gland tissue toward the umbilicus, 1 to 2 cm from the Fascia trunci profunda, 2 to 3 cm medial to the suspensory ligament of the mammary gland.

The following branches of the A. mammaria were dissected:

1. A. mammaria medialis (23) arises shortly after the entrance of the A. mammaria into the parenchyma. It passes medially to reach the suspensory ligament of the mammary gland. It turns in a cranioventral direction and ramifies in the parenchyma. The author could not establish connecting branches between the right and the left vessels as it is reported by Otto (1961) in the goat.

2. A. lateralis sinus (24; Otto, 1961) comes off the A. mammaria, 2 to 3 cm after the A. mammaria medialis arises. It passes toward

the teat and divides in the region of the cystern into two small branches, the Aa. papillares (25; Otto, 1961) which ramify in the wall of the teat. The Circulosus arteriosus papillae, formed by the twigs of the A. lateralis sinus, is not clearly seen in most of the specimens.

3. A. basalis (26: Otto, 1961) forms the continuation of the A. mammaria. It ramifies in the base of the gland, and also supplies the ventral skin of the abdomen in the front of the mammary glands.

The reproductive tract of the ram (see Fig. 11)

The reproductive tract of the ram includes the testicles, epididymis, ductus deferens, ampulla, seminal vesicles, bulbourethral gland, penis and urethra. The latter serves the urinary and the reproductive system.

A. spermatica interna (5) It arises from the lateral wall of the Aorta abdominalis, near the origin of the A. mesenterica caudalis, at the level of the fifth lumbar vertebra, 3 to 4 cm before the bifurcation of the Aorta. Its diameter is 1.9 mm and its length is 15.6 cm (measured to the top of the cone of coils, described later). It passes caudoventrally in the Plica vasculosa, slightly laterally, crosses the ureter, joins the vastus deferens and together with the A. deferentialis and the A. spermatica externa, it descends in the spermatic cord in the inguinal canal to the scrotum. After it enters the inguinal canal, it forms coils which spirally lie on each other, surrounded by the Pampiniform plexus. These coils form a cone with the apex dorsal and the base of the cone on the cranial pole of the testicles.

From the base of this cone of vessels, the A. testicularis (30) comes off, pierces the tunica albuginea obliquely and passes on the lateral

surface of the testicle to the caudal pole. During this course it forms a large curve at the lateral side, and sends two strong branches to this side. It again forms strong coils and enters, accompanied by coils of the lateral branches, around the caudal pole to course forward on the cranial surface of the testicle. Upon arriving at the cranial surface, the A. testicularis passes dorsomedially and sends along its course to both sides large and heavy coiled branches which diminish as they near the cranial pole, because of the numerous twigs, which have already been given off.

The arterial supply of the epididymis is for a great part performed by a branch of the A. spermatica interna, the A. epididymis (25; Beutler, 1926). This artery leaves the parent vessel at the apex of the cone of vessels. It passes ventrally at the cranial face of the spermatic cord toward the epididymis and ramifies in the cranial pole and the body of the organ. The caudal pole of the epididymis receives its blood supply from the A. spermatica externa and the A. deferentialis.

The A. iliaca interna (3) arises, as in the ewe, as one of the terminal branches of the abdominal aorta between the fifth and sixth lumbar vertebra. It is 6.4 mm in diameter and 13.7 cm long. It passes caudoventrally where it divides into two: Ramus parietalis and Ramus visceralis. The latter forms the arterial supply of the reproductive tract. The following branches of the Ramus visceralis were dissected:

1. A. umbilicalis (10) arises from the ventral face of the A. iliaca interna, 1.5 to 2.0 cm from the bifurcation of the Aorta. It has a diameter of 3.3 mm and is 9.4 cm long. It passes toward the urinary

bladder. To the genital tract the A. umbilicalis gives off the A. deferentialis (12). This vessel, 1.0 mm in diameter and 14.0 cm long, leaves the A. umbilicalis 3 to 4 cm from the origin of the latter and passes in a ventral direction toward the spermatic cord. Upon arriving, it descends on the caudal side of the spermatic cord through the inguinal canal. It accompanies the ductus deferens, supplies it and gives fine twigs to the epididymis. These twigs anastomose with branches of the A. spermatic externa.

2. A. urethrogenitalis (15) arises from the ventral wall of the A. iliaca interna at the level of the caudal edge of the ischiatic spine, 8 to 9 cm from the A. umbilicalis. Its diameter is 1.3 mm and its length is 4.0 cm and it descends ventrally and divides into two vessels, the A. vesicalis caudalis (16) and a Ramus muscularis (16'). The former passes toward the seminal vesicles, the ampulla of the ductus deferens and the caudal part of the bladder. Twigs to the latter anastomose with branches of the A. vesicalis cranialis, a branch of the A. umbilicalis. The Ramus muscularis ramifies in the bulbocavernosus muscle.

3. The continuation of the A. iliaca interna, the A. pudenda interna (17) passes toward the ischiatic arch. It is 2.5 mm in diameter, 6.7 cm long and is more developed than in the ewe. After it passes the ischiatic arch the A. pudenda interna either becomes the A. dorsalis penis or the A. profunda penis. The pudenda interna gives rise to the following branches:

The A. rectalis caudalis (18) arises from the dorsal face of the A. pudenda interna. It supplies the rectum and the anus (see page 33).

A. bulbourethralis (20) arises from the ventral face of the A. pudenda interna. In three specimens it is observed that the bulbourethral gland is absent. The vessel ramifies in the caudal part of the bulbourethral muscle. In the other two specimens the artery ramifies in the bulbourethral gland.

A. perinei (19) arises from the dorsal face of the A. pudenda interna. It passes in a caudodorsal direction and gives off branches to the coccygeal muscle, the retractor penile muscle and to the perineal area. One branch descends on the perineum and forms an anastomosis with a branch of the A. pudenda externa.

A. dorsalis penis (21) forms the continuation of the A. pudenda interna. It is 2.0 mm in diameter and 41.2 cm long. In three specimens it arises from the A. pudenda interna sinistra while the A. pudenda interna dextra becomes the A. profunda penis. In the remainder the reverse was observed. The artery passes the ischiatic arch and arrives on the dorsal surface of the penis. It then goes distally and gives off branches to the penis and the retractor penile muscle. Posterior to the sigmoid flexure of the penis the vessel bifurcates into a right and left branch. Depending on the origin of the artery one of them develops well and passes on the dorsal surface of the penis toward the glans penis. Along its course it gives off branches to the penile tissue, the retractor muscle and the glans penis. The vessel continues in the prepuce and terminates at the orifice of the prepuce. Here it forms anastomosis with the A. epigastrica caudalis superficialis (see Fig. 16) of the A. pudenda externa. A recurrent artery of the prepuce from the A. epigastrica

caudalis superficialis was not present in the animals studied.

A. spermatica externa (24) It is observed that in four specimens this artery comes off from the Truncus pudendoepigastricus, shortly after the latter's origin from the A. profunda femoris. In the fifth specimen it comes off from the A. pudenda externa. It is 0.9 mm in diameter and 7.0 cm long. The A. spermatica externa passes in a cranioventral direction toward the inguinal canal. Before it enters in the canal, it gives off a branch which passes to the internal obliqious abdominal internus muscle. The continuing vessel proceeds to pass in the inguinal canal, where it courses along the cremaster muscle. Branches are given to this muscle. The artery passes distally and terminates at the tunica vaginalis. Anastomosis with the A. deferentialis and with its fellow artery are observed.

A. pudenda externa (26) The A. pudenda externa derives from the Truncus pudendoepigastricus which, in turn, derives from the A. profunda femoris. The latter arises from the A. iliaca externa. After leaving the external inguinal orifice the A. pudenda externa gives off a branch to the supramammary lymph nodes. It then proceeds ventrally and divides into a cranial branch, the A. epigastrica caudalis (Ashdown, 1958) and a caudal branch, the Ramus caudalis.

1. A. epigastrica caudalis (27) passes in a cranial direction parallel to the penis and is covered by the retractor preputial muscle. Approximately half way at the length of the penis, it appears dorsal to the muscle and proceeds toward the prepuce and may be called the A. epigastrica caudalis superficialis (Ashdown, 1958). On reaching the prepuce,

the artery turns to the orifice of the prepuce, where it ramifies and forms anastomosis (see Fig. 11) with the A. dorsalis penis. A branch of the A. epigastrica caudalis superficialis continues cranially and anastomoses with the A. epigastrica cranialis of the A. thoracica interna. This anastomosis is variable. In three specimens the A. epigastrica cranialis sinistra anastomoses with the A. epigastrica caudalis superficialis dextra, while in the fifth specimen the A. epigastrica cranialis dextra et sinistra anastomoses with a right and a left branch of the A. circumflexa lateralis respectively.

2. Ramus caudalis (28) passes caudally and gives off the following branches:

Ramus scroti (28') This branch leaves the Ramus caudalis 1.0 to 2.0 cm from the latter's origin and passes to the posterior surface of the tunica dartos of the scrotum. Anastomotic branches with the A. spermatica externa were observed.

Ramus urethralis (29) arises from the caudal surface of the Ramus caudalis, posterior to the sigmoid flexure of the penis. It passes toward the ventral surface of the penis and on reaching this it enters into the corpus cavernosum urethrae. It is observed that this branch is only given off by the Ramus caudalis sinistra. In the fifth specimen both Rami caudales give off this branch; however, the right branch did not enter the urethra, but fades into the surrounding tissue.

The continuation of the Ramus caudalis (32) proceeds toward the perineum and forms an anastomosis with the A. perinei.

DISCUSSION

The Arterial Supply of the Digestive Tract

The principal arterial supply of the stomach in man and animals is derived from the unpaired A. coeliaca (Ellenberger, 1943; Sisson and Grossman, 1953), the first visceral branch of the Abdominal Aorta. Generally speaking, the A. coeliaca divides into three chief branches, the A. lienalis, A. gastrica sinistra and the A. hepatica, which extend to the spleen, the stomach and the liver-duodenum respectively. In the ruminants due to the enormous development of the stomach into four parts, viz.: rumen, reticulum, omasum and abomasum, additional branches are established to accommodate the arterial blood supply to these parts. These are the Aa. ruminalis dextra et sinistra. Consequently, the artery to the spleen arises with the A. ruminalis dextra. The ruminalis sinistra gives rise to the A. reticularis.

It is observed that the A. coeliaca arises from the ventral face of the abdominal aorta at a level between the last thoracic vertebra and the first lumbar vertebra. Happich (1961), however, found a slightly different location, namely at the level of the last thoracic vertebra. In this matter, Scupin (1960) and Otto (1961) in their study of the goat, also found a different result.

In 30% of the specimens in this study the A. coeliaca arises from the common trunk, the Truncus coeliacomesentericus. Kattauer (1926) reported that in the sheep he examined, 20% showed this variation while in the ox Kádár (1926) found a percentage of 4.42. None of the seven goats and three oxes dissected by the students in the classes of gross anatomy

revealed this variation. Scupin (1960) and Otto (1961) did not state the presence of this common trunk in the goat. Sieber (1903), however, observed this variation in the sheep and goat. Franzke (1958) described a case in the sheep, but Happich (1961) did not find this in his specimens that he dissected.

The modes of ramification of the A. coeliaca are various and could be classified into the following types (see Fig. 5).

Type I, 60% of the cases, showed that the A. hepatica and the A. gastrica sinistra arise separately. The A. lienalis and the A. ruminalis dextra have a common trunk, the Truncus lienoruminalis. The ruminalis sinistra and the A. reticularis arise by a common trunk, the Truncus reticuloruminalis.

Type II, 33% of the cases, reveals that the Truncus lienoruminalis gives rise to the A. ruminalis sinistra.

Type III, 7% of the cases, establishes that the Aa. hepatica, gastrica sinistra and ruminalis sinistra have a common trunk.

The parietal branch of the A. coeliaca, the A. phrenica caudalis dorsalis, corresponds with that of the goat and the ox (Scupin, 1960 and Sieber, 1903). The A. phrenica caudalis ventralis as reported by Sieber (1903) in the ox and by Scupin (1960) in the goat, could not be established. This finding is verified by Happich (1961).

The distribution of the A. hepatica corresponds with the investigation of Rustamov and Polyakov (1958) and Happich (1961). Scupin (1960) considered the vessel, which comes from the A. coeliaca as a common trunk. Therefore, he called it the Truncus hepatogastricus. No deviation or

variation are observed in comparison with the ox (Sieber, 1903).

The A. ruminalis dextra, and the A. lienalis always present a common trunk, while the A. ruminalis sinistra occasionally arises from this common trunk (see Fig. 5). The A. lienalis of the ox (Sieber, 1903) ramifies at the surface of the organ, while in the sheep it first enters the hilus, before it ramifies. It was observed that the A. lienalis could be double, even triple although the incidence is very low. If the A. lienalis is double, this shows that these two vessels correspond with the Ramus cranialis and the Ramus caudalis. In the case with three vessels, the middle one becomes the Ramus intermedius.

The course of the A. ruminalis dextra of the sheep resembles that of the goat (Scupin, 1960). It was observed that the A. coronaria dextra ventralis developed extensively due to the great development of the ventral blind sac of the rumen. The coronaria dorsalis dextra does not terminate as the Ramus longitudinalis of the ox. This was established by Rustamov and Polyakov (1958) and Happich (1961).

In 60% of the cases the A. ruminalis sinistra and the A. reticularis arises from a common trunk, the Truncus reticuloruminalis. In opposition to Sieber (1903), in which he stated that the A. ruminalis sinistra in the ox is smaller than its right fellow, in the sheep they are the same size. Occasionally, the A. ruminalis sinistra arises from the Truncus lienoruminalis (see Fig. 5). Consequently, the A. reticularis comes off from the A. gastrica sinistra. According to Sieber (1903), Scupin (1960) and Happich (1961) the A. reticularis gives rise to the A. oesophagica caudalis ventralis which the author could establish. However, the

anastomosis with the A. oesophagica cranialis, a branch of the Truncus bronchoesophageus was not found.

The A. gastrica sinistra is considered to be the continuation of the A. coeliaca. Before the omasum it divides into the dorsal and ventral branches. The former gives rise to the A. reticularis accesoria, which is also found in the goat (Scupin, 1960). Yoshikawa, et al. (1956), however, did not state the presence of this accessory artery. In the ox, this vessel is not present (Chauveau, 1889; Sieber, 1903; Montané et Bourdelle, 1917; Ellenberger und Baum, 1943; Sisson and Grossman, 1953 and McLeod, 1958). In the sheep this A. reticularis accesoria is confirmed by May (1955), Rustamov and Polyakov (1958) and Happich (1961).

The intestinal tract of the sheep is formed by the small intestine, the caecum and the large intestine. Generally speaking, the intestinal tract of man and animal receives its arterial blood supply from three sources:

Firstly: The A. mesenterica cranialis, which supplies the largest part of the tract, that is the small intestine, the caecum and the largest part of the large intestine. It also supplies the pancreas.

Secondly: The A. mesenterica caudalis, which supplies the last part of the large intestine and the rectum.

Thirdly: The A. rectalis caudalis, which in the ewe is a branch of the A. urethrogenitalis and in the ram a branch of the A. pudenda interna. The A. rectalis caudalis ramifies in the ampulla of the rectum and in the anal region.

Due to the fact that the A. mesenterica cranialis supplies the

largest part of the intestinal tract, one is likely to assume that the vessel should be more developed (see table 4 and 5). With reference to tables 2, 3, 4, and 5 the measurements of the A. mesenterica cranialis are the same as the A. coeliaca. It is observed that this artery arises immediately behind the A. coeliaca. According to Happich (1961) it comes off 1 cm behind the latter. This could not be established, which is also confirmed by the findings of the other authors (Sieber, 1903; Montané et Bourdelle, 1917; and May, 1955).

In the sheep the A. mesenterica cranialis does not give rise to the A. duodenalis caudalis, which is present in the goat (Scupin, 1960). Instead, the A. pancreaticoduodenalis caudalis (see Fig. 6/4) is given off by the A. mesenterica cranialis.

The A. mesenterica cranialis gives off the Rami pancreatici, A. pancreatica magna, the A. pancreaticaepiploica and the A. colica media. In contrast to the goat the latter vascularizes the Ansa distalis of the colon descendens. After releasing these branches the A. mesenterica cranialis then bifurcates into the Truncus ileocaecocolicus and the Truncus jejunalis. The former divides into the Truncus colica and the A. ileocaecocolica. Scupin (1960) reported that in the goat the A. ileocaecocolica gives rise to the Ramus ilecus antimesenterialis. In the sheep, this ramus is absent which is confirmed by May (1955) and Happich (1961). The Truncus intestinalis does not give off the Ramus collateralis as in the ox (Sieber, 1903; Montané et Bourdelle, 1917; Martin und Schauder, 1935; and McLeod, 1958). The Truncus intestinalis gives rise to the Aa. jejunales, which supply the jejunum and a part of the ileum. At the

proximal two-thirds of the length of the jejunum the Aa. jejunales forms arcades, however, not more than secondary ones. From these arcades, Rami jejunales enter the wall of the jejunum. Beginning from the point the Rami enter the wall, the term, "mural" branches (Noer, 1943) could be introduced, because of the ramification of these branches in the wall of the intestine. The arcades disappear at the distal part of the jejunum, in contrast to the ox, which show seven part arcades(Sieber, 1903). In the goat, Scupin (1960) made the same observation as the author. The Aa. jejunales in the distal one-third of the jejunum, pass in a relatively straight course, although they bifurcate, before they enter the intestinal wall, to supply the right and the left wall of the intestine. A. Ramus anastomoticus between the Aa. jejunales and the A. ileocaecocolica is established at this distal part, similar to that in the goat (Scupin, 1960). In the ox this anastomosis does not exist (Sieber, 1903).

The Aa. jejunales gives off branches to the last centrifugal coil of the colon. This could be expected since the location of this part of the colon is between the Truncus intestinalis and the jejunum. This is logical if these arteries take care of the vascularization of the colon concerned. No other vessels were observed either mainly or partly to supply this part of the colon.

The A. mesenterica caudalis of the sheep reveals a similar picture in comparison with the goat (Scupin, 1960) and the ox (Sieber, 1903; Martin und Schauder, 1935; and McLeod, 1958).

Regarding the intestinal branch of the A. iliaca interna, that is the A. rectalis caudalis, it should be noticed that in the ewe and the

goat (Scupin, 1960) this vessel is given off by the A. urethrogenitalis, while in the ram the A. pudenda interna gives rise to the A. rectalis caudalis. An A. rectalis media was not observed, and is confirmed by findings of other investigators (May, 1955; Happich, 1961).

The Arterial Supply of the Reproductive Tract

The principal arterial blood supply of the reproductive tract, both in male and female is derived from two sources, namely the A. spermatica interna and the visceral branches of the A. iliaca interna. Additional blood supply is obtained from the A. pudenda externa to the external parts of the genitalia, such as the prepuce and the mammary glands.

The A. spermatica interna arises from the Aorta abdominalis cranial to the aorta's bifurcation. In the ewe this artery is larger (see table 8 and 9), but shorter. Although tables 10 and 11 give an almost equal length in the ewe and the ram, this is due to the fact that the A. spermatica interna of the ram was measured to the top of the cone of the coils. The actual length should be longer because this artery still passes toward the cranial pole of the testicle in a tortuous manner. The A. spermatica interna in the ewe was measured until the bifurcation, forming the Ramus ovaricus and the Ramus uterinus. According to Beutler (1926) the A. testicularis, which comes off from the A. spermatica interna form a mantle of vessels around the testicle of the bull and ram. The author could not establish this type of arrangement in the ram.

The visceral branches of the A. iliaca interna to the reproductive tract, generally speaking, in both sexes are the A umbilicalis and the urethrogenitalis. According to Sieber (1903), the A. umbilicalis of the

cow is larger than in the bull. The author found that in the sheep there is not much difference in size of this vessel in both sexes (see tables 8 and 9). The A. ureterica was observed in the ram as well as in the ewe.

In the ewe the A. umbilicalis gives rise to the A. uterina media, while in the ram the A. deferentialis is given off. The big difference in size of these two vessels (see tables 8 and 9) shows the greater need of vascularization of the uterus. In the ram the A. deferentialis contributes but a small part to the blood supply of the genital tract. The major part of the vascularization is taken care of by the A. spermatica interna. The A. umbilicalis of the ram gives off 3 to 4 branches to the cranial and lateral part of the bladder. These vessels could not be established in the ewe.

The A. urethrogenitalis of the ewe and the ram ramifies differently. In the ewe it divides into a cranial and a caudal branch. In the ewe the cranial branch becomes the A. uterina caudalis which supplies the caudal part of the uterus and the vaginal wall. The caudal branch becomes the A. rectalis caudalis which supplies the rectum and the anus.

In the ram the A. urethrogenitalis gives off the A. vesicalis caudalis which gives off branches to the seminal vesicles, the ampulla of the ductus deferens and the caudal part of the bladder, and the Ramus muscularis which ramifies in the bulbocavernosus muscle.

The A. pudenda interna of the ram is more developed than in the ewe, concordant to the findings of Sieber (1903) in the ox. A small branch of the A. pudenda interna, A. bulbourethralis was seen to supply the

bulbourethral glands when the latter were present. The continuation of the A. pudenda interna of the ram becomes the A. dorsalis penis. According to Magilton* in his study in the goat, in three out of five specimens it was observed that the A. dorsalis penis is formed by the A. pudenda externa. It is established that in the sheep and goat (Magilton*) the A. dorsalis penis always bifurcates posterior to the sigmoid flexure of the penis, one larger than the other. In the sheep the larger vessel passes along the entire length of the penis, giving off branches to the penile tissue and terminates at the orifice of the prepuce.

The contribution of the A. pudenda externa to the blood supply of the male genital tract is performed by its branch, the A. epigastrica caudalis superficialis. This vessel terminates at the orifice of the prepuce. Indeed, anastomosis occurred between these arteries, in the region of the orifice of the prepuce. The teats of the male are supplied by a branch of the A. pudenda externa. According to Ashdown (1958) in the bull a recurrent artery arises from the A. epigastrica caudalis superficialis and anastomoses with the A. dorsalis penis. This vessel could not be established in the ram by the author.

The arterial supply of the mammary glands is derived from the A. pudenda externa. After coursing in the inguinal canal it appears at the external orifice of the canal. It passes ventrally and gives off a branch to the supramammary lymph nodes. A second branch passes to the posterior part of the mammary gland where it ramifies. Since this branch comes off from the A. pudenda externa, the author does not call this vessel

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*Magilton, James H., Ames, Iowa. Arterial supply of the reproductive tract of the goat. Private communication. 1962.

the A. mammaria caudalis (Emmerson, 1940; Ellenberger und Baum, 1943; and Ziegler and Mosimann, 1960) or the descending mammary artery (El Hagri, 1945) as it is established for the cow. The A. mammaria caudalis of the cow arises from the A. mammaria cranialis (Ellenberger und Baum, 1943).

After giving off the second branch the A. pudenda externa divides into the A. epigastrica caudalis superficialis and the A. mammaria. The latter passes into the gland tissue. The fact that the A. mammaria caudalis is absent in the sheep, the author prefers the name A. mammaria. The former passes cranially on the ventral surface of the rectus abdominis muscle. In specimen No. 5 it is observed that the A. epigastrica caudalis comes off from the A. mammaria (see Fig. 10/9).

The A. mammaria gives off the A. mammaria medialis, which forms the largest branch and ramifies extensively in the mammary tissue. The second branch is the A. lateralis sinus (Otto, 1961) for the vascularization of the teat cystern and the wall of the teat. The A. mammaria then becomes the A. basalis (Otto, 1961) to supply the base of the teat and abdominal wall in part. In the sheep the Circulosus arteriosus is not distinct.

In the ram the A. pudenda externa divides into the A. epigastrica caudalis superficialis and a Ramus caudalis. The A. epigastrica caudalis superficialis gives off branches to the inguinal lymph nodes and the teat. The Ramus caudalis gives branches to the scrotum, the corpus cavernosum urethrae and anastomoses with the A. perinei.

SUMMARY AND CONCLUSIONS

1. Attempts were made to improve the method of injection of an entire animal with latex. The use of an anti-coagulant seems to be profitable in order to exsanguinate as much blood as possible. This was promoted by introducing digitalis and normal saline solution. Injection of the cementex was via the A. carotis communis sinistra and the embalming fluid via the V. jugularis externa. Minute anastomosing branches were revealed by circumventing the heart and lung circulation (see Materials and Methods). Embalming of the specimens via the external jugular vein gave satisfactory results for the dissection.

2. In the sheep the occurrence of a common trunk, the Truncus coeliacomesentericus, which gives rise to the A. coeliaca and the A. mesenterica cranialis, is more frequent than in the ox and goat. The ramification of the A. coeliaca was classified in three types.

3. In the sheep and goat the A. ruminalis dextra does not terminate as in the ox as the Ramus longitudinalis. The A. ruminalis sinistra, occasionally arises from the Truncus lienoruminalis.

4. In contrast to the ox and the goat the A. reticularis of the sheep does not give rise to the A. phrenica caudalis ventralis. The vascularization of the ventral caudal part of the diaphragm of the sheep is via the A. phrenica caudalis dorsalis.

5. The Ramus dorsalis of the A. gastrica sinistra of the sheep and goat gives rise to the A. reticularis accesoria, which is absent in the ox. In some cases the A. gastrica sinistra gives off the A. reticularis.

6. The A. mesenterica cranialis arise immediately behind the A.

coeliaca from the ventral surface of the Abdominal aorta. Variations of origin of this artery were observed and are discussed with the A. coeliaca.

7. The Ramus collateralis, a branch of the Truncus intestinalis in the ox, was absent in the sheep and in the goat. The Aa. jejunales form first and second degree arcades before they enter into the intestinal wall in the proximal two-thirds of the jejunum. These arcades disappear at the terminal part of the distal third of the jejunum and are replaced by straight arteries. The Aa. jejunales supply vascularization to the last part of the centrifugal colon.

8. In the sheep and the goat a Ramus anastomoticus exists between the Truncus intestinalis and the A. ileocaecalis. A Ramus ilecus antimesenterialis was only present in the goat.

9. The A. rectalis caudalis of the ewe and goat arises from the A. urethrogenitalis, while in the ram it arises from the A. pudenda interna. The A. rectalis media was absent in the ruminants.

10. The spermatica interna of the ewe and the ram arise at the same location from the Aorta abdominalis. The A. spermatica of the ewe was larger, but shorter than in the ram.

11. The A. dorsalis penis of the ram was formed by the A. pudenda interna. In the goat it was observed that the A. dorsalis penis could arise from the A.pudenda externa. The contribution of the A. pudenda externa to the arterial blood supply of the reproductive tract occurs by its branches, the A. spermatica externa and the A. epigastrica caudalis superficialis. The origin of the A. spermatica externa, however, varied. The A. epigastrica caudalis superficialis supplies the prepuce. A

recurrent artery of the A. epigastrica caudalis superficialis, which anastomoses with the A. dorsalis penis as it occurs in the bull, was not observed in the sheep.

12. The mammary glands receive their arterial blood supply from the A. mammaria cranialis, a branch of the A. pudenda externa. The A. mammaria caudalis of the cow could be compared with a branch of the A. pudenda externa, before it gives off the A. mammaria. This branch vascularizes the posterior part of the mammary gland. The Circulosus arteriosus of the teat is frequently indistinct in the sheep and in the goat.

The teat of the ram receives its arterial blood supply from a branch of the A. pudenda externa.

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TABLES

Table 1. Procedure of preparing the specimens

Animal No. & Sex (F=female; M=male)	1,F	2,F	3,F	4,F	5,F	6,M	7,M	8,M	9,M	10,M
Age in years	6	6	5	7	7	6	7	7	7	8
Weight in lbs.	87	120	80	92	120	130	170	180	180	170
Anesthetic: Chloral Hydrate 12 g., Magnesium Sulfate 6g., H_2O 500 cc) in cc.	100	75	75	75	75	100	100	--	--	--
Equi-thesin in cc.	--	--	--	--	--	--	--	50	50	50
Anticoagulant Chlorazol solution in cc. (See Text)	500	500	500	500	500	500	500	500	500	500
Site of exsanguination	A. Carotis Communis Sinistra									
Injection of saline: Amount in cc.	--	--	--	--	--	2000	2000	2000	2000	2000
Digitalis added 1 cc.	--	--	--	--	--	--	yes	yes	yes	--
Pressure	--	--	--	--	--	gravity	gravity	gravity	gravity	gravity
Site	V. Jugularis Externa									
Bypassing heart and lung	--	done	--	--	done	done	done	--	--	--
Perfusing liquid amount in cc.:	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Pressure in mm. Hg.	120	120	120	120	120	120	120	120	120	120
Site	A. Carotis Communis Sinistra									
Type: Acetic acid 5%	x	x	x	x	x	--	--	--	--	--
Sodium citrate 1%	--	--	--	--	--	x	x	x	x	x
Sodium nitrate	--	--	--	--	--	x	x	x	x	x
Flushing liquid Amount in cc.:	2000	2000	2000	2000	2000	4000	4000	4000	4000	4000
Pressure in mm. Hg.	120	120	120	120	120	120	120	120	120	120
Site	A. Carotis Communis Sinistra									
Type: Saline solution .85%	x	x	x	x	x	x	x	x	x	x
Arterial injection of red cementex: Amount in cc.	500	750	500	500	500	750	750	1500	1500	1500
Diluted with 2% ammonia water 3:1	--	--	--	--	--	--	--	x	x	x
Pressure in mm. Hg.	120	120	120	120	120	120	120	120	120	120
Site	A. Carotis Communis Sinistra									
Venous injection of embalming liquid:										
Amount in liters	10	10	20	20	20	20	20	20	20	20
Pressure in mm. Hg.	120	120	120	120	120	120	120	120	120	120
Site	V. Jugularis Externa									

Table 2. Outside diameter of vessels to the stomach, including liver, spleen, and pancreas in mm in the ewe

Name of artery	Specimen No: 1	2	3	4	5	Average
A. coeliaca	9.5	9.5	9.0	9.5	10.5	9.6
Tr. coeliacomesentericus	10.9	-	-	-	-	10.9
A. hepatica	3.9	3.9	3.8	3.5	3.8	3.8
Tr. lienoruminalis	4.7	4.3	4.2	4.5	4.1	4.4
A. lienalis	3.9	3.6*	3.8	3.5	3.6	3.7
A. ruminalis dextra	3.9	4.1	4.1	3.6	3.8	3.9
Tr. reticuloruminalis	4.3	-	4.4	-	4.3	4.3
A. ruminalis sinistra	3.9	3.8	4.1	3.5	3.7	3.8
A. reticularis	2.7	2.7	2.6	2.3	2.3	2.5
A. gastrica sinistra	4.7	6.3	5.5	6.3	5.1	5.6

*Average of 3.9 and 3.2 (see text)

Table 3. Outside diameter of vessels to the stomach, including liver, spleen, and pancreas in mm in the ram

Name of artery	Specimen No: 6	7	8	9	10	Average
A. coeliaca	11.2	10.5	11.8	10.9	10.5	11.0
Tr. coeliacomesentericus	-	-	-	11.2	-	11.2
A. hepatica	3.0	3.3	3.8	3.5	3.0	3.3
Tr. lienoruminalis	4.8	4.2	4.7	4.2	4.6	4.5
A. lienalis	3.9	2.4*	3.8	3.1	3.0	3.2
A. ruminalis dextra	3.7	4.1	4.2	3.6	3.1	3.7
Tr. reticuloruminalis	4.3	4.3	4.3	-	-	4.3
A. ruminalis sinistra	4.1	4.0	4.1	3.1	3.0	3.7
A. reticularis	2.4	2.5	2.3	2.4	2.3	2.4
A. gastrica sinistra	5.5	4.8	6.5	6.5	6.2	5.9

*Average of 2.7, 2.7 and 2.4 (see text)

Table 4. Length of vessels to the digestive tract in cm in the ewe

Name of artery	Specimen No: 1	2	3	4	5
A. coeliaca	4.0	4.0	4.5	3.5	4.0
Tr. coeliacomesentericus	2.4	-	-	-	-
A. hepatica	7.5	8.0	7.5	8.0	8.0
Tr. lienoruminalis	2.0	1.5	2.0	2.5	2.5
A. lienalis	4.0	3.5	4.5	4.0	4.0
A. ruminalis dextra	40.0	42.0	45.0	43.0	40.0
Tr. reticuloruminalis	4.0	-	3.5	-	4.0
A. ruminalis sinistra	28.0	35.0	35.0	32.5	30.0
A. reticularis	5.5	5.5	6.0	5.0	6.0
A. gastrica sinistra	4.0	5.0	5.0	5.5	4.0
A. mesenterica cranialis	8.5	8.0	7.0	7.5	9.5
Tr. intestinalis	45.0	46.5	45.5	45.0	48.5
Tr. ileocaecocolicus	2.0	2.0	2.5	1.5	2.5
A. ileocaecalis	17.5	18.0	20.0	18.5	19.0
A. mesenterica caudalis	8.0	9.5	6.5	8.0	9.0

Table 4 (Continued)

Name of artery	Specimen No: 11	12	13	14	15	Average
A. coeliaca	3.0	4.0	4.5	4.0	4.5	4.0
Tr. coeliacomesentericus	3.0	-	2.0	1.0	-	1.9
A. hepatica	7.0	8.0	8.5	7.5	8.0	7.8
Tr. lienoruminalis	1.5	2.0	2.0	1.5	2.5	2.0
A. lienalis	4.0	4.0	5.0	4.0	3.5	4.0
A. ruminalis dextra	38.5	42.0	45.0	43.0	45.5	43.4
Tr. reticuloruminalis	-	4.5	4.0	-	4.0	4.0
A. ruminalis sinistra	30.0	35.5	37.0	35.0	40.0	33.8
A. reticularis	3.5	4.0	3.5	3.5	4.5	4.7
A. gastrica sinistra	5.0	4.5	4.0	3.5	3.5	4.4
A. mesenterica cranialis	8.5	8.0	8.5	9.0	10.5	8.5
Tr. intestinalis	42.0	40.0	43.0	39.0	48.0	44.3
Tr. ileocaecocolicus	1.5	1.5	2.0	1.5	2.0	1.9
A. ileocaecalis	18.0	20.0	19.5	17.0	20.0	18.8
A. mesenterica caudalis	8.5	8.0	7.5	7.0	8.0	8.0

Table 5. Length of vessels to the digestive tract in cm in the ram

Name of artery	Specimen No: 6	7	8	9	10	Average
A. coeliaca	4.5	4.5	4.0	5.0	5.0	4.6
Tr. coeliacomesentericus	-	-	-	3.5	-	3.5
A. hepatica	7.5	8.5	8.5	8.5	7.0	8.0
Tr. lienoruminalis	2.0	2.0	2.0	2.0	2.5	2.1
A. lienalis	4.5	5.0	5.5	4.5	4.0	5.8
A. ruminalis dextra	45.0	50.0	50.5	50.5	52.5	49.7
Tr. reticuloruminalis	4.5	4.5	4.0	-	-	4.3
A. ruminalis sinistra	30.9	35.0	35.0	36.0	38.0	34.8
A. reticularis	5.0	4.0	5.0	4.5	4.0	4.5
A. gastrica sinistra	4.5	5.0	4.5	4.0	5.0	4.6
A. mesenterica cranialis	8.5	9.0	9.0	8.5	9.5	8.9
Tr. intestinalis	50.0	50.0	55.0	56.5	58.0	53.0
Tr. ileocaecocolicus	2.5	2.0	2.5	2.5	3.0	2.5
A. ileocaecalis	20.0	20.5	22.0	19.0	23.0	20.9
A. mesenterica caudalis	8.0	9.5	9.5	9.0	9.5	9.1

Table 6. Outside diameter of vessels to the intestine in mm in the ewe

Name of artery	Specimen No: 1	2	3	4	5	Average
A. mesenterica cranialis	10.0	9.2	9.0	9.5	9.9	9.5
A. pancreaticoduodenalis caudalis	1.2	1.1	1.0	1.0	1.0	1.1
A. colica media	1.5	1.4	1.3	1.3	1.4	1.4
Tr. ileocaecocolicus	3.9	3.5	3.8	3.4	3.6	3.6
Tr. colicus	3.1	3.3	3.1	3.7	3.5	3.3
A. ileocaecalis	2.6	2.6	2.7	2.3	2.3	2.5
A. mesenterica caudalis	2.7	3.9	3.0	2.8	3.0	3.1
A. colica sinistra	1.2	1.0	1.0	1.3	1.0	1.1
A. rectalis cranialis	1.2	1.1	1.1	1.2	1.0	1.1
A. rectalis caudalis	1.0	1.0	1.1	1.0	1.0	1.0

Table 7. Outside diameter of vessels to the intestine in mm in the ram

Name of artery	Specimen No: 6	7	8	9	10	Average
A. mesenterica cranialis	10.5	10.5	11.0	10.9	10.0	10.6
A. pancreaticoduodenalis caudalis	1.0	1.1	1.3	1.0	1.0	1.1
A. colica media	1.2	1.2	1.4	1.2	1.3	1.3
Tr. ileocaecocolicus	4.1	3.6	3.8	3.8	3.5	3.8
Tr. colicus	3.3	3.1	3.3	3.5	3.1	3.3
A. ileocaecalis	2.5	2.4	2.7	2.6	2.7	2.6
A. mesenterica caudalis	2.1	2.7	3.0	3.2	3.2	3.8
A. colica sinistra	1.0	1.2	1.2	1.1	1.0	1.1
A. rectalis cranialis	1.1	1.2	1.3	1.2	1.2	1.2
A. rectalis caudalis	1.1	1.1	1.2	1.2	1.1	1.1

Table 8. Outside diameter of vessels to the genital tract of the ewe in mm

Name of artery	Specimen No: 1	2	3	4	5	Average
A. spermatica interna	3.0	3.1	3.3	3.1	3.0	3.1
R. uterinus	1.0	1.0	1.2	1.1	1.1	1.1
R. ovaricus	0.9	1.0	1.0	0.9	1.0	1.0
A. iliaca interna	5.9	6.0	6.0	5.9	6.2	6.0
A. umbilicalis	2.8	2.6	2.6	2.5	2.8	2.7
A. uterina media	3.9	3.1	3.8	3.8	3.7	3.5
A. urethrogenitalis	-	-	1.0	1.0	1.1	1.0
A. uterina caudalis	0.9	1.0	1.0	0.9	1.0	1.0
A. vesicalis caudalis	0.9	0.9	0.9	1.9	0.9	1.1
A. pudenda interna	1.7	1.3	1.0	1.5	1.3	1.3
A. pudenda externa	1.9	2.1	1.9	2.0	2.2	2.0
A. mammaria	1.5	1.2	1.2	1.5	1.2	1.3

Table 9. Outside diameter of vessels to the genital tract of the ram in mm

Name of artery	Specimen No: 6	7	8	9	10	Average
A. spermatica interna	1.6	1.1	2.4	1.6	2.2	1.9
A. iliaca interna	6.2	6.5	6.5	6.4	6.3	6.4
A. umbilicalis	3.3	3.5	3.1	3.1	3.5	3.3
A. deferentialis	1.0	0.9	1.0	1.1	1.1	1.0
A. vesicalis cranialis	1.2	0.9	1.1	1.2	1.2	1.1
A. urethrogenitalis	1.5	1.2	1.2	1.3	1.3	1.3
A. vesicalis caudalis	0.9	0.9	1.0	0.9	1.0	0.9
A. pudenda interna	2.8	2.4	3.0	2.1	2.2	2.5
A. dorsalis penis	2.0	2.4	2.2	2.0	2.0	2.0
A. perinei	0.9	0.9	0.9	0.8	0.9	0.9
A. pudenda externa	2.0	1.8	1.8	2.2	2.2	2.0
A. spermatica externa	0.9	0.9	1.0	0.9	0.9	0.9

Table 10. Length of vessels to the genital tract in the ewe in cm

Name of artery	Specimen No: 1	2	3	4	5
A. spermatica interna	15.5	14.5	15.0	15.0	16.0
A. iliaca interna	17.0	18.5	18.0	17.5	18.0
A. umbilicalis	11.5	12.0	12.0	11.5	12.5
A. uterina media	10.5	12.5	12.0	11.5	13.5
A. urethrogenitalis	-	-	3.5	3.5	3.0
A. uterina caudalis	7.0	6.5	5.0	6.5	6.0
A. pudenda interna	9.0	8.0	9.5	9.5	9.0
A. pudenda externa	6.5	7.0	6.0	7.5	6.5

Table 10 (Continued)

Name of artery	Specimen No: 11	12	13	14	15	Average
A. spermatica interna	14.0	15.0	14.5	16.0	16.5	15.2
A. iliaca interna	16.0	17.0	15.5	18.5	19.0	15.9
A. umbilicalis	13.0	12.0	11.5	11.0	12.5	11.9
A. uterina media	12.0	12.0	11.0	13.5	15.5	12.4
A. urethrogenitalis	3.5	3.0	3.5	3.0	4.0	3.4
A. uterina caudalis	6.0	6.6	6.0	6.5	5.5	6.1
A. pudenda interna	8.5	8.0	9.0	9.0	9.5	8.9
A. pudenda externa	6.0	6.0	6.5	7.0	7.5	6.7

Table 11. Length of vessels to the genital tract in the ram

Name of artery	Specimen No: 6	7	8	9	10	Average
A. spermatica interna	15.0	16.5	15.0	16.0	15.5	15.6
A. iliaca interna	13.0	13.0	14.0	15.0	13.5	13.7
A. umbilicalis	9.0	9.5	9.5	10.0	9.0	9.4
A. deferentialis	14.0	14.0	13.0	14.0	14.5	14.0
A. vesicalis cranialis	3.0	3.0	3.5	3.5	3.0	3.2
A. urethrogenitalis	4.0	4.0	4.5	4.0	3.5	4.0
A. vesicalis caudalis	6.0	6.6	6.0	6.0	6.5	7.2
A. pudenda interna	6.0	6.0	7.0	6.5	8.0	6.7
A. dorsalis penis	40.0	40.0	42.5	43.0	40.5	41.2
A. pudenda externa	10.0	10.0	9.0	9.5	9.5	9.5
A. spermatica externa	7.0	7.0	6.5	7.5	7.0	7.0

ILLUSTRATIONS

Figure 1. The apparatus for injecting the arteries

1. Tube for air inlet
2. Open mercury manometer
3. Valve for air pressure control (pop-off valve)
4. Manometer for large animal injection
5. Y-tube
6. Bottle with red cementex (reserve bottle)
7. Five gallon bottle liquid injection (reserve bottle on right)

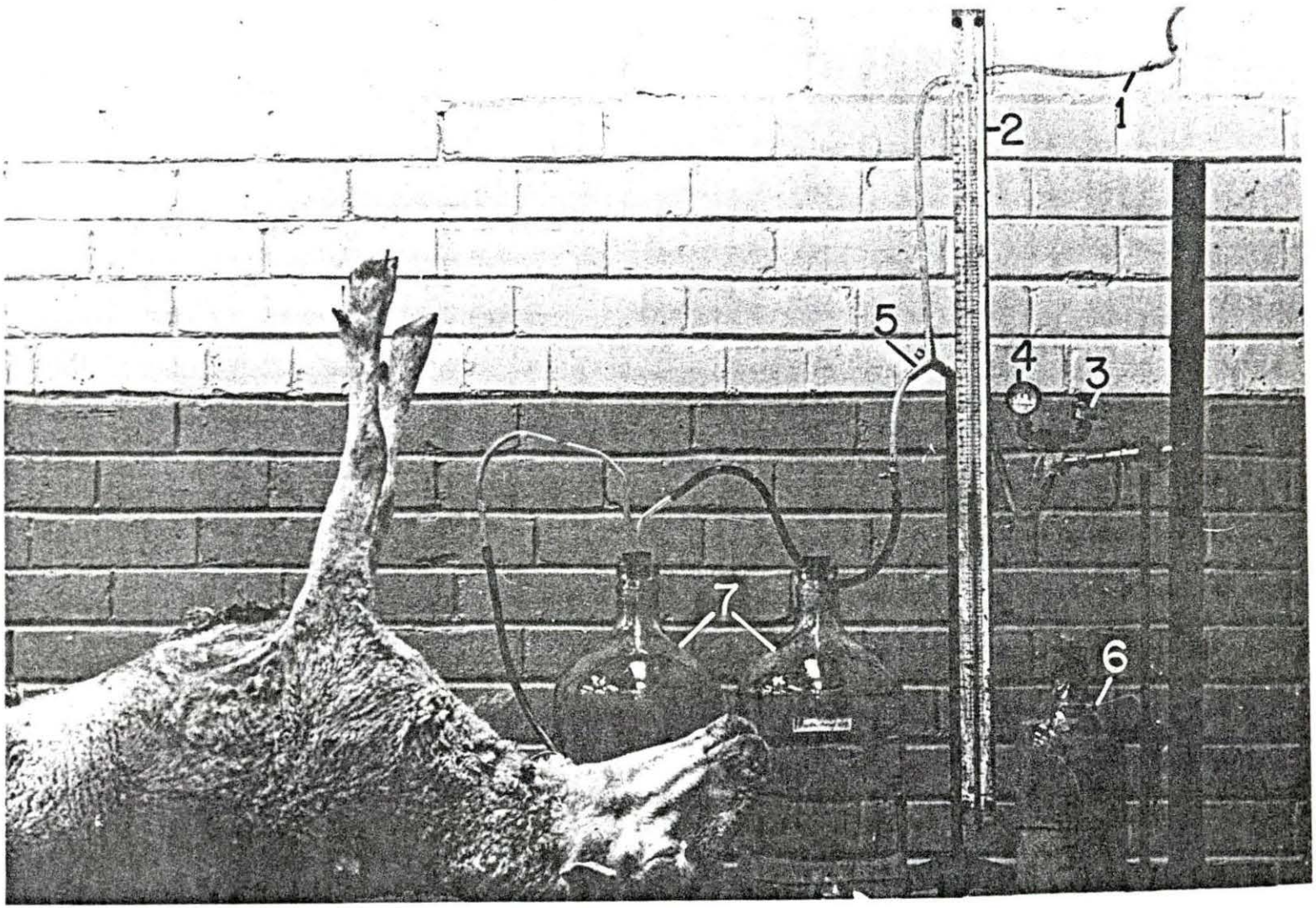
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Figure 2. Arteries to the stomach (schematic). Right view.

A. Rumen
B. Reticulum
C. Omasum
D. Abomasum
E. Esophagus
F. Duodenum
G. Liver
H. Crura diaphragmatica

1. A. coeliaca
2. A. phrenica dorsalis caudalis
3. Ramus proximalis of 2
4. Ramus distalis of 2
5. Ramus distalis of 2
5'. Twig to esophagus
6. Common trunk of 7 and 8
7. Rami pancreatici
8. A. epiploica
9. A. hepatica
10. A. cystica
11. Ramus caudatis et partis dextra hepatis
12. Branch to gall bladder and duct
13. A. gastroduodenalis
14. A. gastrica dextra
15. A. pancreaticoduodenalis cranialis
16. A. gastroepiploica dextra
17. Ramus partis sinistra hepatis
18. Truncus lienoruminalis
19. A. lienalis
20. A. ruminalis dextra
21. Rami dorsales of 20
22. A. coronaria dextra dorsalis
23. A. coronaria dextra ventralis
24. Rami ventrales of 20
25. Rami caudales of 23
26. Ramus cranialis of 23
27. Truncus reticuloruminalis
28. A. reticularis
29. A. ruminalis sinistra
30. Ramus ruminalis of 29
31. A. gastrica sinistra
32. Ramus ventralis of 31
32'. A. gastroepiploica sinistra
33. Ramus dorsalis of 31
34. Rami omasici of 33
35. Rami omasici of 32
36. Rami reticulares of 32
37. A. reticularis accessoria
38. Ramus anastomoticus with 14
38'. Rami abomasici of 38
39. Rami pylorici of 16
39'. Rami abomasici of 32 and 40
40. A. gastroepiploica dextra
41. Branches of 14 to lesser omentum
42. Rami abomasici of 14
43. Rami epiploici of 32' and 40

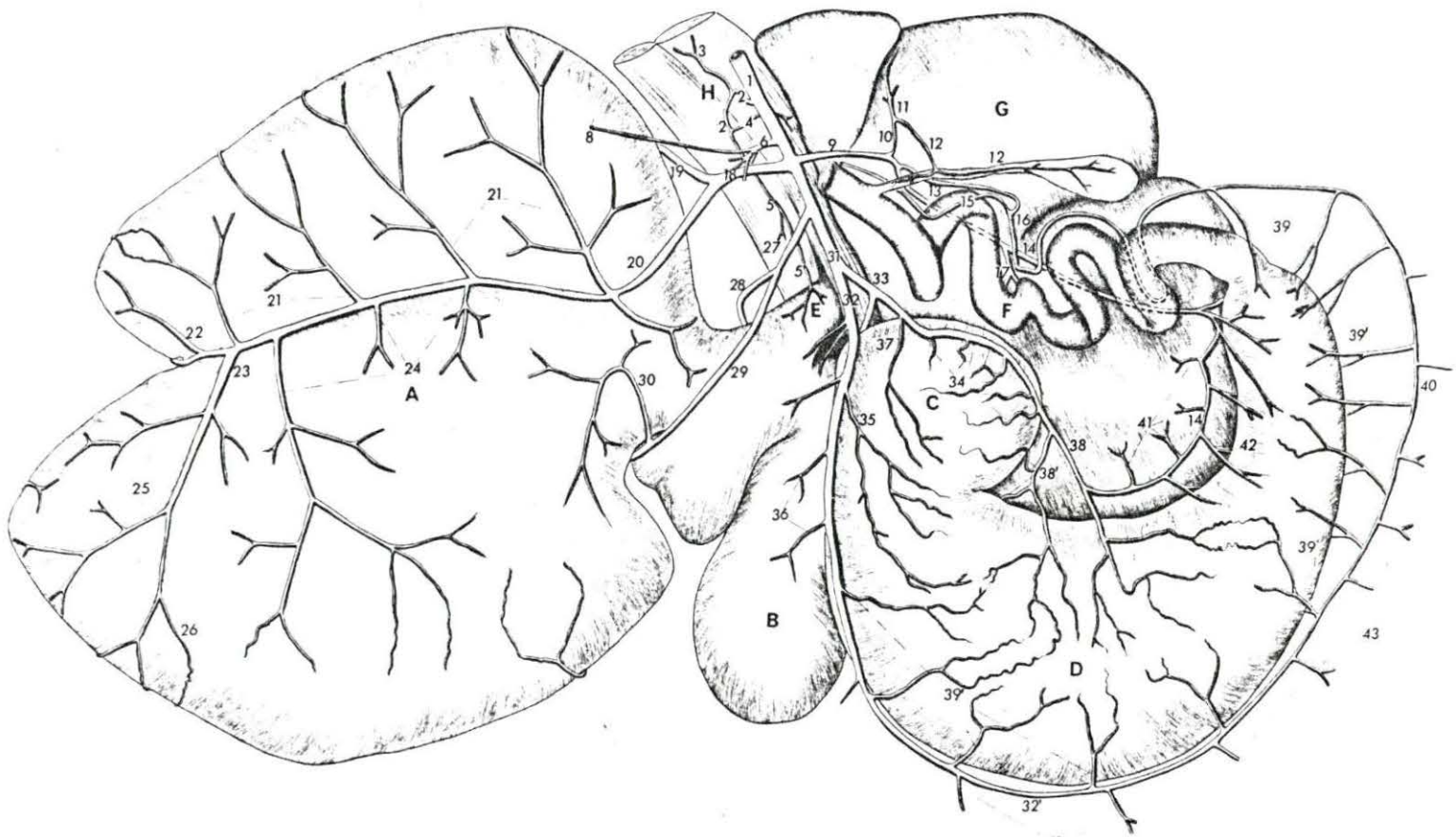
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Figure 3. Arteries to the stomach (schematic). Left view.

A. Reticulum
B. Dorsal sac of rumen
C. Ventral sac of rumen
D. Ventral blind sac of rumen
E. Dorsal blind sac of rumen
F. Esophagus
G. Spleen

1. A. reticularis
2. A. oesophagica caudalis
3. A. ruminalis dextra
4. A. ruminalis sinistra
4'. Ramus ascendens of 4
5. Ramus dorsalis of 4
6. Ramus descendens of 4
7. Ramus ventralis of 4
8. A. coronaria sinistra ventralis
9. A. coronaria sinistra dorsalis
10. Rami cranialis of 8
11. Rami caudalis of 8
12. Branches from A. coronaria dextra ventralis
13. Branch from Ramus dorsalis of 3

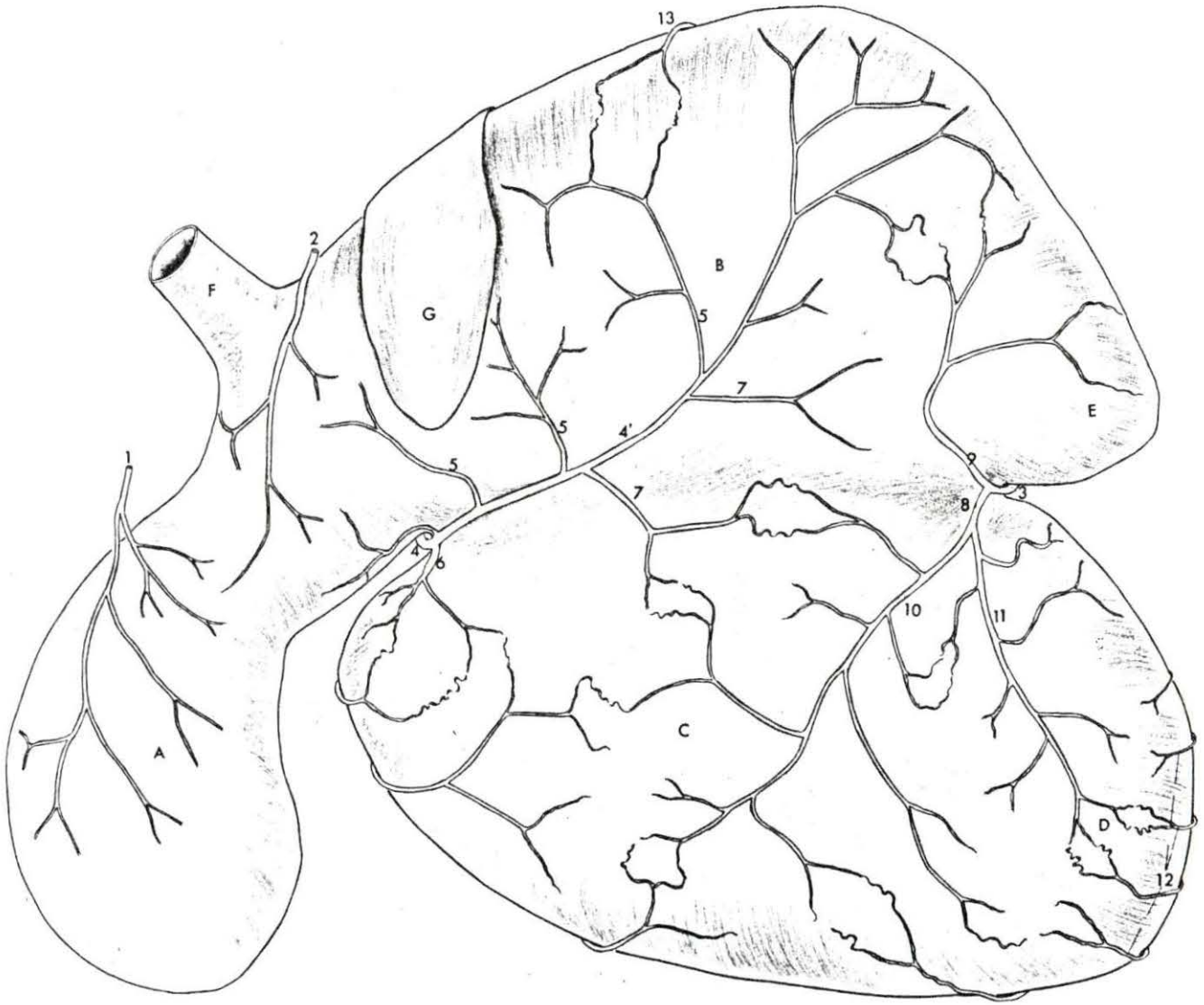
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Figure 4. Variation of origin of the A. coeliaca and the A. mesenterica cranialis.

A. Diaphragm
B. Liver
C. Rumen
D. Omasum

1. Aorta abdominalis
2. Truncus coeliacomesentericus
3. A. coeliaca
4. A. mesenterica cranialis
5. A. hepatica
6. Truncus lienoruminalis
7. A. lienalis
8. A. ruminalis dextra
9. Truncus reticuloruminalis
10. A. gastrica sinistra
11. Ramus dorsalis of 10
12. Ramus ventralis of 10
13. A. renalis

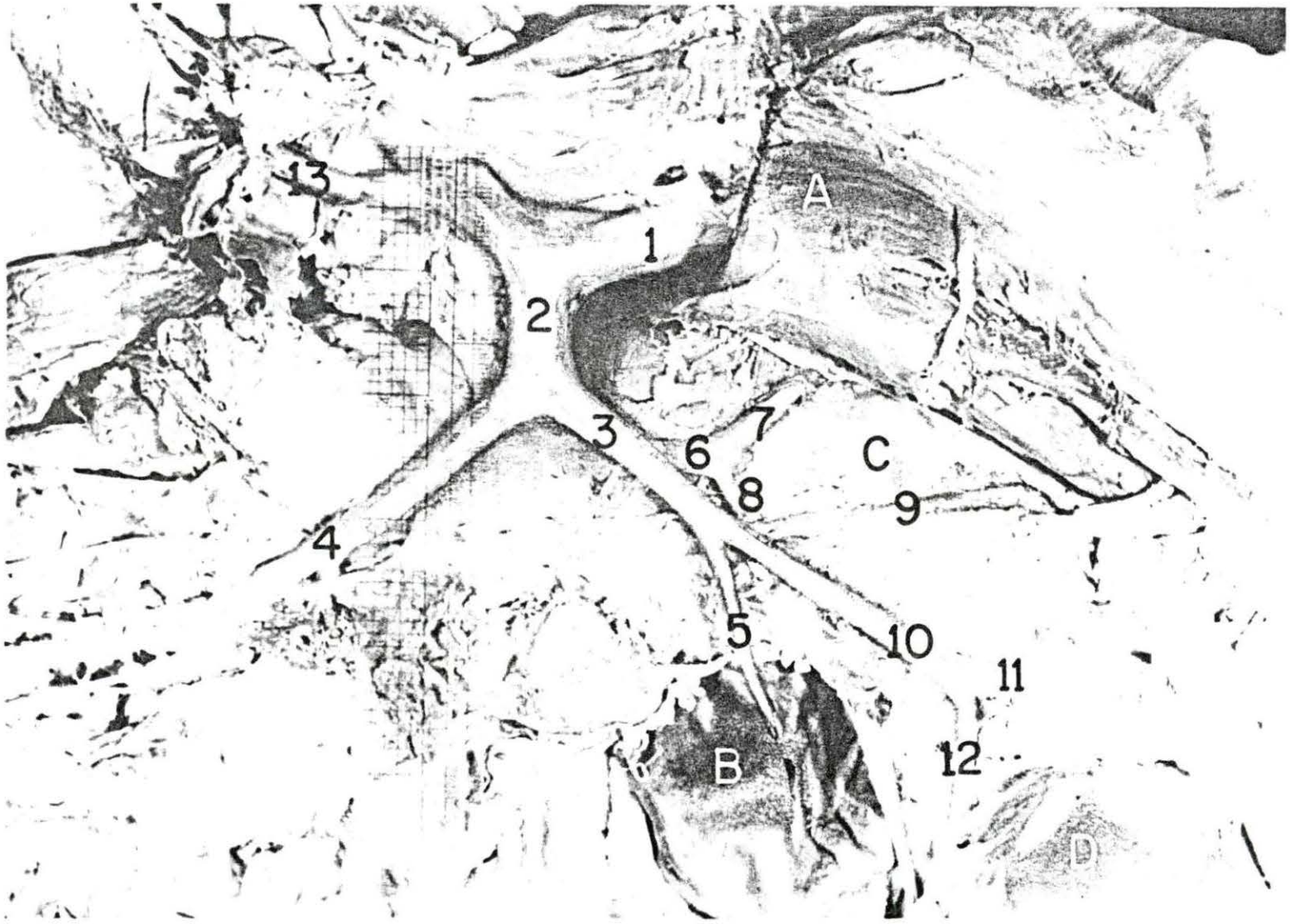
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Figure 5. Types of ramification of the A. coeliaca.

1. Aorta abdominalis
2. Truncus coeliacomesentericus
3. A. coeliaca
4. A. mesenterica cranialis
5. A. hepatica
6. A. Truncus lienoruminalis
7. A. ruminalis dextra
8. A. lienalis
9. Truncus reticuloruminalis
10. A. ruminalis sinistra
11. A. reticularis
12. A. gastrica sinistra
13. Ramus dorsalis of 12
14. Ramus ventralis of 12

Type I 60% Specimen No: 1, 3, 5, 6, 7, 8, 12, 13, 15.
The A. hepatica and the A. gastrica sinistra arise separately. The A. lienalis and the A. ruminalis dextra arise from the Truncus lienoruminalis. The A. ruminalis sinistra and the A. reticularis have a common trunk, the Truncus reticuloruminalis.

Type II 33% Specimen No: 2, 4, 9, 10, 14.
The Truncus lienoruminalis gives rise to the A. ruminalis sinistra.

Type III 7% Specimen No: 11.
The A. hepatica, A. gastrica sinistra and the A. ruminalis sinistra have a common trunk.

Figure 6. Arteries to the intestine (schematic).

A. Duodenum descendens
B. Pelvic flexure of duodenum
C. Duodenum ascendens
D. Jejunum
E. Ileum
F. Caecum
G. Ansa proximalis of Colon descendens
H. Colon labyrinth
K. Ansa distalis of Colon descendens
L. Colon transversum
M. Colon descendens
N. Rectum

1. A. mesenterica cranialis
2. A. pancreatica magna
3. A. pancreaticaepiploica
4. A. pancreaticoduodenalis caudalis
5. A. colica media
6. A. pancreaticoduodenalis cranialis
7. Truncus ileocaecocolicus
8. Truncus colicus
9. Rami colici
10. A. ileocaecolica
11. Rami Ansae proximalis of Colon descendens
12. Rami Ansae proximalis of Colon descendens
13. Ramus ilecus
14. A. ileocaecalis
15. Rami caecales
16. Ramus ileci
17. Ramus anastomoticus of 10 and 18
18. Truncus intestinalis
19. Aa. jejunales
20. Primary arcades
21. Secondary arcades
22. Rami colici
23. Rami ileci of 18
24. A. mesenterica caudalis
25. A. colica sinistra
26. A. rectalis cranialis

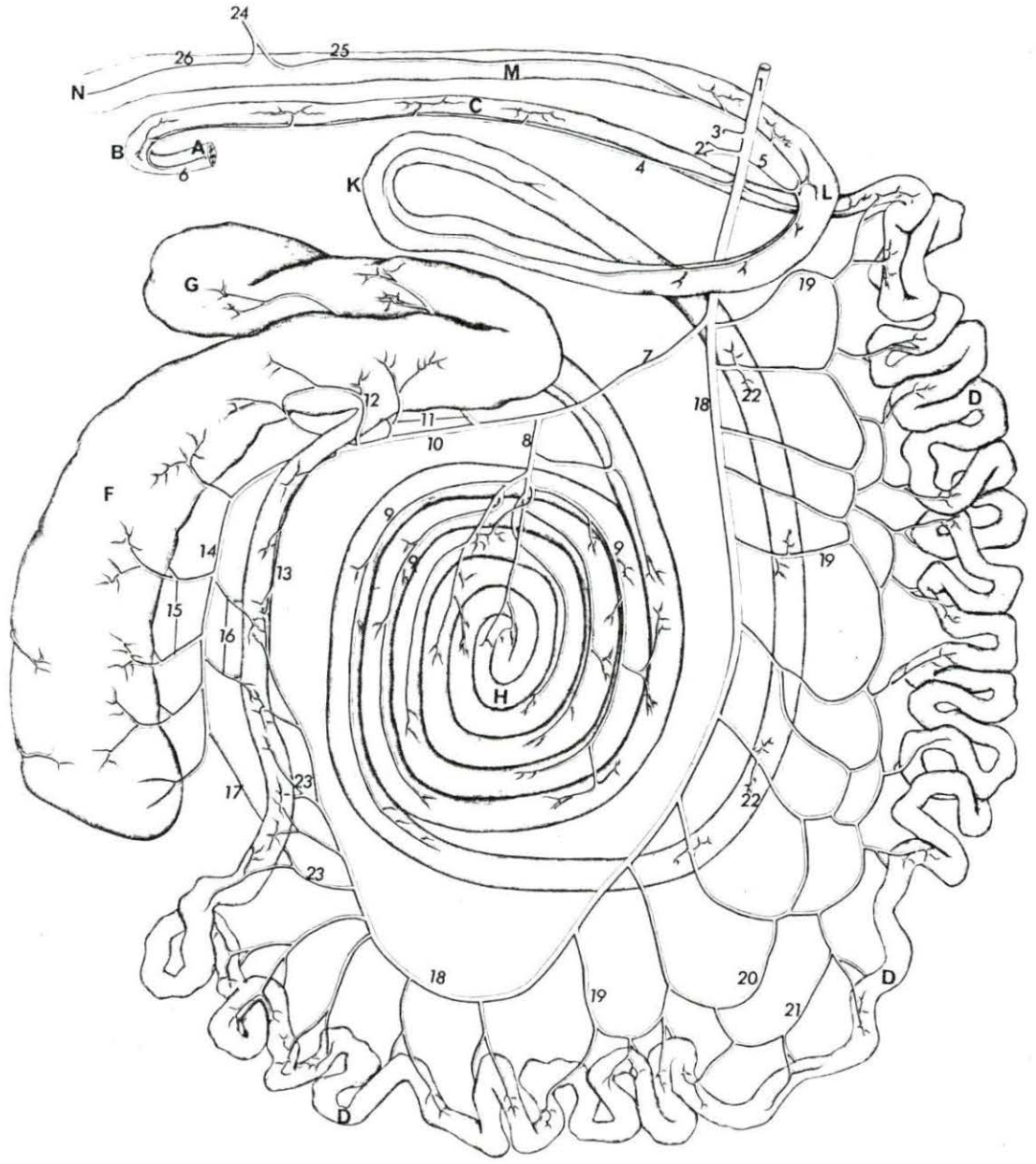
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Figure 7. The formation of the arcades in the intestinal region.

A. Jejunum
B. Last part of the centrifugal colon

1. Truncus intestinalis
2. Aa. jejunales
3. Primary arcade
4. Secondary arcade
5. "Mural" artery
6. Rami colici

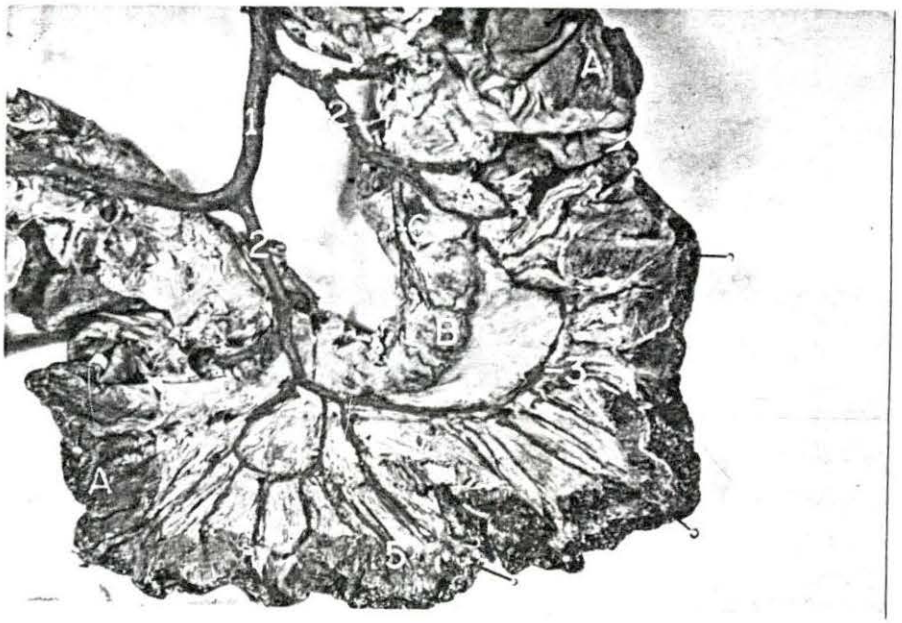
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Figure 8. Arteries to the genital tract of the ewe (schematic).

A. Colon descendens
B. Rectum
C. Anus
D. Ovary
E. Uterus
F. Bladder
G. Vagina
H. Vulva
I. Ureter

1. Aorta abdominalis
2. A. iliaca externa
3. A. iliaca interna
4. A. sacralis media
5. A. spermatica interna
6. A. mesenterica caudalis
7. A. umbilicalis
8. A. ureterica
9. Ramus cranialis of 8
10. Ramus caudalis of 8
11. A. uterina media
12. Ramus caudalis of 11
13. Ramus cranialis of 11
14. Ramus uterinus of 5
15. Ramus ovaricus of 5
16. Rami uterini of 12
16'. Rami uterini of 13
17. A. gluteus cranialis
18. A. gluteus caudalis
19. A. urethrogenitalis
20. A. uterina caudalis
21. Ramus cranialis of 20
22. Ramus caudalis of 20
23. A. rectalis caudalis
24. A. vesicalis caudalis
25. A. pudenda interna
26. A. clitoridis
27. A. perinei
28. Ramus anastomoticus of A. pudenda externa
29. A. colica sinistra
30. A. rectalis cranialis

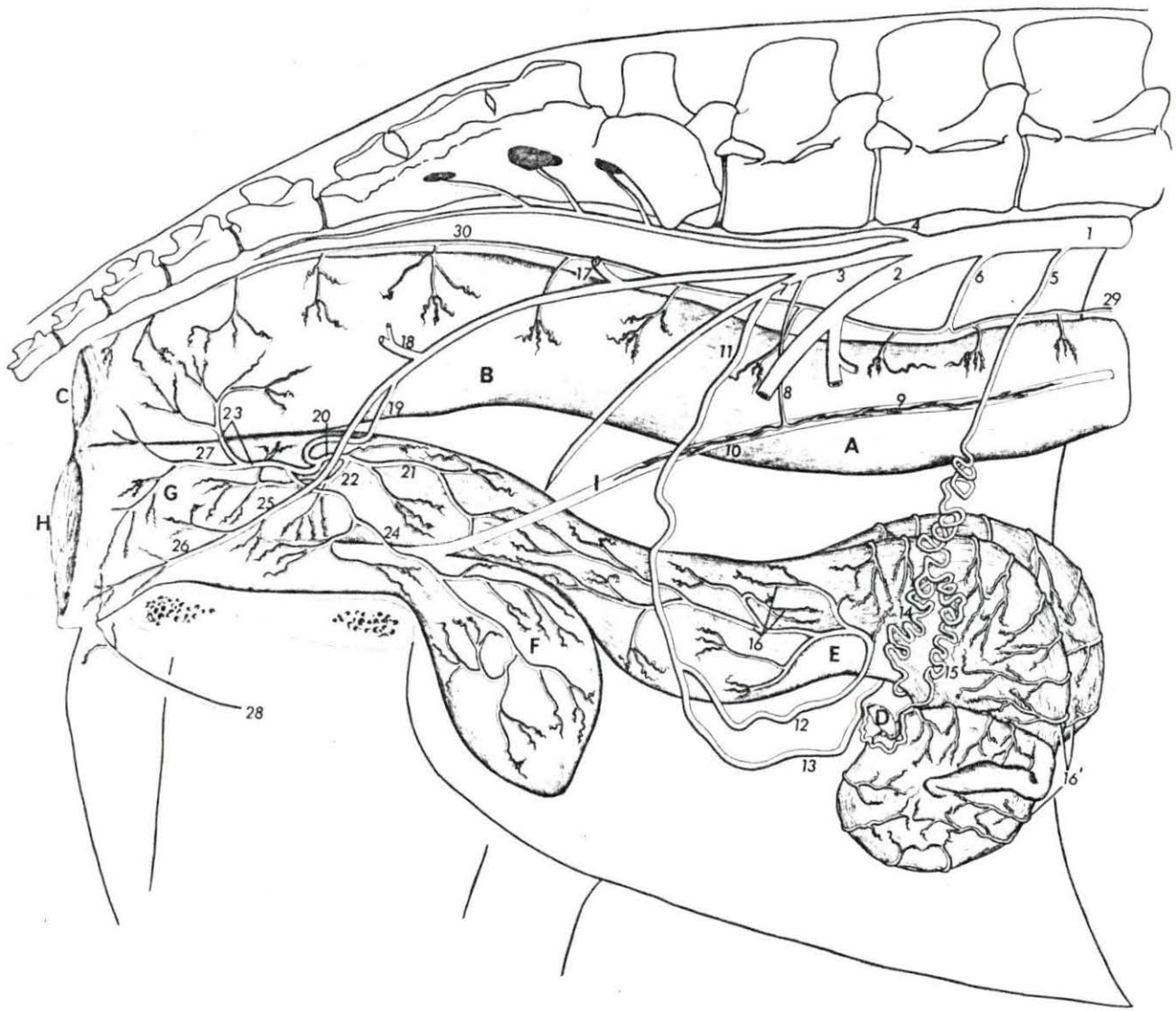
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Figure 9. Arteries to the mammary gland (schematic).

A. Colon descendens
B. Uterus
C. Bladder
D. Ovary
E. Supramammary lymph node
F. Vagina
G. Vulva
H. Rectum
I. Anus

1. Aorta abdominalis
2. A. iliaca externa
3. A. iliaca interna
4. A. sacralis media
5. A. gluteus cranialis
6. A. gluteus caudalis
7. A. umbilicalis
8. A. ureterica
9. A. uterina media
10. A. pudenda interna
11. A. urethrogenitalis
12. A. rectalis caudalis
13. A. uterina caudalis
14. A. circumflexa lateralis
15. A. profunda femoris
16. Truncus pudendoepigastricus
17. A. epigastrica caudalis profundus
18. A. pudenda externa
19. Branch to supramammary lymph node
20. Ramus anastomoticus with A. perinei
21. Branch to caudal part of mammary gland
22. A. mammaria
23. A. mammaria medialis
24. A. lateralis sinus
25. Aa. papillares
26. A. basalis

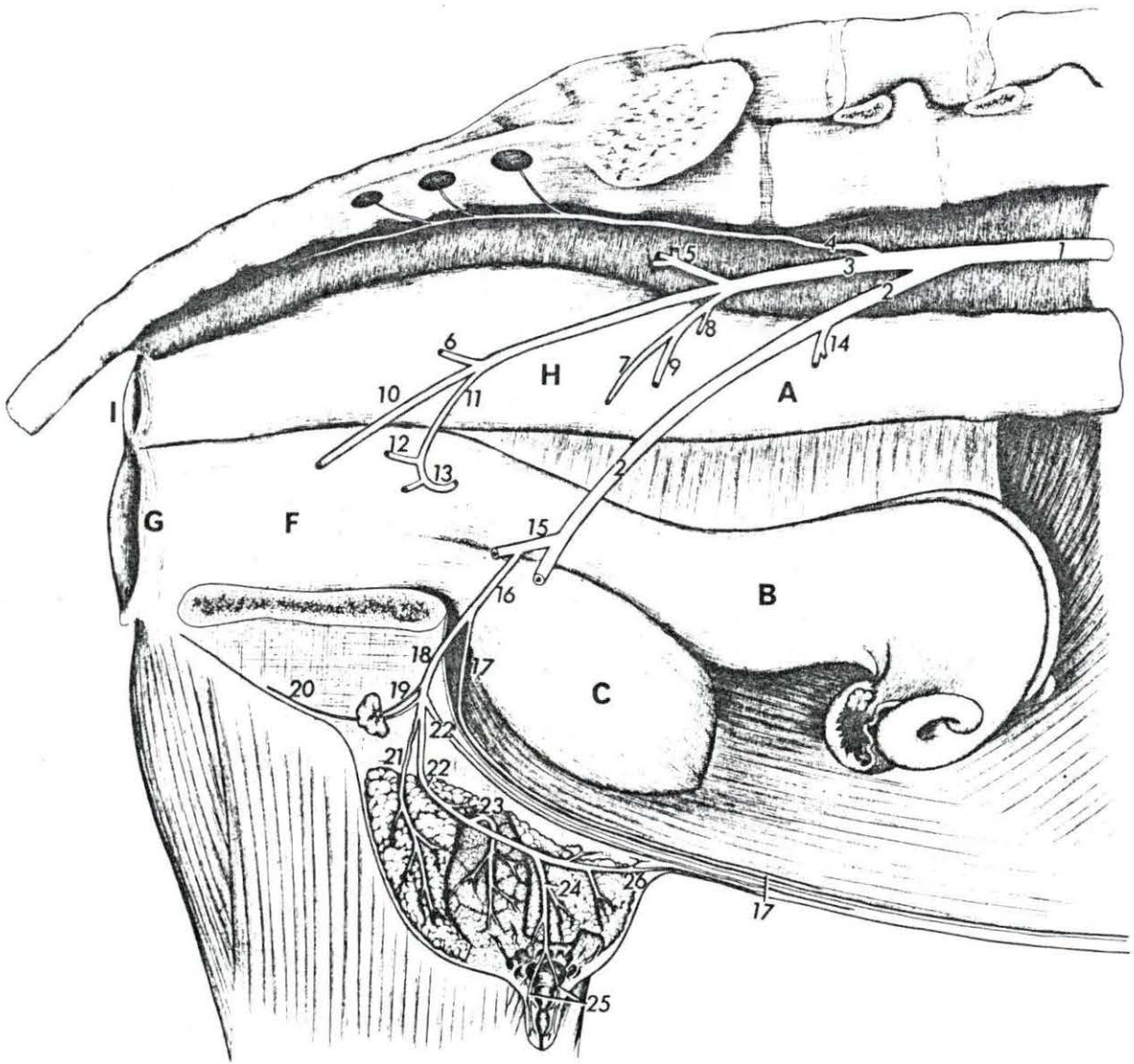
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Figure 10. Arteries to the mammary gland in specimen No. 5.

A. External oblique abdominal muscle
B. External inguinal orifice
C. Internal oblique abdominal muscle
D. Abdominal tunic
E. Teat
F. Supramammary lymph node
G. Gracilis

1. A. pudenda externa
2. Branch to supramammary lymph node
3. Ramus anastomoticus with A. perinei
4. Branch to posterior part of mammary gland
5. A. mammaria
6. A. mammaria medialis
7. A. lateralis sinus
8. A. papillaris
9. A. epigastrica caudalis superficialis
10. A. basalis
11. V. pudenda externa

Notice the origin of the A. epigastrica caudalis superficialis (9) from the A. mammaria (5).

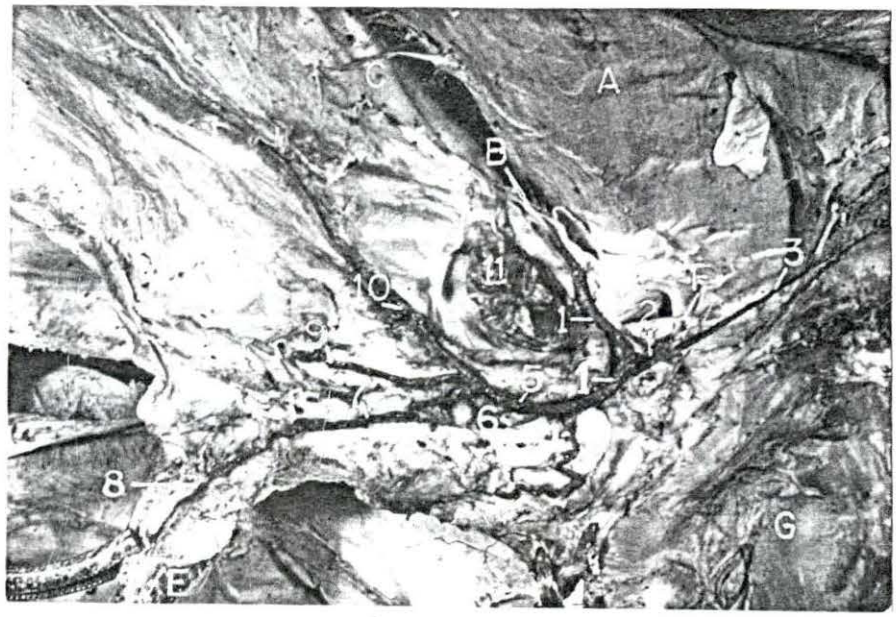
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Figure 11. Arteries to the genital tract of the ram (schematic).

A. Colon descendens
B. Rectum
C. Bladder
D. Seminal vesicle
E. Bulbourethral muscle
F. Ischiocavernosus muscle
G. Penis

H. Retractor penis muscle
I. Testicle
J. Epididymis
K. Glans penis
L. Prepuce
M. Urethral process
N. Orifice of prepuce

1. Aorta abdominalis
2. A. iliaca externa
3. A. iliaca interna
4. A. sacralis media
5. A. spermatica interna
6. A. mesenterica cranialis
7. A. colica sinistra
8. A. haemorrhoidalis cranialis
9. A. gluteus cranialis
10. A. umbilicalis
11. A. ureterica
12. A. deferentialis
13. A. vesicalis cranialis
14. A. gluteus caudalis
15. A. urethrogenitalis
16. A. vesicalis caudalis
16'. Ramus muscularis of 16

17. A. pudenda interna
18. A. rectalis caudalis
19. A. perinei
20. A. bulbourethralis
21. A. dorsalis penis
22. A. profunda femoris
23. Truncus pudendoepigastricus
24. A. spermatica externa
25. A. epigastrica caudalis
26. A. pudenda externa
27. A. epigastrica caudalis superficialis
28. Ramus caudalis
28'. Ramus scroti
29. Branch of 28 to corpus urethrae
30. A. testicularis
31. A. epididymis
32. Ramus anastomoticus with A. perinei

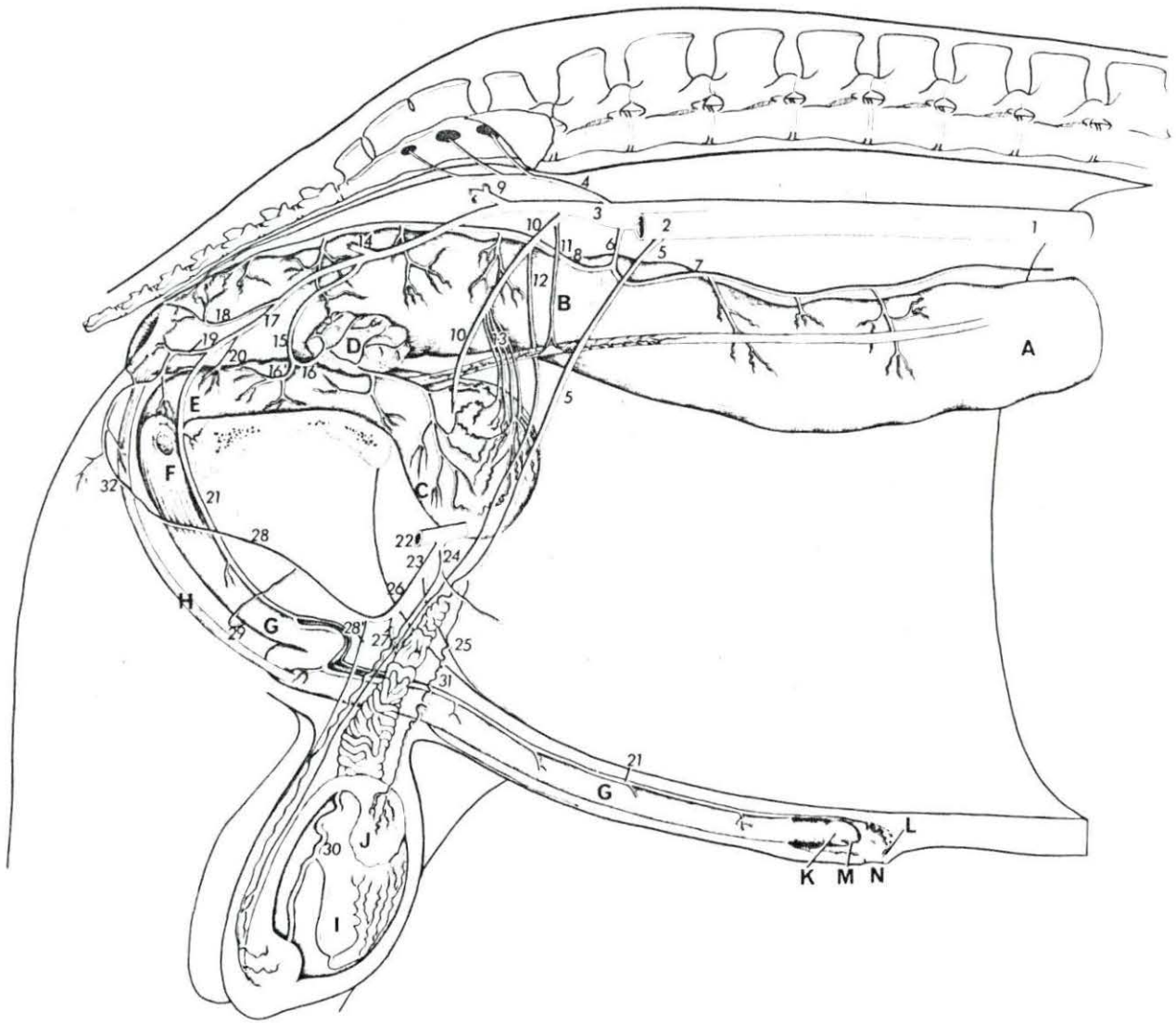
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Figure 12. Arteries to the penis.

A. Penis
B. Glans penis
C. External oblique abdominal muscle
D. Internal oblique abdominal muscle
E. Cutaneous muscle of the trunk
F. Gracilis

1. A. dorsalis penis
2. A. dorsalis penis dextra
3. A. dorsalis penis sinistra
4. A. epigastrica cranialis sinistra

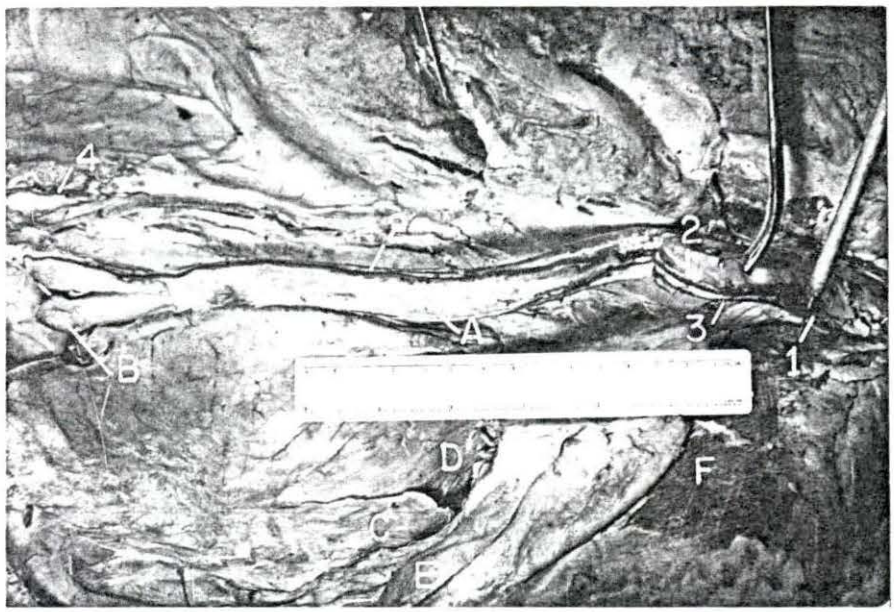
The penis is twisted to the left in order to show the dorsal surface.

Figure 13. Posterior view of the penis.

A. Penis
B. Sigmoid flexure of the penis
C. Gracilis
D. External oblique abdominal muscle

1. A. dorsalis penis
2. A. dorsalis penis dextra
3. A. dorsalis sinistra

The bifurcation of the A. dorsalis penis is located posterior to the sigmoid flexure. The two branches are not the same size.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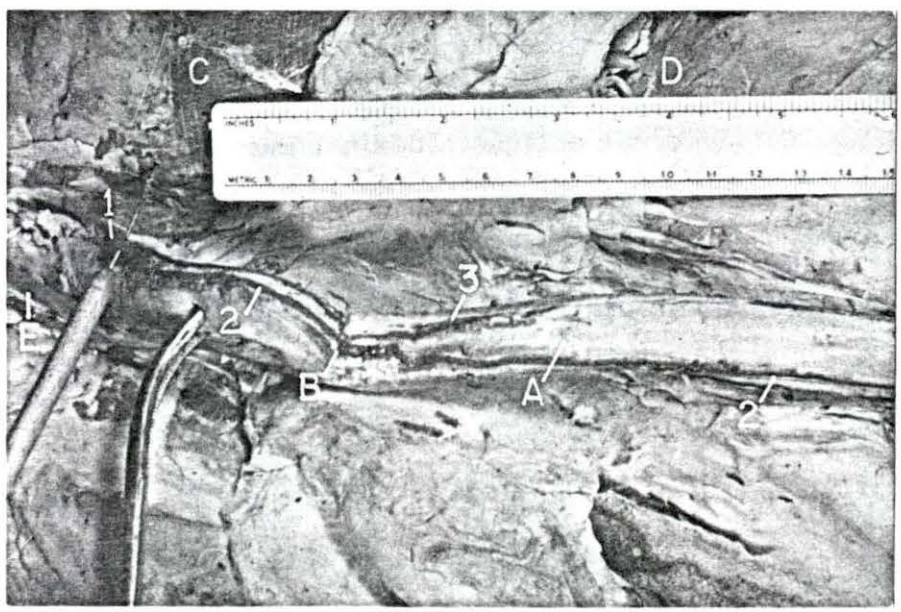
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Figure 14. Cranioventral view of the penis

A. Penis
B. Glans penis
C. Prepuce
D. Retractor prepuce muscle

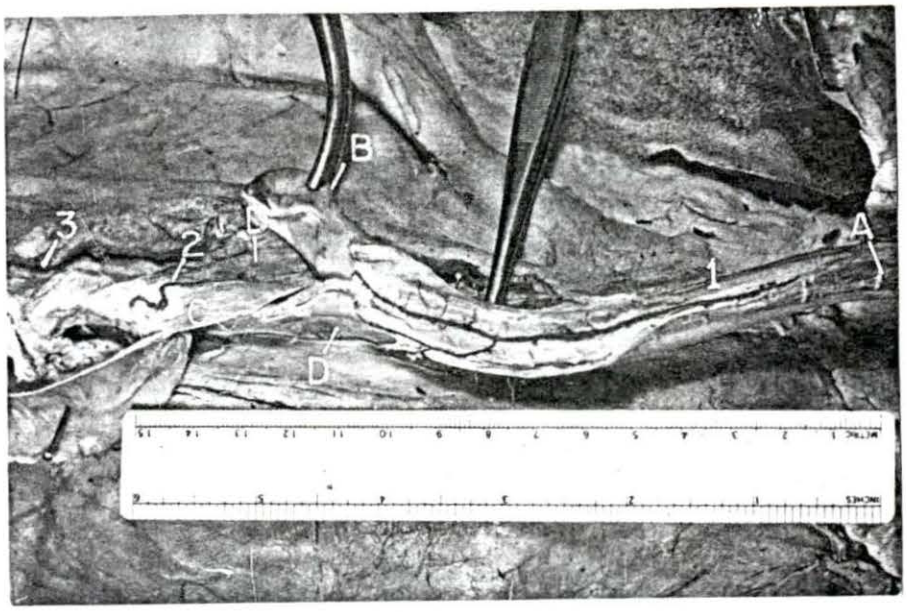
1. A. dorsalis penis sinistra
2. A. dorsalis penis dextra
3. A. epigastrica cranialis

The smaller vessel (here the A. dorsalis penis sinistra) turns to the ventral surface of the penis and terminates in the glans penis.

Figure 15. View of cranial-third of the penis and the preputial region.

A. Penis (covered by the prepuce)
B. Prepuce (parietal layer)
C. Orifice of the prepuce
D. Retractor prepuce muscle
E. Protractor prepuce muscle
F. Cutaneous muscle of the trunk
G. External oblique abdominal muscle

1. A. dorsalis penis
2. A. epigastrica caudalis superficialis dextra
3. A. epigastrica caudalis superficialis sinistra
4. A. epigastrica cranialis dextra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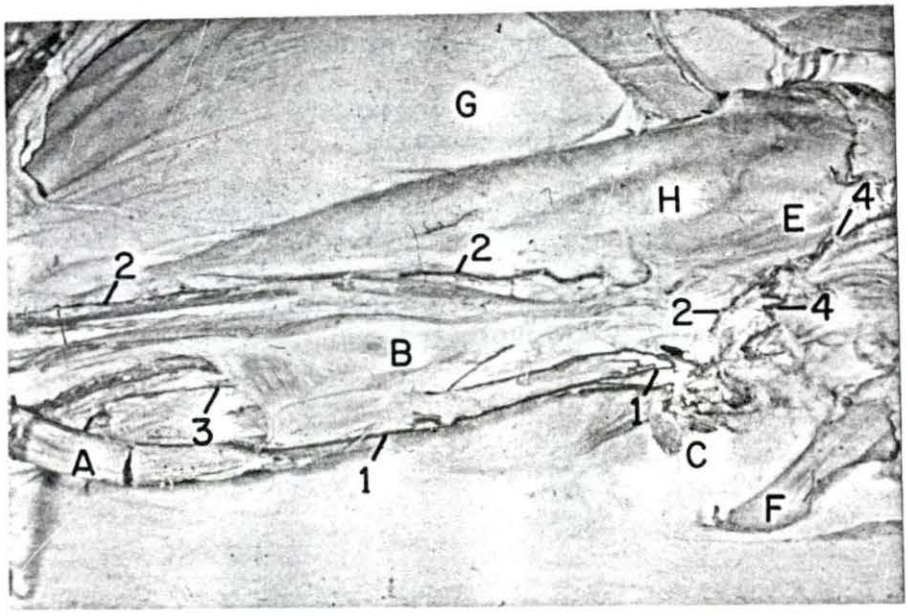
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Figure 16. Termination of the A. dorsalis penis

A. Glans penis
B. Retractor prepuce muscle
C. Protractor prepuce muscle
D. Orifice of prepuce
E. Cutaneous muscle of the trunk

1. A. dorsalis penis dextra
2. Branch to prepuce of 1
3. A. epigastrica dextra
4. A. epigastrica sinistra

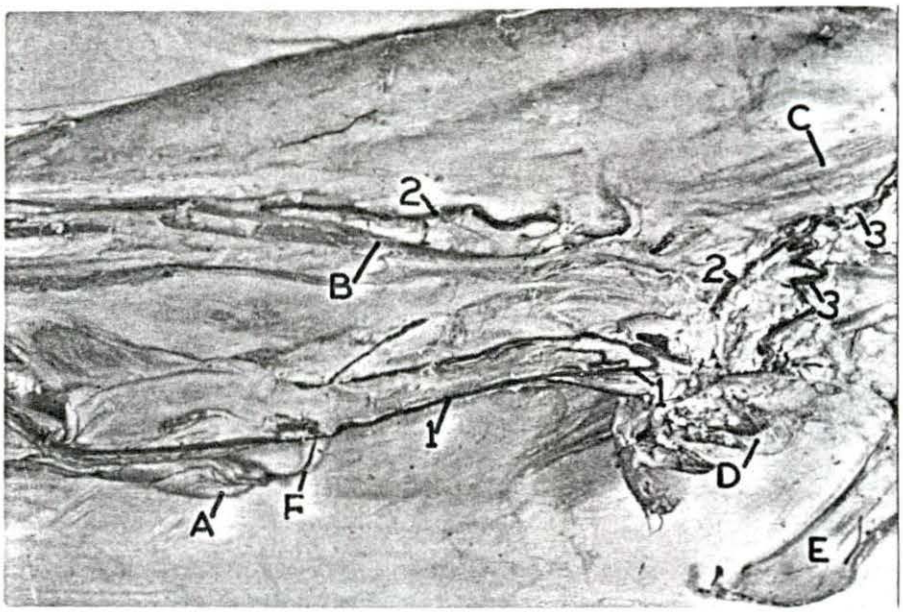
The recurrent artery in the bull (Ashdown, 1958) is not present in the ram.

Figure 17. Dissection of the dorsal fibrous ligament of the penis.

A. Penis
B. Glans penis
C. Prepuce (parietal layer)
D. Retractor prepuce muscle
E. Dorsal fibrous ligament of penis (clamped by forcep)

1. A. dorsalis penis dextra
2. A. epigastrica caudalis

An attempt was made to dissect the dorsal fibrous ligament of the penis of the ram, which up to the present time is assumed as one of the causes of the so-called crooked penis in the bull. This is a dissection of one specimen and should be certainly re-evaluated.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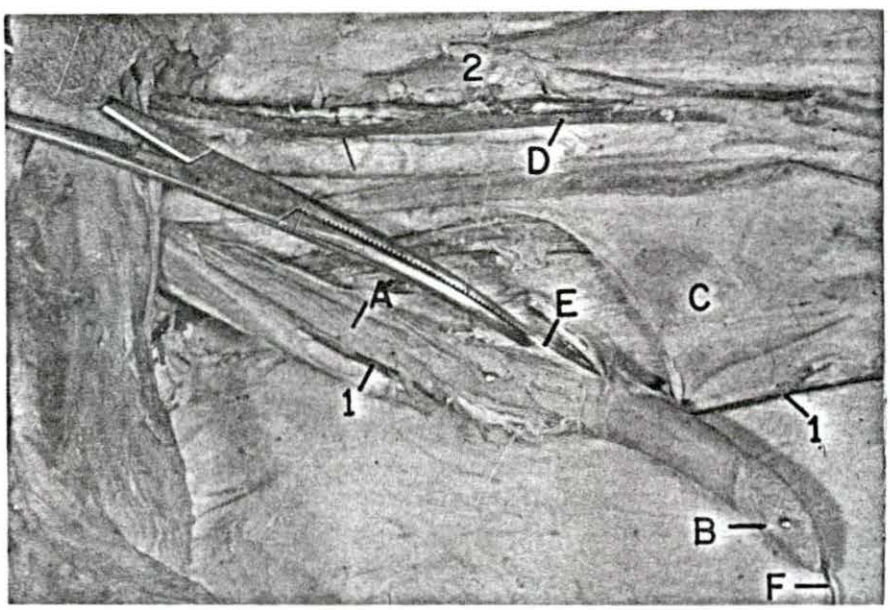
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