The Vascular Anatomy of the Lower Abdomen, Pelvis and Upper Hindleg in *Procavia capensis*×

by
P. S. Swart
Nature Conservation Branch
South West Africa Administration
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INTRODUCTION

The Hyracoides are represented by three genera *Procavia, Dendrohyrax* and *Heterohyrax*. These enjoy a wide distribution throughout Africa and the Middle East while the dassie or rock hyrax, *Procavia capensis,* occurs in particularly large numbers in Southern Africa. This species is of great scientific interest. Firstly its success, particularly in hot arid environments has stimulated interest in its behaviour, ecology and renal physiology in recent years. For example, Sale (1965, 1969) has studied the behaviour and general ecology of several species of Hyracoides with considerable success. Also, Louw (1969) has demonstrated the high renal efficiency of *Procavia* with certain unusual features in regard to calcium excretion. Moreover, various unique features in regard to the morphology of the gastro-intestinal tract remain to be elucidated on a physiological basis.

In addition to these interesting features, the testes of the Hyracoidea are positioned intra-abdominally and the scrotum is absent. This phenomenon, which is very rare among mammals immediately poses various problems in regard to the evolutionary significance of the scrotum. This significance has been examined by Cowles (1958) but fundamental questions in regard to any physiological or ecological advantage of the scrotum remain unanswered. Moreover, the reason why the enzymes, involved in spermatogenesis, should function at an optimum temperature considerably less than abdominal temperature remains obscure. Clearly then, a great deal of research on this fascinating aspect is indicated and the dassie provides ideal material for this purpose.

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In order, therefore, the present investigation was undertaken with the object of getting the anatomical background for the study of the problem of thermoregulation of the testes in the dassie. The purpose, then of this investigation was to examine and describe the vascular anatomy of the lower abdomen, pelvis and upper hind leg in *Procavia capensis*. For comparative purposes the relevant parts of the female vascular system are also described.

MATERIAL AND TECHNIQUE

Three males and four females of *Procavia capensis* were used for this investigation. After narcotization the heart was exposed by a cut through the last sternebra and an incision through the abdominal wall. The arteries were injected with red latex through the thoracic aorta, and the veins with blue latex through the inferior caval vein immediately in front of the diaphragm. Prior to injection the vessels were bled for a while. The injection was done with a 20 ml. syringe in which the needle was replaced with a ¼ inch plastic tube to which the cannula was attached. A few drops of ammonia were added to the latex to prevent coagulation and leakages were stopped by the local application of acetic acid which coagulates the latex. After this treatment the specimens were placed in formalin until the latex in the vessels became coagulated. The alimentary canal was then removed and the vascular system of the abdomen and pelvis regions was dissected. The dissections were drawn to scale.

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ARTERIES OF THE ABDOMEN AND PELVIS

The abdominal aorta (A. ABD.; Figs. 1& 2) begins at the point where it issues from the diaphragm and ends where it bifurcates into the left and right internal iliac arteries. It lies medioventrally to the vertebral column and its posterior end is ventral to that of the inferior caval vein (V. C. INF.).

The branches of the abdominal aorta are: the superior suprarenal (A. SUPR. SUP.), the inferior suprarenal (A. SUPR. INF.), the renal (A. REN.) and the testicular (A. TEST.) or ovarian (A. OV.), the external iliac (A. IL. EXT.) and the internal iliac (A. IL. INT.).

The superior suprarenal artery (Figs. 1 & 2) penetrates the anterior region of the suprarenal gland (SUPR. REN.). The left vessel arises slightly behind the right one. In two of the specimens the right superior suprarenal artery gives off a branch to the diaphragm. In one specimen the left superior suprarenal artery divides into two branches, just after leaving the abdominal aorta.

The inferior suprarenal artery (Figs. 1 & 2) supplies the posterior part of the suprarenal gland. It is apparently subject to more variation than the superior suprarenal artery. In some specimens it arises as a single branch from either the aorta or the renal artery; in others, it issues as two branches from the two anterior branches of the renal artery.

The renal artery (Figs. 1 & 2) arising by a single root from the aorta usually divides into at least two, but in some specimens into as many as four branches before entering the kidney.

The testicular (or ovarian) artery (Figs. 1, 2, 15A, 15B & 16) as the case may be arises either directly from the aorta or from the renal. In those cases in which the renal has multiple branches it arises from the hindmost of these.

Crossing the ventral surface of the ureter (UR.) the testicular artery runs backwards to the testis (TEST.). Behind each kidney (KID.) a prominent branch springs from the testicular and while pursuing an anterolateral course it gives off branches to the intercostal spaces. In one of the specimens the latter branch was found to spring directly from the abdominal aorta. Upon reaching the anteromedial side of the testis, the testicular divides into three major branches: The small anterior branch loops ventrally round the testicular vein (V. TEST.) to supply the fatty tissue anterolaterally to the testis (Fig. 15A); the lateral and shorter of the two remaining branches supplies the anterior part of the epididymis (EPID.) and also sends twigs into the testis (Fig. 15B); the third branch running along the medial side of the testis is distributed to the testis, the posterior part of the epididymis and to the fatty tissue around the testis (Fig. 15B).

As already mentioned the ovarian artery (Figs. 1 & 16) has the same origin as the testicular, i.e. from the abdominal aorta or from the renal artery. It crosses the ureter ventrally and upon reaching the ovary divides into two major branches: The lateral of these supplies the uterine tube (UT. TUB.) and part of the fatty body (F. B.); the medial one, after successively supplying the surrounding fatty body and the ovary, passes backwards dorsally to the uterine tube. In this region it becomes intimately associated with the corresponding vein and anastomoses with the uterine plexus (AN.d; Figs. 2 & 16).

The divission of the aorta in the lower abdominal region follows two main patterns, but, as in many other mammals, the vascular system in this region is subject to variation. In the one group, of which man, the rabbit (Bensley, 1926; Grobbelaar, 1952; Whitehouse & Grove, 1933) and the rat (Greene, 1935; Rowett, 1962; Ulmer, Haupt & Hicks, 1962) are typical examples, the aorta divides into two common iliac arteries each of which subdivides into external and internal iliac arteries; in the other group, of which the cat (Mivart, 1881) and the dog (Bradley, 1896) are the commonest members, there are no common iliac arteries. The dassie belongs to this latter group.

The external iliac artery (Figs. 1, 2, 3, 4 ,5, 6, 7 & 8) originates from the abdominal aorta at the anterior border of the pelvic cavity. It runs posterolaterally along the brim of the pelvic cavity and after penetrating the abdominal wall is continued along the medial surface of the thigh as the femoral artery.

The branches of the external iliac artery are: the iliolumbar (A. ILIOL.) and pudic-epigastric (A. PUD. EP.).

A short distance behind its origin the external iliac gives off the laterally-directed iliolumbar artery (Figs. 1, 2, 4, 6 & 7). Its origin is also subject to variation. In the rat (Greene, 1935; Ulmer, Haupt & Hicks, 1962) both the left and the right iliolumbar may arise from the abdominal aorta, or the left one may arise from the common iliac; in the horse (Schmaltz, 1919; Bradley, 1896) it arises from the internal iliac artery (A. IL. INT.).

The iliolumbar runs laterally across the ventral surface of the psoas minor (P. MIN.), the psoas major (P. MAJ.) and iliac (IL.) muscles. It gives rise to three prominent branches. The medial branch runs anterolaterally to supply the iliac muscle, the quadratus lumborum muscle (Q.L.) and muscles of the abdominal wall. In one male specimen (Fig. 1) the left medial branch arises directly from the external iliac artery. The middle branch arises ventrally to the iliac muscle, which it supplies and then runs anterolaterally to the muscles of the abdominal wall; the lateral branch proceeds laterally and supplies the subcutaneous fat and fascia lata (FAS. LAT.) anteriorly to the thigh.

The pudic-epigastric artery (Figs. 1, 2, 3, 4, 5, 6, 7 & 8) issues slightly anteriorly to the point where the external iliac penetrates the abdominal wall to become the femoral artery (A. FEM.). It runs for a short distance medioposteriorly before it gives rise to two branches: the inferior epigastric (A. EP. INF.) and the external pudendal (A. PUD. EXT.).

In *Procavia* as in other mammals the inferior epigastric artery (Figs. 1, 2, 3, 4, 5, 6, 7 & 8) has a variable origin. In one male specimen the right inferior epigastric arises separately from the external iliac artery (not figured) as do both left and right arteries in the rat (Greene, 1935; Ulmer, Haupt & Hicks, 1962); in man it is usually a branch of the external iliac; in the horse (Schmaltz, 1919) it is a branch of the profunda femoris artery; and in the cat (Mivart, 1881) it springs from the obturator artery. The inferior epigastric artery runs anteriorly with the rectus abdominis muscle (RECT. ABD.) supplying it with blood. It also sends branches to the mammary glands in the female and to the subcutaneous fat in the male.

The external pudendal artery (Figs. 1, 2, 3, 4, 5, 6, 7 & 8) runs medioposteriorly and furnishes branches to each of the following organs: the vagina (VAG.), the bladder (BL.) and the urethra (URET.) in the female and to the prostate (PROS.), the bladder and the urethra in the male. In one female specimen the left external pudendal arises from the superior vesical artery (Fig. 6).

After giving off the external iliac the abdominal aorta continues for a short distance and then divides into the two internal iliac arteries. This is the case also in the cat (Mivart, 1881) and the dog (Bradley, 1896). The internal iliac artery (Figs. 4 & 7) dips down into the pelvis and pursues a posterolateral direction in the course of which it gives rise to a variety of branches. These are: the superior vesical (A. VES. SUP.), the medial sacral (A. SAC. MED.), the superior gluteal (A. GL. SUP.) and the inferior gluteal (A. GL. INF.).

A short distance behind its origin from the abdominal aorta the internal iliac artery gives off the superior vesical artery (Figs. 2, 3, 4, 6 & 7). This is the case in all the specimens which were investigated. The corresponding vein always opens into the external iliac vein. The inferior vesical artery on the other hand is a branch of the superior vesical artery and its corresponding vein drains into the internal iliac vein. In the rabbit (Grobbelaar, 1952; Whitehouse & Grove, 1933); the cat (Mivart, 1881) and the horse (Bradley, 1896) the superior vesical artery also arises from the internal iliac, whereas in the rat (Greene, 1935; Ulmer, Haupt & Hicks, 1962) it is a branch of the common iliac artery.

The superior vesical artery has four major branches in both sexes. In the female the first of these, the uterine artery (Figs. 2 & 16), upon approaching the uterus divides into several branches forming a strongly convoluted plexus surrounding the body and horns of the uterus, and anastomoses with the medial branch of the ovarian artery (AN.d; Figs. 2 & 16). In some specimens (Figs. 2 & 16) the two uterine arteries form an anastomosis ventrally to the body of the uterus (AN.a; Figs. 2 & 16). Twigs from the plexuses and from the anastomosis, when present, are distributed to the various parts of the uterus. Of the remaining three branches of the superior vesical in the female one supplies the ureter, another the ventrolateral and anterior sides of the bladder and the last twig the inferior vesical artery (Figs. 6 & 7) supplies the vagina and its diverticula (DIV. VAG.) as well as the dorsal side of the bladder and the urethra. In the male the first branch supplies the ductus deferens (DUCT. DEF.), the second the seminal vesicle (VES. SEM.), the third the ventrolateral and anterior sides of the bladder and the ureter and the last the inferior vesical artery (Figs. 3 & 4), is distributed to the prostate, the urethra and the posterodorsal side of the bladder. The ductus deferentes open into what apparently represents an unpaired common portion of the Wolffian ducts on either side, thus forming what George (1874) designates as "glandes séminales". But it is clear that the glandular pouch is single. Strangely enough George uses the plural form thus leading one to infer that there are two "vésicules séminales".

The medial sacral artery (Figs. 4 & 7) arising from either the left or the right internal iliac artery, runs backwards below the sacrum supplying twigs to the sacral vertebrae and is continued into the anal region.

The third branch of the internal iliac artery, the superior gluteal artery, (Figs. 4 & 7) runs posterolaterally in the pelvic cavity for a short distance, before leaving it between the gluteus muscles (M. GL.). In passing through the gluteus muscles it sends twigs into its various parts. In the cat (Mivart, 1881) and in the horse (Schmaltz, 1919; Bradley, 1896) the superior gluteal artery has the same origin as in *Procavia capensis*, whereas in the rat (Greene, 1935; Ulmer, Haupt & Hicks, 1962) it arises from the common iliac artery.

The inferior gluteal artery (Figs. 4 & 7) arises behind the superior gluteal artery from the internal iliac. It proceeds posterolaterally for a short distance, before it passes out of the pelvic cavity to the outside of the thigh. It supplies the gluteus, semitendinosus (SEM. T.), semimembranosus (SEM. M.) and biceps femoris (BIC. FEM.) muscles. Close to its origin, the inferior gluteal furnishes the lateral sacral artery (A. SAC. LAT.) (Figs. 4 & 7). This vessel runs posteriorly and passing dorsally to the bladder supplies the diverticulum of the vagina in the female and the prostate in the male. It also sends a small twig to the gluteus muscle. In one female specimen (Fig. 7) the right lateral sacral artery arises directly from the internal iliac artery.

The femoral artery (Figs. 1—8) is the continuation of the external iliac outside the abdominal wall, and it descends along the inside of the thigh. Near its origin the femoral gives rise to the profundal or deep femoral artery (A. PROF. FEM.; Figs. 3—8). The latter takes a deep course posteromedially above the pectineus (PEC.) and adductor (AD.) muscles and supplies the pectineus, adductor, semitendinosus, semimembranosus, gracilis (GRAC.) and biceps femoris muscles (Figs. 5 & 8).

Close to its origin the profundal femoris gives rise to the obturator artery (A. OB.). This vessel proceeds posteromedially for a short distance before it splits up into twigs supplying the obturator and biceps femoris muscles. In one female specimen (Fig. 8) the right obturator arises independently from the external iliac artery whereas in one male (not figured) the right obturator arises from the pudic-epigastric. In mammals like the horse (Schmaltz, 1919; Bradley, 1896) the rat (Greene, 1935) and in man (Gray, 1932) the obturator arises from the internal iliac artery.

The profunda femoris artery also gives rise to the internal pudendal artery (A. PUD. INT.; Figs. 3, 5, 6 & 8). The latter vessel runs posteromedially to the penis (PEN.) in the male and to the clitoris (CLIT.) in the female. It supplies the obturator muscle and upon reaching the base of the clitoris in the female and of the penis in the male it divides

into a medial and a lateral branch. In the female the medial branch supplies the urethra, perineal gland (PER. GL.), clitoris and the semimembranosus muscle. The lateral branch proceeds laterally to the anus supplying the urethra, clitoris, the levator ani muscle and a large twig supplies the semimembranosus muscle. In the male the medial branch supplies the urethra, the bulbourethral gland (BUL. URET. GL.) and eventually it terminates in the artery of the penis (A. PEN.; Figs. 3 & 5). The lateral and larger branch runs alongside the penis to the anal region. It sends twigs to the bulbourethral gland, to the penis and to the bulbocavernosus (BUL. CAV.), ischiocavernosus (ISCH. CAV.), levator ani and semimembranosus muscles. In man (Gray, 1932) and in other mammals like the rat (Greene, 1935; Ulmer, Haupt & Hicks, 1962), the rabbit (Grobbelaar, 1952), the horse (Schmaltz, 1919; Bradley, 1896), the pig and the dog (Bradley, 1896) the internal pudendal artery always arises from the internal iliac artery.

The femoral artery has four other minor branches: the medial femoral circumflex (A. FEM. CIR. MED.; Figs. 5 & 8), the lateral femoral circumflex (A. FEM. CIR. LAT.; Figs. 1—8), the muscular (A. MUSC.; Figs. 5 & 8) and the saphenous arteries (A. SAPH.; Figs. 5 & 8). The medial femoral circumflex supplies the adductor and pectineus muscles and the lateral femoral circumflex supplies the rectus femoris (R. FEM.) and vastus internus (V. INT.) muscles. The muscluar artery originates posteriorly to the two former vessels and supplies the adductor, pectineus and semimembranosus muscles. The saphenous artery originates just anteriorly to the point where the femoral artery disappears between the vastus internus and semimembranosus muscles to become the popliteal artery (A.POP.; Figs. 5 & 8). The saphenous crosses superficially over the insertion ends of the semimembranosus and gracilis muscles, to the lower leg. It supplies the two former muscles as well as the knee joint and tibia (TIB.).

VEINS OF THE ABDOMEN AND PELVIS

The inferior caval vein (Figs. 1, 2, 12, & 13) collects tributaries from all parts of the abdomen. Its position relative to the aorta conforms to the characteristic mammalian type, except that in one of the female specimens dissected it lies on the left side of the aorta (Fig. 2). Its chief tributaries are: The superior suprarenal (V. SUPR. SUP.), the inferior suprarenal (V. SUPR. INF.), the renal (V. REN.), the testicular (V. TEST.) or ovarian (V. OV.), the external iliac (V. IL. EXT.) and the internal iliac (V. IL. INT.). (The lumbar, hepatic and phrenic veins are omitted in this description).

The inferior suprarenal vein (Figs. 1 & 2) collects blood from the posterior part of the suprarenal gland. Owing to the fact that the left suprarenal gland is situated slightly behind the right one, the left superior and inferior suprarenal veins join the inferior caval some distance behind the corresponding veins of the right side.

The renal vein (Figs. 1 & 2) passes out of the kidney at the hilus either as a single vessel or in some cases, as two tributaries which join before entering the inferior caval vein. The left renal vein usually recieves the testicular (V. TEST.) or ovarian vein (V. OV.), but in one of the female specimens both the left and right ovarian veins join the inferior caval vein (Fig. 2). In another specimen (not figured) the right ovarian drains into the renal, whereas in all the others the testicular or ovarian joins the inferior caval vein.

The testicular vein (Figs. 1, 15A & 15B) has three or four tributaries which join anteromedially to the testis. The larger lateral tributary arises by a confluence of vessels draining the whole ventral surface of the testis; the middle tributary (the longest of the three) collects from the anterior part of the ductus deferens, the posterior region of the epididymis and the fatty tissue around the testis. In the specimen figured (Fig. 15A & 15B) there are two tributaries draining these regions. The small medial tributary drains the fatty tissue surrounding the testis.

Slightly behind the kidney a prominent tributary, formed by vessels from the intercostal spaces, join the testicular vein (Fig. 1). In all the specimens this vessel anastomoses either on the right or on the left or on both sides with the medial branch of the iliolumbar vein (V. ILIOL.; AN. b; Fig. 1). Crossing the ventral surface of the ureter the testicular vein, as already mentioned, joins either the renal vein or the inferior caval vein.

One of the major components of the ovarian vein (Figs. 2 & 16) is the tributary which affects an anastomosis with the uterine plexus. It runs anteriorly and is joined by three or four smaller vessels collecting from the fatty tissue, the uterine tube and the ovary itself. As in the case in the testicular vein, a prominent tributary, which is made up of vessels from the intercostal spaces, joins the ovarian behind the kidney. In all the specimens this vessel anastomoses with the medial tributary of the iliolumbar vein (AN. b; Fig. 2). This anastomosis occurs either on the left or the right side and in some cases on both sides. In one specimen (Fig. 2; AN. c) a further anastomosis occurs between the ovarian itself and the medial tributary of the iliolumbar.

As already mentioned, the division of the abdominal aorta in the lower abdominal region in mammals is subject to variation. The construction of the inferior caval vein is subject to a comparable pattern of variation. In one group the inferior caval vein is formed by the junction of left and right common iliac veins.

Man and the rat (Greene, 1935; Rowett, 1962; Ulmer, Haupt & Hicks, 1962) are typical examples of this group. In this group the common iliac vein is formed by the junction of the external iliac and internal iliac veins; in the other group there are no common iliac veins. The dog (Bradley, 1896), the horse (Bradley, 1896; Schmaltz, 1919) and the cat (Mivart, 1881) are members of this group which also includes the dassie. In this group the medial

sacral and the two internal iliac veins join to form a short common vessel, which in turn is joined by the two external iliac veins to form the inferior caval vein.

The external iliac vein (Figs. 1, 2, 9, 10, 11, 12, 13 & 14) lies mediodorsally to the corresponding artery. It is the continuation of the femoral and lies inside the abdominal wall on the medial surface of the thigh, and runs anterolaterally along the brim of the pelvic cavity. At the anterior margin of the pelvic cavity the external iliac vein joins the inferior caval.

The tributaries of the external iliac vein are: The iliolumbar (V. ILIOL.), the superior vesical and the pudic-epigastric (V. PUD. EP.).

The iliolumbar vein (Figs. 1, 2, 10 & 13) has three major tributaries. The medial one drains the muscles of the abdominal wall, and the quadratus lumborum and iliac muscles. Eventually it opens into the iliolumbar ventrolaterally to the iliac muscle. As already mentioned this tributary always anastomosis with the ovarian or testicular, as the case may be, either on the left or right side or even on both sides. In one female specimen (not figured) the medial tributary opens into the middle tributary, instead of into the iliolumbar vein; on the left in one male specimen (Fig. 1) it opens directly into the external iliac. The middle tributary collects mainly from the muscles of the abdominal wall, whereas the lateral vessel drains the fascia lata and tensor fascia lata muscle. Ventrally to the iliac muscle these tributaries join to form the iliolumbar vein.

The junction of the iliolumbar in mammals in general is variable. In the rat (Greene, 1935) both the iliolumbar veins join the inferior caval or the vein on the left side may open into the common iliac vein; in the horse (Schmaltz, 1919; Bradley, 1896) it enters the internal iliac vein.

The superior vesical vein (Figs. 9 & 10) in the male has three tributaries: A small one which collects from the ureter, a longer vessel which drains the ductus deferens and seminal vesicle and one from the ventral side of the bladder. These tributaries join anterolaterally to the bladder to form the superior vesical vein. The position of its junction with the external iliac is variable. In the female, in addition to the tributaries described for the male, the superor vesical also receives a large tributary from the uterus. This tributary, the uterine vein (Fig. 2) originating in a convoluted plexus around the uterine body and horns and opens into the vesical very close to its junction with the external iliac. This plexus is also partly drained by the ovarian vein (AN. d; Figs. 2 & 16). On the ventral side of the body of the uterus the uterine vein of one side anastomoses with the vein of the opposite side (AN. a; Figs. 2 & 16). This is true of all specimens, whereas the corresponding arterial anastomosis is absent in some of them. The junction of the superior vesical vein in mammals is also subject to variation. According to Greene (1935) and Ulmer, Haupt and Hicks (1962), it joins the common iliac vein in the rat, whereas in the rabbit (Whitehouse & Grove, 1933) it opens into the external iliac vein.

The pudic-epigastric vein (Figs. 1, 2, 9, 10, 11, 12, 13 & 14) is a short vessel which joins the external iliac just inside the abdominal wall. Its tributaries are: The inferior epigastric (V. EP. INF.) and the external pudendal (V. PUD. EXT.).

The inferior epigastric vein (Figs. 1, 2, 9, 10, 12 & 13) is made up of two tributaries one of which collects from the slips of the rectus abdominis muscle. The other drains the mammary gland in the female and the subcutaneous fat in the male. In some specimens these two vessels enter the pudic-epigastric separately (e.g. Fig. 9) whereas in other specimens they unite before opening into the pudic-epigastric. The relations of the inferior epigastric vein to the rest of the venous system are similar to the relations that the corresponding artery has to the arterial system.

The external pudendal vein (Figs. 1, 9 & 10) in the male originates at the base of the penis. It is strongly convoluted and in running anteriorly to a point posteroventrally to the bladder, where it is connected by an anastomosing plexus (AN. h; Fig. 9) to the external pudendal of the opposite side, it drains the prostate and the urethra. In front of the anastomosis it receives a twig fro mthe posteroventral side of the bladder and passes laterally to join the epigastric inferior to form the pudic-epigastric.

In the female the external pudendal vein (Figs. 2, 12 & 13) originates in an anastomosis (AN. g; Fig. 12) between the two clitoris veins (V. CLIT.). As in the male this vessel is strongly convoluted on the ventrolateral side of the urethra and vagina which it drains. It runs to a point posteroventrally to the bladder where it forms an anastomosing plexus with the corresponding vein of the opposite side (AN. f; Fig. 12). Before joining the inferior epigastric it receives twigs from the posteroventral side of the bladder and from the diverticulum of the vagina.

In the rat (Greene, 1935) the external pudendal also unites with the inferior epigastric to form the pudic-epigastric, whereas in the rabbit (Grobbelaar, 1952) it enters the external iliac vein and in the horse (Schmaltz, 1919) it opens into the inferior epigastric, which joins the profunda femoris vein (V. PROF. FEM.).

The internal iliac (hypogastric) vein (V. IL. INT.; Figs. 10 & 13) originates on the ventrolateral sides of the caudal vertebrae. It runs anteriorly in the pelvic cavity and proceeds dorsally to the bladder. The left and right internal iliac veins unite in the anterior part of the pelvic cavity to form a short common vessel which in turn is joined by the two external iliac veins to form the inferior caval vein.

The tributaries of the internal iliac vein are: The inferior vesical (V. VES. INF.), the medial sacral (V. SAC. MED.), the superior gluteal (V. GL. SUP.) and the inferior gluteal (V. GL. INF.).

The inferior vesical vein in the male (Figs. 9 & 10) collects from the urethra, prostate and ventrolateral side of the bladder. In the female the inferior vesi-

cal (Fig. 13) drains the urethra, the vagina including its diverticulum, and the ventrolateral side of the bladder. At the anterolateral side of the bladder the tributaries unite to form the inferior vesical. As already mentioned the corresponding artery springs from the superior vesical artery instead of from the internal iliac artery.

The medial sacral vein (Figs. 10 & 13) originates in the region of the anus. It runs along the ventral midline of the caudal and sacral vertebrae and enters either the left or the right internal iliac. In its forward passage it collects from the neighbouring vertebrae, and is connected by several anastomoses to the two internal iliac veins lateral to it.

The superior gluteal vein (Figs. 10 & 13) collects from the gluteus muscles before entering the pelvic cavity. It joins the internal iliac slightly behind the point where the inferior vesical vein enters the former. The variation of this junction in mammals is similar to those of the corresponding artery.

The inferior gluteal vein (Figs. 10 & 13) drains the gluteus, semitendinosus, semimembranosus and becips femoris muscles, before it passes into the pelvic cavity. It proceeds anterolaterally and before joining the internal iliac some distance behind the junction of the superior gluteal vein, it receives a tributary the lateral sacral vein (V. SAC. LAT.; Figs. 10 & 13). The latter vessel drains the prostate in the male and the vagina in the female.

The femoral vein (Figs. 1, 2, 9, 10, 11, 12, 13 & 14) is the continuation of the popliteal vein (V. POP.) of which details are not given in this paper. It becomes superficial between the internal vastus and adductor muscles. Remaining in this position it ascends alongside the corresponding artery and leaves the thigh by penetrating the abdominal wall. Beyond this point it is known as the external iliac vein.

Near the point where the femoral enters the abdominal wall its main tributary the profunda femoris (V. PROF. FEM.; Figs. 11 & 14) joins it. The latter collects from the biceps femoris, semitendinosus, semimembranosus, adductor, pectineus and gracilis muscles, before passing upwards to join the femoral vein.

The profunda femoris receives two tributaries, the obturator (V. OB.) and the internal pudendal (V. PUD. INT.).
The obturator vein (Figs. 11 & 14) receives twigs from the ramus of the pubis, medially to the obturator foramen (FOR. OB.) and from the deeper muscles of the pelvis. After collecting from the biceps femoris and obturator muscles, it enters the pelvic cavity through the obturator foramen and runs upwards with the artery to join the profunda femoris dorsally to the pectineus muscle.

In one female specimen (not figured) the right obturator vein joins the external iliac, whereas in one male specimen (not figured) the right obturator joins the pudic-epigastric vein. The variations in the junction of the obturator vein in mammals correspond to those of the obturator artery.

The internal pudendal vein (Figs. 9, 11, 12 & 14) collects from the sex organs. In the male (Figs. 9 & 11) it originates as the vein of the penis (V. PEN.). It drains the dorsal as well as the deeper region of this organ. At the base of the penis the vein of the penis anastomoses with the corresponding vessel of the opposite side (AN. e; Fig. 9). Laterally to the penis a tributary from the bulbocavernosus, ischiocavernosus, semimembranosus and bulbo-urethral gland unites with the vein of the penis, to form the internal pudendal vein. The latter runs anterolaterally and dorsally to the adductor to join the profunda femoris vein.

In the female the internal pudendal (Figs. 12 & 14) is formed by two major vessels. The medial tributary drains the clitoris as the vein of the clitoris (V. CLIT.). It also collects from the posterior region of the urethra. The lateral tributary collects from the semimembranosus and perineal gland (PER. GL.). At the base of the clitoris there is an anastomosis between the left and right veins of the clitoris (AN. g; Fig. 12).

In certain other mammals like the rat (Greene, 1935; Ulmer, Haupt & Hicks, 1962), the rabbit (Grobbelaar, 1952), the horse (Bradley, 1896; Schmaltz, 1919) and the pig and the dog (Bradley, 1896) the internal pudendal joins the internal iliac.

In addition to the profunda femoris three minor tributaries, the lateral femoral circumflex (V. CIR. FEM. LAT.; Figs. 1, 2, 9, 10, 11 & 14), the medial femoral circumflex (V. CIR. FEM. MED.; Figs. 11 & 14) and the muscular (V. MUSC.; Figs. 11 & 14) join the femoral vein. These vessels collect from the superficial as well as from the deeper muscles of the medial surface of the thigh.

DISCUSSION AND SUMMARY

The vascular system of Hyracoidea shows differences within the species as well as differences from other mammals.

The vascular arrangement of the testes in mammals, especially the arterial system, varies considerably. In some animals where the testes are situated extra-abdominally, the testicular artery encircles the gland before supplying it, while in others it convolutes in the cord before reaching the testes. In another group where the testes have an intra-abdominal position the artery concerned immediately passes into the substance of the gland (Harrison, 1948). Hyracoidea also belongs to the latter group. The testicular artery runs almost straight from the renal artery to the medial surface of the gland. After giving off a few branches it immediately enters the substance of the gland.

The unusual length of the testicular artery in relation to other arteries in most mammals is a striking characteristic. Schweizer (1929) suggested that this unusual length of the testicular artery, slows the blood flow to the testes and according to Harrison and Weiner (1949) this device gives the arterial blood more time and surface for cooling.

The shorter the testicular artery the smaller the gradient tends to be between the testes and abdominal cavity. This is the position with Hyracoidea and apparently spermatogenesis is adapted here to higher environmental temperature.

The venous drainage of the testes shows more uniformity (Harrison, 1948). Vessels, collecting from all over the gland, join at the antero-medial side of the testes. It forms a pampiniform plexus which passes up the spermatic cord. This is the case in mammals where the testes are situated extra-abdominally. In the pampiniform venous plexus, the vein is in close contact with the artery which causes pre-cooling of the artery and pre-heating of the vein (Harrison and Weiner, 1949).

Owing to the intra-abdominal position of the testes in Hyracoidea, the pampiniform plexus is absent. Three major tributaries collect from the ventral surface of the testes, the epididymis, ductus deferens and fatty tissue around the testes. These tributaries join antero-medially of the testes to form the testicular vein.

REFERENCES

BENSLEY, B. A.
1926 *Practical Anatomy of the Rabbit.* P. Blakiston's Son & Co., Philadelphia.

BRADLEY, O. C.
1896 *Outlines of Veterinary Anatomy.* Part I. Bailliére Tindall and Cox, London.

COWLES, R. B.
1958 The evolutionary significance of the scrotum. *Evolution,* **12**: 417—418.

GEORGE, M.
1874 Monographie anatomique des Mammifères du genre Daman. *Ann. Sc. Nat. Zool.,* 6e sér., **1**: 1—260.

GRAY, H.
1932 *Anatomy descriptive and applied.* Longmans, Green & Co., London.

GREENE, E. C.
1935 *Anatomy of the Rat.* The American Philosophical Society, Philadelphia.

GROBBELAAR, C. S.
1952 *Die Ontleding van die Konyn.* Universiteits-Uitgewers en Boekhandelaars (Edms.) Bpk., Stellenbosch.

HARRISON, R. G.
1948 The comparative anatomy of the bloodsupply of the mammalian testis. *Proc. zool. Soc. Lond.,* **119**: 325—344.

HARRISON, R. G. & WEINER, J. S.
1949 Vascular Patterns of the Mammalian Testis and their Functional Significance.*J. exp. Biol.,* **26**: 304.

LOUW, E.
1969 A preliminary study of renal function and thermoregulation in the dassie, *Procavia capensis. M.Sc. thesis, University of Stellenbosch.*

MIVART, St. G.
1881 *The Cat.* John Murray, London.

ROWETT, H. G. Q.
1962 *Guide to Dissection.* John Murray, London.

SALE, J. B.
1965 The feeding behaviour of rock hyraces (genera *Procavia* and *Heterohyrax*) in Kenya. *E. Afr. Wildl. J.* 3: 1—18.

SALE, J. B. (in press)
The behaviour of the resting rock hyrax in relation to its environment. *Zool. Afr.*

SCHMALTZ, R.
1919 *Anatomie des Pferdes.* Verlagsbuchhandlung von Richard Schoetz, Wilhelmstrasse 10, Berlin.

SCHWEIZER, R.
1929 Über die Bedeutung der Vascularisation, des Binnendruckes und der Zwischenzellen für die Biologie des Hodens. *Z. Anat. Entwgesch.,* **89**: 775—796.

ULMER, M. J., HAUPT, R. E. & HICKS, E. A.
1962 *Comparative Chordate Anatomy.* Harper & Brothers, New York.

WHITEHOUSE, R. H. & GROVE, A. J.
1933 *The Dissection of the Rabbit.* Universal Tutorial Press Ltd., London.

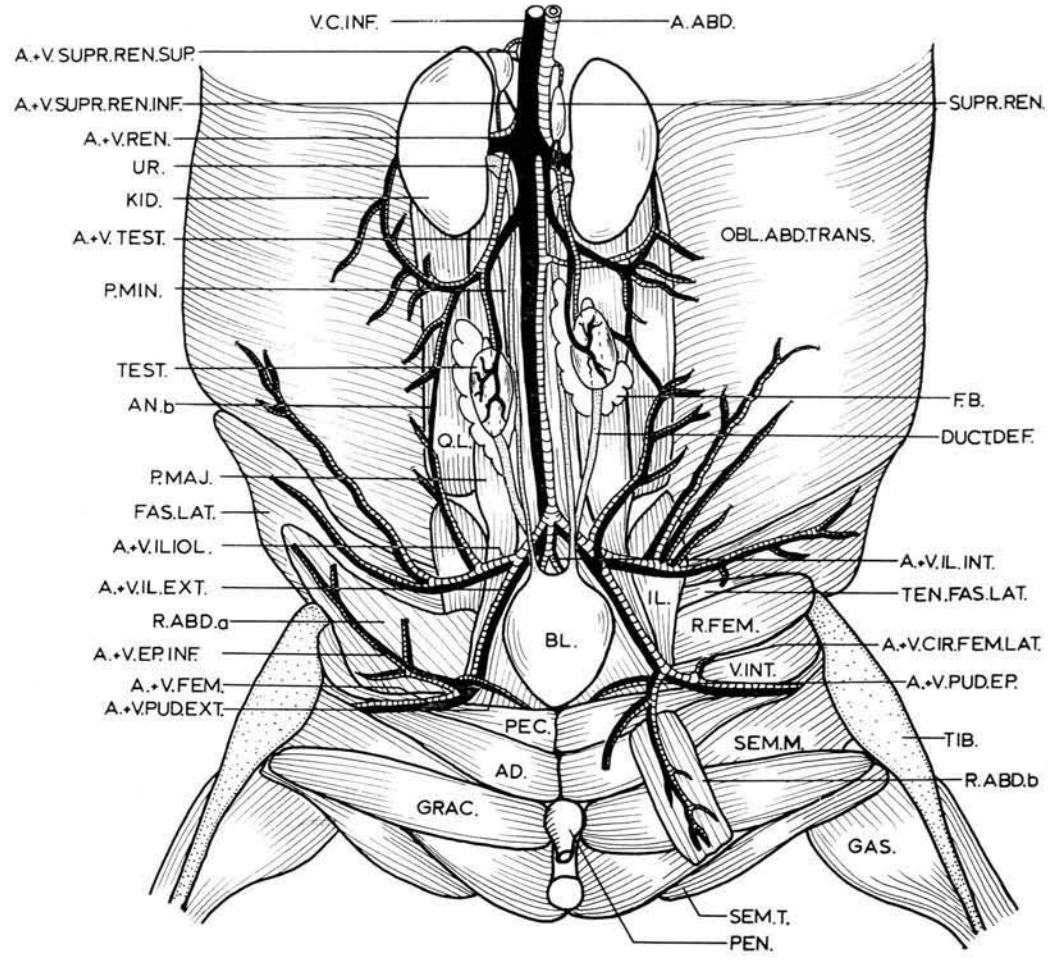

Figure 1. Branches of the abdominal aorta and tributaries of the posterior caval vein in the male: A. ABD., aorta abdominalis; AD., m. adductor; AN. b, anastomosis between medial tributary of vena iliolumbalis and vena testicularis; A. + V. CIR. FEM. LAT., arteria and vena circumflexa femoris lateralis; A. + V. EP. INF., arteria and vena epigastrica inferior; A. + V. FEM., arteria and vena femoralis; A. + V. IL. EXT., arteria and vena iliaca externa; A. + V. IL. INT., arteria and vena iliaca interna; A. + V. ILIOL., arteria and vena iliolumbalis; A. + V. PUD. EP., arteria and vena pudica-epigastrica; A. + V. PUD. EXT., arteria and vena pudenda externa; A. + V. REN., arteria and vena renalis; A. + V. SUPR. REN. INF., arteria and vena suprarenalis inferior; A. + V. SUPR. REN. SUP., arteria and vena suprarenalis superior; A. + V. TEST., arteria and vena testicularis; BL., bladder; DUCT. DEF., ductus deferens; FAS. LAT., fascia lata; F.B., fatty body; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; KID., kidney; OBL. ABD. TRANS., m. obliquus abdominis transversus; PEC., m. pectineus; PEN., penis; P. MAJ., m. psoas major; P. MIN., m. psoas minor; Q.L., m. quadratus lumborum; R. ABD. a, m. rectus abdominis, posterior part reflected sideways; R. ABD. b, m. rectus abdominis, posterior part reflected backwards; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; SUPR. REN., suprarenal; TEN. FAS. LAT., m. tensor fascia lata; TEST., testis; TIB., tibia; UR., ureter; V.C. INF., vena cava inferior; V. INT., m. vastus internus.

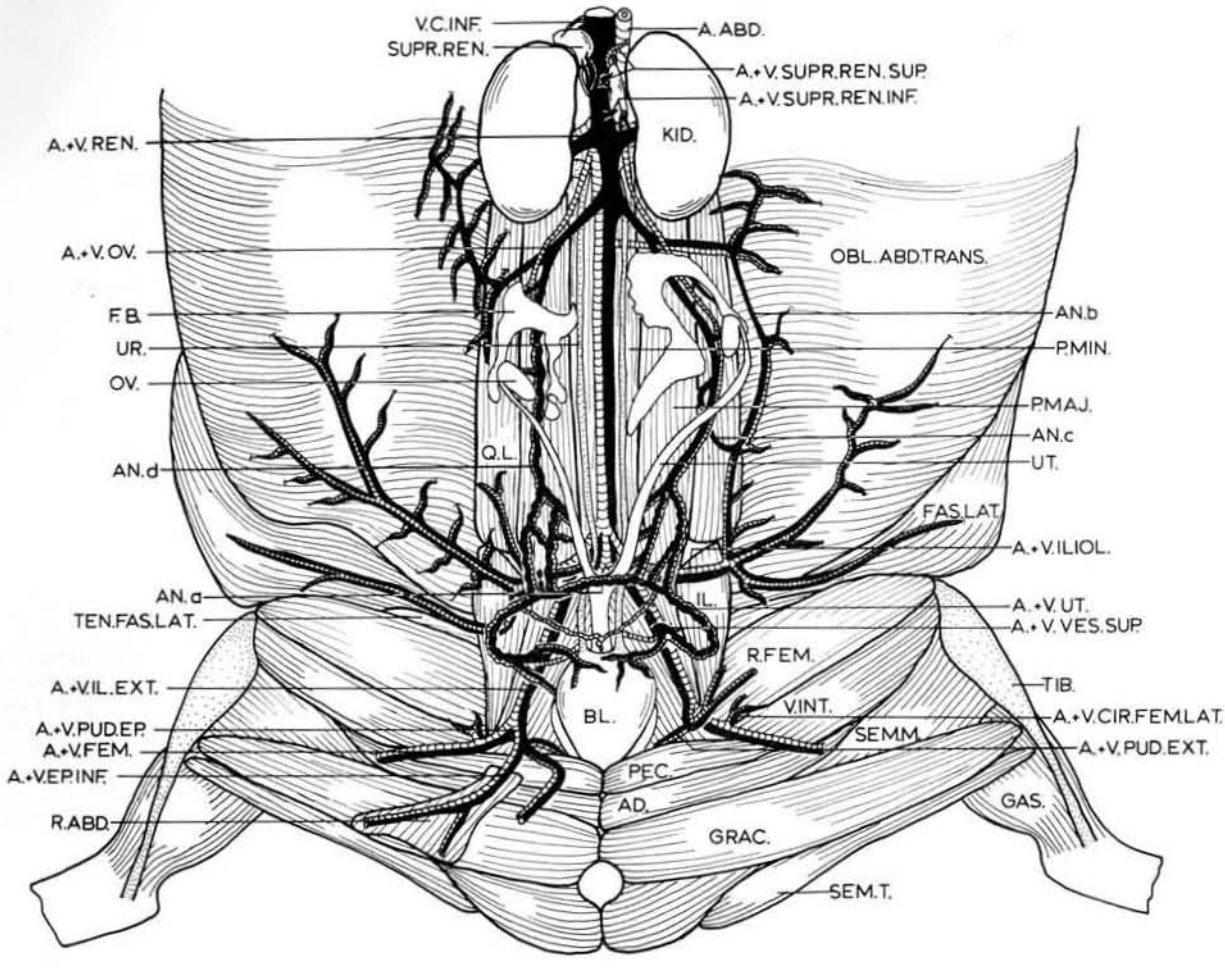

Figure 2. Branches of the abdominal aorta and tributaries of the posterior caval vein in the female: A. ABD., aorta abdominalis; AD., m. adductor; AN. a, anastomosis between left and right venae and arteriae uterinae; AN. b, anastomosis between the lateral tributary of the vena ovarica and the medial tributary of the vena iliolumbalis; AN. c, anastomosis between the vena ovarica and the medial branch of the vena iliolumbalis; AN. d, anastomosis between vena and arteria ovarica and uterine plexus; A. + V. CIR. FEM. LAT., arteria and vena circumflexa femoris lateralis; A. + V. EP. INF., arteria and vena epigastrica inferior; A. + V. FEM., arteria and vena femoralis; A. + V. IL. EXT., arteria and vena iliaca externa; A. + V. ILIOL., arteria and vena iliolumbalis; A. + V. OV., arteria and vena ovarica; A. + V. PUD. EP., arteria and vena pudica-epigastrica; A. + V. PUD. EXT., arteria and vena pudenda externa; A. + V. REN., arteria and vena renalis; A. + V. SUPR. REN. INF., arteria and vena suprarenalis inferior; A. + V. SUPR. REN. SUP., arteria and vena suprarenalis superior; A. + V. UT., arteria and vena uterina; A. + V. VES. SUP., arteria and vena vesicalis superior; BL., bladder; FAS. LAT., fascia lata; F.B. fatty body; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; KID., kidney; OBL. ABD. TRANS., m. obliquus abdominis transversus; OV., ovarium; PEC., m. pectineus; P. MAJ., m. psoas major; P. MIN., m. psoas minor; Q.L., m. quadratus lumborum; R. ABD., part of m. rectus abdominis deflected backwards; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; SUPR. REN., suprarenal; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; UT., uterus; V.C. INF., vena cava inferior; V. INT., m. vastus internus.

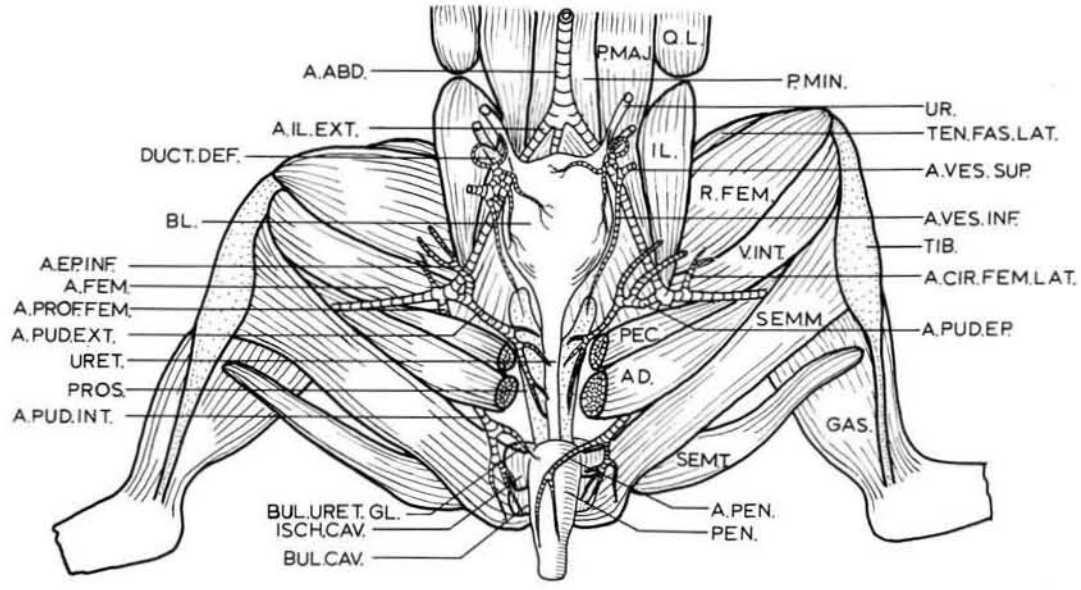

Figure 3. Branches of the external iliac in the male: A. ABD., aorta abdominalis; A. CIR. FEM. LAT., arteria circumflexa femoris lateralis; AD., musculus adductor: A. EP. INF., a. epigastrica inferior; A. FEM., a. femoralis; A. IL. EXT., a. iliaca externa; A. PEN., artery of the penis; A. PROF. FEM., a. profunda femoris; A. PUD. EP., a. pudica-epigastrica; A. PUD. EXT., a. pudenda externa; A. PUD. INT., a. pudenda interna; A. VES. INF., a. vesicalis inferior; A. VES. SUP., a. vesicalis superior; BL., bladder; BUL. CAV., m. bulbocavernosus; BUL. URET. GL., glandula bulbourethralis; DUCT. DEF., ductus deferens; GAS., m. gastrocnemius; IL., m. iliacus; ISCH. CAV., m. ischiocavernosus; PEC., m. pectineus; PEN., penis; P. MAJ., m. psoas major; P. MIN., m. psoas minor; PROS., prostate; Q.L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; URET; urethra; V. INT., m. vastus internus.

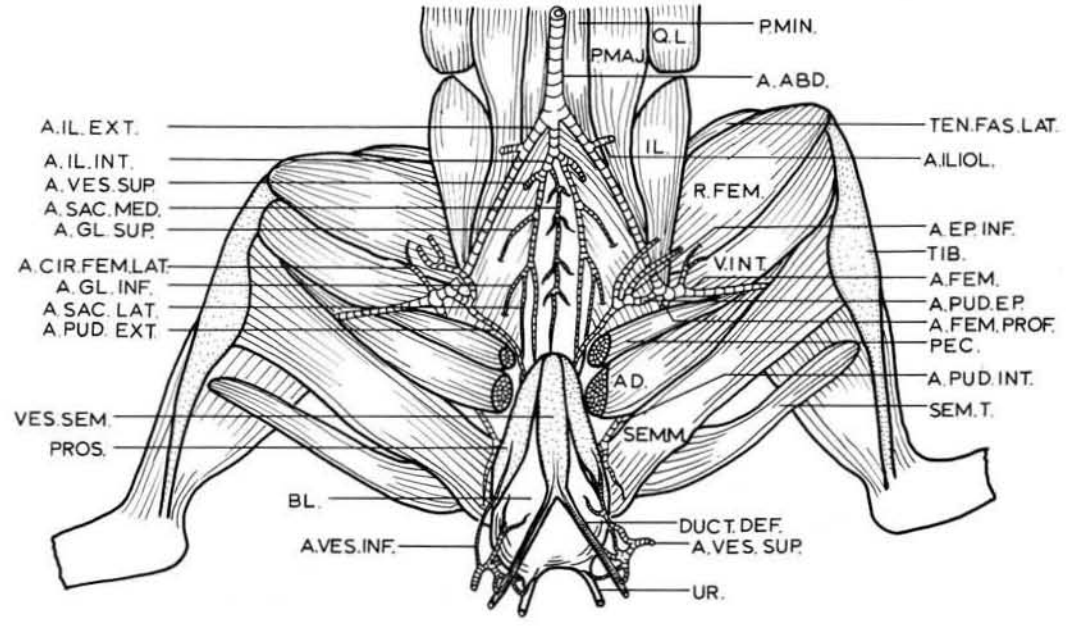

Figure 4. Arteries of the male pelvis: A. ABD., aorta abdominalis; A. CIR. FEM. LAT., arteria circumflexa femoris lateralis; AD., musculus adductor; A. EP. INF., a. epigastrica inferior; A. FEM., a. femoralis; A. GL. INF., a. glutealis inferior; A. GL. SUP., a. glutealis superior; A. IL. EXT., a. iliaca externa; A. IL. INT., a. iliaca interna; A. ILIOL., a. iliolumbalis; A. PROF. FEM., a. profunda femoris; A. PUD. EP., a. pudica-epigastrica; A. PUD. EXT., a. pudenda externa; A. PUD. INT., a. pudenda interna; A. SAC. LAT., a. sacralis lateralis; A. SAC. MED., a. sacralis medialis; A. VES. INF., a. vesicalis inferior; A. VES. SUP., a. vesicalis superior; BL., bladder; DUCT. DEF., ductus deferens; IL., m. iliacus; PEC., m. pectineus; P. MAJ., m. psoas major; P. MIN., m. psoas minor; PROS., prostate; Q. L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; VES. SEM., vesicula seminalis; V. INT., m. vastus internus.

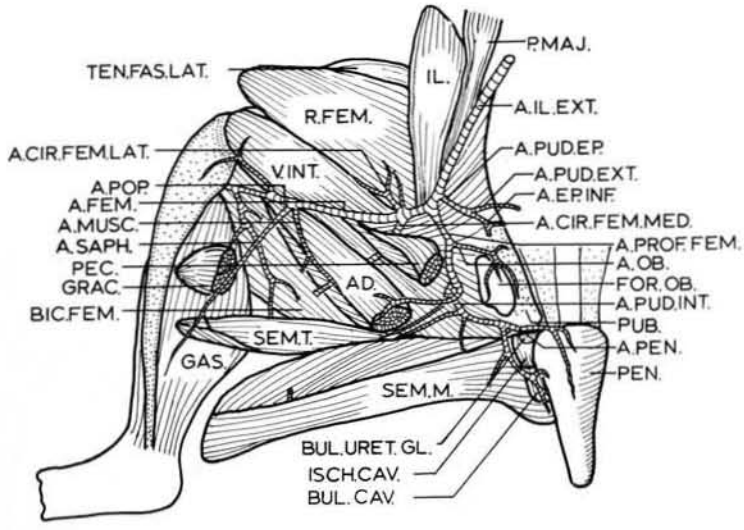

Figure 5. Branches of the femoral artery in the male: A. CIR. FEM. LAT., arteria circumflexa femoris lateralis; A. CIR. FEM. MED., a. circumflexa femoris medialis; AD., musculus adductor; A. EP. INF., a. epigastrica inferior; A. FEM., a. femoralis; A. IL. EXT., a. iliaca externa; A. MUSC., a. muscularis; A. OB., a. obturator; A. PEN., artery of the penis; A. POP., a. poplitea; A. PROF. FEM., a. profunda femoris; A. PUD. EP., a. pudica-epigastrica; A. PUD. EXT., a. pudenda externa; A. PUD. INT., a. pudenda interna; A. SAPH., a. saphenious; BIC. FEM., m. biceps femoris; BUL. CAV., m. bulbocavernosus; BUL. URET. GL., glandula bulbourethralis; FOR. OB., foramen obturatum; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; ISCH. CAV., m. ischiocavernosus; PEC., m. pectineus; PEN., penis; P. MAJ., m. psoas major; PUB., pubis; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; V. INT., m. vastus internus.

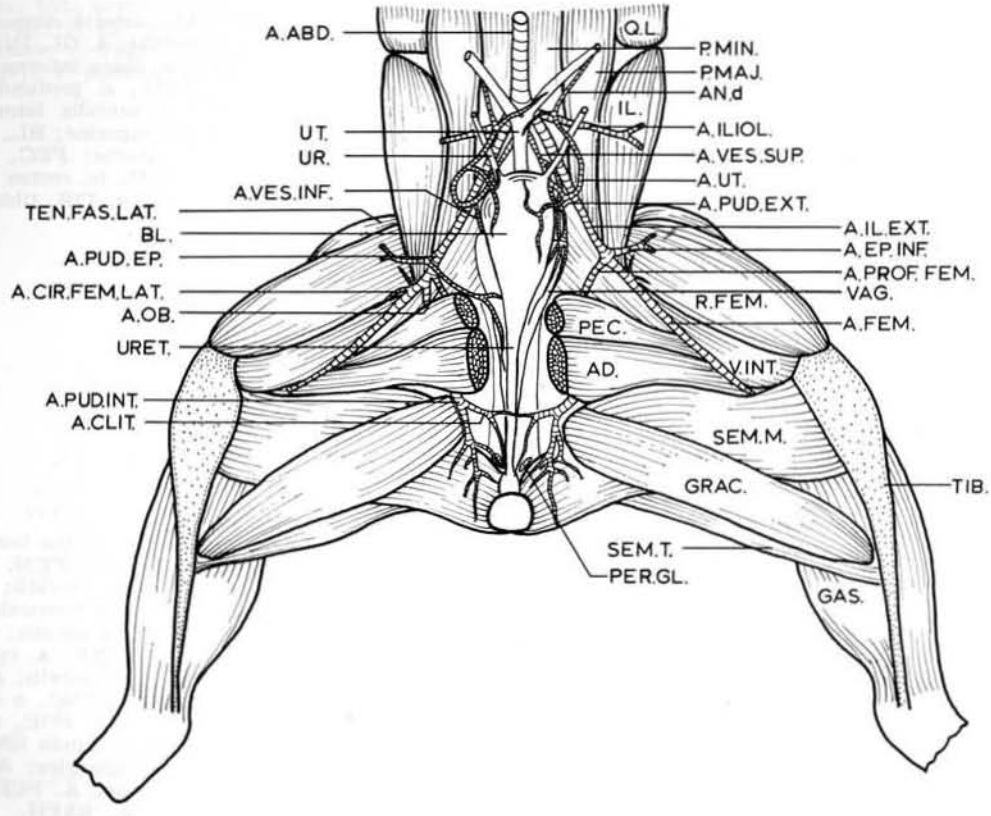

Figure 6. Branches of the external iliac artery in the female: A. ABD., aorta abdominalis; A. CLIT., artery of the clitoris; A. CIR. FEM. LAT., a. circumflexa femoris lateralis; AD., musculus adductor; A. EP. INF., a. epigastrica inferior; A. FEM., a. femoralis; A. IL. EXT., a. iliaca externa; A. ILIOL., a. iliolumbalis; AN. d. anastomosis between a. ovarica and uterine plexus; A. OB., a. obturator; A. PROF. FEM., a. profunda femoris; A. PUD. EP., a. pudica-epigastrica; A. PUD. EXT., a. pudenda externa; A. PUD. INT., a. pudenda interna; A. UT., a. uterina; A. VES. INF., a. vesicalis inferior; A. VES. SUP., a. vesicalis superior; BL., bladder; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; PEC., m. pectineus; PER. GL., glandula perinealis; P. MAJ., m. psoas major; P. MIN., m. psoas minor; Q.L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; URET., urethra; UT., uterus; VAG., vagina; V. INT., m. vastus internus.

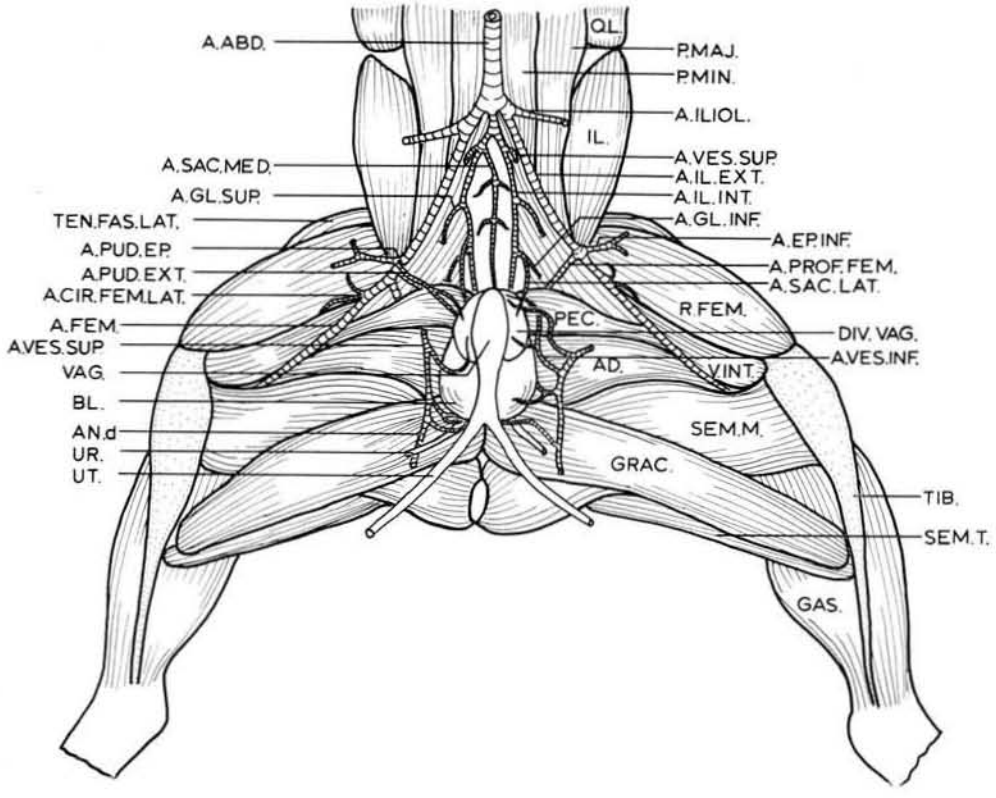

Figure 7. Arteries of the female pelvis: A. ABD., aorta abdominalis; A. CIR. FEM. LAT., arteria circumflexa femoris lateralis; AD., musculus adductor; A. EP. INF., a. epigastrica inferior; A. FEM., a. femoralis; A. GL. INF., a. glutealis inferior; A. GL. SUP., a. glutealis superior; A. IL. EXT., a. iliaca externa; A. IL. INT., a. iliaca interna; A. ILIOL., a. iliolumbalis; AN. d., anastomosis between a. ovarica and uterine plexus; A. PROF. FEM., a. profunda femoris; A. PUD. EP., a. pudica-epigastrica; A. PUD. EXT., a. pudenda externa; A. SAC. LAT., a. sacralis lateralis; A. SAC. MED., a. sacralis medialis; A. VES. INF., a. vesicalis inferior; A. VES. SUP., a. vesicalis superior; BL., bladder; DIV. VAG., diverticula of the vagina; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; PEC., m. pectineus; P. MAJ., m. psoas major; P. MIN., m. psoas minor; Q.L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; UT., uterus; VAG., vagina; V. INT., m. vastus internus.

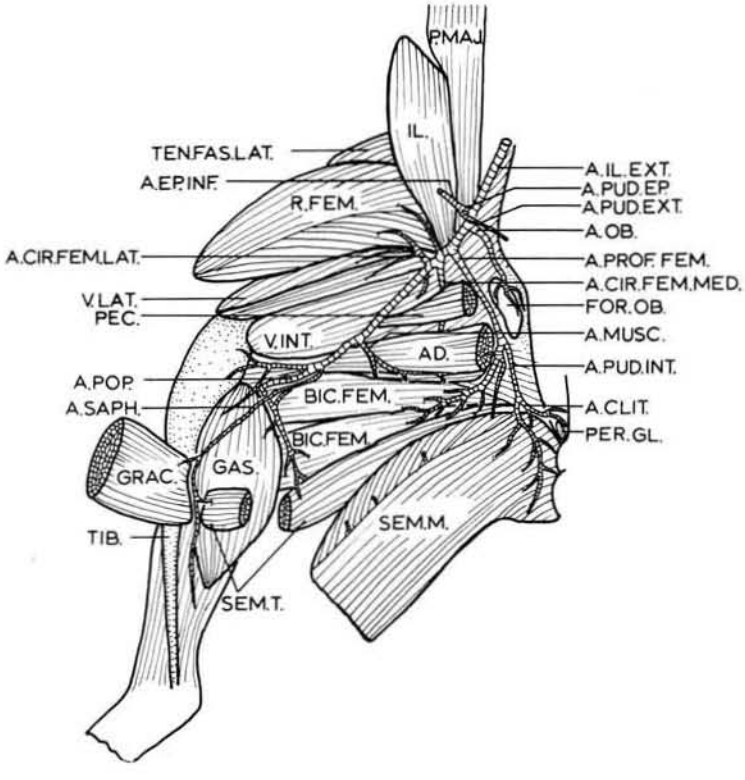

Figure 8. Branches of the femoral artery in the female: A. CIR. FEM. LAT., arteria circumflexa femoris lateralis; A. CIR. FEM. MED., a circumflexa femoralis medialis; A. CLIT., artery of the clitoris; AD., musculus adductor; A. EP. INF., a. epigastrica inferior; A. FEM., a. femoralis; A. IL. EXT., a. iliaca externa; A. MUSC., a muscularis; A. OB., a. obturator; A. POP., a. poplitea; A. PROF. FEM., a. profunda femoris; A. PUD. EP., a. pudica-epigastrica; A. PUD. EXT., a. pudenda externa; A. PUD. INT., a pudenda interna; A. SAPH., a saphenious; BIC. FEM., m. biceps femoris; FOR. OB., foramen obturatum; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; PEC., m. pectineus; PER. GL., glandula perinealis; P. MAJ., m. psoas major; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; V. INT., m. vastus internus; V. LAT., m. vastus lateralis.

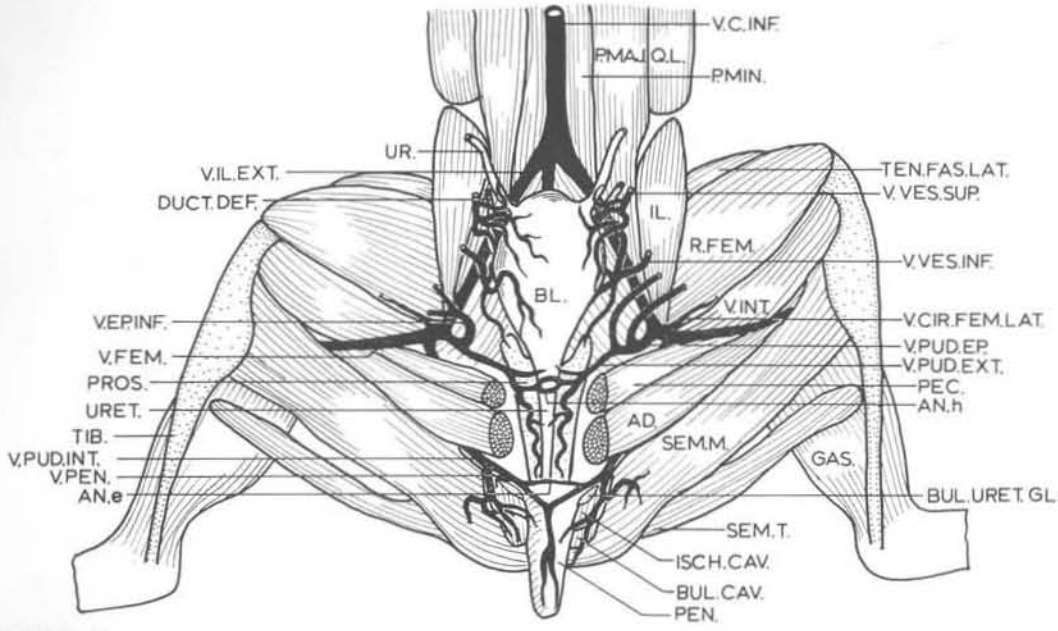

Figure 9. Tributaries of the external iliac vein in the male: AD., musculus adductor; AN. e., anastomosis between left and right venae pudenda internae in the male; AN. h., anastomosis between left and right venae pudenda externae in the male; BL., bladder; BUL. CAV., m. bulbocavernosus; BUL. URET. GL., glandula bulbourethralis; DUCT. DEF., ductus deferens; GAS., m. gastrocnemius; IL., m. iliacus; ISCH. CAV., ischiocavernosus; PEC., m. pectineus; PEN., penis; P. MAJ., m. psoas major; P. MIN., m. psoas minor; PROS., prostate; Q.L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; URET., urethra; V. CIR. FEM. LAT., vena circumflexa femoris lateralis; V. C. INF., vena cava inferior; V. EP. INF., v. epigastrica inferior; V. FEM., v. femoralis; V. IL. EXT., v. iliaca externa; V. INT., m. vastus internus; V. PEN., vein of the penis; V. PUD. EP., v. pudica-epigastrica; V. PUD. EXT., v. pudenda externa; V. PUD. INT., v. pudenda interna; V. VES. INF., v. vesicalis inferior; V. VES. SUP., v. vesicalis superior.

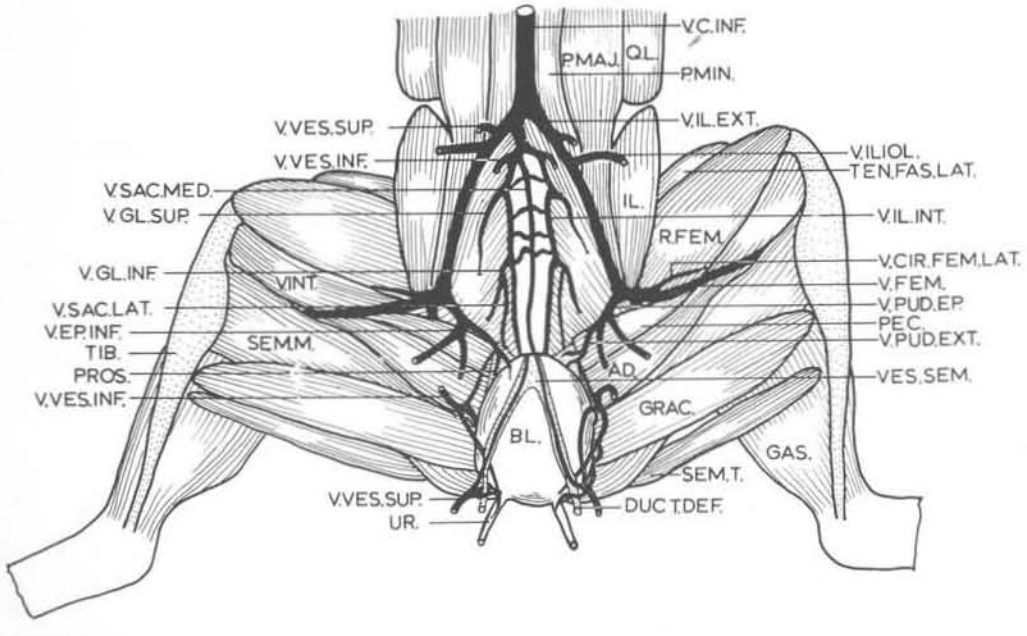

Figure 10. Veins of the male pelvis: AD., musculus adductor; BL., bladder; DUCT. DEF., ductus deferens; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; PEC., m. pectineus; P. MAJ., m. psoas major; P. MIN., m. psoas minor; PROS., prostate; Q.L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; V. CIR. FEM. LAT., vena circumflexa femoris lateralis; V. C. INF., vena cava inferior; V. EP. INF., v. epigastrica inferior; V. FEM., v. femoralis; V. GL. INF., v. glutealis inferior; V. GL. SUP., v. glutealis superior; V. IL. EXT., v. iliaca externa; V. IL. INT., v. iliaca interna; V. ILIOL., v. iliolumbalis; V. INT., m. vastus internus; V. PUD. EP., v. pudica-eqigastrica; V. PUD. EXT., v. pudenda externa; V. SAC. LAT., v. sacralis lateralis; V. SAC. MED., v. sacralis medialis; VES.SEM., vesicula seminalis; V. VES. INF., v. vescalis inferior; V. VES. SUP., v. vesicalis superior.

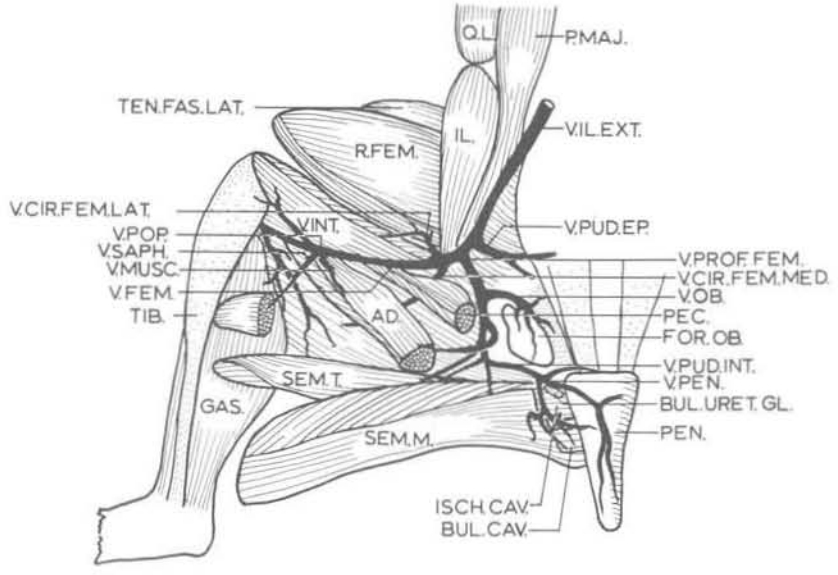

Figure 11. Tributaries of the femoral vein in the male: AD., musculus adductor; BUL. CAV., m. bulbocavernosu BUL. URET. GL., glandula bulbourethralis; FOR. OB., foramen obturatum; GAS., m. gastrocnemius; IL., m. iliacu ISCH. CAV., m. ischiocavernosus; PEC., m. pectineus; PEN., penis; P. MAJ., m. psoas major; Q. L., m. quadrat lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FA LAT., m. tensor fascia lata; TIB., tibia; V. CIR. FEM. LAT., vena circumflexa femoris lateralis; V. CIR. FEM. ME v. circumflexa femoris medialis; V. FEM., v. femoralis; V. IL. EXT., v. iliaca externa; V. INT., m. vastus intern V. MUSC., v. muscularis; V. OB., v. obturator; V. PEN., vein of the penis; V. POP., v. poplitea; V. PROF. FEM., profunda femoris; V. PUD. EP., v. pudica-epigastrica; V. PUD. INT., v. pudenda interna; V. SAPH., v. saphenious.

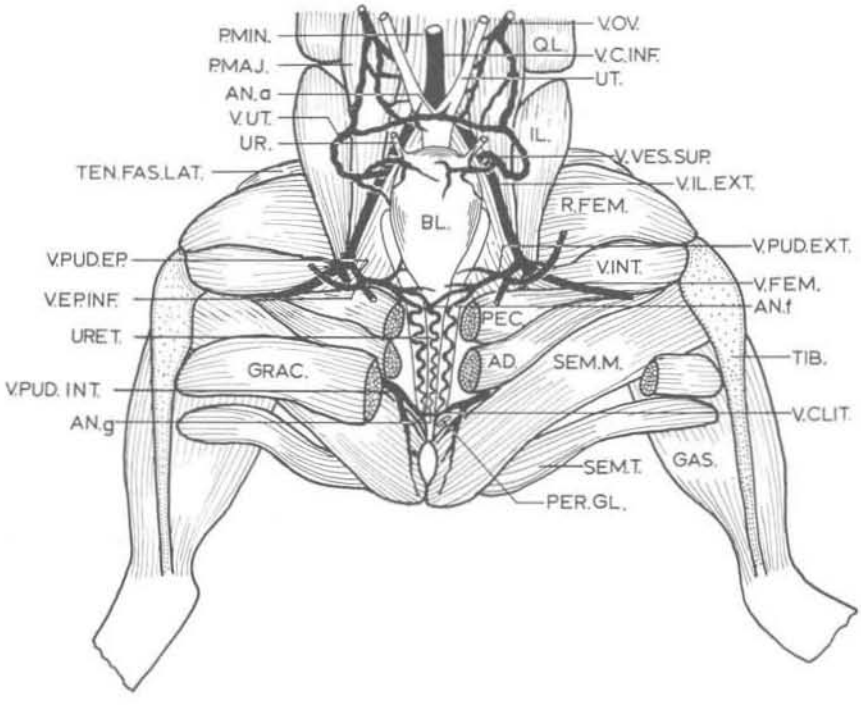

Figure 12. Tributaries of the external iliac in the female: AD., musculus adductor; AN. a., anastomosis between l and right venae uterinae; AN. f., anastomosis between left and right venae pudenda externae in the female; AN. anastomosis between left and right venae pudenda in the female; BL., bladder; GAS., m. gastrocnemius; GRAC., gracilis; IL., m. iliacus; PEC., m. pectineus; PER. GL., glandula perinealis; P. MAJ., m. psoas major; P. MIN., psoas minor; Q. L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; URET., urethra; UT., uterus; V. INF., vena cava inferior; V. CLIT., vein of the clitoris; V. EP. INF., v. epigastrica inferior; V. FEM., v. femoral V. IL. EXT., v. iliaca externa; V. INT., m. vastus internus; V. OV., v. ovarica; V. PUD. EP., v. pudica-epigastrica; PUD. EXT., v. pudenda externa; V. PUD. INT., v. pudenda interna; V. UT., v. uterina; V. VES. SUP., v. vesica superior.

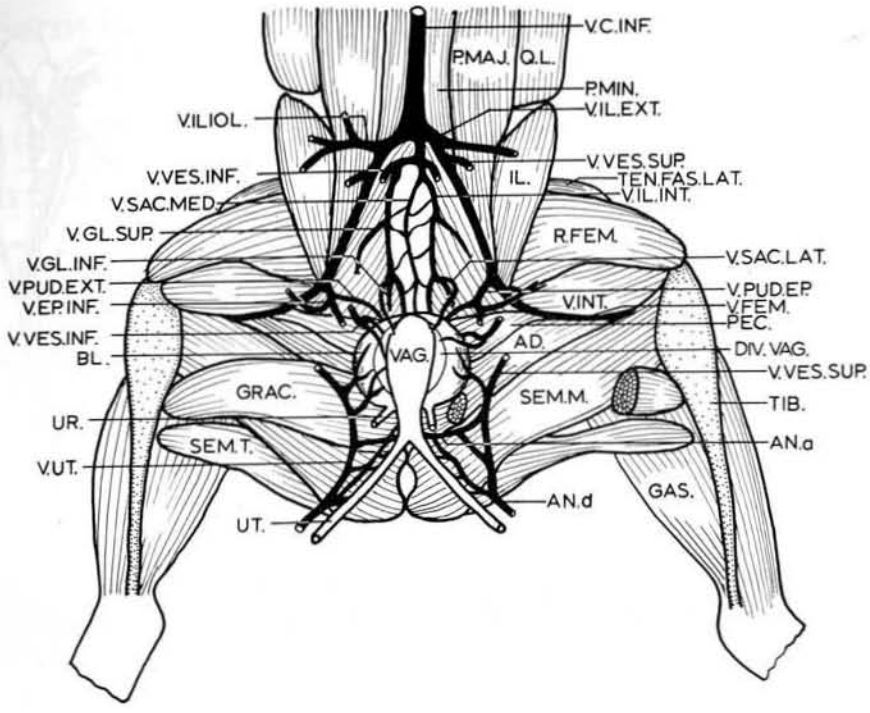

Figure 13. Veins of the female pelvis: AD., musculus adductor; AN., a. anastomosis between left and right venae uterinae; AN. d., anastomosis between v. ovarica and uterine plexus; BL., bladder; DIV. VAG., diverticula of the vagina; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; PEC., m. pectineus; P. MAJ., m. psoas major; P. MIN., m. psoas minor; Q. L., m. quadratus lumborum; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; UR., ureter; UT., uterus; VAG., vagina; V. C. INF., vena cava inferior; V. EP. INF., v. epigastrica inferior; V. FEM., v. femoralis; V. GL. INF., v. glutealis inferior; V. GL. SUP., v. glutealis superior; V. IL. EXT., v. iliaca externa; V. IL. INT., v. iliaca interna; V. ILIOL., v. iliolumbalis; V. INT., m. vastus internus; V. PUD. EP., v. pudica-epigastrica; V. PUD. EXT., v. pudenda externa; V. SAC. LAT., v. sacralis lateralis; V. SAC. MED., v. sacralis medialis; V. UT., v. uterina; V. VES. INF., v. vesicalis inferior; V. VES. SUP., v. vesicalis superior.

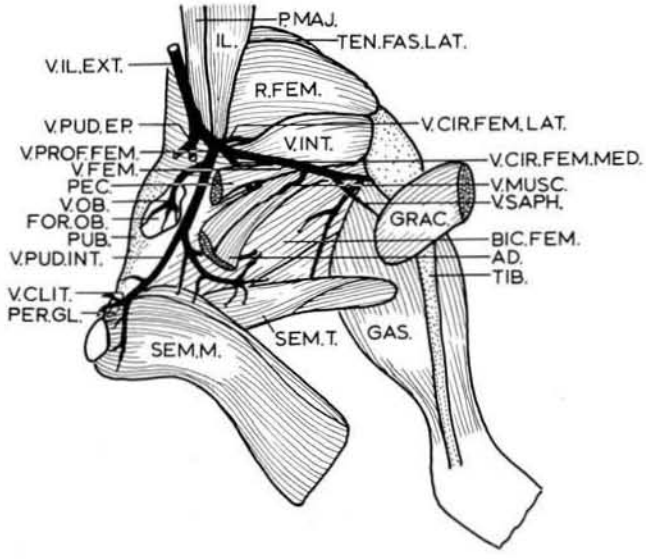

Figure 14. Tributaries of the femoral vein in the female: AD., musculus adductor; BIC. FEM., m. biceps femoris; FOR. OB., foramen obturatum; GAS., m. gastrocnemius; GRAC., m. gracilis; IL., m. iliacus; PEC., m. pectineus; PER. GL., glandula perinealis; P. MAJ., m. psoas major; PUB., pubis; R. FEM., m. rectus femoris; SEM. M., m. semimembranosus; SEM. T., m. semitendinosus; TEN. FAS. LAT., m. tensor fascia lata; TIB., tibia; V. CIR. FEM. LAT., vena circumflexa femoris lateralis; V. CIR. FEM. MED., v. circumflexa femoris medialis; V. CLIT., vein of the clitoris; V. FEM., v. femoralis; V. IL. EXT., v. iliaca externa; V. INT., m. vastus internus; V. MUSC., v. muscularis; V. OB., v. obturator; V. PROF. FEM., v. profunda femoris; V. PUD. EP., v. pudica-epigastrica; V. PUD. INT., v. pudenda interna; V. SAPH., v. saphenious.

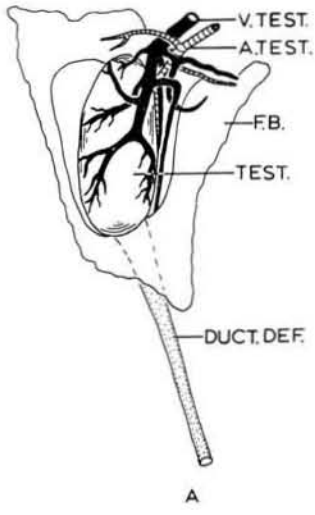

Figure 15A. Arteries and veins of the ventral side of the right testis: A. TEST., arteria testicularis; DUCT. DEF., ductus deferens; F.B., fatty body; TEST., testis; V. TEST., vena testicularis.

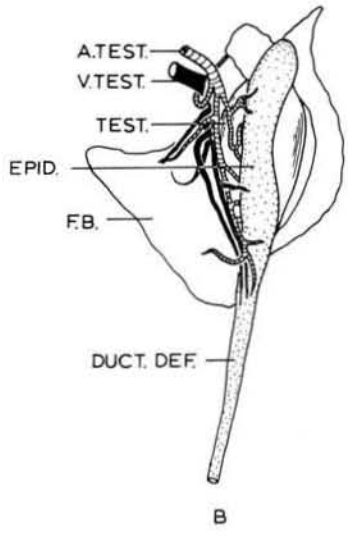

Figure 15B. Arteries and veins of the dorsal side of the right testis: A. TEST., arteria testicularis; DUCT. DEF., ductus deferens; EPID., epididymis; F.B., fatty body; TEST., testis; V. TEST., vena testicularis.

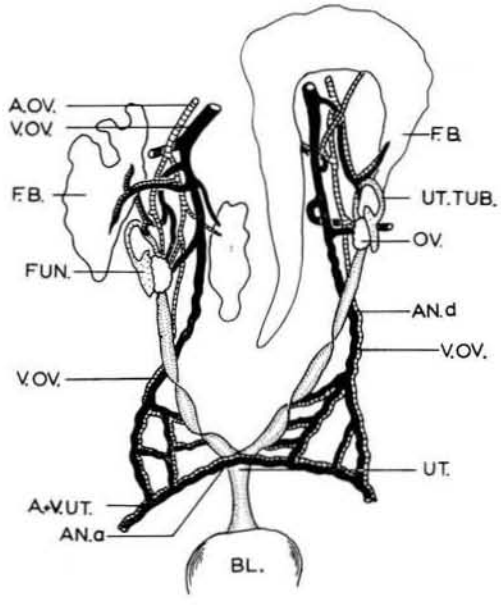

Figure 16. Arterics and veins of the female sex organs in the abdominal cavity: AN. a., anastomosis between left and right venae and arteriae uterinae; AN. d., anastomosis between vena and arteria ovarica and the uterine plexus A. OV., arteria ovarica; A. + V. UT., arteria & vena uterina; BL., bladder; F. B., fatty body; FUN., funnel; OV., ovarium; UT., uterus; UT. TUB., uterine tube; V. OV., vena ovarica.