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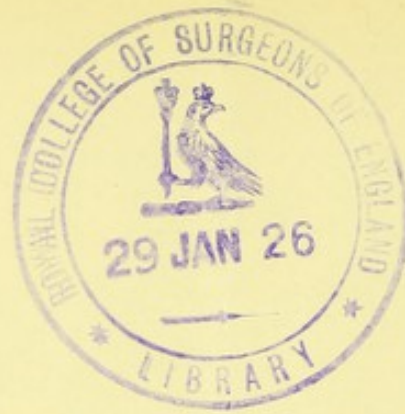






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THE MICROSCOPICAL ANATOMY OF THE GENITAL TRACT
IN THE RAT KANGAROO (FEMALE). By D. BERRY HART,
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Carnegie Research Fellow.*

I MAY briefly state that in this species the female genital tract consists of two ovaries, two tubes, two cornua, and a complicated vaginal tract. This last is made up of two lateral canals, arching up and meeting one another between bladder and cornua, while below they open into the urinogenital sinus. A central vaginal pouch, communicating above with

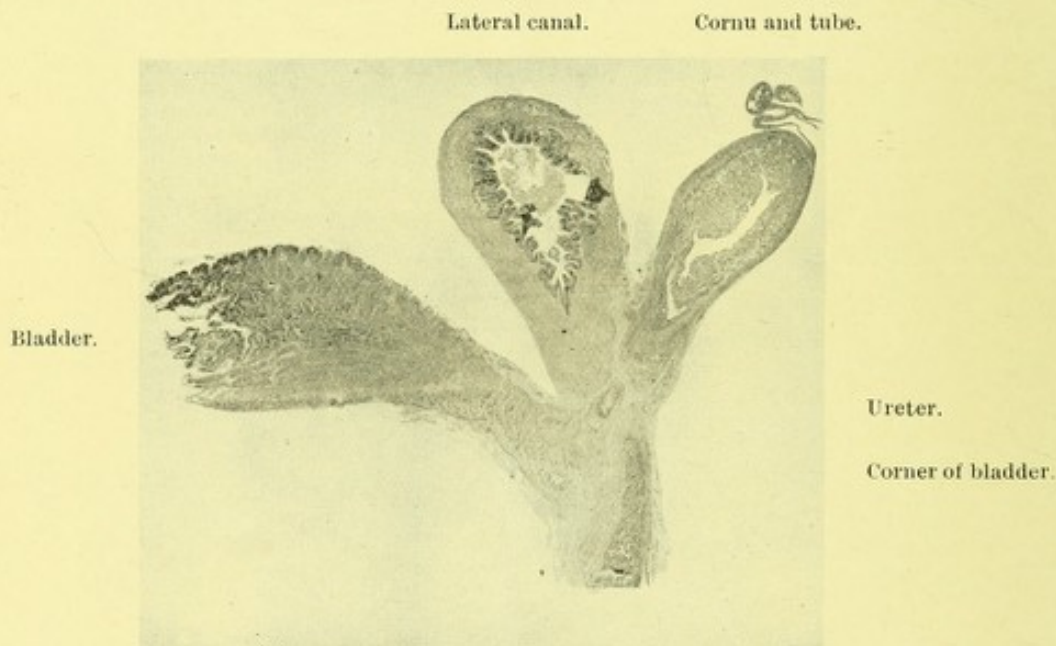


FIG. 1.—Rat kangaroo (female genital tract). $\frac{1}{2}$. Shows ureter and corner of bladder on section, as well as central pouch, cornu, and tube. $\frac{1}{2}$.

the lateral canals, but blind below, lies centrally, and is thus bounded on each side by the lateral canals right and left (see fig. 1).

The morphology of this tract will be best considered afterwards. The microscopical anatomy was investigated on a specimen of the rat kangaroo, and as I obtained it alive I was enabled to preserve the genital organs perfectly. In each organ serial sections were cut with the Cambridge microtome, and the stains used were logwood and eosin. The sections thus obtained amounted to several hundreds.

The Ovary.—With one exception the structure of the ovary closely resembled that of the human female.

The outer surface of the ovary was covered with low columnar epithelium—the germ epithelium—except at the hilum ovarii, where the Fallopian tube was attached by its fimbriated end. Below the germ epithelium is a layer of connective tissue, made up mainly of spindle cells, with their long axes parallel to the long axis of the organ, and forming



FIG. 2. —Tube and ovary, showing duct of Müllerian origin in ovary. $\times 100$.

a distinctly marked-off tunica albuginea. From it passed radiating fibres into the general mass of the ovary.

The general substance of the ovary is made up of connective tissue, Graafian follicles, and corpora lutea cells.

The *general connective tissue* is of a round-celled type, but there were also cells of a more epithelial type adjoining a large corpus luteum.

Graafian Follicles.—These are present in fair amount, but not in the abundance one sees in the rabbit for instance. There is the same grouping as in the human female, of smaller follicles at the periphery, larger ones deeper.

In the larger single Graafian follicles we have externally a well-marked tunic of spindle connective tissue lying between the membrana granulosa inside and the general connective tissue outside.

The membrana granulosa and discus proligerus are well marked and are made up of rounded cells with large, deeply stained nuclei, quite different in appearance from the general connective tissue of the ovary. In the deep layer of the membrana granulosa the cells are distinctly columnar, while above they are rounded. Their appearance is markedly of an epithelial type. Within the discus proligerus lies the ovum, with its zona pellucida, yolk, germinal vesicle, and germinal spot. The Graafian follicles of a medium size all have the same structure practically. The youngest ova are in groups near the surface, have liquor folliculi round them, but no



FIG. 3.—Duct in ovary of Müllerian origin, under higher power. $\times 290$.

membrana granulosa. The tunic is a single layer of spindle-celled connective tissue. Several ova may be enclosed in the one tunic, but one ovum alone is usually present.

A very large and organised corpus luteum is present, with a peculiar structure in connection with it, to be considered now.

Unusual tubular structure in the Ovary.—In the centre of the large corpus luteum and also at its side there is present an arrangement of tubules made up of one branching and larger system, with two to three tubules at the side. This is, of course, as seen on section. The cavities of these are lined with epithelium, but there is no evidence of secretion in the cavity. The wall of this tubular arrangement is made up of connective tissue (spindle-celled) and unstripped muscular fibre embedded in a homogeneous

basis, staining with eosin. All this is surrounded with corpus luteum cells in most of its periphery, and outside the whole is a capsule of unstriped muscle (circular fibres and longitudinal) (figs. 2 and 3). The question has now to be considered as to the nature of this structure. It is impossible to say in this instance whether it is normal or abnormal for this species of animal. Analogous structures have not been described normally in connection with the ovary of any mammal, so far as I am aware.

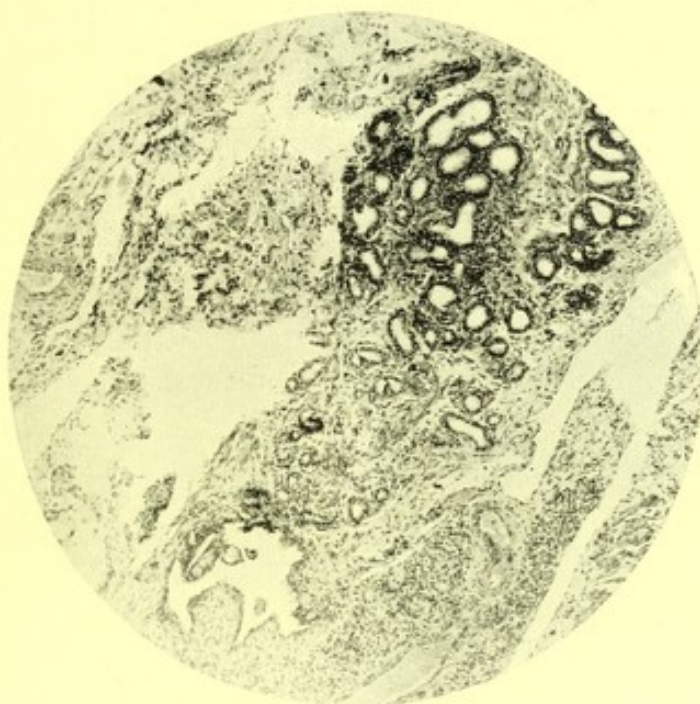


FIG. 4.—Parovarium in broad ligament, with large section of duct of ovary at left lower angle. $\frac{1}{100}$.

The possibilities of its nature are as follows:—

1. *Corpus luteum cyst.*
2. *Papillomatous cyst.*
3. *Wolffian duct.*
4. *Müllerian duct.*

(1 and 2) *Corpus luteum Cyst.*—It is unlikely that this is its nature. It has none of the characteristics of that form of cyst, nor of a papillomatous one, although its relation to the corpus luteum cells is difficult to explain. It is possible, however, that originally a Graafian follicle may have been near the tubules or surrounded by them, had ripened, and thus formed its corpus luteum round them.

(3) At one time I thought the structure was derived from the Wolffian duct, as when traced on serial sections to the broad ligament it came

tudinal (middle), the circular being the thicker. There are also indications of fibres running obliquely.

In the epithelial layer the deep cells stain more markedly, are oval in shape, and have large nuclei. The superficial cells have smaller nuclei and gradually become more squamous in appearance (fig. 6).

In the lumen of the canal (fig. 7) is a considerable amount of cell debris, mainly degenerated shed squamous cells. The whole structure of the lateral canals is characteristically vaginal.

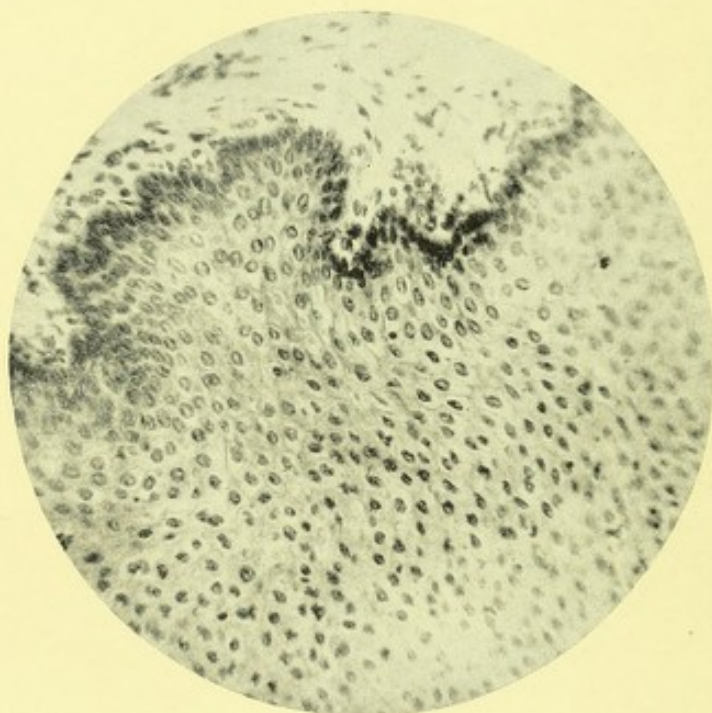


FIG. 6.—Epithelium of lining of lateral canal: the deep layer is upper in the photograph, and the free surface is not shown. $\times 200$.

The *central canal* or *pouch* lies between the lateral canals, and on T.S. of the genital cord we see this very distinctly, the urethra lying in front, and the two lateral canals one on each side of the central one, whose mucous cavity may be described as X-shaped when cut in this direction. It is worthy of note that there is a thin sphincter surrounding these structures (fig. 7).

The "central canal" is lined with single-layered columnar epithelium on papillae of connective tissue, forming in this way wide glandular recesses, with occasional narrow ones, at the sides usually. The epithelial cells are long and somewhat narrow, with marked nuclei. They resemble the cells of the cervical mucous membrane in the human female. Both the connective tissue and muscular coats are only slightly developed, and thus the

epithelial connective tissue and muscular coats are feebly represented as compared with the lateral canals. The muscular coat proper of the central canal surrounds it and the urethra (fig. 7).

The *urethra* is well marked, has a mucous lining of many-layered cells and well-developed connective tissue; muscular coats, longitudinal outer, circular middle, with bundles also in the connective tissue.

In the *external genitals* there was nothing in the microscopical sections

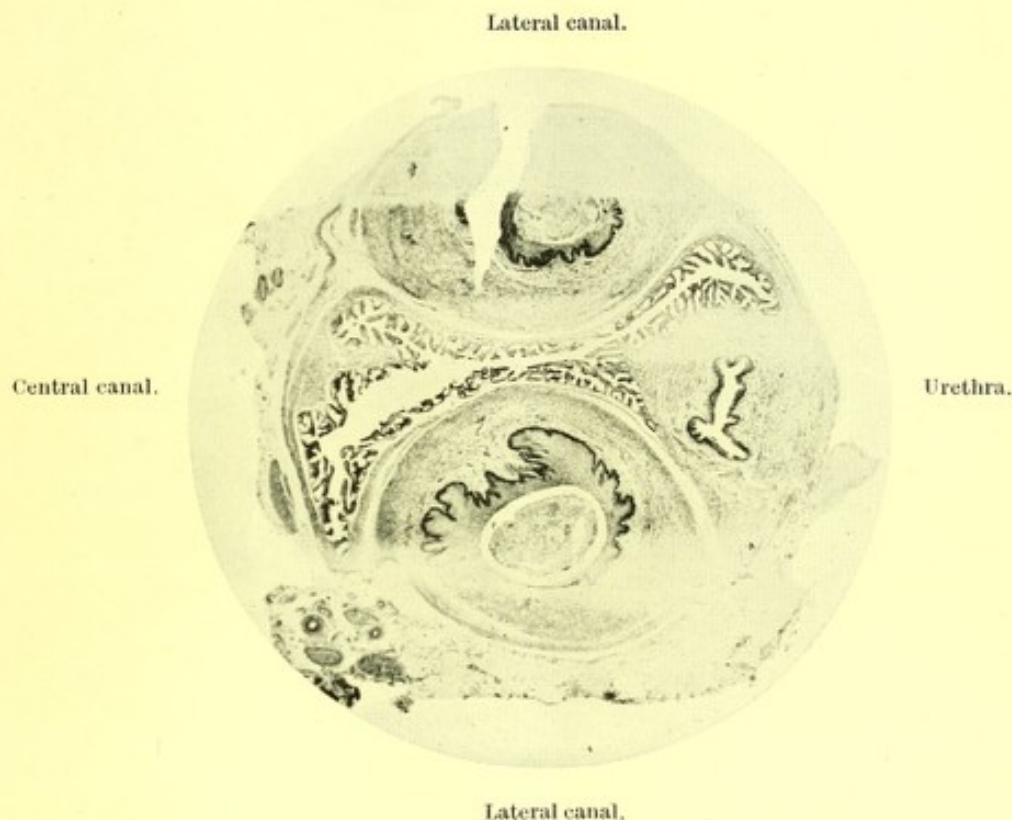


FIG. 7.—Genital cord in rat kangaroo, showing lateral canals, central canal, and urethra. $\frac{1}{10}$.

of any special note. Glandular secreting elements were present, and there was a long tapering clitoris. There were distinct sebaceous glands present, with ducts lined by a single layer of low columnar epithelium.

The genital tract in this animal is bicornuous in its uterine segment, and has the peculiar arrangement in the vaginal segment already described. We are justified in ascribing the bicornuous condition to a non-coalescence of the original Müllerian ducts, the usual developmental explanation applied to the higher mammals. We have a more difficult task in attempting to explain the morphological nature of the vaginal segments.

Nature of the Vaginal Segments.—When the central pouch and lateral canals, all three, communicate with the urinogenital sinus, the arrangement

has been described as a trifid vagina. This, however, does not help us to understand the condition, and does not hold good when, as in the specimens examined, the central vaginal segment is closed below.

The *lateral canals* have an undoubted vaginal structure; their mucous lining is multiple squamous epithelium, like that of the human female vagina, and the main question is whether we are to hold them as derived from the Müllerian ducts or not. We leave this point at present, as it is intimately bound up with the question of the nature of the "central pouch" or "canal."



FIG. 8.—Arrangement of epithelium in central canal. $\times 100$.

In its structure the central canal differs from the lateral canals, as it is lined with columnar epithelium in single layer and has a feebler development of wall. When communicating, as it does in some instances, with the urinogenital sinus below, one is tempted to consider it as almost a prolongation of the cervix.

I have in a previous paper endeavoured to show that the human vagina is not solely derived from the ducts of Müller, but that in its lower one-third it is urinogenital sinus *plus* Wolffian ducts, and that the hymen is a product of the lower ends of the Wolffian ducts. It seems to me more likely that the lateral canals in the kangaroo are really the persistent Wolffian ducts, and that the central canal is vaginal, not cervical, and a product of the Müllerian ducts. The lateral position and structure of the lateral canals

are in favour of this view. We do not know what germ layer the Wolffian ducts are derived from in the kangaroo, but it is probably, as in the human embryo, from the ectoderm, the layer which gives, *inter alia*, the skin-like multiple cells. It may be urged that the central canal has not this epithelial arrangement, but I have to point out that it has been shown by Tourneux and others, including the author, that the first lining of the vagina is single-layered, and comes afterwards to be replaced by the squamous multiple layers, and this I have traced in the human foetus to proliferation from the lower ends of the Wolffian ducts.

The fact that the central canal is cut off in this specimen of kangaroo from the lower ends of the Wolffian ducts may have excluded it from an analogous relining from below, but I must also point out that there is no developmental support of this, as in the human foetus.

In the sections of the kangaroo examined and in those described by other authors (fig. 1) the ureter is seen, but not anything to be considered as a rudimentary Wolffian duct. This is, as I have suggested, represented in the lateral canals. What I believe to be the ureter has the multiple lining of well-formed elongated epidermal cells we usually find in this tube, and this lining is the same as that found in the corner of the bladder lower down, near where the ureter enters. If it be considered as the Wolffian duct, then there is the insuperable difficulty that there would be no ureter represented in the sections.

The view I urge then is, that in the kangaroo genital tract we have a persistence and non-coalescence of the ducts blended to form the vagina in higher mammals, viz. the Wolffian (lateral canals) and Müllerian (central). Thus, while apparently a complicated structure, it is really a persistence and non-coalescence of the primitive Wolffian and Müllerian canals.

In the developing human embryo at the sixth week we have, as shown in Keibel's well-known models, and confirmed by a specimen in my possession, an analogous arrangement. There the Müllerian ducts end blindly in the Müllerian eminence (just as the central pouch of the kangaroo is closed below), while the Wolffian ducts open below into the urinogenital sinus, an arrangement exactly the same as the lower relations of the lateral canals to the kangaroo urinogenital sinus.

The question of what the overarching part of the lateral canals represents has not been considered by anyone so far as I know, but, on the view of the lateral canals given here, it would be equivalent to the broad ligament segment of the Wolffian duct. Sufficient is not known of its early development to explain the union above of the lateral canals in the arching portion.

