

ON THE MALE GENERATIVE ORGANS OF THE KOALA.
(*PHASCOLARCTOS CINEREUS*). By ALFRED H. YOUNG,
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chester.* (Plate XVIII.)

TAKING into consideration the position of typical pre-eminence amongst the Marsupialia which has been claimed for the Koala,¹ because of its manifold structural modifications, it is somewhat surprising to find that there are many points of anatomical interest of which, so far as I am aware, no detailed description exists.

Professor W. Boyd Dawkins recently placed at my disposal the well-preserved body of an adult male Koala, and so, by his kindness, afforded me the opportunity of investigating the anatomy of the species; whilst still more recently a second specimen (also a well-developed male) having come into my possession, I have been enabled thereby to corroborate and verify former observations.

As a contribution to the anatomy of *Phascolarctos*, the object of the present paper is to point out the structural peculiarities of the genito-urinary system in the male: this I do with less hesitation, seeing that hitherto no complete account of them has been published.

Note.—In the following description all measurements are taken from the larger of the two specimens examined—this, from the tip of the nose to the end of the rudimentary tail, being 2 feet 2½ inches in length.

External Parts.

Immediately below the rudimentary tail is the anal aperture, beneath which the penis is situated. Bounding the base of this organ laterally are the prominent and expanded crura of the penis, covered by the erectors muscles; whilst intervening between the crura and the body of the penis there are four

¹ *Cyclopædia of Anatomy*, vol. iii. p. 329, art. "Marsupialia."

prominent glandular-looking bodies, enclosed in muscular capsules. Of these, two are placed, the one above the other, upon each side of the penis. They may be considered, therefore, as being arranged in two pairs, the inferior of which are Cowperian glands, whilst the superior, indistinguishable in appearance from the inferior, are the bulbs of the corpus spongiosum. Other Cowperian glands are situated more deeply, and cannot be seen superficially in the normal position of parts.

The whole of these structures occupy what may be regarded as a common cloacal aperture, and are enclosed by a general muscular sphincter arrangement.

In the flaccid state of the penis this organ is retracted to such an extent that the glans is on a level with the basal glandular bodies above noted, amongst which it occupies a central position; in this condition it is almost entirely concealed by a hooded prepuce.

The *glans penis* measures three-fourths of an inch in length. Bifid at its extremity, it ends in two terminal lobes, the intervening cleft of which extends one-third the length of the glans; the lobes, internally, are simply grooved by the urethral canal, and present no special perforation, or basal apertures, such as exist in *Perameles lagotis*¹ or *Didelphys V.*²

Somewhat cylindrical in shape, the glans is slightly constricted near its base; there is, however, no distinct corona. Numerous strong retroverted spines are scattered over the external surface of the glans, with the exception of its free end.

The prepuce consists of a strong fold continuous above with the mucous membrane of the rectum. Superiorly it forms a hood, which conceals the greater part of the glans when the penis is retracted. Its inner surface, marked by circular rugæ, is seen when retracted to be continuous with the base of the glans, to which it is attached inferiorly by a distinct frænum.

Scrotum.—The scrotum is pendulous. It is situated in front of the penis, in that region of the abdominal wall which in the female is occupied by the marsupial pouch. The surface of the scrotum is covered with light downy hair of a yellowish colour.

¹ Owen, *Anat. of Vertebrates*, vol. iii. p. 647.

² Cowper, "A Male Opossum Dissected," *Phil. Trans.* 1704, (Jones' abridgment), vol. v. p. 174.

Internal Organs.

Kidneys and Ureters.—The kidneys, slightly reniform in shape, occupy a normal position in the abdominal cavity, that on the right side, however, being placed a distance equal to its own length, anterior to that on the left. Of equal size, the kidneys measure 2 inches in length and 1 in breadth at their broadest part. The external surface, except at the hilum, is perfectly smooth and uniform, there being no tendency to a lobar subdivision. Each renal organ is enclosed in a strong capsule. On section, the tubuli uriniferi are seen to terminate on a single ridge-like papilla, which does not project beyond the pelvis, as, according to Owen,¹ is the case in the Opossum. The ureters measure respectively $5\frac{3}{4}$ and $7\frac{1}{2}$ inches. They enter the bladder just behind its neck, apparently, from an external inspection of the parts, close to the vasa deferentia, these latter, however, traverse the wall of the urethra for some distance, and terminate in the prostatic portion of this canal.

Bladder and Urethra.—The bladder possesses a strong and thick muscular wall, the fibres of which are arranged in distinct broad bands; these surround the bladder in a circular manner, and are separated from each other by well-marked intervals. Generally, the direction of the muscular bands is transverse to the long axis of the viscus, but upon its lower surface, near the fundus, they assume a somewhat whorled character. The transversely banded arrangement is very evident on the dorsal and ventral surfaces of the bladder, whilst laterally it is concealed by a series of longitudinal fibres, which pass from the fundus to the neck; a smaller superficial longitudinal band of muscular fibres also runs between the same points along the middle line of the ventral or lower surface. When the walls of the bladder are contracted, the viscus assumes a somewhat triangular shape, the angles corresponding to the longitudinal fibres just described. In this condition the bladder measures 2 inches in length and $1\frac{1}{4}$ in its greatest breadth. Its mucous lining, thick and soft, is thrown into longitudinal plications, which are somewhat irregularly disposed. The orifices of the ureters are placed upon slight mucous elevations, situated $\frac{1}{4}$ of an inch behind the urethral aperture.

¹ *Loc. cit.* p. 606.

The *urethra* extends from the neck of the bladder to the glans penis. According to its situation and character it may be conveniently divided into two portions,—an intra-pelvic and an extra-pelvic. The intra-pelvic portion extends from the neck of the bladder to the entrance of the Cowperian ducts. It measures $1\frac{7}{8}$ of an inch in length, and is almost equally divided into posterior or prostatic, and anterior or membranous parts. The prostatic portion is enclosed in the substance of a well-developed prostate gland; this, though of large size, is small as compared with that of many marsupials. It measures $\frac{3}{8}$ ths of an inch in length and $\frac{5}{8}$ ths in its greatest diameter. Pyriform in shape, its broad end is next the neck of the bladder; in this portion, a well-marked antero-posterior depression on its rectal aspect breaks the otherwise uniform surface of the gland, and shows its tendency to a bilobar condition. The membranous part of the urethra measures 1 inch in length. Its walls are uniform in calibre, and surrounded by muscular fibres. On slitting open the intra-pelvic urethra, a well-marked veru-montanal eminence is seen in the prostatic part, extending as an elongated ridge into the membranous region. On the floor of the urethra on each side of this eminence, the orifices of numerous prostatic ducts are visible.

The veru-montanal eminence is marked at its summit by a shallow depression, representing an ill-defined utriculus, or sinus pocularis. On the sides of this, and opening distinctly into it, are the minute orifices of the seminal ducts. Leuckart has previously described a similar arrangement, though of a much more marked character as existing in the hare and rabbit, and writes thus: "But the most extraordinary circumstance about the utriculus in these animals is this, that it receives the ejaculatory ducts. In all other instances, these open independently by its sides into the urogenital canal; but here, departing from this rule, they open into the undermost part of the Weberian organ."¹ That this rule is by no means so constant as supposed by Leuckart has already been shown—a similar condition existing in the Elk,² and in *Hyaena crocuta*,³ and now, again, we find it in the Koala.

¹ Todd's *Cyclopædia*. art. "Vesicula Prostatica," vol. iv. p. 1419.

² Watson and Young, "Anatomy of the Elk," *Proc. Linn. Soc.* vol. xiv. p. 375

³ Watson, *Proc. Zool. Soc.* April 1878, p. 419.

The extra-pelvic, or spongy portion of the urethra, measures 3 inches from the entrance of the Cowperian ducts to the terminal end of the glans penis. It is situated within the penis, being surrounded almost entirely by the corpus spongiosum of that organ.

Testicles, and Vasa deferentia.—The testicles, each about the size of a horse-bean, are lodged in the prepenial pendulous scrotum. Each is provided with an epididymis, which, as usual in marsupials, is very loosely attached to the corresponding testicle, and in which the respective parts are easily discernible. The vas deferens on either side measures 6 inches in length, taking the usual course through the abdominal wall, and reaching the posterior border of the prostate gland each vas here lies in contact with, but external to, the ureter of the corresponding side. Continuing perfectly distinct and separate, the vas deferens of each side traverses the substance of the prostate to end upon the sides of the so-called vesicula prostatica, as previously described. The lower end of the vas deferens is simple, and, as is the case with all marsupials,¹ presents no trace of lateral diverticula; in other words, there are no vesiculæ seminales, though Martin asserts their presence in a Koala examined by him.² Referring to the absence of vesiculæ seminales in the Opossum, Cowper³ suggests that compensation is provided by the comparative large size of the epididymis.

Cowper's glands.—Situated at the root of the penis are six glandular bodies so named. They are arranged in three pairs, the disposition of which closely resembles that of the corresponding structures in *Hypsiprymnus*, as figured by Professor Owen.⁴ Enclosed within the sphincter cloacæ, each Cowperian gland is also provided with a well-developed muscular capsule. Of the respective glands, one pair, considerably smaller than the others, is placed close to the junction of the crura penis, a small backward projection of the corpora cavernosa intervening to some extent between the glands of opposite sides. Both of these are

¹ Gegenbaur, *Elements of Comparative Anatomy* (Bell's translation), p. 618; also *Cyclopædia of Anatomy*, vol. iv. art. "Vesiculæ Seminales."

² Martin, "Notes on the Anatomy of Koala," *Proc. Zool. Soc.* Part iv. 1836, p. 112.

³ *Loc. cit.* p. 170.

⁴ *Anat. of Vertebrates*, vol. iii. p. 646.

retained in the position indicated by reason of the attachment to the fibrous walls of the corpora cavernosa of the muscular fibres which form the gland capsules. Almost three times the size of the glands just referred to, each gland of the remaining two pairs has a diameter of nearly half an inch. The investing muscular fibres have no attachment to the surrounding structures, so that these glands are quite free; their ducts measure 1 inch in length, those of the same side unite together and form a common duct, which, after receiving superiorly the short duct of the small attached gland of the corresponding side, opens into the urethra, at the junction of its membranous and spongy portions.

Martin does not describe in detail these glands in the Koala examined by him, whilst from his description of what he names the vesiculæ seminales in that specimen, it seems probable that he has mistaken either one pair of Cowperian glands, or else the bulbs of the corpus spongiosum for these structures. His words are: "The vesiculæ seminales are small; they entered $\frac{3}{4}$ ths of an inch below the bladder, with Cowper's glands,"¹—an error which is difficult to understand, considering the distance which intervenes between the vasa deferentia and the so-called vesiculæ seminales.

Close to the Cowperian glands, and so nearly simulating them in appearance that they may easily be mistaken for an additional pair, are two rounded and pedunculated bodies, the external surface of which is covered over by a muscular layer. These are, however, not glands, but simply the posterior bulbs of the corpus spongiosum, with which they will be described.

Penis.—The penis measures 3 inches in length. It consists of cavernous and spongy portions as usual.

The corpora cavernosa commence by large expanded crura, which have no attachment to the bony pelvis, but, remaining quite separate, form rounded bodies of considerable size. The erectores penis, investing the crura, are also distinct from the pelvis; the sphincter cloacæ, indeed, intervenes, and there is no such attachment as Owen describes² in Potoroos and Kangaroos; in this respect the Koala agrees with the Opossum.

¹ Martin, *loc. cit.* p. 112..

² *Anat. of Vertebrates*, vol. iii. p. 313.

The crura soon come into contact, and with the corpus spongiosum form the body of the penis. At their junction, and occupying a superior position, is a well-marked backward projection, which separates the two smaller Cowperian glands, and affords attachment to the muscular fibres investing them.

The corpus spongiosum, as in all described marsupials, presents posteriorly a double bulb, the two halves not having united during development, to form the single bulb as in most male mammals. Correspondingly, the investing muscle (bulbo-cavernosus) is also divided to form a muscular capsule for each bulb. This double character of the bulb is considered by Cowper¹ to be necessary "to maintain the turgescence of the double or forked glans," so characteristic of most marsupials. It has been already stated that the bulbs, both in shape and size, closely correspond to the Cowperian glands. This resemblance is rendered more striking and misleading, by reason of the length and narrowness of the erectile tissue extending from the bulbs to the point where the corpus spongiosum comes into contact with the urethra, a distance of about half an inch. Here, indeed, it is reduced to a narrow pedicle, which, covered by dense fibrous tissue, looks extremely like a duct, and, with the expanded bulb, closely simulates a Cowperian gland and its duct. In the Opossum, the pedicle being short and thick, the bulb no longer has the appearance of being pedunculated, and can hardly be mistaken for a Cowperian gland. The corpus spongiosum, reaching the urethra, almost entirely encloses it, ending anteriorly in the glans.

Muscles of Penis.

Having an important influence in the erection of the penis, and, consequently, to be regarded as one of its muscular agents, the *Sphincter cloacæ* is included under this heading. In the Opossum, Cowper² considers it to be the chief agent in continuing the erection of the penis, and points out that "the muscles of the cavernous bodies of the penis of this creature having no connection with the os pubis, cannot apply the dorsum penis to the last-named bone, whereby to retard the effluent blood

¹ *Loc. cit.* p. 174.

² *Loc. cit.* p. 137.

and cause an erection, as we have observed in other creatures."

The *sphincter cloacæ*, conveniently so named, encloses even in the male both the anus and the urogenital orifice. In the Koala it consists of an external stratum of muscular fibres, which, commencing broad beneath the coccyx, but having no direct attachment to it, passes on each side of the penis, anus, and glands, and surrounds all. Converging, the fibres form a rounded bundle over the dorsum of the penis. Another set of fibres, united with these in the latter situation only, surround the penis and anus, forming a deeper stratum. The Cowperian glands, and the bulbs of the corpus spongiosum, are situated between the two strata, these latter being connected by intermediate muscular fibres which pass between the glands. None of the fibres have any attachment to the pelvis.

Ischio-cavernosi form strong muscular coverings of the crura. These fibres, as before stated, have no bony attachment.

Bulbo-cavernosi consist of muscular fibres, which, in a similar way, enclose the bulbs of the corpus spongiosum.

Retractor penis. These are placed on the under surface of the penis. Two in number, each muscle, which is somewhat riband-like in character, springs from the pelvic surface of the sacrum, crosses the cavity of the pelvis, and, running on the lower aspect of the corpus cavernosum, terminates at the base of the glans.

Levator penis. This muscle, apparently first described by Cowper in the Opossum,¹ was considered by him as peculiar to that animal. According to Owen,² however, it exists in all marsupials possessing a bifid or forked glans, whilst it is absent in the Kangaroo. In the Koala it arises by a fascial origin from the crus penis; fleshy fibres soon appear, and, converging, unite with fibres similarly originating from the opposite crus, to form a muscular arch, the convexity of which is directed forward. In one of my specimens an additional mesial muscular bundle, springing from the backward projection situated at the junction of the crura, joined the arch. Anteriorly, the muscular fibres end on two delicate tendons, which, joining together more or less, terminate on the dorsum of the penis near the glans.

¹ *Loc. cit.* p. 173.

² *Anat. of Vertebrates*, vol. iii. p. 648.

Cremaster.—This muscle is conveniently described here. Very strong, it has an attachment to the crest of the ilium by fascia, and does not spring from the internal oblique, as found by Martin.¹

Concluding Remarks.

In respect of the principal features of its generative system, the male Koala is essentially marsupial. In the foregoing description, however, certain points may be found which, when compared with what obtains not only in other marsupials, but also in the monodelphous mammalia, are of some considerable interest, both morphologically and developmentally. To such it seems advisable that some further reference should be made.

So far as regards the internal organs of generation, Koala differs but slightly from other marsupials. Such differences as do exist, are to be found in the respective lengths of the prostatic and membranous portions of the urethra; as previously noted, these in the Koala are almost equal, the prostatic portion, and, consequently, the prostate gland, measuring $\frac{3}{8}$ ths of an inch, whilst the membranous portion is slightly longer, and measures 1 inch. With the exception of the Wombat,² in other marsupials the prostate gland is apparently very much longer in comparison, and considerably exceeds in length the membranous part of the urethra—*e.g.*, in an Opossum in which “the length of the urethra between the bladder and the penis exceeded 4 inches,” $3\frac{1}{2}$ inches were enclosed by the prostate gland. Cowper,³ giving these measurements, considers it a provision to allow of extrusion of the penis during erection, the prostatico-membranous part of the urethra in this animal being much contorted and folded during retraction of the organ. In the Koala, however, the contortion during retraction of the penis is not intra-, but extra-pelvic, the whole of the penis, and also the Cowperian glands, remaining outside the pelvic cavity, and, along with the pedunculate scrotum, constituting the external organs of generation. In the Opossum, these latter, except during protrusion of the penis, being practically limited to a non-pendulous prepenial scrotum.

¹ *Loc. cit.* p. 110.

² *Cyclop. of Anatomy*, vol. iv. p. 161, art. “Prostate Gland.”

³ *Loc. cit.* 172, 173.

Professor Owen,¹ referring to the large size of the prostate gland in marsupials, suggests, as in some degree explanatory of the circumstance, that, "as the part of the urethral canal immediately succeeding the termination of the sperm ducts is the homotype of the vagina, some modification of this part might be anticipated in the male, corresponding with the extraordinary form and development which characterise the vagina in the female; accordingly we find that the prostatic tract of the urethra is proportionately longer and wider in the marsupial than in any other mammal." Granting even that Professor Owen is right regarding the homotypical relations of that part of the urethra specified and the vagina, still it is not quite clear why this should in any way be connected with the large size of the prostate gland. That it is not so universally, even amongst marsupials, is evidenced by the case of the Wombat, in the male of which the existence of a prostate is doubtful (Adams²). But it does not appear at all likely that the hypothesis with reference to the homotype in the male of the vagina, upon which the conclusion regarding the large size of the prostate is based, is tenable; on the contrary, it seems quite certain that this is to be found, not in any part of the urethral canal, but in such vestiges of the Müllerian ducts as may remain in the male, whilst "the portion of the urethra immediately succeeding the entrance of the sperm ducts" is to be regarded as homologous with the sinus urogenitalis or its vestibular representative.

Considerable light has been thrown on the homologies of the various parts of the sexual apparatus in the two sexes by the observations of Professor Watson,³ with reference to the remarkable arrangements of the genito-urinary organs in *Hyæna crocuta*. In this animal the homology of that part of the urethra immediately succeeding the entrance of the sperm ducts with the commencement of the urino-genital canal in the female is as Dr Watson says, "conclusively proved." Equally certain it is that this part of the urino-genital canal in the female *Hyæna crocuta* does not correspond to what is ordinarily known as a vagina in most female mammals; but to what in them is metamorphosed into

¹ *Loc. cit.* vol. iii. p. 645.

² *Cyclop. of Anatomy*, vol. iv. p. 161, art. "Prostate Gland."

³ *Proc. Zool. Soc. Lond.*, May 1877, p. 370, and April 1878, p. 416.

a vestibule. The condition of these parts in the Spotted Hyæna, whilst it completely refutes the view of Owen, confirms in a very definite manner that adopted by most modern embryologists.

Amongst marsupials, the males of which as a class possess large prostates, the Koala may be regarded as characterised by a prostate gland, which, though extensive, is still comparatively small, whilst moreover, it is peculiar as showing indications of a division into two lobes. The corresponding portion of the urethra presents internally a veru-montanal eminence, remarkable by reason of the so-called utriculus, which exists as a shallow depression on its summit, and receives the openings of the seminal ducts.

Whether this utriculus or vesicula prostatica is to be regarded as the homologue of the vagina alone, of the uterus alone, or of both, in the female marsupial, is difficult to say.

The greater number of embryologists, including Leuckart, Wahlgren, Kölliker, Thomson, and even Meckel,¹ seem now agreed that the Weberian organ is the morphological equivalent of both uterus and vagina in those mammals, the females of which possess both structures; whilst when the females lack the vagina, as in the Indian Elephant and Spotted Hyæna,² then it can no longer be looked upon in this light, but may be regarded as a true "uterus masculinus" representing the uterus solely.³ Inasmuch as in these latter animals the whole of the Müllerian ducts in the progress of their developmental changes become metamorphosed into the uterus,⁴ whilst in other female mammals the genital canal thus derived becomes so differentiated, that the upper part constitutes an uterus and the lower a vagina. It is clear that, even in the somewhat exceptional cases of the Indian Elephant and the Spotted Hyæna, the vaginal canal is morphologically present in the lower end of the uterus, though functionally it is represented by the sinus urogenitalis.

¹ *Cyclop of Anatomy*, vol. iv. art. "Vesicula Prostatica."

² Watson, *loc. cit.* p. 424. ³ Leuckart, *Cyclop. of Anatomy*, vol. iv. p. 1427.

⁴ Miall and Greenwood dispute the assertion as to the absence of a vagina in the Indian elephant, stating that "the united Müllerian ducts appear to us to be plainly divisible (above the urogenital canal) into two parts, which are separated by a constriction and differ in internal structure. The upper part seems to us to represent the uterus, and the lower the vagina, while the internal thickening may well represent an os uteri" (*Journal of Anatomy and Physiology*, vol. xiii. pl. i. p. 31).

In all cases, then, the Weberian organ represents the genital canal, formed by the conduits of Müller, be it differentiated into vagina and uterus or not. In the Koala the case is somewhat different, and the true homological significance of its Weberian organ is not easy to determine. Seeing, however, that in the female marsupial the Müllerian ducts either remain entirely separate, or, if not, that their coalescence is confined to their vaginal ends, it appears more rational to regard the utriculus in the Koala as the homologue of the vagina only.¹

Remembering, however, the close relationship of the Müllerian and the Wolffian ducts in the genital cord, it does not seem impossible that the minute recess or utriculus so-called may in no wise be formed from the Müllerian ducts, but may simply represent a coalescence of the lower ends of the Wolffian ducts.

In no other marsupial has a Weberian organ been described, whilst in many—*e.g.*, *Halmaturus giganteus*, *Phascolomys wombat*, *Sarcophilus ursinus*, *Didelphys virginiana*—its absence is definitely affirmed.²

In the possession of three pairs of Cowperian glands, the Koala agrees, apparently, with the majority of marsupials;³ in some, however, this number may be increased to four,⁴ whilst in the Opossum it is reduced to two.⁵

In the Koala the bulbs of the corpus spongiosum, as in all marsupials, remain separate; this retention of a condition peculiar to the females of most mammals contrasting somewhat forcibly with the almost entire absence of feminine indications in the internal generative organs of male marsupials.

The Koala presents only in a minor degree the tendency to the forked character of the glans penis which exists in many species. According to Owen,⁶ it closely agrees with the Wombat in this respect, and with it occupies an intermediate position between the uniparous marsupials, in which the glans is undivided and single, and the multiparous species, in which it is distinctly bifid.

¹ Gegenbaur (*loc. cit.* p. 619) apparently holds this view of the homological significance of the Weberian organ to be applicable to most mammals.

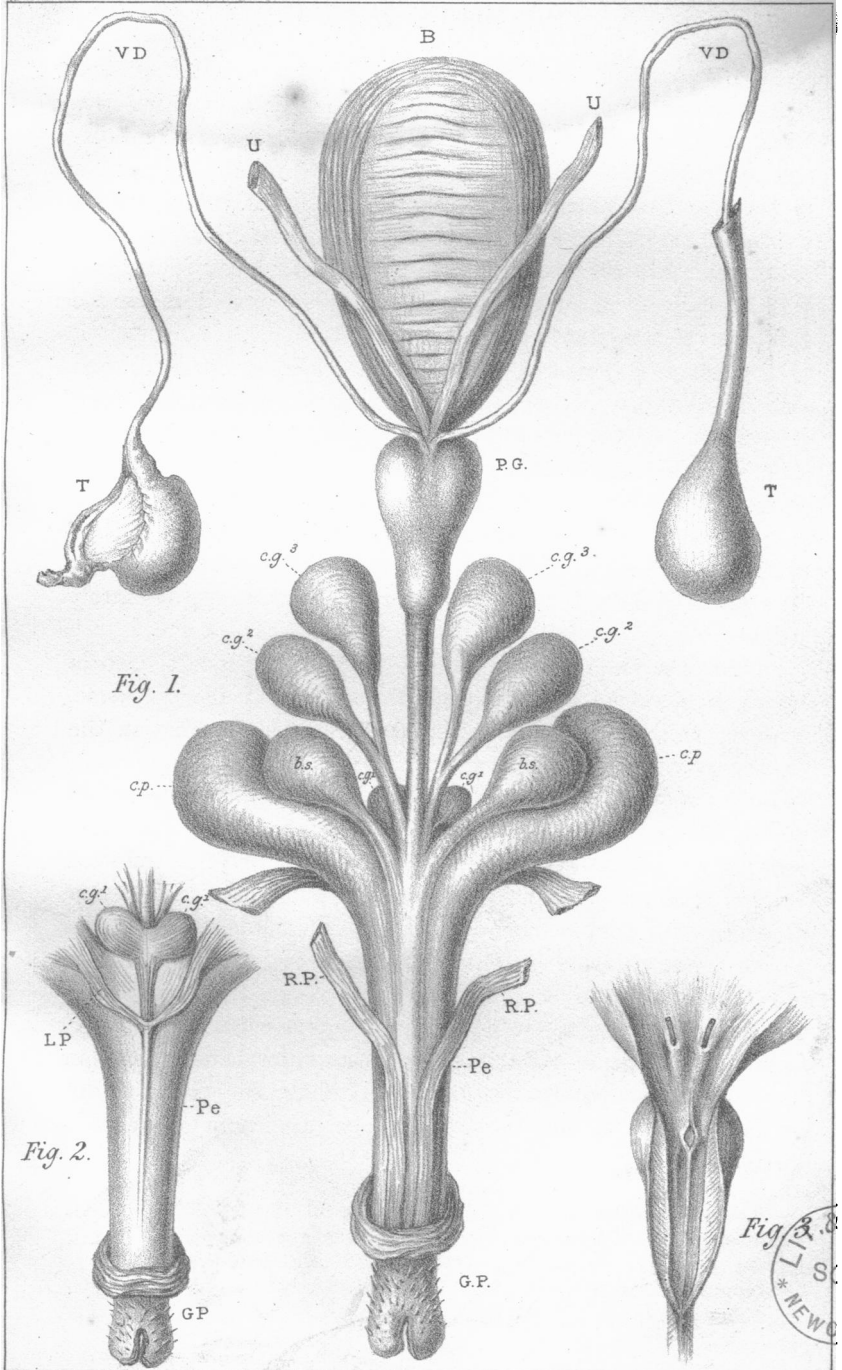
² *Cyclop. of Anatomy*, vol. iv. p. 1428, art. "Vesicula Prostatica."

³ Owen, *loc. cit.* p. 646.

⁴ Gegenbaur, *loc. cit.* p. 623.

⁵ Cowper, *loc. cit.* p. 172.

⁶ *Loc. cit.* p. 647.



Lastly, I may refer to the absence in *Phascolarctos* of the anal glands, so well marked in *Didelphys virginiana*. In the latter animal a single large gland is situated on each side of the rectum, opening into it about a quarter of an inch from the anal aperture.

EXPLANATION OF PLATE XVIII.

Fig. 1. Male generative organs of the Koala, rectal surface (natural size). *B.* Bladder. *UU.* Ureters. *TT.* Testicles (covering removed from left to show the epididymis). *V.D.* Vasa deferentia. *P.G.* Prostate gland. *G.P.* Glans penis; prepuce retracted. *R.P.* Retractores penis. *Pe.* Penis. *c.p., c.p.* Crura penis, with erectores partially reflected. *b.s., b.s.'* The two separate bulbs of the corpus spongiosum. *c.g.¹ c.g.² c.g.³* Cowper's glands (three pairs).

Fig. 2. Pubic aspect of the penis. *L.P.* Levator penis; other letters as in fig. 1.

Fig. 3. Intra-pelvic portion of the urethra, laid open to show the veru-montanum and the utricular depression. The two bristles are placed in the openings of the ureters.