

skeleton is now carefully set up in the small museum in that city. It is 48 feet long; and part of the whalebone remains in the jaw. There are also bones of a whale found in the sands at Deva, in the same museum. I was given part of a whale's rib dug up on the Lequeitio beach; and a jawbone, which was long in the courtyard of the palace of the Marques de San Estevan at Gijon, is now preserved in the Jovellanos Institute of the same town. Of course there must be any number of bones buried in the sand of the beaches where so many hundreds of whales have been flensed in former centuries.

In 1878 the accomplished historian of Guipuzcoa, Don Nicolas Soraluce, printed a pamphlet at Vitoria on "the origin and history of the whale and cod fisheries," which contains much interesting information. I may add that Señor Soraluce is preparing some additional chapters on the whale-fishery, and that he expects to obtain copies of interesting documents relating to the same subject from the archives of the Ministry of Marine at Madrid.

2. On the Condition of the Median Portion of the Vaginal Apparatus in the Macropodidæ. By J. J. LISTER, B.A., F.Z.S., St. John's College, Cambridge, Demonstrator of Comparative Anatomy in the University of Cambridge, and J. J. FLETCHER, M.A. (Syd.), B.Sc. (Lond.).

[Received November 8, 1881.]

In the Marsupialia, as is now well known, the female reproductive organs consist of two ovaries, two oviducts, two uteri, two vaginæ, a urogenital sinus, and a clitoris. The vaginæ are variously complicated in the various families comprising the order; but in the Kangaroos the vaginal apparatus may be described in general terms as consisting of a median portion (formed by the union and more or less complete coalescence of the portions of the Müllerian ducts which succeed the uteri), and of the two lateral portions (which curve outward and backward somewhat like the handles of a vase, and open distally, but without making any projection, into the urogenital chamber). They are what are usually known as the two vaginæ. The median portion is usually described as approaching the urogenital chamber more or less closely, but as ending blindly, thus forming a cul-de-sac, and as being connected with it simply by connective tissue.

A considerable number of observers have met with the median vaginal portion in a condition very different from that just described, inasmuch as its tissue was found to be continuous with that of the urogenital passage, and, what is still more interesting, the two chambers communicated with one another by an aperture situated immediately above that of the meatus urinarius.

Though several anatomists have met with uterine foetuses *in situ*, no one as yet seems to have had the good fortune to find an embryo in any part of the vagina; consequently there has been much controversy as to the route taken by the embryo in passing to the urogenital passage. Some writers maintain that it comes down one of the lateral canals; while others affirm that these serve only for the conveyance of the semen, and that the embryo passes directly from the median vaginal canal into the urogenital chamber.

We have ventured to bring the subject under the notice of the Society for several reasons. First, because we have found the open condition in some species in which it has not hitherto been recorded; secondly, because the text-books used by students in this country either refer to the subject only very briefly, as in Prof. Owen's 'Comparative Anatomy,' vol. iii., or not at all, as in the manuals of Profs. Gegenbauer, Huxley, and Macalister; thirdly, because, with the exception of Home and Owen, no English observers seem to have noticed the open condition of the median cul-de-sac, while it has, as we shall show presently, attracted the attention of a considerable number of continental investigators. As will be pointed out later on, many of the observations already recorded are almost valueless, because the observers have not referred their specimens to any genera or species, or because they have been unable or have neglected to offer any evidence as to whether the animals they are dealing with had certainly produced young or not.

Before giving the details in connection with our specimen, it will be interesting to state briefly the results already obtained. As far as we can learn, the observers who have investigated the condition of the median vaginal canal, and have published the results arrived at, are the following—Home, Cuvier, Seiler, G. St.-Hilaire, Owen, Carus, Vrolik, Poelman, Alix, Lucă, Pagenstecher, Garrod, and Brass.

Sir E. Home¹, who published an account in 1785, seems to have been the first to give a description of the female reproductive organs of the Kangaroo. This writer says that impregnated uteri had reached John Hunter before his death, but that from want of leisure the illustrious anatomist was prevented from giving them the attention they deserved. Home does not say how many specimens came under his own observation, nor to what species they belonged. In one of his specimens he found the median vaginal portion (uterus of Home) a veritable cul-de-sac. In another specimen he found the median vaginal portion (uterus of Home) in communication, by a small aperture, with the urogenital chamber (vagina of Home). Finding what he took to be an embryo in the median vaginal canal (uterus of Home), he supposed that he was dealing in this case with an impregnated uterus, and in the previous case with one in the virgin condition; and he came to the conclusion that the median vaginal portion was impervious in the virgin state, that during pregnancy

¹ Phil. Trans. lxxv. 1785, pp. 222-230; also Lect. on Comp. Anat. vol. iii. pp. 341-370.

an orifice large enough to admit a hog's bristle was to be met with, and that "immediately after parturition, the parts are nearly brought back into their original state; the only circumstance deserving note is, that the opening leading directly from the uterus (that is the median vaginal canal) to the vagina (urogenital sinus), which is not met with in the virgin state, after being enlarged by the passage of the foetus, forms a projecting orifice and almost wholly conceals the meatus urinarius."

Concerning the views of Cuvier and of Geoffroy St.-Hilaire we are not able to say much. From allusions in several of the papers shortly to be mentioned, it would appear that Cuvier was opposed to the view that a direct communication existed between the median vaginal and the urogenital chambers, while G. St.-Hilaire was in favour of such a view. Owing to the want of satisfactory references, we have been unable not only to meet with the original papers in which these two distinguished authors enunciated their views, but also to find any descriptions of actual dissection. In the English edition of the '*Règne Animal*,' however, the following passage occurs:—"The matrix of the animals of this order (Marsupialia) does not open by a single orifice into the extremity of the vagina, but communicates with the canal by two bent lateral tubes."

In 1828 Seiler¹ published his observations on a "Kangaroo" which had a mammary foetus in the pouch. He says:—"Noch immer findet man in mehreren neuern Schriften die alte Meinung wiederholt, es entstehe zur Zeit der ersten Geburt des Fötus eine Oeffnung in dem Gebärmutterhalse, gleich hinter der Harnröhrenmündung, durch welche der Embryo geboren werde. So unwahrscheinlich mir auch immer diese Ansicht erschien, so sprechen doch Home's Beobachtungen dafür, und ich untersuchte daher nicht nur die Gebärmutter ganz genau, sondern füllte sie auch von einer Muttertrompete aus mit Quecksilber so stark an, dass sie ganz gespannt ausegedehnt wurde: allein es zeigte sich keine Spur einer Oeffnung, und es ist mir nun gar nicht mehr zweifelhaft, dass der Embryo durch die seitenkanäle der Gebärmutter geboren werde, deren Uebergangsbildung zu den Eyergängen Geoffroy St. Hilaire sehr richtig nachweist."

In 1834 Prof. Owen² published his paper "On the Generation of the Marsupial Animals, with a Description of the impregnated Uterus of the Kangaroo," from which we quote the following passage:—"The foetus has been conjectured to pass into the urethro-sexual cavity by a direct aperture formed after impregnation at the lower blind end of the cul-de-sac; but I have not been able to discover any trace of such a foramen in two Kangaroos which had born young, and besides I find that this part of the vagina is not continuous by means of its proper tissue with the urethro-sexual canal, but is connected to it by cellular membrane only; and the structure is agreeable to what is presented in the simpler forms of the marsupial uterus, as in *Didelphys dorsigera* and the *Petauri*, in which the culs-de-sac do not even come

¹ Isis, 1828, pp. 475-477.

² Phil. Trans. cxxiv. 1834, pp. 333-364.

into contact with the urethro-sexual passage." Almost identically the same statement is repeated on page 316 of the same writer's article on "Marsupialia" in vol. iii. of Todd's 'Cyclopædia of Anatomy and Physiology' (1839-1847). On page 319 of the same article, moreover, the following words occur:—"I have already shown that one of the chief grounds of the theory of marsupial generation there proposed (that is Home *loc. cit.*) is untenable, the supposed remains of the foetus, described as being situated in the corpus uteri (vaginal cul-de-sac) being nothing more than a portion of the inspissated secretion commonly present both in this sac and the lateral canals. *The temporary orifice by which the foetus is stated to pass immediately from the so-called corpus uteri into the vagina (urogenital passage) does not exist.*"¹ We do not understand why Prof. Owen uses the term "temporary orifice." The passage of Home's already quoted seems to show that after parturition he regarded the orifice as being permanently established. Apart from this, however, it would seem that Prof. Owen did not accept either the conclusions or the facts of Home. As we shall point out further on, in 1868 Prof. Owen made the very important admission that in *H. bennetti* the aperture of communication between the median cul-de-sac and the urogenital canal is doubtless normal, at least, after parturition.

Carus in his Manual² (1834) speaks of having dissected a Kangaroo which had a young one about 8 inches long in the pouch. He found a means of communication between the two chambers. It is true that in this, as in other cases, the aperture was glued up, or plugged with mucus; but this is a matter which has nothing to do with the question whether the median vaginal portion is always and under all circumstances a blind sac, or whether during and after parturition there is not a possible means of communication between the median vaginal portion and the urogenital sinus.

In the same year Prof. Owen³ published an account of the female organs of a specimen of *Macropus parryi*; and alluding to the mesial cul-de-sac of the vagina, the author says that it "did not extend quite so far down in *M. parryi* as it does in the better-known species." No allusion is made to the breeding of the animal; but its history is well known and has been recorded both by Bennett⁴ and by Waterhouse⁵. If this female, whose history is so minutely recorded, had ever produced young, no doubt such an event would not have been passed over in silence. As it is we think it extremely probable that the animal died a virgin.

In Vrolik's paper⁶, "Ontleed en natuurkundige aanteekeningen over den grooten Kangaroo (*M. major*)," published in 1836, the female organs are described and figured. With the aid of a friend we have been able to make out that he found the mesial cul-de-sac

¹ The *italics* are our own.

² Lehrbuch der vergl. Zootomie, 2nd ed., 1834.

³ P. Z. S. 1834, p. 152.

⁴ Trans. Zool. Soc. vol. i. 1833-1835, pp. 295-300.

⁵ Nat. Hist. of Mammalia, vol. i. pp. 113-114.

⁶ Hoeven en Vriese, Tijdschr. iii. pp. 291-356.

closed; but we do not know if he had any evidence whether the animal had ever had young.

In 1851 Prof. Poelman¹, of Gand, published an account of his observations on a female specimen of *Halmaturus bennetti*, in which he found "que la même partie (median vaginal canal) communique librement avec le vestibule genito-urinaire." Prof. Owen was the first who met with this condition in this species. We subjoin his account of his discovery, which was published in 1852²:—"In a specimen of *Macropus* (*Halmaturus*) *bennetti* which I dissected in 1845, I detected a natural aperture of communication between the median cul-de-sac and the urogenital canal. I had the pleasure of showing the specimen to Dr. Poelman during a recent visit of that eminent comparative anatomist to the Hunterian Museum, and of thus confirming the observation which he had, independently, made of a similar modification of the female generative organs in a specimen of the *M. bennetti* dissected by him at the University of Gand."

Prof. Owen, in his "Notes on the Anatomy of *Dendrolagus inustus*," published in 1852³, says:—"The lateral bent vaginal canals are shorter in proportion than in *M. major*; but the median vaginal cul-de-sac was closed, as in that species." This specimen was the first living representative of the species exhibited in Europe. It lived in the Society's Gardens for four years. Of its early history there is no record, as far as we know; but it was probably captured when young. If this rare animal had bred during its sojourn in the Menagerie, such an interesting event would naturally have been mentioned in Prof. Owen's paper. There is no allusion to any such event; and it would seem very probable that the female in question was a virgin.

In a paper published in 1857⁴, Vrolik described the anatomy of a female specimen of *Dendrolagus inustus*. From this we gather that he found the median canal closed.

In 1866 Alix⁵ met with the open condition in a female of *Halmaturus bennetti*, and, being unaware of the papers of Owen and Poelman, published his discovery as a new one. To this Profs. Poelman⁶ and Owen⁷ promptly replied. From the former's reply we subjoin the following extract (p. 399):—"J'ajouterais que, depuis la publication de ce travail [that is, his paper already referred to] j'ai eu l'occasion de vérifier cette disposition anatomique [that is, the open condition] chez d'autres individus appartenant à la même espèce (*H. bennetti*), et en ce moment je ne conserve plus aucun doute sur son existence constante." From Prof. Owen's reply we quote as

¹ Bull. de l'Acad. Roy. de Belgique, xviii. 1851, p. 599.

² P. Z. S. 1852, p. 106.

³ Ibid.

⁴ W. Vrolik, "Ontleed kundige nasporingen omtrent *Dendrolagus inustus*," Verhandelingen der Koninklijke Akademie van Wetenschappen, &c. &c. Amsterdam, vol. v. of series iv., 1857.

⁵ Compt. Rend. Paris, lxii. 1866, pp. 146-148.

⁶ Ibid. pp. 399-400.

⁷ Ibid. pp. 592-596.

follows:—"Dans le *Macropus*, les culs-de-sac vaginaux communiquent entre eux, et la cavité commune s'étend jusqu'au vestibule uréthro-génital, mais sans y déboucher. *C'est ce que j'ai constaté chez des femelles de l'espèce M. major, qui avaient fait les petits au moins deux fois.* Dans l'*Halmaturus*, le cul-de-sac non seulement atteint le fond du vestibule uréthro-génital, mais il y débouche, comme on l'a montré depuis longtemps."

In 1867 Prof. Lucä¹ published the result of his investigations made upon three females, two of which belonged to *H. bennetti*, and the third to *H. billardieri*. The latter and one of the former were adult; and in both cases Lucä found a direct communication between the median vaginal portion and the urogenital sinus. In the third specimen, which was a not full-grown female, he found the median vaginal cul-de-sac closed.

In 1868 Prof. Owen's Comp. Anat. vol. iii. was published, in which the only reference to the subject is as follows (p. 683):—"In *H. bennetti* I found an aperture of communication between the median cul-de-sac and the urogenital canal; and, as the same structure has been observed in two other specimens, it is doubtless normal, at least after parturition. The fact, however, does not justify the conclusion that the lateral vaginal canals convey exclusively the semen for impregnation, and that the median canals, *which, as a rule, are closed* and distinct from each other, serve only to transmit the fœtus to the urogenital passage."

In 1869 Lucä² published an account of his examination of a second adult specimen of *H. bennetti*, which had a mammary fœtus 2-2½ inches long in the pouch. In this case also the median vaginal canal communicated with the urogenital sinus.

In 1871 Prof. Pagenstecher³, of Heidelberg, published an article "Ueber den Embryo von *M. major*." This observer found a fœtus in the left uterus; and he says:—"dass Owen ganz Recht hat, indem er sagt dass bei *M. major* überhaupt eine Kommunikation des mittleren Scheidenblindsacks mit dem von ihm als Vorhof bezeichneten Abschnitt nicht besteht, wogegen *H. ruficollis (bennetti)* die vollständig offene Verbindung zeigt."

In 1875, Prof. Garrod⁴, in speaking of *H. luctuosus (Dorcopsis luctuosa)* writes:—"The uterus is perfectly Macropine, as are the vaginæ. No direct communication could be found between the uterine pouch of the vaginæ and the common vaginal canal."

In a paper by Brass⁵ published in 1880, examples of three genera of Macro-podidæ are described and figured. In no instance is it stated whether young had been born or not. A specimen of "*Macropus giganteus*" was found to have the median vaginal canal ending blindly; and the figure shows its posterior end quite free from the urogenital chamber.

¹ Der zool. Garten, viii. 1867, p. 418 & p. 471.

² Der zool. Garten, x. 1869, p. 61.

³ Halle Zeitschrift, iii. 1871, p. 526.

⁴ P. Z. S. 1875, p. 57.

⁵ Beiträge zur Kenntniss des weiblichen Urogenitalsystems der Marsupialen, von Arnold Brass. Leipzig, 1880.

In three specimens of *Halmaturus bennetti* the condition of the median canal is alluded to. In one (p. 17), "Der durch die Verschmelzung der oberen Theile der vaginæ zu Stande gekommene mittlere Theil desselben, welcher uns bisher [*i. e.* in the forms before described] als Blindsack entgegentrat bleibt bei *Macropus bennetti* nicht Blindsack, sondern öffnet sich direct gegen den sinus urogenitalis hin." Another specimen, named *Macropus bennetti*, and having its generative organs fully developed, agreed with this in all respects except that there was no median communication, a quite thin partition separating the two chambers. This circumstance led to doubt in the author's mind as to the identity of the species. The open condition was also found "bei einem noch nicht ausgewachsenen Exemplare von *M. bennetti*."

In a specimen of the genus *Hypsiprymnus* (sp. ?) the median portion of the vaginæ is described and figured as extending nearly as far back as the urogenital sinus, but not coalescing therewith.

In 1879¹ Alix published the following :—"En étudiant en 1866 les organes de la génération d'un *Halmaturus bennettii* j'avais trouvé que le fond du vagin médian s'ouvrait directement dans le vestibule urogenital et j'avais cru pouvoir en conclure que cet orifice devait donner passage au fœtus conformément à l'opinion admise autrefois par Everard Home—opinion combattue par Cuvier et par M. R. Owen qui n'ont trouvé aucune trace de cet orifice sur le Kangaroo géant. Depuis ce moment cette question n'a pas cessée de me préoccuper, mais je n'ai trouvé que bien rarement l'occasion de faire de nouvelles vérifications. Les *Halmaturus* étant beaucoup plus communs en Europe, j'ai pu renouveler plusieurs fois ma première observation ; mais de l'autre part je n'ai pas trouvé de communication entre le vagin médian et le vestibule urogénital soit sur le Sarigne, soit sur le Péramèle, et je n'en ai pas trouvé non plus chez un Kangaroo géant (*Macropus major*) où le fond du vagin médian était comme sur les sujets disséqués par Cuvier et par M. R. Owen, séparé du vestibule par une petite couche de tissu conjonctif.

"Ces faits me portaient à admettre définitivement que les *Halmaturus* réalisaient une exception, quand de nouvelles observations m'ont faire voir que la question ne peut pas encore être résolue de cette manière.

"1°. Sur une Phascolome wombat le vagin médian communiquait avec le vestibule urogénital par un petit pertuis bien distinct. Une injection d'eau poussée dans la poche sortit par cet orifice, et un petit stylet introduit doucement par l'ouverture pénétra dans la poche.

"2°. Sur deux Kangaroos roux (*M. rufus*) la communication se faisait par un large orifice. L'un d'eux avait produit un petit, mais chez ce petit, qui était une femelle et dont la taille atteignait le $\frac{1}{3}$ de celle de la mère, la communication n'existait pas et la conformation était semblable à celle que l'on a observée jusqu'ici chez le *M. major*.

"En voyant que chez le *M. rufus* la communication ne se fa qu'après la naissance on est porté à penser qu'il pourrait bien

¹ Bulletin Société Zoologique de France, 1879, p. 118.

être de même chez le *M. major* et que la question ne sera entièrement résolue pour cette espèce qu'après l'examen de l'appareil génital d'une femelle qui aura certainement accompli l'acte de la parturition."

We will state here what we have been able to gather from the preparations in the Museum of the Royal College of Surgeons which have any bearing on this point.

The preparation 2739 of the Physiological series is an example of the generative organs of a young *Macropus major*, in which the median canal is stated in the Catalogue to be closed.

No. 2740 and 2740 B exhibit preparations of the same species, in which it is also closed.

No. 2740 c also exhibits the closed condition in the median canal "of the Kangaroo."

No. 2740 D has the following note relating to it in the corrected copy of the Catalogue (vol. iv. p. 157):—"No. 2740 D. The female organs of a small species of Kangaroo (*M. penicillatus*), showing a direct communication, through which a bristle is passed between the common mesial cul-de-sac and the urogenital sinus. (In Museum before 1861, but not catalogued.)"

In vol. v. p. 115 there is the following entry:—"3460 D. The female generative organs of the same species [*M. major*, Shaw] of Kangaroo, killed towards the close of uterine gestation, with the left impregnated uterus laid open, showing a portion of the thin unvascular chorion which enclosed the embryo and its appended sacs.

"Prepared by Mr. Owen from a specimen presented by Dr. Sweatman."

On examining the specimen itself it is found to be in the following condition:—The urogenital sinus has been slit up; and a window has been cut in the wall of the median vaginal chamber. Through the window in the latter the upper end of a brown glass rod is distinctly seen, while its lower portion is as plainly seen in the urogenital sinus. Now, in regard to this structure, upon which the catalogue is silent, the question naturally arises, to what is the glass rod intended to call attention? If its presence does not mean that there was naturally a communication between the two chambers, then what does it mean? If it be true that the two chambers really did communicate, then it is remarkable that such a unique specimen should never have been described.

In the article "Marsupialia" Prof. Owen speaks of having received an impregnated uterus (no gen. or sp. given) from Dr. Sweatman. It is possible that this specimen is identical with no. 3460 D in the Coll. of Surgeons Museum. In the same article there is also a reference to an impregnated uterus of *Macropus penicillatus*, which may possibly be identical with no. 2740 D quoted above; but neither in the Catalogue nor in the article is there any indication whether these specimens had already produced young or not.

The following specimens have come under our observation:—

Macropus rufus (4).

a. Adult, with young in pouch.

- b.* Young of *a.*
- c.* An adult.
- d.* Nearly adult, not bred.

Macropus major (2).

- a.* Adult, bred.
- b.* Adult (?) from the Museum of Comparative Anatomy at Cambridge.

Halmaturus bennetti (1), adult.

Halmaturus derbianus (1), adult from Museum of Comparative Anatomy at Cambridge.

Halmaturus ualabatus (2).

- a.* A young one, not bred.
- b.* An adult, bred.

Petrogale xanthopus (3).

- a.* An adult, bred.
- b.* An adult, bred.
- c.* Young of *b.*, not bred.

Dendrolagus inustus (1), probably not bred.

Hypsiprymnus gaimardi (1), bred.

For permission to examine the two specimens from the Museum at Cambridge we are indebted to the courtesy of Mr. J. W. Clark. The other specimens are from the Gardens of the Society, and have been most liberally placed at our disposal by Mr. W. A. Forbes.

In the cases in which it is not stated whether young have been born or not, we have been unable to ascertain this point.

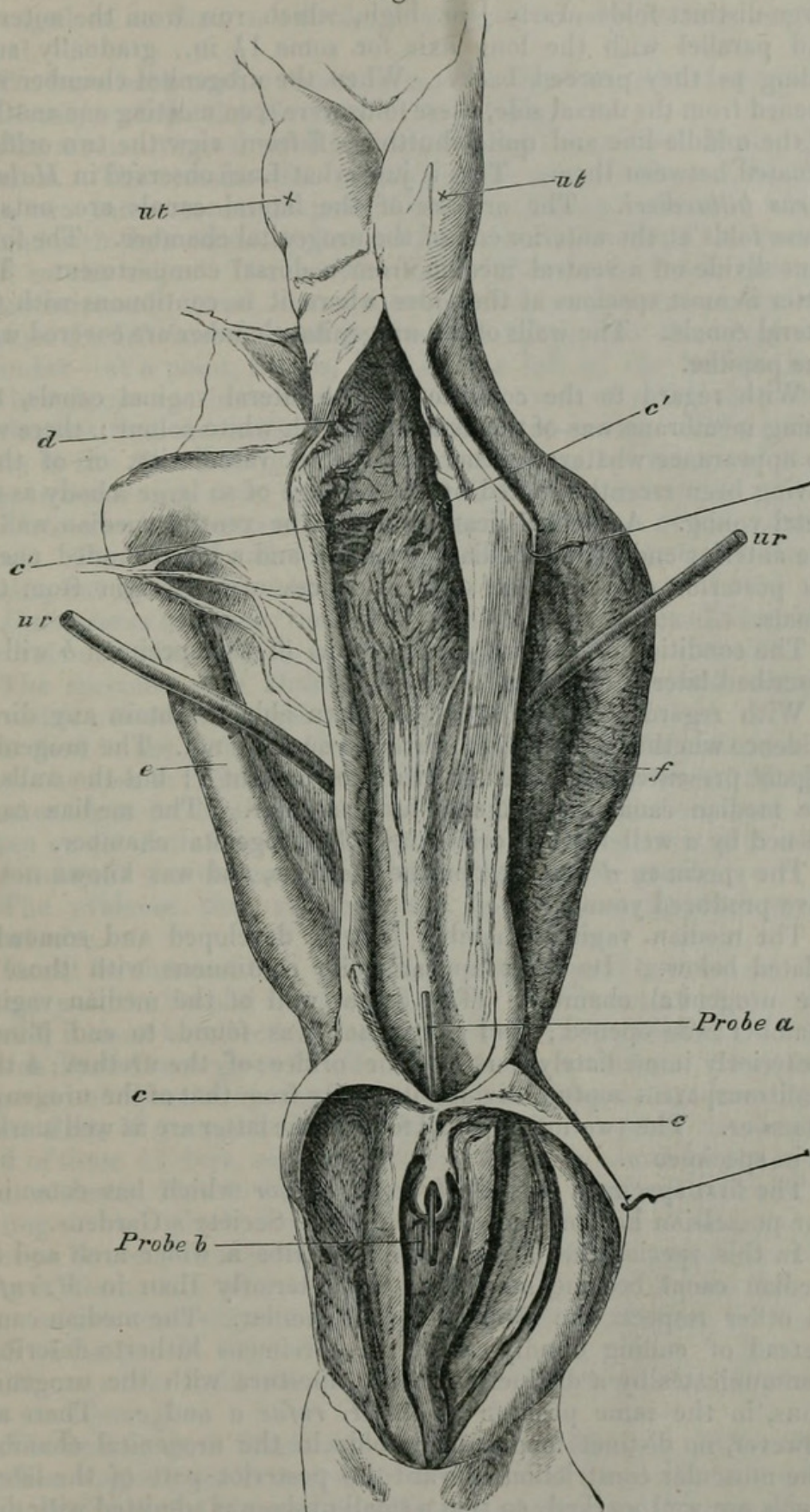
It will be convenient to commence the account of our specimens with the description of the *Macropus rufus* (*a*).

The animal died in the Society's Gardens on Oct. 12th. It was an adult; and a young one (*b*) only $1\frac{1}{2}$ in. long was found attached to a teat. The diminutive size of the young showed that it had only recently been born, and hence that the generative organs were in a condition most favourable for the study of the point under discussion, as they had just passed their condition of functional activity when the animal died.

External examination of them showed a corpus luteum, measuring a little more than $\frac{1}{5}$ in. in its longest diameter, in the left ovary. The blood-vessels supplying the region were much dilated, giving it a very lurid appearance. The median vaginal chamber appeared more dilated, especially at its posterior part, than in the other specimens we have examined.

On opening the median chamber from the dorsal side (fig. 1, p. 985) the mucous membrane presented a red, highly vascular appearance, and it was covered with a soft mucous secretion. When the urogenital canal was opened, the median chamber was seen to open into it posteriorly by a distinct projecting orifice $\frac{1}{7}$ inch in diameter. Immediately below this opening is another, that of the urethra (probe *b*). These two openings are situated in the middle line; on either

Fig. 1.

The vaginal apparatus of *Macropus rufus*, natural size.

The median vaginal canal and the urogenital sinus have been laid open from the dorsal side. A probe, *a*, is passed through the posterior unopened part of the median canal; the projecting orifice of the latter is seen between the two longitudinal folds, lying just dorsad of the opening of the urethra, through which probe *b* is passed. *cc*, the posterior openings of the lateral vaginal canals; *c'c'*, their anterior openings; *d*, the opening of the left uterus; *ef*, the lateral vaginal canals; *ur*, the ureters; *ut*, the uteri.

side the ventral wall of the urogenital chamber is raised into two large distinct folds nearly $\frac{1}{4}$ in. high, which run from the anterior end parallel with the long axis for some $1\frac{1}{2}$ in., gradually subsiding as they proceed back. When the urogenital chamber was opened from the dorsal side, these folds were seen meeting one another in the middle line and quite shutting off from view the two orifices situated between them. This is just what Lucă observed in *Halma-turus billardieri*. The orifices of the lateral canals are outside these folds at the anterior end of the urogenital chamber. The folds thus divide off a ventral median from a dorsal compartment. The latter is most spacious at the sides where it is continuous with the lateral canals. The walls of the urogenital chamber are covered with fine papillæ.

With regard to the condition of the lateral vaginal canals, the lining membrane was of the usual yellowish-white colour; there was no appearance whatever either of special vascularity, or of their having been recently dilated by the passage of so large a body as the foetal young. A small delicate ridge on the ventral median wall of the anterior end of the median chamber, and a low rounded one at its posterior end, are the only evidences of its origin from two canals.

The condition of the urogenital organs of the specimen *b* will be described later. (See Note.)

With regard to *c*, we have not been able to obtain any direct evidence whether it had given birth to young or not. The urogenital organs presented a similar structure to those of *a*; but the walls of the median canal were much less vascular. The median canal opened by a well-marked orifice into the urogenital chamber.

The specimen *d* was bred in the Gardens, and was known not to have produced young.

The median vaginal chamber is well developed and somewhat dilated below. Its walls appear quite continuous with those of the urogenital chamber. The dorsal wall of the median vaginal chamber was opened; and the canal was found to end blindly posteriorly immediately dorsal to the orifice of the urethra; a thin semitransparent septum divided its cavity from that of the urogenital chamber. The two longitudinal folds in the latter are as well marked as in specimen *a*.

The first specimen (*a*) of *Macropus major* which has come into our possession had produced young in the Society's Gardens.

In this species the lateral canals describe a wider arch and the median canal became more narrow posteriorly than in *M. rufus*. In other respects the arrangement is similar. The median canal, instead of ending blindly as in the specimens hitherto described, communicates by a distinct and wide aperture with the urogenital sinus, in the same position as in *M. rufus a* and *c*. There are, however, no distinct longitudinal folds in the urogenital chamber. The muscular constrictions toward the posterior part of the lateral canals are well marked, so that a small probe was admitted with difficulty; a small fold of mucous membrane projects from the outer wall

into the cavity of the canal just beyond the constriction, which is so arranged as to form a valvular barrier to a body passing up the canal.

We have been unable to obtain any history of the second specimen of *M. major*, from the Museum at Cambridge.

The median vaginal canal had been opened in order to display the interior. The remains of a median septum were visible, and, besides this, two low crescent-shaped folds of the lining membrane, which extend with their concavity forward from the middle line of the ventral wall to the sides. The median canal when traced back becomes much narrowed; it can, however, be followed to a point where it abuts against the left lateral canal just as this opens into the urogenital chamber—at a point, that is, just to the left of the middle line. Although our specimen thus agrees with those of other observers, in the fact that the median chamber is a cul-de-sac, it differs from them in the fact that the walls are continuous by means of their proper tissue with those of the lateral and urogenital canals.

Halmaturus bennetti exhibits the open condition of the median canal. There were well-marked muscular thickenings in the lateral canals, but no valvular folds.

Halmaturus derbianus (no history) was in a similar condition; but the valvular fold was well marked.

The specimen *a* of *Halmaturus ualabatus* was the first example in which our attention was drawn to the subject.

It died in the Society's Gardens on June 30th. The measurement from the nose to the root of the tail was 16 inches—that is, 12 inches shorter than its mother. It was bred in the Gardens, and was taken on the list of the Society's collection on May 19th, *i. e.* at the time when it was old enough to leave the mother's pouch.

The evidence that she had not born young appears to us conclusive.

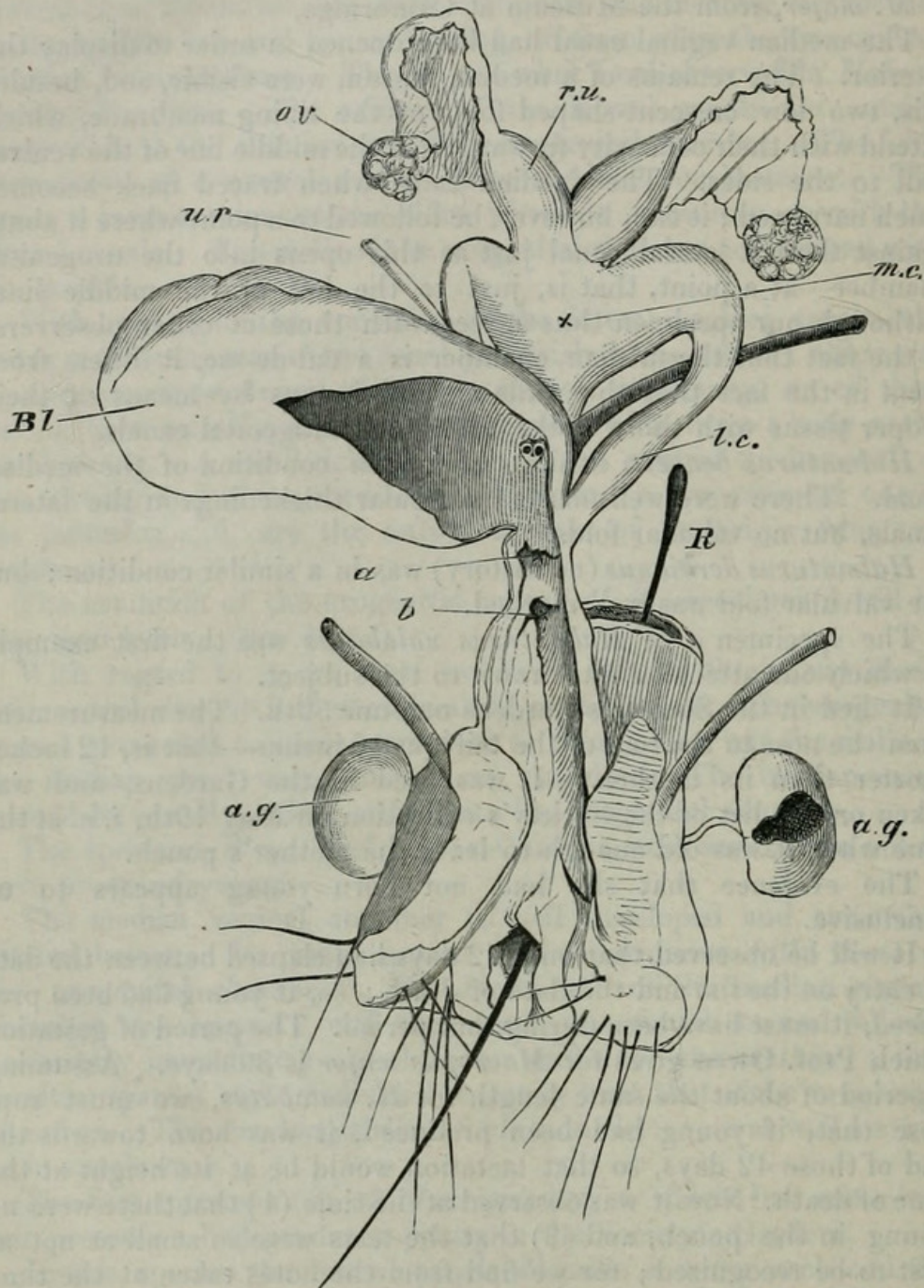
It will be observed that only 42 days had elapsed between the date of entry on the list and the date of death; so, if young had been produced, it must have been during that period. The period of gestation which Prof. Owen gives for *Macropus major* is 39 days. Assuming a period of about the same length for *H. ualabatus*, we must suppose that, if young had been produced, it was born towards the end of those 42 days, so that lactation would be at its height at the time of death. Now it was observed at the time (1) that there were no young in the pouch, and (2) that the teats were so small as not at first to be recognized; for we find from the notes taken at the time that it was not till after a second more careful examination that the four minute teats were seen, arranged in a crescentic line on the body-wall of the pouch.

We may take it for certain, then, that the specimen examined had not born young.

The arrangement found was as follows (see fig. 2, p. 988):—The median vaginal canal was wide in front and gradually contracted posteriorly, where it passed by a distinct opening into the urogenital chamber just above the opening of the urethra. The lateral canals

did not open immediately at the sides of this, but by a common opening about $\frac{1}{4}$ in. further back. The constriction in the lateral canals was very distinct.

Fig. 2.



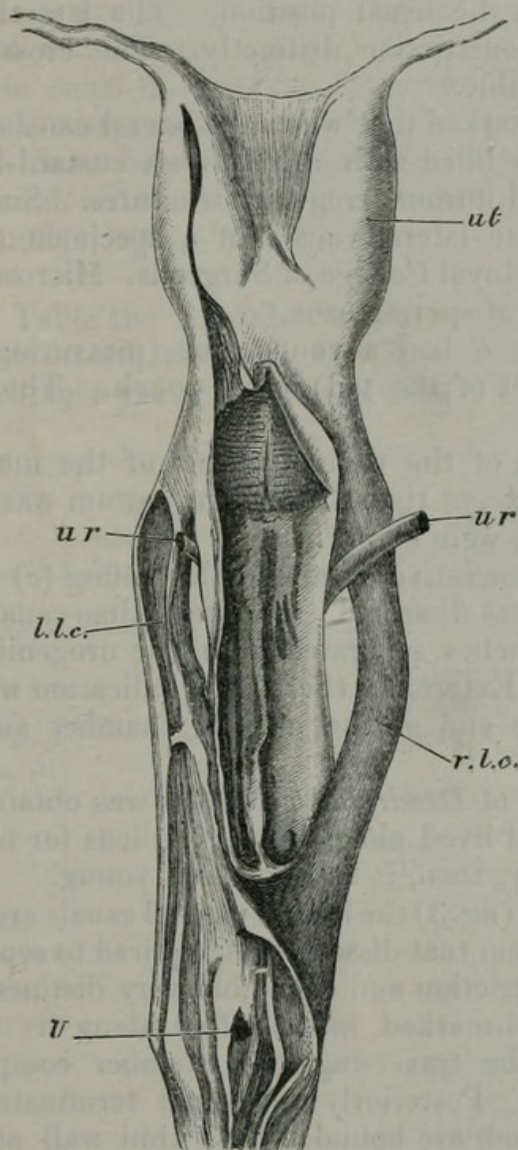
The generative organs of a young *Halmaturus ualabatus* (not bred).

The bladder, urethra, and urogenital sinus have been cut open along the ventral median line. *a*, the opening of the median vaginal canal into the urogenital sinus; *a.g.*, anal glands; *b*, the common opening of the lateral canal into the urogenital sinus; *Bl*, the bladder; *l.c.*, the lateral vaginal canal; *m.c.*, the median vaginal canal; *ov*, ovary; *R*, rectum; *r. u.*, right uterus; *ur*, ureter.

The other specimen (*b*) of this species was an adult which had born young in the Gardens. The median vaginal canal is distinctly

open. The two folds in the urogenital canal are well marked. In this specimen the lateral canals end, as usual, by the sides of this median opening, and not further back as in the young one (*a*). This may have been an individual peculiarity of *a*.

Fig. 3.



The vaginal apparatus of *Dendrolagus inustus*, natural size.

The left uterus, the median canal, the left lateral canal, and the urogenital sinus have been cut open along the dorsal aspect. *l.l.c.*, left lateral vaginal canal; *r.l.c.*, right lateral vaginal canal; *U*, the orifice of the urethra in the urogenital sinus; *ur*, the ureters; *ut*, the right uterus.

The constriction and cross fold in the lateral canals are very distinct.

Of the Rock-Kangaroos (*Petrogale xanthopus*), specimen *a* bore a minute young one in the pouch. The median vaginal chamber

exhibits a rather peculiar structure. The thin median septum—the remains of the coalesced inner walls of the primitively distinct canals—remains more perfect than usual; and at a point rather behind the middle of the median chamber the septum leaves the middle line and becomes joined to the right side, thus forming a right cul-de-sac. The left part of the chamber, however, is continued onward, becomes more spacious where the right-hand one has ceased, and opens by a distinct orifice in the usual position. The lateral canals are long, and show the constriction distinctly. The cross fold, though not prominent, is visible.

It may be remarked that when the lateral canals were opened they were found to be filled with a yellowish custard-like substance, in which lay several fibrous irregular structures. Similar hard bodies were found in the lateral canals of a specimen (2740 B) in the Museum of the Royal College of Surgeons. Microscopic examination showed no trace of spermatozoa.

The specimen *b* had a young one (measuring $8\frac{1}{2}$ in. from the snout to the root of the tail) in its pouch. The young was also a female.

The condition of the vaginal canals of the mother was just as in specimen *a*, except that the median septum was less distinct, and the lateral canals were empty.

The minute generative organs of the young (*c*) (which of course had not bred) were dissected; and the median canal was found to end in two cæcal pouches separated from the urogenital chamber by a thin partition. Externally there is no indication whatever of separation between the end of the median chamber and the urogenital canal.

The specimen of *Dendrolagus inustus* was obtained young by the Society, and had lived alone in the Gardens for nearly three years. In all probability, then, it had not born young.

In this animal (fig. 3) the lateral vaginal canals are so closely applied to the median canal that dissection is required to separate them. They exhibit the constriction and cross fold very distinctly. The median canal has a well-marked median fold along its ventral wall; and delicate trabeculæ traversing the chamber complete the septum here and there. Posteriorly the canal terminates blindly in two lateral cæca, which are bounded by a thin wall at the sides, where they abut against the part where the lateral canals open into the urogenital chamber. The middle line is occupied by a short partition formed by the coalesced inner walls of the converging lateral canals, see p. 989.

The specimen of *Hypsiprymnus gaimardi* had undoubtedly born young. The uteri open on prominences into the anterior end of the median vaginal canal; but the orifices are situated near one another on the dorsal wall, not at the sides as in other forms. The anterior part of the median septum is complete, and separates the two openings. The median canal is long and narrow, and passes down with a median ridge, but no further septum, and ends in two lateral culs-de-sac, one on either side of the middle line; but there is no opening.

The lateral canals pass at first directly outward from a point rather anterior to the uterine orifices; they then turn sharply backward, and after a long even course terminate as usual in the urogenital canal. The chief peculiarity of the lateral canals is that there is no thickening of the muscular walls at any point, and no contraction and no cross fold; the canal pursues an uninterrupted course.

In his paper (already cited) Brass describes a specimen of the genus *Hypsiprymnus* (species not given) which had a large bladder-like prolongation forward of the region, common to the median and lateral canals. The median canal is moreover represented as terminating some distance from the urogenital chamber. In both these points our specimen differs from his. His figure shows the clear passage down the lateral canal, with no muscular thickening and no constriction, very distinctly.

In the following Table the condition of the median canal in the foregoing examples is stated, and also the fact, where it has been ascertained, as to whether young have been born.

Species.	Statement whether young have been born or not.	Condition of median vaginal chamber.	Observers.
Kangaroo (gen.? sp.?)	?	Closed.	Home.
" "	?	Open.	"
" "	Yes.	Closed.	Seiler.
(2) " "	Yes.	"	Owen.
" "	Yes.	Open.	Carus.
(2) <i>Macropus major</i>	Yes.	Closed.	Owen ¹ .
" "	?	"	Vrolik.
" "	?	"	Pagenstecher.
" "	?	"	Alix.
" "	No (?)	"	R.C.S. no. 2739.
(2) " "	?	"	R.C.S. nos. 2740 & 2740 B.
" "	?	Open.	R.C.S. no. 3460 D.
" "	Yes.	"	L. & F.
" "	?	Closed.	L. & F. (Camb. sp.).
(2) <i>Macropus rufus</i>	Yes.	Open.	Alix.
" "	No (young).	Closed.	"
(2) " "	Yes.	Open.	L. & F.
" "	No.	Closed.	"
<i>Macropus parryi</i>	?	Closed.	Owen.
<i>Macropus penicillatus</i> ² ...	?	Open.	R.C.S. no. 2740 D.

¹ It is possible that these two are identical with the "Kangaroos" quoted above.

² We are informed by Mr. Forbes that this animal is properly a *Petrogale*.

TABLE (continued).

Species.	Statement whether young have been born or not.	Condition of median vaginal chamber.	Observers.
(3) <i>Halmaturus bennetti</i>	?	Open.	Poelman.
" "	?	"	Owen.
(3) ¹ " "	?	"	Alix.
" "	?	"	Lucä.
" "	Yes.	"	"
" "	No (young).	Closed.	"
" "	?	Open.	Brass.
" "	?	Closed.	"
" "	No (young).	Open.	"
" "	?	"	L. & F.
<i>Halmaturus ruficollis</i> (<i>bennetti</i>)	?	Open.	Pagenstecher.
<i>Halmaturus billardieri</i> ...	?	Open.	Lucä.
<i>Halmaturus ualabatus</i>	No.	Open.	L. & F.
" "	Yes.	"	"
<i>Halmaturus derbianus</i> ...	?	Open.	L.&F.(Camp. sp.).
<i>Halmaturus agilis</i>	?	Open.	Forbes ² .
<i>Petrogale xanthopus</i>	Yes.	Open.	L. & F.
" "	Yes.	"	"
" "	No (young).	Closed.	"
<i>Dorcopsis luctuosa</i>	Probably not.	Closed.	Garrod.
<i>Dendrolagus inustus</i>	?	Closed.	Owen.
" "	Probably not.	"	L. & F.
" "	?	"	Vrolik.
<i>Hypsiprymnus gaimardi</i> ...	Yes.	Closed.	L. & F.
<i>Hypsiprymnus</i> (sp.?)	?	Closed.	Brass.
<i>Hypsiprymnus murinus</i> ...	?	Closed.	Owen.

Leaving aside for the present the "Kangaroos" which have not been referred to any genus or species, we will proceed to the evidence relating to *Macropus major*. The condition of the median canal in 11 instances is recorded. In two of these young had been produced, and it was closed. In one young had been produced, and it was open. In one young had probably not been produced, for it was a young one, and the median canal was closed. As to the remaining seven, in which the question is uncertain, six of them had the canal closed, and one only had it open. If it be true, as we shall afterwards try

¹ Three is the smallest number ("plusieurs" in addition to the original one.)

² Mr. W. A. Forbes has informed us of this example since the paper was read.

to show, that when the median canal is open and young have been born the young has passed through this opening on its way to the exterior, then the fact that this difference should exist among females which have born young—a difference not only in form but also in function—appears most strange.

With regard to the other species the evidence is far more satisfactory.

Six specimens of *Macropus rufus* have been examined: four of them had born young, and the median canal was open; two of them had not born young (one was not full-grown), and the canal was closed. This seems to show that in *M. rufus* an opening is formed in the median chamber either during pregnancy or at the time of parturition.

The two other species of *Macropus* are isolated examples, and do not throw any additional light on the subject.

The twenty examples of the genus *Halmaturus* may be considered together. It will be observed that in one young one (Lucä's *H. bennetti*) and in one adult (Brass's *H. bennetti*) the median canal was found to be closed, and that in all the rest, including two other young ones (Brass's *H. bennetti* and our *H. ualabatus*), it was open. This seems to show that in the genus *Halmaturus* the median canal may become open before the young have arrived at maturity, but that the thin septum which divides it from the urogenital sinus may remain perfect till after maturity is reached. In either case what evidence there is shows that after young have been born the canal is open.

Our three examples of *Petrogale xanthopus* bear out the same idea; but whether the cul-de-sac is converted into an open canal early (as in some Wallabies), or not till young are about to be born (as in *M. rufus*), the evidence is not sufficient to decide.

As to the specimen of *Dorcopsis luctuosa* and the three of *Dendrolagus inustus*, the evidence as to whether young had been born or not is not conclusive. As far as it goes, however, it is in favour of the latter supposition. That the canal would be open when young had been born, however, in the present state of the evidence it would be rash to assert.

The genus *Hypsiprymnus* offers a different condition from any we have considered: it had undoubtedly brought forth young; and as undoubtedly the median canal is closed. So far our specimen agrees with the examples of *Macropus major* described by Prof. Owen, and with the "Kangaroo" described by Seiler. It differs from the former, however, in the fact that the muscular thickening and constriction in the lateral canals, which are present in all our other specimens, are here absent. Thus in this case, in which the young passed down the lateral vaginal canals, we find a condition of these canals different from that of any of the other Macropodidæ which we have examined.

The observations on the Kangaroos whose species are not given are in agreement with those already considered. Home's two examples are similar to those of *Macropus rufus* already described; but it is not stated whether young had been born.

Carus's specimen, which had bred, corresponds with our example of *Macropus major*, with the other species of *Macropus*, and with the genera *Halmaturus* and *Petrogale*.

Seiler's specimen agrees with Prof. Owen's examples of *Macropus major*; but the extent to which the canals are sometimes found plugged with mucus renders his experiment with quicksilver not perfectly conclusive.

It appears not improbable that Prof. Owen's examples are identical with those of *Macropus major* referred to in his answer to Alix. These have been already considered.

With regard to the course taken by the young in its passage from the uteri, when the median canal is closed it must, of course, pass by one of the lateral canals, whether they be thin-walled and with an even diameter all the way, as in *Hypsiprymnus*, or narrowly constricted at part of their course as in *Macropus*. When the canal is open, however, it appears probable that the young passes through that opening, because it is the directer route and there is no narrow strait to traverse—a view which is supported by the condition in which we found the vaginal canals in the specimen of *Macropus rufus* which had lately produced young, and also by the evidence with regard to the species *M. rufus*; for there is one nearly full-grown example which had not produced young in which the median canal is closed, while in four others which had produced young the canal was open.

Conclusion.

The following statements appear to be borne out by the evidence before us:—

In the very early condition of the Macropodidæ the median canal is closed.

In some genera, viz. *Macropus*, *Halmaturus*, *Petrogale* (*Dorcopsis* and *Dendrolagus*?) an opening is formed in the median canal to give passage to the young. This may take place early in life (*Halmaturus*), or not till young are about to be produced (*Macropus*).

In the species *Macropus major*, however, this opening may or may not exist, and the young may be transmitted either through the median or the lateral canal.

In the genus *Hypsiprymnus* the median canal remains closed, and the young passes down the lateral canals, which differ in their structure from those of the genera above quoted.

Many more observations will be necessary before the question can be settled for the Macropodidæ; and Alix's note on the Wombat shows that the open condition may be found outside the limits of this group.

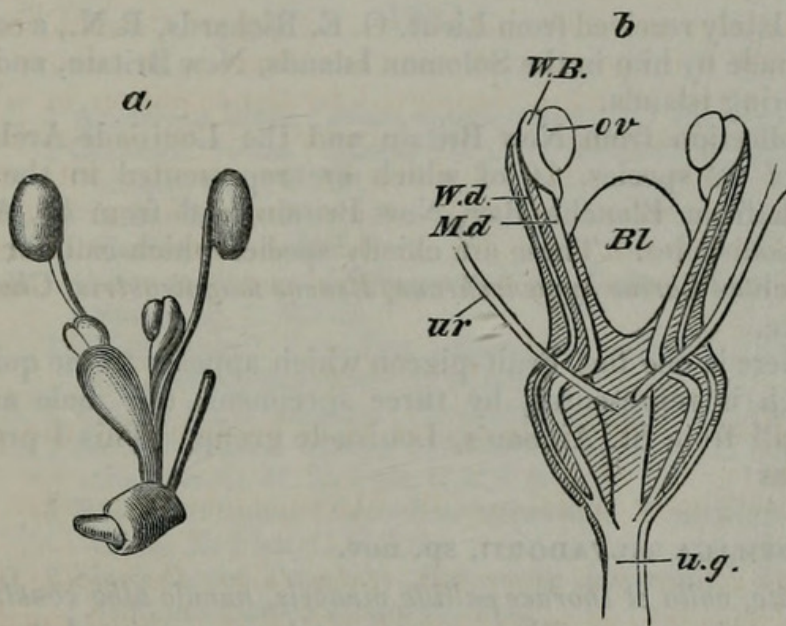
Note.—It may be well to state here the condition of the vaginal canals in the young specimen (*b*) of *Macropus rufus*.

Owing to the very rudimentary condition of the reproductive organs, it is not easy to determine the sex from them. The structure was examined by means of sections cut transverse to the long axis of the

body. The sections of the genital gland were compared with sections of the ovary and testes of the young Rabbit (22–30 days)¹; and the structure was found to resemble the former rather than the latter, although the state of preservation of our specimen is not good enough to allow us to be certain. More satisfactory evidence is afforded by the fact that two oblique folds meeting behind are situated on the ventral abdominal wall, enclosing a rudimentary pouch. As we are not aware that any such rudiment is found in the male, we conclude that the specimen is a female.

Our sections show the Müllerian ducts opening anteriorly into the abdominal cavity. They pass backward along the margin of the Wolffian body by the side of the Wolffian ducts; as these two ducts

Fig. 4.



a. Sketch of urogenital organs of young *Macropus rufus*, from the left ventro-lateral aspect, magnified.

b. Diagram showing the arrangement of the ducts: *Bl*, bladder; *M. d*, Müllerian duct; *ov*, ovary; *u.g*, urogenital sinus; *ur*, ureter; *W. B*, Wolffian body; *W. d*, Wolffian duct.

pass backward they approach the middle line, the Müllerian duct being the inner, the Wolffian duct the outer of the two, while the ureters are external to the Wolffian ducts. Thus at first the Müllerian ducts of the two sides converge; they do not meet, however, the distance between them at their nearest point is three times the diameter of the Müllerian duct. After converging, the ducts pass directly outward, each accompanied by the Wolffian duct, to the outer region of the mass of mesoblast, in which all three sets of ducts (Müllerian, Wolffian, and ureters) are here embedded. They then turn backward again, while the ureters pass inward to the bladder. From this point the Müllerian and Wolffian ducts again converge. Posteriorly

¹ These sections were kindly lent us by Mr. F. M. Balfour.



Lister, J J and Fletcher, J. J. 1881. "On the Condition of the Median Portion of the Vaginal Apparatus in the Macropodidae." *Proceedings of the Zoological Society of London* 1881, 976–995.

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