XVII. *On the Generation of the Marsupial Animals, with a Description of the Impregnated Uterus of the Kangaroo. By* RICHARD OWEN, *Esq., M.R.C.S. and Assistant Conservator of the Museum of the Royal College of Surgeons, London. Communicated by Sir* ANTHONY CARLISLE, *F.R.S.*

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THE *Marsupiata*, or *Animalia crumenata*, as the learned SCALIGER designated the few American species which were known in his time, now form in the systems of natural history an extensive series, embracing genera nourished by every variety of food, and exercising in quest of it as many different modes of locomotion as have been observed in other quadrupeds. Their instruments of progression, prehension, and digestion accordingly exhibit corresponding modifications of structure; while in other parts of their organization peculiarities are found to prevail with a degree of uniformity that justifies the consideration of the *Marsupiata* as a distinct group of *Mammalia*.

In all the genera of this group the uterus is double, and the true vagina is separated, either wholly or for a considerable extent, into two lateral canals. Both the digestive and generative tubes terminate within a common cloacal outlet, and the term *Monotremata*, therefore, though confined to the Edentate *Marsupiata*, is so far applicable to the whole of this aberrant division.

As the females approach the Oviparous *Vertebrata* in their separate genital tubes, so also the males resemble them in the peculiar structure and connexions of the intromittent organ; thus, in the *Macropi*, the *Dasyuri* and the *Phalangistæ*, the corpora cavernosa penis have the same position below the pubis, with the same want of ligamentous attachment to the bony pelvis; and the glans has the same bifurcated form and double groove for the transmission of the semen as in the Opossum, in which these peculiarities of the male organs were first accurately described by COWPER*.

In those genera in which the females have an inward fold of integument, or abdominal pouch, the males have an outward duplicature in the corresponding situation for the lodgement of the testes, which are thus placed anterior to the penis; and it is a remarkable fact, that the muscle which surrounds the mammary gland in the one sex is analogous to the suspensory cremaster of the testis in the other.

Both sexes in the marsupial genera manifest also their affinity to the oviparous classes in possessing two superior venæ cavæ, and in the want of the inferior mesenteric artery: and the marsupial bones, so common in the skeletons of reptiles, are

* Philosophical Transactions, vol. xxiv. (1704.) p. 1576.

limited in the mammiferous class to this division, in which alone, from the peculiarly brief period of uterine gestation, and the consequent non-enlargement of the abdomen, their presence might be expected. But these bones serve important purposes in relation to the generative economy of the *Marsupiata*. In the female they assist in producing a compression of the mammary gland necessary for the alimentation of a peculiarly feeble offspring, and they defend the abdominal viscera from the pressure of the young as these increase in size during their mammary or marsupial existence, and still more when they afterwards return to the pouch for temporary shelter. In the males, with the exception of the edentate genera, the marsupial bones, from their relation to the cremaster muscles, which wind round them like pulleys, assist in the compression and retraction of the testes during coition; a process which, from the peculiar position of the scrotum, has been supposed to differ from that of other quadrupeds. A recent opportunity, however, of observing the coitus of the Kangaroo at the Zoological Gardens, proves that there is no difference as to position, which is the same as in the Dog, but that it is chiefly remarkable for the frequent repetition of the act during a long-continued embrace. The peculiar length and tortuosity of the double vagina, for which the bifurcated glans of the male organ is adapted, may render necessary so efficient a process; and as the testes are then retracted entirely out of sight, it would seem that the marsupial bones have the same relation in the male to their secretion as they have in the female to that of the mammary glands.

The minute size of the young of the American Opossum when found in the marsupium, their pendulous attachment to the nipples, and perhaps the mode in which the latter were developed, gave rise among the earlier observers to a supposition that they were originally formed from those parts, and the gemmiparous theory, which has subsequently often been revived, appears to have been prevalent at the time when Tyson first devoted his attention to the subject.

The discovery of the uterus of the Opossum, recorded by Tyson in the twentieth volume of the Philosophical Transactions (p. 139.), was the first step towards a correct explanation of the generative economy of the *Marsupiata*. That learned and accurate anatomist offers a true conjecture as to the parts of their complex uterine apparatus in which the processes of gestation are carried on, which he denominates the *cornua uteri*, and is the first who distinguishes the true vaginæ from the "*common passage*, or *canalis*," subsequently termed the *urethro-sexual canal*.

The subject of marsupial generation has ever since been regarded as one of peculiar physiological interest, and the labours of Hunter*, Home†, Geoffroy St. Hilaire‡,

* Zoological Appendix to White's New South Wales, p. 272.

† Philosophical Transactions, vol. lxxxv. (1795); Lectures on Comparative Anatomy, iii.

‡ 1) Journal Complémentaire du Dictionnaire des Sciences Médicales, tom. iii. p. 193. (1819.) "Si les animaux à bourse naissent aux tétines de leur mère?" 2) Système sexuel des Animaux à bourse, Mém. du Mus. tom. ix. p. 193. (1822.) 3) Anatomie Philosophique, tom. ii. pp. 354, 397. 4) Art. *Marsupiaux*, Dict. des Sciences Nat. tom. xxix. (1823.)

Fig. 1

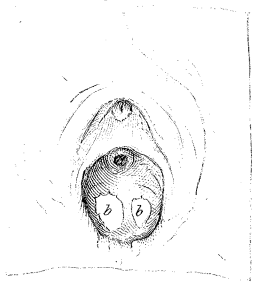


Fig. 2

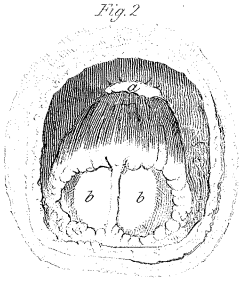


Fig. 3

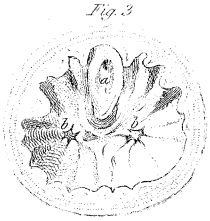


Fig. 7

Fig. 5

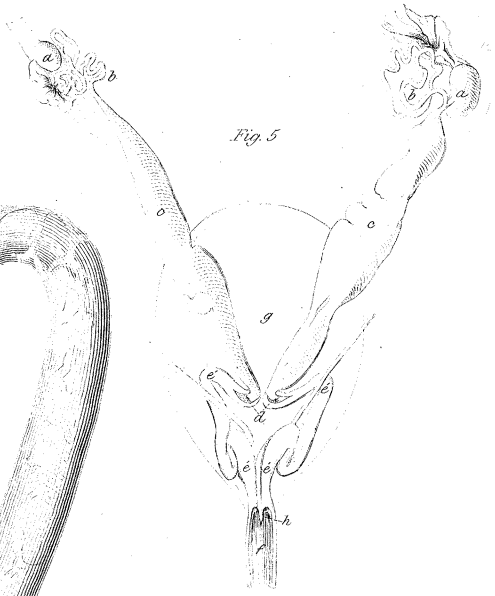


Fig. 4

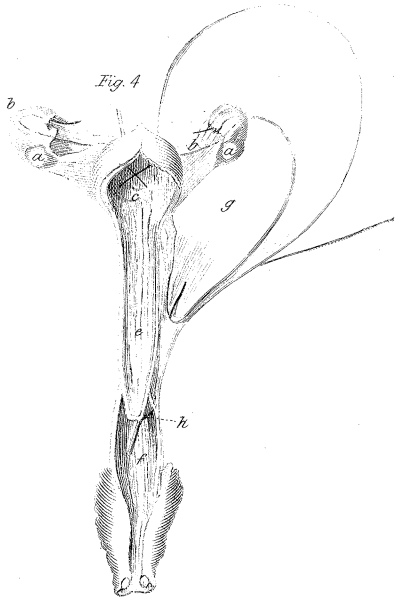
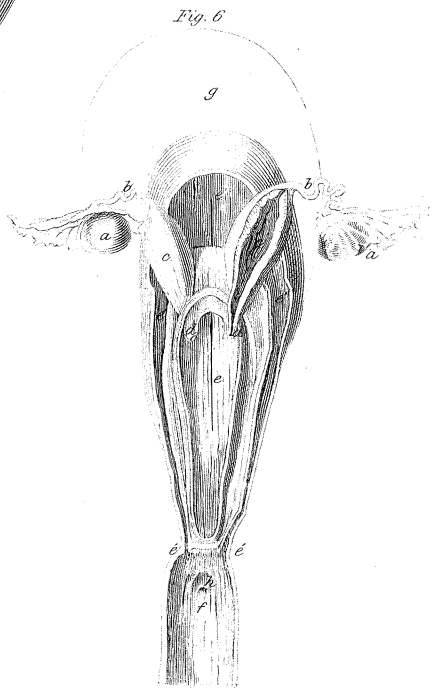


Fig. 6



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Blainville* and Morgan†, have more especially been devoted to its elucidation; but the attainment of a precise knowledge of the mode in which the embryo was developed,—the more desirable on account of the abovementioned affinities of the *Marsupiata* to the *Ovipara*,—has been prevented by the want of opportunities to examine the impregnated uterus, so as to determine the nature of the relations subsisting between the fœtus and mother.

This deficiency I have the good fortune to be in some degree enabled to supply through the exertions of my friend Mr. George Bennett, F.L.S., who during his recent travels in New South Wales procured the gravid uterus of a female of the large Kangaroo (*Macropus major*, Shaw), and safely transmitted it in spirits to the Museum of the Royal College of Surgeons in London, where it is now preserved, and where I have had the opportunity of examining it for the present communication, through the liberal permission of the President and Board of Curators.

The fœtus was contained in the left uterus (Plate VI. fig. 7. *c'*.), which was three times the diameter of the same part in the unimpregnated state. This uterus measured two inches in length and one inch three lines in diameter, exclusive of the Fallopian tubes. Its parietes varied in thickness from one line to two lines, being in the unimpregnated state about half a line; and this increase was not in the muscular coat, but was chiefly occasioned by the thickening of the internal membrane, which was produced into irregular folds and wrinkles, having, however, a smooth surface when put upon the stretch, and closely resembling the same part in the uterus of the *Ornithorhynchus paradoxus*.

The fœtus had been exposed by a longitudinal incision through the coats of the uterus, and a corresponding one in the most exterior of its envelopes, but had not apparently been otherwise disturbed. It was bent upon itself in the usual manner, with the nose almost touching the thick stem of the embryonic membranes, or umbilical chord. Its whole length in a straight line was seven lines, but when measured along the curve of the back to the extremity of the tail, its length was one inch four lines; the length of the head three and a half lines.

The examination into the nature of the connexion between the mother and fœtus was made in presence of Mr. Clift, for whose kind and valuable assistance I am much indebted.

The edges of the uterus where it had been cut open by Mr. Bennett were carefully examined with the lens, whilst immersed in clear spirit, but no trace of a divided placenta could be detected; the pulpy projections from these edges were satisfactorily seen to be folds of the lining membrane. The only point to which the fœtal membranes seemed to adhere was near the cut margin of the uterus on the right side, but this was found to arise from insinuation of the chorion between folds of the lining

* "Sur les Organes femelles de la Génération et les Fœtus des Animaux didelphes;" Bulletin de la Société Philomathique, 1818, p. 25.

† Transactions of the Linnean Society, vol. xvi. pp. 61, 455.

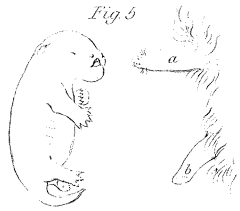
membrane, which came away when these were separated; and there was not any appearance of a placental structure, or of villi, or a determination of vessels to this point, on either of the opposed surfaces of the chorion or uterus. The greater part of the membranes of the fœtus was collected into a wrinkled mass, which was removable from its position, together with the fœtus, by the slightest pressure of the probe.

The chorion was extremely thin and lacerable; and upon carefully examining its whole outer surface, no trace of villi or of vessels could be perceived. Detached portions were then placed in the field of a microscope, but without the slightest evidence of vascularity being discernible. The next membrane, whose nature and limits will be presently described, was seen extending from the umbilicus to the inner surface of the chorion, and was highly vascular. The fœtus was immediately enveloped in a transparent amnios. The four extremities and tail were very obvious, but the toes of the hind legs were not developed. The nostrils were open and proportionately large; the eyelids were not fully formed, but allowed a little of the eyeball to appear. The tongue projected from the mouth, which, from the imperfect growth of the jaws, appeared more naturally open than in the mammary fœtus. The auditory passages were indicated by slight longitudinal depressions, below which the branchial apertures, one on either side, each about half a line in length, were very conspicuous. On dilating these apertures two passages were seen leading from each of them to the pharynx. The anterior extremities were well set off from the body, and the five toes on each were very apparent, terminated by minute glistening horny claws. The length of each fore leg was two lines, that of the hind leg only one line, terminated by a flattened, undivided, club-shaped mass. The tail was two lines long, thick and strong at the commencement. Impressions of the ribs were visible at the sides of the body. The membranous tube of the spinal marrow was visible along the back between the ununited elements of the vertebral spines. Posterior to the umbilical chord there was a small projecting penis, and behind that, on the same prominence, was the anus, which was pervious.

The external membrane, or chorion (Plate VII. fig. 1. *a*.), corresponded in extent with the enlarged cavity formed by the plication of the lining membrane of the uterus which contained the fœtus. Its texture in every part was delicate and almost friable; it was opake and minutely wrinkled. A reiterated examination was made, with a view to discover any trace of a vascular or villous structure, such as exists in the chorion of the Mare and Sow; but the chorion presented in this respect a similar condition with the membrana putaminis or membrana corticalis of the oviparous embryo.

On turning the chorion away from the fœtus, it was found to adhere to the vascular membrane above mentioned, into which the umbilical stem suddenly expanded. With a slight effort, however, the two membranes could be separated from each other without laceration for the extent of an inch; but at this distance from the umbilicus the chorion gave way on every attempt to detach it from the internal vascular mem-

Fig. 5



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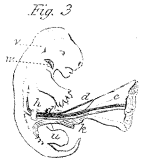

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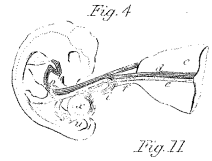

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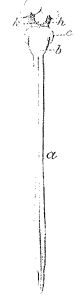

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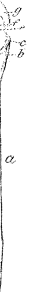
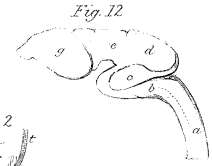


Fig. 6

Fig. 6*

Fig. 12



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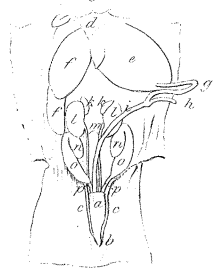

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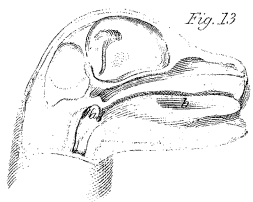

Fig. 14.

brane, which here was plainly seen to terminate in a well-defined ridge, formed by the trunk of a blood-vessel.

When the whole of the vascular membrane (Plate VII. fig. 1. *c*.) was spread out, its figure appeared to have been that of a cone, of which the apex was the umbilical chord, and the base the terminal vessel above mentioned. Three vessels could be distinguished diverging from the umbilical chord, and ramifying over it. Two of these trunks contained coagulated blood, and were the immediate continuations of the terminal or marginal vessel; the third was smaller, empty, and evidently the arterial trunk. Besides the extremely numerous ramifications dispersed over this membrane, it differed from the chorion in being of a yellowish tint, which is still perceptible in the preparation. No trace of any other membrane could be seen extending from the fœtus besides the two above described, and the amnios (Plate VII. fig. 1. *b*.), which was reflected from the umbilical chord, and formed, as usual, the immediate investment of the fœtus.

The umbilical chord measured two lines in length and one in diameter. It was found to contain the three vessels above mentioned, with a small loop of intestine; and from the extremity of the latter, a filamentary process was continued to the vascular membrane. The margins of the umbilicus or abdominal opening were very strong, offering much resistance to their division. On tracing the contents of the chord into the abdomen, the two larger vessels with coagulated blood were found to unite; the common trunk then passed backwards beneath the duodenum, and after being joined by the mesenteric vein, went to the under surface of the liver, where it penetrated that viscus: this was consequently an omphalo-mesenteric or vitelline vein. The third vessel passed between the convolutions of the small intestine, along the mesentery, to the abdominal aorta, corresponding to an omphalo-mesenteric or vitelline artery. The membrane, therefore, upon which they ramified answered to the vascular layer of the germinal membrane, which spreads over the yolk in the oviparous animals, or to the umbilical vesicle of the embryo of ordinary *Mammalia*. The filamentary pedicle which connected this membrane to the intestine was given off near the end of the ileum, and not continued from the cæcum *, the rudiment of which was very evident half a line below the origin of the pedicle.

The small intestine above the pedicle was disposed in five folds. The first from the stomach, or duodenum, curved over the vitelline vein, and the remaining folds were disposed around both the vitelline vessels. From the cæcum, which was given off from the returning portion of the umbilical loop of intestine, the large intestine passed backwards to the spine, and then, bent at a right angle, straight down to the anus. The stomach did not present any appearance of the sacculated structure so remarkable in the adult, but had the simple form of a carnivorous stomach.

* The umbilical vesicle, though small, is very conspicuous in the embryo of the Porpesse when two inches in length, but there is no cæcum in this animal; affording, therefore, with the Kangaroo, both negative and positive proof that the cæcum in *Mammalia* is not a remnant of the yolk-duct.

The liver consisted of two equal and symmetrically disposed lobes. The vena portæ was formed by the union of the vitelline with the mesenteric and doubtless the other usual veins, which were, however, too small to be distinctly perceived. The diaphragm was very perfectly formed.

The vena cava inferior was joined, above the diaphragm, by the left superior cava, just at its termination in a large right auricle. The ventricles of the heart were completely joined together, and bore the same proportions to each other as in the adult; a perfection of structure which is not observed in the embryos of ordinary *Mammalia* at a corresponding period of development. The pulmonary artery and aorta were of nearly the same proportionate size as in the adult: the branches given off by the former to the lungs were of considerable size. The ductus arteriosus, on the contrary, was remarkably small. The aorta, prior to forming the descending trunk, dilated into a bulb, from which the carotid and subclavian arteries were given off. This bulb, which is permanent in Fish and perennibranchiate Reptiles, is always a prominent structure in the earlier stages of the embryonic heart in pulmoniferous *Vertebrata*. I was unable to trace the branchial arteries so satisfactorily as the conspicuous nature of the external openings had led me to expect, owing to the long maceration of the specimen.

The lungs were of equal size with the heart, being about a line in length, and nearly the same in breadth: they were of a spongy texture, and of a red colour, like the veins, from the quantity of blood they contained. This precocious development of the thoracic viscera is an evident provision for the early or premature exercise of the lungs as respiratory organs in this animal; and on account of the simple condition of the alimentary canal, the chest exceeds the abdomen in size.

The kidneys had the same form and situation as in the adult. The supra-renal glands were half the size of the kidneys.

The testes were situated below the kidneys, and were one half larger than those glands, the superiority of size depending on their large epididymis. They continue within the abdomen for six weeks after uterine birth.

There was no perceptible trace of an allantois, nor even of an urinary bladder, in this fœtus*.

With respect to the largely developed umbilical vesicle, as it had been laid open before the parts were immersed in spirit, the nature of its contents could not be ascertained; but the quantity of what must be supposed to have been nutritious material had evidently been abundant. As the affinity of the *Marsupiata* to the oviparous *Vertebrata* has been believed to be manifested more particularly in the development of the ovum and ovisac, or corpus luteum, it may not be superfluous to offer a few observations on the differences observable in this respect between *Mammalia* and

* I have subsequently detected the remains of a urachus and of umbilical or vesical arteries in a mammary fœtus of a Kangaroo about a fortnight old, and of a urachus in very small mammary fœtuses of a *Petaurus pygmæus* and of a *Phalangista*.

Aves, in order to show the extent and nature of the correspondence above alluded to, and at the same time to form a probable opinion of the source whence the contents of the umbilical vesicle had been in the present instance derived. In Birds, the material of the yolk is added to the efficacious part of the ovum (the vesicle of PURKINJE,) while in the ovary, and the ovum consequently acquires a considerable size from the accumulation of the vitelline matter before it passes into the oviduct, which presents a corresponding capacity for its reception. DE GRAAF long ago observed, that small as were the perfected ova in the ovaries of quadrupeds, in comparison with those in the ovaries of birds, yet the vesicle which was discovered after impregnation in the Fallopian tube was still more minute than the ovarian vesicle from which he conjectured that it had escaped. Thus, in his celebrated experiments on the Rabbit, he observes of the female organs seventy-two hours after impregnation: "In altero autem testiculo quatuor folliculos invenimus, quorum tres aliquantulum magis lucidi, minorique foramine pertusi videbantur, in quorum etiam medio tantillum limpidissimi liquoris adinvenimus: at quartus folliculus obscurior erat, nec quicquam liquoris in se continebat; quamobrem ovum ex hoc folliculo elapsum suspicabamur, quâ de causâ ejusdem lateris cornu et oviductum perscrutati sumus, ac unicum tantùm ovum in ipso cornu principio deprehendimus, perpusillis alterius lateris ovis simillimum *."

Mr. CRUIKSHANK, who repeated these experiments of DE GRAAF, succeeded in detecting the ovulum in the Fallopian tube of the Rabbit on the fourth day after impregnation, and believes that he saw it in the corpus luteum, as he terms the Graafian follicle, observing, "The pouting part I believe is the ovum, and stands upon the top of the corpus luteum: it is very vascular, particularly at its basis; but as soon as perfect, or ready for expulsion, carries no red blood: it continues to grow of itself in utero, without adhering to the uterus for two or three days, then takes root and becomes very vascular †."

Any doubts that might still remain as to the pre-existence of the ovulum in the Graafian follicle of the *Mammalia* have been in great measure dispelled by the more recent and accurate observations of VON BAER, who considers it identical with the pellucid vesicle a short time before discovered by PURKINJE in the ovary of the Fowl, around which the yolk accumulates to form the ovum prior to its passage into the oviduct.

Escaping then from the ovary without being inclosed within this superadded material, the ovulum in *Mammalia* passes along the oviduct or Fallopian tube, which is consequently of small diameter. It increases in size, according to DE GRAAF and VON BAER, as it passes along the tube, by imbibition of nutrient material; and this mode of increase goes on rapidly after it has reached the uterus. The granules contained in the so-imbibed fluid accumulate at its periphery, and constitute the germinal membrane; and while the ovum yet floats freely in the uterus, villi, in the ordinary *Mammalia*, are observed to shoot out from the chorion or external membrane. But

* DE GRAAF, Opera Omnia, p. 400.

† Philosophical Transactions, vol. lxxxvii. p. 206.

notwithstanding the different condition of the ovum of the bird when it reaches the oviduct, it must be observed that the material to be employed in constructing the embryo is derived, as in *Mammalia*, from the oviduct. It is the white of the egg which disappears during incubation, while the greater part of the yolk is inclosed in the abdomen of the chick at the conclusion of that process; so that, although the yolk has a prior existence to the albumen, and is generated in the ovary itself, it is analogous in its function to the milk which nourishes the new-born mammal.

Without, however, entering into the further uses of the yolk in birds, which affords an admirable example of prospective design, it is sufficient for the present purpose to observe, that while it affords the chief differential feature between the oviparous and mammiferous ovum as this is first received into the oviduct, so a corresponding difference is manifested in the structure of the recipient tube as well as in the ovary itself.

Now the true Fallopian tubes of the Kangaroo closely resemble, both in relative size and in structure, those of the ordinary *Mammalia*. The difference is manifested in the greater proportional extent of the fimbriated extremity and its relations to the ovary, which are circumstances in which the ordinary *Mammalia* also differ among each other.

From this accordance, therefore, and from the circumstance of the young being nourished after birth by the secretion of mammary glands, it may be safely concluded that the ovulum in the Kangaroo quits the ovisac in a condition corresponding to that in the ordinary *Mammalia*, and increases in a similar manner as it descends to the uterus.

Additional evidence in favour of a correspondence in the original development of the primordial germ in marsupial and ordinary *Mammalia* is derivable from the structure of the ovary itself, and especially from its appearance after impregnation.

The cellular structure or parenchyma of the ovary, in which the ova are developed, is as dense in the Kangaroo as in the ordinary *Mammalia*. The cavity of the Graafian follicle or ovisac from which the germ of the fœtus above described had escaped, was partly occupied by coagulated caseous substance, and partly by the irregularly thickened membrane of the ovisac; thus forming a corpus luteum* as in other *Mammalia*: this was of a large size in proportion to the rest of the ovary, and the external orifice, probably from the abundance of the secretion as well as from the dense structure of the ovarian capsule, had not become cicatrized. In Birds, on the contrary, owing to the delicate and yielding nature of the stroma ovarii and from the tenuity of the capsule of the ovary, permanent corpora lutea are not formed except under accidental circumstances.

* The corpus luteum in another Kangaroo, six months after impregnation, I found to be composed of a spherical body from two to three lines in diameter, of a pink colour and fleshy substance; the membrane covering this body was vascular, and the cicatrix had nearly disappeared. A corpus luteum, eighteen months after impregnation, was of smaller size, did not project from the ovary, and was of a dark colour and firm texture.

Actual observation can alone, however, be relied upon to establish satisfactorily the precise relations subsisting between the *Marsupiata* and ordinary *Mammalia* at the first stages of their development; but so far as analogous reasons can be deduced from observations on the structures immediately concerned, there appears no ground for concluding that any material difference exists in the formation of the ovum in the ovary, or the condition in which it arrives at the uterus. But in the Kangaroo the uterus is evidently destined, from the great development of the lining membrane, to afford an abundant secretion for the increase of the ovum after it has passed into that cavity; and the chorion, when two thirds of gestation have elapsed, still manifests the same condition as in the earliest period of the ovum in ordinary *Mammalia*. No villi have been put forth from its external surface, no adhesion has taken place between it and the inner membrane of the uterus, nor does it appear to have been organized in any part so as to act as a placenta. Granting, therefore, that the membrane organized by the omphalo-mesenteric vessels is an adequate medium for the transmission of the nutrient material to the embryo, it still remains to be determined how its respiration is effected. It is, however, very probable, that notwithstanding the interposition of the chorion, a chemical combination does take place between the carbon of the fœtal blood distributed over the widely extended umbilical vesicle, and the oxygen of the maternal arterial blood distributed over the highly vascular lining membrane of the uterus; and this interchange may be sufficient for the purposes of a fœtus so imperfect, and during an uterine existence so peculiarly brief, as in the Kangaroo.

In the ova of Fishes, the vascular membrane expanded over the yolk, not being separated from the membrana corticalis by an intervening mass of albumen, suffices for respiration as well as nutrition, until the permanent respiratory organs, the gills, are sufficiently developed. And in the higher Reptiles and Birds, the temporary structure superadded to the vascular covering of the yolk, for the more express purpose of eliminating the effete particles of the growing embryo, does not begin to expand until a late stage of formation.

In the Hunterian series of the incubation of the Gosling, the development of the embryo is seen to have advanced to the formation of the head and eyes, and to the distinct production of the four extremities, whilst the allantois is yet a small vesicle protruding at the posterior extremity of the abdomen; and until this membrane, by its rapid increase and the coextension of the umbilical vessels, has attained to, and spread itself over, the inner surface of the shell, it is still more difficult to explain the mode in which respiration is effected in the embryo of the Bird than in that of the Kangaroo.

But limited as these embryos are in their vital actions to that of simple growth, a more perfect means of respiration would seem unnecessary; and among the inferior animals, the *Entozoa* exhibit to us beings totally excluded from the atmosphere, yet enjoying still greater powers of action, and in the Nematoidean order, even generating

by distinct sexes, without the slightest trace in their structure of a respiratory apparatus.

As in the Bird, however, so in the ordinary *Mammalia* there is a period when a temporary respiratory organ is essential to the continuance of intra-uterine existence. But previous to the production of this, it is now ascertained that every mammal is developed by means of omphalo-mesenteric vessels; and it is interesting to observe, that the membrane over which they are spread, or the umbilical vesicle, is largest and most permanent in the order *Glires*, which, next to the *Marsupiata*, exhibit the most striking affinities to Birds, and to which the *Marsupiata* pass by the most natural and unbroken transition.

The temporary organ for the elimination of the effete particles of the mammiferous embryo is at first, as in birds, an allantois, which, extending from the lower part of the intestine, is developed in different proportions in the different orders; but the umbilical vessels coextended with it rapidly seek a more intimate contact with the vascular surface of the womb, and accordingly proceed to organize the chorion, shooting out into villi, either extended over the whole surface, as in the Mare; or disposed in circumscribed tufts, as in the Ruminants; or limited to one particular spot, as in the Human subject and in all the ordinary Unguiculate quadrupeds.

It would appear, indeed, from the examination of the small mammary fœtuses of the Kangaroo, Petaurus, and Phalangista before mentioned, that an allantois and umbilical arteries are developed at a later period of gestation than the uterine fœtus here described had arrived at. None of the above specimens, however, presented any trace of an umbilical vein extending to the liver, and I therefore regard it as improbable that the umbilical arteries spread over the chorion to organize a placenta. As, moreover, the uterine fœtus preserved by Mr. Bennett had attained two thirds of its full size as such, it is not likely that the allantois would afterwards be developed further than to serve as a receptacle of urine; and it is interesting to observe that it is arrested at this point in the Batrachian Reptiles. So far, therefore, as the evidence of this specimen goes, it may be concluded that the chorion does not become organized, and that the *Marsupiata* are essentially ovoviviparous.

In regard to their fœtal membranes and appendages they resemble the embryos of the Fowl and ordinary *Mammalia* at the earliest stages of development; but when growth has extended so far as to render respiration by an umbilical vesicle no longer adequate to the continuance of intra-uterine existence, instead of a temporary structure being specially organized for that purpose, the lungs are precociously developed, and the embryo of the marsupial quadruped quits the uterus prematurely, and breathes the air.

§ 2. *On the Mammary Fœtus of the Marsupiata.*

The period of uterine gestation in the Virginian Opossum, according to Barton, is twenty-six days; the accuracy of which observation is confirmed by Rengger's expe-

riments on an Opossum (*Didelphys Azaræ*, Temm.) of about the same size, in which the uterine gestation lasted twenty-five days.

In the Kangaroo (*Macropus major*, Shaw,) uterine gestation continues thirty-nine days, which seems still more remarkable for its shortness, if we consider the difference in the size of the Opossum and Kangaroo. A longer period has, indeed, been stated to elapse between the impregnation and parturition of the latter animal; but the precautions taken to ensure accuracy in the observations which led to the determination of the period of thirty-nine days were such as to admit of no source of error; and the size of the mammary fœtus figured by Sir Everard Home in the 85th volume of the Philosophical Transactions could hardly be reconciled with the duration of four months assigned to uterine gestation in the Kangaroo by Professor Geoffroy St. Hilaire *.

The period of gestation was determined in a female Kangaroo in the Menagerie of the Zoological Society. She was placed with the male only at such times as they could be watched. She had a young one of the previous year, which had quitted the pouch, but was still sucking occasionally. The coitus was observed on the 27th August 1833, at 1 P.M.; and as it was known that she could not have had intercourse with the male for three months prior to this date, that fact, and the size of the young one when she was selected for the experiment, left no doubt of her being unimpregnated until the date above mentioned. She was separated from the male the same day, and was kept apart in a separate shed and paddock until parturition took place. And here I must express my great obligations to the Council of the Zoological Society for the permission given me to conduct my experiments under circumstances so favourable as are afforded in their noble Vivarium: every arrangement in the building appropriated to the kangaroos which could facilitate my observations on them was promptly effected, and the services of an intelligent keeper were allotted to me.

In order to inure the female to the examinations of the pouch when they should become indispensable, they were commenced six days after the copulation, and were repeated every morning and evening until the 5th October, when, at 7 A.M., the fœtus was discovered in the pouch attached to the left superior nipple. On the preceding day, at the same hour, a greater quantity of the moist brown secretion peculiar to the pouch was noticed, indicating a commencing determination of blood to that part; and at different periods during the day the female was observed to put her head into the pouch and lick off the secretion. When she was again examined at six o'clock in the evening, a slight increase of the secretion was the only perceptible change in the state of the pouch; but there was no appearance in the nipples indicative of the event so soon about to take place.

The nipple in use by the young one of the previous year was the right superior, or anterior one: it was nearly two inches in length, and one third of an inch in diameter, while the other three were about half an inch in length, and about a line in diameter. I took notes of the appearance of the marsupium on the 6th, the 10th, 15th,

* Annales des Sciences Naturelles, tom. ix. p. 340.

21st, 30th, and 38th days of uterine gestation: no material alteration was, however, observable till after the death of the young Kangaroo of the previous year, which took place on the 25th day, when the brown secretion first began to appear, and the nipple that had been in use, to diminish.

As parturition took place in the night, the mode of transmission to the pouch was not observed. No blood or albuminous discharge could be detected on the litter, nor any trace of it on the fur between the vagina and orifice of the pouch; but these might have been removed by the mother. The appearances presented by the little one thus detected within twelve hours after being deposited in the pouch were as follow:—It resembled an earth-worm in the colour and semitransparency of its integument, adhered firmly to the point of the nipple, breathed strongly but slowly, and moved its fore legs when disturbed. Its body was bent upon the abdomen, its short tail tucked in between the hind legs, which were one third shorter than the fore legs, but with the three divisions of the toes now distinct. The whole length from the nose to the end of the tail, when stretched out, did not exceed 1 inch 2 lines.

On the 9th of October I again examined the pouch: the young one was evidently grown, and respired vigorously. I determined to detach it from the nipple for the following reasons: 1st, to decide the nature of the connexion between the fœtus and nipple; 2ndly, to ascertain, if possible, the nature of the mammary secretion at this period; 3rdly, to try whether so small a fœtus would manifest the powers of a voluntary agent in regaining the nipple; and, lastly, to observe the actions of the mother to effect the same purpose, which one might presume would be instinctively analogous to those by means of which the fœtus was originally applied to the nipple.

With respect to the first point, I was aware that the Hunterian dissections as exhibited in the preparations in the Museum of the College, and the observations of Mr. Morgan * and Mr. Collie †, concurred in disproving the theory of a vascular mode of connexion between the mammary fœtus and the nipple; nevertheless, as a discharge of blood had been stated by Geoffroy St. Hilaire to accompany marsupial birth, or the spontaneous detachment of the fœtus from the nipple ‡, and even the anastomoses and distribution of the continuous vessels in the neck of the fœtus had been speculated on by him §, it became desirable to have ocular demonstration of the real state of the facts. The fœtus retained a firm hold of the nipple: when it was detached, a minute drop of whitish fluid, a serous milk, appeared on the point of the

* Transactions of the Linnean Society, vol. xvi. p. 459.

† Zoological Journal, No. xviii.

‡ "Car le sang aperçu à la litière est un indice qu'à ce moment le fœtus s'est detaché de la tétine, et qu'il est né definitivement à la manière des marsupiaux."—Geoffroy St. Hilaire, Annales des Sciences Naturelles, tom. ix. p. 342.

§ "Des vaisseaux nourriciers se repandroient-ils des parties du pharynx le long et entre les lames de la trachée artère pour entrer dans le cœur, et (conjecture de M. Serres,) la gland thyroide seroit-elle le point de leur reunion? J'ai manqué des sujets pour vérifier ses aperçus."—Geoffroy St. Hilaire, Mém. du Muséum, tom. xix. p. 406.

nipple. About half a line of the extremity of the nipple had entered the mouth, which extremity was of smaller diameter than the rest of the nipple, not being as yet so compressed by the contracted orifice of the mouth as to form a clavate extremity, such as it afterwards presents. The young one moved its extremities vigorously after being detached, but did not make any apparent effort to apply its legs to the integument of the mother, so as to creep along, but seemed, in regard to progressive motion, to be perfectly helpless. It was deposited at the bottom of the pouch, and the mother was liberated, and carefully watched for an hour.

She immediately showed symptoms of uneasiness, stooping down to lick the orifice of the vagina, and scratching the exterior of the pouch. At length she grasped the sides of the orifice of the pouch with her fore paws, and drawing them apart, as in the act of opening a bag, she thrust her head into the cavity as far as the eyes, and could be seen moving it about in different directions. During this act she rested on the tripod formed by the tarsi and tail. She never meddled with the pouch while in the recumbent posture, but when stimulated by uneasy sensations, she immediately rose and repeated the process of drawing open the bag and inserting her muzzle, sometimes keeping it there for half a minute at a time. I never observed that she put her fore legs into the pouch; they were invariably employed to widen the orifice. When she withdrew her head, she generally concluded by licking the orifice of the pouch and swallowing the secretion. After repeating the above act about a dozen times she lay down, and seemed to be at ease.

The freedom with which the mother reached with her mouth the orifices both of the genital passage and pouch, suggested at once a means adequate to the removal of the young from the one to the other; while at the same time her employment of the fore paws indicated that their assistance in the transmission of the fœtus need not extend beyond the keeping open the entrance of the pouch while the fœtus was being introduced by the mouth, when it is thus probably conducted to, and held over, a nipple until the mother feels that it has grasped the sensitive extremity of the part from which it is to derive its sustenance.

This mode of transmission is consistent with analogy, the mouth being always employed by the ordinary quadrupeds, as Dogs, Cats, and Mice, for the purpose of removing their helpless offspring. It accords, also, with the phenomena better than those which have been previously proposed; for it is now ascertained, by repeated dissections both of the Kangaroo and Opossum, that there is no internal passage from the uterus to the marsupium; and if the genital outlet can be brought into contact with the orifice of the pouch in the dead Kangaroo by means of great stretching of the relaxed parts, yet such an action has never been witnessed in the living animal*: the tender embryo would be more liable to receive injury from the fore paws; and these, from the absence of a thumb, could not so effectually ensure its passage as the

* This argument is not applicable to those *Marsupiata* which, like *Perameles* and the smaller South American Opossums, have the duplicatures of integument forming the pouch extended close to the cloaca.

lips, which can be opposed to each other. Lastly, the young one did not by any of its actions encourage the idea of its possessing the power of instinctively creeping up to the nipple.

When the female had rested quiet for about half an hour we again examined her, and found the young one not at the bottom of the pouch, but within two inches of the nipple; it was breathing strongly, and moving its extremities irregularly as before. I made an attempt to replace it on the nipple, but without success, and the mother was then released. On an examination two days afterwards, the marsupium was found empty. Every portion of the litter was carefully searched in the hopes of finding the fœtus, but without success. The mother, therefore, owing to the disturbance of the young one, had probably destroyed it. This was a result I had not expected, for the head keeper at the Zoological Farm had twice taken a mammary fœtus from the nipple and pouch of the mother soon after it had been deposited there, and when it did not exceed an inch in length, and it had each time again become attached to the nipple. I afterwards saw this fœtus attached to the nipple, and it continued to grow, without having sustained any apparent injury from the separation, until the death of the mother, when it was nearly ready to leave the pouch. A similar result occurred to Mr. Collie, who, in the letter above quoted*, observes, "I was informed, to my no small delight, that a kangaroo had been caught with its little young in the sac at the teat. This young one, which has not obviously increased since, is of nearly the size of the last and half the middle joint of one's little finger; its integuments are of a flesh colour, and so transparent as to permit the higher coloured vessels and viscera to shine through them, whilst all its extremities seem completely formed; and its muscular power is fully testified by its evident efforts in sucking, during which it puts every part of its body into action. According to the testimony of the person who preserved the mother with this little one for me, the latter by no means passes the whole of its time with the lacteal papilla in its mouth, but has been remarked, more than once, without having hold of it. It has even been wholly removed from the sac to the person's hand, and has always attached itself anew to the teat. Yesterday, on again looking at it, I gently pressed with the tip of my finger the head of the little one away from the teat of which it had hold, and continued pressing a little more strongly for the space of a minute altogether, when the teat, which had been stretched to more than an inch, came out of the young one's mouth, and showed a small circular enlargement at its tip, well adapting it for being retained by the mouth of the sucker. After this I placed the extremity of the teat close to the mouth of the young, and held it there for a short time without perceiving any decided effort to get hold of it anew, when I allowed the sac to close, and put the mother into her place of security. An hour afterwards the young was observed still unattached, but in about two hours it had hold of the teat, and was actively employed sucking."

* Zoological Journal, No. xviii. p. 239.

Mr. MORGAN tried a similar experiment with a mammary fœtus about the size of a Norway Rat, which after two hours' separation from the nipple regained its hold, and sustained no injury from the interruption of the supply of nourishment. The evidence, therefore, which has been adduced establishes the fact that the mammary fœtus at a very early period is at least capable of sustaining a separation from the nipple; and although it may not at this stage of growth possess the power of regaining its hold by its own unaided efforts, it is far from being the inert and formless embryo which it has been described to be: it resembles, on the contrary, in its vital powers, the new-born young of the smaller *Mammalia* rather than the uterine fœtus of a larger species when at a period of development at which this corresponds in size to a new-born Kangaroo.

By comparing the new-born Kangaroo with such a fœtus, we find that although in the Kangaroo the ordinary laws of development have been adhered to in the more advanced condition of the anterior part of the body and corresponding extremities, yet that the brain does not present so disproportionate a size; and the same difference is observable in the uterine fœtus of the Kangaroo (Plate VII. fig. 3.), even when compared with the same-sized embryo of an animal of an inferior class (Plate VII. fig. 4.). This difference, I apprehend, is owing to the rapidity with which the heart and lungs acquire their adult structure in the Kangaroo, whereby the passage of the purer and more nutritious blood through the foramen ovale and left auricle to the primary branches of the aorta is arrested. The brain, however, of the mammary fœtus, though exhibiting a low degree of development, yet is of a firmer texture than in a similarly sized fœtus of a Sheep, and attains its ultimate proportions by a more gradual process of growth.

The brain and spinal chord (Plate VII. fig. 9—12.) were taken from a mammary fœtus of the Kangaroo, which measured one inch and a half in length, and which was kindly presented to me by Mr. ALLAN CUNNINGHAM, of Kew.

In this fœtus I first observed the urinary bladder developed, and adhering by its apex to the peritoneum exactly opposite that part of the abdominal integument where a small linear ridge indicated the previous attachment of the umbilical appendage. There were also minute but distinct traces of umbilical arteries running up the sides of the bladder to this point of attachment. As the urinary bladder becomes afterwards expanded, the peritoneum is gradually, as it were, drawn from this part of the abdominal parietes, forming an anterior ligament of the bladder. In a mammary fœtus of the Kangaroo about a month older than the above, there was at the superior part of this duplicature a small projecting point from the bladder, like the remains of a urachus; but the fundus, now developed considerably above this point, was covered with a perfectly smooth layer of peritoneum, and it is this, I apprehend, which has given rise to the belief that there was no trace of urachus or umbilical arteries in the fœtuses of the *Marsupiata*. In the Sloth, the Manis, and the Armadillo, the ura-

chus is continued in the same manner from the middle of the anterior part of the bladder, and not from the fundus.

In neither of the above fœtuses of the Kangaroo was there any corresponding trace of umbilical vein, although there was a distinct ligamentum suspensorium hepatis, formed by a duplicature of the peritoneum descending from the diaphragm to the notch lodging the gall-bladder, and not entering, as usual, the fissure to the left of that notch.

The small intestines in the lesser mammary fœtus, when compared with those of the uterine fœtus above described, were found to have acquired several additional convolutions: the fold to which the umbilical vesicle had been attached was still distinct, but now drawn in to the back of the abdomen *. The cæcum was much elongated, but the remaining large intestines proportionately no more developed than in the uterine fœtus, resembling those of the Viverrine *Carnivora*; the subsequent modification, therefore, of the large intestines seems evidently destined to complete the digestion of the vegetable food.

The stomach was not sacculated, but the division between the cardiac and middle compartments was more marked than in the uterine fœtus. The liver had now ascended in its development beyond the oviparous form which it presented in the uterine fœtus, the right lobe being subdivided into three. The supra-renal glands bore the same proportionate size to the kidneys. The testes were still larger than the kidneys, and were situated below them, not having yet passed out of the abdomen: this takes place when the mammary fœtus is about three inches long from the nose to the root of the tail. The ductus arteriosus was distinct in the small mammary fœtus, but I could not perceive any trace of the thymus gland. Is this gland unnecessary on account of the precocious development of the lungs? or is its absence connected with the mode in which the fœtus in utero is developed? The latter appears the more probable condition of its absence, as in the oviparous and ovoviviparous classes the thymus gland is rudimental or of doubtful existence.

Notwithstanding that the new-born Kangaroo possesses greater powers of action than the same-sized embryo of a Sheep, and approximates more nearly in this respect to the new-born young of the Rat, yet it is evidently inferior to the latter. For although it is enabled by the muscular power of its lips to grasp and adhere firmly to the nipple, it seems to be unable to draw sustenance therefrom by its own unaided efforts. The mother, as Professor Geoffroy † and Mr. Morgan ‡ have shown, is therefore provided with a peculiar adaptation of a muscle (analogous to the cremaster) to the mammary gland, for the evident purpose of injecting the milk from the nipple into the mouth of the adherent fœtus. Now it can scarcely be supposed that the fœtal efforts of suction should always be coincident with the maternal

* This process may be compared to that by which the testes are drawn out of the abdomen.

† Mémoires du Muséum, tom. xxv. p. 48.

‡ Transactions of the Linnean Society, vol. xvi. p. 61.

act of injection; and if at any time this should not be the case, a fatal accident might happen from the milk being forcibly injected into the larynx, unless that aperture were guarded by some special contrivance. Professor GEOFFROY first described the modification by which this purpose is effected; and Mr. HUNTER appears to have foreseen the necessity for such a structure, for he has dissected two small mammary fœtuses of the Kangaroo for the especial purpose of showing the relation of the larynx to the posterior nares*. The epiglottis and arytenoid cartilages are elongated and approximated, and the rima glottidis is thus situated at the apex of a cone-shaped larynx, which projects, as in the *Cetacea*, into the posterior nares, where it is closely embraced by the muscles of the soft palate. The air-passage is thus completely separated from the fauces, and the injected milk passes in a divided stream on either side the larynx to the œsophagus.

Thus aided and protected by modifications of structure, both in the system of the mother and in its own, designed with especial reference to each other's peculiar condition, and affording therefore the most irrefragable evidence of creative foresight, the feeble offspring continues to increase from sustenance exclusively derived from the mother for a period of about eight months. The young Kangaroo may then be seen frequently to protrude its head from the mouth of the pouch, and to crop the grass at the same time that the mother is browsing. Having thus acquired additional strength, it quits the pouch, and hops at first with a feeble and vacillating gait, but continues to return to the pouch for occasional shelter and supplies of food till it has attained the weight of ten pounds. After this it will occasionally insert its head for the purpose of sucking, notwithstanding another fœtus may have been deposited in the pouch, for the latter, as we have seen, attaches itself to a different nipple from the one which had been previously in use.

§ 3. *On the Structure and Analogies of the Female Generative Organs in the Marsupiata.*

In the oviparous vertebrate animals the variations of structure which the female generative organs present in the different classes are fewer and of less degree than those observable in the different orders and genera of the *Mammalia*.

The most prevailing characteristic of the oviparous type of the female generative organs is the absence of union in the mesial plane of the lateral efferent portions, which consequently continue separate to their terminations in the excretory outlet.

In Birds the genital apparatus is characterized by the superior, and in the female, as far as function is concerned, exclusive development of the left moiety; and the uniformity in the condition of the excluded ovum in this class corresponds with the sameness which prevails in the structure of the organs concerned in its production.

In Reptiles the ovaries and efferent parts of the genital system are equally developed,

* See Nos. 3731, 3734, 3735 in the Physiological Series of the Hunterian Museum, in which there are evidences that Mr. HUNTER had anticipated most of the anatomical discoveries which have subsequently been made upon the embryo of the Kangaroo.

or nearly so, on both sides. But although a considerable uniformity of structure is found to prevail in this system throughout the different orders of the class, the widest difference obtains both in the place of development of the ovum and the condition in which it quits the mother. No one, e. g., could have predicated from a comparison of the structure of the ovaries and oviducts in poisonous and innocuous Serpents that any difference existed in the structure and development of the ovum, much less that the former were ovoviviparous but the latter oviparous; or, from a comparison of the same organs in *Lacerta crocea* and *Lacerta agilis*, that a like difference should exist in the generative economy of species so nearly allied as for a long time to have been confounded together by naturalists. Yet Von Baer has observed that the young of *Lacerta crocea* are completely developed in the oviduct, and come forth active well-formed lizards.

These and similar examples from other cold-blooded *Ovipara* have led him to the conclusion, that the period of intra-uterine existence and the extent of intra-uterine development depend rather upon the original constitution of the ovum than upon the structure of the generative organs; and they show at least of how little value that opinion of the mode of generation of an animal must be which is founded exclusively upon the structure of the efferent portion of the generative apparatus.

In *Mammalia*, however, in most of the orders of which the connexion of the ovum to the uterus is so much more intimate than in the preceding classes, the variations in the structure of the female sexual organs are more numerous and remarkable; and though it be admitted that the nature of the fœtal coverings and appendages results from the original constitution and properties of the ovum, yet the variations of the uterus have evidently in this class a relation to those differences.

In tracing the female generative apparatus from the human subject through the different orders of *Mammalia*, we find that it approximates to the oviparous type of structure in two ways, viz. by an obliteration of the os tincæ, which is the characteristic separation of the uterus from the vagina in this class, and by a gradually increasing division of the uterus and vagina until they become two separate tubes throughout their entire extent. Both these modes of deviation combine in the Edentate *Marsupiata* to give to their generative apparatus its peculiar resemblance to that of the *Reptilia*. But, for the reasons above mentioned, it would be unwarrantable to conclude from the female organs alone of the Ornithorhynchus that its ovum is excluded, as in Birds, with a hard shell, and a corresponding absence of fœtal development.

In no mammiferous genus do the female organs present that character of unity or concentration, with distinction of parts, which is found in the human subject; for in the lower orders, besides the more essential differences above mentioned, there is always an elongation of the uterus, with a thinning of its parietes, and in general a blending together of the urethral and sexual passages. This latter deviation commences in the *Simiæ*. In the *Lemures* the angles of the uterus begin to elongate

and to assume the form of cornua. The mesial cleft increases, and the cornua preponderate in the *Carnivora*, the *Cetacea*, the *Ruminantia*, and the *Pachydermata*; but it is in the *Rodentia*, which present affinities to Birds in other parts of their structure, that the uterus is first found completely divided into two lateral halves. This structure is not, indeed, uniformly met with in all the genera of the order; but besides the Hare and Rabbit, in which the double uterus is allowed to exist by De Graaf and Cuvier*, a similar complete division of the organ obtains in the genera *Sciurus*, *Arctomys*, *Spalax*, *Bathyergus*, *Echimys*, *Eretizon* (F. Cuv.), and *Hydrochœrus*; while in the genera *Mus*, *Cavia*, *Cœlogenys*, and *Dasyprocta* a portion of the true uterus still remains undivided, though this part, to which alone the term corpus uteri can be properly applied, is extremely small or rudimental. Nevertheless, although the corpus uteri exists in these genera, the true vagina is as remarkable for its length and capacity as in those in which the corpus uteri has ceased to exist.

Hitherto the vagina has presented itself under the form of a simple undivided canal, communicating with the urethro-sexual passage, at least after impregnation, by a single aperture. But it is a remarkable and interesting fact that in the Sloth, in the Mare and Ass, in the Pig, in the Cow, and probably also in other Ruminants, the vagina in the virgin state communicates with the urethro-sexual passage by a double aperture, in consequence of being traversed by a narrow vertical septum or chord. This septum has been described by veterinary authors as a hymen in the

* The structure of the female generative organs of the Hare and Rabbit was well known to Daubenton, who has given accurate figures of them; but as he probably regarded the corpus uteri as an essential part of the organ, he describes the true or proper vagina under that name. In speaking, however, of the same parts in the Rabbit, he unconsciously admits the true nature of the latter part, observing, "Chaque corne avançoit dans le vagin de deux lignes de longeur."—Buffon, Hist. Nat., tom. vi. p. 326. And again observes, that in a rabbit ready to bring forth, "les orifices des cornes de la matrice commençaient à dilater pour l'accouchement comme l'orifice interne de la matrice se dilate en pareil cas dans la plûpart des autres animaux."

Supported by the identity of structure in the vagina of the Cavies, in which the true corpus uteri exists, with that of the Hares, and by the authority of Cuvier, I should scarcely have thought it necessary to refer to Daubenton's descriptions had not his views been recently adopted by Geoffroy St. Hilaire and supported by additional arguments, and the same reasoning applied to the determination of the parts of female apparatus in the *Marsupiata*. (See Anatomie Philosophique, pl. 17. fig. 13. pp. 397, 398.) According to this author the cornua uteri and corpus uteri are distinct elements of the efferent portion of the genital apparatus, each being composed of a different substance (tissu), nourished from different arterial branches, and possessing different functions; he proposes therefore to name the former *aduterum, quasi vas vel marsupium ad uterum*. I cannot, however, coincide with this opinion, as I have not been able in any instance to appreciate an essential difference of tissue between the corpus and cornua uteri in those quadrupeds with a partially divided uterus; and I believe such a difference can only be predicated where, as in the Hare and Rabbit, a portion of the vagina is considered as the body of the uterus; and that so far from the corpus uteri not participating in the function of gestation, it is always found traversed by the fœtal membranes in uniparous quadrupeds with the uterus bicornis, as in the Mare, the Deer, and the Porpesse, in all of which I have dissected the pregnant uterus. And Daubenton expressly records an observation he made on the Mouse, in which the corpus uteri is reduced to the smallest proportional size, that in a pregnant female with five young ones in the uterus, two were in the right cornu, two in the left, and one in the corpus uteri.—See Buffon, Hist. Nat., tom. vii. p. 317.

Mare; the analogous part in the human subject also occasionally presents the same structure, and has even been observed in some cases to extend as a mesial partition inwards towards the uterus.

In the *Marsupiata*, where from the small size of the fœtus at birth a similar conformation is permitted to remain as a permanent structure, the vagina is in some genera wholly, and in others partially divided; but the divided portion in the latter is always that which is nearest the urethro-sexual passage.

The true uterus is completely divided in all the genera, and each division is of a simple elongated form, as in the *Rodentia*.

The superadded complications in the female generative organs of the *Marsupiata* are not, then, rightly attributable to the uterus, but to the vagina; and they are of such a nature as to adapt the latter to detain the fœtus, after it has been expelled from the uterus, for a longer period than in other *Mammalia**.

These complications vary considerably in the different marsupial genera. On a comparison of the female organs in *Didelphys dorsigera*, *Petaurus pygmæus*, and *Petaurus Taguanoides*, in *Dasyurus viverrinus*, in *Didelphys virginiana*, in *Macropus major*, and *Hypsiprymnus Whitei*, or the *Macropus minor* of Shaw, I find that the relative capacity which the uteri bear to the vaginæ diminishes in the order in which the above-named species follow, and that the external pouch has a progressively increasing development, corresponding to that of the vaginæ.

In *Didelphys dorsigera* the uteri rather exceed the unfolded vaginæ in length (Pl. VI. fig. 5.). In most *Marsupiata* the vaginæ at first descend, as if to communicate directly with the urethro-sexual passage, but in this small Opossum, in which the abdominal pouch consists of two slight longitudinal folds, and the young, as is implied by its trivial name, are transported by the mother on her back, each tube, after embracing the os tincæ, is immediately continued upwards and outwards, then bends downwards and inwards, and, after a second turn upwards, descends by the side of the opposite tube to terminate parallel with the extremity of the urethra in the common passage.

In the *Petauri* the vaginæ, when unfolded, are a little longer than the uteri. On examining a specimen of the Pygmy Petaurist which had two very small young in the

* It will thus be seen that the mode of considering the marsupial generative apparatus which I have adopted leads to a conclusion, as to its influence on parturition, diametrically opposite to that which Geoffroy St. Hilaire arrives at. He assigns as the cause of the premature birth of the marsupial generative product, the absence of any constriction between the uterus and vagina analogous to the *cervix uteri* in the ordinary *Mammalia*; but the non-existence of the *cervix* and *os uteri* can only be asserted where a portion of *vagina* is regarded as *uterus*. In the comparative sketch of the forms of the uterus given by Burdach, (Physiologie, Bd. i. pl. iv.) the vaginal is appended to the uterine apparatus in the marsupial or first form, but omitted in the rest: this does not, therefore, express its true relations. In respect of figure, the uterus of *Marsupiata* does not deviate from the perfect or human type in a greater degree than that of *Rodentia*. Burdach (Ibid. p. 130.) considers the vaginæ (*Seitencanalen*) of the *Marsupiata* as the fully developed analogues of the glandular canals described by Malpighi and Gærtner in the female organs of the Ruminants, Pachyderms, &c.; but these canals lead from the urethro-sexual passage, not to the os tincæ, but to the broad ligaments and ovaries.

pouch, I found both the true uteri of three times the diameter of the same in an unimpregnated specimen; but the vaginæ were unaltered in size, indicating that the situation in which gestation takes place in this species is the same as in the Kangaroo. The vaginæ, after receiving the uteri, descend close together half way towards the commencement of the urethro-sexual passage, but do not communicate together in this part of their course. From the upper part of these culs de sac they are continued upwards and outwards, forming a curve like the handles of a vase, then descend, converge, and terminate close together, as in the preceding example.

In *Dasyurus viverrinus* and *Didelphys virginiana*, the mesial culs de sac of the vaginæ descend to the urethro-sexual passage, and are connected to, but do not communicate with it. The septum dividing them from each other is complete, being composed of two layers, which can be separated from each other, and which result, indeed, from the apposition and mutual adhesion of the vaginæ at this part. In order to reach the common passage, each tube is continued outwards from the upper end of the cul de sac, and forming the usual curve, terminates parallel to the orifice of the urethra. The vaginæ in the Dasyures are smaller in proportion to the uteri than in the Virginian Opossum, but of a similar form.

In another species, the *Didelphys Opossum* of Linnæus, it would appear from the description and figures of Daubenton*, that the septum of the mesial culs de sac of the vaginæ was imperfect; but it is doubtful whether this intercommunication was not the result of parturition, or of an accidental rupture in the specimen examined. If it should prove to be a specific difference of structure, it is an approximation to the type of the female organs as they exist in the Phalangers, the Wombat, and the Kangaroo.

In the latter animal the vaginæ preponderate in size greatly over the uteri; and the septum of the descending cul de sac being always more or less incomplete, a single cavity is thus formed, into which both uteri open; but however imperfect the septum may be, it always intervenes and preserves its original relations to the uterine orifices.

The fœtus 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 borne young; and besides, I find that this part of the vagina is not continuous by means of its proper tissue with the urethro-sexual passage, but is connected to it by cellular membrane only; and this 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 into contact with the urethro-sexual passage. The evidence of M. Rengger on the development of the young and the parturition of the *Didelphys Azaræ* is also directly opposed to the theory of a temporary orifice in the mesial cul de sac.

* Buffon, Hist. Nat., tom. x.

The last form of the marsupial female organs which may be noticed is that which is found in the Kangaroo Rat (*Hypsiprymnus Whitei*), where they present the most extraordinary appearance (Pl. VI. fig. 6.). The type of construction is, however, the same as in the great Kangaroo, but the mesial cul de sac of the vagina attains a still greater development; it not only reaches downwards to the urethro-sexual passage, but also upwards and outwards, dilating into a large chamber, which extends beyond the uteri in every direction. From the sides of this chamber the separated portions of the vagina continue downwards, to terminate, as usual, in the urethro-sexual canal.

In all the preceding genera the structure of the uteri is as distinct from that of the vaginæ as in the *Rodentia*. The fibrous or proper tunic of the uteri is thicker than that of the vaginæ, and the lining membrane is soft and vascular, and disposed in numerous irregular folds, which in section give apparently a still greater thickness to the uterine parietes. The whole extent of the vaginæ, on the contrary, is lined with a thin layer of cuticle, which is readily detachable, even from the middle cul de sac, so generally considered as the corpus uteri in the Kangaroo.

The inner surface of the culs de sac in the Opossum is smooth, but in the lower part of the single cavity in the Kangaroo and Kangaroo Rat it presents a reticulate structure. The lining membrane in the lateral canals in all the genera is disposed in regular longitudinal folds, a disposition which characterizes the true vagina in most of the ordinary quadrupeds. In the Kangaroo, as in the other *Marsupiata*, the lateral canals communicate with the common or urethro-sexual cavity without making a projection; but at the distance of three fourths of an inch from their termination there is a sudden contraction, with a small valvular projection in each, which probably limits the extent to which the bifurcated glans is introduced in coitu. By those who consider the cul de sac and lateral canals as a modification of the corpus uteri, these projections will probably be regarded as severally representing an os tincæ; but as they do not exist in the Opossums and Petaurists, in which there is simply a contraction of the vaginal canals at the corresponding part, and as in both these, as well as the Kangaroo, the true uteri open in the characteristic valvular manner, as in the *Rodentia*, without the slightest appearance of a gradual blending into the vaginal cul de sac, the above structure cannot be regarded as materially affecting a determination supported both by the general texture and connexions of the part in question, as well as by what is now ascertained to be its limited function. Moreover, in the large single vagina of some of the *Rodentia*, as the Hare, Rabbit, and Paca, there are two corresponding valvular folds of membrane near its commencement, a little way above the urethral aperture, which DAUBENTON consequently regarded as the limits of the corpus uteri.

In endeavouring to trace the purposes answered by the different forms of the female marsupial organs above described, considerable difficulty arises from the want of the necessary evidence which would be afforded by the examination of the pregnant uterus in each of the genera, and by the absence of information as to their respective

periods of gestation, and the powers of the new-born fœtus. As far, however, as a conclusion can be drawn from the relative periods of gestation in the Kangaroo and Opossum, the proportionate capacities of the vaginæ to the uteri would appear to be inversely as that period; and that while the vaginæ are calculated to present fewer obstacles to the escape of the fœtus in proportion to the duration of its uterine existence, so a less capacious and complete external pouch is requisite for its ultimate perfection. From RENGGER's description of the connexion of the fœtal Opossum to the uterus, it might be concluded that the generation in that animal approximated to the true viviparous mode more nearly than in the Kangaroo; but the determination of this interesting question will require a more exact investigation into the nature of the fœtal vessels and membranes in the genus *Didelphys*. The impregnated uteri of the smaller pouchless Opossums of South America would be objects of peculiar interest and value in the present state of the inquiry.

With respect to the variations of structure in the marsupial female organs, it may also be remarked, that though they are apparently most complicated in the Kangaroos and Phalangers, yet in reality they deviate from the type of the normal *Mammalia* in a minor degree in these *Marsupiata* than in the *Didelphides* and *Petauri*. For the essential difference being a division of the vagina into two canals, we find this to be most complete in the latter genera, while in the Kangaroos the division is only partial, and the complexity arises more from augmented capacity and extent.

Now it is important to observe, that the fission of the efferent tube is not continued, as might naturally be supposed, from the uterus into the vagina, leaving its distal extremity single, but commences at the urethro-sexual cavity, and is arrested near the uteri, the orifices of which thus open into a common canal.

The situation of the rudimentary vaginal septum or hymen in the unimpregnated female organs of the normal *Mammalia* before mentioned corresponds with this formation in the Kangaroo; and in a case where this septum was preternaturally developed in the human subject, it was found to obey the same law of formation, and at the same time to have been coincident with a completely divided uterus.

This malformation, so remarkably analogous to the structure of the marsupial uterus, is described by Dr. PURCELL in the sixty-fourth volume of the Philosophical Transactions, and the specimen itself is in the Museum of the Royal College of Surgeons*. The vaginal septum is vertical, commencing at the outlet, and terminating about an inch from the orifices of the uteri; and, as Dr. PURCELL accurately describes, it is "not merely membranous, but fleshy, and of a considerable thickness; and like

* I have subsequently witnessed, through the kindness of my friend Dr. THOMAS BLUNDELL, an accurate model of a similar malformation of the vagina in the human subject: the vertical septum commenced at the vaginal outlet, and extended backwards for an inch, dividing the passage for that extent into two lateral canals. The individual underwent an operation for its removal. In this case the condition of the uterus could not of course be ascertained; but my friend Dr. LAUTH of Strasburg has described and figured two preparations in the Museum of the Faculty of Medicine in that city analogous to the case described by Dr. PURCELL. In one of these the uterus was divided internally into two lateral chambers, and the whole of the vagina was

most other mediastina in the human body, consisted of two laminæ combined. Of these, each vagina furnished one; for each had its own constrictor*."

To understand the relations which the female sexual apparatus of the Ornithorhynchus and Echidna bear to those of the ordinary *Mammalia*, it becomes necessary to consider through what families the human or concentrated form of the apparatus degenerates towards the oviparous structure, by the second mode of deviation. The first step in this descent is presented in the Sloths. The uterus is here of a simple, elongated, undivided form; but the distinction between the vagina and uterus by an os tincæ is lost, and so far it resembles an oviduct of a reptile. The uterus presents a similar form in the Nine-banded Armadillo (Plate VI. fig. 4.), but in the Weasel-headed Armadillo the angles are slightly elongated.

Moreover, in these as well as the more decided Edentate genera, as *Manis* and *Myrmecophaga*, the urethro-sexual canal is formed, as in Tortoises, by a continuation of the urethra or urinary bladder, into which the genital tube opens by a small orifice, (but in the Sloth, in the virgin state, by two small orifices,) just as the urethra communicates with the vagina in other *Mammalia*. The vaginal portion of the tube is indicated by the thinness of the parietes in the lower or distal half, by the smoother and less villous structure of the lining membrane, and its disposition in regular longitudinal rugæ; but the change is gradual, and the exact extent of the uterus is not marked by any constriction.

Now the Ornithorhynchus and Echidna, while they present a complete division of the efferent portion of their generative apparatus like the other *Marsupiata*, maintain, in the composition of each lateral moiety and in its mode of termination, their affinity to the Edentate order, in which Cuvier has placed them; and thus, by combining those characters of the oviparous type of the generative system which separately present themselves in other *Mammalia*, there results that affinity to the structure of the same parts in the *Reptilia* which has led to the supposition of their forming a distinct class of animals. The complex scapular apparatus of the *Monotremata*, the mandibles of the Ornithorhynchus, and the structure of the male intromittent organ, which, though perforated by a complete canal, is adapted to transmit the seminal fluid only, form additional deviations from the mammiferous structure. But the single cloacal outlet, the double superior cava, and the absence of the inferior mesenteric artery are approximations to the oviparous type participated by them in common with the other *Marsupiata*; and the whole may be regarded as an aberrant group of *Mammalia* characterized by an ovo-viviparous generation.

A few remarks remain to be added respecting the vaginæ of the Kangaroo.

separated into two canals, each receiving its corresponding os tincæ, as in the Opossum. In the other case the uterus was divided both externally and internally into two lateral compartments, but the vaginal septum commenced a short distance below the uterine orifices, as in Dr. Purcell's case.—See Breschet's Repertoire d'Anatomie, tom. v. p. 99.

* Philosophical Transactions, vol. lxiv. p. 478.

Sir EVERARD HOME* and M. LEUCKART† have both observed these parts of the generative system distended with a gelatinous adhesive matter, with irregular fibrous masses intermixed. One of these substances, which was found in the mesial cul de sac, Sir EVERARD compares to the vertebral column and occipital bone of a fœtus, and has given a figure of it as such. He appears indeed to have been considerably influenced by this circumstance in forming his theory of marsupial generation. M. LEUCKART, who also found several of these bodies, both in the lateral canals and middle cavity, describes them as consisting of a homogeneous fibro-cartilaginous substance, and compares them to a mola, or false conception, but observes that there was nothing in their structure that would permit him to form a conclusion that they were parts of a fœtus. In this instance, the middle cavity and the two thirds of the lateral canals nearest to it were filled with 'a pultaceous yellowish mucus.'

The female organs of the Kangaroo in this condition were also sent over from New South Wales by Mr. G. BENNETT, along with the impregnated uterus described, accompanied with the following note: "Bottle, No. 2. The uterus of a Kangaroo of the common species, the adjacent parts being preserved. This one had the appearance of having just received the male; and we killed a male specimen, having the appearance of being lately with the female, half an hour afterwards on the same range. The cornua uteri?" (vaginal canals) "are evidently diseased, containing a hard cheesy substance. (This has not been hardened by the spirit, for it was about the same consistence when I examined it in the recent state.)"

Mr. BENNETT also observes, that there was no young one in the pouch of this female; but one of the nipples was largely developed, from which he expressed milk. As this is precisely the condition in which the female at the Zoological Gardens was when she received the male, it corroborates Mr. BENNETT's supposition of the same circumstance having recently preceded the death of the female which he examined, and serves to elucidate in some degree the nature and cause of those appearances, which he regarded as the product of disease.

In the vaginæ of this animal, as in those examined by HOME and LEUCKART, portions of dense fibrous substance, varying in length from half an inch to an inch, and from one to three lines in thickness, were inclosed in a thick mucus. The fibrous substances had an irregular surface, and in some instances a rather brittle fracture: they were of a homogeneous texture when cut with the knife, (and such is also the composition of the substance described by Sir EVERARD HOME,) and they most resemble those coagulated masses that are found in the vesiculæ seminales and sometimes in the urethra of the Agouti, Capromys, Guinea-pig, and others of the Rodent order.

Since the dissection of Mr. BENNETT's specimen, I have had the opportunity of observing the female organs of another Kangaroo, which were obligingly submitted to my examination by Professor GREEN: they presented the same appearances as

* Philosophical Transactions, vol. lxxxv. p. 228. † MECKEL's Archiv fur Physiologie, tom. viii. p. 442.

those above described, and having been successfully injected, showed that the vaginæ were highly vascular. The history of this female is not known, but this additional example of the presence of mucus with fibrous masses in the vaginæ would intimate that it is not an uncommon occurrence, and therefore unlikely to be the result of disease.

I had originally intended to limit myself to the description of the preparation which first called my attention more directly to the subject; but the desire of penetrating, if possible, to the final purpose of marsupial generation, induced me to push my inquiries as far as the means at my disposal allowed; and though I am compelled to acknowledge that the end proposed is still to be attained, yet the collateral inquiries instituted with that view have, I hope, tended to render the subject more intelligible, and to point out its real analogies to other known modes of generation.

The conditions of those modifications of structure which relate to the marsupial fœtus after uterine birth are readily appreciable. An offspring prematurely born, and with a great proportion of its growth yet to be accomplished before it attains the power of existing independently, must obviously be incapable of sustaining life with any considerable intermission of sustenance; and since it has no store of nutriment appended to its digestive canal when excluded from the womb, and is therefore dependent for its support solely upon maternal secretion, the period during which the mother must have been confined to a foreign and artificial nest, supposing no other protection to the offspring had been provided, would have been probably too long to be compatible with her own existence. To obviate this inconvenience a natural and portable nest is superadded to her structure, in order that she may resort, without prejudice to the young, to all the places necessary for her own safety and support; while at the same time the young one is enabled to draw an unintermitting supply of nutriment, and has also its own temperature maintained by close contact with the abdominal surface of the parent, in an analogous, though more complete manner than the egg during incubation.

But when we come to consider why the intra-uterine life of the embryo should be such, both in its nature and duration, as to require these modifications, the subject, at present, eludes every attempt at direct explanation. If an unvascular chorion, with the consequent premature birth and after-incubation in a marsupium, were peculiar to the Kangaroo, these might be regarded as the necessary concomitant phenomena of its strange proportions and violent progressive motion; it might then be considered essential that the fœtus should pass the pelvis before the hinder parts had attained their gigantic proportions; it might also be supposed that saltatory progression was incompatible with the safety of the parent or offspring, if the fœtus were attached to the womb by so delicate but vital a medium as a vascular placenta; and that, therefore, while a premature birth obviated the necessity for the formation of a placenta, an unimpeded delivery was equally secured by the same anticipation.

But such explanations fail when the Jerboas of Africa are considered; for in these animals we find similar proportions of the extremities, and consequently the same kind of locomotion as in the Kangaroo, without any external pouch or internal modification of the female apparatus indicative of a difference in their generation from that of the ordinary *Rodentia*. And, on the other hand, the ovoviviparous or marsupial *Mammalia* include the flying Petaurist, the burrowing Wombat, the swimming Cheironectes, the climbing Koala, Opossums with the hinder thumb and prehensile tail, and the Dasyures, with the ordinary proportions and progression of the corresponding carnivorous genera of the placentally developed *Mammalia*; in all of which genera it is obviously impossible to connect marsupial generation with the outward proportions, locomotion, or habits of the parent.

Perhaps it is more philosophical to consider generation as having reference rather to the whole nature of the thing generated, and its relative perfection as compared with other species, than to partial modifications of the structure of the mother.

The whole of the vertebrated animals are recognised as one great division or group in nature, characterized by a plan of formation which, however varied to suit their different spheres and powers of action, has sufficient basal or permanent characters to be recognised as one type, distinguishable from that which pervades any other lower organized group of the animal kingdom.

But the generation most common to the vertebrated group is the same which chiefly prevails in the lower divisions of the animal kingdom, viz. the oviparous, in which the ovum, when once formed, detached, and impregnated, possesses properties that enable it to accomplish all the steps of its future development, without further connexion with the parent. The generation, therefore, which requires a second connexion of the ovum to the parent, as in the placentally developed *Mammalia*, is an exception to the rule of vertebratal reproduction, and we are led to inquire in what essential points these animals deviate from or are superior to the other classes of the division, that in their generation the parent should be subservient in a so much greater degree to the perfect development of the new being.

Now it is in the *Mammalia* that the brain is perfected: we can trace through the different orders the increasing complication of this organ, until we find it in man to have attained that condition which so eminently distinguishes him from the rest of the class. And if the introduction of new powers into an organism necessarily requires a modification in its mode of development, with what other than the perfection of the nervous system can we connect true viviparous or placental generation? for we do not perceive that in their digestion, circulation, respiration, locomotion, or temperature, the Mammiferous *Vertebrata* are in any degree advanced beyond the bird, in consequence of their more complex, or, as it may be termed, more careful generation.

Agreeably to this view, therefore, we should expect to find in those orders in which the umbilical vesicle is largest and most permanent, and the placenta least

vascular, a corresponding simplicity of the cerebral organ; and accordingly we do find that the brain in the *Cheiroptera* and *Rodentia* resembles that of the Bird in the smoothness of the cerebral hemispheres and their limited extent, the cerebellum being wholly uncovered by the cerebrum throughout these orders *.

Among the *Marsupiata*, the Opossums and Dasyures present a still simpler form of the brain, the cerebral hemispheres being equally devoid of convolutions as those of the Beaver, and leaving the bigeminal bodies as well as the cerebellum uncovered: the fissure also which separates the olfactory tract from the superimposed cerebral mass, instead of being inferior, as in the *Rodentia*, is here lateral: and, lastly, the proportions which the thickness of the medullary covering bears to the extent of the lateral ventricles is less than in any other mammiferous order.

With respect to the brain of the Kangaroo, it must be observed, that although shortly after birth it resembles in structure the brain of the lowest *Vertebrata*, yet it afterwards assumes a more complex form than that of the Opossums or Dasyures, there being a few symmetrical anfractuosities upon the cerebral hemispheres, which also cover a greater proportion of the bigeminal bodies: the hemispheres are, however, more contracted anteriorly, and have a smaller size, in proportion to the body, than in those of the *Rodentia*.

The inferiority of the brain, then, in connexion with the other points of resemblance to the inferior vertebrate classes which may be traced through the organization of the marsupial quadrupeds, seems at present to be the phenomenon most intimately connected with their generation. Those which I have had the opportunity of observing alive at the Zoological Gardens (and there are at present species of *Dasyurus*, *Didelphys*, *Phalangista*, *Petaurus*, *Hypsiprymnus*, *Macropus*, and *Phascolomys*,) are all characterized by a low degree of intelligence; nor can I learn that they ever manifest any sign of recognition of their keepers or feeders. Another character, no less uniformly belonging to them, is the want of a power of uttering vocalized sounds. When irritated they emit a wheezing or snarling guttural sound; that of the *Dasyurus ursinus* is the clearest, and is the nearest approach to a growl. Mr. Harris, however, states, that in addition to this noise, the Ursine Opossum utters a kind of hollow barking. The *Thylacinus cynocephalus*, or large Dog-faced Opossum, he observes, utters "a short guttural cry, and appears exceedingly inactive and stupid, having, like the owl, an almost constant motion with the nictitating membrane of the eye†." The Wombat, when irritated, emits a loud hiss which forcibly reminds one of that of the Serpent. The noise emitted by the Kangaroo under similar circumstances is equally remote from a vocalized sound; the necessary apparatus for producing which Cuvier‡ long ago observed to be wanting in the larynx of this animal.

* It is also in this order that the double superior cava is most frequently found, after the *Marsupiata*; and the Elephant, whose other affinities to the *Rodentia* Cuvier has especially remarked, resembles them in this respect.

† Linnean Transactions, vol. ix. p. 173.

‡ Leçons d'Anat. Comp. iv. p. 509.

It is interesting to find these analogies to the *Reptilia*; and more might be pointed out if it were not a comparison which merits a separate consideration, and would extend the present communication to an undue length.

There is, however, another order of *Mammalia* which, in addition to certain analogies to the *Reptilia* manifested in their generative and other systems, have the brain nearly as simple as in the Opossums: these are the Edentate *Mammalia*; and the Armadillos, Manises, and Anteaters are more especially characterized by their inferiority in this respect, the Sloths, like the Kangaroo, having a few superficial anfractuosities on the cerebral hemispheres. In order, therefore, to test the degree of relationship which exists between a long intra-uterine and placental development, and the perfection of the brain, it will be requisite to possess an accurate knowledge of the mode of development of the above Edentate genera.

This is an inquiry well deserving attention; and it is to be hoped that the desirable materials, viz. the impregnated uteri of the Edentate and Marsupiate genera, will soon be furnished through the exertions of our scientific countrymen abroad.

Description of the PLATES.

PLATE VI.

Fig. 1. Communication of the true vagina with the urethro-sexual passage by a double orifice, resulting from an occasional formation of the hymen, in the Human subject.

Fig. 2. A section of the urethro-sexual canal, showing a similar mode of communication by a double orifice, resulting from a constant formation of the hymen, in the Sow.

Fig. 3. A similar section of the urethro-sexual passage of the Kangaroo.

In each of the figures, *a* is the urethral, and *b b* the vaginal orifices.

Fig. 4. The female organs of an Armadillo (*Dasypus novem-cinctus*, LINN.).

Fig. 5. The female organs of the Merian Opossum (*Didelphys dorsigera*, LINN.), magnified three diameters.

Fig. 6. The female organs of the Kangaroo Rat (*Hypsiprymnus Whitei*, LESSON).

The same letters indicate the same parts in each of the figures.

a. Ovaries.

b. Fallopian tubes. (In figg. 5. and 6. *Membranous portion of the Fallopian tubes*, HOME.)

c. Uteri. (*Cornua uteri*, TYSON, DAUBENTON. In figg. 5. and 6. *Glandular portions of the Fallopian tubes*, HOME; *Aduterums*, GEOFFROY.)

d. Os tincæ. (In figg. 5. and 6. *Valvular termination of Fallopian tube*, HOME.)

e. Mesial cul de sac of the vagina. (*Corpus uteri*, TYSON, DAUBENTON, GEOFFROY; *Uterus*, HOME.) *e'*, *e'*. Divided portion of the vagina. (*Uteri re-*

duplicati, and *Vaginæ*, Tyson; *Vaginæ*, Geoffroy; *Lateral uterine canals*, Home.)

f. Urethro-sexual canal. ('*Canalis communis*,' or *common passage from the urethra and the two vaginæ*, Tyson; *Canal urétro-sexuel*, Geoffroy; *Vagina*, Home.)

g. Urinary bladder.

h. Urethra.

Fig. 7. The impregnated female organs of the Kangaroo (*Macropus major*, Shaw). The gravid uterus *c'* is laid open, and also the chorion *i*, or membrana corticalis of the fœtus, showing the latter suspended from *k*, the umbilical chord. In addition to the letters above explained, *a'* is the left ovary, with a large corpus luteum, showing the orifice from which the ovulum escaped not yet cicatrized. * The ovarian ligaments. Bristles are inserted into the Fallopian tubes. The vaginal apparatus *e*, *e'* *e'*, not having been preserved along with the impregnated uterus, is here added from another specimen, in which the imperfect septum of the mesial cul de sac (*e''*) did not extend to the lower end of that cavity, as is usual in the Kangaroo. The cellular membrane which connects the vaginal cul de sac with the urethro-sexual passage has been removed.

Plate VII.

Fig. 1. The fœtus and membranes of the Kangaroo removed from the uterus. The fœtus magnified two diameters.

a, *a*. The exterior membrane or chorion laid open.

b, *b*. The amnion.

c, *c*. The umbilical vesicle.

d, *d*. The omphalo-mesenteric veins.

e. The omphalo-mesenteric arteries.

f. The pedicle connecting the umbilical vesicle to the intestinum ileum.

g. The stomach.

h. The duodenum.

i. (Fig. 2.) Convolutions of small intestine.

k. The cæcum.

l. The large intestine.

m. The liver.

n. The kidneys.

o, *o*. The testes.

p. The bifid rudiment of the penis at the verge of the anus.

q. The diaphragm.

r, *r*. The lungs.

s. The heart.

t, t. The two superior cavæ.

The pulmonary artery and aorta have the same relative position as in the adult.

u. The rudiments of the posterior extremities.

v. The external orifice of the ear.

w. The branchial orifice.

Fig. 2. The viscera of the preceding fœtus, more magnified: the heart is turned up, to show the auricles, and the whole intestinal canal is seen.

Fig. 3. Outline of the same fœtus, natural size, showing the connexion of the umbilical vesicle.

Fig. 4. Outline of the embryo of the Goose, showing its natural size and state of development when the allantois *x*, is just beginning to expand from the lower part of the intestine. The brain may be observed to be proportionately more developed than in the Kangaroo.

The same letters are used for the different parts as in fig. 1.

Fig. 5. Outline of the Kangaroo about twelve hours after uterine birth, showing its natural size and external development at this period. The elongation of the jaws has reduced the mouth to a simple round anterior orifice, which subsequently becomes even more contracted before the lateral fissures begin to extend backwards. The eye is concealed by the completely formed eyelids. Three divisions are now seen at the posterior extremity. A longitudinal line indicates the separation of the umbilical pedicle.

a. The upper nipple of the left side, to which the above fœtus was attached.

b. The lower nipple of the same side.

Fig. 6. Mammary fœtus of the Pygmy Opossum (*Petaurus pygmæus*), natural size.

6*. The same magnified and dissected, showing,

a. The urinary bladder.

b. The urachus.

Fig. 7. Mammary fœtus of the Kangaroo, about a fortnight old: natural size. The parietes of the abdomen are removed, to show the increased development of the viscera, as compared with the uterine fœtus (fig. 1.); and also the urinary bladder *a*, and its attachment to the abdominal parietes.

Fig. 8. Magnified view of the abdominal viscera of the same mammary fœtus.

a. The urinary bladder.

b. The urachus.

c, c. The umbilical or vesical arteries.

d. The ligamentum suspensorium hepatis, in which there is no trace of umbilical vein.

e. The left lobe of the liver.

f, f. The right lobe now subdivided.

g. The acute fold of the ileum, at the end of which the umbilical vesicle was attached.

h. The elongated cæcum.

i. The large intestine.

k. The supra-renal glands.

l, *l*. The kidneys.

m. The ureters.

n, *n*. The testes.

o, *o*. Epididymis.

p, *p*. Vas deferens.

Fig. 9. The brain and spinal chord of the same fœtus, from the superior or dorsal aspect. Natural size.

Fig. 10. The same, from the inferior or ventral aspect.

Fig. 11. Superior view of the same brain. Magnified three diameters.

Fig. 12. Side view of the same. Magnified three diameters.

The following letters signify the same parts in each figure:

a. Spinal chord.

b. Medulla oblongata.

c. Cerebellum.

d, *e*. The medullary mass, from which the bigeminal bodies are developed. The separation of the ganglions, termed Testes *d*, Nates *e*, is faintly visible.

f. Posterior striated bodies.

g. Cerebral hemispheres.

h. Crura cerebri.

i. (Fig. 11.) The ventricle of the right hemisphere laid open.

k. (Fig. 10.) Mammillary body.

The state of development of the brain of this mammary fœtus corresponds to that of the human fœtus at the ninth week.

Fig. 13. The head of a mammary fœtus of a Kangaroo, about eight weeks old, dissected, to show the relation of the larynx to the tongue and posterior nares.

a. The epiglottis, drawn down out of the aperture in the soft palate.

b. The cavity in the tongue for the reception of the nipple.

Fig. 14. The elongated nipple, withdrawn from the mouth: the dotted line shows the extent to which it is grasped; it never extends into the œsophagus or stomach as has been conjectured.