

On the Wolffian bodies of the foetus, and their remains in the adult : including the development of the generative system / by William Mitchell Banks.

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Publication/Creation

Edinburgh : Maclachlan & Stewart, 1864.

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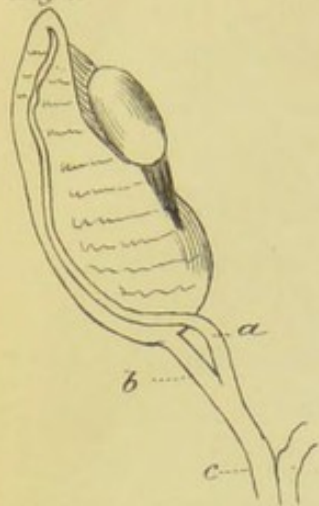




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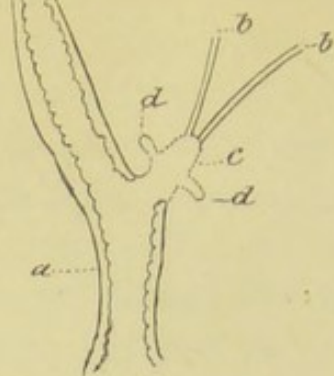


Fig 1



(N^o1.)

Fig 2 (N^o1 & 2)



(N^o2)

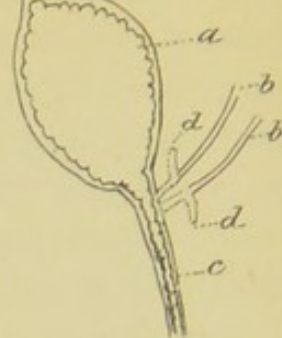


Fig 3 (N^o1, 2 & 3)

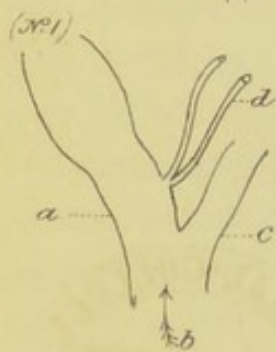
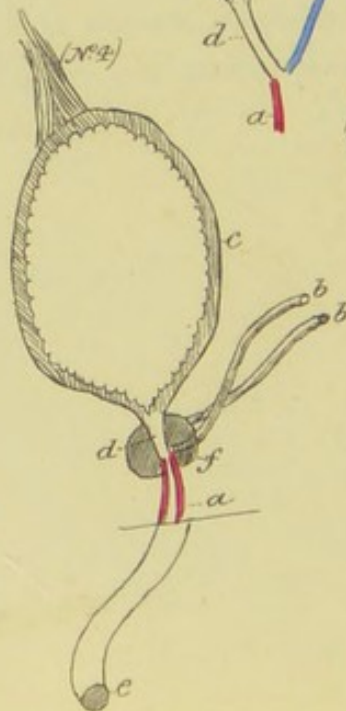
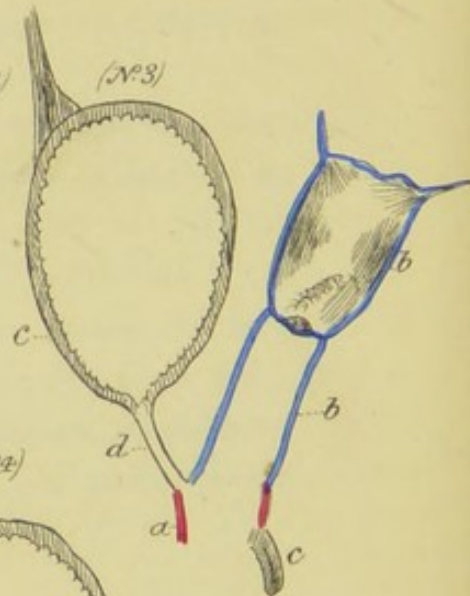
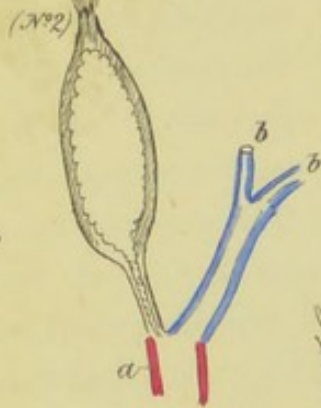
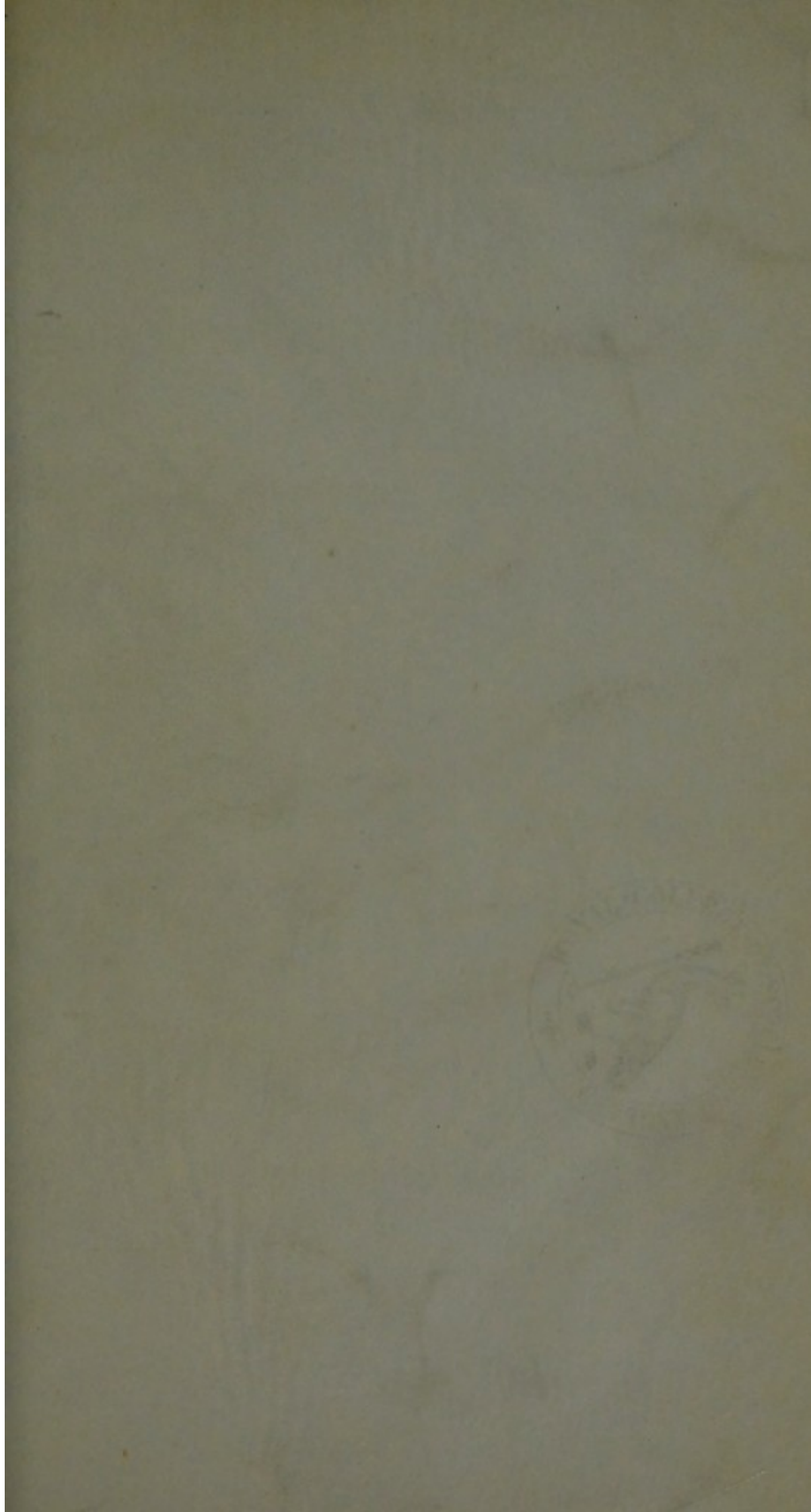


Fig 4. (from 1 to 4)





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ON THE

WOLFFIAN BODIES OF THE FŒTUS,

AND

THEIR REMAINS IN THE ADULT;

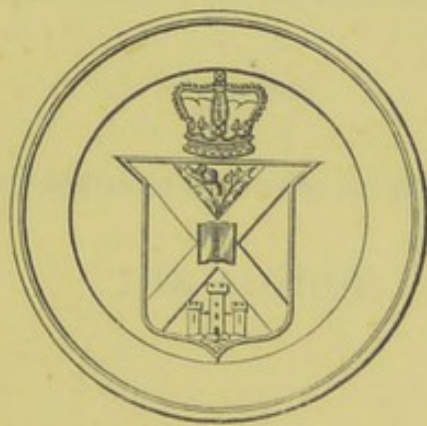
INCLUDING THE

DEVELOPMENT OF THE GENERATIVE

SYSTEM.

BY

WILLIAM MITCHELL BANKS, M.D



PRIZE THESIS.

EDINBURGH :

MACLACHLAN & STEWART.

MDCCCLXIV.

JOHN COOPER, JR., F.R.S.E.

THIS REPLY

TO THE

REPORT OF THE

COMMISSION

ON THE

STATE

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P R E F A C E

WHEN I first began this essay, I had entertained the idea that the testicle was a subject which might still furnish some points for investigation; but on carefully studying the matter, I soon found that the labours of Sir Astley Cooper, Lauth, Curling, &c., had left little or nothing that could be added to our knowledge of the anatomy of the organ itself. Nevertheless, I saw at the same time, that the views of anatomists were by no means equally uniform in regard to the uses or origin of certain *appendages* to the testis, whose presence was sufficiently constant to make it obvious that in some way or other they had an intimate connection with the organ; while, on the other hand, their frequent absence showed that they were by no means essential to its function. These were the Hydatids of Morgagni and the Vas Aberrans Halleri, and Mr Turner kindly drew my attention to the more recently discovered organ of Giralaldés, or Corps Innominé, and its analogue in the female, the organ of Rosenmüller, or Parovarium (Kobelt).

As these bodies are plainly the remains of foetal structures, my thesis thus resolved itself into an examination of certain points in embryology, and I was encouraged to

proceed in this examination by the fact that although I could not hope to make any original observations after such men as Valentin, Bischoff, Rathke, Kobelt, and Kölliker had employed their energies upon the question, yet British anatomists had not devoted the same attention to it that their continental brethren had. In fact, although I have no doubt many of them must have examined the structures which this paper treats of, and so far arrived at opinions of their own upon the various disputable questions, yet I can find no English treatise bearing directly upon the point. My information, consequently, has had to be drawn either from French or German books, or from such translations and reviews of them as I could obtain. The nature of the subject, also, is one which I would humbly venture to think is suitable for a thesis, as enabling a student, who can, from his limited experience, give no opinion of his own upon the more practical parts of his profession, to employ upon it such powers of observation as he may possess, and thereafter draw his own conclusions. For the development of the generative organs offers the most remarkable and interesting series of changes, and has long attracted the especial notice of embryologists, while, as Bischoff observes, we find in their observations, erroneous as many of them were, some of the "finest monuments of man's spirit of investigation."

PART FIRST.

ON THE DEVELOPMENT AND STRUCTURE OF THE WOLFFIAN BODIES.

1. ORIGIN AND DEVELOPMENT.

IN man and the higher classes of mammalia, the development of the generative glands is preceded by that of a pair of organs which, like many others, belong solely to the period of foetal life, leaving behind them, in the adult, mere traces of their previous existence. The first correct description of these bodies was given in his "Treatise on the Theory of Generation," by C. F. Wolff, from whom they derive their name of the Wolffian Bodies, and after him Oken investigated them in the Mammalia (hence the German name, Okenschen Körper). They were regarded by Wolff, who was unaware that they possessed an excretory duct, and more recently by Arnold, as the rudiments of the future kidneys, but Rathke¹ afterwards ascertained that the latter were developed quite independently. Nevertheless, the appellation of false or primordial kidneys, as they are termed by Jacobson and Rathke, is not by any means inappropriate. For it is obvious that organs of such size and high structural development must have some important part to play in the animal economy of the foetus, and since we see that in

¹ Rathke, "Abhandlungen zur Bildungs und Entwicklungsgeschichte des Menschen und des Thiere;" Meckel's Archiv. 1832, p. 379.

proportion as the kidneys increase in size, so the Wolffian bodies diminish and atrophy, we may reasonably infer that, as regards function, there must be some connection between them ; for, as I shall endeavour to show, no part of the latter whatever, in reality, goes to the formation of the generative system, and in the foetus, such a system is unnecessary as regards function. Indeed, there can be little doubt that the Corpora Wolffiana are intended for the elimination of the urinary secretion during the early periods of embryonic life, since Müller has noticed in the bird, both within their tubes and their excretory duct, a whitish-yellow matter which could be pressed from one part of the tubes to another, while Jacobson has detected in the fluid of the allantois of the bird's egg, the presence of uric acid at a very early period of incubation, before the kidneys were sufficiently developed to be able to furnish such a secretion.

To narrate the various opinions and hypotheses which have been advanced in regard to the *primary origin* and the *development* of the Wolffian bodies, would be almost useless, and certainly very perplexing, since, as far as I can see, Baer, Burdach and Rathke, Valentin, Reichart, Bischoff, and Follin, all seem to differ more or less from each other as to the former. Rathke held that they primarily arose from a single mass, but in this view he was singular, every other authority maintaining that at any rate they originated as two distinct bodies, developed in front of the aorta, which separates them.

Regarding their development, suffice it to say that there would seem to be two leading views : (1.) Baer had a theory that the two posterior vertebral arteries of the embryo gave off at short intervals small lateral branches, which, returning on themselves, formed also veins ; and that these vessels poured out along their course a material from which arose a multitude of little sacs, ranged in

transverse lines. These uniting together formed tubules, and thus arose the transverse canaliculi of the Wolffian bodies with their interlying blood-vessels. (2.) Bischoff, again, believed that they arose simply from two little ridges of blastema, in which were formed, under the appearance of little clear vesicles, the canaliculi, which afterwards communicated with a duct running along their outer surface—he ascribes to them the same mode of origin as that which obtains in other secreting glands. This view, which seems the more simple and natural, has been confirmed by the late researches of M. Follin.

On this point of development, I cannot say anything, as I did not feel myself competent to investigate such a delicate question, nor could I easily have procured specimens of a sufficiently early date to work upon.

2. WOLFFIAN BODIES IN ANIMALS.

According to most authors, they seem to be absent in fishes; while Follin, whose thesis I shall frequently have occasion to refer to, states that they *persist* in them through life, and perform the functions of kidneys.

Müller describes their appearance in the batrachians, in whom they exist during the whole period of the larva state, as that of a bunch of cæca situated at the most anterior part of the abdominal cavity, from which an excretory duct passes backwards along the side of the vertebral column. Follin,¹ however, has not been able to find the excretory duct or the cæca, although he recognises two grey masses in the situation Müller refers to, and has even found in frogs two whitish points at the upper part of the abdomen, which, he thinks, are these two

¹ Follin—Recherches sur les Corps de Wolff; Paris, 1850.

bodies in a state of atrophy. In snakes they certainly do exist, as Rathke has pursued his researches on this subject mainly on the *Coluber natrix*.

In birds, the Wolffian bodies can be very readily examined, appearing in them on the third day of incubation, and increasing till they extend along the sides of the vertebral column from the heart to the posterior extremity of the body. Müller¹ figures them as composed of cæcal tubes, running in a lateral direction, and bound together by an excretory duct, which opens at each side into the cloaca. He further particularly notices, that in the female, in addition to this excretory duct, a special oviduct (Fallopian tube) is provided, to which he found no corresponding structure in the male, for in it the excretory duct of the Wolffian body at once formed a junction with the testicle by means of certain vasa efferentia. It is of importance to bear in mind this statement of Müller, because, as will afterwards be seen, his views in regard to the conduct of these bodies and their ducts in the mammalia are very different, whereas, according to the most recent opinions, should his own statement about birds be correct, a distinct homology can be traced between them and the mammalia as regards the development of these structures.

My own observations have been made almost entirely upon the sheep, although I have also examined a good many calves and pigs. I could never obtain a human specimen early enough to shew the Wolffian bodies, but I have examined human foetuses from about the fifth month upwards, in connection with their remains. The period of gestation in the sheep is about nineteen weeks, but I am sorry to say that I never could obtain any correct information as to what might be the various ages of the foetal

¹ Müller's Physiology, translated by Baly, vol. ii. 1664.

sheep which I obtained, and I have accordingly been obliged to give their lengths in place of their ages, in the earlier specimens. In the earliest embryo which I examined ($\frac{3}{8}$ ths of an inch), the Wolffian bodies appeared as two long, narrow, almost cylindrical structures of a fine red colour, which ran along each side of the vertebral column, from the lower extremity of the ventral cavity almost up to the neck (Pl. I. fig. 1, *a*). They had a uniform appearance all over, showing no elevations upon their surfaces, and from their lower extremities proceeded their excretory ducts, which, running down on each side of the rectum, opened into the allantois. At this period the heart was in course of formation, but there were no vestiges of kidneys or genital glands. In the embryo of $\frac{5}{8}$ ths inch (Pl. I. fig. 2), the Wolffian bodies have not the same relation to the whole embryo in point of size, being now much shorter comparatively, so that they appear to be restricted to the abdomen, while their shape tends more to the oval. This may depend either on their upper extremity disappearing while their middle and lower portions go on increasing, or on their not increasing in size with the same rapidity as the other organs of the body; and the latter view seems to be much the more likely of the two. When the embryo attains the length of 1 inch, they are still further altered in appearance, owing to a curving outwards and increase in size of their lower extremities, while on their outer surfaces a clear line or cord is distinctly visible. At $1\frac{1}{8}$ th inch (Pl. I. fig. 3), they have acquired their permanent shape, which is somewhat crescentic, or rather pyramidal, having an anterior (properly inferior) surface, an external one on which the cord is seen, and a posterior (superior), on which the organ rests.

The Wolffian bodies are well supplied with vessels, varying from four to six in number, which penetrate its upper border, and are small parallel branches of the aorta.

After the kidneys have attained some size, and pushed their way up from behind the Wolffian bodies, the vessels can be seen very clearly, running to the upper part of the latter in the stretched peritoneum. They are originally branches of the posterior vertebral arteries; and it is this fact which gave rise to Baer's hypothesis (for it would seem to have been little more) as to the development of the Wolffian bodies (p. 7). As the organs diminish, so their vessels atrophy also, but their remains can be seen as delicate lines running in the peritoneum, till the embryo is 4 to $4\frac{1}{2}$ inches long.

3. THE GENITAL GLANDS.

When the embryo is about half an inch long, we see rising along the inner border of the Wolffian body, but plainly separate from it, a thin white streak, which is the beginning of the future ovary or testis (Pl. I. fig. 2). Kölliker¹ describes the appearance of a section made through the whole embryo at this period, in which the peritoneal covering of the Wolffian body was seen passing over these white streaks, and hence the probability that they arise from some nuclear blastema deposited in the subperitoneal tissue, or what Remak terms the *mittelplatt*. The genital gland increases very rapidly, changing from its streak-like form to a cylindrical, and finally to an oval one, and rising up on the concave inner surface of the Wolffian body, till it finally comes almost to lie upon it. At first the future ovary and testis are perfectly alike in form and position, and continue indistinguishable for some time, but gradually the testicle assumes a rounder, broader shape, while the ovary is longer and narrower; moreover, the former preserves the

¹ Kölliker's *Entwicklungsgeschichte*.

situation which it had from the beginning, viz., with its long axis parallel to that of the Wolffian body, while the latter becomes more horizontal, in accordance with the position in which it is finally to be in the adult.

The forces which induce these bodies so to act we can evidently know nothing of, connected as they are, in so intimate a manner, with the original principle of life implanted in the cells which form them. But from the period when, by these changes in shape and position, the genital glands first show their tendency to one or other sex, the Wolffian bodies and their ducts seem, as it were, to begin to adapt themselves to the special form of generative tube necessary for each sex also; and the whole theory of hermaphroditism depends upon the fact of nature, so to speak, not adapting the one particular tube to the one particular gland.

4. LIGAMENTS OF THE GENITAL GLANDS AND WOLFFIAN BODIES.

In addition to their other appendages, the genital glands and Wolffian bodies possess certain ligaments, which I find nowhere fully described except by Köl liker, and which I think deserve some little notice.

In the sheep a little longer than 1 inch (Pl. I. fig. 4), there may be seen running from the upper end of the Wolffian body a small free-margined membrane, which proceeds to the diaphragm, and terminates in two or three indistinct processes; this is termed by Köl liker the diaphragm ligament (*Zwerfellchbande*). The genital gland is, moreover, attached to the Wolffian body by a membranous duplicature, which has been named by Seiler¹ the *Mesorchium* in the male and the *Mesoarium* in

¹ *Observationes nonnullæ de Testium descensu*, 1817.

the female, and also by continuations of this, superiorly and inferiorly, designated by Kölliker respectively the upper and lower "Bauchfellfalte;" the former proceeding upwards, and merging into the diaphragm ligament, the latter proceeding downwards, and terminating near the ducts of the Wolffian body. Lastly, from these ducts, at the point where they leave the Wolffian body, springs a fine thread-like structure (Leistenband), losing itself in the muscles of the abdominal wall, which, when arrived at its full development, is destined to become the gubernaculum testis of the male, or the round ligament of the female.

As far as I can see, the following is what becomes of these structures in the adult. The diaphragm ligament in the female goes to form the main part of the broad ligament of the uterus, being assisted in this by the mesoarium and the upper and lower "bauchfellfalte." But in the male, when the testis descends, it becomes a mere thread-like structure (Pl. II. fig. 3), running from the top of the epididymis up into the abdomen as far as the kidney, quite visible, however, in the full-grown sheep's foetus. The mesorchium and mesoarium serve as means of permitting the vascular supply to reach the genital gland. Cleland has noticed, and I have myself observed, a fine white line arising in the mesorchium, which is ultimately traceable to the testis and to one of the arterial branches which supply the Wolffian body; this becoming larger and hollowed, forms the future spermatic (or ovarian) artery. In the adult the mesorchium forms the structure which suspends the testicle in the cavity of the tunica vaginalis scroti. The upper "bauchfellfalte" is, I think, a very important membrane, as I am persuaded that it is along it that those tubes which join the testis to the epididymis make their way. The lower one becomes a part of the gubernaculum (Pl. II. fig. 3).

5. STRUCTURE OF THE WOLFFIAN BODIES.

As we have already seen, the Wolffian bodies at their origin seem to consist of an aggregation of little cylinders or pediculated vesicles, placed transversely and abutting on a filament (the excretory duct), which runs from above downwards along the outer margin of the gland. These little cylinders, in course of time, become converted into hollow canals, which, when we follow them from their openings almost at right angles into the excretory duct, are seen to become exceedingly tortuous, and finally terminate in dilated culs-de-sac, situated mainly on the inner aspect of the organ; they have lost their originally parallel distribution, and are now interwoven with each other in all directions. In consequence of this flexuosity, it is almost impossible to get a section which will show a canal in all its course from the cul-de-sac to the excretory duct; but, as far as I could see, the orifices of entrance of the canals were considerably smaller than their calibre in the middle, and more especially in the beginning of their course. The canals vary very considerably in size from each other.

In these tubes and culs-de-sac, there is visible a greyish and often slightly yellow secretion, formed of rounded and amorphous granular matter. Follin states that acetic acid dissolves this, and after the preparation so treated is dried, a number of prismatic crystals is to be seen.

As I mentioned previously, the Wolffian bodies are very vascular, so much so that, when fresh, they have a rosy yellow hue to the naked eye, with which the clear white of the genital gland forcibly contrasts. Rathke has figured the arteries as taking a rounded form towards their extremities, and forming, just as in the kidney, glomeruli similar to those of Malpighi; and, indeed, this has been held as an argument for the probability of the secre-

tion of the Wolffian bodies being similar to that of the former organ. Unfortunately, succeeding investigations have not been able to confirm his observations; at least on mammals and birds, for he seems to have dissected and drawn these glomerules in the embryo of the *Coluber natrix* alone. Follin says, the arteries simply lie in parallel lines between the canalicules, without forming glomeruli.

I have observed that, as the Wolffian bodies begin to atrophy, their culs-de-sac diminish in size and become less numerous, while the tubular element (though the calibre of the *individual* canalicules seems also to be smaller than at first) appears to the eye to increase by comparison, but this is doubtless only due to the disappearance and diminution of the culs-de-sac. In the male it is very noticeable how the canalicules atrophy *from* their points of opening into the excretory duct for a certain way inwards, so as to leave that duct free and detached from them, in order finally to become the vas deferens (Pl. III. fig. 1). As the process of diminution goes on, all structure seems to disappear, and finally the microscope only shows an amorphous mass (Pl. III. fig. 4), having transverse granular bands running through it, with here and there a round dark body indicating the remains of one of the culs-de-sac. In the sheep the bodies begin to disappear when the embryo has attained the length of 4 or 5 inches, and when it is 7 inches long, they are reduced to mere vestiges. And it would seem to be a general rule, that the higher the animal is in the scale of nature, the sooner do the Wolffian bodies disappear, so that when we come to man, we find that even at the end of the second month, only the most feeble remains exist.

As far as I have now gone, all that has been said con-

cerning the development, form, and structure of those remarkable bodies hardly admits of doubt. For although it is true that modern authors have differed upon certain *minute* points, their general conclusions tend pretty much to the same result, while their differences do not materially affect any great question in the development of the genital system. But on the subject which now follows, hangs not only the correct understanding of what in each sex constitutes the efferent tube of the genital gland, but also the explanation of certain forms of hermaphroditism, the knowledge of what are the analogous parts in each sex, and the import of certain structures connected with the genital apparatus, which are possessed of considerable anatomical and some pathological interest. But on this point embryologists, both French and German, of the highest reputation, are even now by no means agreed; and, I think it is the chief point of interest in the whole investigation, I have accordingly bestowed upon it all the care I could. I refer to the nature and development of the two ducts connected with each Wolffian body. Before stating what result I have come to in my own mind, I shall here narrate, in order to show what diversity of opinion there has been and still is upon the point, the views held by Müller, Bischoff, Valentin, Coste, Rathke, Kobelt, Allen Thomson, and Follin.

Müller, then, believed that the excretory duct of the Wolffian body led from the *lower extremity* of the gland to the sinus urogenitalis, and that along the *outer border* of the organ there ran a fine filament, viz., the efferent tube of the generative apparatus, which above terminated by a free extremity, and inferiorly below the base of the gland, merged into the excretory duct (Pl. VI. fig. 1). This efferent tube became in the male the vas deferens, and entered into connection with the testicle. In the female, its upper extremity merely acquired an open mouth, and

so it formed the Fallopian tube. It followed, therefore, that that portion of the *excretory duct* below where the efferent tube joined it, must form in both sexes the lower parts of the two structures above mentioned. The filament or excretory tube, which he describes as running along the outer aspect of the gland, has received from him the name of *the Müllerian duct*, and by that name will be mentioned henceforward, although, as we shall afterwards see, he committed a great error in supposing that that duct joined the excretory duct, for the two are continued downwards separately into the sinus urogenitalis.

Bischoff, in his *Treatise on Development*,¹ describes a band which runs all the length of the organ along its outer and anterior aspect, and he says that this contains both the excretory duct, which on account of its tenuity was very difficult to distinguish, unless when filled by the secretion of the gland, and also a thicker filament (*Müllerian duct*?), which was at first solid, but afterwards came to be developed into the vas deferens or Fallopian tube.

M. Coste² believed, with Bischoff, that there was a complete independence between the excretory ducts and those of the genital glands (*Müllerian*?), and that no part of the Wolffian bodies or their excretory ducts went to the formation of the genital system.

Rathke at first held the opinion that the future vas deferens and Fallopian tube were developed distinct from the excretory ducts,³ but in their immediate neighbourhood, and that when these ducts disappeared, the former occupied their place. But afterwards, from his researches

¹ *Traité du Développement de l'Homme et des Mammifères*. Traduit de l'Allemand. Par A. Jourdan. P. 345.

² *Recherches sur le Développement et la Signification du Système genital*. *Comptes Rendus*, 1839, p. 331.

³ *Abhandlungen zur Bildungs und Entwicklungsgeschichte des Menschen und des Thiere*. *Meckel's Archiv*. p. 379. 1832.

on the *Coluber natrix*, which he believed were also applicable to mammalia, he was induced to alter this opinion;¹ and then he maintained that there was developed alongside of the excretory duct, in both sexes, a filament (Müllerian duct?) at first solid, and afterwards hollow, which terminated above by an open end. This in the female became the Fallopian tube, while the excretory duct disappeared along with the rest of the Wolffian body, but in the male this new canal was absorbed at a certain period, and totally disappeared, while the excretory duct was developed into the vas deferens.

In 1847 Kobelt of Freiburg published a most elaborate treatise on the parovarium of the female as the analogue of the epididymis of the male;² and of all the authors who have written on the subject, none have, I think, done so much to elucidate the true nature of the changes occurring in the Wolffian bodies and their ducts as he, though I venture to differ from his views on some minor points. To quote his own words: "By means of the excretory duct of the generative gland—that is to say, by means of the Müllerian duct in the female, and of the excretory duct of the Wolffian body in the male, and on the other hand by means of the *rudiments mammaires* which exist in all animals, each embryo, according as it develops itself, can take the attributes which characterise one or other sex." He thus agrees perfectly with Rathke in his latter view.

Valentin at first ranged himself on the side of Müller, but in his *Physiology*, published in 1850, he seems to have abandoned his former ideas, for in that edition he merely gives a reprint of Kobelt's, then recent, observations.³

¹ *Entwicklungsgeschichte der Natter*, p. 210. 1835.

² *Das Neben-Eierstock des Weibes, das längst verwischte Seitenstück des Nebenhoden des Mannes entdeckt*. Heidelberg, 1847.

³ *Lehrbuch der Physiologie des Menschen*. Band ii. Dritte Abtheilung, p. 104.

Bergman, Leuckart, and Vrolick, and in this country Dr Allen Thomson—a very high authority on embryological questions—also concur with Rathke and Kobelt. Finally, Kölliker, the most recent writer on development, distinctly adheres to their views.

One would have now thought that such an overwhelming mass of evidence, all tending to prove that in the male the excretory ducts, and in the female the Müllerian ducts, were the real developing tubes, would have been quite conclusive. But in 1850 Dr Follin of Paris published an inaugural thesis, for which he obtained the gold medal of that year, in which, strange to say, he most distinctly denies the modern opinions of the above-mentioned authors, and reverts to the notion of Bischoff and Coste that *in both sexes* the Müllerian ducts form the excretory genital passages. He says—"The Wolffian bodies, as I shall show, form neither the kidneys nor genital glands, nor does their excretory duct form the vas deferens, or its commencement the epididymis; their *rappports de voisinage* are the only grounds for supposing so." And again—"The excretory duct of the *genital gland* is developed independently of the Wolffian body; in the male sex that duct approaches the testicle, unites itself to it by an abrupt hook, next folds itself indefinitely, and so forms the epididymis. In the female sex that duct expands slightly at its upper end, and remains separate from the genital gland. All these phenomena occur apart from the Wolffian bodies."

Finally, Dr Cleland, in an introductory sketch of the development of the testes, prefixed to his Essay on the Gubernaculum, says that the excretory duct becomes concealed among the secreting tubules of the gland, while along its outer border is developed the Müllerian duct, which ends at its *upper part* in a *mass of convoluted tubules*, which are formed independently of those of the

Wolffian body, but in a position originally occupied by them. From the Müllerian duct is formed the vas deferens, and from these convoluted tubules the epididymis in the male; and in the female the *same duct* forms the Fallopian tube, and the convoluted tubules or striæ the fimbriated extremity.

MULLER,	{	Hold various opinions concerning the relations of the two ducts to each other and to the Wolffian body, but believe that in both sexes the Müllerian ducts are the developing tubes.
CLELAND,		
BISCHOFF,		
COSTE,		
FOLLIN,		
VALENTIN (2d opinion)	{	Are agreed as to the relations and conduct of the two ducts, and believe that in the male the excretory duct, and in the female the Müllerian duct, develops.
RATHKE, "		
KOBELT,		
LEUCKART,		
ALLEN THOMSON, &c.		

I am afraid that it will be somewhat difficult to follow the varying and perplexing accounts given above, but in extracting them from the works of their different authors, I have endeavoured to condense and render them as intelligible as possible; and although I have been obliged to employ a considerable amount of repetition, still it is almost necessary to do so, in order to keep the main facts prominently in view.

I will now state what I have observed myself, and how far it accords with the views of others.

6. DUCTS OF THE WOLFFIAN BODIES.

In the embryo which I first examined ($\frac{3}{8}$ ths of an inch) I saw proceeding from the lower end of the Wolffian

body a single duct, which went towards the allantois (Pl. I. fig. 2); this is the excretory duct. When the embryo attained the length of $\frac{6}{10}$ ths, the genital gland was seen as a faint white streak along the inner border of the Wolffian body, and about the same period along its outer edge a fine cord was seen raising itself up, as it were, from the substance of the gland, and evidently continuous with the excretory duct. But in this cord there was rapidly developed, in addition to the excretory duct, a clear white filament, viz., the Müllerian duct, which soon extended also from the top to the bottom of the gland; and in the embryo of $1\frac{4}{10}$ ths of an inch or so, their relations to each other could be distinctly seen (Pl. I. figs. 5, 6). The excretory duct was of a greyish colour, exactly similar to that of the Wolffian body itself, while the Müllerian duct shone out clear and white; and although the former is in reality much the larger of the two, it is only discernible with the utmost difficulty (at least while it lies along the gland), while the latter attracts notice at once; and this, I think, led Müller and Cleland into the error of supposing that the excretory duct *emerged* from the substance of the gland in its lower end, and did not run up along its whole length. The Müllerian duct lay in front of and upon its fellow, having a slightly wavy course, but when the two became free of the gland at its base, Müller's duct formed a graceful curve over the other, and turned completely behind it. Immediately after that, the two ducts from the opposite Wolffian body joined them, and the whole four united into one solid cord, termed Thiersch's Genital Cord (Genitalstrang).

Müller's duct was shown by Rathke to be at first a solid filament, which in process of time became a hollow duct.

This state of matters continues for some time till the embryo is about two inches long, or thereabouts, and then the Wolffian bodies begin, so to speak, to revolve on

their own long axes, so that the ducts, which were at first situated along their outer edges, now come to be almost in front of them, and this goes on till they are, in fact, completely on the inner side, and next to the genital gland. I should suppose that this arises not from any action on the part of the organs themselves, but from the growth of surrounding tissues, from their own commencing atrophy, and from the more compact closing in of the abdominal walls in front, which in a manner roll the organs round.

When the embryo is about three inches long, the upper part of the Wolffian body proper begins to shorten from above downwards, so that the genital gland, which at first lay about the middle of the organ, is speedily found to have its summit on a level with that of the Wolffian body. But still, on a superficial view, that body seems as long as ever. How can this be? The reason is, that as the upper part of the Wolffian body shortens away, its place is taken by a totally new structure, whose lower edge lies just level with the top of the genital gland. In the embryo of the sheep, which is often congested, and its vessels full of blood, the Wolffian body has then a fine orange-pink colour; and in contrast with this the newly-formed structure at its summit is seen to be of a pearly white colour, just like the genital gland (Pl. I. fig. 7).

We saw that at first the two ducts reached quite to the top of the organ, and in reality they still do so; but in consequence of the changes which have been just described, the end of Müller's duct now reaches close to the top of the genital gland, following the margin of the now diminished Wolffian body, but *apparently* seeming to lie *across* it; while the excretory duct at its upper end melts away into the new structure (Pl. I. fig. 7). Bischoff, without knowing the cause of the two ducts thus separating from each other, describes the fact thus: "When,

at the slightly pointed upper extremity of the Wolffian body, the parts of the cord separated from each other, the *excretory duct continued to mount upon the summit of the Wolffian body*, and became continuous with the thread prolonged to the diaphragm (diaphragm ligament?). But the anterior solid filament (Müller's duct) *inflected itself from without inwards over the internal face of the Wolffian body* to reach the upper part of the genital gland." But without an explanation such as I have given above, how is it possible to conceive of a solid filament leaving the side of an organ and travelling over its surface? With it, no such feat is necessary, for in reality it only retains its primary position, following the convex curvature of the Wolffian body. Bischoff, again, thought that the excretory duct merged into the diaphragm ligament; but, as I think, it is simply continued from the proper substance of the Wolffian body into the new structure on its summit.

To Dr Cleland is due the merit of first pointing out the existence of this new structure (the future globus major), though he certainly committed an error in saying that the Müllerian duct terminated in it; it is the excretory duct which really forms a connection with it. But this will be treated of afterwards.

7. CONNECTION OF THE DUCTS WITH THE WOLFFIAN BODY.

Before proceeding to notice the changes which occur in the two ducts, whose origin we have now traced, it is necessary here to show, in a few words, what are their connections with their glands, and with the allantois into which they open below. The excretory duct, as we have seen, runs up along the whole outer border of the gland, and into it open, at short intervals, the tubules of which the

latter is composed, as can be seen on making a longitudinal section of the gland comprising its duct. The ducts seemed to me to be smaller at their mouths than at any other part of their course. It is quite possible, and has been done by many physiologists, to inject the Wolffian bodies, for which purpose filtered ink seems to answer best. A very fine canula is to be pushed into the excretory duct, and the injection being very gently thrown in, is seen to mount up the tube, and then flow into the flexuous canals of the Wolffian bodies. When the new structure appears at the apex of the body, the excretory duct, as far as I can see, seems by degrees to prolong itself upwards into it, and ultimately receive the canals, of which, as I shall afterwards describe, it is composed (Pl. I. fig. 7, and Pl. III. fig. 1). This is a very difficult thing, indeed, to demonstrate; but when we come to consider the formation of the vas deferens and globus major, it will be evident that such must take place.

Müller's ducts are at first mere solid threads (which Kölliker thinks is opposed to the usual formation of such gland ducts), but finally become hollow, and terminate in minute cleft-shaped openings at their upper extremities. In the male they are smaller than in the female, more especially in the human subject; at any rate, those who have examined them in man say so (Pl. I. figs. 5, 6). But in the sheep, the difference is not very well marked, and would at first hardly serve alone as a guide to distinguish the sexes.

8. OPENING OF THE DUCTS INTO THE ALLANTOIS.

In connection with the early history of the Wolffian bodies, we must briefly consider the structure termed the allantois, and the connection between them. There are three views regarding its formation—(1.) That of Reichart;

that it is developed from a growth of cells from the posterior extremity of the corpora Wolffiana. (2.) That of Valentin, Von Baer, &c. ; that it is formed out of a sacular process which passes out from the cloacal termination of the intestines. (3.) That of Bischoff ; that it arises as a double mass of cells projecting from the visceral plate of the tail, which fuses together and forms a single vesicle ; and he overthrows the two former notions by showing that this existed before either Wolffian bodies or intestine were visible.

Be this as it may, the excretory ducts and the lower end of the intestine certainly form a connection with this vesicle, which, when the visceral plates close together, hangs out of the abdomen. The portion of it nearest the embryo, together with the small part already within it, form the bladder, while the most remote part, having become greatly attenuated, is drawn gradually into the abdominal cavity, and forms the urachus. When the ducts of Müller come to be developed, they too open into the allantois (or, as we may by this time more correctly say, the part of it termed sinus urogenitalis), close beside the excretory ducts. The term *canalis* or *sinus urogenitalis* was applied by Müller to the part where the four ducts open. The two excretory ducts open very close to each other, so much so, that Valentin said they opened together by one aperture ; but such is not the case, for a distinct septum can be seen between them. The Müllerian ducts open somewhat in a line with them, and the orifices of the ureters are seen higher up.

9 DEVELOPMENT OF THE DUCTS IN THE FEMALE.

As the Wolffian bodies begin to waste away, the Müllerian ducts, on the contrary, begin to increase in size

and length. At the same time, the ovary comes to lie more and more horizontally, the diaphragm ligament has begun to widen into the broad ligament, and owing to the changes in position, &c., of the Wolffian body, described at p. 25, Müller's duct, in place of having the whole of that gland interposed between it and the ovary, is now on the inner side, and close to the latter. By the time that the embryo is five inches in length, these changes are well seen, and about this period the development of the different parts of the generative apparatus seems to go on with most rapidity, insomuch so, that a quarter of an inch of increase in the length of the animal makes a wonderful difference in their appearance.

At the point whence the round ligament springs, the Müllerian duct makes a curve, and the portion of it below this, which is destined to form the cornu uteri, increases materially in size, while at its upper extremity the duct makes a turn upon itself, much resembling the crook of a bishop's crosier, and its open orifice there becomes more and more patulous and bell-shaped. In the foetus of seven inches, the parts have almost assumed their permanent appearance, the ovaries being now quite horizontal, on a level with the summit of what may now be termed the uterus, and a long way distant from the kidneys (Pl. I. fig. 9, and Pl. II. fig. 1). The lower ends of Müller's ducts are now the horns of the uterus, and the middle and upper portions, forming the Fallopian tubes, begin to acquire numerous folds and convolutions. For some time there has been forming along the margin of the Fallopian tube a fine membrane, which now broadens at its upper part, where the tube takes the curve upon itself, and extends to the bell-mouthed extremity of the latter. In the adult sheep this forms a sort of bag or veil, having at its extremity the pavilion of the Fallopian tube, and adapted, as it were, to envelop the ovary. This bag or net, which

exists also in the pig, is not represented in the drawing of the uterus and its appendages in the sheep, given in Tod's Encyclopædia.¹ The pavilion or morsus diaboli is formed by a simple expansion of the mouth of Müller's duct, aided probably by the addition of a membrane, such as I have described as being connected with the Fallopian tube, which forms the fringe. I have examined it most carefully by steeping it in tartaric acid, and then spreading out on a glass slide, and examining it by the aid of a lens and a strong light, and it appeared perfectly transparent, without the slightest trace of tubular or other remains in it whatever. I mention this as it will be seen to bear on Dr Cleland's idea that the fimbriæ were formed from the striated tubules in the new structure at the top of the Wolffian body, in which he believed that Müller's duct ended. Were such the case, the fimbriated extremity would have infallibly shown some traces of these tubules, which it does not.

The Wolffian bodies and their excretory ducts form no part of the proper generative system of the female.

10. DEVELOPMENT OF THE DUCTS IN THE MALE.

It will be remembered that at pages 20 to 23 I gave a brief account of the different opinions of two sets of anatomists, regarding the formation of the Fallopian tube and vas deferens, the one set believing that Müller's ducts form both, the other that they only form the Fallopian tubes, and that the vasa deferentia arise from the excretory ducts of the Wolffian body.

For a considerable time during my examination of these structures, I held firmly by the first idea. Müller's duct is undoubtedly a more prominent object than the excretory

¹ Tod's Encyclopædia of Anatomy and Physiology, article *Ruminantia*, p. 544.

duct, and its development into the Fallopian tube in the female is so plain and clear, that one is almost tempted to take it as a matter of course that it acts similarly in the other sex. In the male, again, the duct is smaller, and it is more difficult to observe what happens to it; while at a certain period, as I noticed before, the parts of the generative system metamorphose so rapidly, that should a single link or two in the chain of development be missed over (in the shape of embryos of a certain size), the Müllerian duct has faded away, and the excretory has started into full view as the vas deferens, before one can be fully sensible of the change without the minutest examination. Moreover, it appeared so simple to believe that in both sexes the same duct should develop for the same end,—viz., as a genital canal; and it seemed unreasonable to suppose that a special structure should be created in the male, apparently for no other purpose than to atrophy again as soon as it had attained a certain perfection. However, after making sections of the so-called Thiersch's genital cord, and reading Weber and Leuckart's description of the uterus masculinus, I was induced to reconsider the matter on a new series of embryos, and was eventually convinced, although at first much against my own inclination, that the opinion I had espoused was wrong, and that that of Rathke, Kobelt, and Kölliker was the only one which could at once satisfactorily account for the eccentricities, if I may so term them, of hermaphrodism, and give a rational explanation of the origin and anatomical significance of such bodies as the hydatid of Morgagni, or the vas aberrans Halleri, or the organ of Weber. When such men as Valentin and Rathke fell into much the same error (*vide* their first opinions), it is not to be wondered at that one so little accustomed to the study of embryology and the peculiar appearances of foetal structures as I, should have been deceived in a similar manner.

In the male, then, I believe the excretory duct undergoes a process of separation from the canaliculi of the Wolffian body (p. 20), till it is entirely or all but freed from them (Pl. III. fig. 1), while the Müllerian duct, all but its upper and lower ends, almost entirely disappears. Just as in the female we saw Müller's duct come to occupy a position close beside its ovary, so does the excretory duct with regard to the testicle; and at the point whence the gubernaculum (round ligament) springs, it too, like the former, makes a sharp bend (Pl. II. fig. 3). The portion of it between this point and the bladder, remaining straight, becomes the vas deferens; the portion immediately at that point, becoming gradually more and more convoluted, forms the globus minor; and the part above that doing the same, forms the body of the epididymis. As the testis begins to be pulled down by the gubernaculum, it turns gradually on to its outer side, whereas it originally lay on its inner side, and in place of becoming more horizontal, like the ovary, it becomes more vertical in position, so that its vessels come to lie and enter at its upper end. These vessels increase greatly in thickness just above the testicle, thus forming what is termed the "vascular tumour" in the adult (Pl. II. fig. 5). In the bull and ram they get so convoluted as to form a swelling like a coiled rope on the superior extremity of the testis. As the testis approaches the internal abdominal ring, the vas deferens necessarily becomes more horizontal, and when the gland enters the ring and descends into the scrotum, it finally runs perpendicularly from below upwards.

11. FORMATION OF THE GLOBUS MAJOR.

I have now explained the formation of the vas deferens, the globus minor, and the body of the epididymis; but

what forms the *globus major*?—meaning thereby the *coni vasculosi* and *vasa efferentia*—and how does the testis form a junction with its duct? At page 25 I described how, at a certain epoch, the upper part of the Wolffian body atrophied, and its place was taken by a new structure, first noticed by Dr Cleland (Pl. I. fig. 7). As the Wolffian body disappears, this new structure, on the contrary, becomes more and more distinct (Pl. V. fig. 6). It exists both in the male and in the female, but in the former it serves by far the most important end. In a sheep of about 6 inches long, where, from some inflammatory process most likely, the testes had become glued on to the front of the kidneys, it was beautifully seen, forming a sort of cocked-hat shaped body, seated near the summit of the testis, much as the supra-renal capsule is on the kidney. On making microscopic sections of it, this structure is seen to be composed of a homogeneous substance containing within it certain tubules, which, as Dr Cleland remarks, “cannot be composed of the canals of the Wolffian body transformed, for were this the case, we should find them consisting of hollow tubes from the first, whereas they begin as solid bodies, indistinctly separated, and smaller than the Wolffian tubules.”

These tubules, which are about twelve to eighteen in number, as far as I could count (Pl. III. fig. 1), run almost transversely from without inwards, being broad at their outer ends and pointed at their inner, where they converge somewhat towards each other. They are slightly wavy in their course; at their outer ends they are seen to be bound together by a tube running round, into which they would seem to open; and I am convinced that the Wolffian duct, becoming slightly prolonged upwards, effects a junction with this common tube. Here, then, are the future *coni vasculosi* of the adult,

which when unravelled are found each to consist simply of one tube convoluted upon itself, and which all open into a common duct at their outer extremities, continuous with the canal of the epididymis. As was said previously, this new structure comes eventually to rest quite on the summit of the testicle, and then from it there passes a short, straight cord into the substance of the gland, and to this cord the converging points of the coni vasculosi are seen to attach themselves. It soon becomes striated longitudinally, and each striation becomes a distinct vas efferens connected with a conus vasculosus (Pl. III. figs. 2 and 3).

This process, which I have traced all through, and which agrees with Dr Cleland's description, except as regards the duct, affords, I think, the best explanation of the formation of the globus major, and is one of the most interesting points in the whole subject. It will be observed that, according to this theory, no part whatever of the Wolffian body enters into the construction of the generative apparatus, and in consequence we are not under the necessity of supposing the transformation of one kind of secreting structure into another.

Having thus stated my own views, which, to a certain extent, are those also of Dr Cleland, I shall now give those of other authors, and endeavour to point out in what particulars they fail.

Beginning with Müller, he, I think, has approached very nearly to the true state of things, for he says: "In both sexes the Wolffian bodies are not converted *into any other organ*. In the male, the part of the epididymis, which consists of the coni vasculosi, is formed of transverse tubes which connect the efferent tube with the testis, and all that part of the efferent tube which is thrown into strongly-marked convolutions along the outer border of the Wolffian body contributes to the formation of the

epididymis." Had he only given a more minute and accurate account of these "transverse connecting tubules," and had he known that the *excretory duct* was the true efferent tube, his description would have been complete, and, as it is, his evidence is in favour of the probability of the theory I have given above.

Bischoff, again, says that he made vain efforts to discover a communication between the testis and the excretory duct of the Wolffian body; that he *had* often seen a filament (the transverse tubules above mentioned) such as Müller described and figured, but it always turned out to be either a blood-vessel or a fine fold of peritoneum, and that the only origin he could ascribe to the epididymis was that Müller's duct became closed at its upper extremity, folded indefinitely, and so formed it. Follin's account is precisely similar. This theory is, I think, quite untenable. Every anatomist must see that there is no difficulty in understanding how a simple tube may so twist and turn upon itself as to form the body and globus minor of the epididymis, and so enlarge and swell out as to form the Fallopian tube and cornua uteri; but how a simple tube could by any possibility so form a complicated structure, such as is composed of the *coni vasculosi* and *vasa efferentia*, is, I think, quite incomprehensible. Besides, as regards the sheep at least, and we may hence very fairly infer as regards man too, there is nothing I am more certain of than the existence of a distinctly striated cord arising between the testis and the new structure on the top of the epididymis.

Lastly, Kobelt partitions out the various canalicules of the Wolffian body into three distinct sets, an upper, middle, and lower, to each of which he assigns a different destiny: The upper set, along with the ampulla (upper termination) of the excretory duct, being changed into certain vesicles found on or in the epididymis; the middle

becoming the coni vasculosi, and communicating at a later period with the rete testis, as vasa efferentia; while the lower disappear or are changed into the vas aberrantia of Haller; and he gives a drawing which certainly shows these occurrences in a very plain manner,—rather too plain, in fact. But in order that such should take place, it would be necessary for the summit of the testis to remain exactly on a level with the central tubules of the Wolffian body, so that they might readily effect a junction with it. It does not do so: long before any junction can be traced between the two glands, the top of the one is on a level with that of the other. Again, it so happens that it is the bulbous culs-de-sac of the Wolffian bodies which lie next the testis, and it is not likely that they would change into delicate vasa efferentia. This theory also involves the transformation of a structure whose function is that of the kidney, into one whose function is to secrete semen. Moreover, most other anatomists, however they may differ as to the origin of the epididymis, agree that, at any rate, no part of the generative system is formed from the Wolffian bodies. Kobelt published his paper in 1847, but within the last year or two Giraldés of Paris has pointed out that the true vestiges of the Wolffian body (or at any rate the greater part of it) are to be found lying in front of the vascular tumour, at a short distance above the epididymis. How would Kobelt account for these? He would have required to divide the Wolffian body into four sets to provide the form too. Finally, it is perfectly easy, at a certain epoch, to see the new formation at the top of the Wolffian body lying close on the summit of the testis, and the whole length of the Wolffian body, in an advanced state of atrophy, stretching down the side of it. But while thus disagreeing with him as to the conduct of the upper and middle tubules, I reserve my opinion as to the lower (Haller's

vasa aberrantia), regarding which I think he gives a satisfactory account.

Kölliker only differs from Dr Cleland and myself in believing that the caput epididymis is formed by the *altered upper tubules* of the Wolffian body. As the reasons for thinking it an entirely original formation are given at page 33, I need not here recapitulate them.

Resumé.

Müller considers the caput epididymis to be formed from transverse tubules connecting the testis and its duct.

Follin and *Bischoff*—From the convoluted upper end of Müller's duct.

Kobelt—From the middle tubes of the Wolffian body.

Kölliker—From the upper tubes of the Wolffian body.

Cleland—From a new structure formed on top of Wolffian body.

12. FORMATION OF THE VAGINA, UTERUS, AND SEMINAL VESICLES.

It is obvious that to treat of the formation of the various parts of the generative system, at one time or as a whole, would render the subject far too complicated to be easily followed, and I am therefore under the necessity of taking it piece by piece, and following each part to its final development before treating of another. We have traced the progress of the ovary and Fallopian tube in the female, and of the testis, vas deferens, and epididymis in the male; and there now remain to be considered, the uterus and vagina on the one hand, and the vesiculæ seminales on the other, which all arise in connection with a structure not hitherto spoken of—viz., the genital cord—a structure

which seems to have been first carefully investigated by Thiersch.

In a previous part of the paper, I mentioned that the two ducts of the one Wolffian body joined those of the other at a short distance from their respective glands, and that the whole four, after thus forming the genital cord, proceeded on their way to the sinus urogenitalis (Pl. I. fig. 4). Just before the junction is effected, the two Müllerian ducts curve over the two excretory ducts, so that, on making transverse sections of the cord, the former are found to lie posteriorly in it. I do not find that Müller, Bischoff, Follin, or Cleland made such sections—at any rate, they do not mention having done so in their writings; but Thiersch has done so in the sheep, and Kölliker in the calf, with the result of finally settling a number of vexed questions. I have repeated their observations many times on sheep from 2 to 4 inches in length, by hardening them in spirit and making sections through the whole embryo, from the commencement of the genital cord continuously down to the sinus urogenitalis.

In such sections, then, the two Müllerian ducts are found lying behind the two excretory (Pl. III. fig. 6); the former being known by their round shape, clearly defined edges, and thicker walls; the latter being more oval in shape and their walls not half so thick. In the female of about $2\frac{1}{2}$ or 3 inches (Pl. IV. fig. 1), in a slice made at a very short distance from the commencement of the cord, the two Müllerian ducts are seen to approach very close to each other; then (after a few more sections) they coalesce, and finally they join into one tube, which advances somewhat forward in the substance of the cord, so as to lie between, in place of behind, the two excretory ducts, which remain separate during their whole course. But about the middle of the cord, this single tube shows

signs of separating again into its two component halves, and very soon the two Müllerian ducts again appear as separate canals; but this time it struck me that they did not lie so much side by side as one in front of the other, and they had also retreated to their original position behind the other ducts. At the end of the cord they had again united into a common tube. The excretory ducts, which at first were of much greater diameter than the others, gradually diminish in calibre, till at the lower end of the genital string they are much the smaller of the two sets. In older embryos, Müller's ducts get quite united all the way down into a single broad canal, which soon completely occupies the whole cord, while the now comparatively small Wolffian ducts are pushed aside. This canal represents the vagina and body of the uterus, and the remains of the excretory ducts are transformed into the canals of Gaertner, situated, in the adult, in the midst of its anterior walls.

Specimens are occasionally met with in which both uterus and vagina are double, or where the uterus is single and the vagina double, or *vice versá*; and the conduct of Müller's ducts in the genital cord explains these anomalies in the most simple and beautiful manner. In the cords of the earliest embryos which I thus examined, the point of union of Müller's ducts took place first at a spot which in the adult would have corresponded to the cervix uteri. Now, if the union had gone on above that point and ceased below it, a single uterus and double vagina would have resulted; had it gone on below it and not above, we would have had a double uterus with a single vagina; and should no union have taken place at any point, both would have been double. I obtained by chance, at the slaughter-houses, a very fine specimen of double uterus and cervix in the sheep. I now regret exceedingly that I did not preserve the original, as the

man from whom I got it stated that it was a great rarity. Whether the vagina was double or not, I cannot say, as in dressing the sheep, it is always cut away from the uterus.

The single canal formed in the genital cord by the union of Müller's ducts increases with great rapidity both in length and breadth, but still it is a considerable time ere any distinction can be made between vagina and uterus, as seen externally. In the sheep of 4 to 5 inches long, on slitting up the genital canal, several delicate transverse rugæ are seen forming about a third of the way down, and these represent the future cervix. At the same time, at the external outlet of the canal, several longitudinal folds are visible, in one of the largest of which the opening of the urethra is seen. Soon, however, the vagina becomes distinguishable externally, by its bulk greatly exceeding that of the upper part of the canal which forms the uterus and cervix, and when the embryo is 7 or 8 inches long the disproportion is very striking, the vagina being about $2\frac{1}{2}$ times broader than the uterus. On the internal aspect, the rugæ get stronger and stronger, till the cervix is distinctly marked off, and it is remarkable how large this is in comparison with the body of the uterus. Even in the full-grown sheep it measures several inches, is of an almost cartilaginous density, and is possessed of a most complex series of rugæ or folds, up the middle of which the canal winds. Synchronously with the appearance of the rugæ of the cervix, the walls of that part become considerably thickened, more especially at the point where the os externum is to form, and even in mature foetuses they are thicker than those of the vagina or fundus uteri. Towards the end of utero-gestation, the body of the uterus assumes, as regards size, some proportion to the rest of the genital canal.

In the human species, the uterus up to the end of the third month is two-horned, and it is only towards the end of the fourth that it increases in bulk to produce the body and fundus properly;¹ and this is a proof that the uterus in man is formed just as in the lower animals, from the union of the Müllerian ducts, and not from a prolongation from the sinus urogenitalis, which, as will be seen immediately, was the doctrine of Rathke.

In the male (Pl. III. fig. 6), the processes which go on in the genital cord are exactly the same as those in the female—the two Müllerian ducts uniting into one tube, and the excretory remaining separate; and this, I think, is an incontestable proof that the former can by no possibility form the vasa deferentia. It was this that first showed me my error in thinking so; and I am sure that if Bischoff, or Follin, or Cleland had made careful sections of the genital cord for themselves, they would not have fallen into the same mistake. The single tube thus formed by the united Müllerian ducts does not, however, as in the other sex, develop into a large and important organ, but dwindles away (or, to speak more correctly, ceases to grow), till it only remains as the hollow vesicle found in the prostate gland, and known by the name of the Weberian organ, or uterus masculinus.

13. VESICULÆ SEMINALES.

I shall now offer a few remarks on the origin of the Vesiculæ Seminales; for, although the modern opinion would seem to be that they are not absolutely essential to the procreative system, in so far as they do not originate or elaborate seminal animalcules, yet they are most inti-

¹ Meckel—Manuel d'Anatomie. T. iii. p. 660.

mately connected with the structures which have just now been considered.

Rathke, in his writings, gives the following description of their development (Pl. VI. fig. 2). At the point where the ducts of the Wolffian bodies open into the allantois, a small conical diverticulum forms, into which the extremities of these canals open, so that, in fact, they have thus only a single orifice of entrance into the sinus urogenitalis. From this diverticulum the vesiculæ seminales arise under the form of two other small lateral pouches, which necessarily have only an indirect communication with the sinus urogenitalis and vasa deferentia, by means of the primary diverticulum from which they spring; but gradually the latter shortens, so that the vesiculæ seminales come to lie quite close to the sinus urogenitalis (the future urethra, in the male), and also to the openings of the vasa deferentia, which finally coalesce with them. The shortened diverticulum now splits into two, and each vas deferens, carrying with it a seminal vesicle, thus comes to open independently into the urethra.

In the adult human subject, the vesiculæ seminales are two oblong, sacculated bodies, wider behind, but narrow in front, and measuring about $2\frac{1}{2}$ inches long, which lie on the under surface of the bladder, extending forwards and downwards from near the terminations of the uterus to the base of the prostate, and opening into the common seminal or ejaculatory ducts. Their sacculated appearance is owing to their peculiar formation, each consisting of a tube coiled upon itself in a complicated manner, and firmly held in that condition by a very dense fibrous tissue; when unravelled, this tube is found to be from 4 to 6 inches long, and about the width of a quill. Its posterior extremity is closed, so that it forms a long cul-de-sac, but there are generally, if not always, several

longer or shorter branches or diverticula developed from it, which end by closed extremities. Its anterior extremity, which forms the fore part of the vesicula, becomes straight and narrowed, and, joining the narrow termination of the corresponding vas deferens, forms the seminal duct. In structure, the vesiculæ seminales resemble very closely the *adjoining sacculated portions* of the *vasa deferentia*.

I have prefaced this short account of the structure of the fully-formed seminal vesicles, because I think it affords *primâ facie* evidence in favour of, or, at any rate, certainly does not militate against, what seems to be the true account of their mode of formation. In making sections, then, of the genital cord from above downwards, in male sheep from 3 to 4 inches long, we come to a point near its lower end, where the two excretory ducts (*vasa deferentia*) come to be apparently somewhat dilated; but, on careful examination, it is seen that from their outer sides there spring two hollow saccules, which widen at their outer ends, so as to be pear-shaped (Pl. III. fig. 6). After a few more slices of the cord have been removed, these are no longer seen, and the excretory ducts resume their ordinary appearance before entering the sinus urogenitalis. These hollow saccules are the first rudiments of the vesiculæ seminales, and there can be no more difficulty in understanding how, by their elongation and folding upon themselves, they form the vesiculæ, than there is in understanding how the excretory duct can form the convolutions of the body of the epididymis, while the simplicity of this mode of formation contrasts strongly with that detailed by Rathke. They are at first entirely contained within the substance of the genital cord, but soon become visible externally on its lateral walls as two minute points, after which they rapidly increase, keeping pace in growth with the neighbouring structures.

14. THE SINUS UROGENITALIS.

In the foregoing pages, the term sinus urogenitalis has frequently been used, and though there is no doubt as to what that structure really is, there has been considerable contrariety of opinion as to what are the transformations which it undergoes. At a very early period of embryonic life, the allantois and intestine have one common external opening; and, as the allantois receives the ducts of the Wolffian bodies, it thus happens that the urinary, generative, and alimentary conduits all open into one vestibule, termed the cloaca, similar to that which is found permanently in many of the vertebrata. Rathke states that, from the sides of this cloaca spring two lateral folds, which advance to meet one another (Pl. VI. fig. 3), while the part where the intestine and allantois join grows forward towards these folds, till, by the coalescing of all the three, a complete septum is formed, and the intestine shut off from the rest of the cloaca. By the thickening of the septum, the perineum is formed. Valentin and Bischoff, again, think that the cloaca simply shortens and disappears up to the point where the allantois and intestine meet, and thus these organs acquire their external openings (Pl. VI. fig. 3). I have made several dissections of these parts under water with needles and the aid of a lens, but although I was unsuccessful in finding the projections which Rathke says form the septum, I think that, reasoning from analogy, his must be the correct view. For the existence of a raphé, or cord (as on the penis and scrotum), seems to indicate that the parts were formed by the fusion of two originally separate halves; and as we have such a raphé on the perineum, it is reasonable to infer that it, too, is the result of the line of junction of two such septa or projections as Rathke speaks

of. However this may be, the portion of the allantois, from the openings of the ducts of the Wolffian bodies, is now termed the sinus or canalis urogenitalis, serving, as it does, as a common exit for the urinary and genital canals. A few pages back, in Rathke's description of the formation of the seminal vesicles, it was stated that he believed that, in the male, at the point where the ducts of the Wolffian bodies entered, a sort of diverticulum or cul-de-sac formed, from the sides of which the vesicles arose. In the female, however, this diverticulum, in place of disappearing, as it does in the other sex, increases greatly in size, till it quite throws the sinus urogenitalis into the shade, and thus forms the uterus and vagina, Müller's ducts only forming the cornua at most. This proposition seems quite untenable, however, for no other anatomists have ever been able to see this diverticulum either in the male (p. 42) or in the female—I have looked for it in vain. Here, again, if Rathke had practised the mode of investigating these points by making sections of the genital cord, he would have avoided this mistake, for he would then have seen that Müller's ducts, in that cord, unite to form a single canal opening into the sinus urogenitalis, which rapidly increases, and is the true origin of the uterus and vagina. In fact, he simply mistook this canal going *into* the sinus for a prolongation from it.

But what becomes of the sinus itself? In the male, then, it simply contracts to form part of the urethra—that part, namely, which lies between the entrance of the vasa deferentia and the penis, *i. e.*, the membranous and a small part of the prostatic portions, in the adult. The neck of the bladder, and what of the urethra lies between that and the entrance of the vasa deferentia, is produced merely by a narrowing of the allantois at the point where it enters the sinus urogenitalis, while the part

of the allantois above that again swells out into the bladder.

Round the part where the excretory ducts (*vasa deferentia*) open, a deposit of cells takes place, from which the substance of the prostate is developed. In sections through the prostates of six and seven months old children, a number of small ducts were visible running towards the urethra, and terminating in three or four acini at their inner ends,—these being the rudiments of the glandular portion of the organ.

In the female, the sinus urogenitalis forms no part of the urethra, but is developed into the vestibulum vagina; and as I do not think it possible to show how this happens better than in the words of Kölliker, I may be pardoned for here quoting his excellent description of it as it occurs in man:—

“The shortening of the sinus urogenitalis to form the vestibulum vaginæ is only an apparent one, and results from the original sinus growing much more slowly than the surrounding parts, and so eventually coming to appear but a small space by comparison. In the human embryo of three months, the sinus urogenitalis measures $2\frac{1}{2}$ mm., and appears as a canal broader than, and immediately continuous with, the bladder and urethra (which latter is not yet to be distinguished as a separate part)—a canal at whose upper end the vagina, which, along with the uterus, is only 3 mm., opens upon a small elevation.

“In the four-months old embryo, the connections of the canal are the same, but the uterus and vagina measure 6 mm., while the sinus has barely made any increase in size. But, by the fifth or sixth month, the vagina has so broadened as to appear a direct lengthening of the sinus urogenitalis, and the urethra, which is now distinct from the bladder, appears as a canal opening into the vagina.

In the sixth-month foetus, the sinus, which may now be termed the vestibulum vaginæ, is only $3\frac{1}{2}$ mm., while the vagina measures 11, and the uterus 7 mm. These numbers show that the original sinus urogenitalis not only does not disappear, but even grows; but, as the vagina and uterus, and the lower part of the primitive bladder, which becomes the urethra, grow much quicker, the sinus urogenitalis appears finally as a mere appendage. Moreover, as the vagina broadens much more than the urethra, thus the sinus urogenitalis, which was at first the immediate continuation of the bladder, becomes at last the end of the vagina into which the urethra opens."

It will thus be seen that the sinus urogenitalis comes to form very different portions of the urogenital system in the two sexes (Pl. VI. fig. 4): in the male, aiding in the construction of the urethra—in the female, of the vagina. Nevertheless, on careful examination, a close analogy can be seen between the membranous portion of the urethra and the vestibulum vaginæ. For, suppose we were to cut off all that portion of the urethra contained in the bulb and corpus spongiosum, what would then be the lowest portion of it (the membranous part) would exactly correspond to the vestibulum vaginæ, the only difference being that, whereas in the male, the generative ducts (vas deferentia) open into the urethra, in the female, these united generative ducts (vagina) so increase in size as to make it appear that the urethra opens into them: the truth being that the vestibulum vaginæ and the membranous part of the urethra are simply the continuations of the allantois below where the generative ducts open, or in other words, the sinus urogenitalis. Finally, the glands of Cowper are formed in the one, and in the other sex the glands of Bartholini; which are universally admitted to be the homotypes of each other.

DEVELOPMENT OF THE EXTERNAL GENERATIVE ORGANS.

The external organs of generation do not make their appearance till those which are charged with the preparation and maturation of the germ have already made some progress in the interior, so that, according to Tiedemann, there is no trace of them visible till the end of the fifth week in man.

Just as, for a considerable period, the internal organs of the two sexes do not present any characteristic difference, so is it with the external; and furthermore, as in the former, the female presents the type of greater simplicity, and the various parts adhere more to their original plan of formation, we shall find the same rule hold good with regard to the latter.

In the following description I shall employ the terms made use of by Kölliker for the various temporary parts, as I think they are very expressive, and will render the subject more easily understood.

In the first weeks, then, of embryonic life, there is seen at the inferior extremity of the abdomen, and in front of the rudimentary tail, a simple opening—the mouth of the cloaca or common receptacle of the intestine and of the allantois with the ducts of the Wolffian bodies. Before this separates into rectum and urogenital canal, there appears in front of it a gentle elevation, which soon forms itself into a little prominence or hump (the sexual prominence), and about the same period two small swellings are visible on each side of the cloacal aperture (the sexual folds). These three elevations all become more and more prominent, until the sexual prominence clearly shows itself as the future genital member

(clitoris or penis), and then along its under surface, in the embryo of $1\frac{1}{8}$ th inch, a furrow now runs from near its point to the cloacal aperture (the sexual furrow). The small portion at the extremity which is not grooved by this furrow is the glans penis or clitoridis. About this period the separation of the cloaca and formation of the perineum, described at page 44, occurs, and from this stage it is necessary to trace the development of the parts in each sex separately.

In the Female.—Beginning with the female as the more easy, we find that the two sexual folds continuing separate on each side of the urogenital aperture (vestibulum vaginæ) form the labia majora, while the sexual prominence becomes the clitoris. In the human female, the orifice of the vagina, at first small and round, increases in size, and more especially in length, in proportion as the large elongated clitoris diminishes, for the lips of the sexual furrow of the latter, receding considerably from each other, cause it to shorten, and it is finally drawn gradually within the vestibule of the vagina. At the same time the margins of the sexual furrow increase in size, and even become pendulous, so as to form the labia minora, and also a sort of preputial covering for the glans clitoridis. In the sheep, however, the process is more simple, for the clitoris simply diminishes to a sort of pendulous body at the inferior commissure of the vagina, the groove on its upper surface being continuous with the vaginal canal. It is thus not drawn within the vagina, nor do the lips of its sexual furrow form proper labia minora.

The clitoris, however, does not always diminish into a merely rudimentary member, for Fugger has shown that in the monkeys of the genus *Ateles* it is normally of extraordinary length, and is possessed of very large corpora cavernosa; while in another genus, *Stenops*, the urethra traverses the clitoris, although the vagina has its usual

position more posteriorly. In the other genera of monkeys the organ presents nothing unusual.

Regarding the formation of the hymen, I can say nothing from personal observation; but Dr Farre, in his article on the uterus and its appendages, has given a very complete account of it.¹ He states that it belongs to the same class of structures as the valvulæ conniventes and fringe-like folds of mucous membrane, which not unfrequently surround the terminal orifices of mucous tubes. The lower end of the vagina in the foetus *invariably* terminates in a marked projection outwards of the mucous lining of the tube. It takes the form of a laterally compressed conical fold, the base of which is continuous all round with the vaginal walls, but the apex is directed forwards. Its centre exhibits a vertical slit-like orifice, the direction of which is apparently due to the lateral compression of the nymphæ and labia between which it lies. This is the hymen. As growth advances, the posterior half of the fold becomes much more developed than the anterior; and thus it happens that in adults the hymen usually presents the form of a crescentic or semi-lunar fold, the concave border of which is directed upwards or forwards, while that which in the foetus had been the upper half has now become unfolded or lost among the plaits of the mucous membrane, situated at the upper part of the vaginal entrance. But the primary foetal forms may be retained,—viz., the circular fold of mucous membrane, which, as the parts become more expanded, acquires a central *round*, in place of *slit-like* aperture; while, should the margins of the orifice adhere, as is sometimes the result of inflammation in infancy, the completely imperforate hymen is formed.

On the whole, then, the formation of the hymen bears

¹ The Uterus and its Appendages. Supplement to Tod's Encyclopædia, p. 710.

a striking analogy to that of the cervix uteri, to which during foetal life it bears a marked resemblance in form, projecting, as it does, between the nymphæ, just as the latter does into the vagina. Both constitute invaginations or intussusceptions of the same canal, while in both it is the posterior half which is most largely developed.

Bischoff mentions that Virey has attempted to draw a comparison between the hymen and the frænium præputii of the male sex. But the only ground for this which I can see is the slight resemblance which exists between them in their being both composed of a thin structure, formed by a double layer of mucous membrane, with a little connective tissue and some fine vessels interposed; and if we look at them from a developmental point of view, there is no analogy whatever. For where does the hymen exist? It exists at the lowermost part of the genital canal,—that is to say, at the lowermost point of the united Müllerian ducts of the embryo, and these in the male form the structure in the prostate, known as the vesicula prostatica. If, therefore, we are to look for the analogue of the hymen, we must find it in some structure blocking up the entrance of the prostatic vesicle; and it is well known that in many animals this is so completely shut up at its mouth as to form a perfectly shut sac. But furthermore, it is going out of the way to find a representative for the frænium præputii in the hymen, for there really exists a very similar structure in the female attached to the lower surface of the clitoris, where the nymphæ spring from it, and formed by the partial union of the upper ends of these bodies. (It is well represented in Lizars' plate of the external generative organs.¹) What gives additional weight to this is the fact that Kobelt has shown that the nymphæ, which contain no true erectile structure, correspond only to the cutaneous covering of

¹ Lizars' Anatomical Plates. Plate xci.

the male urethra ; the true corpus spongiosum being represented by what he terms the pars intermedia, a vascular plexus running along the under surface of the clitoris, while the halves of the bulb find their homotypes in the masses of vascular parenchyma composed mainly of tortuous veins lying behind the nymphæ, and termed by him vestibular bulbs.¹

In the Male.—In the male the genital member, in place of remaining stationary (like the clitoris), elongates to form the penis, while the margins of the sexual furrow, instead of enlarging and receding from each other (nymphæ in the female), approach, and uniting together, convert the groove into the canal of the urethra. The sexual folds, growing larger and larger, meet over the opening of the sinus urogenitalis and form the scrotum ; and thus the canal of the sinus, in place of opening externally in front of the anus, is prolonged forwards into that which has just been formed in the penis. The sides of the sexual folds which meet and coalesce together are the future septum scroti. Along the line of union of the edges of the sexual groove and of the sexual folds a clear white streak is seen, which in the adult is the raphé of the scrotum and penis. In the sheep the penis forms a remarkable bend, and in place of becoming a free, pendulous organ, as in man, is continued upwards under the skin of the abdomen almost to the umbilicus, and so it is with most other quadrupeds.

While, then, the external parts of the generative system arise in pairs on each side of a median fissure, the tendency in the female is for these parts to remain separate, and for the fissure to remain pervious, while in the male the former unite to form single organs, and the latter closes up.

The mammæ are visible in the embryo of 1 inch long

¹ In the third volume of Quain there are drawings of Kobelt given to show this.

as two small dots situated in front of the sexual folds, the apices of which form two of the mammillæ. It is not till the animal has attained a very considerable size (8 or 10 inches) that other two mammillæ appear in front of the previous ones. They exist in the male also, being situated immediately in front of the scrotum.

I append here a tabular view of the embryonic structures which enter into the formation of the generative system, in accordance with the account which I have now given. In order to have rendered that account complete, I should perhaps have included the internal development of the ovaries and testes, but of this I could only have given a *resumé* compiled from other authors, as I was unable, both from want of time and ability, to examine these structures for myself, and I would prefer here (with a few unavoidable exceptions) to speak only of what I have myself *either seen or endeavoured* to see.

In the Female.

Pavilion of the Fallopian Tube	Upper end of the Müllerian Duct.
Fallopian Tube itself	{ Müller's Duct as far as the Round Ligament.
Cornua Uteri	{ Do. from the Round Ligament to Genital Cord.
Body of the Uterus and the Vagina	{ Müller's Ducts united in the Genital Cord.
Urachus	Upper part of the Allantois.
Bladder	Middle do. do.
Urethra	Lower do. do.
Vestibulum Vaginæ	Sinus Urogenitalis.
Clitoris	Sexual Prominence.
Nymphæ	Edges of Sexual Furrow.
Labia Majora	Sexual Folds.

In the Male.

Caput Epididymis (Coni Vasc. and Vasa Effer.)	{ Tubules arising in New Structure on summit of Wolffian Body.
-----------------------------------------------	----------------------------------------------------------------

Body of Epididymis and Globus Minor	{	Excretory Duct of Wolffian Body as far as Gubernaculum.	
Vas Deferens		Excretory Duct below the Gubernaculum.	
Vesiculæ Seminales		Offshoots from Lower Part of the Excretory Ducts.	
Urachus		Upper part of the Allantois.	
Bladder		Middle	do. do.
Neck of the Bladder and Beginning of Urethra	{	Lower	do. do.
Membranous part of Urethra		Sinus Urogenitalis.	
Spongy part of do.	{	Formed by the union of the edges of Sexual Furrow.	
Penis		Sexual Prominence.	
Scrotum		Sexual Folds.	
Raphé of Penis and Scrotum	{	Line of Union of Sexual Furrow and of Sexual Folds.	

PART SECOND.

OF THE REMAINS OF THE WOLFFIAN BODIES.

HAVING given a description of the Wolffian bodies in the embryo, and of the changes which their ducts and other structures connected with them undergo, I shall now endeavour to describe their mode of atrophy; what parts of them remain; what these remains form in the adult; and what are the analogous parts in the two sexes; in fact, to describe the *development* of the *remains* of the Wolffian bodies.

To return, then, to the early periods of embryonic life, it will be remembered that the Wolffian body, when it had acquired its perfect form, presented the appearance of a three-sided pyramid, with the angles rounded off and bent in a crescentic shape, with its convex aspect directed outwards (Pl. I. figs. 5 and 6). It was of a yellowish red hue, and its two ducts were visible running up, side by side, along its outer border; while on its inner concave surface lay the genital gland. When the embryo is about 3 inches long, they begin to diminish in breadth very considerably, and the process described at page 25, by which the ducts come to lie on their anterior faces, takes place. At $3\frac{3}{4}$ inches, the new body which forms on their upper surfaces is plainly visible, both to the naked eye

and in microscopic sections, through the long axis of the gland. In the male, this, the future epididymis (caput), enlarges pretty rapidly, and gradually attains a position on the summit of the testicle; the excretory ducts come to lie quite on the inside of the Wolffian body; and that body itself, by the time the embryo is 5 or 6 inches long (Pl. II. fig. 3, and Pl. V. fig. 6), is reduced to a mere granular strip running down the side of the duct, and dependent, as it were, from the triangular new structure on the top of the testicle. But it is noticeable that, in this atrophied vestige, the whole length of the Wolffian body is represented, that is to say, it atrophies equally throughout all its length. When the sheep is 7 inches long, the testes have descended into the abdominal wall in process of reaching the scrotum, their vessels are very large, and the shreds of the Wolffian body are seen lying on the vascular tumour (Pl. II. fig. 5), while a mere thread, representing its body and lower part, extends down to where the globus minor is forming; in the foetus of 10 inches (Pl. II. fig. 6), this thread, too, has disappeared, and all of the Wolffian body that is to be seen is a few scattered tubules lying in front of the vessels, and encroaching a little on the epididymis.

In the female there is a very slight difference. There the structure which forms the caput epididymis in the male is not required to perform a similar office, and in consequence it never develops to the same extent as in the male; but still it shows its non-identity of structure with the Wolffian body, by not atrophying in nearly so complete a manner, for that body disappears from below upwards even more thoroughly than in the male, so that, while in the latter a very distinct trace is left in front of the vessels, in the female it all but utterly disappears (Pl. II. fig. 1). By the time that the sheep has woolly down upon it, all we see is a mere speck (Pl. II. fig. 2)

situated in what is now the broad ligament of the uterus, a little way external to the *outer* end of the ovary, or what in the male would be the *upper* end of the testicle. And what is this speck? It is the new structure which existed on the summit of the Wolffian body, and which now survives the ruin of the latter.

The general conclusion, then, is, that while in the male the Wolffian body atrophies into a small mass lying in front of the vascular tumour, and the new structure becomes the caput epididymis; in the female the former all but totally disappears, while the latter still preserves its integrity, being found in the broad ligament, and situated with relation to the ovary, just as the globus major is with relation to the testicle.

1. REMAINS IN THE FEMALE.

(a.) *The Organ of Rosenmüller, or Parovarium.*

In the year 1801, Rosenmüller, while prosecuting anatomical researches at Erlangen, and engaged in observations on the progressive growth of the ovary in the human foetus, was struck by the appearance of a body connected with that organ, which in his Latin treatise on the subject¹ he thus describes: "If now, in the *new-born infant*, the duplicature of the peritoneum, which lies between the ovary and the Fallopian tube, be carefully examined by reflected light, there is perceived to exist in it a sort of conical body, not very pellucid, whose base looks towards the tuba, and its apex towards the outer end of the ovary. At first sight, the body seemed to be of a glandular nature, and composed of numerous acini, but it will appear that such is not the case, and that the granular particles are not acini.

¹ Quædam de Ovariis Embryonum et Fœtuum Humanorum. 1802.

"In the infant of seven days, the conoid body was found to be of considerable size, from numerous canaliculi at its base, broad and convoluted, and proceeding towards the upper end of the ovary, where, becoming very fine, and placed closely side by side, they disappeared. I counted about twenty such canaliculi. I at first sight imagined they were lymphatic vessels, but when I examined them with a magnifying power, a most beautiful spectacle struck me with delight. For I observed not only the before-mentioned pellucid canaliculi, but other more delicate ducts connected with them, which proceeded from the base of the conoid body, convoluted, with serpentine windings, and exhibiting the appearance of ringlets lying close side by side. Towards the ovary they become less tortuous, and after becoming nearly straight, they disappear. The apex of the cone is adherent to the ovary, but the canaliculi and the ducts there become so very fine, that nothing can be seen except a somewhat dark spot, which indicates the ending of the cone.

"Whether there be any resemblance between this conical structure with its ducts and the vas deferens and epididymis of the male, I cannot decide; but I am very desirous to examine more carefully the structure of these parts, and I hope and wish that other skilled anatomists may do so likewise."¹

I have not hesitated to give this long quotation from the original work of Rosenmüller, as it is now so scarce, that any fragments of it are worth recording; and to speak candidly, it is hardly possible to give a better description of the organ which bears his name than he himself has done, while the plates of it which he gives are remarkable for their accuracy. At the conclusion of his paper he

¹ For the perusal of the works of Rosenmüller, Kobelt, and Weber, I am indebted to Professor Simpson, who kindly lent them to me from his own library.

mentions that in the infant of two years old, he saw in each broad ligament a saccule or cyst, but little or no vestiges of the conoid body; however, on opening the cysts, he found, as he had expected, the ducts of that body enclosed within them. He makes no mention of seeing the conoid body in the adult.

Meckel, writing in 1825, gives a brief description of the organ of Rosenmüller, and notices that it had been found impossible to inject its tubules, either from the ovary or from the Fallopian tube, and that, consequently, they could not be a means of communication between these two. Nevertheless, he had observed their resemblance to the epididymis of the male, and hints that from the appearance which the Fallopian tube presents in its early state, it is probable that these tubules of Rosenmüller's organ *do* enable it to communicate with the ovary, but that this communication is soon effaced, when the abdominal extremity of the tuba opens, and a new passage is formed.

Neither Rosenmüller nor Meckel, however, make any mention of what is the origin of this singular body, and even Bischoff (1843) only says that *probably* it is the remains of the canaliculi of the Wolffian body. Indeed Rosenmüller seems to have been under the belief that it existed solely in foetuses and infants; and Follin and Kobelt appear to have been the first to direct attention to its structure and formation in connection with its development in man and animals.

I have examined the organ in human subjects from the seventh month of intra-uterine life, up to sixty years of age, and in none of those which I looked at, did I find it *totally* absent. To see it to advantage, the uterus and broad ligament should be removed as soon as possible after death, and no alcohol applied to them—the less fat there is about the parts, the more easily is it seen. Holding up the broad ligament between the eye and a strong light,

the organ is readily detected at the outer end of the ovary, between it and the Fallopian tube, enclosed between the two layers of peritoneum which form the broad ligament. Some little care is necessary not to confound with the tubules of the organ any of the numerous vessels which radiate behind it in the broad ligament. Having already given Rosenmüller's description of it, I shall be very brief in what I have to state about it. Suffice it to say, that the organ is of a conical or fan-shaped appearance, having its base turned towards the tuba (Pl. IV. fig. 2), while its apex is lost upon the ovary, and that it consists of eighteen to twenty, more or less, wavy tubules, converging towards each other at the apex, and at the base of the organ becoming much thicker and highly convoluted, while they are all connected together at their outer extremities. Besides these tubules which form the body of the organ, there are scattered about in its vicinity sundry little fragments of canaliculi and isolated granules which are not united to the organ itself. By careful dissection it is clearly seen that the tubules which converge to the ovary have no true junction or communication with it, and merely lose themselves in its peritoneal capsule. According to Follin, each tubule consists of a very thick envelope of cellular tissue containing longitudinal fibres, in which, in a fine injection, very delicate vessels can be seen; lining this is a layer of very fine pavement epithelium. Owing to the thickness of their walls the calibre of the tubules is reduced to a minimum. Follin has never been able to see any special product of these tubes beyond the contained epithelium.

In the new-born infant (Pl. IV. fig. 4), a barley-corn might cover the organ, while in the adult it is an affair of considerable magnitude, being nearly an inch broad at its base, while the tubules are about half an inch long; so large is it often, that it seems somewhat strange that

it should have so long escaped the eyes of anatomists. In its growth it seems to keep pace with that of the uterus and its appendages. In the girl its tubules are about the size and thickness of threads, pretty equal in size, and highly convoluted; but in full-grown subjects they are greatly increased in thickness, resembling very fine twine, and are quite opaque. They, moreover, lose their convoluted appearance to a certain extent, and become much straighter (in fact, almost quite straight), except at their outer ends, where they are still curved. In very old people, like the rest of the generative system, they undergo a retrograde change, and many of them atrophy, but still, even in very aged women, they never totally disappear. One of the best specimens I possess was obtained from a woman of from fifty-five to sixty years. It has been noticed that after parturition the organ is red and tumified, and I have observed that it is always best seen in the sheep during pregnancy; indeed, in young sheep which have never had lambs, it is usually very feebly marked; so that in them pregnancy seems to have a decided effect upon its development, much the same as the period of puberty has in the human race.

Having now described the appearance and structure of Rosenmüller's organ, I shall say a few words concerning its origin and analogies.

As I stated previously, the new structure which forms on the summit of the Wolffian body exists not only in the male but also in the female, although in the latter it never (during foetal life at any rate) attains the same proportions, nor do its contained tubuli become equally well developed. Furthermore (page 56), in the female, I believe the Wolffian body all but entirely disappears, and that the vestige which we see in the broad ligament is the new structure, which has *not* atrophied like the Wolffian body proper.

Every observer seems to have been at once struck with the extraordinary resemblance which the organ of Rosenmüller bears to the caput epididymis of the male, and on closely examining it, it becomes plain that there is not only a mere superficial likeness but also a structural one. In the first place, its position with regard to the ovary is precisely the same as that of the caput epididymis with regard to the testicle, while in its fan-like shape it exactly resembles the globus major unravelled and spread out. It consists, like the caput, of hollow tubules, varying in number from sixteen to twenty, and these tubules, straight at the apex of the organ, but highly convoluted and rolled up and thickened at its base, are identical with the coni vasculosi, while, to complete the analogy, the whole are bound and connected together at their outer extremities. There can, I think, be not the slightest doubt that the organ of Rosenmüller is (as he himself imagined it might be) the analogue of the globus major. But whence did this organ take its rise? It is simply the vestige which is visible in the broad ligament of the foetus after the disappearance of the Wolffian body (Pl. II. fig 1), now fully grown and perfected, and that vestige I hold to be the new structure which I have so frequently mentioned, and which, I have endeavoured to show, forms in the male the globus major. The only point of difference between the two organs is, that in the female the cord which, in the other sex, connects the new structure to the testicle, and afterwards splits up into vasa efferentia, does not form, and consequently in Rosenmüller's organ no true representation of these vasa exist.

As I believe, then, that the organ itself is the new structure, on the summit of the Wolffian body, matured and fully grown, so I consider that the remains of that body are to be found in the little fragmentary canalicules

and isolated bodies (Pl. IV. fig. 2) which lie scattered about, and chiefly on the inner side of Rosenmüller's organ.

Kobelt, who, in 1847, published his paper, "Ueber der Neben-Eierstock des Weibes," &c., for the express purpose of proving the analogy of the globus major and organ of Rosenmüller, as he differs from Dr Cleland and myself in regard to the formation of the former, necessarily does so in regard to the latter—the parovarium, as he prefers to designate it. He divides (p. 35) the canalicules of the Wolffian body in the male into three sets, upper, middle, and lower. The upper set disappears, or else forms sundry little cysts on the top of the epididymis; the middle ones effect a junction with the testicle, and form the globus major; and the lower either disappear or form the vasa aberrantia Halleri. Now, he asserts that in the female a similar division occurs, and that he can find in it analogies of the three sets; for, according to his views, the upper set forms certain hydatids at the outer margin of the parovarium (the cysts of the epididymis); the middle set forms the parovarium itself (the globus major); while the lower becomes elongated and intermingled with the vessels of the ovarian plexus (vasa aberrantia Halleri). I must say, that I think Kobelt has been somewhat led away by his desire to prove his analogies correct in the minutest particular. I have, when describing the formation of the globus major, stated what I conceive to be arguments against his plan of dividing the Wolffian body into sets of tubules; and these of course are applicable also to the parovarium. For my own part, I have never been able to see any such series of tubules, forming cysts, disposed along the outer side of the parovarium, as he represents, nor have I seen another series on its inner side, elongated and blending with the ovarian plexus. The cysts, which are common enough, appear to me to form quite indifferently at any part of the organ whatever,

and do not show any preference for the outer side more than the upper or lower. The tubules struck me as all being pretty much of one appearance, and presenting no distinctions by which one could with confidence say that this set corresponded to such and such a structure in the other sex, and that set to such another. The remains of the Wolffian body proper are, I think, to be found in the scattered little pieces of canalicules and small round bodies dispersed about the parovarium; and had Kobelt known of the existence of the organ of Giralaldés in the male, he would have seen that the fragmentary tubes of that organ, lying as they do not far from the caput epididymis, corresponded exactly to those lying near the parovarium.

The parovarium seems to be somewhat more highly developed in man than in the lower animals. In the sheep it consists of very fine tubules indeed—mere threads—which converge towards the ovary, while at their outer extremities they swell out into little saccules, or become thickened and highly convoluted, and often rolled up into little balls; small granules and fragments are scattered abundantly throughout. In the pig and sheep, where I have examined the organ very frequently, small cysts were very common indeed in connection with it, but none of them were larger than a pea.

(b.) *The Canals of Gaertner.*

Having disposed of the Wolffian bodies, with their accompanying new structures, and of the Müllerian ducts, we have now to trace the changes which the excretory ducts undergo. These, it will be remembered, ran in the genital cord in front of the Müllerian ducts; and as these latter were seen to blend together and enlarge to form the uterus and vagina, while the former remained sepa-

rate, and did not increase much in size, we would naturally expect to find them in the adult, as two tubes lying somewhere in front of, that is to say, on the anterior wall of the uterus and vagina. Furthermore, they opened along with the Müllerian ducts into the sinus urogenitalis, but that was shown to become in the female the vestibulum vaginæ, and therefore the probability is, that somewhere at the vaginal outlet we would find their openings.

These probabilities were changed into certainties by the discovery of Gaertner. That anatomist, while engaged in researches on the lymphatics of the cow, discovered by accident two canals full of a clear, slightly yellow fluid, which, from their appearance, he judged to be neither lymphatics nor blood-vessels. By after-examinations he convinced himself that these canals could be traced to within a short distance of the ovary, that they opened below into the vagina on each side of the urethral aperture, and that they possessed, about the middle of their course, sundry branches or diverticula. He was, however, quite unaware of their origin or use. In the works of British anatomists I can find no very detailed account of them; but they have since Gaertner's time been described by many of their continental compeers, and more especially by Kobelt and Follin.

I have dissected them out for myself in a considerable number of pigs, sheep, and cows; and although, most probably from my own want of skill, I have not been able to get in any *one* subject such a connected view of them as Kobelt and Follin give,¹ still I have seen enough to convince me that their descriptions are highly accurate. It may be as well to state here how they are to be found, as this is a matter of some difficulty if not gone about in the proper way. Like the parovarium, they are, I think, best seen in well-grown animals which have at

¹ *Op. cit.* Both give very excellent drawings of Gaertner's canals.

some time been pregnant. Having obtained a subject, carefully isolate the vagina, uterus, and broad ligaments, and then slitting up the *back* wall of the vagina throughout its whole length, a view of the mucous surface of its anterior wall, with the opening of the urethra upon it, is gained. If now a careful search is made on each side of that orifice, the two minute openings of the Gaertner's canals may be found very commonly placed at the base of one of the longitudinal columnar rugæ, which abound at the mouth of the vagina. The openings are, however, frequently indistinguishable, and we must carefully raise the mucous membrane over where we expect them to lie, and try to light on them; failing in that, I have often found them by cutting right through the vaginal wall with a sharp razor, so as to make a clean, smooth cut, and on looking at the surface of the section, the cut ends of the tubes were visible. They lie at a considerable depth from the surface of the mucous membrane, imbedded in the muscular walls of the vagina, from which it is quite possible to isolate them with care. They are very constantly present, so much so, that Follin, out of thirty pigs, found them only wanting in one.

From their openings beside the urethra it is comparatively easy to trace them upwards in the walls of the vagina; but at the point where the vagina and uterus meet, they undergo a sudden contraction, and in most cases I was unable to trace them any further, but in others they could be seen running up along the cervix uteri in its muscular wall, and then, turning somewhat to the sides, they follow the margins of the cornua uteri into the broad ligaments, and terminate not far from the ovary; this I have only seen in one or two very favourable specimens, and more usually they ended in the ligament just a little way from the sides of the cervix uteri, while a few very fine clear vesicles indicated where they had

existed in the broad ligament; sometimes they are much better seen on one side than on the other. Follin, who injected them with coloured turpentine, found that the injection in some cases ran up their whole course, so that he was enabled to trace them all the way up to the organ of Rosenmüller; but in many cases the canals were only permeable as far as the junction of the vagina and cervix uteri, while beyond that a mere filament was all that indicated their existence. When you can trace them in their whole course, they are found to end near or at the parovarium by a fine termination, which undergoes a variety of flexuosities and convolutions, beautifully represented in a plate by Kobelt. Now, admitting these canals to be formed from the excretory ducts, and also that the parovarium corresponds to the globus minor, I think it highly probable that in this tortuous and convoluted condition of the terminal extremities of Gaertner's canals, we find the analogue of that similar condition of the excretory ducts in the male, which I have endeavoured to show forms the body and globus minor of the epididymis.

In addition to the irregularities shown by these canals as regards the point at which they end and the distance to which they are permeable, they often, in place of running their whole course as tubes of an equal, or at any rate progressively diminishing calibre, present numerous cyst-like swellings along their track. These are in reality due to successive contractions and bulgings; the canal swelling out and becoming distended with fluid at one point, and immediately beyond that dwindling down to a thread, and again swelling out beyond that. This is undoubtedly one of the methods in which the canals atrophy; and hence, as I before mentioned, when they could no longer be distinguished as tubes or filaments in the broad ligament, we could trace their course by the minute cysts which constituted their remains.

M. De Blainville held that at their lower ends they dilated, in the cow, into ampullæ; but as a general rule this is not the case (Follin), and they are not larger there than further up. However, there can be no doubt that, under certain conditions, where their outlets get blocked up, they may at their lower extremities get so distended with fluid as to present an ampulla-like appearance. I have seen them myself in the sheep distended and filled up for about $1\frac{1}{4}$ inches with a yellowish matter like the product of a sebaceous follicle.

In the sow, along the vaginal, and even the cervico-uterine portions of their course, there exists, as Gaertner himself knew, a number of small excrescences or diverticula, which Follin states were injectable along with the rest of the canals, and which he has seen existing to the number of twenty. They are sometimes so distinct, that I have been able to dissect a few of them out with the scalpel in a rough way; but owing to my not having attempted the injection of the canals, I cannot say what their whole number might amount to. I do not find any mention made as to the use or morphological meaning of these diverticula, but it would be curious to find if there is anything in the male to which they correspond. They cannot be the analogues of the seminal vesicles in a highly rudimentary form, because they are far too numerous; and, moreover, no trace of them is seen in the female genital cord, while the saccules of the primary seminal vesicles are perfectly distinct. But we know that the vasa deferentia, towards their terminations beneath the bladder, become enlarged and sacculated, approaching thus in character to the seminal vesicles, which are now believed to be of a glandular nature. I am no great advocate for discovering an analogue for every trifling cyst or hydatid in one or other sex, yet if we *are* to look for a structure corresponding to these diverticula of the Gaert-

ner's canals, I would suggest that the sacculated terminations of the vasa deferentia might answer. This, however, is a mere hypothesis, and I would not wish it to be considered anything more.

On slitting up the canals, they are seen to be lined by a smooth, fine mucous lining, and on pressure a thickish liquid may often be squeezed from them, resembling that which exists in the cervix uteri.

With regard to their microscopic characters, I am sorry to say I can state nothing from personal observation, as owing to my having spent so long over the first part of the paper, and from the necessary encroachments made on my time by my other studies, I was afraid that, had I tried to make any such observations, I would have much exceeded the period allowed for preparing the Essay. As, however, Follin has mentioned some very curious and interesting facts connected with their minute structure, I may be pardoned for here quoting *verbatim* what he says: "On submitting to microscopic examination portions of the wall of these canals, we find in them all the elements of a tissue composed of long nucleated fibres, granular in their interior, often very flexuous, and sometimes separated at various points by contractions, to which succeed dilations. These fibres are exactly similar to those which have been recently described by Kölliker, in a remarkable memoir on the unstriped muscles. These fibres have been seen in the skin, in the iris, in the intestinal canal, in the simple glands, in the rings of the trachea and bronchi, in the divisions of the glandular crypts of the liver, of the pancreas, and of the salivary glands, and of a great many other parts. With whatever care I have conducted this examination, I have never been able to find anything else but a bed of longitudinal fibres; the circular fibres seem to be wanting. Internal to this wall, which I consider muscular, lies a layer of nucleated pavement epithelium—the mucous lining."

It is a somewhat singular fact that in woman, in whom the parovarium is so well developed, the canals of Gaertner either do not exist at all, or if they do, are so slightly marked as to have escaped the eyes of most anatomists, although many have searched most carefully for them. Follin has been unable to find them, and places no credit in the accounts of those writers who say they have found in the substance of the uterus branching lacunæ, which might be compared to them; he believes they have mistaken for them either uterine sinuses or some of the large branching uterine arteries. I have looked at the broad ligaments, both before and after steeping in tartaric acid, through a strong light and with a lens, but I cannot say that I have seen anything which I could with certainty say corresponded to Gaertner's canals in that part of their course at any rate, which lies in the *alæ vespertilionis*. Kobelt, however, figures a faint outline of a filament proceeding from the parovarium. Be this as it may, it is pretty plain that if Gaertner's canals do exist in the human species, it must only be in the feeblest and most rudimentary form.

2. REMAINS OF THE WOLFFIAN BODIES IN THE MALE.

(a.) *The Organ of Giralaldés, or Corps Innominé.*

At page 56 it was mentioned that in the male sheep of 10 inches long, the Wolffian body, after the new structure on its summit was fairly formed into the *globus major*, and its efferent duct separated from its tubules, had diminished to a mere speck lying on the front of the vascular tumour, close beside the *caput epididymis* (Pl. II. fig. 6).

In 1857 Professor Giralaldés¹ of Paris announced the dis-

¹ Note sur un Organe placé dans le Cordon Spermatique, &c.

covery of a new body situated in the spermatic cord, which he considered to be the remains of the Wolffian body; and in May 1858 his observations were communicated to the Royal Society of London by Sir Benjamin Brodie.¹ I have sought for and examined the body—the Corps Innominé, as it was termed by its discoverer—in a considerable number of human fœtuses from the sixth month to the time of birth, of new-born infants, of children, adults, and aged persons, and have found it to be of very constant occurrence, more especially in young subjects. Following the directions of Giraldés, I macerated the testicle and cord for some hours in a moderately strong solution of tartaric acid, which has the effect of swelling and gelatinising the connective tissue, and rendering it extremely transparent, and then slit up the sac of the tunica vaginalis, as far up as the point where that membrane comes to be reflected down on the cord. The organ is then seen usually lying beneath the portion of the tunica vaginalis, which goes down along the front of the cord before investing the epididymis and testicle. It varies somewhat in its position, being placed sometimes quite close to the caput epididymis, and at other times higher up on the cord; it may even lie so high up as to be beyond the tunica vaginalis altogether, but this is rare. Its usual appearance is that of a yellowish granular corpuscle, whose colour contrasts with that of the dark venous plexus on which it lies, and whose size varies from that of a mere speck up to that of a body equal to three or four pins' heads. Frequently it is not aggregated in one mass, but is in two or three detached pieces, one being perhaps up on the cord, and another down by the side of the caput epididymis. It is obviously much more easily found in lean than in fat subjects; and, indeed, if much adipose tissue be scattered throughout the cord, it is almost im-

¹ Proceedings of Royal Society of London. May 1858

possible to detect it; but in infants it is commonly distinguishable by the fact that it is of a slightly yellow colour, while the fat granules are usually pure white. In shape, as in position and size, the body varies greatly, being sometimes like a small round ball (Pl. V. fig. 1), at others of an elongated form, and often quite irregular and scattered up and down. (I should have mentioned previously that, to facilitate its detection *in the adult*, Professor Geraldés recommends macerating the cord in dilute nitric acid.)

When examined microscopically, the corps innominé is seen to be well supplied with vessels; and in two specimens of natural injection which I possess, a regular plexus is seen to be distributed on their surfaces. It is mainly composed of tubes which are of very various lengths and diameters; they are usually short and thick, sometimes highly tortuous, and may possess knobs or dilatations in their walls, and are occasionally regularly branched. They end in blind extremities. Very frequently no tubular structure is seen, but simply several rounded granular bodies or vesicles; but in general the organ is a compound of short irregular tubes, with these vesicles scattered about among them (Pl. III. figs. 4 and 5). Geraldés says they are lined with epithelium, and on cracking them between two glass slides, a fluid may sometimes be squeezed out, which I have seen contain fine epithelium cells and granular matter.

The organ is most perfect in the new-born infant, and probably during the first few years of life,—that is to say, it then consists of several tubes or vesicles; but in old subjects these are generally reduced in number by the disappearance of some of them. Still, in the remains which we *do* see in old people the tubes are much larger in calibre, though fewer in number, than in the infant.

In the ram the corps innominé is rather difficult to

detect, owing to the large amount of fat and connective tissue usually present in the cord; but when dissected out, it is found to be a large affair compared with what it is in man, being probably in keeping with the enormous testicles of the animal. It is about the size of a pea, and consists of tubes, imbedded in a matrix of connective tissue, and so wound and twisted about among themselves as to make it quite impossible to unravel them. I hardened some of them, and then made sections through them so as to see the cut ends of the tubes.

I have no hesitation in saying that M. Giralnés' opinion, that the corps innominé is the remains of the Wolffian body, is perfectly correct, as it is quite easy to trace the gradual atrophy of that body down to a small speck in front of the vessels, which can be detected at all periods of life in a more or less altered form, and which is simply the organ which M. Giralnés has described. Dr Cleland, in his Thesis, stated, before M. Giralnés' paper was published, that the "remains of the Wolffian body could be seen in the sheep (at the full time) lying in front of the vascular tumour," and I have no doubt many other anatomists were well aware of this fact; but the merit of Giralnés' observation lies in his having shown that these remains are recognisable in the *adult*, and are persistent throughout the whole period of life. But he, I think, committed an error in saying that it was comparable to the organ of Rosenmüller, for there is not the slightest resemblance between the few scattered microscopic tubes which compose the former, and the large and comparatively well organised structure of the latter. The parovarium is undoubtedly the analogue of the epididymis, and if we are to find in the female a structure corresponding to the organ of Giralnés, it must be in those fragmentary and scattered tubules which lie in the neighbourhood of the parovarium.

Seven years before Giraldés published his observations, M. Follin, in the Thesis which I have so frequently referred to, endeavoured to give an explanation of what became of the Wolffian body in the male as follows: He found, while injecting the testicle, that very frequently on the apex of the caput epididymis a special point was found into which the injection would not at first run, but after it had filled the tubules of the testicle itself to repletion, it regurgitated, as it were, and often filled the canals within this special point, and also a long vessel which proceeded from them, and ran down alongside of the epididymis and vas deferens. Very frequently, however, he could not get this special point injected at all. He calls to his aid the observations of M. Gosselin, who, a few years before, in a paper "*Sur les obliterations des Voies Spermatiques*," had noticed the difficulty of injecting some parts of the caput epididymis; and he comes to the conclusion that in the caput epididymis there exists "a structure composed of several vessels, which is comparable to the organ of Rosenmüller. These canals usually number from seven to ten; they are flexuous, contorted several times upon themselves, and terminate in culs-de-sac. Often they form a group which may be detached from the caput epididymis, and it was easy for me several times to dissect and isolate them with the point of a needle from the rest of the seminal canals. But on testicles not dissected, it is easy to see that they are embodied (*font corps avec le reste, &c.*) with the rest of the efferent vessels. The fibro-serous envelope which covers the caput epididymis surrounds and binds them down also."

After carefully considering the evidence which he adduces in favour of this idea (and which would be too long to insert here), I am induced to think that M. Follin has simply mistaken for adventitious structures some of the usual tubes of the caput epididymis, which, from

some cause or other, were not easily, if at all, injectable. His drawing speaks for itself. The quotations which he gives from M. Gosselin do not, I think, in the least help his theory; for that gentleman was of opinion that the difficulty of injection arose solely from some obstruction of a few of the spermatic canals; and I think, when we consider the extreme prevalence of venereal diseases in France, and the frequency with which inflammations of various kinds, due to them, attack the epididymis (their favourite site), that that explanation is the true one. But besides that, M. Follin *did* succeed sometimes in injecting these diverticular tubules, and not only them, but a long canal proceeding from them, which he considers to be the remains of the excretory duct. Now, I should like to know how M. Follin, holding as he does that no part of the Wolffian body enters into the construction of the genital system, can yet inject its remains from that system? Again, what the tube proceeding from these imaginary remains is, I cannot imagine. It certainly is not in the position in which every other anatomist has represented the vas aberrans; and if it be true, as I have all along been advocating, that the excretory duct forms the vas deferens and epididymis, then it certainly cannot be the remains of that. Moreover, if it were the product of one single duct, how does he account for the presence of three vasa aberrantia, such as Sir Astley Cooper¹ has figured? or how explain satisfactorily the existence of branches from the vas aberrans, as Lauth has described? No anatomist was ever more successful in making injections of the testicle than Sir Astley Cooper, and yet in none of his preparations does he describe any such diverticular canals in the caput epididymis, or any such tube proceeding from them. Not

¹ On the Structure and Diseases of the Testicle, plate ix. fig. 11, and p. 26.

understanding thoroughly the injecting system, I have not tried it here, as I would not be inclined to put much faith in my own preparations in that way; but I have often most carefully unravelled and dissected out the conivasculosi; and although I have found sometimes a few of them of a different colour from the rest, and looking at first sight like a different structure, I never could find such a body as M. Follin describes.

(b.) *The Vas Aberrans Halleri.*

What, then, is the real origin of the vas aberrans first described by Haller? Let us first glance at its anatomy before proceeding to trace its origin. It is a blind duct found connected either to the body of the epididymis or to the vas deferens, but most usually attached at the angle formed by the termination of the one in the other. Monro found it existed four times out of ten, but Curling¹ and Lauth believe it occurs more frequently. Cooper and Lauth, as said before, have found as many as three at once, and the latter has seen it branched. It is a convoluted duct, of about the same calibre as the canal of the epididymis, which is *contracted at its insertion, and terminates in a blind and often dilated extremity*. It runs up along the spermatic cord usually for 2 or 3 inches, and when unravelled varies in length from one to several inches. Luschka states that occasionally it does not communicate with the canal of the epididymis, but appears to be a simple serous cyst. With regard to the uses of the vasa aberrantia, Hunter² considered them as supernumerary vas deferentia (and so, I think, did Sir Astley Cooper), of a nature similar to the double ureters, but they are far too frequent in their occurrence for this

¹ Article Testis, Tod's Encyclopædia, vol. iv.

² Works by Palmer, vol. iv., foot-note to p. 24.

hypothesis, and moreover are not conductors of any fluid as the supernumerary ureters are. Müller¹ makes a simple statement, that their use is to secrete a fluid which they pour into the epididymis; but here, on the other hand, they are too often absent to render this idea tenable, and the secretion from such a small organ could be of no use whatever. Curling is inclined to think that the duct does not serve any particular office, but is a sort of diverticulum, which, though common, must be viewed as accidental, like the process not unfrequently connected with the intestinal canal.

To Kobelt is undoubtedly due the merit of first pointing out the true origin of the vas aberrans (*vide* p. 10 of his essay), when he stated that it, or they (if there be more than one), are formed by one or more of the lower set of cæcal tubes of the original Wolffian body still adhering to their efferent duct the epididymis. By this is easily explained the presence of more than one of these vas aberrantia, and also their occasional branching. The shape of them too, narrowed at their entrance into the canal of the epididymis, but dilated at their cæcal extremity, corresponds exactly with the description of the canaliculi of the Wolffian body given at page 17; while, should a severance take place at the point of entrance, then, in the adult, the form described by Luschka, where the vas is unconnected with the epididymis, and merely forms a simple serous cyst, will result.

Kobelt found the vas aberrans in human foetuses of the third and fifth months just formed, and in the latter foetus a separation had occurred, which would have produced the form Luschka mentions.

I possess a specimen of a seven-months foetus, in which the vas aberrans is excellently seen, of such a shape as to render it impossible to believe it the remains of the

¹ Müller's Physiology, by Baly, vol. i. p. 499.

excretory duct, as Follin thinks, or of any other duct. In a young man of 25, who died much attenuated from phthisis, and where there was no fat in the spermatic cord (Pl. V. fig. 5), I could trace the vas aberrans all the way up to its termination in front of the cord, where it ended by a thickened, slightly convoluted extremity, close beside, and almost in contact with which lay the organ of Giraldés. Here, then, were the whole remains of the Wolffian body lying together, and the connection between some of its tubules and their excretory duct (the epididymis) still kept up by means of the vas aberrans.

(c.) *The Hydatid of Morgagni.*¹

Following the plan pursued in describing the vestiges of the Wolffian body in the female, as we have now finished with that organ itself, there remains to be considered what becomes of that one of its two ducts which does not develop—viz. (in the male), the Müllerian duct.

When the new structure on the summit of the Wolffian body has acquired a considerable size, Müller's duct can be clearly seen lying apparently *across* that body (page 25), but in reality following its convex outer surface, and lying just along the line where the new structure and the Wolffian body are continuous with each other, while its slightly swollen upper end or ampulla projects a little way inwards towards the testis. When the new structure comes to rest on the head of the testicle (Pl. I. fig. 7), it carries with it the upper part of Müller's duct, while the Wolffian body below disappears; and thus it happens that the ampulla of the duct comes to lie in the groove, between the new structure (caput epididymis) and the head of the testicle.

¹ De sedibus et causis morborum, Cooke's translation, vol. iv. p. 423.

Now, in that very position, we find in the adult a curious body known as the hydatid of Morgagni, and, till lately, as inexplicable in its morphology as the *vas aberrans* of Haller. In describing it, I prefer to use the term "hydatid," as it is now familiar to anatomical ears—of course, not meaning by the name any diseased state caused by the presence of an animal.

This so-called hydatid is simply the ampulla of Müller's duct, which has undergone a certain amount of development, while the portion of the duct immediately below generally, though not always, disappears without leaving any traces. It is a small pendulous body, often of a pinkish hue, which is found attached either to the top of the *globus major*, to the part of the testis immediately below, or to the angle between these two points (Pl. V. figs. 3 and 5). It is composed of a duplicature of the *tunica vaginalis*, containing a little fine cellular tissue, and some small vessels disposed in it in loops and festoons. It possesses no tubes whatever, as I have made sure of by repeated sections, both in the adult and in the infant; and hence it cannot be a remnant of any part of the Wolffian body proper, as it would then certainly present some appearance of a tubular nature. It may sometimes become cystic, and contain a little fluid; and, in a man who died of dropsy, I found it partaking of the general malady, and distended with serum to the size of a bean.

There are often more than one of these bodies situated close together. It varies much in size, from that of a pin's head to a pea, and is most commonly suspended from the main organ by a pedicle, which is often extremely fine and thin. It is visible in the foetus, while the testes are still in the abdomen, and it is a very constant appendage of the testicle; Huschke having found it in nine out of ten cases, and Kobelt in twenty-

five out of twenty-nine. I did not think of counting all the testes I examined, in order to determine its frequency; but I find from my notes, that on one occasion, when I examined sixteen testicles of new-born children, in one only could I not detect it. It exists in the ram, but is very small, not so large as in man, and its presence is the exception, and not the rule. From its position, appearance, and structureless nature, there can be little doubt that it is the swollen end of Müller's duct in a persistent state; and indeed it is quite possible to trace its gradual formation in the embryo. In this case it must correspond to the pavilion of the Fallopian tube, which, in the female, is formed by that upper end swelling out and opening up into a trumpet-shaped form. Most authors, it is true, compare it to the pediculated vesicle often found in or about the pavilion of the tuba; but, as far as I can see, when such vesicles do exist, there are usually half a dozen of them scattered about among the fimbriæ of the morsus diaboli and the Ruyschian fringes, which extend between it and the ovary. In fact, with such facilities for their formation as are afforded by the fimbriæ, it would be singular if such vesicles did not occur very frequently. But these vesicles are not like Morgagni's hydatid—a solitary body, constant in its position and appearance; for Kobelt admits, that out of 175 uteri, he only found the vesicle on the pavilion in one half the number. I am inclined, then, to think these vesicles in the female are simply dropsies of the natural fimbriæ; and to consider the whole pavilion or morsus diaboli, and not any occasional morbid structures like these vesicles, as the true representative of Morgagni's hydatid. Of course, if we consider the vesicle as just a part of the whole pavilion, then, no doubt, it does represent Morgagni's hydatid to a certain extent.

On account of that hydatid containing sometimes a

considerable quantity of fat, Huschke was led to believe in the somewhat singular notion, that there was an analogy between it and the appendices epiploicæ,—but the presence of fat in it, to any extent, is a purely accidental and even rare occurrence. Curling suggests that its use may be to extend the serous exhaling surface of the tunica vaginalis. I do not think it has any more purpose to play than the rest of the structures which have been already spoken of; and, certainly, it would be a refinement of physiology to suggest uses for them.

(d.) *Small Cysts on the Testicle.*

The portion of Müller's duct from the ampulla down to the globus minor most usually quite disappears, but still traces of it are met with. Thus, on the caput epididymis of new-born children, I have seen two or three small hydatids running in a line from Morgagni's one; which, I do not doubt, were the remains of the duct, formed just in the same way as we saw (p. 67) the cysts and vesicles were by the canals of Gaertner when partially atrophied.

Again, below the tunica vaginalis testis, which stretches between the body of the epididymis and the side of the testicle, and binds the one to the other, I have seen in the child of four years old distinct traces of a fine cord running down as far as the globus minor, which could be nothing but a lower portion of Müller's duct,—that duct and the excretory one (epididymis) still running down side by side, as in the embryo. An excellent proof of the correctness of this statement was given by M. Gosselin,¹ in a most elaborate treatise on the cysts of the testicle, in which he showed that the small serous cysts, never attaining a greater size than that of a pea, which are so common in that organ, had their favourite and almost

¹ Recherches sur les Kystes de l'épididyme du Testicule et de l'appendice Testiculaire. Gosselin, Archives Gén. de Médecine. 1848. Vol. xvi. p. 25.

sole site along the convex face of the body of the epididymis and the free extremity of the caput, and that they were quite superficial, lying under the tunica vaginalis, and were never imbedded in the substance of the epididymis. These little vesicles occurring in the position of the hydatids and of the cord which I have described above, are no doubt formed by distensions of them, and if so, are consequently traces of that part of Müller's duct which lay alongside of the Wolffian body.

M. Gosselin, who was unaware of the origin of the great majority of these cysts, seems to have been much puzzled to account for them, and was obliged to fall back upon the idea that, as they occurred most frequently in old people, they must have some connection with the diminished activity of the testes occurring at the more advanced periods of life. Nature, he thought, had endowed this organ with a secretory *molimen*, which, when not employed in the production of semen, employed itself in another way, in giving rise to these vesicles. Of course, I do not mean to say that *all* serous cysts are connected with foetal remains, but I am convinced the majority are so; some doubtless occur just as they would in any other organ. To the rest M. Gosselin's theory may be applied or not, as his readers think fit.

So much, then, for the upper part of Müller's ducts, as far as the origin of the gubernaculum,—that is to say, of that part of them which in the female forms the Fallopian tube and its fimbriated extremity. Let us now see what becomes of the rest of them,—of that part of them which should correspond to the cornua and body of the uterus, and to the vagina.

(e.) *The Vesicula Prostatica, or Weberian Organ.*

Ever since the most ancient times, anatomists have been endeavouring to discover in the male mammal some

indications of a structure analogous to the uterus; and by some the vesiculæ seminales, by others the prostate gland, has been so regarded, but it was reserved for Weber¹ to clear up this much disputed point.

Supposing ourselves to be entirely ignorant of the existence of the body which we now know to be the analogue of the female uterus and vagina, let us try to find whether, by a knowledge of the development of the genital system, we could point to a spot in that system, where, in the male, they, by rights, should exist. Now, Müller's ducts were seen in both sexes to unite together in the genital cord, and enter the sinus urogenitalis (*i. e.*, part of the urethra) along with the excretory ducts between which they lay (Pl. III. fig. 6); we would therefore look for a male uterus and vagina somewhere between the points of entrance of the vasa deferentia into the urethra, and in that situation is found the vesicula prostatica, or Weberian organ, so named after its celebrated describer. I do not intend here to enter into any minute or detailed description of this singular organ, as it is now familiar to all anatomists, and has been most amply treated of, not only by Weber himself, but by Huschke, Theile, Duvernay, &c., and more especially by Leuckart. Suffice it to say, that it is a small flask-shaped vesicle, lying between the openings of the vasa deferentia, under the inferior wall of the urethra, and covered in by the prostate gland. It terminates in a round blind end, whose extent is limited by the middle lobe of the prostate, and it possesses a constriction or neck, by whose mouth it opens into the urethra from under the verumontanum. In the Weberian corpuscle of two new-born infants, Meckel found a special variety of structure. It became narrow in its ascent, so as to be only permeable by a hog's bristle, and ended as a

¹ Zusätze zur Lehre vom Baue und den Verrichtungen der Geschlechtsorgane. Leipsic, 1846.

solid thread, which separated by bifurcating. I made sections of a few prostatic vesicles, in infants hardened in spirit, through their whole extent from below upwards, but this variety of conformation did not happen to be present in any of them.

The organ has now been dissected and described in a great variety of animals, and to its appearance in a few of these I would now call attention as being indicative of its morphological value. In the beaver, as first described by Brandt and Ratzeburg, the Weberian organ forms a simple cavity only at its inferior extremity, where it opens into the urethra, and very soon splits into two horns, which ascend in the peritoneal fold between the two seminal ducts, and, finally, after dwindling to mere threads, become united with these, and are traceable along with them as far as the testes. The horns measure as much as $2\frac{1}{2}$ inches, and the lower portions of them contain spacious cavities. Its describers, from the mere resemblance in form, were led to compare this organ to the uterus bicornis of the female, though they imagined its function to be that of a kind of supplementary seminal vesicle.

In the horse, the opening of the Weberian organ is sometimes divided by a median bridge into two apertures, or is even completely closed up at its lower end; and in the feræ this latter condition seems to be constant. In the goat, it consists of a cylindrical body ascending between the two seminal ducts, to which, in its lower half, it is strongly united by areolar tissue. After a course of $1\frac{1}{4}$ inches, it splits into two horns, which are opposed to the seminal ducts, and continue with these to the testicles, where they pass into the covering of the epididymis.

In dolphins, Leydig and Leuckart have both observed that, at the opening of the Weberian organ, a papilla often projects from its lower surface, whose apex was sometimes united with the opposite margin, so as to

divide the opening into two fissures. In the hart, it is in the form of a cylinder about 2 inches long, which is distinctly bi-cleft at its upper extremity, the cavity being prolonged into these cornua. In a large number of animals—indeed, in the majority of those which have been examined—the organ bears traces of having a bifurcated extremity.

Morgagni mentioned that the inner lining of this organ was a mucous membrane, and Huschke and Leydig have succeeded in verifying the existence of a number of small glands therein, which in many animals are actually similar to those of the uterus of the female of the same species.

As the vesicula prostatica is evidently an organ which possesses no physiological use, or, at most, only a very unimportant one (witness its absence in many animals), the probability is that it must be one of that class of structures to which belong the organs of Rosenmüller, Giralvés, and Gaertner, whose presence does not depend upon their functional value, but upon the original typical plan on which both male and female are formed. Its position, shape, and structure all tend to show that it is formed from the united Müllerian ducts, which in the female increase greatly to form the vagina and uterus, but in the male, who has no need of such organs, do not increase to anything like the same extent, but simply form the rudimentary saccule, which remains as an evidence of the primary type of formation which prevails in the embryo of either sex. The opinion of Leuckart¹ (who has devoted very great attention to this point, and has greatly extended the observations of Weber), and also of Wahlgren,² who in 1849 published an inaugural disserta-

¹ On the Vesicula Prostatica—Tod's Encyclopædia, Supplement.

² Ueber den Uterus Masculinus (Weber) bei dem Menschen und den Säugethieren. Müller's Archiv., 1849, p. 688. Translated into German from the Swedish by Dr W. Peters.

tion upon it, is that the Weberian organ represents the whole female genital canal—both uterus and vagina. Weber himself, and the great mass of authors succeeding him, believed that it merely corresponded to the uterus; and recently H. Meckel (though he has since recalled his opinion) held that it was the analogue of the vagina alone. The opinion of Leuckart is, I think, the correct one, and if so, the term *uterus masculinus*, applied to the prostatic vesicle, is clearly a misnomer. That the organ certainly includes the vagina in its morphology, is shown thus: If only the uterus be represented by it, then the vagina must exist somewhere lower down; in other words, it must be that portion of the urethra which lies below the opening of the verumontanum, *i. e.*, a very small piece of the prostatic, and all the membranous part. But, at page 47, it was shown that these parts were distinctly formed from the sinus urogenitalis; and thus, if Weber's theory were correct, it would necessitate the vagina being developed from the sinus urogenitalis, whereas the latter, at most, simply forms the vestibulum vaginæ, and does not enter into the construction of the vagina proper. But we may employ another phase of the same line of argument, for the Gaertner's canals (excretory ducts) open into the vestibulum vaginæ (sinus urogenitalis), and *not* into the vagina proper, which lies above their openings. In the male, then, the vasa deferentia (excretory ducts), whose mouths are on each side of the orifice of the prostate vesicle, would, according to Weber's theory, open into the vagina; but this would be a violation of the laws of development; and they, in reality, open into the sinus urogenitalis, while *above* them lies the true vagina—that is to say, the Weberian organ.

It is thus clear that that organ must include the vagina, and now what facts show that it includes the uterus too? The sections made through the genital cord strongly tend

to prove this; for by them it was evident that, in both sexes, Müller's ducts, from their point of meeting in the cord, to their opening into the sinus urogenitalis, melted together to form a single canal; and not for some time did this canal in the female show any signs of a division, by means of a cervix, into uterus and vagina. Now, we have only to suppose that this division does not take place, and we have the prostatic vesicle in its most common form, viz., a cylindrical body terminating above in two horns. But we do not even need to employ this slight stretch of imagination; for Leuckart has figured and described several newly-born hermaphrodite goats, in which the Weberian organ was separated, by the development of a formal os tinæ, into uterus and vagina, which were nearly as large as the same structures in the female of the same age. It, moreover, possessed long hollow cornua. In these highly interesting specimens, the testes remained in the abdomen, being in one case possessed of alæ vespertilionis, and lay at the ends of the cornua of the Weberian organ, whose outer coverings passed into the sheath of the epididymis. The vas deferentia lay in front of them all the way up to the epididymis; and in one case their lower ends were completely imbedded in the walls of Weber's organ, just as Gaertner's canals are in the walls of the vagina and uterus. The seminal vesicles developed in these vasa deferentia were very small.

In the Weberian organ, then, there can be no doubt that the long sought for vagina and uterus of the male exist, and if this be admitted, it is obvious that a finishing blow is dealt to the opinion of Follin and others, that Müller's ducts are in both sexes the developing canals. For in the hermaphrodite goats above mentioned, *both* the ducts of the Wolffian body have gone on developing, and it is as plain as it possibly can be, that the anterior (or excretory) have now become the vasa deferentia, and the

posterior (or Müllerian) the vagina and uterus. Follin says, indeed, that his view is capable of explaining all the abnormalities of hermaphrodism, but it is a very curious fact that in the whole course of his work, which includes almost every topic connected with the formation of the genital system, he never makes mention of a single case of hermaphrodism, or shows us *how* his theory would explain it.

But the cases of Leuckart are not by any means the only, though they are certainly very convincing, evidences of the truth of the views which in this paper I have endeavoured to support.

In the elaborate and exhaustive treatise of Professor Simpson on Hermaphroditism,¹ numerous cases are cited tending to prove the same points. The celebrated case published by Professor Ackermann of Jena, in 1805, is highly interesting. It occurred in an infant which lived about six weeks after birth. On dissection, two testicles were found, one in the scrotum or labium, the other in the groin, both being perfectly formed. In the situation of the uterus was found a hollow pyriform organ, larger than the proper size of that viscus, and having its coats finer and thinner. Duplicatures of peritoneum, resembling the ligamenta lata, connected this imperfect uterus with the sides of the pelvis, and its cavity opened into a kind of short vagina, which soon united with the urethra, and formed one common canal with it—vagina urethralis (sinus urogenitalis or vestibulum in the normal subject). The vasa deferentia ran from the testes towards the upper angles of the uterus, and penetrated into its substance at the points where the Fallopian tubes are usually placed, and passing down under the internal mucous-like membrane of the uterus and vagina, terminated by two very small orifices in the vagina urethralis.

¹ Obstetric Works, article *Hermaphroditism*, vol. ii. p. 269.

Mayer, in a foetus of the fourth month, found a two-horned uterus terminating in a vagina, which opened into the posterior part of the urinary bladder, and also two male testes, with their epididymes, from the left one of which a contorted vas deferens arose and ran down to the vagina; the right vas deferens was shorter, and becoming thread-like, disappeared near the corresponding corner of the uterus.

Gurlt, in his Handbook of Pathological Anatomy, mentions the case of a goat in which all the internal genital organs were found, with the exception of Cowper's glands. There was also present an uterus, provided with long but narrow and curved cornua, that accompanied the vasa deferentia and testicles through the abdominal rings, and ended blind at the epididymis.

In 1850, Betz¹ described a very interesting case of a large prostate vesicle, about the size of the normal uterus, having, however, only one Fallopian tube. The vasa deferentia ran down its walls imbedded in them.

Finally, Kobelt gives a beautiful engraving at the end of his work, of a young calf, in which regularly formed testes were found in the scrotum; a distinct two-horned uterus was present, along whose anterior walls and cornua the vasa deferentia arched up before descending to the testes, resembling exactly the canals of Gaertner. The cornua were prolonged as membranous filaments down along with the vasa deferentia, and were lost on the caput epididymis.

Hunter² long ago showed in those singular monstrosities the Free Martins, how the existence of both male and female internal generative organs was in them the rule, and not the exception; and without knowing the

¹ Ueber den Uterus Masculinus. Ein Beitrag zur Entwicklungsgeschichte der Geschlechtsorgane. Müller's Archiv. 1850, p. 65.

² Hunter's Works by Palmer, Plate xxxiii.

true explanation thereof, has given plates of them, which serve to confirm the cases above mentioned, especially Plate xxxiii., where the fragments of the vasa deferentia are seen running down in front of the cornua uteri; and also Plate xxxii. But in this latter plate, I think there is an error committed in its explanation, for in the large vestibulum vaginæ, which, in the animal represented, exists below the orifice of the urethra, and which is correctly enough termed the "common vagina," there are drawn two openings (designated in the explanation EE), "Orifices of the ducts of two glands. [The glandular canals of Malpighi and Gaertner.]" But immediately above the meatus urinarius, and at the termination of what is called the "true vagina," are seen the two openings of the vasa deferentia, in a position much more resembling that of the true openings of Gaertner's canals, than that ascribed to them in the explanation. In truth, in such a hermaphrodite as is represented, where a uterus as well as male organs are present, the vasa deferentia *are* the real Gaertner's canals, and it is quite impossible for them to have two other openings further down. The error, doubtless, arose from the openings of Bartholini's glands being larger than usual, and being mistaken for Gaertner's canals. I have thought it right to mention this, for Hunter's works are greatly referred to even now by anatomists, and such a mistake might be productive of much confusion.

In order to bring them clearly before the eye, I append a tabular view of the analogous parts in the male and female, which have been considered in the second part of the paper.

THE WOLFFIAN BODY ITSELF.

In the Female.

Fragmentary tubes and canalicules disposed in neighbourhood of Parovarium.

In the Male.

Organ of Giraldés, and some of the tubules adhering to Excretory Duct, forming the Vasa Aberrantia.

NEW STRUCTURE ON SUMMIT.

*In the Female.**In the Male.*

Parovarium.

Globus Major.

MÜLLER'S DUCTS.

Ampulla forms the fimbriated extremity of Fallopian Tube.*Ampulla* forms the Hydatid of Morgagni.*From Ampulla to Round Ligament* forms the Fallopian Tube itself.*From Ampulla to Gubernaculum* forms small cysts running from Morgagni's Hydatid down along side of Epididymis.*From Round Ligament to Genital Cord* forms the Cornua Uteri.*From Gubernaculum to Genital Cord* forms Cornua of Weberian Organ.*When united in Genital Cord* they form Uterus and Vagina.*When united in Genital Cord* they form Weberian Organ.

EXCRETORY DUCTS.

Gaertner's Canals.

Vas Deferentia, Body and Globus Minor of the Epididymis.

Diverticula in them.

Broad and sacculated ends of the Vas Deferentia.

EXTERNAL ORGANS.

Clitoris.

Penis.

Pars Intermedia.

Corpus Spongiosum.

Labia Majora.

Scrotum.

Bulbi Vestibuli.

Bulb.

Labia Minora.

Cutaneous covering of the Urethra.

SINUS UROGENITALIS.

Vestibulum Vaginae.

Membranous part of the Urethra, and a small portion of the Prostatic.

PART THIRD.

PATHOLOGY OF THE REMAINS OF THE WOLFFIAN BODY.

1. *In the Female.*—The only pathological condition which is seen in connection with the remains of the Wolffian body, is the formation of cysts, and as these are seldom of great size, or cause much suffering, they are comparatively innocuous. In the female, some of the canals of the organ of Rosenmüller not infrequently get distended with fluid, yet the greatest magnitude which they have ever been known to attain, is that of an egg or an orange, and they are not liable to degeneration by the formation of secondary cysts and morbid secretions in their interior. The only danger, if such it can be called, which can arise from them, would be the rupture of their walls, and discharge of their contents into the peritoneal cavity, or the giving way of the pedicle which supports such of them as are of the pendant variety. But they give rise to some little trouble in diagnosis by being mistaken for true ovarian cysts in their early stage. West, however, believes that cysts of the Wolffian body, of a size sufficient to be distinguishable during life, are of very great rarity, while for such cysts to exceed the dimensions of an orange is rarer still, and he deduces from this the practical rule, that when a tumour is discovered in the abdomen which has attained a greater

size than that of the doubled fist, that circumstance may be taken as in itself affording almost conclusive proof that the cyst is a true ovarian one.

2. *In the Male.*—Morgagni's hydatid offers but little scope for pathological inquiry, but still there are some curious points connected with it. For instance, it is often suspended by the merest thread of a pedicle, and it has been suggested that the breaking of this, and the consequent falling of the hydatid into the tunica vaginalis, might prove a cause of hydrocele, by the irritation set up by the loose body. That it does sometimes fall off is a fact, for M. Gosselin has found it lying detached from its pedicle in the new-born child. Every now and then, too, we find in the sac of the tunica, curious little bodies like cartilages, one of which I found in the body of a man of 60. The hydatid was absent from its normal site, and the patient had a hydrocele on his other side, which I unfortunately did not see opened, and so cannot say if there was a loose body there, too, or not. Curling says that they are very frequently found in hydroceles, and I think it very probable that many of them are hydatids which have fallen off, and become hardened. Sir Astley Cooper had an idea that this was the case also.

The hydatid itself is rarely the seat of true cystic enlargement, Gosselin having only seen it seven times, and then it occurred in old people; the contents in these cases were of a slightly yellow colour, and *never* contained spermatozoa.

Müller's duct (in its upper part), as stated before, seems to form the greater number of those small superficial cysts which are so common in the testicle, and which certainly have no communications with its tubes, as Gosselin has shown that injections never by any chance pass into them. Their envelope is of a fibro-cellular nature, and usually very delicate, and their contents, though sometimes clear,

sometimes opaline, never contain seminal fluid. Gosselin is most positive on this point, and I have examined a good many of them myself, and never found spermatozoa in them, but only granules and young pavement epithelium, exactly the same as what I saw in one or two cysts from the parovarium.

(a.) *Cysts of the Organ of Giraldés.*

Probably the most interesting morbid changes are those which occur in connection with the corps innominé. Giraldés observed that cysts were very frequently formed by this body, and he expressed the opinion that in many instances these were probably the beginnings of what are termed encysted hydroceles of the spermatic cord, first, I believe, described by Percival Pott, and well known to Bell¹ and the surgeons of the last century. I have not myself met with any of these cysts in the act of formation, but I see no reason to doubt M. Giraldés' statement. Encysted hydroceles of the cord have been said to originate almost always from a partial or imperfect obliteration of the prolongation of the peritoneum, drawn down at the period of descent of the testis, and no doubt this is probably the origin of by far the greater number of them. But many of them occur close down near the head of the epididymis, *under* the tunica vaginalis (peritoneum), which lies, for a certain way up, in front of the cord, and such cases could not have originated from the non-obliterated peritoneal sac, as they are too low down for that, and are, moreover, beneath the peritoneum. These, then, may very likely be due to the saccules of the corps innominé getting distended with fluid and forming cysts. Curling² mentions having on two or three occasions found small,

¹ On the Hydrocele. 1794.

² On the Diseases of the Testis, p. 204.

thin, delicate, serous cysts in the loose tissue of the cord, which, he thinks, very probably originated independently, and had no connection with the obliterated process of peritoneum. Now this is just the sort of cyst which one would expect to form from the corps innominé, and if they enlarged considerably, they would be considered by the surgeon as encysted hydroceles.

Before concluding the subject of cysts, I may mention an idea which occurred to me, as a possible explanation of some of those which contain seminal fluid. The question with regard to these has all along been, How do the spermatozoa get into them? and many facts and hypotheses have been offered to solve the problem.

(b) Seminal Cysts.

Liston,¹ in 1843, seems to have been the first to notice the presence of semen having been induced by the milky colour of the fluid drawn from a hydrocele (?) to examine it microscopically; and there followed in the same year similar descriptions by Lloyd² and Dalrymple, of spermatozoa occurring in (supposed) common hydroceles. Dalrymple³ made a vain endeavour to prove that they were caused by some accidental puncture of the seminal tubes by the trochar during the operation of tapping, and he advocated this opinion,—(1.) From the rarity of the occurrence of such cases; and (2.) From the fact which Scarpa had long before pointed out, that in hydrocele the position of the cord, vessels, and epididymis being considerably altered, the vas deferens was very likely to be

¹ A few observations on Encysted Hydrocele. Lond. Med. Chir. Transactions. 1843. Vol. xxvi. p. 216.

² On the Presence of Spermatozoa in the Fluid of Hydrocele. Same volume, p. 368.

³ On the Cause of Spermatozoa in Common Hydrocele. Do. Vol. xxvii. 1843.

wounded. But it is perfectly obvious, that no mere puncture of a trochar could ever permit of the escape in a few seconds of such myriads of spermatozoa as have been sometimes found in these cases; in fact, in some, more spermatozoa have been seen than the whole testis and epididymis could ever at one time contain.

In the following year Paget's¹ examination of such a case in the dead body proved that there was no *common hydrocele*, but that the semen was contained in a distinct cyst, situated on the upper part of the epididymis. He could not, however, trace the seminal tubes entering it, and he therefore concluded that it was quite isolated from them. So to explain how the semen got into it, he suggested the somewhat startling idea, that the mere proximity of such cysts to the testicle might enable them to acquire the power of secreting the seminal fluid; and he tried to support it by references to those curious ovarian cysts, which occasionally contain bones, teeth, hair, fat, &c. But no physiologist will, I am sure, acquiesce in the idea, that the semen, the most highly elaborated secretion in the human body, can ever be poured forth by the walls of a trifling and all but structureless cyst. Moreover, his analogy between the ovarian and seminal cyst is not correct. The description given by Kohlrausch² of one of the former is most interesting, and well worth perusing. The walls of that cyst corresponded almost exactly in their structure to that of the skin, and contained hair follicles with their hairs, and also sweat glands perfectly developed, while in an irregularly shaped piece of bone lying in the wall (which possessed very few bone cells), several teeth were found in various stages of development. But it must be observed, that the imperfect bone and

¹ Examination of a Seminal Cyst. Lond. Med. Chir. Trans. Vol. xxvii. 1844.

² Ueber den Baue der haar-und-zahn-haltigen Cysten des Eierstock. Müller's Archiv. 1843. P. 365.

teeth, hair, skin, &c., found in these cysts, all partake, more or less, of the nature of the horny or dermoid tissue, and are not a distinct secretion like semen, but have been formed under certain abnormal conditions of the development of primary cells in many parts of the body. No one ever found a seminal cyst in the heart, yet pieces of bone, with actual bone cells (not mere calcified plates) have been found both there and in other muscles; and hair has often been seen in abnormal localities. That these peculiar ovarian cysts derive no special properties from their proximity to the ovary, is seen by the fact, that cysts containing hair and bone have actually been found in or near the testicle. Curling has noticed true bone cells in one of the loose bodies in the tunica vaginalis which had become ossified.

M. Gosselin gives descriptions of many seminal cysts, and I have found one or two myself. They seem to be nearly all connected with the head of the epididymis, but, unlike the serous variety, are deep seated, and not superficial. M. Gosselin, just like Mr Paget, was however unable to detect the precise spot where the seminal tube entered them; and although I dissected the one or two specimens which I found as carefully as I could, I was not more successful. Nevertheless, though it may be very difficult indeed to point out precisely the aperture by which the semen entered, I think, from their intimate union with the seminal canals, in respect to position at least, the general opinion is correct, viz., that the cysts have their origin in dilatations of these canals. Whether the dilated tube ruptures into the surrounding tissues, and these form by pressure the cyst, is not quite clear; but I think this is not very likely, for the cyst wall is generally too well organised, and too clearly defined, to be a mere condensation of cellular tissue; and, moreover, there is not enough cellular tissue distributed between the vessels

of the globus major to make a cyst. What greatly increases the probability that they are dilated seminal tubes, is the fact of their favourite site being the upper and back part of the caput epididymis, where the tubes (*coni vasculosi*) are not nearly so tightly and compactly bound together as in the body of the testis, and where there is thus more chance of their walls giving way. Again, the caput epididymis is very liable to obstructions of its tubes, the result of deposit, or other effects of venereal inflammatory disease, and the seminal fluid accumulating behind these obstructions, might aid in causing the dilatation of some of them. As to not finding the exact foramen by which the spermatozoa entered, we know that these singular bodies are capable of the most extraordinary power of insinuating themselves into the most minute nooks and crannies. Witness their ascent up the Fallopian tubes, and the impregnation of the ovum there. Now, it may happen that the cyst having become full of them, the orifice by which they entered may close up, and I see nothing to prevent their remaining there alive for long periods.

But there is another though much rarer kind of seminal cyst, of one of which Gosselin gives an excellent description. Examining one day a case of spermatic cyst, supposed to be of the usual variety, projecting into the tunica vaginalis, he found to his astonishment that it in reality lay quite outside of that cavity, and he found the testis lying in the normal and healthy cavity entirely to the inside of this cyst. Here, then, was a cyst full of spermatozoa, at too great a distance from the testicle to admit easily of its being a dilated seminal tube. How got the semen there? The case of the young man, narrated at page 78 (Pl. V. fig. 5), whose testicle I examined, suggested to me this explanation, viz., that such cysts were formed by an enlargement of the dilated end of the vas

aberrans. This duct lies quite outside of the tunica vaginalis, and having no support to its delicate walls, might well be the subject of cystic dilatation; while if it is capable of being easily injected with mercury, I see no reason why spermatozoa should not also find their way into it. I offer this, of course, as a mere hypothetical explanation; but in the absence of all facts, one way or other, it is better than none.

GENERAL CONCLUSIONS.

1. The Wolffian bodies do not enter into the construction of the genital system, and form no part of it whatever.

2. In connection with them are found two ducts, which open below into the sinus urogenitalis: (1.) The excretory duct, receiving the component tubes of the organ. (2.) Müller's duct, a tube quite unconnected with it, though lying upon it, and terminating above by a free extremity.

3. At a certain period, on the summit of the Wolffian body, a new structure forms, distinct and separate from it, though apparently continuous with it; this structure is a distinct formation, and is not an altered condition of the upper tubules of the Wolffian body. In the male this forms the globus major of the epididymis, and in the female the parovarium.

4. In the male the excretory duct of the Wolffian body forms the body of the epididymis, globus minor, and vas deferens, and its upper end merges into the new structure on the summit of the Wolffian body, and becomes connected with the tubules in that structure, which form the future coni vasculosi. A short cord passes from the new structure to the head of the testicle, which is at first solid, but afterwards splits up longitudinally to form the vasa

efferentia. In the female the excretory ducts form the canals of Gaertner.

5. In the female the upper parts of the Müllerian ducts form the Fallopian tubes, and in animals the cornua uteri also, and their lower parts meet together into one canal, and form the uterus and vagina. In the male, the upper parts form the hydatid of Morgagni, and certain small superficial cysts along the course of the epididymis, and their lower united ends, the vesicula prostatica.

6. The hydatid of Morgagni is the analogue of the fimbriated extremity of the Fallopian tube, and not of any vesicle or vesicles found thereon. The parovarium is the analogue of the globus major; and the vesicula prostatica that of the uterus and vagina.

7. The sinus urogenitalis forms the vestibulum vaginæ of the female, and the membranous and a very small part of the prostatic portion of the urethra in the male.

8. The remains of the Wolffian body proper are to be found as small fragmentary tubules and granules scattered about in the neighbourhood of the parovarium; in the male they form the organ of Giraldés, and some of the tubules still remaining in connection with their excretory duct (the body of the epididymis) form the vasa aberrantia of Haller.

9. The majority of seminal cysts are to be found on the *caput epididymis*, and are probably formed from dilatations of the tubules of that body; those found on the *spermatic cord* may possibly result from the dilated ends of the vasa aberrantia.

10. The organ of Giraldés may give rise to cysts on the spermatic cord, which, however, never contain spermatozoa.

EXPLANATION OF ILLUSTRATIONS.

PLATE I.

- Fig. 1.—Foetal pig, natural size, $\frac{3}{8}$ ths of an inch—(a) the Wolffian bodies.
- Fig. 2.—Foetal sheep, $\frac{5}{8}$ ths of an inch—(a) Wolffian bodies, with (b) genital glands as two white streaks on their inner side; (c) Excretory ducts opening into allantois.
- Fig. 3.—Embryonic sheep, $1\frac{1}{8}$ of an inch, shows Wolffian bodies and genital glands in their fully developed form.
- Fig. 4.—Ligaments—(a) Diaphragm ligament; (b) Upper “Bauchfell-falte;” (c) Lower do.; (d) Mesorchium or Mesoarium; (e) Future round ligament or gubernaculum testis.
- Fig. 5.—Male sheep of 2 inches—(a) Müllerian duct, a fine white thread, running internal to the excretory duct, and terminating superiorly in a free bulbous end; (b) Excretory duct, larger than the Müllerian duct, but darker in colour, merging into the gland substance at its upper end; (c) Genital cord formed by the union of the four ducts. The excretory lie in front, the Müllerian (not seen) behind.
- Fig. 6.—The same in the female; here the Müllerian duct is slightly larger.
- Fig. 7.—(a) The new structure on top of Wolffian body (somewhat diagrammatically shown), with the excretory duct entering it, and the Müllerian lying free between it and the upper end of the Wolffian body.
- Fig. 8.—Female sheep of 5 inches—(a) Broad ligament arising from the diaphragm band; (bb) Wolffian bodies atrophied and disorganised; (c) New structure; (dd) Müllerian ducts uniting below to form the common genital canal; (e) Bladder with urethra; (f) Clitoris.
- Fig. 9.—Female of 7 inches—(a) Broad ligaments; (bb) Ovaries; (dd) Müller's ducts, now the Fallopian tubes and cornu uteri; (e) Upper part of genital canal, now the uterus; (f) Bladder and hypogastric arteries.

PLATE II.

- Fig. 1.—Female sheep of 7 inches—(a) The new structure; (b) Atrophied remains of the Wolffian body; (c) Müllerian duct, with its upper end opening out into the pavilion, its middle part forming the Fallopian tube, and its lower the cornu uteri; (d) Membrane or velum extending along its inner edge.
- Fig. 2.—Uterus, ovaries, &c., of an almost full-grown foetal sheep—(a) The new structure (organ of Rosenmüller).
- Figs. 3 and 4.—Male sheep of 6 inches, with the testes approaching the abdominal ring. The left one has turned over. The gubernaculum is seen composed of—(a) the original “Leistenband;” and (b) the lower “Bauchfellfalte;” (c) New structure, now the epididymis; with (d)

Remains of the Wolffian body depending from it; (e) The excretory duct, now the vas deferens.

Fig. 5.—Male sheep of 7 inches—(a) The Wolffian body becoming very fragmentary; (b) The gubernaculum; (c) Vascular tumour.

Fig. 6.—Male sheep near full time; testes now in scrotum; (a) Tunica vaginalis laid open; (b) Vessels of testes; (c) Remains of the Wolffian body on the vascular tumour; (d) Diaphragm ligament, now a mere thread.

PLATE III.

Fig. 1.—Longitudinal section (microscopic) of new structure, and upper part of Wolffian body—(a) Tubules in new structure converging to a point, and bound together by a cord or tube running round their outer ends; (b) Tubules of the Wolffian body proper, distinct from the above, and now separated from (c) the excretory duct.

Fig. 2.—Longitudinal microscopic section of older male sheep. New structure now rests on top of—(a) The testes; (b) A short cord passing between them, striated longitudinally, to which (c) the tubules converge.

Fig. 3.—The same parts still more advanced—(a) Testis; (b) Connecting cord splitting into vasa efferentia; (c) Tubules now forming distinct coni vasculosi.

Figs. 4 and 5.—Corps innominé in children.

Fig. 6.—Transverse sections of genital cord of male—(a) Müllerian ducts; (b) Excretory ducts; (c) Bladder; (d) Vesiculæ seminales. (1) The whole four ducts are here separate, the excretory lying in front, oval, and fine walled; (2) Müller's ducts uniting; (3) Now united; the excretory ducts approaching; (4) The excretory ducts lying on each side of the united Müllerian, having diverticula from their sides (vesiculæ seminales); (6) The diverticula gone; (7) The bladder seen in section, the excretory ducts lying in front of the united Müllerian; (8) The excretory ducts (now the vasa deferentia) entering what is afterwards the urethra on either side of, and slightly in front of, the united Müllerian or vesicula prostatica; (9) The sinus urogenitalis alone seen.

PLATE IV.

Fig. 1.—The genital cord in the female sheep (1), (2), (3), same as in male: at (3) the cervix uteri is forming; (4) Müller's ducts are again separating; (5) Müller's ducts are quite separate; the excretory lie on each side, but are small, and have no diverticula; (6.) Müllerian ducts again uniting; (7) Quite united; this is at lower part of (future) vagina; (8) Bladder seen in front. Excretory ducts, now very small, lying in front of the united Müllerian (*i.e.*, the genital canal or future uterus and vagina) in the position of Gaertner's canals. From this series it is plain that in the female Müller's ducts unite first at two points, viz., where the cervix uteri is to form, and at the lower end of the vagina; in more advanced specimens of the genital cord they are of course united all the way down, and form a single continuous genital canal.

Fig. 2.—Uterus and broad ligament of a young woman *æt.* 20 ; Parovarium (new structure) seen beside the ovary, with scattered fragments (remains of Wolffian body proper) lying around it.

Fig. 3.—Parovarium in the sheep.

Fig. 4.—Uterus and parovarium of infant at time of birth.

PLATE V.

Fig. 1.—Testis of male foetus of sixth month—(a) Vascular tumour, with remains of Wolffian body (organ of Giralde's) upon it ; (b) Vas deferens ; (c) Gubernaculum.

Figs. 2, 3, and 4.—Testis of new-born children, showing Morgagni's hydatid, and similar small projections from the caput epididymis.

Fig. 5.—Testis of young man *æt.* 25 ; tunica vaginalis slit up ; (a) Hydatid of Morgagni ; (b) Vas aberrans Halleri, terminating above by a bulbous extremity on the vascular tumour, near the corpus innominé, and below joining the body of the epididymis, a portion of which is unravelled ; (c) Vas deferens ; (d) Its artery.

Fig. 6.—Male pig of 5 inches—(a) Testis ; (b) New structure on top of Wolffian body, which forms the caput epididymis ; (c) Spermatie vessels forming the vascular tumour ; (d) Remains of the Wolffian body ; (d') Excretory duct or body of the epididymis ; (e) Globus minor ; (f) Gubernaculum.

Fig. 7.—Testis of child of 6 years—(a) Hydatid of Morgagni ; (b) Corpus innominé ; (c) A partly atrophied cord, the remains of a portion of Müller's duct.

PLATE VI.

Fig. 1.—Diagram to represent Müller's view of the ducts of the Wolffian body—(a) Efferent duct of the generative gland or Müllerian duct, which merges into (b) the excretory duct ; (c) Common duct resulting from their union.

Fig. 2.—Diagram to illustrate Rathke's view of the formation of the seminal vesicles—(a) Sinus urogenitalis ; (bb) Excretory ducts ; (c) Diverticulum ; (dd) Lateral pouches ; (2) (a) Bladder ; (bb) Vasa deferentia ; (c) Urethra ; (dd) Seminal vesicles.

Fig. 3.—Diagram to illustrate the division of the cloaca—(1) Rathke's view ; (a) Allantois ; (b) Cloaca ; (c) Intestine ; (d) Ducts ; (2) (a) Sinus urogenitalis ; (b) Septa ; (c) Rectum ; (d) Ducts ; (e) Anus ; (3) Valentin and Bischoff's view—no septa.

Fig. 4.—Diagram to illustrate the sinus urogenitalis—(1) and (2) (a) Sinus urogenitalis ; (bb) Müller's ducts (3) Female ; (a) Vestibulum Vaginalæ ; (bb) Vagina and uterus ; (c) Bladder ; (d) Urethra ; (e) Clitoris ; (4) Male ; (a) Membranous part of urethra ; (bb) Excretory ducts ; (c) Bladder ; (d) Neck of bladder and prostatic part of urethra ; (e) Penis ; (f) Prostate.

