XVIII. *On the Nervous Ganglia of the Uterus.* *By* Robert Lee, *M.D., F.R.S.*

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In a communication to this Society which was read on the 12th December, 1839, I described four great plexuses under the peritoneum of the gravid uterus, which had an extensive connection with the hypogastric and spermatic nerves. From their form, colour, and general distribution, and their resemblance to ganglionic plexuses of nerves, and from their branches actually coalescing with those of the hypogastric and spermatic nerves, I was induced to believe, on first discovering them, that they were nervous ganglionic plexuses, and constituted the special nervous system of the uterus.

Subsequent dissections of the unimpregnated uterus, and of the gravid uterus in the third, fourth, sixth, seventh and ninth months of pregnancy, have enabled me not only to confirm the accuracy of my former observations, but to discover the important fact, that there are many large ganglia on the uterine nerves, and on those of the vagina and bladder, which enlarge with the coats, blood-vessels, nerves, and absorbents of the uterus during pregnancy, and which return after parturition to their original condition before conception takes place.

The uterus and its appendages are wholly supplied with nerves from the great sympathetic and sacral nerves. At the bifurcation of the aorta, the right and left cords of the great sympathetic nerve unite upon the anterior part of the aorta, and form the aortic plexus. This plexus divides into the right and left hypogastric nerves, which soon subdivide into a number of branches to form the right and left hypogastric plexus. Each of these plexuses, having the trunk of the hypogastric nerve continued through its centre, after giving off branches to the ureter, peritoneum, rectum, and trunks of the uterine blood-vessels, descends to the side of the cervix, and there terminates in a great ganglion, which, from its situation and relations, may be called the hypogastric ganglion, or utero-cervical ganglion.

This ganglion is situated by the side of the neck of the uterus, behind the ureter, where it is passing to the bladder. In the unimpregnated state it is usually of an irregular, triangular, or oblong shape, with several lobes or processes projecting from it where the nerves enter, or are given off from it. In the long diameter it usually measures from half an inch to three-quarters of an inch, varying in dimensions with the size of the nerves with which it is connected. The hypogastric ganglion always consists of cineritious and white matter like other ganglia, and gray and white nerves issue from it, which proceed to the rectum, bladder, uterus and vagina. It is covered with the trunks of the vaginal and vesical arteries and veins, and the ganglion has an

artery of considerable size, which enters it near the centre, and divides into branches which accompany the nerves given off from its inner surface, and from its anterior and inferior borders. The hypogastric nerve, after separating into a plexus, enters its upper edge, and branches from the third and other sacral nerves its posterior border, and the whole of its outer surface. None of the branches of the sacral nerves pass over the ganglion to the bladder, though some of them enter its anterior edge where the vesical nerves are given off.

From the inner and posterior surface of each hypogastric ganglion, numerous large nerves are given off, which go backward to anastomose with the hæmorrhoidal nerves, which accompany the arteries to the rectum, and pass with them between the muscular fasciculi of the organ. An extensive connection is thus established between the two hypogastric ganglia and the nerves of the rectum, and many large broad nerves pass off from the posterior and inferior part of these ganglia to ramify on the sides of the vagina, and between the vagina and rectum.

From the inferior border of each hypogastric ganglion several fasciculi of small nerves are sent off, which pass down on the sides of the vagina, and enter several large flat ganglia about midway between the os uteri and ostium vaginæ. From these vaginal ganglia, innumerable filaments of nerves, on which small ganglia are formed, extend downwards to the sphincter, where they are lost in a white dense membranous expansion, from which they cannot be separated without laceration. From this great web of ganglia and nerves on the sides of the vagina, by which it is completely covered, numerous branches are sent to the sides of the bladder, which enter it around the ureter. All these nerves of the vagina are accompanied with arteries, and they often form complete rings of nerve around the trunks of the great veins.

From the anterior margin of each hypogastric ganglion, large white and gray nerves are sent off, some of which pass on the outside, and others on the inside of the ureter, and these branches meet in front of the ureter in a ganglion, which may be termed the *middle* vesical ganglion. There are other two ganglia formed on these nerves, one between the uterus and ureter, and the other between the ureter and vagina. These may be called the internal and external vesical ganglia. The ureter is thus inclosed within a great ring of nerve, which resembles the œsophageal ganglion in some of the Invertebrata. The trunks of the uterine artery and vein are likewise encircled by a great collar of nervous matter, between which and the hypogastric ganglion, several large and some small branches pass.

The internal vesical ganglion, which usually has a flattened or long bulbous shape, is formed entirely upon the nerves which pass from the hypogastric plexus and ganglion, and run between the uterus and the ureter. It has an artery which passes through its centre. It first gives off a large branch to the ring of nerve or ganglion which surrounds the uterine blood-vessels; it then sends branches to the anterior part of the cervix uteri, and afterwards a great number of small filaments to the muscular coat of the bladder behind, where it is in contact with the uterus. The internal vesical

ganglion then sends forward a large branch which terminates in the middle vesical ganglion.

This ganglion sends off a great number of large nerves to the bladder. Some of these accompany the arteries, and can be seen ramifying with them upon the whole of the superior part of the organ, even to the fundus. Filaments of these nerves, scarcely visible to the naked eye, are seen ramifying upon the bundles of muscular fibres, occasionally forming loops, and inclosing them, or passing down between them to the strata of fibres below. Some of the smaller branches of the middle vesical ganglion do not accompany the arteries, but are distributed at once to the parts of the bladder around the ureter.

The external vesical ganglion is formed entirely upon the nerves which proceed from the hypogastric ganglion, and pass on the outside of the ureter. This is a small thin ganglion, the branches of which are sent immediately into the muscular coat of the bladder. It usually sends down a long branch to anastomose with the nerves and ganglia situated on the side of the vagina.

From the inner surface of each hypogastric ganglion numerous small, white, soft nerves pass to the uterus, some of which ramify upon the muscular coat about the cervix, and others spread out under the peritoneum, to coalesce with the great ganglia and plexuses situated on the posterior and anterior surfaces of the organ. Large branches also go off from the inner surface of the hypogastric ganglion to the nerves surrounding the blood-vessels of the uterus, which they accompany in all their ramifications throughout its muscular coat. Other branches of nerves pass down from the ganglion between the vagina and bladder. Soon after conception the blood-vessels of the nervous ganglia and plexuses now described enlarge, and the ganglia and plexuses themselves expand with the uterus. The long diameter of the hypogastric ganglion at the end of the ninth month measures about an inch and a half.

I have published a full description, with illustrations of the great ganglionic nerves surrounding and accompanying the blood-vessels, and of the ganglia and plexuses, situated on the body of the uterus*. The appearances presented in the fourth month of pregnancy by the hypogastric ganglia, and the ganglia and nerves of the rectum, bladder, vagina and uterus, and also the great plexuses of nerves situated on the anterior surface of the uterus, are seen in the Plates which accompany this paper.

From an examination with the microscope of portions of the plexuses under the peritoneum of a gravid uterus of nine months, which had long been immersed in rectified spirit, Professor Owen and Mr. Kiernan were led to conclude that they were not nervous plexuses, but bands of elastic tissue.

"The tissue of the broad, white, reticularly inter-communicating bands of fibrous matter resembling nerves of the uterus," observes Professor Owen, "consisted of minute fibres, which were solid, smooth, equal-sized, cylindrical and nearly transparent, irregularly interblended in their course; their diameter does not exceed $\frac{1}{10,000}$th of a line. These bands correspond in structure with the fibrous modification of cellular

* The Anatomy of the Nerves of the Uterus. London, 1841. Fol.

tissue. The component fibres did not form tubes, nor were their interspaces filled with the primitive granules or cells of the nervous tissue.

"In the nerves of the spinal system, the primitive fibres of the neurilema, which closely resemble those of the ordinary cellular and fibrous tissues, are arranged in the form of tubes, and can be distinguished into cylinder and contents. The same structure, on a minute scale, exists, according to VALENTIN*, in the sympathetic nerves; but according to the observations of REMAK and SCHWANN†, the component fibres form solid bands, and are of a more transparent character than in the spinal nerves, but marked occasionally with swellings, and having granules in the interspaces.

"I consider that the difference between the nerves of the sympathetic and the fibrous cellular tissue to consist, as regards their microscopic character, in the greater proportion of the granules or cells in the interspaces of the fine, reticularly interwoven, component fibres of the nervous band; and this difference I believe to exist between the two nerves of the sympathetic system and the white bands of fibrous matter which connect the peritoneum with the muscular substance of the womb, and which resemble a plexus of nerves."

The tubular structure of the ganglionic plexuses on the body of the uterus has since been observed by Mr. DALRYMPLE, and the perfect resemblance of the uterine nerves to those of the stomach and intestines demonstrated. The following letter contains an account of Mr. DALRYMPLE's microscopical examination of the uterine nerves.

6 Holles Street, April 21, 1841.

MY DEAR SIR,

After having seen and very carefully examined, some weeks since, your very beautiful preparations of the nerves of the impregnated uterus, and after having felt convinced by their continuity, colour, texture, and mode of distribution, that they really were nerves, I was a good deal surprised to hear from you, and others, that their dentity had been doubted. I was aware that it would have been worse than useless to have asked you for a portion of such suspected cords to submit to the microscope, knowing that they had been very many months immersed in strong alcohol. It would neither have been fair to you, nor satisfactory to me, to have made such an attempt at solving the question.

Being anxious, however, to satisfy myself upon the subject, I obtained an uterus (unimpregnated), and while it was quite recent, I traced several nerves, which I recognised, from their situation round the ureter, and upon the body of the uterus, to be similar to some you had previously pointed out to me. These filaments I submitted to the microscope, and used a very beautiful eighth-of-an-inch object-glass made by Ross. I found that it was impossible, with the most careful dissection, to detach any filament of nerve without including a quantity of cellular and elastic tissue; so that although the tubular portion, indicating the nerve, was distinct, yet it

* Repertorium, iii. p. 76.

† Mikroskopische Untersuch., p. 179.

was surrounded by innumerable extremely minute threads, coiled and contorted, such as one finds the component of elastic tissue, and the ultimate element of cellular membrane.

Under slight pressure, however, the tube was plainly discernible, containing granular matter, not uniformly distributed, but collected in minute masses, at intervals. Small blood-vessels were also seen here and there, with blood-discs within them, which served to indicate the difference between the nervous and vascular tubes, and thus to avoid the possibility of error.

Being, however, aware that some of the most distinguished foreign microscopical anatomists had differed as to what was the real characteristic of nerves of the sympathetic system, I should not have troubled you with this communication had I stopped here.

Feeling, from this discordance of opinion, that there was no absolute test, or at least one which was not open to cavil, I thought to try a comparison of the uterine nerves with those that undeniably belonged to the ganglionic system. I traced, therefore, some nerves upon the surface of the stomach, up to the great ganglion that gave them origin; and I selected some also from the small intestine. These I submitted to the same microscopical power, and under the same circumstances of light, and pressure, and medium.

In all of these I observed the tubular part filled with granular matter, and similarly collected in minute masses.

I also observed that each tube was surrounded by the minute serpentine threads before described. In fact so closely did they agree, in every particular, with the appearances presented by the uterine nerves, that it would have been impossible to distinguish the one from the other.

Thus by comparing the unknown with the known, despite the want of any absolute test, I feel perfectly satisfied of the true nervous character of the very beautiful plexuses you have so patiently and with so much labour developed.

Admitting then this intricate structure to be really nervous, it is a matter of no marvel that they increase in size during pregnancy. It would indeed be wonderful if the nerves alone remained stationary, while the muscular and cellular, the serous and mucous, and the vascular tissues increased, as it is notorious those structures of the uterus do during the period of child-bearing.

If, as is also indisputable, nerves shrink and atrophy when the function of an organ they supplied is lost or destroyed, is it singular that the uterine nerves should increase, when that organ rouses itself from inaction, to one of the most extraordinary exemplifications of temporary functional vigour that the animal œconomy can anywhere exhibit? Pardon me this prolixity, and believe me,

My dear Sir,

Yours very faithfully,

JOHN DALRYMPLE.

Dr. Robert Lee, F.R.S.

Explanation of the Plates.

PLATE XXVI.

Exhibits a posterior and lateral view of the gravid uterus in the fourth month of pregnancy, of the vagina, rectum and bladder, with their ganglia and nerves.

A. The fundus and body of the uterus covered with peritoneum.

B. The vagina.

C. The bladder.

D. The rectum.

E, F. The ovaria.

G. The great sympathetic nerve where it divides into the two hypogastric nerves and plexuses. The arteries and veins of the great sympathetic are all injected in the preparation from which the drawing has been made. A little above the bifurcation of the great sympathetic nerve, there is a deposit of cineritious matter in its substance, and the nerve itself is enlarged as high as the kidneys.

H. The right and left hypogastric nerves and plexuses. The artery of the right is injected, and accompanies the nerve to the great ganglion at the cervix in which it terminates.

I. The left hypogastric or great utero-cervical ganglion, with an artery passing into it near the centre.

J. The third and other sacral nerves, sending numerous large branches into the posterior border of the ganglion, and the whole of its outer surface.

K. The hæmorrhoidal nerves accompanying the arteries to the rectum, and sending numerous branches to anastomose with nerves sent off from the posterior edge of the ganglion.

L. Branches of nerves with ganglia sent off from the left hypogastric nerve, which pass down on the inside of the ureter to the trunks of the uterine artery and veins, and enter ganglia which surround these blood-vessels.

M. The left ureter, with a nerve accompanying it, which passes into the vesical ganglion, situated on the anterior part of the ureter.

N. Rings of nerve, surrounding the uterine blood-vessels.

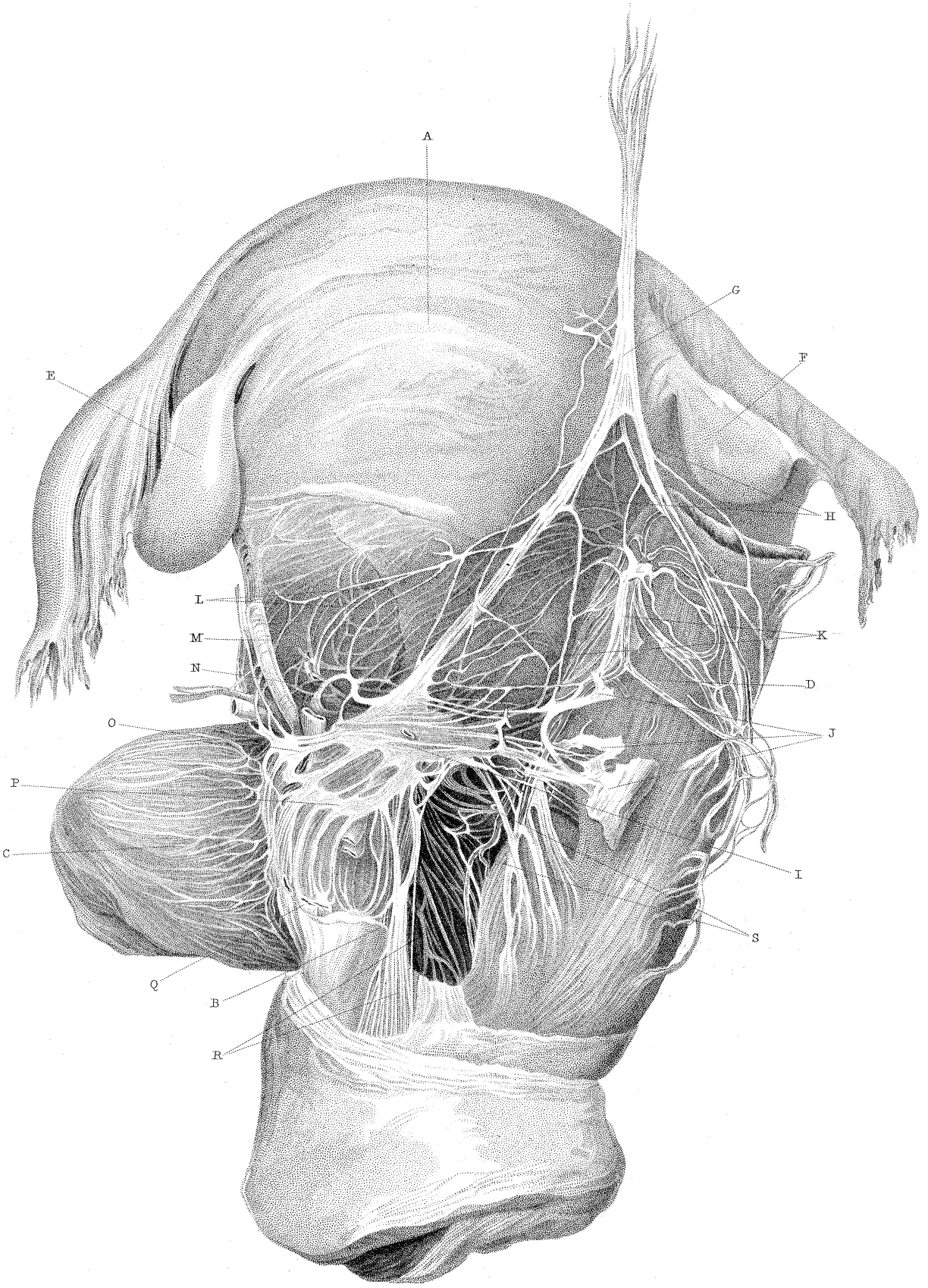
O. The middle vesical ganglion, into which large nerves enter, which are sent off from the anterior border of the left hypogastric ganglion, and pass on the outside of the ureter.

P. Broad, flat ganglia formed on the great plexus of nerves which covers the upper part of the vagina.

Q. The orifices of the divided veins of the vagina, which are completely encircled with ganglionic plexuses of nerves.

R. Filaments of vaginal nerves passing under the sphincter.

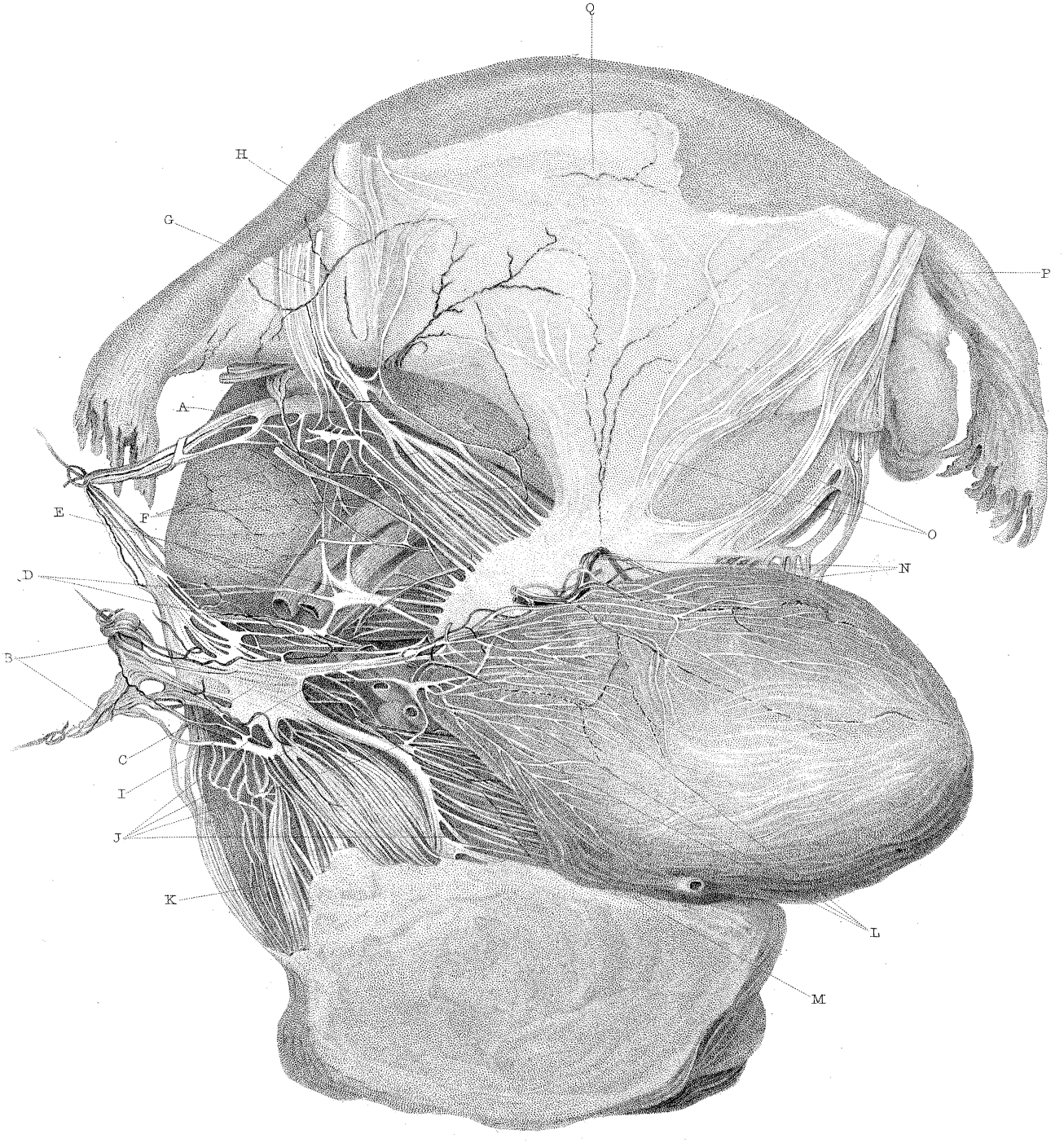
S. Large nerves covering the posterior wall of the vagina, and anastomosing with the hæmorrhoidal nerves.



Joseph Perry del.

¾ the Natural Size.

J. Basire sculp.



Joseph Perry del.

¾ *the Natural Size.*

J. Basire sculp.

PLATE XXVII.

Exhibits an anterior and lateral view of the gravid uterus in the fourth month, and of the vagina and bladder.

A. The right hypogastric nerve.

B. The sacral nerves.

C. The right hypogastric ganglion.

D. Nerves from the hypogastric nerve to the ganglia on the blood-vessels of the uterus.

E. Ganglia surrounding the uterine artery and veins.

F. Ganglionic plexus, under the peritoneum on the fore-part of the uterus.

G. Filaments from this plexus passing out with the round ligament.

H. The round ligament.

I. The right ureter and trunk of the vaginal and vesical veins surrounded with nerves.

J. Ganglia and nerves of the vagina.

K. Nerves passing between the vagina and rectum.

L. Ganglia and nerves of the bladder.

M. Vaginal nerves passing into the bladder around the ureter.

N. Blood-vessels and nerves of upper part of the bladder.

O. Plexus of nerves under the peritoneum on the left side of the uterus, the blood-vessels of which have not been injected.

P. Filaments from this plexus passing out with the round ligaments.

Q. The peritoneum of the anterior part of the body and cervix of the uterus reflected upwards, to expose the ganglionic plexuses situated below.