SOMATIC AND AUTONOMIC NERVES OF THE LUMBAR AND PELVIC

REGIONS OF THE DOMESTIC PIG

by

Yakobo Mabingo Bosa

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INTRODUCTION

There appears to be little detailed information available in recent literature about the peripheral nervous system of the pig. For this reason it was felt necessary to investigate this area to supplement the fragmentary and rather inconclusive records encountered in various textbooks. At first the investigation was directed to the lumbosacral plexus, but in the course of this study it was deemed appropriate to include the observations made on the sympathetic trunks related to the lumbosacral spinal nerves, especially their mode of termination in the coccygeal region. It is hoped that the information accumulated on this species can be correlated to practical applications, e.g., applied anatomy in surgery, clinical diagnosis, obstetrical manipulations, and artificial breeding, all of which necessitate a thorough knowledge of the somatic and autonomic nerves of the lumbar and pelvic regions.

With regard to the autonomic system, the emphasis was directed more to the most caudal terminations of the sympathetic trunks, especially as to whether or not they end by means of a ganglion impar, as is the case in man (Gray and Lewis, 1918), or as indicated in the horse (Sisson and Grossman, 1953), and by Botár (1932) who confirms the presence of this ganglion impar in the pig, especially in the female of the species.

Relative to nomenclature, Leutert's 1963 compilation, together with part of the <u>Nomina</u> <u>Anatomica</u> <u>Veterinaria</u> of 1963 have been consulted wherever appropriate, however, the latter does not include the nervous system.

REVIEW OF LITERATURE

As was stated in the introduction, a search of the literature did not reveal much information dealing with the lumbosacral plexus of the domestic pig, with the exception of the dissertation of Reimers (1913). However, utilization was made of information encountered in existing textbooks (Ellenberger and Baum, 1943; Chauveau and Arloing, 1902; Martin, 1923; Montané and Bourdelle, 1920; Patten, 1948; and Sisson and Grossman, 1953). Bearing in mind that the object of this study was to establish a basis for applicability of the findings for day-to-day practice on the pig, much information concerning other animals has been employed in a comparative manner (Sinclair, 1937; Arnold and Kitchell, 1957; Gleland, 1933; Farquharson, 1940; Habel, 1951; Woollard and Norrish, 1933; Heinze, 1964; and Kuntz, 1953).

Part I. Somatic Nerves

Sinclair (1937) pointed out that the distribution of fibers from any given spinal segment presents certain problems whose answers are embryological. As muscles grow they move in a certain direction to their destination and each one carries a nerve fiber with it. Epaxial muscles are innervated by the dorsal or epaxial rami of spinal nerves, which are the primary division of each segment. Limb mucles are innervated by lateral divisions of the lateral or hypaxial rami

after they pass through a plexus for redistribution. Dorsal rami continue without interruption through the region of the limb girdles. No limb muscle receives nerve fibers from only one spinal root and none from more than three, according to Sinclair. During development nerves reach myogenic cells before the latter are grouped into muscles, and the direction of the axis of each muscle is independent of the original course of the nerve fibers, so that each muscle overlaps two or more fields. The fibers then become grouped into nerves to supply separate muscles, and a plexus results. But the distribution of the root fibers retains the original segmental order on the surface of the skin and on the muscles in both limbs and trunk. It is obvious that since the pig has more segments in the thorax and lumbar regions and less in the sacrum than man has, the pelvic limb of the pig has not developed from exactly homologous segments. Despite this, the similarities in detail are striking. With regard to the autonomic nervous system, there is some loss of segmentation pattern, but the order of the fibers to the head and limbs is not changed. The fibers contributing to each limb come from a very broad spinal origin.

Taking the above as a basis of development of the nerves, and considering all other phenomena to be constant, one would expect to find a consistent formation of the lumbosacral plexus. But as all the different aspects of ontogeny are

affected by variations in environment, so one should not expect to find complete similarity in the morphological make-up of all species and individuals.

The lumbosacral plexus of the pig as described by different observers may be, therefore, a reflection of the environmental effect on the specimens, if not a misinterpretation by the various observers.

The nerve roots forming the lumbosacral plexus, as given by Sisson and Grossman (1953), are the last three ventral branches of the lumbar spinal nerves and the first ventral branch of the sacral spinal nerve; Chauveau and Arloing (1902) reported that the nerve roots arise from the last two lumbar and first three sacral spinal nerves, and regarded the trunk that leaves between the last lumbar vertebra and the sacrum as the sacral nerve. Reimers (1913) treated the lumbar and sacral portions independently. He pointed out that the Ramus ventralis of the N. lumbalis VII, sends the main bulk of its fibers to the sacral plexus, and only gives off a relatively slender branch to the nerves of the lumbar plexus. He further pointed out that all of the seven lumbar nerves came into the formation of the lumbar plexus, although all of them do not regularly communicate with each other.

With regard to the number of lumbar spinal nerves, Reimers (1913), Chauveau (1902), Sisson and Grossman (1953), Ellenberger and Baum (1943), and Montané and Bourdelle (1920)

all report that there are usually seven or sometimes six. On the other hand, Uchida (1929), while working on the sympathetic system of the Asian pig, found a constant number of six pairs of lumbar sympathetic ganglia in the trunks, which coincided with the number of the respective vertebrae and spinal nerves. Whereas, Reimers refers to the first of seven pairs of lumbar spinal nerves as the N. iliohypogastricus accessorius, comparable to the N. iliohypogastricus cranialis in the dog (Miller, Christensen and Evans, 1964) or of the cat and rabbit (Langley and Anderson, 1896); Ellenberger and Baum (1943) refer to this nerve as the N. iliohypogastricus cranialis. But when there are only six pairs of lumbar nerves, the reduction leads to having a N. thoracis accessorius, according to Reimers (1913). Work by Kitchell, Campbell, Quilliam and Larson (1955) elucidating sexual behavior in other species indicated certain lines of study that could also be carried out on the pig. This work also revealed the existence of controversy in the nomenclature of certain nerves, for example, of the two terminal branches of the pudendal nerve (N. pudendus), in the female the term for one, the N. clitoridis is commonly accepted, but the other, which proceeds to the mammary glands, is given various names, N. mammarius (Habel, 1951), N. perinealis (St. Clair, 1940), or N. perinealis superficialis, (Larson, 1953).

Schneider and Zintzsch (1962) have indicated landmarks

for nerve blocks on the extremities of the limbs in the pig.

According to Reimers (1913) there is no communication between the ventral branches of the first two lumbar spinal nerves. The L_3 spinal nerve is the N. ilioinguinalis, which sometimes receives a reinforcing branch from the L_2 spinal nerve. The union of branches from the L_3 and L_4 spinal nerves gives origin to an independent nerve, the N. spermaticus externus (N. genitalis). The latter nerve arises from the L_4 spinal nerve according to Reimers (1913). He states also that the N. genitalis (spermaticus ext.) seldom gives off a twig to the N. cutaneus femoris lateralis. The N. cutaneus femoris lateralis arises from the L_5 spinal nerve, and, in about one third of the cases it receives a contributory branch in its initial course from the L_6 spinal nerve. The N. femoralis is said to arise from the L_6 spinal nerve in common with the N. obturatorius. He notes an inconstant, reinforcing, slender branch from the L_7 spinal nerve in the N. obturatorius, and also apparently continuing fibers from the L_5 spinal nerve to the N. obturatorius.

In the sacral region four pairs of sacral spinal nerves are constantly noted by Reimers (1913). He describes the last lumbar spinal nerve with the sacrals which form a large integral part of the sacral plexus. The L_7 spinal nerve receives a reinforcement from the L_6 spinal nerve, mostly via the N. obturatorius. The N. cutaneus femoris caudalis is

noted to come from the s_2 spinal nerve. The Nn. pudendus and haemorrhoidalis medius (N. rectalis medius) arise from the S_3 spinal nerve. In most cases, the origin of the N. gluteus caudalis is before, and in a few cases after, the N. cutaneus femoris caudalis arises from the ischiatic plexus. Reimers points out that, in one case out of ten, the N. cutaneus femoris caudalis gave off a small loop to the N. pudendus. The latter nerve is said to come from the S_3 spinal nerve, reinforced by the S_2 spinal nerve. The N. pudendus was also shown by him to give off three cutaneous branches designated as the proximal, distal and middle cutaneous nerves. One branch, corresponding to the proximal nerve referred to above, arose directly from the S_3 spinal nerve at the intervertebral foramen.

While there are two spermatic trunks in cattle, according to Reimers (1913), only one trunk, which arises from the L_3 and L_4, or L_2 and L_3, (depending upon the presence of seven or six lumbar spinal nerves), is found in the pig. In addition, he states that in horses, cattle and pigs with six lumbar vertebrae the N. cutaneus femoris lateralis arises from the L_4 and L_3 spinal nerves, while in pigs with seven lumbar vertebrae it arises from the L_4 and L_5 spinal nerves.

He further points out the important differences existing between the lumbar plexus of man and that of domestic animals, and moreover, the differences between the plexuses of the horses, cattle and pigs.

Part II. Autonomic Nerves

The investigations that have been carried out in connection with the somatic nerves of the lumbosacral plexus, led to the necessity of correlating the respective portion of the autonomic nerves by gross observations, especially the termination of the sympathetic trunks in the sacro-coccygeal region. So far the most comprehensive information relating to the sympathetic system in the pig is found in the dissertation work of Uchida (1929), but it deals with the portion cranial to the sacral region. Botár (1932) worked in the same area as the present author. The autonomic nerves of the dog have been more fully investigated (Mehler, 1951 and 1952; Mizeres, 1955; Cloninger and Green, 1955). The neurological studies by Kitchell, Campbell, Quilliam and Larson (1955) on domestic animals, although not including the pig, should not be ignored. Langley and Anderson's (1896) work on the cat and rabbit throws light and caution as regards generalizations which have been relied upon in many instances not only in veterinary work but also in human medical experiments. Larson's (1953) work and that of Dziuk et al. (1954b) further indicate the need for a thorough understanding of the sympathetic system in each and every species of our domestic animals, especially the pig. As indicated by Sisson and Grossman (1953) the autonomic nervous system in the pig has been neglected. It should be pointed out that only some

aspects of the sympathetic nerves have been taken into account and much more needs to be investigated. Just as the present work was still going on, Zintzsch (1964) has published much the same work done on the sheep in the same area as is being pursued in the pig.

Uchida (1929) and Botár (1932) have done commendable work on the sympathetic nerves of the domestic pig, although the work of the former does not extend beyond the lumbar region. Botár's work seems to indicate two patterns in the sacrococcygeal region which are influenced by sex difference. Others (Mizeres, 1955; Langley and Anderson, 1895; Trumble, 1934; Oppenheimer, 1938; Dyce, 1958; and Zintzsch, 1964) have worked on the autonomic nervous system of other animals and man, and have helped to open the door for further work of a similar nature on the pig.

In addition, there are some practical applications which need to be considered. Such work as the collection of semen from bulls, goats, rams and boards, (Dziuk, Graham, Donker, Marion and Peterson, 1954a) by the use of electrical stimulation, necessitates knowledge of the nerves which come into play to produce the desired effect.

Botár's work (1932) also includes the sympathetic nerves of the other domesticmammals. Dyce's work (1958) was on the sympathetic system of the horse. Woollard and Norrish (1933) give a simplified view of the sympathetic nervous system for surgical purposes in their summary:

From a surgical point of view the sympathetic inner-
vation of any particular region can be determined by
the method of macroscopic dissection. Innervation
fibers that cannot be determined by this method are
not of surgical moment.

The same authors (1933) indicated the complexity of the

nervous supply to the viscera, there being no constant pat-

tern in this source, reporting that they may be recieved

from the adjacent plexus, from branches proceeding from

ganglia, or in the fibers which accompany the blood vessels.

Representation may either be oversimplified, if a great deal

of cleaning of the area is done, or may be overwhelming when

the plexus is photographed. Another approach used by many

investigators to elucidate the situation, is to perform a

sympathectomy, which alleviates a functional discomfort

stemming from the sympathetic nervous system.

Kuntz (1956), speaking about the intermesenteric nerves

in man, points out that the middle nerves lead into the in-

ferior mesenteric plexus, and the lateral ones extend into

the hypogastric plexus. He reports on the presence of

special ganglia in the greater splanchnic and lesser splanchnic

nerves in man. He also points out the occurrence of a poster-

ior renal ganglion and aortico-renal ganglion, which are also

reported in the dog (Miller, Christensen and Evans, 1964).

The unmyelinated fibers -- chiefly postganglionic, but some

undoubtedly afferent -- increase, and the myelinated ones

decrease in number from the proximal toward the distal ends

of the nerves. This change is correlated with the occur-
rence of ganglia in the nerves.

The lumbar splanchnic nerves, which number four in the
cat (Kuntz, 1956), either terminate in the renal plexus or
caudal mesenteric ganglion, and contribute rami to the inter-
mesenteric ganglia, and some, also, to the hypogastric plexus.
Direct rami go to the aorta. Macroscopic ganglia are said to
be observed rarely in the lumbar splanchnics in the cat, ex-
cept near the caudal mesenteric ganglia. Although micro-
scopic ganglia are observed they are not present in all nerves
in a single animal. Ganglion cells also occur in sympathetic
rami that extend toward the aorta along the segmental vessels.

Langley and Anderson (1895), after sectioning the dorsal
roots of the sacral spinal nerves, found that there were de-
generations of nerves to the bladder and rectum, fewer to
the urethra and vulva, but none to the uterus and vagina in
the cat and rabbit. Therefore, they concluded that the
sacral nerves do not send sensory fibers to the internal
genital organs in these species.

The pelvic nerve (N. erigentes) in the cat, is composed
of about one-third afferent fibers. In addition, it contains
a few fibers that do not degenerate after sectioning the
sacral nerves. Branches of the pelvic plexus to the rectum
and their modullated fibers are almost entirely sacral af-
ferent fibers. The efferent ractal fibers are connected

with nerve cells in the first group of ganglia occurring on the course of the pelvic nerve. The hypogastric nerve gives a considerable number of medullated fibers to the bladder and uterus, less to the vagina, and a few, or none, to the urethra, in the cat.

MATERIALS AND METHODS

Part I. Somatic Nerves

Fifteen pigs, eight females and seven males (four cas-
trated), of various breeds (six Yorkshire, three Poland-China,
two Landrace and four Yorkshire-Landrace), ranging in age from
3 months to 6-1/2 years, were used.

Most of the specimens were prepared and embalmed in the
manner commonly followed in the department, while a few of
the animals were dissected in the fresh state. The animals
to be embalmed were first anesthetized with pentobarbital
sodium, bled by carotid cannulation and then infused with an
embalming fluid consisting of: 60 percent Isopropyl alcohol,
4 percent Formaldehyde, 6 percent Liquid Phenol, 2-1/2 per-
cent Corn syrup (50 percent H_2O) and 27-1/2 percent Water.
Following embalming and throughout the investigation the
specimens were kept in cold storage between dissections.

The specimens not embalmed were from animals which had
been electrocuted and then bled immediately. These were
gerontological specimens, but they provided the essential
areas for study in the lumbosacral region. These specimens
were kept in cold storage also whenever not being worked
upon, but, of course, after some time it was necessary to
immerse them in a solution of 10 percent formaldehyde.

Two methods of approach were followed. The first,
which was always necessary in the sacral portion, was to

dissect from outside to inside. In this method the skin was incised along the mid-dorsal line and reflected ventrally towards the flank. The lumbar and gluteal muscles were incised one-by-one, reflected, and finally removed as the nerves were dissected to their intervertebral exits. In the first three specimens a laminectomy was performed with concommitant removal of the ossa ilia. However, it was found that the nerves were easily broken before the dissections, so the removal of the ossa ilia was abandoned.

In most cases the second method was pursued, especially for the nerves in the lumbar region. This method consisted of making a longitudinal incision along the mid-ventral line, allowing the removal of the abdominal viscera up to the pelvic inlet, but temporarily leaving the internal genital organs, bladder and rectum in place. As the dissection progressed these organs were removed as necessary. The sublumbar muscles (Mm. psoas major and minor) were removed piecemeal, as were the Mm. iliacus, obturatorius internus, sacrococcygea ventrales, and coccygeus, so as to expose the point of emergence of the spinal nerves. The aorta was temporarily left in place in specimens in which the sympathetic nerves were closely observed, otherwise it was removed, together with its terminal branches, after noting the relationship these had with the various spinal nerves.

Photographs were taken and drawings made of the exposed

structures. These will be found appended to this thesis.

All work was carried out macroscopically, except in one case in which microscopic means were resorted to in order to identify what appeared to be an unusual nerve connection to the N. retractor penis.

In order to make the nerves stand out clearly for photographic procedures, the spinal nerves were painted with yellow latex. Since India ink tends to spread to surrounding tissues, black casein paint[1] was employed for the sympathetic nerves.

The area studied and dissected extended from the last rib caudad, though in one case the dissection was extended to include the last four ribs so as to identify and study the sympathetic trunks.

In one of the specimens (no. 5) the vertebral canal was opened in order to observe the extent of the spinal segments of the cord as indicated by the spinal nerve emergence from the surface of the spinal cord, with and without its meninges. For this the Stryker saw was used to remove the dorsal arches of the vertebrae, and thus expose the spinal cord and its membranes (Plate 3).

Observations were also extended to the dorsal branches of the spinal nerves in the lumbosacral region (Specimen no. 7) (Figure 6; Plates 6 and 7).

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[1]Casein colors prepared by R. Shines of 433 W. Coethe Street, Chicago, Illinois.

Part II. Autonomic Nerves

Five of the specimens which were being used for the study of the lumbosacral plexus have been used also to observe the autonomic nerves in the areas indicated in the introduction. Two of these however were not as carefully treated for this purpose, although some information was collected from them in the light of correlating findings. The remaining three have been so treated as to obtain a clearer picture of the arrangement of the sympathetic trunks. Two of the specimens were females and the rest males, of which one was castrated.

The abdominal viscera, except the kidneys and the terminal portion of the colon and pelvic organs, were removed through a sagittal opening on the ventral aspect of the abdominal wall. A bit of the mesentery was left on the dorsal wall of the abdominal cavity together with the aorta. More working space was obtained by removal of the portion in front of the last four ribs.

Dissection proceeded by gentle removal of the parietal layer of the peritoneum along the lateral borders of the M. psoas major, reflecting it medially. While the various nerves were being located, the M. psoas major and M. psoas minor were removed piecemeal, following the Rami communicantes toward the spinal nerve at their site of emergence. Then the parts in proximity to the aorta were traced toward

the caudal end into the pelvic cavity.

Two more female pig specimens were investigated, making a total of seven specimens on which the autonomic system was examined. One of the specimens after yielding such unexpected results led to the investigation of yet another one of the same sex. The only unfortunate thing about one of these specimens is that it consisted of only a small part of the lumbar region although the sacral and coccygeal regions were almost completely intact with regard to the Trunci sympathici. This specimen had three lumbar vertebrae left and there were still two pairs of lumbar sympathetic ganglia, although one of the ganglia was represented by an extraordinarily placed ganglion on the right side, so that only one ganglion was present on the left side. The Aorta abdominalis and the Vena cava caudalis had already been removed and therefore all of the lumbar splanchnic nerves had been destroyed. The rectum and genitalia and also the pelvic plexus had been removed as far as the caudal third of the pelvic cavity. However, some interesting information was provided by this specimen which was dissected fresh. It was the fourteenth in the series of specimens dissected for the lumbosacral plexus.

The other specimen was a whole pig treated in the usual way of embalming and was prepared for dissection as described above. It was the seventh specimen examined for the Tr. sympathici, the fifteenth in the series of dissections for the lumbosacral plexus.

RESULTS

Part I. Somatic Nerves in the Lumbosacral Region

The Lumbosacral spinal nerves

In all, except two, of the specimens examined there were six pairs of lumbar spinal nerves, and four pairs of sacral spinal nerves. Of the two exceptions, one had five pairs of lumbar, and four pairs of sacral spinal nerves; the other had four pairs of sacral spinal nerves, but the lumbar nerves could not be determined, as only the pelvic part had been saved for determining the terminations of the sympathetic trunks in the sacral and coccygeal regions.

In the following findings, the last pair of thoracic spinal nerves were included and have been discribed first as the cranial landmark for the area examined.

The last thoracic spinal nerve

The ventral branch of the last thoracic spinal nerve of each side leaves the vertebral canal at the caudal end of the last thoracic vertebra. It is so placed that it appears to be a considerable distance from the last rib, especially at the nerve's emergence from the intervertebral foramen. It runs almost parallel to the last rib, and at the lateral border of the M. quadratus lumborum, it enters the vertebral border of the M. transversus abdominis in company with the

cranial-most branch of the A. phrenico-abdominalis. The
nerve divides into two branches in the upper third of its
course. One of these branches passes outwards and innervates
the M. obliquus externus abdominis, M. cutaneus trunci, and
the skin. The second branch descends in a caudoventral
direction in the substance of the M. transversus abdominis,
gives a twig to it and continues ventrocaudally and finally
enters the lateral border of the M. rectus abdominis which
it innervates, in addition to giving off cutaneus branches
which go through the muscle or are given off at its lateral
or medial border, near the cranial border of the umbilicus.
The nerve takes part in the innervation of the mammary glands
and the Mm. praeputiales craniales. In one of the specimens,
the last thoracic nerves had communicating fibers with the
first lumbar spinal nerves. Each of these ran very close
to the body of the vertebra and joined the first lumbar nerve
at its exit from the intervertebral foramen.

The first lumbar spinal nerve (L_1)

The ventral branch of the first lumbar spinal nerve
contributes a small branch to the second lumbar spinal nerve
before the former divides into two main branches near, or at,
the lateral border of the M. quadratus lumborum. It courses
under the transverse process of the succeeding vertebra,
running caudally, laterally and ventrally, and its two
branches accompany the two caudal branches of the A.

phrenico-abdominalis. The short, cranial branch runs later-
ally, supplies innervation to the M. obliquus externus ab-
dominis, and sends out a branch to the skin, about one third
of the way down the flank. The longer, caudal branch passes
inwards and assumes a course between the M. obliquus
internus abdominis and the M. transversus abdominis, giving
branches to both of these muscles and continuing between the
M. transversus abdominis and the peritoneum to the lateral
border of the M. rectus abdominis, at which point it gives
off a cutaneus branch while the main trunk continues in the
substance of the muscle towards the median plane, and behind
the umbilicus. It also innervates the mammary glands in this
region.

The second lumbar spinal nerve (L$_2$)

Immediately on its exit from the intervertebral foramen
the ventral branch of the second lumbar spinal nerve, in
most cases, divides into two branches, which are cranial and
caudal in position. The cranial branch receives the con-
tribution from the first lumbar spinal nerve, as indicated
above, and subdivides into branches, which are again cranial
and caudal in disposition. The cranial subdivision appears
to take the whole of the contribution from the first lumbar
nerve, passes ventrolaterally and gives off a cutaneous
branch and a muscular branch to the M. obliquus externus
abdominis. The caudal subdivision passes caudoventrally

between the Mm. obliquus internus abdominis and obliquus externus abdominis, furnishes them twigs, and gives off a branch which innervates the M. cutaneus trunci and the skin.

The primary caudal branch of the second lumbar spinal nerve also subdivides into two branches which are cranial and caudal in position. The cranial subdivision, after traversing caudal along the dorsal aspect of the M. psoas major for a distance of one and one-half vertebrae, divides at the lateral border of that muscle into a shorter cranial and a longer caudal branch. The former branch accompanies the middle branch of the A. phrenico-abdominalis, and runs through the abdominal wall, giving off branches, first to the M. transversus abdominis, and then to the M. obliquus externus abdominis and ends as a cutaneus nerve. Its counterpart, the caudal subdivision, pursues a course more caudal and towards the inner or peritoneal surface of the M. transversus abdominis, innervating this muscle, the M. obliquus internus abdominis, and the M. rectum abdominis.

The secondary branch of the caudal primary division of the L_2 spinal nerve runs more or less parallel to the preceding branch, and more in the substance of the M. psoas major before emerging at its lateral border (Figure 9: 4) or, on rare occasions, piercing through the muscle emerging on its ventral surface (Figure 8: 4 and 5 and Plate 5) and the whole of it appearing to innervate the M. obliquus internus

abdominis which it enters at a transverse plane passing
through the stifle joint, but at the iliac origin of the
muscle. Sometimes the secondary branches reunite before
reaching their destination and separate again in the subiliac
region, one branch dividing to innervate the Mm. obliquus
internus abdominis and transversus abdominis, and the other
branch descending to join the lateroventral branch which
continues its descent into the M. obliquus internus abdominis,
innervating it and also giving off a cutaneus branch which
appears in the inguinal region (Figure 12: 3 and 4, Figure 1:
7, Plate 8 Top).

There is a communicating branch between the ventral
branches of the L_2 and L_3 spinal nerves. This communication
is between the secondary branch of the L_2 and the main L_3
spinal nerves.

In four specimens (nos. 2, 4, 6, and 12) a branch from
the L_2 spinal nerve either joined the L_3 spinal nerve in the
formation of the N. genitalis (N. spermaticus externus) in
the initial course of their journey, or it sent a branch
separately running alongside the M. psoas major to end in the
M. cremaster externus near the internal inguinal ring (Figure
19: 3 and Figure 20: 12). In other words, a loop was formed
between branches from both the L_2 and L_3 spinal nerves, the
union taking place inside the substance of the M. psoas
major, the branch from the L_3 having run in a cranial direc-
tion to meet the L_2 branch (Figure 8: 6).

The third lumbar spinal nerve (L₃)

The ventral branch of the third lumbar spinal nerve emerges from the vertebral canal between the third and fourth lumbar vertebrae. On its emergence it immediately divides into three branches. Two of these are short stems which receive the contribution from the ventral branch of the second lumbar spinal nerve and go mainly to innervate the Mm. psoas major and minor, though, as mentioned above, one of these conjoined branches may proceed either to the M. obliquus internus abdominis, or to the M. cremaster externus and the M. obliquus internus, and a twig be given off to appear in the inguinal region (Figures 7, 8, and 12). The third branch, however, courses in a medial direction, ventrally and caudally between the M. psoas major and the M. psoas minor, in a more or less horizontal fashion, until it emerges from them at the level of the fifth lumbar vertebra. Before its emergence from the muscles it gives off a proximal communicating branch to the fourth lumbar spinal nerve, and after leaving the muscles it gives off another communicating branch to the same nerve at the level of the cranial border of the transverse process of the sixth lumbar vertebra. In most cases it also receives an exchange branch from the fourth lumbar spinal nerve at the point of the distal branch contribution. In some specimens this return contribution was missing on one side and, rarely, on both sides. Here again,

in some cases, the arrangement was more plexiform than a few simple communicating branches.

Immediately after, or before, the above arrangement, the third lumbar spinal nerve, now called the N. spermaticus externus, or appropriately the N. genitalis, divides into two branches, one of which receives a communicating branch from the fourth lumbar spinal nerve. The two divisions unite after enclosing the deep circumflex iliac vessels and continue caudoventrally with the external iliac vessels, parting with them at the origin of the pudendo-epigastric vascular trunks which they now follow to the internal inguinal ring. Here the stem splits into two branches which in turn subdivide into two each, or one subdivides and the other remains single. Two of the four, or one of the three, branches enter the M. obliquus internus abdominis and the pubic tendinous attachment of the M. rectus abdominis. The remaining two branches follow the external pudendal vessels. One of them gives off a twig to the M. cremaster externus, and in the male it supplies innervation to the tunica vaginalis, the inguinal fascia, prepuce, Mm. praeputiales caudales (Figure 3: 5, 8) and cranial part of the scrotal fascia and skin, and were seen to intermingle with the terminal branches of the Nn. scrotales caudales, while in the female the two branches descend into the inguinal region where they branch to supply the mammary glands located here. The nerves, on emerging

from the external inguinal ring, consistently pass through
and innervate the superficial inguinal lymph node, Figures
13: 3, 5; 20: 13. In many cases branches of the N. cutaneus
femoris lateralis reached the inguinal region and innervated
the area lateral to the superficial inguinal lymph nodes,
and thus came in contact with the foregoing nerves.

The fourth lumbar spinal nerve (L$_4$)

The ventral branch of the fourth lumbar spinal nerve
emerges as a single stem from the intervertebral foramen
between the fourth and fifth lumbar vertebrae. It courses
alongside the body of the fifth lumbar vertebra, in a
caudoventral direction, pierces between the M. psoas major
and M. psoas minor, and emerges from them at the level of the
caudal end of the fifth lumbar vertebra. The nerve divides
into two branches while still inside the substances of the
two previously named sublumbar muscles. The cranioventral
nerve receives the proximal contributory branch from the third
lumbar spinal nerve, and, immediately on leaving the muscles,
receives the distal contributory branch from the third lumbar
spinal nerve now called the N. genitalis. It is here that it
also contributes a twig from its cranioventral branch back to
the N. genitalis. From here the main branch of the fourth
lumbar spinal nerve passes laterally, ventrally and caudally,
obliquely crosses the caudal third of the M. psoas major and
M. psoas minor and the origin of the M. iliacus at the level

of the tuber coxae, pierces the coxal origin of the M. obliquus internus abdominis, or it may course between the caudal border of the muscle and the os ilium, and gains the deep face of the M. tensor fasciae latae, descends along this surface of the muscle together with the descending branch of the A. circumflexa ilium profunda and its satellite veins. Just at its entrance into the M. obliquus interus abdominis it divides into two equal branches, which also subdivide to make four branches in all. Two of the subdivisions run in front of the thigh and stifle joint bearing to the lateral aspect of the thigh as far down the middle third of the leg as the cutaneus nerve. The two remaining branches run towards the inguinal region and along the mammary line and prepuce. Some twigs run horizontally forwards together with the terminal branches of the deep circumflex iliac vessels which appear in the fold of the flank (Figure 12: 5, 13: 4, Plate 8 Top).

One of the primary branches has a short course, as it joins the succeeding ventral branch of the fifth lumbar spinal nerve along the body of the sixth lumbar vertebra, although its fibers are quite apparent as they continue in the N. obturatorius in all cases.

The ventral branch of the L_4 spinal nerve not only constitutes the main root of the N. cutaneus femoris lateralis, but also concurs in the formation of the Nn. femoralis and

obturatorius. It also contributes many branches to innervate
the Mm. psoas major and minor. On some occasions it receives
a small contribution from the second lumbar spinal nerve
(Figure 1: 10, 4: 3, 5: 5).

The fifth lumbar spinal nerve (L_5)

The ventral branch of the fifth lumbar spinal nerve is
much larger than the preceding four nerves. It is the main
constituent of the N. femoralis although the fourth lumbar
spinal nerve appears, on several occasions, to be somewhat
the same size in forming that nerve. This was observed in
all specimens with six pairs of lumbar spinal nerves, but in
the one in which the lumbar nerves were reduced to five pairs,
the fourth took over the lead, while the fifth wentto join
the sacral spinal nerves as well as contributing to the N.
obturatorius.

Contributory branches from the ventral branches of the
L_3 and on rare occasions of the L_6, add to the bulk of the
N. femoralis, and in the same way the N. obturatorius, whose
origins are almost identical with those of the N. femoralis,
(Figures 1, 2, 3, 4, 5, 11, 13, 16, 17, 19, 20, and 21,
Plates 1 and 13).

It lies very close to the body of the sixth lumbar
vertebra as it passes caudoventrally, then inclines latero-
caudally through the substance of the M. iliacus as part of
the N. femoralis which will be described later. The branch

from the preceding lumbar nerve joins this one at the cranial third of the sixth lumbar vertebra, while its contribution to the sixth lumbar nerve joins the latter at the promontory of the sacrum, and/or in some cases, it also received a contribution from the sixth lumbar spinal nerve (Figure 19: L_5, L_6).

The sixth lumbar spinal nerve (L_6)

The ventral branch of the sixth lumbar spinal nerve, constituted the last lumbar nerve in all cases (except one in which the fifth was the last) (Figure 4). Like the preceding nerve, it lies quite close to the vertebral body as it proceeds caudally to cross alongside the promontory of the sacrum on which there is a deep notch in which the nerve lies. It is at this point that the contributions from the preceding nerves join it. As it approaches the caudal end of the first segment of the sacrum, it is joined by the ventral branch of the first sacral spinal nerve, forming a flattened trunk which is joined later by a small contribution from the ventral branch of the second sacral spinal nerve. It is one of the main cores of the Nn. ischiadicus and glutaei, and is seldom a contributor to the Nn. femoralis and obturatorius.

In some cases, the sixth lumbar and first sacral spinal nerves show some interchange of fibers in forming the Nn. ischiadicus and glutaei (Figure 5: 15, 16).

The first sacral spinal nerve (S₁)

The ventral branch of the first sacral spinal nerve is most commonly the central core of the N. ischiadicus, although in some cases many of the first sacral fibers go into the formation of the Nn. glutaeus cranialis et caudalis, pudendus and pelvinus (See Table 1, which shows how the various peripheral nerves derive their fibers).

The ventral branch of the first sacral spinal nerve leaves the vertebral canal through the first ventral sacral foramen, as a conspicuously large cord. It is directed caudolaterally along the ventral surface of the respective vertebra. At the mediocaudal border of the wing of the sacrum opposite to the greater sciatic foramen the first sacral receives the ventral branch of the last lumbar nerve, which already includes fibers from the ventral branches of the preceding two, or at least one, lumbar spinal nerves. Here it also joines the ventral branch of the second sacral spinal nerve, blending to produce a sort of plexus which gives rise to the N. ischiadicus and Nn. glutaei. The internal iliac vessels run on the ventral aspect of these nerve roots, as they all course towards the foramen ischiadicum majus.

The contribution from the second sacral nerve to the first one appears to be given away almost wholly from the N. ischiadicus to the N. pudendus, joining the latter at the

F. ischiadicum minus, this being done through a constant com-
municating branch between the N. ischiadicus and N. pudendus
(Figure 1: 16, 5: 19). This communicating branch was found
in all of the specimens examined.

The second sacral spinal nerve (S_2)

The ventral branch of the second sacral spinal nerve
emerges through the ventral foramen of the sacrum between the
second and third sacral segments. It divides at its exit
into two branches, one of which, usually the larger, joins
the ventral branch of the first sacral spinal nerve, apparent-
ly to form the N. ischiadicus; but closer examination shows
it sending some fibers to the Nn. glutaei and N. pudendus.
The second branch subdivides into two, and sometimes more,
branches; one of these joins with a branch from either the
first or third sacral spinal nerve, in the formation of the
N. splanchnicus pelvinus which participates in the formation
of the Plexus pelvinus. The other branches commonly join
the ventral branch of the third sacral spinal nerve to form
the N. pudendus or by-pass it as the N. cutaneus femoris
caudalis, or as part of the nerve to the M. coccygeus
(Figures 1: 17; 2: 11, 12, 13; 3: 13, 15; 11: 4, 5; Plate
1: 12, 13).

In one case, the S_2 spinal nerve had contributed the
larger root to the N. pudendus, and in eight cases its con-
tribution to that nerve was the same size as the contribution

from the S_3 spinal nerve.

The third sacral spinal nerve (S_3)

The ventral branch of the third sacral spinal nerve is much reduced in size in comparison to the preceding sacral branches. It emerges from the sacral canal in the corresponding ventral foramen between the third and fourth sacral segments. It showed itself to be the outstanding root of the N. pudendus in two-fifths of the cases, and equal in size to the S_2 spinal nerve root in slightly more than half of the cases, about 54 percent, whereas in one case out of fifteen examined it was negligibly small. In a few cases the S_3 spinal nerve sent a twig to join the fourth sacral spinal nerve, and a little less frequently the fourth sacral spinal nerve appeared to have contributed a branch that joined the S_3 spinal nerve (Figures 3, 4, 12, 16, 17). In some cases the nerve to the M. coccygeus sprang from the S_3 spinal nerve as the latter had just emerged from the sacral canal, but mostly, it was given off from the N. pudendus after all contributions had merged (Figure 22: 8, 15; Plate 12). Cases were noted, in which fibers from the S_3 and S_2 nerves coursed together as the N. cutaneus femoris caudalis through the sacro-sciatic attachment of the M. biceps femoris and M. semitendinosus.

As has already been indicated above for the S_2 spinal

nerve, the S_3 spinal nerve contributes a branch to the N. splanchnicus pelvinus.

The fourth sacral spinal nerve (S_4)

The ventral branch of the fourth sacral spinal nerve emerges through the intervertebral foramen between the sacrum and the first coccygeal vertebra. It is the smallest of the ventral branches of the sacral spinal nerves. In most cases this nerve, after detaching a twig to the M. sacrococcygeus ventralis, runs caudally and ends by innervating the M. sphincter ani externus, M. levator ani and the anal skin. In three specimens it sent a small branch which joined the S_3 to form the N. pudendus. One other mode of dispostion of this nerve is that it receives a branch from the N. pudendus, and the trunk so formed goes to innervate the Mm. sphincter ani externus, levator ani, and the anal skin. Still another form of distribution of this nerve is that it sent off a branch which joined the Nn. spinales coccygei with which it was distributed to the muscles of the tail (Figures 1: 19; 2: 14; 3: 16; 4: 11; 5: 25; 11: 7; 12: 18; Plate 1: 15).

The coccygeal spinal nerves (C_y)

The ventral coccygeal spinal nerves were observed to vary from four to six pairs. They emerged through the intervertebral foramina distal to each of the first four or six coccygeal vertebrae. They joined in the formation of the

coccygeal nerve trunks alongside the ventral tubercles of the coccygeal bodies, being covered by the Mm. sacrococcygeus ventralis medialis et lateralis. They innervated these muscles as well as the Mm. intertransversarii ventralis et dorsalis caudae. The first pair often received a branch from the S_4 spinal nerve, and it was observed in one of the specimens to have detached a small branch to join that nerve of the S_4 which innervated the Mm. sphincter ani externus, levator ani, and the anal skin.

At each coccygeal segment there was a branch passing dorsally to join a corresponding branch from the dorsal coccygeal nerve trunk.

The Lumbosacral plexus (Plexus lumbosacralis)

In light of the above observations, it seems evident that the first four ventral branches of the lumbar nerves are most responsible for the innervation of the operational area in the flank, although in some cases the fourth nerve may be limited to the thigh region.

The lumbosacral plexus has been observed as being formed by the ventral branches of the last four lumbar spinal nerves and the first three sacral spinal nerves, and in rare cases include the fourth sacral nerve.

As was noted above on the individual nerves furnishing communicating branches to their successive neighbors in the initial stages of their courses, one is inclined to say that

all of the lumbar and sacral spinal nerves join in the for-
mation of the lumbosacral plexus. But as the plexus in
question is taken to comprise the nerves which have the di-
rect responsibility of innervating the structures of the
pelvic limb, then the first statement furnishes the accent
to the lumbosacral plexus.

It was noted in 8 out of 15 specimens that the ventral
branch of the L_3 spinal nerve detached a branch which
bridged over the medial aspect of the L_4 spinal nerve and
continued into the N. obturatorius, and thus this latter nerve
is included in the formation of the lumbosacral plexus
(Figures 4: 5; 16: 7).

As mentioned previously, Reimers (1913) described the
lumbar and sacral plexuses independently. Ellenberger and
Baum (1943) state that the lumbosacral plexus is formed by
the last three lumbar and first two sacral nerves, while
Sisson and Grossman (1953) do not include the second sacral,
but agree with Ellenberger and Baum on the lumbar roots.
Chauveau and Arloing (1902), on the other hand, take into
consideration the last two lumbar and first two sacral nerves,
but included the last lumbar root as a sacral one.

Nerves Emanating from the Lumbosacral Plexus
and Those Preceding it

The first two lumbar nerves are included with the nerves
which precede those forming the lumbosacral plexus. These

nerves are considered as not taking part in the lumbosacral plexus, although indirectly they do so through the medium of their inconstant communication with each other and with the succeeding nerves. Their courses and branches have been described already. It is now appropriate to consider them as named entities.

N. iliohypogastricus

The ventral branch of the first lumbar spinal nerve (L_1) is the N. iliohypogastricus. But when there are seven lumbar nerves, as recorded in the existing textbooks (Ellenberger and Baum, 1943; and Reimers, 1913), the first lumbar nerve takes the name N. iliohypogastricus cranialis, as is also recorded for the dog (Miller, Christensen and Evans, 1964) and for the cat and rabbit (Langley and Anderson, 1895).

In the present investigation, a case was encountered in which the number of lumbar spinal nerves had been reduced to five pairs. This meant that the N. iliohypogastricus was missing anatomically, but functionally the last pair of thoracic nerves was found to be distributed in exactly the same way as the N. iliohypogastricus of the specimens which had six pairs of lumbar nerves (Figure 4: Th). Reimers (1913) noted that the reduction from seven to six pairs of lumbar spinal nerves, and the thoracic spinal nerve increasing the series in the thoracic region was termed the N. thoracalis accessorius.

N. ilioinguinalis

The ventral branch of the L_2 spinal nerve, is the N.

ilioinguinalis. In most cases, it was seen to divide and sub-
divide making up to four branches which innervated the abdomi-
nal muscles as well as the fascia in the inguinal region and
skin of the flank, mammary glands and prepuce.

In two of the examined specimens, it formed a sizeable
contribution to the N. genitalis (N. spermaticus externus)
(Figure 4: 2 and 5). But one of these was the specimen in
which the lumbar spinal nerves had been reduced to five pairs.
In several cases, one of its branches joined with a branch
given off by the L_3 spinal nerve to form, what appears to be,
a special nerve running along the lateral border of the M.
psoas major and entering either the M. obliquus internus or
the M. cremaster externus or dividing to innervate the two
muscles at the same time (Figures 17: 2; 19: 3; 21: 3).

The two foregoing lumbar spinal nerves are the main
nerves which supply the abdominal wall, especially the area
caudal to the umbilicus and craniomedial to the thigh. It
is in this area also that the N. genitalis and the N. cutaneus
femoris lateralis join in.

The nerves considered to arise from the lumbosacral
plexus are: the N. genitalis (N. spermaticus externus), N.
cutaneus femoris lateralis, N. femoralis, N. obturatorius,
N. glutaeus cranialis, N. glutaeus caudalis, N. ischiadicus,
N. cutaneus femoris caudalis, N. splanchnicus pelvinus, N.
pudendus, N. rectalis caudalis (N. haemorrhoidalis caudalis),

and, indirectly, the Nn. perineales profundus et superficialis, N. rectalis mediús, Nn. scotalis caudalis et medius, N. labialis, N. dorsalis penis, and N. clitoridis. All of the indirect group have a tendency to be branches of the N. pudendus, and are therefore furnished somewhat by roots similar to those which give rise to the N. pudendus.

N. genitalis (N. spermaticus externus)

The N. genitalis arises most of the time from the ventral branch of the L_3 spinal nerve, being reinforced by a twig from the ventral branch of the L_2 spinal nerve in a few cases, and most constantly by a contribution from the ventral branch of the L_4 spinal nerve. In the specimens examined, the frequency of its deriving roots as mentioned above was as follows: In one case it was formed by the ventral branches of the L_2 and L_3 spinal nerves; in two cases it was formed by the ventral branches of the L_2, L_3 and L_4 spinal nerves; in twelve cases it was formed by the ventral branches of the L_3 and L_4 spinal nerves. In all cases, except the one in which it was formed by the L_2 and L_3 spinal nerve, the largest contribution was from the ventral branch of the L_3 spinal nerve. In the exception given the ventral branch of the L_2 spinal nerve was the main root, and that of the L_3 nerve was just contributory (Figures 1, 2, 3, 4).

The N. genitalis courses between the sublumbar muscles, Mm. psoas major et minor, from which it emerges at the caudal

third of them, about the level of the fifth lumbar vertebra.
In this position it is related to the N. cutaneus femoris
lateralis which lies caudal to it between the two muscles.
While inside the substance of these muscles it detaches a
small branch to the N. cutaneus femoris lateralis, on
emerging out of the muscles it detaches another branch to the
same nerve, and it also receives a branch from the N. cutaneus
femoris lateralis. At this point, or before, it divides into
two branches, both of which cross over the medial aspect of
the N. cutaneus femoris lateralis, but separate to enclose the
deep circumflex vessels after which they may join up again,
and, subdividing into four branches, one of which innervates
the M. cremaster externus. The second branch may terminate
in the tendon of insertion of the M. rectus abdominis in
the female, and in the male continues into the tunica
vaginalis and scrotal fascia. Of the remaining two branches,
one innervates the M. obliquus internus abdominis, while the
other continues as the N. inguinalis in the inguinal canal
to ramify in the inguinal region innervating the superficial
inguinal lymph node, mammary gland in the female, and M.
praeputialis caudalis and the prepuce in the male (Figures 1:
9, 9', 9", 9"'; 2: 1, 3, 4; 3: 5,7,8; 4: 2; 5: 4). While
crossing the region of the inguinal lymph node the branches
of this nerve penetrate the body of the lymph node to appear
as if they were its lymph vessels.

N. cutaneus femoris lateralis

This nerve had similar origins as the preceding, but its main root was the ventral branch of the L_4 spinal nerve, except in that specimen in which the lumbar nerves had been reduced to five pairs, in which case the L_3 spinal nerve took the lead, and was supported by the L_2 spinal nerve only. So the distribution was as follows: In one specimen this nerve was formed by the ventral branches of the L_2 and L_3 spinal nerves; in one specimen it was formed by the L_2, L_3, and L_4 nerves; in the rest of the specimens this nerve was formed by the L_3 and L_4 spinal nerves. The course of the N. cutaneus femoris lateralis is at first parallel to that of the N. genitalis in that they both lie in the interstices of the Mm. psoas major et minor where it receives the contribution from the N. genitalis and emerges from the muscle a little caudal to the preceding nerve. On leaving the muscle the N. cutaneus femoris lateralis receives another contributory branch from the N. genitalis, passes lateral to it and bends sharply ventrally and laterally at the level of the tuber coxae, penetrates the coxal attachment of the M. obliquus internus abdominis, or between it and the M. iliacus, and gains the medial surface of the M. tensor fasciae latae, under which it descends, together with the descending branch of the deep circumflex iliac artery. It divided into two branches, then subdivided to produce four branches which were distributed

as previously described (Figures 1: 6, 6'; 12: 5; Plates 1 and 8). However, two of the branches course cranial to the thigh region as they continue downwards, gain its lateral aspect and reach the leg just below the stifle. The other two branches bear a course towards the inguinal region and also send branches cranially in the fold of the flank, being interspersed with the terminal branches of the deep circumflex artery. They innervate the subiliac lymph nodes in addition to the skin of the area.

N. femoralis

The N. femoralis arises from several roots as will be shown by the following recordings: In one case, in which the lumbar spinal nerves were reduced to five pairs only, it was found to arise from the ventral branches of the L_3 and L_4 spinal nerves; in seven cases it was formed by the ventral branches of the L_3, L_4 and L_5 spinal nerves; in four cases it was formed by the ventral branches of the L_4 and L_5 spinal nerves; and in three cases it was formed by the ventral branches of the L_4, L_5 and L_6 spinal nerves. In all, except one case, it had the L_5 spinal nerve as its main root. In the exception indicated the L_4 spinal nerve was the main root. In the three cases in which the L_6 spinal nerve took part in the formations of this nerve, only a very small twig was found in each case.

The nerve takes an oblique course as it leaves the body

of the sixth lumbar vertebra running laterally, and caudo-
ventrally, at first being covered by the M. psoas major on
its ventral aspect, later by the M. iliacus in which the nerve
becomes deeply buried until it leaves the muscle about the
middle of the shaft of the ilium where the nerve crosses over
the lateral aspect of the inguinal ligament. Here it lies at
the caudal border of the origin of the M. rectus femoris,
medial to the origin of the M. vastus medialis and lateral to
that of the M. sartorius. Along this course, extending from
the cranial end of the sacrum, the course of the N. femoralis
is parallel to that of the external iliac vessels on its
medial aspect, although the nerve is inside the above-
mentioned muscles. Just before dipping in between the Mm.
sartorius, vastus medialis and rectus femoris, the N.
femoralis detaches the N. saphenus. The latter nerve descends
on the medial surface of the M. vastus medialis under cover
of the M. sartorius and emerges from the muscles at the mid-
dle third of the thigh. The N. saphenus gives off a branch
to the M. sartorius at its proximal end, but in some cases
this nerve branch arises directly from the N. femoralis,
although in one case it was also found to receive innervation
from the N. obturatorius before the latter nerve bent into the
obturator foramen. The course of the N. saphenus now lies
between the Mm. sartorius and vastus medialis, and it begins
to divide into radiating branches, innervating the skin on

the medial aspect of the stifle region and the leg. The N. saphenus, in one case, was seen to form a sort of plexus on the A. saphenus while still under cover of the M. sartorius.

The N. femoralis, on entering into the space between the Mm. rectus femoris and vastus medialis, immediately divides into branches which innervate these muscles as well as the other muscles of the quadratus group. In its proximal part, it gives off about four to six muscular branches to the M. Psoas minor and M. iliopsoas.

N. obturatorius

This nerve has almost exactly the same roots of origin as the N. femoralis, as the following figures will show: In one case it was formed by the ventral branches of the L_3 and L_4 spinal nerves; in six cases it was formed by the ventral branches of the L_3, L_4 and L_5 spinal nerves; in one case it was formed by the ventral branches of the L_3, L_4 L_5 and L_6 spinal nerves; in two cases it was formed by the ventral branches of the L_4 and L_5 spinal nerves; and in five cases it was formed by the ventral branches of the L_4, L_5 and L_6 spinal nerves. It was the ventral branches of the L_4 and L_5 nerves which formed the outstanding contributions to the N. obturatorius, the other roots giving only small twigs to it. It was in the specimen with a reduced number of lumbar nerves that the L_3 spinal nerve added a large branch to the N.

obturatorius. Just as the N. femoralis was covered by the
M. psoas major and M. psoas minor so also was the N. ob-
turatorius, but the latter nerve has a course almost hori-
zontal as it passes caudally and leaves the named muscles at
the cranial end of the shaft of the ilium and lies dorsal to
the tendon of insertion of the M. psoas minor. In the mid-
dle part of the shaft of the ilium it lies close to the bone
until it enters the M. obturatorius internus to which it
detaches two branches, or one branch which run in the same
direction as the main nerve, appearing on the pelvic surface
of the muscle. The parent trunk sinks into the M. obturatorius
internus about the level of the pubic bone, and bonds ventrally
into the obturator foramen at its cranial border, and immedi-
ately divides into several branches which innervate the Mm.
obturator externus, pectineus, gracilis and adductor. As has
been mentioned before this nerve was observed in one case to
give off a small branch to the M. sartorius before it crossed
over the pubis.

N. glutaeus cranialis

This is one of the nerves whose fibers of origin are so
intertwined with those of the N. ischiadicus and N. glutaeus
caudalis that the roots given from the standpoint of a gross
study may not be correct and should be verified by electrical
stimulation. However, separation was tried as much as was

practicable, and the following roots recorded: In one case it was found to arise from the ventral branches of the L_3, L_4, L_5, S_1 and S_2 spinal nerves; in one case it was from the L_4, L_5, L_6, and S_1 spinal nerves; in nine cases it arose from the L_5, L_6 and S_1 spinal nerves; and in four cases it was made up of the ventral branches of the L_5, L_6, S_1 and S_2 spinal nerves. In the specimen which had five pairs of lumbar nerves the L_3 spinal nerve participated in the formation of the N. glutaeus cranialis. The N. glutaeus cranialis does not emerge as an entity, but as part of a single plexus of which the N. ischiadicus is the most outstanding nerve arising from the plexus opposite to the greater sciatic foramen. The N. glutaeus cranialis leaves the cranioventral border of the above plexus as a very stout nerve for about 1 cm. or less, and soon divides in a radiating manner to innervate the Mm. -glutaeus profundus, glutaeus medius, glutaeus superficialis, and tensor fasciae latae. The nerve of the M. glutaeus pro- fundus runs almost horizontally along the eorsolateral sur- face of the muscle parallel to the lateral border of the N. ischiadicus and appears to be given off by the latter nerve (Figure 12: 7). The nerve to the M. tensor fasciae latae passes either between the ilium bone and the M. glutaeus profundus or between that muscle and the M. glutaeus medius pars accessorius, and reaches the M. tensor fascise latae (Figure 15: 10; Plate 9).

N. glutaeus caudalis

This nerve is one whose fibers are in a sort of common weave with the preceding nerve and the N. ischiadicus. In fact, it could be described as a branch of the N. ischiadicus. Nevertheless, tracing the fibers which constitute the N. glutaeus caudalis the following roots were observed: In one case it was formed by the ventral branches of the L_3, L_4, L_5 S_1 and S_2 spinal nerves (Specimen no. 4); in one case it was formed by the ventral branches of the L_5, L_6 and S_1 spinal nerves (Specimen no. 9, Figure 12); in ten cases it was formed by the ventral branches of the L_5, L_6, S_1 and S_2 spinal nerves; and in three cases the nerve was formed by the ventral branches of the L_6, S_1 and S_2 spinal nerves.

The N. glutaeus caudalis is separated from the previously mentioned plexus in various ways. In most cases this occurs by means of two strands which appear to be detached from the N. ischiadicus before the latter gives off a communicating branch to the N. pudendus (Figures 2: 9; 3: 24; 10: 2). Less frequently, the N. glutaeus caudalis parts with the said communicating branch (Figure 12: 9) and in some cases it has a branch preceding the communicating one, and another branch after it (Figure 15: 3). In other cases, it may run as one trunk with the N. cutaneus femoris caudalis, the two nerves separating in the region of the tuber ischii -- the N. glutaeus caudalis entering the Mm. semitendinosus and biceps

femoris, and the N. cutaneus femoris caudalis penetrating between these two muscles and innervating the skin above their proximal attachment towards the buttocks (Plate 1: 10).

N. ischiadicus

This is the largest of the nerves lying in the gluteal region. It forms a flat band over the femoral part of the M. glutaeus profundus and traverses caudally over the Mm. gemelli, quadratus femoris, and adductor. It separates into its two terminal branches, the N. tibialis and N. fibularis, about the middle of the thigh.

The N. ischiadicus derived its fibers in the following manner: in one case the nerve was formed by the ventral branches of the L_3, L_4, L_5, S_1 and S_2 spinal nerves, and in eleven cases it was formed by the ventral branches of the L_5, L_6, S_1 and S_2 spinal nerves. In the cases where the origin of this nerve included the L_3 spinal nerve, the lumbar spinal nerves were reduced to five pairs only in one case, and in the other case the L_3 spinal nerve had bridged so much onto the succeeding lumbar nerves that it might have fibers crossing together with the ones credibly forming the N. ischiadicus.

After the branches converge, about the caudal end of the first segment of the sacrum (including those fibers which form the N. glutaeus cranialis and N. glutaeus caudalis) they

head caudolaterally and ventrally to gain the greater sciatic foramen, where the K. glutaeus cranialis separates from the trunk (in some cases, one of the two, or sometimes three, components of the N. glutaeus caudalis, separates here also). The main N. ischiadicus continues as a flat band on the surface of the M. glutaeus profundus, courses over the Mm. gamelli and then over the M. quadratus femoris as it bends ventrally at the medial aspect of the trochanter major.

In addition to parting with the Nn. glutaci, it gives off the following branches in succession: 1. A constant communicating branch is given off to the N. pudendus at the caudal limit of the greater sciatic foramen and runs along the dorsal border of the M. glutaeus profundus, gaining entrance between the A. and V. iliacs interna -- the artery being on its dorsal aspect and the vein ventral. The branch thus reaches the lesser sciatic foramen where it joins the N. pudendus. This branch has been found to alternate with that of the N. glutaeus caudalis as described previously. 2. At the level of the trochanter major it gives off a large branch which supplies the proximal parts of the M. biceps femoris and semitendinosus. 3. Sometimes, also, the N. cutaneus femoris caudalis takes origin here to supply the skin just above the proximal attachment of the Mm. biceps femoris by passing between them. 4. At the ventral aspect of the main nerve branches are given off to innervate the Mm. gemelli and M. quadratus femoris. 5. Slightly lower down on the

thigh a large muscular branch is given off to innervate the
Mm. biceps femoris (middle part), semitendinosus, semi-
membranosus, pectineus and adductor. 6. A branch is given
off to innervate the distal part of the M. biceps femoris.
This branch has a sizeable twig which penetrates the center
of the muscle and innervates the skin on the lateral aspect
of the thigh near the distal attachment of the M. biceps
femoris.

After all branches to the muscles in the thigh region
have been given off, the parent trunk of the N. ischiadicus
terminates by dividing into the N. tibialis and N. fibularis
(N. peroneus). The entire course of these latter nerves is
beyond the scope of this present investigation, but their
locations in the thigh are given below.

In the undisturbed state, the parent nerve terminates
in the middle of the thigh. The apparent commencement of
the two terminal branches of the N. ischiadicus appears to be
at the junction of the middle and distal thirds of the thigh,
which is marked by the caudal curvature of the M. gastro-
cnemius, the lateral head of which wedges between the two
nerves. But cleaning of the area shows the branching to
commence even higher up at the proximal end of the thigh, at
the level of the hip joint or even above it. The N. tibialis
lies more medial and somewhat caudal while the N. fibularis
lies craniolateral in position. The N. tibialis descends and
dips in between the two heads of the M. gastrocnemius and

continues its course in the leg. The N. fibularis courses on the lateral aspect of the proximal part of the lateral head of the M. gastrocnemius in a line approximately parallel with the femur when the animal is standing, so as to lie obliquely as it crosses the M. gastrocnemius. The nerve dips between the M. gastrocnemius and the M. soleus to gain the cranial surface of the leg, where it continues its course. At this point the nerve is about a hand breadth distal to the stifle joint.

Just at the point of separation of the Nn. tibialis and fibularis, two, and rarely three, branches arise. The third rarer one, usually given off by the N. fibularis, passes laterally and pierces the distal end of the M. biceps and ends in the skin on the lateral aspect of the leg. One of the more common branches receives a large twig from the N. tibialis and a smaller one from the N. fibularis, follows a course directly caudad, being accompanied by the A. and V. femoris caudalis in the space between the Mm. biceps femoris and semitendinosus, and innervates the skin at the caudal aspect of the leg as the N. cutaneus surae caudalis (medialis). The other of the common branches receives a large contribution from the N. fibularis and only a small contribution from the N. tibialis, and runs along the caudal border of the lateral head of the M. gastrocnemius under cover of the M. biceps femoris, penetrating the aponeurotic attachment of the latter muscle to end in the skin of the caudolateral aspect

of the leg as the N. cutaneus surae caudalis lateralis
(Figure 14 and 15: 8 and Plate 1: 21 and 8 Top).

N. aplanchnicus pelvinus

This is a nerve belonging to the sacral outflow of the
parasympathetic part of the autonomic nervous system. In
the present examination it arose in the following manner:
In three cases it was formed by the ventral branches of the
S_1 and S_2 spinal nerves; and in twelve cases it arose from
the ventral branches of the S_2 and S_3 spinalnnerves. At its
beginning it is under cover of the M. sacrococcygeus ventra-
lis lateralis. Its course and distribution are described
under the autonomic nervous system.

N. pudendus

This is a nerve which derives its fibers from all of the
ventral branches of the sacral region, even though it does
not do so at all times and in all specimens. It was found
to do this in the following manner: In one case it was
formed by the ventral branches of the S_1, S_2 and S_3 spinal
nerves, in eleven cases it was formed by the ventral branches
of the S_2 and S_3 spinal nerves, and in three cases it was
formed by the ventral branches of the S_2, S_3 and S_4 spinal
nerves. In eight specimens, the S_2 and S_3 spinal nerves
contributed equally to the nerve; in six cases only the S_3
spinal nerve had a major contribution, while in one case the

S_2 spinal nerve contributed almost all the fibers to this
nerve (Specimen no. 9, Figure 13: 11).

The N. pudendus, after the joining of its roots, lies on
the deep face of the sacrospinotuberal ligament, being
covered by the M. obturator internus. The nerve enters the
texture of the ligament and traverses in it for a short dis-
tance, leaving it near the lesser sciatic foramen. Here it
is joined by a communicating branch from the N. ischiadicus.
The trunk thus formed divides into four branches, two smaller,
and two larger ones. Sometimes, the nerve divides into two
equal branches which subdivide into two each or, in some
cases into smaller branches, which ultimately end in various
nerves innervating the structures in the perineum, including
the mammary gland in the female, and scrotum in the male.
Inside the pelvis it detaches a branch to the M. occygeus.
This branch may run at the edge of the M. sacrococcygeus
ventralis or in its substance, until it reaches its des-
tination. Another branch given off inside the pelvis is one
of the branches belonging to the N. cutaneus femoris caudalis,
whose fibers come from either the S_1, S_2 or S_3 spinal nerves,
which join to form one nerve, or run in separately, inside
the sacrospinotuberal ligament, only to leave the ligament,
passing out between the Mm. biceps femoris and semitendinosus
to innervate the skin above their proximal attachment. In some
cases, these branches come off from the N. pudendus near the

communication from the N. ischiadicus at the lesser sciatic foramen. In rarer cases, the N. cutaneus femoris caudalis came off from the N. pudendus after receiving the communication from the N. ischiadicus, or came from the branch itself. This was found in those cases in which the N. glutaeus caudalis also contained fibers which included those which innervated the part of the skin normally innervated by the N. cutaneus femoris caudalis.

The following nerves from the conjoined trunk at the lesser sciatic foramen arise in turn. N. perinealis superficialis, N. perinealis profundus, N. dorsalis penis, N. clitoridia, N. mammarius caudalis or N. scrotalis caudalis, depending on the sex of the individual, and the N. labialis.

The N. perinealis superficialis leaves the parent nerve at the lesser sciatic foramen and follows along the medial aspect of the tuber ischii, passing through the attachment of the sacrospinotuberal ligament at this point, and gains the ischioanal fossa, where it divides into two branches, one of which, the N. labialis, courses to the anal aspect ending in the skin (Figure 10: 7 and 8). The other branch, the N. scrotalis caudalis, bears more to the limb aspect arborizing in the skin caudal to the M. semimembranosus and partly in the lateral part of the scrotum, or of the vulva (Figure 12: 17).

The N. perinealis profundus may arise from the same trunk with the N. perinealis superficialis, from which it

separates to innervate the striated muscles of the perineum
(M. sphincter ani externus, M. levator ani, M. constrictor
vulvae, M. ischiocavernosus, and M. bulbocavernosus). These
muscles may also receive separate branches from the continu-
ing trunk of the N. pudendus, but all are included in the
name N. perinealis profundus. A branch always coursed from
the N. pudendus in a cranial direction in both sexes, and
supplied the M. urethralis and M. constrictor vaginae
(vestibuli). In many cases this branch continued towards and
appeared to take part in the formation of the pelvic plexus.
The course of this branch is along the urogenital tract (Figure
2: 20; 5: 20; 18: 16).

The N. pudendus continues its course inclining to the
ischial arch, the right and left nerves being close together in
the midline, but separated by an elastic sheet of fascia which
fixes the penis in this region. The nerves pass on either side
of the urethra, at the bend it makes at the ischial arch and
each gains the dorsal surface of the root of the penis as the
N. dorsalis penis, until the dorsal bend of the sigmoid flex-
ure where they both incline to one side (Figure 13: 14, Plate
8 Bottom). From here it is interesting to note that each
nerve takes a course which is no longer dorsal. Shortly
after crossing the sigmoid flexure, each nerve divides into
two branches which wind themselves onto the body of the
penis as they proceed towards its preputial end. The course
of the nerves is spiral following the general spiral

nature of the body of the penis.

Each nerve gives off two branches near the ischial arch. One of these branches enters the M. ischiocavernosus, while the other one descends by the side of the sigmoid flexure and gains the interscrotal fascia onto which it spreads out as the N. scrotalis medius (Figure 13: 13 and Plate 8: 5 Bottom). Near the sigmoid flexure, the N. dorsalis penis gives off a branch which subdivides to innervate the fascia enveloping the penis and the distal part of the M. retractor penis (Figure 13: 16; 18: 20).

In the female, the N. pudendus terminates near the ischial arch by dividing into two branches, the N. clitoridis and the N. mammarius caudalis. The N. clitoridis is directed somewhat horizontally and caudad from the ischial arch and follows the ventral aspect of the body of the clitoris (Figure 11: 12). From this branch a twig is given off to the fascial covering of the clitoris and, in some cases, more twigs even reach the skin of the vulva (Figure 5: 29; 3: 12).

During its course the N. mammarius caudalis detaches approximately three branches which innervate the skin commencing at the ventral part of the vulva while the remaining portion of the nerve continues to the inguinal mammary glands which it innervates, hence the name.

N. rectalis caudalis

While discussing the nerves of the perineum it is appropriate to mention the N. rectalis caudalis (N. haemor-

rhoidalis caudalis). This nerve arises, in most cases, from the ventral branch of the S_4 spinal nerve. In only three cases was the S_4 observed to communicate with the S_3 spinal nerve in the formation of the N. pudendus. The N. rectalis caudalis passes caudally, being covered by the M. sacro-coccygeus ventralis, and ends in the M. sphincter ani externus and M. levator ani. In some cases a branch, the N. rectalis medius, of the N. pudendus detaches a branch which joins the N. rectalis caudalis, while in other cases the nerve passes to the same area innervated by the N. rectalis caudalis, or it may be missing as such (Figure 12: 18 and 19).

N. cutaneus femoris caudalis

This nerve has various origins, as follows: In one case it was formed by the ventral branches of the S_1 and S_2 spinal nerves; in three cases it was formed by the ventral branches of the S_1, S_2 and S_3 spinal nerves; in five cases it arose from the ventral branch of the S_2 spinal nerve, and in six cases it was formed by the ventral branches of the S_2 and S_3 spinal nerves.

In some cases, the fibers which constitute this nerve ran separately as they crossed the proximal part of the N. pudendus and entered the texture of the sacrospinotuberal ligament. They left the latter under the proximal attachment of the Mm. biceps femoris and semitendinosus between which

they emerged to supply the skin above these muscles. In
other cases, the fibers joined the N. pudendus, descending
with it in the ligament for a short distance after which they
left as a single nerve, or in a succession of two or three
branches which proceded caudally to their destination as
indicated above. This state of the N. cutaneus femoris
caudalis occurs before the N. pudendus has received the com-
municating branch from the N. ischiadicus. In yet another
form of its origin it was found to divert its direction
laterally and penetrate the ligament before reaching the N.
pudendus (Figures 10 and 11: 4). In the rarest cases, the
N. glutaeus caudalis arose, together with some fibers which
were detached from it at the ischial tuberosity, to inner-
vate the same structures described to be supplied by the
N. cutaneus femoris caudalus (Plate 1: 10).

The Origin of the Lumbosacral Nerves from the Spinal Cord

As was stated in the section on materials and methods,
the fifth specimen, a 6-1/2 year old sow, with 16 ribs,
landrace breed, weighing 529 lbs. was examined mainly to
determine the origin of the Nn. lumbales et sacrales from
the spinal cord in relation to the vertebral bodies and
intervertebral foramina. There were sixteen thoracic spinal
nerves the last of which came out at the caudal end of the
last thoracic vertebra.

There were six lumbar vertebrae and six Nn. spinales

lumbales. After removing the muscles from the vertebral
column dorsally, the vertebral arches were sawed and removed
to expose the spinal cord. Observations were made before
and after removal of the dura mater.(Plate 3).

Before the removal of the dura mater

1. The last pair of thoracic nerves and first pair of
Nn. spinales lumbales, left the cord almost opposite to the
intervertebral foramina but at the caudal third of the bodies
of their respective vertebrae.

2. The second and third pair of Nn. spinales lumbales
left the spinal cord slightly more cranial to the cranial
border of the intervertebral foramen and all were in the
middle of their corresponding vertebrae.

3. The fourth and fifth pairs of Nn. spinales lumbales
left the spinal cord in the cranial third of the length of
their respective vertebrae.

4. The sixth pair, however, left the spinal cord at
the junction of the fifth and sixth lumbar vertebrae and
travelled the whole length of the sixth lumbar vertebra to
its exit at the junction of the sixth lumbar vertebra and
the sacrum.

5. The first pair of Nn. spinales sacrales left the
spinal cord at the cranial third of the sixth lumbar
vertebra.

The second pair of Nn. spinales sacrales left the spinal

cord at the middle of the sixth lumbar vertebra.

The third pair of Nn. spinales sacrales left the spinal cord at the junction of the sixth lumbar vertebra and the sacrum.

The fourth pair of Nn. spinales sacrales and all the Nn. coccygei leveled their origin from the spinal cord, within the first segment of the sacrum, but the Nn. coccygei were still matted together as they continued their course caudally to reach their respective exits.

The ganglia of the dorsal root of the spinal nerves

The spinal ganglia for the last thoracic and all the Nn. spinales lumbales and first pair of Nn. spinales sacrales were situated just at the inner edge of their respective intervertebral foramina.

The second sacral spinal ganglia were opposite to the caudal edge of the second ventral sacral foramina.

The fourth pair of sacral and all the coccygeal spinal ganglia were situated at the same level in the middle of the length of the second sacral vertebra.

After the removal of the dura mater from the spinal cord

The last thoracic and the first two lumbar nerve roots were spread more cranially than their extradural origins by 1-1/4 cm.

The roots of the third pair of Nn. spinales lumbales spread over the whole length of the portion of the vertebra

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between the cranial border of their respective intervertebral foramins of exit and the cranial end of the body of their respective vertebra. The spread was more in the ventral root than in the dorsal root.

The fourth pair of Nn. spinales lumbales had its component roots extending craniad from a transverse plane passing through the middle of the transverse process of the fourth lumbar vertebra to the caudal fifth of the third lumbar vertebra.

The fifth pair of Nn. spinales lumbales had its roots occupying the whole of the middle third of the fourth lumbar vertebra, and its ventral roots were spreading 1-1/2 cm. while the dorsal ones spread for 3/4 cm. The ventral roots ended where those of the preceding pair commenced.

The roots of the sixth pair of Nn. spinales lumbales occupied the caudal third of the fourth lumbar vertebra and a cranial eightth of the fifth lumbar vertebra.

The roots of the first paid of Nn. spinales sacrales followed on immediately to occupy the succeeding one-eighth of the fifth lumbar vertebra.

The roots of the second pair of Nn. spinales sacrales through all the roots of Nn. spinales coccygei left the spinal cord immediately caudal to the roots of the first pair of the Nn. spinales sacrales in the caudal half of the fifth vertebra at evenly spaced intervals, and ended in the middle of the sixth lumbar vertebra.

From the above observation it was found that the various segments of the spinal cord for lumbar, sacral and coccygeal nerves extend from the middle of the first lumbar vertebra to the middle of the sixth lumbar vertebra. The lumbar segments end in the cranial eighth of the fifth lumbar vertebra, while the sacral and coccygeal begin here and end in the middle of the sixth lumbar vertebra.

Disposition of the Dorsal Branches of the Lumbar and Sacral Spinal Nerves

The dorsal branches of the Nn. spinales lumbales

The disposition of the dorsal branches of the Nn. spinales lumbales et sacrales were closely examined on specimen no. 7, female (Figure 6: L_1-L_6), and a general account of them is given as it may add to the understanding of certain occurrences in innervation.

These branches were generally smaller than the ventral branches, but in some cases they attained sizes which although not making them appear larger in bulk than the ventral ones, reflected that the ventral branches looked reduced much more than they normally were.

As the whole nerve leaves the intervertebral foramen it divides into two branches, a ventral and a dorsal one. This is so in the first two nerves. In the succeeding nerves, however, the division takes place inside the vertebral canal

and the two branches run for variable distances inside the
vertebral canal before gaining exit. They part immediately
after leaving the intervertebral foramen and become separated by the intertransverse ligaments (Figure 6: G) over
which the dorsal branches of the nerve lie.

Each dorsal branch of the Nn. spinales lumbales divides
into two branches, a larger lateral, and a smaller medial
one. The lateral branch runs laterocaudally in the M.
longissimus dorsi giving branches to it and passes out of it
at its lateral border as a cutaneus nerve. The first three
of these cutaneus nerves were found to reach a plane horizontal with the stifle joint, and transverse planes passing
through the caudal border of the lumbar, and cranial border
of the sixth lumbar vertebra. The last three of these
cutaneus nerves cover a wide area extending in a curved line
through the hip joint to the stifle joint with its convexity
directed caudally.(Plate 6: d.l.).

The smaller medial branches also followed a definite
pattern. Each passed caudally along the vertebra under the
articular process of the caudal vertebra, and ascended
dorsally, meeting the dorsal branches of the Aa. lumbalia
which pass through one or two accessory foramina. Here it
divided into a number of branches most of which innervated
the M. multifidus dorsi, and one ascended with the blood
vessels along the caudal part of the spinous process, pierced

the lumbar fascia and bent laterally on the same side of the body, ran under the subcutaneus tissue caudally and ventrally to reach a horizontal line level with the tuber coxae. These cutaneus nerves were so placed that the ones which come out in the lateral branches alternated with those which ran at first in a caudodorsal direction, although they did not get to the same level under the skin. This arrangement is another explanation to the finding by Arnold and Kitchell (1957), when they were determining dermatomes of the abdominal wall of cattle.

The dorsal branches of the Nn. spinales sacrales

The dorsal branches of the Nn. spinales sacrales had an arrangement slightly different from those of the Nn. spinales lumbales. Their primary divisions are similar but their subdivisions which correspond to the lateral ones of the lumbar region were the only ones observed to have come out to the skin. The medial branches were expended in the muscles on the dorsal surface of the sacrum, and had also partly joined with the dorsal branches of the Nn. spinales coccygei, (Figure 10: 9).

The dorsal branches of the sixth N. spinales lumbalis and first N. spinalis sacralis joined to innervate the medial part of the dorsal surface of the gluteal region. The joined nerve traversed underneath the lateral part of the M. sacro-coccygeus dorsalis lateralis and emerged from it about the

middle of the gluteal region to innervate the skin of the croup (Plate 7) above the greater sciatic foramen.

The Sympathetic Nerve Trunks (Trunci sympathici)

The vertebral sympathetic ganglia in the lumbar and sacro-coccygeal regions were observed. In all of the specimens examined the ganglia were found in the middle part of the corresponding vertebral body on each side. One exception, however, was noted on the left side, where the L_2 sympathetic ganglion was at the intervertebral disc between the L_2 and L_3 vertebrae. They were lying along the medial border of the M. psoas minor, and in some cases slightly covered by the muscle in the middle part of the lumbar region. The Aorta abdominalis and the Vena cava caudalis concealed the ganglia from direct view if the vessels are not displaced. In the sacral region the ganglia were found next to the middle sacral vessels. The first pair of the sacral sympathetic ganglia was slightly away from these vessels and partly covered by the A. and V. iliaca interna. The coccygeal part was quite close to the A. and V. coccygeal mediana.

Shape and size of ganglia

Most of the ganglia in the trunks were spindle-shaped, especially in the cranial part of the lumbar and caudal part of the sacral regions including the coccygeal portion. This was especially so whenever the interganglionic fibers and the

Rami communicantes arose from the ends of these ganglia.
In some cases the Rami communicantes were not only joined to
the middle of the ganglia but also from both ends, thus
tending to produce various shapes -- triangular, stellate
and quadrangular, as also found by Uchida (1929). The first
pair of sacral ganglia have mostly taken a triangular shape.
In specimen no. 12 the first and second sacral ganglia had
fused on each side to produce a club-shaped figure wider
cranially and tapering caudally (Figure 19:20).

The size of the ganglia ranged from 3 x 1-1/2 cm. to
6 x 2-1/2 mm. in the spindle-shaped, and the triangular
ganglion at the first sacral vertebra was of an equilateral
shape 7 mm. each side. The fused first and second sacral
ganglia extended for a length of 18 mm., and were 3-1/2 mm.
at their wider end. In the coccygeal region the ganglia were
seen as far caudally as the third coccygeal vertebra, and
were greatly reduced to much less than 1 mm. in length and
considerably narrow.

Rami communicantes

A variable number of Rami communicantes were encountered
and not all of them were numerically symmetrical in all of
the specimens examined, nor were they symmetrical in number
on both sides in each specimen.

In specimen no. 4 there was a Ramus communicans for each
of the ganglion and the spinal nerves with the exception of

the L_2 which had two Rami communicantes. In all cases, the ganglia were in the middle of the length of the bodies of the vertebrae and the Rami communicantes coursed caudodorsally to join their respective spinal nerves. Some Rami communicantes also coursed dorsocranially (Figure 4).

In specimen no. 11 there was a Ramus communicans to each ganglion on either side. Between lumbar sympathetic ganglia 1 and 2 a Ramus communicans was joined to the L_1 spinal nerve. A Ramus communicans on both sides of the body, ran dorsocranially from the cranial end of the L_3 sympathetic ganglion to the L_2 spinal nerve. In this arrangement, therefore, the L_3 sympathetic ganglion was connected with the L_2 and L_3 spinal nerves. Thus, in this specimen much symmetry on both sides of the body was encountered in the arrangement of the Rami communicantes.

In specimen no. 12, however, a different arrangement was presented. This was much different from the foregoing, as well as being different on the two sides of the body. Considering the left side first, the L_1 spinal nerve was connected with the corresponding sympathetic ganglion by three Rami communicantes (Figure 19). The L_2 spinal nerve had two Rami communicantes; the L_3 - L_5 had each a single Ramus communicans but the L_6 had two Rami communicantes. The right side of the body, presented two Rami communicantes for each of the L_1 - L_3 spinal nerves, relative to their respective sympathetic ganglia. The rest of the lumbar ganglia sent

single Rami communicantes to their respective spinal nerves.

In this specimen, too, a contra-lateral Ramus communi-cans was noted, which extends from the last lumbar sympa-thetic ganglion to the first and second fused sacral ganglia on the right side. This communication ran obliquely across the lumbosacral intervertebral disc (Figure 19: 19).

Another important disposition concerning the sympathetic trunks was found in the sacral region. This was the direct innervation of the proximal part of the M. retractor penis. From two ganglia, one on each side of the distal part of the third sacral vertebra, intercalated in a normal way in the sympathetic chain, arose apparently Rami communicantes, one on the right side and two on the left. On tracing them further, they were found to end in the M. retractor penis of their respective sides (Figures 19: 12 and 21: 23). The latter figure is of specimen no. 13 in which this type of innerva-tion to the M. retractor penis was encountered on the right side. A similar innervation was also momentarily seen in specimen no. 11, but continuity was lost while trying to clarify the situation (Plate 1: A is a photograph of the rami on the left side of specimen no. 11).

Figure 21 represents the findings in specimen no. 13. In this specimen some clearing of the sympathetic trunks was extended slightly craniad to include the last two thoracic ganglia and their connections to the spinal nerves. On the left side the last two thoracic ganglia showed two

Rami communicantes each. There was one other Ramus communi-
cans joining the interganglionic cord immediately caudal to
the last thoracic ganglion. There was one Ramus communicans
for each of the L_1 and L_2 sympathetic ganglia. The L_3
sympathetic ganglion was connected to both L_2 and L_3 spinal
nerves as in specimen no. 11. The L_4 and L_5 sympathetic
ganglia including all the sacral sympathetic ganglia had
single Rami communicantes, but the L_6 ganglion showed two
Rami communicantes.

On the right side, the last two thoracic sympathetic
ganglia and L_1 through all sacral sympathetic ganglia showed
single Rami communicantes. Between the L_1 and L_2 ganglia,
however, there was an extra Ramus communicans which was
connected to the L_1 spinal nerve. Another Ramus communicans
connected to the L_2 spinal nerve was also seen between the
L_2 and L_3 sympathetic ganglia. The latter ramus was con-
nected close to the L_3 sympathetic ganglion to produce a
somewhat similar arrangement as was observed on the left
side (Figure 21).

There was observed, too, a direct sympathetic nerve twig
to the M. retractor penis at its proximal attachment as was
found in the former specimens. This twig was found on the
right side (Figure 21: 23).

In this specimen also nerve filaments were seen arising
from the ganglia and entering the wall of the lumbar arteries

on the left side, as the arteries left the aorta.

Ganglion impar

Conflicting opinions have been expressed as to the existence of a ganglion impar in the hog. The present investigations have not as yet revealed such an arrangement suggesting its presence. The general arrangement of the sympathetic trunks including the ganglia shows close similarity to the results obtained by Zintzsch (1964) in the sheep. In the present work on the five specimens examined no close contact between the ganglia of the two sides had been encountered. This does not suggest that ganglion impar does not occur at all but its presence was not demonstrated in this investigation.

Some of the Visceral Arrangements of the Sympathetic Nerves in the Abdominal and Pelvic Cavities

The lumbar splanchnic nerves

The lumbar splanchnic nerves have been observed on three specimens only. Specimen no. 11 revealed the following: On the left side three branches were noted; one parted from the sympathetic trunk between the L_2 and L_3 sympathetic ganglia. It was joined by another branch from the caudal end of the L_3 sympathetic ganglion, and a third branch arose from the sympathetic trunk between the L_3 and L_4 sympathetic ganglia. They joined together and formed part of the aortic plexus

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which continued caudally to the caudal mesenteric ganglion
(Figure 17: 17 and 18: 3). On the right side two branches
were observed: One branch left the sympathetic trunk be-
tween the L_2 and L_3 sympathetic ganglia, the other arose
from the caudal end of the L_3 sympathetic ganglion and con-
tinued as part of the aortic plexus on this side, and finally
joined the caudal mesenteric ganglion. Both of these aortic
plexuses showed a ganglion at the origin of the A. testi-
cularis on each side; and from here each artery had an
accompanying sympathetic nerve (Figure 17: 17; 25; and 18:
4, 5, and 6).

The caudal mesenteric ganglia had a meshed exchange of
fibers although represented as a simple ganglia in the
figures. From here well identified nerve fibers followed
the two branches of the A. mesenterica caudalis - cranial and
caudal (Figures 17: 18, 19; 18: 4, 7; 19: 17).

From the caudal end of the caudal mesenteric ganglia
proceeded the two Nn. hypogastrici (Figures 17: 21; 18: 9;
and 19: 18). Each N. hypogastricus met with the N.
splanchnicus pelvinus of its respective side on the lateral
aspect of the rectum, being firmly secured by the rectro-
genital fold of the peritoneum.

In specimen no. 12 more lumbar splanchnic nerves were
found. Starting with the left side, the abdominal aortic
plexus showed five communicantions with the sympathetic
trunk and ganglia, and further communication was found in

the sacral region towards the formation of the Nn. hypo-
gastrici. Figure 19 shows these communications. In the
first instance, from the L_1 sympathetic ganglion a single
branch was seen; from the L_2 ganglion arose one branch and
one other was connected to one of the Rami communicantes.
Between the L_2 and L_3 sympathetic ganglia there was one
branch; and from the L_3 sympathetic ganglion arose one branch
and another one connected to a Ramus communicans. All of
these joined the aortic plexus as it passed on caudally to
the genital and caudal mesenteric ganglia (Figure 19: 13, 15
and 16).

On the right side, however, only single branches were
observed coming off from the first three lumbar sympathetic
ganglia. From the last lumbar sympathetic ganglion two
branches arose, one of them being the contra-lateral con-
nection to the first sacral ganglion on the left side as was
mentioned before; the other one joined the N. hypogastricus
of the same side (Figure 19: 19).

In the sacral region, on the left side, two connections
were seen leaving the first two fused sacral sympathetic
ganglia to join the Nn. hypogastricus of the left side.

Specimen no. 13 showed the following formations of the
lumbar sympathetic splanchnic nerves: On the left side,
there was a branch arising from the interganglionic cord of
the sympathetic trunk which coursed caudomedially, passing

cranial to the origin of the Aa. renalis and phrenico-
abdominalis to join the autonomic nerve trunk which ran from
the cranial mesenteric sympathetic ganglion and plexus. The
lumbar splanchnic nerve here seemed to be a continuation of
one of the Rami communicantes connected with the L_1 spinal nerve
and sympathetic ganglion. From the L_2 sympathetic ganglion
arose one branch. This was joined by another one from the
L_3 sympathetic ganglion, and the bundle so formed joined the
aortic splanchnic cord or plexus, as it has been so referred
to previously. A brench arose from the L_2 spinal nerve and
the L_3 sympathetic ganglion. These were joined by another
one from the interganglionic cord between the L_3 and L_4 gang-
lia; and the latter combination was joined by two branches con-
nected with the L_3 spinal nerve, and the resulting bundle
then joined that trunk running along the aorta just between
the genital ganglion and the caudal mesenteric ganglion.

On the right side, quite a different arrangement was
observed. There was no apparent splanchnic connection with
the L_1 sympathetic ganglion. Instead, the apparently lesser
splanchnic nerve took off from the last thoracic sympathetic
ganglion, divided into two branches cranial to the A.
phrenico-abdominalis, one branch passing ventral and the other
dorsal in relation to the artery. The branch ventral to the
artery joined the autonomic nerve trunk from the coeliaco-
mesenteric ganglion and plexus. The other branch dorsal to
the A. phrenico-abdominalis, continued caudal to the artery,

divided again into two branches one of which also joined the
said autonomic trunk running along the aorta, and the other
bent laterally and accompanied the right A. renalis (Figure
21: 18).

From the L_2 sympathetic ganglion a splanchnic branch
left to join that trunk along the aorta. From the L_3 sympa-
thetic ganglion arose a branch to the aortic autonomic trunk
or plexus. Again, from the L_3 spinal nerve came a splanchnic
nerve fiber which was joined by another one from the inter-
ganglionic cord between the L_3 and L_4 sympathetic ganglia,
which subsequently joined the aortic plexus at the spot where
the N. genitalis originated to accompany the respective
artery.

Pelvic visceral innervation

It is already known that the visceral organs in the
pelvic cavity are innervated by both voluntary and autonomic
nerves; but the mode under which this is accomplished in the
domestic pig is still a matter of conjecture. The present
study is most likely to throw light on how the various nerves
concerned are distributed to these organs. Observations so
far indicate that the Nn. hypogastrici, the Nn. splanchnici
and the Nn. pudendi are the ones mainly concerned, but one
also has to include the fourth sacral spinal nerve which,
when it has not contributed to the formation of the N.
pudendus, serves to innervate the most caudal parts of these
organs.

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Nn. hypogastricus and splanchnicus pelvinus

These nerves were observed to come together to produce the pelvic plexus (Figures 18: 9, 11; 2: 21, 22). It was also noted that a branch from the N. pudendus came cranially alongside the M. urethralis and joined the two nerves at the plexus (Figures 18: 16; 2; 20). From this arrangement nerves passed to the M. urethralis, the bulbourethral gland, the prostate gland, and the seminal vesicle, urinary bladder, and one nerve branch was seen running alongside of the ductus deferens into the inguinal canal (Figure 18: 21). Fibers were traced caudally to the middle part of the M. retractor penis and terminal portion of the rectum (Figure 18: 14).

Origin of the N. hypogastricus

The immediate origin of the N. hypogastricus is the caudal mesenteric ganglion and the plexus formed at this point. It is likely that fibers from ganglia as far craniad as the last thoracic may find their way to this nerve via the aortic plexus, or through the lumbar splanchnic nerves. It is at the caudal mesenteric plexus that fibers were recognizable to be crossing from one side to the other. In one case, however, i.e., specimen no. 12, (Figure 19: 19), and at S_1, some more contributions to the Nn. hypogastrici were seen to come from the L_6 and S_1 sympathetic ganglia, where also contralateral communication between these ganglia was found. From the S_1 sympathetic ganglion on the left side

side arose two splanchnic rami which joined the N. hypo-
gastricus of that side; while from the L_6 sympathetic
ganglion on the right side, one splanchnic ramus was ob-
served to join the respective N. hypogastricus.

Origin of the N. splanchnicus pelvinus

Most of the specimens so far examined have had the Nn.
splanchnici pelvini originating from the ventral branches of
the S_2 and S_3 spinal nerves; i.e, 10 specimens out of 13
showed this arrangement. In the remaining 3 specimens the
Nn. splanchnici pelvini were formed by roots from the ventral
branches of the S_1 and S_2 spinal nerves.

The N. splanchnicus pelvinus courses ventrally and
slightly cranially on the medial surface of the M. obturator
internus outside the parietal peritoneum to gain the recto-
vesical fold of peritoneum, where it meets the N. hypo-
gastricus with which it forms the pelvic plexus. At this
point also is found the A. urogenitalis whose branches are
intermingled and distributed together with the nerve fila-
ments arising from the pelvic plexus.

Relationship of Nn. pudendus, hypogastricus and splanchnicus pelvinus

As had been mentioned before, the Nn. pudendus, hypo-
gastricus and splanchnicus pelvinus have a reciprocal re-
lationship in supplying innervation to the pelvic viscera.

The N. pelvinus is principally parasympathetic, the N. hypo-
gastricus sympathetic and the N. pudendus mainly voluntary.
Electrophysiological methods should be used to determine
whether the N. pudendus carries some parasympathetic as well
as sympathetic fibers. In all of the specimens examined, the
N. pudendus had an unique relationship with the N. splanchnicus
pelvinus in that the origin of the former always shared roots
with the latter. It was also noted that the Rami communi-
cantes to the roots concerned in giving rise to the two nerves,
appeared to be joining the roots which formed the N. pudendus.

The N. pudendus in all cases has had a communicating
branch from the N. ischiadicus which joined it at the lesser
sciatic foramen. After this communication the combined trunk
separated into various branches one of which is of immediate
concern here. This branch as shown in Figure 18: 16 and 2: 20,
ran alongside the uro-genital organs in the pelvis and was
seen to intermingle with the pelvic plexus as formed by both
the Nn. hypogastricus and splanchnicus pelvinus. It branched
to supply the M. urethralis up to the neck of the bladder and
the genital organs up to the cranial end of the vagina. This
seems to account for the voluntary innervation in this part
of the uro-genital system.

As the various branches of the N. pudendus are followed,
quite a number are seen to go to structures in the neighbor-
hood of those innervated by nerve branches from the pelvic
plexus as formed by both the Nn. hypogastricus and splan-

chnicus pelvinus. It branched to supply the M. urethralis
up to the neck of the bladder and the genital organs up to
the cranial end of the vagina. This seems to account for the
voluntary innervation in this part of the uro-genital system.

As the various branches of the N. pudendus are followed,
quite a number are seen to go to structures in the neighbor-
hood of those innervated by nerve branches from the pelvic
plexus. Branches of the N. pudendus go to the M. sphincter
ani externus, whereas the pelvic plexus sends branches to the
M. sphincter ani internus. The M. retractor penis has been
innervated in its distal part by the N. pudendus (Figure 18:
20) and by both the Nn. hypogastricus and splanchnicus
pelvinus in its middle part; and in some cases direct
sympathetic splanchnics arising from one of the ganglia of
the sympathetic trunk, as this crosses the proximal attach-
ment of the muscle (Figures 19: 12 and 21: 23). This latter
finding was confirmed by sections made from the nerve fila-
ments shown in microscopic examination which revealed the
nerve fibers (Plate 10).

The sympathetic trunks (specimen no. 14) (Figure 22 and
Plate 12)

The sympathetic trunk on the right side had two remaining
lumbar sympathetic ganglia situated in the middle of the

length of the bodies of the last two lumbar vertebrae as was
noted in the previous specimens. In addition, there was an
extra ganglion placed onto the intervertebral disc between
the last lumbar vertebra and the sacrum, and it was named the
Ganglion paravertebrale assessorus. It was intercalated in
a collateral sympathetic cord which was given off at the
caudal end of the last lumbar sympathetic ganglion. This
extra ganglion then gave rise to two nerve cords one of which
passed laterally and joined the first sacral sympathetic
ganglion, the other had already been severed, but it might
have been joined to the N. hypogastricus of the same side as
was the case in specimen no. 12; or it might have crossed to
the opposite side as also was found in the same specimen.
But the last assumption was proved not to be so because the
sympathetic trunk on the opposite side was quite intact in
the region where the contralateral communication might have
joined it.

On the left side there was only one lumbar sympathetic
ganglion remaining as was mentioned before.

The sacral sympathetic ganglia were all well represented
and the following features were noted. The first pair, which
in most cases was triangular in shape its right side ganglion
took on a quadrangular shpae because of the four cords that
were attached to it; two cranially and two caudally (Figure
22: S_1).

The second pair of the sacral ganglia were joined by a transverse anastomosis from which the A. sacralis mediana received filaments.

The third pair also was communicating in a plexiform manner, the left ganglion appearing more caudally placed than the right one. The cord of the left side split into three branches two of which joined the respective ganglion, and one crossed to the opposite ganglion. From the ganglion on the right side an oblique ramus joined the ganglion on the left side (Figure 22: 12).

The fourth sacral and the two conspicuous coccygeal ganglia were closely applied to the A. coccygea mediana. Small filaments were seen to be joining the artery in this region caudally. After the fourth coccygeal vertebra the sympathetic trunks became very tiny and difficult to isolate, but they showed themselves to be fusing at one point and separating at another to allow passage to blood vessels going to the dorsal aspect of the tail.

The findings in specimen no. 14 stimulated more interest to check on another female specimen with the hope of finding some similar arrangements of the Tr. sympatheci in the lumbo-sacral region. Fortunately enough this turned out to be the case. The specimen was the fifteenth as already stated before. It was a gilt about eight months old and 120 pounds body weight. The specimen was embalmed and dissection com-

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menced one day after embalming. The stomach, intestines
(except rectum), spleen, liver and pancreas were removed through
a longitudinal incision made along the ventral midline from
the pubis to the xiphoid cartilage. The kidneys, genitalia,
rectum and the aorta were left in position. Dissection to
expose the Tr. sympathici was carried out by gentle removal
of the parietal peritoneum along the lateral borders of the
sublumbar muscles, reflecting it toward the medial aspect of
the muscles, locating the various sympathetic nerve rami and
splanchnic nerves as far forward as the last three ribs. It
was necessary also to remove the costal parts of the diaphragm
up to the level of the aortic hiatus, but leaving the crura
of the diaphragm intact as the last thoracic splanchnic
nerves traversed their lateral surfaces (Figure 23).

The ganglia

In the exposed thoracolumbar part of the right side,
three thoracic and six lumbar sympathetic ganglia were seen
along the main sympathetic trunk. Both these and those on
the left side appeared to be poorly formed, as their bound-
aries were not clearly demarcated.

On the left side, too, three thoracic ganglia were ex-
posed, and there were six lumbar sympathetic ganglia placed
similar to those on the right side, and an extra one in the
course of the Nn. splanchnici lumbales (Figure 23: 2).

The coelico-mesenteric ganglia

The coeliac and mesenteric ganglia formed two thick portions which were quite well interconnected by several bands in a form of network. The portion on the right side was situated more caudal than the left portion. It was more quadrangular in outline. That on the left side was of a narrow triangular shape whose apex was directed caudally. It extended cranially to the left lateral aspect of the A. coeliaca. Each of these portions was covered ventrally by the respective adrenal gland (Figure 23: 4). From these ganglia on the left side, were seen strands which joined up to form the renal plexus by joining first with one of the Nn. splanchnici lumbales (Figure 23: 3). After meshing caudal to the ganglia and then joining the renal ganglion. Figure 23: 6 shows the renal plexus on the right side represented by two strands, and had no visible renal ganglion.

There was a well developed and separate Ganglion renale on the left side (Figure 23: 5).

The genital and caudal mesenteric ganglia

In two of the previous specimens examined the genital and the caudal mesenteric ganglia were separate. In this specimen, however, the two ganglia were combined at the site of origin of the A. mesenterica caudalis, from where also the two Aa. utero-ovaricae took origin. No definite indication as to their having joined was observed, but it was an

assumption taken as a result of the arrangement of the nerves originating from here to the parts of the genitalia which had a separate ganglion in the previous specimens. In other words, it may be said that in this particular specimen the caudal mesenteric ganglion served all the organs as shown in Figure 23: 7, 8, 9, and that there was no genital ganglion. The fact that separate vessels to the genitalia arose from the same spot as the A. mesenterica caudalis, may be an influencing factor to support the assumption that the genital and the caudal mesenteric ganglia had joined (Figure 23: 7, H and J; 25: 1).

Ganglia in the sacral and coccygeal regions

Four pairs of sacral sympathetic ganglia were seen. The first two ganglia on each side were well developed and triangular in outline, but the last two were rather small. All of them were evenly placed in the middle of the vertebral bodies (Figure 24: 1, 2).

The coccygeal sympathetic ganglia appeared to fluctuate in size, some being imperceptibly small and others just large enough to identify. Three pairs and one single ganglia were found, all lying in the middle of the vertebral bodies, along the A. coccygea mediana up to the fourth coccygeal vertebra where the single ganglion was found. The two sympathetic cords converged to this ganglion so that it took

a position dorsal to the artery. It seems this may be the pattern in the female pig. Botár (1932) shows a similar finding (Figure 24: at Cy_4).

The interganglionic sympathetic cords

The interganglionic cord on the right side, as seen at the level of the last three thoracic vertebra, was thick. Almost all of it formed the two last thoracic splanchnic nerves which joined the adrenal plexus as well as the coeliaco-mesenteric ganglion and plexus. A small cord, however, continued to the last thoracic sympathetic ganglion from which the last thoracic splanchnic nerve arose to join the caudal part of the coeliaco-mesenteric ganglion. From the last thoracic sympathetic ganglion to the second sacral sympathetic ganglion, the interganglionic cord maintained an even size. After the second sacral ganglion the cord diminished considerably, until it joined the single ganglion which it shared with the cord of the opposite side at the middle of the fourth coccygeal vertebra (Figure 24: Cy_4).

On the left side, also starting with the last three thoracic vertebrae, the interganglionic sympathetic cord was a very small strand lateral to the cranial part of the last three thoracic splanchnic nerves. It, however, fused with the splanchnic nerves at the last thoracic vertebra before the splanchnic nerves parted from it to join the coeliaco-mesenteric ganglion and the adrenal plexus. From here it

maintained a fairly even size, slightly bigger than the cord
on the right side, down to the second sacral sympathetic
ganglion. Although at this point it began to diminish in
size, it was still proportionately larger than the cord on
the right side.

As mentioned before, the two interganglionic cords,
right and left, joined at a coccygeal ganglion placed at the
middle of the body of the fourth coccygeal vertebra. From
here they irregularly branched and reunited, forming loops
around the vertebral arterial branches from the A. coccygea
mediana, and at the same time enlacing the main artery as
shown in Figure 24: 1 and 2.

Transverse communications were seen at the first, second
and third coccygeal sympathetic ganglia also (Figure 24: 2).

The Rami communicantes

Right side   The cranial ganglion of the last three
thoracic ganglia exposed had one Ramus communicans each, the
next two, although the caudal of these was away from the
ganglion and appeared to go direct into the formation of the
splanchnic nerve. The last thoracic ganglion had two Rami
communicantes one of which was caudal to the ganglion.

The first lumbar spinal nerve was joined by two Rami
communicantes one from the first lumbar ganglion and the
other from the cranial end of the second lumbar ganglion.

There were two Rami communicantes to the L_2 spinal nerve, one from each of the L_2 and L_3 sympathetic ganglia, but part of the Ramus from the L_3 ganglion appeared to be continued by the second of the Nn. splanchnici lumbales on this side. The L_3, L_4, L_6, the sacral and all of the coccygeal sympathetic ganglia had single Rami communicantes, whereas the L_5 ganglion had two.

Left side   The last three thoracic ganglia had arrangement of the Rami communicantes similar to that noted for the Rami of the right side.

All of the sympathetic ganglia except the L_4, in the lumbar region had two Rami communicantes each. It was noted too, that the caudal Rami communicantes between the L_2 and L_3, and the L_3 and L_4 ganglia were either joining the interganglionic cord or appeared to be joining the Nn. splanchnici lumbales.

The sacral and coccygeal ganglia had single Rami communicantes.

The splanchnic nerves

Thoracic   The part of the thorax exposed showed two splanchnic nerves on the right side. Both of these nerves appeared doubled as they left the immediate ganglia. From the cranial of them one small N. splanchnicus entered the cranial third of the adrenal gland, whereas the remainder joined the coeliaco-mesenteric ganglion. From the coeliaco-

mesenteric ganglion, four twigs were observed to enter the caudal half of the adrenal gland (Figure 23: at 2).

On the left side, the thoracic splanchnic nerves appeared to be six in number as they left the sympathetic cord. Three of them were large and three small ones. The cranial two small ones and one large entered the adrenal gland, while the caudal two large ones joined the tapering caudal end of the coeliaco-mesenteric ganglion; and the most caudal and small N. splanchnicus divided towards its termination, one branch joining the ganglion and the other branch joining one of the branches of the A. adrenalis which came from the A. renalis by a common trunk with the A. phrenico-abdominalis. Four twigs were seen passing between the adrenal gland and the coeliaco-mesenteric ganglion on the left side.

On the right side, two nerves sprang form the coeliaco-mesenteric ganglion and ran along the A. renalis as the renal plexus (Figure 23: 6).

On the left side, from the tapered part of the coeliaco-mesenteric ganglion, a thick cord extended to a separate ganglion -- the renal ganglion -- from which four filaments arose. One of these filaments followed the A. renalis, one the A. phrenico-abdominalis, and two crossed over the ventral and dorsal aspects of the A. renalis and joined the Nn. splanchnici lumbales (Figure 23: 3, 5, 6).

Lumbar   There were three Nn. splanchnici lumbales on

the right side. The first N. splanchnicus lumbalis joined
the caudal part of the coeliaco-mesenteric ganglion on the
same side. The second N. splanchnicus lumbalis parted with
the sympathetic cord between the L_2 and L_3 sympathetic
ganglia, while the third N. splanchnicus lumbalis appeared
to spring from the cranial end of the L_3 sympathetic ganglion
and partly as a ramus communicans to the L_2 spinal nerve.
The L_2 and L_3 splanchnic nerves joined together at the level
of the fifth lumbar vertebra, and the resulting trunk joined
the caudal mesenteric ganglion, which, as described before
had fused with the genital ganglion (Figure 23: 3 and 7).

On the left side there were about five Nn. splanchnici
lumbales which appeared to have taken origin from one spot
between the L_2 and L_3 sympathetic ganglia, and one N.
splanchnicus lumbalis was from between the L_3 and L_4 ganglia.
They all joined up at the level of the fifth lumbar vertebra
then separated into two cords which joined the cranial wide
part of the caudal mesenteric ganglion on the same side
(Figure 23: 7, cranial end).

Sacral and coccygeal regions

The caudal mesenteric ganglion gave rise to a number of
nerves. This statement does not imply that the nerves solely
started from here, as it is understood many of their fibers
may have passed without synapsing at all. From this ganglion
arose the N. hypogastricus, as well as nerves which followed

the two branches of the A. mesenterica caudalis, and nerves
to the genitalia -- ovary and uterus.

N. hypogastricus   This nerve left the caudal end of
the ganglion in a similar manner on the two sides of the body,
coursed horizontally alongside the rectum, and turning some-
what ventrally and caudally in the cranial third of the
pelvic cavity, came in contact with the N. splanchnicus
pelvinus with which it formed the pelvic plexus at the neck
of the urinary bladder and cervix uteri (Figure 25: 2,3).
Along with the nerve was the A. urethrogenitalis (Nunez, 1964)
or A. urogenitalis (Getty, 1964) which vessel is distributed
together with the various filaments of the pelvic plexus
(Figure 25: M). A well isolated nerve was seen following the
rectogenital branch of the A. urethrogenitalis towards the
anus. To the same point, i.e., at the place where the N.
hypogastricus and N. splanchnicus pelvinus joined, came a
branch from the N. pudendus which also took part in the
plexus production, as was found in the male pig (Figure 25:
2, 3, 4, and 9).

Nerve plexus to A. colica sinister and A. hemorrhoidalis

    At least three filaments were seen proceding from the
caudal mesenteric ganglion on the left side following the
arterial branches of the A. mesenteric caudalis. They arose
from the medial aspect of the ganglion, cranial, middle and
caudal in relation to the main body of the ganglion. The

cranial and caudal components appeared to be formed by fibers from the right and left ganglia, while the medial component sprang directly from the ganglion. Two of the filaments accompanied the A. colica sinistra and the third followed the A. hemorrhoidalis. In specimen no. 12 another nerve arose together with the N. hypogastricus on either side, and these converged to follow the A. hemorrhoidalis a short distance from the bifurcation of the A. mesenterica caudalis (Figure 23: 10, 11, H).

Nerve plexus to the genitalis

In specimen no. 15 the nerves contributing to this plexus arose from the amalgamated genito-mesenteric ganglion. These nerves separated from the ventromedial aspect of each ganglion and descended together with the A. utero-ovarica. As these nerves gained the meso-ovarium they divided after the manner of the vessels, but their final branches were not easily traceable. A ureteral nerve was observed to come from the same point and followed the A. ureteralis to the ureter. The relationship of the N. hypogastricus and N. splanchnicus pelvinus was much the same as that found in specimens no. 11 and 12 (Figure 25: 2, 3 and 6 shows the nature of their arrangement into the pelvic plexus). The nerve pudendus also anastomosed with the N. hypogastricus and N. splanchnicus pelvinus. From here some filaments were traceable to the bladder, vagina and caudal part of

the uterus. A considerably large strand runs from the meeting point of the three components of the plexus, in company with a recto-anal branch of the A. urethro-genitalis, to reach the M. sphincter ani internus (Figure 25: 5).

DISCUSSION

The Somatic Nerves

The somatic nerves in the lumbar and pelvic regions

The number of the lumbar vertebrae determines the number
of the lumbar spinal nerves present. In the present investi-
gation all specimens, except two, had six lumbar vertebrae.
In the two exceptions one had five lumbar vertebrae as a re-
sult of the presence of an extra pair of ribs, the other
specimen was not examined fully to count the number of the
lumbar vertebrae and only its sacro-coccygeal part was
salvaged for studying the caudal termination of the Truncus
sympatheci.

All of the textbooks consulted (Ellenberger and Baum,
1943; Martin, 1923; Montané and Bourdelle, 1920) agree that
there are usually seven lumbar vertebrae, or sometimes six
in the pig, and consequently the corresponding number of
nerves. The present investigator, however, found in his
specimens that there were six lumbar vertebrae in most of
the cases, 13 out of 14 (this excludes the one specimen whose
lumbar vertebrae were not examined). One out of fourteen
specimens had only five lumbar vertebrae. The work of
Reimers (1913) confirms the presence of generally seven lum-
bar vertebrae with a reduction to six. Uchida (1929) found
six pairs of lumbar sympathetic ganglia in all the specimens

he examined. These, in the opinion of the present investigator, were equated with the lumbar vertebrae present.

Horses, cattle, goats, and sheep each have six lumbar vertebrae, but the dog, cat and rabbit mostly have seven, although in the cat and rabbit the reduction to six lumbar vertebrae is more likely than it is in the case of the dog.

After encountering an extra pair of ribs in one specimen, it was deemed proper to find out whether or not the varying numbers of ribs had any influence on the number of the lumbar vertebrae. However, this was not so because in those animals which had fifteen or sixteen pairs of ribs, the number of lumbar vertebrae still was six.

Intercommunication between the ventral branches of the lumbar spinal nerves

As indicated before, the intercommunication between the ventral branches of the Nn. spinales lumbales made it possible to say that all spinal nerves in the lumbar region play a part in forming the lumbosacral plexus. It is worth while reporting how they do so.

In specimen no 4 (Figure 4: Th and L) a communication was observed on the left side between the last thoracic spinal nerve and the ventral branch of the L_1 spinal nerve before they subdivided. It is the only case in which this communication was observed, probably because the number of the lumbar nerves had been reduced.

In specimens no. 2, 3, 4, 11, 12 (Figures 1, 3, 4, 18 and 19, respectively) a communication between the ventral branches of the L_1 and L_2 spinal nerves occurred. This seems to disagree with the findings of Reimers (1913) whose specimens did not reveal this communication between the first two ventral branches of the lumbar spinal nerves, notwithstanding the fact that his specimens had seven lumbar spinal nerves excepting one case in which six lumbar spinal nerves occurred.

The distance from the intervertebral foramen at which this communication takes place varies from animal to animal and also in the same specimen on the two sides of the body. In some cases this communication takes place near the nerve exit from the vertebral canal as shown (Figure 19) on the right side of specimen 12, or the communication may be several cm. away, as shown in the same specimen on the left side (Figure 19); still in other cases communication occurs at the point where the various branches begin to subdivide, this form of communication being the most common and involving all of the ventral branches of the lumbar spinal nerves from and including the L_2 spinal nerve.

Specimens were encountered in which the communicating branches joined, not only their immediate neighbors, but coursed to succeeding branches. This is examplified in the ventral branches of the L_3 spinal nerve, in which fibers

could be traced from the L_3 across the L_4 and L_5 to continue in the N. obturatorius, at the same time receiving contributory fibers from the nerves crossed over.

It is this type of communication which led the investigator to include the ventral branches of the last four lumbar spinal nerves in the formation of the lumbosacral plexus.

The nerves to the sublumbar muscles

The sublumbar muscles which comprise the Mm. psoas major, minor and quadratus lumborum iliacus are innervated by muscular branches from the L_1 through the L_6 (or to the last lumbar spinal nerves, as there is a variation in this number).

While the first two and last two lumbar spinal nerves do give well isolated muscular branches to these muscles, the nerves in the middle section of the series, particularly the L_3 and L_4 spinal nerves, tend to produce a secondary plexus which innervates the Mm. psoas major and minor (Figure 13: between the L_3 and L_4). The ventral branch of the L_3 spinal nerve, in all of the specimens, gave off a stout branch which ran cranially into the substance of the M. psoas major as far as its cranial attachment. As was mentioned in the findings, one similar branch traveled cranially through the muscle of one side and joined with another branch from the L_2 inside the muscle; the conjoined

nerve branch penetrated the ventral surface of the M. psoas major and turned caudally to terminate in the M. obliquus internus abdominis. This occurred in specimen no. 6 (Figures 7: 6 and 8: 6). The joining of the L_2 and L_3 spinal nerves was common in all specimens, except specimen no. 4 in which it occurred between the L_1 and L_2 spinal nerves (Figures 1: 7; 4: 1, 2; 21:). In some cases again the conjoined branch innervated the M. cremaster externus, (Figures 19: 3; 21: 3) taking an independent course from that of the N. genitalis (N. spermaticus externus). The nerve arrangement for the M. psoas major is shown in Figures 1: 8; 3; 4; 5: 3a, 8; 17: 3; 21: 4.

The ventral branches of the L_5 and L_6 spinal nerves give off numerous branches which innervate the M. iliacus, and come off more or less from the N. femoralis.

The somatic nerves in the lumbar region should be related to the function of the animal's parts innervated by those nerves. The first four Nn. spinales lumbales together with the last thoracic spinal nerve, as considered in this work, innervate the abdominal wall. The formation of the plexus and the continuation of some of their fibers into the pelvic cavity and hind limb is in a metameric manner, where a nerve in the cranial part has an overlapping area of distribution in which the succeeding nerve takes part thus causing a wave of movement starting in the cranial

portion of the body carried on harmoniously to the caudal portion. Table 1 shows the arrangements of these nerves.

The numbers of the nerves as given in this table are a result of macroscopic observations on teased nerves. Some could be followed on but others, although formed in a similar way, were too delicate for much teasing and follow up, so that some doubt will still exist until physiological electrical stimulation is performed to confirm or verify the morphological findings.

Further consideration is given to such nerves as the N. genitalis (N. spermaticus externus) and N. obturatorius. The choice of the name N. genitalis as against N. spermaticus externus was initiated by the fact that it can be used on both sexes. As was noted in the findings, it came mostly from the ventral branch of the L_3 spinal nerve with a contribution from the ventral branch of the L_4 spinal nerve, and in a few cases the N. genitalis was formed mainly by the ventral branch of the L_2 spinal nerve and a contribution from the ventral branch of the L_3 spinal nerve.

Although Reimers (1913) points out the singleness of this nerve in the pig as compared to two in cattle, cases were encountered where the branch which forms the second nerve in cattle, was the one running separately from the ventral branches of the L_2 and L_3 spinal nerves which terminated in the M. cremaster externus (Figures 5: 4a; 19: 3; 20: 12; 22: 3). However, the main nerve in all cases separates after

the exchange of fibers with the N. cutaneus femoris lateralis. Thus the N. genitalis enters the inguinal canal by two branches which then constitute the N. inguinalis which continues to the inguinal region in both the male and female.

Reimers (1913) noted that the N. obturatorius received an inconstant, reinforcing slender branch from the L_7 spinal nerve, and apparently continuing fibers from the L_5 spinal. The difference here then is the presence of seven pairs of lumbar nerves in Reimer's specimens, otherwise his finding agrees closely with the present investigation.

The sacral somatic nerves

The sacral somatic nerves arise from the caudal part of the lumbosacral plexus. These nerves have already been considered under results, but further explanation is given here. The ventral branches of the N. spinales lumbales which cross over to the sacral region and join with the ventral branches of the N. spinales sacrales are responsible for the formation of the lumbosacral plexus. While most of the nerves emanating from this part of the plexus are fairly distinct a few of them tend to be confusing.

The N. glutaeus cranialis tends to split up immediately on leaving the plexus at the craniolateral border of the greater sciatic foramen. In some cases it consists of widely separated twigs radiating from the sciatic foramen. Reimers (1913) also noted the shortness of this nerve and its

immediate dividing. The nerve to the M. glutaeus profundus
runs caudally in a horizontal manner on the surface of the
muscle and in many cases appears to be an independent nerve
branch of the N. ischiadicus lying in series with the branches
which leave the latter nerve to supply the M. gemellus.
Reimers points out muscular branches to the Mm. gamelii and
M. obturator externus to be given off from the ischiatic
plexus or later from the N. ischiadicus.

The N. ischiadicus is the most well formed member in the
sacral region of the lumbosacral plexus. It appears as a
wide flat band lying upon the M. glutaeus profundus, gamellus
and quadratus femoris as it turns at the hip joint to de-
scend into the thigh. Its full course is described under
results. However, it is worthy of mention that there is a
very constant communicating branch between the N. ischiadicus
and the N. pudendus. In most cases after this branch has
joined the N. pudendus the branches resulting from a con-
joined trunk shared the fibers of the two, thus, for in-
stance, the continuation of the N. pudendus as the N.
clitoridis or N. dorsalis penis and the N. mammarius or N.
scrotalis medius shared the fibers which came from the roots
of the N. pudendus as well as those which came via the com-
municating branch from the N. ischiadicus. There were
nevertheless twigs which split from the communicating branch
which passed on without joining the N. pudendus. These,
apart from being part of the N. glutaeus caudalis were

included in the N. cutaneus femoris caudalis (Figures 2: 8, 10, 16, 17; 3: 13, 19, 20, 21, 22; 5: 15, 19, 24, 26, 27; and 10: 1, 3, 5, 6, 7, 8).

Reimers (1913) shows the communicating branch heretofore referred to as the N. cutaneus femoris caudalis. Fibers from it, at times together with some from the N. pudendus and sometimes fibers from the N. glutaeus caudalis, form the representative of the N. cutaneus femoris caudalis.

Larson and Kitchell (1958) working on bull calves and rams indicated that the nerve branch proceeding from the N. ischiadicus to the N. pudendus joined the N. perinealis and no fibers passed to the N. pudendus. Thus, apparently there is a difference between species since the arrangement in the pig was different.

The N. pudendus, as was described before, has as its main root the ventral branch of the S_3 spinal nerve and the S_2 spinal nerve, while the S_1 and S_4 spinal nerves take part on rarer occasions. The most important point to realize about the N. pudendus is the role it plays in innervating many and variable structures, especially those of the reproductive intrapelvic and extrapelvic parts. In the intrapelvic part it sends a branch cranially which innervates the striated muscles of the urogenital tract, and, has appeared to reach, and be distributed with, branches of the pelvic plexus (Figures 2: 20; 5: 20). The other branches given off

by the N. pudendus are: a muscular branch to the M. coccygeus and the N. cutaneus femoris caudalis has arisen most commonly with the N. pudendus, although it may not at all times first join it and then separate from it before dipping into the lesser sciatic foramen. Here also should be mentioned the Nn. perineales profunda which represent numerous branches arising sometimes independently, or together with the N. perinealis superficiales, at the lesser sciatic foramen (Figures 2: 11, 12, 15, 16, 17; 3: 13, 15, 18, 21; 5: 24, 27, 28).

The N. pudendus continues ventrally to the ischial arch where it divides into its terminal branches, in the male the N. dorsalic penis and N. scrotalis medius, or in the female, the N. clitoridis and N. mammarius. While in the male the N. dorsalis penis is the longer, in the female it is the N. mammarius which is longer.

The N. perinealis superficialis has been termed the N. labialis in the female, and the N. scrotalis caudalis in the male; the continuing branch to the mammary glands has been termed the N. mammarius caudalis, the corresponding nerve in the male is the N. scrotalis medius. The latter two nerves are arborized in the septum scroti.

N. cutaneus femoris caudalis

The N. cutaneus femoris caudalis varies much in its origin and course. It has been described, and given as its

origin the ventral branches of the S_1, S_2 and S_3 spinal nerves, with the S_2 spinal nerve being the most frequent and the S_1 spinal nerve the least frequent. In most cases it consisted of several strands, one of which coursed in the texture of the sacrospinotuberal ligament for some time before lying between the proximal parts of the Mm. biceps femoris and semitendinosus. Other strands run in one bundle with the N. pudendus and part with it as it gains the gluteal surface of the sacrospinotuberal ligament. Frequently, the strands forming the N. cutaneus femoris caudalis spring by the exits of the ventral branches of the S_1 and S_2, and S_2 and S_3 spinal nerves and join together immediately at, or after, crossing the S_3 spinal nerve by running through the ligament and arriving at their destination (Figures 2: 12; 3: 13; 5: 23; 13: 12; 15: 4). In some cases in which only the ventral branch of the S_2 spinal nerve constitutes the N. cutaneus femoris caudalis, the latter runs independent of the N. pudendus (Figures 10: 4; 11: 4).

It was noted in connection with the N. glutaeus caudalis that some fibers running together with it were to be regarded as part of the N. cutaneus femoris caudalis as they innervated the same area. However, this need not be considered as a criterion for determining any particular nerve, for the basically termed nuscular nerves also have some cutaneus nerve branches associated with them.

The Nn. perineales

These nerves exist as branches of the N. pudendus, and
are easily confused with the N. cutaneus femoris caudalis at
the point where they branch off from the parent nerve. They
consist of superficial and deep sets whose numbers are un-
defined. They may arise in succession or as single stems
which separate during their course near their origin or later
near their terminations. The ones which innervate the skin
of the perineum are included in the superficial set and those
which end in the striated musculature of this region are the
deep set (Figures 2: 15, 16, 17; 3: 18, 21; 5: 27, 28; 10:
7, 8; 12: 16, 17; 18: 15).

The Nn. perineals superficials begin as a common trunk
with the Nn. perineales profundi, which separate soon or
late and run near the tuber ischii, and penetrate the
tuberous attachment of the sacrospinotuberal ligament after
which they divide. One or more branches pass medially to
the skin around the anus and upper part of the vulva; the
other, usually larger branch continues over the ischial end
of the M. semimembranosus, and supplies branches to the skin
here as well as that below the vulva in the female, or that
of the scrotum on the perineal surface in the male (Figures
2: 15; 3: 18; 5: 27; 10: 8; 12: 17). In the female these
nerves have been termed the Nn. labiales caudales and in the
male, Nn. scrotales caudales. Further branches which did
not travel the way described separated from branches of the

Nn. perineales profundi and coursed laterally to the anus and upper part of the vulva (Figure 10: 7).

The Nn. perineales profundi after parting with the superficial set, in their initial part course through the ischiorectal fascia and gain entrance to the Mm. sphincter ani externus and constrictor vulvae in the female, and a homologue of the latter muscle of the male. They also innervate the M. levator ani in conjunction with the Nn. rectales caudales. As indicated above these nerves are not completely restricted to the muscles, but send cutaneus twigs around their respective areas of innervation (Figures 2: 15; 10: 7). Arising separately from the N. pudendus are the branches which innervate the Mm. ischiacavernosus, sphincter urethrae and bulbourethralis.

N. mammarius caudalis s. N. scrotalis medius

While still discussing the Nn. perinei, it is worthwhile to correlate the behavior of the N. mammarius. This nerve is one of the terminal branches of the N. pudendus given off at the ischial arch. It sends cutaneous branches along its course in the female (Figures 2: 19; 3: 23; 5: 30). Its terminal branches anastomose with the terminal branches of the N. genitalis, which are by this time called the N. inguinalis.

In the male (Figure 13: 13) the N. scrotalis medius also anastomosed with the N. inguinalis, the continuation of the

N. genitalis which gives off a branch that goes towards the scrotum.

This nerve was grouped as the N. perinealis superficialis by Larson and Kitchell (1958) in the bovine and ovine. The argument here was that it does not innervate the skin and therefore should not be termed superficial. As is shown here in the pig this particular nerve innervated the skin as it courses towards its destination to the mammary glands or the scrotum depending on sex. It therefore carried both cutaneus and deep structure fibers.

It must be emphasized here that the mode of disposition of the Nn. perineales, both superficial and deep, is frequently difficult to delineate.

The N. rectalis caudalis

This nerve arises mainly from the ventral branch of the S_4 spinal nerve and in all cases it had either direct or indirect communication with the ventral branches which form the N. pudendus. The N. rectalis caudalis runs caudally under cover of the M. sacrococcygeus ventralis which it leaves near the anal region to innervate the Mm. sphincter ani externus and levator ani and the skin around the anus. Sometimes it runs alone but often a branch from the N. pudendus may join it early or near its termination. The branch from the N. pudendus running alone to the same area tempts one to use the name N. rectalis medius, but as it is

not enlisted in the nonenclature followed, it is less con-
fusing to include it as either the Nn. rectales caudales or
Nn. perineales profundi. In the case in which it innervates
very closely related structures to the ones innervated by
the nerve from the S_4 spinal nerve, it is included in the Nn.
rectales caudales (Figures 1: 19; 2: 14; 3: 16; 4: 11; 5:
25; 26; 11: 7; 12: 18, 19; Plate 1: 15).

The end of the spinal cord relative to the origin of the spinal nerves

The vertebral canal was opened and the spinal cord was
exposed to obtain a definite idea about the best place where
each nerve could be stimulated following laminectomy.
Jankovic (1954), as quoted by Goller (1959), found that the
first lumbar segment lies in the corresponding number of the
vertebra, but the succeeding lumbar segments show a cranial
displacement. The lumbar segment ends at the cranial border
of the sixth lumbar vertebra, but the intumescentia lumbalis
lies between the fourth and sixth lumbar segment. In the
present investigation the lumbar segment ended slightly short
of the caudal end of the fifth lumbar vertebra. This is
fairly in agreement with Jankovic's findings.

In the present investigation the sacral and all the
coccygeal segments occupied the part extending from the caudal
eighth of the fifth, to the middle of the sixth, lumbar
vertebra. In Jankovic's (1954) work, as quoted by Goller

(1959), the Pars sacralis (S_1 - S_4) extends from the cranial border of the sixth lumbar vertebra to the cranial third of the second sacral vertebra. The Pars coccygealis lies in the caudal two thirds of the second and third sacral vertebra. This segmentation is obviously quite different from that found in the present investigation. The age of the animal examined has much to do with this variation, for example, in the lamb at birth the spinal cord (conus medullaris) extends to the middle of the fourth sacral vertebra, at two months of age to the middle of the third sacral vertebra, and in full grown sheep to the middle of the first sacral vertebra (Gollar, 1959).

The Autonomic Nerves

The sympathetic trunks (Trunci sympathici)

The sympathetic trunks in the lumbar region are regularly located between the M. psoas minor on the right and left, dorsolateral to the Aorta abdominalis and Vena cava caudalis. They are beset with constant ganglia placed alongside the middle of the body of each vertebra. According to Botár (1932) they are similar to those of the cat and dog except that they have more regular relationships. Dyce (1958) states that they show a tendency to coalescence in the horse, which quality, although seen in a few cases in the sacral region (Figure 18: 20), was not observed in the

lumbar region. There were six pairs of ganglia in most of the specimens except two, one of which had five lumbar vertebrae and the other in which the whole of the lumbar region was not utilized (Figures 4; 17; 18; 21). In one other specimen, however, the ganglia and trunk on the right side were obviously less pronounced than those on the left side (Figure 23). Uchida (1929) had a similar number of pairs of the lumbar sympathetic ganglia. The shape of the ganglia were much more influenced by the Rami communicantes which connected them with the spinal nerves. The general shape is spindle, but when the Rami communicantes are joined to the side a triangular shape results.

An extra ganglion was found at the disc of the lumbosacral junction (Figure 22: 11) and Botár (1932) had named a similar finding the Ganglion paravertebrale accessorium. Although it did not occur in the same position as the one shown in the illustration, this name seems worthy of adopting. In specimen no. 12 (Figure 19: 19) are shown two oblique Rami on the right side. Both of them started at the L_6 sympathetic ganglion and ended by joining the N. hypogastricus; the other ramus continued its oblique direction to the S_1 sympathetic ganglion. From the latter ganglion two splanchnic rami ran mediocaudally and ventrally to join the N. hypogastricus.

In the lumbar region some rami were seen following the

lumbar vessels, but no transverse communication between the
two trunks were found. Botár (1932) recorded a number of
them, and Zintzsch (1964) shows these to be present at almost
every segment in the sheep.

The sympathetic trunks in the sacral region lie closer
to the A. sacralis mediana after the second segment of the
sacrum and continue in this manner along the A. coccygea
mediana. The first pair of the sacral sympathetic ganglia
is very outstanding in point of size, and usually has an
equilaterally triangular shape. Each lies near the course
of the A. iliaca interna. In specimen no. 12, the first and
second ganglia fused and produced a club-stick shape, wider
cranially and tapering caudally (Figure 19: 20).

There were observed Rami transversi between some of the
sacral and coccygeal ganglia starting with the second sacral
segment to the fourth coccygeal vertebra, at which point
the trunks joined to form a single ganglion in specimen no.
15. The ganglion was slightly on the left side although
somewhat dorsal to the A. coccygea mediana (Figure 24: at
Cy_4). In specimen no. 14 the S_3 sacral sympathetic ganglia
were close together and had strands of nerves meshing be-
tween them (Figure 22: 12).

In the part beyond the fourth coccygeal vertebra the two
trunks joined and separated again alternately and at the same
time detaching oblique rami which passed either dorsal or

ventral from one side to the other, thus enlacing the A.
coccygea mediana. Two of the specimens, no. 14 and 15, re-
vealed this type of arrangement. In most cases the ganglia
were not easily seen and the sympathetic trunk was difficult
to pursue beyond the ninth vertebra. Botár (1932) reports
that beyond the sixth coccygeal vertebra the trunks dis-
appear near the artery. The specimens, no. 14 and 15, in
which this arrangement was observed were both females, and
in the illustrations shown by Botar the one for the female
has a resemblance to Figure 22 and 24; Plates 12, 13).
Frewein (1962) reported that, in the ox, macroscopically
visible ganglia and rami transversi occurred in relation to
the first four, or five in one case, coccygeal segments, and
that at the end of the chain ganglia, a Ganglion coccygicum
impar is regularly found. He continues to report that from
that ganglion a filament goes to form the coccygeal plexus
along the A. coccygea mediana.

At each vertebral segment fine filaments were given to
the A. sacralis mediana and the A. coccygea media. In
specimen no. 14, the first sacral sympathetic ganglion formed
a loop surrounding the vessel that was passing into the
sacral canal. Their fine nature makes it easy to miss these
branches in some specimens, Botár (1932) experienced a simi-
lar problem. Still Zintzsch's (1964) illustrations show
their common occurrence in the sheep.

The Rami communicantes

These are irregular in the number present on both sides of the body, especially in the lumbar region, where at some segments there are two or three rami and at others only one Ramus communicans is found. In the sacral and coccygeal region single Rami communicantes are constantly found (Figures 4, 17, 19, 21, 22, 23, 24). While most of the Rami communicantes are connected to the ganglia some of them join the trunks between ganglia and in some cases they appear to continue as the Nn. splanchnici (Figures 17, 19, 21, 23; Plates 11, 13, 14a).

The splanchnic nerves (Nn. splanchnici)

The Nn. thoracici splanchnici were observed, appearing at the level of the last two thoracic vertebrae winding lateral to the crura of the M. diaphragma. There were more of these on the left side than on the right (Figures 17, 21, 23; Plates 13, 14a). They joined the G. Coeliaco-mesentericum and adrenal plexus.

The lumbar splanchnic nerves were observed again to be more on the left than on the right side (Figures 17, 19, 21, 23; Plates 13, 14a). Four to five or more were present on the left side while up to three could be made out on the right side. The first of these partly joins the caudal part of the G. coeliaco-mesentericus or adrenal plexus or it may join the G. renalis. The rest join the intermesenteric

trunks and pass on the ventrolateral aspect of the Aorta abdominalis and end by joining the G. genitalis and G. mesentericus caudalis, but some of them bypass these ganglia and are continued into the Nn. hypogastrici.

The intermesenteric trunks run from the caudal end of the G. coeliaco-mesentericus to the G. mesentericus caudalis and G. genitalis. On their way caudally they receive the Nn. splanchnici lumbales.

The prevertebral ganglia

These comprise the G. coeliaco-mesentericus, G. renalis, G. genitalis, and G. mesentericus caudalis. In the pig these ganglia were all found.

The G. coeliaco-mesentericus as the name indicates results from the fusion of the G. coelicus and G. mesentericus cranialis. They were combined in such a way as to make two masses which were more or less almost fused completely because of the many communicating branches between the two and also between the ganglia and the underlying adrenal glands (Figure 23: 4). The dorsal branch of the N. vagus is also shown (Figure 23: 1). The ganglia surrounds the Aa. coelica and mesenterica cranialis. Dyce (1958) found, in the horse, that the right G. coelicus and G. mesentericus cranialis of the same side join and, in turn, join the opposite side resulting in two masses.

From the fused ganglia run the two intermesenteric trunks.

While a separate G. renalis was found on the left side in one of the specimens there was none seen on the right and the renal plexus on the right side started from the caudal end of the G. coeliaco-mesentericus of the respective side. The ganglion renalis seen on the left side was placed ventral to the origin of the A. renalis and was connected with the G. coelico-mesentericus and with the first N. splanchnicus lumbalis.

The G. aortico-renalis, as noted in the horse by Dyce (1958) and in the dog by Miller, Christensen and Evans (1964), was not easily made out in the pig.

The G. genitalis was seen separate in three of the specimens examined for this study, and in one specimen it was considered fused with the G. mesentericus caudalis. The arteries were also fused at their origin (Figure 23: 7, H, J). The G. mesenterici caudales appear fused and lying on either side of the A. mesenterica caudalis, with the A. genitalis interposed on either side between the former vessel and the gangliar mass. The whole arrangement was plexiform. The ganglia are located at the level of the six lumbar vertebra near the origin of the A. iliaca externa. From this ganglion arises the Plexus mesentericus which divides to follow the two branches of the artery, cranially and caudally (Figures 17: 20, 18; 19; 18: 4, 7, 8; 19: 16, 17; 20: 2; 21: 20, 22; 23: 7, 8, 9, 10, 11). Here also arises

the Nn. hypogastrici, which follow the lateral aspect of the rectum and meet with the N. splanchnicus pelvinus at the neck of the urinary bladder to form the Plexus plevinus.

In one specimen in which the G. genitalis was fused into the G. mesentericus caudalis, the N. genitalis (N. utero-ovarica in this case) arose from here on either side and accompanied the A. utero-ovarica and divided in the manner of the vessel to the ovary, uterine tube and uterine cornu. The ureteral branch arose from the same place and ran cranial along the ureter. Frewein (1962) states that the ureter receives the sympathetic supply from the internal spermatic plexus, Plexus pelvinus, and rarely from the Plexus renalis, this is for the bovine; the latter nerves were not accompanied by vessels.

The Plexus pelvinus N. splanchnici sacrales

The Plexus pelvinus is a bilateral plexus formed by the N. hypogastricus, N. splanchnicus pelvinus and in some cases a contribution from the N. pudendus (Figures 2, 5, 18, 20, 25). It is a plexus responsible for the innervation of the urogenital and terminal digestive tract. The relationship of the three nerve components has been fully described before.

This plexus sends innervation to the bladder, to the ureter, the caudal part of the uterus, the vagina, and the accessory sexual glands. There was also found a branch which followed the ductus deferens which appeared to be continued

from the N. splanchnicus pelvinus (Figures 18: 21; 20: 9;
25: 9). A well established nerve runs from the plexus and
continues caudally to the rectum and middle part of the M.
retractor penis (Figures 20: 10; 25: 5). While the plexus
innervates the smooth muscle organs the N. pudendus inner-
vates those organs having a striated voluntary muscle.

SUMMARY AND CONCLUSIONS

The Somatic Nerves

The somatic and autonomic nerves in the lumbar and pelvic regions of the domestic pig, Sus scrofa domesticus, were studied. This was done by dissections on fifteen specimens consisting of eight females and seven males (four castrated), ranging in age from three months to 6-1/2 years. They were of various breeds: 6 Yorkshire, 3 Poland-China, 2 Landrace, and 4 Yorkshire-Landrace. Lateral and medial approaches were followed to expose the nerves.

The Nn. spinales lumbales consisted of six pairs in thirteen specimens, five pairs in one, and was not counted in one specimen since the cranial part of the lumbar area had previously been removed. The Nn. spinales lumbales showed two modes of arrangement in relation to the Mm. psoas major and minor. In the most commonly encountered mode they leave the intervertebral foramina and pass between the M. quadratus lumborum dorsally and the Mm. psoas major and minor ventrally to emerge from them at their lateral border. The Nn. L_3 and L_4, however, emerged ventrally between the M. psoas major and M. psoas minor, in 13 cases. In one case in which the lumbar vertebrae were five, the Nn. L_2 and L_3 were the ones which emerged between the M. psoas major and M. psoas minor. The ventral branches of the L_2 spinal nerve penetrated the M.

psoas major and emerged from it on the ventral surface of its cranial third in the other mode of arrangement, which was seen in one specimen.

The ventral branches of the L_1, L_2, L_3 and L_4 spinal nerves innervate the paralumbar area of the abdominal wall including the inguinal, caudal preputial, mammary and cranial scrotal areas; the remainder course to the hind limb and the perineum.

All of the ventral branches of the Nn. spinales lumbales have intercommunicating branches between the L_2 and L_6 spinal nerves, inclusively. On occasions connections were seen between the L_1 and L_2 on one side or the other.

The lumbosacral plexus is formed by the ventral branches of the last three Nn. spinales lumbales and the first three Nn. spinales sacrales. In about 46 percent of the cases the fourth component from the lumbar region comprised by the L_3 spinal nerve joined in the formation of the plexus.

The Nn. hypogastricus and ilioinguinalis were present, except in one case in which the former was usurped by the extra pair of ribs and the naming shifted caudally.

There was no specimen presenting seven pairs of Nn. spinales lumbales.

N. genitalis (N. spermaticus externus) was formed by:

L_2, L_3 in 2 cases

L_2, L_3, L_4 in 2 cases

    L_3, L_4 in 10 cases.

The most common contributor to the nerve was the L_3.

N. cutaneus femoris lateralis was formed by:

L_2, L_3 in 2 cases

L_2, L_3, L_4 in 1 case

    L_3, L_4 in 11 cases.

Although L_3 appears to have contributed more frequently than any other, the main contributor was the L_4. The N. cutaneus femoris lateralis, in addition to the destination bearing its name, innervates part of the paralumbar and inguinal region. It almost always exchanges fibers with the N. genitalis (N. spermaticus externus).

N. femoralis was formed by:

L_3, L_4 in 1 case

L_3, L_4, L_5 in 6 cases

    L_4, L_5 in 4 cases

    L_4, L_5, L_6 in 3 cases.

In this nerve the L_5 was the main root but the L_4 had contributed equally in more than half of the cases.

N. obturatorius was formed by:

L_3, L_4 in 1 case

L_3, L_4, L_5 in 5 cases

L_3, L_4, L_5, L_6 in 1 case

    L_4, L_5 in 2 cases

    L_4, L_5, L_6 in 5 cases.

In this nerve the L_4 and the L_5 were the main contributors.

N. glutaeus cranialis was formed by:

L_3, L_4, L_5 S_1, S_2 in 1 case

    L_4, L_5, L_6, S_1 in 1 case

        L_5, L_6, S_1 in 8 cases

        L_5, L_6, S_1, S_2 in 4 cases

In this nerve the L_5, L_6 and S_1 are the main contributors.

N. glutaeus caudalis was formed by:

L_3, L_4, L_5 S_1, S_2 in 1 case

        L_5, L_6, S_1, S_2 in 10 cases

            L_6, S_1, S_2 in 3 cases

Here again it is the S_1 and S_2 which are the predominant con-
tributors to N. glutaeus caudalis.

N. ischiadicus was formed by:

L_3, L_4, L_5 S_1, S_2 in 1 case

L_3, L_4, L_5, L_6, S_1, S_2 in 1 case

    L_4, L_5, L_6, S_1, S_2 in 2 cases

        L_5, L_6, S_1, S_2 in 10 cases

As can be deduced from these figures the L_5, L_6, S_1 and
S_2 are the most common contributors to the N. ischiadicus.

N. splanchnicus pelvinus was formed by:

S_1, S_2 in 3 cases

    S_2, S_3 in 12 cases

In this nerve the figures show the S_2 to be the central

core to which others converge, but it is safe to say that the S_2 and S_3 are the main contributors.

N. pudendus was formed by:

S_1, S_2, S_3	in 1 case
S_2, S_3	in 11 cases
S_2, S_3, S_4	in 3 cases

This nerve is obviously formed by the S_2 and S_3 in most of the cases. The N. pudendus terminates by dividing into the Nn. clitoridus and mammarius in the female, or the Nn. dorsalis penis and scrotalis medius in the male.

N. cutaneus femoris caudalis was formed by:

S_1, S_2	in 1 case
S_1, S_2, S_3	in 3 cases
S_2	in 5 cases
S_2, S_3	in 6 cases

Again here the S_2 and S_3 are the main contributors to the N. cutaneus femoris caudalis.

Nn. rectales were formed by:

S_1, S_2, S_3, S_4	in 1 case
S_2, S_3, S_4	in 11 cases
S_3, S_4	in 3 cases

By virtue of the communications which the N. pudendus has with the S_4, it can be said that the Nn. rectales are formed mainly by the S_3 and S_4.

The Nn. perineales have similar origins to those of the

N. pudendus, and it should be remembered that they also receive a constant contribution by means of the communicating branch from the N. ischiadicus to the N. pudendus, which allows nerve fibers from the lumbar region to reach the perineum.

The N. dorsalis penis has a spiral and wavy course on the corpus cavernosum.

The Autonomic Nerves

Observations were made on the sympathetic trunks in the lumbar and pelvic regions including the coccygeal area. The general arrangement of the ganglia in the sympathetic trunks, and the collateral ganglia in the abdomen and pelvis were investigated. The relationship of the sympathetic and parasympathetic nerves in the formation of the abdominal and pelvic plexuses was investigated. This was carried out on seven specimens.

There were constantly six pairs of sympathetic ganglia in the lumbar region, four pairs in the sacral and between four to six macroscopically visible pairs of sympathetic ganglia in the coccygeal region. Although there was one case in which the first and second sacral pairs had fused on their respective sides, there was no such tendency in the lumbar area, instead a ganglion paravertebrale accessorium was found at the lumbosacral disc on the right side.

The G. coeliacus and a mesentericus cranialis of each side joined into a G. coeliacomesentericus by means of transverse fibers.

A G. renalis was present on the left side, but the Plexus renalis on the right side appeared to come off the caudal border of the G. coeliacomesentericus.

A G. genitalis was present on both sides, but in one case it was fused with the G. mesentericus caudalis. The latter, in some cases, fused closely, but in other cases they remained conspicuously separate.

From the fused G. mesentericus caudalis arise the N. hypogastricus, N. genitalis, Plexus mesentericus caudalis and Plexus uretericus.

The G. genitalis gave rise to the N. utero-ovaricus in the female and the N. testicularis in the male. They follow their respective arteries.

The N. hypogastricus traverses along layers of the peritoneum to meet the N. splanchnicus pelvinus arising from the sacral roots of the spinal nerves to form the Plexus pelvinus in the area of the neck of the bladder.

Often the N. pudendus gives off a branch which continues its course in a cranial direction and joins the Plexus pelvinus. On its course it innervates the striated muscles of the urogenital tract as far craniad as the neck of the bladder.

From the Plexus pelvinus arise the secondary plexuses to the bladder, the urethra, the accessory sex glands, the neck, body and caudal part of the horns of the uterus, the vagina, and the ductus deferens. A fairly large fiber passes caudally along the rectum to innervate the middle part of the M. retractor penis and partly penetrates the wall of the rectum to innervate the M. sphincter ani internus.

There were two cases, one in the sacral region and one in the coccygeal region, in which the sympathetic ganglia joined to produce a Ganglion impar. In the former case it occurred at the third pair of sacral sympathetic ganglia and in the latter case it was at the fourth pair of the coccygeal ganglia. In the sacral instance the trunci sympathici ran separately from the fused ganglia, with large ganglia discernable up to the second coccygeal vertebra, after which the ganglia were too small to observe macroscopically. However, the trunks joined at the fourth coccygeal vertebra. From here the behavior of the trunk in both cases was similar. The A. coccygea mediana is enclosed by a meshwork of fibers from these trunks.

The Rami communicantes were commonly paired in the lumbar region, and on very rare occasions at the first sacral sympathetic ganglia.

The Rami communicantes transversi were not observed in the lumbar region, but were irregularly found in the sacral and coccygeal regions.

In order to determine a statistically significant figure for the number of lumbar spinal nerves, more specimens need to be investigated, as well as various breeds. The results of this limited study emphasize the fact that there exists a wide variation in the origin of the component rami which form the lumbar nerves.

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APPENDIX A

Table 1. Comprehensive table for specimens examined showing the origin of somatic nerves in lumbar and sacral regions

A[a]	B	C[b]	D	E	F	G	H	I
1	Yorkshire	M-	180 lb	8 mo	6	$L_{3,4}$	$L_{3,4}$	$L_{4,5}$
2	Yorkshire	M-	195 lb	9-1/2 mo	6	$L_{2,3,4}$	$L_{2,3,4}$	$L_{4,5}$
3	Yorkshire	F	183 lb	10 mo	6	$L_{3,4}$	$L_{3,4}$	$L_{4,5}$
4	Yorkshire	F	590 lb	6-1/2 yr	5	$L_{2,3}$	$L_{2,3}$	$L_{3,4}$
5	Landrace	F	529 lb	6-1/2 yr	6	$L_{3,4}$	$L_{3,4}$	$L_{3,4,5}$
6	York-Landrace	F	452 lb	2-1/2 yr	6	$L_{2,3}$	$L_{2,3}$	$L_{3,4,5}$
7	York-Landrace	F	410 lb	2 yr	6	$L_{3,4}$	$L_{3,4}$	$L_{3,4,5}$
8	York-Landrace	F	535 lb	2 yr	6	$L_{3,4}$	$L_{3,4}$	$L_{4,5}$
9	Poland-China	M	729 lb	5 yr	6	$L_{3,4}$	$L_{3,4}$	$L_{3,4,5}$
10	York-Landrace	M-	175 lb	8 mo	6	$L_{3,4}$	$L_{3,4}$	$L_{3,4,5}$
11	Yorkshire	M	30 lb	3 mo	6	$L_{3,4}$	$L_{3,4}$	$L_{4,5,6}$
12	Yorkshire	M	60 lb	4 mo	6	$L_{2,3,4}$	$L_{3,4}$	$L_{4,5,6}$
13	Poland-China	M-	150 lb	6 mo	6	$L_{3,4}$	$L_{3,4}$	$L_{3,4,5}$
14	Yorkshire	F	658 lb	6 yr	6			
15	Poland-China	F	180 lb	8 mo	6	$L_{3,4}$	$L_{3,4}$	$L_{4,5}$

[a] A-Specimen no.; B-Breed; C-Sex; D-weight; E-Age; F-No. lumbar nerves; G-N. genitalis; H-N. cut. fem. lateralis; I-N. femoralis; J-N. obturatorius; K-N. glut. cranialis; L-N. glut. caudalis; M-N. ischiadicus; O-N. pudendus; P-N. cut. fem. caudalis; Q-N. rectalis caudalis.

[b] F = female; M = male; M- = male castrated.

J	K	L	M	N	O	P	Q
$L_{4,5,6}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{2,3}$	$S_{3,4}$
$L_{4,5,6}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{2,3}$	$S_{2,34}$
$L_{4,5,6}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{2,3}$	$S_{2,3,4}$
$L_{3,4}$	$L_{3,4,5}S_{1,2}$	$L_{3,4,5}S_{1,2}$	$L_{3,4,5}S_{1,2}$	$S_{2,34}$	$S_{1,2,3}$	$S_{1,23}$	$S_{2,3,4}$
$L_{3,4,5,6}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{1,23}$	$S_{3,4}$
$L_{3,4,5}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{2,3}$	$S_{2,34}$
$L_{3,4,5}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{1,23}$	$S_{2,3,4}$
$L_{4,5}$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$L_{4,5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	S_2	$S_{2,34}$
$L_{3,4,5}$	$L_{5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{3,4,5,6}S_{1,2}$	$S_{1,2}$	$S_{2,3}$	S_2	$S_{2,3,4}$
$L_{3,4,5}$	$L_{5,6}S_1$	$L_6S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{2,3,4}$
$L_{4,5,6}$	$L_{5,6}S_1$	$L_6S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,34}$	$S_{2,3}$	$S_{2,3,4}$
$L_{4,5,6}$	$L_{5,6}S_1$	$L_6S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3,4}$	S_2	$S_{2,3,4}$
$L_{3,4,5}$	$L_{4,5,6}S_1$	$L_{5,6}S_{1,2}$	$L_{4,5,6}S_{1,2}$	$S_{1,2}$	$S_{1,2,3}$	S_2	$S_{1,23,4}$
	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	$S_{1,2}$	$S_{3,4}$
$L_{4,5,6}$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$L_{5,6}S_{1,2}$	$S_{2,3}$	$S_{2,3}$	S_2	$S_{2,3,4}$

Table 2.   Distribution of the roots which form the somatic nerves in the lumbar[a] and sacral[b] regions

Name of nerve	L1	L2	L3	L4	L5	L6	L7	S1	S2	S3	S4	Cases
N. iliohypogastricus	+											14
N. ilioinguinalis		+										14
N. genitalis		+	+									2
(N. spermaticus		+	+	+								2
externus)			+	+								10
N. cutaneus femoris		+	+									2
lateralis		+	+	+								1
			+	+								11
N. femoralis			+	+								1
			+	+	+							6
				+	+							4
				+	+	+						3
N. obturatorius			+	+								1
			+	+	+							5
			+	+	+	+						1
				+	+							2
				+	+	+						5
N. glutaeus cranialis			+	+	+	+		+	+			1
				+	+	+		+				1
					+	+		+				8
					+	+		+	+			4
N. glutaeus caudalis			+	+	+			+	+			1
				+	+			+	+			10
					+			+	+			3
N. ischiadicus			+	+	+			+	+			1
			+	+	+	+		+	+			1
				+	+	+		+	+			2
					+	+		+	+			10
N. splanchnicus pelvinus								+	+			3
									+	+		12

[a] 14 specimens.

[b] 15 specimens.

Table 2. (Continued)

Name of nerve	L_1	L_2	L_3	L_4	L_5	L_6	L_7	S_1	S_2	S_3	S_4	Cases
N. pudendus								+	+	+		1
									+	+		11
									+	+	+	3
N. cutaneus femoris caudalis								+	+			1
								+	+	+		3
									+			5
									+	+		6
Nn. rectales[c]								+	+	+	+	1
									+	+	+	11
										+	+	3

[c]The Nn. rectales include those other nerves that either join the S_4 or reach the same destination separately.

APPENDIX B

Figure 1. The lumbosacral plexus of the pig, left side,
           ventral view

Specimen no. 2 ♂

1 Th = last thoracic spinal nerve - has a cutaneus branch and
   a branch to the Mm. obliquus externus abdominis, trans-
   versus abdominis and rectus abdominis
2 Cranial branch of N. iliohypogastricus - to the skin and M.
   obliquus externus abdominis
3 Caudal branch of N. iliohypogastricus - to the Mm.
   transversus abdominis and rectus abdominis
4 Cranial branch of N. ilioinguinalis - to M. obliquus
   externus abdominis and skin
5 Cranial intermediate branch of N. ilioinguinalis - to Mm.
   obliquus internus abdominus and rectus abdominis and
   skin
6 Caudal intermediate branch of N. ilioinguinalis - to Mm.
   obliquus internus abdominis, obliquus externus ab-
   dominis and skin
7 Caudal branch of N. ilioinguinalis - special to M.
   obliquus internus abdominis
8 Branches to Mm. psoas major and minor
9 N. genitalis (N. spermaticus externus)
9' Branch of 9 to M. obliquus internus abdominis
9" and 9"' Continuation of 9 through inguinal canal as
   N. inguinalis
10 N. cutaneus femoris lateralis
11 Branches to M. psoas major
12 N. femoralis
13 N. obturatorius
14 N. glutaeus cranialis
15 N. ischiadicus
16 Communicating branch from N. ischiadicus to N. pudendus
17 N. pudendus
18 N. splanchnicus pelvinus
19 Nn. rectales caudales (Nn. haemorrhoidales caudales)
L_1 - L_6 Ventral branches of Nn. spinales lumbales
S_1 - S_4 Ventral branches of Nn. spinales sacrales
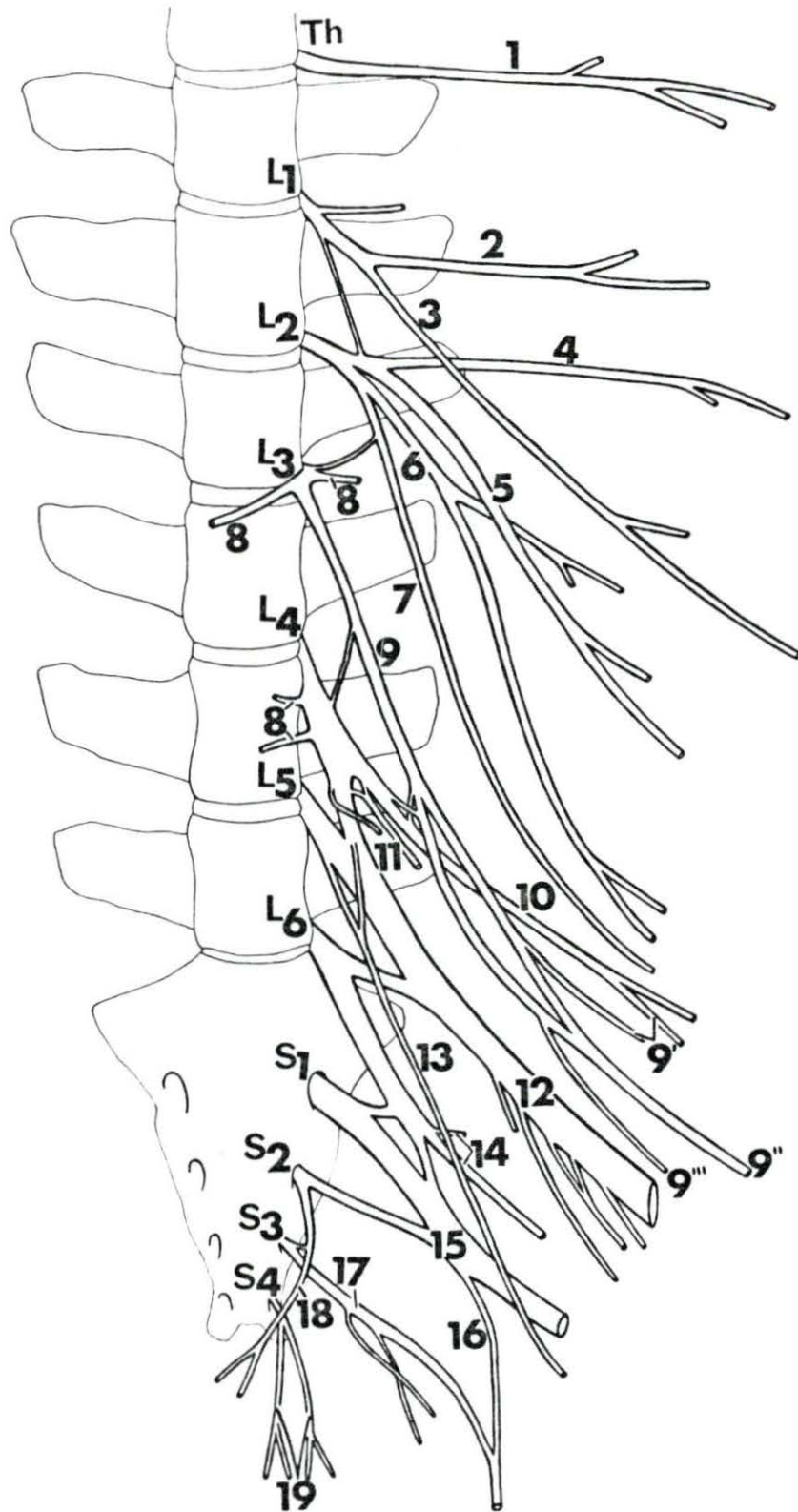
Figure 2. The lumbosacral plexus. Right side.

Specimen no. 3 ♀

1 N. genitalis (N. spermaticus externus)
2 N. cutaneus femoris lateralis
3 Branch of 2 to Mm. obliquus internus abdominis and cremastericus externus
4 N. genitalis continued into the inguinal region
5 N. femoralis
6 N. obturatorius
7 N. glutaeus cranialis
8 N. ischiadicus
9 N. glutaeus caudalis
10 Communicating branch from N. ischiadicus to N. pudendus
11 N. pudendus
12 N. cutaneus femoris caudalis
13 Branch of 11 to M. coccygeus
14 Nn. rectales caudales (Nn. haemorrhoidales caudales) to M. levator ani and
    anal skin and a branch joining Nn. coccygei
15 N. perinealis superificialis (N. labialis) from 11
16 and 17 Nn perineales profunda from 11 to Mm. sphincter ani externus and
    constrictor vulvae and adjacent skin
18 N. clitoridis from 11
19 N. mammarius caudalis from 11
20 Branch from 11 to urogenital tract
21 N. splanchnicus pelvinus
22 N. hypogastricus (sympathicus)
    L_3 - L_6 Ventral branches of Nn. spinales lumbales
    S_1 - S_4 Ventral branches of Nn. spinales sacrales
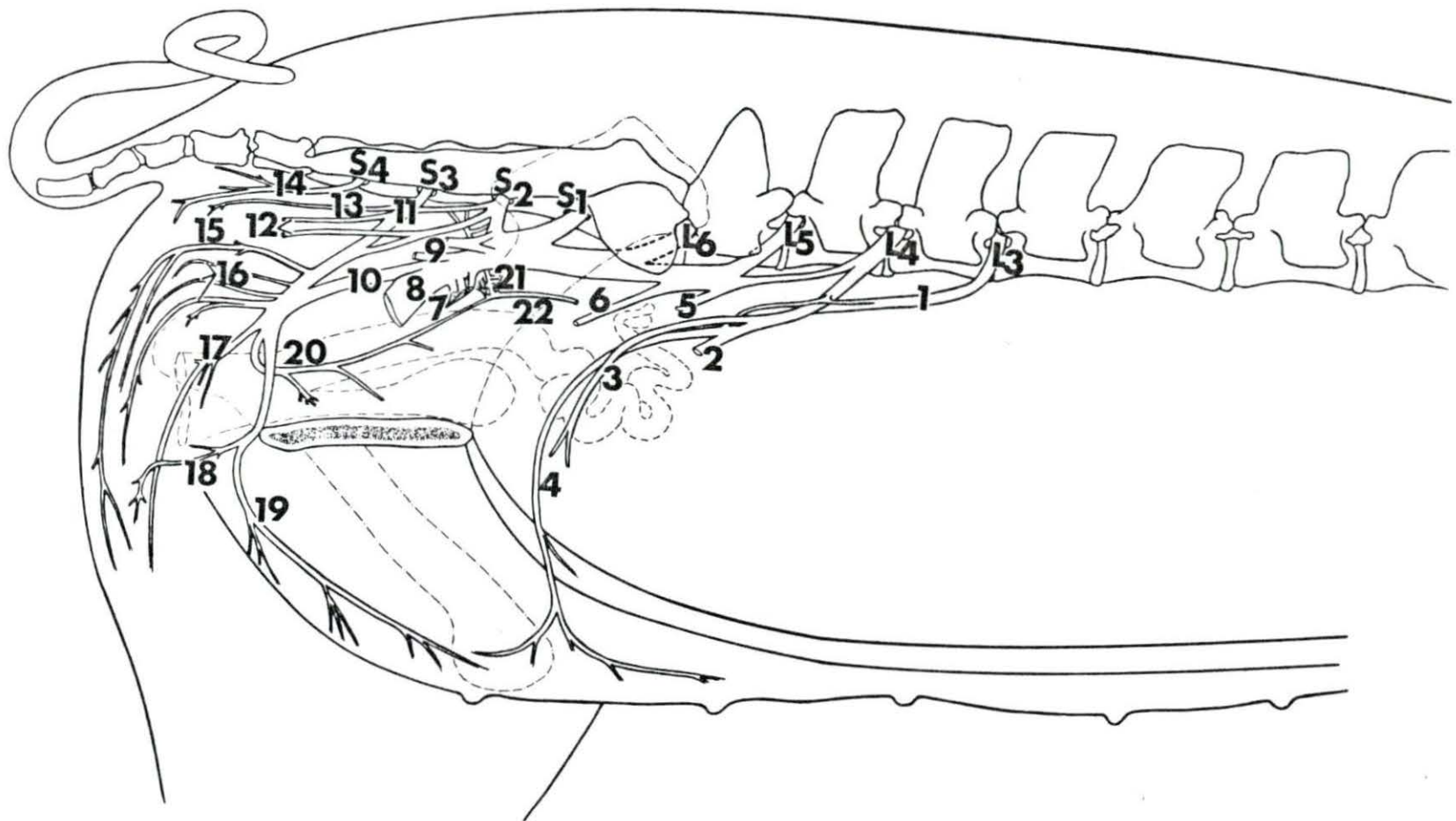
Figure 3. The lumbosacral plexus of the pig, left side

Specimen no. 3 ♀

1 N. iliohypogastricus
2 N. ilioinguinalis
3 Branch to M. psoas major
4 Branch to M. obliquus internus abdominis
5 N. genitalis (N. spermaticus externus)
6 N. cutaneus femoris lateralis
7 Branch to Mm. obliquus internus abdominis, and cremastericus externus
8 Continuation of 5 (N. inguinalis)
9 N. femoralis
10 N. obturatorius
11 N. glutaeus cranialis
12 N. splanchnicus pelvinus
13 N. pudendus
14 Branch of 13 to M. coccygeus
15 N. cutaneus femoris caudalis
16 Nn. rectales (Nn. haemorrhoidales caudales) to M. levator ani
   and adjacent skin
17 Branch from S_4 joining Nn. coccygei for ventral coccygeal mucles
18 N. perinealis superficialis (N. labialis) from 13
19 N. ischiadicus
20 Communicating branch from N. ischiadicus to N. pudendus
21 N. perinealis profundus to M. sphincter ani externus and M.
   constrictor valvae and adjacent skin
22 N. clitoridis
23 N. mammarius caudalis
24 N. glutaeus caudalis
   L_1 - L_6 = ventral branches of Nn. spinales lumbales
   S_1 - S_4 = ventral branches of Nn. spinales sacrales
   Th = ventral branch of last thoracic spinal nerve
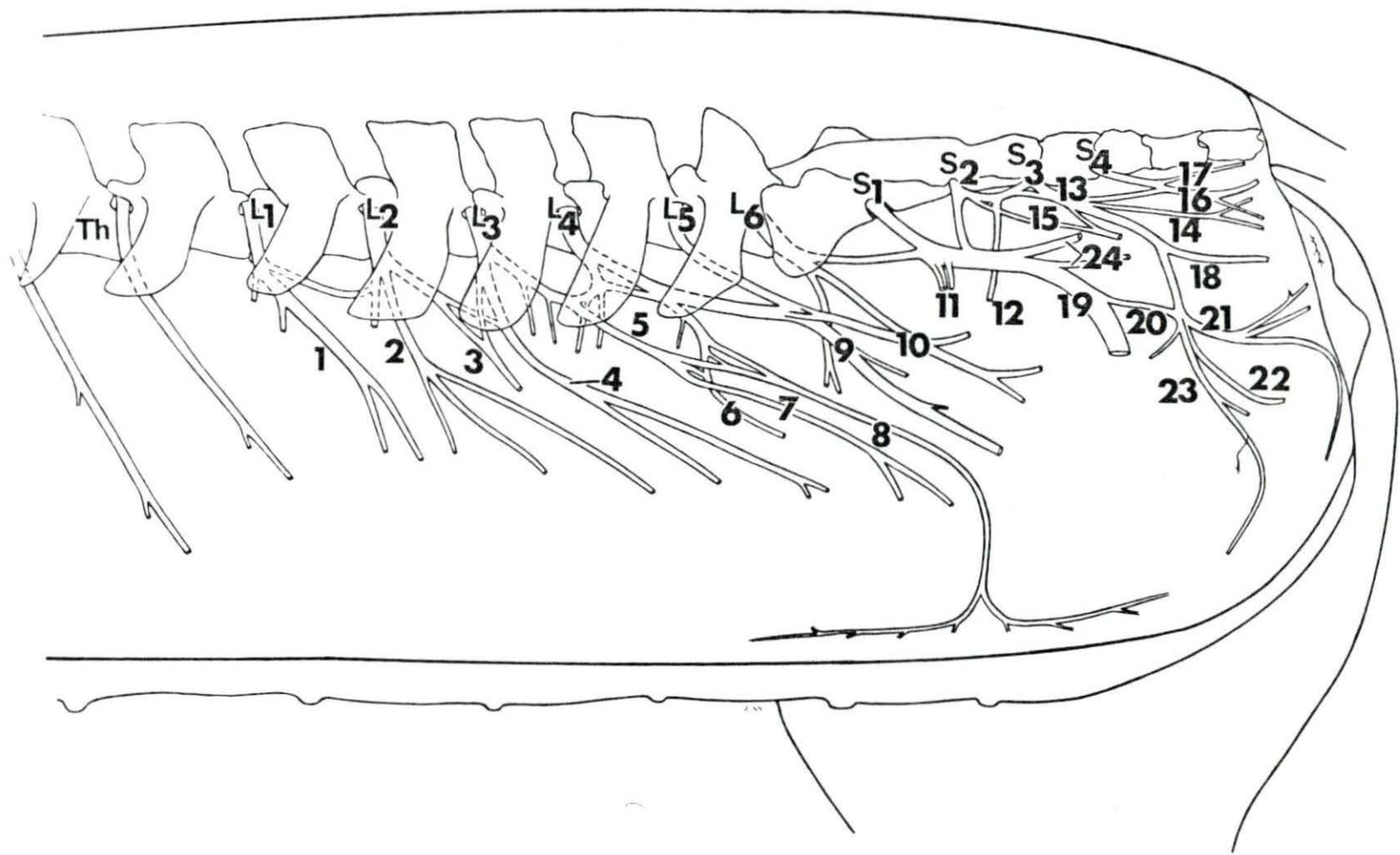
Figure 4.   Ventral branches of the lumbar and sacral
            spinal nerves and the sympathetic trunk,
            ventral view

Specimen no. 4   ♀

 1 N. ilioinguinalis
 2 N. genitalis (N. spermaticus externus)
 3 N. cutaneus femoris lateralis
 4 N. femoralis
 5 N. obturatorius
 6 N. ischiadicus
 7 N. pudendus
 8 Communicating branch from N. ischiadicus to
    N. pudendus
 9 N. cutaneus femoris caudalis
10 Branch of 7 to M. coccygeus
11 Nn. rectales caudales (Nn. haemorrhoidales caudales)
    to M. levator ani and anal skin
12 N. glutaeus cranialis
13 Truncus sympathicus
14 Ganglion sympathicum sacrale primum
 A Rudiments of last rib on left side
 B M. transversus abdominis
 C M. psoas major incised and displaced to the side to
    show the nerves innervating it
    L_1 - L_5 Ventral branches of Nn. spinales lumbales
    S_1 - S_4 Ventral branches of Nn. spinales sacrales
    Th Ventral branch of the last thoracic spinal nerve

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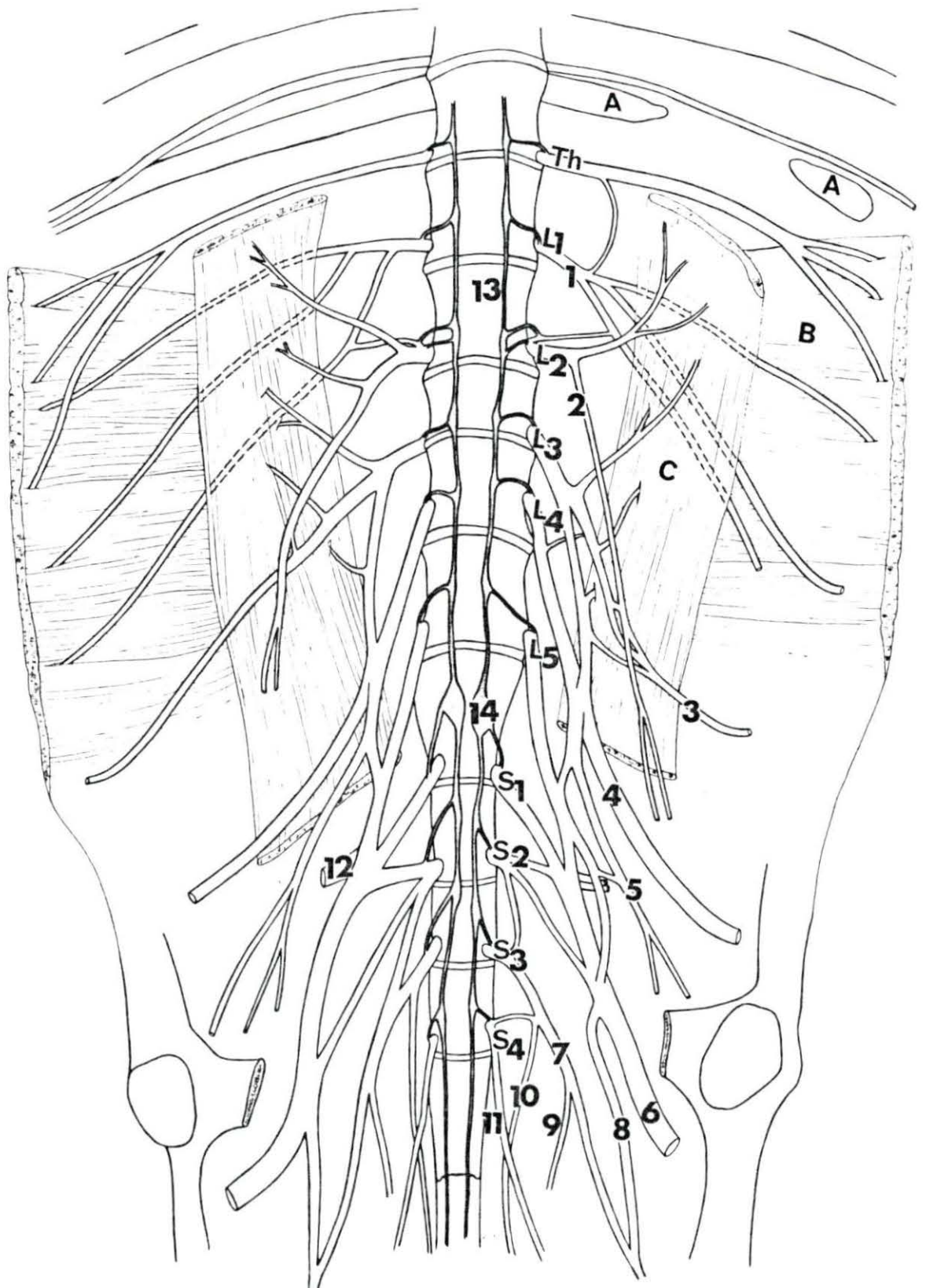
Figure 5. The lumbosacral plexus: nerves spread out, lateral view

Specimen no. 6 ♀

1 Ventral branch of last thoracic spinal nerve (Th)
2 N. iliohypogastricus
3 a,b,c, and d N. ilioinguinalis and its branches
4 and 4a N. genitalis (N. spermaticus externus) and its continuation through inguinal canal
5 N. cutaneus femoris lateralis
6 Branch of 4 and 5 forming N. inguinalis
7 Branch of 4 to M. ogliquus internus abdominis
8 Branch of 4 to M. cremastericus externus
9 Branch of N. femoralis to M. iliacus
10 N. femoralis
11 Branches of 10 to M. iliopsoas
12 N. saphenus from 10
13 Branches of 10 to M. quadratus femoris
14 N. obturatorius
15 N. ischiadicus
16 N. gluteaus cranialis
17 N. gluteaus caudalis
18 N. splanchincus pelvinus
19 Communicating branch from N. ischiadicus to N. pudendus
20 Branch of N. pudendus to urogenital tract
21 N. hypogastricus (sympathicus)

22 Branch of N. pudendus to M. coccygeus
23 N. cutaneus femoris caudalis
24 N. pudendus
25 Nn. rectales caudalis (Nn. haemorrhoidales caudales)
26 N. rectalis medius (N. haemorrhoidalis medius)
27 N. perinealis superficialis (N. labialis) from 24
28 N. perinealis profundus to Mm. sphincter ani externus and constrictor vulvae
29 N. clitoridis
30 N. mammarius caudalis
L_1-L_6 Ventral branches of Mn. spinales lumbales
S_1-S_4 Ventral branches of Nn. spinales sacrales
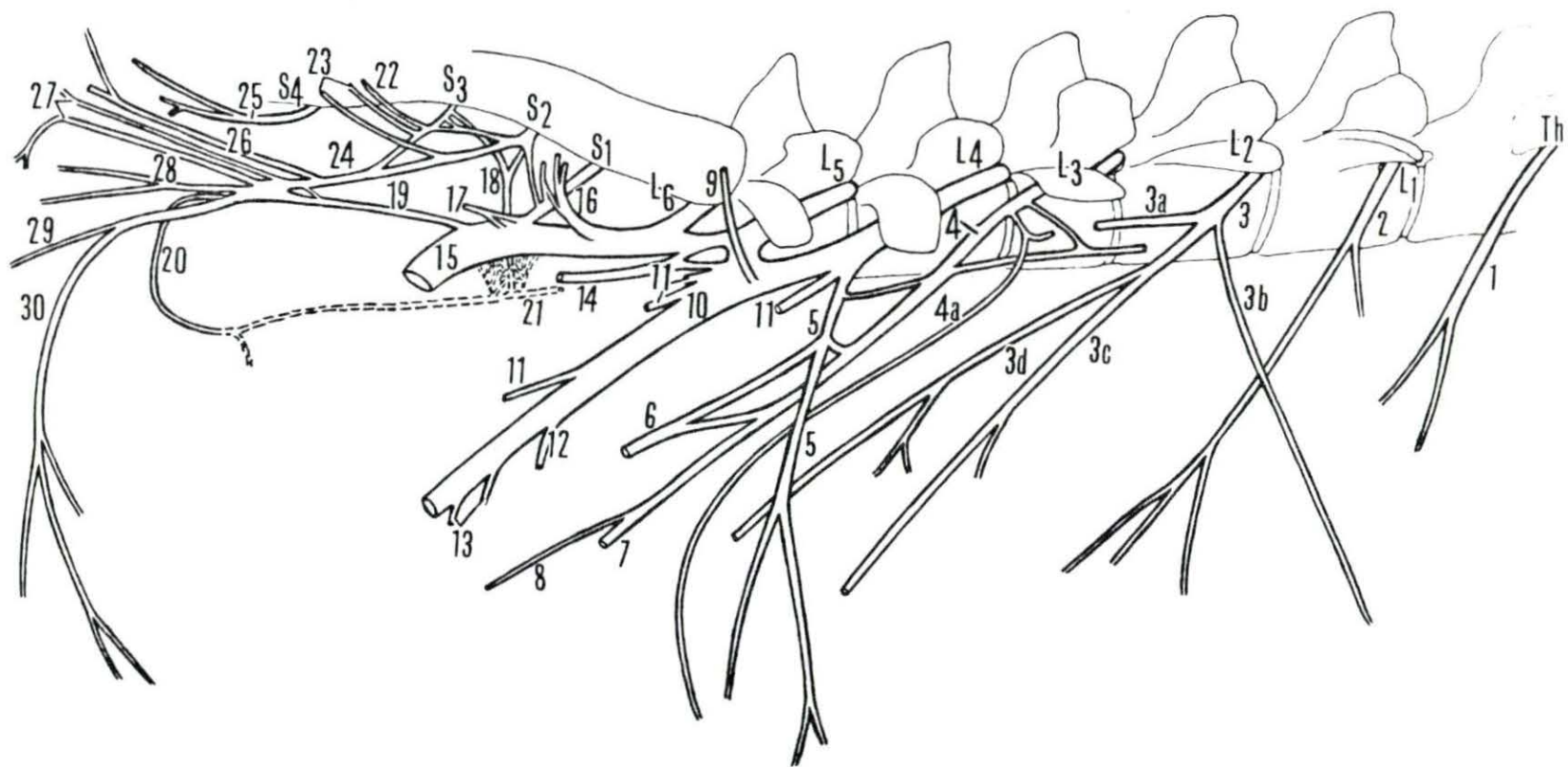
Figure 6.   Arrangement of the dorsal branches of lumbar spinal nerves
            revealed after removal of Mm. longissimus dorsi and
            multifidus dorsi   Dorsolateral view

                    Specimen no. 7   ♀

Th   Dorsal branches of last two thoracic spinal nerves
Th'   Dorsomedial branch of the last thoracic spinal nerve
Th"   Dorsolateral branch of the last thoracic spinal nerve
L_1 - L_5 Dorsal branches of Nn. spinales lumbales
 A   Remains of M. longissimus dorsi
 B   M. transversus abdominis
 C   M. obliquus externus abdominis
 D   M. obliquus internus abdominis
 E   M. tensor fasciae latae
 F.   M. glutaeus medius, reflected
 G   Ligsmenta intertransversaria
 H   Ligaments interspinalia
 S   Sacrum
DS   Dorsal spinous process of L_1 vertebra
TP   Transverse processes of lumbar vertebrae
 W   Wing of Os ilium
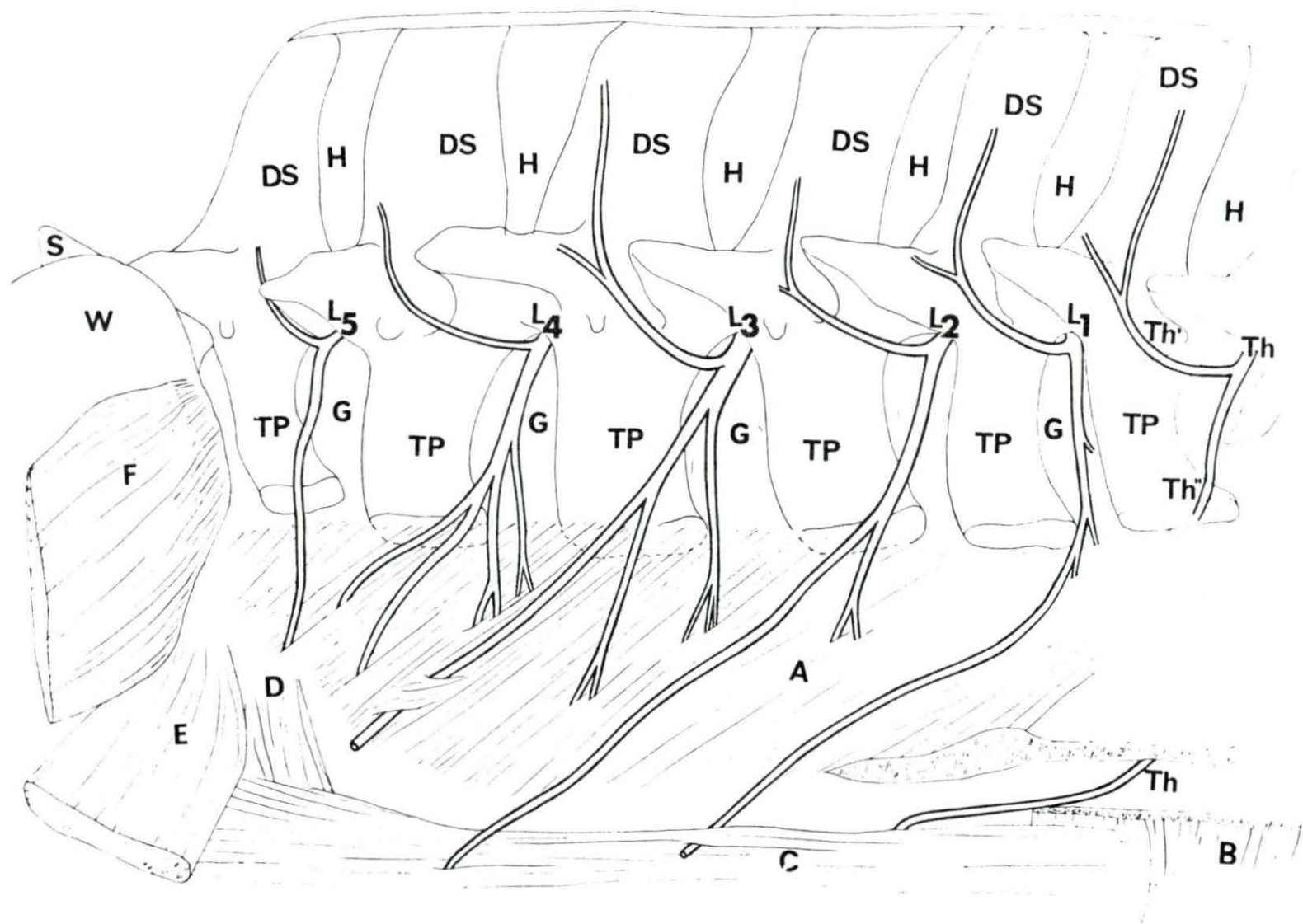
Figure 7. Superficial view revealing one of the modes of arrangement
of the ventral branches of the lumbar spinal nerves in
relation to Mm. psoas major and minor in Situ, right side
Ventral view

Specimen no. 6   ♀

1   Last intercostal nerve
2   Ventral branch of last thoracic spinal nerve
3   Ventral branch of L_1 spinal nerve
4 and 5   Ventral branches of L_2 spinal nerve
6   Communicating branch from L_3 spinal nerve to L_2 spinal nerve
7   Ventral branch of L_3 spinal nerve (N. genitalis)
8   Ventral branch of L_4 spinal nerve leading to N. cutaneus femoris
    lateralis
9   Continuation of 7 as N. inguinalis
10 Branch of 7 to M. cremaster externus
11 Continuation of 8
12 Branch of 7 to M. obliquus internus abdominis
A   Right crus of M. diaphragma
B   M. psoas minor
C   M. psoas major
D   M. transversus abdominis
E   M. quadratus lumborum
F   M. obliquus internus abdominis
G   M. rectus abdominis
H   M. cremaster externus
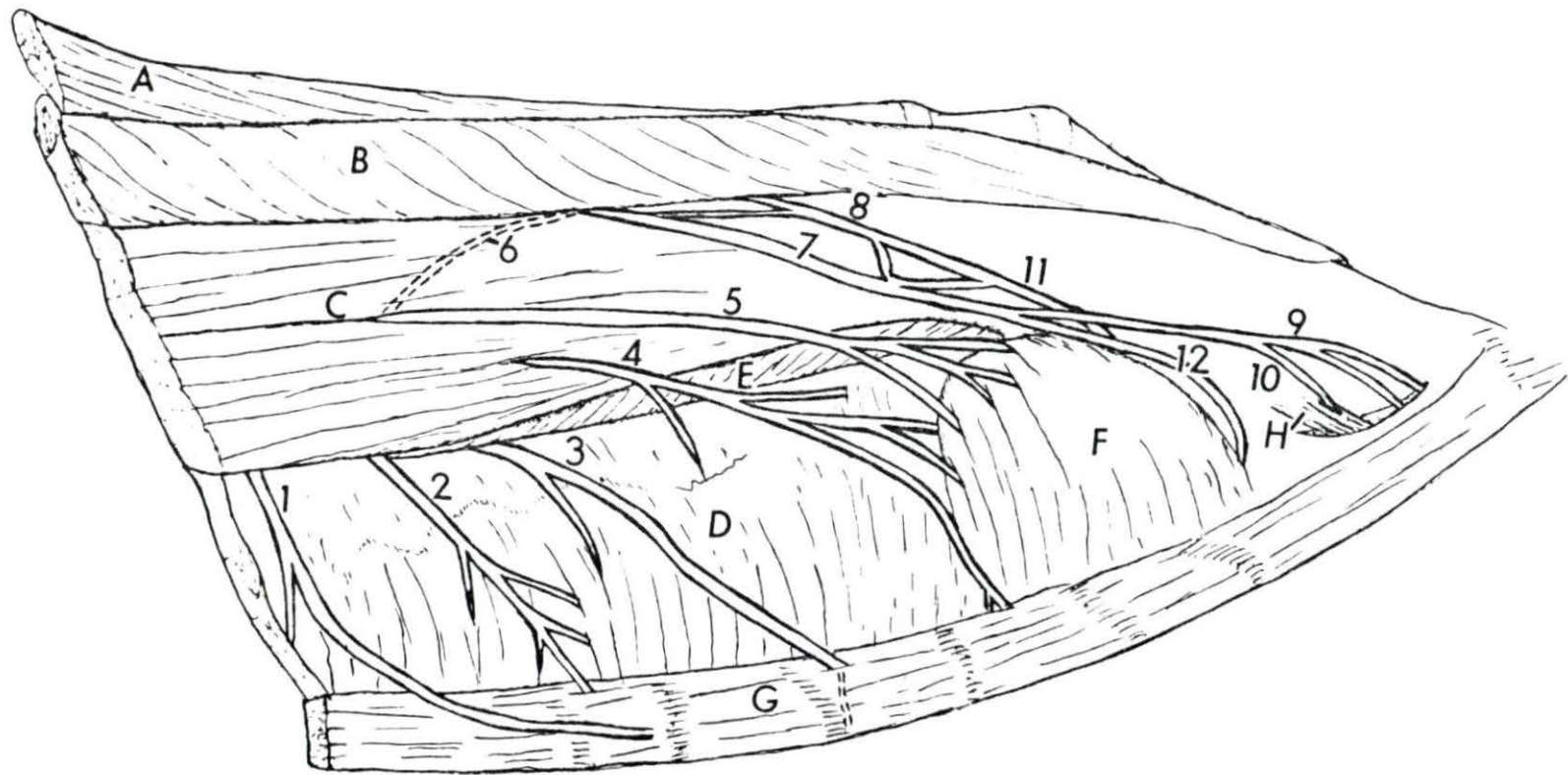
Figure 8. Deeper view of the arrangement of the ventral
          branches of lumbar spinal nerves after part
          of M. psoas major and minor have been removed
          to reveal loop formed between L_2 and L_3
          spinal nerves, right side, ventral view

Specimen no. 6   ♀

1   Last intercostal nerve
2   Ventral branch of last thoracic spinal nerve
3   Ventral branch of L_1 spinal nerve
4 and 5   Ventral branches of L_2 spinal nerve
6   Communicating branch from L_3 to L_2 spinal nerves
    forming a loop
7   Ventral branch of L_3 spinal nerve (N. genitalis)
8   Ventral branch of L_4 spinal nerve (N. cutaneus
    femoris lateralis)
9   Continuation of 7 as N. inguinalis
10 Branch of 7 to M. cremaster externus
11 Continuation of 8
12 Branch of 7 to M. obliquus internus abdominis
A   Right crus of M. diaphragm, reflected
B   M. psoas minor
C   M. psoas major
D   M. transversus abdominis
E   M. quadratus lumborum
F   M. rectus abdominis
G   M. obliquus internus abdominis
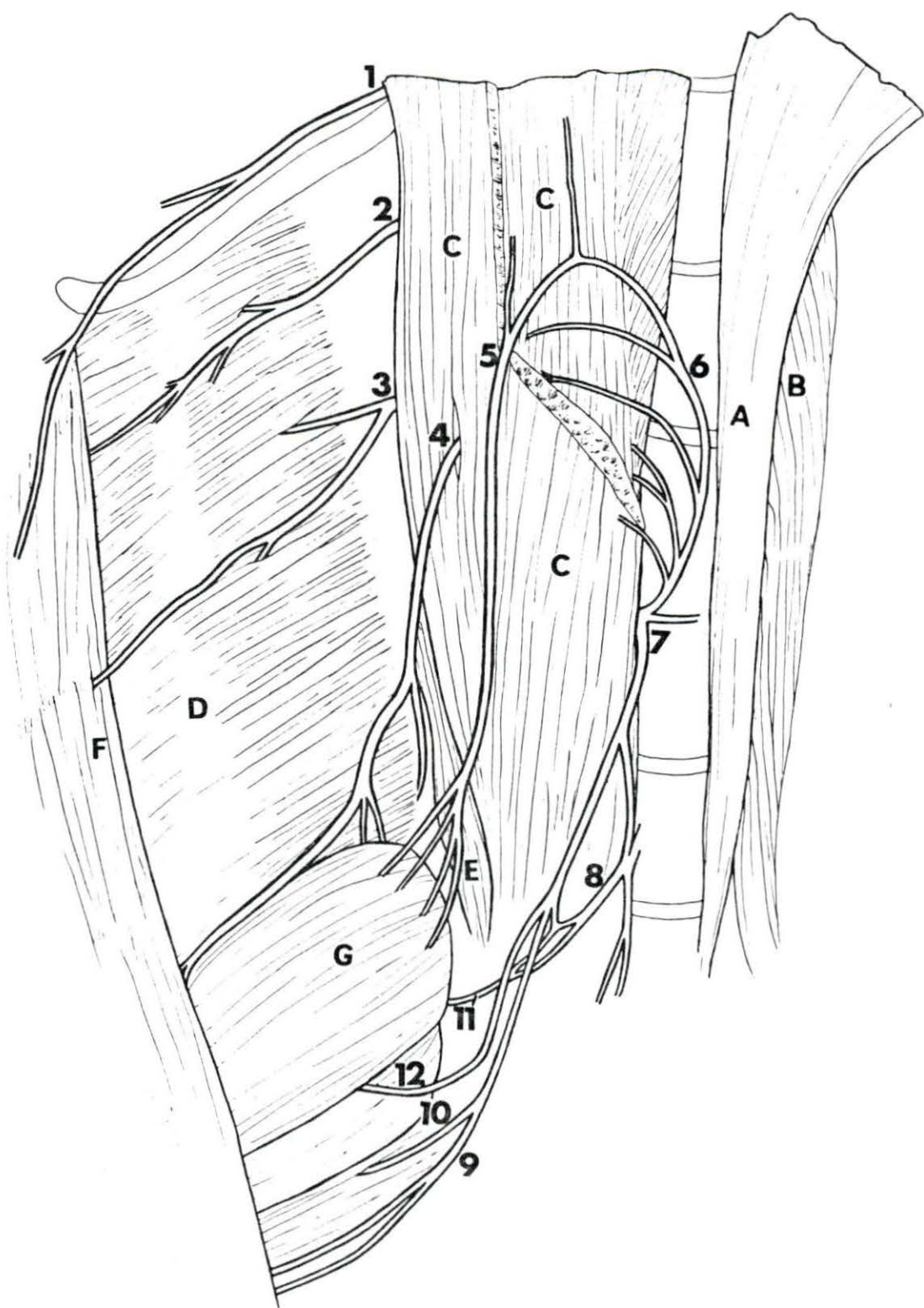
Figure 9. Another mode of arrangement of the ventral branches of the
          lumbar spinal nerves in relation to Mm. psoas major and
          minor in situ, ventral view

                    Specimen no. 8   ♀

 1 Last intercostal nerve
 2 Ventral branch of last thoracic spinal nerve
 3 Ventral branches of L_1 spinal nerve
 4 Nerve formed by branches from both L_1 and L_2 spinal nerves
 5 Ventral branch from L_3 spinal nerve to M. obliquus internus abdominis
 6 Branch from L_3 spinal nerve to N. genitalis
 7 Ventral branch of L_4 spinal nerve to N. cutaneus femoris lateralis
 8 Continuation of 7
 9 Branch of 6 to M. obliquus internus abdominis
10 Continuation of 6 through inguinal canal as N. inguinalis
11 Branch of 6 to M. cremaster externus
 A M. psoas minor
 B M. psoas major
 C M. retractor costae
 D M. transversus abdominis
 E M. quadratus lumborum
 F M. obliquus internus abdominis
 H M. cremaster externus
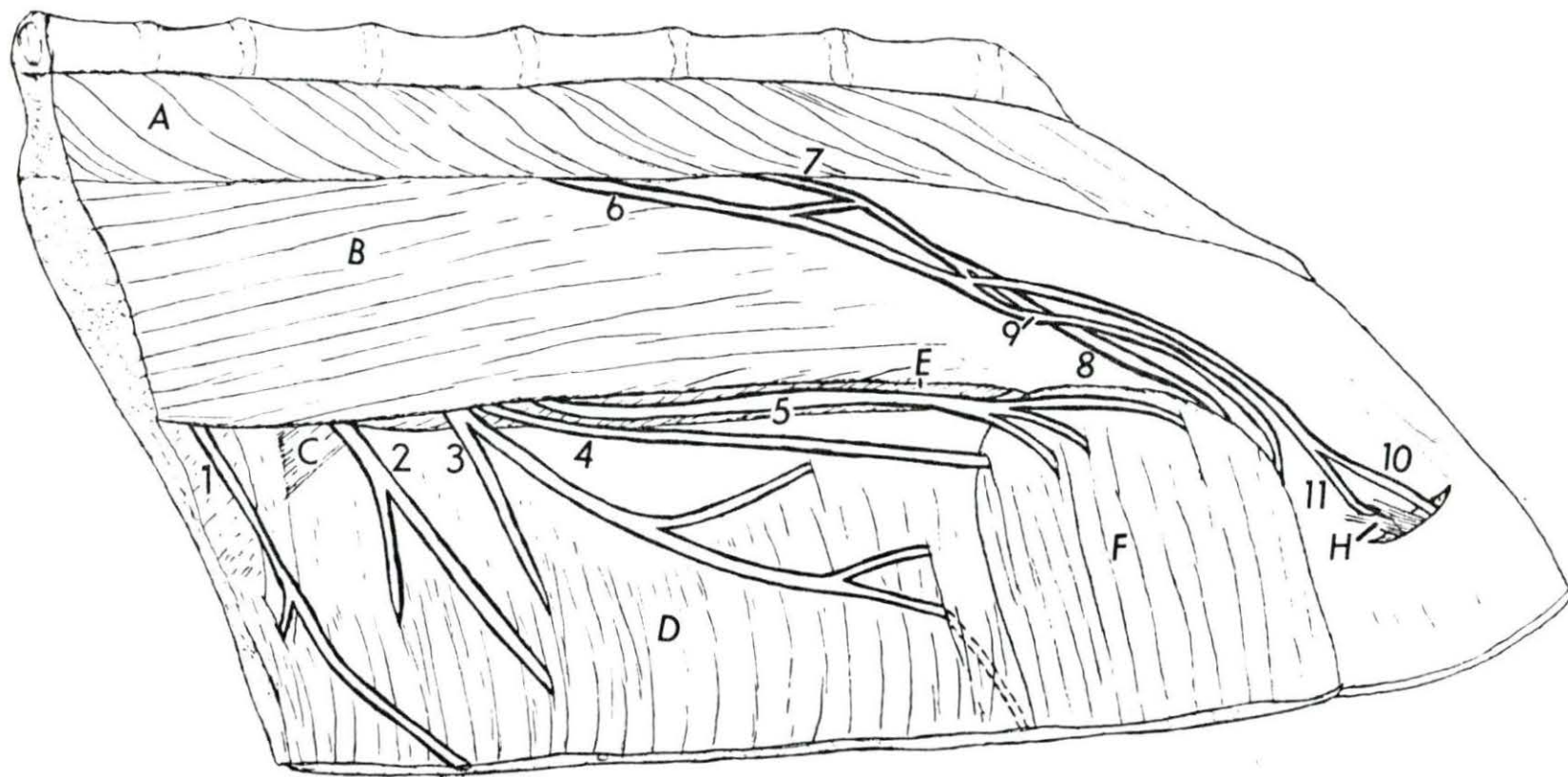
Figure 10. The gluteal region and the ischio-anal fossa, left side
            dorsolateral view

Specimen no. 8 ♀

```
 1  N. ischiadicus
 2  N. glutaeus caudalis
 3  Communicating branch from N. ischiadicus to N. pudendus
 4  N. cutaneus femoris caudalis
 5  N. pudendus
 6  Continuation of 5 to ramify as N. clitoridis and Ramus mammarius caudalis
 7  Common trunk for Nn. perinei
 8  N. perinealis superficialis (N. labialis) from 5
 9  Dorsal branches of Nn. spinales sacrales
10  Dorsal branches of Nn. spinales coccygei
 A  Lig. sacrospinotuberale
 B  M. glutaeus profundus
 C  M. obturatorius internus
 D  M. coccygeus
 E  M. levator ani (M. retractor ani, M. coccygeus medialis)
 F  Mm. sphincter ani externus and constrictor vulvae
 G  M.  ischiocavernosus and constrictor vestibuli
 H  Vulva
 I  Subcutaneus anal fat
 J  M. semimembranosus
 K  M. semitendinosus
 L  Tuber ischii
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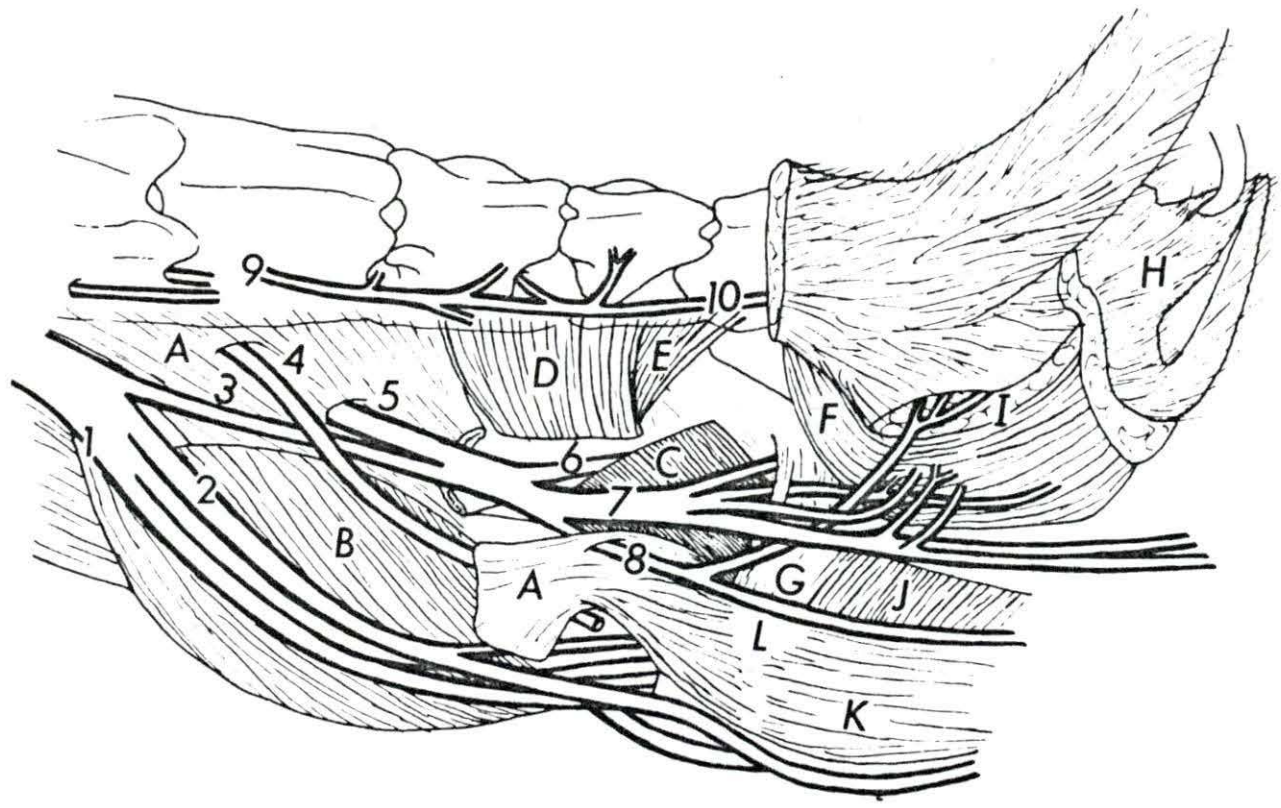
Figure 11.   The roof of the pelvis showing sacral and some
              of the coccygeal nerves   left side, ventral
              view

                    Specimen no. 8   ♀

 1   N. femoralis
 2   N. obturatorius
 3   N. ischiadicus
 4   N. cutaneus femoris caudalis
 5   N. pudendus
 6   Branch of 5 to M. coccygeus
 7   Nn. rectales caudales (Nn. haemorrhoidales caudales)
 8   Urogenital branch of 5
 9   Origin of Nn. perinei from 5
10   Branch to Mm. constrictor vulvae and urethralis from 8
11   N. mammarius caudalis from 8
12   N. clitoridis from 8
13   N. splanchnicus pelvinis
 A   N. obturatorius internus
 B   Lig. sacrospinotuberale
 C   M. coccygeus
 D   M. biceps femoris
 E   M. semitendinosus
 F   M. semimembranosus
 G   Mm. ischiocavernosus and constrictor vestibuli
 H   Mm. sphincter ani externus and constrictor vulvae
 I   Vagina
 J   Rectum
 K   Clitoris
     S_1 - S_4 Ventral branches of Nn. spinales sacrales
     Cy_1 and Cy_2 Ventral branches of Nn. spinales coccygei
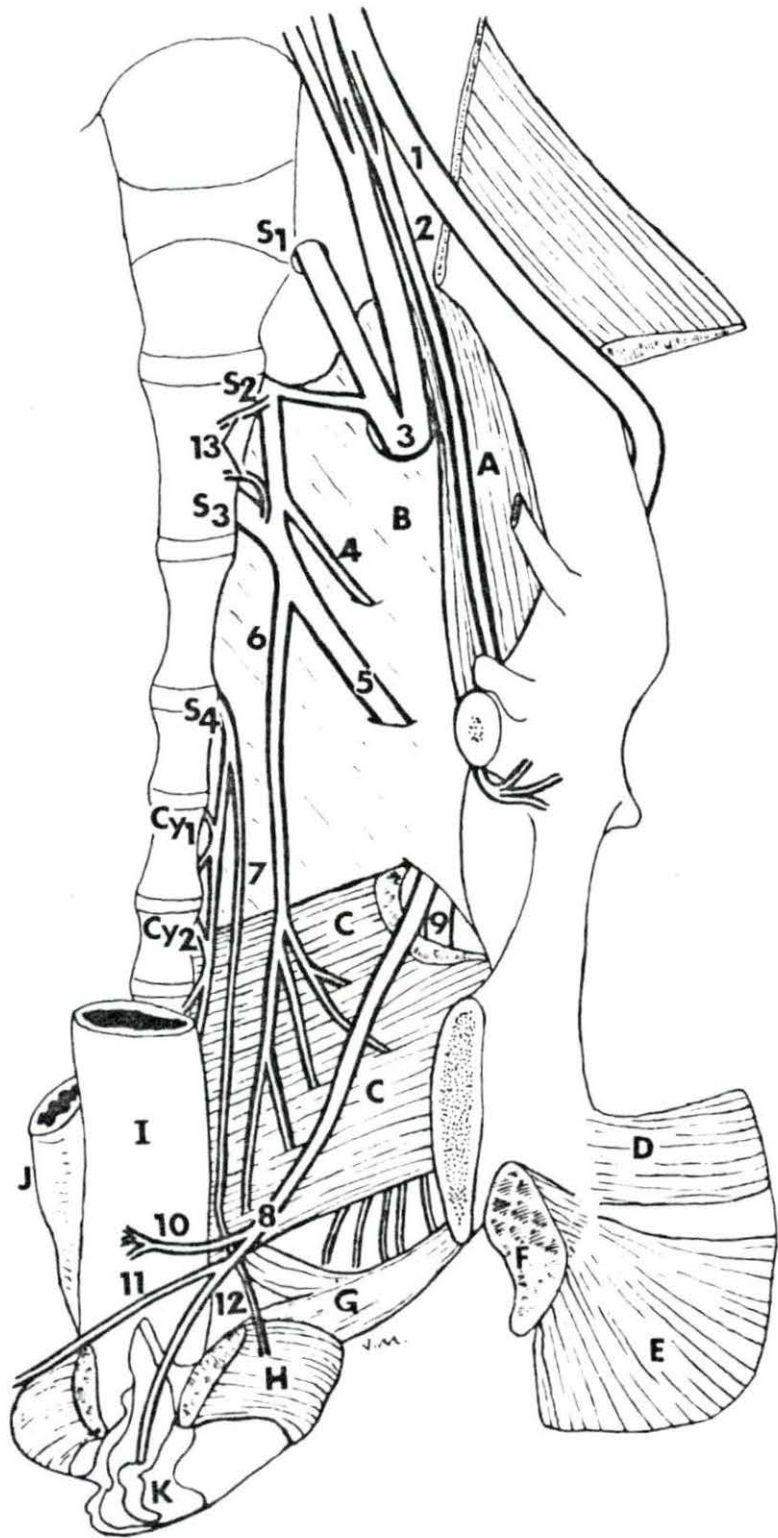
Figure 12. Paralumbar, gluteal and femoral regions, left side

Specimen no. 9 ♂

1 Ventral cutaneus branch of the last thoracic spinal nerve
2 Ventral cutaneus branch of L_1 spinal nerve
3 and 4 Ventral cutaneus branch of L_2 spinal nerve
5 N. cutaneus femoris lateralis
6 N. glutaeus cranialis
7 Branch of 6 to M. glutaeus profundus
8 N. ischiadicus
9 N. glutaeus caudalis
10 Communicating branch from N. ischiadicus to N. pudendus
11 N. pudendus
12 N. cutaneus femoris caudalis
13 Branch of 11 to M. coccygeus
14 Branch of 11 to urogenital tract
15 Continuation of 11 as N. dorsalis penis and N. scrotalis medius
16 N. perinealis profundus
17 N. perinealis superficialis
18 Branch from S_3 to M. sphincter ani externus (N. rectalis medius)
19 N. rectalis caudalis (N. haemor-rhoidalis caudalis)
20 Branch from 8 to proximal part of M. biceps femoris
21 Branch from 8 to Mm. semitendinosus and semimembranosus
22 Branch of 8 to distal part of M. biceps femoris
23 N. cutaneus surae caudalis medialis

24 N. tibialis
25 N. fibularis (N. peroneus)
A M. longissimus dorsi
B M. obliquus internus abdominis
C M. obliquus externus abdominis
D M. iliacus
E M. vastus lateralis
F M. biceps femoris
G M. gastrocnemius
H M. soleus
J M. semitendinosus
K M. semimembranosus
L M. retractor penis
M M. levator ani (M. retractor ani, M. coccy. medius)
N M. coccygeus
O Glandulae vesiculae seminales
P M. rectus femoris
Q M. glutaeus profundus
R M. sphincter ani externus
S M. transversus abdominis
S_1 - S_4 Ventral branches of Nn. spinales sacrales
Cy_1 Ventral branch of N. spinalis coccygis
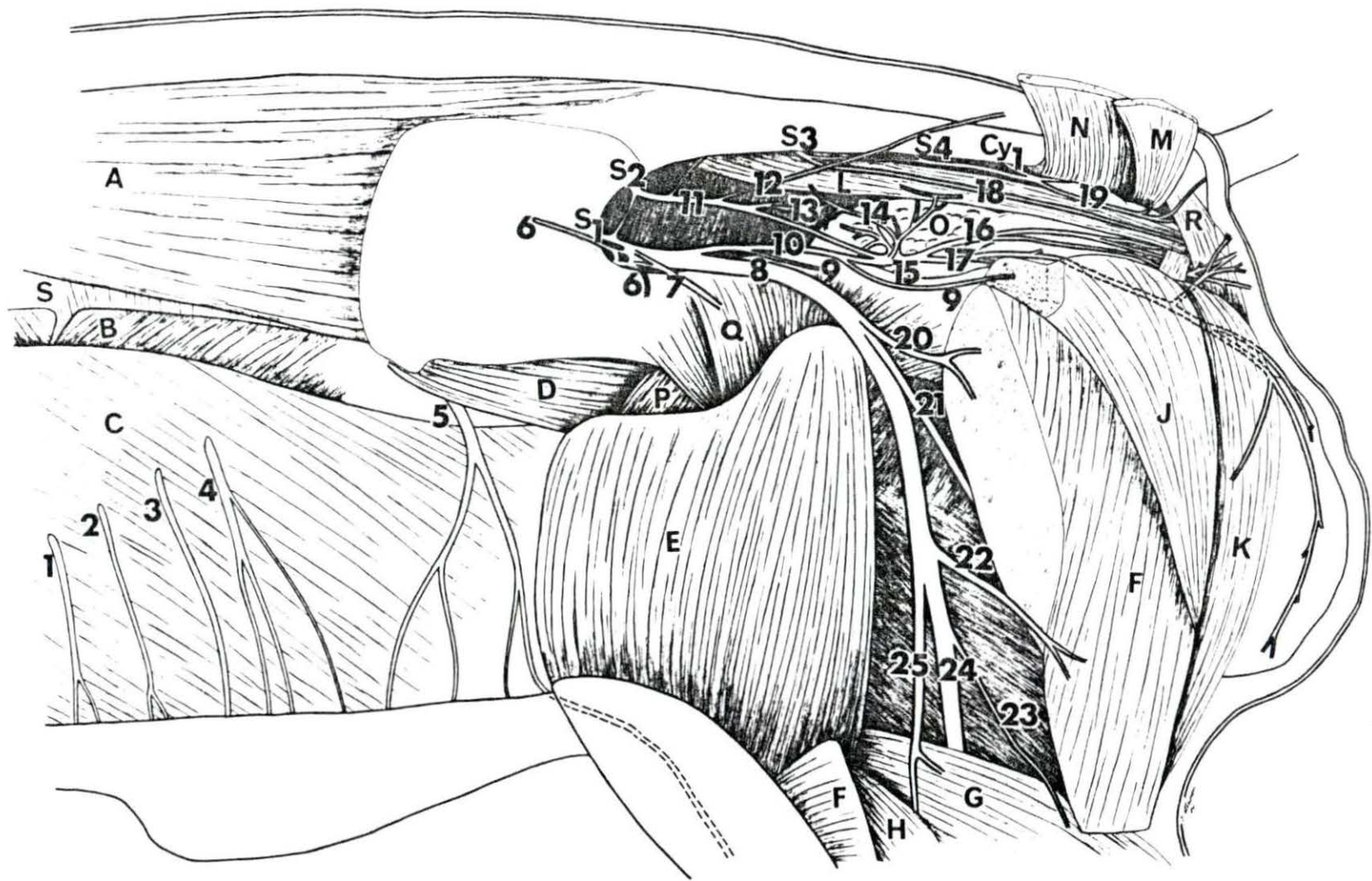
Figure 13. The lumbosacral plexus, left side, medial view

Specimen no. 9   6

1	N. iliohypogastricus	A	M. transversus abdominis
2	N. ilioinguinalis	B	M. rectus abdominis
3	N. genitalis (N. spermaticus externus)	C	M. quadratus lumborum
4	N. cutaneus femoris lateralis	D	Penis
5	Continuation of 3, N. inguinalis	E	M. cremaster externus
6	Branch of 3 to M. cremaster externus	F	M. retractor penis
7	N. femoralis	G	Gl. bulbourethralis
8	N. obturatorius	H	M. gracilis
9	N. ischiadicus	J	Urethra
10	N. splanchnicus pelvinus	K	Rectum
11	N. pudendus	M	M. obliquus internus abdominis
12	N. cutaneus femoris caudalis	N	Ligamentum inguinalis
13	N. scrotalis medius (sinister) from		
	N. dorsalis penis	L_1 - L_6	Ventral branches to Nn.
14	N. dorsalis penis from 11		spinales sacrales
15	Branch of 3 to M. obliquus internus	S_1 - S_2	Ventral branches of Nn.
	abdominis		spinales sacrales
16	Branch of 14 to M, retractor penis	Th	Ventral branches of last thoracic spinal nerve
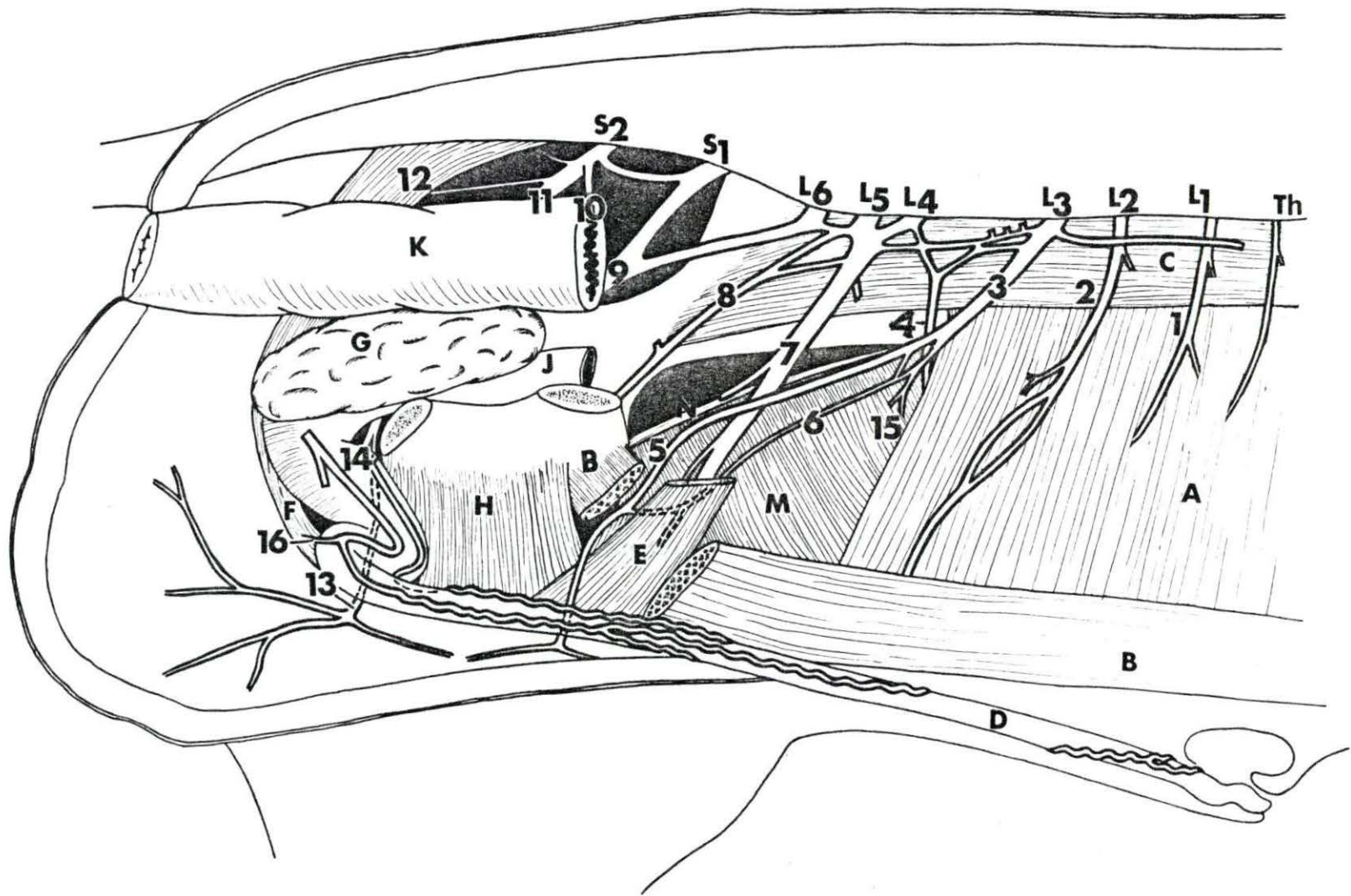
Figure 14. Gluteal region showing nerves before removal of the sacro-
         sciatic ligament, right side, lateral view

Specimen no. 10 ♂

 1 N. ischiadicus
 2 Communicating branch from N. ischiadicus to N. pudendus
 3 N. glutaeus caudalis
 4 N. cutaneus femoris caudalis
 5 Branch from 1 to Mm. biceps femoris and semitendinosus
 6 Branch from 1 to distal part of M. biceps femoris
 7 N. tibialis
 8 N. cutaneus surae lateralis
 9 N. fibularis (N. peroneus)
10 Branch from N. glutaeus cranialis to M. tensor fasciae latae
 A M. glutaeus medius (reflected)
 B M. semitendinosus
 C M. biceps femoris
 D M. vastus lateralis
 E M. tensor fasciae latae
 F M. glutaeus profundus
 G Mm. gastrocnemius and soleus
 H Lig. sacrospinotuberale
 J Trochanter major
 K M. adductor
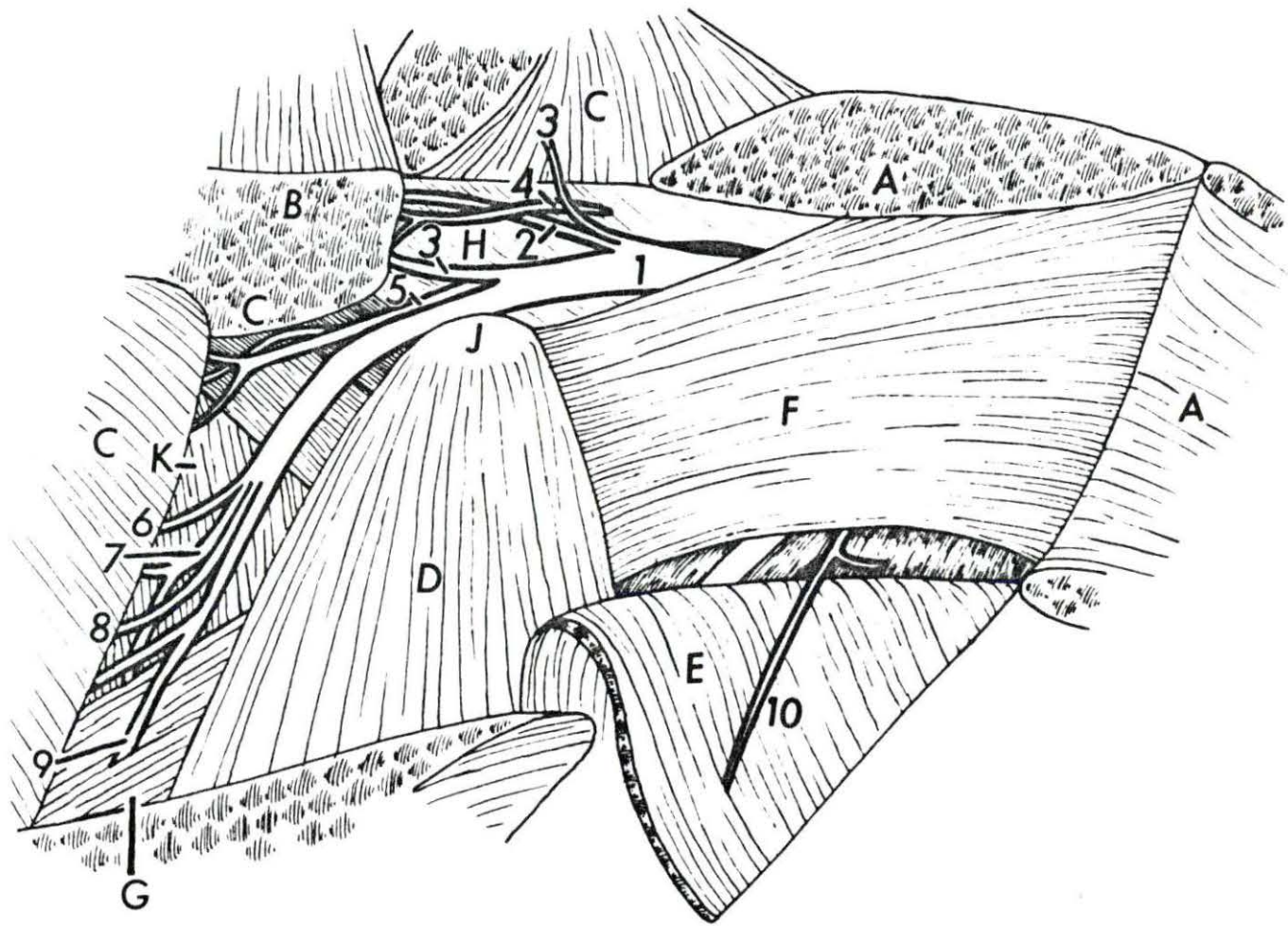
Figure 15. The gluteal region showing arrangement of nerves after removal
of part of sacro-sciatic ligament, right side, lateral view

Specimen no. 10   ♂

1   N. ischiadicus
2   Communicating branch from N. ischiadicus to N. pudendus
3   N. glutaeus caudalis
4   N. cutaneus femoris caudalis
5   Branch from 1 to Mm. biceps femoris, and semitendinosus
6   Branch of 1 to distal part of M. biceps femoris
7   N. tibialis
8   N. cutaneus surae lateralis
9   N. fibularis (N. peroneus)
10 Branch from N. glutaeus cranialis to M. tensor fasciae latae
11 N. pudendus
A   M. glutaeus medius reflected
B   M. semitendinosus
C   M. biceps femoris
D   M. vastus lateralis
E   M. tensor fasciae latae
F   M. glutaeus profundus
G   Mm. gastrocnemius and soleus
H   Lig. sacrospinotuberale
J   Trochanter major
K   M. adductor

S_2 and S_3 Ventral branches of Nn. spinales sacrales
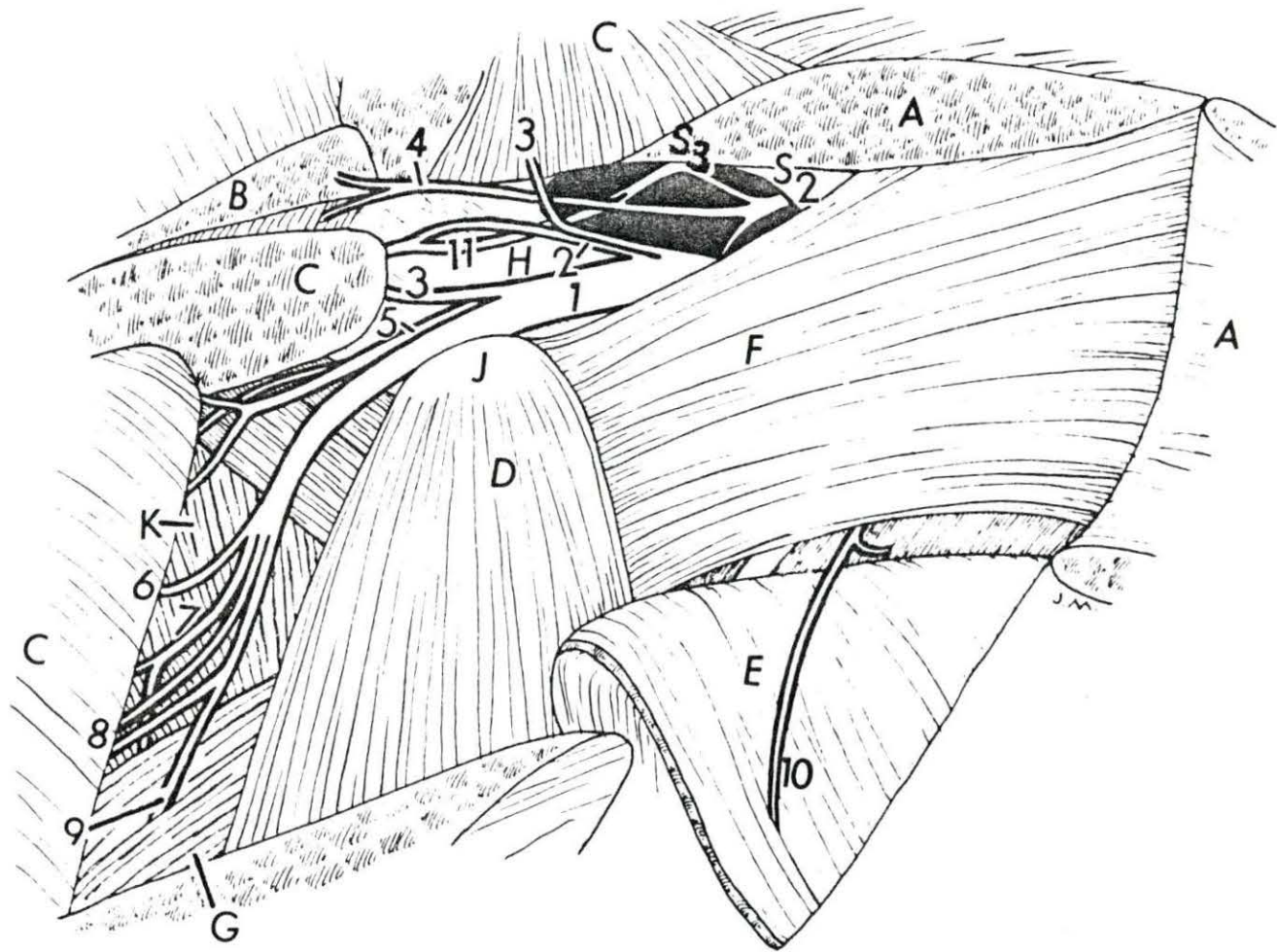
Figure 16. The lumbosacral plexus of the pig, right side,
            ventral view

                    Specimen no. 10   ♂

 1 N. iliohypogastricus
 2 N. ilioinguinalis
 3 Branch of N. genitalis to M. psoas major
 4 N. genitalis (N. spermaticus externus)
 5 N. cutaneus femoris lateralis
 6 N. femoralis
 7 N. obturatorius
 8 N. ischiadicus (here includes Nn. glutaei)
 9 N. cutaneus femoris caudalis
10 N. pudendus
11 N. rectalis caudalis (N. haemorrhoidalis caudalis)
12 Branch of 10 to urogenital tract and towards the
    pelvic plexus
13 N. dorsalis penis
14 N. splanchnicus pelvinus
 A rectum
 B Urethra
    $L_1 - L_6$ Ventral branches of Nn. spinalis lumbales
    $S_1 - S_4$ Ventral branches of Nn. spinalis sacrales
    Th   Ventral branch of last thoracic spinal nerve
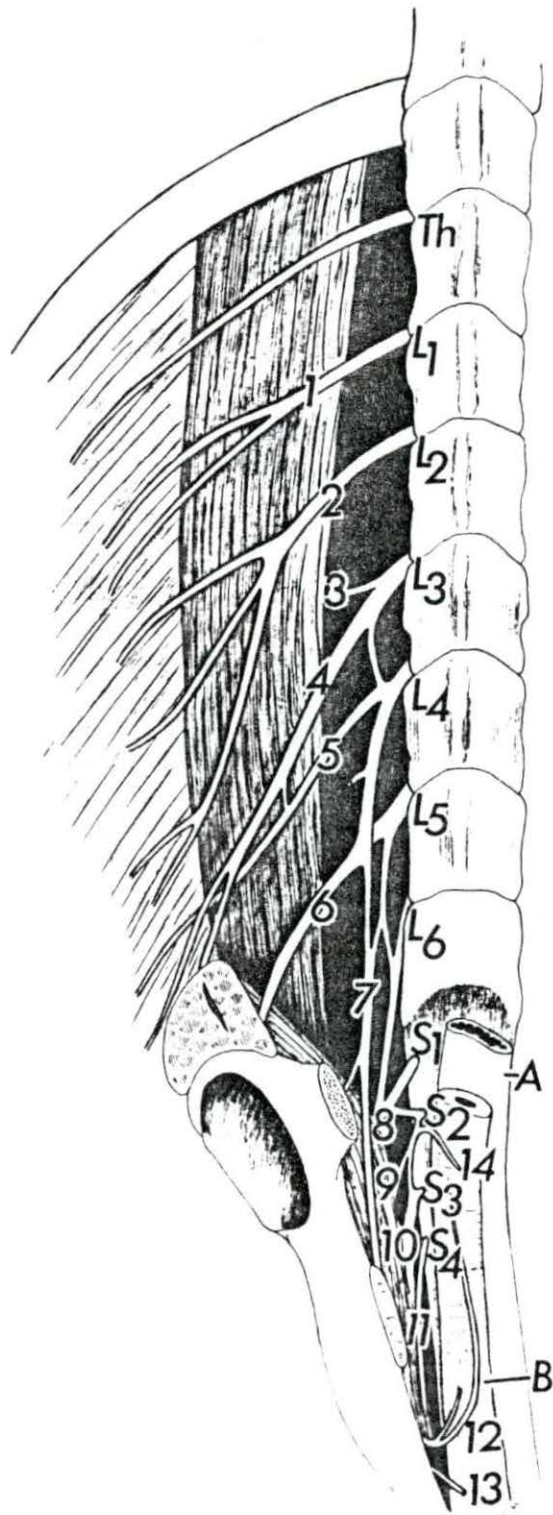
Figure 17. Somatic and autonomic nerves of the lumbar
and pelvic regions, ventral view

Specimen no. 11 ♂

1 N. iliohypogastricus
2 N. ilioinguinalis
3 Branch of L_3 to Mm. psoas major et minor
4 N. genitalis (N. spermaticus externus)
5 N. cutaneus femoris lateralis
6 N. femoralis
7 N. obturatorius
8 N. ischiadicus
9 N. glutaeus cranialis
10 Nn. splanchnici pelvini
11 Communicating branch from N. ischiadicus to N. pudendus
12 N. pudendus
13 Branch of 12 to M. coccygeus
14 and 14' N. splanchnicus major (thoracic splanchnic
   nerve)
15 Truncus sympathicus
16 Ganglia lumbalia (syst. sympathici)
17 Plexus aorticus abdominalis (systematis autonomici)
18 Cranial branch of plexus mesentericus caudalis
19 Caudal branch of plexus mesentericus caudalis
20 Ganglion mesentericus caudalis
21 N. hypogastricus (dexter et sinister) to plexus pelvinus
22 Ganglion sympathicum sacrale primum
23 N. perinealis superficialis from 12
24 Continuation of 12 as Nn. dorsalis penis and
   scrotalis medius
25 Ganglion et nervus testicularis at the base of A.
   testicularis (A. spermatica interna)
   L_1 - L_6 Ventral branches of Nn. spinales lumbales
   S_1 - S_4 Ventral branches of Nn. spinales sacrales
   Cy_1 Ventral branch of first coccygeal spinal nerve
Th Ventral branches of last two thoracic spinal nerves
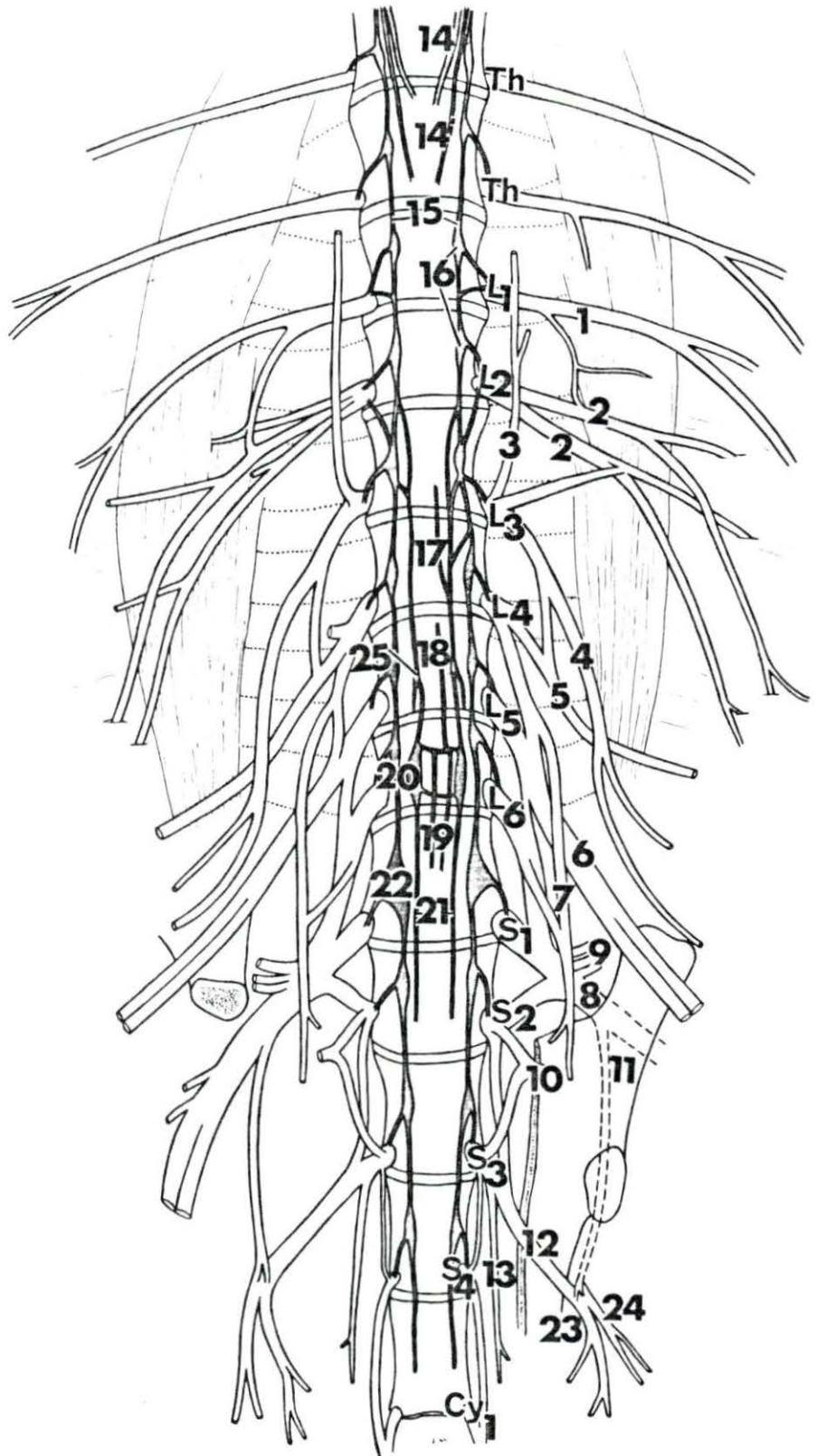
Figure 18.   The sympathetic trunks and their relationship to the pudendal
             and pelvic nerves, lateral view

Specimen no. 11 ♂

1 Nn. splanchnici major et minor
   (thoracic and abdominal splanchnic
   nerves)
2 Trunci sympathici (dexter et sinister)
3 Plexus aorticus addominalis (syste.
   autonomici)
4 Cranial branch of plexus mesentericus
   caudalis (along cranial branch of A.
   mesenterica caudalis)
5 N. testicularis (N. spermaticus
   internus)
6 Ganglion for 5
7 Ganglion mesentericus caudalis
8 Caudal branch of plexus mesentericus
   caudalis (along caudal branch of A.
   mesenterica caudalis)
9 N. hypogastricus (dexter)
10 Ganglion sympathicum sacrale primum
11 N. splanchnicus pelvinus
12 N. pudendus
13 Communicating branch from N. ischiadicus
   to N. pudendus
14 Branches from pelvic plexus to M.
   retractor penis and to rectum
15 Common nerve trunk for Nn. perinei
16 Branch of 12 to urogenital tract
17 Branch of 15 - N. perinealis
   superficialis (N. scrotalis caudalis)
18 N. scrotalis medius from 12
19 N. dorsalis penis (continuation of 12)
20 Branch of 19 to distal part of M.
   retractor penis

21 N. deferentialis (syst. sympathici)
   from 11
A ureter
B bladder
C ductus deferens
D glandula vesicula seminales
E glandula bulbo-urethralis
F rectum
G M. retractor penis
H M. sphincter ani externus
J testis
K M. cremaster externus
M M. ischiocavernosus penis
N penis
O preputial diverticulum
$L_1 - L_6$ Lumbar vertebrae
$S_1 - S_4$ Sacral vertebrae
$Cy_1 - Cy_2$ Coccygeal vertebrae
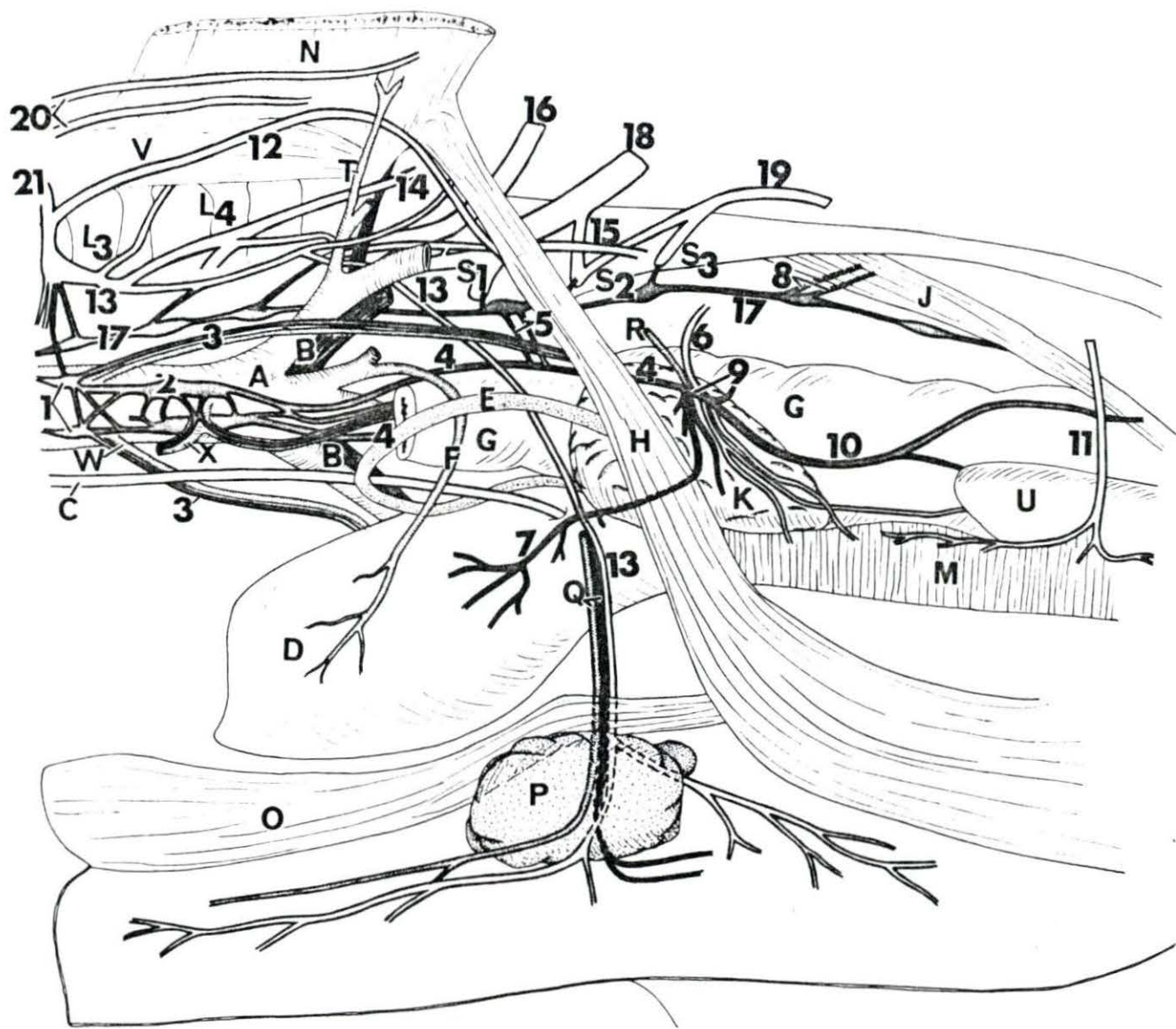Th   Last two thoracic
         vertebrae

Figure 19.   Somatic and autonomic nerves of the lumbar
             and pelvic regions, ventral view

Specimen no. 12   ♂

 1   N. iliohypogastricus
 2   N. ilioinguinalis
 3   Branch from L_2 and L_3 to M. cremaster externus
 4   N. genitalis (N. spermaticus externus)
 5   N. cutaneus femoris lateralis
 6   N. femoralis
 7   N. obturatorius
 8   N. ischiadicus
 9   N. glutaeus cranialis
10   N. splanchnicus pelvinus
11   N. pudendus
12   Branches from Truncus sympathicus to M. retractor
     penis
13   Plexus aorticus abdominalis (syst. autonomici)
14   Truncus sympathicus (sinister)
15   Ganglion testicularis at the base of A. testicularis
     (A. spermatica interna)
16   Ganglion mesentericus caudalis
17   Caudal branch of plexus mesentericus caudalis (along
     caudal branch of A. mesenterica caudalis)
18   Nn. hypogastrici to plexus pelvini
19   Communication between last lumbar ganglion of right
     side and first two fused sacral ganglia of the left
     side
20   First two fused sacral ganglia of the right side
21   M. retractor penis
     L_1 - L_6 Ventral branches of Nn. spinales lumbales
     S_1 - S_4 Ventral branches of Nn. spinales sacrales
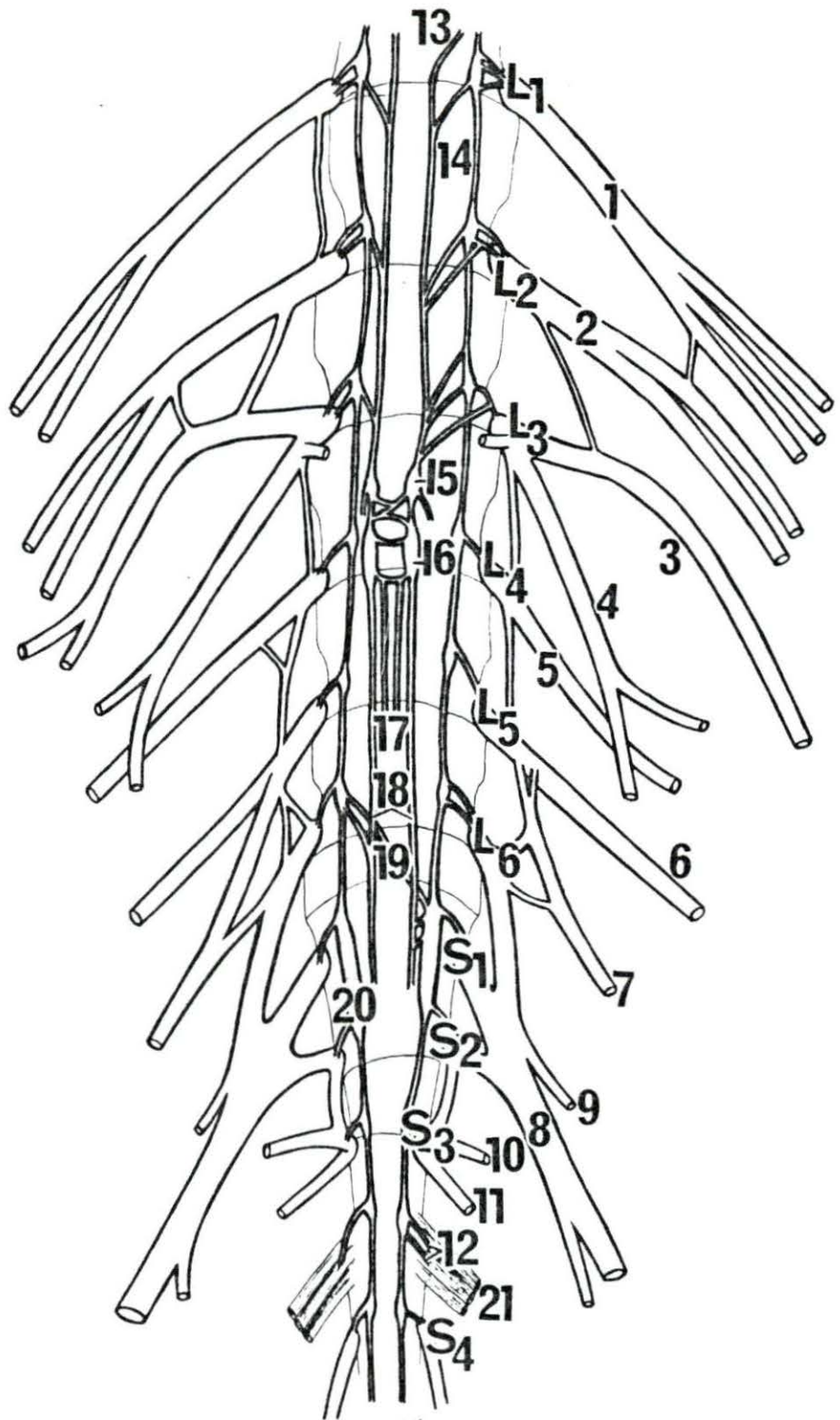
J.M

Figure 20. Somatic and autonomic nerves of the lumbar and pelvic regions,
         ventral view

Specimen no. 12   ♂

1 Ganglion testicularis	A Aorta
2 Ganglion mesentericus caudalis	B A. and V. iliaca externa
3 N. testicularis (N. spermaticus internus)	C Ureter
4 N. hypogastricus	D Bladder
5 Rami splanchnici sacrales joining 4	E Vas deferens
6 N. splanchnicus pelvinus (severed from S_2 and S_3)	F. As. umbilicalis et vesicalis cranialis
7 Plexus vesicalis	G Rectum
8 Branches from Truncus sympathicus to M. retractor penis	H M. cremaster externus
9 Plexus pelvinus	J M. retractor penis
10 Plexus rectalis to terminal part of rectum and M. sphincter ani internus	K Glandula vesicula seminalis
11 Branch from N. pudendus to urogenital tract	M Urethra and M. urethralis
12 Branch from L_2 and L_3 to M. cremaster externus	N M. obliquus internus abdominis
13 N. genitalis (N. spermitcus externus)	O M. rectus abdominis
14 N. cutaneus femoris lateralis	P Ln. inguinalis superficialis
15 N. obturatorius	Q A. and V. pudenda externa
16 N. femoralis	R A. urethrogenitalis
17 Trucus sympathicus	T A. circumflexa ilium profunda
18 N. ischiadicus	U Glandula bulbourethralis
19 N. pudendus	V M. quadratus lumborum
20 Branches of L_2 and L_3 to M. cremaster externus	W A. testicularis (A. spermatic interna)
21 Branch of L_3 to M. psoas major	X A. colica sinister

L_3 and L_4 Ventral branches of Nn.
               spinales lumbales
S_1 and S_3 Ventral branches of Nn.
               spinales sacrales

Figure 21.   Somatic and autonomic nerves of the lumbar
and pelvic regions, ventral view

Specimen no. 13   ♂

1 N. iliohypogastricus
2 N. ilioinguinalis
3 Branch from 2 to M. cremaster externus
4 Branch from 3 to M. psoas major
5 N. genitalis (N. spermaticus externus)
6 N. cutaneus femoris lateralis
7 N. femoralis
8 N. obturatorius
9 N. glutaeus cranialis
10 N. ischiadicus
11 Communicating branch from N. ischiadicus to
    N. pudendus
12 N. pudendus
13 Branch from S_3 to M. coccygeus
14 N. splanchnicus pelvinus
15 N. splanchnicus major (thoracic splanchnic nerve)
16 Ganglion coeliacus
17 Ganglion mesentericus cranialis
18 Ganglion et plexus renalis
19 Ganglion testicularis at base of A. testicularis
    (A. spermatica interna)
20 Ganglion mesentericus caudalis
21 N. hypogastricus
22 Caudal branch of plexus mesentericus caudalis (along
    caudal branch of A. mesenterica caudalis)
23 Branch from Truncus sympathicus to M. retractor penis
24 N. splanchnicus minor (lumbar splanchnic nerve)
A Aorta abdominalis
B Vena cava caudalis
C M. retractor penis
D A. phrenico-abdominalis
E A. renalis
   L_1 - L_6 Ventral branches of Nn. spinales lumbales
   S_1 - S_4 Ventral branches of Nn. spinales sacrales
 Cy_1 Ventral branch of first coccygeal nerve
   Th   Last thoracic spinal nerve
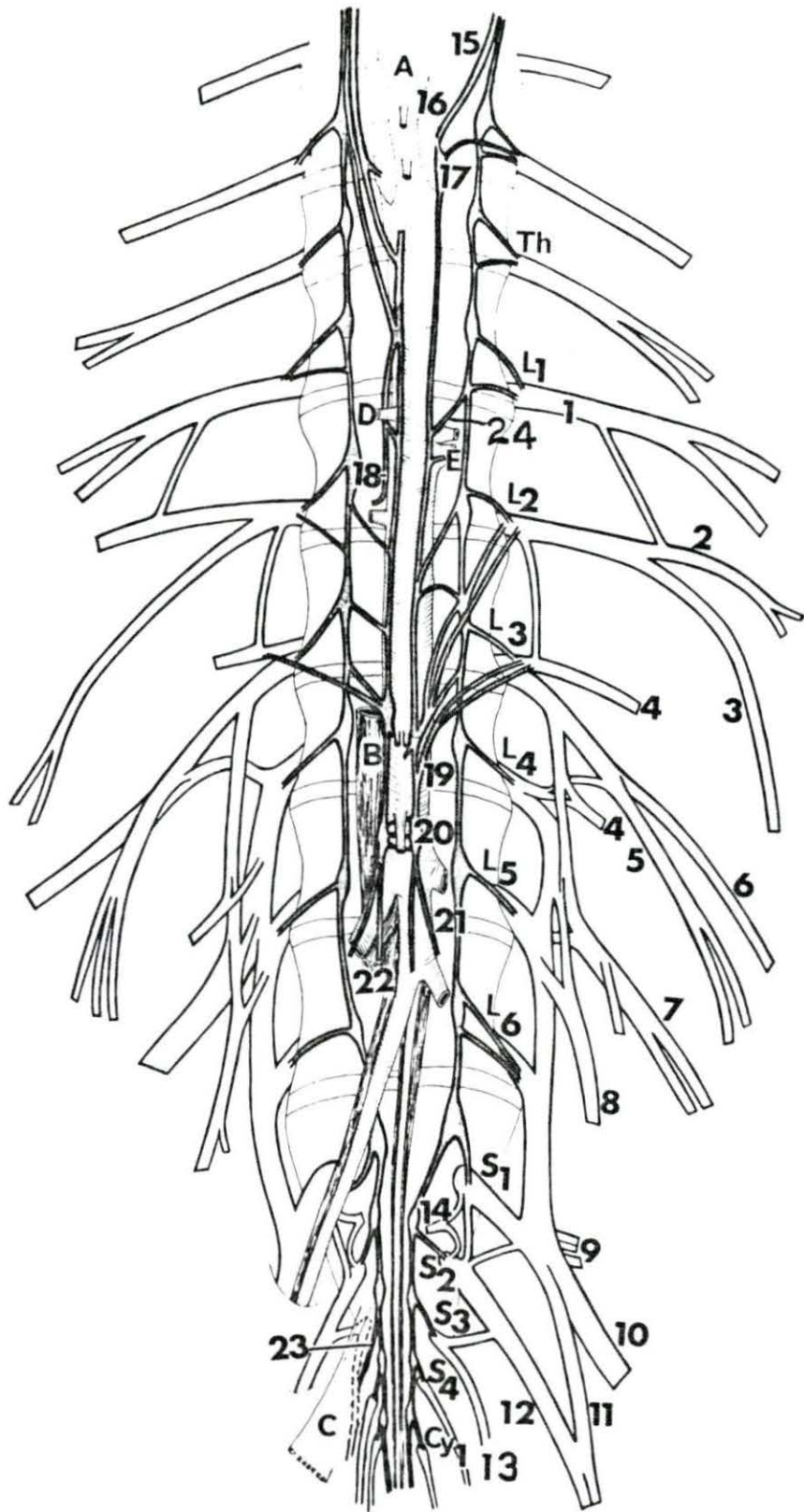
Figure 22.   Somatic and autonomic nerves of the pelvic
and coccygeal regions, ventral view

Specimen no. 14   ♀

1 N. femoralis
2 N. obturatorius
3 N. ischiadicus
4 N. splanchnicus pelvinus
5 N. cutaneus femoris caudalis
6 N. pudendus
7 Communicating branch from N. ischiadicus to N. pudendus
8 Branch from 6 to M. coccygeus
9 Continuation of 6 as Nn. clitoridis and mammarius
   caudalis
10 Branch of 6 as Nn. perinei
11 Ganglion paravertebrale accessorius
12 Plexus formed by the right and left sympathetic trunks
   at the third sacral ganglia
13 N. glutaeus caudalis
14 N. rectalis caudalis (N. haemorrhoidalis caudalis)
15 Branches from S_3 to M. sphincter ani externus (N.
   perinealis profundus)
A M. quadratus lumborum
B M. transversus abdominis
C Os ilium (cut)
   L_4 - L_6 Ventral branches of Nn. spinales lumbales
   S_1 - S_4 Ventral branches of Nn. spinales sacrales
   Cy_1 - Cy_2 Ventral branches of Nn. coccygei
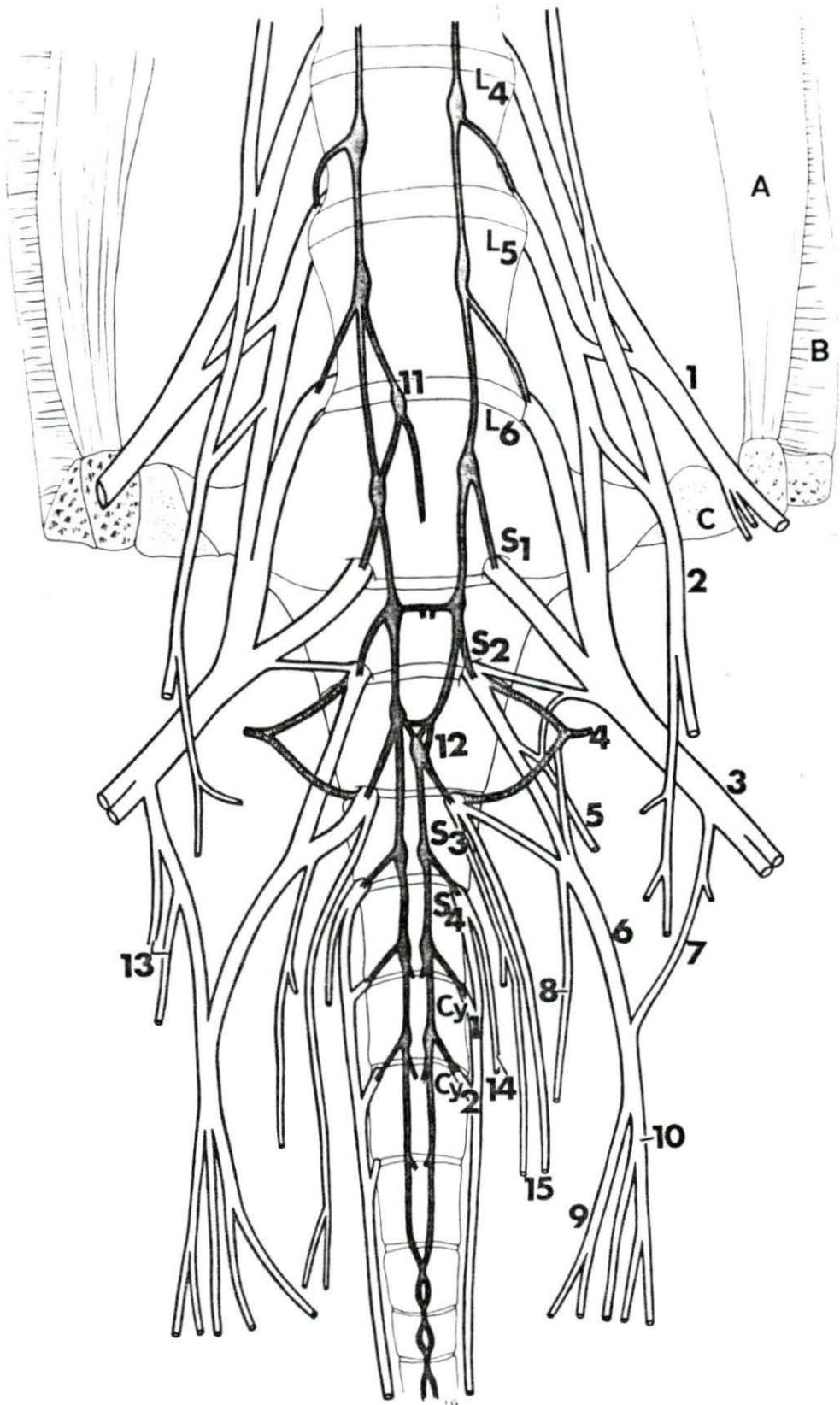
Figure 23. Disposition of the sympathetic trunks and
            collateral ganglia in the lumbar region,
            ventral view

                    Specimen no. 15   ♀

 1 Truncus vagalis dorsalis (dorsal esophageal branch
    of vagus nerve)
 2 Nn. splanchnici major (thoracic splanchnic nerves),
    including those to the Ganglia coeliaco-mesentericus
    and plexus adrenalis
 3 Nn. splanchnici lumbales
 4 Ganglia coeliaco-mesenterici
 5 Ganglion renalis
 6 Plexus renalis
 7 Ganglion mesentericus caudalis
 8 N. hypogastricus
 9 N. ovaricus (N. utero-ovaricus)
10 Cranial branch of plexus mesentericus caudalis
    (along cranial branch of A. mesenterica caudalis)
11 Caudal branch of plexus mesentericus caudalis
    (along caudal branch of A. mesenterica caudalis)
 A M. psoas major
 B Aorta
 C A. coelica
 D A. mesenterica cranialis
 E A. renalis
 F A. and V. phrenico-abdominalis
 G Arteries to Glandula adrenalis
 H A. mesenterica caudalis
 J A. ovarica (A. utero-ovarica)
 K A. iliaca externa
    L_1 - L_6 Ventral branches of Nn. spinales lumbales
    Th   Last thoracic spinal nerve
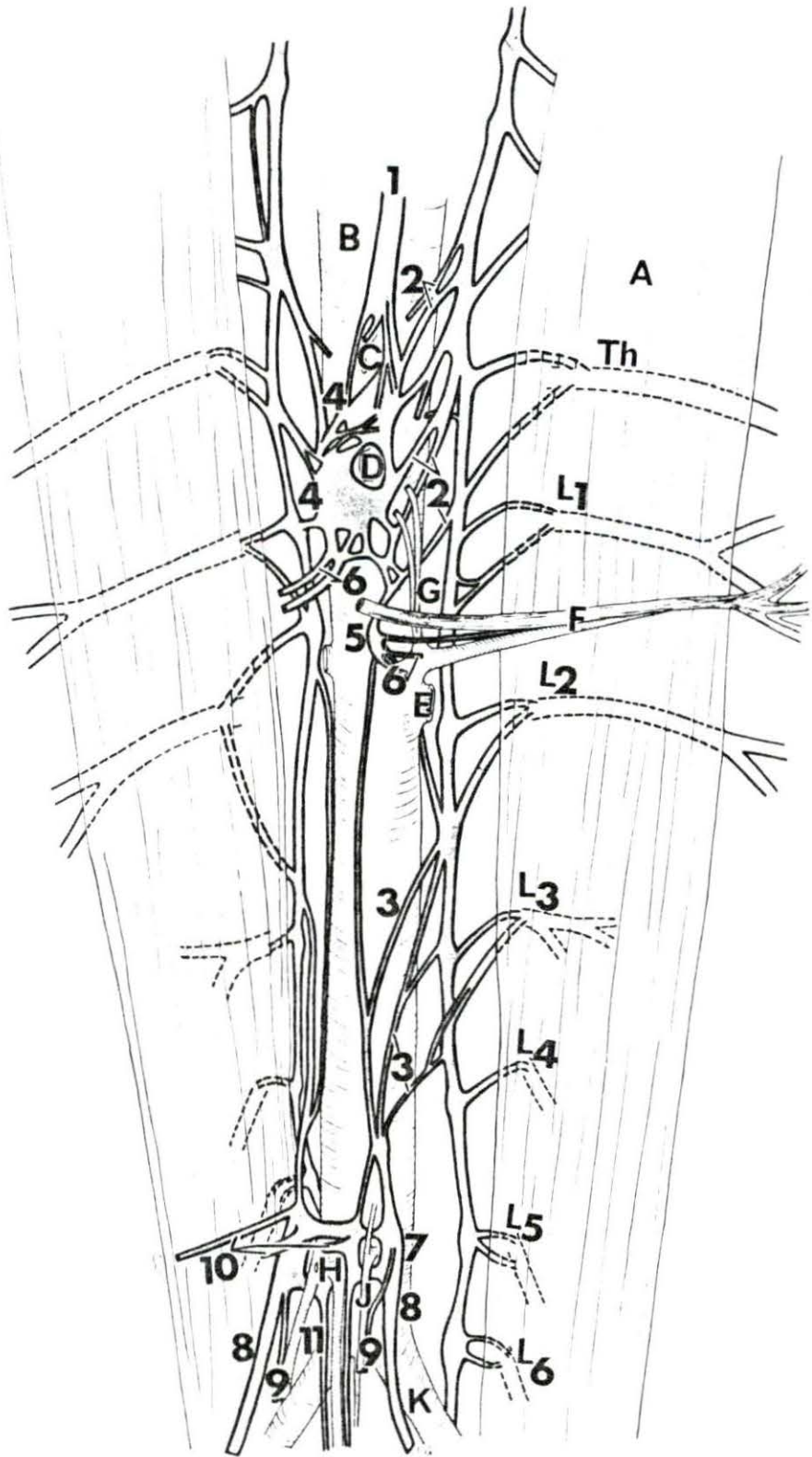
Figure 24.   The sacro-coccygeal part of the sympathetic
             trunks, ventral view

Specimen no. 15   ♀

1   Truncus sympathicus (Pars sacralis)
2   Truncus sympathicus (Pars coccygealis)
B   Terminal part of the Aorta abdominalis
K   A. iliaca externa
M   A. iliaca interna
N   A. sacralis mediana
O   A. coccygea mediana
S_1 First sacral vertebra
Cy_1 First coccygeal vertebra
Cy_4 Fourth coccygeal vertebra
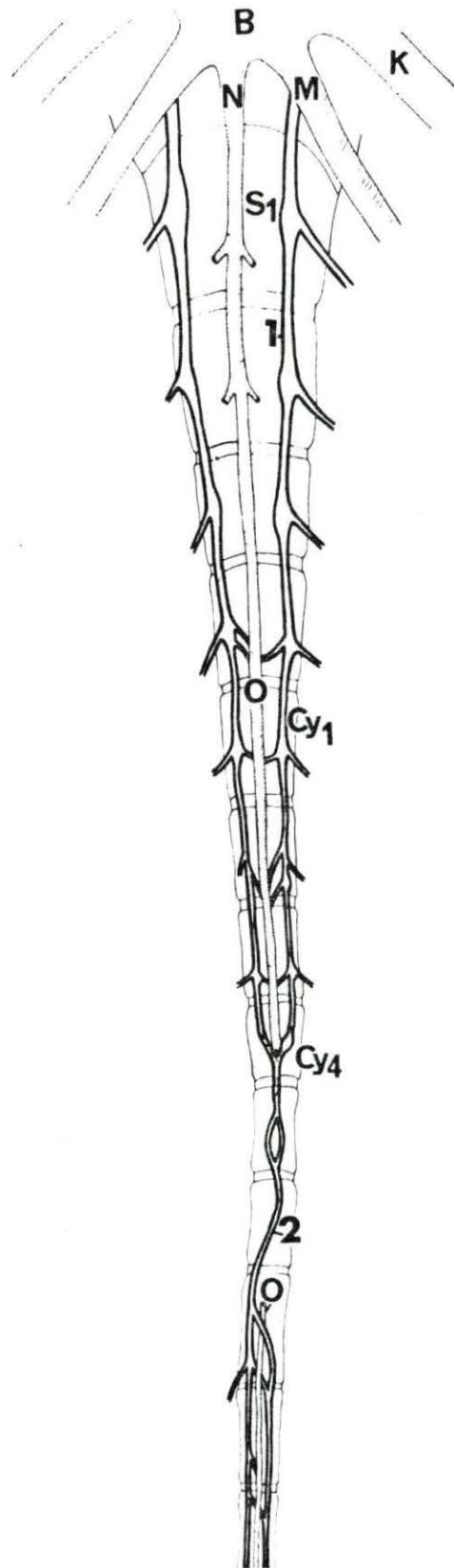
Figure 25. Disposition of the pelvic plexus left view

Specimen no. 15 ♀

```
 1  Ganglion mesentericus caudalis
 1' N. ovaricus (N. utero-ovaricus)
 2  N. hypogastricus
 3  N. splanchnicus pelvinus
 4  Branch from N. pudendus toward Plexus pelvinus
 5  Plexus rectalis (Plexus haemorrhoidalis)
 6  N. pudendus
 7  N. mammarius caudalis
 8  N. clitoridis from 6
 9  Plexus pelvinus
10  Plexus vesicalis
 A  Ovary
 B  Uterus
 C  Vagina
 D  Ureter
 E  Bladder
 F  Rectum
 G  A. ovarica (A. utero-ovarica)
 H  A. umbilicalis
 J  A. iliaca interna
 K  A. glutaea cranialis
 M  A. urogenitalis
 N  Ramus uterinus of A. urogenitalis
 O  A. rectalis media (A. haemorrhoidalis media)
 P  Anastomosis between A. urogenitalis and A. pudenda interna
 R  A. pudenda interna
 S  A. clitoridis
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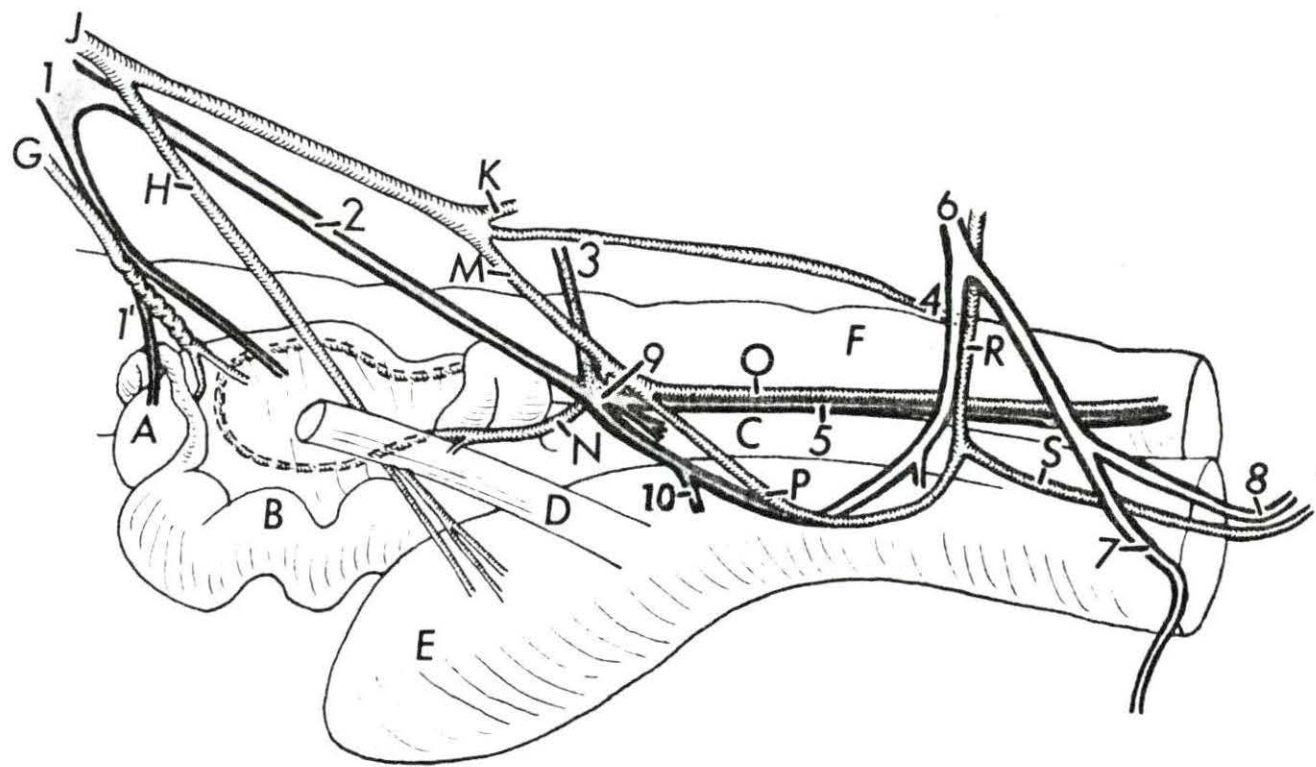
APPENDIX C

Plate 1.   The lumbosacral plexus of the pig, left side, lateral view

Specimen no. 3

1	N. iliohypogastricus
2,2'	N. ilioinguinalis and its cutaneus branches
3	Branch of L_2 and L_3 to M. obliquus internus abdominis
4	Branch of L_3 to M. psoas major
5	N. genitalis (N. spermaticus externus)
6,6'	N. cutaneus femoris lateralis and its continuation
7	N. femoralis, and beside it caudally, N. obturatorius
8	Ventral branch of L_6 spinal nerve joining S_1
9	N. glutaeus cranialis
10	N. glutaeus caudalis (had fibers of N. cutaneus femoris caudalis in it)
10'	N. glutaeus caudalis
11	N. ischiadicus
12	N. pudendus
13	Communicating branch from N. ischiadicus to N. pudendus
14	N. perinealis profundus
15	N. rectalis caudalis (N. haemorrhoidalis caudalis)
16	N. perinealis profundus (N. perinealis medius)
17	Branch of S_4 to Nn. coccygei
18	Branch from N. ischiadicus to proximal part of M. biceps femoris
19	N. fibularis
20	N. tibialis
21	N. cutaneus surae lateralis (caudalis)
22	Dorsal branch of L_1 spinal nerve
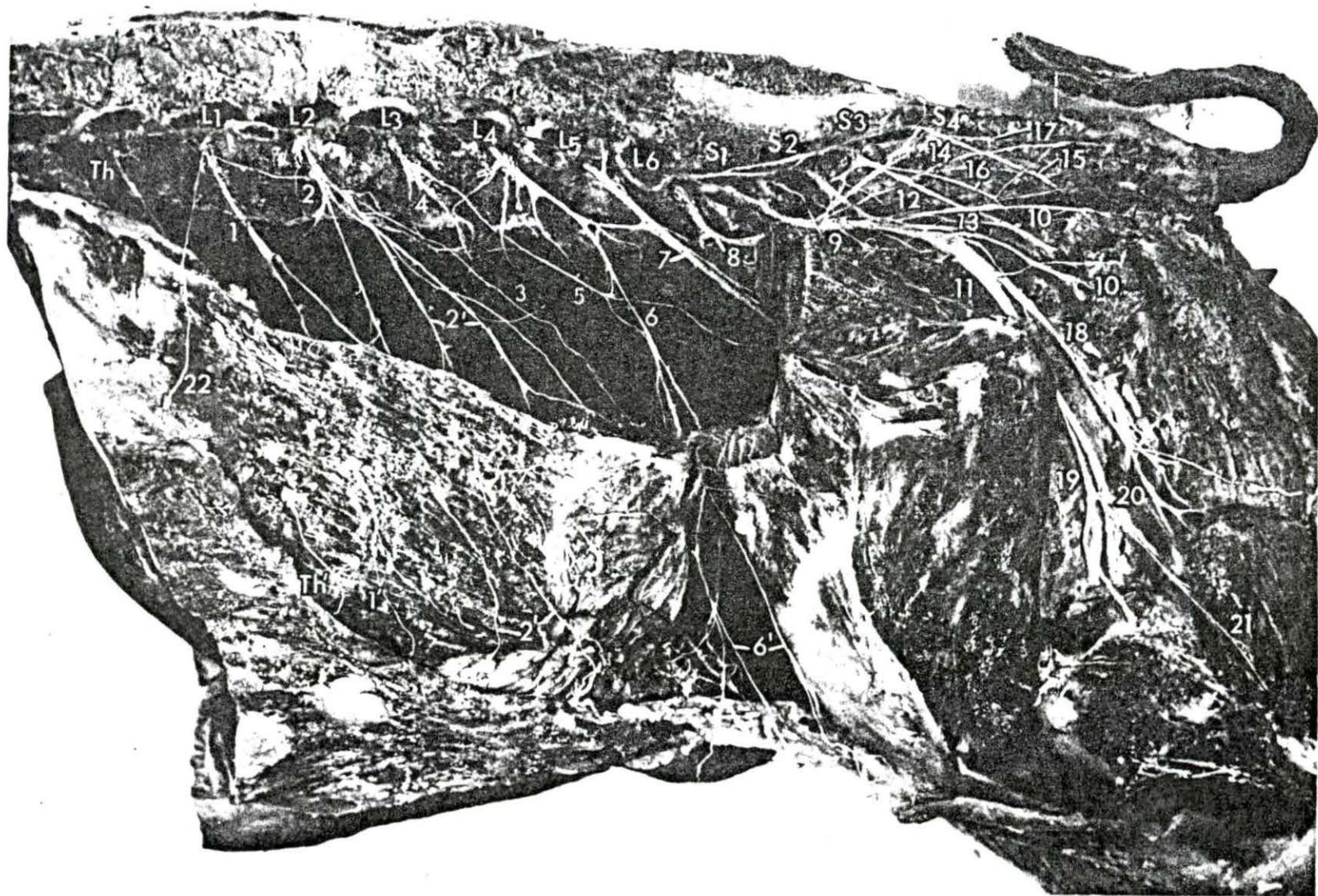
Plate 2:   The gluteal and ventral views of the lumbosacral
           plexis.

                  Specimen no. 4   ♀

           Top: The gluteal region showing the sacral
                 part of the lumbosacral plexus. Dotted
                 line is course of N. cutaneus femoris
                 caudalis.

           Bottom: Ventral branches of the lumbar and
                    sacral spinal nerves and the sympa-
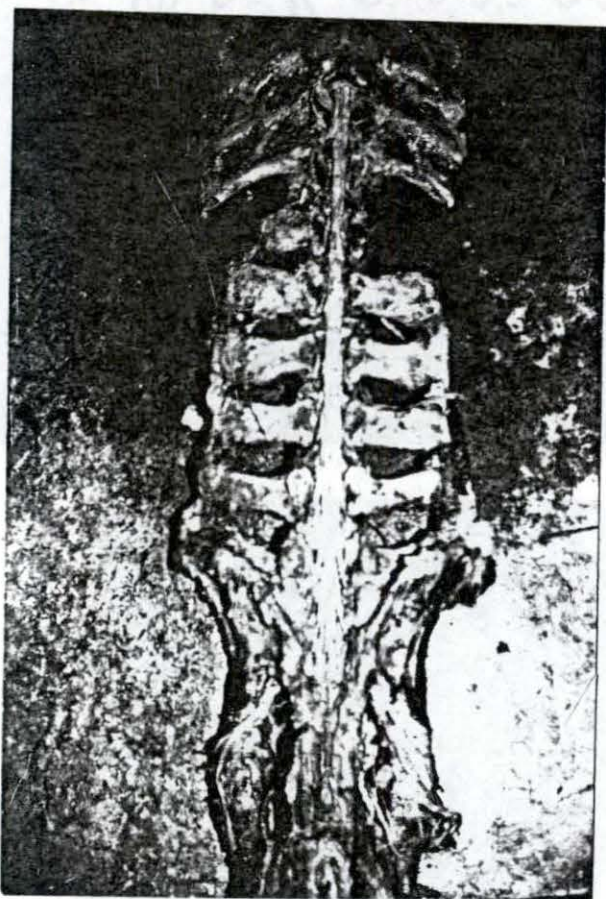   thetic trunks ventral view specimen
                    no. 4. Same as Figure 4.
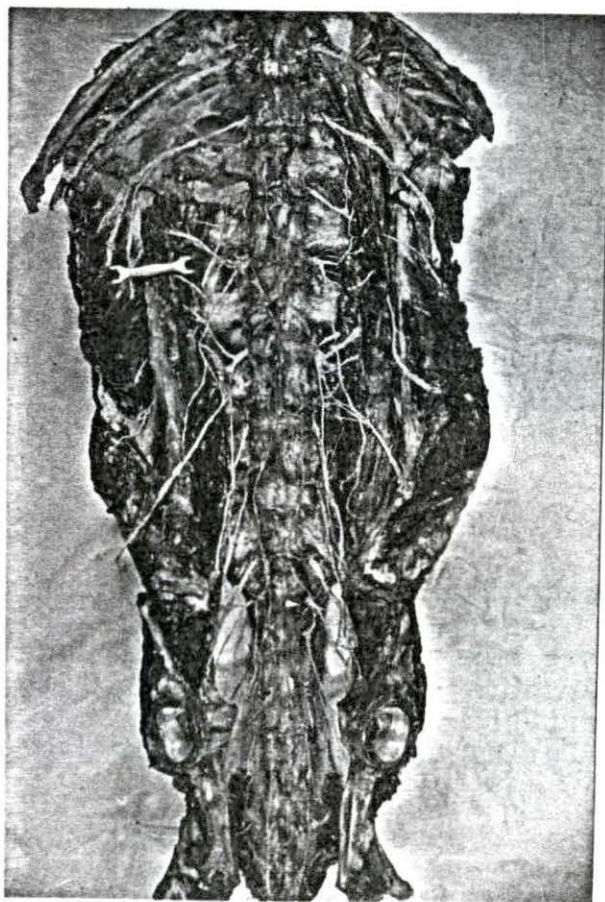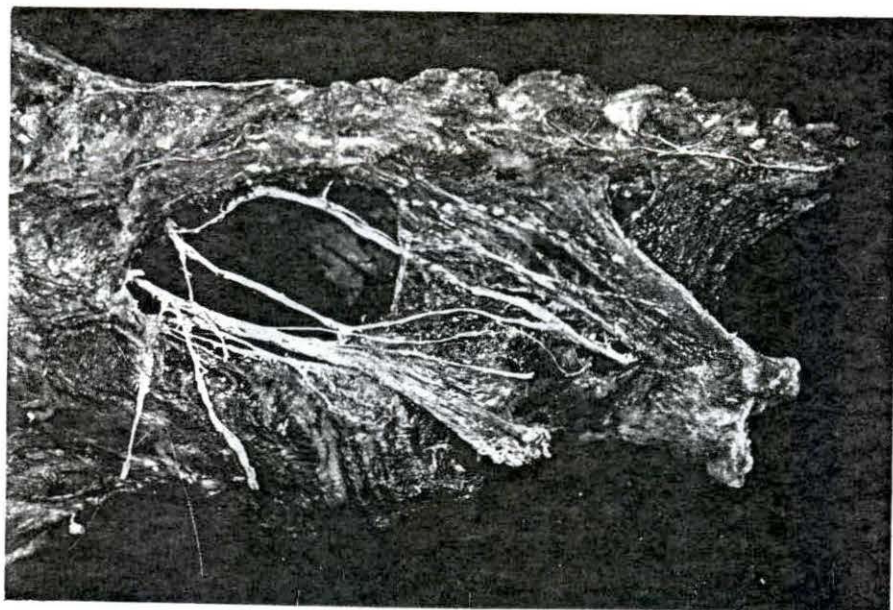
Plate 3. Spinal cord dissected out to show the different
segments of spinal nerve origins. The last pair
of openings bordering transverse process of the
lumbar vertebra caudally is cranial to the sixth
lumbar vertebra which is closely adhered to the
sacrum. Dorsal view specimen no. 5 ♀.

Plate 4. Superficial view of the arrangement of the ventral
branches of the lumbar spinal nerves in relation
to Mm. psoas major and minor in situ ventral view
specimen no. 6 ♀. Same as Figure 7. Note the
branches of the L_2 spinal nerve emerging from the
proximal third of M. psoas major.
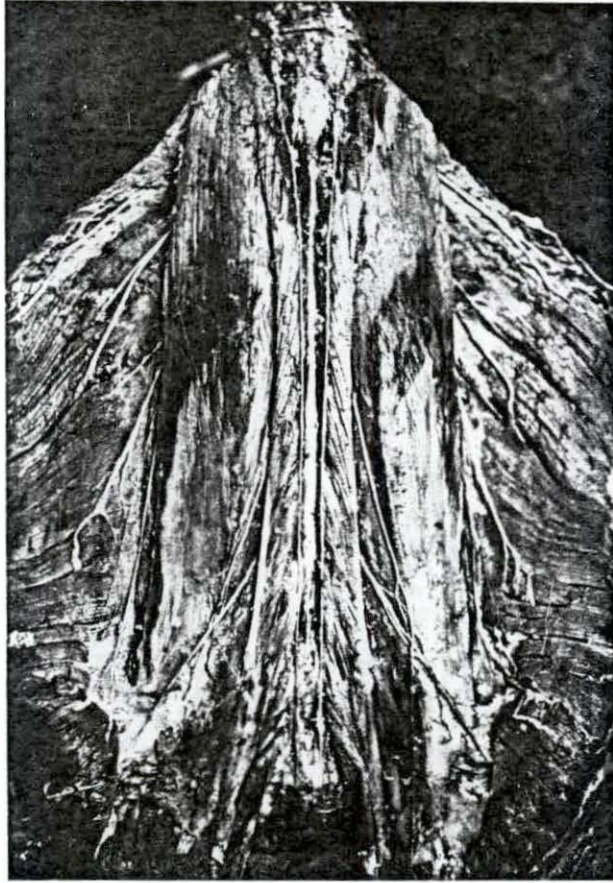
Plate 5.   Another mode of the arrangement of the ventral
            branches of lumbar spinal nerves in relation to
            Mm. psoas major and minor. Ventral view
            specimen no. 8 ♀. Same as Figure 11. It is
            the most common arrangement of the nerves in
            the lumbar region. Note the emergence of the L_2
            spinal nerves from the lateral border of each
            M. psoas major.
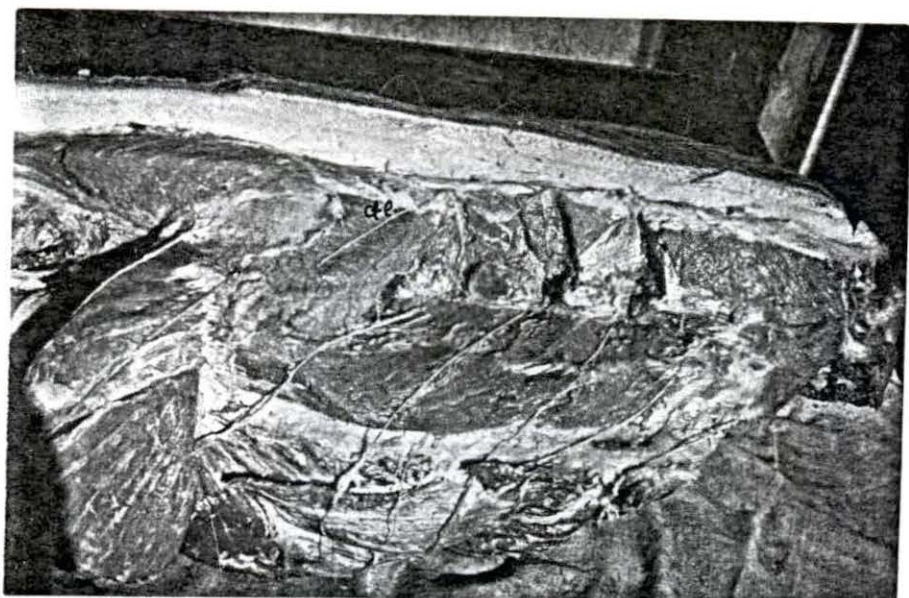
Plate 6. The dorsal branches of the lumbar spinal nerves
specimen no. 7 ♀. Note how the medial branches
course under the articular processes emerge at the
summit of spinous processes and then pass latero-
caudally under the skin, (d.l.) dorso-lateral
cutaneus branch. See Figure 6.

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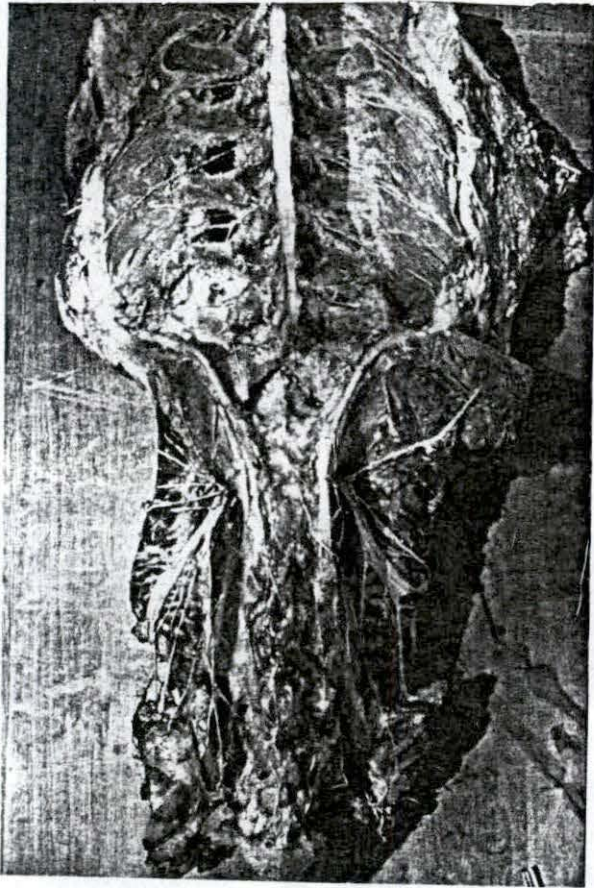
Plate 7. The lumbar, gluteal and ischio-anal fossa,
          dorsalateral view specimen no. 8Q. Note the
          dorsal branches in the lumbar and sacral
          regions. Also note the nerves in the ischio-
          anal fossa as shown in Figure 10.

Plate 8:   Lateral and medial aspects of the lumbar
           sacral and femoral regions

                   Specimen no. 9   ♂

       Top: Paralumbar, gluteal and femoral regions
               left side lateral view specimen no. 9
               ♂. Same as Figure 12. Note the branches
               of N. cutaneus femoris lateralis.

       Bottom: Pelvic cavity medial aspect of left
                half of scrotum showing the N. pudendus
                (1) emerging under accessory sex glands;
                Nn. perineales profunda (2); N.
                scrotalis caudalis (3); Nn. dorsalis
                penis (4); N. scrotalis medius (5).
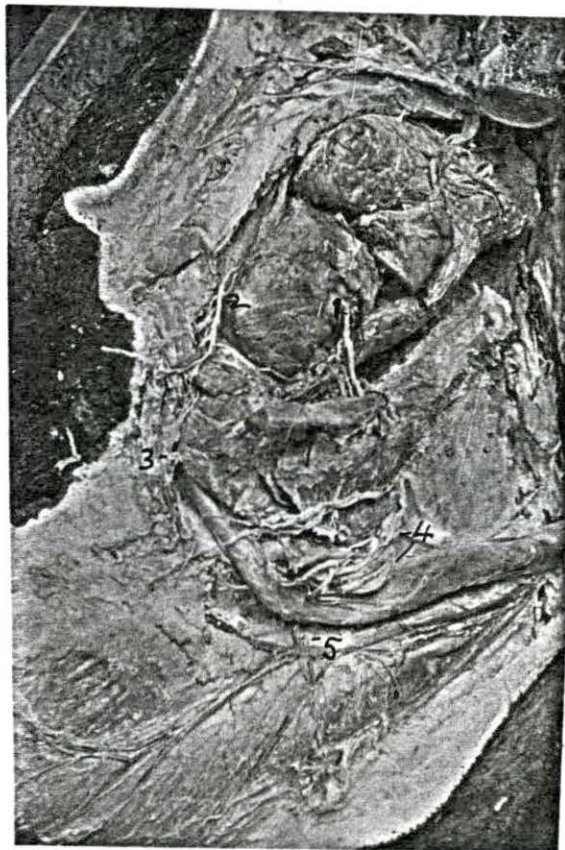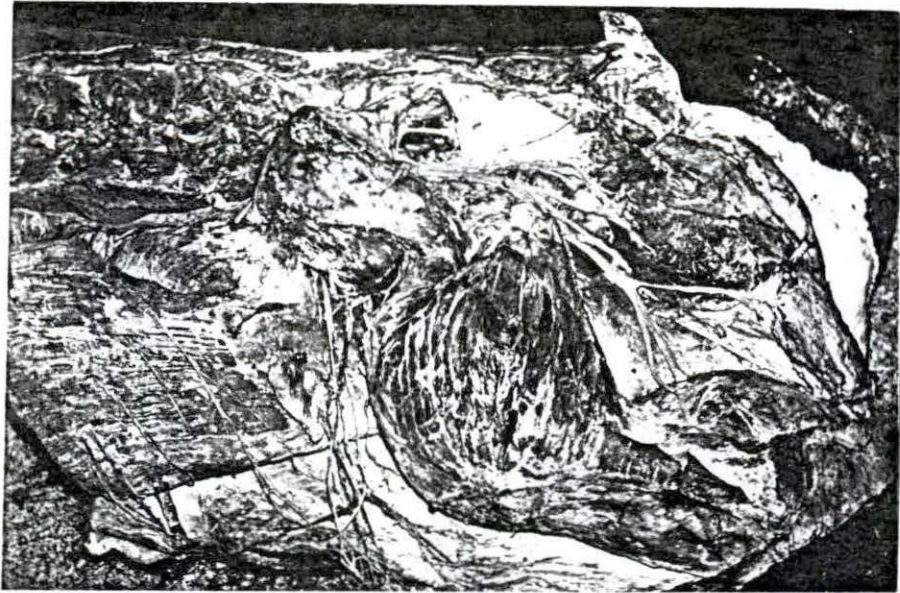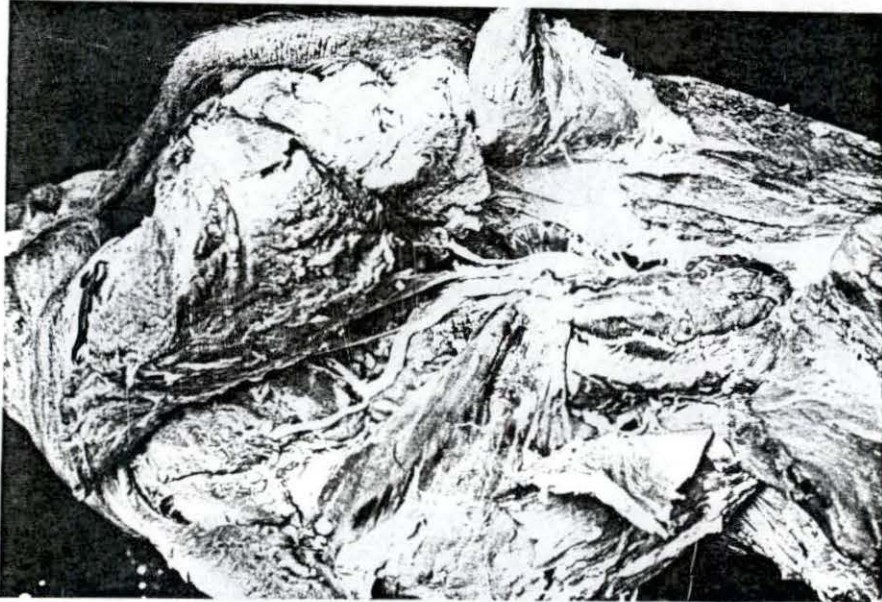
Plate 9. Gluteal and lateral femoral region showing Nn.
          ischiadicus, glutaeus cranialis glutaeus caudalis,
          tibialis, fibularis and cutaneus femoris caudalis,
          right side lateral view. Sprecimen no. 10 (♂)
          Male castrated - same as Figures 14 and 15.

Plate 10. Opened pelvis showing sympathetic trunk (s.t)
          with two rami to the vertebral end of M.
          retractor penis r.p at R. Specimen no. 12
          ♂. See Figure 19: 12.

Plate 11. Somatic and autonomic nerves of the lumbar and
           pelvic regions - left side, ventro-lateral view.
           Observe the Truncus sympathicus (1), Nn.
           splanchnici lumbales (2) and Nn. intermesen-
           terici (3) stretching along the Aorta abdomin-
           alis. (Same as Figure 21).

Plate 12. Somatic and autonomic nerves of the pelvic
           and coccygeal regions ventral view.
           Specimen no. 14 ♀. Same as Figure 22 in
           labelling.
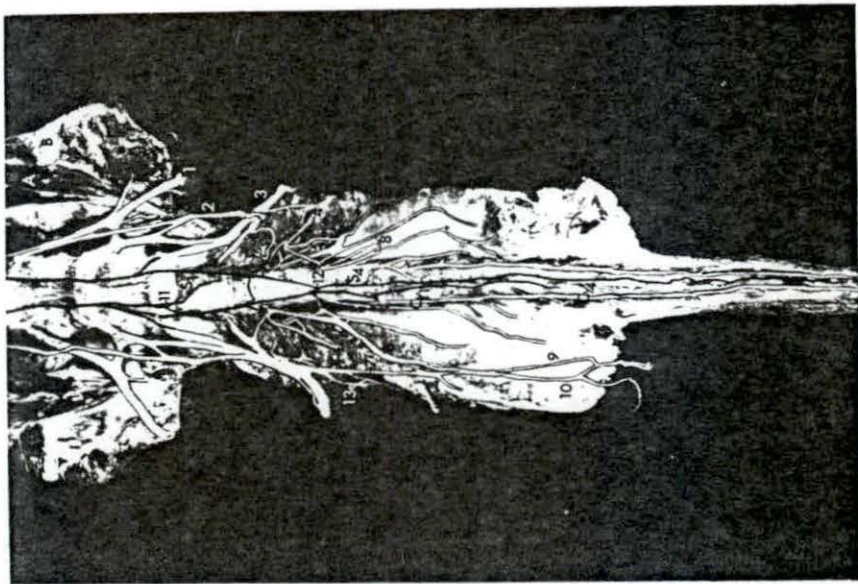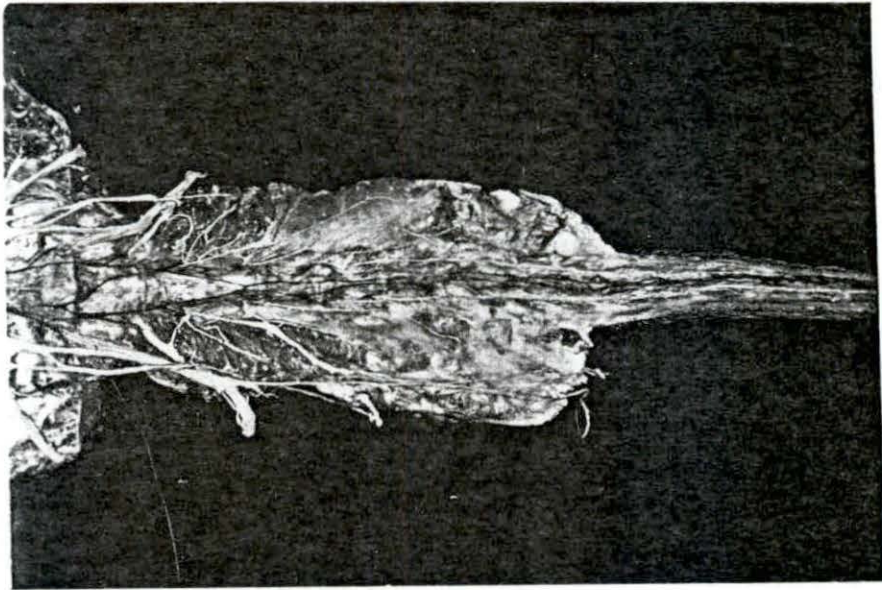
Plate 13.   Disposition of the sympathetic trunks and collateral
            ganglia in the lumbar and sacro-coccygeal regions
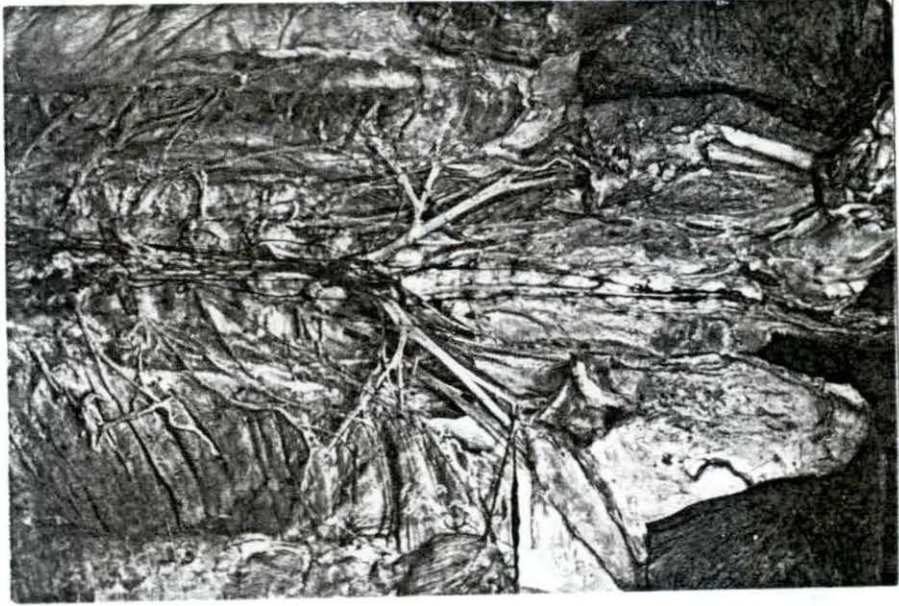   ventral view.   Specimen 15 ♀.   Labelled as Figures
            23 and 24.
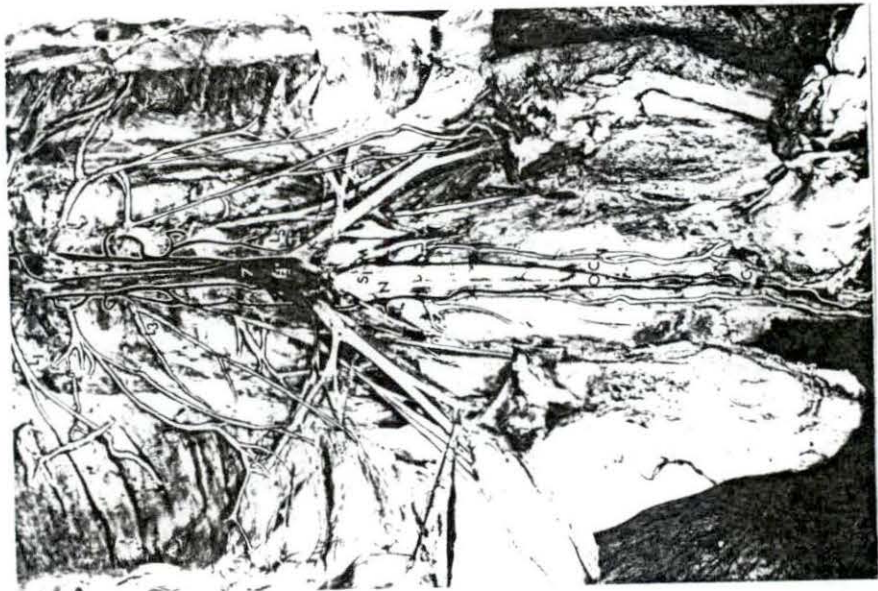
Plate 14a. Disposition of the sympathetic trunk, thoracic and lumbar splanchnic nerves and rami communicantes, left side, ventral view. Specimen no. 15 ♀. As Figure 23.
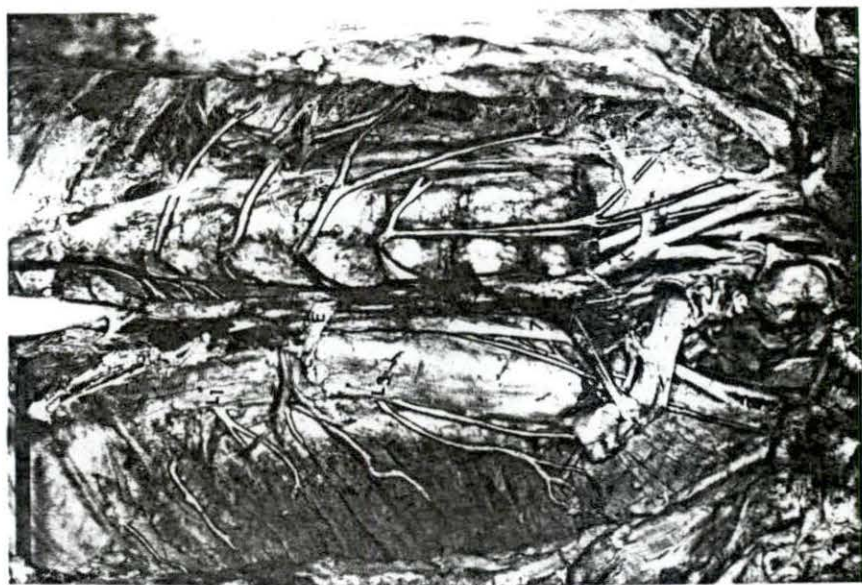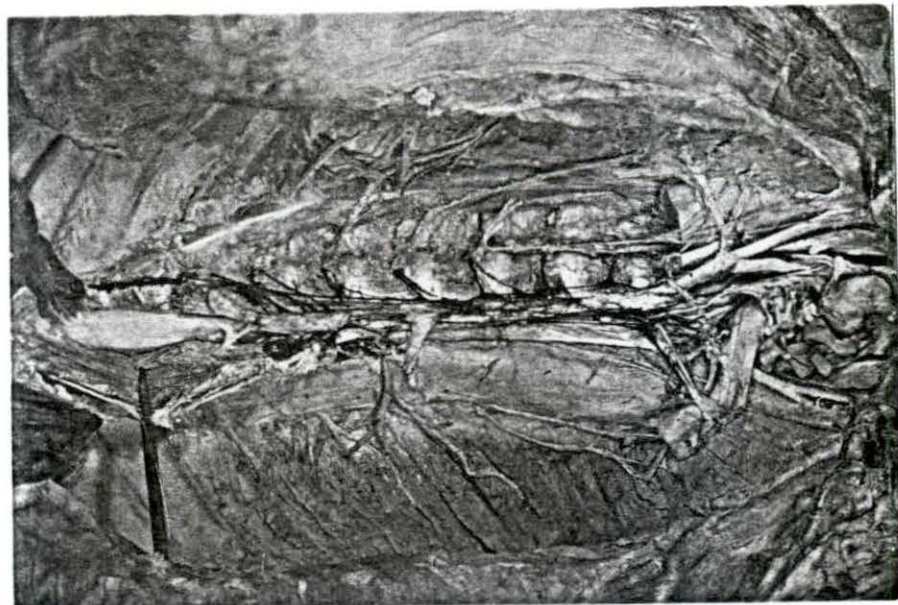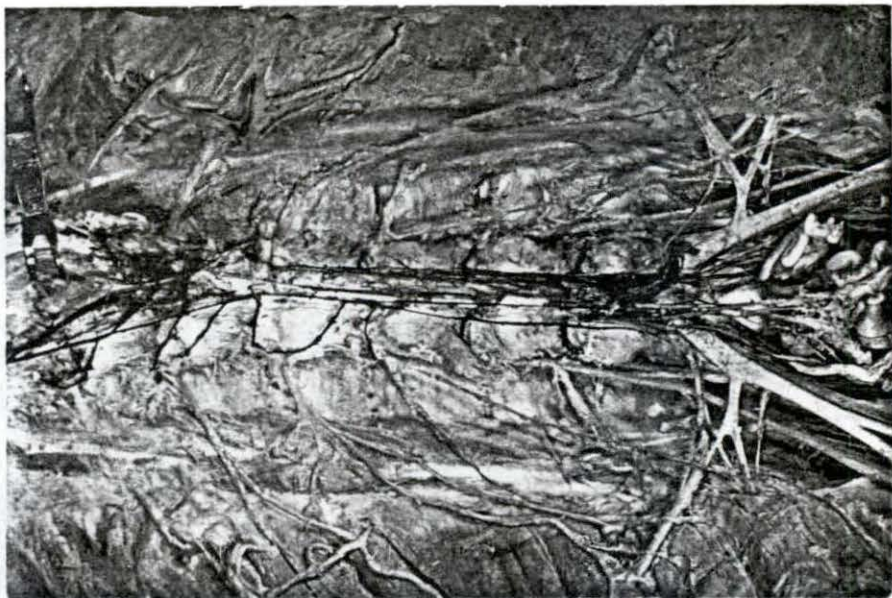
Plate 14b. Disposition of the sympathetic trunk, thoracic
           and lumbar splanchnic nerves and Rami com-
           nunicantes, right side, ventral view. Specimen
           no. 15 ♀ as Figure 23.
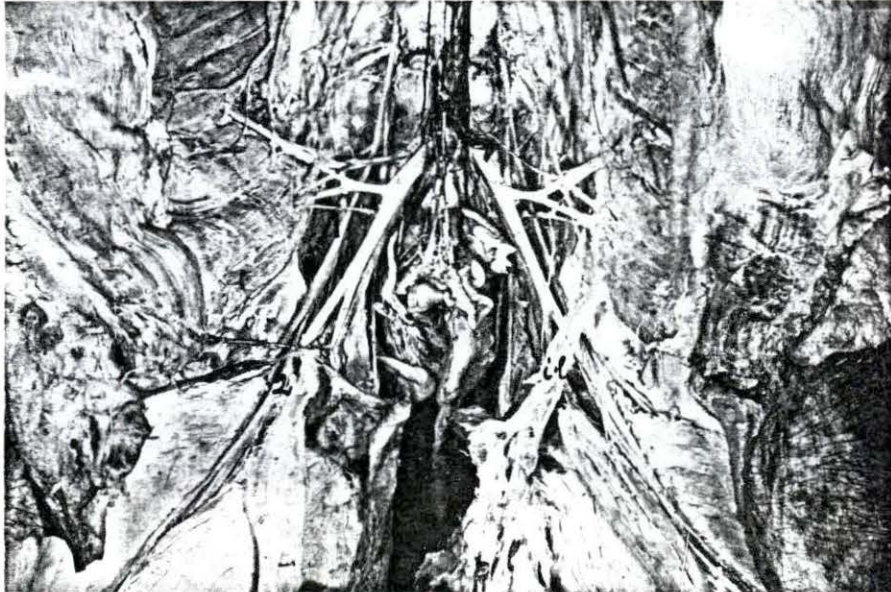
Plate 15. Origin of N. femoralis (1) and branching off
           of N. saphenus (2). Note the inguinal
           ligament (i.l) ventral view specimen no.
           15 ♀.