

STOWELL (T.B.)

THE LUMBAR, THE SACRAL, AND THE COCCYGEAL
NERVES IN THE DOMESTIC CAT.

With Plate XXIII.

T. B. STOWELL, A.M., PH.D., ✓

Principal of the State Normal and Training School at Potsdam, N. Y.



Extracted from

THE JOURNAL OF COMPARATIVE NEUROLOGY.

C. L. HERRICK, EDITOR.

CINCINNATI, OHIO, U. S. A.

THE LUMBAR, THE SACRAL, AND THE COCCY-
GEAL NERVES IN THE DOMESTIC CAT.

With Plate XXIII.

T. B. STOWELL, A.M., PH.D.,

Principal of the State Normal and Training School at Potsdam, N. Y.

The present contribution to comparative neurology is offered in the hope that it may serve as a factor to strengthen the argument in favor of the substitution of comparative anatomy for anthropotomy in the first year's work of our medical courses, and also to justify the practice of calli-section or painless physiological experimentation. The constancy of character, *i.e.*, the slight variation in nerve ramuli and their distribution, seems to favor making neurology the basis of comparative anatomy, rather than osteology or myology. Believing such to be the case, it is hoped that this study may prove helpful in establishing doubtful homologies. If the educational or cultural in contradistinction to the utilitarian view of the subject be considered, there seems abundant demand for the work undertaken by the paper as a guide to laboratory students with whom the end is general and not specific. For it is quite generally conceded that comparative anatomy furnishes one of the most available means for training the perceptive activities as well as those of comparison and induction. Furthermore, physiology is almost wholly a comparative science; while some of the facts known to physiology have followed direct experiment, the great majority are the results of partial experimentation upon other mammals. It needs no proof beyond mention to show

[287]



that the present plan of study in the medical college is not as extensive as it should be to furnish the technical skill and exact knowledge which the profession demands. That human physiology is largely comparative will be readily admitted, but unless the student knows that the structures in the animal experimented upon are strictly homologous with the structures in man the physiological experiment becomes merely an illustrative exercise, interesting and instructive, but not a demonstration of function in man.

When it is shown that the nerve-supply is identical with the nerve-supply in man, then these experiments in which the nervous system is a controlling factor are conclusive evidence in human physiology also; *e.g.*, at this moment my mind selects the elaborate experiments of Dr. H. P. Bowditch upon the vaso-motor nerves, the results of which were presented before Section F, A. A. A. S., Buffalo meeting, 1886.

Among reasons for the selection of a small mammal may be named the cost and convenience of suitable preparation, preservation and manipulation. In regard to cost, it should be remembered that for exact work each individual should dissect an entire body—the reserve half serving for corroboration, verification, correction of errors from accident or oversight, study of variations in the same individual, etc. The writer found it a matter of no small expense and labor to prepare and to preserve in alcohol the adult cadavers which formed the basis of his studies in anthropotomy; the convenience of manipulation will be appreciated by those who have had the experience of transferring a large adult cadaver from tank to table.

The adaptation of the domestic cat to the ends sought (comparative neurology) may be briefly stated as follows:

1. The readiness with which structures may be homologized with corresponding structures in man (certain nerves in the dog are quite unlike those in man, *e.g.*, vagi). That there are marked differences between the human brain and

other mammalian brains is generally known, and possibly some other animal is preferable to the cat as a type for this portion of the neur-axis.

2. The abundance of material for study.

3. The inexpensiveness of (*a*) the body; (*b*) of suitable preparation of the same, injection, etc.; (*c*) of preservation of the same.

4. The ease of manipulation; the tissues are much firmer than they are in a small human subject, fœtus or infant.

To these more apparent considerations may be added the fact that already elaborate works on felitomy are accessible, *e.g.*, Straus-Durckheim's monogram on the "Skeleton Ligaments and Muscles of the Cat" ("Anatomie du Chat," two vols.), or the less expensive reduced copies with "Explanations" by Prof. H. S. Williams; St. George Mivart's "The Cat," although this work does not seem to be a reliable guide to the study of American cats; the more scientific and exact work of Wilder and Gage, entitled "Anatomical Technology," and the numerous papers and addresses of the same authors, a partial list of which is found in the work cited; and the papers embodying some of the writer's studies in comparative neurology.⁽¹⁾

PREPARATION.

The cats were killed with chloroform and both arteries and veins were injected with the *starch injection mass*. When not in use the body was wrapped in a napkin saturated with alcohol and then placed in a tight vessel; the tissues are by this means preserved in excellent condition.

GENERAL DESCRIPTION.

The myel may be regarded anatomically as an elongated mass of alba and cinerea, and functionally as an aggregation

¹ "The Vagus Nerves in the Domestic Cat:" The Trigemini, The Facial, The Glosso-pharyngeal, The Accessory, The Hypoglossal, The Soft Palate. The literature of the subject was cited in a paper read before the American Philosophical Society, May 21, 1886.

of sensory and motor centres especially characterized by reflex action. Corresponding to its relations with the vertebræ, it is usually divided into the five regions, *cervical*, *thoracic*, *lumbar*, *sacral*, and *coccygeal*; and the myelic nerves are named from the vertebræ cephalad of which they have their respective ectal origins. The lumbar and the sacral nerves form open plexuses (Pl. lumbalis and Pl. sacralis), from which nerves are distributed to the integument and the subjacent muscles.

POSTURE.

Ventri-cumbent, head toward dissector's left, or lateri-cumbent, with the venter toward the dissector.

EXPOSURE.

It is not imperative that the dissection begin at any particular point, but most of the nerves send branches caudad rather than cephalad (v. diagram), hence it is recommended to begin at the thirteenth thoracic nerve and dissect caudad, removing the neural arch and exposing the myel as the dissection progresses. Make a long incision through the integument about 2 cm. sinistrad of the dorsi-meson, from the tenth thoracic vertebra to the base of the tail. From the cephalic end of this incision make a second incision ventrad 4-6 cm., and reflect the flap of integument over the twelfth and thirteenth ribs. With the arthrotome remove the dorsal muscle from the sinistral side of the meson to the level of the vertebral laminæ of the twelfth and the thirteenth thoracic vertebræ. With the tracer find the thirteenth thoracic and the first lumbar nerves just peripherad of the vertebræ, trace them centrad to the foramina intervertebrales, separate the connecting tissues from the foramina, then with the side-cutting nippers remove the neural arch of the thirteenth thoracic vertebra, taking the precaution to make the first incision near the neuropophysis, to insure protection to the myel. The dextral lamina can be removed without injury to

the dorsal muscles or integument, making it possible to use the dextral side to corroborate and to correct results obtained by dissecting the sinistral. The exposure of the myel in the arch of the caudal thoracic vertebra (thirteenth) exposes the ectal origin of the first lumbar nerve. The arch can be removed in a similar manner caudad and dextrad as the dissection requires, using the precaution to trace the dorsal division of each nerve before removal of the dorsal muscle. The nerves should be traced from the ectal origin peripherad.

LUMBAR NERVES. NERVI LUMBALES.

Common Characters.—The lumbar nerves are seven pairs, and have characters in common. They are related with the sympathetic system by anastomotic filaments to the adjacent ganglia (Fig. Pl. S. and S.), which filaments leave the ental surface of the nerve as it traverses the groove from the neural arch to the inter-vertebral foramen (foramen of exit); these anastomotic filaments are apposed to an arteriole—the dorsal branch of the A. lumbalis. At the ectal border of the foramen of exit, each nerve divides into a dorsal and ventral portion; the dorsal nerve divides into two or more branches, which innerve the muscles of the back (MM. quadratus lumborum, erector spinæ, intervertebrales) (Fig. M. dor.), which are especially large in the cat. A branch from each dorsal nerve can be traced to the integument (Fig. Int.), where it joins in an open plexus with the adjacent nerves.

The nerve trunk or ventral division dips ventrad close to the border of the centrum and mesad of the diapophysis; the origin is thus concealed by fascia, aponeuroses and superposed muscles. At the ventral border of the centrum the nerve usually passes laterad (except the branch to form the lumbar plexus) apposed to the abdominal branch of the lumbar artery. From the ental surface of the trunk adjacent to the centrum a branch is given off which separates into three to five ramuli to the proximal or aponeurotic portions of the M. psoas (Fig. Pso.), and two anastomotic rami to the sym-

pathic ganglia (Fig. S.) cephalad and caudad; in the cephalic three lumbar nerves, these rami join the great solar plexus (Fig. Pl. S.).

The lumbar nerves are conveniently grouped into two groups, those which do not enter into the lumbar plexus, viz., *the cephalic four pairs*, comparable with the first lumbar (anthropotomy), and those which are so related, viz., *the caudal three pairs*, comparable with the lower four lumbar nerves (anthropotomy).

Special Characters.—*The first and second lumbar nerves* give the first branch to the diaphragm (Fig. Dia.) instead of the M. psoas; they join the solar plexus (Pl. S.), they follow the abdominal lumbar artery through the aponeurotic origin fibres of the diaphragm, and lie upon its cephalic surface 25 mm. peripherad of the foramen of exit. Five mm. still peripherad, in the aponeurotic interdigitations of the ectal oblique muscle (M. abdominis obliquus ectalis), the trunk separates into cephalic (Fig. ce.) and caudal (Fig. ca.) divisions. *The cephalic division* follows the abdominal artery, penetrates the overlying (ectal) muscle, innerves the ental, the transverse and the rectus muscles of the abdomen, anastomoses with the cephalic divisions of the adjacent nerves (Fig. anas.), and sends terminal filaments to the adjacent integument (umbilical and hypogastric). *The caudal division* has its course caudad and slightly ventrad; it lies upon the ectal surface of the ental muscle, to which it gives filaments in the umbilical and the hypogastric regions. This division lies entad of the cephalic division of the lumbar nerve next caudad.

The third and fourth lumbar nerves (first lumbar of anthropotomy). These nerves have the ectal origins and proximal rami similar to the first and second. The third nerve joins the solar plexus cephalad, but the sympathetic ganglion caudad. The fourth does not anastomose with the plexus. *The cephalic divisions* are distributed farther caudad, reaching the gluteal (Fig. Th.) and inguinal regions (Fig.

Pub.), and giving numerous filaments in plexiform relations over the hypogastric integument. *The caudal division* of the third lies entad of the cephalic division of the fourth, and ectad of the cephalic ramus of the ilio-lumbar artery; 20 mm. from its origin it crosses a ramulus of the caudal ramus of the same artery as the arteriole perforates the lateral border of the *M. abdominis rectus*. The nerve gives filaments to the transverse (Fig. trans.) and to the ental oblique (Fig. M. ent.) muscles. *The caudal division* of the fourth lies apposed to the caudal ramus of the ilio-lumbar artery for 15–20 mm.; it passes between the cephalic and the caudal divisions of the genito-crural nerve. It innerves the transverse and ental muscles 10–15 mm. dorsad of the region supplied by the caudal division of the third, and terminates in the *rectus abdominis* muscle.

The fifth, sixth and seventh lumbar nerves are distinguished from the other lumbar nerves by the plexus (*Pl. lumbalis*) formed by the dorsal or caudal divisions of the ventral nerve trunks. These nerves rapidly increase in size, the seventh being considerably the largest. The union of the divisions or branches just ventrad of the vertebral diapophyses forms not only an important part of the lumbar plexus, but constitutes the lumbo-sacral cord of anthropotomy, from which nerves take their ectal origins, v. below.

N. GENITO-CRURALIS, N. LUMBO-INGUINALIS; N. PUDENDUS
EXTERNUS.

The genito-crural nerve (second lumbar of anthropotomy) has its ectal origin by two roots; the cephalic root seems to be the lateral continuation of the fifth lumbar nerve, the caudal root is a large branch of the sixth lumbar nerve, given off at the foramen of exit centrad of the plexus. The root nerves are inter-related by anastomotic filaments. The trunk formed by the union of the roots penetrates the aponeurosis of the *M. psoas*, lies upon its ectal surface about 2 mm. laterad of the mesal border of the muscle, and separates into

two divisions, cephalic and caudal. *The cephalic division, the crural branch (crur.)*, bends around the lateral border of the M. psoas, and 20 mm. peripherad of its origin it accompanies the ilio-lumbar artery into the transverse muscle. Its course is caudad in the transverse and ectal muscles, and leaves the pelvis by the ectal abdominal ring entad of Poupart's ligament; its course outside the pelvis is along the ectal fascia over the caudal thigh to the knee, and terminates in the integument of the proximal crus, where it joins filaments of the external cutaneous nerve. *The caudal or dorsal division, the genital branch (gen.)* lies upon the meso-ental surface or border of the M. psoas, entad of the ilio-lumbar artery, at which point it gives a large anastomotic branch to the open plexus of nerves and vessels of that region, and thence continues caudad in the ental muscle, to which it gives several filaments. At the Poupart's ligament (Fig. P.) it is reflected ventro-cephalad, and terminates in the integument of the hypogastric region; filaments from the point of reflection extend to the integument over the pubes. (I have not traced this nerve in the male.)

N. CUTANEUS ECTALIS.

The external cutaneous nerve (Ext. Cut.) has its ectal origin by two roots; the cephalic root is a branch of the loop (Fig. Loop) between the fifth and the sixth lumbar nerves; the caudal root is a branch of the sixth nerve in common with the caudal root of the genito-crural. The origin and the distribution of the genito-crural and the external cutaneous nerves indicate an intimate inter-relation.

The course of the nerve lies ectad of the anastomotic branch from the G. sympathicus to the sixth lumbar nerve; it runs obliquely through the origin fibres of the M. psoas and comes to superficial view at the mesal border of that muscle at the point where the iliac artery lies apposed to the aponeurosis of the M. psoas, about 20-30 mm. cephalad of the ramus of the pubis. Exposure is readily made by

tracing the mesal border of the *M. psoas caudad* from this point.

The nerve lies ectad (ventrad) of the external iliac artery and vein, and entad of the common iliac vein which is ventrad of and apposed to the artery; it bends around the artery and lies upon its ental surface, ectad (ventrad) of the hypogastric artery just cephalad of the ramus pubis.

It leaves the pelvis through the abdominal ring, 20 mm. peripherad of which it separates into two divisions, one of which (Fig. ce.) is distributed to the integument of the hip (Fig. H.) and the proximal half of the caudal thigh (Fig. Th); the other division (Fig. ca.) is distributed to the integument over the biceps muscle as far as the knee. The nerve was wanting on the sinistral side of one specimen (female).

N. CRURÆUS ANTERIOR.

The anterior crural (Ant. Crur.), the seventh lumbar nerve, is the largest of the spinal nerves whose origin is not referable to the union of two or more nerve trunks. It supplies *muscular* branches to the psoas, the iliacus, the sartorius, the pectineus muscles and the muscles of the cephalic (inner) thigh except the tensor vaginæ femoris, which is innerved by a slender ramus of the superior gluteal nerve (q. v.); and *cutaneous* branches to the integument of the thigh, the leg, the cephalic part of the foot and the plantar surface of the toes.

The seventh lumbar nerve at the foramen of exit sends anastomotic branches to the adjacent sympathetic ganglia; its dorsal division innerves the muscles of the back (Fig. M. dor.) and the adjacent integument (Fig. Int.); the large ventral division (2 mm. in section) lies close to the lateral surface of the centrum and at its ventral border receives the large trunk (Fig. L. S. C.) of the sixth lumbar nerve, and sends an equally large trunk caudad (Fig. L. S. C., lumbosacral cord of anthropotomy) to the first sacral nerve.

Origin.—The anterior crural nerve is the ventral division of the seventh lumbar, of which it is strictly the continuation with a large accession from the sixth—or its origin may be referred to the lumbar plexus.

Principal Rami.—The ectal origin of the nerve lies entad of the M. psoas, to which several filaments are given (Fig. Pso.) 2 mm. peripherad of its origin; 5 mm. peripherad a large branch is given caudad to the M. iliacus (Fig. M. il.). The general course of the nerve trunk is embraced by the M. psoas, the nerve reaching the ectal surface or lateral border of the muscle in the region of the iliac notch, or 20 mm. ventro-caudad of its origin. Entad of Poupart's ligament (Fig. P.) it gives from its lateral border a large ramus which innerves the sartorius muscle (Fig. Sar.), which ramus lies entad of a ramus of the profund artery 10 mm. from its origin. As the nerve crosses the artery a slender branch passes ectad of the artery to the mesal border of the sartorius muscle. The larger portion of this branch lies upon the ental surface of the muscle, and can be traced to its distal extremity or insertion, thus innerving its distal three-fourths; the smaller portion of the nerve is reflected proximad at the profund artery, and innerves the proximal (origin) one-fourth of the sartorius muscle, lying upon its ental surface.

Entad of Poupart's ligament and 2 mm. peripherad of the sartorial branch, from the mesal border of the nerve is the ectal origin of the long saphenous nerve (N. cutaneus internus longus, Fig. Saph. l.).

THE LONG SAPHENOUS NERVE.

This nerve lies ectad of the femoral artery and apposed to it and the long saphenous vein, the vein being mesad, the artery in the middle, and the nerve laterad upon the surface of the thigh.

Principal Rami.—The first branch is given to the artery (Fig. A. fem.). At the knee (Fig. K.) two ramuli are given off; the *lateral* ramulus (Fig. l. r.) is cutaneous; it accom-

panies an arteriole and is distributed to the integument over the cephalic surface of the proximal third of the crus; the *mesal ramulus* (Fig. m. r.) lies ectad of the artery and vein and is distributed to the integument mesad of the vein, its terminal filaments anastomosing with other filaments of the nerve trunk. Below the knee (Fig. K.) (upon the crus) the nerve continues as two divisions corresponding with the two arteries, with whose courses they are nearly parallel; the *lateral division* is distributed to the integument over the cephalic surface of the distal half of the crus and the pes; the *mesal division* lies in the fascia ectad of the tibia; its course is just mesad of (behind) the cephalic malleolus, ectad of the tendon of the M. tibialis anticus; it forms a dense plexus upon the cephalic metatarsale (2) and joins the plantar plexus (Fig. Pl. Plan.), its terminal filaments being traceable to the distal extremities of the toes and to the plantar pads.

The muscular division (deep layer of anthropotomy) of the anterior crural nerve, near its origin at Poupart's ligament, follows the profund artery, dips entad in Scarpa's triangle, and gives a branch to the M. sartorius (Fig. Sar.), which branch, 5 mm. peripherad (at the border of the M. rectus femoris), lies entad of the artery and separates into a peripheral and a central portion; the peripheral branch may be traced in pinniform arrangement throughout the distal three-fourths of the muscle to the knee; the central branch is reflected at the artery and is distributed to the proximal fourth of the muscle.

At the origin of the last branch the nerve penetrates the M. rectus femoris (Fig. M. r. fem.), to which three rami are given. The proximal ramus innerves the proximal third of the muscle, the second lies upon the ental surface of the muscle and innerves its distal two-thirds, to the insertion at the patella; the third ramus enters the caudal border of the muscle near its middle. These three rami are motor. Five mm. peripherad of the branch to the M. sartorius a ramus is

given to the *M. vastus internus* (*V. int.*) and to the *M. crureus*. At the caudal border of the *M. vastus internus* filaments are given to the muscle; the nerve lies entad of the *M. rectus femoris* and the adjacent *M. vastus externus*, whose ental surface it penetrates, accompanied by an artery, and distributes filaments from three ramuli to the *M. vastus externus*. The nerve can be traced around the lateral border of the femur with the internal circumflex (?) artery into the *M. pectineus*.

N. OBTURATOR.

Origin.—The obturator nerve (*N. Obt.*) has its ectal origin from the lumbo-sacral cord between the seventh lumbar and first sacral nerves, 16 mm. caudad of the anterior crural nerve; in one specimen the origin was by the union of a lumbar (seventh) and a sacral (first) root at the ventral border of the ilium. Its course is caudad, ectad of the ental iliac artery and ventro-mesad of the ventral border of the ilium; it pierces the obturator muscle 30 mm. caudad of the origin of the nerve; it leaves the pelvis through the *Fm. obturator*, peripherad of which it divides into several rami.

Principal Rami.—The first ramus (*N. obturator accessorius* (?)) is directed ectad to the superposed *M. pectineus* (*Fig. M. Pec.*). A long ramus bends over the cephalic surface of the origin of the adductor muscle, lies upon the ental surface of the *M. gracilis* apposed to an arteriole, and innerves the *gracilis* (*Fig. M. grac.*), in which muscle it may be traced to its aponeurotic insertion at the knee, centrad of which anastomotic filaments relate it with the long saphenous nerve.

Four rami lie upon the ectal surface of the proximal end of the adductor muscles (*MM. magnus* and *brevis*), just peripherad of the foramen, in which muscles they terminate.

Entad of the *M. adductor longus*, between it and the *M. adductor brevis*, two ramuli cross the *M. adductor brevis* and are distributed to the *M. adductor magnus*, attended by rami

of the internal iliac artery. Terminal ramuli like a leash supply the M. adductor longus and the M. obturator externus.

SACRAL NERVES.

General Description.—The sacral vertebræ are three, and the nerves are corresponding three pairs. These nerves are characterized by the length of the ectal roots and by the distance through which they are traced in the neural arch and in the groove from the arch to the intervertebral foramina. At their respective foramina of exit they separate into two unequal divisions, the dorsal and the ventral; *the dorsal division* passes directly dorsad and divides into cephalic and caudal rami, each of which anastomoses with the terminal filaments of the adjacent nerves, and each sends a considerable branch to the open plexus of cutaneous nerves; *the ventral division* passes directly ventrad and laterad to join in the formation of the sacral plexus, from which nerves are distributed to the caudal extremity. Each ventral nerve receives an anastomotic nerve from the adjacent sympathetic ganglia (Fig. S.).

THE FIRST SACRAL NERVE.

Special Description.—The first sacral nerve is the largest of the spinal nerves, and has its ectal origin in the neural arch of the sixth lumbar vertebra, at the caudal border of which may be found its dorsal root ganglion; it traverses the long groove (10 mm.) in the seventh lumbar vertebra, and finds its exit through the foramen mesad of the crista ilii and ventro-mesad of the broad diapophysis of the first sacral vertebra. Immediately peripherad of the foramen of exit it is joined by the lumbo-sacral cord (Fig. L.-S. C.)—which in a medium-sized cat is 2 mm. in section—and has its course mesad and ventrad of the diapophysis and the crista ilii, by which it is concealed, and which renders its exposure somewhat difficult. The nerve trunk at this point (its central 10 mm.) is about 4 mm. in section.

Principal Rami.—The first nerve from the sacral plexus, *N. Gemellus* (Fig. Gem.), is given from the ectal surface of the first sacral nerve where it is joined by the lumbo-sacral cord (Fig. L.-S. C.) at the caudal border of the first sacral vertebra, and is directed dorsad; it lies close to the vertebra for its central 5 mm., and then passes laterad into the gemellus muscle, and is distributed by three branches. This muscle has its origin along the sacral vertebræ, but its relation with the *M. gluteus maximus* and its insertion with the *M. obturator internus*, as well as the innervation, lead to its identification as the *M. gemellus superior*.

From the cephalic border of the first sacral nerve a branch is sent laterad and around the ramus of the ilium cephalad of the acetabulum to the *M. pyriformis* (Fig. Pyr.). The nerve trunk lies ectad of the sacral artery and vein, and leaves the pelvis through the great sciatic foramen upon the ectal surface of the *M. quadratus femoris*, the *M. obturator* and the *M. pyriformis*, and entad of the *MM. glutei*.

About 10 mm. caudad of the foramen of exit a branch from the ental surface is given to the *M. gluteus maximus* (Fig. *M. gl. max.*), and 5 mm. still peripherad a branch caudad and entad of the *M. obturator internus* (*M. obt. in.*), which branch divides into two rami, the shorter being distributed to the overlying obturator and the longer terminating in the quadratus muscles. The nerve to the *M. gluteus* is sometimes a branch from the second sacral nerve (see Fig. F).

THE SECOND SACRAL NERVE.

The ventral division of this nerve is much smaller than the first sacral nerve; it takes a ventro-laterad course, and joins the first sacral just mesad of the trochanter. The union of these two trunks constitutes the great sciatic nerve \blacksquare q. v. \blacksquare .

Principal Rami.—*The dorsal division* is already described in common with the other sacral nerves, v. "General Description." Its caudal branch joins the plexus which innerves

the dorsal muscles and the integument of the tail. A large anastomotic *loop* joins the *ventral division* of the third sacral nerve just peripherad of the foramen of exit. A slender branch is sometimes given as a distinct nerve to the overlying M. gluteus maximus (Fig. M. gl. max.).

THE THIRD SACRAL NERVE.

The ventral division is the smallest of the sacral nerves; it divides into ental and ectal branches. *The ental or deep branch* lies upon the ectal surface of the long levator ani muscle (Fig. L. A.), to which it is distributed. *The ectal branch* joins the second sacral nerve in a large anastomotic branch or *loop*, and peripherad of this a smaller loop joins the first coccygeal nerve (Fig. N. Coc.) and at the same point gives off the second root of the N. coccygeus (Fig. N. Coc.).

Principal Rami.—The nerve trunk divides into three branches, which lie entad of the rami to the M. gluteus maximus and the M. obturator internus, already described. *The cephalic branch* joins the N. ischiadicus at the origin of the sciatic root of the pudic nerve; *the middle branch* is the sacral root of the pudic nerve; *the caudal branch* separates into two rami, one of which is the sacral root of the N. gluteus (N. glut.), and the other forms, with a branch from the first coccygeal nerve (q. v.) and a branch from the pudic, a slender nerve to a ribband muscle (Fig. M?) described below v. N. Coccygeus.

N. GLUTEUS SUPERIOR.

At the union of the lumbo-sacral cord with the first sacral nerve to form the main trunk of the great sciatic, a large branch, the superior gluteal nerve (N. gl. S.), is sent laterad and bends over the dorsal border of the ilium just cephalad of the acetabulum and entad of the MM. glutei. It leaves the pelvis by the great sciatic foramen, and 10 mm. peripherad of its origin divides into three branches; *the*

cephalic branch is distributed to the M. gluteus medius (M. gl. med.), which lies ectad of the nerve and whose ental surface it penetrates; *the caudal branch* is distributed to the M. gluteus minimus (M. gl. min.), which lies entad and caudad—these two rami are the homologue of the *superior branch* of anthropotomy; *the middle branch*—inferior of anthropotomy—the largest branch, perforates the M. gluteus minimus and innerves the M. tensor vaginae femoris (T.V.F.), in which it can be traced to the distal fourth. A few filaments are given to the M. gluteus minimis.

N. ISCHIADICUS.

The great sciatic nerve (Fig. Ischiad.) is the largest of the spinal nerves; its ectal origin is the sacral plexus, or the union of the first and second sacral nerves. Within the pelvis, its course is caudad to the sciatic foramen; peripherad of the pelvis it lies upon the ectal border of the M. obturator internus and the MM. gemelli, mesad of the great trochanter, laterad of the ischiac tuberosity, and entad of the MM. pyramiformis, biceps and glutei. Its exposure is effected in the meros by the removal of the M. gluteus maximus and the M. biceps. The great sciatic nerve is cutaneous and muscular in its distribution; it supplies the integument of nearly all the caudal limb, and the muscles of the meros, the crus, and the pes as given below.

Principal Rami.—*The first branch* is given off at the union of the second sacral nerve, and innerves the M. quadratus femoris (Fig. Quad.). *The second branch* is the sciatic root of the pudic nerve (q. v.), in common with the root of a gluteal nerve (b. v.). *The third branch* is a considerable nerve entad of the M. pyriformis, and which is divided into three smaller rami: (a) the first of which enters the ental surface of the M. biceps, 5–8 mm. peripherad of its origin (Fig. M. bi.); (b) the second is covered by the M. biceps, to which it gives it ramulus at its mesal (lower) border, and continues entad of the M. semi-tendinosus and a plexus of

vessels (ramuli of the profund artery and veins (?)); it lies upon the ental surface of the muscle 20-30 mm., then penetrates its substance as two terminal ramuli (Fig. M. semi-ten.); (c) the third ramus crosses the ectal surface of the vessels named, peripherad of which, or 20 mm. from its origin, it enters the M. semi-membranosus as two terminal ramuli (Fig. M. semi-mem.). *The fourth branch* is a slender filament, about the middle of the thigh, which is given to the distal half of a ribband muscle (Fig. M?) 2 mm. in width, which lies in the fascia upon the ental surface of the M. biceps, which muscle it crosses obliquely—this muscle has its origin just cephalad of the M. pyriformis upon the diapophysis of the first caudal vertebra, lies entad of the M. pyriformis and the M. biceps, and is inserted in the aponeurotic fascia of the mesal border of the biceps about midway between knee and ankle; it is readily separable from the biceps; the total length in a cat of medium size is about 90 mm.; the proximal end of the muscle is innervated by a ramulus whose roots are traceable to the third sacral, the first coccygeal and the pudic nerves. *The fifth branch* innervates the distal third of the M. biceps (M. bi.); it is given off 40 mm. peripherad of the trochanter, just centrad of the short saphenous nerve.

N. CUTANEUS INTERNUS.

The short saphenous nerve (Saph. br.) has its ectal origin just centrad of the division of the sciatic trunk into the popliteal and the peroneal nerves. It crosses the popliteal space embedded in the adipose which occupies this region, is ectad of the artery and entad of the M. biceps; it lies apposed to the artery upon the dorsal surface of the biceps and entad of the ectal fascia. Its filaments terminate in the integument over the caudal side of the foot and the fifth toe.

The great sciatic trunk divides into two unequal nerves, the caudal and smaller, N. peroneus, and the cephalic, larger nerve, N. popliteus.

N. PERONEUS.

This nerve lies entad of the insertion third of the M. biceps and ectad of the M. gastrocnemius, which muscle it crosses a bout 10 mm. peripherad of the caudal condyle. As the nerve dips between the M. peroneus longus and the M. peroneus tertius, the

N. MUSCULO-CUTANEUS

(Fig. mus.-cut.) takes its origin and has its course entad of the M. peroneus, apposed to the anterior tibial artery; it becomes ectal (superficial) with the artery about midway between the knee and the ankle, or near the tendinous part of the M. peroneus longus; following the artery its ramuli may be traced to the integument upon the dorsum of the foot and the second, third and fourth toes. Its caudal filaments anastomose with the short saphenous nerve. Ten mm. peripherad of its origin it gives a branch to the M. peroneus tertius, and 10 mm. still peripherad a large ramus passes entad and lies upon the ectal surface of the M. peroneus brevis, apposed to an arteriole (a branch of the anterior tibial artery), which muscle it innerves. The trunk crosses the ectal surface of the muscle (peroneus brevis) obliquely and bends around the caudal border of the large tendon as it passes through the sheath caudad of the malleolus; it then lies entad of the tendon and upon the ectal surface of the short extensors of the toes, which muscles it penetrates, lying between the fourth and the fifth metatarsalia, and entad of the tendon to the fifth toe, but ectad of the one to the fourth toe at the distal end of the metatarsale, at which point it joins a ramus of the (?) nerve, thence it is distributed to the integument of the fourth toe.

The nerve trunk at the origin of the musculo-cutaneous branch gives a ramus to the overlying M. peroneus longus, which nerve accompanies an arteriole from the anterior tibial artery. Entad of the M. peroneus longus with the last

described nerve, an equally large branch lies just entad and dips between the M. extensor digitorum longus and the M. peroneus tertius. Ten mm. peripherad of its origin the nerve bifurcates, the anterior tibial artery (Fig. A.) occupying the angle between the branches. *The cephalic branch* (Fig. ce.) innerves the M. extensor longus digitorum; *the caudal branch* (Fig. ca.) lies entad of the anterior tibial artery and accompanies the artery to the dorsum of the foot. Entad of the groove a ramus is given to the tarsal ligament and the origin fibres of the M. extensor brevis. The terminal filaments join in the plexus to the integument of the dorsum of the foot and toes.

N. TIBIALIS ANTICUS.

This branch (Fig. Tib. a., and m.) of the peroneal is given off between the origin of the musculo-cutaneous nerve and the bifurcation of the peroneal; it can be traced 30-40 mm. in the substance of the M. tibialis anticus, and sends a ramus peripherad to the M. extensor longus digitorum.

N. POPLITEUS.

The cephalic division of the great sciatic nerve crosses the popliteal space and continues peripherad between the heads of the M. gastrocnemius. At the proximal end of the crus it gives its *first branch* to the ectal surface of the caudal head of the M. gastrocnemius (Fig. M. gas.), and immediately peripherad a large ramus penetrates the same muscle and is distributed to the muscle from its ental surface; a considerable portion of this ramus perforates the gastrocnemius and innerves the M. Soleus (Sol.), which is entad; from this penetrating ramus ramuli are given to both heads of the muscle. Twenty mm. peripherad a *second large branch* to the body of the same muscle (Fig. M. gas.), peripherad of which the nerve trunk bifurcates, forming ental (Fig. dv. ent.) and ectal (Fig. dv. ect.) divisions.

N. POST-TIBIALIS.

The *ental division* of the popliteal nerve is muscular in distribution. Ten mm. peripherad of its origin a large ramus innerves the *M. popliteus* (Fig. Pop.), which lies just entad. The trunk crosses the ectal surface of the post-tibial artery, and 10 mm. peripherad it innerves the *M. flexor longus digitorum* (*M. fl. long. dig.*) by several pinniform ramuli. As the nerve penetrates the flexor muscle a ramus is given to the *M. tibialis posticus*, and still peripherad three or four filaments are given to the *M. flexor longus pollicis?*—a muscle whose tendon unites in the plantar surface with the broad tendon of the long flexors (pollex is wanting in the cat).

The *ectal division* lies apposed to the post-tibial artery and gives no rami centrad of the groove of the long flexor muscle, in which groove are the tendon, the nerve and the post-tibial artery. Peripherad of the groove the nerve bifurcates and lies upon the ental surface of the *M. flexor brevis digitorum*. The cephalic ramus,

N. INTER-PLANTARIS,

innerves the short flexor muscles, lies along its cephalic border, and terminates in cutaneous ramuli to the pads of the second and third toes; a few filaments are directed entad to the underlying muscle, the *M. flexor accessorius* (*fl. ac.*).

N. PLANTARIS,

The caudal ramus of the ectal division, lies upon the broad tendon of the long flexor muscle and the second layer of muscles. A slender ramus is given caudad to a small muscle upon the distal end of the calcaneum—the fibres of this muscle run transverse and the aponeurosis joins the broad tendon of the long flexor. Near the proximal end of the meta tarsalia a branch is given entad,

THE ENTAL PLANTAR NERVE,

which lies ectad of the proximal end of the interosseus muscles and within their substance, and crosses the foot obliquely from the head of the metatarsale of the fifth toe toward the distal end of the metatarsale of the second. The nerve trunk lies entad of the caudal border of the short flexor and at the distal end of the second metatarsale (pollex wanting); it divides into a leash of four nerves, each of which dichotomoses and innerves the interosseous muscles (*M. int.*); slender filaments are given to the third layer of muscles. The ental branch innerves the third and fourth lumbricales, the three plantar interossei muscles, and the four muscles which occupy the plantar arch of the metatarsalia—these muscles have their origins at the proximal end of the metatarsalia and insertion in the aponeurosis of the common extensor tendon and by a short tendon into the proximal end of the proximal phalange. A portion of the muscle seems to be equivalent to the dorsal interossei (anthropotomy), and a portion is not satisfactorily homologized. The deep plantar also innerves a muscle, which has its origin from the os cuboides and crosses the plantar metatarsus obliquely and inserts by a tendon upon the caudal surface of the proximal phalange of the second toe, probably an adductor muscle.

THE ECTAL PLANTAR NERVE

bends around the tendon of the muscle, and, crossing its ectal surface, lies entad of the tendon of the long flexor of the second toe. At the distal end of the proximal segment of the fifth toe it bifurcates, and can be traced to the pad of the fourth and fifth toes. A slender filament is given to the *M. abductor minimus* (Fig. *M. ab. min.*).

N. PUDICUS (N. PUDENDUS).

The pudic nerve (*Pud.*) has its ectal origin by two roots. The sacral root is the largest of the terminal branches of the

third sacral nerve, and lies entad of the pudic artery; the sciatic root is given off from the sciatic nerve about 15 mm. peripherad of the union of the first and second sacral nerves, in common with the sciatic root of the N. gluteus to the M. glutei (Fig. N. glu.). It leaves the pelvis through the sacro-sciatic foramen, and is apposed to the pudic artery; its general course is meso-caudad, entad of the pudic artery and vein, upon the ectal surface of the internal obturator muscle. Twenty mm. peripherad of the union of the two root nerves, the pudic separates into dorsal and ventral divisions, which are muscular and cutaneous respectively in distribution.

N. PERINEUS DORSALIS,

The dorsal division (Fig. dor.), lies upon the ectal surface of the rectal muscle; its branches innerve the broad M. levator ani (Fig. L. A.), the M. sphincter ani (Fig. sph. A.), and 20 mm. of the longitudinal rectal muscles (Fig. rec.), which muscles are supplied by the hemorrhoidal artery and vein. The last nerve is the

N. HÆMORRHOIDES.

A branch is given to the anal gland (Fig. gl.)—a large olive-colored gland just laterad of the anus, whose duct opens ectad of the sphincter muscles, or sometimes just entad. Another ramus,

N. PERINEUS DORSALIS,

Innerves the sphincter vaginae and the ectal labium(?).

N. PERINEUS VENTRALIS,

The ventral division (Fig. ven.), is distributed to the vagina, the ectal labium, the perineum, the urethra, the M. accelerator urinæ, and the transverse muscle just entad of the perineal integument. A considerable ramus is given to its plate-trope (Plat.) in the meson, and the nerve terminates as a large nerve in the glans clitoridis (N. dorsalis penis seu clitoridis,

Fig. Cl.), the peripheral 5 mm. being parallel with its plate-trope.

NN. COCCYGEI.

The coccygeal nerves are seven or more pairs, and with the exception of the first (cephalic) one, innerve the caudal muscles and integument. They decrease in size caudad, until it may be questioned whether the extreme filaments are properly designated nerves. The ectal root fibres are attenuated and the dorsal ganglion is hardly distinguishable caudad of the seventh; hence I have mentioned the number as seven. Like the other spinal nerves, they divide into dorsal and ventral divisions; *the dorsal* innerve the dorsal muscles and integument and form the roots of a single nerve trunk,

N. DORSALIS

(Fig. dor.?), caudad of the seventh caudal vertebra, whose filaments innerve the adjacent structures. *The ventral* divisions join their fellows to form a ventral nerve trunk,

N. VENTRALIS

(Fig. vent.?). The rami of the ventral trunk have a two-fold distribution; the first ramulus innerves the ental or the inter-vertebral muscle (Fig. M. ent.), and midway between the several pairs a ramulus innerves the ectal muscle of the tail (Fig. M. ect.). The plan of formation of the dorsal and the ventral caudal nerves is seen in the diagram (Fig. B).

N. COCCYGEUS CEPHALICUS.

The first coccygeal nerve has a distinctive distribution, and requires a separate description. The ventral division separates into a ventral and a dorsal or caudal branch. *The ventral branch* becomes the anastomotic loop to the third sacral nerve, the coccygeal or principal root of the

N. COCCYGEUS

(Fig. N. coc.) to the muscle by the same name, one root of a nerve to the urocyt (Fig. Uro.), and one root of the nerve to the ribband muscle ? (Fig. M.?).

RECAPITULATION.

The cat is a good type for the study of comparative anatomy. The nervous system offers special advantages, as a basis of comparison, for establishing homologies, for identification, etc.

Zootomy should precede anthropotomy in the collegiate and the medical curricula.

Preparation.—Injection of arteries and veins with *starch injection mass*.

Posture.—Ventre-cumbent, head sinistrad.

Exposure.—By reflection of integument over caudal thorax, sinistral side, beginning with removal of neural arch of caudal thoracic vertebra; dissection caudad.

LUMBAR NERVES.

Characters in common: Paired; dorsal and ventral divisions at ectal origin; related with sympathetic system; muscular and cutaneous in distribution; two groups, *cephalic four* not involved in lumbar plexus, *caudal three* so involved; the cephalic group innerve muscles and integument of back, MM. psoas, phrenicus, abdominis entalis, ectalis, transversalis and rectus, and the abdominal integument.

N. Genito-cruralis.—*Origin:* Fifth and sixth lumbar nerves, *two roots.* *Distribution:* *Crural* division, integument of caudal meros, and proximal crus; anastomoses with N. N. cutaneus ectalis; *genital* division, plexus at ilio lumbar artery, hypogastric and ventro-perineal integument.

N. Cutaneus Ectalis.—*Origin:* Loop and sixth lumbar nerve, *two roots.* *Distribution:* Integument of hip and thigh, joins last described nerve.

N. Cruræus Anterior.—*Origin:* Seventh lumbar. *Distribution:* MM. psoas, iliacus, sartorius, vastus externus, V. internus, rectus femoris, cruræus, pectineus, and gives origin to

N. Cutaneus Internus Longus.—*Distribution:* To integument of cephalic crus, dorsum of foot and plantar plexus.

N. Obturator.—*Origin:* Loop between seventh lumbar and first sacral nerves, *lumbo-sacral cord* (anthropotomy). *Distribution:* MM. pectineus, obturator, adductor magnus and longus, gracilis.

SACRAL NERVES.

Characters in common: Paired, three pairs; dorsal and ventral divisions; related with sympathetic system; muscular and cutaneous; unequal size; formation of sacral plexus, which is the origin of several nerves.

Special Characters: *First sacral nerve*, largest of spinal nerves; joined with the lumbar cord in the lumbo-sacral cord.

N. Gemellus.—*Origin:* Ramus of first sacral at foramen of exit. *Distribution:* M. gemellus superior.

Second Sacral Nerve.—Much smaller than the first nerve; union with first nerve forms N. ischiadicus; joins the third nerve in the anastomotic loop.

Third Sacral Nerve.—Smallest sacral nerve; joins sacral and coccygeal plexuses; innerves the M. levator ani; the urocyst; by its rami becomes the sacral root of NN. coccygeus, gluteus, pudicus, and a nerve not homologized.

N. Gluteus Superior.—*Origin:* Sacral plexus at first sacral nerve. *Distribution:* *Cephalic* branch to M. gluteus medius, *caudal* branch to M. gluteus minimus, *middle* branch to M. tensor vaginæ femoris.

N. Ischiadicus.—*Origin:* Union of first and second sacral nerves. *Distribution:* MM. quadratus femoris, glutei, pyramiformis, biceps, semi-tendinosus, semi-membranosus, obturator internus, ribband muscle?

Rami Known as Nerve Trunks.—NN. pudicus, cutaneus internus brevis, popliteus, peroneus, gluteus, q. v.

N. Peroneus.—*Origin:* Division of N. ischiadicus central of knee. *Distribution:* *Rami:* *N. musculo-cutaneus*, integument of dorsum of foot, and second, third and fourth toes, *M. peroneus brevis*, *M. peroneus tertius*; *N. tibialis anticus*, MM. tibialis anticus, extensor longus digitorum, extensor brevis digitorum; ligamentum tarsale; plexus dorsalis pedis.

N. Popliteus.—*Origin:* Division of N. ischiadicus, central of knee. *Distribution:* MM. gastrocnemius, soleus, popliteus, flexor longus digitorum, tibialis posticus, flexor longus pollicis(?), flexor brevis digitorum, transversus, abductor minimi, interossei; integument of foot and pads.

N. Pudicus.—*Origin:* Two roots, sciatic and sacral. *Distribution:* *Dorsal* division, to MM. levator ani, sphincter ani; rectum, vagina, anal gland; *ventral* division, to *M. accelerator urinæ*, perineum, vagina, ectal labium, urethra, glans clitoridis, platetrope.

COCCYGEAL NERVES.

Characters in common: Paired, seven or more pairs; great length of ectal roots; rapid decrease in size, caudad; dorsal and ventral divisions; dorsal divisions unite to form a dorsal trunk, N. dorsalis, and the ventral divisions form ventral trunk, N. ventralis.

Distribution: Muscles and integument of tail.

N. Coccygeus cephalicus.—*Origin:* First coccygeal nerve. *Distribution:* MM. levator ani, sphincter ani; gives anastomotic loop to third sacral nerve in the sacral plexus; by its rami forms the coccygeal roots of several nerves—N. coccygeus, nerve to the urocyst, nerve to ribband muscle.

DESCRIPTION OF DIAGRAM.

A. fem., arteria femoralis; *Acc.*, musculus accelerator urinæ; *anas.*, N. anastomoticus; *Ca.*, divisio caudalis; *Ce.*, divisio cephalica; *Cl.*, glans clitoridis; *crur.*, crural division of the genito-crural nerve; *dac.*,

dactylus; *Dia.*, diaphragm, *M. phrenicus*; *Dv. dor.*, divisio dorsalis; *Dv. ven.*, divisio ventralis; *Fm.*, foramen exitus; *gen.*, genital division of the genito-crural nerve; *Gl.*, glandula ani; *H.*, hip, integument over the gluteal region; *int.*, integument, cutaneous nerve; *isch.*, ischium; *k.*, knee; *Lab.*, labium ectale; *loop*, anastomotic nerve joining nerve trunks in plexiform relation; *L.-S. C.*, lumbo-sacral cord; *l.r.*, ramus lateralis; *M.?*, muscle not identified, v. text; *M. ad. long.*, *M. adductor longus*; *M. ad. mag.*, *M. adductor magnus*; *M. bi.*, *M. biceps*; *M. crur.*, *M. cruræus*; *M. dor.*, *musculi dorsales*, quadratus lumborum, erector spinæ, inter-vertebrales, etc.; *M. ect.*, *M. obliquus abdominis ectalis*; *M. ent.*, *M. obl. abd. entalis*; *M. flex. long. dig.*, *M. flexor longus digitorum*; *M. flex. br. dig.*, *M. flexor brevis*; *M. flex. long. pol.*, *M. flexor longus pollicis*; *M. gas.*, *M. gastrocnemius*; *M. gl. max.*, *M. gluteus maximus*; *M. gl. med.*, *M. medius*; *M. gl. min.*, *M. minimus*; *M. gl. S.*, *M. superior*; *M. grac.*, *M. gracilis*; *M. ili.*, *M. iliacus*; *M. l. A.*, *M. levator ani*; *M. obt.*, *M. obturator*; *M. obt. int.*, *M. internus*; *M. pec.*, *M. pectineus*; *M. pso.*, *M. psoas*; *M. pyr.*, *M. pyriformis*; *M. quad.*, *M. quadratus femoris*; *m.r.*, ramus mesalis; *M. rect.*, *M. abdominis rectus*; *M. fem.*, *M. rectus femoris*; *M. sar.*, *M. sartorius*; *M. semi-mem.*, *M. semi-membranosus*; *M. semi-ten.*, *M. semi-tendinosus*; *M. sph. a.*, *M. sphincter ani*; *M. tib. p.*, *M. tibialis posticus*; *M. trans. M.*, *abdominis transversalis*; *M. T. V. F.*, *M. tensor vaginæ femoris*; *M. v. ext.*, *M. vastus externus*; *M. v. int.*, *M. vastus internus*; *N. coc.*, *N. coccygeus*; *N. crur.*, *N. ramus cruræus*; *N. gem.*, *N. gemellus*; *N. gen.*, *N. ramus genitalis*; *N. glut.*, *N. gluteus*; *N. gl. s.*, *N. gluteus superior*; *N. mus.-cut.*, *N. musculo-cutaneus*; *N. obt.*, *N. obturator*; *N. per.*, *N. peroneus*; *N. pop.*, *N. popliteus*; *N. saph. br.*, *N. cutaneus internus longus, long saphenous*; *N. saph. l.*, *N. cutaneus internus longus, long saphenous*; *P.*, Poupert's ligament; *peri.*, perineum; *plat.*, platetrope; *Pl. plan.*, Plexus plantaris; *Pl. S.*, plexus solaris; *pub.*, pubes; *S.*, ganglium sympathicum; *Th.*, integument over the meros, thigh; *ure.*, urethra; *uro.*, urocystis; *vag.*, vagina.

WEIGERT'S METHOD OF STAINING THE MEDULLARY SHEATH OF NERVES.⁽¹⁾

In the paper quoted, Dr. Weigert gives a full account of the famous method bearing his name, together with a historical review of the stages in its differentiation.

The method, as now revised, consists of four stages, as follows: (1) Hardening in chromic salts; (2) introduction

¹ WEIGERT, "Zur Markscheidenfärbung" Deutsche medicinische Wochenschrift. Festnummer zur Ehren Rudolf Virchows, October 13, 1891.

of copper in the chromium compound within the sheaths; (3) staining with hæmatoxylin; (4) differentiation by means of borax-ferricyanid of potassium. The precipitate which tends to appear during the staining is prevented by the addition of the carbonate of lithium.

The modified method, as here published for the first time, is as follows: Fragments suitable for microscopic sections are thoroughly hardened in bichromate of potassium, and, after treatment with alcohol, are imbedded in celloidin. After coagulation in 80 per cent. alcohol they were, according to the old method, brought into a solution of neutral cupric acetate in an equal volume of water and kept in the brood-oven twenty-four hours. The modification consists in the substitution of equal volumes of neutral cupric acetate and tartrate of soda ($C^4H^4O^6KNa+4H^2O$). Large fragments may remain for forty-eight hours without injury, provided the temperature is not permitted to rise too high. The fragment then is passed into an aqueous solution of cupric acetate and remains twenty-four hours longer in the warm chamber. After rinsing, the specimens go into 80 per cent. alcohol, where they become available for sectioning any time after an hour or so.

For staining, two stock solutions are required: (*A*) 7 c.cm. saturated aqueous solution of carbonate of lithium + 93 c.cm. distilled water; (*B*) 1 gm. hæmatoxylin + 10 c.cm. alcohol. These are to be combined just before using in the proportion of 9 volumes of *A* to 1 volume of *B*. Sections stain in three or four hours, though the staining is not injured by leaving them twenty-four hours in the fluid. This process is, unfortunately, only available for free sections, which then require no development, but, after rinsing, are brought into 90 per cent. alcohol and are cleared in a mixture of 2 volumes of analin oil + 1 volume of xylol, followed by pure xylol and balsam.

