THE ANATOMY OF THE AUTONOMIC NERVOUS SYSTEM OF THE FOX SQUIRREL, SCIURUS NIGER RUFIVENTER (GEOFFROY)

Thesis for the Degree of M. S.

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Nicholas James Mizeres

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The Anatomy of the Autonomic Nervous System of the Fox Squirrel, Sciurus niger Rufiventer (Geoffroy).

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H R Hunt
Major professor

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THE ANATOMY OF THE AUTONOMIC NERVOUS SYSTEM OF THE FOX SQUIRREL, *SCIURUS NIGER RUFIVENTER* (GEOFFROY)

By

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I. INTRODUCTION

Although there is abundant literature on the histological analysis of the mammalian autonomic nervous system, very little detailed anatomical work has been done on mammals, excluding man. In the rat and cat, Greene (1935), Reighard and Jennings (1935) and others present a generalized account of the autonomic nervous system but little or no attempt has been made to study in detail the various types of ganglia, their connections with the various plexuses, or their variations. Also, no attempt has been made to interpret anatomically the autonomic ganglia of the head region.

The fox squirrel was chosen not only because of its relative abundance and importance in game management but also because it is a typical mammal that may be used as a laboratory study when feasible. It is hoped that this work will offer some help in the better understanding of the mammalian autonomic nervous system and to provide a small link in its evolution.

II. MATERIALS AND METHODS

Six adult specimens, three males and three females, of the fox squirrel were live-trapped in the Baker Wood Lot on the campus of Michigan State College. After chloroforming, they were immediately embalmed with a formalin preservative injected through the femoral vein. No color injection was used because it would have made it difficult to separate vessels from the fine plexuses and small ganglia. Most of the dissection was done with the aid of a 3x magnifier. For the fine plexuses and the ganglia of the head region the binocular dissecting microscope was used extensively.

Fourteen pen and ink drawings accompany the description. At the bottom of each drawing a scale in millimeters will be found. The drawings were made during the time of dissection and the photographs represent a reduction of about four-fifths the original drawings.

Since this work is anatomical in its scope the terms, "sympathetic" and "parasympathetic," have not been used in describing the various subdivisions of the system. These terms are mainly physiological concepts and do not necessarily conform to anatomical description. The anatomical terms, "thoraco-lumbar" and "cranio-sacral," also were not used because this work is based upon regional dissection.

III. THE AUTONOMIC GANGLIA OF THE CEPHALIC REGION

The four autonomic ganglia of the cephalic region in the fox squirrel are extremely small and difficult to dissect even with a binocular dissecting microscope. Therefore, in this work, the interpretation of these ganglia and their connections is based entirely upon observational microdissection. The ganglia may be described as follows:

A. The Sphenopalatine Ganglion (Plate I-A).

The sphenopalatine ganglion is the largest of the four ganglia, averaging one millimeter in length. It is longer than wide and lies just inside the large sphenopalatine foramen closely adherent to the lateral ventral surface of the maxillary division of the trigeminal nerve (Plate I, 13). It seems to appear as if it were one of the fasciculi of the nerve but upon careful probing it defied breaking apart. It is attached to the maxillary nerve by means of two small roots, one longer and thinner than the other. A variable number of strands emerge from the distal portion of the ganglion and follow the maxillary nerve and its branches into the nasal cavity and pharyngeal region. The large Vidian nerve (Plate I-B) may be seen to enter the proximal border of the ganglion after emerging from its canal (Plate I-11) in the pterygoid bone. This nerve, when followed caudally, descends over the caudal border of the pterygoid plate,

enters the foramen lacerum, and passes into the auditory bulla where it is formed by the union of the large deep petrosal and the large superficial petrosal nerves (Plate I-C, D). The large deep petrosal nerve arises mainly from the tympanic plexus (Plates I-E; V-B). The large superficial petrosal nerve arises from the geniculate ganglion (Plate I-10) of the facial nerve located in the facial canal in the auditory bulla.

B. The Otic Ganglion (Plate I-F).

The otic ganglion is a minute oval body, about two-thirds of a millimeter in length, imbedded in a loose mass of fat and connective tissue located in the region where the mandibular nerve just begins to divide (Plate I-15). In the majority of the specimens it was difficult to decide without histological slides whether a ganglion or a minute plexus was present. Only two of the specimens exhibited a definite ganglion. It is attached by means of two filaments to the lateral surface of the mandibular nerve. In contrast to the sphenopalatine ganglion it is loosely placed. From its distal border three main branches arise. Two establish connection with the chorda tympani nerve (Plate I-17) and the other enters the internal pterygoid muscle (Plate I-H). Other connections may have been present but only these three fibers were discernible with the dissecting microscope.

C. The Ciliary Ganglion (Plate II-C).

The ciliary ganglion is about the same size as the otic. It is located just caudad of the ventral surface of the optic nerve (Plate II-13). It is attached by means of two filaments. One connects to the nasociliary nerve (Plate II-1), a branch of the ophthalmic division of the trigeminal nerve. The other joins the lower division of the oculomotor nerve (Plate II-2, 8). The ganglion sends out three main fibers, the short ciliary nerves (Plate II-D), that follow the optic nerve and spread out and pierce the sclerotic coat of the eyeball (Plate II-10). No root from the internal carotid plexus to the ganglion was discernible in any of the specimens.

D. The Submaxillary Ganglion (Plate III-A).

The submaxillary ganglion is a little less than one millimeter in length and is found deeply imbedded in the submaxillary gland. It lies adherent to the dilatation or approximate origin of the submaxillary duct (Plate III-10). Its two roots are extremely long and sinuous, arising from the lingual nerve near the caudal border of the sublingual gland (Plate III-B, 14). These two roots unite just before entering the submaxillary gland. The medial root sends fine branches to the submaxillary duct and sublingual gland (Plate III-C). While within the substance of the submaxillary gland the main root, before joining the ganglion, sends a few fibers to the submaxillary

vein (Plate III-8). The ganglion itself sends fine numerous fibers to the submaxillary gland. In all but one specimen the ganglion was definite. In the one specimen, a plexus replaced the ganglion.

Just about one centimeter laterad to the two sinuous roots of the ganglion the chorda tympani nerve joins the lingual nerve (Plate III-4). When followed to the auditory bulla it enters the bulla through the petrotympanic (Glaserian) fissure (Plate V-A, 1), hooks around the ligament of the malleus (Plate V-18), enters a small canal, the iter chordae posterius (Plate V-16), and finally joins the facial nerve at the brim of the facial canal (Plate V-15, 17).

PLATE I. LATERAL VIEW OF THE BRAIN

A. Sphenopalatine Gln.
B. Vidian N.
C. Large Superficial Petrosal N.
D. Large Deep Petrosal N.
E. Part of the Tympanic Plexus.
F. Otic Gln.
G. Root to the Chorda Tympani N.
H. Nerve to the Internal Pterygoid M.

1. Right Cerebral Hemisphere.
2. Posterior Perforated Substance.
3. Oculomotor N.
4. Pons.
5. Abducens N.
6. Trapezoid Body.
7. Auditory N.
8. Peduncle of Paraflocculus.
9. Facial N.
10. Geniculate Gln. of VII.
11. Vidian Canal.
12. Gasserion (Semilunar) Gln.
13. Maxillary N. of V.
14. Ophthalmic N. of V.
15. Mandibular N. of V.
16. Lingual N.
17. Chorda Tympani N.

PLATE I

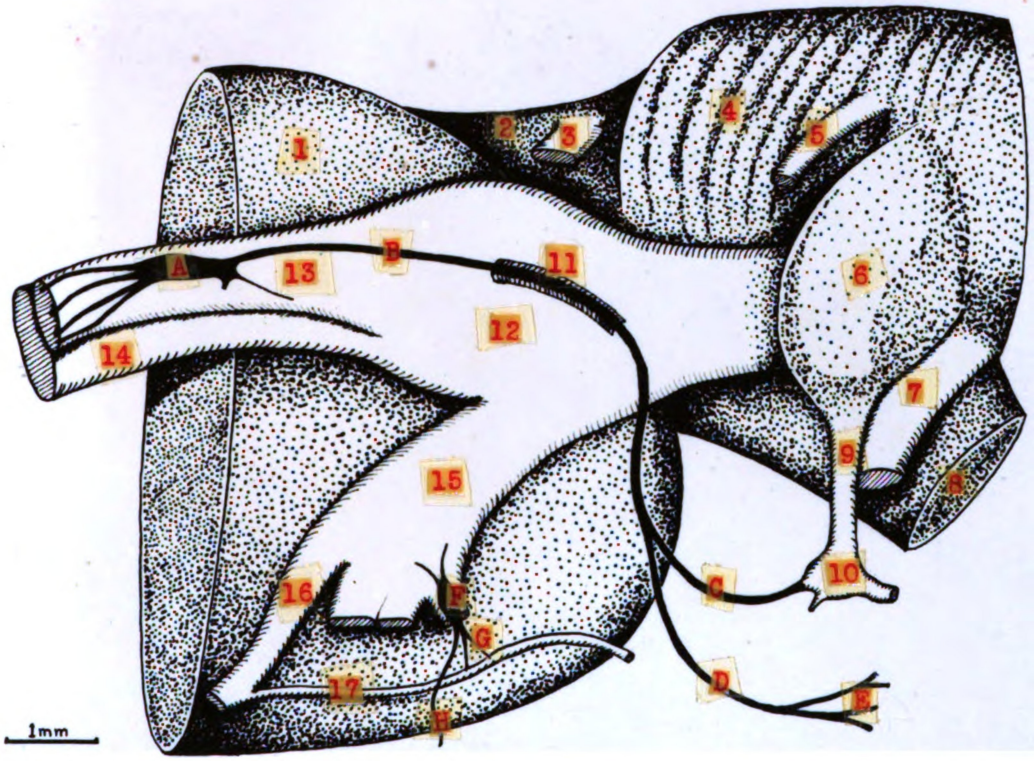


PLATE II. CILIARY GANGLION OF THE LEFT EYE,

VENTRAL ASPECT.

A. Root from the Nasociliary N.
B. Root from the Lower Division of III.
C. Ciliary Gln.
D. Short Ciliary N.

1. Nasociliary N.
2. Oculomotor N.
3. Abducens N.
4. Upper Division of III.
5. Lateral Rectus M. (cut).
6. Inferior Rectus M. (cut).
7. Superior Rectus M.
8. Lower Division of III.
9. Inferior Oblique M. (cut).
10. Sclera of Eyeball.
11. Inferior Rectus M. (cut).
12. Lateral Rectus M. (cut).
13. Optic N.
14. Long Ciliary N.

PLATE II

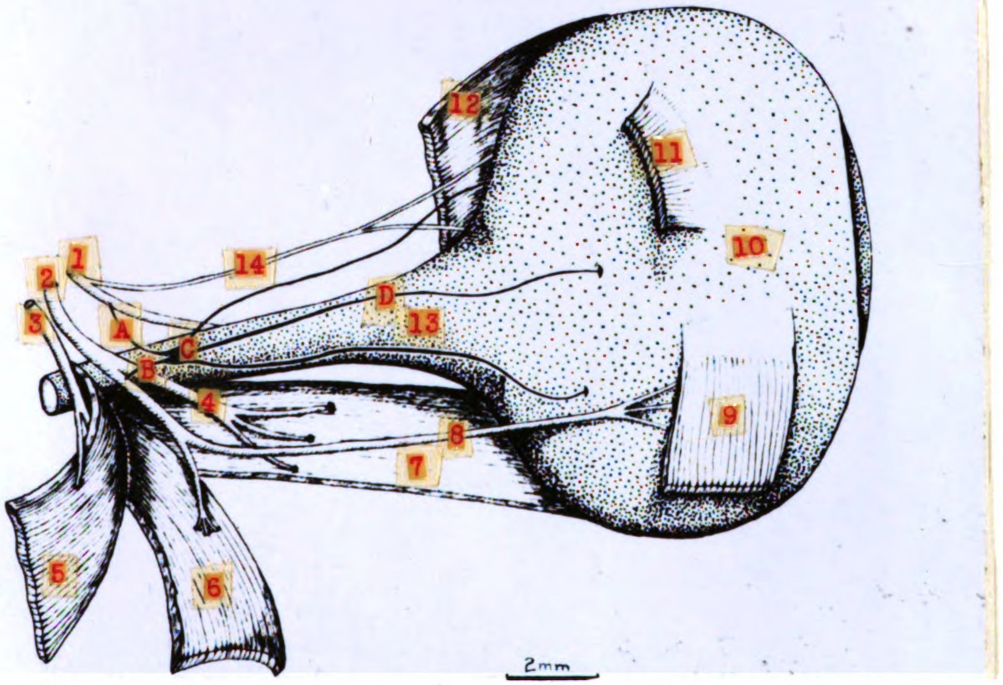
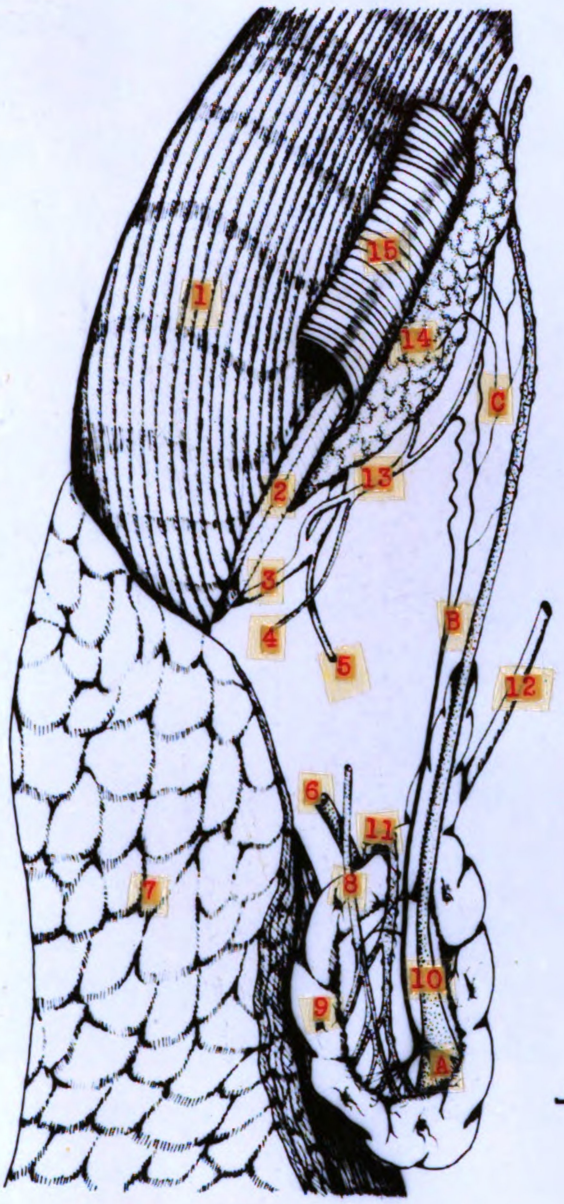


PLATE III. THE SUBMAXILLARY GANGLION, VENTRAL VIEW.

A. Submaxillary Gln.
B. Roots from the Lingual N.
C. Branches to the Sublingual Gld. and Submaxillary Duct.

1. Masseter M.
2. Ramus of Mandible (cut).
3. Inferior Alveolar N.
4. Chorda Tympani N.
5. Mylohyoid N.
6. External Maxillary A.
7. Parotid Gld.
8. Submaxillary V. and N. Plexus.
9. Submaxillary Gld. (cut).
10. Submaxillary Duct.
11. Submaxillary A. and N. Plexus.
12. Hypoglossal N.
13. Lingual N.
14. Sublingual Gld.
15. Hyoglossus M.

PLATE III



IV. THE GANGLIONATED CORD AND THE VAGUS NERVE OF THE CERVICAL REGION

Instead of the usual segmented condition as found in the rest of the body the cervical ganglia of the cord become variously fused. The cervical ganglionated cord may be said to begin with the anterior (superior) cervical ganglion located just below the auditory bulla and ends with the stellate ganglion at the level of the first rib. Due to the variations encountered each ganglion will be discussed separately.

A. The Anterior (Superior) Cervical Ganglion.

As the cervical ganglionated cord ascends on the right side from the middle cervical ganglion and on the left side from the subclavian plexus, it enters the carotid sheath (Plate VI-38) along with the vagus nerve and common carotid artery. Just before reaching the base of the auditory bulla it gives rise to the anterior cervical ganglion (Plate IV-G). It is relatively constant in shape and size, being pyriform, and averaging about three milimeters in length. It is located just behind the bifurcation of the common carotid artery adhering very closely to a mass of fibrous tissue surrounding the area. Its branches and connections may be grouped as follows:

1. Caudal Fibers.

About five millimeters below the anterior cervical ganglion the ganglionated cord gives off a long branch which descends over the second and third cervical nerves, giving off rami communicantes to the latter, and joins the thymus gland (Plate IV-B). Since this branch was the only discernible one from anywhere near the ganglion that reached the region of the heart it may have contained branches destined for the heart, but none were revealed by binocular dissection. In addition, no rami communicantes were found to connect with the fourth or fifth cervical nerves.

From the caudal region of the ganglion a long ramus communicans descends to reach the first cervical nerve (Plate IV-D). Just above the origin of this ramus an additional fiber arises which joins the anterior (superior) laryngeal nerve of the vagus (Plate IV-F, 7).

2. Lateral Fibers.

Two main short branches arise from the lateral portion of the ganglion. One connects with the spinal accessory nerve (Plate IV-8) as it leaves the jugular foramen and another connects with the hypoglossal nerve (Plate IV-2) as it leaves the hypoglossal canal.

3. Medial Fibers.

From the medial portion of the ganglion three main branches arise. One ramifies on the bifurcation of the common carotid artery and forms the common carotid plexus (Plate IV-A). A second branch ascends on the external

carotid and forms the external carotid plexus (Plate IV-5) which anastomoses with the common carotid plexus. The third branch is very short and connects with the glossopharyngeal nerve (Plate IV-14) after it leaves the jugular foramen.

4. Cranial Fibers.

Three branches may be seen to originate from the cranial portion of the ganglion. One, the internal carotid nerve (Plate V-C), follows the internal carotid artery into the foramen lacerum becoming plexiform as the internal carotid plexus (Plate V-6). The second is the largest of the three and follows the pterygopalatine artery for a short distance and at the same time branching to form a fine plexus which follows the pterygopalatine artery into its canal inside the auditory bulla (Plate V-14). The main portion of the branch turns toward the promontory of the middle ear where it forms most of the tympanic plexus (Plate V-B). The tympanic artery, a branch of the pterygopalatine, follows this branch very closely. The third branch is minute and forms a fine plexus on the posterior meningeal artery (Plate V-13).

B. The Middle Cervical Ganglion.

The middle cervical ganglion appeared in all six specimens only on the right side. It exhibited great variability in size and form. Its size ranged from one-half to two millimeters in length and in five of the six specimens it showed a bilobed condition with the

size of the lobes varying in all five specimens (Plate VII - figs. 1, 3, 4, 5, 6). The sixth specimen exhibited a single large ganglion (Plate VII - fig. 2). In all cases it was found on the ventral surface of the origin of the vertebral artery (Plate VII-3). On the left side of each specimen the ganglion was conspicuously absent. Instead, a plexus was found which may be designated as the subclavian plexus (Plate VI-T).

1. Branches and Connections of the Middle Cervical Ganglion.

In all five cases the lateral one of the paired ganglia connected with the stellate ganglion (Plate VI-H). The medial one connected to the vagus nerve by means of two or three filaments. Cranially, the lateral ganglion, including the unpaired one, gave rise to the cervical ganglionated cord (Plate VII-B). In all six cases the ganglia gave rise to a variable number of strands that joined the axillary plexus (Plate VI-8). The rami communicantes to the sixth, seventh, and eighth cervical nerves arose either from the ganglia or from their branches (Plate VI-C, D).

C. The Stellate Ganglion.

The stellate ganglion in the fox squirrel is relatively large measuring from three to five millimeters in length. It is pyriform in shape and lies dorsad and caudad to the subclavian artery at the level of the origin of the first rib (Plate VI-H, S). The supreme

intercostal artery lies behind the ganglion and the phrenic nerve traverses over it (Plate VI-34, 35). In four of the six specimens the ganglion represents a fusion of the inferior (posterior) cervical and the first thoracic ganglion (Plate VI-H, P, S). In the remaining specimens, it represents a fusion of the inferior cervical and the first and second thoracic ganglia. In the cat (Reighard and Jennings 1935, p. 409) and the rat (Greene 1935, fig. 193) the stellate ganglion represents a fusion of the inferior cervical with the first three thoracic ganglia. The fox squirrel, therefore, differs in this respect and resembles more closely the condition found in the human where the stellate usually is a fusion of the inferior cervical and the first thoracic ganglia (Morrill 1948, p. 25).

1. Branches and Connections of the Stellate Ganglion.

From the cranial portion of the ganglion four main roots arise. One traverses laterad over the subclavian artery to the axillary artery where it joins the axillary plexus (Plate VI-8). A second one ascends behind the subclavian artery, variably giving off a ramus to the eighth cervical nerve, and follows the vertebral artery into the sixth intervertebral foramen to form the vertebral plexus (Plate VI-E). The remaining two ascend, one dorsally and the other ventrally, to enclose the subclavian artery. The ventral root, the ansa subclavia (Plate VI-G), is larger than the dorsal root in contrast to the rat (Greene 1935, fig. 193) and human (Morrill 1948, p. 25)

where the ventral root is smaller. On the right side, after encircling the subclavian artery, these two roots join the middle cervical ganglion whereas on the left, they fuse and join the subclavian plexus.

From the middle portion of the right stellate ganglion a small branch is given off and along with an anastomotic branch from the right vagus nerve form the right posterior (inferior) cardiac nerve (Plates VI-J; VIII-S) which descends medially behind the innominate artery to join the deep cardiac plexus. From the left stellate ganglion the left posterior cardiac nerve (Plate VI-O) arises by a fusion of two small roots and descends over the descending aorta to join the superficial cardiac plexus. In contrast to the right cardiac nerve it has no connection with the vagus nerve.

In two cases the rami communicantes arising from the stellate ganglion differed on both sides. The right stellate gave off rami directly to the second and the first thoracic nerves (Plate VI-10), whereas the left ganglion gave off a ramus to the first thoracic nerve and a ramus to an anastomotic root which connected the first and second thoracic nerves (Plate VI-R). The condition of this left stellate was found on both sides in the remaining four specimens.

V. THE AUTONOMIC PLEXUSES OF THE CERVICAL REGION

The cranial plexuses of the cervical region are formed mainly from branches of the anterior cervical ganglion. In the lower cervical region the plexuses are formed by branches from the cervical ganglionated cord and the middle cervical and stellate ganglia. They may be grouped as follows:

A. The Tympanic and Internal Carotid Plexuses.

The tympanic plexus consists of a linear network of anastomotic fibers located on and within the groove of the promontory of the middle ear (Plate V-B, 4). It is formed mainly by a branch from the anterior cervical ganglion and the tympanic (Jacobson's) nerve from the petrous ganglion of the glossopharyngeal nerve (Plate V-G). From the cranial portion of the plexus which dips down in front of the promontory, the large deep petrosal nerve arises (Plate I-D) and ascends on the inner wall of the auditory bulla. Just before the large deep petrosal nerve ascends, the internal carotid plexus located in the foramen lacerum (Plate V-5) anastomoses with the tympanic plexus. The internal carotid plexus is formed from the internal carotid nerve originating from the anterior cervical ganglion (Plate V-6).

B. The Common Carotid Plexus and its Subdivisions.

At the bifurcation of the common carotid artery, just caudad of the auditory bulla, a thick network of fibers, the common carotid plexus, may be seen adhering to the artery (Plate IV-A). It originates by several fibers from the anterior cervical ganglion and sends subordinate plexuses which follow the branches of the common carotid artery including the anterior thyroid, external carotid, posterior auricular, lingual, external maxillary, and submaxillary arteries (Plates IV-1, 4, 5, 6; III-11).

C. The Subclavian Plexus and its Subdivisions.

The subclavian plexus is found only on the left side, the right side being replaced by the middle cervical ganglion from which identical subordinate plexuses arise. The subclavian plexus is a dense network of fibers formed mainly from the cranial branches of the left stellate and lateral branches of the left vagus nerve including the lower portion of the cervical ganglionated cord (Plate VI-T). It lies ventrad to the lateral surface of the esophagus and longus colli muscle and just mediad to the origin of the vertebral artery (Plate VI-5, 36, 39). It sends rami communicantes to the sixth, seventh, and eighth cervical nerves (Plate VI-T).

Along with a branch from the stellate ganglion the subclavian plexus sends subordinate plexuses to the

axillary artery (Plate VI-8) and to the cervical axis (Plate VI-6) following their branches into the lower cervical region and upper limb.

PLATE IV. VENTRAL VIEW OF THE RIGHT AUDITORY BULLA AND ADJACENT STRUCTURES PULLED LATERALLY.

A. Common Carotid Plexus.
B. Branch to the Thymus Gld.
C. Cervical Ganglionated Cord.
D. Ramus Communicans to C-1.
E. Vagus N.
F. Branch to the Anterior Laryngeal N.
G. Anterior Cervical Gln. (dorsal surface).
H. Ganglion Nodosum of X.

1. Lingual A. and N. Plexus.
2. Hypoglossal N.
3. Pharyngeal Branch of X.
4. Posterior Auricular A. and N. Plexus.
5. External Carotid A. and N. Plexus (dorsal surface).
6. Anterior Thyroid A. and N. Plexus.
7. Anterior Laryngeal N.
8. Spinal Accessory N.
9. Common Carotid A. (dorsal surface).
10. First Cervical N.
11. Hypoglossal Canal.
12. Jugular Foramen.
13. Internal Carotid A. and N. Plexus.
14. Glossopharyngeal N.
15. Auditory Bulla.

PLATE IV

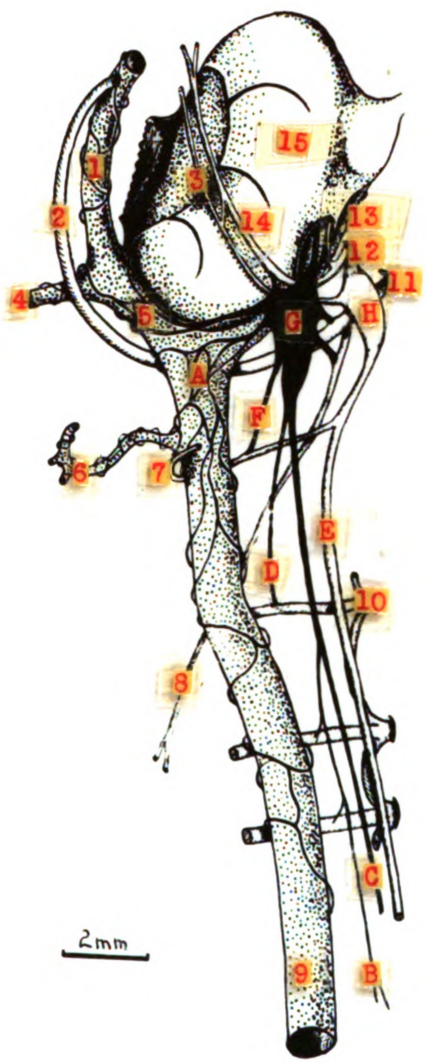


PLATE V. INTERNAL VENTRAL VIEW OF THE LEFT AUDITORY BULLA.

A. Chorda Tympani N.
B. Tympanic Plexus.
C. Internal Carotid N.
D. Ganglion Nodosum of X.
E. Anterior Cervical Gln.
F. Branch to the Tympanic Plexus.
G. Tympanic (Jacobson's) N. from the Petrous Gln. of IX.

1. Petrotympanic (Glaserian) Fissure.
2. Canal in the Glaserian Fissure.
3. Auditory Bulla (cut).
4. Promontory of the Middle Ear.
5. Foramen Lacerum.
6. Internal Carotid A. and N. Plexus.
7. Hypoglossal Canal.
8. Spinal Accessory N.
9. Hypoglossal N.
10. Glossopharyngeal N. and Petrous Gln.
11. External Carotid A.
12. Jugular Foramen.
13. Posterior Meningeal A. and N. Plexus.
14. Pterygopalatine A. and N. Plexus in its Canal.
15. VII N. in the Facial Canal.
16. Canal (iter chordae posterius) for the Chorda Tympani N.
17. Facial N.
18. Ligament of the Malleus (cut).
19. Epitympanic Recess.
20. Incus.
21. Handle of the Malleus.
22. Attachment of the Handle of the Malleus.
23. Tympanic Membrane.

PLATE V

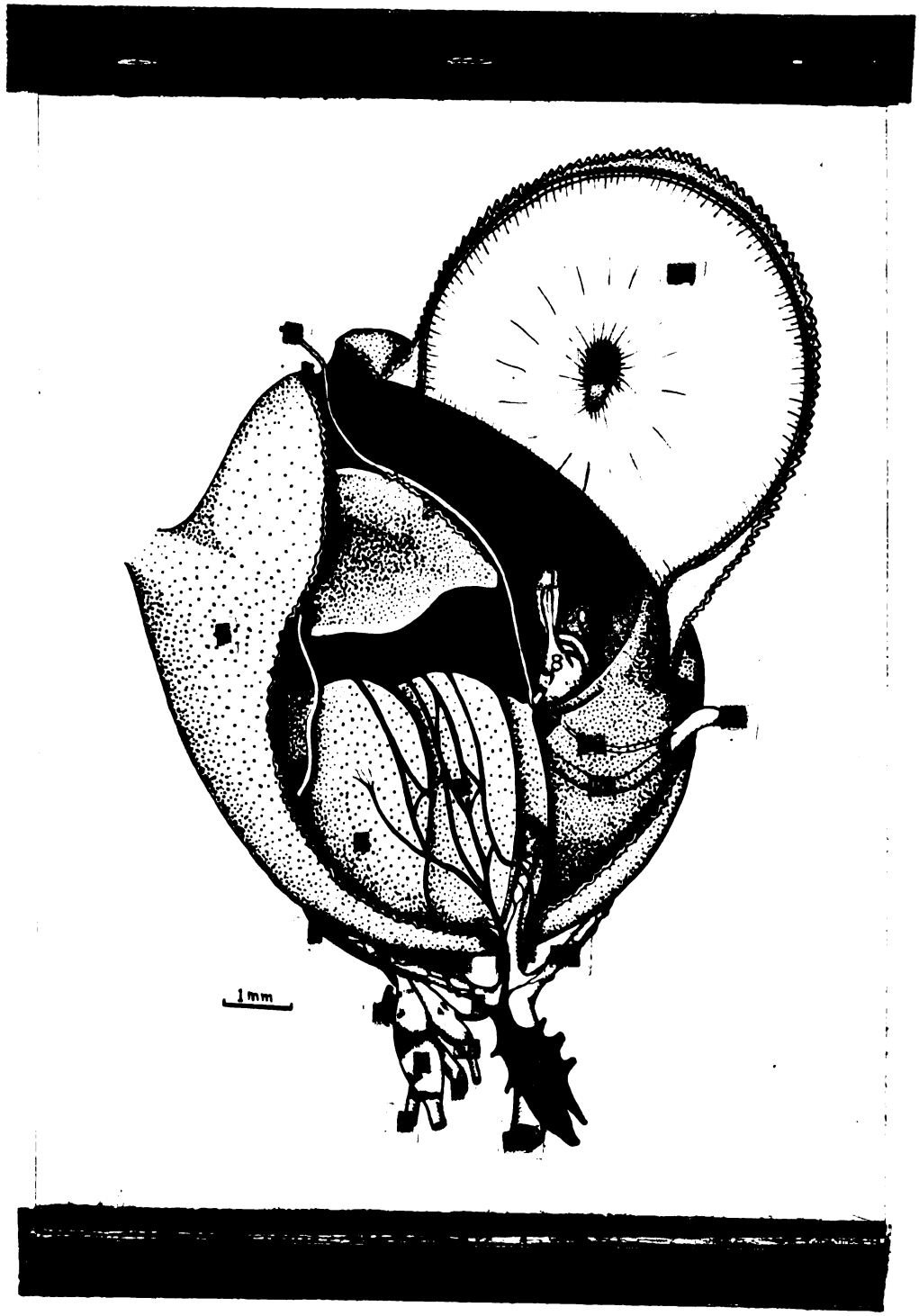


PLATE VI. VENTRAL VIEW OF THE NECK AND THORAX.

A. Cervical Ganglionated Cord.
B. Right Vagus N.
C. Ramus Communicans to C-7.
D. Paired Middle Cervical Gln. with Rami to C-6 & C-7.
E. Branch to the Vertebral Plexus.
F. Right Recurrent Laryngeal N.
G. Ansa Subclavia.
H. Right Stellate Gln.
J. Right Posterior Cardiac N.
K. Deep Cardiac Plexus.
L. Thoracic Cardiac N.
M. Right Vagus N.
N. Superficial Cardiac Plexus.
O. Left Posterior Cardiac N.
P. Left Second Thoracic Gln.
R. Ramus Communicans.
S. Left Stellate Gln.
T. Subclavian Plexus with Rami to C-6, C-7, & C-8.
U. Left Recurrent Laryngeal N.

1. Right Common Carotid A.
2. Fourth Cervical N.
3. Thyroid Gld.
4. Trachea.
5. Longus Colli M.
6. Cervical Axis and N. Plexus.
7. Sixth Cervical N.
8. Axillary A. and N. Plexus.
9. First Rib (cut).
10. First Thoracic N.
11. Innominate A.
12. Aortic Arch (cut).
13. Right Phrenic N. (cut).
14. Right Precava.
15. Azygos V.
16. Right Auricular Appendage.
17. Right Phrenic N.
18. Postcava.
19. Esophagus
20. Pulmonary Arch.
21. Ligamentum Arteriosum.
22. Right Ventricle.
23. Left Ventricle.
24. Thoracic Aorta.
25. Left Pulmonary V.
26. Left Bronchus.
27. Left Pulmonary A.
28. Left Auricular Appendage.
29. Left Phrenic N.
30. Left Precava.
31. Descending Aorta.
32. Third Rib (cut).
33. Left Subclavian A. (cut).
34. Supreme Intercostal A.
35. Left Phrenic N. (cut).
36. Vertebral A.
37. Left Common Carotid A.
38. Carotid Sheath.
39. Esophagus.

PLATE VI

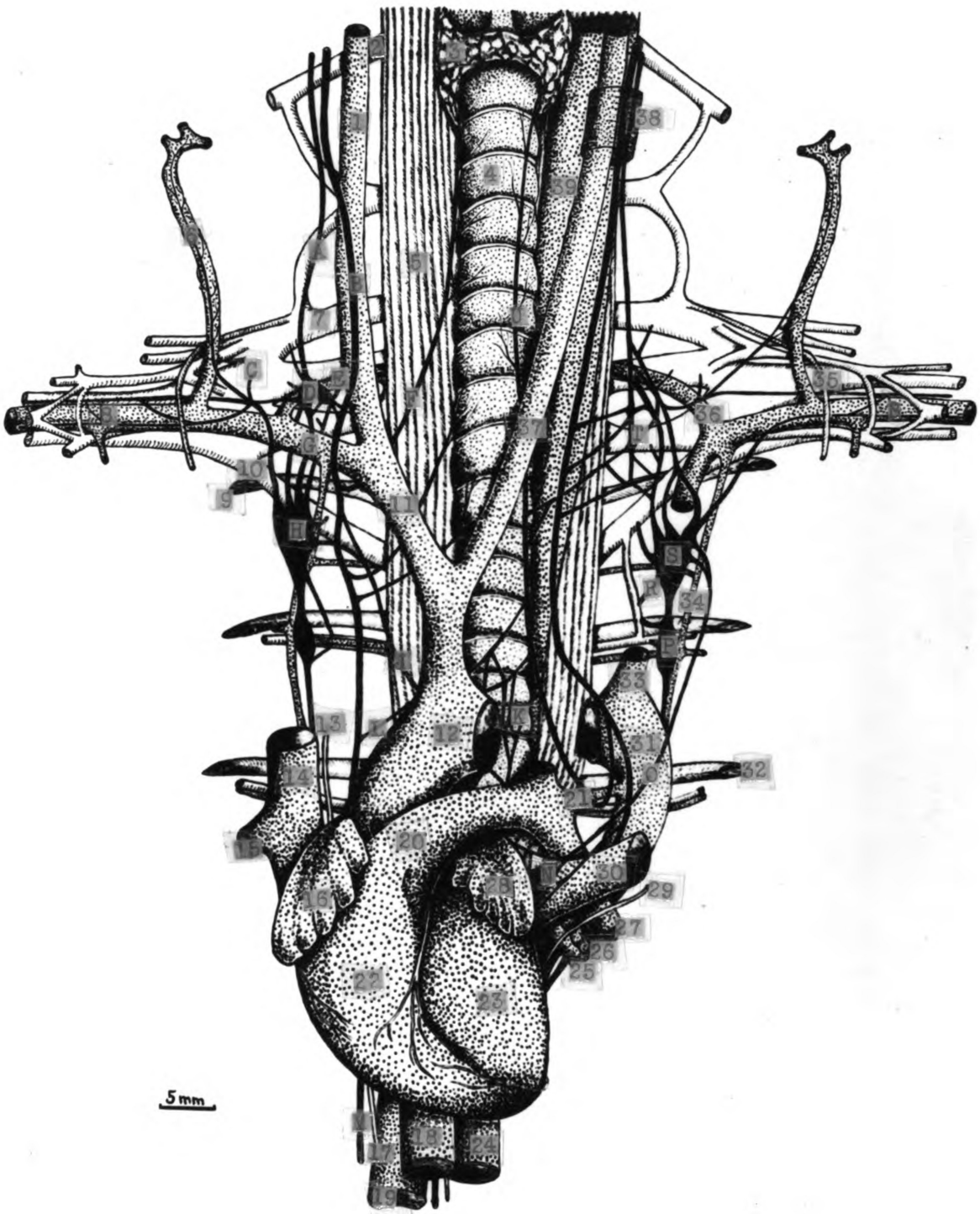


PLATE VII. VARIATIONS IN THE MIDDLE CERVICAL GANGLION.

A. Right Vagus N.
B. Cervical Ganglionated Cord.
C. Middle Cervical Gln.
D. Ansa Subclavia.
E. Right Recurrent Laryngeal N.

1. Right Subclavian A.
2. Innominate A.
3. Right Vertebral A.
4. Right Common Carotid A.

PLATE VII

Fig. 1

Fig. 2

Fig. 3

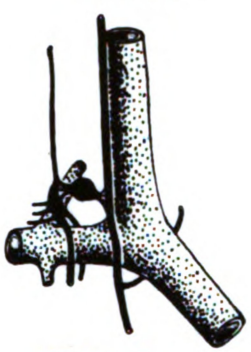


Fig. 4

Fig. 5

Fig. 6

VI. THE GANGLIONATED CORD OF THE THORACIC REGION

The ganglionated cord of the thoracic region begins at the level of the first rib and extends to just caudad of the twelfth rib where the cord, after giving off the splanchnic nerve and passing under the central tendon of the diaphragm, enters into and among the fibers of the psoas muscles. It is retro-peritoneal and from the ninth to the twelfth rib it is in relation to the azygous vein, the thoracic duct, the esophagus, and the thoracic aorta. Continuing cephalad, the cord begins to diverge from the median axis of the body and ends with the stellate ganglion, near the commencement of the subclavian artery where the supreme intercostal artery is given off. The ganglia of the cord greatly diminish in size beginning at the level of the sixth intercostal artery down to the level of the eleventh intercostal. A few of these ganglia can hardly be distinguishable (Plate VIII).

A. Communications with the Thoracic Nerves.

Each ganglion of the cord lies directly on the surface of each corresponding intercostal nerve and artery near their stems. Just below each ganglion a long ramus communicans is given off to each of the corresponding thoracic nerves (Plate VIII-G). Generally the second thoracic ganglion (Plate VI-P) gives off an additional ramus to an anastomotic root which connects the second and the first thoracic nerves.

B. Medial Branches of the Cord.

Just craniad to the twelfth thoracic ganglion, a large splanchnic nerve (Plates VIII-K; IX-D) arises and descends for a short distance, turns medially, and pierces the crura of the diaphragm to join the aorticorenal ganglion. No lesser or least splanchnic nerves were discernible in the fox squirrel.

From the ninth, tenth, and eleventh ganglia fine filaments arise which traverse medially along the corresponding intercostal artery toward the ventral surface of the thoracic aorta where they ramify. From the sixth, seventh, and eighth ganglia identical filaments are given off which, in addition, branch to contribute to the esophageal plexus and anastomotic filaments to the vagus nerves. From the fifth and sixth ganglia additional filaments arise to enter the pulmonary plexuses (Plate VIII-F). From the third, fourth, and fifth ganglia fine filaments are given off which follow the intercostal arteries medially and contribute to the deep cardiac plexus located between the aortic arch and the bifurcation of the trachea (Plate VIII-P). The second thoracic ganglion does not seem togive off any medial branches.

VII. THE COURSE OF THE VAGUS NERVES IN THE THORACIC CAVITY

A. The Left Vagus Nerve.

The left vagus nerve in the thoracic cavity may be said to begin at the level of the first rib where it contributes to the subclavian plexus (Plate VI-T). It then descends ventrad to the esophagus and the left longus colli muscle. Upon reaching the base of the left subclavian artery it curves ventrad over the aortic arch. The left vagus then continues dorsad to the left pulmonary vessels and bronchus and after coursing medially for a short distance, it comes into close relation with the left side of the esophagus and anastomoses with the right vagus nerve. Upon entering the abdomen it enters the concavity between the termination of the esophagus and the lesser curvature of the stomach where it anastomoses with branches from the right vagus and forms the left gastric plexus (Plate VIII-M). Its branches may be described as follows:

1. The Left Recurrent Laryngeal Nerve (Plate VI-U).

The left recurrent laryngeal nerve arises just ventrad to the base of the left subclavian artery and descends to loop under the ligamentum arteriosum (Plate VI-21). While it ascends toward the trachea it contributes to the bulk of the deep cardiac plexus. Upon reaching the left side of the trachea it continues to

ascend and gives off branches to the trachea, esophagus, and anastomotic branches to the cervical ganglionated cord. It then terminates within the larynx as the inferior laryngeal nerve.

2. Branches to the Thoracic Plexuses.

At the level of the first rib the left vagus gives off distinct filaments which connect with the left cervical ganglionated cord to form part of the subclavian plexus. After giving off the left recurrent laryngeal nerve the vagus contributes a few filaments to the superficial cardiac plexus (Plate VI-N). At the origin of the left bronchus it branches to form the left pulmonary plexus and descends toward the dorsal surface of the esophagus to contribute to the esophageal plexus and communications with the right vagus nerve (Plate VIII-H).

B. The Right Vagus Nerve.

The thoracic portion of the right vagus may be said to begin at the level of the first rib in front of the right subclavian artery where the right recurrent laryngeal nerve arises (Plate VI-F). It then descends laterad to the trachea and comes into close relation with the right side of the esophagus. Upon reaching the cardiac stomach it branches and anastomoses with branches from the left vagus to form the right gastric plexus (Plate VIII-L). Its branches may be described as follows:

1. The Right Recurrent Laryngeal Nerve (Plate VI-F).

At the ventral surface of the root of the right subclavian artery the recurrent laryngeal nerve arises and turns dorsomediad to the innominate artery and ascends on the right lateral surface of the trachea giving off branches to the trachea and continuing up into the larynx. In contrast to the left recurrent nerve it does not contribute to the deep cardiac plexus.

2. Branches to the Thoracic Plexuses.

At the origin of the right recurrent laryngeal nerve the vagus gives off a short communication to the right posterior cardiac nerve which contributes to the deep cardiac plexus. In addition, the vagus itself sends two or three branches, the thoracic cardiac nerves, to contribute to the same plexus (Plates VI-L; VIII-R). Unlike the left vagus it sends several branches directly to the trachea. At the level of the origin of the right subclavian artery it is connected to the middle cervical ganglion by means of a variable number of fine filaments (Plate VII - figs. 1-6). After giving off the right pulmonary plexus on the right bronchus the right vagus descends on the ventral surface of the esophagus where it contributes to the esophageal plexus and communications to the left vagus nerve (Plate VIII-H).

VIII. THE AUTONOMIC PLEXUSES OF THE THORACIC REGION

A. The Deep Cardiac Plexus (Plates VI-K; VIII-P).

The deep cardiac plexus consists of a closely woven network of fibers located between the bifurcation of the trachea and the aortic arch. It is made up of fibers contributed directly by the left recurrent laryngeal, the thoracic cardiac nerves of the right vagus, andthe right posterior cardiac nerve of the stellate ganglion. A few filaments from the third, fourth, and fifth ganglia of the thoracic ganglionated cord also contribute to the plexus.

B. The Superficial Cardiac Plexus (Plate VI-N).

The superficial cardiac plexus is a thin network of fibers located in a space bounded by the concavity of the pulmonary arch, the left auricular appendage, and the base of the left precava. It is made up of branches contributed by the left posterior cardiac nerve of the stellate ganglion and variably by the left vagus and recurrent laryngeal nerves.

C. The Pulmonary Plexuses (Plate VIII-F).

The right and left pulmonary plexuses lie at the roots of the right and left bronchi and follow the corresponding pulmonary vessels and secondary bronchi into the lungs. They are made up of fibers arising from the

right and left vagi and a few filaments from the fifth and sixth ganglia of the thoracic ganglionated cord.

D. The Esophageal Plexus (Plate VIII-H).

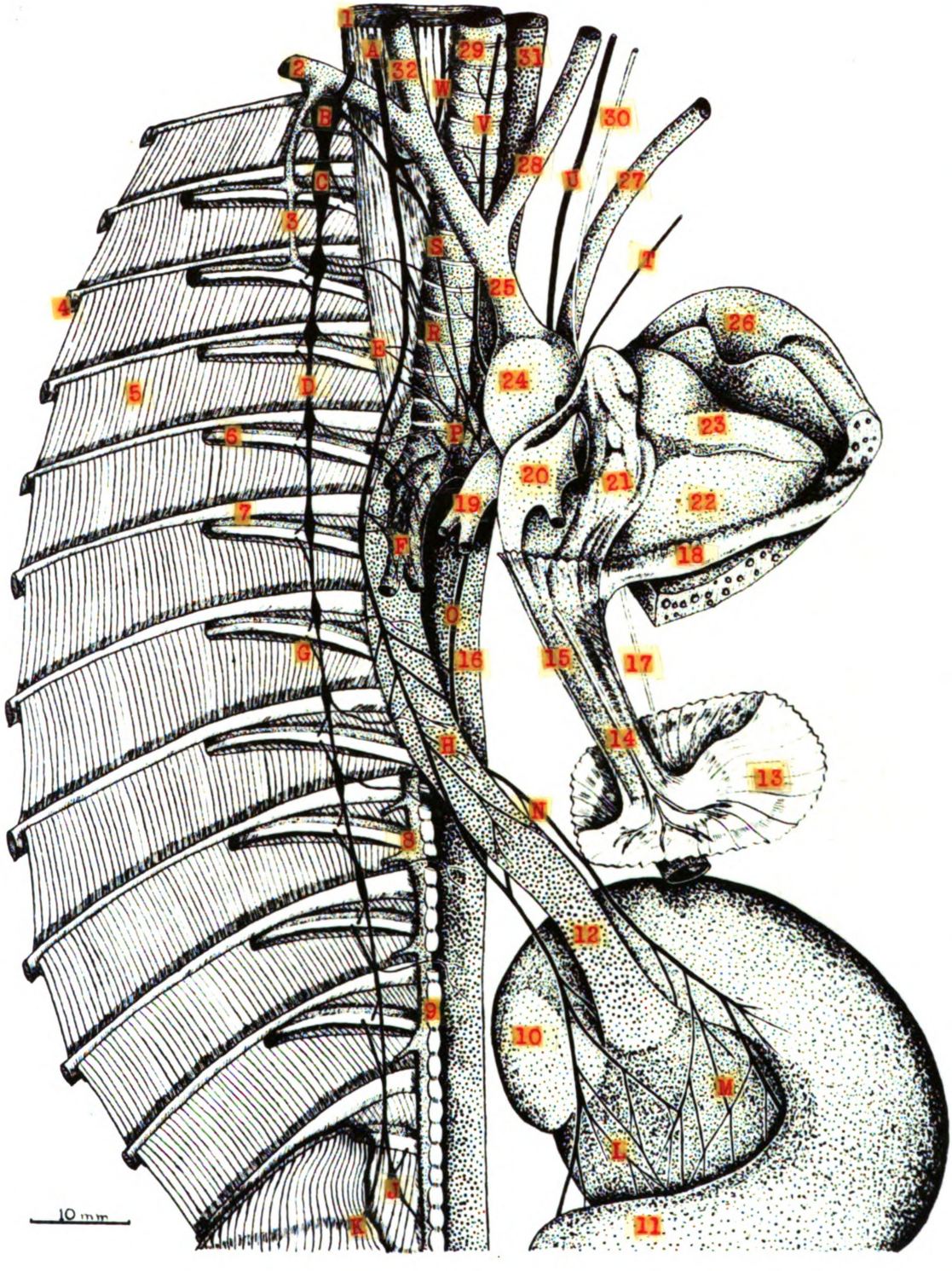
At the level of the eighth rib the two vagi come into close relation with the esophagus giving off anastomotic branches that seem to enclose the esophagus in this region. This plexus also receives a few filaments from the sixth, seventh, and eighth ganglia of the thoracic ganglionated cord.

PLATE VIII. THE VAGUS NERVES AND GANGLIONATED CORD OF THE THORACIC CAVITY WITH THE HEART PUSHED TOWARD THE LEFT SIDE.

A. Right Vagus N.
B. Stellate Gln.
C. Second Thoracic Gln.
D. Thoracic Ganglionated Cord.
E. Branch to the Deep Cardiac Plexus.
F. Right Pulmonary Plexus.
G. Ramus Communicans.
H. Esophageal Plexus.
J. Twelfth Thoracic Gln.
K. Splanchnic N.
L. Right Gastric Plexus.
M. Left Gastric Plexus.
N. Left Vagus N.
O. Left Vagus N.
P. Deep Cardiac Plexus.
R. Thoracic Cardiac N.
S. Right Posterior Cardiac N.
T. Left Posterior Cardiac N.
U. Left Vagus N.
V. Left Recurrent Laryngeal N.
W. Right Recurrent Laryngeal N.

1. Longus Colli M.
2. Right Subclavian A.
3. Supreme Intercostal A.
4. Third Rib (cut).
5. External Intercostal M.
6. Fifth Intercostal N.
7. Sixth Intercostal A.
8. Azygos V.
9. Thoracic Duct.
10. Fundus of Stomach.
11. Pylorus of Stomach.
12. Esophagus.
13. Diaphragm (cut).
14. Right Phrenic N.
15. Postcava.
16. Thoracic Aorta.
17. Left Phrenic N.
18. Pericardium.
19. Right Pulmonary A.
20. Right Precava.
21. Right Auricle.
22. Left Ventricle.
23. Right Ventricle.
24. Aortic Arch.
25. Innominate A.
26. Left Cardiac Lobe of Lung (cut).
27. Left Subclavian A.
28. Left Common Carotid A.
29. Trachea.
30. Left Phrenic N.
31. Esophagus.
32. Right Common Carotid A.

PLATE VIII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IX. THE COLLATERAL GANGLIA OF THE ABDOMINAL REGION

A. The Coeliac Ganglia.

The coeliac ganglia are flat, somewhat semilunar-shaped masses that lie on both sides of the origin of the coeliac artery. They are connected to each other by plexiform fibers which follow the coeliac artery and contribute to the coeliac plexus. The right coeliac ganglion lies dorsad to the postcava and ventrad to the right crus of the diaphragm whereas the left coeliac lies dorsad to the omental bursa and stomach and ventrad to the left crus of the diaphragm (Plate IX-H, L). The length of the ganglion varies from a little under seven millimeters to such a small size as to be indistinguishable as a ganglion (Plate XI - figs. 1-6). The measurable average length in the six specimens was found to be around four and a half millimeters. Based upon this average measurement the coeliac ganglion may be considered the largest autonomic ganglion in the fox squirrel. In one case the right coeliac ganglion gave off an accessory ganglion that contributed a few fibers to the right renal plexus (Plate XI - fig. 2-C). Although the size of the ganglion varies to a great extent, the paired condition seems to be persistent. In the rat, another rodent, the coeliac ganglion is not paired (Greene 1935, p. 135) whereas in the cat (Field and Taylor 1950, plate 49) it may or may not be paired. In man (Gray 1936,

p. 974) the paired condition resembles that of the fox squirrel.

B. The Aorticorenal Ganglia.

Although variable in size and position, the aorticorenal ganglia in the fox squirrel can always be recognized because of the constancy of the splanchnic nerves to enter directly into the ganglia (Plates IX-G, D; XI - figs. 1-6 -A, G). In the majority of cases they appeared to be segmented off from the coeliac ganglia. In one case the right aorticorenal gave off a small accessory ganglion which contributed a few filaments to the right adrenal plexus (Plate XI - fig. 6-C). The relations of the ganglia are the same as those for the coeliac with the exception of the phrenic arteries which lie immediately dorsad. According to Greene (1935, p. 135) the aorticorenal ganglion is absent in the rat. In the cat, Field and Taylor (1950, plate 49), Reighard and Jennings (1935, p. 413), and Davison (1947, p. 299) do not mention the possible existence of this ganglion. The aorticorenal ganglion of the fox squirrel resembles more closely the condition found in man where the ganglion is usually, but not always, distinguishable (Morrill 1946, p. 89).

C. The Anterior (Superior) Mesenteric Ganglion.

The anterior mesenteric ganglion is a thick pyramidal-shaped mass that is closely adherent and caudad to the

base of the anterior mesenteric artery. Its shape and size is relatively constant measuring approximately three and a half millimeters in length. It connects with both coeliac ganglia by means of two large strands, variable in thickness, arising from its lateral tips (Plates IX-N; XI - figs. 1-6). In two cases a small accessory ganglion was found to branch off, one from the ganglion and the other from the right connecting strand (Plate XI - figs. 1, 6-C). Both ganglia contributed a few filaments to the renal plexuses. In none of the specimens did the ganglion exhibit any complete or partial fusion with the coeliac in contrast with both the human (Ranson and Clark 1947, p. 134) and the cat (Field and Taylor 1950, plate 49) where the ganglion is often found fused with the coeliac ganglia. In the rat (Greene 1935, p. 135) (Hunt 1931, p. 112) the anterior mesenteric ganglion is apparently absent.

D. The Posterior (Inferior) Mesenteric Ganglion.

Just craniad to the origin of the posterior mesenteric artery lies the posterior mesenteric ganglion. It is relatively constant in size, measuring about three and a half millimeters in length. Its shape is extremely variable. Its longitudinal axis may vary from horizontal to vertical (Plate XI - figs. 7, 8, 9). In two cases it exhibited a bilobed condition (Plate XI - figs. 10, 12). In another case it appeared to be almost circular (Plate XI - fig. 11). In still another case a small accessory

ganglion was found to arise from one of its anterior roots (Plate XI - fig. 8-C). Besides its relation to the posterior mesenteric artery and abdominal aorta the lumbar lymph trunks, which are ventrad to the postcava, lie immediately dorsad to the ganglion (Plate X-6). In relation to the size of the animal the posterior mesenteric ganglion is larger than that found in the cat or man. In the rat it is apparently absent (Greene 1935, p. 135). In the cat (Reighard and Jennings 1935, p. 413) (Field and Taylor 1950, plate 49) it is small and may be paired while in man it is generally absent (Gray 1936, p. 976).

PLATE IX, COLLATERAL GANGLIA AND PLEXUSES OF THE ABDOMINAL REGION, RIGHT VENTRAL ASPECT.

A. Abdominal Ganglionated Cord.
B. Ramus Communicans.
C. Twelfth Thoracic Vertebral Gln.
D. Splanchnic N.
E. Adrenal Plexus and A.
F. Renal Plexus.
G. Aorticorenal Gln.
H. Right Coeliac Gln.
J. Phrenic Plexus and Inferior Phrenic A.
K. Branches of the Right Vagus N.
L. Left Coeliac Gln.
M. Anterior Mesenteric Plexus.
N. Anterior Mesenteric Gln.

1. Psoas M. (cut).
2. Adrenal Gld.
3. Right Kidney.
4. Ureter.
5. Postcava.
6. Right Renal A.
7. Right Crus of the Diaphragm.
8. Inferior Phrenic A.
9. Coeliac A. and N. Plexus.
10. Diaphragm (cut).
11. Small Intestine (cut).
12. Anterior Mesenteric A.
13. Cisterna Chyli.
14. Abdominal Aorta.
15. Left Renal A.

PLATE IX

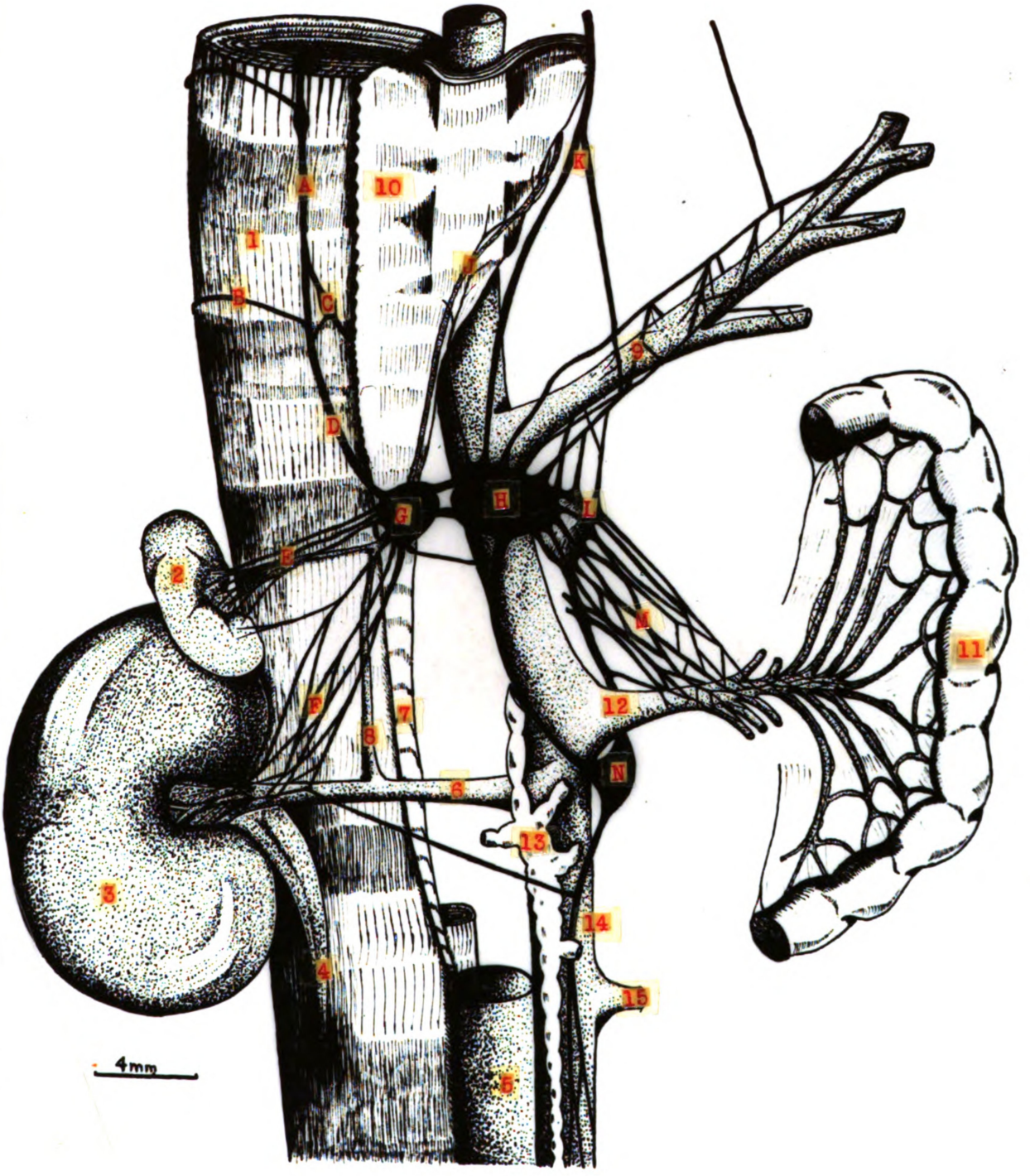


PLATE X. THE POSTERIOR MESENTERIC GANGLION AND PLEXUS, FEMALE.

A. Posterior Mesenteric Plexus.
B. Posterior Mesenteric Gln.
C. Ganglia of the Aortic Plexus.
D. Left Lumbar Ganglionated Cord.

1. Left Colic A.
2. Colon.
3. Lumbar Aortic Lymph Node.
4. Anterior Hemorrhoidal A.
5. Posterior Mesenteric A.
6. Lumbar Lymph Trunk.
7. Postcava.
8. Lumbar Aorta and Aortic Plexus.
9. Psoas M. (cut).
10. Iliolumbar A. and N. Plexus.
11. Uterine A. and N. Plexus.

PLATE X

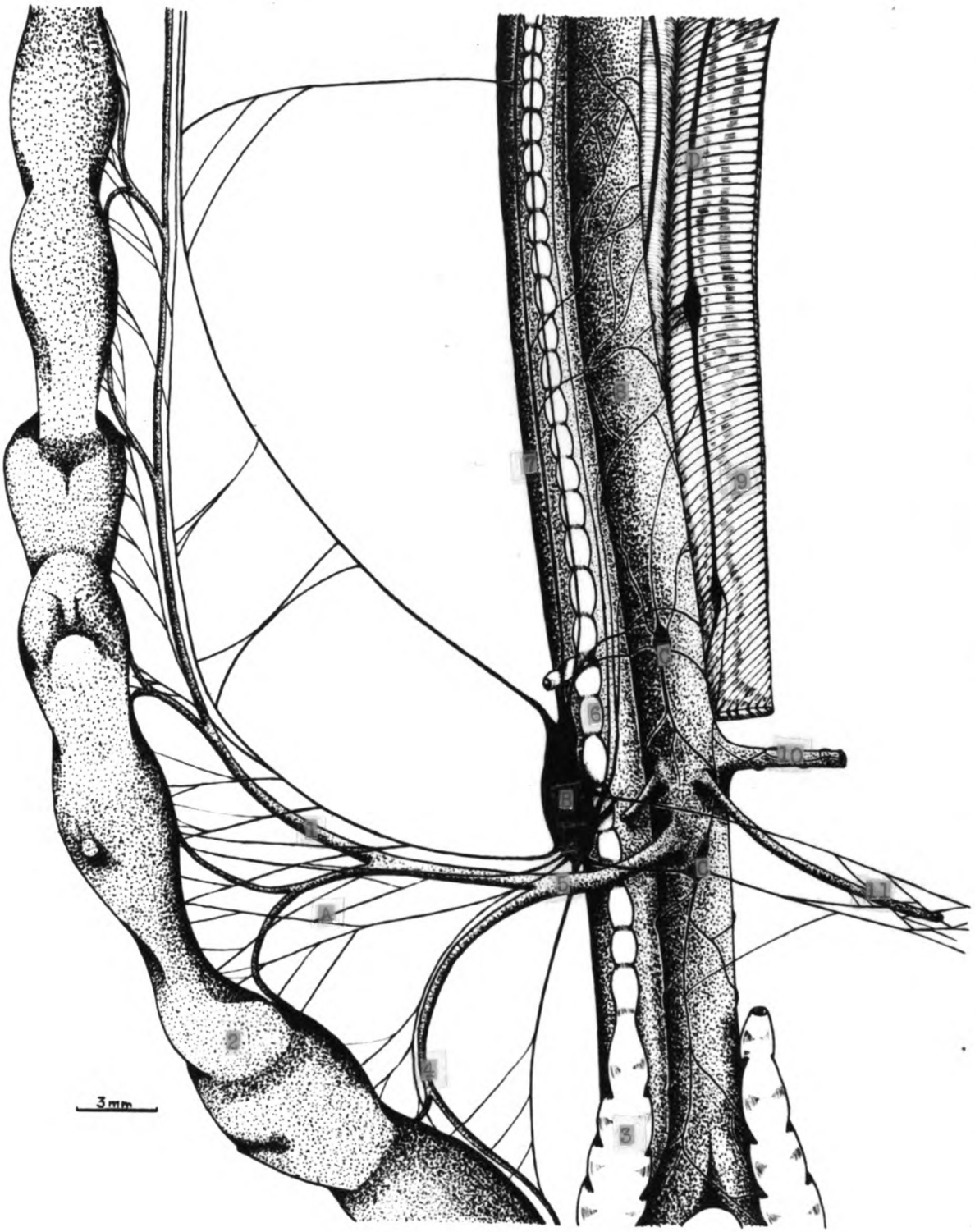


PLATE XI. VARIATIONS IN THE ABDOMINAL COLLATERAL GANGLIA.

Figures 1 — 6. The Coeliac, Aorticorenal, and Anterior Mesenteric Ganglia.

Figures 7 - 12. The Posterior Mesenteric Ganglion.

A. Right Splanchnic N.
B. Right Aorticorenal Gln.
C. Accessory Ganglia.
D. Anterior Mesenteric Gln.
E. Left Coeliac Gln.
F. Left Splanchnic N.
G. Right Coeliac Gln.
H. Left Aorticorenal Gln.
J. Accessory Gln. of the Aortic Plexus.

PLATE XI

Fig. 1

Fig. 2

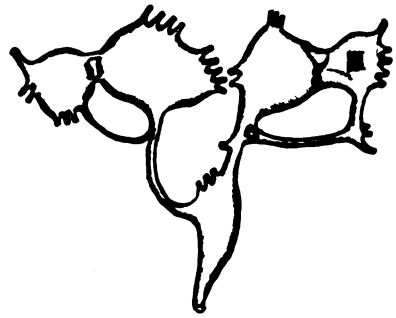


Fig. 3

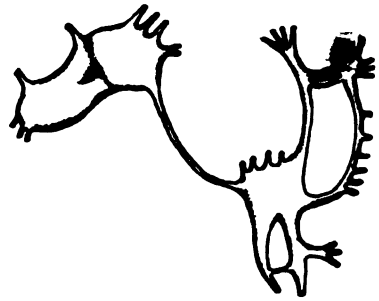


Fig. 4

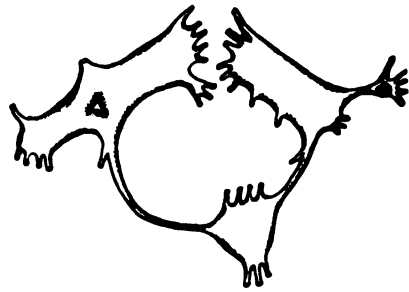


Fig. 5

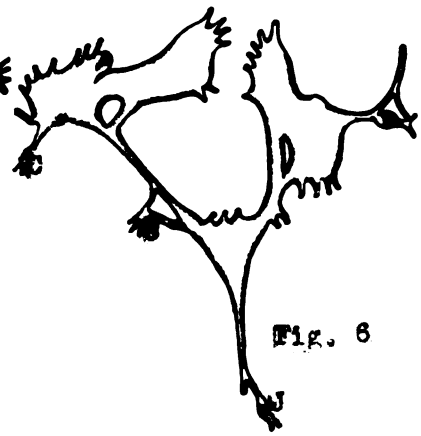


Fig. 6

Fig. 7

Fig. 8

Fig. 9

2mm

Fig. 10

Fig. 11

Fig. 12

X. THE GANGLIONATED CORD OF THE ABDOMINAL REGION

The ganglionated cords of the abdominal region consist of two long chains of six pairs of vertebral ganglia extending from the first lumbar vertebra to the center of the pelvic brim where the sixth and largest lumbar vertebra lies (Plate XII-D). The ganglia lie ventrally between the intervertebral discs of the vertebral column and are imbedded among the fibers of the origin of the psoas muscles. The abdominal aorta covers most of the cords and are thus retroperitoneal. From the upper three lumbar vertebrae, the three tendinous origins of the diaphragm cover a portion of the chains. The four lumbar vessels from the aorta and postcava are in immediate relation with the ganglia and cords, traversing dorsad and caudad to each of the four ganglia. The branches and connections of the ganglionated cord may be grouped as follows:

A. Branches to the Aortic Plexus and Posterior Mesenteric Ganglion.

From each of the second, third, fourth, and fifth ganglia of the cord single filaments arise which follow the four lumbar arteries and upon reaching the aorta anastomose and contribute to the aortic plexus (Plate XII-3, E). In addition, from the fourth ganglion and that part of the cord connecting the fourth and fifth ganglia, two filaments arise which traverse ventrally over the

lower part of the abdominal aorta and establish anastomotic connections with the cranial roots of the posterior mesenteric ganglion. These two filaments may be spoken of as the "lumbar splanchnics" (Plate XII-C) corresponding to the human lumbar splanchnics of which Morrill (1946, p. 90), gives an account. According to Morrill, the lumbar splanchnics correspond to the thoracic splanchnics since they also contain afferent fibers which pass without interruption into the pelvic viscera.

B. Connections to the Lumbo-Sacral Plexus.

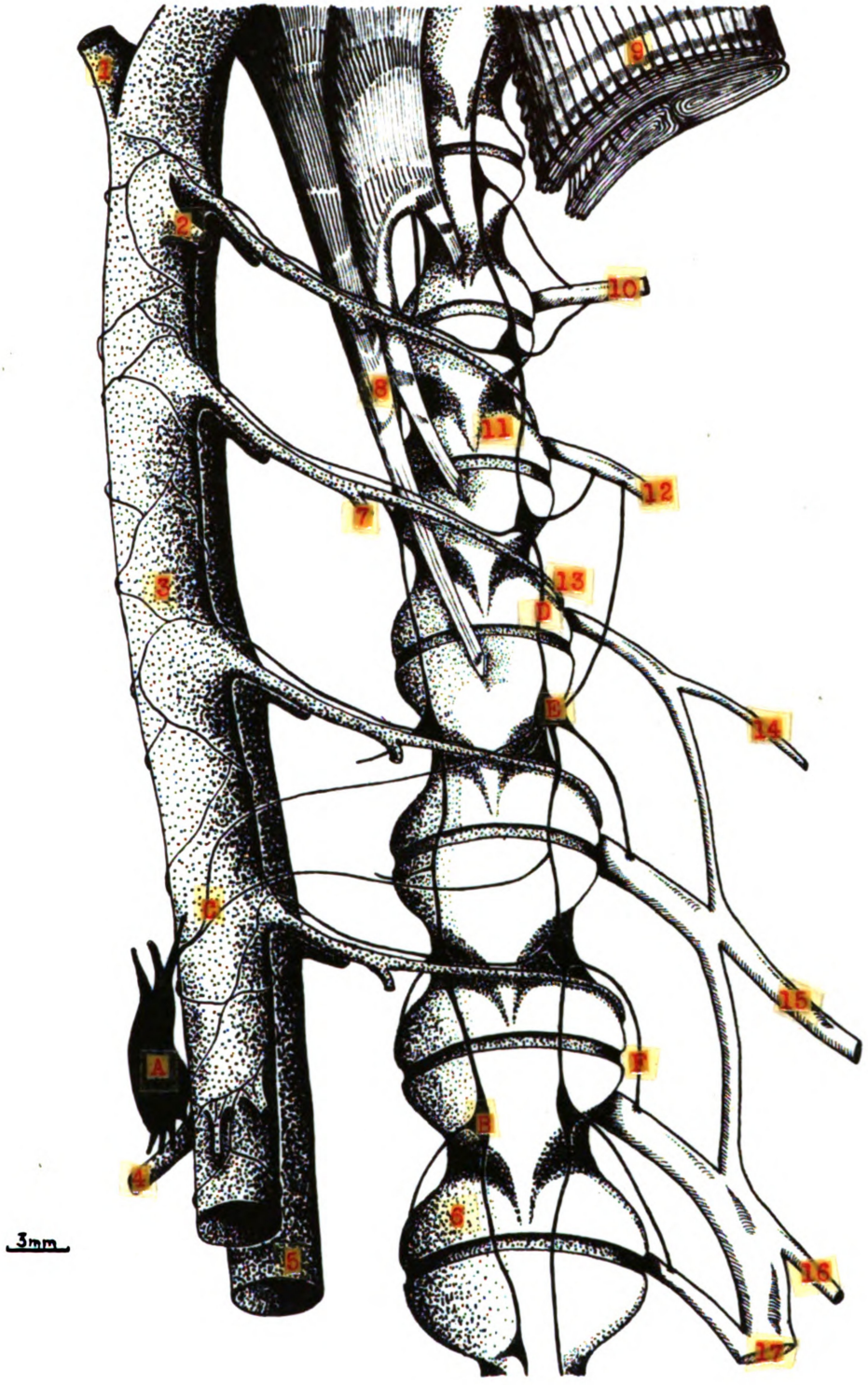
In order to show the connections of the cord to the lumbo-sacral plexus parts of the psoas muscles had to be cut away, for the connections are very fine and deeply imbedded among the muscle fibers. The rami communicantes from the first and second ganglia connect with the ventral root from which the iliohypogastric nerve arises (Plate XII-10). The third ganglion gives off a ramus communicans to the ventral root from which the ilioinguinal nerve arises (Plate XII-12). From the fourth ganglion a ramus communicans connects with the ventral root from which the femoral nerve arises (Plate XII-15). In addition, the fourth ganglion gives off a moderately thick strand to the base of the ilioinguinal nerve. The fifth and sixth ganglia establish ramal connections with the two roots that contribute to the make-up of the sciatic stem (Plate XII-17).

PLATE XII. THE GANGLIONATED CORD OF THE ABDOMINAL REGION, VENTRAL ASPECT.

A. Posterior Mesenteric Gln.
B. Sixth Lumbar Vertebral Gln.
C. Lumbar Splanchnic Nerves.
D. Left Lumbar Ganglionated Cord.
E. Fourth Lumbar Vertebral Gln.
F. Ramus Communicans

1. Anterior Mesenteric A.
2. Left Renal A.
3. Lumbar Aorta and N. Plexus.
4. Posterior Mesenteric A.
5. Postcava.
6. Sixth Lumbar Vertebra.
7. Right Lumbar A.
8. Tendinous Origin of the Diaphragm.
9. Psoas Muscles (cut).
10. Iliohypogastric N.
11. Second Lumbar Vertebra.
12. Ilioinguinal N.
13. Left Lumbar A.
14. Lateral Cutaneous N.
15. Femoral N.
16. Obturator N.
17. Sciatic N.

PLATE XII



XI. THE AUTONOMIC PLEXUSES OF THE ABDOMINAL REGION

All the plexuses of the abdomen may be conveniently designated as subdivisions of the coeliac plexus. The reason for this interpretation is that all the plexuses are connected to the coeliac either directly through fibers or indirectly through collateral ganglia and their branches. These subdivisions fall into two categories. Those that are paired and those that are unpaired. The following plexuses are paired:

A. The Gastric Plexuses (Plate VIII-L, M).

The gastric plexuses consist of a very thick network of fibers bounded by the lesser curvature of the stomach and are made up of branches from the vagus nerves and filaments from the plexus on the coeliac artery (Plate IX-9).

B. The Phrenic Plexuses (Plate IX-J).

These plexuses are found in the proximal regions of the origins of the crura of the diaphragm and are formed from filaments from the right and left coeliac ganglia.

C. The Adrenal Plexuses (Plate IX-E).

The adrenal plexuses are located in the vicinity of the hiluses of the adrenal glands and are made up of fibers contributed by the right and left aorticorenal

ganglia. A few fibers arising from the aorticorenal branches to the kidneys may also contribute to the plexuses.

D. The Renal Plexuses (Plate IX-F).

The right renal plexus is located just at the hilus of the right kidney and is made up of fibers from the aorticorenal ganglion and occasional filaments arising from the proximal portion of the main connection between the anterior and posterior mesenteric ganglia. The left renal plexus is generally made up of fibers from the left aorticorenal ganglion.

E. The Uterine Plexuses (Plate X-11).

The uterine plexuses are derived from a few fibers arising from the posterior mesenteric ganglion and from the aortic plexus. After pursuing the uterine arteries they divide into subordinate plexuses supplying the ovaries, cornua, body of the uterus, and vagina. These plexuses are very minute and are difficult to locate with the unaided eye.

F. The Spermatic Plexuses (Plate XIII).

The spermatic plexuses were well developed in all three male specimens. The plexuses arise mainly from the lateral portions of the posterior mesenteric ganglion. As several large strands, they follow closely the course of the spermatic vessels, the caudal portion of the ureters, and the vasa deferentia, giving off fine filaments

to the structures named and also anastomotic fibers to the hypogastric plexus (Plate XIII-B, C, F). Upon reaching the neck of the bladder these strands branch and form a dense network of fibers (Plate XIII-E) which are distributed to the trigone, urethra, prostate gland, penis, and associated glands. Just caudad of the trigone and imbedded in the surface of the prostate gland several ganglia of moderate size can be discernible. Of the three male specimens, one exhibited both ganglia on the right; one showed both ganglia on the left side; and the other had one ganglion on either side. These unnamed ganglia may be conveniently designated as the ganglia of the prostate gland (Plate XIII-D).

The following Plexuses are unpaired:

A. The Hepatic, Splenic, and Pancreatic Plexuses (Plate IX-9).

These plexuses arise from branches given off mainly by the coeliac ganglia. The branches follow the corresponding branches of the coeliac artery and form fine plexuses on the surfaces of the corresponding viscera. These plexuses are difficult to observe without histological slides.

B. The Aortic Plexus (Plate X-8).

The aortic plexus may be described as a dense network of fibers adherent to the abdominal aorta and extending from the base of the left renal artery down to the region of bifurcation of the aorta near the pelvic

brim. The plexus itself sends minute filaments to supply all the aortic and postcaval branches below the left renal artery. It is made up of fibers contributed by the connection between the third and fourth ganglia of the cord; from fibers arising from the connections between the anterior and posterior mesenteric ganglia; and from a few filaments arising from the posterior mesenteric ganglion itself. In one case, just between the origin of the posterior mesenteric artery and the left iliolumbar artery, two small accessory ganglia were found on the ventral surface of the aorta. They were fused perpendicularly to each other and sent connective filaments to the uterine plexus, posterior mesenteric ganglion, and to the ganglionated cord. Just about five millimeters above these two ganglia, a third ganglion was discernible that connected to the fused ganglia and also sent filaments to the ganglionated cord (Plate X-C). In one other case, one ganglion was found just a few centimeters below the anterior mesenteric ganglion (Plate XI - fig. 6-J). These ganglia may be considered as the ganglia of the aortic plexus.

C. The Anterior (Superior) Mesenteric Plexus (Plate IX-M).

The anterior mesenteric plexus consists of a dense network of fibers concentrated around the anterior mesenteric artery. Upon entering the intestinal mesentery the plexus sends out numerous fine filaments that follow the terminal branches of the artery into all parts

of the small intestine, including a part of the proximal portion of the large intestine. It is made up of a number of large fibers arising from the anterior mesenteric and coeliac ganglia.

D. The Posterior (Inferior) Mesenteric Plexus (Plate X-A).

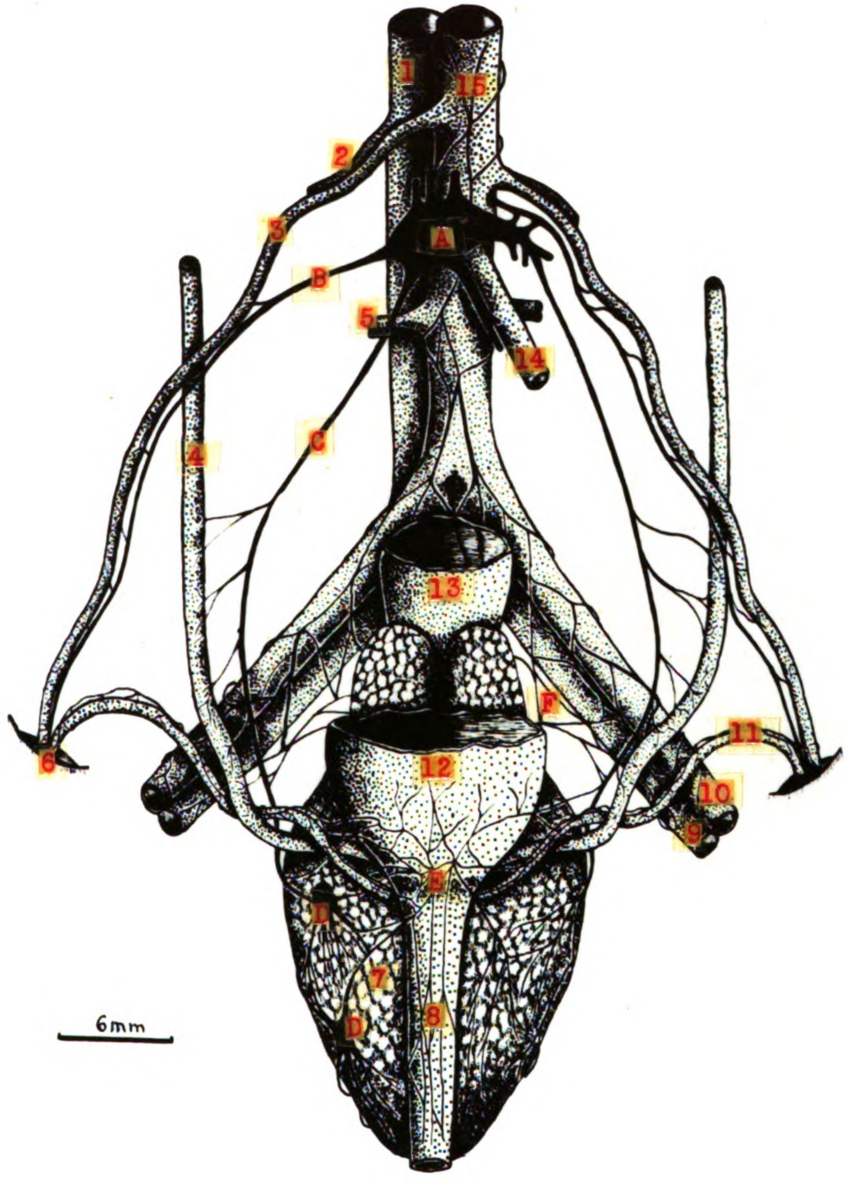
The posterior mesenteric plexus is a linear network of fibers that begins at the base of the posterior mesenteric artery, spreads, and extends along the dorsal border of the large intestine and along with the arterial branches it is distributed to the distal part of the large intestine, including the upper part of the rectum. The bulk of the plexus in the fox squirrel is made up of fibers originating from the posterior mesenteric ganglion in contrast to the human in which the bulk of the plexus is made up of fibers from the aortic plexus (Morrill 1946, p. 88) (Gray 1936, p. 976).

PLATE XIII. VENTRAL VIEW OF THE MALE HYPOGASTRIC REGION SHOWING THE SPERMATIC PLEXUSES.

A. Posterior Mesenteric Gln.
B. Branch to the Spermatic A. and V.
C. Branch to the Ureter.
D. Ganglia of the Prostate Gld.
E. Plexus of the Neck of the Bladder.
F. Hypogastric Plexus.

1. Postcava.
2. Spermatic V.
3. Spermatic A.
4. Ureter.
5. Iliolumbar A. and V.
6. Internal Inguinal Ring.
7. Prostate Gld.
8. Urethra and N. Plexus.
9. Common Iliac V.
10. Common Iliac A.
11. Vas Deferens and N. Plexus.
12. Bladder (cut).
13. Rectum (cut).
14. Posterior Mesenteric A.
15. Lumbar Aorta and N. Plexus

PLATE XIII



XII. THE HYPOGASTRIC PLEXUS AND THE PELVIC VISCERAL NERVES

The hypogastric plexus is a continuation of the aortic plexus commencing at the caudal bifurcation of the aorta. It receives fibers mainly from the first and second sacral vertebral ganglia (Plate XIV-G). It appears as a group of plexiform fibers enclosing the origin of the common iliac vessels and anastomoses with the uterine and spermatic plexuses (Plate XIII-F).

At the level of the third and fourth sacral vertebrae the posterior caudal trunk (Plate XIV-4), a part of the caudal or sacral plexus, gives rise totwo groups of fibers, the pelvic visceral nerves (Plate XIV-D), which directly enter the pelvic viscera and bypass the caudal ganglionated cord. These nerves variably anastomosed with the hypogastric plexus and were thus not very definite.

XIII. THE GANGLIONATED CORD OF THE PELVIC REGION

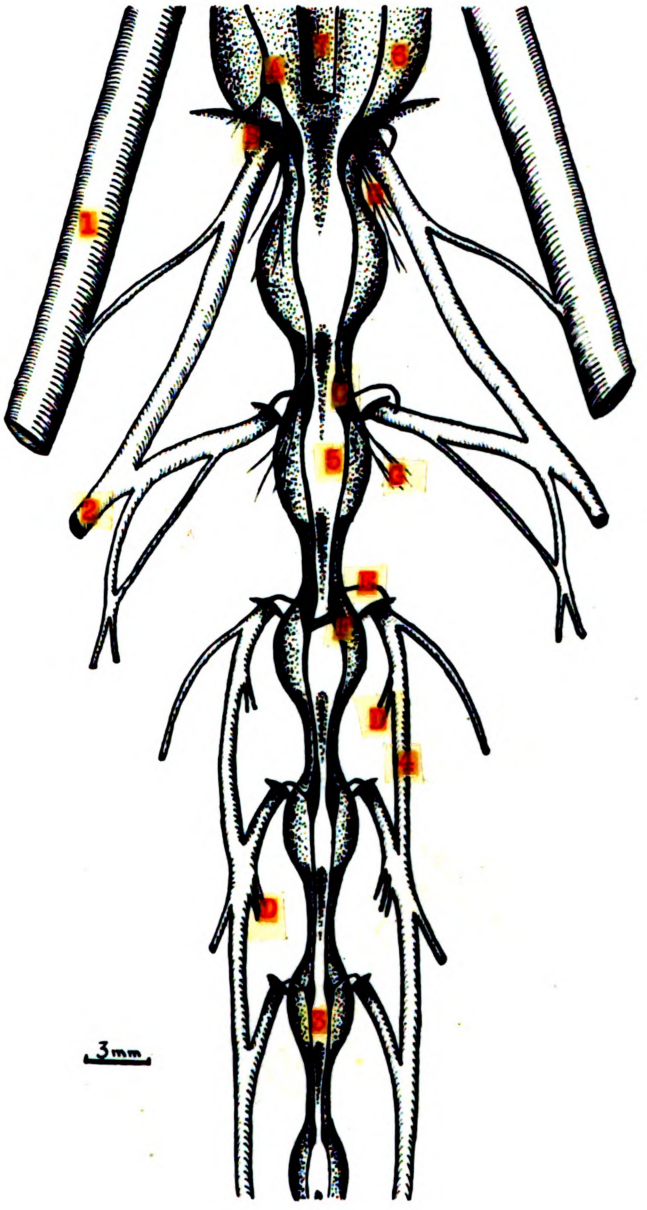
Most of the pelvic and caudal musculature had to be cut away in order to observe the cord. Both ganglionated cords commence on the ventral surface of the promontory of the sacrum and begin to converge and decrease in size toward the caudal vertebrae where they eventually become so minute that for purposes of gross dissection they may be said to disappear (Plate XIV). The terminal portion of the abdominal aorta, the middle sacral artery, comes into immediate relation with both cords and extends into the tail. In one case, at the caudal portion of the right side of the sixth lumbar vertebra an extra ganglion was observed in the ganglionated cord. In other words, on the right side there were seven lumbar vertebral ganglia instead of the usual six (Plate XIV-A). Except for this one situation, the sacral vertebral ganglia generally conform to the number of sacral vertebrae. Each ganglion gives off a ramus communicans to all the roots of the sacral plexus and to the sacral roots of the posterior caudal trunk. On the third sacral vertebra, the two ganglia are found to be connected to each other by a couple of fine filaments whereas the rest of the ganglia are quite separate from each other (Plate XIV-F). This latter condition persisted in all six specimens.

PLATE XIV. THE GANGLIONATED CORD OF THE PELVIC REGION.

A. Extra Sixth Lumbar Vertebral Gln.
B. Ramus Communicans.
C. Second Sacral Vertebral Gln.
D. Pelvic Visceral Nerves.
E. Ramus Communicans.
F. Third Sacral Vertebral Gln.
G. Fibers to the Hypogastric Plexus.

1. Sciatic N.
2. Pudendal N.
3. First Caudal Vertebra.
4. Posterior Caudal Trunk.
5. Second Sacral Vertebra.
6. Sixth Lumbar Vertebra.
7. Middle Sacral A.

PLATE XIV



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XV. CURRICULUM VITAE

Nicholas James Mizeres was born in Pittsburgh, Pennsylvania, in 1924. His early education was obtained in Canton, Ohio, where he was graduated from McKinley High School in 1942. The following year he entered the service of the Army of the United States, where he spent the next three years in the states and overseas.

In 1948 he was graduated from Kent State University in Ohio with a Bachelor of Science degree. While at that institution, he was an undergraduate assistant in comparative and mammalian anatomy.

At the present time he is a graduate student in the Zoology Department at Michigan State College.

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