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Course and distribution of the nervi craniales in the Sus scrofa domesticus : a gross anatomical study.

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COURSE AND DISTRIBUTION OF THE NERVI CRANIALES

IN THE SUS SCROFA DOMESTICUS

A GROSS ANATOMICAL STUDY

by

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INTRODUCTION

The Department of Anatomy of Iowa State University, in view of the necessity for a better gross morphological knowledge of the peripheral nervous system in our domestic animals, has reopened investigations on this important sector of the animal body.

The demand for such studies is probably greater in swine species because: (a) the interest in the pig as an experimental animal has been steadily increasing, along with the importance of the swine industry and (b) only scattered and rather incomplete accounts were available in the literature. Veterinary anatomical textbooks, as a rule, have covered the subject, in the pig, in a comparative manner in which only slight remarks about the actual anatomical disposition are made (Chauveau and Arloing, 1891; Chauveau and Arloing, 1905; Montané and Bourdelle, 1920; Martin, 1923; Ellenberger and Baum, 1943; Bruni and Zimmerl, 1951; Sisson and Grossman, 1953; and Koch, 1965).

New information, however, has been obtained, thanks to the effort of Bosa (1965), Gandhi (1966), Ghoshal (1966) and Magilton (1966) whose work, with the exception of the cranial nerves, has covered and re-evaluated the entire peripheral nervous system of the pig.

The present work deals primarily with the gross anatomical aspects of the cranial nerves in the pig and was designed to give an account of the most frequent pattern of their course and distribution. For this, gross dissections on the commonly embalmed or decalcified specimens were performed along with the study of frozen frontal sections of the head.

The olfactory nerve and the posterior cervical, thoracic and abdominal portions of the vagus nerve were not included in the investigation because they are currently being studied in the same department.

With respect to the nomenclature, the author followed, as closely as possible, that approved by the 6th meeting of the World Association of Veterinary Anatomists held in Giessen and Wiesbaden, Germany during the period of August 7 to 10, 1965.

REVIEW OF LITERATURE

N. opticus

The optic nerve, also designated as the optic fascicle or optic fiber tract, since for embryological reasons it may be compared with the fiber tracts of the brain, is a structure constituted by the reunion of axons of the ganglion cells of the retina. It connects the eyeball with the brain.

In the pig, it resembles that of the horse (Martin, 1923) and that of the ruminant (Ellenberger and Baum, 1924).

The optic nerve emerges at the nasal side of the posterior pole of the eyeball. In the orbital cavity it is fairly cylindrical, measuring, with its sheaths, about 2.8 mm (Nicolas, 1924).

The total number of optical fibers has been evaluated at 681,000 by Bruesch and Arey (1941).

After entering the cranium through the optic foramen they unite with each other to form the optic chiasma, in which an almost complete decussation of their fibers take place. A few fibers remain uncrossed at the optic chiasm (Nicolas, 1924).

The N. opticus, according to Prince et al. (1960), does not take a straight course within the orbit but first turns slightly medially and then turns quite sharply in a dorsolateral direction. Finally, it turns ventrally for a few millimeters to enter obliquely the globe, medial to the posterior pole.

N. oculomotorius

The oculomotor nerve consists of several radicles which arise from the ventral surface of the cerebral peduncle just lateral to the interpeduncular fossa.

It leaves the cranial cavity and joins the trochlear, ophthalmic and maxillary divisions of the trigeminal and abducent nerves (Montané and Bourdelle, 1920; Martin, 1923; Bruni and Zimmerl, 1951; and Sisson and Grossman, 1953).

Martin (1923) describes it as similar to the horse, whereas Ellenberger and Baum (1943) indicate its similarity to the ruminants.

According to Winckler (1936) the oculomotor nerve divides into dorsal and ventral branches in the orbital cavity. The former innervates the rectus dorsalis and the levator palpebrae superioris muscles. It reaches the levator palpebrae superioris muscle after perforating the rectus dorsalis. Both the ventral and dorsal surfaces of the rectus medialis muscle receive fibers from the dorsal branch of the oculomotor nerve. The frontal nerve also sends some branches to these muscle. These branches come from the same branch which pass to the obliquus dorsalis and reach the dorsal surface of the muscle. Some fibers anastomose before reaching the muscle with branches of the oculomotor nerve, meanwhile other fibers reach the muscle alone. The ventral branch is larger and longer than the dorsal one and supplies the rectus medialis, rectus ventralis, and obliquus ventralis muscles. It also gives motor fibers to the ciliary ganglion.

The ventral branch of the oculomotor nerve also innervates the ventral oblique muscle. The nerve runs on the lateral margin of the rectus ventralis muscle before entering the ventral oblique. Winckler (1936) dissected the orbital cavities of an adult pig and some foeti without finding remarkable variations. He concludes that the double (motor and sensory) innervation of the extrinsic muscle of the eye can be easily examined in the pig. The proprioceptive fibers reach these muscles through trigeminal branches. The motor nerves reach, with few exceptions, the orbital muscles on their dorsal surface and the sensory nerves on their ventral surface. He also describes a connection in *Sus scrofa* between the trochlear and ophthalmic nerves.

Kovács and Fehér (1958) assert that the N. oculomotorius does not contribute to the innervation of the M. retractor bulbi.

Prince et al. (1960) report that the oculomotor nerve lies a little below and lateral to the ophthalmic nerve within the orbitorotundum foramen where it bifurcates. Its dorsal division further divides to innervate the superior rectus and levator palpebrae superioris muscles. The larger inferior division drops to the infralateral aspect of the optic nerve to innervate the medial rectus muscle. Another drops to the inferior rectus muscle below. The largest branch passes forward and shortly the motor root passes from it to the ciliary ganglion. These motor nerves to the ciliary ganglion gain access to the globe via the short ciliary nerves. The oculomotor branch now turns to the lateral edge of the inferior rectus muscle and then continues forward to innervate the inferior oblique muscle.

Ganglion ciliare

Szákall (1902) describes the Ganglium ciliare as located 1 cm. from the division of the N. oculomotorius. Four to five nerve fibers which arise from the long branch of the N. oculomotorius constitute the motor root. These fibers may be confused with the sensory root because the sensory fibers are not only located cranially but also ventrally to the ganglion. The location of the ganglion is only confusing in this aspect because the N. oculomotorius is covered by the sinus venosus orbitalis.

Mobilio (1912) states that there are two ophthalmic ganglia. One is small but well distinct and receives the sensory root from a branch of the superior maxillary nerve and the motor root from the small pathetic nerve (Ramus ventralis of the N. oculomotorius). The other ganglion is less developed and is united with the first one by a small twig. It is placed at the level of the second curvature of the optic nerve. It also receives the motor root from the small pathetic while the sensory root is furnished by the nasopalpebral nerve. The presence of three ophthalmic ganglia were observed in one specimen. The first was attached to the small pathetic and received the sensory root from the superior maxillary nerve whereas others received the sensory root from the nasopalpebral nerve. The motor root for the second and third originated from the small pathetic.

Nervus trochlearis

The trochlear nerve arises from the anterior medullary velum just behind the anterior cerebellar peduncle, curves outward and forward and pierces the tentorium cerebelli.

According to Ellenberger and Baum (1943) it resembles that of the ruminants.

It leaves the cranial cavity along the ophthalmic, and maxillary divisions of the trigeminal, abducent, and oculomotor nerves through the foramen orbitorotundum (Montané and Bourdelle, 1920).

Bruni and Zimmerl (1951) describe the trochlear nerve as coursing in association with the ophthalmic branch of the trigeminal and the oculomotor nerves. Before entering the dura mater the nerve sends off branches to the tentorium cerebelli.

According to Mobilio (1910) as referred to by Mobilio (1912) and Bruni and Zimmerl (1951) the trochlear nerve gives off, in the intrameningeal portion, another branch, the recurrent accessory of the tentorium cerebelli.

Winckler (1936) writes that the trochlear nerve enters the obliquus dorsalis muscle on the dorsal surface of its posterior third.

On the other hand, Law (1956) relates that the trochlear nerve enters the orbital surface of the dorsal oblique muscle at approximately the junction of the posterior and middle thirds and divides into three branches. From these, a short trunk supplies the posterior third and tendon of origin, while the remaining two pass anteriorly.

The trochlear nerve reaching the cranial border of the dorsal oblique muscle is described by Baptista (1944) whereas, Prince et al. (1960) describe it as coursing outside of the extraocular muscle cone to enter the superior oblique muscle at its supralateral edge.

N. trigeminus

The trigeminal nerve emerges from the lateral aspect of the pons and consists of two roots - the sensory and motor. It bears the large Ganglion trigeminale and divides into three nerves.

The ophthalmic nerve is the smallest of the three branches and gives off the lacrimal, frontal and nasociliary nerves.

The second division of the trigeminal nerve, the maxillary nerve, is much larger than the ophthalmic. It extends forward in the pterygopalatine fossa and continues in the infraorbital canal as the infraorbital nerve.

The mandibular nerve arises from the trigeminal ganglion and also receives the motor root of the trigeminal nerve. It gives off the following nerves: masseteric, buccinator, pterygoids, auriculotemporal, mandibular alveolar and lingual.

Ellenberger and Baum (1943) and Sisson and Grossman (1953) state that the lacrimal nerve resembles that of the horse. In the horse, according to the latter authors, it runs forward on the rectus dorsalis and the levator palpebrae superioris muscles and ramifies chiefly in the lacrimal gland and the upper eyelid. A branch, R. zygomaticotemporalis, exchanges twigs with the zygomatic branch of the maxillary nerve, perforates the periorbita and emerges from the orbital fossa behind the supraorbital process. It forms a plexus with branches of the auriculopalpebral and frontal nerves, and ramifies in the skin of the temporal region.

Prince et al. (1960) mention that the lacrimal nerve quickly divides into two branches and they both travel supralaterally between the orbital venous sheath and the periorbita to enter the lacrimal gland and some branches pass into the upper eyelid.

The dorsal oblique muscle receives a branch from the frontal nerve (Winckler, 1936 and Bruni and Zimmerl, 1951) whose fibers come from an anastomosis with the oculomotor nerve (Bruni and Zimmerl, 1951).

The frontal nerve also sends off branches to the dorsal rectus and levator palpebrae superioris muscles (Winckler, 1936).

The frontal nerve resembles that of the ox, emerging from the orbit below the supraorbital process (Martin, 1923; Ellenberger and Baum, 1943 and Sisson and Grossman, 1953).

According to Chauveau and Arloing (1891) the palpebronasal branch anastomoses with a motor nerve of the eye on the deep face of the lateral rectus muscle.

Chauveau and Arloing (1905) relate that the palpebronasal ramus of the ophthalmic nerve gives off several twigs to the eye muscle and anastomoses with a motor nerve on the deep surface of the external rectus muscle.

The nasociliary nerve is relatively large (Martin, 1923 and Ellenberger and Baum, 1943) and sends off numerous filaments to the ocular muscle (Montané and Bourdelle, 1920 and Sisson and Grossman, 1953).

The maxillary nerve leaves the cranial cavity through the great sphenoidal slit (Chauveau and Arloing, 1891).

Prince et al. (1960) state that the ophthalmic nerve, which is the superior and the smallest of the three main branches of the trigeminal nerve, takes a superior position in the orbitorotundum foramen and, before emerging from it, gives off the frontal nerve dorsally. Initially the frontal nerve lies along side the lacrimal nerves which pass above the venous sheath next to the periorbita. For most of its intraorbital course the frontal nerve lies above the superior rectus muscle until it divides. It divides before arriving below the superior orbital rim. It contributes to the innervation of the upper lid and then passes on to the forehead where its several branches disperse. The pig does not have a nerve passing through the frontal foramen but the distribution of the frontal nerve obviously compensates for the lack of a supraorbital nerve. The latter name might have been retained for what we have called the frontal nerve but, as in the cow, in view of its course, the term "frontal" seemed more adequate. Before leaving the orbitorotundum foramen the ophthalmic nerve gives rise to two long ciliary nerves. The first of these passes into the retractor bulbi muscle from which it receives small sensory branches. It then leaves the muscle to lie in contact with the dorsomedial surface of the optic nerve and finally it enters the globe close to the entrance of the optic nerve. The second long ciliary nerve also enters the retractor bulbi muscle for a brief part of its course, but more anteriorly it lies on the lateral surface of the optic nerve, retaining this position as it enters the globe. The next branch of the ophthalmic (now nasociliary) nerve, which also leaves it within the foramen, is the sensory root. This travels forward and drops slightly to join the ciliary ganglion which lies close to the optic nerve at its infra-lateral aspect. Several small short ciliary nerves leave the ganglion and travel anteriorly upon the surface of the optic nerve until they enter the globe.

The nasociliary nerve now advances within the orbit beneath the superior rectus and superior oblique muscles. While beneath the latter it divides into the ethmoidal and infratrochlear nerves. The former emerges from beneath the superior oblique muscle and then passes through the ethmoidal foramen close by. The infratrochlear nerve travels anteriorly at the inframedial edge of the superior oblique muscle and soon divides into two or three branches. They pass into the upper eyelid and also contribute to the innervation of the forehead.

According to Chauveau and Arloing (1905) the superior maxillary nerve penetrates, almost immediately after its exit from the cranial cavity the superior dental canal. The staphylin branch (sphenopalatine nerve of Sisson and Grossman, 1953) courses ventrally to the maxillary tuberosity where it divides into several branches: one passes into the staphylin sulcus and constitutes the posterior palatine nerve, others constitute the middle palatine nerve and one branch penetrates the palatine canal as the anterior palatine nerve. The infraorbital branches are relatively large and terminate in the superior lip and snout.

Mobilio (1912) reports that, from the superior maxillary nerve, behind the origin of its orbital branch, originates a branch that courses on the lateral rectus muscle. Although it divides into several twigs the majority of them unite with the small pathetic and together reach the small pathetic muscle and first ophthalmic ganglion. The branch of the superior maxillary nerve to the small pathetic and ophthalmic ganglion sends off in some cases a slender twig which courses on the lateral rectus and after a long course ends in the small pathetic nerve and small oblique muscle.

Montané and Bourdelle (1920) affirm that the maxillary nerve gives off an orbital branch and the nasal nerve from its dorsal surface. From its ventral surface the nerve gives off the staphyline and palatine branches. The sphenopalatine branch of the maxillary nerve passes at once below the maxillary tuberosity, where it divides into several rami: one, entering the palatine fissure, forms the posterior palatine nerve; the other passes into the palatine arch at various distances, to constitute the middle palatine nerves; some of them even enter the palatine canal with the anterior palatine or palato-labial nerve.

The maxillary nerve, as described by Winckler (1936), sends off, by way of its orbital branch, twigs to the lateral surface of the lateral rectus, ventral rectus and ventral oblique muscles while the lateral nerve also gives off branches which pierce the surface of the lateral rectus muscle. The retractor bulbi muscle receives branches coming from the nasal and lacrimal nerves. They reach the muscles on the dorsal and lateral surface, respectively.

The nasal nerve, then bifurcates into internal nasal and external nasal nerves and sends off three or four twigs which penetrate the medial surface of the medial rectus muscle.

Winckler (1936) states that the ventral rectus muscle receives motor innervation on its dorsal surface and the superior maxillary nerve sends off fibers which enter its ventral surface. One of the superior maxillary nerve branches reaches the posterior third of the muscle. A second branch reaches the middle third and a third branch reaches the posterior third of the muscle. Finally several slender branches reach the cranial third.

According to Ashton and Oxnard (1958) the maxillary and ophthalmic divisions of the trigeminal nerve leave the cranial cavity, each being within its own sheath of connective tissue, with the maxillary division lying lateral to the ophthalmic. The maxillary then passes forward on the orbital floor. The zygomatic nerve arises from the maxillary trunk and passes laterally through the periorbital fascia to supply the area of skin near the outer canthus. A fine filament connects the zygomatic and lacrimal nerves. In one of the dissected pigs the zygomatic nerve separated from the maxillary trunk in the sphenopalatine fossa, passing subsequently into the periorbital fascia through a spiral opening. In all other instances, the zygomatic branch separated from the main trunk after it had entered the orbit. In three specimens the zygomatic nerve was divided into two distinct filaments, while in a further two dissections it was split into three filaments.

Ashton and Oxnard (1958) also report that the infraorbital nerve, after entering the orbit, gives off two or three posterior superior dental filaments which pass into fine canals in the maxillary tuberosity. More anteriorly, the labial division gives off a number of fine middle superior dental nerves. In all specimens, an anterior superior dental nerve passed laterally into a bony canal in the maxilla to supply the anterior teeth. In nine of the ten dissections of the pig, the middle and anterior superior dental nerves arose from the lateral side of the undivided infraorbital nerve as it traversed the infraorbital canal. In the tenth specimen, these branches arose from the labial division. The infraorbital nerve splits into nasal and labial divisions while passing through the exceptionally long infraorbital canal. The nasal division is much bigger than the labial. In nine of the ten specimens of pig there was no primary subdivision of the infraorbital nerve, the entire trunk apparently corresponding to the nasal division. In the tenth specimen, a labial division, much smaller than the nasal, separated from the lateral side of the infraorbital nerve as this traversed the infraorbital canal.

Ashton and Oxnard (1958) further report that the nasal division of the infraorbital nerve splits into a small superior and bigger inferior nasal branch. The former ramifies on the dorsum of the snout, some of its twigs reaching the extreme anterior end. The inferior nasal branch divides into superficial and deep bundles. The superficial bundle gives twigs to the anterior region of the upper lip. The deep bundle is distributed to the nasal vestibule. After emerging onto the face, the labial division splits into two small branches which supply an area of skin on the posterior part of the upper lip near the angle of the mouth. They receive one or two fine filaments from the facial nerve. The most anterior twigs of the superior nasal branch supplied both the rim and the upper part of the anterior surface of the disc-like ending of the snout, the remainder ramifying on the surface of the snout. In the nine specimens lacking in a labial division, a few filaments of the superficial bundle of the inferior nasal branch passed posteriorly to supply the skin behind the angle of the mouth. In all ten dissections, the deep bundle of the inferior nasal branch divided into three: one group of fibers supplied the inferior part of the surface of the disc, another its internarial part, while a third was distributed to the area of the snout lateral to the nares, some of its fibers reaching the vestibule of the nose.

According to Prince et al. (1960) the maxillary nerve emerges from the orbitorotundum foramen as the infraorbital nerve. This is because the sphenopalatine has already branched from it ventrally. The infraorbital nerve is extremely thick and lies just below the orbit, advancing to the maxillary foramen. By comparison the sphenopalatine nerve is very small. The latter maintains a course ventral to the maxillary nerve, and later turns slightly medially to enter the sphenopalatine foramen. It has one branch, the palatine nerve, which passes from it ventrally and enters the palatine canal to reach the hard and soft palates. There does not appear to be a minor palatine nerve present. The sphenopalatine ganglion lies on the upper surface of the sphenopalatine nerve. There are usually three zygomatic nerves within the orbit, coursing close together, and these may arise from the maxillary nerve individually, or as a single branch dividing later. They also course outside of the venous sheath and disperse in the lower eyelid and the region of the lateral canthus.

A fairly full picture of what appears to be sensory nerves passing from the extraocular muscles to various branches of the fifth nerve was observed in the pig. These small nerve fibers were traced from the superior oblique muscle to the frontal nerve. The nasociliary nerve receives fibers from the superior rectus, the medial rectus, and the retractor bulbi muscles. Two or three more fibers from the retractor bulbi join one of the long ciliary nerves. Finally a nerve branch from the motor nerve that serves the inferior oblique muscle receives a group of very fine nerves from the lateral rectus muscle. This branch then passes out of the orbit to join the maxillary nerve dorsally just anterior to the orbitorotundum foramen. This therefore appears to be a route for the sensory fibers from the inferior oblique, the lateral rectus, and probably the inferior rectus muscles, those from the inferior oblique muscle passing within the motor nerve initially.

The mandibular nerve emerges from the cranial cavity through the foramen ovale according to Montané and Bourdelle (1920). While Martin (1923), Ellenberger and Baum (1943) and Sisson and Grossman (1953) state that the nerve emerges through the foramen lacerus anterius.

Chauveau and Arloing (1905) mention the inferior maxillary nerve as dividing in the inferior dental canal in several branches which leave the various mentioned foramina. Relative to the innervation of the parotid gland the authors refer to the report of Moussu (1889).

The superficial temporal nerve sends off, according to Moussu (1889), a branch - the superior parotid nerve - to the parotid gland which detaches from the former dorsocaudally to the mandibular articulation and dorsally to the facial nerve and reaches the medial surface of the parotid gland. Another branch, the inferior parotid nerve, comes from the mylohyoid nerve and divides into two branches. The smallest one runs on the maxillary groove with the mandibular duct and the largest is a satellite to the mylohyoid artery and crosses laterally the inferior branch of the facial nerve, reaches the mandibular duct and pierces on the medial surface of the parotid gland.

According to Montané and Bourdelle (1920) the mandibular nerve traverses the structure of the pterygoid muscle, enters the inferior dental canal and terminates by the mental nerves which pass through several mental foramina to ramify in the lower lip. The mandibular nerve gives off the following branches: masseteric and buccal nerves which reach the masseter muscle, buccinator muscle and the molar glands, respectively; deep temporal branches to the temporal muscle; lingual nerve which runs between the pterygoid muscle and the pharynx and reaches the lateral surface of the tongue beneath the mucous layer and along the inferior border of the superior lobe of the sublingual gland. It sends off two branches to the gland and penetrates laterally into the tongue, between the genioglossus and basioglossus muscles. The chorda tympani comes off the lingual nerve at the level of the sublingual gland and then turns back to the submaxillary gland following the mandibular duct. The mandibular nerve also gives off the pterygoid nerves to the ptery-goid muscle. Finally the mandibular nerve gives off the superficial temporal nerve which turns around the man-dibular articulation and will contribute to the formation of the subzygomatic plexus. In the mandibular canal the nerve sends off strong dental branches to the molar, canine, and incisive teeth.

Schumacher (1904) states that the M. depressor mandibulae is constituted by only one belly which is innervated by the N. mylohyoideus. There is an anasto-mosis, as in other animals, between the N. mylohyoideus and the N. facialis at the level of origin of the branch to the M. depressor mandibulae. The lateral cutaneous branch of the N. mylohyoideus anastomoses with the N. facialis and terminates in the skin of the region. The medial cutaneus branch continues as the R. submentalis and innervates the skin of the mental region. In some cases it may reach the lower lip. The anastomotic branch of the N. mylohyoideus to the N. facialis may be con-sidered as a sensory nerve and is similar to the other connecting branches of the N. trigeminus with the N. facialis.

The mylohyoid nerve has also been studied by Sauer (1956-57). He points out that the nerve detaches from the alveolar mandibular nerve before the penetration of the latter in the mandibular foramen. The mylohyoid nerve lies on a sickle-shaped bony groove (sulcus n. mylohyoideus) which extends from the border of the mandibular foramen to below the caudal border of the pars aboralis of the mylohyoid muscle. The groove is approximately 4 cm. long. In this groove the nerve runs in an oroventral direction between the medial pterygoid muscle and the mandible. Then it passes along the pars aboralis of the mylohyoid muscle and the bone and soon gives off a strong branch which extends between the digastric muscle and mandible in the direction of the ventral facial branch. This branch corresponds to the lateral branch of Schumacher (1904). A similarly strong branch continues on the dorsal border of the digastric muscle in an oral direction and, therefore, would possibly correspond to the medial branch of Schumacher (1904). From this dicotomic branching, two small branches arise. One branch extends laterally to the digastric muscle. Before this branch enters the muscle it divides into several fine twigs. Therefore, the assumption of Schumacher (1904) that the digastric muscle would be supplied by the mylohyoid nerve is correct. The other branch extends medially to the aboral portion. The remaining trunk extends further between the oral portion of the mylohyoid muscle and the mandible to the ventral angle and, according to Schumacher (1904), also reaches the lower lip.

The peripheral connections between the lingual and the hypoglossal nerves have merited special study by Fitzgerald and Law (1958). According to them the most complex form of lateral lingual-hypoglossal connection was found in the adult pig. In this animal the issuing fibers enter the tongue along the whole length of the styloglossus and inferior longitudinal muscles beyond the hyoglossus. A medial lingual hypoglossal connection was constantly present in the tongue of the pig. This connection is formed by the union of one or more branches of the lingual nerve with fibers of the medial division of the hypoglossal. In the pig, both proximal (among the lateral fibers of the genioglossus) and distal (near the tip of the tongue) connections were found.

The course of the incisive nerve in the pig was studied by Wedgewood (1962) in four, 7-week old pigs. Each individual incisive nerve gave off four branches:

(1) a large, superficial, mucosal branch, piercing the anterior surface of the mandible, traced as far as the submucosa (an overlapping of innervation of contralateral nerves occured in submucosa adjacent to the first two incisor teeth); (2) a small branch to the pulp of the deciduous teeth; (3) a small branch to the periodontal membrane of the deciduous teeth; and (4) a periodontal branch. The nerve passed medially to the root of this tooth (giving off branches to the follicle) and then passed through the follicle, again entered the bone on the medial wall of the crypt, and terminated in the periodontal membrane of the deciduous tooth.

According to McClure and Garrett (1966) the nomenclature of the ophthalmic nerve in domestic animals as it exists in current textbooks is confusing, particularly for ruminants (ox, sheep, goat) and the pig. The confusion arises primarily from the fact that in the ruminant, pig and sometimes the horse, the ophthalmic and maxillary divisions of the trigeminal nerve emerge from the cranial cavity as a common trunk through one opening, the foramen orbitorotundum. In man and other common domestic animals (dog, horse) the ophthalmic and maxillary nerves emerge through the orbital fissure and round foramen, respectively. Nomenclature based on comparable areas of nerve distribution dictates that the following terms in Nomina Anatomica (1960) should be utilized. The term lacrimal nerve is applied only to the branch distributed to the lacrimal gland and occasionally a very small area of skin related to the gland. The term zygomaticotemporal nerve is applied to the branch distributed to the horn and skin between the eye and the horn in ruminants, and a corresponding area in the horse and pig. This nerve has been commonly referred to as the lacrimal nerve. The term zygomaticofacial nerve is applied to the branch(es) distributed to the skin ventral to the lateral palpebral commissure. It is difficult to delineate the zygomaticotemporal and lacrimal nerves at their origin because they commonly arise as a common trunk, which sometimes even includes the frontal nerve.

Ganglion submandibulare

Catania (1924) describes the submaxillary ganglion as presenting the shape of a small node of 4-5 mm. in length and 1-1.5 mm. in diameter. It is in relation to the medial surface of the grandicanalaris sublingual gland (ventral portion of the sublingual gland), laterally and the hyoglossus, medially. The afferent rami, numbering seven to ten, are slender and present a variable length, according to the distance between the ganglion and the lingual nerve. They originate from a segment of the nerve and, coursing rostrocaudally and dorsoventrally, reach the rostrodorsal pole of the ganglion. The efferent rami distribute to the submaxillary gland, Wharton's duct and sublingual gland. Their number varies from two to four. From the caudoventral pole constantly emerges a thick efferent branch which courses caudoventrally, passes underneath the stylohyoid ligament and reaches the hylus of the submaxillary gland in which it penetrates. It establishes a close relationship along its course with the posterior portion of the grandicanalaris sublingual gland and Wharton's duct giving off twigs to both and finally, before reaching the submaxillary gland, divides into several branches which penetrate the hylus of the gland. Another coarse branch which is not always present detaches from the caudoventral pole of the ganglion and ramifies in the last portion of the Wharton's duct and to the lower extremity of the grandicanalaris sublingual gland.

According to Bruni and Zimmerl (1951) the submandibular ganglion is a single one.

<u>Ganglion pterygopalatinum</u>

Witmer (1925) reports on the maxillary nerve and sphenopalatine ganglia. He points out that the N.

maxillaris is very strong as well as the N. infraorbitalis because of the great development of the snout. Five to eight Ganglia sphenopalatina are covered by the N. infraorbitalis.

If one cuts and reflects cranially the N. infraorbitalis then the ganglia of the N. sphenopalatinus are exposed. Approximately 1 cm. cranial to the division of the N. maxillaris in its terminal branches and medial to it are the most caudal ganglia. The ganglia are arranged in a chain directed dorsally and rostrally which separates more and more from the dorsal side of the N. sphenopalatinus. The ganglia are located close to the bone at the angle formed by the maxillary, lacrimal and orbital portions of the frontal bone. The chain is 2 cm. in length and the most cranially located ganglion is 1 cm. dorsal to the N. sphenopalatinus. Each ganglion is about 2.5-3.0 mm. The limits of each ganglion are not sharply delineated, however, their grey-reddish color makes them outstanding.

N. abducens

The abducent nerve emerges from the ventral surface of the medulla oblongata just caudal to the pons and lateral to the pyramid. It leaves the cranial cavity in association with the oculomotor, trochlear, ophthalmic and maxillary nerves. In the orbital cavity the nerve divides into two short branches which penetrate the lateral rectus and retractor bulbi muscles.

According to Martin (1923) it resembles that of the horse.

Winckler (1936) states that the abducent nerve reaches the lateral surface of the retractor bulbi muscle, and the medial and lateral surfaces and also the dorsal border of the lateral rectus muscle.

Ellenberger and Baum (1943) affirm that the N. abducens supplies only the lateral and dorsal portions of the retractor bulbi muscles, the rest being supplied by the N. oculomotorius.

Kovács and Fehér (1958) report that not only the M. rectus lateralis but also the M. retractor bulbi is innervated by the N. abducens.

N. facialis

Chauveau and Arloing (1891) describe the facial nerve as dividing beneath the parotid gland into several branches, of which there are three principal ones. One of these branches is directed upwards and passes in front of the ear, this is the smallest. The second proceeds forward, crosses the masseter muscle near the zygomatic process, unites with the inferior branch and is expended among the suborbital branches of the superior maxillary nerve. The third passes downward and forward, under the parotid gland, arrives in the intermandibular space, is inflected in front of the masseter muscle to become superficial and terminates with the middle branch. Towards the maxillo-labiales muscles, this inferior branch gives off a ramuscule (twig) to the lower lip.

Chauveau and Arloing (1905) state that the facial nerve, beneath the parotid gland and after giving off the auricular nerves and the nerves to the occipto-hyoideus, stylo-hyoideus and digastric muscles, terminates into the temporo-facial and cervico-facial branches. The former anastomoses with the superficial temporal nerve, crosses the masseter muscle and mixes with the infraorbital branches. The cervico-facial branch courses dorsoventrally and caudorostrally under the parotid gland, reaches the intramaxillary space and turns in front of the masseter muscle. It courses along the anterior border of the masseter muscle and reunites with the temporo-facial branch before the latter gives off the anastomotic twigs to the infraorbital branches. The cervico-facial branches also furnish, at the inferior border of the buccinator muscle, a branch which reaches the inferior lip.

According to Montané and Bourdelle (1920) the subzygomatic plexus constitutes a small fascicle dissociated in secondary branches. It is constituted by the superficial temporal nerve and by the main portion of the facial nerve. They emerge separate from each other, underneath the preparotid lymph node to soon join in a common flat band. This band crosses the surface of the masseter muscle near the superior third. It soon bifurcates into two main branches, one superior and the other inferior, which join the termination of the superior and inferior maxillary nerves. Toward the anterior border of the masseter muscle the divisions of the plexus anastomose with an important branch from the facial nerve. The latter descends underneath the anterior border of the parotid gland, running along the posterior border of the mandible, reaches the mandibular space and then bends on the lateral surface of the head along with Stenon's duct. This nerve represents the true inferior branch, or cervico-facial branch, of the facial nerve. That which passes on the surface of the masseter muscle is the temporal branch.

Martin (1923), Ellenberger and Baum (1943) and Sisson and Grossman (1953) describe the inferior buccal nerve as passing downward and forward under cover of the parotid gland and accompanying the parotid duct, with which it turns around the lower border of the jaw in front of the masseter muscle.

Martin (1923) and Ellenberger and Baum (1943) further state that the inferior buccal nerve releases several fibers which form a plexiform arrangement with the dorsal buccal nerve.

According to Nikolai (1954) the N. facialis first gives off two branches which course caudally to the ear and are denoted as Rr. retroauricularis I and II. The R. retroauricularis I is a slender branch which runs dorsally with R. retroauricularis II and innervates the third layer of the ear muscles. Before entering these muscles it gives off, between the Pars auris and the M. cervicoauricularis posterior medius, branches to the dorsal surface of the conchal cartilage where they innervate the Mm. transversi et obliqui and M. antitragicus (Pars marginalis of the Mm. transversi et obliqui). The R. retroauricularis II is placed caudally to the R. retroauricularis I and courses toward the second layer of muscles where it ramifies. A more considerable branch, however, courses rostrally and gives off a twig to the M. cervicoauricularis anterior medius. The branch then appears below the conchal insertion of the first layer of the muscles. From here it penetrates and innervates the M. helicis retroauricularis and its fibers terminate in the M. mandibuloauricularis. From this branch a small twig is detached and anastomoses with twigs of the R. temporalis which innervates the M. auricularis anterior superior. From the main trunk of the R. retroauricularis II twigs are detached to both sides of the second layer. One of these twigs turns around the M. cervico-auricularis anterior medius and is distributed in the first layer.

The R. temporalis and R. zygomatico-orbitalis leave the main trunk of the N. facialis together. The branches that run dorsally correspond to the R. temporalis whereas the branch which courses toward the canthus of the eye constitutes the R. zygomatico-orbitalis. The most caudal branch of the R. temporalis travels dorsally underneath the three portions of the M. auricularis anterior inferior and terminates in the M. trago-helicinus. The two other branches anastomose freely with each other and also with the caudal branch. The main portion of the middle branch ends in the M. auricularis anterior superior whereas the rostral branch runs partially over and then under the scutulum to reach the M. interscutularis. The R. zygomatico-orbitalis also subdivides into two branches which pierce the M. auricularis anterior inferior near the insertion and course partially medial and partially over the M. frontalis. They also anastomose among themselves; the caudal branch anastomoses also with the R. temporalis. They give off several branches to the M. frontalis and course as an arciform nerve around the eye. Some of the branches run to the M. orbicularis oculi and to the canthus of the eye. Two twigs travel dorsally to the M. superciliaris.

The R. buccolabialis superior courses rostrally under the parotid gland. Two small branches leave the main trunk, course under the Platysma and innervate its Pars buccalis. At the same level, a branch to the M. zygomatico-labialis is given off. The Pars palpebralis and part of the lower lid also receive branches from the R. bucco-labialis superior.

The R. bucco-labialis inferior also courses under the parotid gland, at first ventrally and then around the ventral border of the M. masseter without any ramification. Ventrocaudal to the labial commissure it divides into two branches. The slender branch is the one that continues in the same direction. It gives off branches to the Pars mentalis and Pars orbicularis of the M. buccinator, ramifies on the jaw and innervates the M. mentalis. This branch could correspond to the R. marginalis mandibulae in Orycteropus. From the bifurcation, the other branch courses dorsally, receives the long anastomotic branches from the R. bucco-labialis superior and gives off branches to the Pars profunda and Pars orbicularis of the M. buccinator. Below the origin of the M. maxillo-labialis this branch anastomoses with the R. bucco-labialis superior. These twigs may traverse the M. zygomatico-labialis, however, they do not innervate this muscle. The final common tract of the Plexus buccalis courses rostrally under the M. maxillo-labialis. It gives off, dorsally, three branches to the latter muscle and the M. dilatotor nasi to finally ramify in the snout. The facial fibers here are intimately united with trigeminal fibers, however, the facial fibers to the M. naso-labialis profundus and M. naso-labialis superficialis are very distinct.

Many of the branches that pierce the Parotis and anastomose among themselves run toward the superficial plane of the Platysma and are considered as R. colli.

N. vestibulocochlearis

The N. vestibulocochlearis arises from the lateral part of the caudal border of the pons and resembles that of the horse (Martin, 1923).

The bibliographical search revealed no particular article with the exception of the one above and no citations were found in standard anatomical textbooks concerning the N. vestibulocochlearis in the pig.

N. glossopharyngeus

The glossopharyngeal nerve emerges from the lateral aspect of the anterior part of the medulla. It leaves the cranial cavity through the foramen lacerum posterior in company with the tenth and eleventh nerves. The nerve has a motor component to the stylopharyngeus muscle and parotid gland. The sensory component constitutes the larger portion and innervates the taste buds of the posterior third of the tongue and the pharynx.

According to Montané and Bourdelle (1920) the glossopharyngeal nerve passes through the foramen lacerum posterior, crosses the pharynx and is distributed to the base of the tongue after giving off a small pharyngeal branch.

It resembles that of the horse (Martin, 1923).

In a recent article, Frewein (1965) reports two ganglia in the N. glossopharyngeus. Five to seven bundles of the N. glossopharyngeus pass together with those of the N. vagus and N. accessorius through a large opening in the dura mater and terminate in the spindle-shaped Ganglion superior. Similarly, immediately outside the dura mater the large Ganglion superior of the N. vagus is situated and encloses directly the caudal and medial aspects of the Ganglion superior of the N. glossopharyngeus. Very little connective tissue is found between both ganglia. They appear to form a uniform node. In carefully prepared specimens they can be bluntly separated from one another. The Ganglion superior of the N. glossopharyngeus was spindle-shaped in all pigs investigated and had an average length of 2.3 mm. and a diameter of 1.2 mm. The Ganglion inferius is situated far outside the jugular foramen and in the posterior surface of the Pars tympanica of the Os temporale. It is light gray in color and likewise spindle-shaped. Its average length is 5.5 mm. and the diameter at the thickest place is 2 mm. In the pig the two ganglia are relatively and absolutely farther apart from one another than they are in the horse, sheep, goat, rabbit, cat and bovine. The distance amounts to 17.5 mm. in a pig with 30 Kg. body weight. The N. tympanicus which detaches from the upper pole of the Ganglion inferius runs along the medial border of the N. glossopharyngeus toward the base of the skull and extends closely below the jugular foramen in the tympanic cavity between the Pars petrosa and Pars tympanica.

N. vagus

Chauveau and Arloing (1891) relate that the vagus nerve joins the sympathetic trunk near the upper third of the neck.

Chauveau and Arloing (1905) state that the pneumogastric nerve presents a greyish ganglion the size of a small pea. It is located at the origin of the superior laryngeal nerve. The segment preceeding the ganglion is constituted by two loosely related branches - one of these terminates in the jugular ganglion and belongs to the vagus nerve, the other is the internal branch of the spinal nerve.

According to Montané and Bourdelle (1920) the vagus nerve leaves the cranial cavity through the foramen lacerum posterior in company with the internal branch of the spinal accessory nerve. The union of the two nerves is made at the level of a greyish intumescentia called the plexiform ganglion of the vagus nerve. The vagus nerve descends in the vicinity of the internal carotid artery, then follows the common carotid artery in the neck and thorax. Beneath the plexiform ganglion, it joins the cervical sympathetic trunk. In its guttural course the nerve gives off the pharyngeal and superior laryngeal nerves. The pharyngeal nerve originates well above the plexiform ganglion and seems to come exclusively from the internal branch of the spinal accessory nerve. It constitutes a voluminous fascicle which is placed craniocaudally on the lateral wall of the pharynx to the beginning of the esophagus, where it becomes the superior esophageal nerve. It is distributed, by means of numerous branches, to the pharyngeal muscles. Those more anterior join the pharyngeal ramification of the glossopharyngeal nerve while a posterior branch pierces the crico-thyroid muscle. The superior laryngeal nerve arises at the level of the plexiform ganglion. After giving off a small external laryngeal nerve to the crico-thyroid muscle it penetrates the larynx under the anterior border of the thyroid cartilage.

Lesbre and Maignon (1907) have stated accurately the anatomical disposition and demonstrated experimentally that, in the pig, all that is motor in the vagus nerve belongs to the internal branch of the spinal accessory nerve.

In the neck region there are several connections between the N. vagus and N. accessorius. The N. depressor is divided and originates from two roots of the N. vagus and N. laryngeus cranialis (Martin, 1923 and Ellenberger and Baum, 1943).

Grau (1943) describes the Ganglium nodosum of the pig as being well developed and located at the emergence of the N. laryngicus cranialis.

N. accessorius

Chauveau and Arloing (1891) state that this nerve commences and terminates as in Solipedes. After being inflected backward on the anterior border of the mastoid-humeralis muscle it divides into two branches - a deep and a superficial. The first is confounded with a cervical nerve, near the intervertebral foramen through which the latter passes; the second goes to the trapezius muscle in which it is expended.

Chauveau and Arloing (1905) state that the internal branch of the spinal nerve fuses with the pneumogastric nerve at the plexiform ganglion. Its external branch, after being inflected rostrocaudally on the anterior border of the mastoid portion of the mastoid-humeralis muscle, passes beneath the trapezoid portion of the same muscle to course attached to the deep surface of the trapezius muscle.

According to Montané and Bourdelle (1920) the spinal accessory nerve, after giving the internal branch to the vagus, becomes the strong external branch below the foramen lacerum posterior. It is directed caudally, gives off an important branch to the sterno-mastoid muscle and goes around the wings of the atlas to descend in the neck beneath the mastoid-humeralis muscle and trapezius muscle in which it terminates.

The N. accessorius of Martin (1923) is essentially the same as in the horse.

Bruni and Zimmerl (1951) write that the internal branch of the spinal accessory nerve reaches the vagus nerve more caudally in the pig than in the other animals.

N. hypoglossus

According to Chauveau and Arloing (1891) and Chauveau and Arloing (1905) the hypoglossal nerve is distributed in the muscles to the tongue and also in the geniohyoid muscle.

The hypoglossal nerve may present a small dorsal root on which there is a minute hypoglossal ganglion (Sisson and Grossman, 1953).

Luschka (1856) describes the presence of a dorsal root provided with a ganglion in the pig and other animals.

These observations were also confirmed by Vulpian (1862) and Chiarurgi (1889). However, according to the latter they disappeared during ontogenesis and were not found in adults.

Beck (1895), studying the dorsal root of the hypoglossal nerve in 58 species of mammals, including the pig, confirms that the ganglion and the dorsal root exist in a transitory condition in certain mammal embryos and foeti and they persist in the adults, principally in ungulates.

For Montané and Bourdelle (1920) the hypoglossal nerve descends from the condyloid foramen on the lateral surface of the pharynx and tongue to reach the lateral interstice of this organ where it ramifies with the lingual nerve. It receives, in the guttural region, an anastomotic branch from the first cervical pair. Towards the base of the tongue it gives off a distinct branch to the genioglossus muscle.

Ganglion cervicale craniale

Chauveau and Arloing (1905) state that the Ganglion cervicale craniale is long and fusiform. It gives off filaments to the vagus nerve and middle cervical ganglion.

MATERIAL AND METHODS

Eighteen pigs of both sexes and different breeds were used. Eleven were embalmed according to the usual procedure followed by the Department of Anatomy of Iowa State University. The animals were first anesthetized with pentobarbital sodium. After cannulation of the left or right common carotid artery was accomplished, the animals were bled through the cannula. Using the same passage, the embalming solution, consisting of: 60% isopropyl alcohol, 4% formaldehyde, 6% liquid phenol, 2.5% corn syrup (50% water) and 27.5% water, was injected. The embalmed animals were placed in a refrigerator for a variable period of days.

The head and part of the neck were cut off from the rest of the body at the level of the third cervical vertebra. The specimens were kept in the refrigerator between dissections until such time as it became necessary to transfer them into containers with a 5% formaldehyde solution.

The following dissection method was used:

1. Dissection of the superficial lateral nerves - The skin of the head and part of the neck was removed to expose the superficial nerves, mainly the R. buccalis dorsalis, R. buccalis ventralis, N. auriculopalpebralis and their branches and plexuses. The dorsal portion of the

parotid gland was then dissected as the N. auriculotemporalis of the N. trigeminus and the branches coming off of the N. facialis at the stylomastoid foramen were identified. The origins of the N. auriculopalpebralis, N. auricularis posterior, N. auricularis internus, N. digastricus and R. colli were noted and their patterns recorded. The N. infraorbitalis, its branching, ramification and connections with the branches of the N. facialis were observed. At the ocular region, several fine twigs were dissected and their identifications postponed until the dissection of the orbital nerves was accomplished. Finally, the nerves of the lateral mandibular region were studied, such as the Nn. mentales and branches of the R. buccalis ventralis. The large plexus formed by the latter together with the R. buccalis dorsalis and N. buccalis was studied. After this last observation this phase of the dissection was completed.

2. Dissection of the deep lateral nerves - In order to extend the observations to the deep lateral nerves the following procedure was necessary: the R. buccalis dorsalis, R. buccalis ventralis and R. transversus faciei were cut and reflected. The cutaneus faciei and masseter muscles were completely removed. The latter was detached from its mandibular and zygomatic insertions.

The zygomatic arch was removed with a hand saw. The mandible was then disconnected from its medial muscular insertions, disarticulated from the temporal bone and was partially removed by making a frontal section passing immediately in front of the first molar tooth. In 4 specimens the N. mandibularis alveolaris was followed inside the mandibular canal which was exposed by chiselling from the lateral side. After removing a large amount of fat from the exposed area, the N. lingualis, Chorda tympani, N. mandibularis alveolaris, N. mylohyoideus and the origin of the N. auriculotemporalis were observed. The connections between the N. mylohyoideus and N. facialis and the innervation of the ventral portion of the parotid gland were noted in this region. It was necessary to partially remove the lateral pterygoid muscle to observe the origin of the N. buccalis, N. temporalis profundus and Nn. pterygoidei. The medial pterygoid muscle was also partially removed to observe the course and distribution of the N. hypoglossus and its relationship to the N. lingualis. At this point the course of the N. maxillaris as well as the Rami alveolares maxillares posteriores could be traced. In adult pigs the N. palatinus minor was observed at this stage, but in young animals, it was necessary to remove the well developed maxillary tuberosity in order to observe the nerve. The N. maxillaris was then followed into the infraorbital canal. After dissecting both sides of the head to the above point, it was sawed longitudinally, along the median plane.

3. Dissection from the medial side of the head - The dissection from this side started by removing the Mm. longus capitis and longus colli so as to expose the retropharyngeal region. The courses of the last four cranial nerves, in this region, were studied and their relationship and branching observed. The Ganglion cervicale craniale was exposed and its branches identified. From its dorsal pole, the large N. caroticus internus was followed toward the base of the cranium. Here, the medial wall of the foramen lacerum was removed in order to obtain a complete view, not only of the penetration of the N. caroticus internus but also to observe the exit from the cranial cavity of the N. vagus and N. glossopharyngeus. The N. caroticus internus and its ramifications were followed in the fibrocartilage that covers the foramen lacerum. The dissection then proceeded toward the pharynx and larynx. The Plexus pharyngeus was dissected and the Ramus lingualis of the N. glossopharyngeus was picked up piercing through the hyopharyngeus muscle and followed until it penetrated the tongue. In

the larynx, the N. laryngeus cranialis and N. laryngeus caudalis were dissected and their distribution and termination noted. Finally, the courses of the terminal segment of the N. hypoglossus and N. lingualis were dissected and their relationship and distribution in the tongue studied.

4. Dissection of the nerves of the orbit - In order to dissect the nerves of the orbit, it was necessary to completely remove the temporal muscle and the external ear. The brain was also removed and at this time the apparent origins of the cranial nerves were studied. The nerves of the orbit were approached from the dorsal aspect, initially. The medial bony wall of the orbit was removed with a Strycker saw. For this removal two frontal sections were made: the first passed just caudal to the supraorbital foramen toward the anterior margin of the optic foramen; the second passed from the occiptal bone, following the petrosal crest, to the lateral portion of the foramen lacerum. Using a bone chisel and a pair of pliers, the apex of the orbit as well as the optic canal, orbitorotundum foramen and the anterior and lateral portions of the foramen lacerum were opened, permitting adequate room for dissection of the nerves. The first to be followed was the N. trochlearis which was dissected

from its penetration in the tentorium cerebelli to the dorsal oblique muscle. The dissection of the Ganglion trigeminale was made. Then the branches of the N. ophthalmicus were followed through the orbit and nasal cavity as in the case of the N. ethmoidalis. Following the dissection of the N. ophthalmicus, the proximal portions of the N. oculomotorius and N. abducens were studied. The study of the orbital nerves was then completed from a lateral approach in which the N. oculomotorius and N. abducens were dissected to their terminations. From this side the branches of the N. maxillaris to the orbit were seen. The Ganglion ciliare and its branches also merited study from this side as well as from the dorsal side.

Photographs were taken throughout the dissection and drawings were made from specimens which represented the most frequently observed pattern.

The topographical anatomy of the cranial nerves was studied by way of transverse serial sections. In one specimen, the head was cut from the body at the 3rd cervical vertebra and fixed to a square board. It was placed in a freezing compartment about 72 hours. After the head was frozen, six transverse sections of approximately one inch in thickness were cut. The sections were photographed and then fixed in 10% formaldehyde solution and later dissected. The positions of the nerves and other structures were determined in the photographic prints which were retouched to better demonstrate the nerves and associated structures. In order to more easily dissect the intraosseous courses of the N. trigeminus, N. facialis, N. vestibulocochlearis, N. glossopharyngeus and N. vagus, four specimens were decalcified in a 20% hydrochloric acid bath for about 45 days. For this, the heads were sawed along the median plane, the mandible was removed and a frontal section separating the cranium from the face was made. Only the piece containing the segments of the nerves under consideration was dropped into the decalcifying solution. The bones, being softened, allowed easier dissection. The nerves became more firm and resistant to traction during the dissection.

Two heads were obtained from specimens used by the Department of Anatomy in gerontological studies. The following structures, taken from the two heads, were studied histologically: G. ciliare, G. oticum, G. pterygopalatinum, G. submandibulare and N. lingualis. The tissues were fixed, embedded and cut in the usual manner and stained with hematoxylin and eosin and Weigert-Heidenhain-Van Gieson stain.

RESULTS

<u>Nn. olfactorii</u>

The study of the origin, course and distribution of the <u>Nn. olfactorii</u> as well as the extension and limits of the olfactory mucosa is being made separately involving both the microscopic and macroscopic aspects.

<u>N. opticus</u>

The optic tracts joined together to form the optic chiasm and from it the <u>N. opticus</u> arose. After a short course it traversed the optic canal and foramen to reach the apex of the orbital cavity. At the orbital cavity the <u>N. opticus</u> was surrounded throughout the course by the cranial meninges. It ran at first dorsolaterally then bent slightly dorsoanteriorly to reach the eyeball. The <u>N. opticus</u> was related to the rétractor bulbi muscles and, on its dorsal aspect, with the ophthalmic artery and the ciliary nerves. Laterally it was crossed by the <u>N. oculomotorius</u>. The <u>G. ciliare</u> was placed on its ventrolateral surface, at its proximal curvature in the orbit. The <u>Ganglion ciliare accessorius</u>, when present, was located on the dorsolateral surface of the <u>N. opticus</u>, at its distal curvature.

N. oculomotorius

The N. oculomotorius (Figures: 3/33, 7/33 and 8/12) was the largest of the nerves to the extrinsic muscles of the eye. It emerged on the ventral side of the cerebral peduncle, at the border of the interpeduncular fossa, and coursed forward and outward to perforate the dura mater at the ventral attachment of the tentorium cerebelli, ventrally to the tentorial segment of the N. trochlearis. The N. oculomotorius left the cranial cavity through the orbitorotundum foramen in company with the N. maxillaris, N. ophthalmicus, N. abducens, and N. trochlearis. At the orbital apex it was related medially with the N. nasociliaris and divided into the R. dorsalis and R. ventralis. The site of bifurcation was variable. More often it occurred before the nerve had reached the oculi muscles, whereas in other instances, the division took place at the ventral surface of the dorsal rectus muscle. The R. dorsalis was very short in length and penetrated, immediately, the dorsal rectus muscle. Some of its fibers perforated the latter to innervate the levator palpebrae superioris muscle. The R. ventralis (Figures: 3/33 and 8/12) was thicker. It dipped between the N. opticus and the retractor bulbi muscles to course along the ventrolateral surface of the

N. opticus where it gave off short branches to the internal surface of the medial and ventral rectus muscles. Fibers (Radix oculomotoria) to the G. ciliare were dedetached from the R. ventralis together with those to the ventral rectus muscle. The R. ventralis continued rostrally and passed on the lateral surface of the ventral rectus muscle to end in the ventral oblique muscle. In some cases the R. ventralis, instead of coursing over the dorsolateral border of the ventral rectus muscle, traversed the structure of the latter in order to reach the ventral oblique muscle.

Ganglion ciliare

The Ganglion ciliare (Figure 13/8) was located on the ventrolateral surface of the N. opticus at its first curvature in the orbital cavity. It was connected to the R. ventralis of the N. oculomotorius by means of several radicles - the Radix oculomotoria. The distance between the ganglion and the R. ventralis of the N. oculomotorius was variable. In some specimens the ganglion was situated very close to the nerve, whereas in others they were up to 5 mm. apart. Usually, the ganglion was round, 1 or 2 mm. in diameter, and circumscribed by a neural plexus. However, elongated or flat spindle-shaped ganglia were observed. In one specimen the Ganglion ciliare was not found as such, being replaced by a neural plexus. In a large number of specimens, a Ganglion ciliare accessorius was observed, situated on the dorsolateral surface of the N. opticus. It was smaller, 3 to 6 mm. apart from the main ganglion, and associated with the latter by means of one or two connecting twigs. The Ganglion ciliare and also the Ganglion ciliare accessorius gave off two or three slender Nn. ciliares breves (Figure: 9/9) which coursed along the N. opticus to end in the posterior part of the eyeball. The Nn. ciliares breves, in some specimens, were joined by some twigs of the Nn. ciliares longi. The Ganglion ciliare received fibers from a large branch originating from the N. maxillaris - the R. communicans cum. n. oculomotorii (Figures: 3/32, 8/13 and 9/7) which, coursing dorsally, reached the R. ventralis of the N. oculomotorius. Some of its fibers passed over the latter and joining the Radix oculomotoria, reached the Ganglion ciliare. Finally, the Ganglion ciliare received a twig from the N. nasociliaris, the R. communicans cum n. nasociliari, which joined the R. ventralis of the N. oculomotorius at the orbital apex and ended in the ganglion.

N. trochlearis

The N. trochlearis (Figure: 7/15) was a slender fiber bundle that emerged from the anterior cerebellar peduncle close to the corpora quadrigemina. It coursed laterally around the lateral part of the pons, continued ventrally and penetrated the tentorium cerebelli a little above the N. trigeminus. The nerve coursed in the edge of the tentorium cerebelli which in some cases did not constitute a complete canal for the nerve thus missing in some points parts of its wall. In the tentorium cerebelli the nerve released a relatively strong branch, the R. meningeus, which, after a recurrent course, disappeared in the structure of the dura mater. The N. trochlearis left the cranial cavity through the upper portion of the orbitorotundum foramen. Coursing over the insertion of the dorsal rectus and levator palpebrae superioris muscles it reached the dorsal surface of the posterior third of the dorsal oblique muscle. Here it divided into two or three branches which disappeared grossly into the lateral border or dorsal surface of the latter muscle.

N. trigeminus

The N. trigeminus emerged from the lateral aspect of the pons by means of two roots - the large Radix sensoria (Figure: 7/2) and the small Radix motoria (Figure: 7/1). The Radix sensoria ran forward to reach the G. trigeminale (Figure: 7/4) which was placed laterally to the hypophyseal fossa and covered, in part, the foramen lacerum. The Radix motoria crossed underneath the ganglion to constitute part of the N. mandibularis. From the G. trigeminale most of the fibers coursed forward into the orbitorotundum foramen and gave rise to the N. maxillaris and N. ophthalmicus, whereas a portion of them joined the N. mandibularis constituting the great part of its bulk. Other fibers, after a short recurrent course, penetrated dorsally the meninges and constituted the R. meningei.

The N. mandibularis (Figures: 3/11, 5/20 and 7/3) left the cranial cavity through the lateral portion of the foramen lacerum. At its exit the nerve was flat, large and covered the anterolateral portion of the bulla tympanica. It ran downward, forward and a little outward, at first between the bulla tympanica and the lateral pterygoid muscle and then on the dorsal surface of the medial pterygoid muscle where it divided into two terminal branches - the N. lingualis and N. alveolaris mandibularis.

Immediately after leaving the foramen lacerum the N. mandibularis gave off three nerves on its dorsal aspect. The N. buccalis was the anterior one whereas the N.

masseterics and the N. temporalis profundus emerged by means of a common trunk.

The N. buccalis (Figures: 1/10, 2/17 and 3/16), after its origin, traversed, in part, the structure of the lateral pterygoid muscle to run between the latter and the lower portion of the temporal muscle. At the pterygoid crest it sent off a small twig to the temporal muscle. Then the nerve curved, in a twisted manner, around the maxillary tuberosity where it was joined by the buccal artery and vein. On its course the N. buccalis furnished twigs to the buccal glands and split into several branches which, piercing through the buccinator muscle, ramified in the mucosa of the cheek. Before entering the buccinator muscle the nerve sent off a branch which connected with the N. buccalis ventralis near the buccal commissure. The N. buccalis furnished, near its origin, the N. pterygoideus lateralis, a small twig that penetrated the posterior border of the lateral pterygoid muscle.

The N. massetericus (Figure: 3/13) ran outward at the anterior surface of the temporomandibular articulation and, crossing over the mandibular notch, reached the deep surface of the masseter muscle in which it ramified.

The N. pterygoideus medialis arose from the anterior border of the N. mandibularis. This nerve followed the course of its parent trunk, behind and parallel with the pterygoid crest to reach the medial pterygoid muscle close to its insertion on the pterygoid process of the sphenoid bone.

The lateral branch resulted from the bipartition of the N. mandibularis was the N. alveolaris mandibularis (Figures: 3/19 and 5/22). After a short course it gave off the N. mylohyoideus and penetrated the mandibular foramen. Inside the mandibular canal the N. alveolaris mandibularis gave off the Nn. mentales (Figures: 1/14 and 3/25). These nerves, usually two in number, after a short course inside the canal traversed the mental foramina and were distributed in the skin of the lower jaw. Some branches of the Nn. mentales anastomosed with the terminal branches of the R. buccalis ventralis and R. marginalis mandibulae. The N. alveolaris mandibularis also furnished the R. alvolares mandibulares caudales, R. alveolares mandibulares medii and the R. alveolaris mandibularis rostralis. The latter gave off the R. dentales for the canine and incisor teeth. The premolar and molar teeth received their innervation by means of the R. dentales which were furnished by the Plexus dentalis mandibularis. The latter was formed from the anastomoses between the R. alveolares mandibulares caudales and R. alveolares medii. The plexus also gave off the R. gingivales mandibulares to the gum.

The N. mylohyoideus (Figure: 3/20) arose just before the N. alveolaris mandibularis entered the mandibular foramen. At first the nerve ran along a slight groove in the ramus of the mandible and then on the dorsal face of the medial pterygoid muscle close to its mandibular insertion. At the rostral margin of the muscle the N. mylohyoideus divided into two branches, the R. medialis (Figure: 3/23) and R. lateralis (Figure: 3/22). The latter sharply curved ventro-aborally to course parallel with the external maxillary artery where periarterial sympathetic fibers were incorporated in the nerve. The R. lateralis then crossed laterally the belly of the digastric muscle where several twigs, R. parotidei ventrales, were released to the deep face of the ventral portion of the parotid gland. At this point it crossed the R. buccalis ventralis of the N. facialis with which some fibers were exchanged. The ramus finally passed through the lower portion of the cutaneus faciei muscle and was distributed to the skin of the corresponding region. The R. medialis was the direct continuation of the N. mylohyoideus. It coursed forward on the ventrolateral surface of the mylohyoid muscle, medially to the digastric muscle. Both muscles received their innervation from this ramus. At the anterior border of the mylohyoid muscle the R. medialis pierced the superficial fascia of the anterior portion of the intermandibular space.

The N. lingualis (Figures: 3/17, 4/2 and 5/21) was the medial branch of the terminal division of the N. mandibularis. After separating from the N. alveolaris mandibularis it passed over the medial pterygoid muscle near its medial insertion. The Chorda tympani, which left the petrobasilar canal and crossed beneath the N. mandibularis, became associated with the N. lingualis near its origin. On the dorsal surface of the medial pterygoid muscle the N. lingualis furnished the R. isthmus faucium (Figure: 3/18) which innervated the buccal glands and mucosa of the isthmus faucium. In one specimen a minute ganglion had been observed associated with this branch. At the anterior border of the medial pterygoid muscle, or a little forward, the N. lingualis sent off the slender N. sublingualis (Figure: 4/2) which coursed forward on the ventral border of the dorsal portion of the sublingual gland. Then it ran between the dorsal and ventral portions of the gland and, following the course of the mandibular duct, finally pierced the submucosa of the anterior floor of the mouth. Some twigs originated from the N. sublingualis to both portions of the sublingual gland. The N. lingualis then described a medial curvature around the anterior border of the medial pterygoid muscle. Here the N. lingualis emitted a series of fibers which terminated in the Ganglion submandibulare, located at the lateral side of the mandibular duct. On its course the N. lingualis was related to the dorsal portion of the sublingual gland and the anterior border of the hyoglossus muscle and just behind the latter the nerve divided into a medial and lateral branch. The R. lateralis was the actual continuation of the trunk. The R. medialis soon divided into two or three branches which reached the dorsum of the middle third of the tongue running between the hyoglossus and genioglossus muscles. Connections between this branch and the N. hypoglossus were present. The R. lateralis, after a short course, split into several branches which also ran between the two above cited muscles to the anterior third of the tongue. Some connecting branches with the N. hypoglossus were also present.

The N. auriculotemporalis (Figures: 2/11 and 3/12) detached from the posterior border of the N. mandibularis a little before the origin of the N. alveolaris mandibularis and the N. lingualis. It ran backward and then outward around the posterior border of the ramus of the mandible, covered by the parotid gland, to split into a variable (two to four) number of branches. Some of these branches supplied areas of the cheek skin whereas others anastomosed with branches of the R. buccalis dorsalis and the N. auriculopalpebralis of the N. facialis, constituting an intricate plexus, the Plexus parotideus. The branches given by the N. auriculotemporalis were as follows:

Ramus transversus faciei (Figures: 1/6 and 2/5) - It is a branch having a variable arrangement. In the majority of the cases, it divided into two groups of twigs, the dorsal one, following the vessels of the same name, ramified in the skin of the cheek and anastomosed with the R. palpebralis of the R. buccalis dorsalis. The ventral group united with a twig from the Ramus buccalis dorsalis and, after piercing through the cutaneus faciei muscle, it ramified in the skin of the masseteric region. In other instances the R. transversus faciei did not divide into dorsal and ventral groups but remained as a single nerve trunk which coursed with the transverse facial vessels and ramified in the skin of the cheek region. In one specimen the R. transversus faciei anastomosed with the R. zygomaticus of the N. auriculopalpebralis and from this combined trunk a twig was given off and ran parallel to the dorsal twig of the R. transversus faciei. In the other cases the coarse dorsal branch of the R. transversus faciei, after coursing together with the transverse facial vessels, joined the R. zygomaticus of the R. buccalis dorsalis.

A strong anastomotic branch was often seen joining the R. buccalis dorsalis after passing under the transverse facial artery.

The R. caudalis exchanged several twigs with the N. auriculopalpebralis and some of them passed directly to the dorsal portion of the parotid gland as R. parotidei dorsalis (Figure: 2/4). The R. caudalis then bent dorsally under the parotid gland to join the auricular branch of the N. auriculopalpebralis.

N. maxillaris - It was the largest division of the N. trigeminus. It left the cranium through the orbitorotundum foramen and coursed along the pterygopalatine fossa to enter into the infraorbital canal. At the pterygopalatine fossa it gave off from its dorsal aspect the R. zygomaticofacialis (Figures: 3/30, 7/6, 8/10 and 9/4) and the R. zygomaticofacialis accessorius (Figures: 3/31 and 8/11) which were closely associated. They perforated the periorbita and coursed on the external surface of the lateral rectus muscle along the lateral wall of the orbit. Near the orbital ligament the R. zygomaticofacialis broke up into three or four branches which reached the skin of the lower lid. The R. zygomaticofacialis accessorius then diverged rostrally from the R. zygomaticofacialis and terminated in the skin adjacent to the medial canthus of the eye. Although variable in the specimens dissected, the N. maxillaris contributed with some fibers to the formation of the R. zygomaticotemporalis of the N. ophthalmicus. Close to the origin of the R. zygomaticofacialis and R. zygomaticofacialis accessorius, the N. maxillaris gave off the R. communicans cum n. oculomotorii (Figures: 3/32, 8/13 and 9/7). This was a strong branch that, emerging from the dorsal aspect of the trunk of the N. maxillaris, reached the R. ventralis of the N. oculomotorius at the dorsolateral border of the ventral rectus muscle. Some of its fibers did not course along the R. ventralis of the N. oculomotorius but crossing it they reached the Ganglion ciliare.

From its lateral aspect the N. maxillaris gave off the R. alveolaris maxillares posteriores. They were two or three in number which, after passing over the internal maxillary artery, penetrated the maxillary tuberosity and innervated the molar teeth (Figure: 3/35).

Before entering the infraorbital canal the N. maxillaris gave off the R. alveolares maxillares medii. They penetrated the infraorbital canal ventrally to the N. maxillaris and formed the Plexus dentalis maxillaris. From the latter the R. dentales maxillaris to the premolar teeth and the R. gingivales maxillares to the gum were given off.

From its ventral aspect the N. maxillaris gave off the N. pterygopalatinus (Figure: 8/3). It ran ventrorostrally and in young animals was covered at the pterygopalatine fossa by the well developed maxillary tuberosity. The nerve received several branches from the Plexus pterygopalatinum and gave off the following nerve at the pterygopalatine fossa:

N. palatinus minor (Figure: 8/4) - It originated from the posterior border of the N. pterygopalatinus and descended in the groove behind the maxillary tuberosity ramifying in the soft palate.

The N. pterygopalatinus then penetrated the corresponding foramen and soon divided into the N. nasalis posterior and N. palatinus major. The former reached the nasal cavity and divided into two branches. The R. medialis ran forward, at first on the lateral side of the nasal cavity, and later on the floor under the mucosa. It sent off fine twigs to the ventral turbinate and pierced the mucosa of the anterior part of the floor of the nasal cavity. The R. lateralis curved around a bony sulcus on the anterior limit of the lateral masses of the ethmoid bone to reach the mucosa of the maxillary sinus as R. sinuum maxillaris.

The N. palatinus major was constituted by the majority of fibers of the N. pterygopalatinus. It ran forward in the palatine canal and was distributed chiefly in the hard palate and gum. It also sent off some twigs to the soft palate.

The N. infraorbitalis was the continuation of the N. maxillaris in the infraorbital canal. Along its course in the infraorbital canal it gave off the R. alveolares maxillares medii.

Before leaving the canal the nerve gave off the R. alveolaris anterior which penetrated the incisor canal and innervated the canine and incisor teeth as well as the corresponding parts of the gum.

As it emerged from the infraorbital foramen the N. infraorbitalis divided into superior, middle and inferior groups of branches.

The superior group was constituted by small branches, the R. nasales externi (Figure: 3/36), which ran forward and upward to the dorsal part of the nose.

The middle group was constituted by usually three strong branches, the R. nasales anterior (Figure: 3/37), which supplied the lateral part of the nostril and snout.

The inferior group was formed by a variable number of branches (four to eight), the R. labiales maxillares (Figure: 3/38). The most posterior branches of this group originated from the N. infraorbitalis in the infraorbital canal and ran forward and downward to the posterior half of the skin of the upper lip. The anterior group of branches was larger than the former and innervated the anterior half of the skin of the upper lip.

N. ophthalmicus - It was the smallest division of the N. trigeminus. It originated at the exit of the orbitorotundum foramen from a common trunk with the N. maxillaris. The N. ophthalmicus, immediately after its origin, divided into three primary branches: N. nasociliaris, N. frontalis and N. lacrimalis. Besides the three main nerves it furnished fibers to the dorsal rectus and levator palpebrae superioris muscles. In some specimens fibers were observed reaching the dorsal oblique muscle. The above muscular fibers reached the external surface of the respective muscles. The N. ophthalmicus also was the main contributor to the formation of the R. zygomaticotemporalis and furnished, in some cases, fibers to the R. zygomaticofacialis and R. zygomaticofacialis accessorius.

The N. nasociliaris (Figure: 7/10) represented the continuation of the N. ophthalmicus in the orbit. It traveled forward and laterally to the N. oculomotorius. Here it gave off one or two branches, the Radix sensoria of the G. ciliare, which, joining the R. ventralis of the N. oculomotorius, reached the G. ciliare. The nerve passed between the dorsal rectus muscle and retractor bulbi muscle and, at the medial border of the latter, it gave off two or three slender Nn. ciliares longi which, coursing over or in the structure of the retractor bulbi muscle, perforated the sclera near the attachment of the optic nerve. The N. nasociliaris then divided into two branches: the N. ethmoidalis (Figure: 7/11) which, after passing between the levator palpebrae superioris and the medial rectus muscle, left the orbital cavity through the ethmoidal foramen in company with the ethmoidal artery. Coursing on a bony sulcus of the upper part of the ethmoidal fossa, it furnished the R. meningeus and reached the medial side of the cribriform plate close to the crista galli. The N. ethmoidalis then left the ethmoidal fossa through a small bony canal, traversed the cribriform plate and reached the nasal cavity. In the latter it coursed rostrally on the dorsal turbinate bone and sent off branches, the R. nasales interni, to the mucous membrane of the dorsal turbinate and septum nasi. The main trunk of the N. ethmoidalis continued forward and terminated as R. nasalis externus which contributed to the innervation of the nostrils. The other branch, resulting from the division of the N. nasociliaris, was the N. infratrochlearis (Figure: 7/12). This nerve ran upwards on the medial surface of the medial rectus muscle, passed below the trochlea for the dorsal oblique muscle and then divided, usually into two branches, the R. palpebrales. Finally these branches, after crossing over the dorsal lacrimal duct, reached the skin of the upper portion of the medial canthus where they were distributed.

The N. frontalis (Figures: 1/7, 2/14, 3/27 and 7/9) emerged from the N. ophthalmicus in a very close association with the N. lacrimalis. It traveled rostrodorsally underneath the periorbita and then at the level of the periorbital ligament it perforated the latter to distribute in the skin of the middle portion of the upper lid. At a level that varied from the orbital apex to the periorbital ligament the N. frontalis divided into the N. supratrochlearis and N. supraorbitalis. The former was usually the smaller and was medially located whereas the N. supraorbitalis represented the continuation of the N. frontalis and was laterally located. The N. frontalis, in some cases, presented a slender communicating branch with the N. lacrimalis. It released fibers to the dorsal oblique and dorsal rectus muscles which end in the lateral border of the former and external surface of the latter.

The N. lacrimalis, after a short course, divided into two or three branches and ascended the orbit on the dorsal surface of the dorsal rectus and lateral rectus muscles (Figures: 3/28, 7/8 and 8/8). On their course the most lateral branch of the N. lacrimalis received a branch from the R. zygomaticotemporalis. Usually the smallest branch penetrated the lacrimal gland whereas the others reached the skin of the lateral portion of the upper lid and adjacent area where they were distributed.

The R. zygomaticotemporalis (Figures: 3/29, 7/7 and 8/7) was observed detaching from the lateral aspect of the N. ophthalmicus and coursing on the lateral face of the lateral rectus muscle. After perforating the periorbit it reached the skin of the lateral canthus of the eye. In a few specimens it sent off a branch which anastomosed with the N. lacrimalis.

Ganglia pterygopalatina

The Ganglia pterygopalatina (Figure: 9/1) were located on the wall of the pterygopalatine fossa and covered laterally by the N. maxillaris and N. pterygopalatinus. They were four to eight in number, small greyish ganglia, united by a large number of fibers giving the appearance of a large plexus. The plexus was connected by several twigs with the N. maxillaris and N. pterygopalatinus and its branches. A large number of fibers had originated from the dorsal margin of the plexus and coursed dorsally to reach the periorbit in which they penetrated. The N. canalis pterygoidei after emerging from the pterygoid canal coursed dorsally and was distributed in the posterior margin of the plexus (Figures: 8/5 and 9/2).

Ganglion oticum

The Ganglion oticum was found, inconstantly, on the rostromedial side of N. mandibularis, near the origin of the N. buccalis. It had an irregular semilunar shape and closely adhered to the N. mandibularis by means of several twigs and received the N. petrosus minor from the N. facialis. It sent off fibers to the N. auriculotemporalis, N. lingualis and N. mandibularis, traversed the ganglion and, after coursing caudally through the lateral portion of the foramen lacerum, penetrated the middle ear cavity and was distributed in the tensor tympani muscle.

Ganglion submandibulare

The Ganglion submandibulare (Figure: 4/4) was found to be a small, round, yellowish node, 2 to 3 mm. in diameter. It was located on the dorsal aspect of the submandibular duct where the latter crossed the medial surface of the caudal end of the sublingual gland. The N. lingualis, after passing over the medial pterygoid muscle, furnished 5 to 10 fine twigs to the Ganglion submandibulare, the R. communicantes cum n. linguali (Figure: 4/3). The fibers originated from the ventral border of the N. lingualis and, coursing ventrally, terminated in the ganglion. The ganglion emitted several R. glandulares (Figure: 4/5) to the submandibular gland which traveled caudally along the submandibular duct and penetrated the hylus of the gland. The ganglion also released fibers to the sublingual gland.

N. abducens

The N. abducens (Figures: 7/14 and 9/5) arose from the medulla ablongata just laterally to the pyramid and behind the pons. It coursed forward on the floor of the cranial cavity and crossed obliquely to the ventral surface of the pons. Piercing through the dura mater the N. abducens traversed the rete mirabile cerebri of the internal carotid artery where it received fibers from the N. caroticus internus. The nerve coursed medially to the N. trigeminus, in company of which it left the cranial cavity through the orbitorotundum foramen. In the orbit the N. abducens passed dorsally over the N. maxillaris and in front of the N. ophthalmicus. It then gave off branches to the dorsal and ventral portions of the retractor bulbi muscle. Near the orbital insertion of the lateral rectus muscle the nerve divided into two main branches and reached the internal face and medial border of that muscle. Fibers from the N. lacrimalis were observed joining the terminal branches of the N. abducens. In one case, the N. abducens furnished a large branch which penetrated the ventral rectus muscle, in company with branches of the R. ventralis of the N. oculomotorius.

N. facialis

The N. facialis arose from the brain immediately behind the pons at the lateral part of the Corpus trapezoideum and was soon related with the N. vestibulocochlearis. Together they reached the internal acoustic meatus of the temporal bone. At the latter the N. facialis diverged dorsorostrally and entered the facial canal. Then the nerve ran shortly outward and upward to course, slightly bent, in a caudal direction. At the genu of the facial canal the nerve bore the Ganglion geniculi which was located on its dorsorostral surface. During the caudal course the nerve was related dorsally with the M. tensor tympani. The nerve again changed its direction to then run directly downward and, after coursing in the stylomastoid fissure, it emerged at the lateral surface of the head. Just before running in the stylomastoid fissure the N. facialis had a close lateral relationship with the M. stapedius. In the stylomastoid fissure the nerve was joined by the R. auricularis of the N. vagus. The N. petrosus major left the Ganglion geniculi and coursed downward and a little forward, passing underneath the Ganglion trigeminale. It traversed the Rete mirabile of the internal carotid artery where it received a small branch, the N. petrosus profundus from the N. caroticus internus. Then it penetrated the pterygoid canal as the N. canalis pterygoidei and, by way of this passage, reached the pterygopalatine fossa to terminate in the Plexus pterygopalatinum.

The Chorda tympani arose from the N. facialis at the upper portion of the stylomastoid fissure and then pursued a recurrent course to reach the tympanic cavity. It traversed the latter from its posterior to anterior wall coursing between the handle of the malleus and the long branch of the incus. After traversing the petrotympanic fissure (which in the pig is a complete canal) it ran forward and downward medial to the N. mandibularis to incorporate finally in the N. lingualis.

After leaving the stylomastoid fissure the N. facialis gave off a series of nerves:

N. auricularis posterior (Figure: 2/3) - It arose from the dorsal edge of the N. facialis at the stylomastoid foramen. Near its origin the nerve divided into a R. rostralis and R. caudalis. Both ran dorsocaudally in company with the posterior auricular artery and the N. auricularis internus, under the parotid gland. They were related deeply first to the M. sternocephalicus and then to the M. brachiocephalicus. The R. caudalis was the smaller and, before penetrating the lateral border of the M. cervicoauricularis profundus, it split into several twigs which innervated the Mm. transversi et oblique auriculae. In two cases the R. caudalis also sent twigs to the M. parotidoauricularis and in one case fibers of the R. caudalis were observed penetrating the M. cervicoauricularis medius.

The R. rostralis coursed dorsally and medially and passed between the auricular fat pad and the ventral surface of the M. cervicoauricularis profundus, where it divided into several twigs which end in the Mm. cervicoauricularis medius and superficialis. In one specimen, one of those twigs anastomosed with others from the caudal branch forming a small plexus. In the same specimen, the R. rostralis also contributed some twigs to the innervation of the M. cervicoauricularis profundus. It was also observed, in some cases, that the R. rostralis innervated the Mm. transousi et oblique articulae.

At a variable level between the temporomandibular articulation and the ventral surface of the M. cervicoauricularis medius, the R. rostralis gave off constantly a branch to the M. helicis retroauricularis (Nikolai) and M. tragicus. This branch passed, depending upon the point of emergence, under the Mm. cervicoauricularis superficialis medius and profundus and around the conchal cartilage of the ear. At the anterior surface of the latter it coursed under the M. scutuloauricularis superficialis and dorsal portions of the M. scutuloauricularis profundus. It then penetrated the hellicine fissure of the conchal cartilage where it released fibers to the M. helices retroauricularis (outer and inner portion) to finally terminate in the M. tragicus (Figures: 1/2 and 2/12).

N. auricularis internus (Figure: 2/1) - This nerve originated at the dorsal edge of the N. facialis together with the N. auricularis posterior. After a short course it divided into two branches: R. lateralis and R. medialis.

The R. lateralis, after crossing laterally the posterior auricular artery under the parotid gland, coursed dorsocaudally and penetrated the base of the conchal cartilage to ramify in the skin of the internal surface of the ear. In some cases the branch split into two twigs before penetrating the cartilage.

The R. medialis ascended toward the conchal cartilage, medial to the posterior auricular artery. At a variable point between the temporomandibular articulation and the base of the conchal cartilage, the R. medialis gave off a twig which followed the latter and divided into two or three small twigs before piercing the medial surface of the conchal cartilage. The main trunk of the R. medialis, coursing dorsally and slightly cranially, was related deeply with the M. cervicoauricularis profundus. Then, it traversed the M. scutuloauricularis profundus near the cartilagineal insertion, before penetrating the conchal cartilage.

Another branch, coming from the trunk of the N. facialis, was found in some specimens coursing upward, lateral to the posterior auricular artery, to penetrate at the notch of the ventral edge of the tragus.

N. auriculopalpebralis (Figure: 2/2) - It originated from the N. facialis in a common trunk with the R. buccalis dorsalis. During its upward course behind the ramus of the mandible the nerve exchanged, in a variable pattern, twigs with the N. auriculotemporalis. At the lateral surface of the M. masseter the nerve divided into the R. auriculares anteriores and R. zygomaticus.

The R. auriculares anteriores (Figures: 1/4 and 2/13) ran upward and divided several times into small twigs which innervated the M. scutuloauricularis superficialis, M. scutuloauricularis profundus and M. frontoscutularis. Some of the twigs anastomosed with those from the R.

zygomaticus and also branches of the N. frontalis and N. lacrimalis.

The R. zygomaticus (Figures: 1/3 and 2/15) coursed toward the lateral canthus of the eye. In some specimens anastomotic twigs were found between this branch and the R. transversus faciei of the N. auriculotemporalis. It finally divided into several twigs, the R. palpebrales, which were distributed to the frontoscutolaris, corrugator supercilli, and orbicularis oculi muscles and upper lid.

The R. buccalis dorsalis (Figures: 1/9, 2/8 and 3/5) emerged between the parotid gland and the masseter muscle and ran on the lateral surface of the latter along the dorsal border of the cutaneus faciei muscle. The nerve sent some twigs to the muscle and a branch which, running dorsally, was distributed in the orbicularis oculi muscle, malaris muscle and lower eyelid. In the majority of the cases it was joined by a branch of the R. transversus faciei. The R. buccalis dorsalis then passed between the depressor palpebrae inferioris and the zygomatic muscle to constitute, together with branches of the N. buccalis and R. buccalis ventralis, an extensive plexus dorsolaterally to the angle of the mouth. In one specimen, the R. buccalis dorsalis sent off a branch which coursed ventrorostrally, passed over the R. buccalis ventralis and terminated in the *M. depressor labii mandibularis*. From this plexus several twigs were given off to the orbicularis oris, depressor labii inferioris, zygomaticus and buccinator muscles. A large branch formed by the *R. buccalis dorsalis* and *R. buccalis ventralis* coursed dorsally and then rostrally and after a short course divided into two main groups of branches. The posterior group crossed ventrally the depressor labii maxillaris and caninus muscles releasing several fibers to them to finally end in the levator labii maxillaris muscle. The anterior group continued its course forward and medially to the tendons of the above muscles to become associated with the *R. nasales anterior* of the *N. infraorbitalis*. At this level some fine branches were given to the levator nasolabialis muscle.

After separating from the *N. facialis*, the *R. buccalis ventralis* (Figures: 1/11, 2/9 and 3/7) passed downward and forward covered by the parotid gland and in front of the mandibular gland and lymph node. Then it coursed in company with the parotid duct. At the ventral border of the masseter muscle it received anastomotic twigs from the *R. lateralis* of the *N. mylohyoideus*. The nerve ran along the ventral border of the masseter muscle and, as soon as it began to course dorsally, gave off the *R. marginalis mandibulae*. The *R. buccalis ventralis*, following the course of the facial vein and parotid duct, sent some twigs to the depressor labii mandibularis cutaneus faciei and buccinator muscles, contributed to the formation of the plexus at the angle of the mouth and finally anastomosed with the R. buccalis dorsalis. The R. marginalis mandibulae (Figures: 1/12 and 3/24), sometimes double, ran forward along the lateral surface of the body of the mandible and divided into several twigs to the ventral portion of the cutaneus faciei, depressor labii inferioris and mentalis muscles. Some of these twigs anastomosed with branches of the Nn. mentales.

R. stylohyoideus (Figures: 2/6 and 3/8) - This branch emerged from the inferior edge of the N. facialis at the petrotympanic fissure. It coursed ventrally on the lateral face of the M. rectus capitis lateralis, crossed caudally the external carotid artery where sympathetic fibers associated with this vessel usually anastomosed with it. The R. stylohyoideus then reached the M. stylohyoideus in which it penetrated the anterior border after coursing on the lateral edge.

R. colli (Figures: 1/1, 2/7 and 3/6) - It emerged from the N. facialis together with the R. buccalis ventralis. It ran laterocaudally piercing through the dorsal portion of the parotid gland where it furnished branches to the deep portion of the parotidoauricularis muscle.

The R. colli, after emerging laterally, terminated in the cutaneus faciei muscle. This branch in some specimens consisted of two fascicles.

N. vestibulocochlearis

The N. vestibulocochlearis emerged from the medulla in close association with the N. facialis and penetrated the internal acoustic meatus where it divided into two parts - Pars vestibularis and Pars cochlearis. The Pars vestibularis was distributed to the utriculus, sacculus and to the ampullae of the semicircular canals. The Pars cochlearis ended at the base of the cochlea where its fibers penetrated and met the Ganglion spirale.

N. glossopharyngeus

The N. glossopharyngeus (Figures: 5/1 and 6/1) was connected by a linear series of roots with the ventro-lateral margin of the medulla. They perforated the dura mater laterally leaving the cranium through the foramen jugulare in company with the N. vagus and N. accessorius. Just outside the cranial cavity the nerve bore the small Ganglion petrosus, an ovoid gray mass which was situated very close to the Ganglion superior of the N. vagus. From the ganglion the slender N. tympanicus emerged and, after a short course, penetrated one small Canaliculus tympanicus in the petrous portion of the temporal bone to reach the tympanic cavity. The N. glossopharyngeus then ran downward and forward behind the bulla tympanica, and crossed laterally the internal carotid artery where it sent off the R. sinus carotici (Figures: 5/2 and 6/2). The latter, in some specimens, received a twig from the Ganglion cervicale craniale and the N. vagus and terminated at the carotid sinus. Then the nerve emitted another branch, the R. pharyngeus (Figures: 5/3 and 6/3) which soon reunited with the R. pharyngeus of the N. vagus and sympathetic fibers from the Ganglion cervicale craniale to constitute the Plexus pharyngeus. The plexus then sent branches to the musculature of the pharynx and soft palate, with the exception of the tensor palatini muscle. The N. glossopharyngeus passed behind the stylopharyngeus muscle and released a short branch to it (Figures: 5/4 and 6/4). The nerve then reached the lateral surface of the pharynx and, after piercing through the hyopharyngeus muscle as the R. lingualis (Figures: 5/5 and 6/5), it penetrated the tongue behind the insertion of the hyoglossus muscle. Here it sent a branch to the mucosa of the pharynx.

N. vagus

The N. vagus (Figures: 5/6, 6/6 and 6/15) originated at the lateral surface of the medulla in close association with the N. accessorius and left the cranium through the foramen jugulare together with the latter and the N. glossopharyngeus. The flat and small Ganglion superior was located at the entrance of the foramen jugulare and from this ganglion a large branch, the N. auricularis, arose. Running outward and a little downward the latter joined the N. facialis in the stylomastoid fissure. Beyond the Ganglion superior the N. vagus ran caudoventrally with the N. accessorius, both forming a fold in which the N. hypoglossus coursed. The nerve crossed laterally the internal carotid artery and here it furnished, by means of a common trunk, the R. pharyngeus (Figures: 5/7 and 6/7) and the N. pharyngoesophageus. The former took part in the formation of the Plexus pharyngeus whereas the N. pharyngoesophageus (Figure: 5/8) traveled caudally on the lateral face of the larynx, sent branches to the thyropharyngeus muscle and finally reached the origin of the esophagus in which musculature it penetrated.

The N. vagus bore a distinct Ganglion inferior (Figures: 5/3 and 6/16) located dorsally to the common carotid artery and larynx. The N. laryngeus cranialis left the trunk of the N. vagus at the level of the Ganglion inferior and coursed ventrally toward the larynx (Figures: 5/10 and 6/17). At the lateral side of the latter it subdivided into two branches. The R. externus (Figure: 5/11) was the smaller and ran parallel to the N. pharyngoesophageus and terminated in the cricothyroid muscle. The other branch, the R. internus (Figure: 5/12), which was the actual continuation of the N. laryngeus cranialis, penetrated the lateral wall of the larynx and innervated the laryngeal mucosa. At a variable distance from the Ganglion inferior the N. vagus joined the sympathetic trunk.

N. accessorius

The N. accessorius (Figure: 3/1) was formed by the Radices craniales and Radices spinales. The latter arose from the lateral aspect of the cervical portion of the spinal cord and the former from the medulla in series with the rootlets of the N. vagus. The N. accessorius left the cranial cavity through the foramen jugulare in company with the N. vagus and N. glossopharyngeus. It ran ventrocaudally associated by a common epineural sheath with the N. vagus. It crossed laterally the internal carotid artery and at that point the nerve divided into R. internus and R. externus. The R. internus again joined the trunk of the N. vagus at the level of the Ganglion inferior. The R. externus coursed laterally between the brachiocephalicus and sternocephalicus muscles where it divided into the R. ventralis and R. dorsalis. The former penetrated at once in the sternocephalicus muscle whereas the R. dorsalis coursed along the lateral aspect of the neck to innervate the trapezius muscle. The R. externus and later the R. dorsalis established anastomosis with the R. ventralis of the N. cervicalis II, III and IV.

N. hypoglossus

The fibers of the N. hypoglossus (Figures: 3/10, 4/6 and 5/16) arose from the lateral surface of the medulla. The nerve left the cranium through the Canalis n. hypoglossi and, at the base of the cranium, was related caudally with the N. vagus and N. accessorius. Then it passed between the R. internus and R. externus of the N. accessorius. Coursing ventrorostrally it described a curve having a slight dorsal concavity. At the upper third of its course it is joined by a branch from the first cervical nerve forming the Ansa cervicalis. The nerve then passed forward in a lateral relationship with the stylohyoid and digastric muscles and medially with the hyopharyngeus and hyoglossus muscles. After sending branches to the hyoglossus and geniohyoid muscles it turned medially around the anterior border of the latter muscle to ascend in the tongue between them. Anastomoses between this nerve and the N. lingualis had been found and were already described.

Ganglion cervicale craniale

The Ganglion cervicale craniale (Figure: 6/8) was a greyish fusiform structure located on the medial side of the common trunk of the internal carotid and occiptal artery. The ganglion measured 14 to 18 mm. in length and 9 to 12 mm. in width and its longitudinal axis was oriented dorsoventrally. The ganglion presented a dorsal and ventral pole. The cranial extremity of the cervical portion of the Truncus sympaticus (Figures: 5/18 and 6/9) was connected with the ventral pole. From the dorsal pole, the coarse N. caroticus internus (Figure: 6/10) was detached and coursed upward, medial to and then in front of the condyloid artery. The nerve reached the medial surface of the tympanic bulla where it ran on a slight bony sulcus. Here the N. caroticus internus divided into several twigs which ran in the fibrocartilage of the foramen lacerus and turning forward they passed through the lateral portion of the rete mirabile cerebri. The most dorsal twigs, usually two in number, crossed on the dorso-medial surface of the accessory tympanic membrane. Inside the rete mirabile cerebri a twig from the N. caroticus internus, the N. petrosus profundus, coursed ventrally and joined the N. petrosus major. The other twigs, coursing medially to the Ganglion trigeminale, ended in the N. maxillaris, N. ophthalmicus and N. abducens. The Ganglion cervicale craniale emitted, from its rostral border, one or two short branches, the R. pharyngi (Figure: 6/11), which, coursing rostroventrally, joined the pharyngeal plexus. It also emitted from the same border the coarse N. caroticus externus (Figure: 6/12) which joined the external carotid artery and was distributed mainly to the external maxillary and lingual arteries. Some fibers from the former joined the R. stylohyoideus. The rostral border of the Ganglion cervicale craniale also gave off a branch which terminated in the N. laryngeus cranialis or in the trunk of the N. vagus, near the Ganglion inferior. From the posterior border, the ganglion furnished, in all specimens, the R. communicans cum n. cervicale prime (Figures: 5/17 and 6/13) which coursed dorsocaudally and terminated in the first cervical nerve. In one specimen, a common branch to the second and third cervical nerve was present. The communicating branch to the first cervical nerve originated together with branches to the occiptal artery (Figure: 6/13). However, a separated origin for both was also found in some specimens. The Ganglion cervicale craniale emitted, from the posterior border, branches to the N. vagus, N. accessorius and N. hypoglossus.

DISCUSSION

The account, that the present investigator gives of the N. opticus, corresponds to that of Nicolas (1924) and Prince et al. (1960).

There is general agreement among the authors (Montane' and Bourdelle, 1920; Martin, 1923; Bruni and Zimmerl, 1951 and Sisson and Grossman, 1953) and the present worker that the N. oculomotorius left the cranial cavity through the orbitorotundum foramen, in company with the N. maxillaris, N. ophthalmicus, N. abducens and N. trochlearis. The present findings concerned with the bifurcation of the N. oculomotorius into the R. dorsalis and R. ventralis and the course and distribution of these branches correspond, in part, with the description given by Winckler (1936) and Prince et al. (1960). It was also shown that the medial rectus muscle received neural supply only on its internal surface. The innervation of both external and internal surfaces, as stated by Winckler (1936), was not observed. The R. ventralis penetrated the ventral oblique muscle after coursing over the dorsolateral border of the ventral rectus muscle. This disposition was the most frequently observed and was in agreement with the description of Winckler (1936) and Prince et al. (1960). However, the R. ventralis, on its way to the ventral oblique muscle, may traverse the structure of the ventral rectus muscle instead of coursing on its dorsolateral border. The retractor bulbi muscle was described by Ellenberger and Baum (1943) as being innervated, in part, by the N. oculomotorius. Kovács and Fehér (1958) affirmed that this nerve did not contribute to the innervation of the muscle. The present study, after careful dissections of this area, revealed no participation of the N. oculomotorius in the innervation of the retractor bulbi muscle. The N. oculomotorius, and later the R. ventralis, contained pre-ganglionic parasympathetic fibers which left the R. ventralis and constituted the Radix oculomotoria of the Ganglion ciliare (Szákall, 1902; Winckler, 1936; and Prince et al., 1960). The N. oculomotorius also received fibers from the N. nasociliaris which traveled along, or was incorporated with, the R. ventralis and reached the Ganglion ciliare amidst fibers of the Radix oculomotoria.

The Ganglion ciliare was constantly found on the ventrolateral surface of the N. opticus, except in one case where it was replaced by a neural plexus. Another ganglion, usually smaller and located cranially to the Ganglion ciliare, was found frequently in the orbital cavity of the pig. The latter was described by Mobilio (1912) and not mentioned by Szákall (1902) or Prince et al. (1960).

In the present study, it appeared in a large number of specimens, was usually 3 to 6 mm. apart from the main ganglion and was called the Ganglion ciliare accessorius because of its proximity and connections with the main Ganglion ciliare. Both ganglia gave off two or three slender Nn. ciliares breves. The Ganglion ciliare received its motor root from the Ramus ventralis of the N. oculomotorius, according to Szákall (1902), Mobilio (1912), Winckler (1936) and Prince et al. (1960). The motor fibers, according to Szákall (1902) may be confused with the sensory root because the latter is located cranially and ventrally to the ganglion. In agreement with Mobilio (1912), two routes for the sensory fibers to reach the Ganglion ciliare may be described. First, they may reach the ganglion by means of the R. communicans cum n. nasociliari. The fibers of this branch left the N. nasociliaris near its origin from the N. ophthalmicus and, joining the R. ventralis of the N. oculomotorius they traveled together to the proximity of the Ganglion ciliare. Here, they separated from the R. ventralis and reach the ganglion amidst the fibers of the Radix oculomotoria. The second course was by means of the R. communicans cum n. oculomotorii, which originated from the N. maxillaris at the pterygopalatine fossa and coursed dorsally to join the

R. ventralis of the N. oculomotorius. Some of its fibers joined the Radix oculomotoria and together they reached the ganglion. The presence of three ciliary ganglia, as was noted in one specimen by Mobilio (1912), was not confirmed by the present study.

The N. trochlearis was reported by Bruni and Zimmerl (1951) as giving off branches to the tentorium cerebelli before penetrating it. The N. trochlearis, in the tentorium cerebelli, also gave off another branch, the recurrent accessory nerve of the tentorium cerebelli, according to Mobilio (1910) as referred to by Mobilio (1912), and Bruni and Zimmerl (1951). In the specimens dissected for the present study, the N. trochlearis coursed around the lateral surface of the pons and penetrated the edge of the tentorium cerebelli. It was observed that no fibers left the nerve at this point to the tentorium as mentioned by Bruni and Zimmerl (1951). Coursing on the edge of the tentorium, the N. trochlearis released a strong branch which was named the R. meningeus, and, after a recurrent course, pierced the dura mater. The recurrent accessory branch of the tentorium cerebelli described by Mobilio (1910) would probably correspond to the R. meningeus. The N. trochlearis left the cranial cavity at the upper portion of the orbitorotundum foramen and, after a short course in the orbital cavity, penetrated the dorsal oblique muscle. The site of termination of the nerve in the dorsal oblique muscle was variable. It terminated in the posterior third of the muscle, in agreement with Winckler (1936) and, in part, with Law (1956). The nerve penetrated the dorsal surface of the dorsal oblique muscle, according to Winckler (1936) and Law (1956). According to Prince et al. (1960), the penetration was made in the supralateral border whereas, Baptista (1944) described it as penetrating the cranial border. Our results indicated that the nerve may penetrate either the dorsal surface or the lateral border.

Apart from the description of Montané and Bourdelle (1920), most authors (Martin, 1923; Ellenberger and Baum, 1943; and Sisson and Grossman, 1953) agreed that the N. mandibularis left the cranial cavity through the foramen lacerus. Montané and Bourdelle (1920) referred to it as the foramen ovale. The recently approved (Hanover, 1963) Pars prima of the Nomina Anatomica Veterinaria, containing the chapter on Osteologia gives a new nomenclature for that area of the base of the cranium. It was decided then to name it simply the foramen lacerum - the anterior part of the large irregular opening in the base of the skull, bounded medially by the occiptal and sphenoid bones, laterally by the petrous portion of the temporal bone, and in front by the temporal wing of the sphenoid bone. Sisson and Grossman (1953) named it the foramen lacerum anterior. The divergence between Montané and Bourdelle (1920) and the other authors cited seems to consist only of nomenclature. They were probably referring to the same foramen.

The innervation of the parotid gland was worked out by Moussu (1889). According to his descriptions there were two routes by which the dorsal and ventral portions of the parotid gland received innervation. The fibers to the dorsal portion traveled with the N. auriculotemporalis, detached from the latter at the level of the mandibular articulation and constituted the superior parotid nerve which then penetrated the dorsal portion of the parotid gland. The ventral portion of the gland received innervation by means of the inferior parotid nerve which originated from the mylohyoid nerve. Our findings are, in part, similar to those of Moussu (1889). However, it seems necessary to point out that the fibers to the dorsal and ventral portions of the parotid gland did not reunite in a single nerve as cited by Moussu (1889), but they instead reached the respective portion of the gland by way of several branches. Thus, the expressions Rami parotidei dorsales and ventrales seem more appropriate than that used by Moussu (1889). According to Montané and Bourdelle

(1920) the _N. mandibularis_ traversed the structure of the pterygoid muscle. This disposition was not observed in our specimens. Here, the N. mandibularis, after leaving the cranial cavity, ran ventrally, at first between the bulla tympanica and the lateral pterygoid muscle where it divided into the _N. lingualis_ and _N. alveolaris mandibularis_. This was the normal way in which the _N. mandibularis_ secured relationships with the lateral and medial pterygoid muscle. Montané and Bourdelle (1920) did not consider the division of the _N. mandibularis_ as a terminal one. They described the _N. lingualis_ as being a collateral branch of the _N. mandibularis_. The subzygomatic plexus described by Montané and Bourdelle (1920) corresponded to the _Plexus parotideus_ of the present study.

The _N. mylohyoideus_ has been studied by Schumacher (1904) and Sauer (1956-57). Our description of this nerve corresponded, in general, with that of these authors. Relative to the innervation of the _M. depressor mandibulae_ (_M. depressor labii mandibularis_), Schumacher (1904) stated that it was made by the _N. mylohyoideus_. Although our results seem to indicate that the _R. marginalis mandibulae_ of the _N. facialis_ was responsible for the innervation of that muscle, there is a chance that fibers of the _N. mylohyoideus_ may reach the _M. depressor labii mandibularis_, by means of the existing connections between the _N._

mylohyoideus and R. buccalis ventralis.

According to McClure and Garrett (1966) the nomenclature of the ophthalmic nerve in the domestic animals, as it exists today in the textbooks, is confusing. The primary reason is that in ruminants, the pig and sometimes the horse, the N. ophthalmicus and N. maxillaris emerge as a common trunk from the cranial cavity through one opening, the orbitorotundum foramen. For the same reason, it seems to us that the nomenclature of the N. maxillaris and its first branches is also confusing, as it is presented in the literature.

An orbital branch given off by the N. maxillaris was described by Montané and Bourdelle (1920), Winckler (1936) whereas Ashton and Oxnard (1958) referred to it as the N. zygomaticus. According to Winckler (1936) the orbital branch supplied twigs to the lateral surface of the lateral rectus, ventral rectus, and ventral oblique muscles. Ashton and Oxnard (1958) reported that the N. zygomaticus was connected with the N. lacrimalis by means of a fine twig and in three specimens the N. zygomaticus was divided into two distinct filaments, while in two other dissections it was split into three filaments. In our dissections, the N. maxillaris was seen giving off two branches which coursed in the orbit very close to each other, but remained separated from the N. maxillaris at their origin. They were named the R. zygomaticofacialis, the caudal branch, and the R. zygomaticofacialis accessorius, the rostral one. The area of distribution of the R. zygomaticofacialis corresponded to that described by Ashton and Oxnard (1958) for the zygomatic nerve. The R. zygomaticofacialis accessorius was distributed to the skin adjacent to the medial canthus of the eye. As already mentioned, Ashton and Oxnard (1958) verified, in three cases, that the N. zygomaticus was divided into two filaments which corresponded to the R. zygomaticofacialis and R. zygomaticofacialis accessorius described in the present study. In our observations in this area, the presence of three filaments as stated by Ashton and Oxnard (1958) and Prince et al. (1960) was not verified. The R. communicans cum n. oculomotorii was a large branch which emerged from the N. maxillaris and joined the R. ventralis of the N. oculomotorius at the dorsolateral border of the ventral rectus muscle. This branch has received very little attention, if any, in the veterinary anatomical textbooks. Mobilio (1912) gave a complete gross anatomical description of it which was entirely confirmed by the present investigations. However, twigs from the R. communicans cum n. oculomotorii directly to the ventral oblique muscle, as described by Mobilio (1912), were not observed in our dissections. Winckler (1936) described twigs of the so-called orbital branch to the lateral surface of the lateral rectus, ventral rectus and ventral oblique muscles. In the present investigations such twigs were not observed. The direct connection between the N. maxillaris and the Ganglion ciliare suggested another route for the sensory fibers from the eyeball to the N. trigeminus. However, only morphological studies associated with physiological experiments could establish the functional characteristics of the neural fibers making up this communicating branch. The statement of Winckler (1936) that the ventral rectus muscle received fibers from the N. maxillaris was not confirmed by the present investigations. The description of Ashton and Oxnard (1958) for the intraosseous course of the N. infraorbitalis was confirmed by the present study, except the ramification of the nerve after leaving the infraorbital canal. According to them, the N. infraorbitalis split into nasal and labial divisions while passing through the infraorbital canal. They further reported that the nasal division then split into s amall superior and bigger inferior nasal branch. The former ramified on the dorsum of the snout. In our findings, as it emerged from the infraorbital foramen, the N. infraorbitalis divided into superior, middle and inferior groups of branches. The superior group constituted the R. nasales externi and corresponded to the superior nasal branch of Ashton and Oxnard

(1958). The middle group was constituted by three strong branches, the R. nasales anterior and corresponded to the inferior nasal branch of Ashton and Oxnard (1958). The inferior group was formed by four to eight branches, the R. labiales maxillares and they corresponded to the labial division of Ashton and Oxnard (1958). According to Chauveau and Arloing (1905) and Montané and Bourdelle (1920), the N. pterygopalatinus divided into anterior, middle and posterior palatine nerves whereas Prince et al. (1960) stated that the N. pterygopalatinus entered the sphenopalatine foramen and gave one branch, the palatine nerve, which entered the palatine canal to reach the hard and soft palates. According to Prince et al. (1960) there did not appear to be a minor palatine nerve. In our observations, the N. palatinus minor was a constant feature. It originated from the N. pterygopalatinus and descended in the groove behind the maxillary tuberosity ramifying in the soft palate. The N. pterygopalatinus penetrated the corresponding foramen and divided into the N. nasalis posterior and N. palatinus major. The latter ramified in the hard palate and gums whereas the former reached the nasal cavity where it innervated the mucosa of the ventral turbinate and maxillary sinus by way of the R. sinum maxillaris.

The term lacrimal nerve, according to McClure and Garrett (1966), was applied only to the branch distributed to the lacrimal gland and occasionally to a very small area of skin related to the gland. The term zygomaticotemporal, according to them, was applied to the branch distributed to the horn and skin between the eye and horn in ruminants and a corresponding area in the horse and pig. The division of the N. lacrimalis into two branches was described by Prince et al. (1960). One coursed dorsally to enter the lacrimal gland and some branches passed into the upper lid. In our results, both nerves, lacrimal and zygomaticotemporal, were present independently of one another. The N. lacrimalis divided into two or three branches which ascended the orbit and usually the smallest branch penetrated the lacrimal gland, whereas the others reached the skin of the lateral portion of the upper lid and adjacent area. The R. zygomaticotemporalis detached from the lateral aspect of the N. ophthalmicus and was distributed to the skin of the lateral canthus of the eye. Thus, the concept of the N. lacrimalis and the R. zygomaticotemporalis expressed by McClure and Garrett (1966) did not seem to apply effectively to the pig. Ellenberger and Baum (1943) and Sisson and Grossman (1953) affirmed that the N. lacrimalis resembles that of the horse and described it together with the R. zygomaticotemporalis. For the same reasons expressed above, our findings seem to indicate that the N. lacrimalis and R. zygomaticotemporalis of the pig are not comparable with those of the horse. The N. frontalis, in our observations, was well developed and, in the orbital cavity it furnished branches to the dorsal rectus and dorsal oblique muscles, in agreement with previous workers (Winckler, 1936; Bruni and Zimmerl, 1951 and Prince et al., 1960). The N. frontalis divided constantly into two branches which were named the N. supraorbitalis and N. supratrochlearis. Despite the absence of the supraorbital foramen in pigs, the name N. supraorbitalis seems appropriate in view of its distribution and for comparative anatomical reasons. In this aspect the N. frontalis resembles that of the ox as stated by Martin (1923), Ellenberger and Baum (1943, Sisson and Grossman (1953) and Prince et al. (1960). The N. nasociliaris represents the continuation of the N. ophthalmicus in the orbit. Montané and Bourdelle (1920) and Sisson and Grossman (1953) stated that the N. nasociliaris sent numerous filaments to the ocular muscles. In this study, it was not possible to trace fibers from this nerve that would end in the ocular muscles. However, the N. nasociliaris did give off two or three fine Nn. ciliares longi which traversed the structure of the retractor bulbi muscle, and perforated the sclera near the attachment of the optic nerve. Our results confirm the descriptions of Prince et al. (1960) for the Nn. ciliares longi, except for the origin of them. These authors described the Nn. ciliares longi as emerging from the N. ophthalmicus before the orbitorotundum foramen. In the present study, the Nn. ciliares longi are mentioned as originating in the orbital cavity, at the medial border of the retractor bulbi muscle.

The literature search revealed no special article or citation in veterinary anatomical textbooks about the Ganglion oticum for the pig. The Ganglion oticum was inconstant and when present occupied the rostromedial side of the N. mandibularis, near the origin of the N. buccalis. The N. tensoris tympani did not originate from it but only traversed its structure. In some cases the ganglion was replaced by a loose neural plexus.

The gross and microscopic anatomy of the Ganglia pterygopalatina was described by Witmer (1925). He pointed out that there were five to eight ganglia arranged in a chain located close to the bone at the angle formed by the maxillary, lacrimal and orbital portion of the frontal bone. Our results agree with his. The expression Ganglia pterygopalatina was chosen because of the number of small ganglia that are connected by fibers to each other, constituting a plexiform chain. The N. canalis pterygoidei emerged from the pterygoid canal and coursed dorsally toward the posterior margin of the plexus.

The review of literature showed that very little has been written about the cranial ganglia in the domestic animals. About the Ganglion submandibulare, except the commendable work of Catania (1924), no other article has been found for the pig. The ganglion was located on the dorsal aspect of the submandibular duct where it crossed the medial surface of the caudal end of the sublingual gland. In our dissections, the Ganglion submandibulare was not related to the N. hypoglossus as stated by Catania (1924). As far as the efferent and afferent branches of the ganglion and their distribution were concerned, our observations agree with those of Catania (1924).

The N. abducens traversed the rete mirabile cerebri where it received fibers from the N. caroticus internus. The nerve then left the cranial cavity through the orbitorotundum foramen in company with the N. maxillaris, N. ophthalmicus, N. oculomotorius and N. trochlearis. At the orbital cavity it gave branches to the dorsal and ventral portions of the retractor bulbi muscle. This finding was not in agreement with Ellenberger and Baum (1943) who stated that the N. abducens innervated only partially the retractor bulbi muscle, the rest being supplied by the N. oculomotorius. However, our results are supported by Kovács and Fehér (1958) who, studying this area in the pig, stated that the N. abducens not only innervated the lateral rectus muscle but also the retractor bulbi muscle. Moreover, in our specimens, branches of the N. oculomotorius supplying the latter muscle were not found. In one case the N. abducens also supplied the ventral rectus muscle by means of a large branch which penetrated the muscle in company with branches of the R. ventralis of the N. oculomotorius.

The intraosseous course of the N. facialis offered, in the pig, a great analogy with that of the other domestic animals. Here the nerve successively gave off the N. petrosus major, N. petrosus minor, twigs to the stapedius muscle, and the Chorda tympani and was joined by the N. auricularis of the N. vagus. Nikolai (1954) gave a report on the distribution of the N. facialis after its emergence from the stylomastoid foramen. He stated that the N. facialis first gave off two branches, the R. retro-auricularis I and II which in the present investigation correspond to the R. rostralis and R. caudalis of the N.

auricularis posterior, respectively. These two branches, in our dissections, emerged from the N. facialis as a single trunk, the N. auricularis posterior, which then divided into two branches near its origin. From the report of Nikolai (1954) it would appear that the Rr. retroauricularis I and II originated separately from the N. facialis. However, in one of his diagrams they are shown as a single branch, at the origin in the N. facialis. There is a discrepancy as to the ramification and distribution of the branches of the N. auricularis posterior between Nikolai (1954) and the present investigation. According to Nikolai (1954) the R. retroauricularis I was slender, innervated the third layer of muscles (M. cervicoauricularis profundus) and the Mm. transversi et obliqui. The R. retroauricularis II innervated the second layer (M. cervicoauricularis medius) and the M. helicis retroauricularis. In our investigations the R. rostralis, which corresponded topographically to the R. retroauricularis I of Nikolai (1954), was larger, furnished the branch to the M. helicis retroauricularis and innervated the M. cervicoauricularis medius and superficialis. The R. caudalis was responsible for the innervation of the M. cervicoauricularis profundus. The N. auriculopalpebralis originated from the N. facialis in a common trunk with the R. buccalis dorsalis. It divided into the R. zygomaticus and R. auriculares anteriores. Our results correspond, in part, with those of Nikolai (1954) on the distribution of these two branches, despite the different nomenclature used. The R. buccalis dorsalis has received names which vary with the different authors, such as temporo-facial nerve by Chauveau and Arloing (1905), temporal branch by Montané and Bourdelle (1920), dorsal buccal nerve by Martin (1923) and Ellenberger and Baum (1943) and R. bucco-labialis superior by Nikolai (1954). The R. buccalis dorsalis constituted, with branches of the N. auriculotemporal, the Plexus parotideus which was named Plexus subzygomaticus by Montané and Bourdelle (1920). The R. buccalis ventralis has also, as the R. buccalis dorsalis, received several names, such as cervico-facial nerve by Chauveau and Arloing (1905) and Montané and Bourdelle (1920), inferior buccal nerve by Martin (1923), Ellenberger and Baum (1943) and R. bucco-labialis inferior by Nikolai (1954). Our findings, concerning the course and distribution of both the R. buccalis dorsalis and ventralis, corresponded with that of Nikolai (1954).

The N. vestibulocochlearis was formerly named the acoustic nerve. Since it actually was constituted of two functionally different components - one to the vestibule and the other to the cochlea of the inner ear, the *Pars vestibularis* and *Pars cochlearis*, respectively - it is now listed in the *Nomina Anatomica Veterinaria* (cranial nerves part) as the *N. vestibulocochlearis.* A gross anatomical study of this nerve revealed very little of its morphology.

The *N. glossopharyngeus* left the cranial cavity through the foramen jugulare in company with the *N. vagus* and *N. accessorius*. The nerve traversed the dura mater and, according to Frewein (1965) exhibited a spindle-shaped *Ganglion superior* which was enclosed on its caudal and medial aspects by the *Ganglion superior* of the *N. vagus.* He further stated that they appeared to form a uniform node with little connective tissue between them but, they could be separated from one another in carefully prepared specimens. Frewein (1965) also described a second ganglion, the *Ganglion inferior*, which was located in the nerve at the level of the posterior surface of the *Pars tympanica* of the temporal bone. The *N. tympanicus*, according to Frewein (1965) was detached from the *Ganglion inferior* and ran along the medial border of the *N. glossopharyngeus* toward the base of the skull. In our specimens, only one ganglion was found in the *N. glossopharyngeus* and it was named the *Ganglion petrosus*, which was the nomenclature used by Chauveau and Arloing (1891), Ellenberger and Baum (1943) and Sisson and Grossman (1953) for the domestic animals. The Ganglion petrosus was located just outside the cranial cavity and was situated very close to the Ganglion superior of the N. vagus. From the Ganglion petrosus emerged the slender N. tympanicus which, after a short course, penetrated the small Canaliculus tympanicus in the petrous portion of the temporal bone. This description of the Ganglion petrosus corresponded with that given by Frewein (1965) for the so-called Ganglion superior. Additional gross and microscopical investigations are being conducted in this department in order to clarify this controversy. In their account of the N. glossopharyngeus, Montané and Bourdelle (1920) did not mention the presence of any ganglionic structure or the R. sinus carotici.

The N. vagus left the cranial cavity through the foramen jugulare in company with the N. glossopharyngeus and N. accessorius. At the entrance of that foramen it presented the small Ganglion superior which Chauveau and Arloing (1920) named the jugular ganglion. The nerve then coursed with the N. accessorius and furnished, by a common trunk, the R. pharyngeus and the N. pharyngoesophageus. According to Montané and Bourdelle (1920) the fibers to the R. pharyngeus seemed to come exclusively from the internal branch of the N. accessorius. In our observations, this disposition was not as evident as stated by Montané and Bourdelle (1920). The N. vagus bore a well developed Ganglion inferior. At the level of the latter, the N. vagus gave off the N. laryngeus cranialis, in agreement with Montané and Bourdelle (1920) and Grau (1943). At a variable distance from the Ganglion inferior the N. vagus joined the sympathetic trunk.

After leaving the cranial cavity the N. accessorius coursed in association with the N. vagus by a common epineural sheath. The nerve then divided into the R. internus and R. externus. The R. internus again joined the trunk of the N. vagus at the level of the Ganglion inferior. This statement is in agreement with Chauveau and Arloing (1905). The N. accessorius, after releasing the R. internus, became the strong R. externus (Montané and Bourdelle, 1920).

The N. hypoglossus arose from the lateral surface of the medulla and left the cranial cavity through the Canalis n. hypoglossi. The presence of a small dorsal root provided with a small ganglion was described by Luschka (1856), Vulpian (1862) and Chiarurgi (1889). However, according to the latter, they disappeared during ontogenesis and were not found in adults. Beck (1895) studied the dorsal root of the N. hypoglossus in 58 species of mammals, including the pig, and stated that they persisted in adult life, mainly in ungulates. In the specimens dissected, we did not have the opportunity to observe the dorsal roots in the N. hypoglossus. The peripheral connections between the N. hypoglossus and the N. lingualis have been studied by Fitzgerald and Law (1958). According to them, these connections are formed by the union of one or more branches of the N. lingualis with fibers of the medial division of the N. hypoglossus. In the study made by Fitzgerald and Law (1958) the connections were found between the N. hypoglossus and the R. lateralis and R. medialis of the N. lingualis.

Besides the work of Mannu (1914) and Schreiber (1958) no other investigation on the Ganglion cervicale craniale of the domestic animals has been found in the literature. Chauveau and Arloing (1905) stated briefly that the pig had a Ganglion cervicale craniale which was fusiform and very long. At its lower extremity it gave off several filaments, one of which lay beside the N. vagus in the cervical region, but separated from it to join the middle cervical ganglion. The others passed to the tenth nerve, and were confounded with it at the ganglionic enlargement it showed behind the pharynx. Mannu (1914) had studied the cervical sympathetic trunk, including the _Ganglion cervicale craniale_, in the rabbit, horse, ass, mule, goat, sheep, dog and cats. Schreiber (1958) investigated the _Ganglion cervicale craniale_ of the bovine. Our results are, in part, comparable with the description of Chauveau and Arloing (1905).

SUMMARY AND CONCLUSIONS

The origin and distribution of the cranial nerves were studied in the domestic pig. The cranial portion of the autonomic nervous system was also included. A total of eighteen specimens were used. Detailed dissection was performed in 11 specimens using the lateral and medial approaches to expose the nerves. The topographical anatomy of the cranial nerves was re-evaluated at the end of the dissection by doing, in one specimen, frontal serial sections of the head, followed by identification of the nerves and photographic recording. The cranial portion of the autonomic nervous system was studied in four specimens in which bones were previously softened in a 25% hydrochloric acid solution bath. Two specimens were used for histological studies of the ciliary, oticum, pterygopalatine and submandibular ganglions.

The cranial nerves of the pig presented a very stable organization with few variations, and those were observed mainly in the last ramification and the termination branches. They corresponded to the general plan of structure for the domestic mammals, particularly that of the Artiodactyla.

The study of the <u>Nn. olfactorii</u> was not included in the present investigation.

The N. opticus, at the orbital cavity, ran first dorsolaterally and then bent dorsoanteriorly to reach the eyeball. It was related to the retractor bulbi muscles and was crossed laterally by the N. oculomotorius. The Ganglion ciliare was placed on its ventrolateral surface.

The N. oculomotorius originated from the ventral side of the cerebral peduncle, at the border of the interpeduncular fossa. After perforating the dura mater, the nerve left the cranial cavity through the orbitorotundum foramen in company with the N. maxillaris, N. ophthalmicus, N. abducens and N. trochlearis. At a variable site, the N. oculomotorius divided into the R. dorsalis and R. ventralis. The former was shorter and terminated in the dorsal rectus and levator palpebrae superioris muscles. The R. ventralis innervated the medial rectus, ventral rectus and ventral oblique muscles. It also gave fibers to the Ganglion ciliare and the Radix oculomotoria.

The Ganglion ciliare was located on the ventral surface of the N. opticus, at its proximal curvature in the orbital cavity. The Ganglion was connected with the N. oculomotorius by means of the Radix oculomotoria. It measured 1 to 2 mm. in diameter. In a large number of specimens, a Ganglion ciliare accessorius was observed, situated on the dorsolateral surface of the N. opticus.

It was smaller, located 3 to 6 mm. from the main ganglion. It was associated with the latter by means of one or two connecting twigs. The Nn. ciliares breves originated from both ganglia. The Ganglion ciliare also received the R. communicans cum n. nasociliaris. The N. trochlearis emerged from the anterior cerebellar peduncle, close to the corpora quadrigemina. It coursed for a long distance in the tentorium cerebelli where it released the R. meningeus. The nerve ended in the dorsal oblique muscle.

The N. trigeminus had two roots, the Radix sensoria and the Radix motoria. A well developed Ganglion trigeminale was placed laterally to the hypophyseal fossa and covered, in part, the foramen lacerum. From the trunk of the N. trigeminus, several small twigs reached the dura mater as the R. meningei.

The N. mandibularis left the cranial cavity through the lateral portion of the foramen lacerum. Immediately after leaving the foramen lacerum, the nerve gave off the N. buccalis, N. massetericus and the N. temporalis profundus. The N. buccalis traversed the lateral pterygoid muscle, sent a small twig to the temporal muscle, furnished twigs to the buccal glands and split into several branches which, piercing through the buccinator muscle ramified in the submucous tissue of the cheek. The N. buccalis furnished, near its origin, the N. pterygoideus lateralis to the lateral pterygoid muscle. The N. buccalis was also connected with the R. buccalis dorsalis of the N. facialis. The N. massetericus and N. temporalis profundus originated in a common trunk. They innervated the masseter and temporal muscles, respectively. The N. mandibularis also gave the N. pterygoideus medialis to the muscle of the same name and divided into the N. lingualis and N. alveolaris mandibularis. The latter was the lateral branch resulting from the bipartition of the N. mandibularis. After a short course it gave off the N. mylohyoideus and penetrated the mandibular foramen. The N. mylohyoideus divided into the R. lateralis and R. medialis. The R. lateralis coursed outward, exchanged fibers with the R. buccalis ventralis of the N. facialis and terminated in the skin of the lower portion of the masseteric region. The R. medialis supplied the digastric and mylohyoideus muscles and were distributed to the skin of the intermandibular region. The R. mentales were given off by the N. mandibularis alveolaris, inside the mandible. They innervated the skin of the mandibular region and were connected with fibers of the R. marginalis mandibulae. The N. lingualis was the medial division of the N. mandibularis and was joined, at its origin, by the Chorda tympani. The nerve furnished the R. isthmus faucium and the N. sublingualis. At the anterior border of the medial pterygoid muscle, the N. lingualis gave a series of fibers which terminated in the Ganglion submandibulare. Running between the hypoglossus and genioglossus muscle, the N. lingualis reached the dorsum of the anterior two-thirds of the tongue. Connections between the N. lingualis and N. hypoglossus were detected here.

The N. maxillaris left the orbitorotundum foramen to course along the pterygopalatine fossa and entered the infraorbital canal. At the pterygopalatine fossa it gave off the R. zygomaticofacialis and R. zygomaticofacialis accessorius and the R. communicans cum n. oculomotorii. The R. zygomaticofacialis and R. zygomaticofacialis accessorius originated very close together and coursed along the lateral wall of the orbit where they diverged from each other and terminated in the skin of the lower lid and adjacent area. The R. communicans cum n. oculomotorii was a strong branch which joined the R. ventralis of the N. oculomotorius, at the dorsolateral border of the ventral rectus muscle. Some of its fibers, however, passed over the R. ventralis to end in the Ganglion ciliare. Its probable functional significance was discussed. The N. maxillaris gave off from its lateral side, the R. alveolares maxillares posteriores. The N. pterygopalatinus originated from the ventral side of the N. maxillaris and was very wide and thin. In young animals, the nerve was covered by the maxillary tuberosity. It gave off the following nerves: N. palatinus minor, to the soft palate; N. nasalis posterior which penetrated into the nasal cavity and innervated the mucosa of the latter and the maxillary sinus by means of the R. sinum maxillaris and the N. palatinus major which was constituted by the great majority of the fibers of the N. pterygopalatinus. It coursed in the palatine canal and was distributed to the hard palate and gum. The N. infraorbitalis was the continuation of the N. maxillaris in the infraorbital canal where it gave off the R. alveolares maxillares medii and the R. alveolaris anterior. The latter penetrated the incisor canal and innervated the canine and incisor teeth. The N. infraorbitalis left the canal and divided into the R. nasales externi, R. nasales anteriores and R. labiales maxillares which innervated the skin of the nasal region and snout.

The N. ophthalmicus originated at the exit of the orbitorotundum foramen from a common trunk with the N. maxillaris and divided into the N. nasociliaris, N. frontalis, branches to the dorsal rectus, levator palpebrae superioris and dorsal oblique muscle, N. lacrimalis and the R. zygomaticotemporalis. The N. ophthalmicus contributed also, in some specimens, to the formation of the R. zygomaticofacialis and R. zygomaticofacialis accessorius. The N. nasociliaris gave off the slender Nn. ciliares longi and divided into the N. ethmoidalis and the N. infratrochlearis. The N. ethmoidalis traversed the cribiform plate and reached the nasal cavity where it terminated as the R. nasalis externus. The N. frontalis was very large and originated in close association with the N. lacrimalis. The N. zygomaticotemporalis was detached from the lateral aspect of the N. ophthalmicus and, in some cases, together with the N. lacrimalis.

There were 4 to 8 small greyish Ganglia pterygopalatina united by a number of fibers giving the appearance of a large plexus. The latter was connected by several twigs with the N. maxillaris and N. pterygopalatinus and its branches.

The Ganglion submandibulare was a small, round node located on the dorsal aspect of the submandibular duct. It was connected with the N. lingualis by 5 to 10 Rami communicantes cum n. linguali and furnished twigs to the submandibular and sublingual glands.

The Ganglion oticum was found, inconstantly, on the rostromedial side of the N. mandibularis and adhered to it by several twigs. It sent fibers to the N. auriculotemporalis, N. lingualis and N. mandibularis alveolaris.

The N. abducens originated from the medulla and traversed the rete mirabile cerebri where it received twigs from the N. caroticus internus. In the orbital cavity, it divided into two branches which innervated, respectively, the retractor bulbi and lateral rectus muscles.

The N. facialis bore the Ganglion geniculi from which the N. petrosus major originated. The latter received the N. petrosus profundus from the N. caroticus internus, penetrated the pterygoid canal as the N. canalis pterygoidei and terminated in the Ganglia pterygopalatina. In the facial canal the N. facialis also gave fibers to the stapedius muscle and the Chorda tympani. After leaving the stylomastoid fissure the N. facialis gave a series of nerves to the ear and facial musculature. The N. auricularis posterior innervated the M. cervicoauricularis profundus, medius and superficialis. A branch coursing around the conchal cartilage innervated the M. helicis retroauricularis and M. tragicus. The N. auricularis internus divided into two branches before ramifying in the internal surface of the pinna. The N. auriculopalpebralis divided into the R. auriculares anteriores and R. zygomaticus. The former innervated the M. scutulo auricularis superficialis, M. scutuloauricularis profundus and M. frontoscutularis. The R. zygomaticus innervated the M. corrugator supercilli and M. orbicularis oculi. The R. buccalis dorsalis and ventralis were responsible for the innervation of the facial musculature.

The R. stylohyoideus innervated the M. stylohyoideus, whereas in one specimen it also innervated a rudimentary posterior belly of the digastric muscle. The R. colli was distributed mainly in the facial cutaneus muscles. The R. buccalis dorsalis and ventralis, under the parotid gland, were connected with branches of the N. auriculotemporalis constituting the Plexus parotideus. They also were connected with branches of the N. buccalis near the buccal commissure.

The N. vestibulocochlearis emerged from the brain stem close to the N. facialis. It penetrated the internal acoustic meatus and divided into the Pars vestibularis and Pars cochlearis to the utriculus, sacculus and cochlea, respectively.

The N. glossopharyngeus left the cranial cavity in company with the N. vagus and N. accessorius. The nerve presented, just outside the dura mater, the Ganglion petrosus, situated close to the Ganglion superior of the N. vagus. The N. tympanicus arose from the Ganglion petrosus. The N. glossopharyngeus gave off the N. sinus carotici and the R. pharyngeus which soon united with the R. pharyngeus of the N. vagus and Ganglion cervicale craniale to constitute the Plexus pharyngeus. The nerve also furnished the R. stylopharyngeus to the muscle of the same name and continued as the N. lingualis to penetrate the tongue behind the insertion of the hypoglossus muscle.

The N. vagus originated from the lateral surface of the medulla in close association with the N. accessorius. The Ganglion superior was located at the foramen jugulare and the R. auricularis emerged from it. The N. vagus coursed together with the N. accessorius. It gave, by way of a common trunk, the R. pharyngeus and N. pharyngoesophageus. At the origin of the N. laryngeus cranialis, the Ganglion inferior was present. At a variable distance from the Ganglion inferior, the N. vagus joined the Truncus sympaticus.

The N. accessorius was constituted by the Radices craniales and Radices spinales. The nerve, after coursing together with the N. vagus, divided into the R. internus and R. externus. The former again joined the N. vagus, at the level of the Ganglion inferior, and the latter coursed on the lateral surface of the neck and terminated in the trapezius muscle.

The N. hypoglossus left the cranial cavity through the hypoglossal canal, coursed caudally to the N. vagus and N. accessorius, and passed between the R. externus and R. internus of the N. accessorius. It then was connected by a branch of the first cervical nerve forming the Ansa cervicalis. After sending branches to the hypoglossus and genioglossus muscles it penetrated the tongue.

Due to the absence of reports in the literature about the Ganglion cervicale craniale in the pig, it was also included in the present investigation. The ganglion was present as a greyish fusiform structure located on the medial side of the common trunk of the internal carotid and occiptal arteries. From the dorsal pole of the ganglion the coarse N. caroticus internus was detached. From its rostral border, the ganglion emitted the R. pharyngi, N. caroticus externus and a branch to the N. vagus. The R. communicans cum n. cervicale prime was detached from the posterior border. In one specimen, a branch to the second and third cervical nerves was present.

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ILLUSTRATIONS

FIGURE 1. Nerves of the superficial lateral surface of the head (semischematic)

A	Glandula parotis	N	M. caninus
B.	M. helicis retroauricularis	O	M. levator nasolabialis
C	M. scutuloauricularis superficialis	P	M. masseter
D	M. tragohelicinus	Q	Ductus parotideus
E	M. tragicus	R	V. facialis
F	M. parotidoauricularis	S	M. zygomaticus
G	M. interscutularis	T	M. cutaneus faciei
H	M. frontoscutularis	U	M. orbicularis oris
I	M. corrugator supercilii	V	M. depressor labii mandibularis
J	M. orbicularis oculi	W	M. mentalis
K	M. malaris	X	M. trapezius
L	M. levator labii maxillaris	Y	M. brachiocephalicus
M	M. depressor labii maxillaris	Z	M. omotransversarius
1	R. colli (N. facialis)	8	R. zygomaticus (N. facialis)
2	N. auricularis posterior	9	R. buccalis dorsalis
3	R. zygomaticus (N. auriculopalpebralis)	10	N. buccalis
4	Rr. auriculares anteriores	11	R. buccalis ventralis
5	Communicating branch of 6 to 3	12	R. marginalis mandibulae
6	Branches of R. transversus faciei	13	R. nasalis externus
7	N. frontalis	14	Nn. mentales
		15	R. lateralis (N. mylohyoideus)

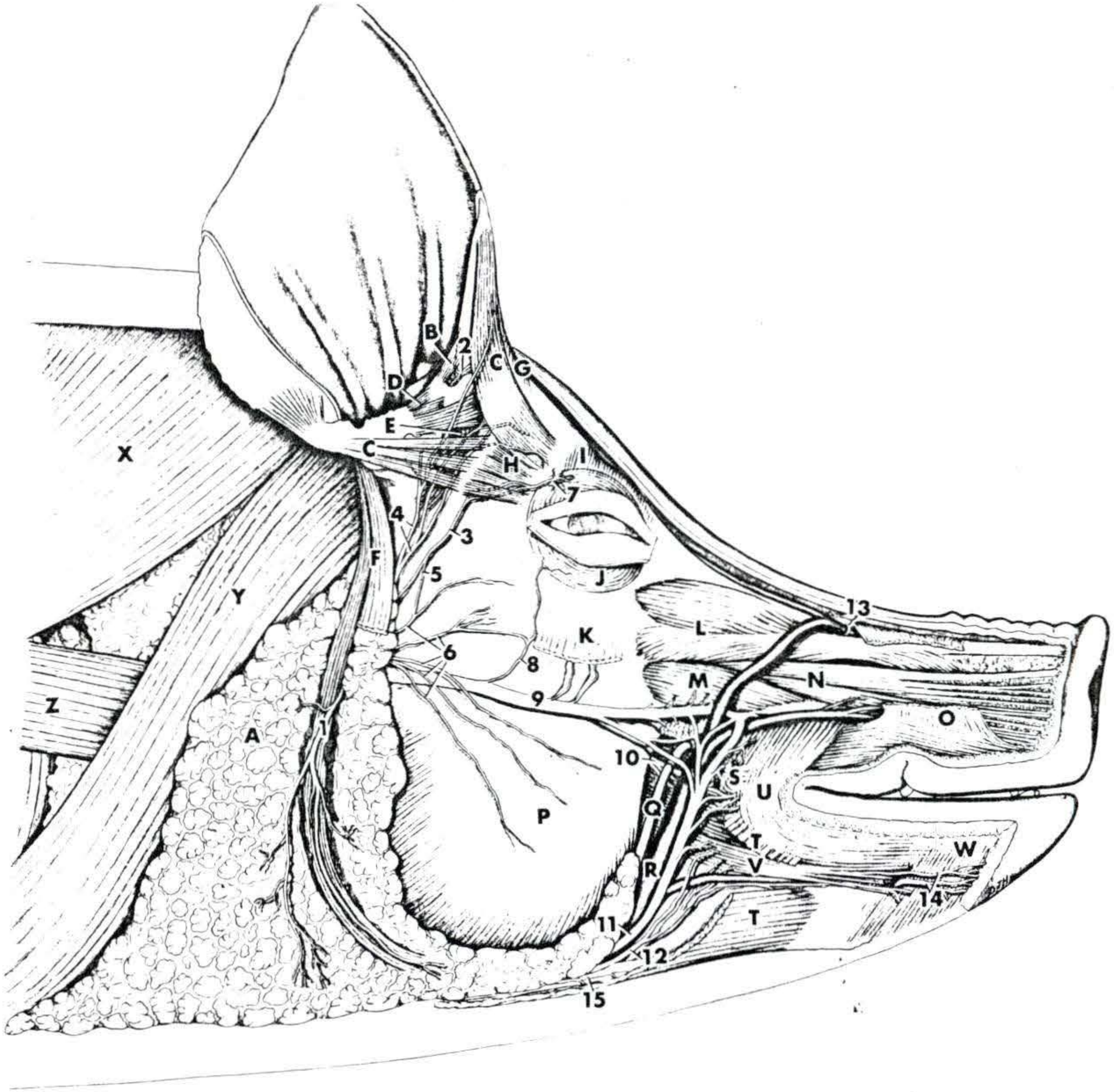
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FIGURE 2. Nerves of the face and ear (semischematic)

A Pinna
B Cartilago annularis
C Processus zygomaticus (Os temporalis)
D Foramina lacrimalia
E Foramen infraorbitalis

1 N. auricularis internus
2 N. auriculopalpebralis
3 N. auricularis posterior
4 Rr. parotidei dorsales
5 R. transversus faciei
6 R. stylohyoideus
7 R. colli
8 R. buccalis dorsalis
9 R. buccalis ventralis
10 Communicating branch of 11 to 2
11 N. auriculotemporalis
12 N. auricularis posterior (muscular branch)
13 Rr. auriculares anteriores (N. auriculopalpebralis)
14 N. frontalis
15 R. zygomaticus (N. auriculotemporalis)
16 R. zygomaticus (N. facialis)
17 N. buccalis

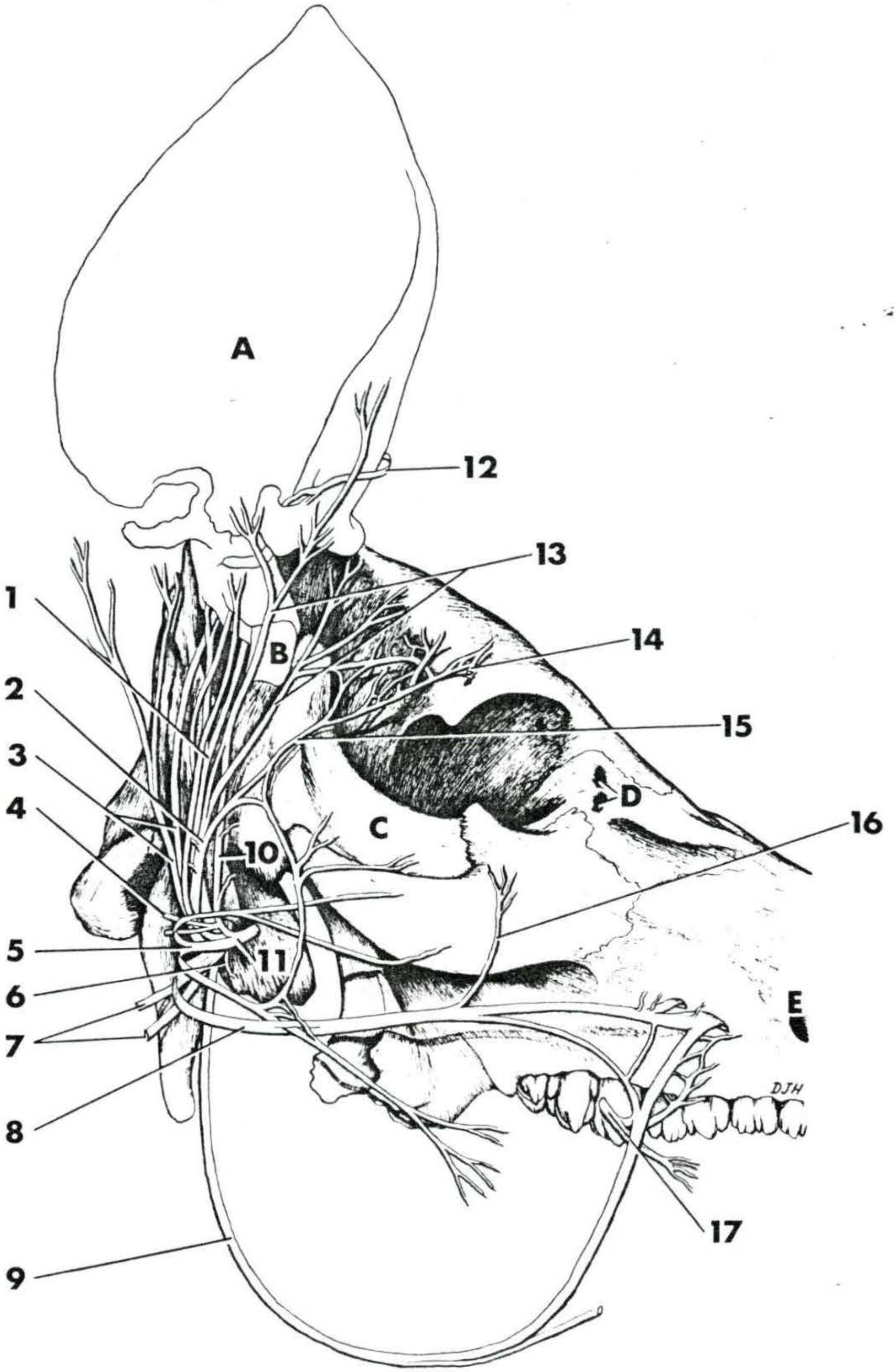
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FIGURE 3. Nerves of the deep lateral surface of the head (semischematic)

A M. brachiocephalicus
B M. sternocephalicus
C Glandula submandibularis
D Glandula parotis (ventral portion)
E Processus zygomaticus (Os temporalis), cut
F A. maxillaris externa
G A. maxillaris interna
H M. pterygoideus lateralis
I M. stylohyoideus
J M. pterygoideus medialis
K Ductus submandibulare
L M. orbicularis oculi
M M. obliquus ventralis
N Glandula palpebrae tertiae profunda
O Glandula buccalis
P M. buccinatorius
Q M. depressor labii mandibularis
R M. mylohyoideus
S M. digastricus
T M. levator labii maxillaris
U M. caninus
V M. depressor labii maxillaris
W M. orbicularis oculi
X M. levator nasolabialis
Y M. mentalis

1 N. accessorius
2 N. facialis
3 N. auricularis internus, cut
4 N. auricularis posterior, cut
5 R. buccalis dorsalis, cut
6 R. colli, cut
7 R. buccalis ventralis
8 R. stylohyoideus
9 Branch of N. caroticus externus
10 N. hypoglossus
11 N. mandibularis
12 N. auriculotemporalis
13 N. massetericus
14 N. temporalis profundus
15 Branch of N. buccalis to M. temporalis
16 N. buccalis
17 N. lingualis
18 R. isthmus faucium
19 N. alveolaris mandibularis
20 N. mylohyoideus
21 Communicating branch of 9 to 20
22 R. lateralis of N. mylohyoideus
23 R. medialis of N. mylohyoideus
24 R. marginalis mandibulae
25 Nn. mentales
26 R. buccalis dorsalis, cut
27 N. frontalis
28 N. lacrimalis
29 R. zygomaticotemporalis
30 R. zygomaticofacialis
31 R. zygomaticofacialis accessorius
32 R. communicans cum n. oculomotorii
33 R. ventralis of N. oculomotorius
34 N. maxillaris
35 R. alveolaris maxillaris posterior
36 Rr. nasales externi
37 Rr. nasales anteriores
38 Rr. labiales maxillares
39 Muscular branches of R. buccalis dorsalis
40 Muscular branches of R. buccalis dorsalis

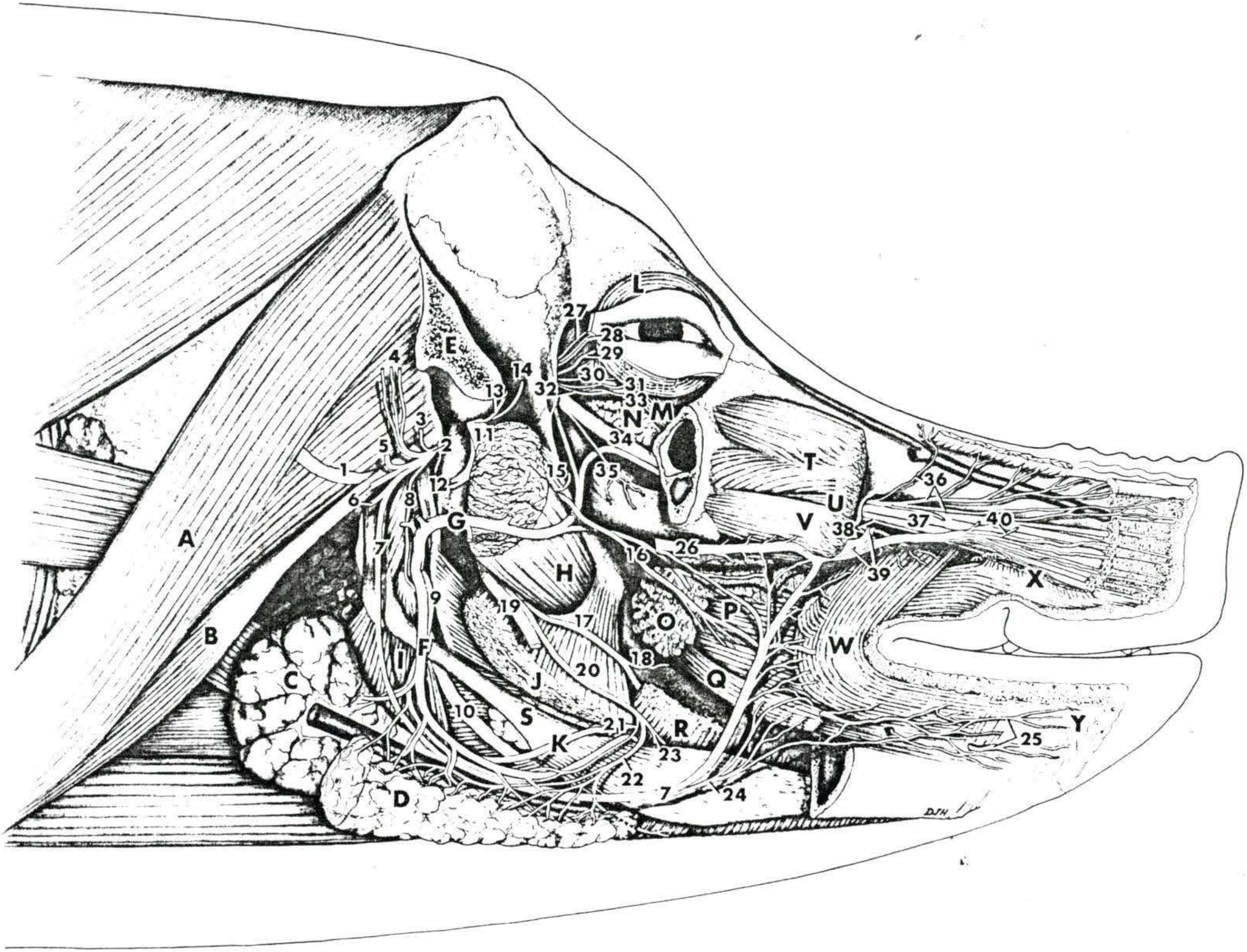
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FIGURE 4. Lateral view of the Ganglion submandibulare and related structures (semischematic)

A M. styloglossus

B M. pterygoideus lateralis

C M. pterygoideus medialis

D M. hyoglossus

E Ductus submandibulare

F M. geniohyoideus

G M. mylohyoideus

H Glandula buccalis

I Lingua

J Glandula sublingualis

1 N. lingualis

2 N. sublingualis

3 Rr. communicantes cum n. linguali

4 Ganglion submandibulare

5 Branches to G. submandibulare and G. sublingualis

6 N. hypoglossus

7 Muscular branches of N. hypoglossus .

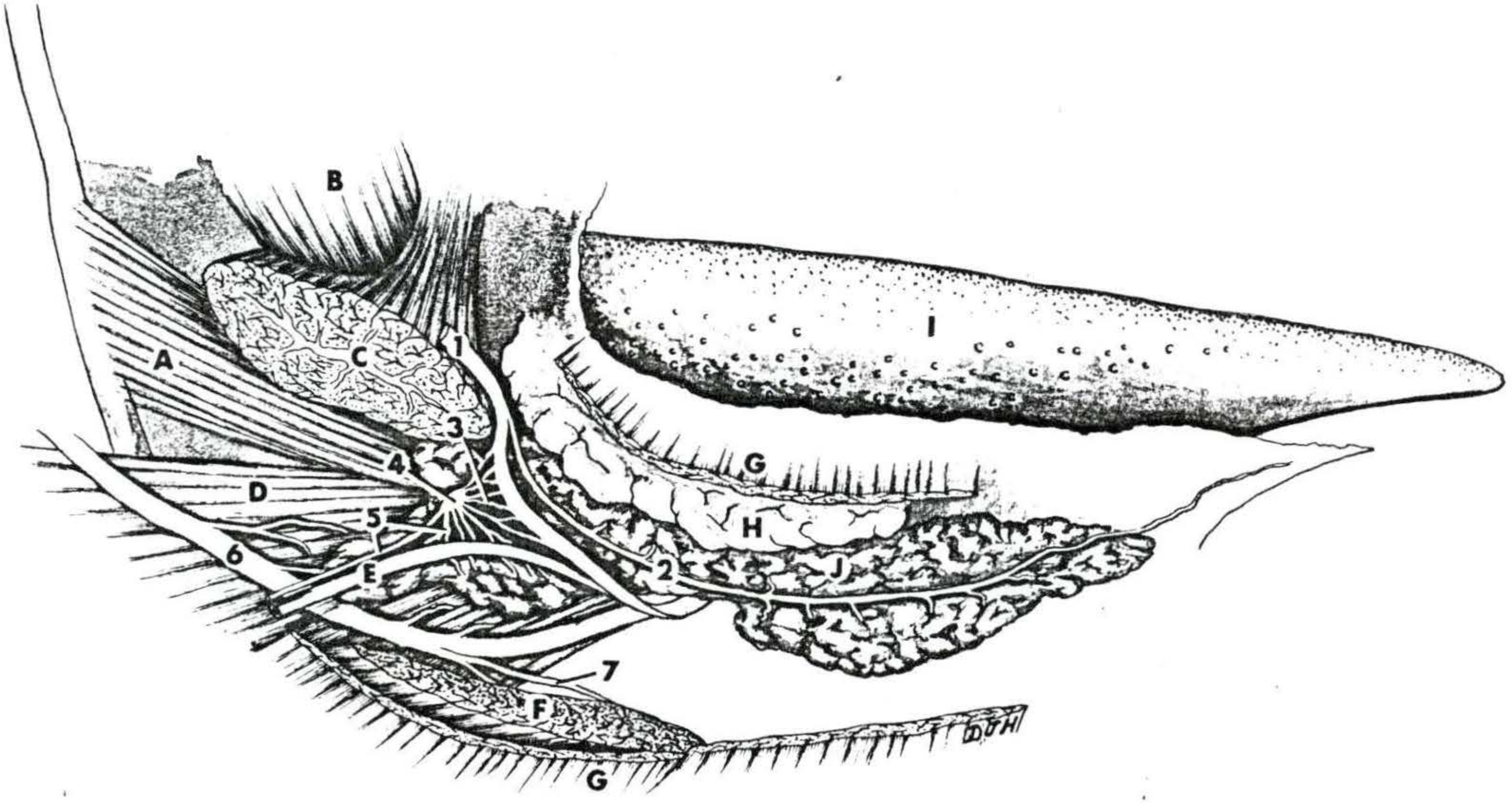
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FIGURE 5. Innervation of larynx and pharynx. Lateral view (semischematic)

A	Esophagus, cut	K	M. stylohyoideus
B	Trachea, cut	L	M. hyoglossus
C	M. cricothyroideus	M	M. mylohyoideus
D	M. sternothyroideus	N	M. styloglossus
E	M. cricopharyngeus	O	M. pterygoideus medialis
F	M. thyropharyngeus	P	A. carotis communis
G	M. hyopharyngeus	Q	A. lingualis
H	M. thyrohyoideus	R	A. occipitalis
I	M. sternohyoideus	S	A. carotis interna
J	M. omohyoideus	T	Bulla tympanica, cut

1	N. glossopharyngeus	12	R. internus of 10
2	R. sinus carotici	13	N. accessorius
3	R. pharyngeus of 1	14	R. externus of 13
4	Branch of 1 to M. stylopharyngeus	15	R. internus of 13
5	R. lingualis of 1	16	N. hypoglossus
6	N. vagus	17	N. cervicalis prime
7	R. pharyngeus of 6	18	Truncus sympathicus
8	R. pharyngoesophageus	19	Truncus sympathicus and N. vagus
9	Ganglion inferior of 6	20	N. mandibularis
10	N. laryngeus cranialis	21	N. lingualis
11	R. externus of 10	22	N. alveolaris mandibularis

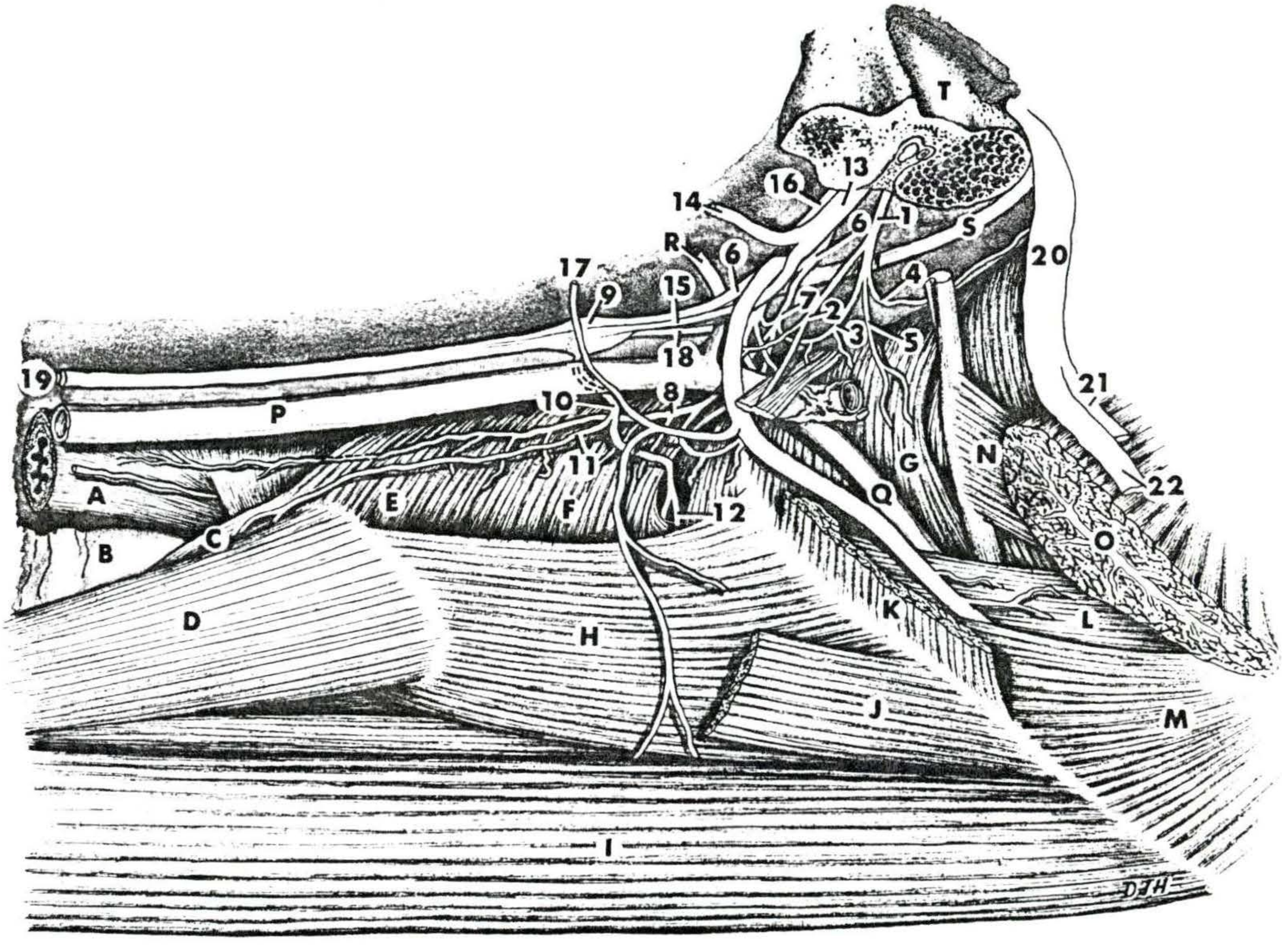
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FIGURE 6. Innervation of larynx and pharynx. Medial view (semischematic)

A	Atlas	G	Esophagus
B	Axis	H	Epiglottis
C	A. carotida communis	I	Cartilago cricoidea
D	A. occipitalis	J	Ventriculus laryngis lateralis
E	A. carotida interna	K	Cartilago thyroidea
F	M. stylopharyngeus	L	M. sternohyoideus
1	N. glossopharyngeus	10	N. caroticus internus
2	R. sinus carotici	11	R. pharyngeus of 8
3	R. pharyngeus of 1	12	N. caroticus externus
4	Branch of 1 to M. stylopharyngeus	13	R. communicans cum n. cervicali prime
5	R. lingualis of 1	14	N. cervicalis prime
6	N. vagus	15	N. vagus
7	R. pharyngeus of 6	16	Ganglion inferior of 15
8	Ganglion cervicale craniale	17	N. laryngeus cranialis
9	Truncus sympathicus	18	N. hypoglossus

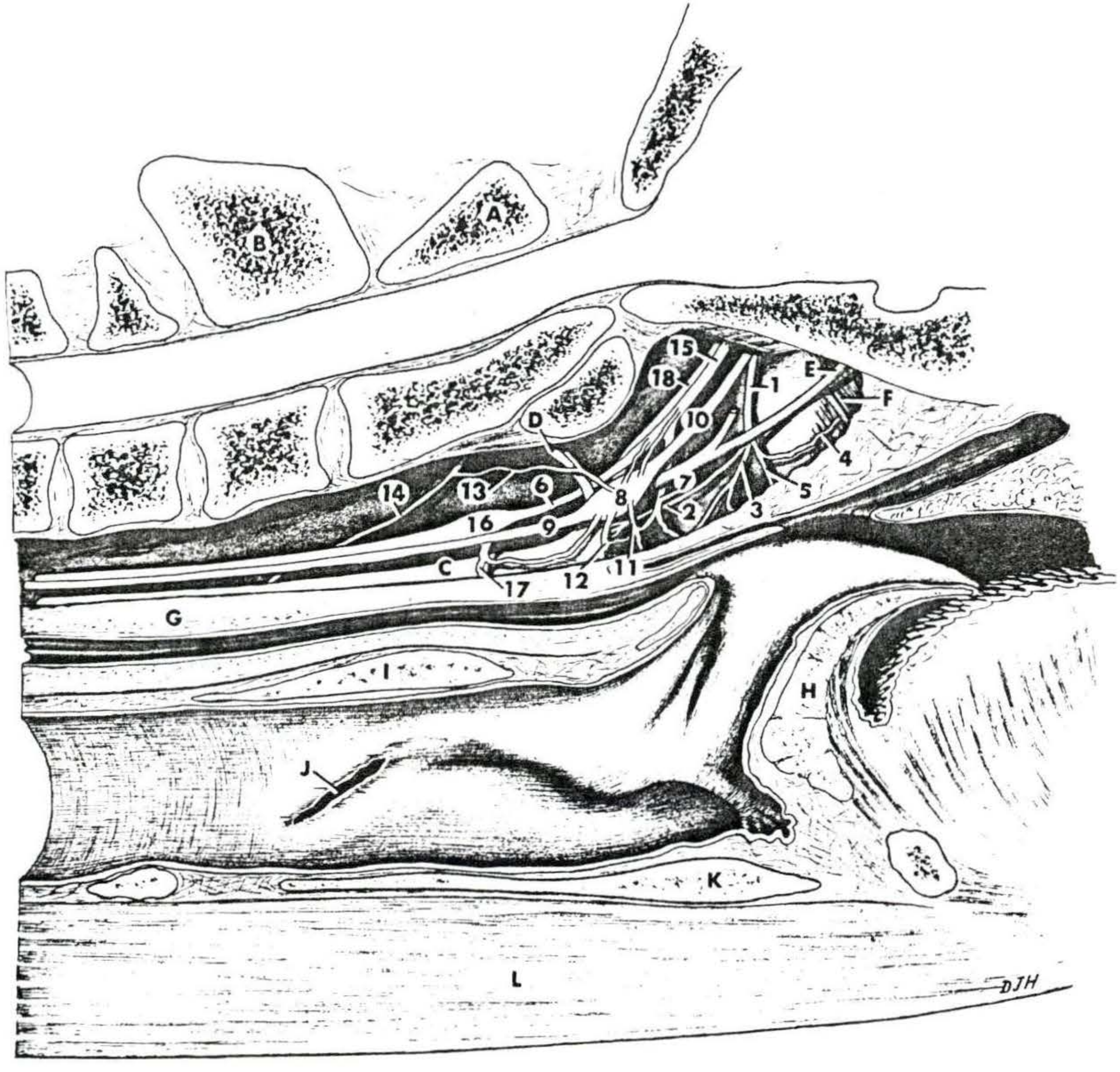
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FIGURE 7. Nerves to the orbit structures. Dorsal view (semischematic)

A Os nasalis
B Sinus frontalis
C Foramina lacrimalia
D Processus zygomaticus, cut
E Bulbus oculi
F Fossa ethmoidalis
G M. obliquus dorsalis
H Glandula lacrimalis
I M. rectus dorsalis
J Canalis n. hypoglossi

1 Radix motoria n. trigemini
2 Radix sensoria n. trigemini
3 N. mandibularis
4 Ganglion trigeminale
5 N. maxillaris
6 R. zygomaticofacialis
7 R. zygomaticotemporalis
8 N. lacrimalis
9 N. frontalis
10 N. nasociliaris
11 N. ethmoidalis
12 N. infratrochlearis
13 N. oculomotorius
14 N. abducens
15 N. trochlearis, cut

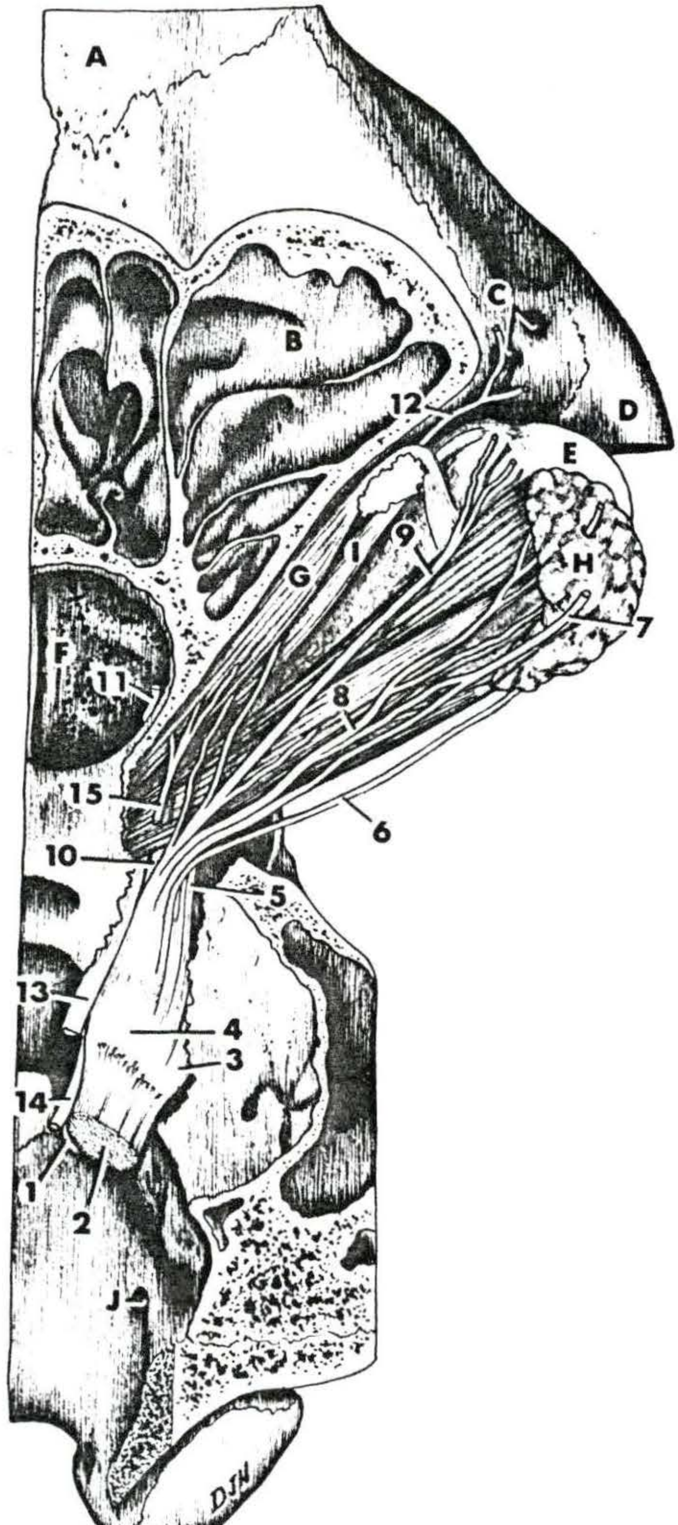
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FIGURE 8. Nerves of the lateral surface of the orbital and pterygopalatine regions (semischematic)

A Bulbus oculi
B Glandula lacrimalis
C M. obliquus dorsalis
D M. rectus dorsalis
E M. rectus lateralis
F M. obliquus ventralis
G Glandula palpebrae tertiae profunda

1 N. maxillaris
2 R. maxillaris alveolaris posterior
3 N. pterygopalatinus
4 N. palatinus minor
5 N. canalis pterygoidei
6 Cutaneus branch of 8
7 R. zygomaticotemporalis
8 N. lacrimalis
9 Communicating branch between 7 and 8
10 R. zygomaticofacialis
11 R. zygomaticofacialis accessorius
12 R. ventralis of N. oculomotorius
13 R. communicans cum n. oculomotorii


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FIGURE 9. Nerves of the lateral surface of orbit and pterygopalatine regions. Deep view (semischematic)

A Bulbus oculi
B Glandula lacrimalis
C M. obliquus dorsalis, cut
D M. rectus lateralis, cut

1 Ganglia pterygopalatina
2 N. canalis pterygoidei
3 N. maxillaris, cut
4 N. zygomaticofacialis, cut
5 N. abducens

E M. rectus ventralis
F M. obliquus ventralis
G Glandula palpebrae tertiae profunda
H M. retractor bulbi

6 R. ventralis of N. oculomotorius
7 R. communicans cum n. oculomotorii
8 Ganglion ciliare
9 Nn. ciliares breves


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