ANATOMY OF THE FLOOR OF THE FOURTH VENTRICLE.

(The relations between the surface markings and the underlying structures.)

BY

GEORGE L. STREETER, M. D.,

Demonstrator, Anatomy of the Nervous System, Albany Medical College.

From the Senckenbergisches anatomisches Institut, Frankfurt, a. M.

WITH 4 PLATES AND 2 TEXT FIGURES.

In the following study I have undertaken to find out how much of surface anatomy can be seen in the floor of the fourth ventricle, and what relation this bears to the underlying structures. This has been done with the end in view that it might lead, not only to a more accurate knowledge concerning the anatomy of the nuclei and the tracts which lie in the ventricular floor, but also might be of immediate practical use to the pathologist in the cutting of material from this region to the best advantage, and in the identification of the extent and situation of morbid processes.

Naturally, this is not the first time that the task of determining the relations between the surface anatomy of the floor of the medulla and the underlying parts has been undertaken. As far back as 1840 Arnold and Stilling were working on the same problem, and later we have the remarkable work of Clarke. But from that time on, following the introduction of new staining methods, the attention of anatomists has been given almost entirely to the study of the finer histology of sections without regard to surface relations. On going back through the literature, one finds everywhere the same descriptions of the floor of the ventricle, and all based on the researches of the previous investigators. In 1896, however, Retzius published his admirable work showing how much more complete the gross description of the brain could be made by a careful study, such as modern anatomy demands. On reading his description of the floor of the fourth ventricle, one first realizes how many structures had been overlooked which can be seen in the ventricular floor, and how far the descriptions commonly given in textbooks vary from the conditions actually present. Retzius, however, does not include in his description of the brain the finer internal anatomy, and so makes no attempt to explain the significance of the various

structures which he describes as forming a part of the floor of the fourth ventricle, and their relation to the underlying parts.

Since now we know, after many investigations, so much concerning the finer structure of the oblongata, and also have from Retzius such an accurate description of the surface, what a tempting task is offered in the study of the relation of the one to the other! A more complete knowledge of this relation, it may indeed be hoped, will render the understanding of the structure of this complicated region somewhat easier.

The simple plan was adopted of making a drawing of the floor of the ventricle, and then preparing from the same specimen a series of transverse sections taken at recorded levels. An adult brain was selected which had been hardened in formaline and showed distinctly the various structures in the ventricular floor. Regard was given to the fact that some variation exists in the arrangement of the markings in different brains. A specimen was therefore selected that showed best the more constant arrangement. A drawing of this was then made, the specimen being carefully studied under water and the finer structures brought out with a simple lens. Each part was measured as accurately as possible and reproduced in the drawing enlarged twice. This is shown in Plate I. Photographs and tracings were then made from the drawing to serve as duplicates, for purposes of additional record. The specimen was then cut transversely into measured segments, either 2 or 4 mm. thick, varying according to the complexity of the region, the level of the segments being recorded on a duplicate of the drawing. By reconstructing the specimen after section it was possible to see exactly through what parts the incisions were made, and so a control record of the levels was kept. The segments were then mordanted preparatory to the myelin sheath method, imbedded in celloidin, and cut. During this process there was some warping of the segments, so that in trimming on the microtome the final sections were in some cases not exactly transverse. Such corrections were recorded. The first sections taken from the blocks were kept apart, as corresponding to the recorded levels on the drawing; the deeper ones were preserved as a series for purposes of identification. The sections, thus prepared, were stained by Weigert's myelin sheath method. Some of the more important ones are reproduced in Plates III and IV, the enlargement being twice that used in the drawing of the floor of the ventricle, *i. e. four times natural size.* The levels corresponding to the sections are indicated on Plate II. For accuracy in identification of structures, comparison was made with other series, taken from the collection of the Institute, and with prepa-

rations stained in various ways, including a series of neuroglia fibre specimens prepared by Weigert, and kindly loaned for this purpose.

Before giving the results of the study of these preparations we will briefly review that which has already been found out concerning the anatomy of the ventricular floor.

Stilling, sixty years ago, in describing the floor of the fourth ventricle, divided the caudal half of it, on each side of the median line, into three triangles (Bau des Nervensystems, 1842). One of these, the "Ala cinerea," owing to its darker color, stands out prominently, its apex extending forward to the "transverse fibres of the acustic nerve," and its base resting against the "Calamus scriptorius." This he determines to be the nucleus of the vagus nerve. He observes a small ridge running across the base of this triangle, cutting off a distal segment, and so separating the anterior part, or "Vagus nucleus," from the caudal border of the ventricle. The posterior segment he names "Nucleus of the Accessorius" (Stilling, Taf. VII, fig. 9). The other two triangles, separated by the ala cinerea, lie with their apex directed backwards. The median one is his "Hypoglossal nucleus," and the one lateral to the ala cinerea he calls the "Nucleus of the Glossopharyngeus." In the anterior division of the floor of the ventricle, *Arnold* had previous to Stilling described the "Eminentia teres," the "Fovea anterior," and "Locus coeruleus." The first of these Arnold had identified as the "Nucleus nervi facialis" (Icon. nerv. cap. Taf. I, fig. 8). He also describes the "Striae medullares" and suggests their association with the auditory nerves.

That much, then, was found out regarding the floor of the fourth ventricle, without the aid of any imbedding or staining methods, and from sections cut with a razor.

A quarter of a century later *J. Lockhart Clarke* (Phil. Transact., 1868, p. 263), from specimens stained with carmine and cleared in the oil of turpentine, concludes that the triangle lying lateral to the ala cinerea is the "inner nucleus of the auditory nerve." He also makes out the course of the facial nerve with its knee and two arms. He considers its nucleus of origin to be situated beneath the fasciculus teres, in common with that of the abducens. The loose strands of the posterior arm he describes as an association bundle between the facial and the motor nucleus of the trigeminus.

From this time until *Retzius* published his work on the "Menschenhirn," in 1896, we find no important contribution to our knowledge of the floor of the fourth ventricle. *Henle's* work (Nervenlehre des Menschen, 1879) should perhaps be mentioned as giving the most careful

review of the subject. It is a curious fact that, as the anatomies become more modern, the descriptions and illustrations of this part of the nervous anatomy correspond less and less to nature, and drift toward misleading multicolored diagrams. Retzius points this out, and produces a page of drawings taken from different sources showing a lamentable lack of faithfulness on the part of the more modern writers. Stimulated by this, Retzius makes a careful study of one hundred specimens, and illustrates the typical forms with drawings and well executed photographs. His description of the floor of the fourth ventricle is so complete that we cannot do better than to follow it more or less in detail:

The ventricular floor, in the majority of cases, is divided by the striae medullares into three regions, namely: The "frontal," the "median" (a region occupied by the striae), and the "caudal." The striae, however, as is well known, present a great individual variation. They may be large, small, or entirely absent. When present they lie parallel, convergent, divergent, transverse, oblique, or longitudinal. Owing to this irregularity, *Retzius* agrees with *His* in recommending, for descriptive purposes, a longitudinal division of the floor,—each side to be divided into a median and lateral area, which is indicated by a more or less well marked groove connecting the superior and inferior (ala cinerea) foveae. This groove is called the "lateral furrow," and the foveae are merely parts of it widened out. Such a groove in a gross way separates the motor and sensory fields of the floor of the ventricle, the former of the two lying mesial. In adults' brains at the caudal tip of the ventricle (calamus scriptorius) there is usually present a small triangular bridge-like structure (obex), extending between the prominent nuclei of the posterior columns of the cord (clavae), and covering in the tip of the ventricle in the median line. Arising from under this and out of the opening of the central canal and extending from the median line along the edge of the clava is the "*Area postrema*," a rounded tongue shaped space with a fine granular surface and brownish color. This area was already known to Stilling and Henle, but is especially described by Retzius. Two other structures come out with this from the region of the central canal, the ala cinerea and, next to the median line, the hypoglossal field or the trigonum hypoglossi. The area postrema is distinguished from the ala cinerea by its color, rougher surface, and by a glistening light colored ridge, which separates the two. This ridge is usually well marked, and extends laterally and anteriorly to the inferior end of the area acustica, in the structure of which it is lost. From its position Retzius names this ridge the "*Funiculus*

separans." The ala cinerea bounded by the funiculus separans posteriorly, and arising with it from the median line out of the central canal, extends forward, more or less triangular in shape, wedging itself in between the area acustica and the trigonum hypoglossi. It ends anteriorly with a pointed tip in the region of the striae medullares. Its surface as a whole is depressed, and forms a shallow pit, the floor of which is slightly convex.

Lying median to the ala cinerea is the hypoglossal field, arising out of the central canal by a slender stile or wedge, gradually broadening, and ending in the region of the striae. In the foetus and yet more evident in the adult the trigonum hypoglossi is resolved longitudinally into two fields, of which the one lying on the median side is the narrower. The boundary between them consists, as a rule, of a single or double formation of numerous short oblique furrows and ridges, or a series of wrinkles of the surface of the floor, affording a " feathered " appearance. This is brought out strongly by magnification under water with a simple lens. This peculiar wrinkling occurs also between the lateral division of the hypoglossal field and the ala cinerea, giving the appearance of a " bird feather." *Retzius* therefore designates this lateral field as the *" Area plumiformis."* The narrow field, median to the area plumiformis, he calls the *"Area medialis trigoni hypoglossi."* Near the middle of this field there often is a slight enlargement and elevation—the *" Eminentia medialis trigoni."*

The area acustica is an irregularly triangular or quadrilateral raised surface with its convex base toward the median line, and extending laterally to the insertion of the tela choroidea inferior, and into the recessus lateralis. Its superior or frontal portion is usually covered by the striae medullares, with the consequent irregular elevations. Its inferior end extends caudally as far as the area postrema, and forms the lateral boundary of the ala cinerea. The acustic area is more prominent in the foetus, and forms a projection or tubercle, which Schwalbe designated the " Acustic tubercle." Later Dejerine (Anatomie des Centres Nerveux, 1901, Tome Deuxieme, p. 498) has suggested the limiting of this name to the nucleus of termination of the cochlear nerve, which properly corresponds to the tuberculum acusticum of mammals other than man.

Regarding the superior part of the floor of the ventricle, Retzius has found little that is new. He describes a " Fovea mediana "—a depression of the median sulcus slightly frontal to Arnold's eminentia teres. The superior fovea and locus coeruleus in his description do not differ from what we have already learned from Arnold, Stilling, and Clarke.

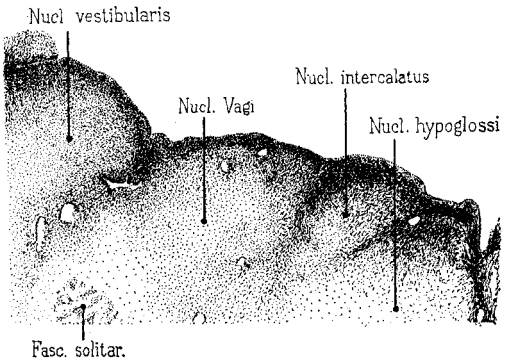
The question that now arises is: what significance have all these structures? *Retzius* makes no attempt himself at explanation. *Dejerine,* who is acquainted with his description, concludes (*op. cit.,* page 501) that the funiculus separans corresponds to the situation of the fasciculus solitarius, and that the area postrema forms the ventricular portion of the nuclei of the posterior columns. In the trigonum hypoglossi he finds only the nucleus of the hypoglossus. *Obersteiner* (Nervose Centralorgane, 1901, p. 74) about the same time concludes that the narrow median zone of this field corresponds to the nucleus funiculi teretis. *Miss Sabin's* reconstruction of the medulla (Model of Medulla, Pons, and Midbrain, Vol. IX, Johns Hopkins Hospital Reports, and Atlas of the Medulla and Midbrain, Baltimore, 1901) shows the structures beneath the ventricular floor, but the details of their relations with surface markings are not especially treated.

We will now take up in order the study of our series of preparations. Typical sections out of the series have been selected, and drawings of them, four times enlarged, are reproduced in Plates III and IV. The numbers correspond to the levels indicated in Plate II. In the most caudal sections (figs. 1, 2, and 3) the fourth ventricle does not appear. We see, however, the transition from the spinal cord type of fig. 1 to the medulla type of fig. 4. In fig. 1 the posterior longitudinal fissure forms a cleft between the nuclei of the posterior columns of the cord, and extends ventrally to the grey substance surrounding the central canal. In this grey substance antero-laterally there are a few motor cells belonging to the hypoglossal nucleus, which nucleus, however, in sections just above this, between fig. 1 and fig. 2, becomes more distinct as a compact group of cells. In fig. 2 the posterior longitudinal fissure is shorter, owing to the dorsal migration of the central canal. Lying at the bottom of this fissure is an area of loose vascular tissue containing a few myelinated fibres, and extending ventrally as a wedge into the grey substance surrounding the central canal. In this section the grey substance can be seen to be differentiated into a darker and a lighter area. The former lies ventral, and forms the hypoglossal nucleus. The latter lies dorsal to this, and is contiguous with the vascular area in the posterior longitudinal fissure. It forms the beginning of the vagus nucleus. On one side of the section the fasciculus solitarius can be seen lying lateral to the nucleus of the vagus. In fig. 3 the posterior longitudinal fissure has become continuous with the central canal, but is bridged over dorsally by the obex. The obex has a similar histological structure, and in following through the series is apparently continuous with the wedge shaped area described in fig. 2. The vagus and hypoglossal nuclei retain the same relations as in the previous sections.

Fig. 4 shows the floor of the fourth ventricle bounded on each side by the insertion of the tela choroidea inferior, the torn edge of which shows in the sections, situated at a point corresponding to the descending root of the vestibularis. Lateral to it lie the nuclei of the posterior columns. The space between the attachment of the tela and the median line is divided by surface furrows into three areas. The outermost area consists superficially of a loose vascular tissue, similar in structure to the vascular area seen in sections 1 and 2. Here it corresponds to the area postrema of Retzius. Median to this there are two other areas separated by a sharply cut furrow. The one at the median line forms the beginning of the trigonum hypoglossi. The smooth rounded area between this and the area postrema consists of a thickened ependyma overlying the vagus nucleus. By tracing this structure through the sections between 4 and 5 it is found to correspond to the funiculus separans. It appears in the section somewhat broader than in the drawing of the floor of the ventricle (Plates I and II). This is due to the fact that the structure curves caudally towards the median line, and is therefore in fig. 4 cut in an oblique direction. A relation between the funiculus separans and the fasciculus solitarius, as found by *Dejerine*, is not found in any of our sections. It will also be observed in section 4 that the area postrema does not represent an intraventricular part of the nuclei of the posterior columns of the cord, but is a vascular structure overlapping the vagus nucleus, and associated in structure and position with the obex, tela choroidea, and the wedge shaped area seen in fig. 2.

Fig. 5 forms a favorable place for the consideration of the finer surface structures in the floor of the ventricle. The three major areas are distinctly marked out. The area corresponding to the trigonum hypoglossi is subdivided into a median and lateral area. Also at this level there exists the most marked formation of ridges and furrows, which give rise to the feathered appearance as described by Retzius. So here perhaps we can learn what these markings of the floor signify. Sections of this region were studied which had been prepared by various methods. The most information regarding the histology of the markings of the floor, however, was obtained from a neuroglia fibre series prepared by Weigert, and I will take this opportunity to express my thanks for his kindness in loaning them for use in this study. In this neuroglia series one finds directly beneath the ventricular epithelium a compact layer of neuroglia fibres, the ependyma, and it is found to be this that forms the substance of the small wrinkles seen in the floor. They appear in sections as ridges of compact neuroglia fibres,

and from Nissl and myelin sheath preparations are found to be devoid of nerve cells, axis cylinders, and blood vessels. The ependyma extends into the grey matter and median raphe in the form of processes, forming well defined partitions between the dorsal nuclei which Weigert, in his monumental work (Beiträge zur Kenntnis der Normalen Menschlichen Neuroglia), describes as "kielstreifen," or the tracks left by embryonal sulci. In adult specimens the place at which a process takes its origin is generally indicated on the surface of the ventricular floor by a more or less well marked groove (text fig. 1). The size and form of the groove correspond in some degree to the size and compactness of the neuroglia process. That is: when the process is compact and slender the surface groove is usually sharply cut, and when the process is broader and less compact the surface depression is shallower and more rounded out. Owing to this partition formation it is possible with low magnification to make out in glia fibre preparations the definite boundaries of the dorsal nuclei. So we have, in the comparison of these specimens with myelin sheath and Nissl preparations, another means of determining the size and arrangement of the dorsal nuclei.



TEXT FIG. 1. Section showing the distribution of the neuroglia fibres in the floor of the fourth ventricle at a level corresponding to fig. 5, Plate III. The drawing represents the appearance as seen under low magnification.

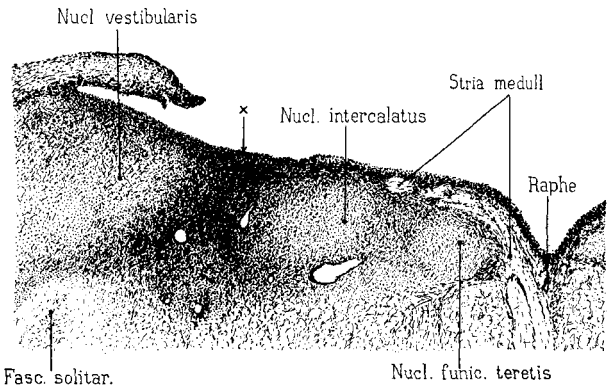
In fig. 5, by comparison with text fig. 1, it is easy thus to determine that the three major areas are occupied by the vestibular, vagus and hypoglossal fields. We further see that the hypoglossal field is subdivided, and that the lateral subdivision (area plumiformis) corresponds to the "nucleus intercalatus" of *Staderini* and *Van Gehuchten* (Van Gehuchten—Recherches sur l'origine réele des nerfs craniens. III. Le nerf glosso-pharyngien et le nerf vague. Journal de Neurologie 1898-1899), which nucleus forms a dorso-lateral cap over the hypoglossal nucleus. The hypoglossal nucleus, itself, appears in the floor of the ventricle only in the median division of the trigonum. We find that it is the prominence of the hypoglossal nucleus and small development of the nucleus intercalatus that results in the rounded surface elevation called eminentia medialis trigoni by *Retzius* (Eminentia hypoglossi, Plates I and II).

In the region of fig. 6 we observe adjoining the median line on each side the nucleus funiculi teretis, overlapped by the obliquely cut fibres of the striae medullares. In some of the sections studied, to all appearances many of the fibre bundles of the striae ramified in the nucleus, and seemed to terminate there. It is realized, however, that such histological pictures may be very misleading. It is considered to be far from conclusive evidence regarding the relation between the two structures. The distal and proximal ends of the nucleus are indicated in Plate II. It will be observed that the nucleus corresponds in its position very closely to the area of the striae. It is distinctly separated from the eminentia teres.

There is a large field of grey matter, in fig. 6, bounded by the nucleus funiculi teretis mesially, the descending bundles of the vestibularis laterally, and ventrally by the formatio reticularis and the fasciculus solitarius with its nucleus. Concerning the signification of this field there is at present a divided opinion. The majority of writers consider the entire space to belong to the dorsal vestibular nucleus. There are others, however, who consider the median part of this field to belong to the nucleus of the glosso-pharyngeus. By going through a series it is easy to see that the median part of this field is a continuation of what *Staderini* and *Van Gehuchten* in more caudal sections call the nucleus intercalatus. The area occupied by this nucleus is indicated on Plate II as Nucleus intercalatus. In the region of fig. 6 this nucleus seems to fuse with the dorsal vestibular nucleus, and in myelin sheath and Nissl preparations the two areas have the same structure and no dividing line can be made out. That they, however, are not the same, but, on the contrary, have different functions is supported by the following reasons:

Firstly. If the nucleus intercalatus belonged to the vestibular nucleus the area occupied by the two would be greater than that occupied by the combined nuclei of the glossopharyngeus, vagus and hypoglossus. This would be out of all proportion to the function of the vestibular nerve, as we at present understand it. Secondly. In many human specimens where the striae are absent or only faintly marked, and even better in other mammalians (calf and sheep), the naked eye appearance of the floor shows the vestibular nucleus to be separated from the nucleus intercalatus by the lateral furrow which connects the superior and inferior foveae. Thirdly. We have already seen that in neuroglia fibre specimens, processes extend from the ependyma ventrally into the grey matter forming partitions between the dorsal nuclei. In specimens of this region prepared in that manner there exists a neuroglia parti-

tion between the dorsal nucleus of the vestibularis and the nucleus intercalatus. This is indicated in text fig. 2, which represents a neuroglia



TEXT FIG. 2. Neuroglia preparation made in the region corresponding to fig. 6, in Plate IV. The magnification is the same as text fig. 1.

fibre preparation taken from the region under consideration. In sections from other specimens we have observed a distinct notch in the floor at the point indicated in text fig. 2 by a cross. These would correspond to brains with a well marked lateral furrow.

As bearing on this subject, I may further mention a case, reported by Neubürger and Edinger (Berliner klin. Wochenschr., 1898, No. 4), in which there was a congenital absence of one-half of the cerebellum. On the abnormal side the vago-glossopharyngeal and vestibular nuclei were found to be devoid of the network of fine fibres, which presumably forms the origin of their central cerebellar sensory tract. The nucleus intercalatus was not described. I have recently, however, had the opportunity of examining the preparations from this case, and find that the so-called nucleus intercalatus, in its greater part, is normal in appearance, and equally rich in fibre network on both sides. It thus stands out separated in sharp contrast from the pale and transparent field occupied by the vagus and vestibular nuclei.

In fig. 6, overlying laterally the restiform body, there is seen a nuclear structure in the substance of the tela choroidea inferior. This can be traced through the sections between 5 and 6 as a thin nuclear layer or lamella which extends caudally from the nucleus cochlearis, and laterally from the nucleus vestibularis. Whether it is a part of either or both of these we were unable to satisfactorily make out. In Plate II it is represented as belonging to the cochlear area. The cochlear nucleus proper does not make its appearance until we reach the sections lying between figs. 6 and 7.

The frontal ends of the nucleus funiculi teretis and the nucleus intercalatus are cut across in fig. 7. These disappear between figs. 7 and 8. Lateral to the nucleus intercalatus is the vestibular field, and lateral to that is the nucleus cochlearis, and the stile of the flocculus. In this section the nucleus and most of the fibres of the glossopharyngeus have disappeared.

Fig. 8 represents a section through the nucleus of the nervus abducens forming, together with the genu of the N. facialis, an elevation of the floor (eminentia facialis). On one side can be seen the fibre bundles of the N. abducens leaving the nucleus. A few fibres connecting the nucleus with the superior olive are present. Of the N. facialis three portions can be seen in this section; the loose strands coming from its nucleus, a cross section of the genu, and the nerve trunk in its ventral course of exit. Overlapping the N. facialis and the nucleus abducentis is the distal extremity of a mass of grey matter, which increases in size as we approach the aqueduct of Sylvius. Since as yet we are ignorant concerning its function, this structure will be spoken of as the "*nucleus incertus.*" At this level the fibres from the nucleus and trunk of the vestibular nerve and the restiform body are seen passing dorsally in their course to the cerebellum. Some of the more frontal fibres can be seen of the root of entrance of the vestibular nerve.

Fig. 9 is in the trigeminal region, and shows the root of that nerve, the motor nucleus, and the bundle of decussating fibres, the latter seeming to pass into the region of the nucleus lying lateral to the posterior longitudinal fasciculus. The posterior longitudinal fasciculus, except for ependyma, lies at this level exposed in the floor of the ventricle, and corresponds to the broadening of the longitudinal median furrow, situated in the floor of the ventricle proximal to the eminentia facialis (fovea mediana of Retzius). The layer of grey matter seen in previous sections and called nucleus incertus is here little changed. In fig. 10, however, it is much enlarged in width and thickness. Underlying it are the large pigmented cells of the trigeminus (locus coeruleus), and mesially is the posterior longitudinal fasciculus. Lateral to it is the superior root of the trigeminus. The nucleus consists of a network of fine fibres in the meshes of which lie scattered groups of medium sized multipolar nerve cells. In its appearance and position it bears a somewhat similar relation to the trigeminus to that which exists between the nucleus intercalatus and the vago-glossopharyngeus. It is possible that these nuclei, the nucleus incertus and the nucleus intercalatus, may represent central sympathetic centers, which we are led to expect in the floor of the medulla, as analogous to the grey matter surrounding

the central canal of the spinal cord, in which *Onuf* and *Collins* (Experimental researches on the central localization of the sympathetic. Archiv. Neurol. and Psychopath., 1900) have traced secondary degenerations following removal of sympathetic ganglia.

CONCLUSION.

Now, that we have examined our series individually, we are in a position to consider the floor of the ventricle as a whole, and the position and arrangement of the structures of which it consists. The fact that we have the levels of the sections exactly recorded enables us to plot out the areas of the various nuclei and tracts, as far as we were able to identify them in section. Further, as all the drawings were enlarged according to a definite scale, we are enabled to give their exact size in length and width. In Plate II the different areas have in that way been outlined. If we compare this plate with the original drawing (Plate I), we can see the relations of the outlined areas to the superficial structure of the floor. As a résumé, therefore, that which we see in the floor of the fourth ventricle, when looking at our specimen from above, and taking in consideration but one side of the median line, may be described somewhat as follows:

Lying against the median line in the caudal half of the floor is an oval elevation, 5.2 × 1 mm. This represents the rounded frontal end of the hypoglossal nucleus, and may therefore be called "*eminentia hypoglossi*" (eminentia medialis trigoni of Retzius). It varies somewhat in prominence in different specimens according to the development of the structures lateral to it. In the specimen illustrated in Plate I it is less prominent than is usual. The remainder of the hypoglossal nucleus is completely covered by other structures. The entire nucleus measures 12.3 × 2.2 mm. The intraventricular portion is 7 mm. long, and except at the eminentia hypoglossi is overlapped by the nucleus intercalatus and nucleus vagi. The extraventricular portion extends 5.3 mm. caudad to the tip of the calamus scriptorius, and lies ventral to the vagus nucleus and the nucleus of the funiculus gracilis.

Situated at the median line frontal to the eminentia hypoglossi, and separated from it by a slight depression, is a somewhat similar, but less prominent, elevation formed by the nucleus funiculi teretis. This measures 5.7 × 1 mm. The appearance of this structure varies according to the arrangement of the striae, which have their median termination in this region. It is possible that there is an intimate relation between the striae and this nucleus.

Lying lateral to the elevations formed by the nucleus funiculi teretis and the nucleus hypoglossi is the elongated wedge shaped elevation formed by the nucleus intercalatus (area plumiformis), which measures 11 mm. long, and 2.2 mm. in greatest width. The frontal portion forms the body of the structure and is situated in the region of the striae. The tapering caudal extremity extends from this, between the eminentia hypoglossi and the vagus area, as far as the tip of the calamus scriptorius, overlapping a portion of the hypoglossal nucleus. The nucleus intercalatus lies superficial in the floor throughout its entire extent, except in the frontal part, where it is more or less covered by the striae medullares. This nucleus is probably not a part of the vestibular nucleus.

In different parts of the floor of the ventricle can be seen a formation of fine ridges. They are particularly numerous in the region of the nucleus intercalatus, and from their regularity often present the appearance of a "bird feather." They consist of small neuroglia elevations covered by a single layer of epithelium, and are devoid of nerve cells or fibres. They are present in fresh brains, but show more distinctly in hardened specimens. They radiate on the surface of the ventricular floor from regions where neuroglia processes ("Kielstreifen") extend inward as partitions between the dorsal nuclei. It is possible that they serve as a support to these processes.

Lateral to the nucleus intercalatus is the fovea vagi (ala cinerea), which represents the middle one-third of the vago-glossopharyngeal nucleus, and is the only part of this nucleus that lies superficial in the floor of the ventricle. The entire vago-glossopharyngeal nucleus is 13.5 mm. long, and averages 2 mm. in width. Frontal to the fovea vagi, the nucleus lies concealed beneath the vestibular nucleus. The distal one-third extends 2.5 mm. caudad to the tip of the calamus scriptorius, the extraventricular portion lying ventral to the nucleus gracilis, and dorsal to the hypoglossal area. The intraventricular portion of the caudal one-third of the nucleus is covered by a layer of loose vascular tissue, which is continuous with the obex, and which extends into the dorsal region of the central canal. This is the area postrema of *Retzius*. Separating it from the fovea vagi there is usually some thickening of the ependymal neuroglia forming a translucent cord-like elevation, the funiculus separans. The fasciculus solitarius lies lateral and ventral to the vago-glossopharyngeal nucleus throughout its course. It nowhere lies superficial, and bears no apparent relation to the funiculus separans.

All that part of the floor of the ventricle that lies lateral to the anterior fovea (fovea trigemini) and the fovea vagi (ala cinerea) and the

lateral furrow, which connects the two, belongs to the acustic area. This area consists of a median, or vestibular field, and a lateral, or cochlear field. The vestibular field forms an irregular spindle shaped elevation, 16.1 × 4.5 mm., extending from the anterior fovea to the nucleus gracilis. Its median border is convex, and is more or less completely separated from the nucleus intercalatus by the lateral furrow. In other mammalians (sheep and calf) this furrow of separation is more distinct than in man. The cochlear field is that portion of the floor that extends into the recessus lateralis.

Lying near the median line, proximal to the striae medullares, and 16 mm. cephalad to the obex, is a rounded elevation, 4 mm. in diameter, formed by the genu of the facial nerve, inclosing the nucleus of the abducens. This we call the "*eminentia abducentis.*" Partly overlapping this, and extending forwards to the aqueduct of sylvius, is a longitudinal elevation, averaging 2.7 mm. in width. This is due to a field of grey substance consisting of fine fibres, in the meshes of which lie scattered groups of small and medium sized multipolar nerve cells, which area begins as a thin layer in the region of the eminentia facialis, and gradually becomes thicker as it extends into the region of the mid-brain. Its function is unknown, and we therefore call it the "*nucleus incertus.*" In its position it is closely related to the nucleus nervi trigemini, overlapping it throughout its course.

Between the nuclei incerti, in the median line, is a shallow depression of the floor of the ventricle, measuring 5.7 × 1 mm. which forms the fovea mediana. The posterior longitudinal bundle here lies superficial in the floor covered only by a thin layer of ependyma.

Lateral to the nucleus incertus, and the eminentia facialis is an elongated depression of the floor 3.2 mm. in its greatest width caudally, and gradually narrowing as it extends forward. It is due to the exit at this point of the root of the trigeminal nerve. It may therefore be called "*fovea trigemini*" (anterior fovea).

It may be hoped that familiarity with the facts pointed out in the above description will make more instructive the examination and dissection of material from this region of the brain.

In conclusion I wish to acknowledge my obligation and gratitude to Professor Edinger, at whose suggestion, and under whose guidance this work was done.

Senckenbergisches anatomisches Institut, Frankfurt a. M.

DESCRIPTION OF PLATES.

PLATE I.

Drawing showing the floor of the fourth ventricle of an adult human brain, enlarged twice.

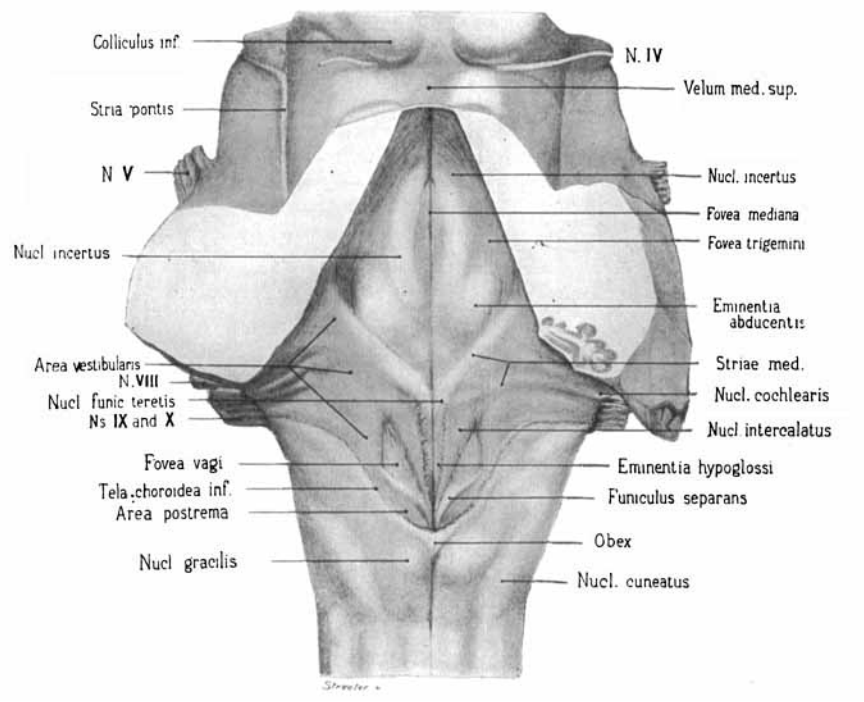
PLATE II.

The same, showing by interrupted cross lines the sections illustrated in Plates III and IV. The size and position of the various nuclei situated in the floor are indicated in outline on the right side. Where one lies beneath another the outline is dotted. Thus one recognizes that the hypoglossal nucleus is covered in greater part by the nucleus of the vagus and the nucleus intercalatus. Antero-laterally the vagus nucleus extends beneath the acustic field. The fasciculus solitarius is indicated by a lateral sub-division of the vago-glossopharyngeal area and is shaded slightly darker. The nucleus intercalatus and nucleus funiculi teretis, except for the striae medullares, lie superficial throughout their whole length. Together with the nucleus cochlearis is included the thin lamella-like nucleus situated in the tela choroidea inferior, overlapping the corpus restiforme.

PLATES III AND IV.

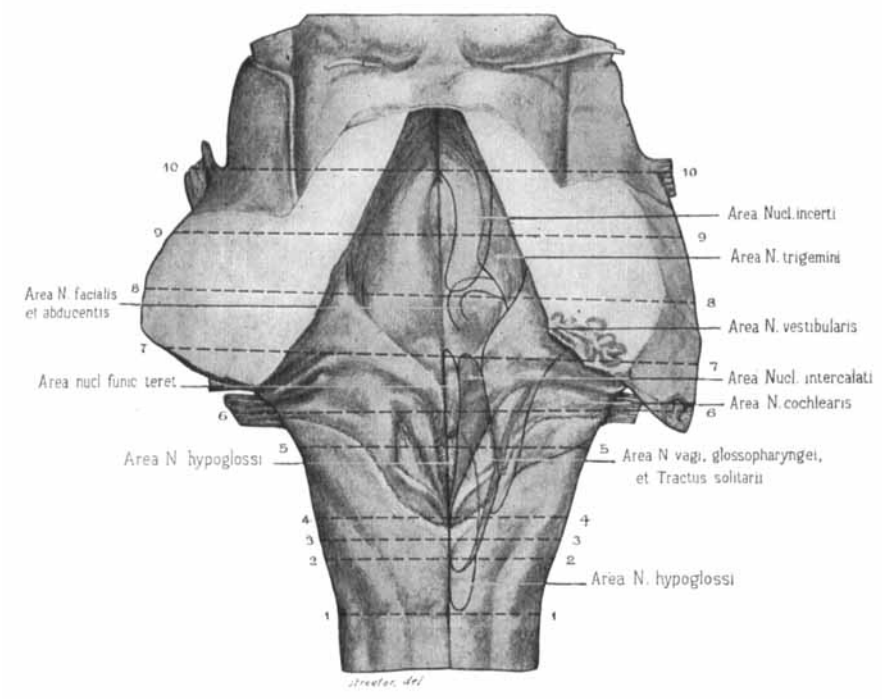
Frontal sections of the floor of the fourth ventricle, the numbers of which correspond to the interrupted cross-lines of Plate II. These figures represent sections enlarged twice as much as are the surface views on Plates I and II, i. e. four times natural size. Especial care has been taken to represent the furrows and ridges on the edge of the specimens, and the attachment of the tela choroidea inferior.

G. L. STREETER



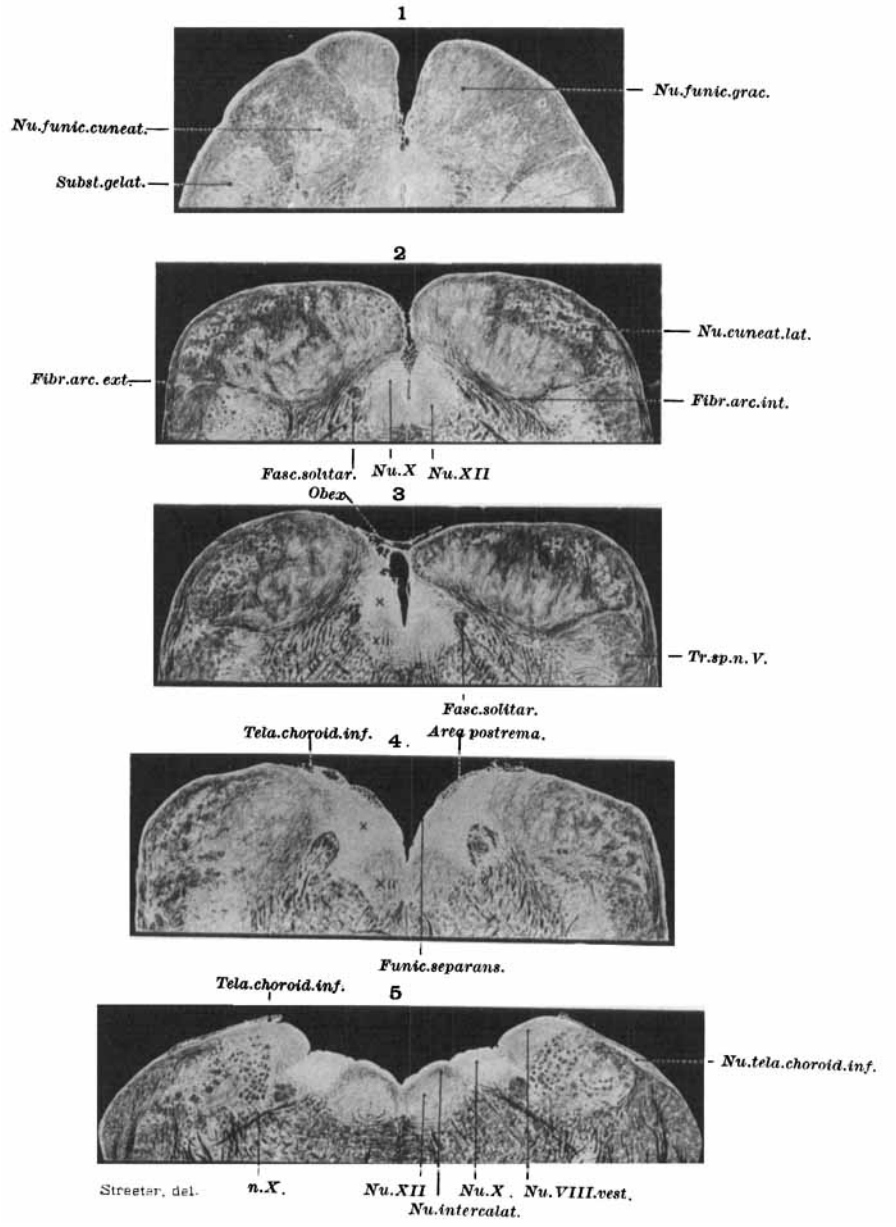
SURFACE MARKINGS OF FLOOR OF FOURTH VENTRICLE

(*Man*)



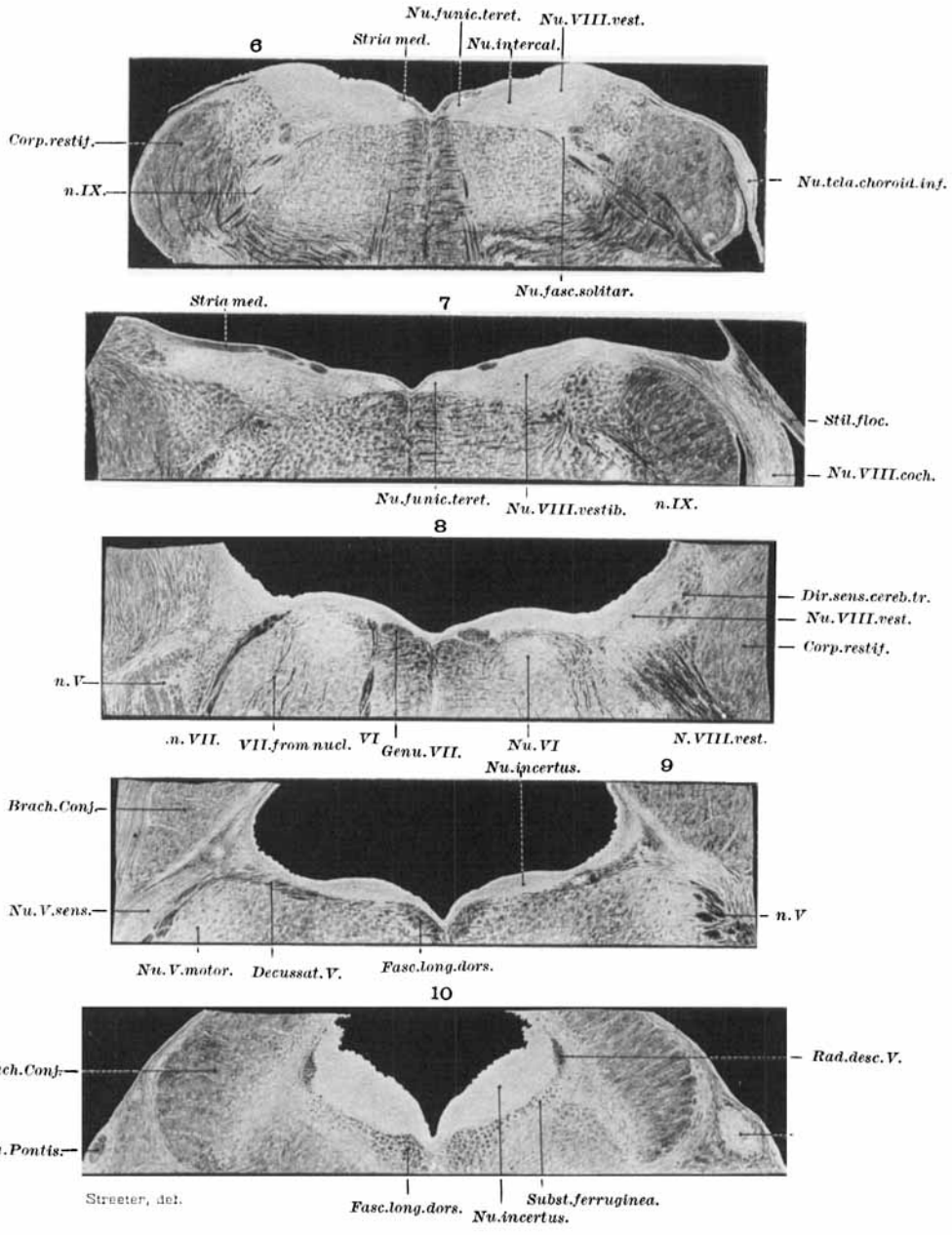
POSITIONS OF NUCLEI AND PLANES OF SECTIONS ILLUSTRATED ON PLATES III AND IV

G. L. STREETER.



HELIOTYPE CO., BOSTON.

G. L. STREETER.



HELIOTYPE CO., BOSTON.