ATLAS OF THE CANINE BRAIN

By

O. S. Adrianov and T. A. Mering

Brain Institute, Academy of Medical Sciences, USSR

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АТЛАС
МОЗГА СОБАКИ

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Editor's Remarks

Translation of information from one language to another inevitably loses some of the flavor of the original. This book is no exception. We have tried to retain the style of authors Adrianov and Mering as much as possible consistent with understandable English. It is our belief that this atlas of the canine brain offers data and a point of view which so far have been unavailable to Western scientists. The increasing use of the dog in experimental neurology, physiology and pharmacology makes this atlas especially important. It is a valuable adjunct to other atlases of the dog brain now available in English.

Publication of this atlas has been made possible by Mrs. Edith Price who helped in the translation, Mrs. Ruth Good for editorial assistance, and Mrs. Ellen Howard for typing the manuscript. Mrs. Edith Ignatieff, our translator, deserves a special debt of gratitude for the many long hours required to make this book a reality. Translation errors in the scientific aspects of this book are the editor's. It is hoped that there are not too many.

E.F. Domino
January, 1964
Ann Arbor, Michigan

Annotation

This atlas offers a systematic and detailed analysis of the structure, connections, and functional peculiarities of various parts of the canine central nervous system, from the spinal cord through the cerebral cortex. The cytoarchitectural areas in the cerebral cortex, shown in a new map devised by the authors, are based on the principles of I.P. Pavlov's teaching on analysors. The exact information on the topography of various areas will permit the experimentor to destroy a selected portion of the brain without materially disturbing the other parts.

The reader of the atlas will become acquainted with structural details not by means of schematic drawings, but primarily through photographs of specimens prepared in the laboratories of cytoarchitecture of the Brain Institute of the Academy of Medical Sciences, USSR.

The atlas provides a bibliography compiled according to the various sections of the central nervous system, in conformity with the text.

The atlas is meant for a wide circle of practical and scientific workers: physicians, biologists, and veterinarians.

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The photographs were made in the
Photolaboratory of the Brain Institute
AMN USSR, by A.A. Kudriashov

Preface

One of the most widely used subjects for experimental neuroanatomical studies is the dog. This makes it necessary to have detailed and systematic information on the central nervous system of this animal. However, in the literature on this subject there are no studies that delineate the macro- and microscopic structure of all sections of the spinal cord and cerebral cortex of the dog. There are many reports containing data on the brain of the rabbit and of the cat (Winkler and Potter, 1911, 1914; Papez, 1929), the horse (Ellenberger and Baum, 1932), man and animals (Konova, 1947). Some studies include a minute description of the structure of only one portion of the canine central nervous system (Klempin, 1921; Filimonov, 1928, 1949; Rioch, 1929; Gurevich and Bykhovskaya, 1927; Rose, 1927 and others).

The present atlas gives a systematic description of the macro- and micro-anatomic structure of the canine spinal cord, brainstem, and cerebral hemispheres. The atlas is divided into three chapters.

The first chapter sets forth in detail the macroscopic structure of the spinal cord, the brainstem, and the subcortical formations. There is also a detailed analysis of a great number of serial sections made through the entire brain and the spinal cord. The original photomicrographs of the spinal cord and the brainstem shown in the atlas have been enlarged so as to make it possible to inspect the entire area of the sections and to expose with precision the various nuclear groups and conducting tracts of the canine brain.

The second chapter contains a description of sulci and gyri of the hemispheres of the dog's brain. The cytoarchitecture of various regions and areas of the cerebral cortex is described minutely. Comparatively little research has been devoted to this subject (Betz, 1874; Campbell, 1905 and others). Widest attention has been given to the investigations and maps compiled by Klempin (1921) and Gurevich and Bykhovskaya (1927). These studies do contain interesting material; however, supplemental data and certain corrections are required. The data on the boundaries of some sections and areas of the cortex are rather ambiguous, and there are no photomicrographs of the cellular structure of many areas.

The present atlas includes photomicrographs of all sections of the cortex and a map of the cytoarchitectural areas of the neocortex, based on extensive material. The materials of Filimonova were used for the description of the areas of the paleocortex, the archiocortex, and the intermediate cortex.

In their studies of the cellular structure of the cortex, the authors proceeded from Pavlov's viewpoint with respect to the end stations of various analysors. The cortex is divided (where this is possible) into regions corresponding to the analysors.

The third chapter, written by Leontovich and Mering gives details on the topography of subcortical nuclei and their projection upon the cranium. Photographs of a series of sections through the cranium and the brain are presented, as well as the projections of the cerebral hemispheres, basic sulci, and

subcortical formations on the surface of the cranium. Also, calculations of the location of the most important subcortical formations are included. A similar report on the canine does not exist in the literature.

The material in this atlas greatly enriches our concepts of the structure of the dog's central nervous system.

The uniqueness of this atlas of the canine brain lies in the fact that its authors are not only morphologists, but are also qualified physiologists, which enhances considerably the value of their complex morpho-physiological work.

The atlas will be indispensable to a wide circle of scientific workers: physicians, morphologists, physiologists, and biologists who are studying problems of experimental medicine and biology and whose subject is primarily the dog.

<div style="text-align: right">

Professor S.A. Sarkisov,
Active Member of the
Academy of Medical Sciences USSR

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CHAPTER I

STRUCTURE OF THE SPINAL CORD, BRAINSTEM, AND SUBCORTICAL NUCLEI

General Characteristics

There are numerous reports in the literature on the structure of the spinal cord, brainstem, and subcortical nuclei in the carnivores. The subject has been dealt with in great detail in the atlas of Winkler and Potter (1941), the handbook of Papez (1929), and the works of Ingram, Hannett, and Ranson (1932), Monnier (1943, 1949), and Rexed (1954), in which there are drawings of serial sections of the cat's brain and photomicrographs of separate cellular groups. A description of the macroscopic structure of the canine brain is given in the handbooks of Flatau and Jacobsohn (1899), Ellenberger and Baum (1891, 1932). Extensive material on the macro- and microstructure of the human and animal brainstem can be found in the atlas compiled by E.P. Kononova (1947); however, the number of photomicrographs of serial sections of the canine brain is not adequate. In the studies by Langley (1884), Bekhterev (1896, 1898), Levandovski (1904), Nerding (1911), Rioch (1930, 1931), Papez (1937) and others, there are descriptions of diverse areas or portions of the central nervous system of the dog.

In the investigations mentioned above there are a number of discrepancies particularly in the data on the structure of the optic thalamus. The information on the conducting tracts of the spinal cord and cerebrum of the dog is incomplete.

In writing this chapter, a great many publications concerning the structure and function of the various parts of the central nervous system were consulted. There is a description of original photomicrographs of sections of the spinal cord and cerebrum, stained according to Nissl's method. The brain was treated in a manner used by the Brain Institute (Kononova, 1949). After the cranium was opened, the brain was fixed in formalin for 3 to 5 days and then photographed, the photographs showing all sulci; after further induration, the brain was dehydrated in alcohol of increasing strength, then embedded in paraffin. After that, serial sections were prepared and stained with cresyl violet. The thickness of each section was 20 u, or approximately 40 sections to 1 mm.

Fig. 7 shows a photograph of the canine brain, with lines indicating the position of the sections represented in Chapter I of the atlas. As seen in this figure, the distance between the sections is usually from 1 to 1.5 mm.

The Spinal Cord (Medulla Spinalis)
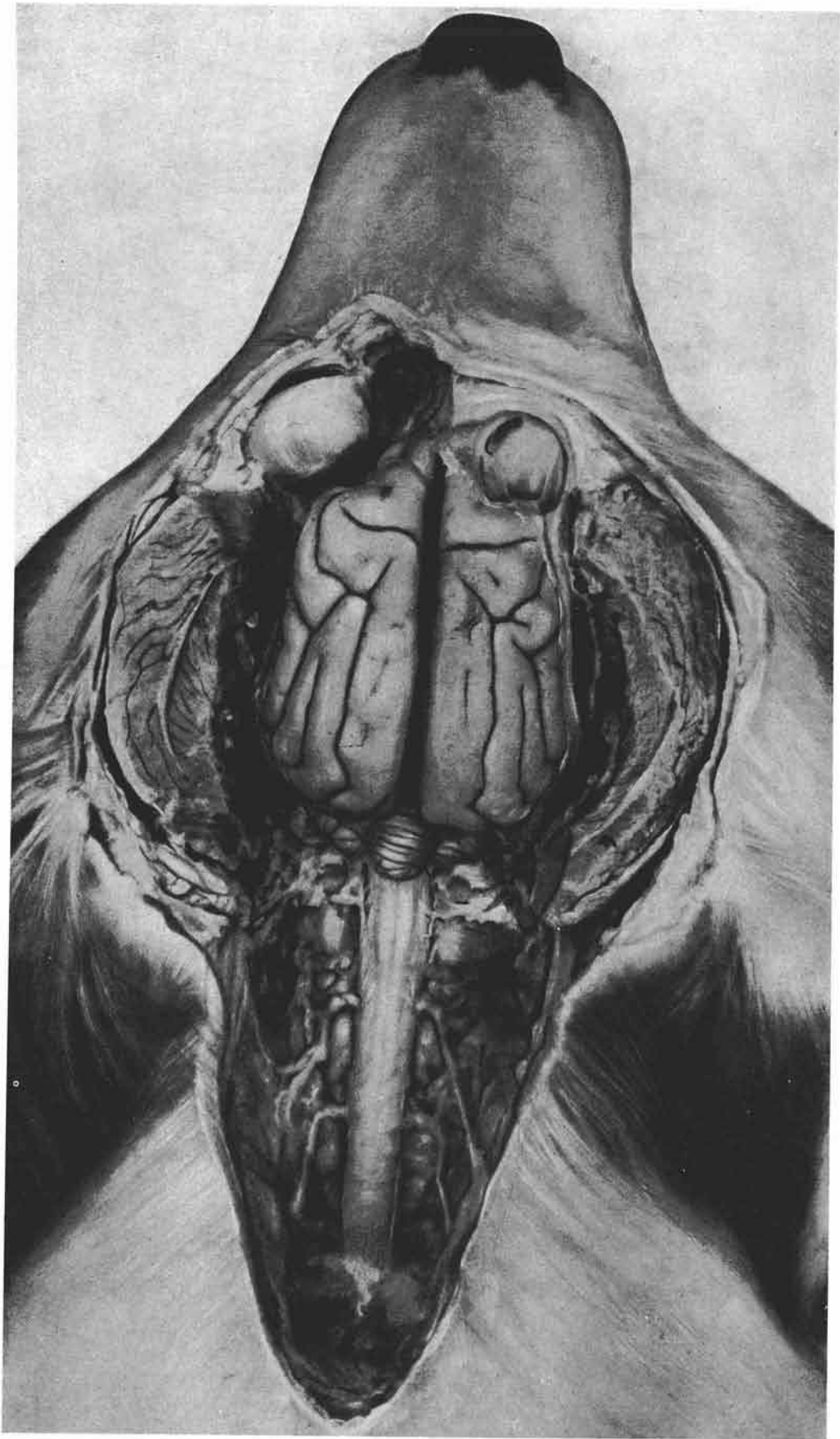
(Fig. 1, 2, 3, 8, 9, 10)

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Fig. 1.   The Cerebrum and the Spinal Cord of the Dog.   Enlargement 1:1
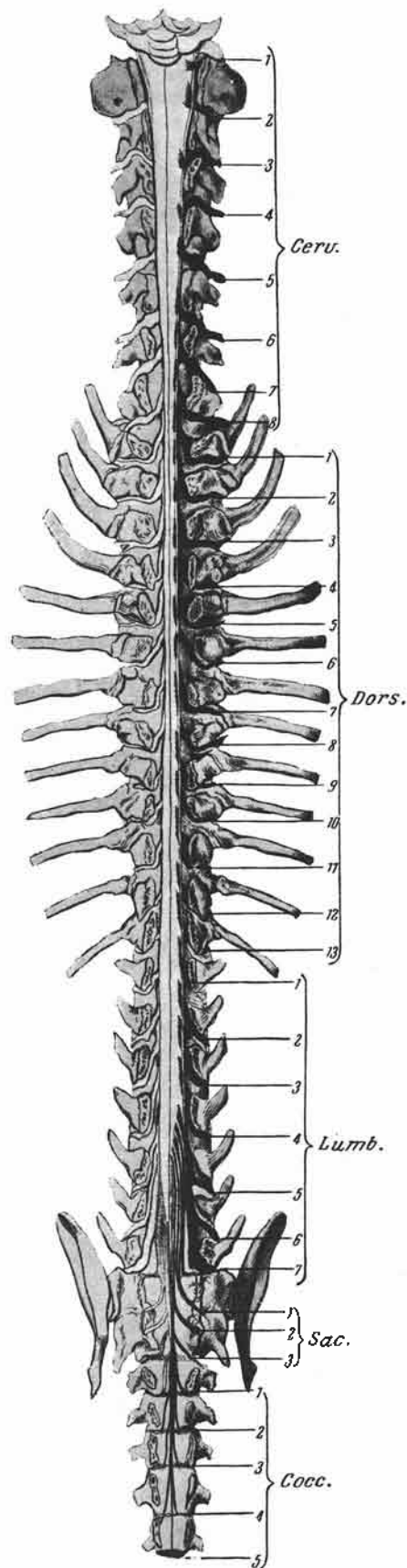Photograph Made From a Preparation of the Brain Institute by V.P. Zvorykin.

Fig. 2. The Spinal Column With an Open Spinal Canal (after Flatau).
Enlargement 0.44:1

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The canine spinal cord has the shape of a long cylinder and reaches a length of 38 cm.

The spinal cord is constructed on a segmental principle and is subdivided into segments; 8 cervical, 13 thoracic, 7 lumbar, 3 sacral, and 5 to 6 coccygeal (Fig. 2). Each segment has corresponding pairs of ventral (anterior) and dorsal (posterior) roots. Thus, from each side extend 8 pairs of cervical roots, 13 pairs of thoracic, 7 pairs of lumbar, 3 pairs of sacral, and 5 to 6 pairs of coccygeal roots. The canine spinal cord, as is the case in other mammals, lengthwise does not completely fill the vertebral canal in which it is encased. For this reason, only the more central cervical roots extend from the spinal cord in a horizontal direction. The remaining roots extend at an angle, which become more pointed in the posterior regions of the spinal cord. The lower lumbar, sacral, and coccygeal roots lie completely vertical, and form the so-called horse tail (cauda equina). The posterior segments of the spinal cord form the conus medullaris, which in the canine, is located on the same level as lumbar vertebrae VI to VII.

The cervical and lumbar swellings of the spinal cord correspond to the beginning of those roots which innervate the upper and lower extremities.

On the ventral surface of the spinal cord, along the midline, lies the anterior medial fissure (fissura mediana anterior, fma). The dorsal surface of the spinal cord is separated in the middle by a shallow posterior median, or longitudinal fissure (sulcus medianus posterior, smp). Lateral to the anterior median fissure, on each side, lie anterior lateral fissures (sulci laterales anterior, sla). On both sides of the posterior longitudinal fissure are the posterior lateral fissures (sulci laterales posterior, slp).

Every segment of the spinal cord, composed of two symmetrical halves, consists of gray matter (nerve cells) surrounded by white substance (nerve axons). In general, the shape of the gray matter resembles a butterfly. This shape varies from one area to another in the spinal cord; however, it can always be discerned in the anterior and posterior horns. The anterior horns are composed mainly of large neural cells of polyangular shape, which send their axons in the form of the anterior roots to the periphery, to the skeletal muscles of the trunk and extremities. The posterior horns consist of sensory neural cells.

In the thoracic segments of the spinal cord, there can be observed also lateral horns, situated between the anterior and posterior horns. The lateral horns are smaller in the lumbar area, and in the cervical area they merge with the very massive anterior horns.

The lateral horns contain groups of cells which form Jacobsohn's external sympathetic nucleus (nucleus sympaticus lateralis Jacobsohni). From these cells extend preganglionic sympathetic fibers toward the sympathetic ganglia. The latter are, as we know, outside the spinal cord.

Lateral to the base of the posterior horns is a reticular process (processus s. formatio reticularis, ret) formed by seams of gray and white matter.

In the sacral part of the spinal cord is the so-called sacral portion of

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Fig. 3. Cross Section Through the Cervical Portion of the Spinal Cord.
Enlargement 20:1

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the vegetative neural system. It consists of cells which send preganglionic fibers of the parasympathetic system to the parasympathetic ganglia.

In the center of the gray matter lies the central canal which has an oval or circular shape (canalis centralis, cc), which continues in the brain and connects to the ventricles.

The white matter of the spinal cord is divided into columns: anterior, lateral, and posterior, which are penetrated by systems of short and long centripetal (ascending) and centrifugal (descending) neural fibers (Fig. 3).

The major portion of this section is devoted to a description of the conducting tracts of the spinal cord of carnivores (Yacubovich, 1857; Lebedev, 1873; Schifferdecker, 1876; Lenhossek, 1889; Bekhterev, 1890; Goltzinger, 1896; Vorotynskiy, 1897; Troshin, 1899; Amassian, 1951; Getz, 1952; Glees, 1953; Verhaart, 1953, 1955; Maffre, 1955 and others).

We are providing a short description of the conducting tracts, so that the reader may later obtain a more precise concept of the topography and the functions of various cellular groups of the spinal cord, described and illustrated in the series of figures.

Ascending (Centripetal) Tracts of the Spinal Cord.

The peripheral neuron of the centripetal tracts is represented by the cells of the cerebrospinal or intervertebral ganglion (gangl. spinale s. intervertebrale), located on the outside of the spinal canal, in the intervertebral foramen. The peripheral processes of these cells, in the shape of diverse receptor endings, begin in the skin, the muscles, fascias and internal organs. The central processes of the cells of the cerebrospinal ganglia, in the form of the posterior roots, enter the spinal cord and separate into different portions according to length and direction; the longest fibers go from the posterior root into the posterior column of the spinal cord, forming Goll's fasciculus and Burdach's fasciculus. The shorter fibers end at the cells of the anterior horns, as the afferent part of the simplest or direct reflex arc, consisting of only two neurons, the sensory and motor. There is also an indirect reflex arc, which consists of a sensory, internuncial, and motor neuron. The shortest fibers of the neural cells of the cerebrospinal ganglia end at the cells of the posterior horns and Clark's column.

Goll's Fasciculus and Burdach's Fasciculus (Fasciculus Golli et Fasciculus Burdachi).

In the posterior column of each half of the spinal cord, lateral from the longitudinal fissure, lie Goll's fasciculus gracilis (fasciculus s. funiculus gracilis Golli, fg) and Burdach's fasciculus cuneatus (fasciculus s. funiculus cuneatus Burdachi, fc). Goll's fasciculus extends the entire length of the spinal cord and carries the impulses from the hind legs. Goll's and Burdach's fasciculi end in the medulla oblongata in the nuclei corresponding to those of the gracilis funiculus (nucleus funiculi gracilis, ng) and the cuneiform funiculus (nucleus funiculi cuneati, nc). The axons of these nuclei extend toward the

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midline as the internal arcuate fibers (fibrae arcuatae internae, ari) and form a decussation (decussatio lemniscorum, dlm), and as the medial lemniscus (lemniscus medialis, lm) they ascend to the nuclei of the optic thalamus.

There are indications that there is a connection between the medial lemniscus and the reticular formation (Jacobson, 1955). The nuclear cells of the optic thalamus send out fibers through the posterior portion of the internal capsule, to the sensory as well as the motor cortex of the analysors. The above system serves mainly for conduction of impulses of epicritical sense (deep and kinesthetic) and represents one of the main conductive systems of the motor and cutaneous analysors. Some of the fibers of Goll's and Burdach's nuclei enter in the shape of external posterior acriform fibers (fibrae arcuatae externae posteriores, arep) into the restiform bodies (corpora restiformia, rest) and reach the vermis cerebelli through the cerebellar peduncle.

Straight or Dorsal Cerebellospinal Flechsig's Tract (Fasciculus spinocerebellaris dorsalis, fscd).

The fibers of the cells of the intervertebral ganglia end at the cells of Clark's column; the axons of the latter ascend within the lateral column on the ipsilateral side of the spinal cord, occupying its external posterior section. The fasciculus keeps the same position in the rear area of the medulla oblongata. Out of the medulla oblongata the fibers of the dorsal spino-cerebellar tract, as a component of the restiform body, enter into the cerebellum and end in the cells of the cortex of the vermis cerebellum, mainly in the lobulus centralis and partly in the culmen (Grundfest and Campbell, 1942).

The Decussated or Ventral Spinocerebellar Tract of Govers (Fasciculus spinocerebellaris ventralis, fscv).

The fibers of the cells of the intervertebral ganglia end at the column cells of the posterior horn; the axons of the latter extend to the opposite side through the commissura anterior alba, and ascend within the anteroexternal section of the lateral column of the spinal cord, through the medulla oblongata to the pons varolii. Gower's tract rounds the upper cerebellar peduncles, enters into the anterior cerebellar vellum, where it decussates and ends in the cortex of the vermis and the adjacent areas of the cerebellar hemisphere.

The above tracts conduct the impulses from the receptors of proprioception to the cerebellum; i.e., they are included in the system of reflex coordination of movements, and play an important part in the activity of the kinetic analysor.

Cerebrothalamic Tract (Fasciculus spinothalamicus, fsth).

The fibers of the cells of the intervertebral ganglia enter the posterior roots and end at the cells of the posterior horns. The axons of these cells cross into the lateral column of the opposite side and end at the cells of the lateral nucleus of the optic thalamus. The cerebrothalamic tract extends the length of the spinal cord and the medulla oblongata toward the medial side of Gower's tract, but is located in the pons varolii between the fibers of the medial and the lateral lemniscus. This tract conducts the impulses of pain,

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temperature and, partly, tactile sensitivity. In other words, it is one of the main systems of the cutaneous analysor.

Side by side with the tracts discussed above, there also exist other ascending conductive systems, the course of which has not been sufficiently investigated: the dorsotactile tract (fasciculus spinotactalis), which begins in the cells of the gray matter of the spinal cord, crosses through the commissura alba into the lateral column of the spinal cord of the opposite side and ends in the cells of the lamina quadrigemina; the spino-olivary tract (fasciculus spino-olivarius), which ends in the olivary body of the medulla oblongata. Brodal, Walberg, and Blackstad (1950) pointed out that the fibers of this tract pass through the anterior (ventral) column, and partly the lateral column of the spinal cord; most of these fibers decussate on the level of the cervical sections of the spinal cord and end mostly in the ventrolateral parts of the dorsal and medial supplementary olivary body. These authors are of the opinion that a great number of impulses from the spinal cord, by way of this tract and the olivocerebellar connections, go to the anterior lobe of the vermis, some of them to the pyramis and a few to the uvula and nucleus fastigii. Grundfest and Garter (1954) assume that this anatomically isolated tract is polysynaptic. Di Bagio and Grundfest (1955, 1956), Krieger and Grundfest (1956) are of the opinion that the synapse of this tract occurs on a level with the second cervical vertebra in a special lateral nucleus of the spinal cord. The above authors point out the functional similarity of the spinoolivary and the dorsal spinocerebellar tract.

Insufficiently investigated also are the spinoreticular tract (fasciculus spinoreticularis) leading toward the cellular formation of the brainstem, and the spinopontine tract fibers leading to the nuclei of the pons. These surround the pyramidal tracts (Walberg and Brodal et al., 1953).

Descending (Centrifugal) Tracts of the Spinal Cord.
Corticospinal or pyramidal tract (Fasciculus corticospinalis s. pyramidalis, py).

This tract begins primarily in the cells of the motor area and partly in the sensory area; it descends through the posterior part of the base of the cerebellar peduncle and enters the base of the pons varolii and the medulla oblongata. On the borderline between the medulla oblongata and the spinal cord, most of the fibers of the pyramidal tract cross to the opposite side, forming a decussation of the pyramids (decussatio pyramidum, dpy), and descend within the posterior section of the lateral column of the spinal cord to the cells of the anterior horns. Half of the fibers of this fasciculus end in the cervical area and only a few reach the sacral area. Until now, data on the existence of a direct or non-decussated pyramidal tract, in the case of the Carnivora, have been contradictory. Bekhterev (1896), Lewandovsky (1904), Lassek (1954), Lance (1954), Chiarugi, Rossi, and Zanchetti (1955) deny the existence of such a tract, while Romanov (1898), Papez (1929), Brodal and Walbert (1952), Brodal and Kaada (1953) affirm the presence of the tract in the anterior column on the ipsilateral side of the spinal cord. The pyramidal tract, as it descends, sends collaterals to the motor nuclei of the brainstem, in particular to the trigeminal, facial, glossopharyngeal, and hypoglossal nerves, to the nuclei of the vestibular nerves, and to the cells of the reticular formation.

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In recent years, reports have been published on the formation of a pyramidal tract, apart from the sensorimotor area, in the temporal and occipital areas of the cat's cerebral cortex, and also on the existence of ascending fibers in the cat's pyramidal tract (Brodal and Walberg, 1952; Brodal and Kaada, 1953).

The pyramidal tract conducts the impulses from the cortical end of the motor analysor to the muscular apparatus. It is therefore one of the important tracts which mediate the motor reactions of the animal.

Rubrospinal Tract or Monakov's Fasciculus (Fasciculus rubrospinalis, frs).

The tract begins in the macrocellular part of the red nucleus. Below this site of origin, the tract immediately decussates (Forel's decussation - decussatio Foreli, dF) and continues in the region of the brainstem tegmentum, descending in the lateral column to the lowest levels of the spinal cord.

The rubrospinal tract lies above and lateral to the pyramidal tract. This tract is considerably developed in the subprimates and plays a vital part in the conduction of impulses from the red nucleus, and through the latter also impulses from the cerebellum, in the regulation of the contractile (contracting) muscle tone (Magnus, 1924; Rademaker, 1931 and others).

Tectospinal or Predorsal Tract (Fasciculus tectospinalis s. praedorsalis, fts).

The fibers of this tract begin primarily in the cells of the anterior corpus bigeminum (stratum griseum profundum), continue in a ventromedial direction, completely decussate along the midline (Meynert's fountain-shaped decussation - decussatio Meynerti, dM) and pass near the midline ventrally in the posterior longitudinal fasciculus.

In the spinal cord, the tract descends within the anterior column, close to the anterior medial fissure, and ends at the cells of the anterior horns.

Posterior Longitudinal Fasciculus (Fasciculus longitudinalis posterior s. medialis, flp).

The majority of authors are of the opinion that the posterior longitudinal fasciculus is formed by ascending and descending fiber systems. There is some question, however, as to where the fibers of this fasciculus begin.

It was determined that the beginning of the descending system of fibers of this fasciculus is represented by the cells of Cajal's interstitial nucleus (Muskens, 1913-1914; van Gehuchten, 1904; Klosovskiy, 1939 and others). However, there are indications that the formation of the descending fibers of the posterior longitudinal fasciculus also occurs in Darkshevich's nucleus (Bekhterev, 1896; Lewandovsky, 1904; Blumenau, 1925; and others). In the brainstem, the descending fasciculus goes straight down to the base of the Sylvian aqueduct and the fourth ventricle; in the spinal cord, it lies in the anterior column, close to the anterior medial fissure.

The ascending fibers of the posterior longitudinal fasciculus consist of two systems which begin in the vestibular nuclei of the brainstem. Through the

lateral part goes a direct, non-decussated, vestibulo-mesencephalic system which begins in Bekhterev's nucleus and ends in the nuclei of the oculomotor and trochlear nerves. Through the medial part passes a decussated, vestibulo-mesencephalic system which begins in the cells of the triangular nucleus (dorsal nucleus of Schwalbe) and also ends in the nuclei of the oculomotor and trochlear nerves (van Gehuchten, 1904; Muskens, 1913, 1934; Gray, 1926; Rasmussen, 1930; Klosovskiy, 1939 and others).

According to Muskens, and also to Buchanan (1937), Deiter's nucleus sends out fibers into the ascending decussated part of the posterior longitudinal fasciculus where these fibers end in the nuclei of the oculomotor, trochlear, and abducent nerves.

According to some authors, the posterior longitudinal fasciculus regulates the associated movements of both eyeballs, takes part in the combined work of the vestibular and oculomotor apparatus, and plays an important part in the mechanism of vestibular nystagmus.

Vestibulospinal Tract or Lowental's Fasciculus (Fasciculus vestibulospinalis Lowentali).

The tract begins, for the most part, in the cells of the vestibular nuclei; according to some authors, it begins in the cells of Deiter's nucleus. It descends as a whole, not decussating, within the outer portion of the lateral column, on the borderline between the lateral and anterior column of the spinal cord, and ends at the cells of the anterior horns.

The topography of other centripetal tracts, in the case of the dog, has not been investigated adequately. This includes: the olivospinal tract, the Bekhterev-Gelweg fasciculus (fasciculus olivospinalis Bekhterevi-Wegwegi), leading from the cells of the inferior olivary body to the upper parts of the spinal cord. It occupies the periphery of the antero-lateral column of the spinal cord; the thalamospinal tract (fasciculus thalamospinalis), proceeds from the cells of the optic thalamus in the lateral column of the spinal cord.

Reticulospinal Tract (Fasciculus reticulospinalis).

The tract begins in the cells of the reticular formation of the brainstem and descends to the first lumbar segment of the spinal cord (Verhaart, 1953), with three (Papez, 1926) or two (Niemer and Magoun, 1947) large systems of diffusely located fibers: the medial reticulospinal tract, going through the anterior column of the spinal cord, and the lateral reticulospinal tract in the lateral column of the spinal cord.

Thus the spinal cord consists of an apparatus which regulates the spinal cord's own functions, and of a long conducting apparatus (of projective conducting tracts), which carries the stimulation from the receptors to the cerebrum and, conversely, from the cerebrum to the muscles. The actual functions of the canine spinal cord include the innervation of all skeletal muscles of the body and the extremities, which are responsible for simple reflex motor reactions, for instance: the flexor and extensor, the tendinous, and several other reflexes.

The spinal cord makes possible the reflex regulation of the activity of the internal organs. The spinal cord is also responsible for the operation of reflexes from the urinary bladder and the rectum, the majority of vascular reflexes, the reflex regulation of heat exchange, and the metabolism of most tissues. Consequently, the spinal cord is responsible for the realization of many simple unconditioned reflex actions of a somatic and vegetative type (Goltz and Ewald, 1896; Sherrington et al., 1935; Rademaker, 1931; Popov, 1934; Tower, 1937; Asratian, 1955, 1957; Gambarian, 1953 and others). The part played by the spinal cord in conditioned reflexes has been investigated (Novikova and Khanutina, 1939; Gambarian, 1953; Barsegian, 1957; Urgandzhian, 1957 and others).

The Brainstem

The brainstem is located between the spinal cord and the hemispheres of the cerebrum (Figs. 4 and 5). The brainstem is subdivided into the medulla oblongata (mo), the pons Varolii (pV), the cerebellum (cer), the mesencephalon and the diencephalon.

The Medulla Oblongata (medulla oblongata, mo)
and the Pons Varolii (pons Varolis, pV)
(Figs. 4, 5, 11-27)

The medulla (Figs. 4, 5), the immediate continuation of the spinal cord, appears in the shape of a coniform body which becomes narrower toward the back. The ventral surface of the medulla is divided into two symmetrical halves by the sagittal fissure (sulcus sagittalis s. fissura mediana anterior, fma). Along the sides of the fissure extend two pyramids (pyramis, py), which narrow toward the back and gradually disappear in the decussation of the pyramids (decussatio pyramidum, dpy). On the outside, the pyramids are almost entirely separated by the anterior lateral sulcus (sulcus lateralis anterior, sla) from the olivary bodies (olivae, o). The latter are represented by long, narrow protractions, bounded in the back by the posterior lateral sulcus (sulcus lateralis posterior, slp). On the average the width of these bodies is 1-2 mm.

The posterolateral border of the medulla is formed by restiform bodies (corpora restiformia, rest).

Laterally from the anterior segment of the pyramids, perpendicular to the latter, are clearly seen the fibers of the trapezoid body. The greater part of the dog's trapezoid body, in contrast to the primates, is not covered by the fibers of the pons, because of their insufficient development in the carnivores.

In connection with this, some authors refer the above mentioned area of the spinal cord in carnivores to the medulla, others to the pons varolii.

Anterior to the fibers of the trapezoid body are the transverse fibers of the pons varolii, making its surface uneven, as if crenated. The pons varolii is the continuation of the medulla. Through the middle of the pons passes a slightly raised, basal or longitudinal sulcus (sulcus basilaris s. sulcus longitudinalis, sln, Fig. 4), which frequently does not reach the posterior border of the pons. Laterally, the pons narrows and becomes the cerebellar peduncles
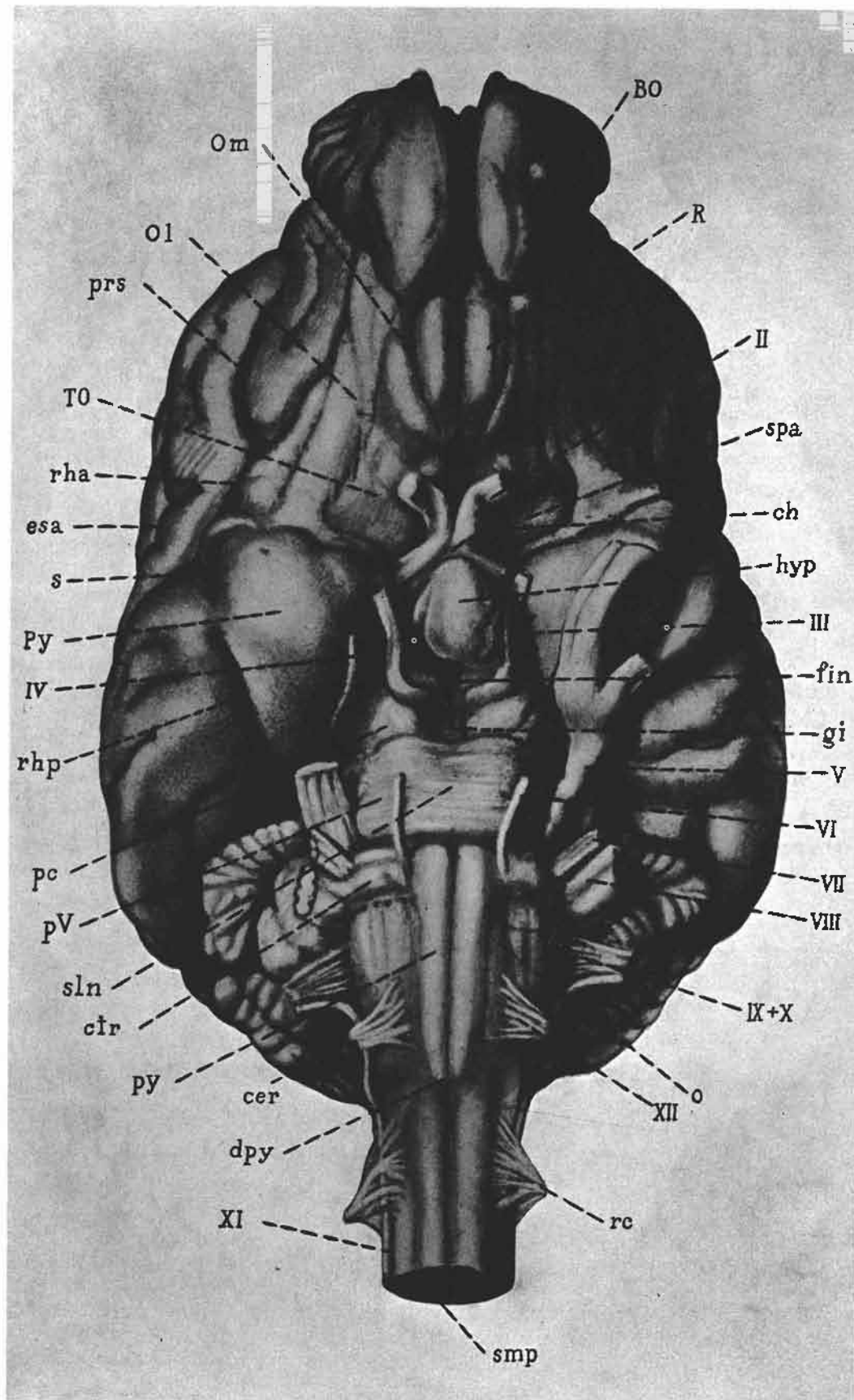
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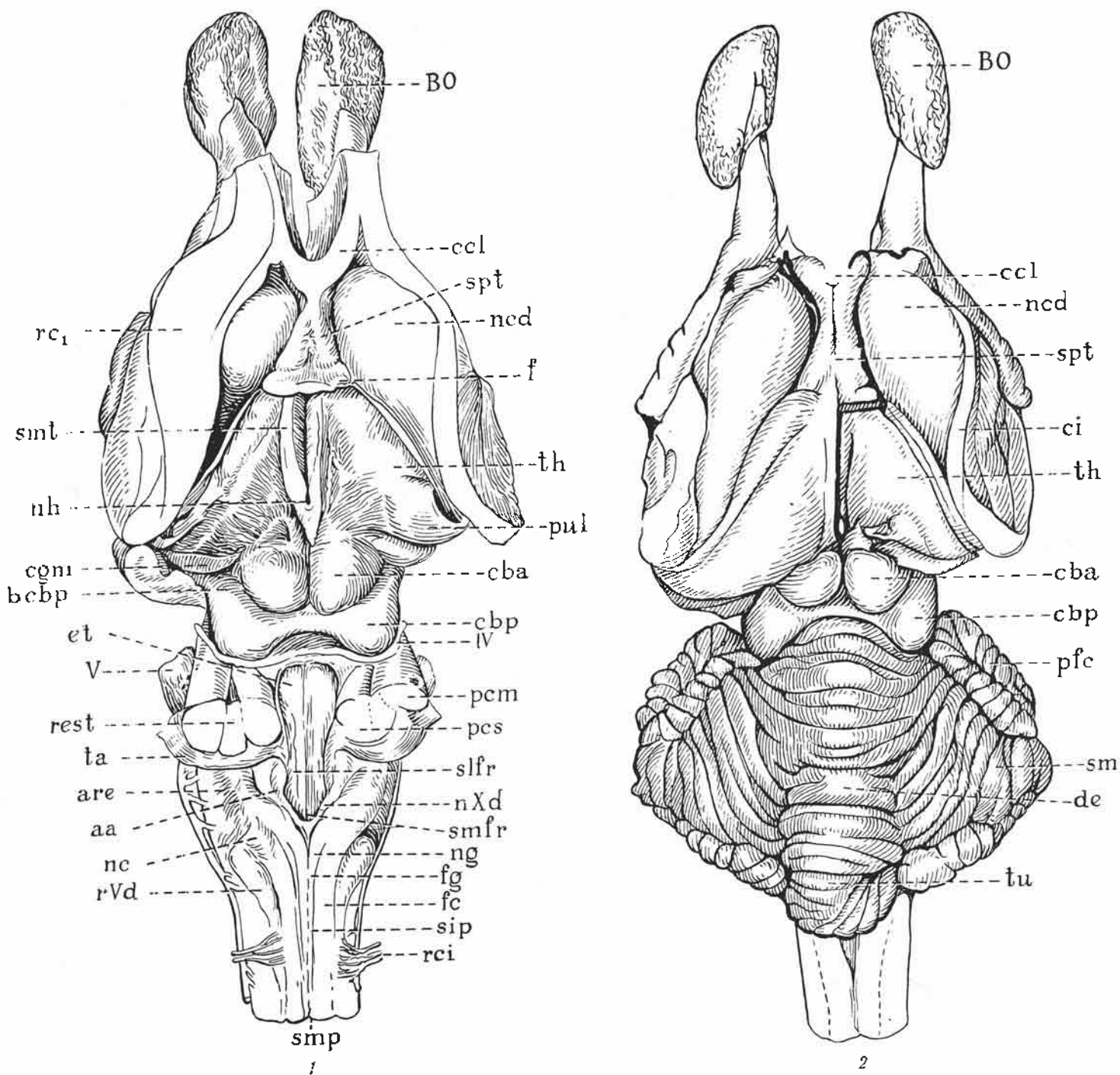Fig. 4.   The Base of the Cerebrum.   Enlargement 2:1

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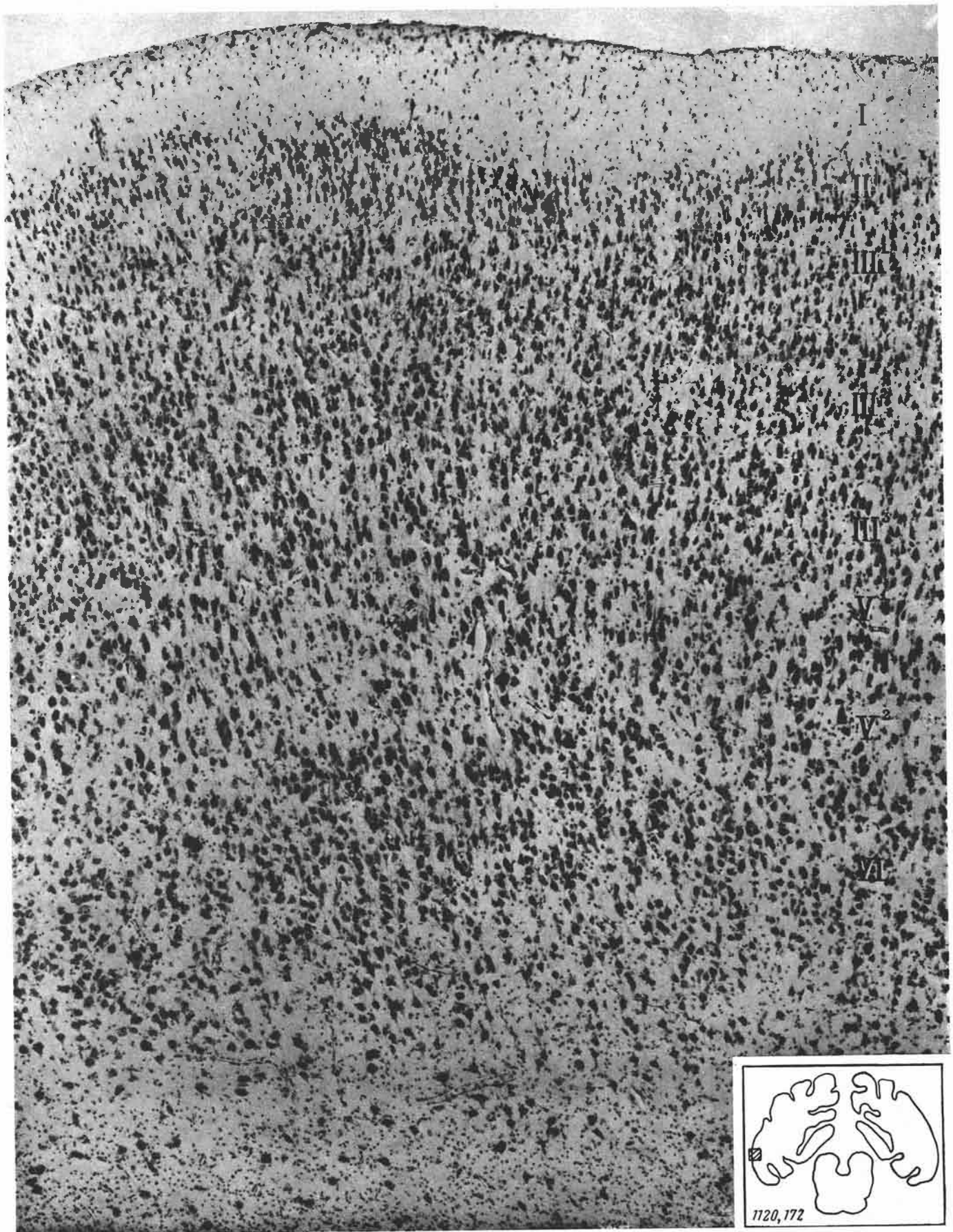Fig. 5. Illustrations 1 and 2 Depict the Dorsal Surface of the Brainstem (after Papez). Enlargement 2.5:1

Fig. 69. Area PI₁. Enlargement 82:1

Area PI$_2$ (Area Parainsularis Secunda)

(Fig. 70)

Area PI$_2$ is located on the external surface of the hemisphere in the superior part of the sylvian gyrus, in the shape of a horseshoe, above area I$_1$ and PI$_1$ (Fig. 50 and 51). The anterior, superior, and posterior boundaries extend deep within the ectosylvian sulcus, separating area PI$_2$ from areas TPC, T$_3$, and T$_2$. The inferior boundary extends across the surface of the sylvian gyrus, parallel to the ectosylvian sulcus.

Area PI$_2$ has a wide cortex (about 2.5 mm) with clearly visible radial striations. The upper layers are richer in cells than the lower layers; the lower layers are wider than the upper layers. The majority of the cells of the upper layers are of triangular and pyramidal form. In the lower layers there is a predominance of cells of a rounded and irregular form. The cortex shows striae of cellular accumulations in layer II, III, and V. The transition into white matter is gradual.

Layer I is of medium width.

Layer II consists of a large number of cells of small size. It is clearly isolated from layer III by the translucent stria.

Layer III is wide, rich in cells, and distinctly divided into three sublayers: Sublayers III^1 and III^3 contain somewhat fewer cells than the clearly defined sublayer III^2; sublayer III^2 is composed of larger cells than sublayer III^3.

Layer IV is missing.

Layer V is wide and is divided into two sublayers: Sublayer V^1 is rich in cells of medium size mostly irregular but occasionally triangular, with a few single larger cells; sublayer V^2 is formed by a stria of translucence.

Layer VI is wide and contains a great number of cells of various forms. It is not distinctly separated from layer V, and the number of cells gradually decreases toward the white matter.

Area PI$_2$ differs from area PI$_1$ in the structure of layer III. Sublayers III^1 and III^3 in area PI are less rich in cells than sublayer III^2; area PI$_1$ sublayer III^2 is rather translucent.

In area PI$_2$, as compared with area PI$_1$, layer IV is missing. Also area PI$_2$ is characterized by a finer radial striation. In comparison with area I$_1$, the layers in area PI$_2$ are better differentiated: there is a translucence on the boundary of layers III and III and in sublayer III^3, and a fine radial striation (Fig. 72).

Area PI$_2$ differs from area T$_3$ in that it shows clearer separation of the layers, it has larger cells in layer III and V, and the transition into white matter is gradual rather than abrupt.
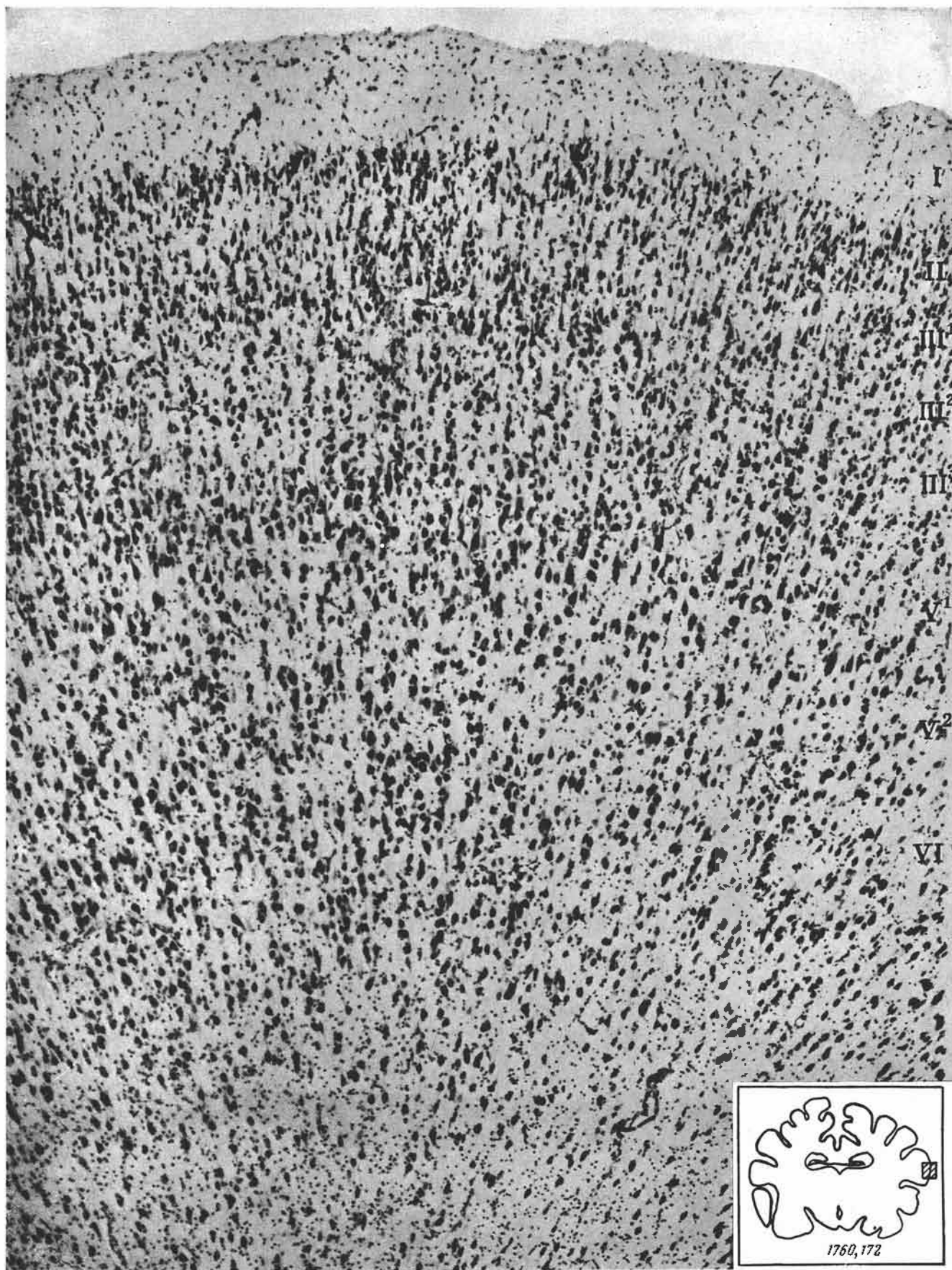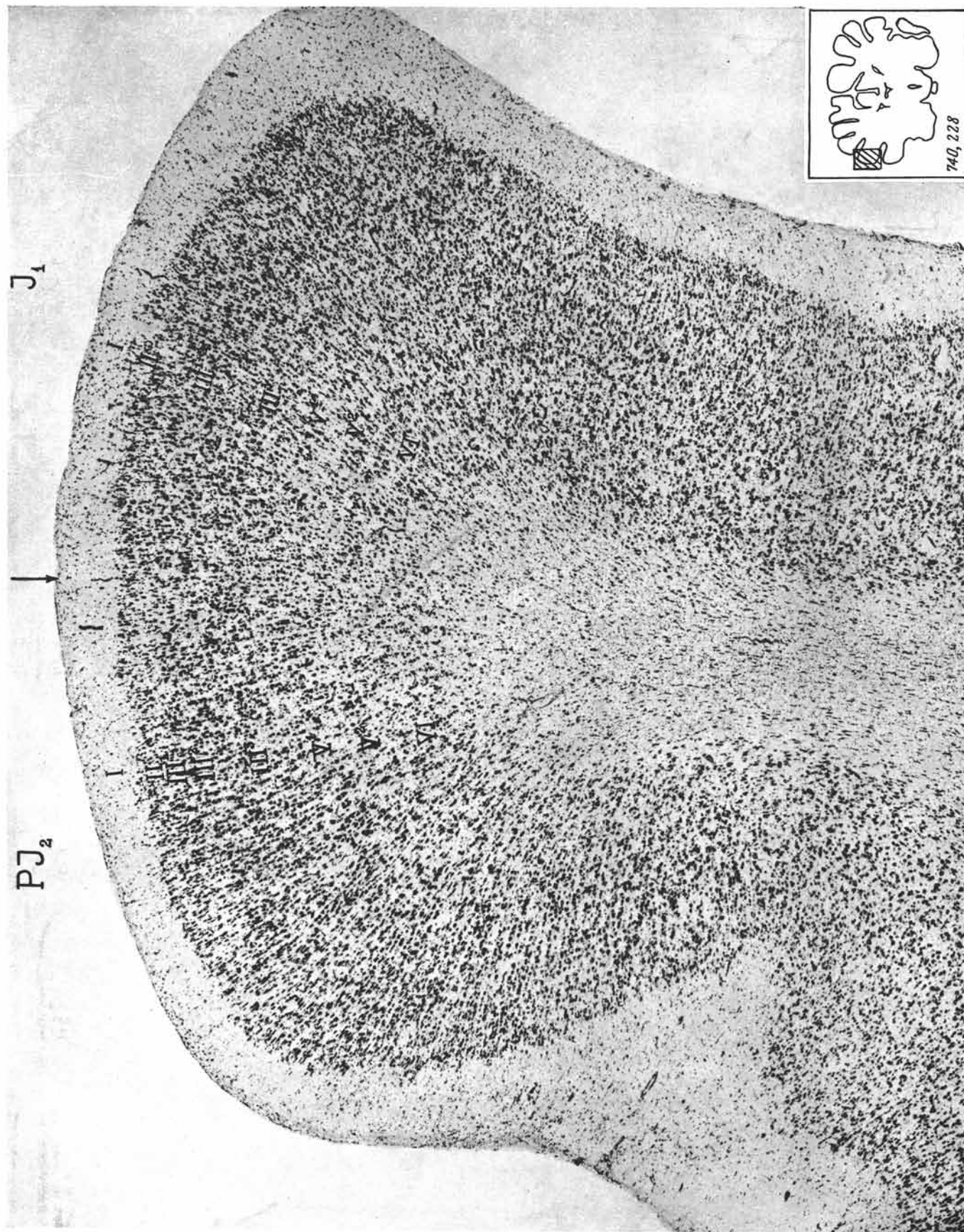
166

Fig. 70. Area PI₂. Enlargement 82:1
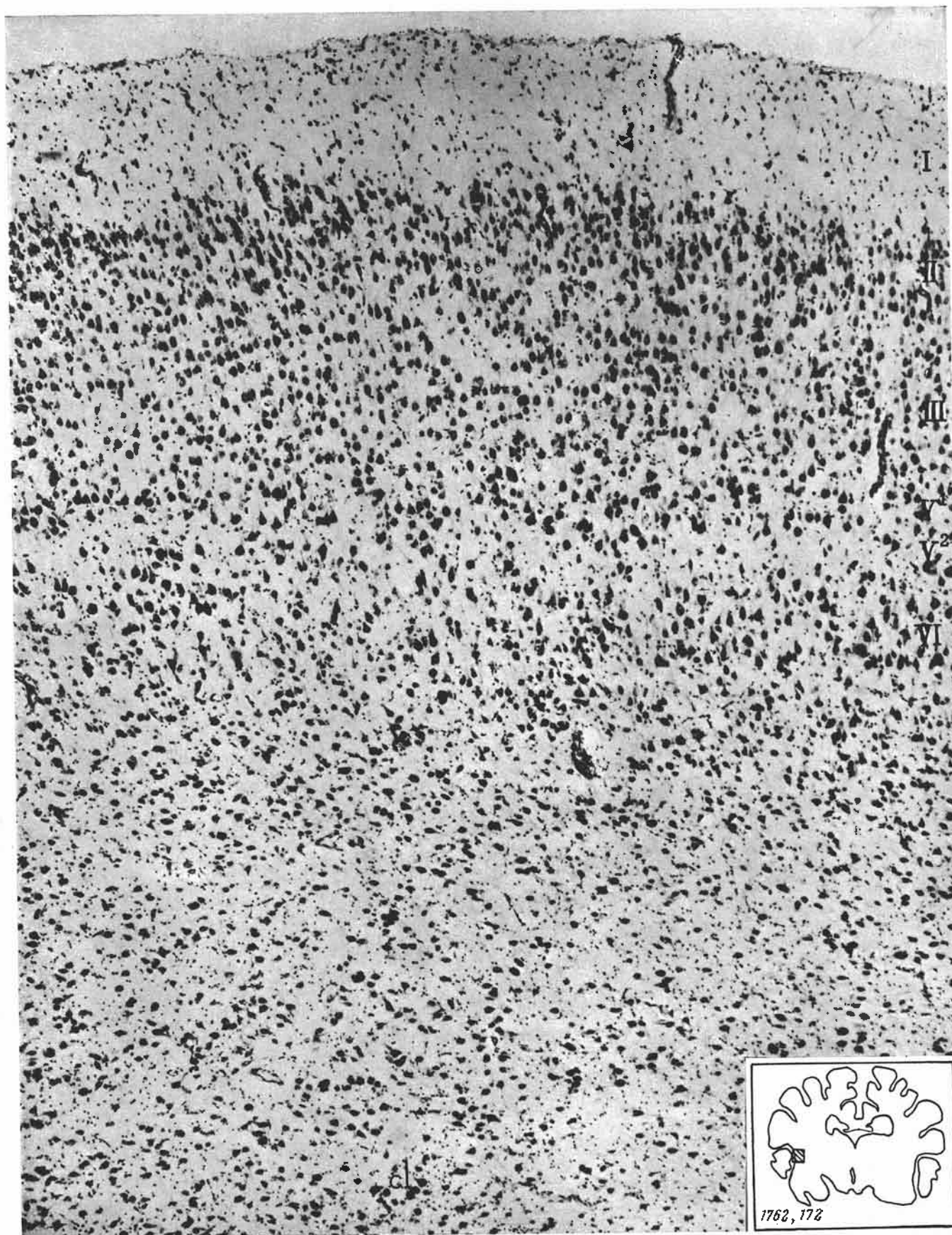
Fig. 71. The Border of Areas I₁ and PI₂. Enlargement 40:1

Fig. 72. Area I₁. Enlargement 82:1

The Postcoronal Region (Regio Postcoronalis)

(Fig. 73-80)

In conformity with the research of Pavlov and his pupils, one has to regard the postcoronal area of the hemispheres (the coronal gyrus, the anterior and partly the middle sector of the ectosylvian gyrus), as the zone of the cutaneous analysor. In this area occurs the analysis and synthesis of so-called cutaneomechanical stimuli (caused by touching the skin, etc.). The relation of this region in the dog to the analysis of temperature and pain stimuli seems debatable.

The connections of the cortical end of the cutaneous analysor have not been sufficiently investigated. It is well known that the postcoronal region receives the fibers from the lateral as well as the ventral group of nuclei of the optic thalamus, where the spinothalamic tract and the medial lemniscus end.

The function of the cutaneo-mechanical analysor was investigated in detail in the laboratories of Pavlov, Krasnogorskiy (1911), Arkhangelskiy (1922), Voskresenskiy (1941), and Kupalov (1926). It is not very difficult to obtain in the dog spacial differentiation of cutaneo-mechanical stimuli at the place of contact. Differentiation of cutaneous irritation through frequency of contact is usually very difficult for the dog.

In case of removal of the zone of the cutaneo-mechanical analysor, one can observe the disappearance for a more or less prolonged time of cutaneo-mechanical conditional reflexes. Gradual restoration of function, which is usually not complete, can possibly be explained by the activity of scattered elements of the analysor. In the removal of the zone of this analysor the greatest damage is done to differentiation of successive cutaneo-mechanical complex stimuli (Voskresenskiy, 1941).

Krasnogorskiy determined that in the dog the centers of cutaneo-mechanical and motor analysors are topographically delimited. At the same time, since both analysors play a basic role in the realization of motor reactions, and since in the case of removal of one of them the activity of the other is often interrupted (Rosenthal, 1938; Asratian, 1935; Anokhin and Chernevskiy, 1935; Zhuravliov, 1940) one has to admit the possibility of an especially wide and close overlapping of the central zones of the cutaneo-mechanical and motor analysors in the cortex of the hemispheres of the canine and other carnivora. Another indication of this is the closeness of the structures of the areas of the postcoronal region and the areas of the precoronal region (the center of the motor analysor) and finally the electrophysiological investigations of somatic sensation in the dog and cat (Dusser de Barenne and McCulloch, 1938; Marshall, Woolsey and Bard, 1941; Woolsey, 1947; Robiner, 1950; Hamuy, Bromiley and Woolsey, 1950; Zubek, 1952; Scherrer and Oeconomos, 1955; and others).

According to our investigations, the postcoronal region occupies the coronal gyrus, the anterior sections of the lateral suprasylvian and ectosylvian gyri. This region has four areas of its own: Pc1, Pc2, Pc3, Pc4, and area TPc, a transitional area toward the temporal region.

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All the areas of the postcoronal region have a cortex rich in cells. The cortex is of medium width with a clear stria of translucence in layer V. There can be observed, against the general background of small cells, a considerable number of large cells of pyramidal form in layer III, and especially large cells, closer in size to the pyramidal cells of Betz, in layer V. A great number of large pyramidal cells are in areas Pc_1 and Pc_2, and also in the transitional area TPc. All areas are characterized by a sharply defined boundary with white matter.

Area Pc_1 (Area Postcoronalis Prima)

(Fig. 73)

Area Pc_1 is located on the external and medial surface of the hemisphere, occupying the posterior part of the coronal gyrus and the anterior section of the marginal gyrus (Fig. 50 and 51). On the external surface of the hemisphere, the lower boundary passes across the anterior sector of the suprasylvian sulcus, separating area Pc_1 from area TPc; the anterior boundary (with area Prc_1 and Pc_2) and the posterior boundary (with area P) extend over the free surface of the above mentioned gyri. On the medial surface of the hemisphere, the inferior boundary extends in the depth of the anterior portion of the splenial sulcus (separating area Pc_1 from the limbic areas).

The cortex of this area is rich in cells, especially in the upper portion. The basic mass of cells are of an irregular and polyangular form. A subdivision of the cortex into layers is clearly visible. There are a great number of large cells in layers III and V, similar in size to the pyramidal cells of Betz in layer V. In the lower layers there is a clearly defined radial striation. The boundary with white matter is abrupt. The diameter of the cortex averages 1.7 mm.

Layer I is narrow and relatively rich in cells.

Layer II is narrow, rich in cells, mostly of small size and rounded and irregular form. It is rather clearly separated from layer III.

Layer III is wide; the size of its cells increases as one penetrates deeper into the layer. This makes it possible to divide this layer into three sublayers: Sublayer III^1 contains small cells of a pyramidal and polyangular form; sublayer III^2 is formed of larger cells than sublayer III^1, in sublayer III^3 there are sometimes large cells of a triangular and an irregular form.

Layer IV contains small cells of irregular form. It is penetrated by the cells of layers III and V.

Layer V is not wide, and is divided into two sublayers: Sublayer V^1 contains numerous very large cells occurring in groups or singly, and similar in size and form to the gigantic pyramidal cells of Betz; sublayer V^2 has few cells.

Layer VI is of medium width and contains a great number of medium-sized, triangular and spindle-shaped cells, arranged in radial rows.

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Of all postcoronal areas, area Pc_1 has the most cells and contains the greatest number of large cells. Area Pc_1 differs greatly in structure from the adjoining area P. Area Pc_1 contains a great number of cells, especially in layers II and III. Its cells are much larger than the cells in area P. Layer V contains very large cells similar in size to the gigantic pyramidal cells of Betz.
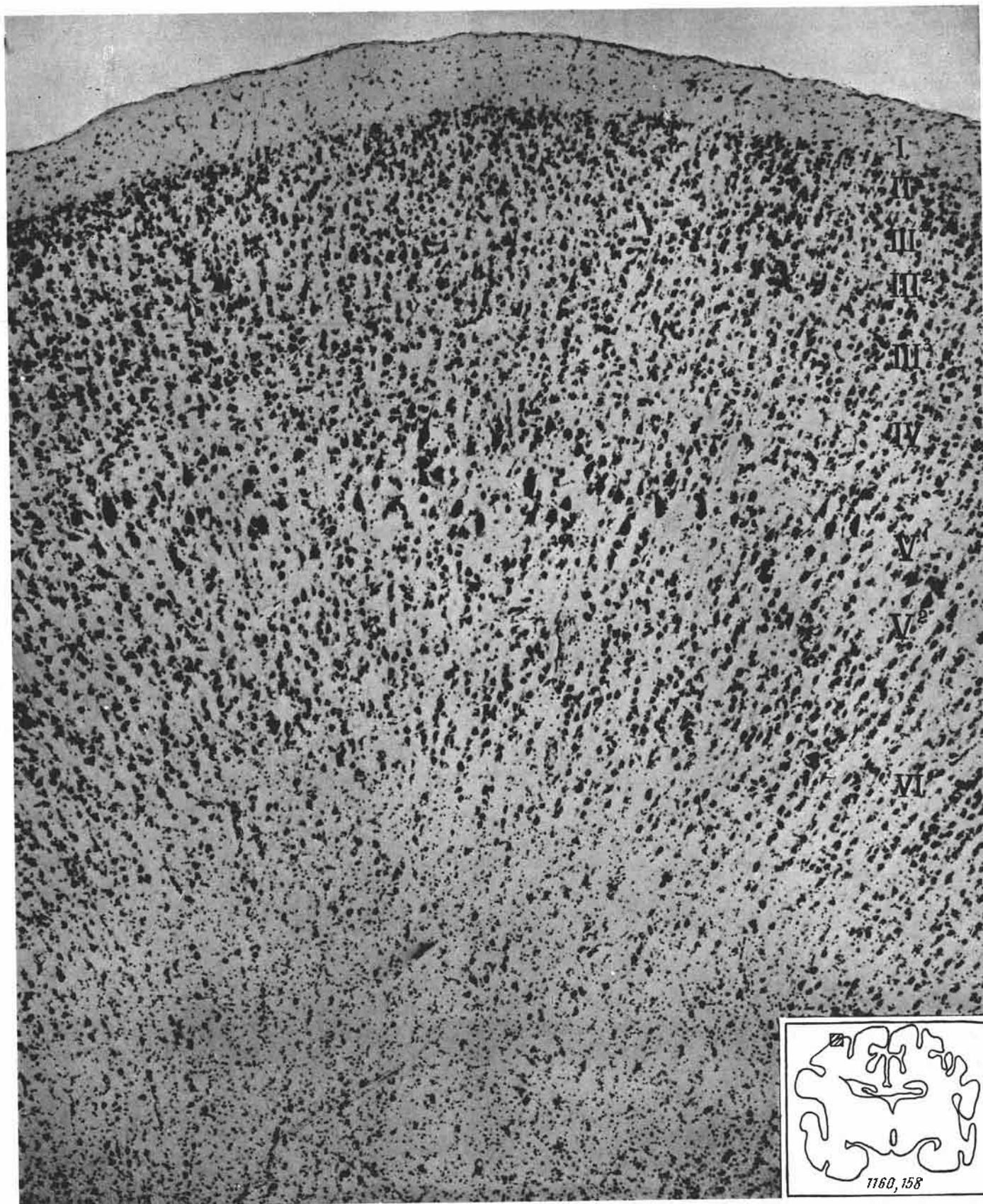
Fig. 73. Area Pc₁. Enlargement 82:1

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Area Pc2 (Area Postcoronalis Secunda)

(Fig. 74)

Area Pc2 is located in the middle portion of the coronal gyrus (Fig. 50 and 51). The lower boundary, separating area Pc2 from area TPc, extends along the anterior section of the suprasylvian sulcus. The superior boundary is in the depth of the coronal sulcus; the anterior (with area Pc3) and the posterior (with area Pc3) boundaries extend over the free surface of the coronal gyrus.

Of all postcoronal areas, area Pc2 has the smallest number of cells. The cortex of this area is of medium width (1.8 mm). The upper part is relatively rich in cells and the lower part is rarefied and somewhat wider. By far the greatest number of cells of layers II, III, and V are of a triangular and pyramidal form. Layers IV and VI are composed of rounded and spindle-shaped cells. Layer V contains single, very large cells of a pyramidal form. Radial striations are more distinct in the lower level.

Layer I is narrow and relatively rich in cells.

Layer II is narrow and is composed of small triangular and irregular cells. It is well separated from layer III by a stria of translucence.

Layer III is of medium width and is divided into two sublayers: Sublayer III^{1+2} has fewer small and medium sized cells; sublayer III^3 contains a great number of large cells of a pyramidal form.

Layer IV is poorly developed. It is penetrated by large cells of layers III and V.

Layer V is wide and has few cells. One finds in it single very large cells of a pyramidal form.

Layer VI is of medium width and is relatively rich in cells of small and medium size, arranged in columns. It is well separated from the less dense layer V.

Area Pc2 differs from area Pc1 in that it has fewer cells, less pronounced differentiation of the layers, larger cells in layer III and fewer very large cells in layer V (Fig. 79).
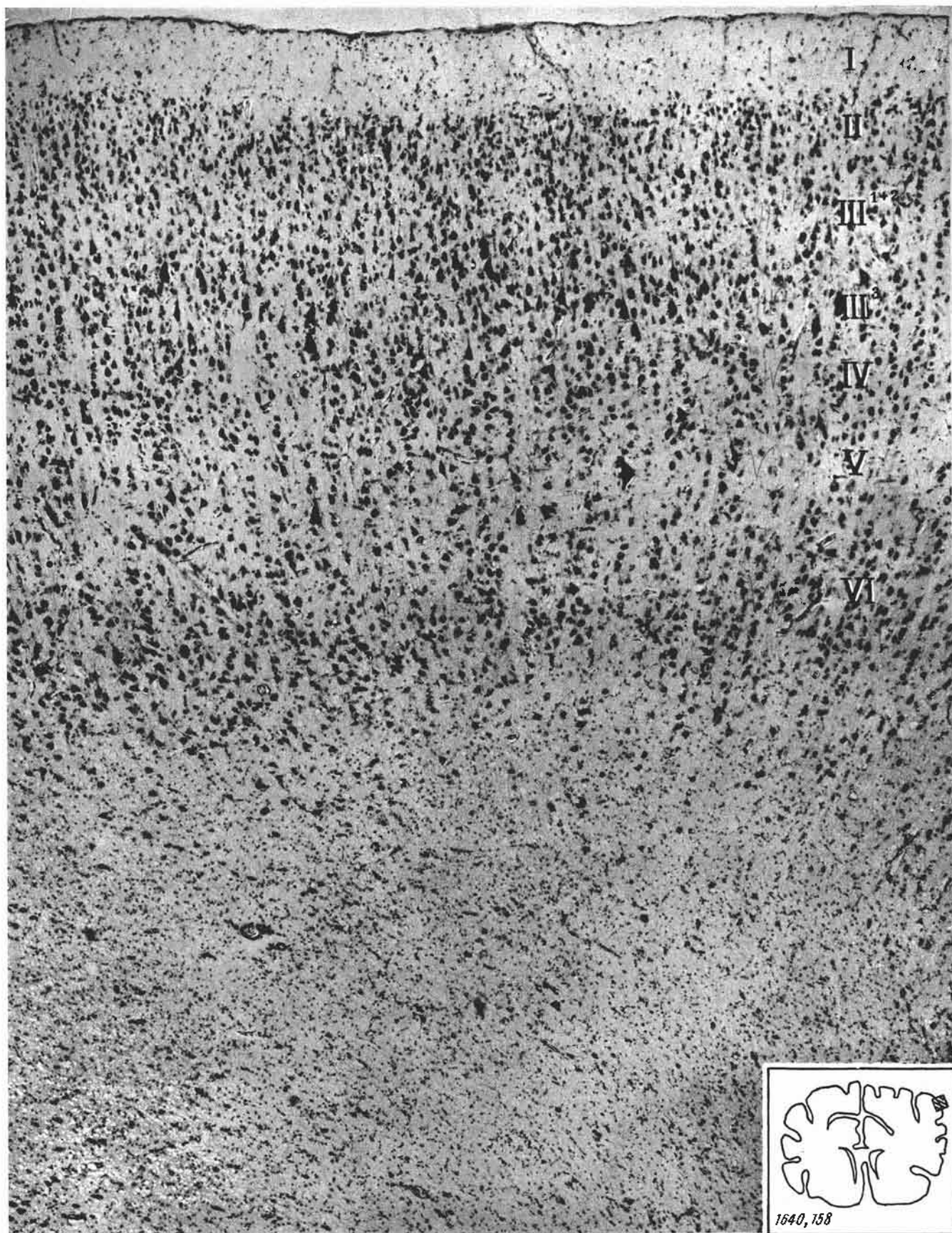
174

I,

II

III[1-2]

III[3]

IV

V

VI

1640, 158

Fig. 74. Area Pc2. Enlargement 82:1

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Area Pc₃ (Area Postcoronalis Tertia)

(Fig. 75)

Area Pc_3 lies in the anterior portion of the coronal gyrus (Fig. 50 and 51). The superior boundary (with area Prc_1) extends along the coronal sulcus; the posterior boundary (with area Pc_2) is along the free surface of the coronal gyrus; the inferior boundary (with area Pc_4) is partly along the anterior sector of the suprasylvian sulcus and partly along the free surface of the coronal gyrus.

The width of the cortex of area Pc_3 is 1.6 mm. The upper portion (especially layers II and III) is rich in cellular elements of various forms; the lower portion is less rich in cells. One finds rather large cells in layer III and V, closer in form to the pyramidal cells, but there are fewer of them than in areas Pc_1 and Pc_2. The cortex is characteristic for its radial striation, which extends over all layers, for an abrupt boundary with white matter, and for a clearly expressed stria of translucence in layer V.

Layer I is narrow and rich in cells of a rounded form.

Layer II consists of a great number of small cells, mostly of irregular form and is poorly separated from layer III.

Layer III is rich in cells. Their size increases as one penetrates deeper into this layer. As a result, one can distinguish sublayer III^{1+2}, consisting of cells of small and medium size, and sublayer III^3 consisting basically of large cells.

Layer IV is narrow and is composed of cells of predominantly rounded and irregular form. It is penetrated diffusely by cells of layers III and V.

Layer V is rarefied and composed of medium sized cells. One also finds in it single large and even gigantic cells of a pyramidal form.

Layer VI is rich in cells of various forms; it is distinctly separated from layer V.

Area Pc_3 differs from area Pc_2 in that it has fewer large cells in layers III and V, more cells in the upper portions, and a clearer isolation of layer IV.
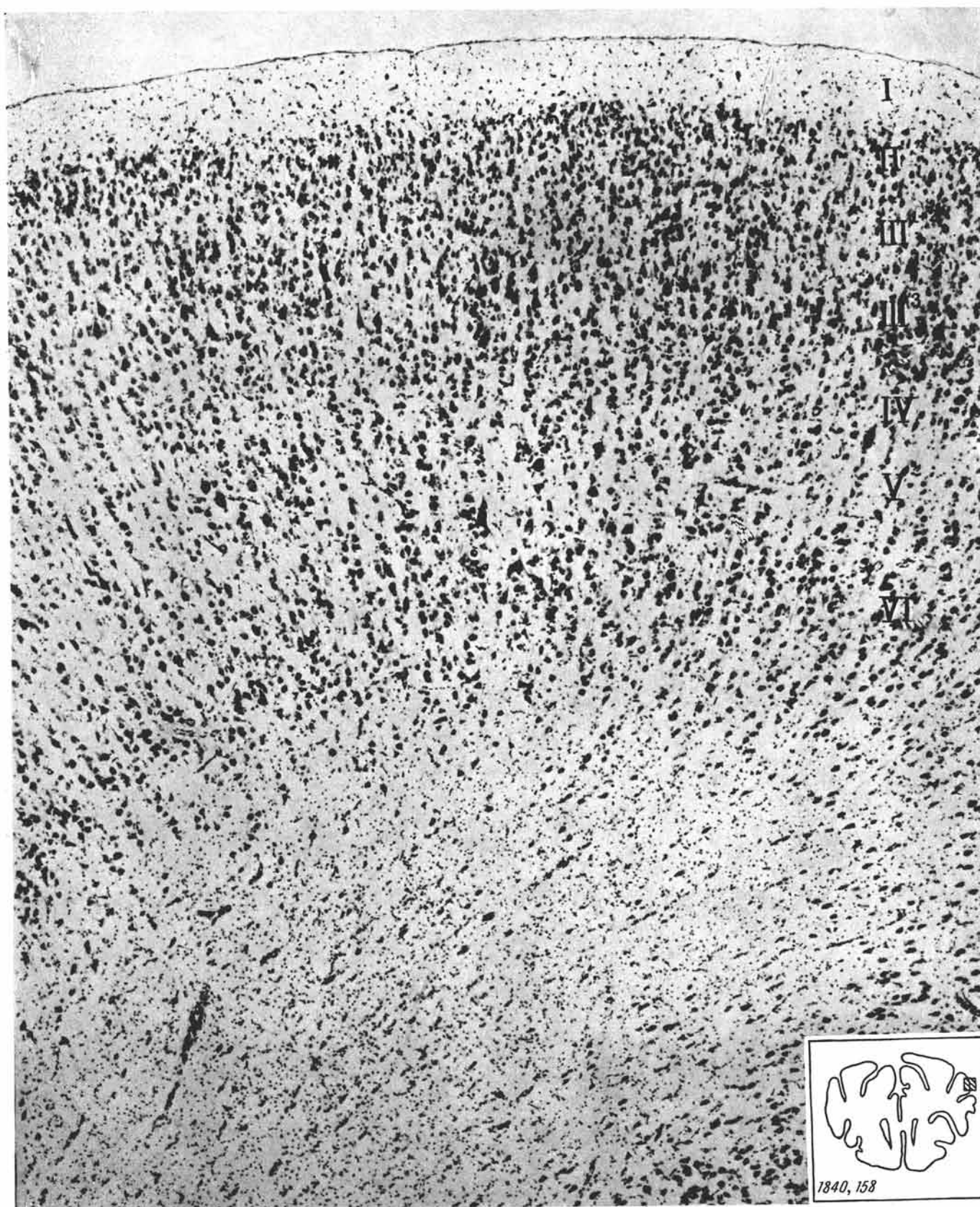
176

Fig. 75. Area Pc3. Enlargement 82:1

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Area Pc4 (Area Postcoronalis Quarta)

(Fig. 76, 77)

Area Pc4 lies in the anterior sections of the ectosylvian and sylvian gyri (Fig. 50 and 51). The anterior boundary (with area Prc_2) extends partly along the presylvian sulcus and partly along the free surface of the ectosylvian gyrus parallel to the presylvian sulcus. The superior boundary (with area Pc_2) coincides with the anterior portion of the suprasylvian sulcus; the posterior (with area TPc) and inferior (with area I_1) boundaries extend over the free surface of the ectosylvian and sylvian gyri.

Area Pc4 can be divided into two subareas: Pc^s_4 (subarea postcoronalis quarta superior) and Pc^i_4 (subarea postcoronalis quarta inferior).

Subarea Pc^{s}4 (Subarea Postcoronalis Quarta Superior)

(Fig. 76)

Subarea Pc^s_4 is characterized by a cortex of medium width (1.8 mm), rich in cells. The upper portion is much wider than the lower and contains a great number of cells, mostly of triangular and less frequently of an irregular form. In layers III and V there are large cells of a pyramidal form but there are fewer of them and they are smaller than in the corresponding layers of areas Pc_1, Pc_2, and Pc_3. The radial striations extend across the entire diameter of the cortex. The boundary with white matter is clearly defined.

Layer I is of medium width and contains fewer cells than areas Pc_1, Pc_2, and Pc_3.

Layer II is composed of small, densely grouped cells, and as a result it is well separated from layer III which is less rich in cells.

Layer III is wide and consists of two sublayers: Sublayer III^{1+2} contains fewer and smaller cells than sublayer III^3; sublayer III^3 is rich in cells of medium size. One finds in them single large cells of a pyramidal form.

Layer IV is composed of a considerable number of smaller cells of a rounded form. The separation from layers III and V is less abrupt.

Layer V is of medium width and is divided into two sublayers: Sublayer V^1 is rich in cells and contains single large cells of a pyramidal form; sublayer V^2 has fewer cells.

Layer VI is rich in cells of medium size and of a rounded and irregular form. It is well separated from layer V, which has fewer cells.
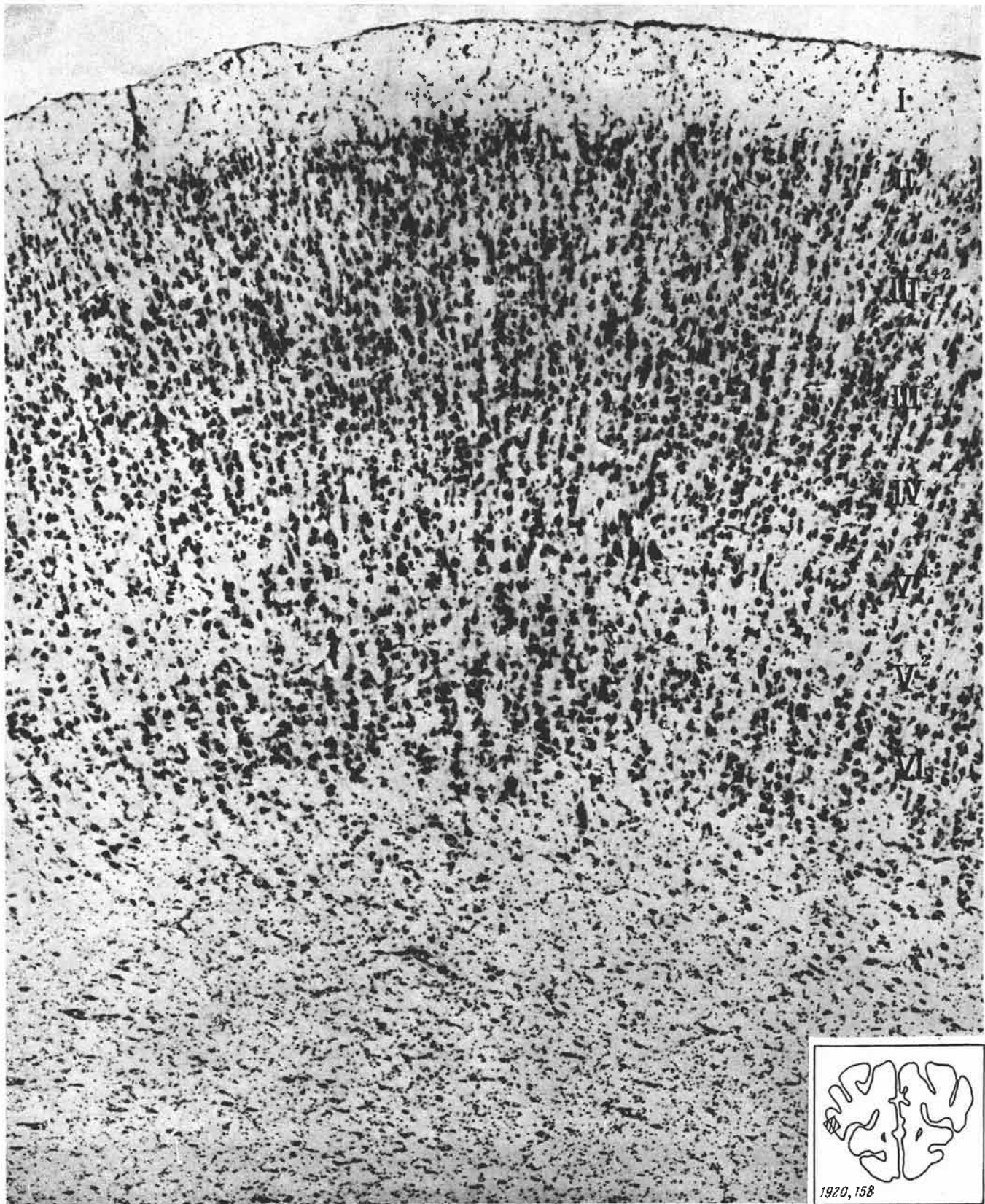
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Fig. 76. Subarea Pcs4. Enlargement 82:1

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II - nervus opticus
III - nervus oculomotorius
IV - nervus trochlearis
V - nervus trigeminus
VI - nervus abducens
VII - nervus facialis

VIII - nervus statoacusticus
IX - nervus glossopharyngeus
X - nervus vagus
XI - nervus accessorius
XII - nervus hypoglossus

A

a   -processus acominis
aa   -area acustica
am   -amygdala
an   -sulcus ansatus
and -nucleus anterodorsalis
anm -nucleus anteromedialis
anv -nucleus anteroventralis
ap   -area postrema
are -fibrae arcuatae externae
area -fibrae arcuatae externae anteriores
arep -fibrae arcuatae externae posteriores
ari -fibrae arcuatae internae
aS   -aqueductus Sylvii s. cerebri
asp -ramus ascendens sulci splenialis

B

bb   -"bigeminal body"
bcbp -brachium corporis bigemini
        posterioris
BO   -bulbus olfactorius

C

c   -central group of cells of the anterior horn of the spinal cord
C   -gyrus cinguli
ca   -cornu anterius
caa -commissura alba anterior
CA, CAi, CAs, CAp. h^1, h^2, h^3, h^4, h^5 - cornu Ammonis et area cornu Ammonis
cag -commissura grisea anterior
cal -calamus scriptorius
can -commissura anterior
cba -corpus bigeminum anterius
cbp -corpus bigeminum posterius
cc   -canalis centralis
ccba -commissura corporis bigemini anterioris
ccbp -commissura corporis bigemini posterioris
ccgm -capsula corporis geniculatum medialis
ccl -corpus callosum
ce   -capsula externa
cer -cerebellum
cex -capsula extrema
cf   -columna fornicis
cgl -corpus geniculatum laterale

cgm -corpus geniculatum mediale
ch   -chiasma nervorum opticorum
ci   -capsula interna
cl   -cornu lateralis
cL   -corpus Luysi
cla -columna anterior
cll -columna lateralis
clp -columna posterior
cls -claustrum
cm   -commissura grisea media
cmd -centrum medianum Luysi
cml -nucleus lateralis corporis mamillaris
cmm -nucleus medialis corporis mamillaris
cmp -commissura posterior
cnl -nucleus centralis lateralis thalami optici
cnm -nucleus centralis medialis thalami optici
cor -sulcus coronalis
Cor -gyrus coronalis
cp   -cornu posterius
cpg -commissura grisea posterior

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ctr-corpus trapezoides
cr -sulcus cruciatus
cu -culmen

D
D -regio diagonalis D
D1, D2 - areae regio diagonalis
de -declive
dF -decussatio Foreli
dg -sulcus diagonalis
dlm-decussatio lemniscorum medialium
dM -decussatio Meynerti s. decussatio
    tecto-spinalis
dpy-decussatio pyramidum
dW -decussatio pedunculorum cerebelli
    anteriorum s. decussatio Wernekinki

E
E, ea, ea^l, epr, epr^o, epr^l, epr^{la}, epr^{lam}
    epr^{le}, ep, eps, eta, etl, etp - area
    regio entorhinalis
ecl-sulcus ectolateralis
Ecl-gyrus ectolateralis
egn-sulcus ectogenualis
enl-sulcus entolateralis s. fissura
    confinis
Enl-gyrus entolateralis
Ep -epiphysis
es, esa, esm, esp-sulcus ectosylvius (es),
    anterior (esa), medius (esm),
    posterior (esp)
Es, Esa, Esm, Esp-gyrus ectosylvius (Es),
    anterior (Esa), medius (Esm),
    posterior (Esp)
et -eminentia teres

F
f -fornix
F1, F2, F3, F4-area frontalis prima,
    secunda, tertia, quarta
fa -nucleus filiformis anterior
FD, FDs, FDi-fascia dentata
fc -funiculus cuneatus
fct-fasciculus centralis tegmenti
fg -funiculus gracilis
fhp-fasciculus habenulo-peduncularis
fin-fossa interpeduncularis
fl -flocculus
F-L$_2$-subarea frontolimbica
flc-fissura longitudinalis cerebri
flp-fasciculus longitudinalis posterior,
    s. medialis
fM -foramen Monroi

fma-fissura mediana anterior
fmt-fasciculus mamillo-thalamicus
    Vicq d'Azyri
foc-fibrae olivo-cerebellares
fp -nucleus filiformis principalis
fpm-fissura paramediana
fpr-fissura prima
frM-fasciculus retroflexus Meynerti
frs-fasciculus rubro-spinalis
fs -fissura secunda
fscd-fasciculus spino-cerebellaris
    dorsalis Flechsigi
fscv-fasciculus spino-cerebellaris
    ventralis Gowersi
fsl-tractus s. fasciculus solitarius
fsp-fasciculus striopeduncularis
fsth-fasciculus spino-thalamicus
fts-fasciculus tecto-spinalis
fvc-fasciculus vestibulo-cerebellaris

G
G -gyrus genualis
GVII-genu nervi facialis
gc -substantia grisea centralis
gen-genu corporis callosi
gi -ganglion interpedunculare
gn -sulcus genualis

H
h$_1$, h$_2$ . . . - (cm. CA)
H$_1$ -fasciculus thalamicus Foreli
H$_2$ -fasciculus lenticularis Foreli
hip-fissura hippocampi s. sulcus
    cornu Ammonis
hp -nucleus tractus habenulo-
    peduncularis
hpa-nucleus hypothalamicus anterior
hpf-nucleus perifornicalis
hpl-area hypothalamica lateralis
hpmd-nucleus hypothalamicus dorso-
    medialis
hpmv-nucleus hypothalamicus ventro-
    medialis
hpp-nucleus hypothalamicus posterior
hpr-area praeoptica hypothalami
hprl-area praeoptica hypothalami
    lateralis
hprm-area praeoptica hypothalami
    medialis
hps-ramus horizontalis posterior
    sulci splenialis
hyp-hypophysis

I

I_1, I_2-area insularis prima, secunda
iam -nucleus interanteromedialis thalami optici
imd -nucleus intermediodorsalis thalami optici
in -infundibulum
ipr -sulcus interprorealis s. sulcus intraorbitalis

L

l   -sulcus lateralis
L_1, L_2-area limbica prima, secunda
lc   -lobulus centralis
li   -lingula
ll   -lemniscus lateralis
lm   -lemniscus medialis
lmd -lamina medullaris
lmi -sulcus lateromedialis inferior
lms -sulcus lateromedialis superior
lmt -nucleus limitans
lp   -sulcus limitans posterior
lpm -lobulus paramedianus
lqd -lobulus quadrangularis
lsm -lobulus semilunaris
lta -pars anterior nucleus lateralis thalami optici
lti -pars intermedia nucleus lateralis thalami optici
ltp -pars posterior nucleus lateralis thalami optici

M

m   -inner group of cells of the anterior horn of the spinal cord
md   -nucleus medialis dorsalis
mo   -medulla oblongata

N

nIII-nucleus nervi oculomotorii
nIIIE-nucleus Edinger-Westphali
nIIIm-nucleus motorius nervi oculomotorii
nIIIP-nucleus Perlia
nIV -nucleus nervi trochlearis
nVa -nucleus radicis ascendentis (s. mesencephalicus) nerve trigemini
nVd -nucleus radicis descendentis nervi trigemini
nVm -nucleus motorius nervi trigemini
nVs -nucleus sensibilis nervi trigemini
nVI -nucleus nervi abducentis
nVII-nucleus nervi facialis

nVIIIcv-nucleus s. ganglion ventralis nervi cochlearis
nXa -nucleus ambiguus nervi vagi
nXd -nucleus dorsalis nervi vagi
nXId-nucleus dorsalis nervi accessorii
nXIv-nucleus ventralis nerve accessorii
nXII-nucleus nervi hypoglossi
na -nucleus album
narc-nucleus arcuatus
nB -nucleus angularis Bechterevi
nc -nucleus funiculi cuneati
nC -nucleus interstitialis Cajali
nc₁ -nucleus nervi cervicalis primus
nca -nucleus interstitialis commissurae anterioris
ncd -nucleus caudatus
nce -nucleus externus funiculi cuneati
ncp -nucleus commissurae posterioris
ncr -nucleus centralis formatio reticularis
nct -nucleus centralis tegmenti
nD -nucleus Deitersi
ndn -nucleus dentatus
nDr -nucleus Darkschewitschi
ndv -nucleus radicis descendentis nervi vestibularis
neb -nucleus emboliformis
nfs -nucleus fastigii
ng -nucleus funiculi gracilis
ngb -nucleus globosus
ngc -nucleus giganto-cellularis
nh -nucleus habenulae
nhl -nucleus lateralis habenulae
nhm -nucleus medialis habenulae
nin -nucleus intercalatus
nll -nucleus lemniscus lateralis
nlt -nucleus lateralis medullae oblongatae s. nucleus lateralis reticularis
nod -nodulus
npar-nucleus paraventricularis
npc -nucleus pontis caudalis
npd -nucleus peripeduncularis
npo -nucleus pontis oralis
npp -nuclei proprii pontis
nr -nucleus ruber
nR -nucleus Rolleri
nret-nucleus reticularis thalami optici
nsl -nucleus tractus solitarius
nsp -nucleus supraopticus diffusus

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nst -nucleus interstitialis stria
 terminalis
ntr -nucleus triangularis
nvest-nuclei nervi vestibularis

O

O$_1$, O$_2$-area occipitalis prima, secunda
o -oliva
oi -oliva inferior
oid -oliva inferior accessoria dorsalis
oin -sulcus occipitalis inferior
oiv -oliva inferior accessoria ventralis
Ol -gyrus olfactorius lateralis
Om -gyrus olfactoris medialis
OP -area occipito-parietalis
or -sulcus orbitalis
Or -gyrus orbitalis
os -oliva superior
osl -oliva superior lateralis
osm -oliva superior medialis
ot -sulcus occipito-temporalis

P

p -sulcus posticus
P -area parietalis
pas -ramus praeascendens sulci splenialis
Pas -parasubiculum
Psb, Psb$_1$, Psb$_2$-area regio praesubicularis
Pc$_1$, Pc$_2$, Pc$_3$, Pc$_4$-area postcoronalis:
 prima, secunda, tertia, quarta
Pcs$_4$, Pci$_4$-subarea quarta superior et
 inferior
pc -pedunculi cerebri
pci -pedunculi cerebelli inferior s. pedun-
 culi cerebelli ad medullam oblongatum
pcm -pedunculi cerebelli medius, s.
 pedunculi cerebelli ad pontem
pcn -nucleus paracentralis
pcs -pedunculi cerebelli superior s.
 pedunculi cerebelli ad corpora
 quadrigemina
pe -pallidum externum
per -massa periventricularis
pev -sulcus praectolateralis verticalis
pfl -paraflocculus
PJ$_1$, PJ$_2$-area parainsularis prima et
 secunda
pi -pallidum internum
Pi -gyrus piriformis
pl -sulcus postlateralis
pm -pedunculi corporae mamillariae

Pm, Pmm, Pml^1, Pml^2-areae regio
 periamygdalaris
post-nucleus posterior thalami optici
pp -pes pedunculi cerebri
Pp, Pp^1, Pp^2, Ppo^I, Pp^o, Pp^{oo}, Pp^I_e,
 Pp^I_i, Pp^{Ia}-areae et subareae regio
 praepiriformis
pr -sulcus proreus
Pr -prorea s. gyrus proreus
pra -nucleus paraventricularis anter-
 ior
Prc$_1$, Prc$_2$-areae praecoronalis prima
 et secunda
Prc$_2$-L$_2$-subarea praecoronalis limbica
prcr-sulcus praecruciatus
prf -nucleus parafascicularis thalami
 optici
prs -sulcus praesylvius
prp -nucleus paraventricularis posterior
Prspl-gyrus praesplenialis
prt -area praetectalis
Psb -regio praesubicularis
Psb^1, Psb^2-areae regio praesubicularis
pscr-sulcus postcruciatus
Pspl-gyrus postsplenialis
pssp-sulcus praesuprasplenialis
pt -nucleus parataenialis
Pt$_1$, Pt$_2$, Pt$_3$-area peritectalis prima,
 secunda et tertia
pul -pulvinar thalami optici
put -putamen
py -pyramis, fasciculus pyramidalis
pyr -pyramis vermis cerebelli
pV -pons Varolii

R

r -raphe
R -gyrus rectus
RIII-radix nervi oculomotorii
rV -radix nervi trigemini
rVd -radix descendentis nervi
 trigemini
rVl -radix nervi abducentis
rVII-radix nervi facialis
rVIIIc-ramus cochlearis nervi acustici
rVIIIv-ramus vestibularis nervi
 acustici
rXII-radix nervi hypoglossi
Rb -regio retrobulbaris
rc -radix nervi cervicalis
rdv -radix descendesn nervi
 vestibularis
rest-corpus restiforme

ret -formatio reticularis
reu -nucleus reuniens thalami optici
rha -sulcus rhinalis anterior
rhm -nucleus rhomboidalis
rhp -sulcus rhinalis posterior
ros -sulcus rostralis
rslp-sulcus retrosplenialis

S

s   -sulcus Sylvii
S   -gyrus Sylvii
sa -striae acusticae
Sa -gyrus Sylvii anterior
sam -stratum album medium corporis
     bigemini anterioris
sap -stratum album profundum corporis
     bigemini anterioris
scc -sulcus corporis callosi
scg -nucleus suprageniculatus
scm -nucleus supramamillaris
Sg -gyrus sigmoideus
Sga -gyrus sigmoideus anterior
sgc -substantia gelatinosa centralis
sgm -stratum griseum medium corporis
     bigemini anterioris
sgp -stratum griseum profundum corporis
     bigemini anterioris
Sgp -gyrus sigmoideus posterior
sgR -substantia gelatinosa Rolandi
sgs -stratum griseum superficiale
     corporis bigemini anterioris
sip -sulcus intermedius posterior
siR -substantia innominata Reicherti
sla -sulcus lateralis anterior
slfr-sulcus lateralis fossae rhomboideae
sln -sulcus longitudinalis
slp -sulcus lateralis posterior
sma -sulcus medianus anterior
smd -nucleus submedius thalami optici
smfr-sulcus medianus fossae rhomboideae
smp -sulcus medianus posterior
smt -stria medullaris thalami
sn -substantia nigra Soemmeringi
snc -substantia nigra (zona compacta)
snr -substantia nigra (zona reticularis)
so -stratum opticum corporis bigemini
     anterioris
Sp -gyrus Sylvii posterior
spa -substantia perforata anterior
spl -sulcus splenialis
Spl -gyrus splenialis
spn -splenium corporis callosi

spp -sulcus praepyramidalis
sprf-nucleus subparafascicularis
     thalami optici
spt -septum pellucidum
ss -sulcus suprasylvius
Ss -gyrus suprasylvius
ssa -sulcus suprasylvius anterior
Ssa -gyrus suprasylvius anterior
ssc -stratum subcallosum
ssm -sulcus suprasylvius medius
Ssm -gyrus suprasylvius medius
ssp -sulcus suprasylvius posterior
Ssp -gyrus suprasylvius posterior
sspl-sulcus suprasplenialis
Sspl-gyrus suprasplenialis
st -stria terminalis
stc -stratum complexum pontis
stp -stratum profundum pontis
sts -stratum superficiale pontis
sz -stratum zonale corporis bigemini
     anterioris
sub -subiculum

T

T_1, T_2, T_3, T_4-areae temporales:
     prima, secunda, tertia, quarta
T_1^s, T_1^i-subarea temporalis prima
     superior et inferior
ta -taenia anterior
tac -tuberculum acusticum
tc -tuber cinereum
TE_1, TE_2-area temporoentorhinalis
     prima et secunda
tg -nucleus tangentialis
th -thalamus opticus
to -tractus opticus
TO -tuberculum olfactorium
TO_1, TO_2-area prima et secunda
     tuberculi olfactorii
TPc -area temporopostcoronalis
tr -sulcus transsecans
trn -truncus corporis callosi
tt -taenia tecta
tub -tuber vermis cerebelli

U

uv -uvula

V

v   -ventral group of cells of the
     anterior horn of the spinal cord
vIII-ventriculus tertius

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vIV -ventriculus quartus
vl -ventriculus lateralis
vmp -velum medullare posterius
vna -pars anterior nucleus ventralis
     thalami opticii
vnar-pars arcuata nucleus ventralis
vne -pars externa nucleus ventralis
vnm -pars medialis nucleus ventralis
vs -fasciculus vestibulo-spinalis

Z
zin -zona incerta
zm -zona marginalis