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AN ASCENDING FIBER PROJECTION PATHWAY FROM THE PONTINE RETICULAR FORMATION TO THE HYPOTHALAMUS IN THE CAT

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THEODORE DEAN MC CLURE

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AN ASCENDING FIBER PROJECTION PATHWAY FROM

THE PONTINE RETICULAR FORMATION TO

THE HYPOTHALAMUS IN THE CAT

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DISSERTATION COMMITTEE

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CHAPTER I

INTRODUCTION

It has been demonstrated that the tegmental reticular nucleus of the pons receives fibers from various areas of the central nervous system. One of these fiber systems is a portion of the descending pathways from the hypothalamus and they have been demonstrated anatomically to occupy two different positions in the brain stem: a medial and a lateral one. The medial pathway, which has been identified only by anatomical methods, passes caudally in the medial forebrain bundle in the anterior midbrain, then turns medially and terminates in the caudal midbrain and anterior pons (Beattle, Brow and Long, 1930; Morin, 1950; Guillery, 1957; Nauta, 1958; Wolf and Suttin, 1966; McClure and Clark, 1968). The lateral pathway has been demonstrated anatomically by its diffusely scattered degeneration throughout the reticular formation of the mesencephalon, pons and upper medulla (Cheatham and Matzke, 1966) and corresponds to the pathway demonstrated neurophysiologically (Kabat, Magoun and Ranson, 1936; Kabat, 1936; Wang and Ranson, 1938; Magoun, Ranson and Heatherington, 1938; Keller and Blair, 1946).

In addition to the above mentioned descending hypothalamic pathways which either terminate in or pass through the tegmental reticular nucleus, numerous investigators utilizing anatomical degeneration procedures have demonstrated other fiber systems which contribute fibers to this nucleus, i.e. (a) from rostral areas: retroflex bundle (Nauta, 1958), dorsal tegmental nucleus (Morest, 1961), sensory I-motor cortex (Zimmerman, et al., 1964) and orbital gyrus (Mizuno, et al., 1968); (b) from caudal areas: nuclei of the dorsal funiculus and spinopontine fibers (Walberg and Brodal, 1953), reticular formation of the medulla (Nauta and Kuypers, 1958), and pyramidal tract at the level of the trapezoid body (Zimmerman, et al., 1964); (c) from the cerebellum: interpositus and dentate nuclei (Cohen, et al., 1958), dentate nucleus (Carpenter and Nova, 1960), and fastigial nucleus (Walberg, et al., 1962).

Utilizing retrograde techniques, Brodal and Jansen (1946) and Brodal (1956) demonstrated chromatolytic changes in the neurons of the tegmental reticular nucleus following decerebellation in the cat. In addition, Brodal and Rossi (1955) failed to demonstrate any chromatolytic changes in these neurons following a hemisection of the brain stem at the di-mesencephalic junction or at the level of the inferior colliculus and pons in the cat. They concluded that the tegemental reticular nucleus projects all of its fibers to the cerebellum and that this nucleus lacks any long ascending and/or descending fibers. In contrast, Cowan, et al. (1964) demonstrated chromatolytic changes in the neurons of this nucleus following lesions placed in or near the mammillary nucleus in the rat, but failed to demonstrate these same chromatolytic changes following similar experiments in the rabbit.

Since projections from so many widely different areas of the central nervous system have been demonstrated by anatomical procedures to terminate within the tegmental reticular nucleus, it was postulated that this nucleus is more than just a cerebellar relay nucleus. Brodal and Jansen (1946) and Brodal (1956) considered that this nucleus projects all of its fibers to the cerebellum, while Cowan, et al. (1964) demonstrated a hypothalamic projection from this nucleus. The present study was undertaken in an effort to ascertain whether ascending fibers originate from the tegmental reticular nucleus of the pons in the cat.

CHAPTER II

MATERIALS AND METHODS

In 16 adult cats, under nembutal anesthesia, small electrolytic lesions were placed in the rostral portion of the pons with the aid of a stereotaxic instrument. The electrode passed through the inferior colliculus just rostral to the edge of the tentorium and medial to the brachium conjunctivum.

On the 8th post-operative day, lethal doses of nembutal were administered, then 500 ml of 8.5% sucrose followed by 500 ml of 10% formalin containing 7.5% sucrose were injected into the left ventricle of each animal. The brains were immediately removed and then stored in 10% formalin for at least 1 month before further processing.

The brains were sectioned by frozen technique at 35 μ in the sagittal plane. At least every 10th section was impregnated by the method of Nauta (1957). Other sections were stained either with cresyl violet acetate or with Weil's iron hematoxylin to aid in the localization of the lesions.

CHAPTER III

OBSERVATIONS

Suitable lesions were obtained in 12 animals. On the basis of the position of these lesions, the experimental material was divided into four different groups: (A) lesion in the rostral portion of the tegmental reticular nucleus; (B) lesion in the central portion of the tegmental reticular nucleus and the ventral portion of the nucleus reticularis pontis oralis; (C) lesion in the posterior portion of the tegmental reticular nucleus and the ventral portion of the nucleus reticularis pontis caudalis; (D) lesion in the central portion of the tegmental reticular nucleus and the dorsal portion of the nucleus reticularis pontis caudalis. In addition to the above mentioned structures, all of the lesions included the medial portion of the medial lemniscus, a small portion of the pyramidal tract, and an area of the pontine gray. In no case did the lesion cross the midline. Only the fiber degeneration extending rostralward from the lesions will be described in detail.

Group A

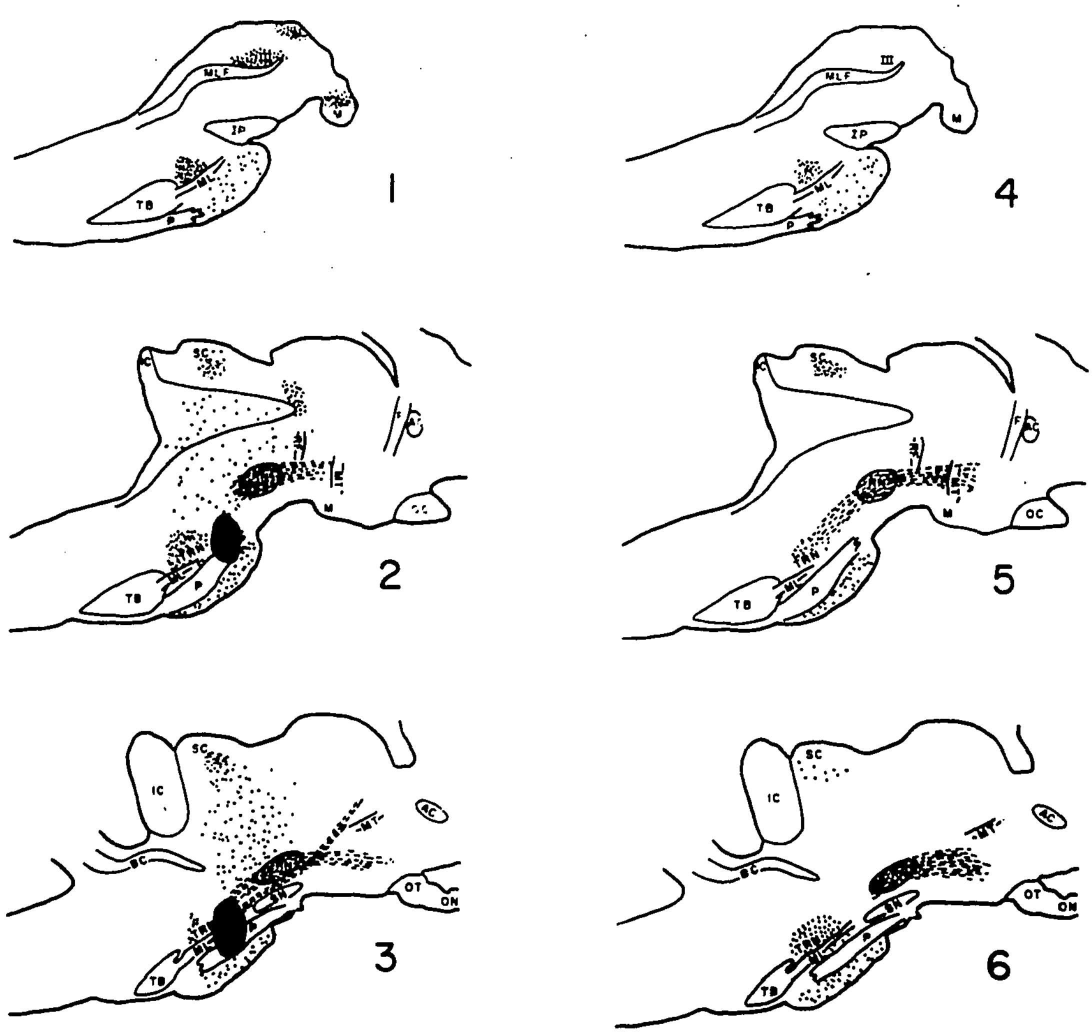
The lesion was placed in the rostral portion of the tegmental reticular nucleus. The projection and distribution of the degenerating ascending fibers are represented in Figures 1-6. Representative diagrams of this lesion are

LEGEND

AC	anterior commissure
BC	brachium conjunctivum
F	fornix
IC	inferior colliculus
IP	interpeduncular nucleus
M	mammillary body
ML	medial lemniscus
MLF	medial longitudinal fasciculus
MT	mammillothalamic tract
OC	optic chiasma
ON	optic nerve
OT	optic tract
P	pyramidal tract
RF	retroflex bundle
RN	red nucleus
SC	superior colliculus
SN	substantia nigra
TB	trapezoid body.
TRN	tegmental reticular nucleus of the pons
III	oculomotor nucleus

GROUP A

IPSILATERAL CONTRALATERAL



Figures 1-6: Diagrammatic representation of the fiber degeneration following a lesion of the rostral portion of the tegmental reticular nucleus. The lesion is indicated in black. The diagrams are in the parasagittal plane, separated by 1.4 mm. Figures 1 and 4 are most medial. Pathways are indicated by dash lines, preterminal endings and scattered degeneration are indicated by dots.

illustrated in Figures 2 and 3.

Two distinct compact ascending pathways were identified. One was represented bilaterally and the other ipsilaterally. Fascicles of degenerating fibers of the bilaterally represented pathway were identified extending rostrally from the tegmental reticular nucleus to the posterior and lateral hypothalamus. Although no crossing fascicles of fibers were identified in these specimens it appeared that a significant number of fibers immediately decussate at the level of the nucleus. Preterminal degeneration was identified throughout both tegmental reticular nuclei (Figures 1-6; Plate 1, Figures 25, 26 in Appendix). However, it should be noted that the majority of these crossing fibers undoubtedly project rostrally, as this pathway is represented on the contralateral side. The ascending pathway from the tegmental reticular nucleus passes rostrally through the fibers of the brachium conjunctivum to enter the red nucleus where preterminal degeneration was identified (Figures 2, 3, 5, 6; Plate 1, Figures 27, 28 in Appendix). Rostral to the red nucleus some of the fibers pass through the fields of Forel and into the posterior and lateral hypothalamic areas where they appear to terminate (Figures 2, 3, 5, 6; Plate 1, Figures 29, 30 in Appendix).

The other large pathway which was present only ipsilaterally follows the course described for the medial lemniscus to the ventral nucleus of the thalamus (Ranson and Ingram, 1932, Matzke, 1951). The degenerating fibers from this system were identified ventral and lateral to the red nucleus in the mesencephalon (Figure 3; Plate 2, Figure 31 in Appendix). The contralateral medial lemniscus was free of degenerating fibers (Figure 6; Plate 2, Figure 32 in Appendix).

Scattered degeneration was identified ipsilaterally in the oculomotor and trochlear nuclei, periaqueductal gray, central median nucleus, intralaminar nuclei, parafascicular nucleus, pretectal area and mammillary body. Bilaterally scattered degeneration was identified in the superior colliculus and in the central tegmental tract.

In addition to the previously mentioned patterns, heavy degeneration was identified bilaterally in the brachium pontis and in the cerebellum. No degeneration was identified in the inferior colliculus, trapezoid body, brachium conjunctivum, subthalamic nucleus, substantia nigra, retroflex bundle, mammillary peduncle, and medial longitudinal fasciculus.

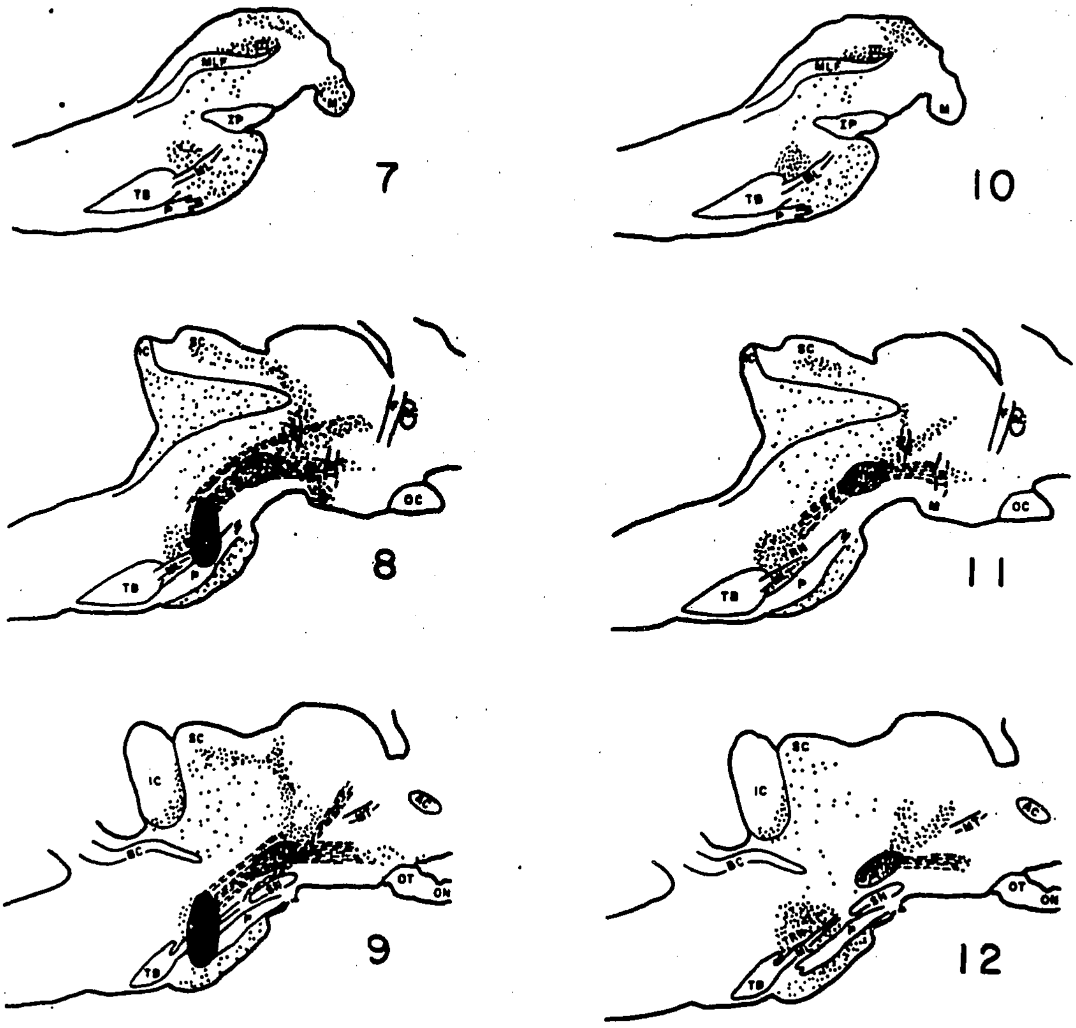
Group B

The lesion was placed in the central portion of the tegmental reticular nucleus and the ventral portion of the nucleus reticularis pontis oralis. Representative diagrams showing the extent of this lesion and the distribution of the degenerating ascending fibers are illustrated in Figures 7-12.

Ascending degeneration from the tegmental reticular nucleus to the hypothalamus and from the medial lemniscus to the thalamus, as demonstrated in Group A (Figures 2, 3, 5, 6), was identified (Figures 8, 9, 11, 12). In addition, as shown in Figures, 7-9, an ipsilateral pathway exhibiting dense degeneration was identified in the region assigned to the central tegmental tract, dorsal to the red nucleus and ventral to the medial longitudinal fasciculus (Figures 8, 9; Plate 2, Figure 33 in Appendix). This degeneration pattern

GROUP B

IPSILATERAL CONTRALATERAL



Figures 7-12: Diagrammatic representation of the fiber degeneration following a lesion in the central portion of the tegmental reticular nucleus and the ventral portion of the nucleus reticularis pontis oralis. The lesion is indicated in black. The diagrams are in the parasagittal plane, separated by 1.4 mm. Figures 7 and 10 are most medial. Pathways are indicated by dash lines, preterminal endings and scattered degeneration are indicated by dots.

was represented in Group A (Figures 2, 3) as scattered degeneration. This pathway corresponds to the lateral reticulothalamic tract (Russell and Johnson, 1952; Russell, 1954), the dorsal secondary trigeminal tract (Walker, 1939), or the diffuse fiber system (Nauta and Kuypers, 1958). Contralaterally, only scattered degeneration was identified in this area (Figures 11, 12; Plate 2, Figure 34 in Appendix).

The diffuse degenerating patterns previously described in Group A were identified in these specimens. Also, other scattered degeneration patterns were identified: ipsilaterally, in the anterior hypothalamic areas; bilaterally, in the inferior colliculus; contralaterally, in the oculomotor and trochlear nuclei, periaqueductal gray and pretectal area.

In one specimen of this group, degenerating fascicles of fibers were identified crossing the midline coursing between the fibers of the medial lemniscus (Plate 2, Figure 35 in Appendix).

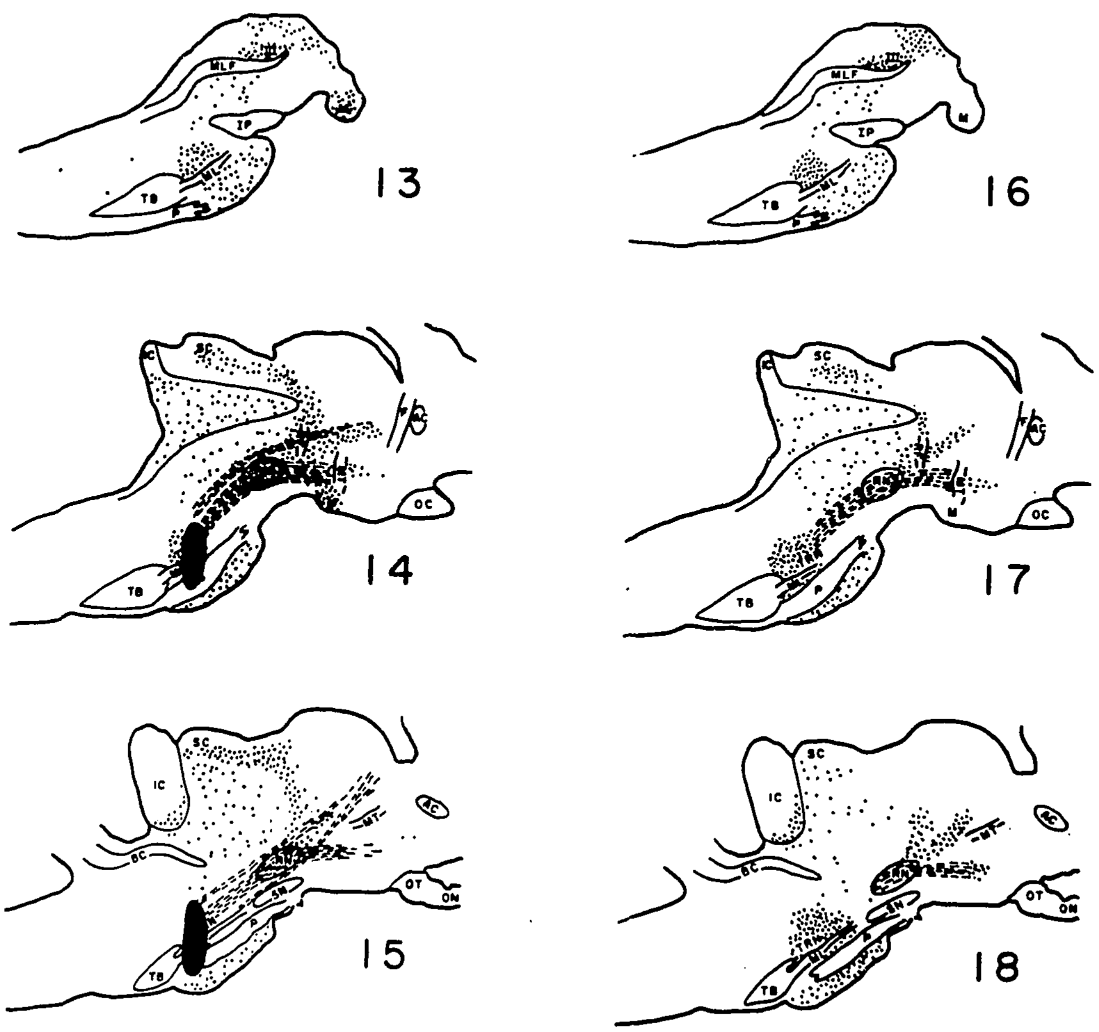
Group C

The lesion was placed in the posterior portion of the tegmental reticular nucleus and the ventral portion of the nucleus reticularis pontis caudalis. Representative diagrams showing the extent of this lesion and the distribution of the degenerating ascending fibers are illustrated in Figures 13-18.

No additional areas of degeneration were identified beyond those demonstrated in Group B (Figures 7-12).

GROUP C

IPSILATERAL CONTRALATERAL



Figures 13-18: Diagrammatic representation of the fiber degeneration following a lesion in the posterior portion of the tegmental reticular nucleus and the ventral portion of the nucleus reticularis pontis caudalis. The lesion is indicated in black. The diagrams are in the parasagittal plane, separated by 1.4 mm. Figures 13 and 16 are most medial. Pathways are indicated by dash lines, preterminal endings and scattered degeneration by dots.

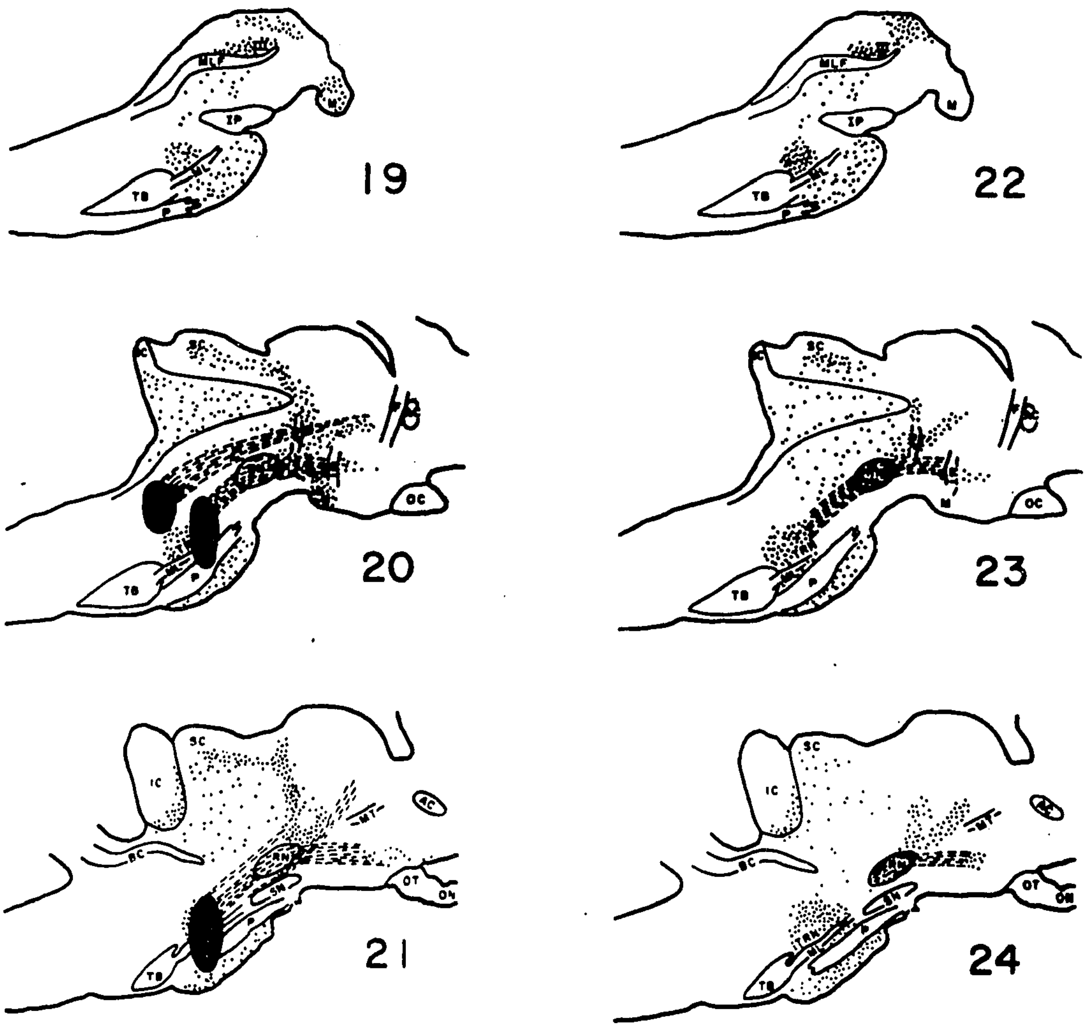
Group D

The lesion was placed in the central portion of the tegmental reticular nucleus and the dorsal portion of the nucleus reticularis pontis caudalis. Representative diagrams showing the extent of this lesion and the distribution of the degenerating ascending fibers are illustrated in Figures 19-24.

No additional areas of degeneration were identified other than those previously described. It should be noted that there is an increase in the quantity of degeneration dorsal to the red nucleus and ventral to the medial longitudinal fasciculus on the ipsilateral side as compared to Groups B (Figures 7-12) and C (Figures 13-18).

GROUP D

IPSILATERAL CONTRALATERAL



Figures 19-24: Diagrammatic representation of the fiber degeneration following a lesion in the central portion of the tegmental reticular nucleus and the dorsal portion of the nucleus reticularis pontis caudalis. The lesion is indicated in black. The diagrams are in the parasagittal plane, separated by 1.4 mm. Figures 19 and 22 are most medial. Pathways are indicated by dash lines, preterminal endings and scattered degeneration by dots.

CHAPTER IV

DISCUSSION

The primary interest in this study is the demonstration of a possible ascending fiber system from the tegmental reticular nucleus of the pons to the hypothalamus in the cat as was suggested by the chromatolytic studies in the rat by Cowan, et al. (1964).

Lesions placed in the brain stem reticular formation invariably involve some of the known ascending pathways. Therefore, ascending projections from these lesions cannot be interpreted without an understanding of the ascending pathways from the brain stem and spinal cord and the brain stem reticular formation and its known ascending tracts.

Medial Lemniscus and Associated Ascending Pathways

The medial portion of the ipsilateral medial lemniscus was destroyed in all of the lesions. The ascending projections from the nuclei of the dorsal funiculus of the spinal cord have been described in the cat by Ranson and Ingram (1932), Matzke (1951), and Nauta and Kuypers (1958). Degeneration resulting from lesions of these nuclei were found to be limited almost entirely to the classical bundle. The fibers of the medial lemniscus cross in the sensory decussation and pass rostralward just dorsal to the pontine nuclei. They were reported in man and dog (Bechterew, 1899) and in the gorilla (Noback, 1959) to traverse the ventral portion of the tegmental reticular nucleus. Taber (1961) and Berman (1968), in their studies of the cytoarchitecture of the brain stem of the cat, failed to demonstrate this relationship. In the midbrain, the fibers of the medial lemniscus migrate dorsolaterally to be in contact with the substantia nigra, passing ventrolaterally to the red nucleus. The fibers terminate in the ventral nucleus of the thalamus. Ranson and Ingram (1932) reported a few fibers in the red nucleus and inferior colliculus, but Matzke (1951) failed to demonstrate these degeneration patterns. Matzke (1951) stated that at the level of the mammillary body an aberrant bundle of fibers separates from the medial lemniscus and ascends ventrally to the tegmental fields of the subthalamic nucleus to the thalamus.

It has been described in the cat (Nauta and Kuypers, 1958; Anderson and Berry, 1959) and in the monkey (Poirier and Bertrand, 1955; Mehler, et al., 1960) that some of the ascending fibers from the ventral and lateral funiculi of the spinal cord have an intimate relationship with the medial lemniscus. These pathways appear as a peripherally situated compact bundle containing the ventral spinocerebellar, lateral spinothalamic, and spinotectal tracts (Gower's tract; ventral lateral pathways). In addition to these pathways, Walker (1939), Russell (1954), Nauta and Kuypers (1958), and Dunn and Matzke (1968) stated that the ventral secondary trigeminal tract also joins the medial lemniscus.

The ventral spinocerebellar component of Gower's tract occupies a superficial position in the lower part of the medulla. In the pons, it is separated from the other tracts by the superior olivary nucleus (Nauta and Kuypers, 1958). It then arches dorsally around and between the roots of the trigeminal nerve in the ventrolateral portion of the tegmentum. At the level of the inferior colliculus it passes in the brachium conjunctivum toward the cerebellum.

The spinotectal and lateral spinothalamic tracts in the brain stem are incorporated within and follow the classical pathway of the medial lemniscus. In the upper pons these tracts pass dorsolateral around the brachium conjunctivum. The spinotectal tract then separates from the lemniscal pathway and swings medially and dorsally to terminate in the superior colliculus (Poirier and Bertrand, 1955; Nauta and Kuypers, 1958; Anderson and Berry, 1959; Mehler, et al., 1960).

The lateral spinothalamic tract continues rostrally intermixed with the fibers of the medial lemniscus. Its ventromedial fiber groups clearly contribute to the diffuse tegmental pathway (Nauta and Kuypers, 1958), which is found in the area assigned to the central tegmental tract. The lateral spinothalamic tract is distributed to the ventral nucleus of the thalamus. According to Anderson and Berry (1959) and Mehler, et al. (1960) this tract also terminated in the intralaminar nucleus, subthalamus and posterolateral hypothalamus. These additional sites of termination were considered by Nauta and Kuypers (1958) to be sites of termination of their diffuse tegmental pathway.

Ascending projections associated with the trigeminal complex have been described by Walker (1939), Russell (1954), Berry, et al. (1956), Nauta and Kuypers (1958), and Dunn and Matzke (1968). Two different trigeminal projections have been proposed: a ventral secondary trigeminal tract and a dorsal secondary trigeminal tract.

As stated previously, the ventral secondary trigeminal tract also joins the medial lemniscus. This tract is distributed to the ventral nucleus of the thalamus.

In addition to these pathways, which have an intimate relationship to the medial lemniscus, there is a centrally located more diffuse spinoreticular fiber system which ascends in the area assigned to the central tegmental tract (Nauta and Kuypers, 1958; Anderson and Berry, 1959; Mehler, et al., 1960). Rossi and Brodal (1957) reported that the degeneration associated with the spinoreticular tract becomes scanty in the rostral part of the pontine reticular formation and areas more rostral. It should be noted that the dorsal secondary trigeminal tract (Walker, 1939), the lateral reticulothalamic tract (Russell, 1954), and the diffuse tegmental system (Nauta and Kuypers, 1958) are inseparable from this system, in that they also occupy the area assigned to the central tegmental tract.

The dorsal secondary trigeminal tract, as described by Walker (1939), is located in the lateral part of the reticular formation. Russell (1954) stated that this fiber system could not be demonstrated following lesions placed in the trigeminal complex, but he was able to demonstrate this pathway following lesions in the reticular formation adjacent to the trigeminal complex. He concluded that the dorsal secondary trigeminal tract was homologous to his pathway, the lateral reticulothalamic tract. Nauta and Kuypers (1958) reported that this system shows an almost perfect resemblance to their diffuse tegmental system. They stated that lesions placed in the trigeminal complex invariably involved the narrow reticular cell zone between the main sensory nucleus and the motor nucleus of the trigeminus. Therefore, they were unable to conclude from their animals the homology of the lateral reticulothalamic tract and the dorsal secondary trigeminal tract.

Brain Stem Reticular Formation and Associated Ascending Pathways

The brain stem reticular formation is described as a mixture of gray and white matter. In the normal brain stem it is characterized by concentrated groups of neurons and by large numbers of small fiber bundles containing both ascending and descending fibers.

One of these groups of neurons associated with the reticular formation of the pons was described in man and dog by Bechterew (1899) as the nucleus reticularis tegmenti pontis. Subsequently, this nucleus has been identified in the rabbit by Meessen and Olszewski (1949) and in the gorilla by Noback (1959) as the nucleus papilioformis, in the guinea pig by Petrovicky (1966) and in the cat by Taber (1961) and Berman (1968) as the tegmental reticular nucleus of the pons.

This nucleus is situated in the rostral part of the pons, ventral to the nucleus reticularis pontis oralis, dorsorostral to the trapezoid body, and dorsal to the medial lemniscus. Bechterew (1899) and Noback (1959) both reported that some of the fibers of the medial lemniscus traverse the ventral portion of this nucleus.

The ascending projections from the reticular formation have been considered as having the structure of a multiple chain system by the anatomical studies of Verhaart (1956) and Valverde (1961) and by the neurophysiological studies of Moruzzi and Magoun (1949), Starzl, et al. (1951), French, et al. (1952), Magoun (1952), and French, et al. (1953). In contrast, the anatomical studies of Lewandowsky (1904), Russell and Johnson (1952), Russell (1954), Scheibel (1955), Scheibel and Scheibel (1958), and Nauta and Kuypers (1958) and the neurophysiological studies of Morin (1953) and Adey, et al. (1957) have demonstrated an ascending system arising from the brain stem reticular formation comprised of long fibers. In addition, the existence of long ascending fibers from the brain stem reticular formation have also been suggested by the retrograde studies of Brodal and Rossi (1955), Brodal (1956), and Cowan, et al. (1964).

Following lesions in the reticular formation of the medulla and pons adjacent to the trigeminal complex, Russell and Johnson (1952) and Russell (1954) identified an uncrossed ascending system of fibers that projected to the thalamus, which they named the lateral reticulothalamic tract. This tract ascended between the deep tegmental nucleus and the brachium conjunctivum where it spread ventrally into the tegmentum then through the midbrain in the central tegmental tract, on its course to the thalamus. Nauta and Kuypers (1958) following lesions in the medullary or pontine tegmentum demonstrated this same pathway which they termed the diffuse tegmental pathway. In addition, they reported a contralateral component of reduced size.

The long ascending fiber system emits fibers to the periaqueductal gray substance (Johnson, 1954; Nauta and Kuypers, 1958; Scheibel and Scheibel, 1958; Mehler, et al. 1960), cranial nerve nuclei (Scheibel and Scheibel, 1958), pretectal area and superior colliculus (Nauta and Kuypers, 1958), but mainly terminates in the ventral nucleus of the thalamus (Russell and Johnson, 1952; Russell, 1954; Nauta and Kuypers, 1958), central median nucleus (Russell and Johnson, 1952; Russell, 1954; Nauta and Kuypers, 1958; Anderson and Berry, 1959), intralaminar nuclei (Russell, 1954; Nauta and Kuypers, 1958; Anderson and Berry, 1959), subfascicular nucleus (Papez, 1956), parafascicular nucleus (Nauta and Kuypers, 1958; Anderson and Berry, 1959), subthalamus (Morin, 1953; Nauta and Kuypers, 1958; Anderson and Berry, 1959), and fields of Forel and zona incerta (Nauta and Kuypers, 1958).

A Reticulorubrohypothalamic Pathway

In the present study, a pathway of long ascending fibers has been shown to arise from the tegmental reticular nucleus of the pons and to terminate in the red nucleus and the hypothalamus. The ascending pathway from the nucleus passes rostrally through the fibers of the brachium conjunctivum to enter the red nucleus. Preterminal degeneration was identified throughout this nucleus. Rostral to the red nucleus, the fibers pass through the fields of Forel to terminate in the posterior and lateral hypothalamus. A large number of these fibers immediately decussate at the level of the tegmental reticular nucleus and these fibers either terminate in the contralateral nucleus or follow the same pathway on the contralateral side. This fiber system was called the reticulorubrohypothalamic pathway.

The absence of demonstrable degeneration in the fibers of the brachium conjunctivum or its decussation was evidence that the lesion did not involve its rostral projection nor the ventral spinocerebellar tract. The degeneration to the cerebellum was only found in the brachium pontis. If the fibers from neurons of the tegmental reticular nucleus project to the cerebellum, as suggested by the retrograde studies of Brodal and Jansen (1946), Brodal (1956) and Brodal (1958), they must course through the brachium pontis. However, due to the lesions involving the pontine gray, ventral to the tegmental reticular nucleus, it could not be determined if any of the degenerating fibers actually originate from the neurons of this nucleus. This question still remains to be answered. In addition, the massive bilateral degeneration associated with the red nucleus apparently involves another system than the ascending cerebellar pathway. Ranson and Ingram (1932) reported some degeneration in the red nucleus from lesions involving the medial lemniscus and Nauta and Kuypers (1958) reported degeneration from lesions in the reticular formation. Conversely, Russell and Johnson (1952) and Russell (1954) noticed the absence of preterminal degeneration in the red nucleus following lesions in the caudal reticular formation. Since the bilateral degeneration demonstrated in all of these groups of animals is too extensive to be entirely attributed to the preceding systems, it is evident that the majority of these degenerating fibers are a part of the reticulorubrohypothalamic pathway.

The lateral reticulothalamic tract, the dorsal secondary trigeminal tract, and/or the diffuse tegmental pathway can be identified in the area assigned to the central tegmental tract. These pathways have been previously identified to terminate on various structures of the brain. As determined in Groups B, C, and D the pathway of these systems lies dorsal to the tegmental reticular nucleus as they project rostrally. This observation is supported by the failure to identify a major degenerating pathway in the area of the central tegmental tract in Group A, in which the lesion was restricted to the rostral pole of the tegmental reticular nucleus. Heavy degeneration was identified in the area assigned to the central tegmental tract only when the lesions involved the reticular area dorsal to the tegmental reticular nucleus. The scattered degeneration identified in Group A was undoubtedly the result of the lesion involving a small portion of the reticular formation dorsal to the tegmental reticular nucleus, but ventral to this previously identified system. Since only scattered degeneration was identified contralaterally in Groups

B, C, and D, the projection of the fibers of this pathway are for the most part uncrossed or are crossed prior to this level of the brain stem. Brodal (1956) concluded that the ascending fibers are chiefly uncrossed and that most of them appear to course in the territory of the central tegmental tract. Nauta and Kuypers (1958) reported that this pathway was represented bilaterally, but that the contralateral component was greatly reduced in numbers. It should be noted that their lesions are dorsal and caudal as compared to those in this study.

It was demonstrated in this study that there was degeneration in the pretectal area, periaqueductal gray, cranial nerves, ventral nucleus of the thalamus, central median nucleus, parafascicular nucleus and interlaminar nuclei. The majority of these fibers are probably derived from areas dorsal to the tegmental reticular nucleus and follow the area of the central tegmental tract as described by Russell and Johnson (1952), Russell (1954), Nauta and Kuypers (1958), Scheibel and Scheibel (1958), Anderson and Berry (1959), and Mehler, et al. (1960), but it should be noted that a few of these fibers could be from the reticulorubrohypothalamic pathway. This cannot be evaluated in these specimens.

Matzke (1951) stated that, at the level of the mammillary body, an aberrant bundle of fibers separate from the medial lemniscus and ascend ventral to the tegmental fields in the subthalamic nucleus to the thalamus. This aberrant bundle of fibers was not identified in this study. The subthalamic nuclei were free of degenerating fibers. Since this lesion only involved the medial portion of the medial lemniscus, there is the possibility that the fibers of this aberrant lemniscal system are located lateral to the filet.

Bilateral degeneration was identified in the colliculi in all groups of animals with the exception of Group A. In this group, the inferior colliculus was free of degeneration. From this evidence, it can be concluded that the reticulorubro-hypothalamic pathway apparently does not contribute fibers to this nucleus. The degeneration demonstrated in the inferior colliculus was attributed to fibers from the medial lemniscus as reported by Ranson and Ingram (1932) and from the brain stem reticular formation as reported by Scheibel and Scheibel (1958).

The bilateral degeneration demonstrated in the superior colliculus was attributed to the termination of the spinotectal tract (Poirier and Bertrand, 1955; Nauta and Kuypers, 1958; Anderson and Berry, 1959; Mehler, et al. 1960). In addition, Mehler, et al. (1956), Nauta and Kuypers (1958), Scheibel and Scheibel (1958), Mehler, et al. (1960), and Faull and Carman (1968) have reported other fiber systems projecting to this nucleus. From these data, it cannot be determined if any fibers from the tegmental reticular nucleus project to the superior collicular nucleus.

Degeneration was determined in the ipsilateral mammillary nucleus in all groups of animals. The mammillary peduncle, according to Fox (1941), Morin (1950), and Bürgi and Bucher (1956), and the medial forebrain bundle, according to Guillery (1957), both contribute fibers to this nucleus. No degeneration could be demonstrated in the mammillary peduncle. The medial forebrain bundle has been demonstrated to arise from the ventral part of the midbrain or pons (Guillery, 1957). It is questionable that all of the degeneration demonstrated in the mammillary nucleus can be attributed to this bundle. The tegmental reticular nucleus could supply some of these fibers but if the contralateral pathway is representative of the ipsilateral component by the crossing fibers, some degeneration would be expected in the contralateral mammillary nuclei. A mammillary projection from this tegmental nucleus still remains to be answered. In addition, the medial forebrain bundle projects fibers to the lateral hypothalamus (Bucher and Bürgi, 1953; Guillery, 1957). The amount of degeneration demonstrated in these specimens could not be attributed to this system only.

In closing this discussion it must be emphasized that there are long ascending fibers that take origin from the tegmental reticular nucleus of the pons. This pathway terminates in the red nucleus and in the hypothalamus.

CHAPTER V

SUMMARY

It has been demonstrated by anatomical procedures that the tegmental reticular nucleus of the pons receives fibers from various areas of the central nervous system.

The present study was undertaken in an effort to ascertain whether ascending fibers originate from the tegmental reticular nucleus of the pons in the cat.

Lesions were placed in the tegmental reticular nucleus in adult cats and the resulting ascending degeneration was studied by the Nauta (1957) technique.

In the present study, a pathway of long ascending fibers has been shown to arise from the tegmental reticular nucleus of the pons and to terminate in the red nucleus and in the hypothalamus. The ascending pathway from the nucleus passes rostrally through the fibers of the brachium conjunctivum to enter the red nucleus. Preterminal degeneration was identified throughout this nucleus. Rostral to the red nucleus, the fibers pass through the fields of Forel to terminate in the posterior and lateral hypothalamus. A large number of these fibers immediately decussate at the level of the tegmental

reticular nucleus and these fibers either terminate in the contralateral nucleus or follow the same pathway on the contralateral side. Bilateral preterminal degeneration was recognized throughout both tegmental reticular nuclei. This fiber system was called the reticulorubrohypothalamic pathway.

The identification of this pathway is further evidence that there are long ascending fibers that take origin from the brain stem reticular formation.

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APPENDIX

Plate I

Figure 25: Photomicrograph of the ipsilateral tegmental reticular nucleus. 320 X.

Figure 26: Photomicrograph of the contralateral tegmental reticular nucleus. 320 X.

Figure 27: Photomicrograph of the ipsilateral red nucleus. 320 X.

Figure 28: Photomicrograph of the contralateral red nucleus. 320 X.

Figure 29: Photomicrograph of the ipsilateral hypothalamus. 320 X.

Figure 30: Photomicrograph of the contralateral hypothalamus. 320 X.

PLATE I

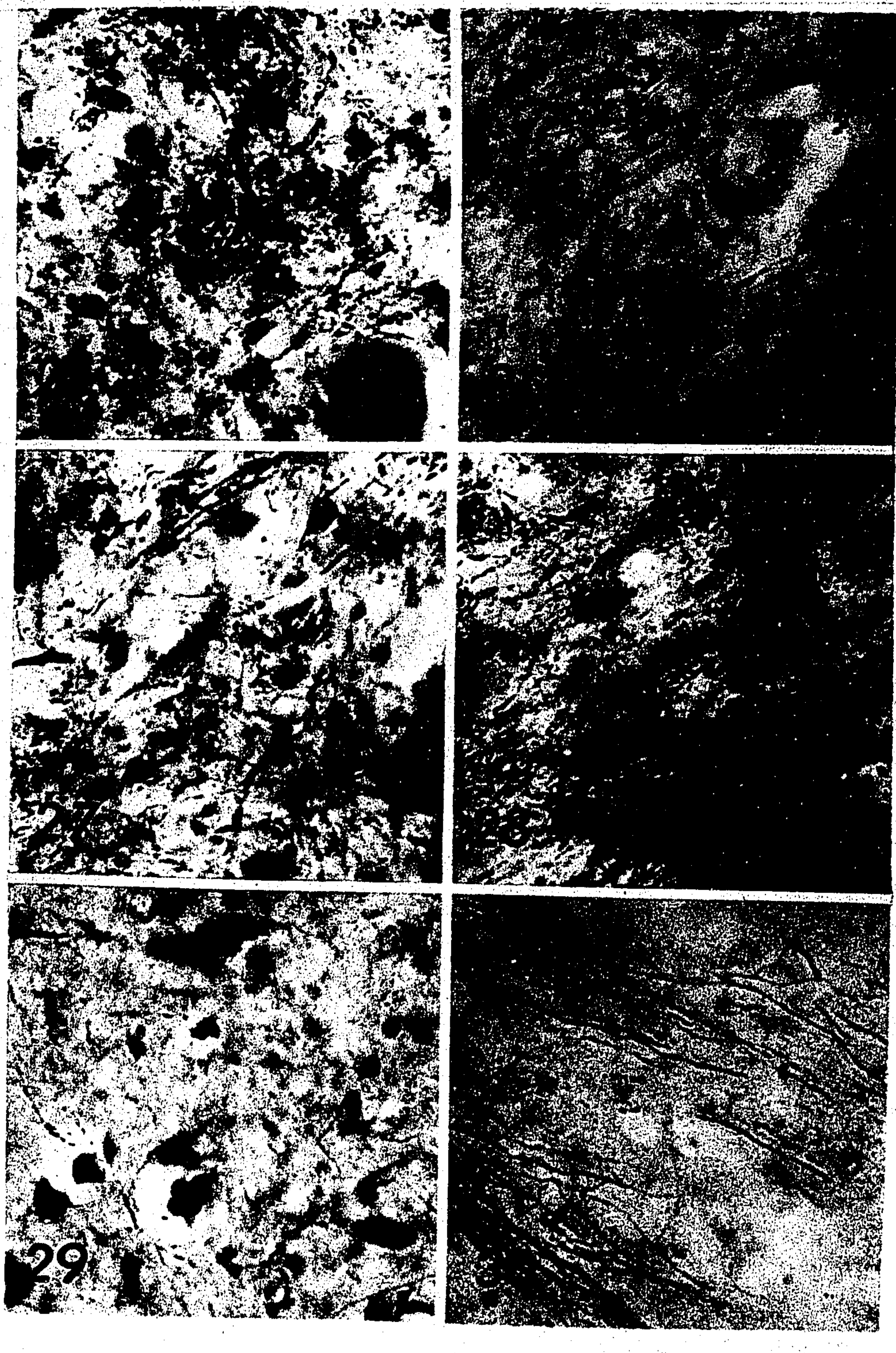

Plate II

Figure 31: Photomicrograph of the ipsilateral medial lemniscus, ventral to the red nucleus. 320 X.

Figure 32: Photomicrograph of the contralateral medial lemniscus, ventral to the red nucleus. 320 X.

Figure 33: Photomicrograph of the ipsilateral central tegmental tract, dorsal to the red nucleus. 320 X.

Figure 34: Photomicrograph of the contralateral central tegmental tract, dorsal to the red nucleus. 320 X.

Figure 35: Photomicrograph of the crossing fibers in the medial lemniscus of a specimen in Group B. 320 X.

PLATE II