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# AN HISTORICAL REVIEW OF THE ACCESSORY OPTIC TRACTS*

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## INTRODUCTION

In addition to the main optic tracts leading from the eyes to the lateral geniculate nuclei, two pairs of accessory optic tracts have been reported to be present in many animals including man. These two pathways have been extensively studied by early anatomical investigators. These investigations consisted of anatomical and histological examinations of the brains of various normal and experimental animals.

In the normal animals, serial sections of the brains were examined to trace the pathway of the accessory optic tracts. The sections were stained either for the nerve fibers or for the cell bodies.

In the experimental animals, a lesion was produced in a part of the visual system. If the operation was performed in the newborn animal (Gudden's experiment), evidence of the lack of development of the tracts was sought in the adult brain. If the lesion was produced in the adult, the pathway of the accessory optic tracts was traced by following the course of the degenerated fibers.

## HISTORICAL SURVEY

In 1870, Gudden[1] noted a nerve fiber bundle which appeared at the anterior edge of the superior colliculus and passed laterally and basally. This bundle ran transversely over the cerebral peduncle and entered the midbrain near the exit of the III nerve. He named it the tractus peduncularis transversus. This tract was first observed in the brain of a rabbit and was later noted in the goat, sheep, pig, dog, and fox. In man, the tract is delicate and very often not seen. Gudden was not able to report on the origin or on the termination of the tractus peduncularis transversus although he demonstrated that its existence depended

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on the retina, i.e., if the retina is destroyed the development of the tract is retarded.

In a more extensive paper appearing in 1881, Gudden[2] reported on this tract in more detail. He stated that, in 1875, in an Italian journal, Inzani and Lemoigne[3] claimed to have discovered the tractus peduncularis transversus and described it in a paper published in 1861. However, Gudden reported that even as early as 1810 the superficial course of this tract had been illustrated in a textbook by Gall and Spurzheim but his paper of 1870 was the first to describe the course of the tractus peduncularis transversus in detail.

The intracranial course of the tract was described in the later paper. Gudden studied frontal, sagittal, and horizontal brain sections in normal and experimental animals. He stated that the tract did not originate from the superior colliculus since the latter can be destroyed without affecting the tract. In cross-sections of brains stained with carmine, Gudden was able to see the tract enter the midbrain medial to the cerebral peduncle and lateral to the mammillary body. He was able to follow it dorsally and somewhat laterally between the substantia nigra and a bundle named "Reichert's loop." The tract disappeared in this region and could not be followed. He was not able to detect any atrophy in the midbrain after destroying one or both tracts.

Ganser,[4] 1882, was able to detect the tractus peduncularis transversus in the cat using the Marchi technique.* He also found that the destruction of the occipital cortex did not affect the tractus peduncularis transversus.

Perlia,[6] 1889, reported the presence of the tractus peduncularis transversus in the rabbit. He used the Marchi and Weigert preparations in his investigations. He reported that the fibers of the tractus peduncularis transversus curved around the cerebral peduncle and entered the midbrain and were lost in the reticular substance.

In 1889 Singer and Münzer,[7] employing the Marchi technique, reported that in the adult rabbit, the contralateral tractus peduncularis transversus degenerated after enucleation of one eye. If the enucleation was performed at birth, the tractus peduncularis transversus did not develop.

In his textbook appearing in 1898, Obersteiner[8] described the tractus peduncularis transversus as a thin nerve tract which is very visible

*When a myelinated nerve fiber is cut or injured, the distal portion of the axon degenerates. This is accompanied by chemical changes of the myelin, and the myelin aggregates into small globules of varying sizes. At the same time oleic acid appears which stains readily with osmic acid. By staining the degenerated portions of the myelin with osmic acid, the course of degeneration can be followed.[5]

in many animals but rarely seen distinctly in man. It proceeds from the front of the superior colliculus downwards, centralwards, and backwards across the brachia. It then runs across the cerebral peduncle but its termination is never distinctly seen.

Koelliker,[9] 1896, investigated the tractus peduncularis transversus in the rabbit. Besides confirming the observations of the previous investigators he reported two new findings. First, the nucleus or place of origin of the tractus peduncularis transversus occupied the ventral side of the brain and its end, he felt, would be found in the lower part of the superior colliculus. Second, he observed two other bundles which ran parallel to the "main" tractus peduncularis transversus.

In his investigation of pupillary fibers, Massaut,[10] 1896, noted that the contralateral tractus peduncularis transversus was lost after enucleation of one eye in the rabbit. In several iridectomized rabbits, slight changes were noted in the contralateral tractus peduncularis transversus which led him to conclude that the tractus peduncularis transversus probably contains pupillary fibers.

In a paper dealing with the lateral surface of the midbrain, Retzius,[11] 1898, reported and illustrated the tractus peduncularis transversus in man, chimpanzee and orangutan. He also presented beautiful illustrations which showed the tractus peduncularis transversus in the bear, dog, sheep, pig, rabbit, cow, horse and reindeer. Only in the kangaroo was the tractus peduncularis transversus not observed.

In 1898, Tümianzew[12] reported his findings in two rabbits. Using the Marchi technique, he noted degeneration of the contralateral tractus peduncularis transversus after enucleation of one eye. He did not find any degenerated fibers going to the oculomotor nucleus. He stated that the tractus peduncularis transversus did not take origin from the superior colliculus. He concluded that a part of the tractus originated from a ganglion which lay near the anterior edge of the superior colliculus.

Bach,[13] 1900, reported that the contralateral tractus peduncularis transversus degenerated after evisceration of the bulb. He was not able to find the tractus peduncularis transversus in the cat, ape and in man.

In a paper dealing mainly with the relationship of the superior colliculus to the visual system Pavlow,[14] in 1900, observed a small bundle of degenerated fibers between the cerebral peduncle and the corpus Luysi (nucleus subthalamicus) which he recognized as the tractus peduncularis transversus. This observation was made in rabbits after one eye was enucleated and the brains prepared by the Marchi method.

Berl,[15] 1902, also used the Marchi technique in his investigation of the rabbit. He found degeneration of the contralateral tractus peduncularis transversus after enucleation of one eye as reported by previous investigators. An occipital lesion did not affect the tract. Very strangely, the tractus peduncularis transversus degenerated on both sides when an occipital lobe lesion and an enucleation were performed.

Frankel-Hochwart,[16] 1902, reported that the tractus peduncularis transversus was not present in the congenitally blind mouse, *Spalax typhlus*.

Münzer and Wiener[17] reported their findings in 1902. As reported by Berl, the tractus peduncularis transversus was not affected when the occipital lobe was destroyed. In addition they were able to trace the course of the tractus peduncularis transversus in the midbrain. Part of the fibers end dorsal to the substantia nigra while a second part progresses further upwards to enter the superior colliculus above the nucleus suprageniculata. A fiber bundle which originated from the nucleus suprageniculata was traced back to the nucleus tractus peduncularis transversus. They believed that these fibers were centrifugally active.

In 1903, Marburg[18] presented the results of his comparative investigation of the basal optic root. In the guinea pig he was able to trace the fibers of the tractus peduncularis transversus to the nucleus which lies ventrolateral to the red nucleus, dorsal to the substantia nigra and at the level of the posterior end of the mammillary body. He also observed the tractus peduncularis transversus in the marsupial (*Marcopus, Phascolarctus* and *Perameles*), the sloth, the opossum, the pig and the horse. In the seal only part of the tractus peduncularis transversus was noted. In two human series he detected the tractus peduncularis transversus. From comparative studies on lower vertebrates he concluded that the tractus peduncularis transversus was homologous to the basal optic root of amphibians, reptiles and birds. The nucleus tractus peduncularis transversus was homologous to the ganglion ectomammillaris. Marburg could not find any fibers which passed from the nucleus tractus peduncularis transversus to the superior colliculus.

During the course of his experiments on the basal olfactory bundle, Wallenberg,[19] 1903, destroyed the optic tract in guinea pigs. He noted a narrow bundle of blackened fibers between the angle of the superior colliculus and the medial geniculate body. He was able to follow this bundle, the tractus peduncularis transversus, to its nucleus in the midbrain. He was unable to trace any fibers to the superior colliculus as reported by Münzer and Wiener.

Bochenek,[20] in 1908, examined the brains of seven rabbits. The rabbits were killed 14 to 15 days after unilateral enucleation and the brains were prepared by the Marchi technique. Bochenek followed the entire path of the degenerated tractus peduncularis transversus easily. His observation on the course of these fibers is identical with those of the previous investigators.

Next to the tractus peduncularis transversus, Bochenek found, in all seven rabbit brains, an optic fiber bundle which had not been described until then. He named it the fasciculus accessorius optici anterior. This tract could be first seen as a distinct bundle at the most posterior part of the chiasma and consisted of crossed fibers. At this level the fibers lay on the bottom of the brain under the fibers of Gudden's commissure.* They were separated from the fibers of the primary optic tract by the non-degenerated fibers of Gudden's commissure. The bundle followed the base of the brain back to the level of the mammillary body at which point it bends medially under the cerebral peduncle. It runs dorsally between the fibers of the cerebral peduncle and ends in the gray substance which corresponds to the posterior part of the nucleus subthalamicus. Bochenek concluded that the anterior accessory optic tract runs from the retina to the nucleus subthalamicus because of the Wallerian degeneration after enucleation. However, Bochenek stated that it was not out of the question that centrifugal fibers were associated with the centripetal fibers.

In his book published in 1911, Edinger[21] summarized his findings on the tractus peduncularis transversus. In the experiments using the Marchi technique, he noted some Marchi granules in the tractus peduncularis transversus; however, the majority of the fibers remained normal. This finding plus the observation of fibers passing from the III N to the nucleus tractus peduncularis transversus led Edinger to state that the tractus peduncularis transversus was actually part of the ciliary nerve. The nucleus tractus peduncularis transversus, he felt, was part of the ciliary ganglion that had failed to migrate orbitally.

In 1911, Loepp[22] also reported his findings in the rabbit. The rabbits had one eye enucleated and were killed about 20 days after the

*Three supraoptic commissural systems have been described:[25, 26, 36] (1) Commissure of Ganser—lies below the floor of the third ventricle and above the optic chiasma. The fibers are heavily myelinated and can be traced laterally and dorsally to the subthalamic region. This bundle most likely connects the subthalamic regions of opposite sides. (2) Commissure of Meynert—lies slightly dorsal and caudal to the chiasma and ventral to the Commissure of Ganser. It consists of myelinated fibers which run laterally and dorsally. Some of the fibers penetrate the medial forebrain bundle and end in the region of the nucleus subthalamicus. Others pass into the zona incerta. (3) Commissure of Gudden—lies ventral to the chiasma and optic tract. It runs dorsally and laterally and ends in the medial geniculate body. It is generally believed to connect the two medial geniculate bodies. None of these commissural systems has been found to degenerate after enucleation.

operation. He observed some degenerated fibers, the anterior accessory optic tract, ventrolateral to the third ventricle. These fibers penetrated the cerebral peduncle and passed into the nucleus subthalamicus. Thus he was able to confirm the observations of Bochenek.

Loepp also described the course of the tractus peduncularis transversus. He reported that this tract consisted only of crossed fibers. It splits from the main optic tract at the lateral margin of the medial geniculate body and passes ventromedially around the cerebral peduncle. Just anterior to the exit of the III N, between the medial margin of the cerebral peduncle and the lateral margin of the mammillary body, it penetrates the midbrain. The fibers of this tract end in a nucleus which lies ventrolateral to the red nucleus.

In his book, Ramon y Cajal,[23] 1911, presented a description of the course of the tractus peduncularis transversus. He also presented a detailed histological description of its terminal arborization in the midbrain.

In 1915 Kosaka and Hiraiwa[24] published their experimental findings on various animals using the Marchi technique. Their observations in the rabbit were in a large part identical with that of Bochenek and Loepp. On the lateral side of the tuber cinereum, they saw a small bundle of optic fibers which was separated from the main mass of optic fibers by Meynert's and Gudden's commissures. The fibers passed into the cerebral peduncle and, as stated by Bochenek and Loepp, are destined for the nucleus subthalamicus. In Kosaka and Hiraiwa's preparations only a few fibers passed to the nucleus subthalamicus; some bend laterally while others proceed dorsally. The fibers passing laterally re-enter the main optic tract while the dorsally proceeding fibers end in the ventral part of the lateral geniculate nucleus with the other optic fibers. Thus Kosaka and Hiraiwa concluded that the "anterior accessory optic tract" represented a small aberrant bundle of optic fibers which separated from the main optic tract only to rejoin it more caudally.

Kosaka and Hiraiwa were able to detect degeneration of the tractus peduncularis transversus in rabbits, guinea pigs and rats after enucleation. The tract, however, showed no Marchi granules after damage to the occipital lobe in these same animals. They were also able to demonstrate that the tractus peduncularis transversus contained no commissural fibers. In dogs, cats, goats, and apes, Kosaka and Hiraiwa were not able to detect any degeneration of the tract following enucleation. This they believed was due to the fact that the fibers of this tract are so finely myelinated. The cells of the nucleus tractus peduncularis transversus showed no chromatolysis after enucleation in rats, rabbits, guinea pigs and dogs. However, the nucleus was somewhat increased in size and the cells were displaced by swollen degenerated fibers. They believed that no optic fibers originated from this nucleus; also it did not send fibers dorsally or spinally.

Tsai,[25] in 1925, studied serial sections of the brain of the opossum, *Didelphis virginiana,* stained by either the Wright or silver method. The tractus peduncularis transversus was noted as a small fascicle which splits off the main optic tract near the lateral geniculate nucleus. This small bundle courses caudally over the cerebral peduncle and takes a superficial position on the ventrolateral surface of the hypothalamus and mesencephalon. Just anterior to the exit of the III N it curves medially under the peduncularis tegmenti to end in the nucleus tractus peduncularis transversus. This nucleus was observed to be medial to the substantia nigra, lateral to the nucleus tegmenti ventralis and ventral to the red nucleus.

Tsai noted that the anterior accessory optic tract splits from the main optic tract midway between the chiasma and the cerebral peduncle. It ran caudally and dorsally with the commissure of Meynert and lay medial to the main mass of optic fibers. About the middle of the cerebral peduncle some of the fibers, together with the fibers of Meynert's commissure, turned medially to penetrate the longitudinal bundles of the cerebral peduncle and end in the nucleus subthalamicus. Other fibers were observed to curve over the dorsal surface of the cerebral peduncle and turn ventrally to reach the nucleus subthalamicus.

Gurdjian,[26] 1927, examined 36 complete brain series of the normal albino rat. He was able to identify the tractus peduncularis transversus and its nucleus. However, he was not able to identify the anterior accessory optic tract or any fibers entering the nucleus subthalamicus. He felt that this would be mechanically impossible.

In 1931, Rioch[27] reported his findings in the brains of dogs, cats and aevis (a small carnivore) stained for the myelin sheath. At the dorsal margin of the cerebral peduncle a group of fibers was noted which turned caudally out of the posterior border of the optic tract. At the level of the red nucleus the fibers course dorsally around the medial margin of the cerebral peduncle to end in the nucleus tractus peduncularis transversus.

As the main optic tract passed over the cerebral peduncle, Rioch observed some fibers leaving its medial surface to mix with the fibers or Meynert's commissure. These fibers ran diagonally through the cerebral peduncle toward the zona incerta and the nucleus subthalamicus.

In two papers, 1931 and 1932, Le Gros Clark[28, 29] presented his findings on the accessory optic tracts in the rat. Using the Marchi technique, he was able to see the anterior accessory optic tract. It consists of fibers which leave the main tract as it passes obliquely across the crus cerebri. However, he was able to follow these fibers only to the superficial aspect of the cerebral peduncle. No degenerated fibers could be seen penetrating the cerebral peduncle to reach the nucleus subthalamicus.

The posterior accessory optic tract leaves the main optic tract as the latter lies in topographical relation with the medial geniculate body. It forms a fine strand which runs obliquely in a caudoventral and medial direction across the cerebral peduncle. The fibers end in the nucleus opticus tegmenti and the medial end of the substantia nigra. Some fibers were observed extending more dorsally into the tegmental region of the midbrain.

Lashley,[30] in a paper appearing in 1934, reported on his findings in the rat. The retina was destroyed by an incision through the back of the bulb and the brain prepared by the Marchi technique. He observed that only the contralateral anterior accessory optic tract showed any degeneration. The fibers of this tract travelled with the fibers of Meynert's commissure up to the inferior margin of the cerebral peduncle where they divided into two branches. The superior branch continued along the superficial margin of the cerebral peduncle and the majority of the fibers rejoined the main optic tract. The inferior branch, which contained the greater numbers of fibers, passed along the ventromedial edge of the cerebral peduncle and finally joined the fibers of the posterior accessory optic tract. Thus Lashley concluded that the "anterior accessory optic tract" is really part of the posterior accessory optic tract.

Although a special effort was made, Barris, Ingram and Ranson,[31] 1935, were able to detect neither the anterior, nor the posterior accessory optic tracts. They used the Marchi technique in cats with various types of lesions.

A good description of the accessory optic tracts is presented by Ariens-Kappers, et al.[32] in their excellent textbook of neuroanatomy published in 1936.

Frey,[33] 1937, reported on his comparative study of the basal optic root. His findings led him to conclude that the basal optic root was homologous to the anterior accessory optic tract of Bochenek and not to the tractus peduncularis transversus as stated by Marburg. The main part of the fibers go to the basal optic nucleus which lies in the region of the exit of the III N. Only a few fibers go in the direction of the nucleus subthalamicus. The fibers that pull away from the anterior edge of the superior colliculus and run toward the medial geniculate body, the classical tractus peduncularis transversus, represent a secondary connection from the basal optic nucleus.

Tsang,[34] 1937, was not able to identify the anterior accessory optic tract nor to detect any changes in the nucleus subthalamicus in unilaterally and bilaterally enucleated rats. However, he did observe the posterior accessory optic tract and described its course. His description of the posterior accessory optic tract is similar to the reports of previous investigators. In the bilaterally enucleated rats, he noted that the tract was atrophied proportionately to the period of enucleation. However, even seven months after enucleation some fibers were still present in this tract. This suggested that the posterior accessory optic tract was really composite in nature, i.e., it contained both centripetal and centrifugal fibers.

Bodian,[35] in 1937, examined the brain of the opossum. He noted that the posterior accessory optic tract degenerated completely following lesions in the retina and could be easily followed. An intensive search failed to reveal any fibers which might be called the anterior accessory optic tract.

Jefferson,[36] 1940, concerned with the effect of light on the gonads, studied both normal and experimental brains of ferrets to see if a pathway could be found which might account for this phenomenon. He was unable to detect either the anterior or the posterior accessory optic tract.

In a paper published in 1941, Packer[37] reported the presence of both accessory optic tracts in the *Phalanger* (a marsupial). In experimental animal degeneration granules were observed in both tracts but he noticed that the two tracts joined together just anterior to the nucleus of the posterior accessory optic tract and ended in this nucleus. Thus his findings are similar to those of Lashley.

In a very comprehensive paper appearing in 1941, Gillilan[38] reported her findings on the accessory optic tracts in various normal and experimental animals.

In the chiroptera (three different species of bats), the posterior accessory optic tract (Gillilan preferred to call it the basal optic root) was present although very thinly medullated. Its origin in the retina was proved by enucleation experiments. Primary optic fibers were traced to the reticular gray, the substantia nigra, the oculomotor nucleus and the nucleus interpeduncularis. Secondary fibers connected the nucleus of the posterior accessory optic tract with the reticular gray, the substantia nigra, the oculomotor nucleus and the contralateral nucleus of the posterior accessory optic tract. The anterior accessory optic tract was also observed.

In the insectivora (shrew) the posterior accessory optic tract is a small bundle which takes the usual course. The anterior accessory optic tract was also noted.

In the rodentia, Gillilan examined the brains of white rats, mice, guinea pigs and squirrels.

The posterior accessory optic tract in the white rat consisted of finely medullated fibers and followed the usual course. Primary fibers were traced to the contralateral nucleus of the posterior accessory optic tract through the supramammillary decussation. Secondary connections pass to the substantia nigra, the reticular gray, the oculomotor nucleus and possibly other nuclei. The anterior accessory optic tract, although very difficult to identify, was observed passing through the cerebral peduncle in scattered fibers and entering the nucleus subthalamicus.

The findings in the mouse were similar to those in the rat.

The posterior accessory optic tract is especially well medullated in the guinea pig and can be easily followed to the nucleus. Secondary fibers from the nucleus can be followed to the same midbrain nuclei.

Gillilan reported that the posterior accessory optic tract in the squirrel took the usual course and was large and well medullated. Primary and secondary fibers ran to the same nuclei. The anterior accessory optic tract fibers were fine and very thinly medullated.

Gillilan reported that the posterior accessory optic tract existed in the carnivora (cat). It is primarily an unmedullated tract and therefore only identifiable in silver material. Although the anterior accessory optic tract could not be identified, Gillilan felt that it too may exist as an unmedullated tract.

In the ungulata (elephant) the posterior accessory optic tract is relatively small and follows the same pattern as in the other mammals. The anterior accessory optic tract could not be identified with certainty.

In monkeys *(Macaca mulatta)* the posterior accessory optic tract was noted as it crossed in the ventrocaudal part of the chiasma. The fibers are very thinly medullated and unmedullated but can be readily distinguished from the heavily myelinated optic tract fibers. They separate from the main optic tract as the latter enters the lateral geniculate nucleus and course medially and caudally below the peduncle. The nucleus of the posterior accessory optic tract is a fairly small, elongated mass that lies dorsomedial to the cerebral peduncle. The substantia nigra, pars compacta, adjoins the nucleus immediately at its dorsal tip and the mammillary body lies medial to the rostral portion of it. Further connections of the nucleus could not be determined nor could the anterior accessory optic tract be identified in normal materials.

The Marchi materials confirmed the observations made in the normal materials.

A section on the accessory optic tract is included in a review article on the visual centers of the brain by Le Gros Clark.[39]

In his book on "The Brain of the Tiger Salamander," C. J. Herrick,[40] 1948, stated that the basal optic root is present in all classes of vertebrates from cyclostomes to man. He stated that two possible functions had been suggested for it in the *Amblyostoma*. The more primitive of these is to act as a general activator of the ocular and somatic muscles in response to visual stimuli manifested in such behavior as the "regarding reaction." In the second place the structure and connections of the area centrolateralis pedunculi, within which the basal optic fibers terminate, suggests that this neuropil may be part of the apparatus of conditioning of visual reflexes.

Hess,[41] in 1958, removed one eye from fetal guinea pigs ranging in gestation age from 35 to 55 days. He observed that the posterior accessory optic tract was present only on the ipsilateral side, i.e., the contralateral posterior accessory optic tract had not developed.

DISCUSSION

There is very little doubt that the posterior accessory optic tract exists in all of the animals studied. Only Barris, et al., in cats, and Jefferson, in the ferret, were unable to detect this tract. It is not surprising that these two negative reports occurred in carnivores since Gillilan has reported that this tract is unmedullated in the carnivores.

There seems to be some evidence that the posterior accessory optic tract contains centrifugal fibers in addition to the centripetal ones. Münzer and Wiener felt that the tractus peduncularis transversus had some centrifugal action. Edinger stated that the tractus peduncularis transversus was actually part of the ciliary nerve. Tsang noted that even seven months after enucleation, some fibers were still present in this tract. These observations would indicate that the tractus peduncularis transversus may be composite in nature, i.e., containing both centripetal and centrifugal fibers.

A few authors have commented on the probable function of the posterior accessory optic tract. Massaut stated that the tractus peduncularis transversus probably contained pupillary fibers. As stated above, Edinger felt that the tractus peduncularis transversus was part of the ciliary nerve. Rioch suggested that it is concerned with muscular coordination because of the close association of this tract with the extrapyramidal system. Gillilan stated that the function of the accessory optic tracts was to establish a pathway between the retina and various subthalamic and midbrain efferent centers, such as the nucleus subthalamicus, the substantia nigra, the oculomotor nucleus and the midbrain tegmental gray. It has also been thought that the influence of light on the gonads may be mediated by these pathways via the pituitary gland.

The existence of the anterior accessory optic tract is more doubtful. Four different observations have been reported: (1) it exists as a separate and distinct bundle; (2) it is an aberrant branch of the primary optic tract and rejoins it; (3) it runs as a separate bundle but joins the posterior accessory optic tract and ends in the same nucleus; and (4) it does not exist.

Only Tsai and Le Gros Clark, et al.,[42] have commented on the probable function of the anterior accessory optic tract. Tsai postulated that these optic connections are significant for the coordination of vision and motility because of the connections of the nucleus subthalamicus with the substantia nigra and globus pallidus.

Le Gros Clark, et al., showed that the estrus cycle in the ferret was altered if the optic nerves were cut. However, the estrus cycle remained normal when the dorsal lateral geniculate nucleus, or the superior colliculus or other parts of the midbrain were destroyed. Therefore, they concluded that the pathway is either through the ventral lateral geniculate nucleus or by the anterior accessory optic tract and the nucleus subthalamicus.

## SUMMARY

There is very little doubt that the tractus peduncularis transversus (posterior accessory optic tract, basal optic root) exists. It has been reported to be present in chiropteres, insectivores, rodents, carnivores, ungulates and primates.

It consists of decussated fibers and runs with the main optic tract to the ventral margin of the lateral geniculate nucleus. At this level it splits off and runs as a separate bundle ventrocaudally over the cerebral peduncle to the region of the exit of the III N. The fibers turn dorsally over the medial edge of the cerebral peduncle and enter the nucleus. The nucleus of the posterior accessory optic tract lies ventrolateral to the red nucleus, medial to the substantia nigra, posterior to the mammillary body and anterior to the exit of the III N.

Primary fibers have been observed to pass to the substantia nigra, the lateral reticular gray, the oculomotor nucleus and the interpeduncular nucleus. Secondary fibers have been traced from the nucleus of the posterior accessory optic tract to these same nuclei as well as to the contralateral nucleus. Fibers have also been reported either to go to or to come from the superior colliculus.

There is some evidence that the tractus peduncularis transversus contains both centripetal and centrifugal fibers.

The presence of the anterior accessory optic tract is more doubtful. It has not been observed in the carnivores and primates although it has been reported in chiropterers, insectivores and rodents. The fibers are reported to originate from the retina and are completely decussated. They run with the main optic tract up to the level of the mamillary body. Here the fibers bend dorsally and penetrate the cerebral peduncle. The fibers pass through the cerebral peduncle and end in the nucleus subthalamicus.

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