THE CONNEXIONS OF THE POSTERIOR COMMISSURE

A STUDY OF ITS DEVELOPMENT AND MYELINATION IN THE HUMAN FOETUS AND YOUNG INFANT, OF ITS PHYLOGENETIC DEVELOPMENT, AND OF DEGENERATIVE CHANGES RESULTING FROM CERTAIN EXPERIMENTAL LESIONS

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INTRODUCTION

During an investigation (Keene & Hewer, 1933) of the development and connexions of the medial longitudinal bundle in the human, the posterior commissure was brought frequently to our notice, and we were impressed not only by the early date at which it may be detected in the human embryo, but also by the early definition of its pattern during development. The latter suggests that this commissure possesses very constant connexions but, on referring to the literature on the subject, it was found that except for one generally accepted connexion (the nucleus of the posterior commissure, also known as the nucleus of Darkschewitsch), other connexions were often vaguely described and varied greatly according to different authors. A further investigation of this region was therefore undertaken, and the scope of the proposed research was designed to include a study of the development, myelination and connexions of the commissure in the human, and also a review of its phylogenetic development.

However, when this work was nearly complete, it was recognized that though a study of the onset of myelination of the fibres of the commissure in a large series of human foetuses affords a means of differentiating between the fibres, and defines certain connexions, yet it yields very little information as to the precise disposition of its component neurones. Prof. W. E. Le Gros Clark suggested that examination of degenerated fibres following section of the commissure would throw light on this point, and also kindly offered to perform the experiment. The work therefore includes some observations on the results of certain experimental lesions.

MATERIAL

The material on which this paper is based includes serial sections of brains of forty-four human specimens, and serial sections of brains of twenty-one specimens of vertebrate animals.

The following list gives the method of staining of the material, and in the case of human material gives the age.

Human material

Age	No. of specimens	Staining	Age	No. of specimens	Staining
*9 mm.	2	H. and B.S.	80 mm.	2	R.
*10 mm.	2	H. and B.S.	80 mm.	1	H. and B.S.
*12 mm.	3	H. and B.S.	*14–16 week foetus	1	W.P.
*12·5 mm.	1	H. and B.S.	15 week foetus	1	R.
*16 mm.	1	R.	16–18 week foetus	1	Bielschowsky
*17 mm.	1	H. and B.S.	18 week foetus	1	R.
*18 mm.	2	H. and B.S.	*24 week foetus	1	R.
*19 mm.	2	H. and B.S.	24–26 week foetus	2	W.P.
*20 mm.	1	H. and B.S.	26–28 week foetus	1	H. and B.S.
*25 mm.	1	H. and B.S.	36 week foetus	1	W.P.
*32 mm.	1	H. and B.S.	Full-time foetus	2	W.P.
8 weeks	2	H. and B.S.	3 day infant	1	W.P.
37 mm.	1	H. and B.S.	*3 month infant	2	W.P.
10 weeks	1	H. and B.S.	6 month infant	1	W.P.
67 mm.	1	R.	7 month infant	1	W.P.
75 mm.	1	Picrocarmine	8 month infant	1	W.P.
76 mm.	1	H. and B.S.	9 month infant	1	W.P.

Vertebrate animal material

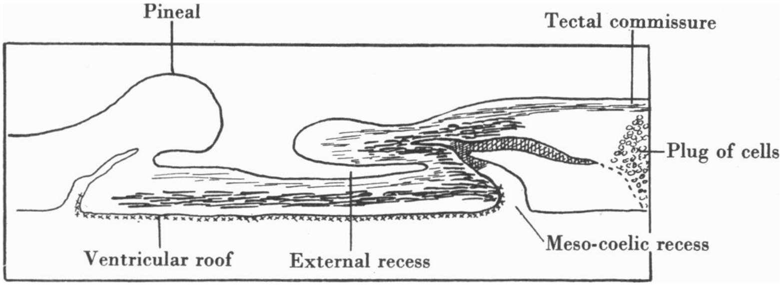
Specimen	Number	Staining	Specimen	Number	Staining
**Petromyzon*	1	H. and B.S.	Salamander	1	H. and B.S.
*Skate	2	H. and B.S.	Chameleon	1	H. and B.S.
*Dogfish	1	H. and B.S.	Mole	1	W.P.
**Necturus*	3	H. and B.S.	*Kitten	1	W.P.
Necturus	1	R.	Cat	1	Osmic
Frog	2	H. and B.S.	Monkey	3	Osmic
Sphenodon	2	Ranson			

Note. H. and B.S. = Scott's haematoxylin and Biebrich Scarlet.
W.P. = Weigert-Pal's method.
R. = Ranson's method modified by Hewer (1933).
* denotes serial every section.

THE POSTERIOR COMMISSURE IN MAN

(*a*) *Position and general arrangement of the fibres within the tract*

The posterior commissure extends from the region of the pineal recess to the tectal commissure. Its caudal end corresponds with the position of the orifice of the mesocoelic recess (which closes soon after birth), and in the foetus the epithelial roof cells related to the commissure form the subcommissural organ. The plan of the developing commissure can be followed by reference to Text-fig. 1, which is a rough linear reconstruction of the tract in a 3-day infant. It is seen that the component fibres are of two kinds, coarse and fine. The coarse fibres lie close to the ventricular roof and also skirt the mesocoelic recess, whereas the fine ones occupy a position nearer to the exterior, and are continued into the tectal commissure. The curious fold of the roof of the mesencephalon in the cephalad direction which includes the mesocoelic recess occurs very early in embryonic life and is well seen in a 32 mm. embryo, but, as noted in a previous paper (Keene & Hewer, 1935), it tends to disappear together with the mesocoelic recess 3 or 4 months after birth. The arrangement of the coarse and fine fibres of the commissure, however, remains undisturbed in spite of the disappearance of the fold. In fact the arrangement of the fibres in the caudal part of the commissure is such as one would expect if the external recess had become occluded by adhesion of its surfaces. Thus the cephalic part of the commissure consists of ventral coarse fibres and fine dorsal ones, and the caudal part (i.e. that part which in the foetus was related to the mesocoelic recess) has a more complicated arrangement of fibres, due to the forward folding of the roof of the mid-brain in that region.



Text-fig. 1. Linear reconstruction showing arrangement of coarse and fine fibres in the posterior commissure. (From 3-day infant.) × × × × denotes position of subcommissural organ.

(*b*) *Development and myelination*

Sections of human embryos of 9 and 10 mm. were examined, and in these the commissure was not identified but, in the 12 mm. embryo of this series, a large posterior commissure is present. The fact that the tract is so well developed in the 12 mm. embryo suggests that it must have been present though unrecognized in the younger specimens. Frazer (1931) states that it develops early in the second month.

The 12 mm. embryo exhibits a commissure formed chiefly of rather coarse fibres which may be traced ventrally, but no nucleus was identified. Some fibres connect with the subcommissural organ, others with the thalamus and tegmental region Embryos of 25–37 mm. (about 7–8 weeks) present a very well-developed commissure, and fibres still connect with the cells of the subcommissural organ.

About the 14th week myelination begins, and proceeds to develop in the various fibres in the following order:

(1) At the 14th week a few myelinated fibres are found in the ventral part of the commissure, and also in the nucleus chiefly connected with this group of fibres, the nucleus of the posterior commissure.

(2) At about the 24th week myelination is found in the fibres connecting with the subcommissural organ: and at this time the medial longitudinal

bundle shows a myelinated connexion with the nucleus of the posterior commissure, and also with the nucleus of the third cranial nerve.

(3) At the 36th week there are present delicate myelinated connexions with the medial habenular nucleus, with the habenulo-peduncular tract and with the pineal gland (Pl. I, fig. 5); and myelination is found in fibres connecting with the tegmentum and the red nucleus.

(4) At 3 months after birth the thalamic connexions are myelinated, and at about the same time myelination appears in some horizontal laterally directed fibres.

The myelination of each group is at first very fine and increases later, particularly with regard to the ventral group.

The connexion with the subcommissural organ is curious. It is large and unmyelinated at 8 weeks, at 24 weeks it appears to be diminished though a few myelinated fibres are seen, and later on in foetal life the whole connexion disappears. In a previous paper the atrophy of the subcommissural organ in man has been noted (Keene & Hewer, 1935).

(*c*) *Connexions*

A very careful study of the development and myelination of the commissure in human specimens up to 9 months after birth permits the following summary of its connexions:

(1) The main bulk of the coarse fibres in the commissure connect with the nucleus of the posterior commissure (nucleus of Darkschewitsch of some observers) and also indirectly through the nucleus of the posterior commissure or interstitial nucleus with the ipsilateral medial longitudinal bundle (Pl. I, fig. 2).

(2) Other fibres, chiefly coarse ones, connect with the regions of the tegmentum and the capsule of the red nucleus (Pl. I, fig. 1).

(3) Fine fibres situated in the dorsal part of the commissure connect with the thalamus (Pl. I, fig. 3).

(4) There is a well-marked component of the commissure consisting of horizontal fibres which may be traced in a lateral direction. After repeated examination of the sections it was thought that this connexion may be striatal, or possibly cortical (Pl. I, fig. 4).

(5) There is a small connexion with the habenular ganglia, and the habenulo-peduncular tracts (Pl. I, fig. 5).

(6) A fine connexion with the pineal gland is also established.

THE PHYLOGENY OF THE POSTERIOR COMMISSURE

Petromyzon (Pl. II, fig. 1)

The posterior commissure of petromyzon and other myxinoids has been well described by several observers (Johnston, 1907; Herrick, 1913; Jansen, 1929; Schilling, 1907; Kappers, 1936). It consists of a commissural mass of fibres related to the caudal part of the subcommissural organ, and both structures end abruptly at the opening into the recess of the mid-brain. A marked connexion exists between the commissure and the subcommissural organ, but the cells of this organ also connect with many fibres which lie in the commissural mass but which do not cross.

The nucleus of the posterior commissure is not identified in our specimens. Most of the fibres spread ventrally amongst some scattered cells, and then are lost among the other fibre tracts. Jansen (1930), having examined 200 myxine brains, could not identify a nucleus of the posterior commissure.

The tectal component described by Johnston and Tretjakoff (Tretjakoff, 1909) was not seen by us, and the posterior commissure is separated from the tectum by an extensive evagination of the epithelial roof of the mid-brain.

Skate and dogfish

The brains of skate (Pl. II, fig. 2) and dogfish show a very large posterior commissure, exhibiting a great advance on that of petromyzon, and corresponding very closely in form and extent with the human type. The nucleus of the posterior commissure was not identified, but the coarse ventral fibres in the commissure correspond very closely to those which in the human are derived from this nucleus. Other fibres appear to connect (as in the human) with the diencephalon and the tegmentum. Some spread in a lateral direction, possibly representing the external geniculate connexion mentioned by Kappers (1936). There is a well-marked connexion with the subcommissural organ.

Necturus

The posterior commissure in *Necturus* is much simpler in form than that of skate or dogfish.

It is related dorsally to the commissura tecti diencephali which overlaps the posterior commissure both cephalically and caudally. The subcommissural organ is very large and lines the roof of the aqueduct as high up as the habenular commissure and extends below the caudal range of the posterior commissure. The chief connexion of the commissure apart from that with the subcommissural organ, appears to lie with cells of the grey matter in the ventral region of the brain stem, probably the nucleus tuberculum posterius of Herrick (1928).

It was felt that the selection of necturus for exhibiting the amphibian type of the posterior commissure was not doing justice to that order, and the brain of a frog was next examined.

Frog

The posterior commissure is well developed, and exhibits most of the features described in the human, including the coincidence of the position of the orifice of the mesocoelic recess with the lower limit both of the commissure, and of the subcommissural organ. The bulk of the ventral fibres of the commissure connect with cells situated close to the upper limit of the nucleus of the third nerve and the medial longitudinal bundle. It is difficult to differentiate a definite nucleus in this situation, but the position of these cells corresponds very closely to that of the nucleus of the posterior commissure in the human. The commissure exhibits a marked connexion with the subcommissural organ.

The commissure differs from the human in that it does not extend up to the pineal recess, and also that a large bulk of the dorsal group of its fibres connect with the optic lobes.

Salamander (Pl. II, fig. 3)

The posterior commissure is relatively simple, consisting mainly of coarse fibres which, when traced ventrally and caudally, lose their identity by mingling with other fibre tracts in close relation with the third nerve nucleus.

There are, however, in addition to this ventral bundle, a few fine fibres passing dorsal to a small mesocoelic recess which correspond to the dorsal component of the commissure found in skate and frog. There is a marked connexion in the cephalic part with the cells of the subcommissural organ.

Chameleon

The commissure in this reptile follows very closely the human plan. The coarse ventral fibres are derived very largely from a nucleus situated in close relation to the nucleus rotundus. Traced from the commissure in a caudal direction, these fibres continue for some distance in the ventral part of the brain stem and lose their identity when in close relation to the third nerve nucleus, by mingling with other coarse fibre bundles. The components of the dorsal group of fibres of the commissure connect with the tectum and with the ventrolateral region of the brain stem. The ventral fibres of the commissure connect freely with the subcommissural organ.

Sphenodon[1]

The commissure is well developed and differs only in certain respects from the human type. The mesocoelic recess is absent in the two specimens examined.[2] There is a very well-marked connexion with the subcommissural organ and with the optic lobes.

The coarse ventral fibres of the commissure connect with ventrally placed cells of the grey matter in the mid-brain, but no nucleus of the posterior com-

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[1] Kindly lent by the late Dr McMaster.

[2] It must be remembered however in regard to the presence or absence of this recess that in comparing the series of animals with the human series a comparison is being drawn between post-natal, often adult, material on one hand with foetal or very young post-natal material on the other.

missure is defined. Compared with chameleon, the cephalic end of the commissure exhibits a marked difference in that it effects a delicate connexion with epiphyseal structures and with the habenular ganglia.

Mole (Pl. II, fig. 4)[1]

The commissure in the mole consists of very heavily myelinated fibres occupying chiefly the ventral part of the commissure, though some of these fibres pass into the dorsal part. They connect on either side with the nuclei of the posterior commissure, and appear to arise from cells of this nucleus. Other heavily myelinated fibres lying in the ventral part connect with the tegmental region. In addition to the coarse fibres mentioned above, there are also fine myelinated fibres in the dorsal part of the commissure which are directed laterally and horizontally. This dorsal part of the commissure is confluent with the tectal commissure. A well-developed subcommissural organ is present, and a mesocoelic recess is also seen. The commissure thus very closely resembles that in the human.

In mole and in the kitten examined (Pl. III, fig. 1), there is found in addition a well-marked bilateral nucleus lying rather dorsally placed among the fibres approaching the commissure. This nucleus is also figured by Rioch (1929) in his studies on the diencephalon of carnivora, and called by him the "nucleus of the posterior commissure", but it does not give rise to a great many fibres entering the commissure; it must not be confused with the large nucleus lying more ventrally in close relation with the red nucleus and nuclei of the third nerve, which does furnish abundant fibres to the commissure, and which he calls the nucleus of Darkschewitsch, and which corresponds to the one described in this paper as the nucleus of the posterior commissure. Attention has already been drawn in another paper (Keene & Hewer, 1933) to the great confusion that reigns regarding these nuclei. This confusion is probably due to the fact that the dorsally placed nucleus consists of only a few cells in the human, whereas in the lower mammals that we have examined (cat, mole) it is certainly a well-marked collection of cells, though not so important to the commissure as regards fibre connexions, as the more ventrally placed nucleus.

Kitten (*3 weeks*) (Pl. III, figs. 1, 2)

In this specimen stained by the Weigert-Pal method, the commissure is seen to conform closely to that in the newborn infant. The ventral fibres of the commissure are well myelinated and consist chiefly of fibres connected with the nucleus of the posterior commissure, and also with a nucleus (Pl. III, fig. 1) situated dorsally, actually lying among the fibres approaching the commissure. Tegmental fibres also join the ventral part of the commissure. In the dorsal part are finely myelinated fibres which enter the commissure from a lateral direction. No connexion is seen with the subcommissural organ, which is well

[1] Kindly lent by Dr Una Fielding.

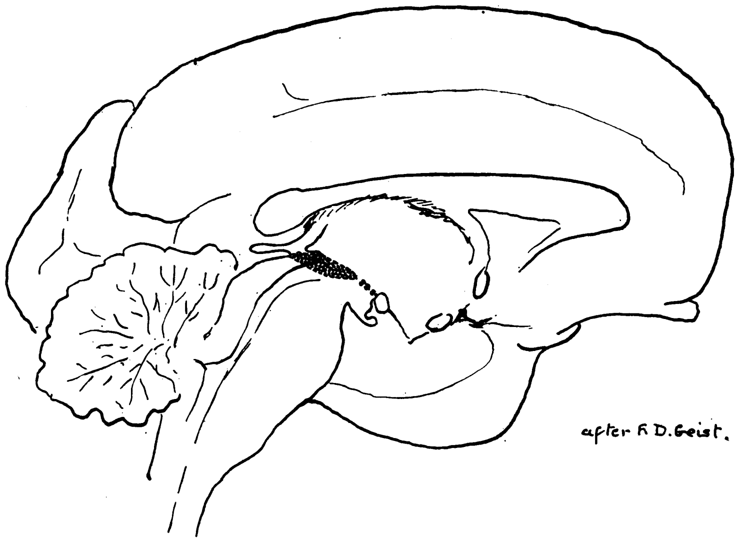
developed in the region of the commissure. A mesocoelic recess is not present in the specimen examined, possibly its presence post-natally varies as it does in man, for it has been observed in the adult cat. The medial longitudinal bundle is well myelinated and its cephalic fibres appear to connect with cells, probably belonging both to the nucleus of the posterior commissure and to the interstitial nucleus (Pl. III, fig. 2).

OBSERVATIONS ON EXPERIMENTAL MATERIAL

Operation

Rhesus monkey (O.M. 45) operated[1] 4 June 1936, killed 18 June 1936.

The operation was undertaken with the object of cutting through the posterior commissure, the animal being under nembutal anaesthesia.



Text-fig. 2. Diagram of brain of *Rhesus* monkey to show position of lesion.

The brain was exposed by raising an osteoplastic flap, and, approach being made from the left side, the left occipital lobe was drawn laterally and section of the commissure was made with a knife. The animal made a good recovery, and suffered no apparent disability, though no special tests were carried out. After fourteen days the animal was killed by an overdose of chloroform; the brain was removed and serial sections were stained by the Marchi method.

The lesion (Text-fig. 2) was found to cut the commissure just to the left of the median plane. In the cephalic direction it involved the habenular region and here extended near to the ventral surface of the brain in the mammillary region. In the region of the commissure it extended through the grey matter

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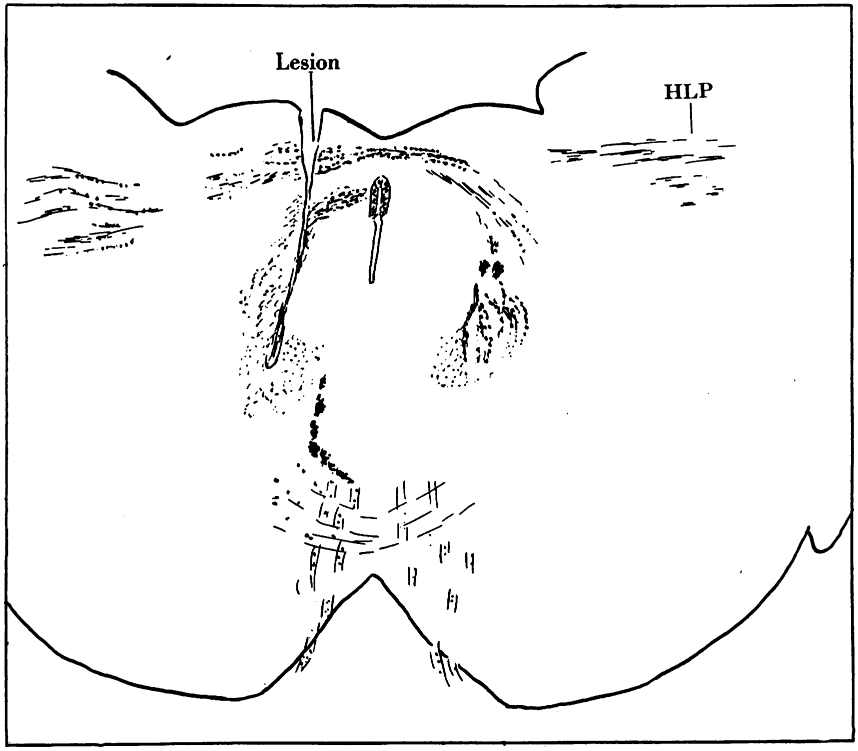
[1] The operation was performed at the Anatomical Department, University Museum, Oxford, by Prof. W. E. Le Gros Clark, M. F. L. K. assisting.

of the mid-brain, seriously damaging the nucleus of the posterior commissure and the interstitial nucleus, and caused some damage to the red nucleus and possibly very slightly affected the third nerve nucleus.

Caudally the cut was shallower and just impinged on the tectal commissure.

Degenerative changes

As may be seen from Text-fig. 3, degenerated fibres pass into both ventral and dorsal parts of the commissure, and these fibres may be traced into the regions of the opposite commissural nuclei (nucleus of the posterior commissure and interstitial nucleus) to the red nucleus and towards the tegmentum. The cephalic fasciculi of the ipsilateral medial longitudinal bundle are almost entirely degenerated and when traced caudally (Pl. III, fig. 3) these degenerated fibres are seen to occupy for the most part the medial part of the bundle.



Text-fig. 3. Diagram showing lesion in monkey (O.M. 145). Degenerated fibres are dotted in.

HLP = horizontal laterally placed group of fibres.

Slight degeneration is found as follows:

(*a*) In ipsilateral horizontal laterally placed fibres (Text-fig. 3).

(*b*) In fibres of the third nerves, more marked on the side of the lesion.

(*c*) In a very few fibres of the contralateral medial longitudinal bundle.

Other degeneration found but not germane to this investigation was in the rubro-spinal decussation, in the habenular commissure, in the ipsilateral habenulo-peduncular tract, and further the contralateral habenular nucleus and habenulo-peduncular tract were also very slightly affected.

We were further indebted to Prof. Le Gros Clark for the loan of serial sections of experimental material in which the lesions which were designed for other investigations produced degeneration in fibres of the commissure. The evidence afforded by these sections relating to the posterior commissure is briefly noted.

In one specimen (cat 7) the lesion involved the right nucleus of the posterior commissure and in addition to finding the principal degeneration in the ventral part of the commissure, very definite degeneration was seen in fibres connecting with the contralateral thalamus.

In another specimen (monkey 46A) the nucleus of the posterior commissure was undamaged and the ipsilateral medial longitudinal bundle was found to be intact.

DEDUCTIONS BASED ON THE EVIDENCE OFFERED BY ALL PARTS OF THIS INVESTIGATION

(*a*) Efferent fibres arise in the nucleus of the posterior commissure of one side and pass to the nucleus of the commissure and interstitial nucleus of the other side, also to the contralateral red nucleus and tegmental region.

(*b*) The fibres shown to be degenerated passing from the nucleus of the posterior commissure to the opposite tegmentum do not appear sufficient in number to account for the large tegmental component of the commissure part of which must therefore be composed of fibres passing from the tegmentum to the commissure. It is suggested that these tegmental fibres may represent the secondary ascending vestibular tracts (Text-fig. 4), which have left the lateral part of the medial longitudinal bundle lower down.

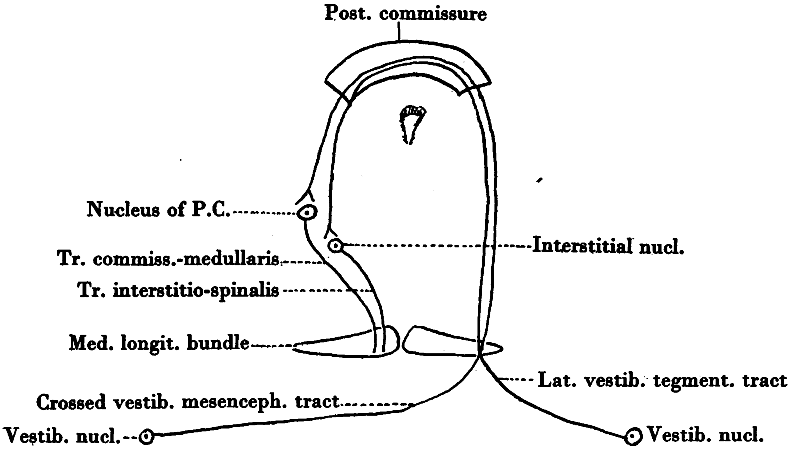
(*c*) The cephalic part of the medial longitudinal bundle is almost entirely composed of descending fibres arising in the nucleus of the posterior commissure and interstitial nucleus, and lower down these fibres occupy chiefly the medial part of the bundle.

(*d*) Very few fibres which have crossed in the commissure pass directly into the medial longitudinal bundle.

(*e*) The degenerated fibres found among the horizontal laterally placed groups of fibres must be derived from ipsilateral cells, otherwise there would be degeneration in corresponding fibres on the other side.

(*f*) As there is practically no degeneration in the fibres of the horizontal laterally placed group on the side opposite the lesion, it follows that these fibres must be still in relation with their cells of origin, and possibly indicates the presence of some descending fibres amongst this group (e.g. thalamo-commissural, striato-commissural, or perhaps cortico-commissural).

(*g*) The connexions that have been established show that the posterior commissure is of the nature of a decussation rather than a commissure. The only true commissural fibres appear to be those connecting the commissural nuclei (i.e. nuclei of the posterior commissure, and interstitial nuclei, and, in Carnivora, the dorsally placed nuclei of the posterior commissure of Rioch).



Text-fig. 4. Diagram illustrating connexions of secondary ascending vestibular tracts as described by Muskens.

(*h*) The chief connexions of the posterior commissure consist of the following groups of fibres:

(1) A ventral group present throughout the series, consisting of coarse fibres which in mammals connect with the nuclei of the commissure.

(2) Coarse fibres which connect with the tegmental region.

(3) Fine horizontal laterally placed fibres, possibly providing a striatal connexion.

(4) Fine fibres connecting with the thalamus.

(5) Fibres connecting with the tectum, found only in chameleon and in frog.

DISCUSSION

With respect to the bearing that the findings in this investigation have on the work of other observers, there is evidence offering confirmation for Muskens' (1922, 1935) conclusion that the secondary ascending vestibular tracts (the crossed vestibular mesencephalic, and the lateral vestibular tegmental) cross in the commissure before connecting with the nucleus of the posterior commissure, and the interstitial nucleus. They further confirm his experiment which showed that the commissuro-medullaris, and interstitio-spinalis tracts (Text-fig. 4) are conducting in a downward direction, and occupy at lower levels the medial part of the medial longitudinal bundle. As already noted, we go further and offer evidence that these tracts form the most cephalic portion of the medial longitudinal bundle.

The degeneration in some of the horizontal laterally placed fibres indicates their ascending course and would support Muskens' suggestion that there are fibres passing from the commissural nuclei to the ipsilateral globus pallidus.

It has been noted that our sections show some degeneration in the red nucleus opposite to the lesion. Vogt (1919) and Riese (1924) observe some fibres which pass from the globus pallidus to the contralateral red nucleus. We in common with other workers can only note this commissuro-rubral connexion, but have no definite evidence as to the source of the fibres.

Table I

	Petromyzon	Skate	*Necturus*	Salamander	Chameleon	Mole	Kitten
Groups of fibres of commissure referred to on p. 498	**1**	**1234**	**1** ? 2	**1** ? 2	**125**	**123**	**1234**

Table showing composition of the posterior commissure in certain of the vertebrates studied. The numbers refer to the analysis of groups of fibres in § (*h*), p. 498. The figures in heavy type denote the groups furnishing the bulk of the fibres in each case.

With regard to any deductions that may be drawn from the phylogenetic study, it is recognized that this survey of the phylogeny of the commissure is very limited, and therefore any deductions from this part of the investigation are very tentatively made. It appears however fair to assume from the appearances of the tract in the various animals examined that the ventral part of the commissure is phylogenetically the oldest (Table I).

As to any information regarding functions of the commissure that may be suggested by the phylogenetic review, it is appreciated that the ground for argument is very uncertain. Several workers (Collier, 1927; Muskens, 1935; Duke-Elder, 1932) have recently offered evidence that the posterior commissure serves as a pathway for impulses relating to eye-movements, and the close association that exists between the posterior commissure and the medial longitudinal bundle tends to emphasize the importance of the commissure in this respect. On the other hand, this investigation shows that though the mole is blind, it has a very well developed commissure and this fact suggests that the important functions of the posterior commissure may be other than those associated with movements of the eyes.

A comparison between the phylogenetic development of the posterior commissure and that of the cerebellum presents another view regarding the problem of the functions of the commissure. It is recognized that the cerebellum is relatively small in amphibia and reptiles, and this fact has been correlated with the comparatively sluggish habits of these animals. Reference to Table I shows that in the vertebrates selected for this investigation the development of the posterior commissure as regards size and complexity runs closely parallel with the development of the cerebellum. This parallelism existing between the development of the cerebellum and that of the posterior commissure, and also the fact that the blind mole presents a well-developed commissure, suggests that the more important functions of the commissure may be associated with posture and the integration of body movement rather than with movements of the eyes and visual influences.

SUMMARY

1. The connexions of the posterior commissure have been described in a selected series of vertebrate animals, and in the human foetus and young infant.

2. The dates of myelination of its component fibres in the human have been noted.

3. The degenerative changes resulting from an experimental lesion have been noted and discussed.

4. The bearing of the results of this investigation on the work of other observers has been noted.

5. Deductions that might be drawn from the phylogenetic review have been discussed.

ACKNOWLEDGEMENTS

I would wish to offer my best thanks to Prof. le Gros Clark, whose help with the experimental work has assisted in rounding off what might otherwise have been a very inconclusive investigation.

My colleague Dr E. E. Hewer, who began this investigation with me, was unable owing to illness to pursue it to its conclusion, and I wish to acknowledge her very great help in the arduous work involved in the examination of the serial sections which form the basis of this research.

Finally, grateful acknowledgement is due to the Thomas Smythe Hughes Medical Research Fund and to the Waller Research Fund which have in part paid the expenses incurred in this investigation.

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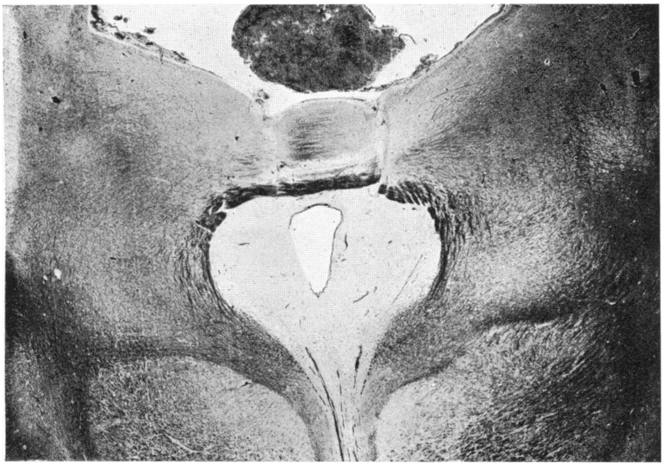

Fig. 1.

Fig. 2.

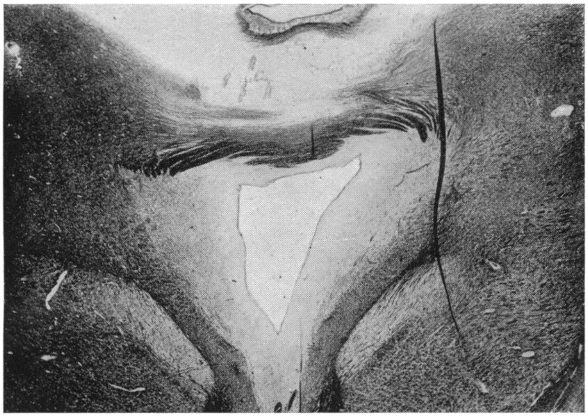

Fig. 3.

Fig. 4.

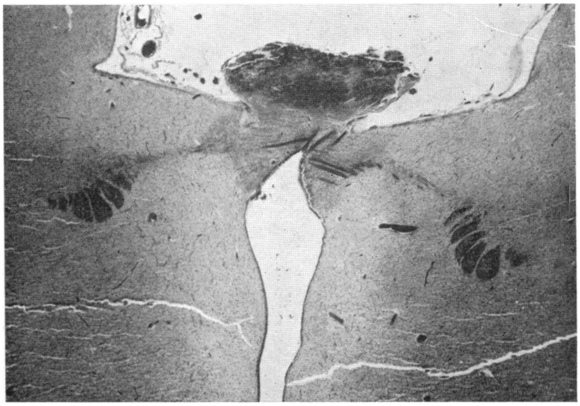

Fig. 5.

KEENE—The Connexions of the Posterior Commissure

Fig. 3.

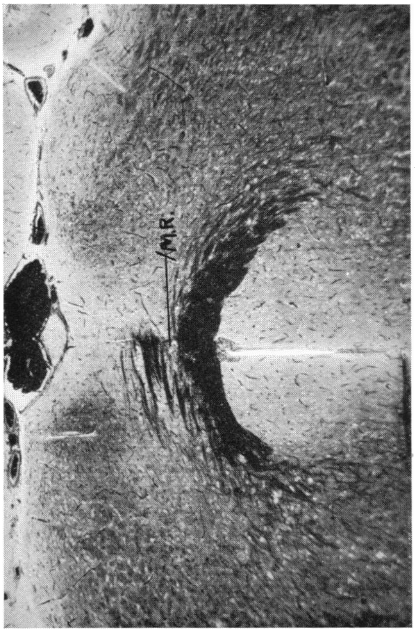

Fig. 4.

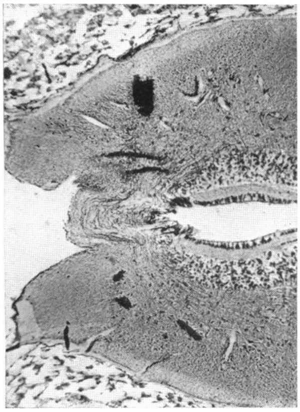

Fig. 1.

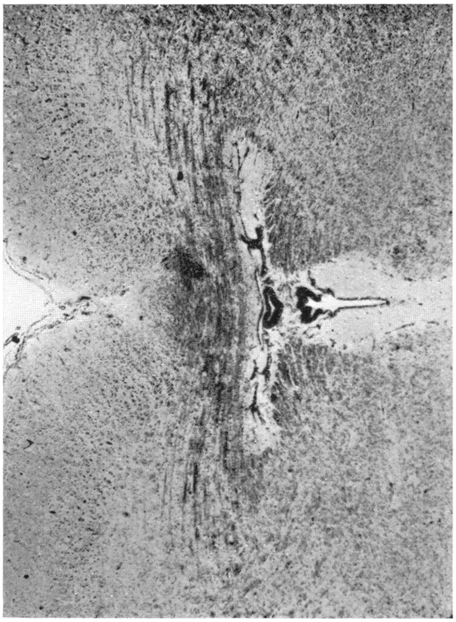

Fig. 2.

KEENE—THE CONNEXIONS OF THE POSTERIOR COMMISSURE

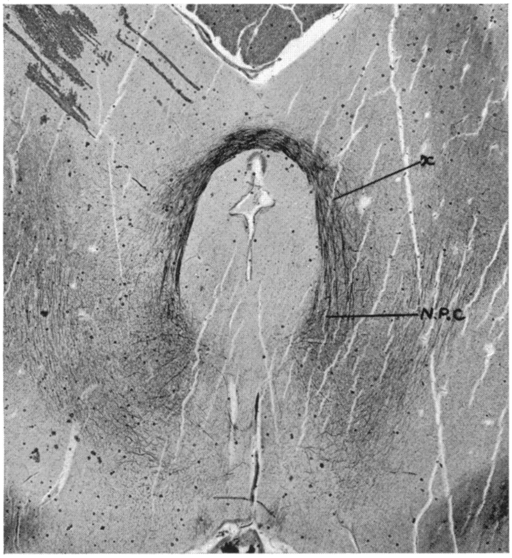

Fig. 1.

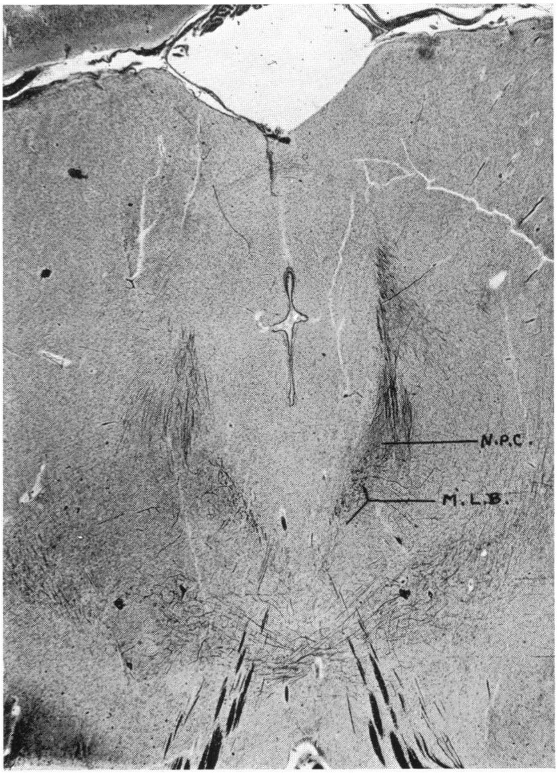

Fig. 2.

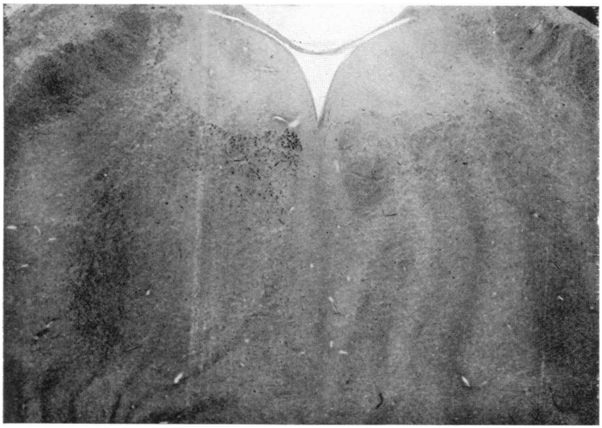

Fig. 3.

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EXPLANATION OF PLATES I–III

PLATE I

Fig. 1. Section through posterior commissure of infant aet. 3 months (2312), showing general arrangement of commissure. × 9·5.

Fig. 2. Section showing coarse commissural fibres arising in nucleus of the posterior commissure (*N.P.C.*) and the close relation with the medial longitudinal bundle (*M.L.B.*). Infant aet. 3 months (2312). × 10.

Fig. 3. Section showing fine fibres in dorsal part of the commissure connecting with the thalamus. Infant aet. 9 months (2296). × 7·5.

Fig. 4. Section showing horizontally directed fibres joining commissure. Infant aet. 8 months (1164). × 7.

Fig. 5. Section through cranial part of the commissure showing connexion with habenular ganglion, and habenulo-peduncular tract. Infant aet. 3 days (2338). × 5. [The commissural fibres are running in a horizontal direction. The three vertical dark streaks are not fibres, two are blood vessels and one is a fold in the section.]

The above figures are photomicrographs of human material prepared by the Weigert-Pal method.

PLATE II

Fig. 1. Section through posterior commissure of petromyzon, showing ipsilateral subcommissural organ connexion (339). × 40.

Fig. 2. Section showing posterior commissure in skate (95). × 6.

Fig. 3. Section showing the posterior commissure in Salamander. *M.R.* = mesocoelic recess. *D.F.* = dorsal fibres. × 25.

Fig. 4. Section (kindly lent by Dr Una Fielding) showing posterior commissure in mole. *M.R.* = mesocoelic recess. × 10.

PLATE III

Fig. 1. Section of brain of 3 weeks old kitten (38); Weigert-Pal preparation, showing myelinated fibres connecting with nucleus of posterior commissure (*N.P.C.*), and also the site of the dorsally placed nucleus (*x*, see text) lying among the commissural fibres. × 8.

Fig. 2. Section of brain of 3 weeks old kitten (38), Weigert-Pal preparation, showing medial longitudinal bundle (*M.L.B.*) arising close to region occupied by cells of the nucleus of the posterior commissure (*N.P.C.*). × 17.

Fig. 3. Section through region of the pons of *Rhesus* monkey (O.M. 145), showing degeneration in fibres of medial longitudinal bundle on same side as the lesion. × 5.

All the figures are photomicrographs of sections made approximately in the coronal plane. The figures in brackets refer to the serial number of each specimen.