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Research Article

ORGANIZATION OF MESENCEPHALON OF INDIAN HOUSE WALL LIZARD *HEMIDACTYLUS FLAVIVIRIDIS*

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ABSTRACT
Topological organization of the mesencephalon of Indian house wall lizard has been studied by Eager's method. The mesencephalon is well developed in Indian house wall lizard *Hemidactylus flaviviridis*.From the study of different sulci and the relationship of different grooves from nuclear groups of Indian house wall lizard, *H. flaviviridis*, the mesencephalon has been divided into two main longitudinal zones. These are motor basal plate and sensory alar plate. The motor basal plate is situated medially. The sensory alar plate is located laterally. The motor basal plate is further divided into area ventralis and area intermedio ventralis. The area ventralis is somatic motor zone. The area intermedio ventralis is visceral motor zone.
The area ventralis somatic motor zone includes motor nucleus of III cranial nerve and motor nucleus of IV cranial nerve. The rostral part of mesencephalon has nucleus of fasciculus longitudinalis medialis (NFLM), nucleus of interstitialis fasciculus longitudinalis medialis (NIFLM), nucleus opticus tegmenti (OPT) and third ventricle (V-III). The caudal part of the mesencephalon includes griseum centrale (GC), nucleus centralis, torus semicircularis (TORC) and tectum mesencephali (TM).

Keywords: *Mesencephalon, Organization, Eager's Method 1970*

INTRODUCTION
The lizards are among the most commonly spotted of all reptiles. There are over 3500 different types of lizards existing in all climates throughout India. The walls and ceilings are their niche where they walk and live their lives. The house wall lizard *Hemidactylus flaviviridis* belongs to the family Gekkonidae of suborder Sauria or Lacertilia is second largest family of this suborder. It is said that lizards are poisonous except two species *Heloderma suspectum* and *Heloderma hornidum* are poisonous. The lizards are predator of insects hence they are useful for farmers and agriculture. They can be used for pest management.
In our present study the mesencephalon region of the brain of *Hemidactylus flaviviridis* for better understanding of its anatomy and phylogenetic character has been presented.

MATERIALS AND METHODS
Ninety seven adult lizards, Sauria or Lacertilia of both sexes weighing 45 to 70 gms were used in this experiment. Animals were kept in the cage in the light and cool atmosphere at a room temperature (25 to 30°C). The experimental lizards were kept isolated in the separate cage from normal animal. Prior to the experiment, the specimens were acclimatized at room temperature for one day. Surgical procedures were performed with sterilized dissecting instruments. The specimens were anaesthetized by immersing with 10% formalin for 10 to15 minutes prior to the surgery.

Operation Procedure
For perfusion, animals were anaesthetized with chloroform for 2 to 5 minutes. Completely anaesthetized lizard was kept in the operating tray. After fixing the lizard, a small longitudinal incision was made in the middle of the thorax (1cm). The rib cage was cut open right from the middle to expose the viscera. The thorax was opened to expose the heart. The pericardium was removed. Fine syringe of the perfusion set was inserted in the aorta through the posterior part of the ventricle. First of all 50 ml of physiological

saline (0.75%) was allowed to pass through the aorta to the entire body, lower part of the ventricle was cut and blood was allowed to release. The whole blood of the body was replaced by physiological saline. One hundred ml. of fixative (10% formalin) was allowed to perfuse through the heart in continuation with saline. Precaution was taken to avoid the clotting of the blood which actually leads to incomplete perfusion. After the perfusion of the fixative, the animal become totally stretched. Following perfusion for 15 minutes, the whole brain and spinal cord were dissected out and post fixed in the perfusion fluid at 4°C for twenty four hours. The brain and spinal cord were cut at 40 µm thick on AO HistoSTAT microtome at –20°C. The serial sections were put in section collecting trays containing 2 to 10% formaldehyde solution. For maintaining the serial orders only 5 sections were placed in each bin of the tray. The sections were processed with Eager's method (1970).

Perfusion

This method is conventional technique for preserving the whole animal body by pumping the fixative through the heart in to the whole body, via vascular system. The perfusion is performed by a simple infusion set. This technique works on the gravity flow principle. The perfusion bottle was kept three feet above to the operating table. The infusion set comprises to ordinary infusion set, a bottle with lid having two outlets, in one of them infusion needle was inserted and in other normal injection needle was inserted to avoid air lock. The infusion set comprises of plastic tube, an air column on both side, needle and a stopper.

RESULTS

The mesencephalon is well developed in Indian house wall lizard *H. flaviviridis*. The midbrain anteriorly joins with the caudal diencephalon of the posterior part of the prosencephalon. The mesencephalon posteriorly joins with the anterior part of the cerebellum of the rhombencephalon. The mesencephalon includes two large rounded optic lobes. These two optic lobes are placed dorso – laterally.

From the study of different sulci as sulcus medianus inferior (SMI), sulcus intermedius ventralis (SIV), sulcus limitans of His (SLH) and sulcus medianus superior (SMS) and the relationship of different grooves from nuclear groups of Indian house wall lizard, *H.flaviviridis*, the mesencephalon has been divided into two main longitudinal zones (Figs.1,2&3). These are like motor basal plate and sensory alar plate. The motor basal plate is located medially. The sensory alar plate is situated laterally. The motor basal plate is further divided into two areas as ventralis and intermedio ventralis. The area ventralis is somatic motor zone. The area intermedio ventralis is visceral motor zone. The area ventralis somatic motor zone has two motor nuclei as motor nucleus of III cranial nerve (Fig.3) and motor nucleus of IV cranial nerve (Fig.3).

In addition to these nuclear groups some scattered cells are present in this region showing different organization of neurons. These are designated as following reticular (network) regions or reticular formation. This network of neurons is present very distinct rostrally to caudally tegmentum mesencephali. The zones of reticular formation can be mentioned in the following nuclear groups. These are like nucleus of the fasciculus longitudinalis medialis (NFLM) (Fig.4A&B), nucleus interstitialis of fasciculus longitudinalis medialis (NIFLM) (Fig.4A&B) and nucleus reticularis isthmi (RIS) (Figs.7A,B-9A&B). The sections of mesencephalon from rostral to caudal part (Figs.1-10) includes the following structures / nuclei and cell masses.

Optic lobe (OL):

This is located in between diencephalon and cerebellum. It is two in number. These are situated laterally (Fig.1).

Motor nucleus of III cranial nerve / nucleus nervi oculomotorii (III):

It extends from lower region of NFLM to beginning of nervi trochlearis regions throughout most of the length of tegmentum mesencephali (lateral side of IIIrd ventricle). This shows an elongated aggregation of neurons of small and medium size. It is clearly separated from the motor nucleus of nervi trochlearis. The cells are ellipsoid in shape. The longitudinal column of nervi oculomotorii is

divided into pars dorsalis, pars intermedia and pars ventralis. The pars dorsalis and pars intermedia are broader while the pars ventralis is less thicker as compared to other two regions of motor nucleus of nervi oculomotorii (Figs.7A,B,8A&B).

Abbreviations used in figures

GC griseum central
TORC nucleus centralis, torus semicircularis
NFLM nucleus of the fasciculus longitudinalis medialis
IPD nucleus interpeduncularis, pars dorsalis
IPV nucleus interpeduncularis, pars ventralis
NIFLM nucleus of the interstitialis fasciculus longitudinalis medialis
ICO nucleus intercollicularis
TORL nucleus laminaris, torus semicircularis
VME nucleus mesencephalicus nervi trigemini
III nucleus nervi oculomotorii
III-D nucleus nervi oculomotorii, pars dorsalis
III-I nucleus nervi oculomotorii, pars intermedia
III-V nucleus nervi oculomotorii, pars ventralis
IV nucleus nervi trochlearis
OPT nucleus opticus tegmenti
PRMC nucleus profundus mesencephali, pars caudalis
PRMR nucleus profundus mesencephali, pars rostralis
RIS nucleus reticularis isthmi
OL optic lobe
SAC stratum album centrale
SGC stratum griseum centrale
SGFS stratum griseum et fibrosum superficiale
SGP stratum griseum periventriculare
SO stratum opticum
SN substantia nigra
SLH sulcus limitans of His
SIV sulcus intermedius ventralis
SMS sulcus medianus superior
SMI sulcus medianus inferior
TM tectum mesencephali
V-III third ventricle
VTA ventral tegmental area

Motor nucleus of IV cranial nerve / nucleus nervi trochlearis (IV):
This is present just below the nucleus nervi oculomotorii. It is clearly differentiated and demarcated from other regions. The cells are the same like cells of nucleus nervi oculomotorii. Below this interpeduncular nucleus is present. The area of it is demarcated in figs.3,7A&B.

Nucleus of fasciculus longitudinalis medialis (NFLM):
At the caudal most level of mesencephalon in the tegmentum mesencephalic region a small region of scattered cells is called as nucleus of fasciculus longitudinalis medialis. The cells are small to medium star shaped. The exact boundary of this cell mass can not be made because of the scattered cells. (Fig.4A&B).

Nucleus interstitialis of fasciculus longitudinalis medialis (NIFLM):
In addition to NFLM a small group of cells has been differentiated as NIFLM. It also contains small to medium sized cells but at certain places it is difficult to demarcate boundary between NFLM and NIFLM. This region can not be demarcated clearly as found in lower vertebrates (Fig.4A&B).

Nucleus opticus tegmenti (OPT):
This is located in middle ventro-lateral part. It is almost oval or spherical in shape (Figs.3,4A&B).

Third ventricle (V-III):
It is cavity of diencephalon. This is also known as diocoel. It is small cavity present in the region of diencephalon (Figs.3,4A&B).

Nucleus mesencephalicus nervi trigemini (VME):
This is present at the dorsolateral region of the rostral most level of mesencephalon. The nucleus extends from the mesencephalon to the upper region of spinal cord and can be divided into mesencephalic sensory nucleus, the principal sensory nucleus and mesencephalic nucleus of spinal tract. The cells of this are very conspicuous in the rostral level of mesencephalon. The cells show polygonal shape scattered small to medium sized but large sized cells are also observed in the rostrolateral region of the nucleus (Figs.3,5A&B).

Stratum album centrale (SAC):
It is situated ventro-laterally below the stratum griseum centrale (SGC) and dorso-laterally above

the stratum griseum periventriculare (SGP). It is almost U-Shaped (Figs.3,5A&B).

Stratum griseum centrale (SGC):

This is located ventro-laterally below the stratum griseum et fibrosum superficiale (SGFS) and dorso-laterally above the stratum album centrale (SAC). It is almost U-shaped (Figs.3,5A&B).

Stratum griseum et fibrosum superficiale (SGFS):

It is situated ventro-laterally below the stratum opticum (SO) and dorso-laterally above the stratum griseum centrale (SGC). This is almost U- shaped (Figs.3,5A&B).

Stratum griseum periventriculare (SGP):

This is located ventro-laterally below the stratum album centrale (SAC) and dorso-laterally above the tectum mesencephali (TM). It is almost U-shaped (Figs.3,5A&B).

Stratum opticum (SO):

It is situated dorsally and dorso-laterally above the stratum griseum et fibrosum superficiale (SGFS). This is almost U- shaped (Figs.3,5A&B).

Tectum mesencephali (TM):

This is located almost dorso-laterally the third ventricle (V-III) and ventro-laterally below the stratum griseum periventriculare (SGP) (Figs.3,5A&B).

Nucleus laminaris, torus semicircularis (TORL):

It is depicted dorsally the nucleus profundus mesencephali, pars rostralis (PRMR), ventrally the tectum mesencephali (TM) and latero-ventrally the third ventricle (V-III) (Figs.3,6A&B).

Nucleus profundus mesencephali, pars rostralis rostralis (PRMR):

This is located above the nucleus profundus mesencephali, pars caudalis (PRMC) (Figs.3&6B).

Nucleus profundus mesencephali, pars caudalis (PRMC):

It is situated ventro-laterally in between the nucleus intercollicularis (ICO) and griseum centrale (GC) (Figs.3,6B,9A&B).

Griseum centrale (GC):

The griseum centrale (GC) is located below the fourth ventricle (V-IV) and above the fasciculus longitudinal medialis (FLM) (Figs.3,7A&B).

Nucleus interpeduncularis, pars dorsalis (IPD):

This is situated ventro-laterally the nucleus nervi trochlearis (IV) and dorso-laterally the nucleus interpeduncularis, pars ventralis (IPV) (Figs.3,7A&B).

N**ucleus interpeduncularis, pars ventralis (IPV):**

It is located in ventral part. This is represented ventro-laterally the nucleus interpeduncularis, pars dorsalis (IPD) (Figs.3,7A&B).

Nucleus nervi oculomotrii, pars dorsalis III- D):

This is depicted laterally in between griseum centrale (GC) and third ventricle (V-III) and above the nucleus nervi oculomotrii, pars intermedia (III-I) (Figs.3,7A&B).

Nucleus nervi oculomotrii, pars intermedia (III-I):

It is situated ventro-laterally the griseum central (GC), laterally the nucleus reticularis isthmi (RIS) and ventro-laterally the third ventricle (V-III) (Figs.3,7A&B).

Nucleus nervi oculomotrii, pars ventralis (III-V):

This is located ventrally the third ventricle (V-III), laterally the nucleus reticularis isthmi (RIS) and latero-dorsally the ventral tegmental area (VTA) (Figs.3,8A&B).

Nucleus reticularis isthmi (RIS):

It is also a small group of small to medium sized cells which can be differentiated from the caudal region of tegmentum mesencephali to the rostral part of rhombencephalon. This region can be observed in figs.2,3,7A,B-9A&B.

Substantia nigra (SN):

This is depicted in ventral portion, ventrally the nucleus reticularis isthmi (RIS) and laterally the ventral tegmental area (VTA) (Figs.3,8A&B).

Ventral tegmental area (VTA):
It is represented in ventral part. This is located laterally the substantia nigra (SN) and ventrally the nucleus reticularis isthmi (RIS) (Figs.3,8A&B).

Nucleus intercollicularis (ICO):
This is located almost laterally the nucleus profundus mesencephali, pars caudalis (PRMC) and ventrally the tectum mesencephali (TM) (Figs.3,9A&B).

Nucleus centralis, torus semicircularis (TORC):
It is situated dorsally above the griseum centrale (GC) and dorso-medially in between tectum mesencephali (TM) (Figs.3&9B).

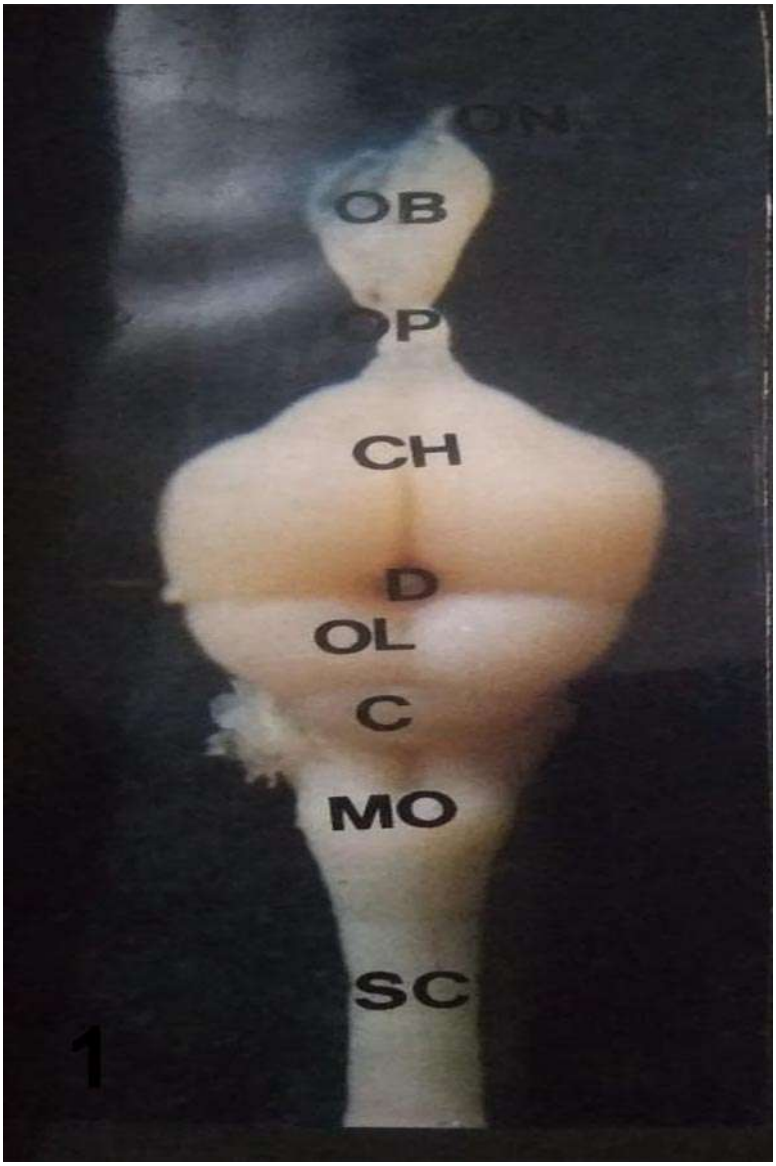

Figure 1

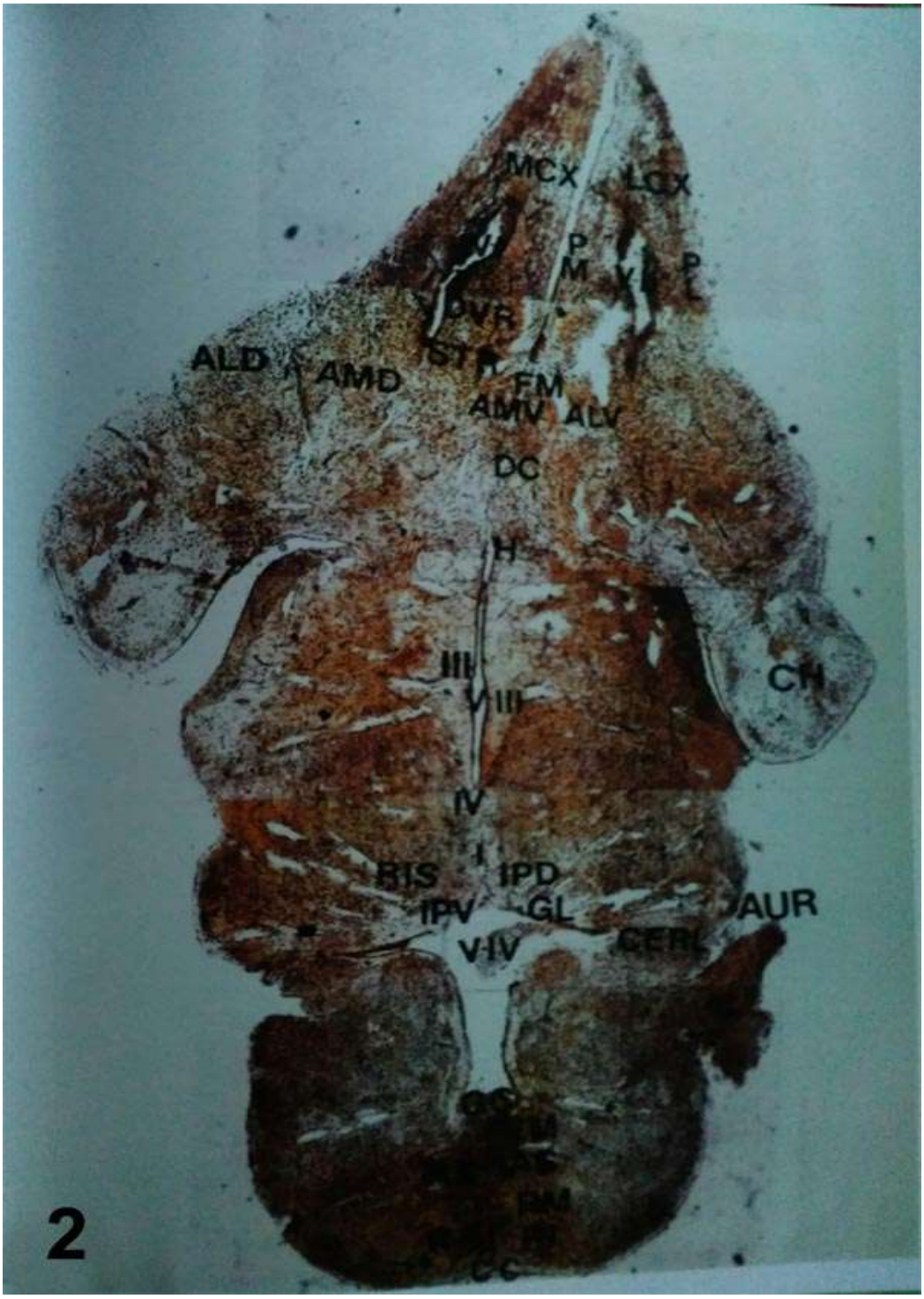
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Figure 2

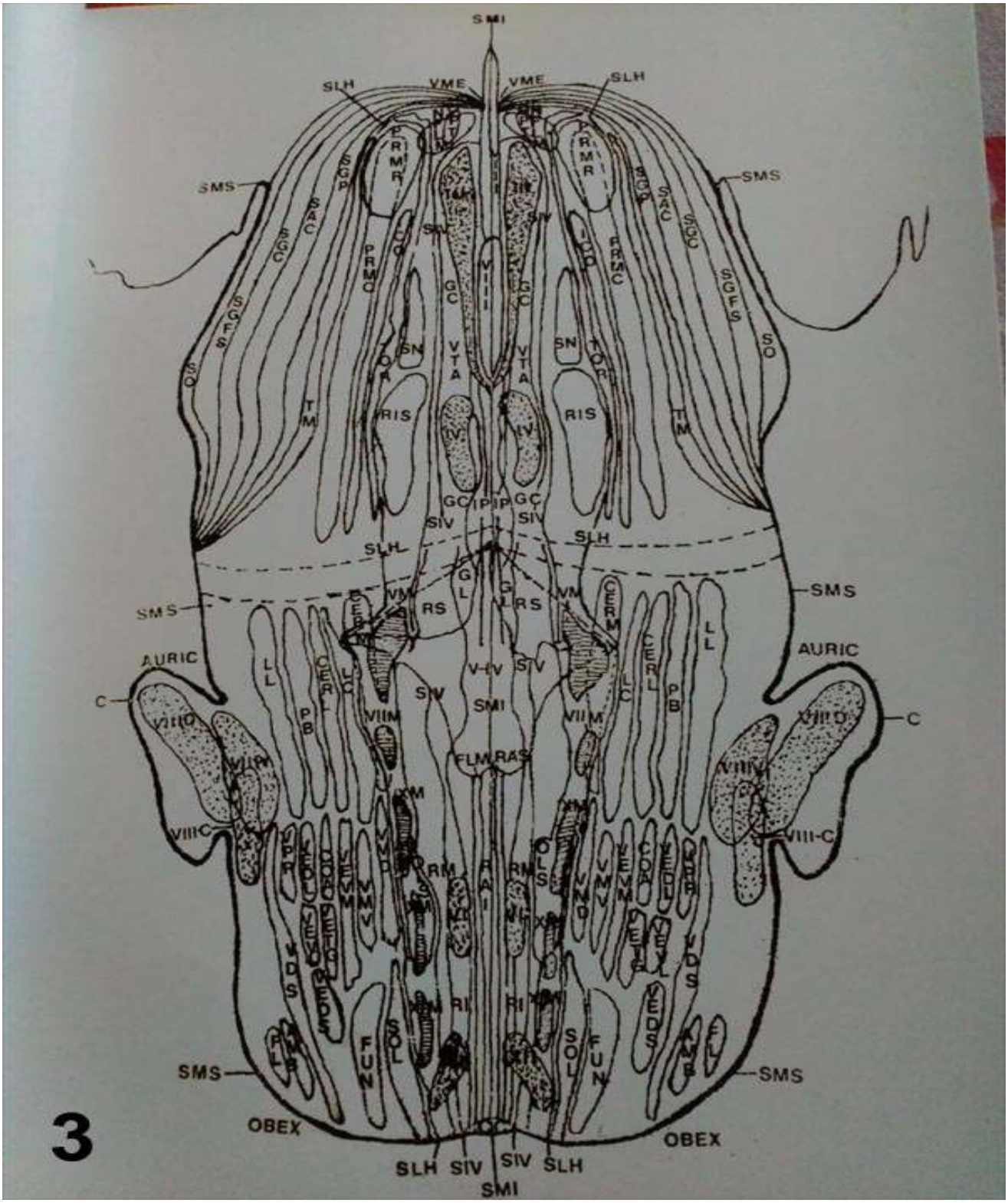
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Figure 3

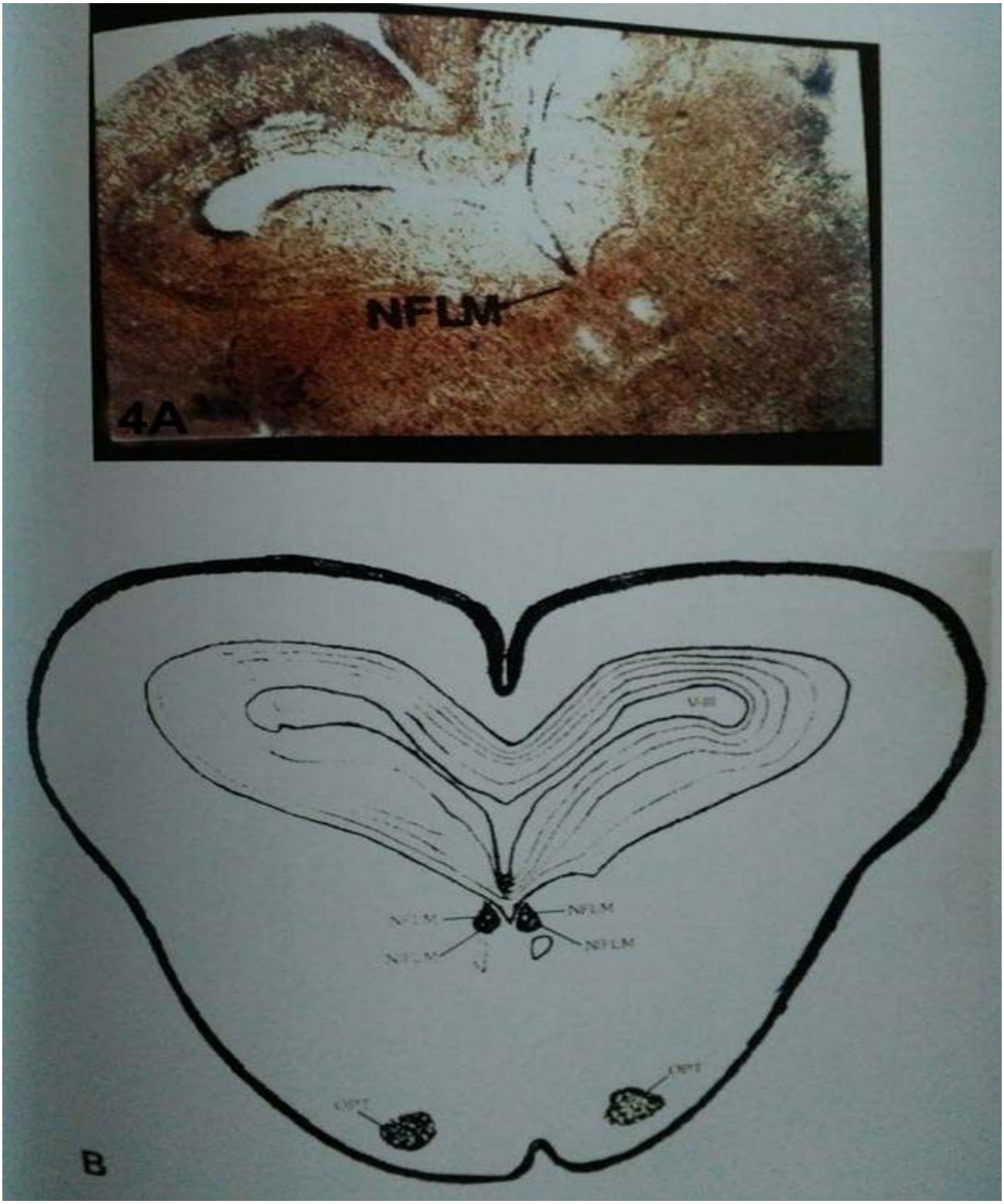

Figure 4A & B

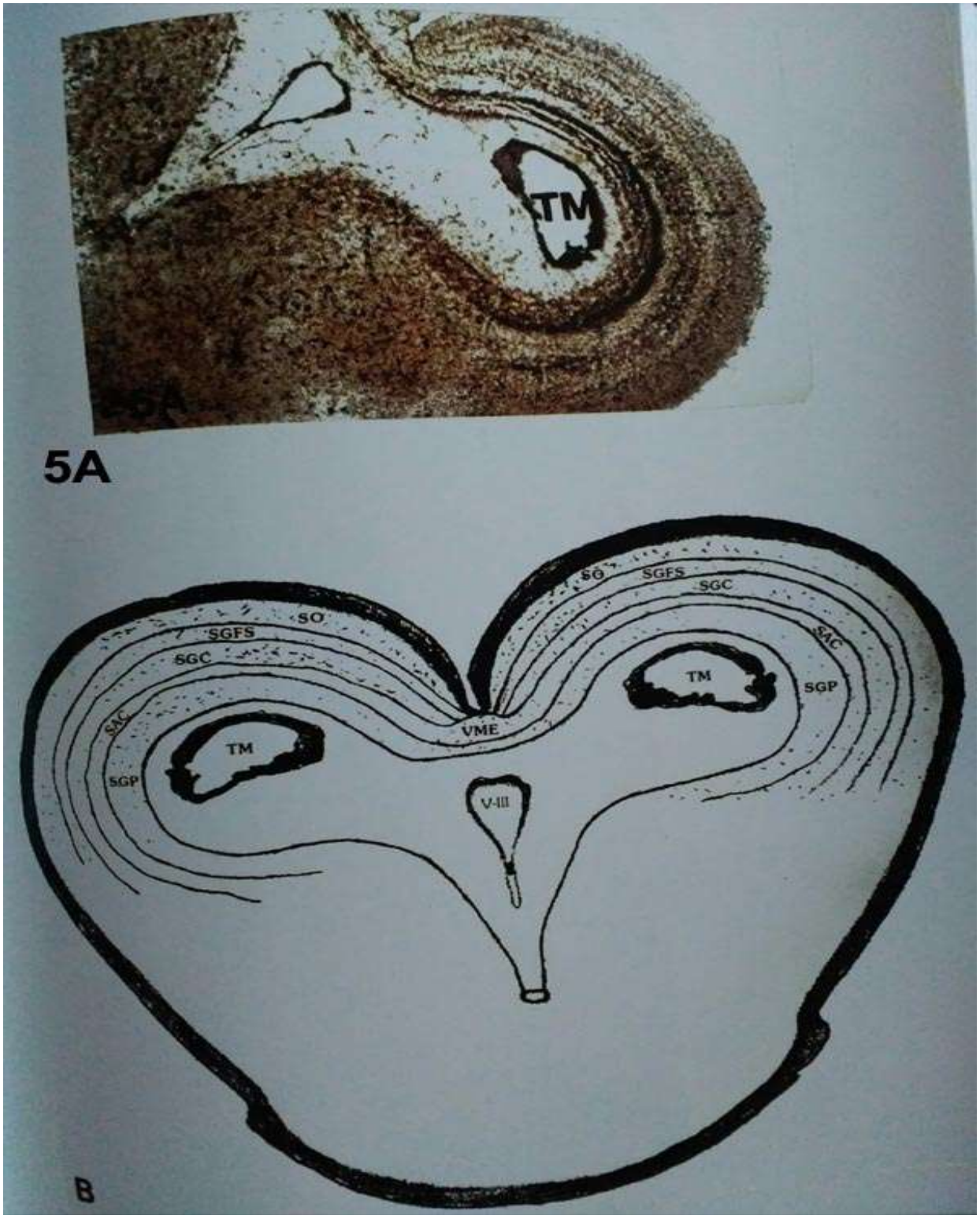

Figure 5A & B

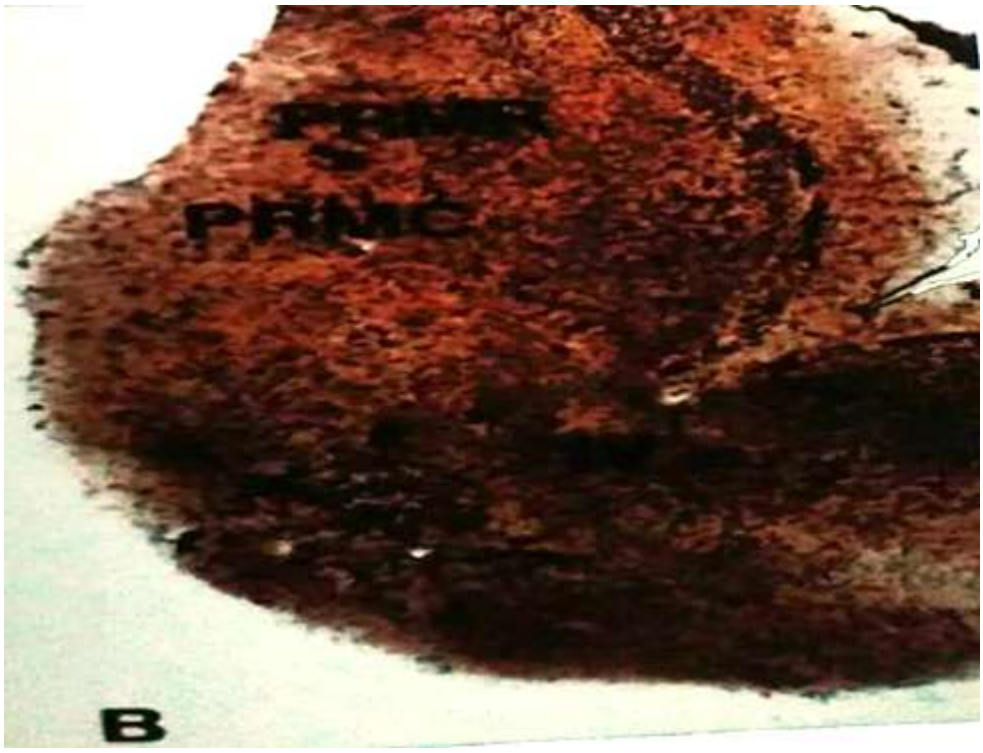

Figure 6A & B

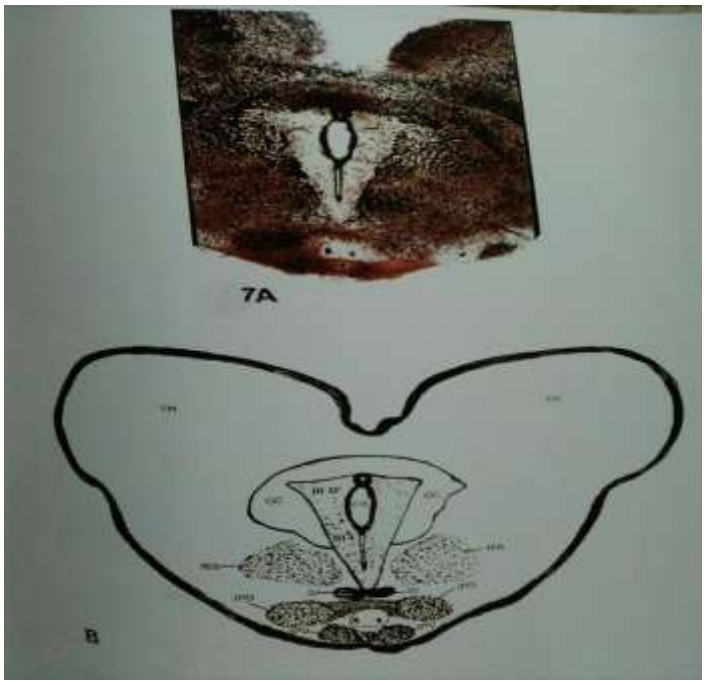

Figure 7A & B

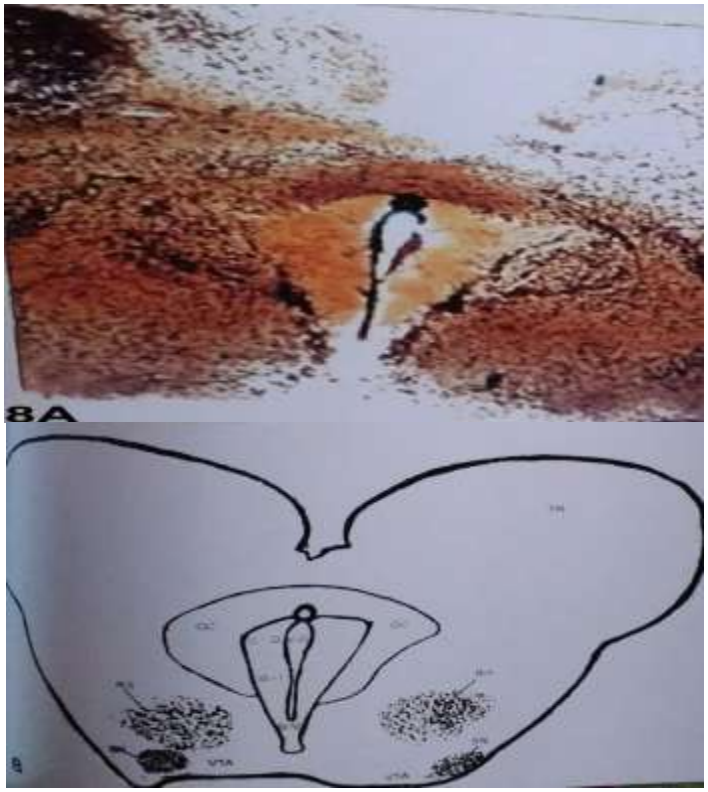

Figure 8 A & B

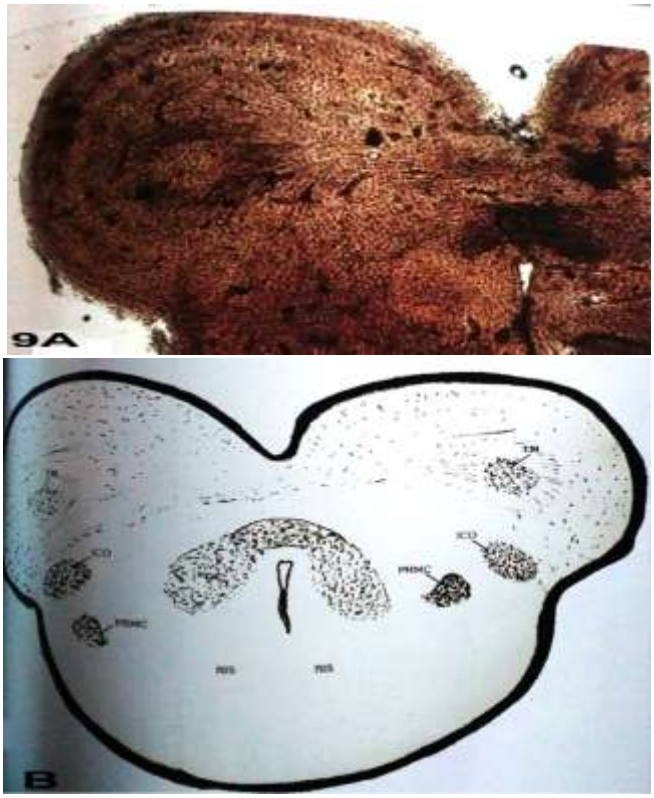

Figure 9A & B

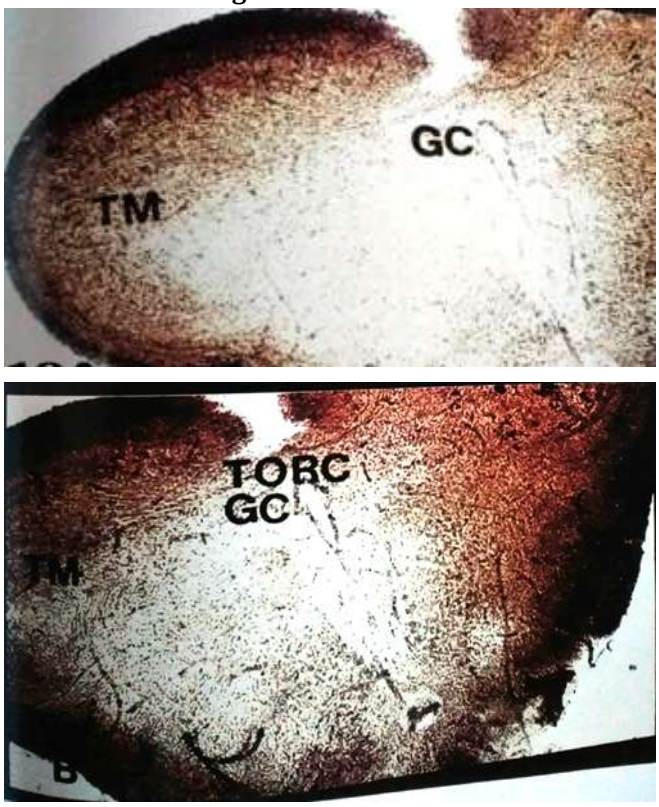

Figure 9A & B

DISCUSSION

The midbrain is well developed in Indian house wall lizard *H. flaviviridis*. The midbrain rostrally associates with the caudal thalamencephalon of the posterior portion of the forebrain. The midbrain caudaly unites with the rostral part of the metencephalon of the hindbrain. The midbrain contains two large rounded optic lobes. These two optic lobes are located dorso – laterally.

From the study of different sulci like sulcus medianus inferior (SMI), sulcus intermedius ventralis (SIV), sulcus limitans of His (SLH) and sulcus medianus superior (SMS) and the relationship of different grooves from nuclear groups of Indian house wall lizard, *Hemidactylus flaviviridis*, the mesencephalon has been divided into two main longitudinal zones. These are as motor basal plate and sensory alar plate. The motor basal plate is situated medially. The sensory alar plate is located laterally. The motor basal plate is further divided into two areas like ventralis and intermedio ventralis. The area ventralis is somatic motor zone. The area intermedio ventralis is visceral motor zone.The mesencephalon of *Hemidactylus flaviviridis* can be divided into two separate longitudinal columns due to longitudinal zones into basal plate and alar plate. The basal plate which is situated medially contains all the nuclei of motor cranial nerves. It is designated as motor basal plate. The laterally situated plate is designated as sensory alar plate. This includes the nuclear groups of sensory nerves.

In addition to ventricular furrow the sulcus medianus inferior is the axis of brain showing bilateral symmetrical condition. The sulcus intermedio ventralis divides the basal plate into two longitudinal zones. The medial is known as the area ventralis. The lateral one is called area intermedio ventralis. The area ventralis has the cranial nerve nuclei of IIIrd and IVth called as somatic motor zone of basal plate. The lateral area intermedio ventralis includes the nucleus of Vth cranial nerve.

Rostrocaudally the tegmentum mesencephali most part the different somatic nerve nuclei are located in a definite plane. It is close to median line. This longitudinal column of reticular formation continues with the nuclei of IVth and IIIrd cranial nerves. These nuclei are also present in the same plane *i.e.* close to the median line.

The presence of sulcus medianus inferior, sulcus intermedio ventralis, sulcus limitans of His, sulcus medianus superior and also the formation of motor basal plate and sensory alar plate including different nuclei of cranial nerves in the present study mentioned above are in harmony with those of previous investigators (Potter, 1965; Senn,1972; Opdam *et al*.,1976; Fuller and Ebbesson,1973a,b; Srivastava and Srivastava,1991,1992).

The nucleus oculomotorii in the present investigation is present throughout the length of tegmentum mesencephali. It is divided into pars dorsalis, pars intermedia and pars ventralis. The size of neurons is the same in all the region. This division of the nucleus of IIIrd cranial nerve has not been observed in frog (Srivastava and Srivastava, 1992) but has been observed in mammals.

The motor nucleus of IVth cranial nerve *i.e.* nucleus nervi trochlearis is present just below the nucleus nervi oculomotorii in the present investigation. This observation is comparable to that of frog (Srivastava and Srivastava, 1992). However, trochlear nucleus in *Varanus* (Barbas-Henry and Lohman, 1988) is found overlapping the oculomotor nuclear complex. It is the greater part of a comma-shaped cell group. This is situated lateral, dorsal and medial to the medial longitudinal fasciculus. This arrangement is not confirmed in the present study.

In the present investigation four functional zones in the alar plate of wall lizard are found. These zones are also found in frog (Opdam *et al*., 1976).

REFERENCES

Barbas-Henry HA and Lohman AH (1988) Primary projections and efferent cells of the VIIIth cranial nerve in the monitor lizard – *Varanus exanthematicus. Journal of Comparative Neurology*. **277** (2) 234-249.

Fuller PM and Ebbesson SOE (1973a) Central projections of the vestibular nuclear complex in the bull frog (*Rana catesbeiana*). *The Anatomical Record* **175** 325.

Fuller PM and Ebbesson SOE (1973b) Central projections of the trigeminal nerve in the bull frog (*Rana catesbeiana*). *Journal of Comparative Neurology* **152** 193-199.
Opdam P, Kemali M, Nieuwenhuys R (1976) Topological analysis of the brainstem of the frogs *Rana esculenta* and *Rana catesbeiana*. *Journal of Comparative Neurology* **165** 307-331.
Potter HD (1965) Mesencephalic auditory region of the bull frog. *Journal of Neurophrology* **28** 1132-1154.
Senn DG (1972) Development of tegmental and rhombencephalic structurures in frog (*Rana temporaria* L.). *Acta Anatomica* (Basel.). **82** 528-548.
Srivastava UC and Srivastava S (1991) Nuclear groups of alar plate of brain stemof *Rana tigrina. Proceedings of National Academy of Sciences*, India, **61** (B) **3** 303-309.
Srivastava UC and Srivastava S (1992) Nuclear groups of basal plate of brain stemof *Rana tigrina. Proceedings of National Academy of Sciences* India, **62** (B) I 1-13.