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Research Article

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

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ABSTRACT
Topological organization of the amygdala of Indian house wall lizard has been studied by Eager's method. The amygdala is well developed in Indian house wall lizard *Hemidactylus flaviviridis.*
The cerebral hemisphere is divided into a dorsal pallium component and a ventral subpallium region. The pallium of Indian house wall lizard is diversified brain structure. The DVR of pallium has an anterior ADVR and a basal or posterior PDVR. The ADVR is a periventricular structure located immediately dorsal to the corpus striatum. The ADVR is made up of a core, a nuclear structure and periventricular zone which contains small number of cells. The anterior dorsal ventricular ridge (ADVR) in the present study has been differentiated into dorsolateral and ventromedial regions. The dorsolateral ventricular ridge corresponds to dorsolateral claustrum, dorsal endopiriform nucleus and basomedial amygdala. The ventromedial anterior dorsal ventricular ridge corresponds to ventromedial claustrum, ventral endopiriform nucleus and laterobasal amygdala of mammals. The posterior dorsal ventricular ridge (PDVR) is comparable to the other parts of mammalian amygdalar complex.
The dorsolateral region of anterior dorsal ventricular ridge shows scattered neurons but groups of neurons have been observed at certain places. The ventromedial region of anterior dorsal ventricular ridge has less densely packed cells as compared to dorsolateral region.
The neurons of posterior dorsal ventricular ridge (PDVR) which can be compared with mammalian amygdalar complex showed uniformly distributed cells. These cells are more dense as compared to cells of ADVR. The dorsolateral and ventromedial differentiation of PDVR is not observed. The different cells have different structures. They are not present in groups. Because of the densely packed neurons the nucleus of each neuron shows large sized structure.

Keywords: *Amygdala, 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. These can be used for pest management.
In our present study the amygdala region of cerebral hemisphere of the forebrain 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 to 15 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 about 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

In general, the posterior region of lateral cortex of vertebrates extends to form a distinctive cup-shaped nucleus which is amygdaloid nucleus. This region shows densely packed cells showing rounded mass. The anterior most region of amygdala forms the part of lower cerebral hemisphere. The caudal end of the amygdala is present in the medial part of telencephalon. It is located in the gray matter surrounding the third ventricle. The caudal half of the amygdala is in cellular continuity with the gray of the preoptic area. The rostral end of the ventral thalamic nuclei is located immediately caudal to the posterior pole of the amygdala. Although the location of amygdala differs in different regions from rostral to caudal region, it is single unit of amygdaloid nucleus (Fig.1C).

In the present study the cerebral hemisphere is divided into two components. These are like a dorsal pallium and a ventral subpallium components. The pallium of Indian house wall lizard is diversified brain structure. The DVR of pallium contains an anterior ADVR and a basal or posterior PDVR. The ADVR is a periventricular structure. It is located immediately dorsal to the corpus striatum. The ADVR is composed of a core, a nuclear structure and periventricular zone. This has small number of cells. The anterior dorsal ventricular ridge (ADVR) in the present study has been differentiated into dorsolateral and ventromedial regions. The dorsolateral ventricular ridge corresponds to dorsolateral claustrum, dorsal endopiriform nucleus and basomedial amygdala. The ventromedial anterior dorsal ventricular ridge corresponds to ventromedial claustrum, ventral endopiriform nucleus and laterobasal amygdala of mammals. The posterior dorsal ventricular ridge (PDVR) is comparable to the other parts of mammalian amygdalar complex (Fig.2A).

The dorsolateral region of anterior dorsal ventricular ridge presents scattered neurons but groups of neurons have been observed at certain places. The ventromedial region of anterior dorsal ventricular ridge includes less densely packed cells as compared to dorsolateral region (Fig.2B). The neurons of posterior dorsal ventricular ridge (PDVR) which can be compared with mammalian amygdalar complex presented uniformly distributed cells. These cells are more dense as compared to cells of ADVR. The dorsolateral and ventromedial differentiation of PDVR is not observed. The different cells contain different structures. They are not show in groups. Because of the densely packed neurons the nucleus of each neuron presents large sized structure.

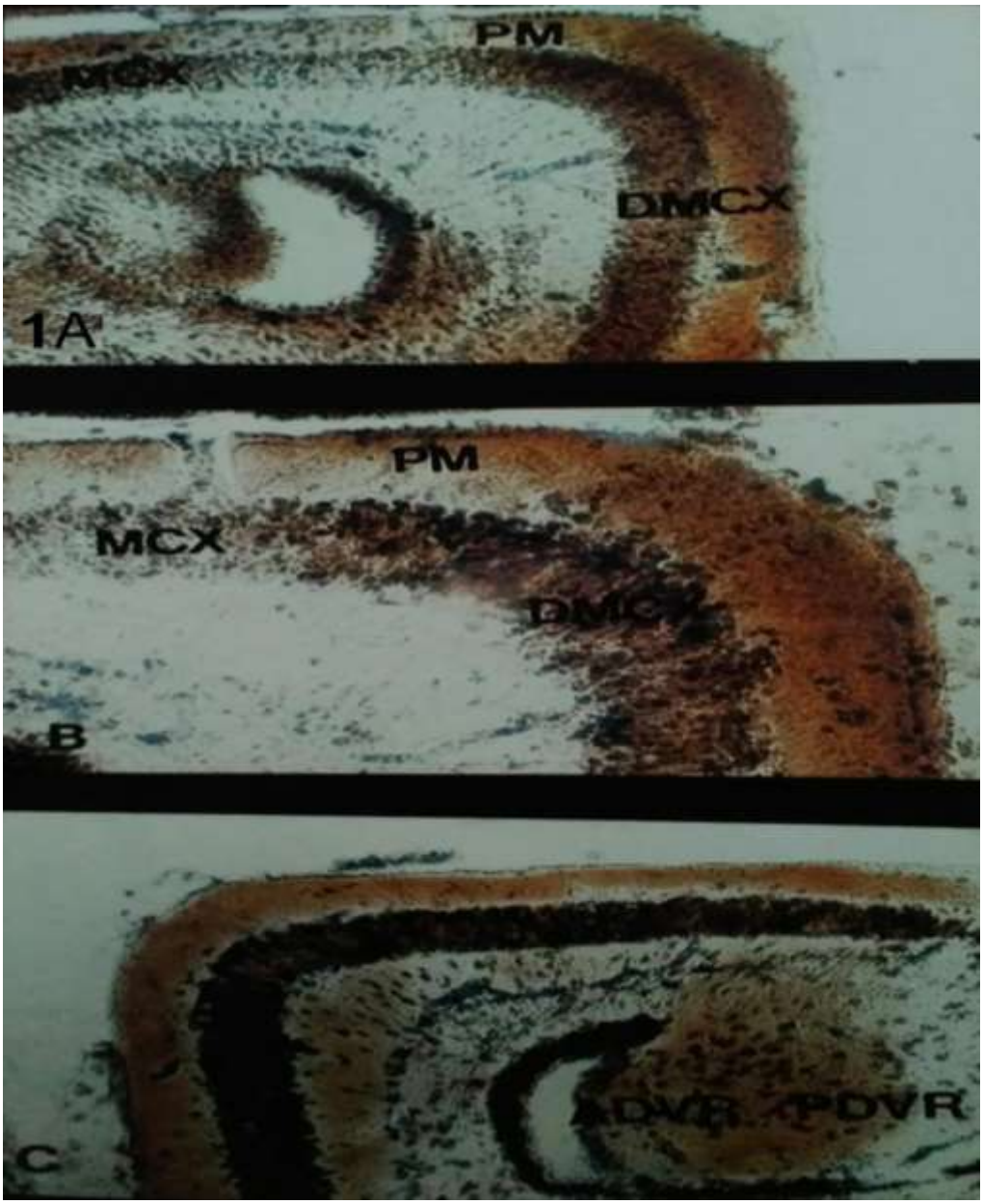

Figure 1A-C

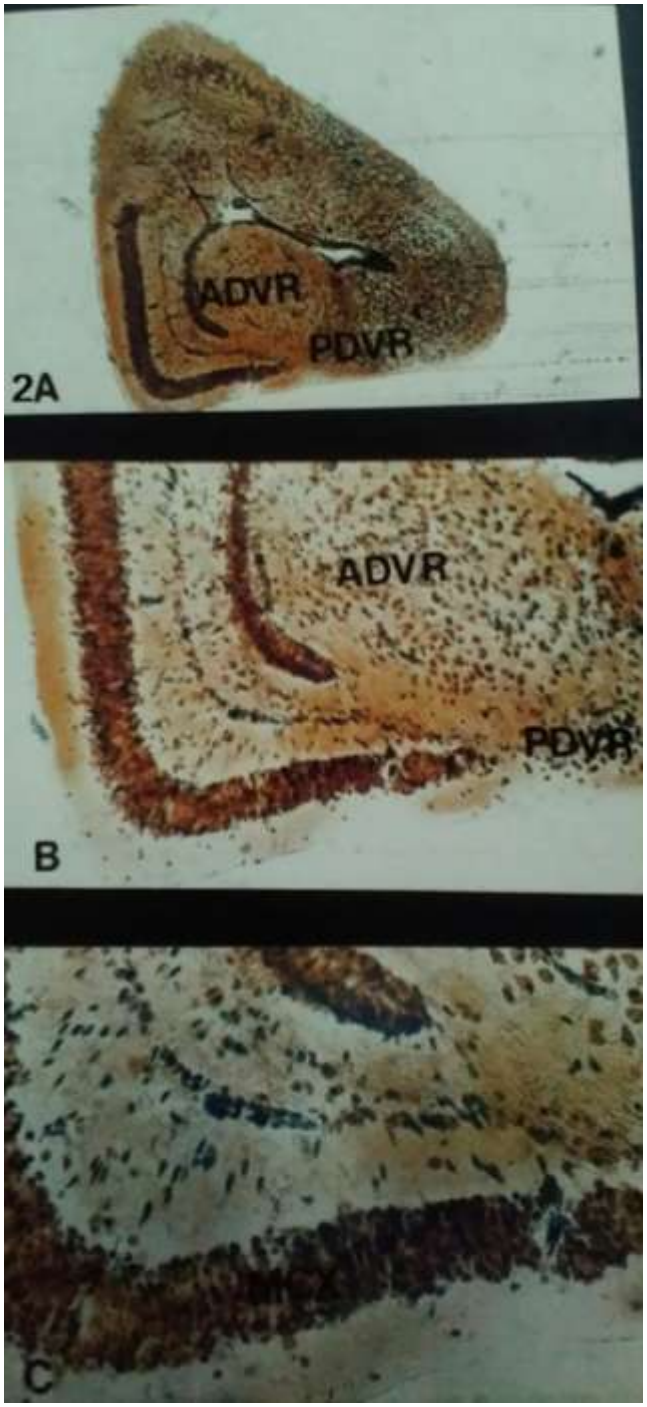

Figure 2A-C

DISCUSSION

The amygdala is well developed in Indian house wall lizard *Hemidactylus flaviviridis.* The cerebral hemisphere is separated into two as a dorsal pallium region and a ventral subpallium component. The pallium of Indian house wall lizard is diversified brain structure. The DVR of pallium includes an anterior ADVR and a basal or posterior PDVR. The ADVR is a periventricular structure situated immediately

dorsal to the corpus striatum. The ADVR is formed of a core, a nuclear structure and periventricular zone. It includes small number of cells. The anterior dorsal ventricular ridge (ADVR) in the present study has been differentiated into dorsolateral and ventromedial regions. The dorsolateral ventricular ridge corresponds to dorsolateral claustrum, dorsal endopiriform nucleus and basomedial amygdala. The ventromedial anterior dorsal ventricular ridge corresponds to ventromedial claustrum, ventral endopiriform nucleus and laterobasal amygdala of mammals. The posterior dorsal ventricular ridge (PDVR) is comparable to the other parts of mammalian amygdalar complex.

In the present study, below the layer of cortex a region known dorsal ventricular ridge (DVR) is present. It is divided into anterior dorsal ventricular ridge (ADVR) and posterior dorsal ventricular ridge (PDVR). The DVR is divided into mainly dorsal and ventral zones but an intermediate zone between dorsal and ventral zones has been situated. The DVR is a pallial structure. This is characteristic of reptiles and birds. During the embryonic development the telencephalon of different vertebrates develops as a vesicle at the rostral end of neural tube. After this the formation differs among the different vertebrates (both reptiles and aves) show the formation of DVR. It protrudes into the lateral ventricle. This becomes the lateral wall of the telencephalon. In mammals the floor of the hemispheres protrudes into the lateral ventricles to form the basal ganglia while the telencephalic roof expands and forms the six layers of neocortex (Ulinski, 1983). The embryonic development of telencephalon of reptiles, birds and mammals supports the homology of a part of the avian pallium called the Wulst with the superior part of mammalian neocortex (Medina and Reiner, 2000; Wild and Williams, 2000).

The DVR of reptiles is divided into Type I and Type II DVR. This division is based on the presence and distribution of neurons. The type I is called as cortical band core arrangement. The Type I DVR demonstrates three distinct zones having cell poor zone of dorsal zone, densely packed stellate neurons of second zone and scattered and at some places clusters of a neurons in the third ventral zone. Both spiny and spine poor stellate neurons are present in second and third layers. This first pattern of DVR organization is found in snakes, *Sphenodon*, turtles and most lizards (Ulinski, 1983). The results of the present observation of DVR in Indian house wall lizard clearly show dorsal, ventral and intermediate zones of DVR having spiny and non spiny stellate neurons.

The present observations on *H. flaviviridis* are in harmony with those of previous investigators on snakes, *Sphenodon*, turtles and most lizards (Ulinski, 1983).

In aves and crocodiles Type II DVR is found. This type does not contain distinct periventricular cell cluster zone in ADVR. Isolated neurons and prominent neuronal clusters scattered in the different regions of telencephalon are characteristic of type II DVR. In addition to this, spiny with stellate shaped dendritic regions having variable number of spines are found. In *Alligator*, there is a tendency for clusters to form a periventricular zone with in the dorsomedial area but not in other areas as observed in type I DVR of reptiles.

It is important to mention that the present observations of DVR in Indian house wall lizard *H. flaviviridis* correspond well with Type I DVR but different from type II DVR which is also found in birds. Despite difference in DVR organization of different reptiles there is a similarity in the basic connectivity of ADVR of reptiles and BDVR of aves. It has been suggested by Ulinski (1983) that the basic organization of the DVR is to serve as a linkage between sensory inputs and motor output. ADVR receives visual auditory and somato sensory information and sends output to the BDVR and basal ganglia. This is the basic function of mammalian isocortex. Anatomical connections indicate that the nuclear groupings of DVR could be homologous to certain areas of mammalian isocortex.

The anterior dorsal ventricular ridge (ADVR) of present investigation and other reptilia is divided into dorsolateral and ventromedial regions. The dorsolateral region corresponds to hyperstriatum of birds while the ventromedial ADVR is comparable to the neostriatum of birds. The hyperstriatum

of birds and dorsolateral components of reptilian ADVR correspond to mammalian dorsolateral claustrum, dorsal endopiriform nucleus and basomedial amygdala. The ventromedial ADVR of reptilia and neostriatum of aves correspond to the ventromedial claustrum, ventral endopiriform and laterobasal amygdala of mammals. The posterior dorsal ventricular ridge (PDVR) of reptiles is comparable to the parts of mammalian amygdalar complex. This homology has been made on the basis of present observations and others reported in previous findings (Ariens Kappers *et al*., 1936; Northcutt, 1981; Ulinski, 1990; Aboitiz, 1995).

Smith Fernandez *et al*., (1998) confirmed that the amphibian dorsal pallium, reptilian dorsal cortex and the avian Wulst express the same pallial markes as the isocortex.

The subpallium region of cerebral hemisphere includes striatum and septum. The area medioventralis zone of the forebrain includes septal nucleus in the septum which is differentiated into medial and lateral septal nucleus. Both run parallel to each other.

Halpern (1972) has shown that a large part of the medial forebrain bundle arises in the septal region and these fibers pass caudally into the preoptic area and ventral thalamus. This observation has been confirmed in the present investigation.

The boundary between septum and striatum can be observed at the ventral side of lateral ventricle. There is no change in the cellular density of septum and striatum. Although the demarcation of striatum region has been shown in coronal section of the cerebral hemispheres of reptiles, birds and mammals Aboitiz *et al.*, (2002a,b) , there is a difference in the thickening of subpallial structures in the striatum of house wall lizard, presently studied and reported previously by investigators. The difference actually lies in the thickening of pallial structures which differentiate the striatum of subpallium structure.

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