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ORIGINAL ARTICLE

EMBRYONIC DEVELOPMENT OF CEREBRUM IN *PYCNONOTUS LEUCOTIS* (GOULD, 1836) (AVES, PASSERIFORMES, PYCNONOTIDAE)

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ABSTRACT

The present work aims to study the embryonic development of forebrain (Cerebrum) of a white-cheeked bulbul *Pycnonotus leucotis* (Gould, 1839) (Aves, Passeriformes, Pycnonotidae). Specimens for embryonic development were processed for paraffin embedding and stained with haematoxylin and eosin for histological study. The forebrain incubation consists of three layers, ependymal, mantle and marginal. The thickness of telencephalon was 43 µm while the thickness of diencephalon was 37 µm in an embryo of 48 hours incubation. The telencephalon consisted of two vesicles called cerebral hemispheres. The thickness of the telencephalon wall was 57 µm. The cerebral hemispheres in the embryo at 72 hours of incubation were differentiated, and the average thickness was 97 µm. The cerebral hemispheres contained two lateral ventricles, including right and left ventricles.

Keywords: Birds, Brain ventricles, Cerebrum, Diencephalon, Telencephalon.

INTRODUCTION

The birds are important animals because they play an important role in biocontrol against insects and rodents that threaten the economy of countries. The *Pycnonotus leucotis* (Gould, 1839) (Aves, Passeriformes, Pycnonotidae) is a bird species found in Southwest Asia, from India to the Arabian Peninsula, as it has a limited distribution compared to other birds. It can also be seen in valleys and near palm plantations in addition to the fields. It prefers to live in warm with a plentiful lunch (Allouse, 1960; Dintzis and Treuting, 2012).

The breeding season of the bulbul bird varies from place to place until is usually synchronized with the availability of fruits such as figs or dates, and takes place in the period between March and June and may continue to the 8th month of the year, when these birds build their nests in tall trees like palms, and the female lays up to 3 eggs decorated with purple. The incubation period lasts up to 15 days to bring the young out of the nest, and up to 20 days of hatching. Usually lays 2 to 3 eggs per year (Eroschenko, 2008).

The nervous system is formed in vertebrates as a result of the induction of mesoderm and notochord from ectoderm that has spots above it where the ectoderm forms the neural plate that is the beginning of formation of the nervous system (Glover, 1991).

The central nervous system consists of a primary beginning, the neural tube, which is formed through the process of primary neurolation. The neural tube is wide in its anterior part to differentiate into the brain, and narrow in its posterior part to differentiate into the spinal cord (Gilbert, 2000).

Sadler (2012) described, after the neural folds fuse, the brain is divided into three divisions or vesicles, named as the prosencephalon (forebrain), mesencephalon (midbrain), and rhombencephalon (hindbrain).

The aim of study was to document the embryonic development of the forebrain cerebrum of a white cheeked bulbul *Pycnonotus leucotis*.

MATERIALS AND METHODS

Six white-cheeked bulbuls were obtained from the agricultural area of Salah Al-Din Province to obtain the eggs that would be incubated to obtain embryos for each age stage: 40, 48, and 72 hours. Accordingly, the ethical approval obtained from the local committee of ethical approval in the College of Education for Pure Science (Ibn Al-Haitham), University of Baghdad (Ref. EC-79 in 28.iv.2025).

The embryos were placed in 10% neutral buffered formalin solution for fixing them. Then they were put in ascending concentrations of ethyl alcohol for removing water from them, and then three embryos for each age stage, 40, 48, and 72 hours of incubation, were cleared in xylene, and then they were infiltrated and embedded in paraffin wax.

The samples were cut with a microtome (5 µm thickness) and then stained with haematoxylin and eosin. The slides were examined with a light microscope (Olympus), and thereafter the slides were photographed with a digital camera (Canon) attached to the compound microscope and laptop (Lenovo) (Bancroft and Stevens, 2010; Abed, 2020; Abed and Abed, 2021).

RESULTS AND DISCUSSION

In the forebrain, the embryo's, were age of 40 hours of incubation, the layers of its walls were differentiated into the ependymal layer, which was in the form of a layer of cells arranged regularly around the cavity, and then the cells of the mantle layer consisted of several rows of spherical cells, most of which were neuroblasts and appeared gray-colored, their axes out warded within the next layer, which was the marginal layer in which the nerve fibers were located, so this layer appeared white in color. The average thickness of the telencephalon was 43 µm, and the diameter of the telencephalon cavity was 95 µm, and the average of diencephalon wall thickness was 37 µm.

The connection of optic vesicles to the diencephalon was observed through the optic stalk, with a visible evagination at the bottom of the diencephalon known as the infundibulum. In the embryo of age 48- hour incubation, the average thickness of the telencephalon wall was 57 µm. The beginning of the appearance of evagination on both sides of telencephalon was noted, representing the beginning of the formation of the two telencephalic vesicles, which represent the future cerebral hemispheres. The average diameter of the telencephalon cavity was 185 µm. The average thickness of the diencephalon wall was 24 µm. It was also noted that the pineal body began to form, and it appeared as an evagination from the roof of the diencephalon.

The forebrain wall was composed of a layer of ependyma with pseudostratified columnar epithelial tissue followed by a mantle layer composed of several rows of cells spherical in shape and the marginal layer composed of cells and neurons. In the embryo at the age of 72-hour incubation a differentiation of the cerebral hemispheres, with an average wall thickness of 97 µm, and their cavity was called lateral ventricles, which were the right and left ventricles.

The ependymal layer surrounded the prosocoele, while the mantle layer was dark gray in color; most of it was where neuroblasts and their axons were directed outward to be added to the marginal layer. The diameter of the telencephalon cavity was 650 µm.

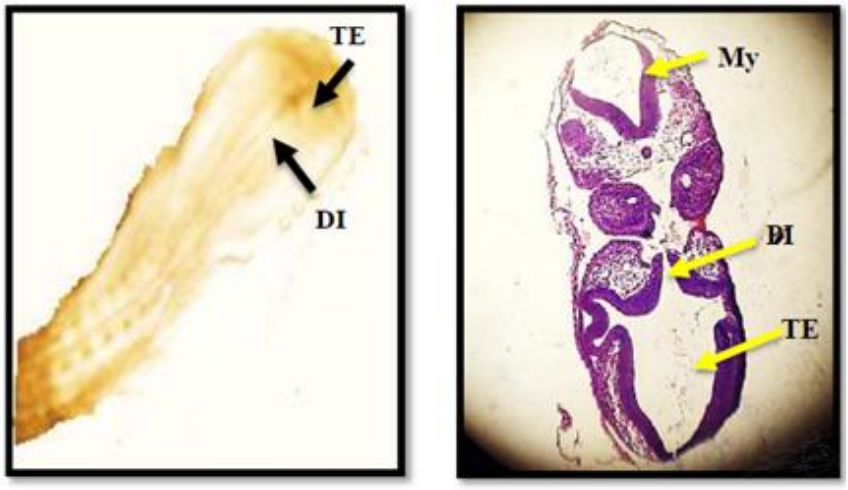

Plate (1): White-cheeked bulbul embryo at 40 hours incubation; (A) Whole mount embryo, (B) Transverse section through embryo. [Myelencephalon (My), Telecephalon (TE), Diencephalon (DI).]. (H & E stain, 10x).

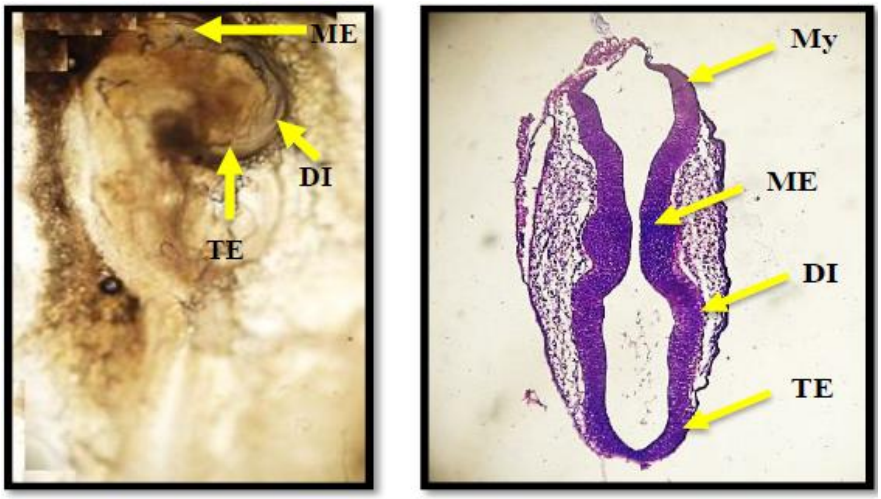

Plate (2): White-cheeked bulbul embryo at 48 hours incubation; (A) Whole mount embryo, (B) Transverse section through embryo. [Myelencephalon (My), Mesencephalon (ME), Diencephalon (DI), Telecephalon (TE).]. (H & E stain, 10x).

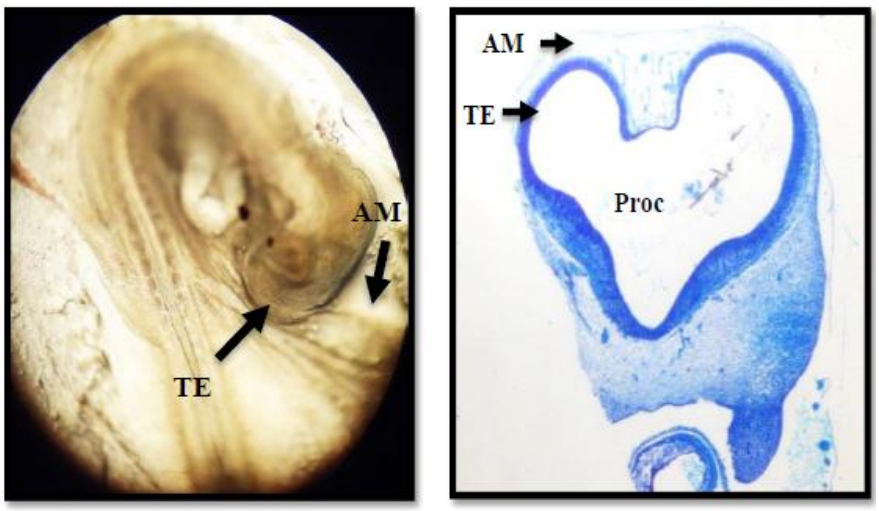

Plate (3): White-cheeked bulbul embryo at 72 hours incubation; (A) Whole mount embryo, (B) Transverse section through embryo. [Telecephalon (TE), Procoele (Proc), Amnion (AM)]. (Methylene blue, stain, 10x).

The early stages of the embryonic development of the brain are similar in most types of vertebrates, but in the advanced stage of embryonic development, they are differentiated according to the type of animal, as the cells located in the walls of the neural tube would begin to differentiate and migrate to form the layers of brain (Goldman-Raic, 1987; Solimon *et al*., 1994; Hodge, 2010; Abed, 2016).

The neural tube is formed by the process of primary neurulation through the differentiation of the neural plate and elevation of its edges to form the two neural folds and their house in the neural groove (Davidson and Keller, 1999; Abed, 2016). The neural tube formation proceeds in an antero-posterior direction. The neural plate appears in the brain, while the gastrulation movements are still in full swing. There is a large cell adhesion between neurons in the stage of neural plate formation, so the neural plate appears to be thickened in chicken embryos (Bellairs *et al.*, 1978).

The thickening of the neural plate that appeared in this study as pseudostratified columnar epithelium tissue, called the neuroepithelial tissue was continuous with the epidermal ectoderm representing the epidermis, and this was in agreement with many researchers (O'Rahilly and Müller, 2007; Abed, 2016).

The telencephalon in birds consists of two hemispheres of brain, which are large in size, separated by a deep groove, and connected from the front by small olfactory lobes (Kent and Carr, 2001). Müller and O'Rahilly (1988) pointed out that when the neural tube is closed in the brain works to put pressure on the walls of the brain, leading to expansion of the cavity and the formation of hemispheres.

The internal and external morphology changes of the forebrain are the results of complex histological changes in the wall of the brain vesicles (Hatanak, 1997). Alicelebic *et al.* (2004) indicated that there were morphological changes in the forebrain during embryonic development, where the brain was at the beginning of the formation tubular in shape with thin wall and would descends into a large ventricle and then would turns into a structure with thick walls with a complex ventricular system. Birds are among the most abundant vertebrates that have brain size and ecological diversity (Sayol *et al.*, 2016).

CONCLUSIONS

The study concluded that the forebrain is differentiated into three layers: ependymal, mantle, and marginal in the embryo at 40 hours incubation. Two evaginations appear on both sides of the forebrain, which represent the beginning of the formation of cerebral vesicles in an embryo at 48 hours. The two cerebral hemispheres are cleansed in embryos at 72 hours. The study of embryonic development of the cerebrum in *Pycnonotus leucotis* provides valuable insights into the neurodevelopmental processes in avian species. It enhances understanding of brain formation patterns in passerine birds and contributes to comparative anatomy and evolutionary biology. Such research also lays a foundation for future studies on avian behavior, neurological function, and developmental abnormalities. Additionally, it

supports conservation efforts by deepening biological knowledge of this widely distributed species.

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CONFLICT OF INTEREST STATEMENT

"The author has no conflicts of interest to declare".

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التكوين الجنيني للمخ في البلبل ابيض الخدين
Pycnonotus leucotis (Gould, 1836)
(Aves, Passeriformes, Pycnonotidae)

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الخلاصة

تضمنت الدراسة الحالية التكوين الجنيني للدماغ الامامي (المخ) للبلبل ابيض الخدين *Pycnonotus leucotis* (Gould, 1836) (Aves, Passeriformes, Pycnonotidae). حضرت عينات التكوين الجنيني لغرض الطمر بشمع البرافين ولونت بالهيماتوكسلين والايوسين لغرض الدراسة النسجية. وكان الدماغ الامامي متكون من ثلاث طبقات وهي طبقة البطانة العصبية، وطبقة الجبة والطبقة الحافية. وكان سمك مقدم الدماغ 43 مايكرون، بينما كان سمك سرير الدماغ 37 مايكرون في جنين بعمر 48 ساعة من الحضانة ويتكون مقدم الدماغ من حوصلتين يطلق عليهما نصفي كرة المخ وكان سمك جدار مقدم الدماغ 57 مايكروميتر. وفي جنين بعمر 72 ساعة من الحضانة كان نصفا كرة المخ متمايزان ومعدل سمكها 97 مايكروميتر. و كان نصفا كرة المخ يحتويان على بطينين جانبيين هما البطين الايمن والبطين الايسر.