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THE CHONDROCRANIUM DEVELOPMENT OF *STENODACTYLUSSLEVINI*(SQUAMATA: GEKKONIDAE) II. STAGE II

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ABSTRACT

This work aims to study the development of the chondrocranium genus Stenodactylusslevini from Gekkonidae family. This stage was determined in length 35 mm, based on the hatched embryo, and cleared and double-stained specimens, it has been examining by light microscope and then for graphic reconstruction using Ken-a-vision microprojector, and describing them in three regions: dorsal, ventral, and lateral view, and then comparingthemwith other families of lizards and species of reptiles. However, it is characterized by the full development of several regions: the olfactory region, orbital region, basicranial and auditory region. While the dermatocranium absence appears in the fully formed stages, the olfactory region instenodactylussleviniischaracterized with features and elements of high evolution and obvious nasal capsule which starts with the cupola anterior. The wideparietotecal cartilage and paranasal cartilage gets together sphenethmoid commissure and planum antorbitale. It also containsparaseptal cartilage which is located on both sides of nasal septum. In addition, the auditory region of the chondrocranium consists of two large auditory capsules which containcomplex elements.

Keywords: Anatomy, Chondrocranium, Development, Gekkonidae, Squamata, *StenodactylusSlevini*.

Introduction

Avian and reptilian embryos exhibit a set of primitive features that are characteristic of amniotes but are missing in mammalian embryos. For instance, the neurocranium is generally chondrified in birds and reptiles to give out parachordal cartilage and orbital cartilage that includes the neural tube (Kuratani, 1999).

Gekkonid reptiles of the family,Stenodactylus, are a standout amongst the most trademark and plentiful components of the fauna of the bone-dry and hyper-bone-dry areas of Arabia and North Africa. The genus involves twelve species that are conveyed in a pretty much nonstop range crosswise over northern Africa and Arabia, with an evidently detached populace in northern Kenya and stretching out around the Arabian Gulf to the beachfront of southwestern Iran. Up to three species may happen at a solitary region and where such sympatry exists. Asset dividing is to a great extent accomplished by microhabitat isolation, with species involving diverse soil compose (Metallinouet al., 2012).

Rock fields, hard sand and aeolian delicate sand all have their trademark species that show specific morphological adjustments. These incorporate the nearness of discouraged and bordered toes, which increment the surface zone and enhance hold in the aeolian sand hill experts Stenodactylusdoriae (Blanford, 1874) Stenodactyluspetrii (Anderson, 1896) and Stenodactylusarabicus (Haas, 1957). Broad webbing is additionally seen between the fingers for effective sand tunneling in Stenodactylusarabicus (Arnold, 1977,1980; Bauer and Russell, 1991). At the point when two species are routinely found on a similar substrate, they significantly vary in size and there are comparing contrasts in the measure of prey taken (Arnold, 1977).

The chondrocranium in all amniotes is a brief cartilaginous embryonic organ, which shapes the base and structural system for the future skull. Its improvement is firmly connected with among others, for example, advancement of cerebrum, sensory organs, veins, nerves, bones, and head musculature that ponders on chondrocranial advancement and life systems which help illuminating key parts of general skull development including corresponding changes and homology issues in vertebrate advancement (Yaryhin, 2017).

The morphology of the full-fledged chondrocranium of the Lacertilia may now be viewed. There are various broad works in the writing concerning this subject. There are two old broad works managing the improvement of the chondrocranium of Lacertilia, by (De Beer, 1930) and (EL-Toubi and Kamal, 1959).

The chondrocranium of Lacertilian has been described by several authors, as regards the family Geckonidae which isan interesting family of lizards. There are many works found concerning the chondrocranium or some structure from it, *Tropiocolotestripolitanus* (Kamal, 1960), *Ptyodactylushasselquistii*(EL-Toubi and Kamal, 1961),*Psammophissibilans*(Kamal andHammouda, 1965), *Acanthodactylusboskiana*(Kamal andAbdeen, 1972), *malpolonmonspessulana*(EL-Toubi et al., 1973 a, b), *Agama pallida* (Zada, 1981), *PtychoglossusBicolor* (Hernandez-Jaimeset al., 2012), *Mabuya*(Jerez et al., 2015), *L. viridis*and *L. agilis*(Yaryhin and Klembara, 2015).

This study aims to develop the chondrocranium of Geckos genus Stenodactylusslevini and describes the morphological changes that occur during the development. This is considered useful in taxonomy and fossils. It also benefits in comparative anatomical of embryos with different lengths and compared with some other reptiles. Furthermore it was a first time study on reptiles in Saudi Arabia in addition to the knowledge of the changes and mutations that occur in chondrocranium development such as changes occurring in sense capsules.

Material and Methods

Sample eggs were collected from a farmer in Jizan city, South of Saudi Arabia. First the embryos from the egg membranes were extracted and then the embryos head was put in 10% formalin andBouin's fluid for about 24 – 48 hr. Then the samples were washed from fixation by 70% alcohol and dehydrated. The specimens were stained in toto with borax carmine, then embedded by using paraffin wax. The sample was cut in a transverse series section at 5 μm using a microtome stained with picroindigo carmine and then with hematoxylin and eosin. Later, using a light microscope to examine. for graphic reconstruction using Ken-a-vision microprojector (Wassersug, 1976; Taylor and Van Dyke, 1985).

Results

Total body length: 35 mm., **Figures1-3**

Descriptions follow a begin to end of head, the chondrocranium of*Stenodactylusslevini, slevin's*was described into several regions: an olfactory region, an orbital region, a basicranial, and an auditory region **Figures1,2,3.**

1- The olfactory region.

Olfactory region consists of two olfactory capsules which represent quarter of the total length and is wider than the length. The nasal septum (NA.SEP.) has extended forward between the olfactory organs and it's unfenestrated. At the foremost of the nasal capsule, there is a rudiments cartilage of rostral part of the nasal cartilage called cupola anterior (CUP.A.), which is located at the anterior end of the chondrocranium on both sides of the olfactory sacs (OLF.SAC.), in cross sections appearance as a concave cartilage to outward and then approach each other posteriorly till they combine **(Figure4A)**. Each cupola anterior is punctured laterally by a small foramen which is known as the foramen apical (F.AP.) that passes through the ramus medialis of the ethmoid nerve.

The floor of the nasal capsule, which is known the solum nasi (SO.NA.) (**Figure 4B**), is rather reduced. In addition it is considered the floor cupola anterior. In its present stage ,the fenestra olfactoria (FEN.OLF.) is relatively medium to small in size **(Figure 4D).**

Laterally, there is a hole found at the foremost end of the nasal capsule known as fenestra narina (FEN.NAR.). There is a processusalaris inferior (P.AL.IN.) at the front border of the fenestra narina while the processusalaris superior is totally absent. This fenestra closes posteriorly by contact between parietotectal cartilage (PARI.TE.C.) and lamina transversalis anterior (LAM.TR.A.). The parietotectal cartilage comes out from the upper edge of the half foremost nasal septum on the two sides and represents the roof of the nasal capsule and the lateral wall when it fused with paranasal cartilage (PAR.NA.C.) from posterior end. The parietotectal cartilages grow out on both sides from the dorsal edge of nasal septum formthe groove of parietotectal (GR.PARI.TC.) **(Figure3).**

Lamina transversalis anterior is attached at the ventral edge of the nasal septum on either side. In this stage, the lamina is composed of two lamina parts connected to each other, the ventral one called ventral lamella of lamina transversalis anterior (VEN.LAM.TR.A.), the lateral part called lateral lamella of lamina transversalis anterior (LA.LAM.TR.A.). The ventral part forms the floor upon which Jacobson's organ (JC.ORG.) rests. The lateral part which is lateral to this organ is fused frontally with the ventral edge of nasal septum. Inside

Jacobson’s organ there is a cartilage called Jacobson organ cartilage (JC.ORG.C.) that continues from the lamina transversalis anterior**(Figure 4C).** The lateral lamella of lamina transversalis anterior continuous posteriorly to form a part of concha nasalis (CN.NA.) wall. The ventral lamella of lamina transversalis anterior continues posteriorly with tow process, with paranasal cartilage medially, and with ectochoanal cartilage (EC.CHO.C.) laterally.

There is a cavity between parietotectal cartilage and the inner wall of paranasal cartilage kwon as cavum conchale (CV.CN.) which opens forward by aditus conchae (AD.CN.) where the side nasal glands reside. This entire structure is known as concha nasalis which resembles the cone shape and goes down to the cavity of olfactory sac. The posterior process of lamina transversalis anterior (POS.P.LAM.TR.A.) forms the ventral wall of concha **(Figure 4D).**

The floor of the nasal capsule is secludedfrom the paraseptal cartilages (PAR.SEP.C.), which stretch out for just a short path underneath the ventral edge of the nasal septum. It is additionally totally reaching out from the rear edge of lamina transversalis foremost to the planum antorbitale (PLA.AT.OR.), and ends anteriorly with theanterior end of paraseptalcartilage (A.E.PAR.SEP.C) which is the posterior wall of the olfactory capsule. Ventrally, the ectochoanalis cartilage is long and barrel-shaped above paraseptal cartilages which reach out from the back edge of the lamina transversalis foremost and terminates freely. The sphenethmoid commissure (SPH.ET.COM.) is a short and small rod cartilage with finger shaped ends free from the posterior end, located above the planum antorbitale or called lamina orbitonasalis, that extends postero-medially from the parietotectal and paranasal cartilage **(Figure 5A).**

There is a cartilage formed on the lateral wall of the olfactory capsule called paranasal cartilage, which integrates with the external part of the parietotectal cartilage**(Figure 4D)**. It extends posteriorly with two ends- one to the inside to form the planum antorbitale and end freely near to paraseptal cartilage, other one to the outside to form posterior processes maxillaries (POS.P.MX.).The processusmaxillaris anterior is totally absent like other different geckos **(Figure 5A).**

At this stage, the parietotectal cartilage gives way to the formation of large and extensive fenestra olfactoria, and is bounded by the nasal septum medially, the sphenethmoid commissure laterally, the paranasal cartilage anterolaterally, and parietotectal cartilage anteriorly.

2- **Orbital Region**

The interorbital septum (I.OR.SEP.) is an independent structure that separates between the eyes (E.) and continues posteriorly from the nasal septum **(Figure 4D)**. It is presently broader and has turned out to be associated with the trabeculae communis (T.C.) below, and the planum supraseptale (PLA.S.SEP.) displayed above. The two parts of the planum supraseptale begin to appear as two separate rudimentary cartilage connected to each other in the middle and with the dorsal edge of the interorbital septum to shape the floor of the fore-brain. Taenia marginalis (TA.M.) is long and fine and continues posteriorly from the dorso-lateral edge of the planum supraseptale **(Figures 1 and 5B)** and connects with the top of the auditory capsule (AUD.CAP.).

The bar taenia medialis (TA.ME.) which appears in parallel of taenia marginalis and extendspostero- ventrally from the planum supraseptale by some distance with attached to the pila metoptica (PIL.MET.OP.)**(Figure5C)**, taenia medialis ends free in lateral view while in dorsal and ventral articulate with meniscus pterygoideus cartilage (MEN.PT.) which articulate processusascendens (P.ASC.)**(Figure5D)**. The two pila metopticaalso extends ventrally and medially to fuse with each other forming the subiculum infundibuli (SU.INF.). It continues from the anterior edge by cartilaohypochiasmatica (C.HY.CH.), the optic chiasm (OP.CH.) that appears in the cross-sections **(Figure5C).**

There are four fenestrae that can be seen in this region: fenestra optica (FEN.OP.), fenestra epioptica (FEN.EP.OP.), fenestra metoptica (FEN.MET.OP.), and fenestra prootica (FEN.PRO.OT.). The fenestra optica can be seen only from the lateral view; it can't be found in a dorsal and ventral views of the chondrocraniumwhich transmits the optic nerve that in turn transmits vision information to the brain (BR.). It is bound by the hind edge of the interorbital septum anteriorly, the pila metoptica posteriorly, the taenia medialis above, and the subiculum infundibula below. The three other fenestrae are completely fused together in lateral view.

3- **Basicranial**

The trabeculae cranii (T.) arise as two small rounded cartilages and extend forwards to contact with each other after they fuse together forming the trabecula communis, which connects with interorbital septum. Posteriorly, the trabeculae cranii are fused with the basal plate (BAS.PL.) **(Figure 6A).** There are two fenestrae on the floor of chondrocranium: the anterior one called fenestra hypophyseos (FEN.HYP.) approximately oval shaped which passes through itsinternal carotid artery to the inside of the skull and has the pituitary gland and a posterior one fenestra basicranialis (FEN.B.). The crista sellaris (CR.SE.) is a bar separating the fenestra hypophyseos from the fenestra basicranialis.

There are two processes that arise laterally from the hindmost part of each trabecula cranii called basipterygoid process (BAS.PT.P.) or basitrabecular. This process is a triangular plate and expands to the antero-along the side. Notochord (N.) is observed as a long pillar from the hind edge of crista sellaris, dorsally through posteriorly above the basal plate.

The occipital condyle (OCC.CON.) observed in posterior edge of basal plate, is separated from each other by incisura intercondyloidea (INC.I.CON.), and above it with lateral prominence of occipital condyle (LA.PR.OCC.CON.). Ventrally two auditory capsules are connected together by occipital arch (OCC.AR.) which continuous from end of occipital condyle. There are three hypoglossal foramina (H.F). on each side of the sidelong back edge of the basal plate, and posteriorly foramen jugulare (F.J.) from the passage of the vagus and spinal accessory nerves. There is one foramen pentagonal shape known as foramen magnum (F.MG.).

Notochord is totally implanted in the occipital condyle. The thin cartilaginous layer found over the notochord is constant with the foremost end of the odontoid procedure. In this manner, the association between the occipital condyle and the odontoid procedure continues to the full-fledged stage. Laterally observed, a small opening called the facial foramen (FA.F.), is located between the anterior end of the auditory capsule and the ventral part of the basal plate and passes through the facial nerve.

What is worth mentioning at this stage, is the one roof of chondrocranium represented in tectum synoticum (T.SN.). It is a cartilage structure consisting of the posterior edge from lower part of each auditory capsule at the middle line above the brain, and passes over the notochord, which connects two auditory capsules inanterior part while the posterior part is connected by occipital arche.

4- **The Auditory Region**

The auditory capsules occupy one-third of the total length of the chondrocranium It features two large auditory capsules. There is space observed between the auditory capsule on the horizontal edge of the parachordal plate (PAR.CH.PL.) and the occipital arch called fissurametotica. It is divided into two parts, the recessusscalae tympani (REC.SCA.TY.) the anterior part that passes through glossopharyngeal and the foramen jugularethe posterior part that passes through the vagus and spinal accessory nerves. Also, **is** present a large foramen on the ventral surface of the cavum cochleare called foramen perilymphaticum (F.PE.). Along the side the fenestra ovalis (FEN.OV.) is seen from auditory capsule with an oval shape.

The quadrate cartilage (Q.C.), which appears as a large,thick, rectangular cartilage located at the posterior end with a circular cartilage called the crista parotica (CR.PA.OT) by processusparoticus (P.PAR.OT.), and articulates from the inner side with the columella auris, which appears in the form of L.

The columella aurisis composed of two separated parts- proximal part called stapes (ST.) which rests on the auditory capsule, while the distal part called insertion plate (INS.PL.COL.) It is shaped like a stick that rests on the cartilage. The two parts are connected to each other by cartilaginous rod (C.RO.).

Laterally from the columella auris, there are four protrusions of the compact plate: pars superior of insertion plate of columella auris (PA.SU.INS.PL.COL.), pars inferior of insertion plate (PA.INF.INS.PL.COL.), processusaccessorius anterior of columella auris (P.ASC.A.COL.), and processusaccessorius posterior of columella auris (P.ASC.POS.COL.). There is also a crest of quadrate (CRE.Q.) that is located above the quadrate. Semi-circular canals located behind the vestibule consists of three channels; anterior semicircular canal (A.SC.CA.) first and then the side lateral semicircular canal and rear posterior semicircular canal **(Figure 6B).**

FIGURES

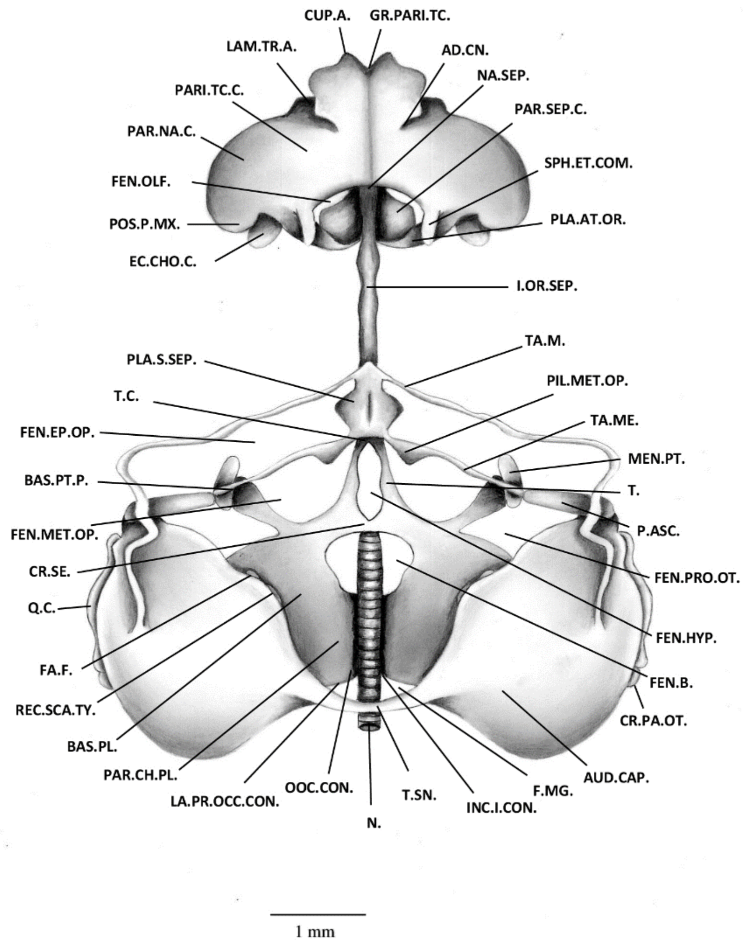

Figure1: Graphic reconstruction of the fully formed chondrocranium of *Stenodactylusslevini* in a dorsal view.

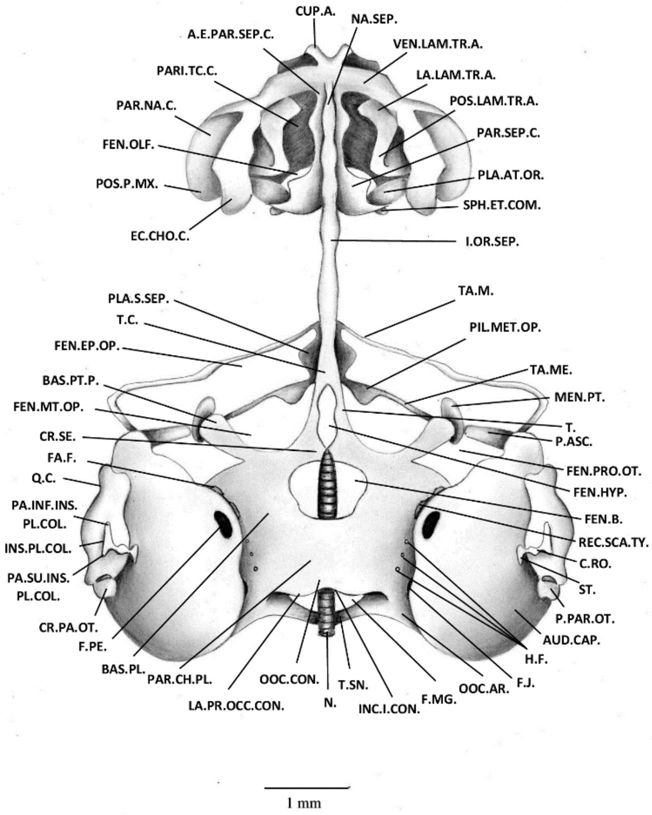

Figure2: Graphic reconstruction of the fully formed chondrocranium of *Stenodactylusslevini* in a ventral view.

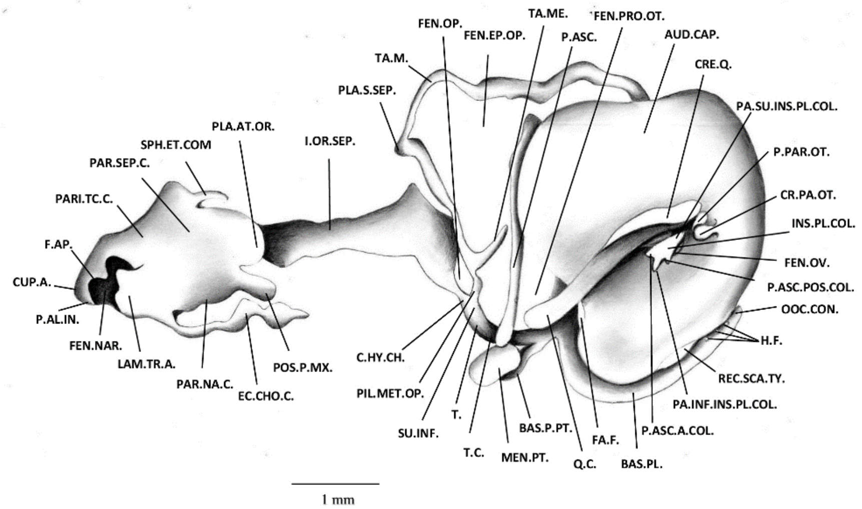

Figure3: Graphic reconstruction of the fully formed chondrocranium of *Stenodactylusslevini* in a lateral view.

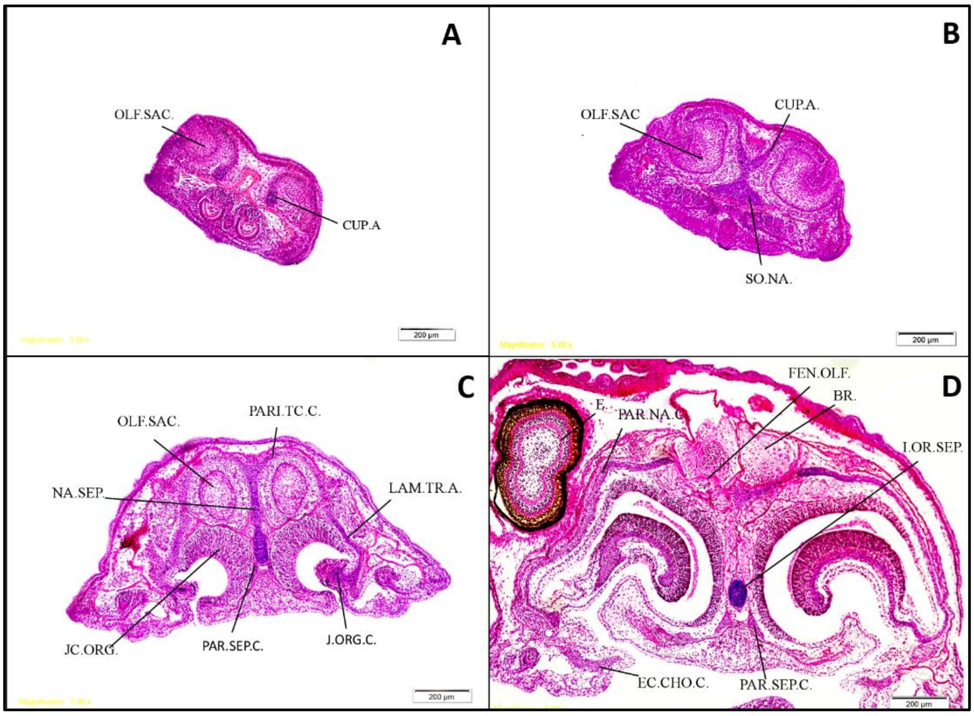

Figure4.A: A cross section of the olfactory region shows the two-cupola anteriorlike a concave cartilageoutward and then approaching each other posteriorly till they combine. **B:** A cross section of the olfactoryregion shows the olfactory sacs and solum nasi connected with cupola anterior. **C:** A cross section of theolfactory region shows the Jacobson's organ and its cartilage continues from thelamina transversalisanterior. There is a nasal septum in middle connected withthe parietotectal cartilage. **D:** A cross section ofthe orbital region shows the two paranasal cartilage and the fenestra olfactoria between them, and alsoshows the brain, eye, paraseptal cartilage and ectochoanal cartilage.

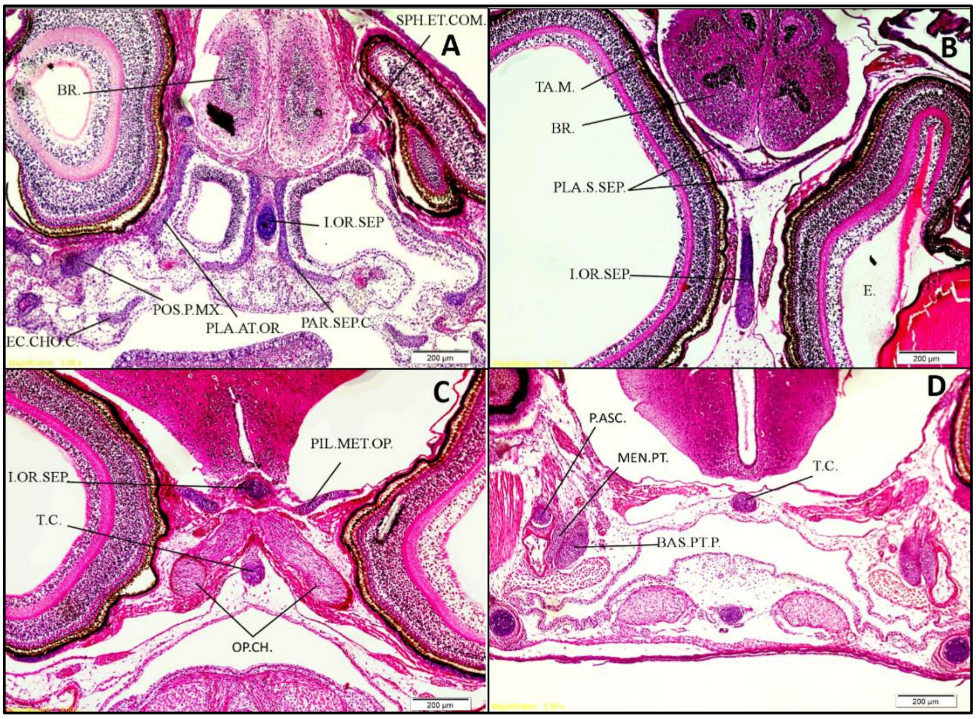

Figure5.A: A cross section of the orbital region shows the paranasal cartilage separating to get the sphenethmoid commissure and the planum antorbitale, the posterior processes maxillaries is observed. **B:** A cross-section of the orbital region shows planum supraseptale above the interorbital septum and two taenia marginalis. **C:** A cross section of the posterior orbital region shows optic chiasm, pila metoptica, and trabeculae communis. **D:** A cross section of the posterior orbital region shows basipterygoid process, pterygoideus cartilage, and processusascendens.

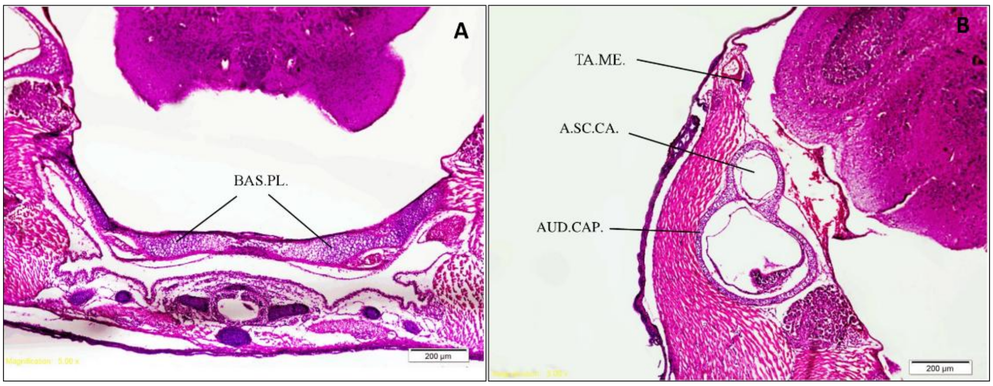

Figure6:A:A cross section of the floor of the neurocranium shows the basal plate. **B:** A crosssection of theauditory region shows the auditory capsule.

DISCUSSION

Several studies have described the chondrocranium of lizards: such as *ChalcidesOcellatus*, *Tropiocolotestripolitanu*, *Ptyodactylushasselquistii*, *PtychoglossusBicolor*, and *Mabuya*. Here, comparisons of the chondrocranium *ofstenodactylusslevini* with other reptiles are evident, and focus on the olfactory region, orbital region, auditory region, and basicranial.

The nasal capsule in of *stenodactylusslevini* is very complicated and exhibits an advanced development structure, and it is more wider thanbeing longer, such as lizards; *ptychoglossusbicolor*, *mabuya*, and geckkos; *ptyodactylushasselquistii*, while the nasal capsules is relatively wide and concave in *GraptemysPseudogeographic*a, Anatomy of the nasal capsules varies within Emydidae. In *Emydurasubglobos*the nasal locale represents one-fourth the length of the chondrocranium and the nasal capsule is powerful and the nose is to some degree tubular. In addition, it is large in size and oval and four times longer than higher in *Trachemysscripta*. In a snake, the nasal capsule appears in *malpolonmonspessulana* the posterior half which is wider than its anterior half. (EL-Toubiand Kamal, 1961; TulenkoandSheil, 2007; Daniel and Christopher, 2012; Hernandez-Jaimes*et al.*, 2012; Jerez *et al.*, 2015; Danielson andSheil, 2017)

The fenestra olfactoria vary in size. They are large or medium or small, but observed large in *mabuya*(Jerez *et al.*, 2015) similar to other lizards, otherwise confirmed (El-Toubiand Kamal, 1959) The fenestra olfactoriaevehens is bounded antero-laterally by the hind edge of the roof of the nasal capsule- the nasal septum medially, and the sphenethmoid commissure postero-laterally. In *Trachemysscripta*(TulenkoandSheil, 2007)the fenestra olfactoriaadvehens is explainedas large, the fenestra olfactoriaevehens remains incomplete (not shown), (Danielson andSheil, 2017) disagrees in *G.pseudogeographica* it is elongated and openposterolateral. At this stage of studythe specimen is medium to small and absent in snake for lack of sphenethmoid commissure such as *malpolonmonspessulana*and*Psammophissibilans*(Kamal andHammouda, 1965; EL-Toubi *et al*., 1973 a, b).

Generally, fenestra superior is observed in the roof of nasal capsule. Dorsally, in *Ptychoglossusbicolor*, a large fenestra superior is present in the anterior region between parietotectal cartilage and paranasal cartilage. However, it islarge likewise and involves around one third of the nasal rooftop. It becomes rather small in early thestage of *PtyodactylusHasselquistii* and then becomes bigger (EL-Toubiand Kamal, 1959,1961;

Hernandez-Jaimes*et al.*, 2012). It is completely absent in snakes, *Tropiocolotestripolitanu*, *Acanthodactylusboskiana*, *malpolonmonspessulana*, and turtles *Carettacaretta*, *Trachemysscripta*, *Emydurasubglobosa*, *Graptemyspseudogeographica*, same of*stenodactylusslevini*. (Kamal, 1960; Kamal andAbdeen, 1972; EL-Toubi *et al*., 1973a, b; Kuratani, 1999; TulenkoandSheil, 2007; Daniel and Christopher, 2012; Danielson andSheil, 2017).

The parietotectal cartilages grows out on both sides from the dorsal edge of nasal septum forming a groove of parietotectal, paranasal cartilage and is totally melded with the ventral portion of the parietotectal cartilage, shaping the basic of the concha nasalis which end blindlyfrom posterior and open anteriorly by aditus conchae. The solum nasi represents the floor of the nasal capsule in most reptiles (lizards and turtles). The paranasal cartilage and concha nasalis are completely absent in *Agama pallida*(Zada, 1981).

In most reptiles the sphenethmoid commissure considered as the contact center between the nasal capsule and planum supraseptale, where they are confirmed in lizards *chalcidesOcellatus*, *PtychoglossusBicolor*, and*Mabuya.* Turtle *Carettacaretta*, *Trachemysscripta*, and*Emydurasubglobosa*(Kuratani, 1999; Daniel and Christopher, 2012; Danielson andSheil, 2017). disagreed (De Beer, 1930) The sphenethmoid commissures end freely in front and hind connected to planum supraseptal. It is absent in *Bachiabicolor* (Tarazonaand Ramírez-Pinilla, 2008).

Orbital region development startsvery well with interorbital septum which separate between eyes. It is continuous from the hind of nasal septum. It is completely lacking in Ophidia such as *PsammophisSibilans*, and the cartilage structuresare reduced (Kamal and Hammouda,1965; El-Toubi*et al.*, 1973a, b; Bellairsand Kamal, 1981).

Generally, this region consists of many structures either more developed or reduced to absent, and are different in size and shape in different species. Most lizards contain taenia marginalis, taenia medialis, pila accesoria, pila metoptica, pila antotica. In *Bachia bicolor*, notably reduced, only consists of planum supraseptale, trabeculae cranii, interorbital septum and sphenethmoid commissure.

The planum supraseptale is narrow and extended anteroposteriorly, lying horizontally and parallel to the trabecula communis,the anterior end is sharp and widens posteriorly reaching its maximum midlateral extension (Tarazonaand Ramírez-Pinilla, 2008). In *stenodactylusslevini*the pila accesoria was absent.

Taenia marginalis starts dorso-along the side, expanding posteriorly in generally a level from planum supraseptale to theroof of auditory capsule, such as *Emydurasubglobosa*(Daniel and Christopher, 2012), *Acanthodactylusboskiana*(Kamal andAbdeen, 1972), *Tropiocolotestripolitanus* (Kamal, 1960).

(De Beer, 1930) suggests the taenia marginalis arises from the auditory capsule to planum supraseptale, like *Lacertaagilis*, and extends from the posterior edge of planum to acrochordal cartilage in *Trachemysscripta* (TulenkoandSheil, 2007). The taenia marginalis in *Ptychoglossusbicolor* originates independently near to planum supraseptale, and elongates posteriorly and rostrally to contact the optic capsule and the planum supraseptale (Hernández-Jaimes*et al.*, 2012). It is absent in *Psammophissibilans*, *malpolonmonspessulana*, and*Graptemyspseudogeographica* (Kamal andHammouda, 1965; EL-Toubi *et al*., 1973a, b; Danielson andSheil, 2017).

In *Stenodactylussleviniw*hich composed of trabeculae craniiforwards to interorbital septum, and parachordal cartilage extends posteriorly representing the basal plate. In *Ptychoglossusbicolor* there isa parallel cartilage behind and above the trabecula cranii called acrochordal cartilage. In early embryos of the lacertid *L. agilis*, a very thin paired mesenchymal condensations were found at the base of the developing skull.

There are two fenestrae on basicranial fenestra hypophyseos that is triangular shape between trabeculae cranii and basicranial fenestra. The formation of the basicranial fenestra is different among Squamata species indicating nonhomology of the fenestra, such as a *malpolonmonspessulana* snake and other groups of turtles. Basicranial fenestra is heart-shaped in *Trachemysscripta*, and ovoid in *C. caretta*, and *Emysorbicularis*, rectangularshape in *G.pseudogeographica*.

The basipterygoid processes observed in most lizards from the posterior part of trabeculae cranii continues ventrally with the growth of mesenchymal cells such as thestudy sample, *L. viridis*, *Tropiocolotestripolitanus*, but in *L.agilis*the process arises as an independent nodule of cartilage and it fuses with the trabecula only later in ontogeny (Kamal, 1960; YaryhinandKlembara, 2015).

In *Ptychoglossusbicolor* development of the basipterygoid processes from the acrochordal cartilage which represent orbital posterior cartilage (Hernández-Jaimes *et al.*, 2012. It is lacking in *carettacaretta, Trachemysscripta, Emydurasubglobosa*(Kuratani, 1999;

TulenkoandSheil, 2007; Daniel and Christopher, 2012), *malpolonmonspessulana*, *Psammophissibilans* (Kamal andHammouda, 1965; EL-Toubi*et al*., 1973 a,b).

Auditory capsule has septa for the semicircular canals - anterior and lateral and the posterior not showing in *Malpolonmonspessulanus*. There is also a wall between the inner ear and brain that separates them and passes through the eighth nerve. The posterior semicircular canal is very weak in development in *sammophissibilans*. In *Ptyodactylushasselquistii*threecanals are very well formed such as *Stenodactylusslevini*.

Columella auris consists of proximal and distal portion that arise from two separate centers. It is made up of a cartilaginous bar extended medially framing the footplate which fits in the fenestra ovalis. The distal part of the columella is a connection with a thick bar of cartilage directed ventrally called ceratohyal. Then again, the distal segment of the columella auris is very free.

On the other hand, (De Beer) 1930 suggests that in Lacerta the formation of the fenestra ovalis is quite different. It is seen as free knob of cartilage located behind the quadrate, amidst that diligently membranous part of the side mass of the auditory capsule which will progress toward becoming fenestra ovalis. This knob illustrates the proximal part of the columella auris known as stapes. Fenestra ovalis, located between lateral wall of parachordal plate and basal of auditory capsule, is similar to other lizards *Acanthodactylusboskiana*, *ChalcidesOcellatus*, but opposite in*Ptyodactylushasselquistii* the columella auris chondrified from distal portion.

ABBREVIATIONS TO FIGURES

A.E.PAR.SEP.C.	anterior end of paraseptal cartilage.
AD.CN.	aditus conchae.
A.SC.CA.	anterior semicircular canal.
AUD.CAP.	auditory capsule.
BAS.PL.	basal plate.
BAS.PT.P.	basipterygoid process.
BR.	brain.
C.HY.CH.	cartilaohypochiasmatica.
C.RO.	cartilaginous rod (connecting insertion plate with stapes).

CN.NA.	concha nasalis.
CR.PA.OT.	crista parotica.
CR.SE.	crista sellaris.
CRE.Q	crest of quadrate.
CUP.A.	cupola anterior.
CV.CN	cavum conchale.
E.	eye.
EC.CHO.C.	ectochoanal cartilage.
F.AP.	Foramen apical.
F.J.	foramen jugulare.
F.MG.	foramen magnum.
F.PE.	Foramen perilymphaticum.
FA.F.	facial foramen.
FEN.B.	fenestra basicranialis.
FEN.EP.OP.	fenestra epioptica.
FEN.HYP.	fenestra hypophyseos.
FEN.MET.OP.	fenestra metoptica.
FEN.NAR.	fenestra narina.
FEN.OLF.	fenestra olfactoria.
FEN.OP.	fenestra optica.
FEN.OV.	fenestra ovalis.
FEN.PRO.OT.	fenestra prootica.
GR.PARI.TC.	groove of*parietotectal*.
H.F.	hypoglossal foramina.
I.OR.SEP.	interorbital septum.
INC.I.CON.	incisura intercondyloidea.
INS.PL.COL.	insertion plate of columellaauris.
JC.ORG.	jacobson's organ.
JC.ORG.C.	jacobson organ cartilage
LA.LAM.TR.A.	lateral lamella of lamina transversalis anterior.
LAM.TR.A.	lamina transversalis anterior.
MEN.PT.	meniscus pterygoideus.

N.	notochord.
NA.SEP.	nasal septum.
OCC.AR.	occipital arch.
OCC.CON.	occipital condyle.
OLF.SAC.	olfactory sacs.
OP.CH.	optic chiasm.
P.AL.IN.	processus alaris inferior.
P.ASC.	processusascendens.
P.ASC.A.COL.	processusaccessorius anterior of columella auris.
P.ASC.POS.COL.	processusaccessorius posterior of columella auris.
P.PAR.OT.	processusparoticus.
PA.INF.INS.PL.COL.	pars inferior of insertion plate.
PA.SU.INS.PL.COL.	pars superior of insertion plate of columella auris.
PAR.CH.PL.	parachordal plate.
PAR.NA.C.	paranasal cartilage.
PAR.SEP.C.	paraseptal cartilage.
PARI.TE.C.	parietotectal cartilage.
PIL.MET.OP.	pila metoptica.
PLA.AT.OR.	planum antorbitale.
PLA.S.SEP.	planum supraseptale.
POS.P.LAM.TR.A.	posterior process of lamina transversalis anterior.

POS.P.MX.	Posterior Processes maxillaries.
Q.C.	quadrate cartilage.
R.C.	rostal cartilage.
REC.SCA.TY.	recessusscalae tympani.
SO.NA	solum nasi.
SPH.ET.COM.	sphenethmoid commissure.
ST.	stapes of columella auris.
SU.INF.	subiculum infundibula.
T.	trabeculae cranii.
T.C.	trabeculae communis.
T.SN.	tectum synoticum.
TA.M.	taenia marginalis.
TA.ME.	taenia medialis.
VEN.LAM.TR.A.	ventral lamella of lamina transversalis anterior.

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Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflict of interest.

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