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Description of the Early Developmental Stages of the Sense Organs of the Egyptian *Passer Domesticus*

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Abstract

The present study deals with the development of the early embryonic stages of the sense organs and their surrounding mesenchyme of *Passer domesticus* at 8, 10, 15 and 19 mm total body lengths. The olfactory organs began its appearance in 15 mm stage as two olfactory placodes. They are formed ventro-laterally to most anterior part of the fore brain then they invaginated forming two olfactory pits. An olfactory sac and its lateral and medial nasal processes formed in19 mm stage. The two eyes arised as two optic vesicles in 8 mm stage simultinously with the lens placode opposing to them. The optic vesicle invaginated in 10 mm stage to form the optic cup simultaneously with the invagination of the lens placode forming the lens pit. In15 mm stages, a double layered optic cup with its choroid primordium are formed. Also, the primary fibers of the lens are formed and arranged in concentric layers with lens epithelium. In 19 mm stage, the optic cup gave two layers; inner neural and outer pigmented layers. Also, the corneal epithelium was formed. The first appearance of sclera primordium was in 19 mm stage. The membranous labyrinth of the inner ear began to appear at 8 mm stage as an otic placode from the ectodermal layer at the level of the hind brain. Then it invaginates to form the otocyst. The invagination process of the otocyst was completed in 10 mm stage. The ductus endolymphaticus appeared in the dorso-lateral portion of the middle part of otocyst in 15 mm stage, followed by the ductus cochleararis from the ventro-medial wall in 19 mm stage. The beginning of condensation process; the first step towards the otic capsule chondrogenesis was in 19 mm stage. By comparing the present results with other studied avian species revealed a similar genesis of the early development of the main three sense organs when compared to the other studied avian species.

Keywords: Passer, Embryo, Early Stages, Olfactory, Eye, Ear, Mesenchyme, Development.

1. Introduction

It is known that the vertebrate skull is a complex structure housing the brain and specialized sensory organs including the olfactory, the optic and otic organs [1].

Concerning the olfactory organ, many structures derived from the epidermis make their appearance first in the form of plate-shaped thickenings of the epidermal epithelium called placodes. A pair of placodes develops into the olfactory sacs which are later separated from the epidermis forming two vesicles one on each side of the telencephalon. Classical neuroanatomical studies have investigated the olfactory system in a number of species of different taxa including amphibians [2], reptiles [3], birds [4] and mammals [5].

In birds, [6] and [7] studied the nasal cavity in the duck and Wanxi- white geese and in the Japanese Crow, respectively. Development of the olfactory organ in the bird *Coturnix coturnix* was studied by [8]. However, [9] examined the vertebrate nose concentrating their study on the embryonic nasal capsule. In addition, [4], **[**10] and [11] reported that the olfactory organ originates from a cephalic placode, the olfactory placode, which gives rise to olfactory and non-olfactory epithelia.

With regards to the eye development, it represents the greatest complexity in terms cell diversity, tissue and parts unified to form an optical instrument of amazing proficiency and efficiency. In birds the sight is considered very important sense as they are very mobile animals. The avian eyes are large in relation to the size of their heads; larger than those of other vertebrates [12]. The eye rudiments are large in bony fishes, reptiles and birds, smaller in amphibians and relatively very small in mammalian embryos [13]. The size of the orbit and the eye has both increased substantially in the evolution of terrestrial vertebrates [14]. Generally, the optic cup arises from the forebrain as two optic vesicles on either side of the brain, then push outwards displacing the mesenchyme to meet the inner surface of the epidermis. The optic vesicles vary in different vertebrates even in one order as in the frog [13].

The vertebrate eye at different developmental origins were studied [15]. The same authors described the the neuroectodermal derivatives of the eye cup, ectodermal derivatives and mesenchymal derivatives of the neural plate, respectively. In addition, [16] and [17] described the development of the eye and postulated the mechanisms which are regulating progenitor patterning and their gradual differentiation into diverse tissue types. [18] studied the retina and the pigmented lineages of the vertebrate eye that originate during development from the optic vesicle. Also, formation and development of the eye cup and its dorsal and ventral layers were described by [8] and [19]**.**

Considering the otic organ, birds are generally highly vocal animals [20]. The avian ear is composed only of two anatomical parts; the middle and the inner ear. Development of the embryonic ear shows a considerable similarity to the olfactory placode, as it also converted by invagination into a sac-like structure, but in early stages there are important differences. In amniotes the whole epidermal layer is involved in the formation the auditory placode [13]. Whereas in the frogs the auditory placode is formed by thickening of the interior layer of the epidermis, the external layer is not involved at all.

The development and formation of the middle ear and its flexibility in some vertebrates were carried out by many investigators [21] and [22]. In birds, many studies were carried out on the embryonic development of the avian the middle ear such as [23] on *Strix*, [24] on *Podiceps*, [25] on *Grus* and [26] on *Columba*. Evolution of the middle ear and its anatomy were described in different orders of birds by saiff [27], [28] and [29] on *Struthio*, *Apteryx* and *Rhea* respectively. The same author investigated the middle ear in other avian orders Falconiformes [30] and Cariamiformes [31]. Also, [32] and [33] presented a full detailed study and descriptions of the middle ear in reptile, aves and mammals.

On the other hand, different aspects of the developing avian inner ear were described by a number of authors [34]**, [**35] and [36]. The origin of the avian inner ear origin and its developmental stages showed that the inner ear originates from the otic placode that formed from an ectodermal thickening of the epidermis [37] and [38]. In addition, the morphology of the inner ear, besides the number, type, positon and shape sensory patches that is hosts were described by a number of authors ([39], [40] and [41]. Furthermore, the problem of hearing in the chicken embryo and auditory evoked responses in the cochlea were studied by [42].

The present investigation was undertaken to study the development of the early embryonic stages of the sense organs and their surrounding mesenchyme of the bird *Passer domesticus*, order Passeriformes.

2. Materials and methods

The fertilized eggs of the *Passer domesticus* are collected randomly from farms of Tukh, Qalubia, Egypt. After careful re-moving of the developmental embryo stages (8, 10, 15 and 19 mm total body length) from the shells, they were fixed in an aqueous Bouin's solution for 12 hours. Then they were washed in 70 % ethyl alcohol for several times to remove the excess of the fixative. The total body length of the embryo was measured from the tip of the beak to the cloacal opening. Heads of the collected embryos were stained with Borax carmine for 12 hours and then dehydrated, cleared, embedded in paraplast wax and serially sectioned transversally at 4-5 µm thick and stained with Picroindigocarmine stain. Photomicrographs of the serial sections were captured by the light microscope leica DM 3000 at Histlogy department, Faculty of Veterinary Medicine, Benha University, Egypt.

3. Results:

3.1 Stage I: 8 mm total body length

The olfactory organ

The present stage did not show any sign of the olfactory organ development.

The optic organ

The eye of this embryo arise from the neuroepithelium of the ventral forebrain that evaginates laterally to from the optic vesicles with a large cavity; optocoele (FB., OP.V.,OPC., Fig 1, A). The two optic vesicles extend laterally towards the opposite ectoderm. Their connection to the forebrain become slightly constricted forming the optic stalk (OP.ST., Fig 1, A). At the same time, the lens placode arises as an ectodermal thickening opposite to the developing optic vesicle (L.PC., Fig 1, A).

The otic organ

The membranous labyrinth of this stage appears as an ectodermal thickening forming the otic placode on each side of head at the level of the hindbrain from the ectodermal germinative layer (HB., O.PC, Fig 1, B). The otic placode soon sinks forming a slightly elongated oval pit. It gradually becomes deeper and invaginates forming a fliud filled sac called the auditory vesicle or the otocyst (OT, Fig 1, B).The otocyst has a thick wall composed of pseudostratified columnar epithelium with an oval or rounded nuclei (OT.W., PST.EP., Fig 1, C). The otocyst is surrounded by otic mesenchyme; mesenchyme of the head in the auditory region (OT.MS, Fig 1, B). The otic mesenchyme is the origin of all cartilaginous elements of the otic capsule in the following stages.

3.2. Stage II: 10 mm total body length

The olfactory organ

The present stage did not show any sign of development of the olfactory organ.

The optic organ

The optic vesicle becomes flattened and invaginates to form a cup shaped structure; the optic cup (OP.CU, Fig 1, D). This process occurs simultaneously with the invagination of the lens placode forming the lens pit (L.PT, Fig 1, D). The two structures have thick walls which are composed of pseudostratified columnar epithelium with oval nuclei (PST.E, Fig 1E).

The otic organ

In this stage, the invagination process of the otic vesicle of the inner ear has been completed. The otocyst has been entirely closed (OT, Pl.1, F). Also, the connection of the otic ectoderm with the exterior is entirely lost.

3.3.Stage III:15 mm total body length

The olfactory organ

The olfactory organ is firstly seen in the present stage as an ectodermal thickening; the olfactory placode (OL.PC, Fig 2, A). It grows ventro-laterally to the most anterior part of the forebrain and separates from the forebrain by condensed mesenchymal cells (FB., C.MS., Fig 2, A). The olfactory placode invaginates forming an olfactory pit (OL.PT, Fig 2, A). A few nerve fibers originate from the olfactory epithelium and penetrate the ventral wall of the anterior part of the forebrain (OL.NV.FP, Fig 2, A).

The optic organ

The double layered optic cup is formed at this stage at the lateral sides of the forebrain. The outer layer of the optic vesicle facing to the lens placode invaginates to form a double layered optic cup (OP.CU. Fig 2, B, C & D). The double layered optic cup has a slightly thin outer layer that gives the future pigmented layer of the retina and a thick inner layer that gives the future neural layer of the retina (TN.LA., TK.LA, Fig 2, C, D, E & F; Fig 3, A).

The wall of the optic cup of the present stage is not complete due to the presence of a break or a cleft in its ventral lip. This break forms the retinal fissure (RT.F, Pl. 2, F). Through this fissure, the mesenchymal cells and blood vessels enter the vitreous cavity

The optocoele (OPC, Fig 2, E & F) becomes very reduced as a result of invagination process and formation of a new cavity; the vitreous space between the lens vesicle and the optic cup medially (VT.SP, Fig 2, D, E & F). The two optic vesicles extend laterally towards the opposite ectoderm. But they are still connected to the fore brain by the optic stalk (OP.ST, Fig 2, F). A mesenchymal condensation was found external to the outer layer of the optic cup. This condensation represents the choroid primordium (CD.PM, Fig 2, E & F; Fig 3, A). The innermost layer of this condensation is surrounded by a layer of blood vessels (B.CS, Fig 3, A). The medial wall of the lens vesicle becomes thicker than its lateral one. Cells of this medial wall are elongated having their nuclei rearranged so as to occupy a zone between its two surfaces; the lenticular portion of the lens (LE.PO, Pl. 3, A). The lateral sides become thin forming the lens epithelium (L.EP, Fig 3, A).

The cells of the middle and posterior end of the lens lenticular portion begin to elongate toward the anterior end of the vesicle. These elongated cells eventually fill in the lumen of the vesicle to form the primary fibers (PI.FI, Fig 3, A). These fibers become the embryonic nucleus in the mature lens. The lens fibers stretch lengthwise from the posterior to the anterior poles appeared arranged as concentric layers in the transverse section. The middle of each fiber lies on the equator. These fibers form the bulk of the lens. The ectodermal layer facing the lateral wall of the lens vesicle forms the future corneal epithelium (CR.EP. Fig 2, F; Fig 3, A).

The otic organ

In the pharyngeal region of the present stage, the origin of the future middle ear structures are formed of four pharyngeal arches and their pouches on the two lateral sides (1^{st} PH.A., 1^{st} PH.PO., 2^{nd}PH.A., 2^{nd}PH.PO., 3^{rd} PH.A., 3^{rd} PH.PO., 4^{th} PH.A., and4^{th} PH.PO., Fig 3, B).The origins of the middle ear elements are the proximal pharyngeal mesenchyme, the pharyngeal endoderm of the first pharyngeal pouch, first pharyngeal cleft and the endodermal layer of the first pharyngeal pouch. The middle ear that will be formed including columella, the air-filled cavity (tympanic cavity or cavum tympani), the tympanic membrane (tympanum or ear drum) that separates the middle ear from outside and the paratympanic organ.

The columella is mesodermal in origin and arises from the proximal pharyngeal mesenchymal cells of the second pharyngeal arch (PH.MS., 2^{nd} PH.A., Fig 3, B). These mesenchymal cells are in direct contact with the pharyngeal endoderm of the first pharyngeal pouch (1^{st} PH.PO., Fig 3, B). From the latter pouch, the tympanic cavity will be formed and still opened as an opening to the two lateral sides (1^{ST} PH.PO., Fig 3, B).

The tympanic membrane is a trilaminar membrane and consists of three layers. The origin of these layers is established in this stage. These layers are an outer ectodermal layer; first pharyngeal cleft-derived squamous epithelial layer (1^{st} PH.CE., Fig 3, B), a middle mesenchymal layer which derived from the embryonic mesenchyme of the otic region (OT.MS., Fig 3, D) and an inner endodermal layer which is first pouch pharyngeal endodermal derived layer (1^{st} PH.PO., Fig 3, D).

The otocyst appears as an otic plate at the most anterior part of the auditory region (O.PL., Fig 3, C). At the middle part, the otocyst has a pear shape and a thin wall (OT., Fig 3, D).The otocyst is surrounded by otic mesenchyme of the head in the auditory region (OT.MS., OT., Fig 3, D). The dorso-lateral portion of the middle part of the otocyst bulges out as a small protrusion to give the ductus endolymphaticus at the lateral wall facing the hindbrain (D.EN., HB., Fig 3, D).

3.4.Stage IIV: 19 mm total body length

The olfactory organ

The present stage reveals that the olfactory pit is transformed into a blind olfactory sac (OL.SA., Fig 4, A, B, C & D) on each side of the nasal region of the head. Along the medial and lateral walls of the two olfactory sacs, there is an increase in the mesodermal aggregations. These two mesenchymal codensations form the lateral and medial nasal processes, respectively (L.N.PR.; M.N.PR., Fig 4, A, B & C). There is also an increase in number of the olfactory epithelial cells. These cells originate from the inner surface of the olfactory sac from which the olfactory nerve grows more fibers than the previous stage. These fibers penetrate the ventral wall of the anterior part of the prosencephalon (OL.NV.F., OL.NV.CS, Fig 4, B & C).

The space found beneath the brain and between both of the olfactory sacs and eyes is filled with loose mesenchymal cells. The nasal and interorbital septum first appears within the tissue between the two olfactory sacs (OL.SA., Fig 4, D) as a parallel paired rod-like condensation of mesenchyme. These condensations represent the anlage of the trabecules (TR, Fig 4, D).

The optic organ

Between the two eyes, a mass of condensed mesenchymal cells becomes obvious (E., C.MS., Fig 4, E). Cells of this mass are proliferated and broaden out and become continuous dorsally on either side with another mesenchymatous condensation lying lateral to the brain from which the anterior orbital cartilage will later be derived. Also, at this level a small mass of dark condensed mesenchyme appears on either side of the ventro-median walls of the two eyes (C.MS., E, Fig 4, F). Then each one swells out and gives primordium of the inferior oblique muscle of the eye.

At this stage, the optic cup of this stage still has rudiments of the optocoele (OPC., Fig 5, B & D). The optocoele appears reduced at the middle region than at its marginal sides and is still connected to the brain cavity through the optic stalk (OP.ST, Fig 5, B & E). The vitreous space becomes larger than before. Also, the wall of the optic cup is still incomplete due to the presence of the retinal fissure (RT.F, Fig 5, A). The closure of the choroid fissure begins in this stage at the middle region of the developing eye (Fig 5, A).

The retina of the optic cup consists of two layers; neural and pigmented layers (NE.LA, PG.LA, Fig 5, A, D & E). The two layers become closely applied together with a narrow optocoele in between (OPC, Pl.5, B & D). Cells of the outer pigmented layer begin to form pigmented granules, while the inner neural cells become thicker. The present vitreous space becomes invaded by mesenchymal tissue, which will form the vitreous body of the adult eye. This mesenchymal tissue enters the vitreous space through the retinal fissure (RT.FS, Pl. 5, A). Howevwe, the inner retinal layer enfolds and extends into the lumen of the optic stalk (NE.LA.EN, Fig 5, A, B & E). Then a fusion begins at the apex of the fold through the active cellular proliferation. The fold then bridges the lumen of the optic stalk (OP.ST, Fig 5, B & E) providing a pathway for the exit of the optic nerve fibers from the retina (OP.N, Fig 5, B & E). The nerve fibers grow out towards the brain along the stalk of the eye cup. Later the stalk of the eye cup becomes transformed into the optic nerve.

The lens at this stage increases in thickness (L., Fig 5, B & C). The cells of the lenticular portion of the medial wall elongate and become more fibrous than before by formation of more primary fibers (LE.PO., PI.FI, Fig 5, C). Meanwhile, the lateral wall layer appears as a thin layer of a uniform lens epithelium covering the lens externally (L.EP, Fig 5, C). As a result there is a reduction in the lens cavity. Now, both of the corneal and the lens epithelium become completely separated by a cavity; the anterior eye chamber (A.E.C, Fig 5, C).

The choroid layer becomes more obvious (CD., Fig 5, D). The capillary layer of the choroid is well developed containing large number of blood capillaries (B.CA, Pl. 5, D). The first appearance of the sclera primordium occurs in the present stage. It has two centers, dorsal and ventral to the optic cup (SC.PM, Fig 5, B & D; Fig 6, A).

The otic organ

The paratympanic organ is firstly appeared as a vesicle at the inner end of the first pharyngeal pouch (1st PH.PO., PT.O., Fig 6, A & B).

In this stage, the inner ear otocyst is more enlarged and has a wide cavity and the acousticus or the cochleo-vestibular (VIII) ganglion is clearly seen as a compact mass above the dorsal wall of the otocyst then it gradually enters the hindbrain (N.VIII., HB., Fig 6, C, D, E & F). The otocyst at the anterior and middle portion, is divided into a dorsal part; the pars superior (PA.S., Fig 6, D, E & F) and a ventral one; the pars inferior (PA.I., Fig 6, D & E). At the anterior portion of the otocyst, the ductus endolymphaticus continues its growth as a sac from the pars superior (D.EN., Fig 6, D). At the anterior and the middle parts of the otocyst, the ductus cochleararis begins to originate from the ventro-medial wall of the pars inferior as slightly curved duct (D.C Fig 6, D & E).

Beginning of condensation process (the first step towards the capsule chondrogenesis) is indicated by presence of numerous nuclei in the surrounding mesenchymal cells around the wall of the otocyst forming the condensed mesenchyme of the otic capsule (C.MS., Fig 6, C, D , E & F).

3.5. Discussion

3.5. 1: The olfactory organ

In the present study, the olfactory organ of Passer *domesticus*, as in other studied avian species, is the last organ to appear during the early embryonic development rather than being the second one in other vertebrate classes. This difference in avian sense organs origination is due to the precociousness of the lens development [43]. This appears to be a characteristic feature of birds [8] and [44].

In Passer *domesticus*, the olfactory placode is formed at the 15 mm total body length stage. Other previous studies on birds recorded that the olfactory placode is firstly seen at the second day of incubation as in *Coturnix coturnix* [8], at stage 4 with total body length of 30 mm in *Bubulcus ibis* at [44] and at NF 39 and 40 NF, stages according to [45], in *Discoglossus pictus* [46]. In *Bubulcus ibis* the olfactory pit appeared at 12 mm total body length [44]. Also, the olfactory pit of the chick became already formed at the 96 hours of incubation [47]. However, in mammalian embryos such as mouse embryos, the olfactory placode is seen at the ninth day of gestation [48] and [5].

In the present study, the medial and lateral nasal processes are formed at 19 mm stage as a result of the mesenchymal tissue condensation surrounding the olfactory sacs. Such processes are formed at the fourth incubation day as in *coturnix coturnix* [8] and at 26 mm stage of *Bubulcus ibis* [44]. The same results were confirmed by [49] in mammals**.**

3.5. 2: The optic organ

In most vertebrates, a direct causal relationship between the developing lens and the optic vesicle. As the optic vesicle touches the epidermis placode, it gives off a stimulus which causes the epidermis cells to develop into the lens rudiments [50].

The optic cup of the present study appears at 10 mm stage. [51] Showed that the optic cup appears at 20 mm stage of *Columba livia*. In *coturnix coturnix* and *Bubulcus ibis,* the optic cup appears at the second day of incubation and at 0.7 cm total body lenght [8] and [44] respectively. Also, the part of the opening of the optic cup, lying ventromedial to the lens vesicle forms the retinal fissure [52] and [44]**.** With advancing development, the rim of the optic cup becomes different from the deeper laying parts. The thinned portion of the eye cup becomes the iris of the eye [13]. Later the lens vesicle is lying in the opening of the iris.

The lens placode has an origin from the ectodermal cells facing the optic vesicle in *Passer domesticus* at 8 mm stage. These cells thicken and elongate giving the lens placode which comes in contact with the optic vesicle. This result agreed with the findings of [53] and [44]. Also, [54] revealed that the lens placode formed next to the optic vesicle from the ectoderm close to the neural plate and it is the only cranial placode that does not give rise to neurons. In amphibians and bony fishes, the thickening of the inner layer of the epidermis takes a part is nipped off from the epidermis a solid mass of cells, later these cells rearrange themselves into a vesicle [50]. In *Passer domesticus*, the lens placode invaginates to form lens pit then it constricts to give the lens vesicle. The previous process occurs simultaneously with that of the optic vesicle. The same results were obtained by [54], [8] and [44]**.** The present results of *Passer domesticus* agree with that of **[**55] in *Xenopus leavis***,** [56] in the zebra fish and [8] and [44] in the common quail and the cattle egret, respectively. They explained that the lens placode invaginates and forms the lens pit. Subsequently, the lens pit deepens and the connection with the overlying surface ectoderm, the prospective cornea, is abolished resulting in the formation of the lens vesicle.

In 15 mm stage embryo of the present study, after formation of the lens vesicle, cells at the centre of the posterior side of the lens elongated and differentiated into primary lens fibers cells. Whereas the lens epithelial cells at the anterior side of the lens retained their ability to proliferate and will generate fiber cells throughout life. The same results were recorded by [57].

3.5. 3: The otic organ

The present study revealed that the three germ layers are sharing in the development of *passer* otic organ. These findings were observed by [58] in their studies on chick and mouse and [59] in their studies on human embryo.

3.5. 3. I. The middle ear

The *Passer* as an avian species has well developed middle ear. Most avian species have nearly similar middle ear structures and share common features [22], [26], [30] and [60]. [61] and [62] revealed that the columella of the middle ear is the equivalent to the hyoid-drived mammalian stapes. In birds, the columellar anlage of *Bubulicus ibis* appeared as human stapedial anlage [63].

The middle ear of 19 mm stage of the present study has a paratympanic organ which is formed from the 1st pharyngeal pouch. The paratympanic organ is a small mechano –sensory pouch embedded in the wall of the middle ear cavity in close to the tympanic membrane. The same result was found in studies carried out by [64] and **]**65] on chick and [26] on *Columba livia* embryo. They showed that the paratympanic organ is found in many amniote species. However, the paratympanic organ of most birds is found in a form of a small epithelial pouch embedded in connective tissue in the wall of the middle ear cavity.

3.5. 3. II. The inner ear

In the present study, the inner ear of *Passer* firstly appear as an ectodermal thickening; the otic placode in 8 mm total body length. Then it is followed by completely closed otocyst that is clearly seen at 10 mm total body length. This otocyst is a vesicle consists of columnar cells on both sides of the hind brain and it is formed by the placodal invagination. This description is consisted with that observed by [34]**,** [35] and [66].These auothers revealed that the entire inner ear and its associated sensory ganglia are derived from the otic placode which is morphologically visible as a thickened patch of the ectoderm. The latter invaginates forming the otic cup that closes to form the otic vesicle.

The otocyst of the present early developmental stages is surrounded by the periotic mesenchyme. Beginning of the condensation process (the first step towards the capsule chondrogenesis) is indicated by presence of numerous nuclei in the surrounding mesenchyme around the wall of the otocyst forming the condensed mesenchyme. This process occurs in 19 mm stage. The process of mesenchyme condensation is also observed in other studies carried out by [58], [67] and [1].

At 15 mm embryo stage, the ductus endolymphaticus is firstly appeared from the latero-dorsal part of the otocyst. Then it enlarges to form a sac; the saccus endolymphaticus. This sequence agrees with the studies of [68] in the mouse and [69] in Zebra fish. They explained that the first structure of the membranous labyrinth that evolved from the otocyst close to the closure point at HH23 chicken (Hamburger and Hamilton, stage 23) and E10 (tenth embryonic day) in the mouse is the endolymphatic duct.

In the present study, the ductus cochlearis is the auditory organ in *Passer.* It is the following structure to be appeared in the developing otocyst from its ventral wall at 19 mm embryo stage. [70] in their studies on the chick inner ear development observed the same result and the chick cochlear duct is apparent in HH23. The twisting of the cochlear duct is quite complex and appeared as a long ducts as in the Owl [71] and [72].

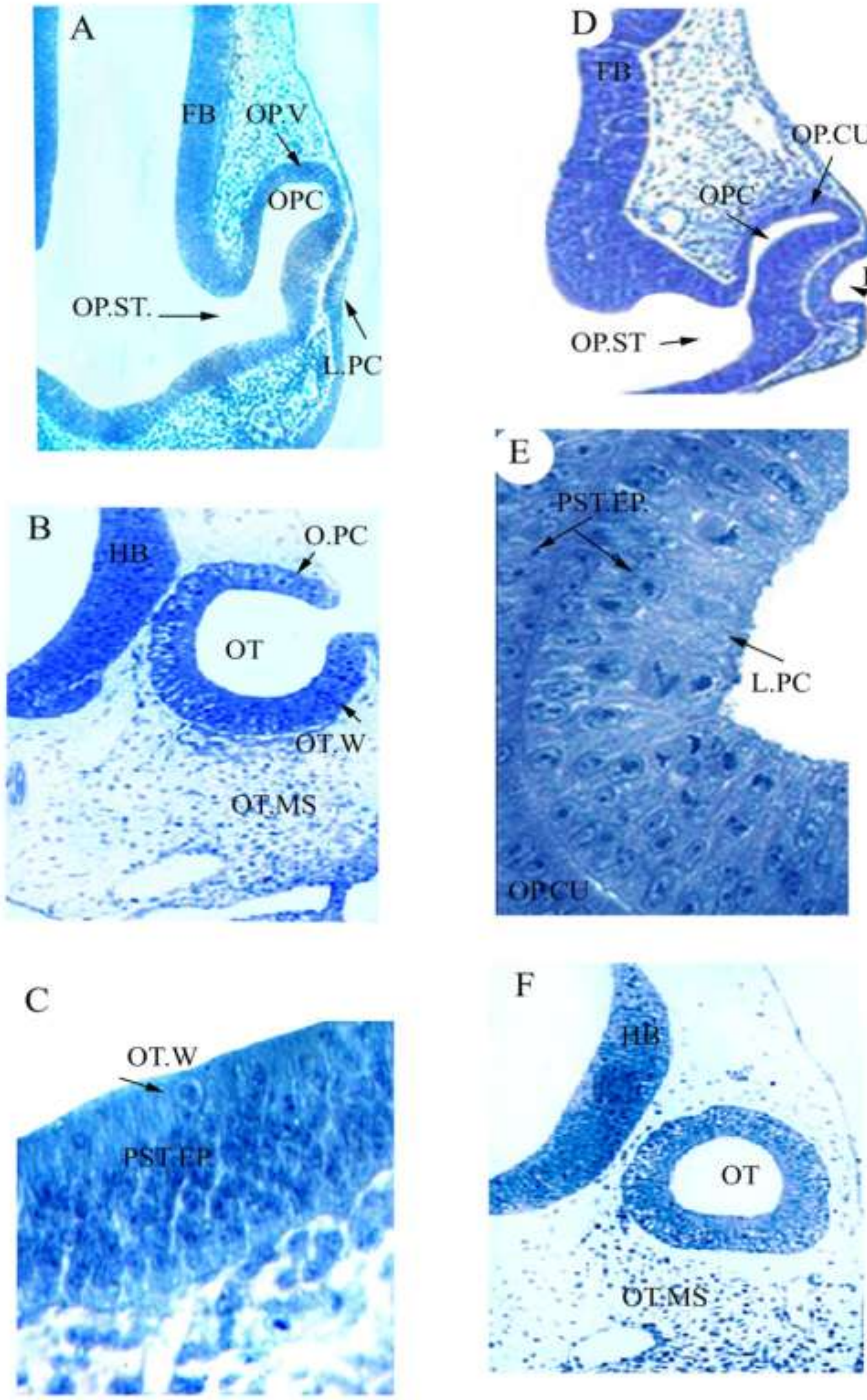

Fig (1): Stage 1, Photomicrographs of transverse sections in the anterior optic (A, 100X) to the posterior otic (B, 100X; C, 400 X) regions of the neurocranium. **Stage 2,** Photomicrographs of a transverse sections arranged in the anterior optic (D, 100X; E, 400 X) to the posterior otic (F, 100X) regions of the neurocranium.

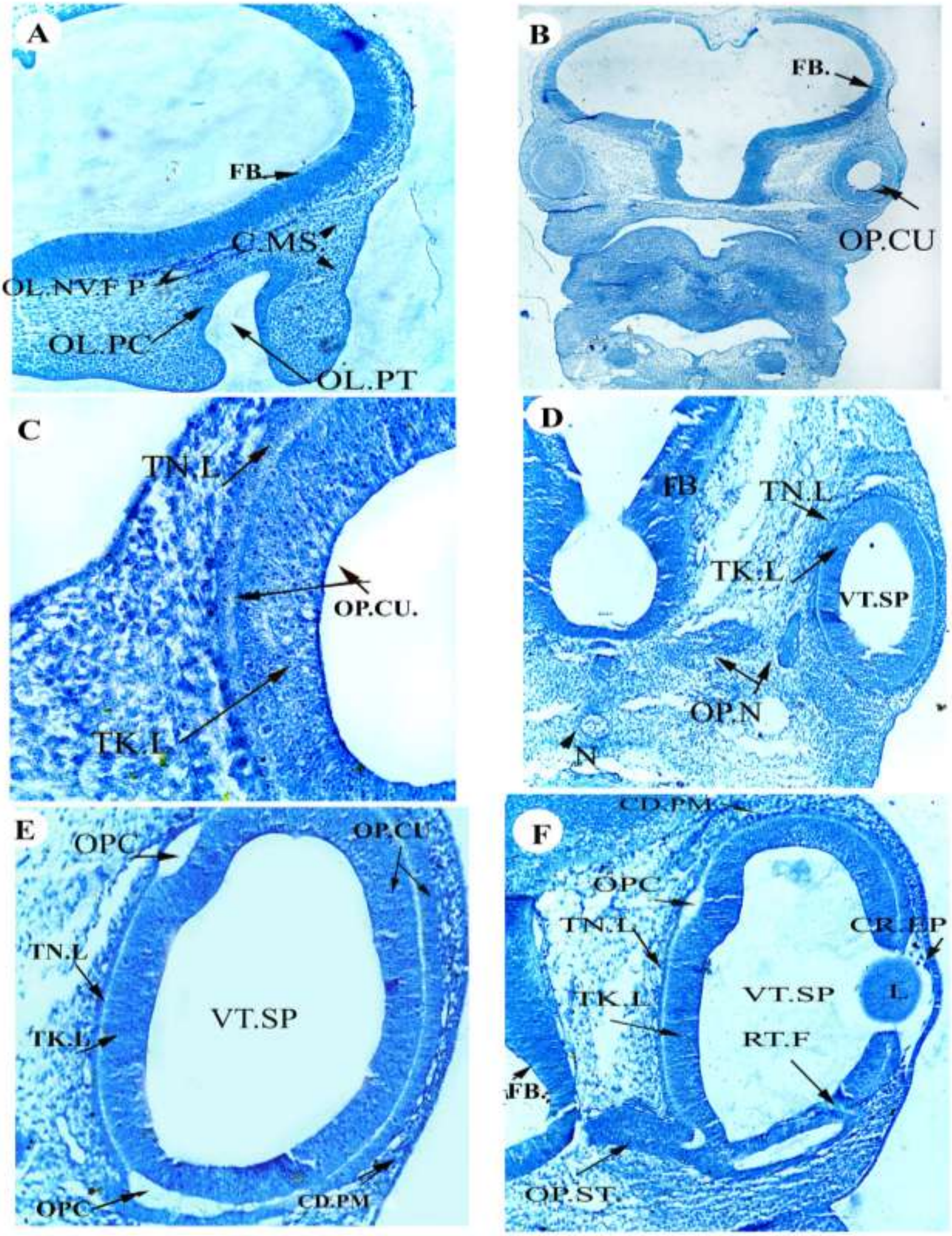

Fig (2): Stage 3, Photomicrographs of transverse sections in the anterior olfactory (A, 100X) to the middle optic (B, 40X; C, 200; D, 100X; E, 200X; F, 200X) regions of the neurocranium.

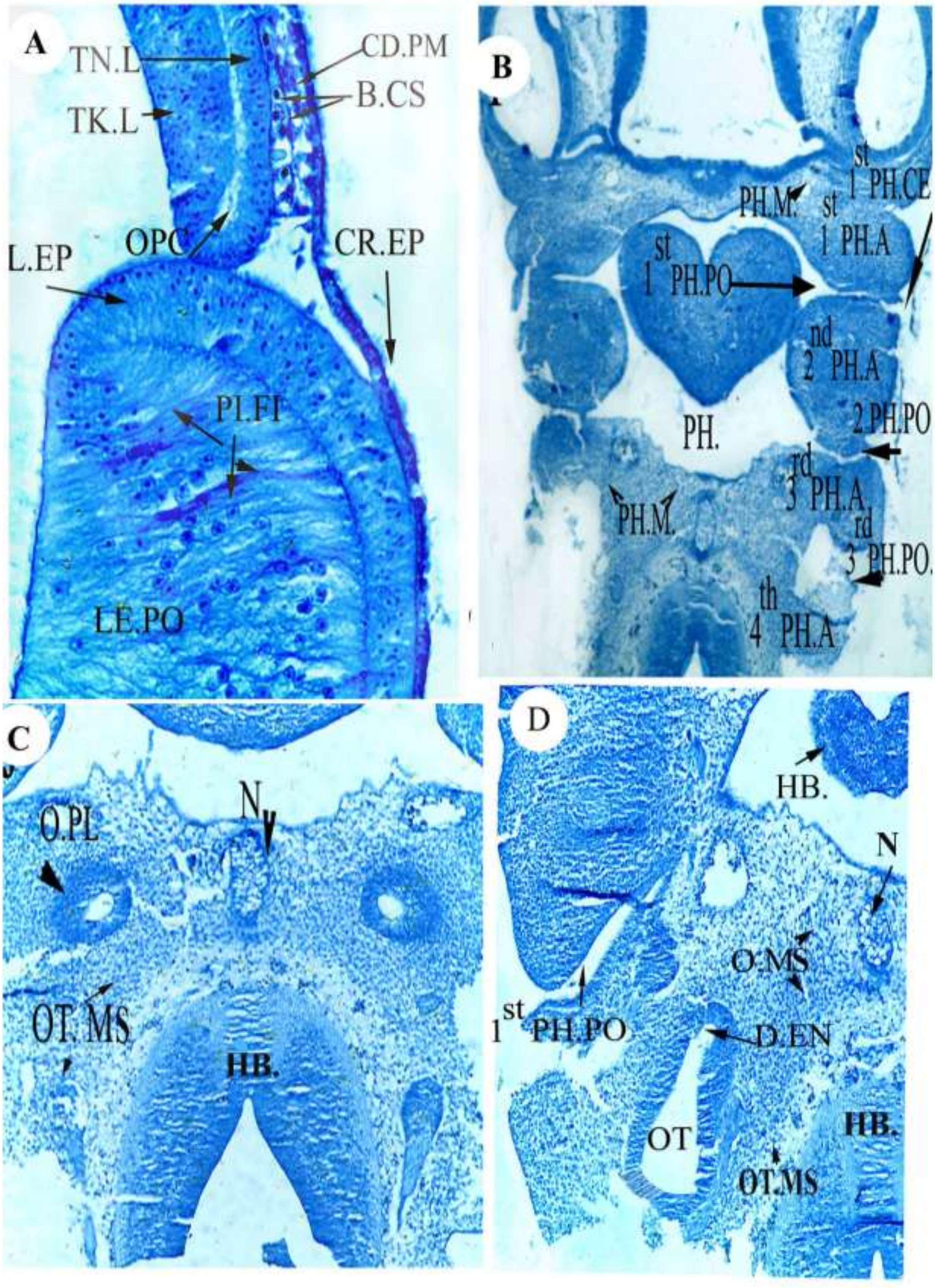

Fig (3): Stage 3, Photomicrographs of transverse sections in the middle optic (A, 400 X) to the posterior otic (B, 40X; C, 100X; D, 100 X) regions of the neurocranium.

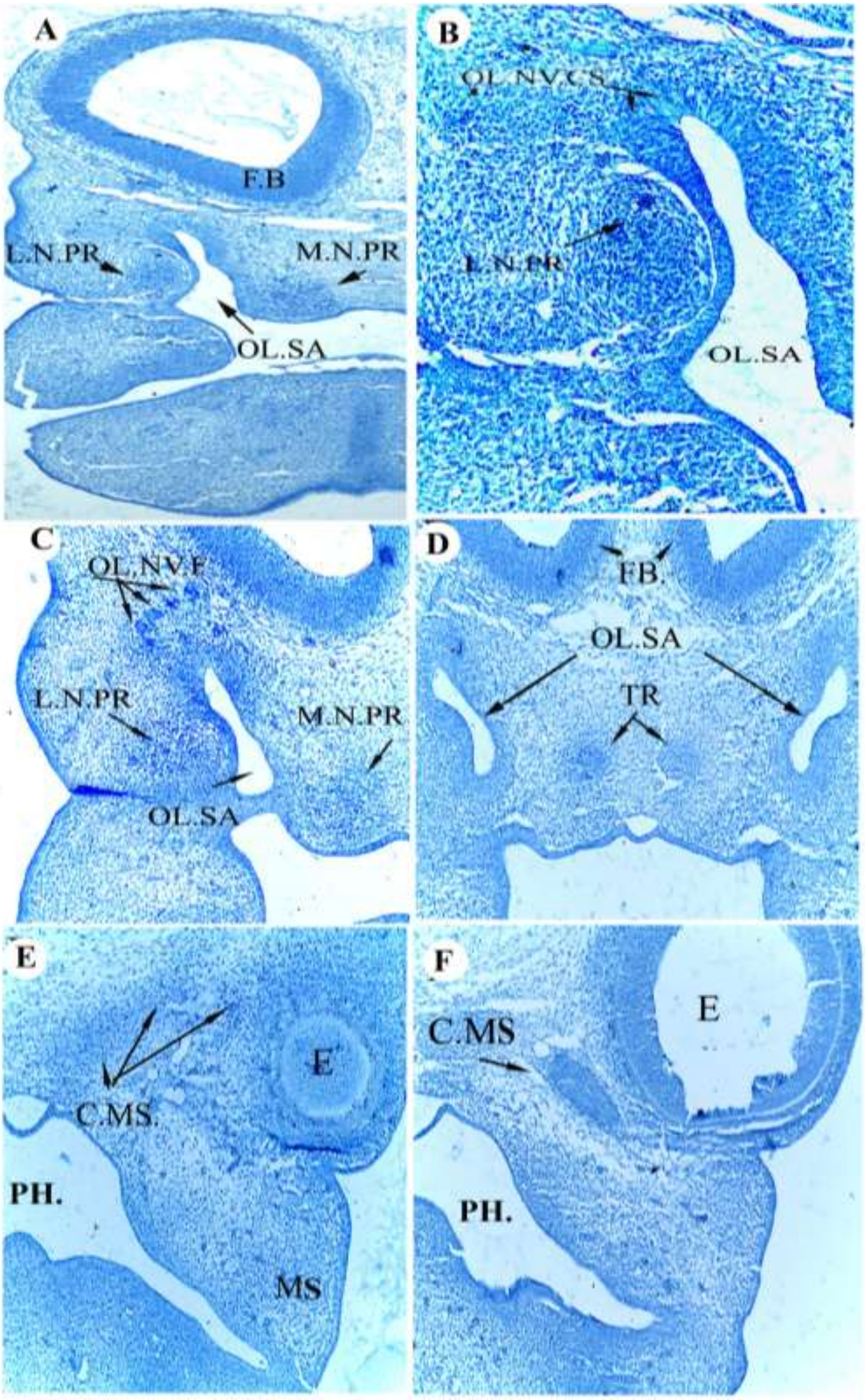

Fig (4): Stage 4, Photomicrographs of transverse sections in the anterior olfactory (A, 100X; B, 200X; C, 100; D, 100X) to the middle optic (E, 100X; F, 100) regions of the neurocranium.

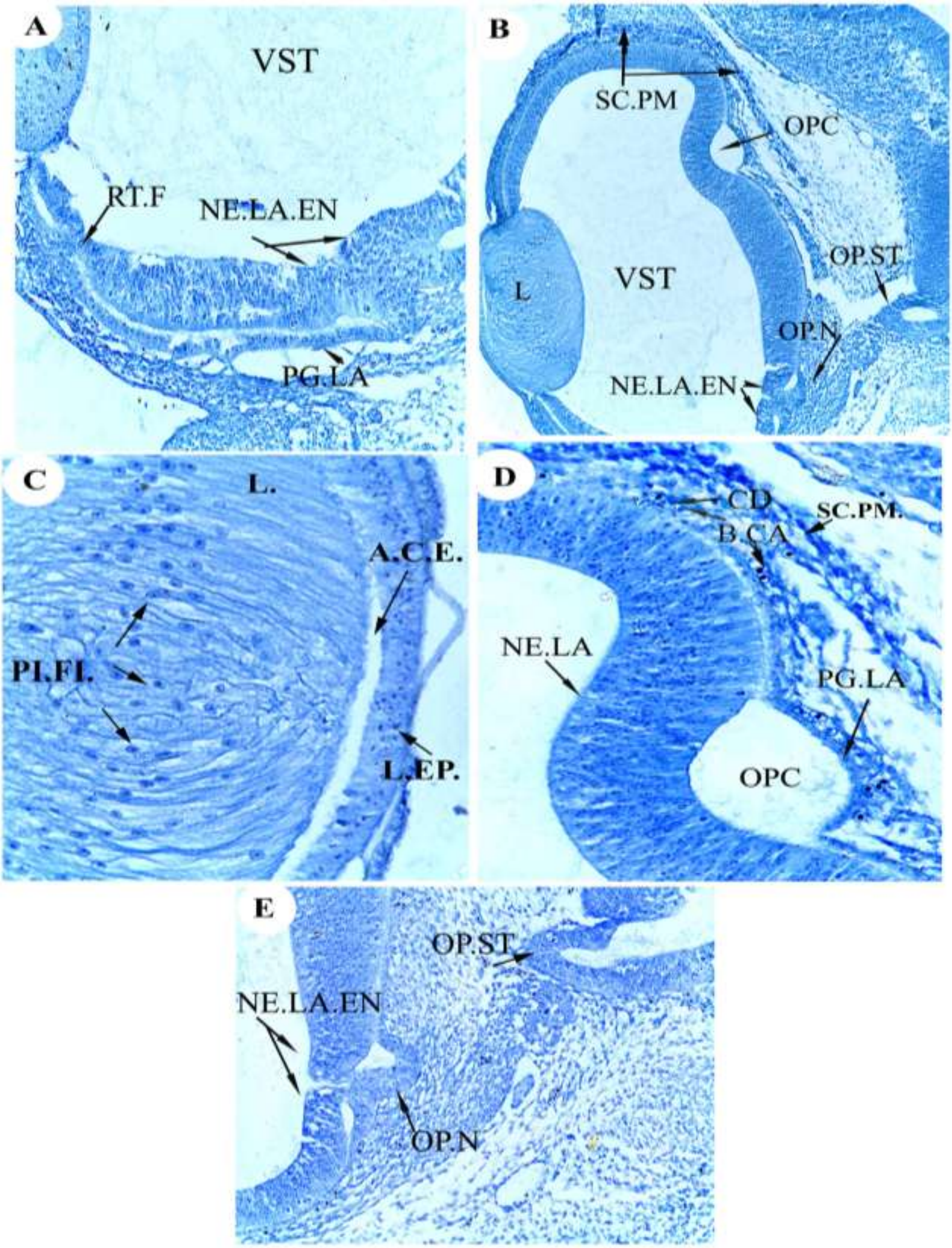

Fig (5): Stage 4, Photomicrographs of transverse sections in the middle optic (A100X; B, 100X; C, 200X; D, 200X; E, 200) regions of the neurocranium.

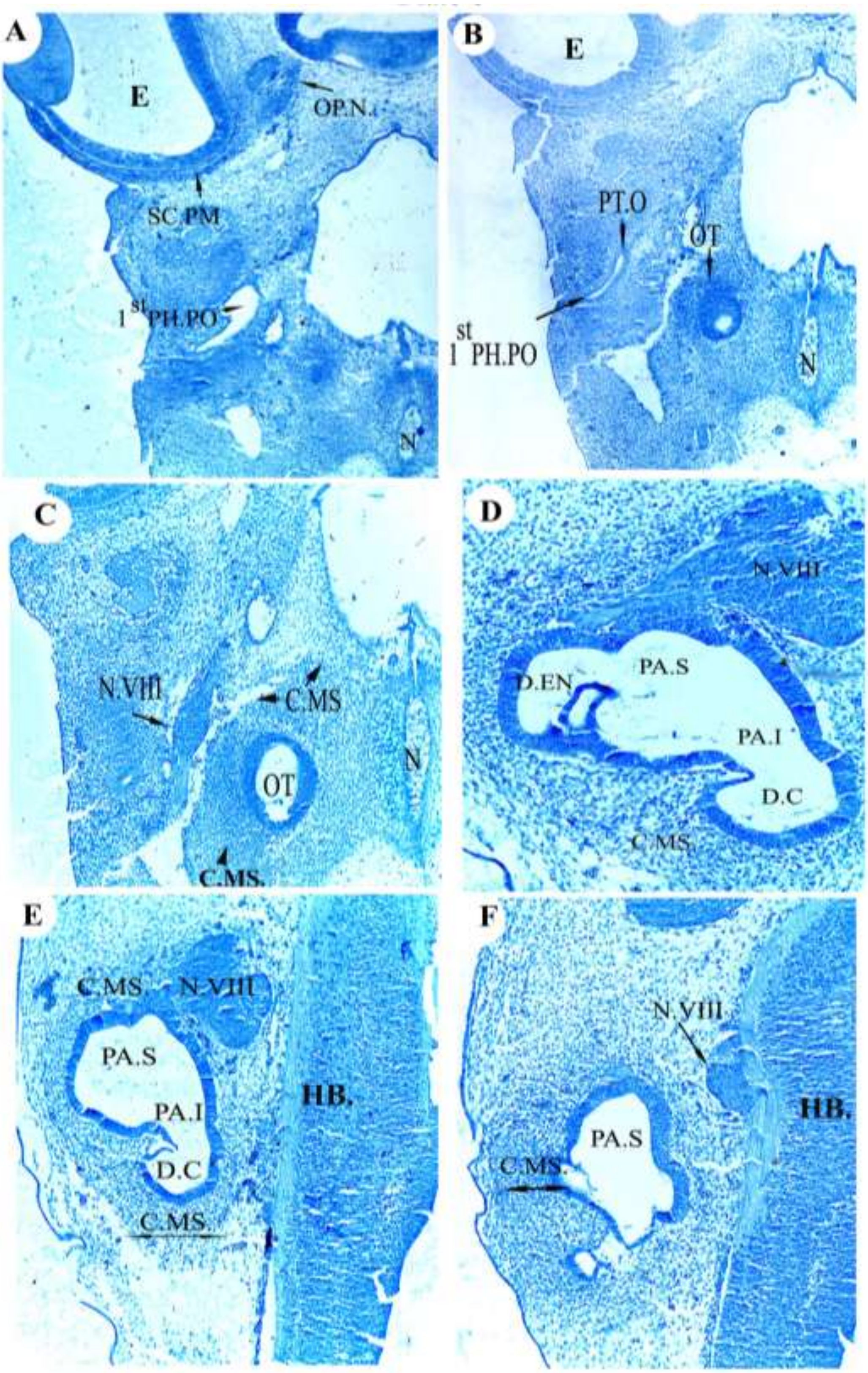

Fig (6): Stage 4, Photomicrographs of transverse sections in the posterior optic (A, 100X) and the otic regions of the neurocranium (B, 100X; C, 100X; D, 200; E, 100X; F, 100X).

5. CONCLUSION

The three sense organs of the bird *Passer domesticus* described in the present study exhibit the same general structural organization found in birds and other vertebrates. The olfactory organ started its development at15 mm stage as an olfactory placode that soon invaginates forming the olfactory pit. Then a deep sac followed by a nasal groove is formed at 19 mm stage. The groove is formed due to the fusion of the lateral nasal process with the maxillary process and the fusion of the medial nasal process with the frontal process. The eye of the bird *passer domesticus* begins development as a two lateral optic vesicle at the 8 mm stage. At the same stage, the lens placode also appeared. The lens placode invaginates forming the lens vesicle.

At 10 mm stage the lens capsule surrounds the lens vesicle medially. The double layered optic cup is formed at 15 mm stage with its retinal fissure. At 19 mm stage, the pigment granules are formed in the retinal pigmented layer. The lateral wall of the lens forms a thin layer of lens epithelium while its lenticular portion becomes fibrous. The corneal primordium appears outer to the lens. During the ear development (8 mm stage), neuroepithelium of the ventral rhompencephalon evaginates laterally to form an ectodermal thickening, the otic placode. The latter invaginates forming the otocyst .The endolymphatic duct is the first appeared structure in 15 mm stage, followed by the cochlear duct in 19 mm stage.

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