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## Histomorphological study of olfactory organ in rock dove, *Columba livia* Gmelin, 1789

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**Abstract.** The present study aimed to investigate the morphological description and histological structure of olfactory organ in rock dove (*Columba livia*). Results of the present study revealed that the nasal cavity of the species under investigation is anteriorly located, starting with a pair of external nares which located at the dorsal side of the base of upper beak. The external nares lead to two short nasal cavities. Each nasal cavity consist of three conchae or turbinates represented by anterior or vestibular concha, middle or respiratory concha and posterior or olfactory concha. The nasal cavity ended by a pair of internal nares which opened at mouth cavity. Results related with the histological structure of olfactory organ revealed that the vestibular concha lined by stratified squamous epithelium, the respiratory concha lined by ciliated pseudostratified columnar epithelium, and olfactory concha lined by ciliated pseudostratified columnar epithelium. The last concha showed three types of differentiated cell represented by basal cells, supporting cells, and receptor cells.

**Keywords.** Olfactory organ, Rock Dove, Morphology, Histology.

### 1. Introduction

The olfactory organs of vertebrates play an important role for feeding, reproduction, behavior and migration [1, 2, 3]. All vertebrates have olfactory regions which are represented by an internal invagination of the ectoderm to form the olfactory sacs in fish and the lining of nasal passages in tetrapoda [1, 2]. The avian olfactory organs are differ in different species of birds according to the differences of their position at the beak, feeding and behavior [4]. Generally the olfactory organs are located at the base of the beak or in some species of birds at the anterior end of beak [5], they are opened to outside via the external nares which leads to the nasal cavity, while they are opened in the mouth or oral cavity via the internal nares [1, 2, 5]. The ability of olfaction in birds is differ according to the structure of olfactory organs and the environment in which birds live [4, 7]. Review of the literature revealed that there are almost lack information related with olfactory organs of Iraqi birds with the exception of [7] on the morphology and histology of olfactory organ in local chicken, and the study of [8] who studied the cellular differentiation in the olfactory epithelium in chick embryo. This situation support our suggestion to investigate the olfactory organ in rock dove (*Columba livia*). This



study is a part of an extensive study conducted to investigate the olfactory organs in several Iraqi vertebrates in addition to the current study [7, 9, 10].

## 2. Materials and Methods

A total of 16 birds were collected from Al-Madhatia region /Babylon province. The olfactory organs removed after dissection the head of animals [11]. Paraffin wax methods were used for histological study according to the methods of [12].

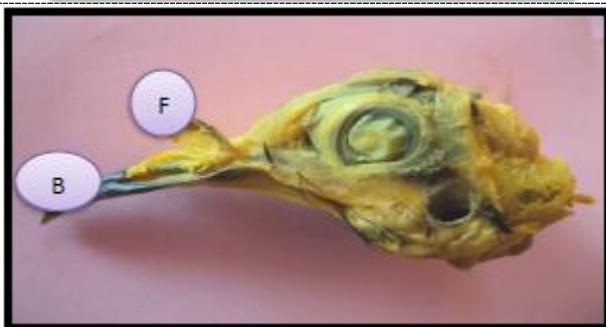
## 3. Results and Discussion

### 3.1. Morphological description

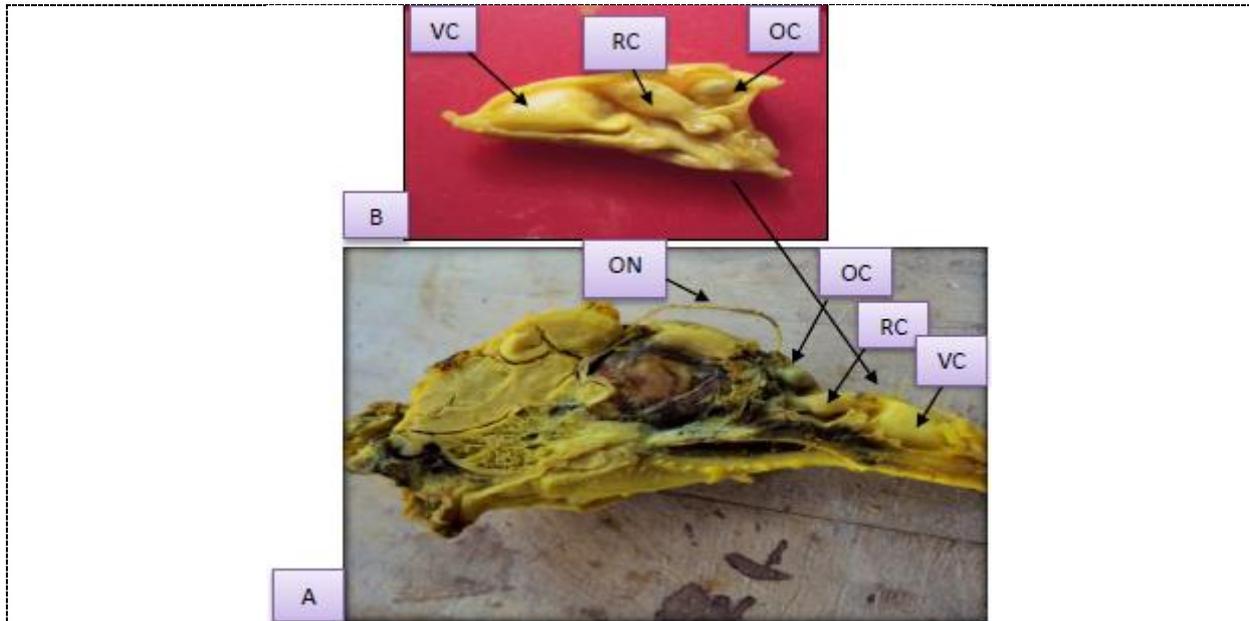
Results of the present study revealed that the olfactory organ in bird under investigation started with two external nares which located at the dorsal surface of the upper beak base. The opening of external nares appear as a longitudinal slits with about (6 mm) length, they are covered by a keratinized flaps and the distance between them was (2.5-3.0 mm) (Figure 1 and 2). Each external naris lead to the nasal cavity. The nasal cavity was cone-like, with confined anterior part and wide posterior part, separated into left and right halves by incomplete cartilaginous septum. Each nasal cavity in the bird under investigation consist of three conchae or turbinates, which were respectively situated in the anterior, middle, and posterior parts of nasal cavity, their internal surface being covered with mucosa. The anterior concha represented the vestibular region of the nasal cavity, the middle concha represented the respiratory region of nasal cavity, and the posterior concha represented the olfactory region of the nasal cavity (Figure 3). The nasal cavity ended by a pair of internal nares, which are (5-6mm) in length and located in a V-shaped slit situated at the roof of the mouth cavity (Figure 4). The olfactory region attached to the olfactory bulb via the first cranial nerve (I-Olfactory nerve) (Figure 5). The olfactory bulb is triangular- shaped and situated at the anterior end of brain at eye level, which mean that the olfactory bulb of the studied bird is pedunculated bulb.



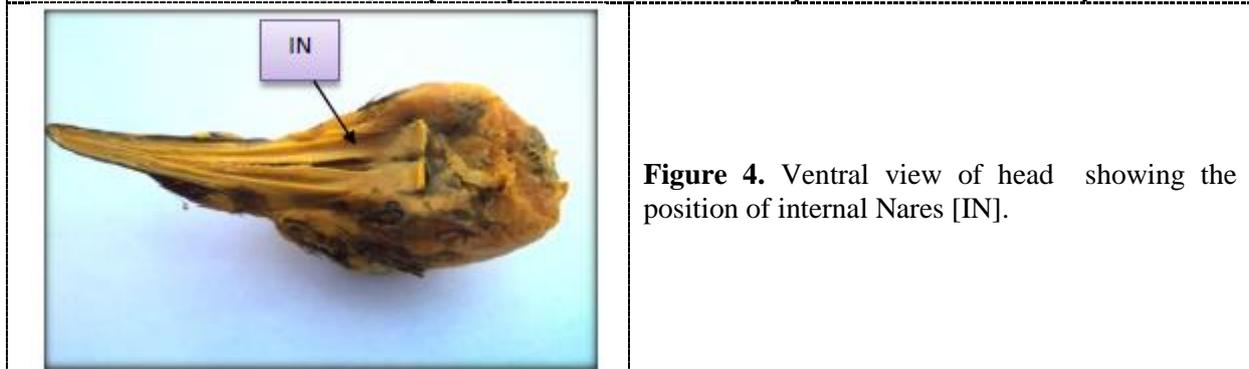
**Figure 1.** Dorsal view of the head showing the position of external nares (→).



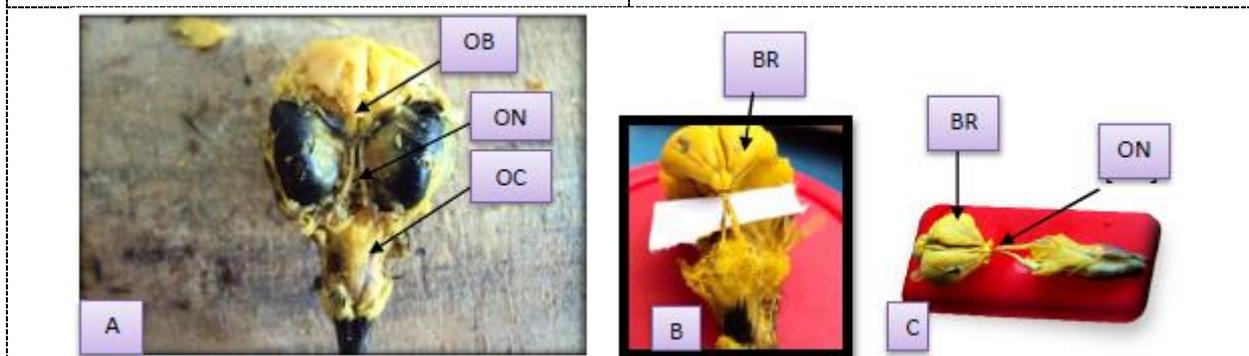
**Figure 2.** Lateral view of head showing the external naris and flap, (B) beak, (F) flap.



**Figure 3.** (A) Mid-section in bird head showing the conchae and olfactory nerve.(B) nasal cavity, [VC] Vestibular concha, [RC] Respiratory concha, [OC] Olfactory concha, [ON] Olfactory nerve.



**Figure 4.** Ventral view of head showing the position of internal Nares [IN].

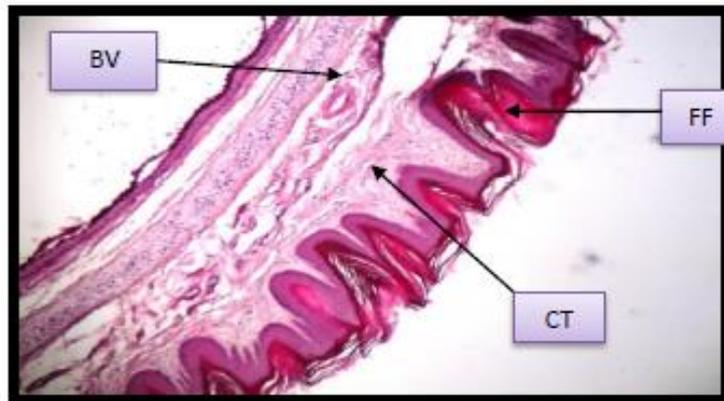


**Figure 5.** (A) Dorsal view of head showing, the olfactory bulb[OB], olfactory nerve [ON], Olfactory concha [OC],(B) Olfactory nerve, [BR] brain, (C) The connection of olfactory nerve with the olfactory concha [BR] brain, [ON] olfactory nerve.

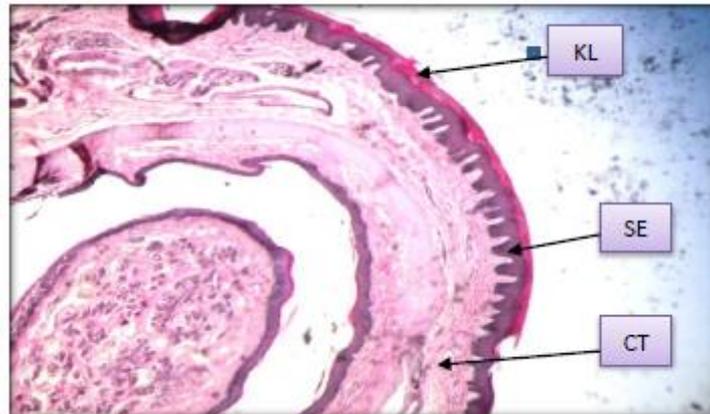
### 3.2. Histological Structure

Results of the present study revealed that the histological structure of the integument (the flap) that surrounded the external nares is keratinized stratified squamous epithelium (Figure 6). The vestibular

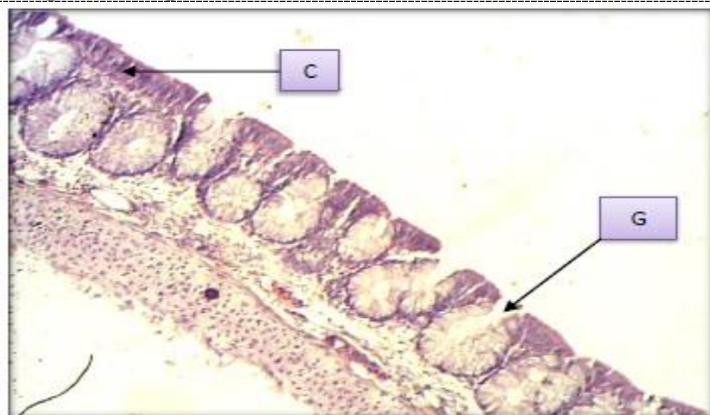
concha is lined by stratified squamous epithelium, which called vestibular epithelium (Figure 7), the respiratory concha lined by ciliated pseudostratified columnar epithelium rich with goblet cells that secret mucin to protect the epithelial surface (Figure 8), and the olfactory concha lined by ciliated pseudostratified columnar epithelium which consist of three types of cells represented by basal cells, supporting or sustentacular cells, and receptor cells (Figure 9 and 10). Results revealed that Bowman's glands are located beneath basement membrane in the lamina propria and the ducts of the glands pass through the basement membrane and the olfactory epithelium, their mucous secretion reach to the epithelial surface to protect it from drying (Figure 11).



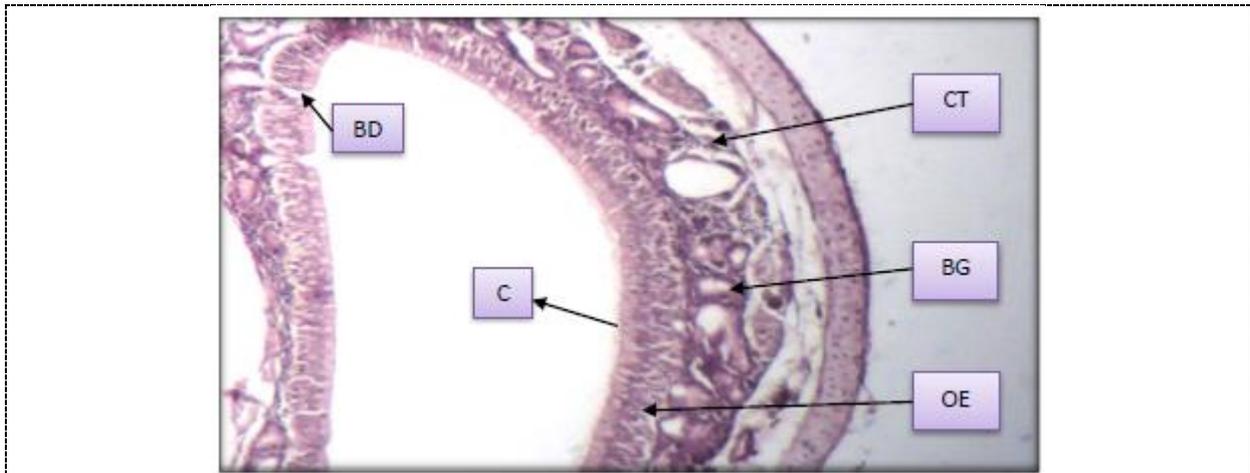
**Figure 6.** Cross section through the fleshy flap of external naris, [BV] blood vessel, [CT] connective tissue, [FF] feather follicle, (H&E stain), (10x).



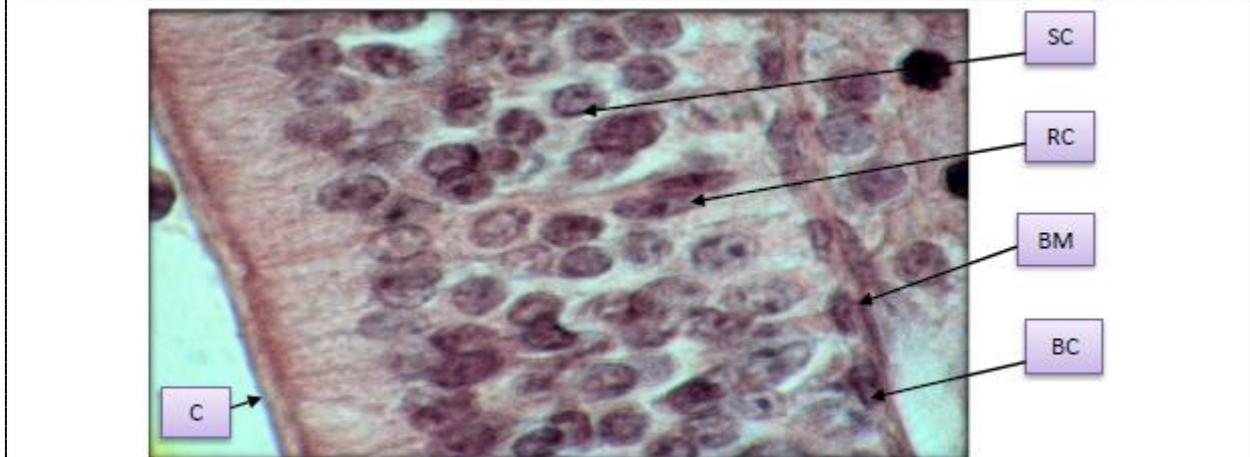
**Figure 7.** Cross section through the vestibular concha of rock dove, [CT] connective tissue, [KL] keratinized layer, [SE] squamous epithelium, (H&E), (10x).



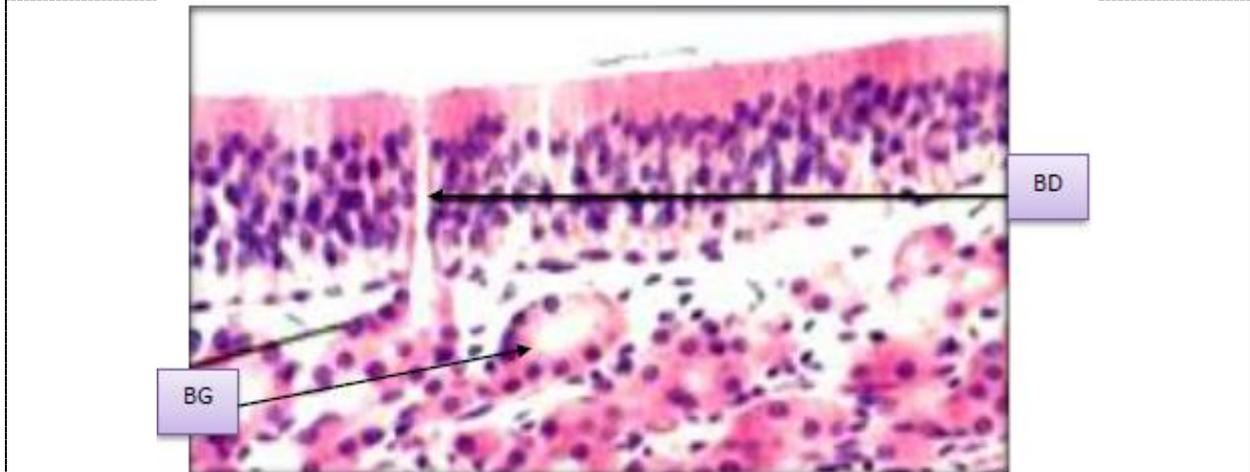
**Figure 8.** Cross section through the respiratory epithelium, [C] cilia, [G] gland, (H&E), (10x).



**Figure (9).** Cross section through olfactory epithelium of rock dove [BD] duct of Bowman's gland, [BG] Bowman's gland, [C] cilia, [CT] connective tissue, [OE] olfactory epithelium, (H&E), (10x).



**Figure 10.** Cross section through olfactory epithelium showing the different type of cells, [BC] basal cell, [BM] basement membrane, [C] cilia, [RC] receptor cell, [SC] supporting cell (H&E) (40x).



**Figure 11.** Cross section through the olfactory epithelium showing the Bowman's gland, [BD] Bowman's gland duct, [BG] Bowman's gland, (H&E), (20x).

#### 4. Discussion

The external nares of vertebrates located at different sites of head region but mostly at the dorsal surface of anterior region of head [1, 2, 7]. In birds external nares located at different sites of head according to the type of food and feeding behaviour [13,14]. In penguin external nares located at the middle of beak [14], in kiwi the external nares located at the tip of the beak [16]. The external nares opening appear oval, elliptical, tubular and even spiral in different species of birds [13, 19]. In the species under investigation the external nares are slits-like located at the base of upper beak, which revealed poor olfaction due to this position [8]. The external nares in some species are protected by a keratinized flap [7, 17, 18]. Results of the present study revealed that the external nares in rock dove are covered by keratinized membranous layer. This results agree with [18, 20] foundation. The nasal septum showed clear variation in different species of birds, as it is appeared a complete septum and called naris impervia in ostrich [13], or the nasal cavities are fused and have a long narrow opening in the nasal septum, which is called naris pervia [20], in species under investigation the nasal cavities similar to Demirkan foundation[20]. The nasal cavity in rock dove located anteriorly started with the external nares which extend longitudinally at the upper part of the beak base, which is suitable with the shape of bird and the feeding habit [21]. Birds have in their nasal cavities three conchae or turbinates vary in their shapes in different species. They are represented by vestibular, respiratory, and olfactory conchae respectively [17, 21]. In sulida birds the vestibular concha is lost, while in palacoracida birds the middle concha is lost, and in collacoilia and jungle crow olfactory concha is lost [22, 23, 24]. Results of the present study revealed that in species of bird under investigation, there are three conchae which confirm the results reported by [17, 19]. The intensity of olfaction can determined through the correlation of the diameter of the olfactory bulb and the brain diameter of each species [25]. Generally the birds with large olfactory bulbs have high intensity of olfaction and vice versa [25, 26]. Results of the present study revealed that the olfactory bulb of the species under investigation is small and connected with the olfactory epithelium via relatively long olfactory nerve. These results agree with Allison [27]. Results of the present study showed that the tissue surrounded the external nares represented by keratinized stratified squamous epithelium, which agree with foundation of [28]. The wavy surface of the squamous epithelium in rock dove is agree with [2, 28, 29]. The degree of keratinization is high in the species under investigation perhaps due to the location of the external nares. The histological structure of respiratory epithelium is formed from ciliated pseudostratified columnar epithelium rich with goblet cells to prevent drying and give a chance to perform the function [29, 30]. Results of the present study agree with the above foundation due to the function need. The olfactory epithelium in vertebrates including birds is ciliated pseudostratified columnar epithelium with three types of cells represented by basal cells, supporting cells, and sensory receptor cells [28, 29]. This result agree and confirm the present study results and the agreement probably related with the function need.

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