Quails constitute the third largest avian species in number in our country, only next to chickens and ducks, used for commercial production (Shanaway, 1994). This species is a good “dual-purpose” bird and is now reared for meat and egg production. Though the morphology and the function of the avian oviduct have been much described for domestic hen in the literature, but very few reports are available on surface morphology of the oviduct of Punjab White Quail. This prompted this present study on the transmission electron microscopic details of different parts of oviduct in Punjab white quail.

The present study was conducted on different segments of oviducts of 6 Punjab White quail at 36 weeks of age. These tissues were the properly processed, sectioned, stained and photographed using standard protocol (Pathak et al., 2014).

**Infundibulum**

Transmission electron microscopic study revealed that the infundibulum was lined with two types of cells, ciliated and non-ciliated. The ciliated cells showed bunch of cilia emerging from the apical surface into lumen. The nuclei of these cells was apically placed and ovoid in shape while non-ciliated cells had elongated and basally placed nuclei. The non-ciliated cells were either secretory or non-secretory in nature. The ciliated cells had darkly stained basal bodies from where the cilia sprung out of the cells. The root of the cilia was seen attached to the basal bodies. The apical surfaces of the ciliated cells were crowded with cilia. The apical part of the cytoplasm had numerous mitochondria and rough endoplasmic reticulum (rER). The non-ciliated cells of magnum were mostly secretory in nature and apical part of cytoplasm was filled with secretory vesicles. The lining epithelium of vagina was composed of stratified squamous epithelium.
were observed by Ozen et al. (2009) in pekin duck. They reported that the lamina epithelialis was composed of mono layered prismatic ciliated and secretory cells. They also reported the arrangement of the microtubules in the nine plus two formation in the transverse sections of the apically located cilia of ciliated cells. They observed short microvilli present in the apical region of the secretory cells.

**Magnum**

The lining epithelium of magnum was also consisted of two types of cells namely ciliated and non-ciliated cells. There was distinct lamina on which these cells lied. At places basal cells were also seen. Propria - submucosa consisted of tubular glands lined with granule filled pyramidal cells. The ciliated cells of the lamina mucosae were columnar in nature. The nuclei of these were oval to elongated with euchromatin material and disperse heterochromatin material. Supra nuclear compartment of cytoplasm had number of mitochondria. The apical part of cell showed number of kinocilia that emerged from basal bodies which were connected with electron dense filamentous structure referred as root (Fig. 1C, D).

The non-ciliated cells were mostly secretory in nature and apical part of cytoplasm was filled with secretory vesicles. The apical cytoplasmic membrane was reflected in the form of microvilli towards the lumen. The cells of tubular glands had round nucleus and few heterochromatin clumps. The cytoplasm of these cells towards the tubular lumen was filled with electron dense granules with diameter. The cytoplasm consisted of laminae of Golgi complex, secretory vesicles, smooth endoplasmic reticulum and a few mitochondria (Fig. 1C). Fertuck and Newstead (1970) observed that the Golgi apparatus was directly involved in the formation of secretory granules in the magnum and isthmus in Pekin duck. The cytoplasm of granulated cells was filled with extensive network of rER and secretory vesicles. The cytoplasm had dispersed ribosome (Fig. 1E). Similar observations have also been reported by Draper et al. (1972) in Gallus domesticus. They observed three types of surface epithelial cells. About half were ciliated cells, and contained scattered electron dense granules, lysosome-like bodies and secretory cells filled with aggregations of electron dense granules.

**Isthmus**

The isthmus was lined with ciliated and non-ciliated cells. The ciliated cells were more in number in contrast to infundibulum and magnum. The non-ciliated cells had cytoplasm filled with electron dense granules (Fig. 1E). Similar to the findings of the present study, Bansal et al. (2011) reported that surface epithelium was lined by ciliated and non-ciliated granular cells in the isthmus of domesticated hen. The granular cells contained supra nuclear electron-dense granules of different density and showed blebbing in supra nuclear portion. The lamina propria submucosae showed tubular glands which were lined with pyramidal cells. These cells contained electron dense and electron opaque granules (Fig. 1E). Ozen et al. (2009) reported that the glands were demonstrated to contain electron dense secretory granules in the magnum and isthmus in Pekin duck. The cytoplasm of granulated cells was filled with extensive network of rER and secretory vesicles. The cytoplasm had dispersed ribosome (Fig. 1E). Similar observations have also been reported by Draper et al. (1972) in Gallus domesticus. They observed three types of surface epithelial cells. About half were ciliated cells, and contained scattered electron dense granules, lysosome-like bodies and secretory cells filled with aggregations of electron dense granules.

**Uterus**

Transmission electron microscopic study revealed that the uterus was lined by two different types of cells namely ciliated and non-ciliated cells (Fig. 1F) as also reported by Bansal et al. (2011). The ciliated cells possessed numerous cilia randomly interspersed with long slender microvilli. The cilia emerged from darkly stained basal bodies which were attached to the root of cilia. The apical part of cytoplasm of cells was filled with the numerous
Ultrastructure of oviduct of Punjab White Quail

Fig. 1: Transmission electron micrograph of oviduct PWQ32 week of age showing. (A) Infundibulum with ciliated and non-ciliated cell, non-ciliated cells with microvilli (MV), nucleus (N), Golgi complex (G), mitochondria (M), rough endoplasmic reticulum (rER), tight junction (TJ) at apical surface and secretory vesicle (SV) ×2550; (B) Infundibulum with ciliated and non-ciliated cell. ×2550; (C) Magnum with ciliated and non-ciliated cell, non-ciliated cells with microvilli, nucleus, secretory vesicle, secretory granule (SG), basal nucleus (BN), nucleus of mucosal gland (mN) and lumen (L). ×830; (D) secretory granule, rough endoplasmic reticulum. ×1100; (E) Isthmus with abundant number of secretory granule and rough endoplasmic reticulum. ×1550; (F) Uterus with ciliated and non-ciliated cell, non-ciliated cells with microvilli, nucleus, nucleolus (Nu), mitochondria, secretory granule and rough endoplasmic reticulum. ×830; (G) Uterus with ciliated and non-ciliated cell, non-ciliated cells with microvilli, nucleus, secretory granule and rough endoplasmic reticulum, inset showing 9+2 arrangement. ×2550; (H) Vagina with ciliated and non-ciliated cell, non-ciliated cells with cilia, microvilli, nucleus, mitochondria and secretory vesicle. ×830
large size granules. The granules were electron dense (Fig. 1F, G). In between the granules numerous mitochondria and rough endoplasmic reticulum were observed. Basal compartment of the cytoplasm was filled with rER and free ribosomes and very few mitochondria. Ozen et al. (2009) also found that the proprial glands of the uterus contained electron light granules.

Apical cytoplasm of non ciliated cells was filled with electron dense granules which were smaller in size as compare to ciliated cells. The apical surface showed microvillus projections (Fig. 1F, G). At higher magnification distinct basal bodies of cilia were observed. The cross section of cilia presents in the lumen of uterus revealed the typical nine plus two arrangement of microtubules (Fig. 2F). The non-ciliated cells were secretory in nature and contained variable density of granules. The apical surface had microvillus projections. The cytoplasm consisted of rER and few ribosomes.

At further magnification distinct cell junction in form of gap and tight junctions were observed. The elongated cristae were observed in mitochondria.

Vagina

The lining epithelium of vagina showed stratified squamous epithelium as also seen in domestic hen (Bansal et al., 2011). The apical surface of the epithelium revealed ciliated and non-ciliated cells. The nuclei of the ciliated cells were oval to elongated in shaped with few heterochromatin clump. Cilia showed basal bodies and root (Fig. 1H). Wyburn et al. (1970) reported in fowl that vaginal ciliated cells were narrow with an expanded apex carrying the cilia and microvilli and contained oval or round shaped nuclei, while the secretary granules and vacuoles were reported to be located either in the middle or apical regions of the non-ciliated cells. In present study, based on the electron density two types of cells were distinguished as electron lucent and electron opaque. The non-ciliated cells were mostly electron opaque, whereas ciliated cells had both electron lucent and opaque granules.

CONCLUSION

The present investigation using TEM revealed that the different segments of oviduct of Punjab white quail were lined by two types of cells viz: ciliated and non-ciliated cells. The non-ciliated cells were either secretory or non-secretory in nature. The non-ciliated cells of magnum were mostly secretory in nature.

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