RESEARCH ARTICLE
JIVA 18 (2) August 2020

Received: 14-05-2020
Accepted: 22-06-2020

SCANNING ELECTRON MICROSCOPY AND CORROSION CAST OF LUNGS IN KUTTANAD DUCK
(Anas platyrhynchos domesticus)

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ABSTRACT

The study of lungs using scanning electron microscopy and corrosion cast was carried out on six female adult Kuttanad ducks. The lungs of Kuttanad ducks presented three surfaces and four borders. Among the secondary bronchi, medio-ventral secondary bronchi was the largest followed by medio-dorsal and latero-ventral secondary bronchi. The secondary bronchi gave rise to large freely anastomosing mass of the tubules, the tertiary bronchi or parabronchi which in turn were pierced by numerous openings which led into the spherical or ovoid spaces, the atria, underlying the parabronchial wall. The increased number of secondary bronchi proportionately increases the number of the parabronchi arising from it, which in turn led to the integrated increase in number of air capillaries and efficiency of the lungs.

Key words: Corrosion cast, Scanning electron microscopy, Lungs, Kuttanad duck

INTRODUCTION

The avian respiratory system is different from that of other vertebrates, having relatively small lungs plus nine air sacs that play an important role in respiration and thermoregulation. Parabronchi and air capillaries, a special feature of birds unlike those of mammals, increases the surface area of the lungs enormously for gaseous exchange. Understanding the lung – parabronchi system is very essential for the diagnosis and treatment of diseases affecting the system. Moreover, the literature gives only sporadic information on scanning electron microscopy and corrosion cast study of lungs in Kuttanad Duck and hence this work was done to throw light on the ultrastructural morphology of lungs.

MATERIALS AND METHODS

The study was carried out using six female adult Kuttanad ducks selected randomly from a single hatch reared at the University Poultry and Duck Farm, Mannuthy under semi-intensive system of management. For corrosion study, silicon sealant diluted with equal volumes of chloroform was injected into the trachea under constant pressure. The specimens were macerated with three per cent potassium hydroxide (KOH) at 40^0C for 48 hours. Finally, the casts were rinsed in tap water, dried and observations were made. In order to prepare specimens for scanning electron microscopy the lungs were fixed in 2.5 per cent glutaraldehyde. The specimens were dehydrated in ascending concentrations of ethanol, critical point dried in liquid carbon dioxide, mounted on aluminum stubs and sputter-coated with gold-palladium complex before observing under scanning electron microscope.

RESULTS AND DISCUSSION

The lungs were trapezium-shaped, bright red in colour and spongy in nature (Fig. 1). The lungs extended cranio-caudally between first and sixth ribs, with six grooves on their surface (Fig. 2). Payne (1960) reported similar findings in domestic fowl. Lungs of Kuttanad ducks presented three surfaces and four borders. Hodges (1974) in domestic fowl observed that ventral surface of the lungs was slightly convex, covered by a thin, double membrane of pleura. The lungs of Kuttanad ducks held in thoracic cavity indented by the ribs can be considered as a rigid immobile system of tubes as supported by the several lines of evidences by Duncker (1974) in domestic fowl. The extra pulmonary primary bronchi (EPPB) after entering the lungs at the hilus continued inside the parenchyma as the IPPB giving off four medio-ventral, nine medio-dorsal, nine latero-ventral and 36-40 latero-dorsal secondary bronchi with no vestibule formation. Payne and King (1959) reported the absence vestibule in aves. In Kuttanad ducks, the medio-ventral secondary bronchi were the largest secondary bronchi (Fig. 3). Mediodorsal secondary bronchi were the second largest secondary bronchi. Lateroventral secondary bronchi were uniform in diameter. The laterodorsal secondary bronchi were the smallest among all secondary bronchi. All the secondary bronchi gave off numerous small tertiary bronchi which anastomosed with one another at ends to form long curved bronchial circuits. The parabronchi were running between medioventral and mediodorsal secondary bronchi and together formed paleopulmonic lung. Caudo-ventrally and caudo-dorsally, the lung contained networks of parabronchi arising from laterodorsal and lateroventral secondary bronchi anastomosing with each other and with the other two groups of secondary bronchi. This part was very small and constituted a very little portion of the lungs in Kuttanad ducks and formed

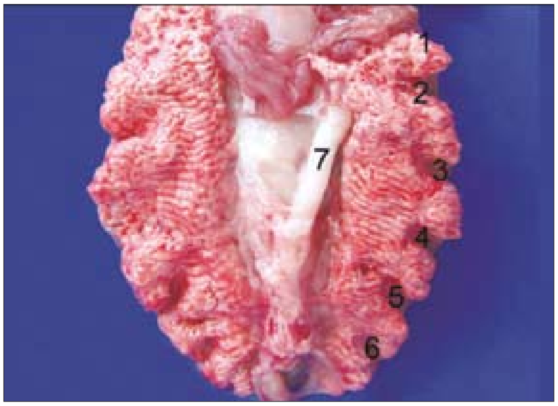

Fig. 1 Ventral surface of lung of Kuttanad Duck 1-6. Costal impressions 7. Blood vessel

Fig. 2 Corrosion cast of lung in Kuttanad Duck 1.Medio-dorsal secondary bronchi 2. Parabronchi

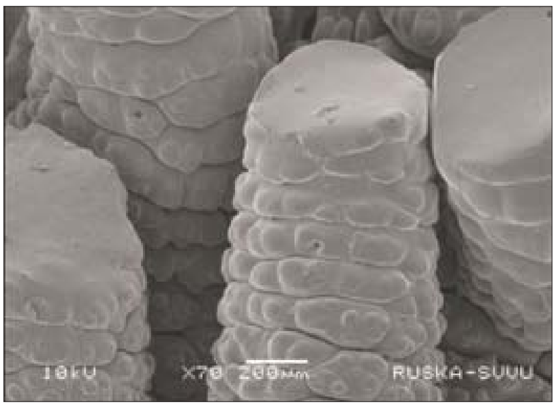

Fig. 3 Scanning electron microscopic picture of corrosion cast of Lung in Kuttanad duck to show medio-dorsal secondary bronchi x 70

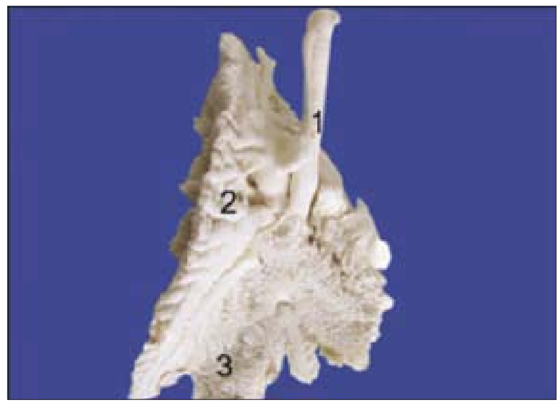

Fig. 4 Corrosion cast of Lung in Kuttanad duck to show Paleopulmonic and Neopulmonic lung.1.EPPB 2. Paleopulmonic lung 3. Neopulmonic lung

the neopulmonic lung (Fig. 4). IPPB were lined by tall ciliated columnar type of epithelium with simple alveolar mucous glands and abundant goblet cells (Fig. 5). Secondary bronchi presented infiltration of the lymphocytes and increased vascularity in the lamina propia forming the Bronchi Associated Lymphatic Tissue (BALT) in accordance to the findings of Reese *et al.* (2006). In the secondary bronchi, the simple mucous glands were seen in the initial parts, but were replaced by goblet cells in the distal parts (Fig. 6)

The secondary bronchi gave rise to large freely anastomosing mass of the tubules, the tertiary bronchi or parabronchi that filled all the spaces of the lungs between the main bronchi (Fig. 7). The wall of each parabronchi was pierced by numerous openings which led into the spherical or ovoid spaces, the atria, underlying the parabronchial wall (Fig. 8). A thin film of lipoprotein, the surfactant or surface active lining complex, lined the inner wall of the parabronchi and atria. Miller and Bondurant (1961) claimed that the lining

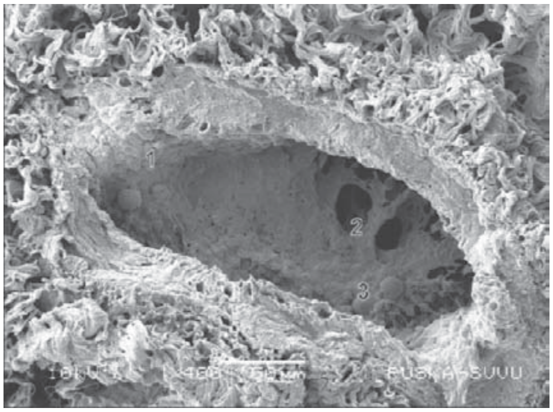

Fig. 5 Section of Lung in Kuttanad Duck showing IPPB SEM x 400
1. Linning epithelium 2. Secondary bronchi
3. Goblet cell

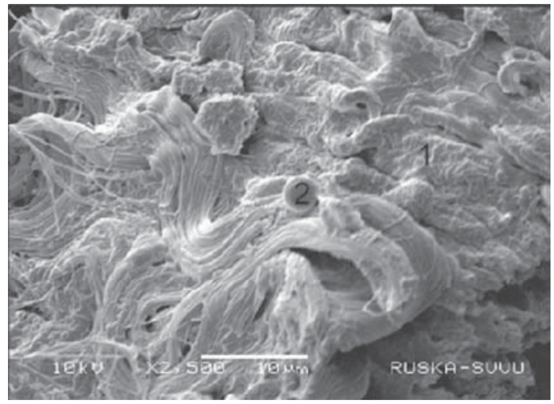

Fig. 6 Section of Lung in Kuttanad duck to show epithelium of secondary bronchi SEM x 2500
1. Linning epithelium 2. Goblet cell

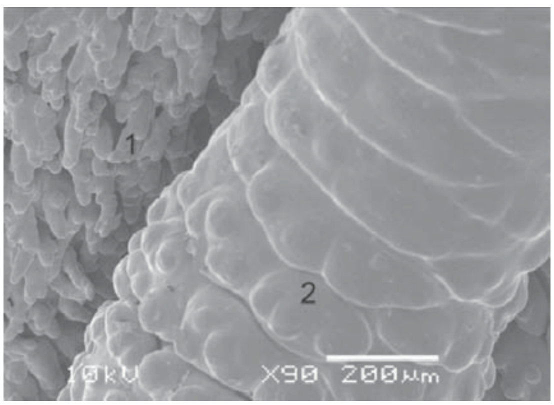

Fig. 7 Section of Lung in Kuttanad duck to show Parabronchi SEM x 99
1. Parabronchi 2. Secondary bronchi

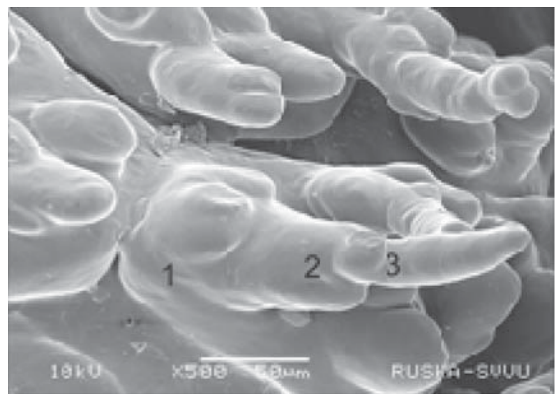

Fig. 8 Section of Lung in Kuttanad duck to show Atrium SEM x 500
1. Parabronchi 2. Atrim 3. Infundibulum

complex was present only in mammals and absent in birds. However, Pattle (1958) demonstrated that extracts from avian lungs do have a surface tension reducing effect. Certainly, this would be of paramount importance in the air capillaries where accumulation of fluid would depreciate the value of the exceptionally thin blood-gas barrier and may prevent distortion and collapse of the thin walled parabronchi. The floor of the atrium continued into two or three smaller and well-defined cavities, the infundibula. In pigeon, Policard *et al.* (1962) noted a further subdivision of the air capillaries giving rise to minute respiratory diverticula, but this further subdivision of air capillaries was not seen in the present study in Kuttanad ducks.

SUMMARY

In Kuttanad ducks, as compared to most of the birds including domestic fowl, the number of secondary bronchi was more which proportionately increased the number of the parabronchi arising from it, which in turn led to the integrated increase in number of air capillaries and efficiency of the lung. In spite of being considered as an immobile organ, the increase in number of parabronchi and air capillaries increases the surface area of the lungs enormously for gaseous exchange. Being the swimmers or deep-water divers, the increased number of secondary bronchi, parabronchi and air capillaries help the Kuttanad ducks to meet the profound demands of gaseous exchange needed for deriving energy.

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