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Anatomical and Morphometrical Comparative Analysis of the Crop of Brooding Versus Non-brooding Java sparrows '*Lonchura oryzivora*'

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Abstract:

Background: In certain bird species, such as the Java sparrow, the crop plays a role in parental care, particularly in the production of crop milk to feed the offspring. Despite its importance, limited studies have focused on it. Thus, the crops of 12 Java birds were used in this study and divided into brooding and non-brooding groups to highlight the differences between them and to document the morphometrical adaptations associated with brooding behavior.

Aims: This study aimed to precisely identify and characterize the distinct anatomical differences in the crop of Java sparrows (e.g., location, shape and dimensions of the brood patch as well as to assess the morphological changes that occur between brooding and non-brooding periods).

R**esults**: The crop is located at the center of esophagus as simple fusiform or spindle-shaped. Its outer surface was thick and encircled by skin and adipose tissue in the brooding birds, in contrast to only skin of the non-brooding. In brooding birds, the inner surface of the crop contains circular and longitudinal folds, whereas in non-brooding only longitudinal folds in both sexes were observed. Moreover, in brooding birds, the weight and dimensions of the crop were varied and appeared longer and wider than non- brooding species in both sexes.

Conclusions: The observed variations highlight the functional adaptation of the crop to meet the physiological needs of parental care, providing valuable insights into avian reproductive anatomy.

Keyword: Java birds, crop, anatomical, brooding birds, non-brooding birds.

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Introduction:

The Java sparrow (Lonchura oryzivora) is classified within the order Passeriformes and the family Estrildidae. This avian species is native to Bali, Java and the adjacent islands. This bird is distinguished from other avian species by its red beak, black head and white cheek (MacKinnon and Phillipps, 1993; Lambert, 2017; Islam, 2020). The length of the Java sparrow, from the beak to feather tip of the tail, is around 15 to 17 cm. It may be the biggest species within the Estrildidae family. It is slightly heavier (weighing 24.5 g) than the black-bellied seedeater (Dunning and John, 2008). It belongs to a monomorphic group, which means that males and females exhibit identical feather coloration and both genders exhibit similarities in this regard (Suratno et al., 2011). Historically, substantial flocks of this bird were prevalent in the rice field region. Nonetheless, locating them in their natural habitat has become incredibly challenging. These birds are generally resided in rice fields or grasslands. These migrating birds are frequently observed in flocks. Besides consuming fruit and insects, these birds also ingest seeds (granivorous), particularly rice grains. The primary reason for the significant population fall is the unlawful capturing for pet trade (Chng et al., 2016).

Saliva lubricated the feed of the bird as it passed down through its esophagus. Due to the muscles contractions which lead to peristalsis movement, the feed passed down through the esophagus in waves and ends up in the crop (Ingluvies). The feed is softened here before entering the stomach (Rebecca, 2004). After hatching, sparrows are unable to feed themselves and must only consume the milk that the parent pigeon' crop releases, which is then consumed by the squab (Ma et al., 2020; Mahdy, 2021). Several bird species use their crops to raise their hatchlings, including finches, pigeons, and parrots. The crop secretes crop milk in some species, including pigeons (Columbiformes) and flamingos (e.g., Phoenicopterus ruber). Also, it stores ingested grains that can be received directly by the hatchlings (Gillespie et al., 2012). Apocrine milk secretion occurs in animals, whereas crop milk is a holocrine secretion. The crop milk is rich in fat and protein. Sparrow's crop milk is composed of a suspension of cells that split and detach from the crop lining (Chng and Eaton, 2016).

Materials and Methods:

Twelve Java birds were used in this study. These were divided into two groups: brooding and non-brooding. Each group consisted of three males and three females birds. Following the euthanasia (Ibrahim, 2024; Farhan and Hussein, 2024), each bird was weighed at first and then the neck, chest and feathers were removed. In the ventral part (midline) of the neck of birds, an incision was performed. Crop and esophagus were imaged in-situe. The lumen of esophagus was incised lengthwise to check the measurements. Then, the crop was removed from the body and cleaned with tap water. Additionally, weight, color, and shape of the crop were recorded.

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Ethical approval: Ethical approval was obtained from the Research Ethics Committee at the University of Diyala, College of Veterinary Medicine (no.: Vet Medicine (112); September 2024, A and H).

Results:

The Java bird crop was found on the right side of both males and females of brooding and non-brooding birds unilaterally in the right midline and laterally to the trachea; and it was filled with crop milk and grains (Fig. 1). Its morphology resembled a simple fusiform (spindle-shaped) which represented a slight esophageal bulge in the middle (Fig. 2). In brooding birds, the outer surface of the crop was thick and surrounded by adipose tissue in both males and females (Fig. 3). Moreover, the outer surface of the crop of non-brooding birds was very thin, membrane-like, and bulgy; and covered by skin only in both males and females (Fig. 4).

The longitudinal and circular folds on the inner surface of the crop appeared in both males and females of brooding birds. However, the folds appear more developed in females than in males because of the production of crop milk (Fig. 5). In contrast, the non-brooding birds have only longitudinal folds on the inner surface of the crop in both males and females (Fig. 6). Additionally, the color of the crop was different in the birds. It was ranging from light pink in the brooding birds to pinkish red in the non-brooding birds (Figs. 5, 6).

The body weight range of these birds showed that the brooding birds of both sexes recorded higher weights compared to the non-brooders. Also, the weights of the crops appeared to be similar in males and females in the brooding and non-brooding (Table 1). As for the dimensions of the crop, the length and width of the crop in the brooding males were greater than those in the non-brooding males (Table 2). The same applies to the dimensions of the crop in females, which were longer and wider in the brooding than the non-brooding birds (table 3).

Blood Supply of the crop

The crop in the Java bird received arterial blood from two branches of the common carotid artery, which arose from the brachiocephalic trunk. These branches were shown to deliver blood to the crop through two primary branches (right and left) that further divided into smaller branches across the dorsal surface of the crop (Fig. 7a, b).

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) software was utilized to identify the impact of various groups on research parameters. The differences within the selected groups were assessed using the T test, and the differences between the parameters of the selected groups were evaluated using the two-way ANOVA test.

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Table (1): Morphometric data comparing body weight (gm) and crop weight (gm) of brooding and non-brooding birds.

Parameters	body weight	crop weight
Non-Brooding male	22.391 ±1.17	0.087 ±0.02
Non-Brooding female	20.233 ±0.93	0.122 ±0.01
Brooding male	24.18 ±1.46	1.25 ±0.29
Brooding female	20.342 ±1.06	1.53 ±0.29

Table (2) Morphometric data comparing Length (mm) and Width (mm) of brooding and non-brooding Males.

Parameters	Length(mm)	Width(mm)
Male non brooding	5.41 ±0.32 c	0.48 ±0.05 c
Male brooding	12.16 ±0.48 b	18.53 ±0.79 c

Table (3) Morphometric data comparing Length (mm) and Width (mm) of brooding and non-brooding Females.

Parameters	**Length (mm)**	**Width(mm)**
Female non broobing	7.21 ±0.36 b	5.28 ±0.26 b
Female brooding	18.10 ±1.37 c	18.21 ±0.74 c

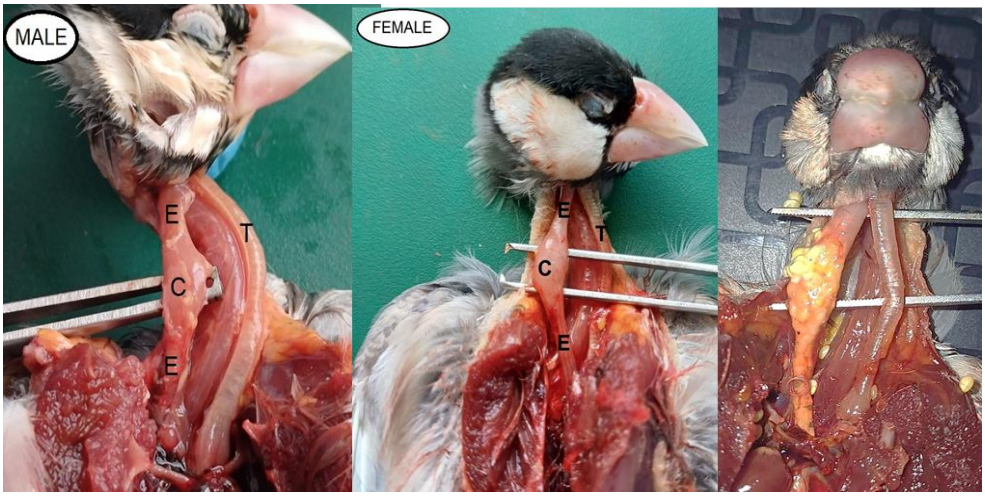

Fig. (1) Photograph of the crop in brooding Java bird (male and female) showed the crops are located unilaterally, right to the midline, at the center of the esophagus, laterally to the trachea, filled with the crop milk and grains. Crop (C), esophagus (E), trachea (T).

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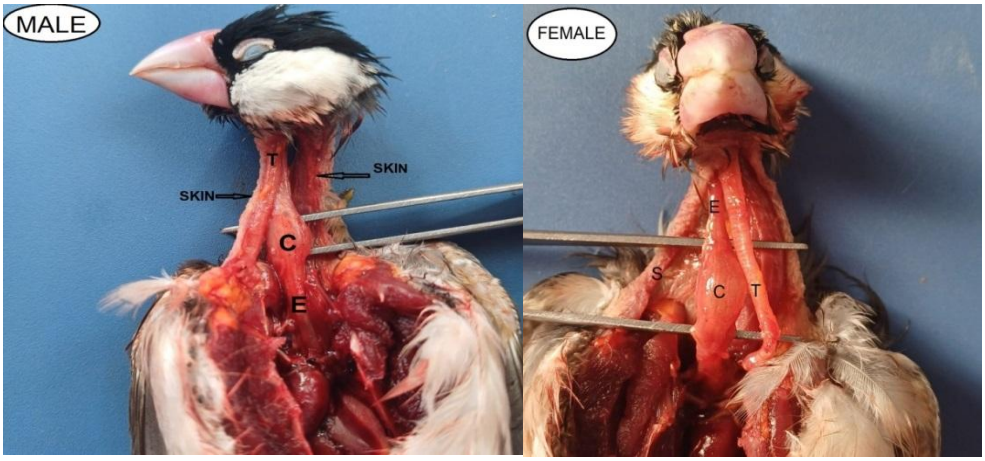

Fig. (2) Images of the non-brooding Java birds (male and female) show the following anatomical structures: crop (C), esophagus (E), trachea (T) and skin (S)**.**

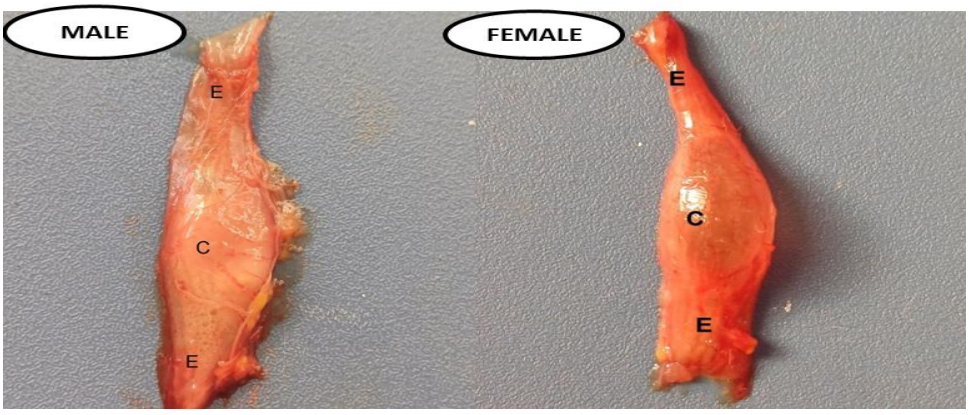

Fig. (3) Photographs show the spindle shape of the crop in male & female of the non-brooding Java bird. Esophagus (E) and crop (C).

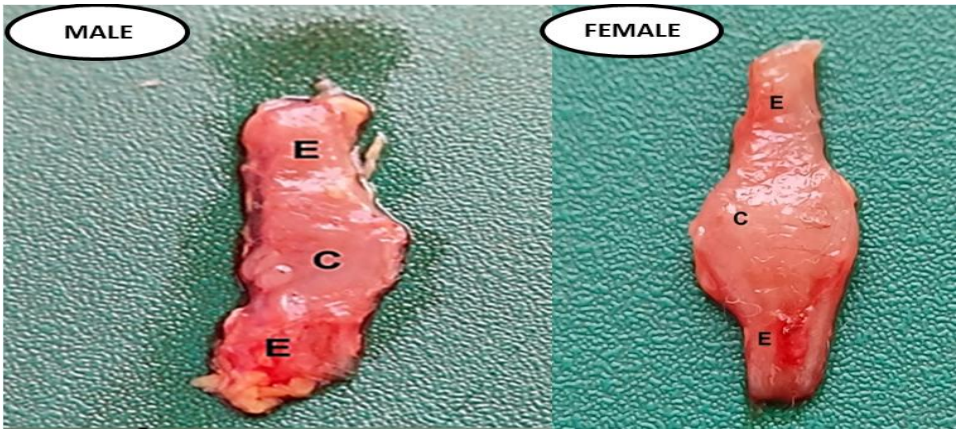

Fig. (4) Photographs show the spindle shape of the crop in male & female of the brooding Java bird. Esophagus (E) and the crop (C).

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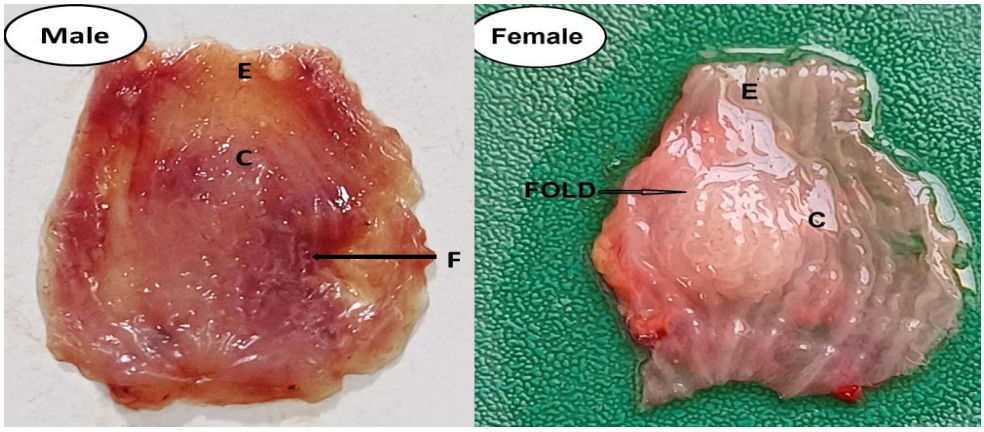

Fig. (5) Photographs show the inner surface of the crop of male and female in brooding Java bird. Cervical part of esophagus (E), crop (C) and folds (F).

Fig. (6) Photographs of the crop of non-brooding Java bird show the longitudinal folds of the crop that are more developed in females than in males.

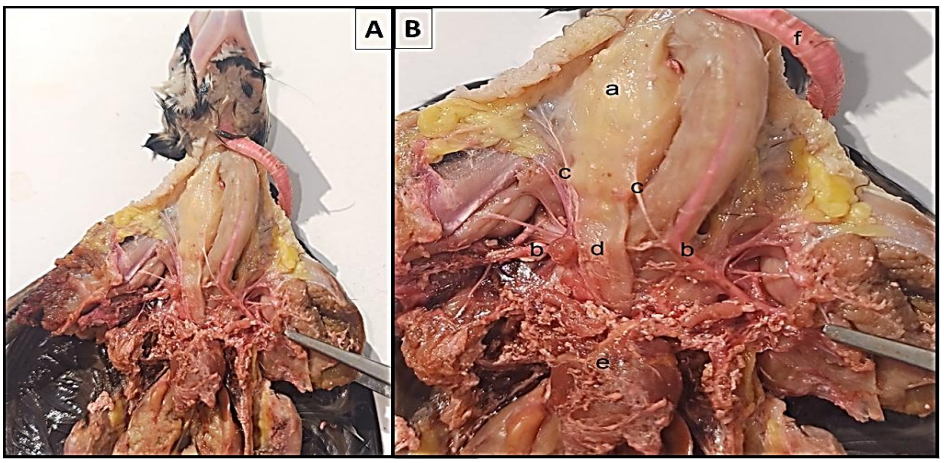

Fig. (7): Photographs show blood supply of the crop in Java bird. a- the crop, b- common carotid artery, c- left and right branches of common carotid artery, d- thoracic part of esophagus, e- the heart and f- the trachea**.**

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Discussion

The anatomical results of the present study in Java birds showed that the crop location is similar to the previous findings mentioned by Taha and AL-Duleemy (2020). In addition, the shape of the crop in Java birds was appeared like a simple fusiform (spindle- shaped). These results were also similar to the previously published study in ducks and geese by Saran *et al.*, (2019) who mentioned that the crop is symbolized by an enlarged spindle. These findings are also consistent with the earlier study that was reported by Shehan (2012) which claimed that the crop in other birds (geese) are fusiform or two-lobed pear-shaped.

The findings of this study revealed the outer surface of crop in both male and female brooding Java bird and showed the outer surface of the crop of males in the non-brooding birds. These results were disagreed with those mentioned by Nikel *et al.* (1977) in fowl. In contrast, the results in female birds were similar to those mentioned by King and Mclalland (1984).

In this study, the description of the inner surface of the crop in the brooding Java birds was similar to that described in the previously published studies (Klem *et al.*, 1982; Denbow, 2015). These studies demonstrated that the inner surfaces of the crops of pigeons, doves, quails, sparrows, gallinaceous birds, and chickens have longitudinal folds. These folds make the crop distensible to accommodate large amounts of rapidly swallowed grains. While these findings were disagreed with the observations that were previously reported by Al-Juboory *et al.* (2015) in common wood pigeons. The results of the color of the crops were disagreed with those mentioned by Hamdi *et al.* (2013) in Elanus caeruleus and with Al-Juboory *et al.* (2015) in common wood pigeons; and with Saran *et al.* (2019) in guinea fowl. The blood supply of the crop in this bird was in agreement with Nikel *et al.* (1977).

Conclusions

The present results showed that the crop undergoes significant anatomical and morphometric changes depending on the reproductive status of the bird. The brooding Java birds have larger, heavier, and more complex crops than the non-brooding birds. In the brooding birds, the crop plays a critical role in producing and storing crop milk. The increased size and weight, as well as the presence of both circular and longitudinal folds in the crop are likely enhance the storage capacity and increase surface area and secretory efficiency of the crop.

Conflict of interest

The authors declare no conflicts of interest.

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Both of authors contributed equally to the conception, design, data collection, analysis, and writing of the manuscript.

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