

Morphological Description of the Pancreas in Indian Roller *Coracias benghalensis* (Linnaeus, 1758)

Haneen Saad Khamas¹, Intidhar Mohammed Mnati²

^{1,2}Department of Biology, College of Education for Pure Science (Ibn Al-Haitham), University of Baghdad, IRAQ.

*Corresponding Author: Haneen Saad Khamas

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ABSTRACT: The current study aimed to determine the morphological description of the pancreas in the Indian Roller *Coracias benghalensis* (Linnaeus, 1758). In this study 15-10 adult live birds were used, which were anesthetized with chloroform and then dissected and the pancreatic gland was removed, then the samples were fixed with fixative solutions. The morphological examination revealed that the Indian roller bird's pancreas is rounded and long, and is a pale pink color. It is found on the lower right side of the body cavity and it has three lobes: the ventral lobe, the dorsal lobe, and the splenic lobe. The ventral lobe was the longest and largest cylindrical lobe and extends within the mesenteric tissue of the duodenal loop. While the dorsal lobe appears flat and lay parallel to the descending arm of the duodenum, the splenic lobe appears in the form of a small volume pear-shaped lobe extending from the end of the dorsal lobe of towards the spleen.

Keywords: Bird, *Coracias benghalensis*, Indian Roller, Morphological description, Pancreas.



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1. INTRODUCTION

The study of the digestive system of birds and animal groups is of great importance due to the mutations and the morphological and histological differences that occur in its parts, and the mechanism of food plays an important role in determining the success of birds' adaptation to their environment. The type of food and the way it is obtained directly affects the formation of these differences, which provides the body with the nutrition necessary to carry out daily activities [1; 2; 3].

Many researchers have studied the gut in various vertebrates, including birds, from different morphological aspects, as well as studies that focused on functional aspects [4; 5; 6].

The pancreas in vertebrates is one of the large glands of the digestive system, a flat and long gland that plays a role in the digestive process and in the regulation of blood glucose levels [7; 8; 9].

The pancreas in birds has been identified as a pale pink lobulated gland with a shape similar to that of a lobule and is situated between the arms of the duodenum and on the right side below the abdominal cavity. The gland may consist of two lobes, a dorsal and a ventral lobe as in the white-eared bulbul *Pycnonotus leucotis* [10], or it may consist of three lobes, the dorsal, the ventral and the splenic lobe, as in *Anas platyrhynchos* [11], while in *Columba livia* the gland contains four lobes represented by the dorsal lobe, the ventral lobe, the splenic lobe and the third lobe [12].

The Indian Roller (*Coracias benghalensis*) (Fig. 1) is classified as follows:

Kingdom: Animalia

Phylum: Chordata

Sub phylum: Vertebrata

Class: Aves

Order: Coraciiformes

Family: Coraciidae

Genus: Coracias

Species: benghalensis

Scientific name: Coracias benghalensis (Linnaeus, 1758)

Common name: Indian roller.

The Indian roller is characterized by a large head and a full body, with its head appearing inconspicuous at rest, but its bright blue colors stand out clearly in flight [13].

Its main habitat is agricultural environments, light forests and pastures. This bird catches insects and frogs and dives into the water to search for fish, as insects make up the majority of its diet, which it consumes throughout the year, thus acting as one of the active biological control agents against agricultural insect pests [14; 15].

This study was prompted by the lack of studies that have investigated the morphological description of the pancreas in Iraqi wild birds, particularly those that have not looked in detail at the components of this gland within the gut. The present study aims to determine the phenotypic description and investigate the morphological measures of the pancreas in a migratory bird species inhabiting the Iraqi environment, the Indian roller (*C.benghalensis*).

2. MATERIALS AND METHODS

This study was carried out on 5 birds of the Indian roller. The samples were collected in the area of Al-Yusufiyah, Najaf Al-Ashraf and Al-Qazel market in Baghdad during the period from September 2024 to the end of December 2024, this bird was classified in the Iraqi Natural History Museum, University of Baghdad and the scientific name was proven. Dissecting microscope was used to identify the general morphology of the organ to be studied and determine its location in the body cavity and between the visceral inside the animal's body and photographed this organ with a Sony digital camera, and measured the weights and sizes of the pancreas in its entirety, as well as measuring the weights, sizes and dimensions of each lobe of the pancreatic (length, width and thickness). A sensitive balance was utilized to measure the weight, while a displacement method was employed based on the Saad and Dle method [16] to measure the volume, while the rest of the measurements were measured using the usual ruler.

3. RESULTS AND DISCUSSION

The results of the recent study on the anatomical and macroscopic examination of the Indian roller *C.benghalensis* showed that the pancreas is a flat, elongated gland of pale pink color. The pancreas occupies the space between the duodenum's arms and is situated in the lower right side of the abdominal cavity where the duodenum ascends and descends (Fig. 1 B and A).

In the current study, three lobes were observed in the pancreas of the Indian roller bird, which are the ventral, dorsal, and splenic lobes. The ventral lobe was the longest and largest lobe and had a cylindrical form and extends within the mesenteric tissue of the duodenal loop and is represented by the ascending part of the duodenum and the descending part of the duodenum and bends near the pyloric part of the pylorus. Whereas the dorsal lobe appears more lobe high and has a flat shape and is smaller than the ventral lobe and is about half the length of the ventral lobe and extends from the beginning of the duodenum to the middle part of the ventral lobe and splits incompletely into two unequal parts from the end of the lobe, whereas the third lobe was the splenic lobe, which extended from the end of the dorsal lobe to the spleen and had the shape of a small pear-shaped lobe (Fig. 2 B and A).

Three pancreatic ducts are present along the ventral side of the duodenal loop in the Indian roller bird's pancreas, as indicated by the current study results, namely the dorsal pancreatic duct and the accessory pancreatic duct, called the Santorini duct, both originating from the dorsal lobe, and the ventral pancreatic duct, called the Wirsung duct, that originates from the ventral lobe and drains its secretions in the ascending part of the duodenum, near the junction area of the duodenal bile (Fig. 3 B and A).

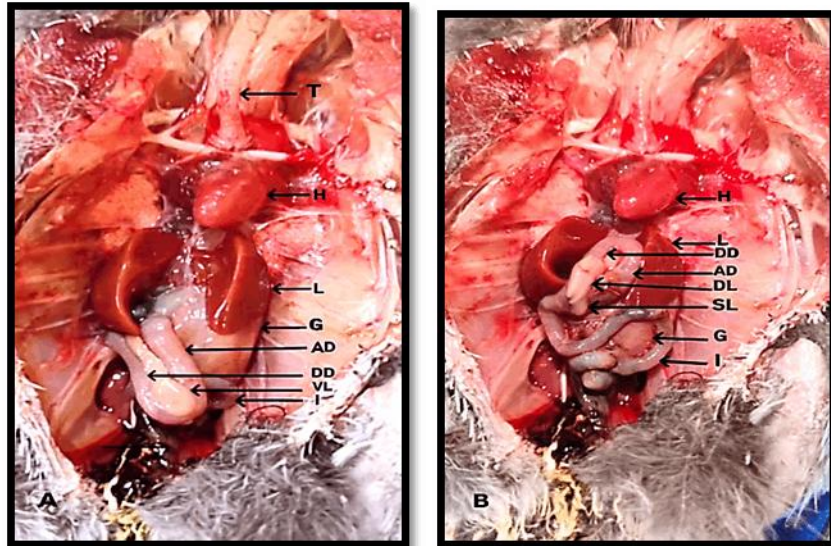


FIGURE 1 A and B. - The internal anatomy of the Indian roller bird shows the general appearance of the digestive system and the position and shape of the pancreas in the body cavity and adjacent organs. Note: trachea (T), heart (H), gizzard (G), liver (L), ventral lobe (VL), dorsal lobe (DL), splenic lobe (SL), ascending duodenal part (AD), descending duodenal part (DD), intestine (I).

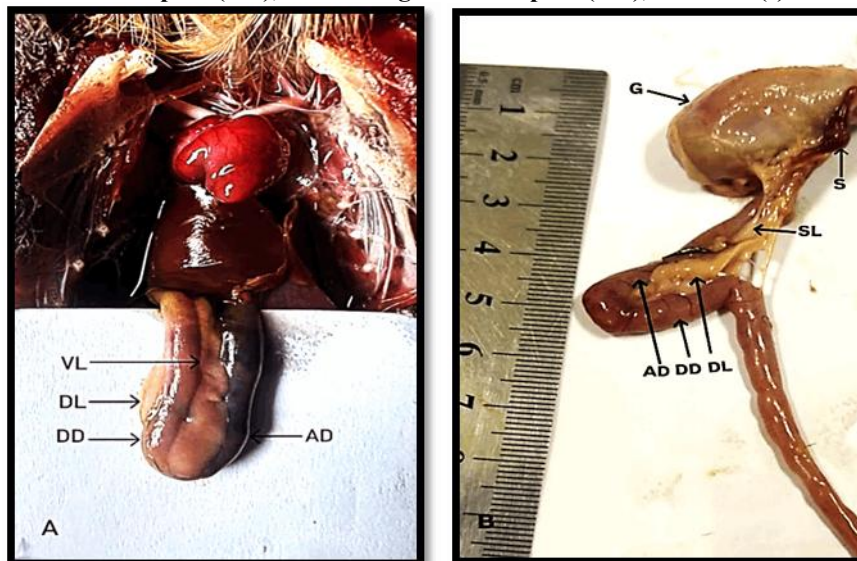


FIGURE 2 A and B. - Ventral and dorsal views showing the location of the pancreas of the Indian roller. note: dorsal lobe (DL), ventral lobe (VL), splenic lobe (SL), spleen (S), gizzard (G), ascending duodenal part (AD), descending duodenal part (DD).

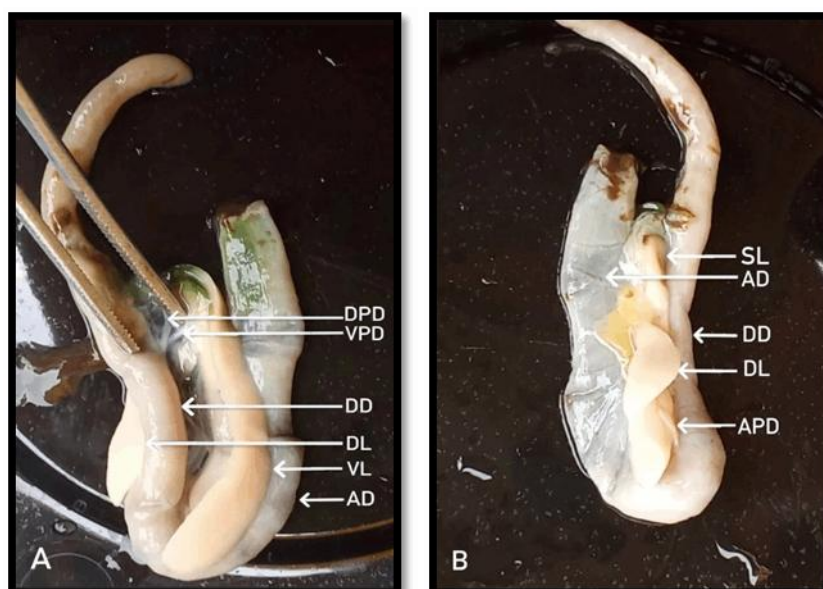


FIGURE 3 A and B. - The lobes and ducts of the Indian roller, note: dorsal pancreatic duct (DPD), ventral pancreatic duct (VPD), accessory pancreatic duct (APD), dorsal lobe (DL), ventral lobe (VL), ascending duodenal part (AD), descending duodenal part (DD).

Based on the morphological description of the Indian roller bird's digestive system, it has been found that the pancreas is a long gland located on the lower right side of the abdominal cavity between the ascending and descending parts of the duodenum, satisfying the space between the arms of the duodenum, and The findings presented are in accordance with the findings of the study by Mahmood *et al.* [11] on domestic ducks *A.platyrhynchos* and Ibrahim [17] in *Alectoris chukar* and *Gallinula chloropus*, but it is not consistent with the results of Al-Agele & Mohammed [18] in *Aquila chrysaetos* and yhe pancreas in white-eared bulbul *P. leucotis* was reported by Al-Khakani *et al.* [10] to be short and thick, and the lobes don't fill the gap between neighbouring arms of the duodenum..

The results of the recent study definite that the pancreas was pale pink in color, and this result was consistent with some studies in different avian species, such as the study of Abd & Faris [12] in *C.livia*, the study of Saad & Dle [16] in the swan geese, and the study of Alkhazraji & Naser [19] in *Francolinus francolinus*, which stated that the pancreas was pale pink.

While the results of the existing study are not consistent with the findings of the study by Hamodi *et al.* [20] for the pancreas of *Numida meleagris* and the study by Al-Khakani *et al.* [10] for the white-eared bulbul *P.leucotis* and the results of the study indicate that the pancreas of *N.meleagris* has a yellow color while the pancreas of the white-eared bulbul is pale white.

The macroscopic study showed that the pancreas consists of three lobes represented by the ventral lobe, dorsal lobe and splenic lobe and this result is in agreement with the results of the study by Yadav *et al.* [21] in *Chabro* and Mahmood *et al.* [11] in domestic ducks *A.platyrhynchos* and Ibrahim [17] in *A.chukar* and *G.chloropus*.

The results of this study were entirely in line with what was mentioned above, but they were not in accordance with the findings of Al-Khakani *et al.* [10] on white-eared bulbul *P.leucotis*, which showed that the pancreas contains two lobes, a dorsal lobe and a ventral lobe, and also disagree with the results of the study by Abd and Faris [12] on *C. livia* and Saad and Dle [16] on swan geese and Naser *et al.* [22] on *Linnaecus corvus* and the Iraqi black quail *Melanoperdix niger*. The results of all these studies showed that the pancreases of different bird species consist of four lobes: the dorsal lobe, the ventral lobe, the splenic lobe and another lobe that protrudes from the end of the ventral lobe, the so-called third lobe.

The results of the existing study indicate that the ventral lobe is the longest and largest lobe and has a cylindrical shape. It extends within the mesenteric tissue of the duodenal loop, which is represented by the ascending duodenal part and the descending duodenal part, while the dorsal lobe appears more elevated lobe and had a flat shape and smaller than the ventral lobe and is about half the length of the ventral lobe is located parallel to the descending arm of the duodenum and splits an incomplete split from the end of the lobe into two parts unevenly, while the splenic lobe spreads from the end of the dorsal lobe towards the spleen and has the shape of a small pear-shaped lobe.

The results of this study are consistent with the results of the study by Abd and Faris [12] in *C. livia*, but differ from the results of the study by Al-Khakani *et al.* [10] in the white-eared bulbul *P. leucotis*, which showed that the ventral lobe was boat-shaped, while the dorsal lobe appeared very thin and triangular and was longer than the ventral lobe, and disagrees with the study by Saad and Dle [16] in the swan geese, which showed that the ventral lobe was more extensive

than the dorsal lobe. It contradicts the results of the study by Naser *et al.* [22], whose results showed that the ventral lobe was shorter than the dorsal lobe, while the splenic lobe in the black partridge *M.niger* has the smallest lobes extending forward towards the spleen, while the dorsal lobe in *L.corvus* appears rod-shaped, the ventral lobe was the longest lobe and the splenic lobe was arranged parallel to the spleen.

As for the pancreatic ducts, the results of the recent study showed the presence of three ducts in the pancreatic duct: the dorsal pancreatic duct, the ventral pancreatic duct and the accessory pancreatic duct, and this result confirmed the findings of Alkhazraji and Naser [19] in their study on *F. francolinus* and Naser *et al.* [22] in their study on *L.corvus* and black quail *M.niger*, which showed that the pancreas has three pancreatic ducts, namely the dorsal pancreatic duct, the ventral pancreatic duct and the accessory pancreatic duct.

While the results of the current study contradict the results of Yehia *et al.* [23] in *Coturnix coturnix japonica* and *Bubulcus ibis* and the study by Mahdi and Bargooth [24] in *N.meleagris*, whose results showed that the pancreatic has only two main ducts, the dorsal pancreatic duct and the ventral pancreatic duct, and that there is no additional duct, and that these two ducts extend from the pancreas to the point where its contents drain into the duodenum, and compared to the study by Mahmood *et al.* [11] in *A.platyrhynchos* and Saad and Dle's [16] study in the swan goose, it was found that the pancreas has a main duct, called Wirsung's duct, and the duodenum is the point where the pancreatic duct opens into the duodenum.

As for morphological measurements, the results of the statistical study on the morphological measurements of the pancreas in the Indian roller showed that the mean weight of the pancreas was 1.04 ± 0.15 g and its size was 0.26 ± 0.03 cm³. As for the morphological measurements for each lobe, the results of the statistical analysis of the weight, size and dimensions of the pancreatic lobes were recorded as follows:

(ventral lobe weight 0.01 ± 0.10 g, ventral lobe volume 0.01 ± 0.15 cm³, ventral lobe length 0.14 ± 1.99 cm, ventral lobe width 0.02 ± 0.45 cm, ventral lobe thickness 0.01 ± 0.33 cm), (dorsal lobe weight 0.01 ± 0.09 g, dorsal lobe volume 0.02 ± 0.21 cm³, dorsal lobe length 0.06 ± 1.51 cm, dorsal lobe width 0.05 ± 0.59 cm, dorsal lobe thickness 0.03 ± 0.45 cm), (splenic lobe weight 0.01 ± 0.06 g, splenic lobe volume 0.01 ± 0.04 cm³, splenic lobe length 0.10 ± 1.12 cm, width of the splenic lobe 0.02 ± 0.28 cm, thickness of the splenic lobe 0.02 ± 0.21 cm). The mean weight of the ventral lobe and the dorsal lobes was not significantly different, but the splenic lobe and the size and dimensions of the three lobes had significant differences, which is shown by this, as shown in Tab. (1).

TABLE 1. The mean morphological measurements for each lobe of the Indian roller *C. benghalensis*.

Studied characteristic Type of lobe	Weight g S.E±M	Length cm S.E±M	Width cm S.E±M	Thickness cm S.E±M	Volume cm ³ S.E±M
Ventral lobe	0.01 ± 0.10^a	0.14 ± 1.99^a	0.02 ± 0.45^a	0.01 ± 0.33^a	0.01 ± 0.15^a
Dorsal lobe	0.01 ± 0.09^a	0.06 ± 1.51^b	0.05 ± 0.59^b	0.03 ± 0.45^b	0.02 ± 0.21^b
Splenic lobe	0.01 ± 0.06^b	0.10 ± 1.12^c	0.02 ± 0.28^c	0.02 ± 0.21^c	0.01 ± 0.04^c
P value [#]	0.105**	0.001*	0.001*	0.001*	0.001*

The values represent the mean and standard error (S.E±M) Different letters indicate significant differences at the $p \leq 0.001$ probability level, and similar letters indicate no significant differences

The results of the statistical study indicate that there are significant differences in mean weight and pancreas size. The results of the recent study displayed that the mean weight and size of the pancreas reached 1.04 ± 0.15 g and 0.26 ± 0.03 cm³, respectively, and this result is confirmed by some studies, including the study of Abd & Faris [12] in *C. livia*, a small difference in pancreas weight was observed, which was 0.867 ± 0.07 g, and the study by Farhan [25] in owl (*Strix aluco*) and *G.chloropus*, which weighed 1.1 ± 1.15 g and 0.7 ± 0.37 g, respectively.

However, the results of the present study contradict the results of Saad & Dle [16] study of swan geese, which weighed 5.72 ± 0.010 g and measured 11.39 ± 0.08 ml, and Naser *et al.* [22] study of *M.niger* and *L. corvus*, which weighed 283.18 ± 0.03 g and 206.818 ± 0.22 g, respectively.

As for the morphological measurements for each lobe, the mean length, width and thickness of the ventral pancreatic lobe of the current study bird were 1.99 ± 0.14 cm, 0.45 ± 0.02 cm, 0.33 ± 0.01 cm and in the dorsal lobe 1.51 ± 0.06 cm, 0.59 ± 0.05 cm, 0.45 ± 0.03 cm, while the length, width and thickness of the splenic lobe were 1.12 ± 0.10 cm, 0.28 ± 0.02 cm, 0.2 ± 0.02 cm, respectively. Mahmood *et al.* [11] in their study on the pancreas of *A.platyrhynchos* found that the length of the dorsal lobe was 6.83 ± 0.76 cm, the length of the ventral lobe was 4.72 ± 0.34 cm and the length of the splenic lobe was 0.63 ± 0.97 cm.

While the study by Khuluf [26] on the pancreas of the Iraqi toothed cat *Pterocoles alchata* showed that the length of the ventral lobe was 27.88 ± 0.38 mm, the width of the ventral lobe was 4.38 ± 0.38 mm and the height of the ventral lobe was 3.00 ± 0.00 mm, while the length, width and height of the dorsal lobe reached 19.25 ± 0.63 mm, 0.26 ± 0.38 mm and 0.00 ± 2.00 mm, respectively, while the length, width and height of the splenic lobe reached 10.00 ± 0.00 mm, 0.00 ± 4.00 mm and 0.00 ± 1.00 mm, respectively. These results contradict the results of the current study.

The mean weight and size of the pancreas of the current study bird differed from the results of other studies. The mean weight and size of the ventral lobe were 0.01 ± 0.10 g and 0.01 ± 0.15 cm³, respectively, while the weight and volume of the dorsal lobe were 0.01 ± 0.09 g and 0.02 ± 0.21 cm³, respectively. The mean weight and volume of the splenic lobe were 0.01 ± 0.06 g and 0.01 ± 0.04 m³, respectively. Al sharoot [27] stated in his study on the goose (*Anser anser*) that the weight of the ventral lobe was 1.576 ± 0.02 g, while the weight of the dorsal lobe was 2.085 ± 0.02 g and the weight of the splenic lobe was 0.033 ± 0.01 g. This is not consistent with the results of the study by Al-Khakani *et al.* [10], who found the mean weight of the dorsal and ventral lobes to be 0.034 ± 0.005 g and 0.036 ± 0.0054 g, respectively.

The reason for the different weight, size and dimensions of the pancreas in different birds lies in the different physiological adaptations of the bird depending on its size. For example, large birds such as geese have a larger pancreas than small birds due to their different body size, metabolic needs and age. The size of the pancreas changes with age to meet nutritional needs. Birds that feed on a diet high in protein and fat require a larger pancreas to produce sufficient digestive enzymes, whereas birds that feed on fruit and grains do not require large amounts of enzyme activity [10, 16, 26].

It has been observed that there are differences in the different types of birds with the results of the recent study with regard to the morphological description of the pancreas. Perhaps the reason for this difference between the species of birds is due to the living environment and the variation of their distribution methods, the nature and type of food, metabolic requirements and their locations [26].

4.CONCLUSIONS

The current study of anatomical examination in the Indian Roller showed that the pancreas is a flat elongated gland with a pale pink color that fills the space between the arms of the duodenum and is situated in the lower right side of the abdominal cavity between the ascending and descending part of the duodenum consisting of three lobes, a long ventral lobe, and the dorsal lobe splits incomplete fission from the end of the lobe into two unequal parts, and the splenic lobe spreads from the middle of the dorsal part of the ventral lobe towards the spleen also has three pancreatic ducts; dorsal pancreatic duct, the Accessory pancreatic duct and the ventral pancreatic duct. The morphological measurements of the weight and size of the pancreatic duct, as well as measuring the weights, sizes and dimensions of each lobe of the pancreas showed significant differences at the level of probability $p \leq 0.001$.

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