Diyala Journal for Veterinary sciences
Open Access Journal Published by College of Veterinary Medicine
University of Diyala, Iraq
P-ISSN: 2410-8863
E-ISSN:2958-6178
Vol. 2, NO. 1, March 2024
https://doi.org/10.71375/djvs.2024.02104

A Comparative Histomorphological Study of the Pancreas in the Chukar Partridge *(Alectoris chukar*)and Moorhen Bird *(Gallinula chloropus*).

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Abstract

The objective of this study was to conduct a comparative analysis of the structural and histological characteristics of the pancreas in Chukar Partridges and Moorhen birds. The focus of this study was to assess the worth of these avian species in terms of their potential as viable sources for meat and egg production. The avian specimens were categorized into two distinct groups: one designated for anatomical examination, while the other was allocated for histological analysis. The pancreas in Chukar Partridge was characterized by its white, pinkish coloration and weighs around 0.880± 0.67 g. It is 8.3±1.35 cm in length and 1.3± 0.56 cm in width. The pancreas of common moorhen birds was characterized by its white to pinkish coloration. It weighs around 0.994± 0.89 g, has a length of 9.1± 1.93 cm, and a width of 1.5± 0.84 cm. From a histological perspective, it appears that the connective tissue capsule was comparatively thinner in the Chukar partridge as compared to the Moorhen bird. The connective tissue capsule spans from the septa to the parenchyma of the pancreas, exhibiting a lower abundance in the Chukar partridge compared to the moorhen bird. Serous tubulo-acinar glands were present in the exocrine glands of both birds. The acinar cells of the Chukar partridge's secretory acini had a pyramidal morphology. The secretory acini of the moorhen bird was characterized by the presence of acinar cells that have an oval, elongated form. The morphology of the islets exhibited irregular or elongated shapes in Chukar Partridge, whereas in Moorhen Bird, they appeared as oval or uneven structures. The Chukar partridge showed a greater abundance of endocrine cells compared to the Moorhen bird, as evidenced by the higher density of small blood arteries inside these cells.

Keywords: Chukar partridge, Moorhen Birds, pancreas, exocrine glands.

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Introduction

The Alectoris chukar is a well-recognized avian species belonging to the partridge family. It has a size that surpasses that of quails, although remains smaller in comparison to pheasants (1). It has been reported that their numbers are largely impacted by changeable weather during its breeding time (2). The Moorhen bird, scientifically known as Gallinula chloropus, is a species of avian that predominantly consumes aquatic vegetation. In contrast, the Chukar partridge is classified as an omnivorous gamebird. The Moorhen possesses a bodily structure that is characterized by a streamlined form, which enables it to navigate through water with enhanced efficiency (3). Additionally, this avian species is equipped with webbed feet, further contributing to its adeptness in swimming (3). The pancreas in vertebrates is histologically divided into two distinct sections. The first area is the exocrine portion, responsible for the secretion of digesting enzymes. The second region is the endocrine portion, which releases regulating hormones such as insulin, glucagon, and somatostatin into the bloodstream (4, 5). As stated by reference (6), avian pancreases are characterized by the presence of four lobes, namely ventral, dorsal, third, and splenic. These lobes are accompanied by three ducts, specifically ventral, dorsal, and third, as observed in chickens and quail. The avian pancreas has distinct characteristics compared to other animals since it is comprised of many lobes and contains two distinct kinds of islets. Numerous variations exist across bird species concerning the anatomical and histological structures of the pancreas, including the division of lobes, the arrangement of islets within lobes, the characteristics and occurrence of endocrine cells within islets, as well as the construction of ducts (7). The pancreatic endocrine component is comprised of both big and tiny islets, also known as Langerhans islets (8). The user's text does not contain any information to rewrite. The pancreatic capsule, seen in avian species, is a delicate connective tissue layer that envelops the pancreatic parenchyma (9). The exocrine component of the pancreas is a glandular structure composed of tubuloacinar units, namely serous acini. The acini are lined with a kind of tissue known as low columnar epithelium, characterized by a rounded, big, and basal nucleus (8). The drainage of pancreatic acini products in vertebrates occurs sequentially through the pancreatic ducts, starting with center acinar cells, followed by intercalated ducts, interlobular ducts, and pancreatic (main) ducts (10). The avian pancreas typically consists of two lobes that span from the apex of the duodenal loop to the location where the pancreatic ducts enter the distal duodenum. However, few studies have shown the presence of four lobes: dorsal, ventral, splenic, and third [6; 9; and 11]. The aim of this study was to do a comparative investigation of the structural and histological features of the pancreas in Chukar Partridges and Moorhen birds.

Materials and methods

The specimens were collected from avian marketplaces of a commercial nature located in Baghdad. A total of twelve adult males (six for the chukar partridge and six for the moorhen bird) were included in the study. The avian specimens were segregated into two distinct cohorts, with individuals allocated for anatomical examination and an additional

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individuals designated for histological analysis. The avian subjects were administered anesthesia through intravenous injection into the alar vein with a dosage of 25 mg/kg ketamine and 5 mg/kg xylazine, as described in a previous study (12). Subsequently, the abdominal cavity was incised to investigate the morphology, spatial orientation, and anatomical associations of the pancreas. The specimens were extracted and immersed in a fixative solution containing 10% formalin for 27 hours. Subsequently, they underwent a two-hour rinsing process using tap water. The dehydration process is facilitated by the use of alcohol, which is incrementally upgraded from concentrations of 70%, 80%, 90%, and 1001% to reach a final concentration of 1002%. Each stage of this process lasts for 2 hours. Subsequently, the sample was subjected to two rounds of xylene treatment, with each step lasting for half an hour. The specimens were meticulously immersed in a solution consisting of molten paraffin wax and xylene for 30 minutes at a temperature of 60 °C. While the filtering process was ongoing, it involved three iterations of milted paraffin at a temperature of 60 °C for 30 minutes in each iteration. Afterward, the sample was embedded by employing paraffin wax for three hours. The utilization of a rotary microtome results in the production of cutting sections with a thickness ranging from about 5 to 6 µm. The thin tissue was affixed to the slide using a combination of egg albumin and glycerin in a 1:1 ratio, known as Mayer's albumin. The sections underwent staining with hematoxylin and eosin followed by examination under a light microscope (13).

Anatomical results and discussion

The pancreas in both birds was enclosed by the pancreatic duodenal ligament, situated on the right side of the celomic cavity between the descending and ascending duodenal loops. The anatomical examination conducted in this study revealed that the pancreas of both birds consisted of three lobes: the dorsal, middle, and ventral lobes. The well-developed interlobar connections made it challenging to differentiate between these lobes (see Fig. 1, 2, 3, 4). These findings support a previous study by (14) on adult Kestrels, which also reported the presence of three lobes in the pancreas: the dorsal (lobus pancreatic dorsalis), middle (middle pancreatic lobus), and ventral (lobus pancreatis ventralis) lobes. However, our results contradict the findings of (15) in ducks, who reported that the pancreas of ducks has two lobes, with the dorsal lobe being divided into three distinct segments. Additionally, our findings disagree with the observations made by (16) in early hatched geese, who described the pancreas of early hatched geese as a vital lobulated organ consisting of four lobes. These lobes were located between the descending and ascending duodenal loops but did not fill the space between the two limbs of the duodenum. The pancreas of the Chukar Partridge had a white, pinkish coloration and possessed dimensions of approximately 0.880 ± 0.67 g in weight, 8.3 ± 1.35 cm in length, and 1.3 ± 0.56 cm in width (as seen in Fig. 1). The pancreas of common moorhen birds was characterized by its white to pinkish coloration. It had an average weight of around 0.994± 0.89 g, a length of 9.1± 1.93 cm, and a width of 1.5± 0.84 cm (as indicated in Table 1).

Histological result and discussion

The present investigation showed that the pancreas was enveloped by a delicate connective tissue capsule, which extends septa

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into its structure, effectively partitioning the pancreatic lobules. The connective tissue capsule was upheld by a fragile coating composed of reticular fibers, collagen, and elastic fibers. The capsule was also equipped with an extensive network of blood and lymph veins, nerves, and excretory ducts (see Fig. 5, 6, 7, 8). The histological findings indicated that the mean thickness of connective tissue capsules in Chukar partridge and Moorhen bird were 3.43± 0.74µm and 5.11± 1.18µm, respectively. The thickness of the connective tissue capsule appears to be comparatively reduced in the Chukar partridge as compared to the Moorhen bird (as seen in Table 2). The connective tissue capsule spans from the septa to the parenchyma of the pancreas, exhibiting a smaller presence in the Chukar partridge compared to the moorhen bird (Fig. 5, 6, 7, 8). The present outcomes exhibited resemblance to the findings reported by Jaafar (18) in their study conducted on Falcon. The authors observed that the pancreas is comprised of parenchyma and is enveloped by capsules, which consist of various connective tissue fibers such as collagen fibers, elastic fibers, and reticular fibers, along with the presence of fibroblasts. The capsules of both avian species exhibited a mesothelial layer, with connective tissue septa extending from the capsules to the parenchyma (as seen in Fig. 5, 6, 7, 8).

The glandular parenchyma of avian species consisted of exocrine and endocrine components (as seen in Fig. 9,10). The exocrine glands in avian species constitute the predominant portion of the pancreas and were comprised of secretory units known as acini. This pattern is also observed in the majority of avian species (17, 19) and other vertebrates (20, 21). However, in certain fish species, the pancreatic cells are located within the liver tissue, which is referred to as the hepatopancreas. The centroacinar cells are situated in the central region of the pancreatic acini and may be identified by their distinct characteristics, including their dark-stained appearance, relatively large size, and sparsely distributed nuclei (as seen in Fig. 9, 10). This finding supports the previous study conducted by (22), which demonstrated that the bizonal nature of acinar cells is due to the presence of mitochondria and zymogen granules in both the basal and apical regions. In study on the pancrease of goose also observed that the cytoplasm contained acidophilic zymogenic granules, while small centroacinar cells lacking granules were present in the acinus lumen. In contrast to the findings of Hamodi *et al*. (23) about the absence of centroacinar cells in Guinea fowl and common gull, our study reveals the presence of serous tubulo-acinar glands in the exocrine glands of the chukar partridge. The acinar cells of the Chukar partridge's secretory acini have a pyramidal form. The secretory acini were bordered by a layer of simple columnar epithelium. This finding aligns with the observations made by (14) in adult Kestrel when they reported that the exocrine component of the pancreas mostly comprises serous acini.

The moorhen bird possessed serous tubulo-acinar glands inside its exocrine glandular system. The secretory acini of the moorhen bird were characterized by the presence of acinar cells that have an oval, elongated form. The secretory acini were lined by a transition from simple cuboidal to columnar epithelium. The present findings align with the research conducted by authors (5, 19), who observe that the exocrine component of the pancreas consists of serous tubuloacinar glands and

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comprises a substantial portion of its overall structure. The average diameters of acini in Chukar partridge and moorhen birds were recorded as 9.13± 0.96µm and 12.65±1.21µm, respectively, (as shown in Table 2). In both birds, the exocrine portion of the pancreas exhibits a ductal system of intralobular ducts, interlobular ducts, intercalated ducts, and a major duct. These structures are situated amidst the pancreatic acini and are enveloped by connective tissue containing a layer of smooth muscle. The intralobular ducts, as well as the interlobular ducts, are characterized by a lining of simple cuboidal to low columnar cells. Additionally, the mucosa of the main duct exhibited longitudinal folds that were lined with pseudostratified ciliated columnar epithelium (as seen in Fig 11, 12). The moorhen bird exhibited a bigger diameter of the duct system in its exocrine region compared to the Chukar partridge (as seen in Table 2). The endocrine component, also known as the islets of Langerhans, consisted of discrete, lightly stained regions located amidst the acini. The average diameter of Langerhans islets in Chukar partridge and moorhen birds were recorded as 6.26±0.78µm and 8.59±1.43µm, respectively (as presented in Table 2). The average diameter of Langerhans islets in chukar partridges was found to be smaller compared to that of moorhen birds. The morphology of the islets exhibited irregular or elongated shapes in the Chukar partridge, whereas the Moorhen bird had oval or irregular shapes (see Fig 9, 10). This findings aligns with the results reported by Chabro *et al*. (24, 25, and 26) in their studies on Chabro chickens, wood pigeons, and golden eagles. They observed that the islets exhibited a variety of shapes, including oval, rounded, irregular, elongated, and quadrilateral forms. The Chukar partridge exhibited a higher abundance of endocrine cells compared to the Moorhen bird, as evidenced by a greater distribution of small blood arteries inside these cells.

Table (1):- Morphometric measurements (weight, length, width) of the pancreas in chukar partridge and moorhen bird (Mean ± SE).

Organ / Parameters	Pancreas	
	Chukar partridge	Moorhen bird
Weight/gm	0.880 ± 0.67	0.994 ± 0.89 *
Length/cm	8.3 ±1.35	9.1 ± 1.93*
Width/cm	1.3 ± 0.56	1.5 ± 0.84*

***denote significant differences horizontally (P ≤ 0.05) between chukar partridge and moorhen bird**.

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Table (2):-Shows the capsule thickness, diameter of acini, diameter of interlobular duct, diameter of intralobular duct, diameter of main duct and diameter of islets of Langerhans in chukar partridge and moorhen bird (Mean ± SE).

Parameters	Chukar partridge	Moorhen bird
Capsule thickness/ µm	3.43±0.74	5.11±1.18 *
Diameter of acini/ µm	9.13± 0.96	12.65± 1.21*
Diameter of intralobular duct / µm	62.98± 2.11	67.85±2.67*
Diameter of interlobular duct / µm	89.68± 1.18	102.78± 2.10
Diameter of main duct/ µm	266.62 ± 3.76	189.62 ± 4.18*
Diameter of islets of langerhans/ µm	6.26±0.78	8.59± 1.43*

***denote significant differences horizontally (P ≤ 0.05) between chukar partridge and moorhen bird.**

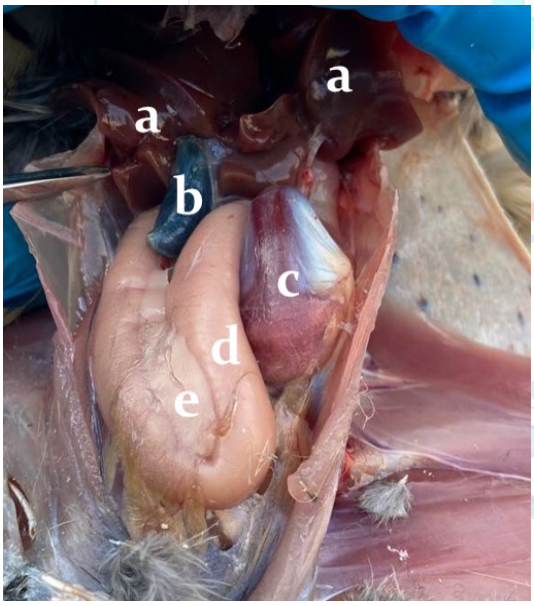

Fig (1): Photograph of the pancreas of chukar partride shows: liver (a), gall bladder (b), gizzard (c), duodenum (d), pancreas (e).

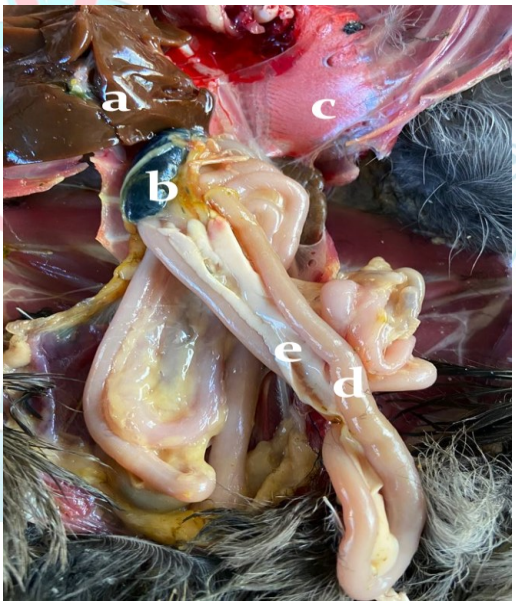

Fig (2): Photograph of the pancreas of moorhen bird shows: liver (a), gall bladder (b), gizzard (c), duodenum (d), pancreas (e).

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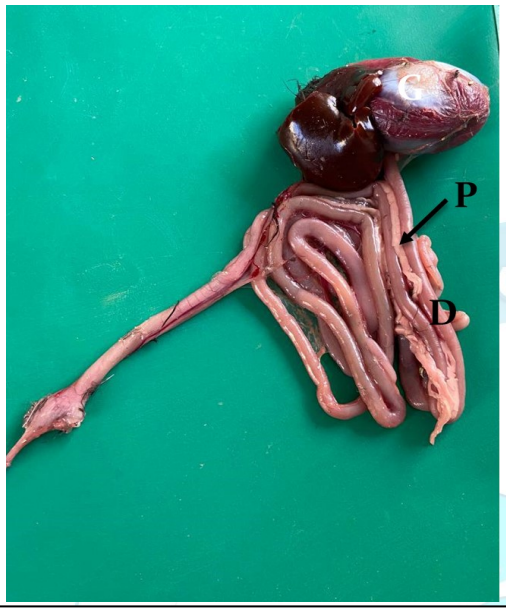

Fig (3): Photograph of the pancreas of chukar partride shows: Gizzard(G), pancreas (P), duodenum (D).

Fig (4): Photograph of the pancreas of moorhen bird shows: Gizzard(G), pancreas (P), duodenum (D).

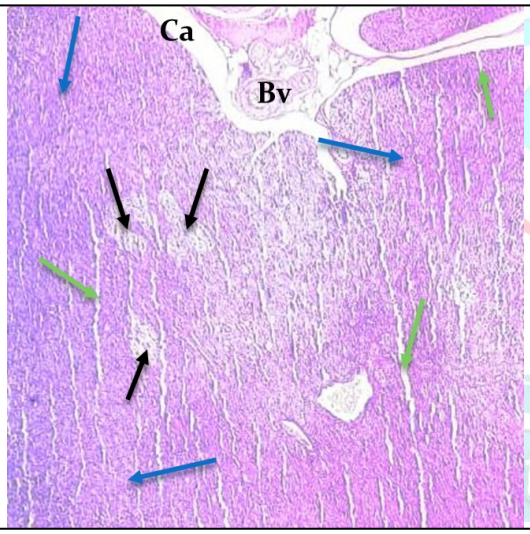

Fig (5): Histological section of the Pancreas in chukar partridge showed: Capsule (Ca), blood vessels (Bv), connective tissue septa (green arrows), exocrine gland (blue arrows), Islets of langerhans (black arrows). (H&E, 100X).

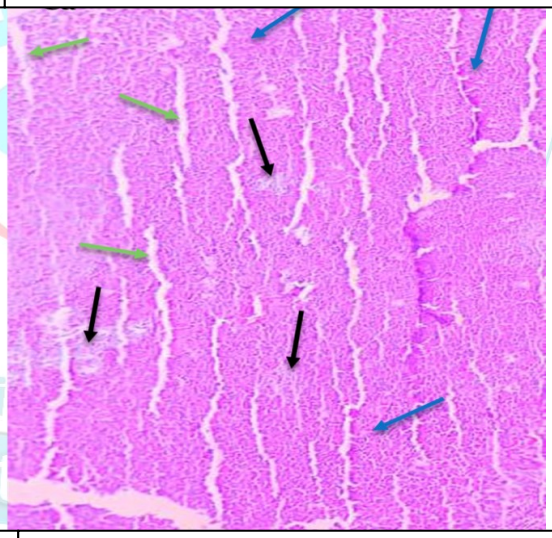

Fig (6): Histological section of the Pancreas in moorhen bird showed: capsule (Ca), connective tissue septa (green arrows), exocrine gland (blue arrows), Islets of langerhans (black arrows). (H&E, 100X).

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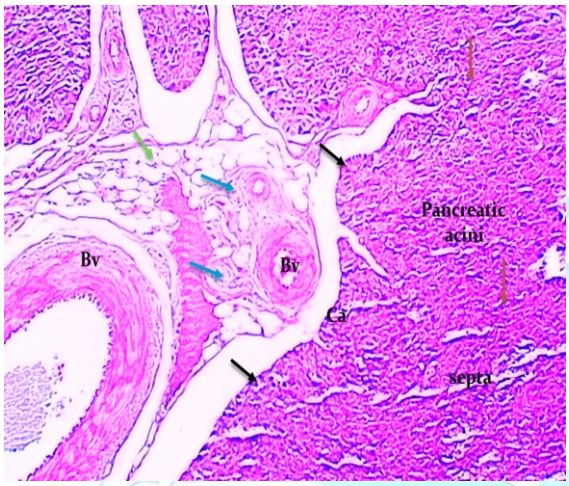

Fig (7): Histological section of the Pancreas in chukar partridge showed: capsule (Ca), blood vessels (Bv) between pancreatic acini, connective tissue septa (septa), mesothelial layer (black arrows), ganglionic nerve (blue arrows), fibroblast (green arrow), connective tissue fibers (red arrows). (H&E, 100X).

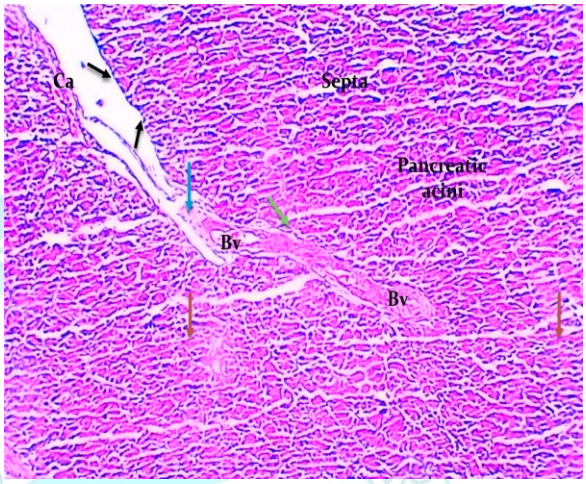

Fig (8): Histological section of the Pancreas in moorhen bird showed: capsule (Ca), blood vessels (Bv) between pancreatic acini, connective tissue septa (septa), mesothelial layer (black arrows), ganglionic nerve (blue arrows), fibroblast (green arrow), connective tissue fibers (red arrows). (H&E, 100X).

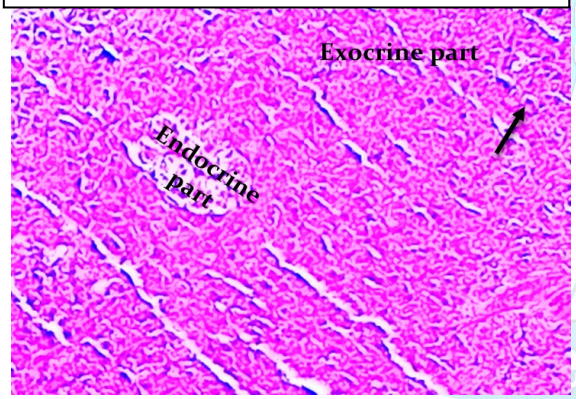

Fig (9): Microphotograph of the pancreas in chukar partridge showed: Exocrine and Endocrine part of pancreas, the centroacinar cells (black arrows) in the center of acini. (H&E, 200X).

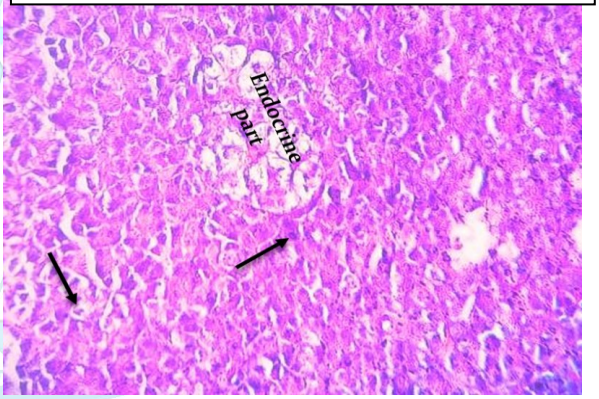

Fig (10): Microphotograph of the pancreas in moorhen bird showed: Exocrine and Endocrine part of pancreas, the centroacinar cells (black arrows) in the center of acini. (H&E, 200X).

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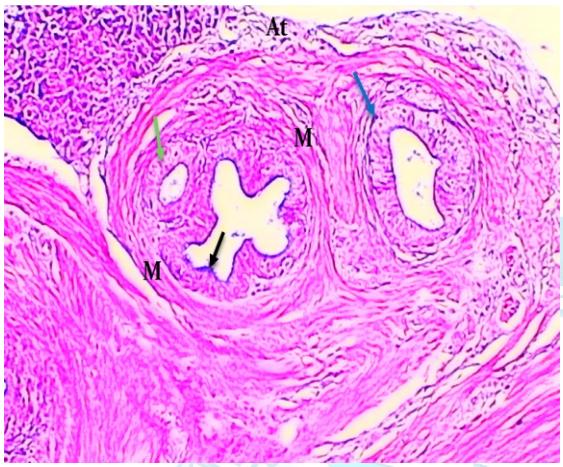

Fig (11): Microphotograph of the pancreas in Chukar partridge showed: longitudinal folds in its mucosa lined by pseudostratified ciliated columnar epithelium (black arrow), interlobar duct (blue arrow), intralobular duct (green arrow), muscular layer (M) which surrounding by adipose tissue (AT). (H&E, 100X).

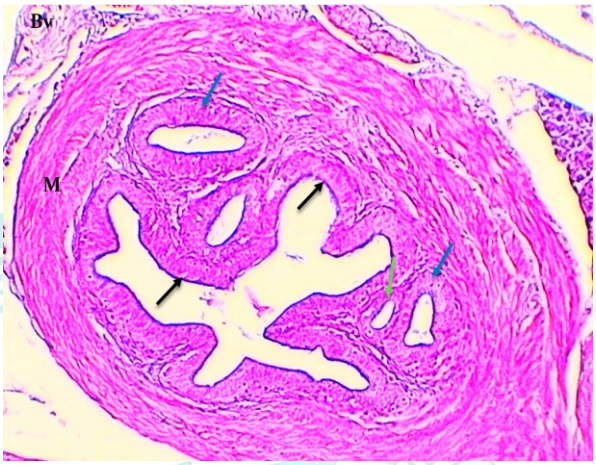

Fig (12): Microphotograph of the pancreas in moorhen bird showed: longitudinal folds in its mucosa lined by pseudostratified ciliated columnar epithelium (black arrow), interlobar duct (blue arrow), intralobular duct (green arrow), muscular layer (M), blood vessel (Bv). (H&E, 100X).

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P-ISSN: 2410-8863
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