Egyptian Veterinary Medical Society of Parasitology Journal

Original Article

Incidence, Morphometric identification and Histopathological changes of *Eimeria* species infecting domestic pigeons in Giza, Egypt

Fatema A. Gamal[1], Azza M. Abdel-Wahab[1],

Marwa M. Khalifa[1],

Marwa S. Khattab[2]

Ahmed M. Nassar[1]*

[1]Department of Parasitology, Faculty of Veterinary Medicine, Cairo University.

[2]Department of pathology, Faculty of Veterinary Medicine, Cairo University.

***Corresponding author** (drahmednassar22@cu.edu.eg), (drahmednassar22@yahoo.com)

Abstract *Eimeria* spp. is a common protozoan parasite that infects domestic pigeons (*Columba livia domestica*) globally. This study aimed to detect the incidence and morphometric identification of *Eimeria* spp. in domestic pigeons in the Giza governorate, Egypt. Also, the clinical symptoms and histopathological changes in experimentally infected squabs were studied. *Eimeria* spp. was detected in 27.43% of the 350 intestinal samples collected from domestic pigeons. Seasonal incidence revealed that winter had the highest rate of infection (30.68%), while summer had the lowest one (15.66%). Five species of *Eimeria* were identified morphologically as *Eimeria labbeana* (18.75× 16.5 µm), *E. columbarum* (19.5×18.5µm), *E. columbae* (16.25×14µm), *E. columbinae* (14.75×13.25µm) *and E. chalcoptereae* (22.5×21.5µm). This study showed that *E. columbinae and E. chalcoptereae* were morphologically identified for the first time in domestic pigeons in Egypt. The experimentally infected squabs showed ruffled feathers, greenish-watery mucoid diarrhea, weakness and decrease in body weight. The prepatent period was 6 days, while the patent period was 18 days. Histopathological changes of the small intestine's lining epithelium (duodenum, jejunum and ileum) of the experimentally infected squabs revealed severe diffuse enteritis with sloughing of lining epithelium, blood vessels congestion and severe leukocytic infiltration with different *Eimeria* developmental stages.

Key words: *Eimeria* spp., pigeons, incidence, morphology, histopathology

Introduction

Pigeons (*Columba livia*) are reared as a source of food, hobby and recently as laboratory animals **(Santos *et al.,* 2020).** Pigeons are infected with a variety of parasites, including *Eimeria* spp., which is an apicomplexan protozoan parasite causes a disease called coccidiosis **(Aboelhadid *et al.,* 2021).** It is more common in young squabs especially when they are maintained under intensive systems with poor hygienic conditions while adults act as carriers and appear apparently healthy **(Ali *et al.,* 2015).** Pigeon coccidiosis may cause weakness, ruffled feathers, anorexia, greenish watery mucoid diarrhea, decreased in body weight and even mortality particularly in young squabs resulting in economic losses for the pigeon business **(Arafa *et al.,* 2020).** Pigeons were more likely to be infected with mixed *Eimeria* spp. than single one **(Dong *et al.,* 2018).**In Egypt, the incidence rates in different governorates ranged from 10.86% to 77.5% as recorded in Ismailia (**El-Sheshtawy, 1982, Abdallah and Fetaih, 1995 and Ibrahim *et al.*, 1995),** Cairo and Giza (**Ibrahim, 1997** and **Badawy *et al.,* 2008),** Qaliubia (**El-Madawy, 2001),** Sharkia (**Mahdy,1980** and **El-Sayed, 2009),** Gharbia (**Nagwa *et al.,* 2013),** Upper Egypt (**Thabet, 2015**), Qena (**Elseify *et al.,* 2018),** Minia (**Gadelhaq & Abdelaty, 2019)** and Assiut (**Mahmoud, 2015** and **Mahmoud *et al.,* 2021).** Regarding prevalence in other countries, *Eimeria* spp. in pigeons were found in different localities throughout the world with incidence ranging from 5.2 % (**Albogami *et al*., 2023**) to 100 % **(Marques *et al.,* 2007** and **Vijayakumar *et al.,* 2018).** Different *Eimeria* species have been identified by the use of traditional morphological methods in various localities. In Egypt, five *Eimeria* species were detected as *E. labbeana, E. columbarum, E. columbae, E. labbeana like* and *E. gourai* (**Elseify *et al.,* 2018** and **Gadelhaq & Abdelaty, 2019)**. In other countries, the recorded species were *E. labbeana, E. columbarum, E. columbae, E. tropicalis, E. kapotei, E. janovyi, E. livialis, E. sphenocerae, E choudari, E. turturi, E. waiganiensis, E. duculai, E. gourai, E. palumbi, E. curvata, E. mauritiensis E. columbapalumbi* and *E. zenaidae* **(Yang *et al.,* 2016)**. While **Khan *et al.* (2021)** mentioned that nine species of the genus *Eimeria* have been studied globally, but only three (*E. labbeana, E. columbarum and E. columbae*) have been found to be economically significant in pigeons and are distinguished by various levels of pathogenicity. Macroscopic findings showed hemorrhage and congestion in the mucosa of the small and large intestines due to coccidiosis while histopathological changes revealed the presence of different developmental stages of *Eimeria* in enterocytes, necrosis in the intestinal tract ,sloughing of the intestinal villi , destruction of the intestinal glands , congestion and dilatation in the blood vessels (**Saikia *et al.,* 2017, Elseify *et al.,* 2018** and **Santos *et al.,* 2020).**

The current study aimed to update the incidence, morphometric identification and histopathological changes of *Eimeria* spp. infecting domestic pigeons in Giza governorate, Egypt.

Materials and methods

1. Collection of samples

Intestinal samples were collected from 350 domestic pigeons from poultry markets in Giza governorate (29°59′13.2″N, 31°12′42.48″E**)** Egypt from September 2022 to August 2023. Each sample was collected in mini-plastic bags and transported to the parasitology department lab, Faculty of Veterinary Medicine, Cairo University. The intestinal contents were examined for detection of *Eimeria* spp. oocysts on the same day of collection.

2. Laboratory investigations (Soulsby, 1982)

2. A. Examination of the intestinal contents

The intestinal samples of pigeons were opened by a scissor and their contents were investigated microscopically using the concentration floatation technique with a saturated sodium chloride salt solution for detection of the oocysts of *Eimeria* spp.

2. B. Sporulation of *Eimeria* spp. oocysts

The collected *Eimeria* spp. oocysts were washed and incubated at 27^{o}C in medium-sized Petri dishes with a 2.5% aqueous solution of potassium dichromate ($K_2Cr_2O_7$) and monitored every day until complete sporulation**.**

2. C. Morphology of the investigated *Eimeria* spp. oocysts

The morphological features of 100 *Eimeria* spp. oocysts were studied using a light microscope and their measurements were recorded using a calibrated ocular micrometre. The morphological characteristics of the sporulated oocysts in this study were compared to the published data of other *Eimeria* spp. previously recorded in pigeons and the taxonomic review provided by **Ortúzar-Ferreira *et al.* (2020)**. The morphological features (oocyst shape, presence/absence of micropyle, oocyst residuum, sporocyst residuum and polar granules) were used in the identification of the investigated *Eimeria* spp. oocysts.

3. Experimental design

3. A. Preparation of the inoculum

The sporulated *Eimeria* oocysts were washed with distilled water three times and counted using the McMaster technique for preparation of the inoculum for experimental infection (**Soulsby, 1982).**

3. B. Experimental infection

Twenty-five apparently healthy squabs (3 weeks old) were obtained from a poultry market in Giza, Egypt. The squabs were maintained indoors in well-ventilated cages with food and water ad libitum. The squabs were examined daily by flotation technique for 7 days to ensure that they were free from any parasitic infection. Twenty squabs were inoculated orally, each with 3×10^4 sporulated *Eimeria* spp. oocysts (**Qudoos *et al.*, 2020)**. Five squabs were kept as a non-infected negative control. The experimentally infected and non-infected squabs were observed daily to record the clinical signs and their feces were examined daily to record the

pre-patent and patent periods of infection. Tissue specimens were collected from the duodenum, jejunum and ileum of infected and noninfected squabs, sacrificed at 2 days, 7 days, 8 days and 9 days post-infection (PI) and fixed in formalin 10% for histopathology.

4. Pathological studies

4. A. Gross pathology

Each infected and non-infected squab was observed in situ post-mortem. The intestines were examined to record the lesions due to coccidiosis.

4. B. Histopathology

Tissue specimens were prepared from duodenum, jejunum and ileum, of infected and non-infected squabs then fixed in 10 % neutral buffered formalin. The tissues were processed by ascending concentrations of ethanol and xylene and embedded in paraffin wax. Tissue sections (4µm thickness) were made by rotary microtome (Leica 2135) and stained by hematoxylin and eosin stain (H&E) (**Carleton *et al.,* 1967**). The jejunum tissue sections were stained by Periodic acid-Schiff (PAS) **(Suvarna *et al.,* 2018**) at different time intervals. A light microscope with a fixed digital camera was used for examination and capturing photomicrographs.

Results

1. Incidence of *Eimeria* spp. in examined domestic pigeons

Examination of 350 intestinal samples of domestic pigeons collected from Giza governorate revealed that the incidence of *Eimeria* spp. was 27.43% (96/350). Seasonal incidence showed that winter had the highest rate (35.58%) while the lowest one was in summer (15.66%) (Table1 & Fig.1).

2. Morphology of the investigated *Eimeria* spp. oocysts

The morphometric characteristics of the detected *Eimeria* species were compared with the recorded characters in the original descriptions, it was found that five species were identified as *E. labbeana, E. columbarum, E. columbae, E. columbinae and E. chalcoptereae*. Their oocysts had variable shapes including spherical, subspherical and ovoid, with measurements ranging from 13–24 µm in length to 12–23 µm in width with an average size of 20.5×17.4 µm. Their morphological features are summarized in Table 2. The unsporulated oocysts had different sizes and shapes (Fig.2.A&B). The investigated *Eimeria* spp. oocysts were sporulated at 48-72 hours. The morphology of the detected *Eimeria* spp. oocysts as following: *E. labbeana* oocysts were subspherical to ovoid in shape. It had an average size of 18.75 x 16.5 µm and no micropyle. Oocyst residuum was absent but polar granules and sporocyst residuum were present (Fig.3.A). *E. columbarum* oocysts were larger than *E. labbeana;* their average size was 19.5 x 18.5 µm, with a spherical to subspherical shape and no micropyle. The oocyst residuum was absent, with the presence of polar granules and sporocyst residuum (Fig. 3.B). *E. columbae* oocysts had 14.25 x 13.25 µm average size and were spherical in shape without micropyle. The sporulated oocysts had oocyst and sporocyst residuum and no polar granules (Fig.

3.C). *E. columbinae* had subspherical to ellipsoidal oocysts, 14.75 × 13.25 µm average size and with inconspicuous micropyle, but noticeable as an invagination of the inner layer. The oocystic and sporocyst residuum were present but no polar granule was found (Fig. 3.D). *E. chalcoptereae* oocysts were subspherical, had the largest size (22.5 × 21.5 µm) in comparison with the detected *Eimeria* spp., the micropyle was present but inconspicuous. The oocyst residuum was absent, sporocyst residuum and polar granules were present (Fig. 3.E).

3. Experimental infection

Experimental infection was performed in apparently healthy squabs by inoculation of 3×10^4 mixed *Eimeria* spp. oocysts. The pre-patent period was 6 days. The patent period was 18 days (end of the experiment). No *Eimeria* spp. oocysts were detected in the droppings of the negative control group and they appeared healthy during the experiment. The experimentally infected squabs exhibited signs of infection as weakness, ruffled feathers, low feed intake, decreased body weight and greenish watery mucoid droppings.

4. Pathological findings

4. A. Gross pathology

The gross pathological findings observed in experimentally infected squabs included congested blood vessels, prominent intestinal thickening due to increased mucus production in the intestinal lumen in addition to necrotic and hemorrhagic lesions.

4. B. Histopathology

Microscopy of the duodenum of squabs in the control group revealed normal histological structure (Fig.4.A). The duodenum of the infected group showed at 2 days PI, acute severe diffuse enteritis in which the lamina propria was severely infiltrated by leukocytes leading to thickening of intestinal villi (Fig.4.B). After 7 days PI, the inflammation was slightly regressed however blood vessels were congested, the lining epithelium was sloughed and the intestinal villi were indistinct (Fig.4.C). After 8 days PI, different developmental stages of *Eimeria* were observed in hyperplastic epithelium lining of intestinal villi of duodenum (Fig.4.D). After 9 days PI, hyperplasia of the lining epithelium with *Eimeria* stages were observed (Fig.4.E).

Microscopy of the squabs jejunum revealed normal histological structure in the control group (Fig.5.A). The infected group showed at 2 days PI, mild diffuse enteritis in the jejunum (Fig.5.B). At 7 days PI, severe diffuse enteritis was observed with epithelial sloughing and indistinct intestinal villi (Fig.5.C). At 8 and 9 days PI, different developmental stages of *Eimeria* spp. were observed in the hyperplastic epithelium lining the intestinal villi with leukocytes infiltrating the lamina propria (Fig.5.D.E.). Different stages of *Eimeria* spp. were stained positive by PAS in the lining epithelium of jejunum at different time intervals (Fig.6).

Microscopy of the ileum of squabs revealed normal histological structure in the control group (Fig.7.A). The infected group showed at 2 days PI, hyperplasia

of lining epithelium of ileum and mild leukocytes infiltration (Fig.7.B). At 7 days PI, histopathology of ileum revealed acute severe diffuse enteritis with sloughing of lining epithelium, blood vessels congestion and severe leukocytic infiltration (Fig.7.C). At 8 days PI, different developmental stages of *Eimeria* spp. were observed in the lining epithelium of ilium (Fig.7.D). At 9 days PI, few stages of *Eimeria* spp. were seen in the lining epithelium (Fig.7.E).

Discussion

The current study found that the incidence of *Eimeria* spp. in domestic pigeons in Giza governorate was 27.43% (96/350).While **Ibrahim (1997)** and **Badawy *et al.* (2008)** recorded that the incidence in the same governorate was 77.5% and 52% respectively. Our finding was nearly identical to the incidence rates reported in other Egyptian governorates by **Ibrahim *et al.* (1995), El-Madawy (2001) and Gadelhaq & Abdelaty (2019)** which were 29.5%, 28.7%, and 27% in Ismailia, Qaliubia, and Minia governorates, respectively. It was lower than that of **El-Sayed (2009) , Nagwa *et al.* (2013)** and **Elseify *et al.* (2018)** who recorded 49.38%, 34.2% and 58.3% in Sharkia, Gharbia and Qena governorates respectively. In contrast, our results were higher than those reported by **Abdallah and Fetaih (1995) Mahmoud (2015)** and **Thabet (2015)** who reported incidence rates of 23.4%, 10.86% and 12.6% in Ismailia, Assiut and Upper Egypt (Assiut and Sohag and El-Wady El-Gadid) governorates respectively. Furthermore our results were relatively similar to those reported worldwide in other countries, in India, **Bandyopadhyay *et al.* (2006)** (28.96%), Nigeria, **Opara *et al*. (2012)** (28%) and Bangladesh, **Islam *et al*. (2017)** (29.23%)**.** While our results were higher than the reported findings in Iran (21.6%, **Bahrami *et al*., 2012**), South Korea (19.2%, **Kim *et al.,* 2015**), Nigeria (19.44%, **Mohammed *et al.*, 2017** and 18%, **Dikwa *et al.,* 2023),** Iraq (8.1%, **Aljoburi *et al*., 2019** and 14%**, Alasadiy *et al.,* 2022)** and Saudi Arabia (5.2%, **Albogami *et al*., 2023)**. On the other hand, it was lower than those from Turkey (59.6%, **Sari *et al.,* 2008** and 67.58%**, Gül *et al.,* 2009**)**,** Iran (40.19%, **Radfar *et al*., 2012**), India (77%, **Parsani *et al*., 2014** and 58.3%, **Mehmood *et al*., 2019),** Iraq (84%, **Ali *et al.,* 2015** and 42%, **Amin and Kakabwa, 2019**), China, (91.4%, **Li *et al.,* 2016** and 52.8%, **Dong, *et al.,* 2018**), Nigeria (40.6%, **Joseph *et al.,* 2017),** Libya (72%, **Al-Agouri *et al.,* 2021)** and Pakistan (88.8%, **Khan *et al.,* 2021).** Variation in incidence rates may be due to several factors such as the site of samples, number of samples, age of the pigeons, environmental conditions, hygiene measures and preventative programs.

Regarding the seasonality of *Eimeria* spp. infection in pigeons, this study found that the highest incidence was in winter (35.58%) while the lowest one was in summer (15.66%). Our findings agreed with **Nagwa *et al.* (2013**)*,* **Elseify *et al.* (2018)** and **Gadelhaq & Abdelaty (2019)** in Egypt who recorded that winter had the highest infection rates (42%, 75.6% and 33.33% respectively). On the other hand, **Latif *et al.* (2016),** in Pakistan, mentioned that

the incidence of coccidiosis in pigeons increased with the high temperature. Although coccidiosis was recorded during all seasons of the year, these differences may be caused by climate changes, fluctuating temperatures and humidity that may act as stress conditions for the birds.

In the present study, five species were detected in domestic pigeons in Giza governorate, Egypt (*E. labbeana, E. columbarum, E. columbae, E. columbinae and E. chalcoptereae*) while **Ibrahim (1997) and Badawy *et al.* (2008)** recorded only two species of *Eimeria* in the same governorate (*E. labbeana* and *E. columbae*). On the other hand, the previous studies in different Egyptian governorates revealed the presence of *E. columbae* only (**Ibrahim *et al.,* 1995**), two species of *Eimeria*; *E. labbeana* and *E. columbae* **(El-Sheshtawy, 1982, Abdallah and Fetaih, 1995, El-Sayed, 2009** and **Nagwa *et al.,* 2013**). While four species of *Eimeria* were recorded by **Elseify *et al.* (2018)** (*E. labbeana, E. columbarum, E. columbae* and *E. gourai*) and **Gadelhaq & Abdelaty (2019)** (*E. labbeana, E. columbarum, E. columbae* and *E. labbeana like*).

Morphological identification of *Eimeria* spp. oocysts infecting pigeons depended on their morphometric characters. Five species of *Eimeria* were identified morphologically in this study as *E. Labbeana* (18.75 × 16.5 µm), *E. columbarum* (19.5 × 18.5 µm), *E. columbae* (16.25 × 14 µm), *E. columbinae (*14.75 × 13.25 µm) *and E. chalcoptereae* (22.5 × 21.5 µm). These measurements were nearly similar to those reported by the original authors, **Pinto (1928), Nieschulz (1935), Mitra and Das Gupta (1937), Ortúzar-Ferreira *et al*. (2020)** and **Yang *et al*. (2020)** respectively. For *E. labbeana*, which was originally described by **Pinto (1928)**, as cited by **Yang *et al.* (2016)** who mentioned that only oocyst and sporocyst measurements were available, no other features were recorded in the original report of **Pinto (1928).** The *E. labbeana* oocysts detected in our study were subspherical to ovoid in shape. No micropyle or oocyst residuum was found, but polar granules and sporocyst residuum were present. These results agreed with **Nieschulz (1935), Ibrahim (1997)** and **Badawy *et al.* (2008).**

Regarding *E. columbarum* oocysts, they were spherical to sub spherical in shape and without micropyle. Polar granule was present. Oocyst residuum was absent while sporocyst residuum was present. Similar morphological findings were reported by **Nieschulz (1935)** and **Gadelhaq & Abdelaty (2019)** in addition to **Elseify *et al*. (2018)** who described only the shape, dimensions and the micropyle which were similar to present finding**.** While *E. columbae* oocysts were smaller in size as compared with *E. labbeana* and *E. columbarum*, spherical in shape without micropyle, had oocyst and sporocyst residuum, but had no polar granules. Similar results were reported by **Mitra and Das Gupta (1937), Badawy *et al.* (2008)** and **Gadelhaq & Abdelaty (2019)**. Oocysts of *E. columbinae* had inconspicuous micropyle, oocystic and sporocyst residuum, but no polar granules were found. This description was similar to that reported by **Ortúzar-Ferreira *et al*.**

(2020). *E. chalcoptereae* oocysts had the largest *Eimeria* spp. size detected in the present study and the micropyle was present. No oocyst residuum, but sporocyst residuum and polar granules were present. This description was agreed with **Yang *et al*. (2020)**. So, in the present study *E. columbinae and E. chalcoptereae* were morphologically identified in domestic pigeons for the first time in Egypt. The above mentioned *Eimeria* spp. descriptions revealed that there was a considerable variety in measurements, shapes and internal characteristics of sporulated oocysts which indicate the presence of mixed infection with *Eimeria* spp. This assumption agreed with **Dong *et al.* (2018)** who stated that mixed infections with two or five *Eimeria* species were more common than infections with a single one. The variation in the descriptions of *Eimeria* spp. supposed by different authors may be due to stress conditions, nutrition and immune status of the bird, infective dose and use of anticoccidial drugs (**Ortúzar-Ferreira *et al.,* 2024**).

Concerning the experimental infection, the pre patent period was 6 days. These findings were in agreement with **El-Sayed (2009)** and **Aboelhadid *et al.* (2021)**.While **Saikia *et al.* (2017)** and **Abdel-Gaber *et al.* (2023)** recorded that the prepatent period was five days post infection. Concerning the patent period in this study, it was 18 days (end of the experiment) while it was 14 days (**Aboelhadid *et al.,* 2021** and **Abdel-Gaber *et al.,* 2023)** and 21 days (**El-Sayed, 2009**). These variations may be due to the age and immune status of the pigeons, infection dose and virulence of *Eimeria* strain.

The observed clinical signs in experimentally infected squabs in this study involved weakness, ruffled feathers, low feed intake, decreased body weight and greenish-watery mucoid droppings. Similar findings were observed by **Mahdy (1980)**, **Saikia *et al.* (2017), Arafa *et al.* (2020), Aboelhadid *et al.* (2021)** and **Abdel-Gaber *et al.* (2023)**.

The histopathological changes detected in the duodenum, jejunum and ileum of the experimentally infected squabs revealed severe diffuse enteritis with sloughing of lining epithelium, blood vessels congestion and severe leukocytic infiltration with different *Eimeria* developmental stages.These findings were nearly similar to those recorded in pigeons by **Saikia *et al.* (2017), Elseify *et al.* (2018)** and **Arafa *et al.* (2020).**

Conclusion

The current investigation recorded that the incidence of *Eimeria* spp. was 27.43% in the examined 350 domestic pigeons. Seasonal incidence revealed that winter had the highest rate of infection (30.68%), while summer had the lowest one (15.66%). Five species of *Eimeria* were identified morphologically; *E. labbeana*, *E. columbarum*, *E. columbae*, *E. columbinae and E. chalcoptereae.* To the best of our knowledge, this is the first record of *E. columbinae* and *E. chalcoptereae* in domestic pigeons in Egypt. Further molecular approach will be accomplished for confirmation of the identified *Eimeria* spp. morphologically.

Ethical statement

Approved by the Institution Animal Care and Use Committee (IACUC-Vet-CU-09092023773) of Cairo University's Faculty of Veterinary Medicine.

Conflict of Interest

The authors declare no competing interests.

Table 1: Seasonal incidence of *Eimeria* spp. infecting domestic pigeons.

Seasons	Intestinal samples		
	Examined	Infected	Positive %
Autumn	88	27	30.68%
Winter	104	37	35. 58%
Spring	75	19	25.33%
Summer	83	13	15.66%
Total	350	96	27.43 %

Table 2: Morphometric measurements and morphology of *Eimeria* spp. oocysts detected in the current study

Eimeria spp.	Measurements			Morphology					
	Length (µm)	Width (µm)	L/W ratio	Shape	Micropyle	Oocystic residuum	Sporocystic residuum	Polar granules	References
E. labbeana	17- 20.5 (18.75)	15-18 (16.5)	1.14	Subspherical to ovoid	-	-	+	+	Pinto, 1928 and Nieschulz, 1935
E. columbarum	18 - 21 (19.5)	17-20 (18.5)	1.05	Spherical to subspherical	-	-	+	+	Nieschulz, 1935
E. columbae	14.5- 18 (16.25)	12-16 (14)	1.2	Spherical	-	+	+	-	Mitra and Das, 1937
E. columbinae	13-16.5 (14.75)	12.5-14 (13.25)	1.1	subspherical to ellipsoidal	+ (inconspicuous)	+	+	-	Ortúzar-Ferreira *et al.,* 2020
E. chalcoptereae	21-24 (22.5)	20-23 (21.5)	1.05	Subspherical to spherical	+ (inconspicuous)	-	+	+	Yang *et al.,* 2020

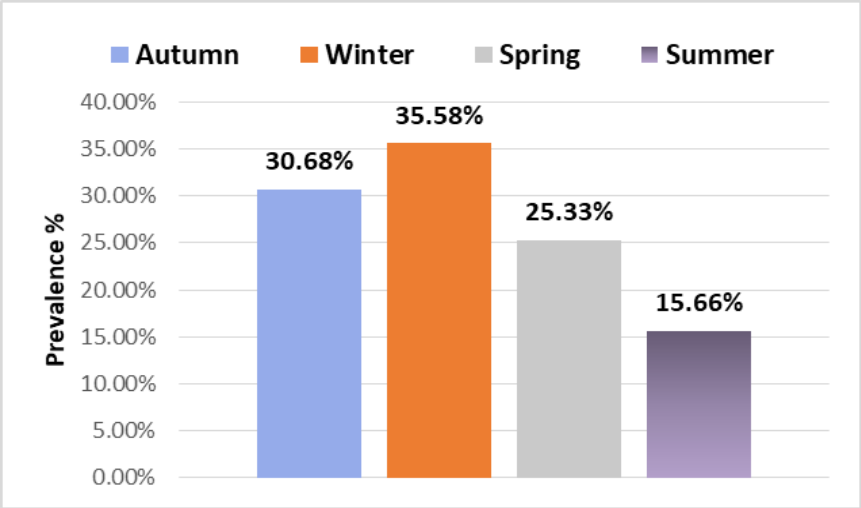

Fig. 1: Seasonal incidence of *Eimeria* spp. infecting domestic pigeons.

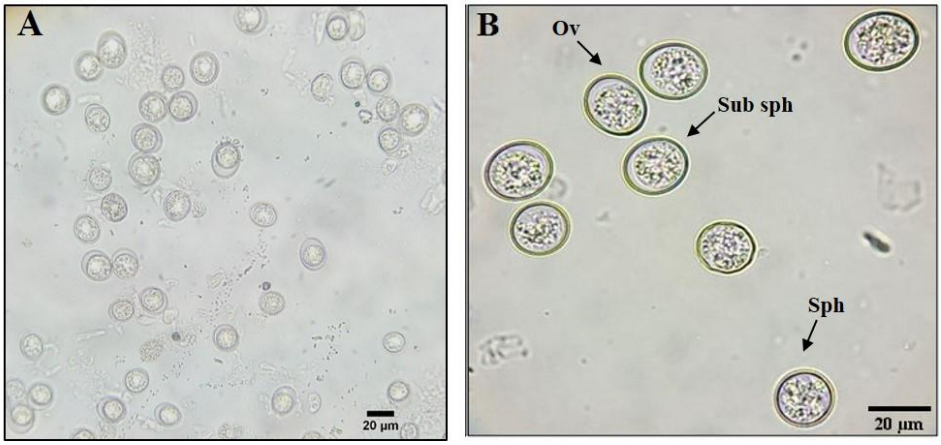

Fig. 2: Photomicrographs of unsporulated oocysts of *Eimeria* spp. showing different shapes and sizes (A):100x , (B): 400x, (Sph: spherical, Sub sph: subspherical, Ov: ovoid).

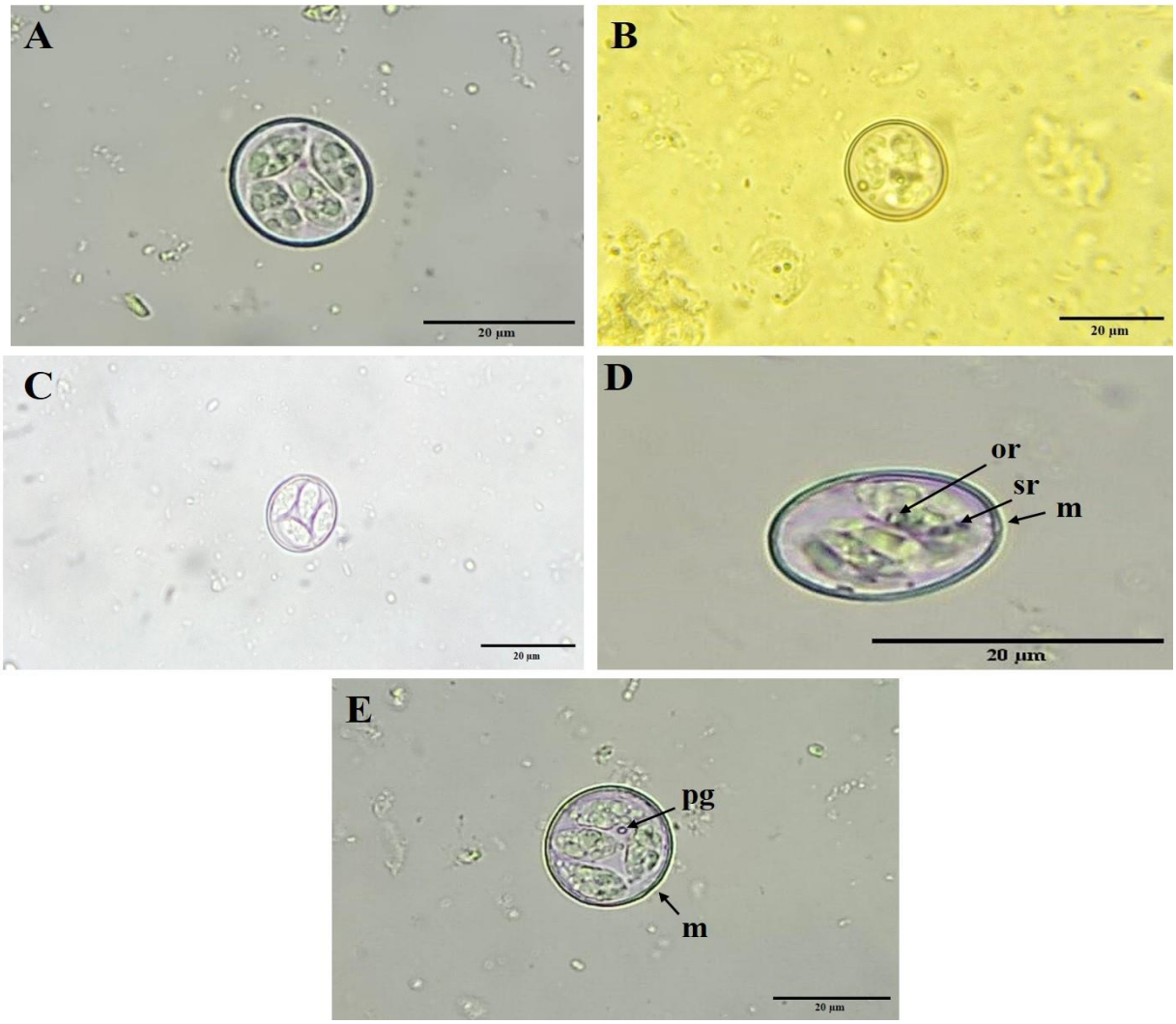

Fig. 3: Photomicrographs of sporulated oocysts of *Eimeria* spp. infecting pigeons (A): *E. labbeana*, (B): *E. columbarum*, (C): *E. columbae*, (D): *E. columbinae* and (E): *E. chalcoptereae*. (m: micropyle,or: oocyst residuum, sr: sporocyst residuum and pg: polar granule).

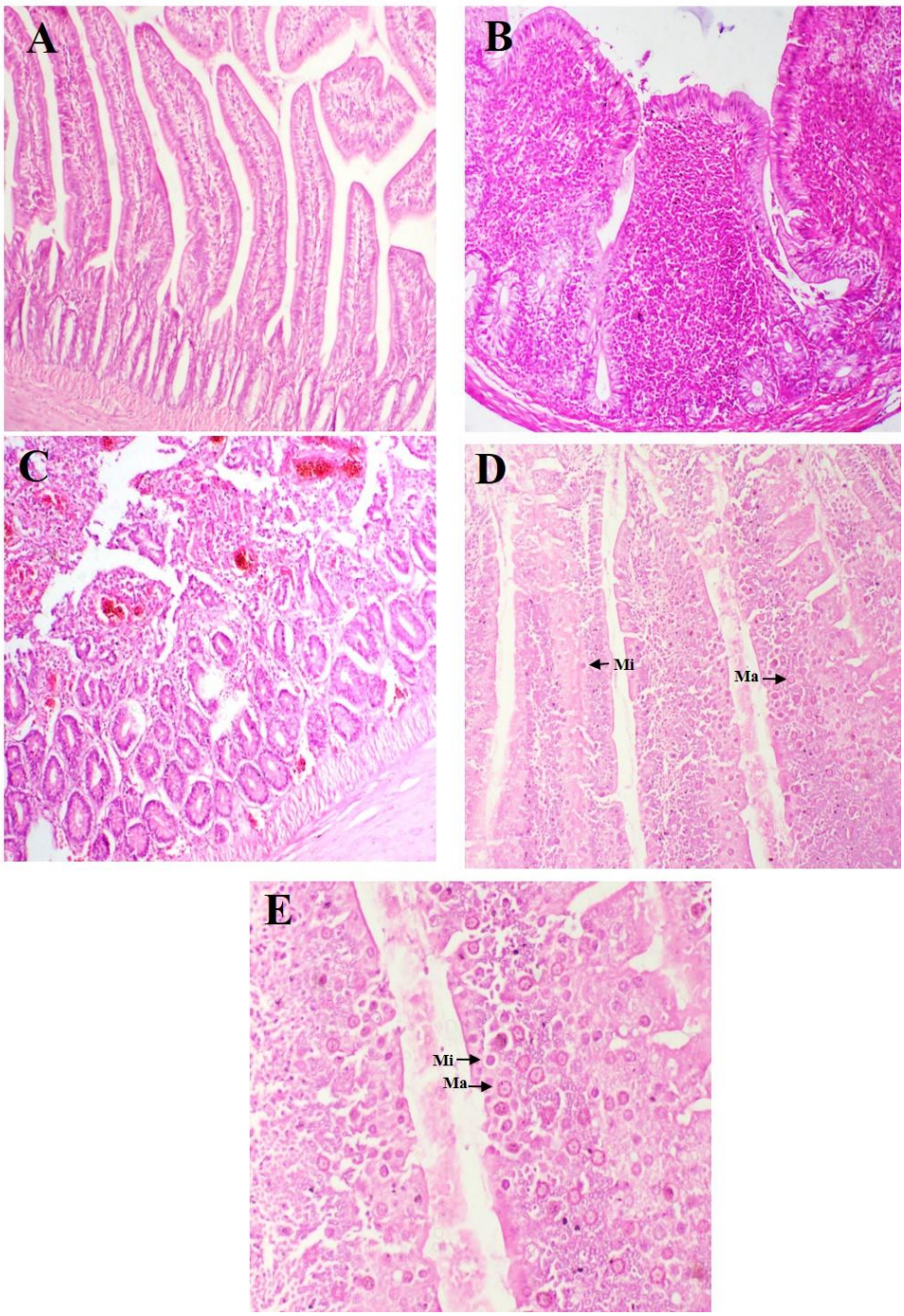

Fig. 4: Duodenum of squabs showing histopathology changes at different time intervals. (A) Normal histological structure of duodenum in the control group. (B) Acute severe diffuse enteritis in the duodenum of infected group after 2 days PI. (C) Sloughing of lining epithelium, congestion, and leukocytic infiltration of the submucosa at 7 days PI. (X100) (D) Different stages of *Eimeria* spp. in hyperplastic epithelium lining intestinal villi at 8 days PI. (E) Hyperplastic lining epithelium with few *Eimeria* spp. stages at 9 days PI (X400). Ma: macrogametocyte, Mi: microgametocyte. H&E stain.

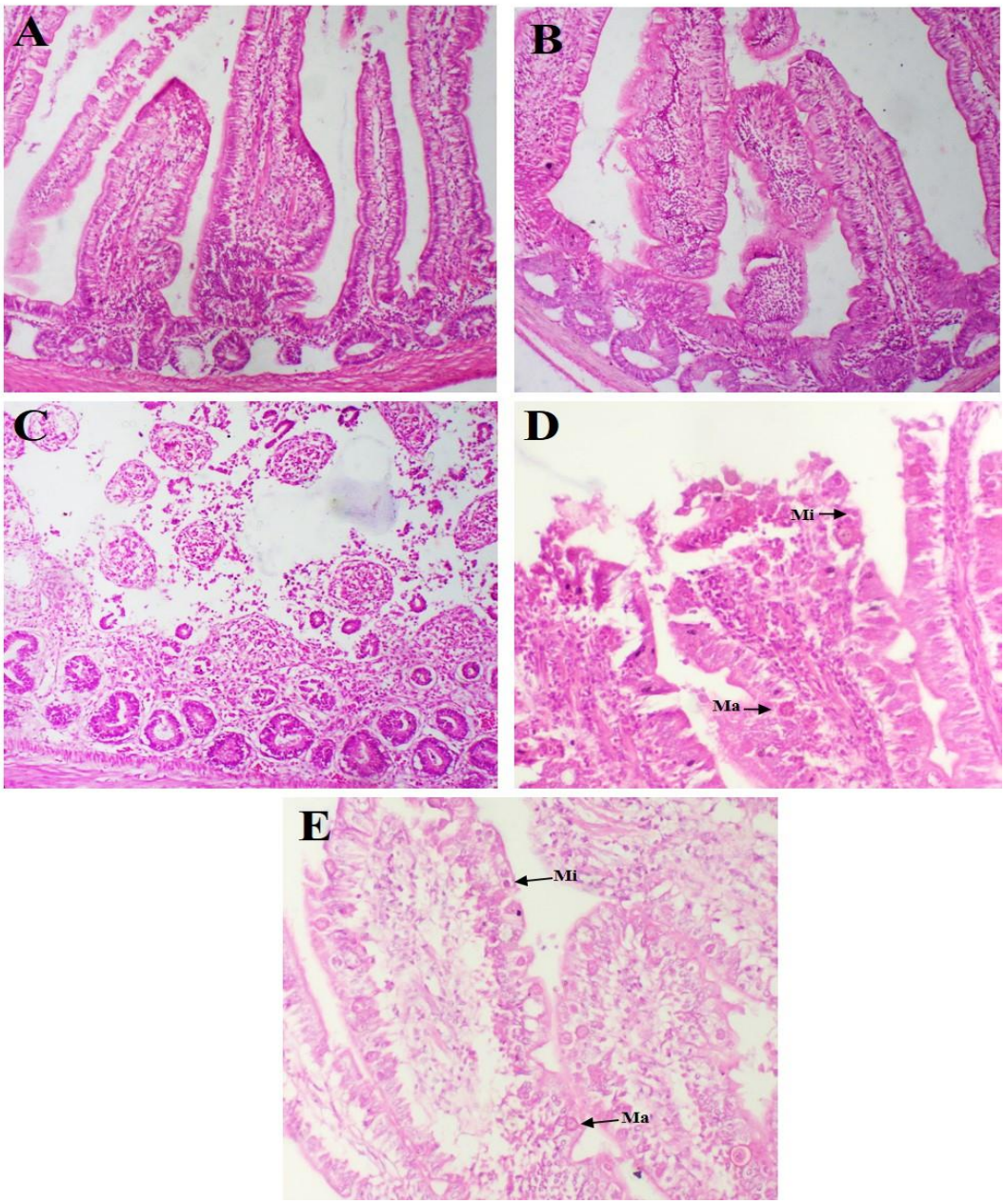

Fig. 5: Jejunum of squabs infected with *Eimeria* spp. at different time intervals. (A) Normal histological structure of intestinal villi in control group. (B) Mild diffuse enteritis after 2 days PI. (C) Severe diffuse enteritis with epithelial sloughing at 7 days PI. (X100) (D, E) different stages of *Eimeria* spp. in the lining epithelium at 8 and 9 days PI. Ma: macrogametocyte, Mi: microgametocyte**.** H&E stain (X400).

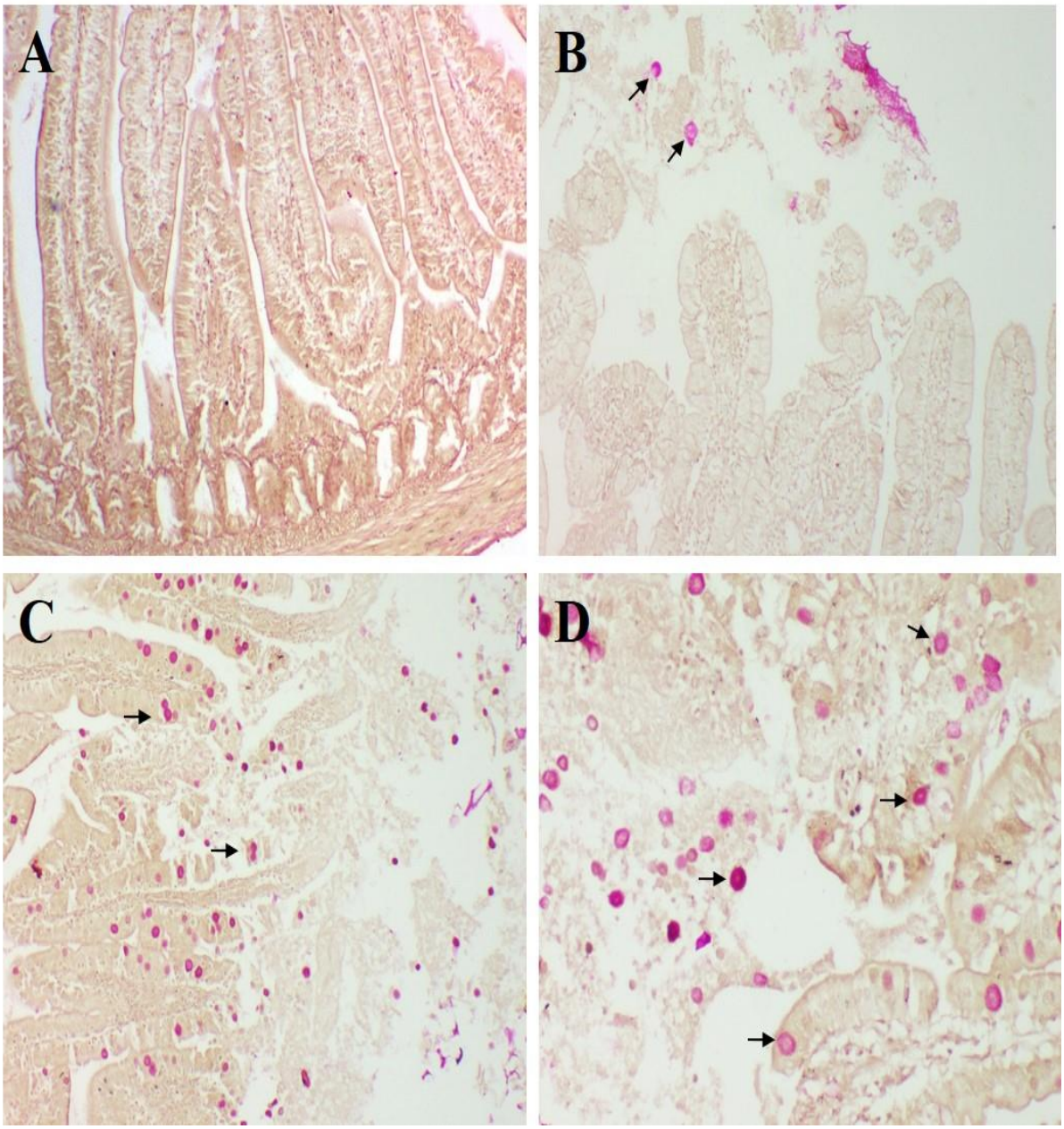

Fig. 6: Jejunum of squabs infected by *Eimeria* spp. at different time intervals stained by PAS. (A) At 2 days PI. (B) At 7 days PI. (C) At 8 days PI (X200). (D) At 9 days PI (X400). Arrows refer to different developmental stages of *Eimeria* spp.

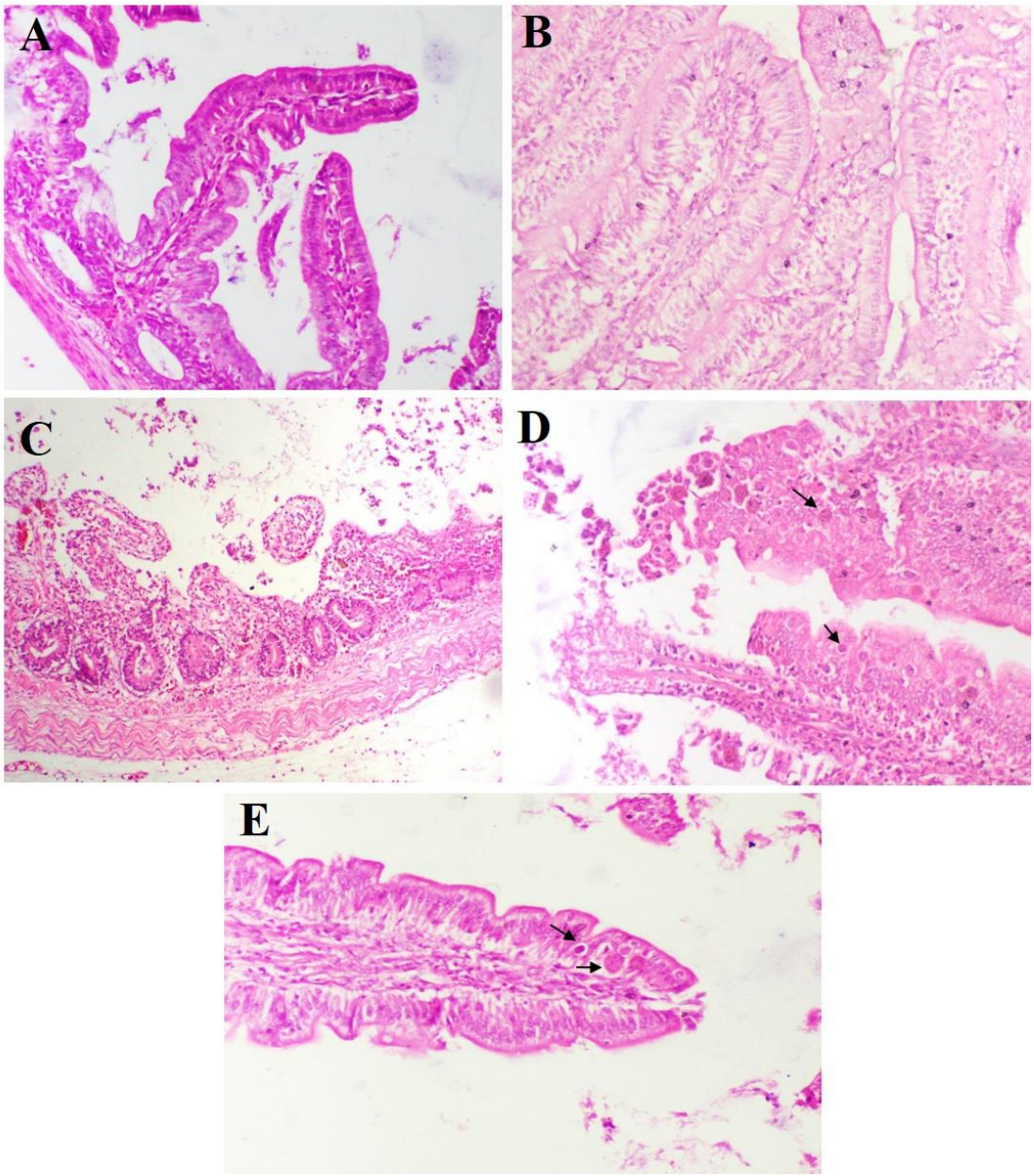

Fig. 7: Ileum of squabs at different time intervals. (A) Normal histological structure in control group (X100). (B) Epithelial hyperplasia and few leukocytic infiltration at 2 days PI (X400). (C) Acute severe diffuse enteritis with sloughing of lining epithelium at 7 days PI (X100). (D, E) Different stages of *Eimeria* spp. in the lining epithelium at 8 days PI and 9 days PI (X400). Arrows refer to different developmental stages of *Eimeria* spp. H&E stain.

References

Abdallah, O., and Fetaih, H. (1995): Clinicopathological and histopathological studies on coccidiosis in pigeons. Egyptian journal of comparative pathology and clinical pathology, 8: 100-107.

Abdel-Gaber, R., Quraishy, S. A., Al-Hoshani, N., Al-Shaebi, E. M., Mohammed, O. B., Marey, A., and Dkhil, M. (2023): Observations of the coccidian infection, Eimeria labbeana-like, in

experimentally infected domestic pigeons (Columba livia domestica) associated with pathology-ical `effects. Arquivo Brasileirode Med-icina Veteriná riae Zootecnia, 75(6): 1127-1135.

Aboelhadid, S. M., Arafa, W. M., Abdelaty, A. S., Moawad, U. K., El-Ashram, S., and Gadelhaq, S. M. (2021): Remarks on *Eimeria labbeana* infection in domestic pigeons "Columbia livia domestica." Journal of Parasitic Diseases, 45(4): 1145–1151.

Al-Agouri, S., Alrwab, N., Amgawer, H., Sadaga, G., and Alshelmani, M. I. (2021): Prevalence of coccidia in domestic pigeons (Columba livia domestica Gmelin, 1789) in Benghazi city, Libya. Aceh Journal of Animal Science, 6(2): 52-56.

Alasadiy, Y. D. K., Mukdad, R. M., and Alhasnawi, A. N. (2022): A comparative study of parasitic infections in domestic and wild pigeons in Iraq. Archives of Razi Institute, 77(2): 709-715.

Albogami, B., Hassan, N. A., Mansour, A. M. and Hussien, N. A. (2023): Prevalence of Intestinal Parasites Infesting Domestic Pigeons with Histopathological Changes at Taif Governorate, KSA. Egyptian Journal of Veterinary Sciences, 54(3): 433-443.

Ali, J. K., Alewi, H. H., and Sawdi, H. A. (2015): Treatment of natural infection in pigeons birds with coccidiosis by using ginger extract in Babylon province. Kufa Journal for Veterinary Medical Sciences, 6(1): 15-21.

Aljoburi, A. M. H., Jassim, N. A. and Hasan. I. I. (2019): Detection of the parasites which infect the pigeons in the Sharqat City, Salah Al-Deen province. Assiut Veterinary Medical Journal, 65(160): 25-30.

Amin, O. M., and Kakabwa, S. R. (2019): Prevalence of gastrointestinal parasites in domestic pigeons and backyard chickens in Kalar and Khanaqin districts, Iraq. Journal of Garmian University, 6 (SCAPAS Conferance): 1-7.

Arafa, W. M., Abolhadid, S. M., Moawad, A., Abdelaty, A. S., Moawad, U. K., Shokier, K. A., Shehata, O., and Gadelhaq, S. M. (2020): Thymol efficacy against coccidiosis in pigeon (Columba livia domestica). Preventive veterinary medicine, 176: 104914.

Badawy, B. A., Tantawy, L. A. and Youssef, A. I. (2008): Parasitological and pathological field investigations in pigeons. 13th Sci. Cong. Fac. Vet. Med.Assiut Univ., Egypt, 253–276.

Bahrami, A. M., Monfared, A. L., and Razmjoo, M. (2012): Pathological study of parasitism in racing pigeons: An indication of its effects on community health. African Journal of Biotechnology, 11(59): 12364 - 12370.

Bandyopadhyay, P. K., Bhakta, J. N., and Shukla, R. (2006): A new *Eimeria* species (Protozoa: Apicomplexa: Sporozoea) from the blue rock pigeon Columba livia (Aves: Columbidae). Zoos' Print Journal, 21(9): 2386-2387.

Carleton, H. M., Brownsword Drury, R. A., and Wallington, E. A. (1967): Carleton's Histological technique (4thed.), Oxford University Press, New York.

Dikwa, K. B., Bukar, M. F., and Vantsawa, P. A. (2023): Detection and morphological identification of *Eimeria* species in migratory birds and chickens in some poultry farms in Kaduna north lga of Kaduna state. Fudma journal of sciences, *7*(3): 215-222.

Dong H., Zhao Q., Zhu S., Han H., and Huang B. (2018): Prevalence of *Eimeria* infection in domestic pigeons (Columba livia domestica) in Shanghai, China. J. Vet. Med. Res. 5(8): 1155.

El-Madawy, R.S. (2001): Studies on some protozon parasites in birds M.Vet.Sci. Thesis, Fac. Vet. Med Zagazig University, Egypt.

El-Sayed, K. M. (2009): Field survey on coccidiosis in pigeons in Sharkia Governorate. M.V. Sc. Thesis, Fac. Vet. Med. Cairo Univ.

Elseify, M. A., Metwally, A., Mahmoud, S., and Abdelrheem, E. (2018): Prevalence of coccidia infection among domestic pigeon (Columba livia domestica) and quails (coturnix ypsilophora) in Qena province, southern Egypt. Kafrelsheikh veterinary medical journal, 16(2): 1-21.

El-Sheshtawy, E.A. (1982). Incidence of pigeons coccidiosis and the effect of some coccidial drugs. M.D. Thesis, Assuit Univ. Dept. of Vet. Med. And Poult. Dis.

Gadelhaq, S.M. and Abdelaty, A.H. (2019): The occurrence and distribution pattern of *Eimeria* species among domestic pigeons in Minia, Egypt. Journal of Veterinary Medical Research, 26(2): 164-173.

Gül, A., Özdal, N., Değer, S., and Denizhan, V. (2009): Prevalence of coccidia and helminth species in domestic pigeons (Columba livia domestica) in Van. Yüzüncü yıl Üniversitesi Veteriner Fakültesi Dergisi, 20(2): 45-48.

Ibrahim, A. I., Hassanin, H. H., Aly, S. E. M., and Abdel Aal, A. A. (1995): A study on some parasitic affections in domestic pigeons in Ismailia province. Assiut Veterinary Medical Journal, 34(67): 153-161.

Ibrahim, M. F. (1997): Studies on *Eimeria* species infesting pigeons. Ph.D. Fac. Vet. Med., Cairo Univ.

Islam, T., Uddin, F., Hossain, M. A., Rana, M. S., Rahman, M. U., Roy, A. K., and Rahman, M. M. (2017): Prevalence of gastro-intestinal protozoan infestation of pigeon at Sylhet District in Bangladesh. Journal of Wildlife Research, 5(02): 24-27.

Joseph, J., Emmanuel, W. B., Yafeh, V. A., and Ndimkaoha, I. O. (2017): *Eimeria* species oocyst morphometry and prevalence of Infection in domesticated pigeon (Columba livia domestica) in Maiduguri Metropolis Borno State, Nigeria. African Journal of Parasitology Research, 4(8): 244-248.

Khan, W., Das, S. N., Mahmoud, A. H., Rafique, N., Anwar, K., Khan, B. T., Ullah, I., Khan, M., Gul, S., Gul, R., and Mohammed, O. B. (2021): Evaluation of sulfadimidine, amprolium and triquen to treat coccidiosis in wild pigeons. Braz J Biol, 82, e238673.

Kim, S.M., Lee, S.E., Kim,N., Kim, H., Kim, Y., Lee, J.,Cho,S.H.,Lee,W.J.,Park, B.K., Jung, B.D., and Kim, H. C. (2015): Parasites of feral pigeon (Columba livia) by fecal examination from some areas in Seoul, Korea. *Korean* Journal of Veterinary Service, 38(2): 77-81.

Latif, A. A., Fazal, S., Manzoor, F., Maqbool, A., Asghar, S., Wajid, I., and Ashraf, A. (2016): A comparative study on prevalence of coccidian parasites in broiler chicken (Gallus gallus domesticus), Japanese quail (Coturnix coturnix japonica) and wild pigeon (Columba livia). Pakistan Journal of Zoology, 48(1): 295-297.

Li J., Lin X., Wu C., Liao S., Qi N, Lv M. and Sun M. (2016): High Prevalence of *Eimeria* infection in Domestic Pigeons (Columba Livia Domestica) in Guangdong Province, Southern China. Agricultural Science & Technology, 17(1): 115-116.

Mahdy, M.S. (1980): Identification and some biological studies on coccidiosis of pigeons in Sharkia governorate. M.V.Sc. Thesis (Parasitology), Zagazig Univ.

Mahmoud, W. G., Hassan, E.-S. M., and Abdel Hafez, M. S. (2021): Effect of medicinal plants against intestinal coccidiosis and capillariasis infecting pigeons. Journal of the Egyptian Society of Parasitology, 51(1): 51-54.

Mahmoud, W. G. M., (2015): Pathological and parasitological studies of endoparasites of pigeons in Assuit governorate. Ph.D., Fac. Vet. Med. Assuit Univ.

Marques, S. M. T., De Quadros, R. M., Da Silva, C. J., and Baldo, M. (2007): Parasites of pigeons (*Columba livia*) in urban areas of Lages, southern Brazil. Parasitología latinoamericana*,* 62: 183–187.

Mehmood, S., Nashiruddullah, N., Ahmed, J. A., and Borkataki, S. (2019): Parasitic affections of domesticated pigeons (Columba livia) in Jammu, India. Annals of Parasitology, 65(1): 53-64.

Mitra, A.N., Das-Gupta, M., (1937): On a species of *Eimeria* (Coccidia-Sporozoa) from the intestine of a pigeons, Columba intermedia. Proc. 24th Indian Sci. Cong. Assoc. 24: 291.

Mohammed, B. R., Simon, M. K., Agbede, R. I., and Arzai, A. H. (2017): Coccidiosis of domestic pigeons (Columba livia domestica Gmelin, 1789) in Kano State, Nigeria. Annals of parasitology, 63(3): 199–203.

Nagwa, E. A., El-Akabawy, L. M., El-Madawy, R. S., and Toulan, E. I. (2013): Studies on intestinal protozoa of poultry in Gharbia Governorate. Benha Veterinary Medical Journal, 5(2): 78–83.

Nieschulz, O., (1935): Ueber Kokzidien der Haustauben. Zentralbl Bakteriol Mikrobiol Hyg 134:390–393.

Opara, M. N., Ogbuewu, I. P., Iwuji, C. T., Ihesie, E. K., and Etuk, I. F. (2012): Blood characteristics, microbial and gastrointestinal parasites of street pigeons (Columba livia) in Owerri Imo State, Nigeria. Scientific Journal of Animal Science, 1(1): 14-21.

Ortúzar-Ferreira, C. N., Oliveira, M. S., Andrade, L. D. A. S., de Mello, E. R., Lima, V. M., and Berto, B. P. (2024). Molecular and statistical approaches to the delimitation of Eimeriidae species: a case of extreme polymorphism in eimerian oocysts from the plumbeous pigeon Patagioenas plumbea (Vieillot,1818) (Columbiformes) in South America. Parasitology Research, 123(1): 1-18.

Ortúzar-Ferreira, C. N., Oliveira, M. S., Genovez-Oliveira, J. L., Franco, H. A., Thode-Filho, S., Cardozo, S. V., Oliveira, Á. A., Lima, V. M., Ferreira, I., and Berto, B. P. (2020): Coccidia of Columbiformes: a taxonomic review of its Eimeriidae species and *Eimeria columbinae* n. sp. from Columbina talpacoti (Temminck, 1809) from Brazil. Parasitology Research, 119: 267-281.

Parsani, H. R., Momin, R. R., Lateef, A., and Shah, N. M. (2014): Gastro-intestinal helminths of pigeons (Columba livia) in Gujarat, India. Egyptian Journal of Biology, 16: 63-71.

Pinto, C., (1928): Synonymien de quelques species du genre *Eimeria* (Eimeriida, Sporozoa). C.R. Seance Soc. Biol. Paris 98: 1564–1565.

Qudoos, A., Iqbal, A., Ahmad, S. S., Khan, M. S., and Bayram, İ. (2020): Effects of some alternative plant extracts used as natural coccidiostat for pigeons. Hayvan Bilimi ve Ürünleri Dergisi, 3(1): 20-31.

Radfar, M. H., Asl, E. N., Seghinsara, H. R., Dehaghi, M. M., and Fathi, S. (2012): Biodiversity and prevalence of parasites of domestic pigeons (Columba livia domestica) in a selected semiarid zone of South Khorasan, Iran. Tropical Animal Health and Production, 44: 225–229.

Saikia, M., Bhattacharjee, K., Sarmah, P. C., Tamuly, S., Dutta, B., and Konch, P. (2017): Pathology and molecular detection of coccidiosis in experimentally infected domestic pigeon. Journal of Entomology and Zoology Studies, 5(5): 1841-1845

Santos, H. M., Tsai, C. Y., Catulin, G. E. M., Trangia, K. C. G., Tayo, L. L., Liu, H. J., and Chuang, K. P. (2020): Common bacterial, viral, and parasitic diseases in pigeons (Columba livia): A review of diagnostic and treatment strategies. Veterinary Microbiology, 247, 108779.

Sari, B., Karatepe, B., Karatepe, M., and Kara, M. (2008): Parasites of domestic (Columba livia domestica) and wild (Columba livia livia) Pigeons in Nigde, Turkey. Bulletin of the Veterinary Institute in Puławy, 4(52): 551-554.

Soulsby,E.J.L.(1982):Helminths. Arthropo ds and Protozoa of domesticated animals, 291.

Suvarna, K. S., Layton, C., and Bancroft, J. D. (2018): Bancroft's theory and practice of histological techniques. Elsevier health sciences.

Thabet, M. M., (2015): Some studies on parasitic infestation of domestic pigeons. PhD. Fac. Vet. Med. Assuit Univ.

Vijayakumar, S., Dhandapani, K., and Ravi, R. (2018): Incidence and management of parasitic diseases amongst pigeon (Columba livia) population. Intas Polivet, 19(2): 354-356.

Yang, R., Brice, B., Berto, B. P., and Ryan, U. M. (2020): Morphological and genetic characterization of *Eimeria chalcoptereae* n. sp. (Apicomplexa: Eimeriidae) in a common bronzewing pigeon (Phaps chalcoptera) (Latham, 1790) in Western Australia. Parasitology Research, 119: 3729-3737.

Yang, R., Brice, B., Elloit, A., and Ryan, U. (2016): Morphological and molecular characterization of *Eimeria labbeana-like* (Apicomplexa: Eimeriidae) in a domestic pigeon (Columba livia domestica, Gmelin, 1789) in Australia. Exp Parasitol, 166: 124-130.

دراسة نسبة الإصابة والوصف المورفولوجى والتغيرات النسيجية المرضية لأنواع الأيميريا التي تصيب الحمام المستأنس في الجيزة، مصر

فاطمة الزهراء جمال أحمد[١]، عزة محمد عبد الوهاب[١]، مروة محمد عيد خليفة[١]،مروة محمد صلاح الدين خطاب[٢]،

أحمد صديق حسانين محمد نصار[١]*

قسم الطفيليات - كلية الطب البيطرى- جامعة القاهرة[١]

قسم الباثولوجيا- كلية الطب البيطرى- جامعةالقاهرة[٢]

*للمراسلة(drahmednassar22@cu.edu.eg), (drahmednassar22@yahoo.com)

الملخص العربى

أجريت هذه الدراسة لمعرفة نسبة إصابة الحمام المستأنس بالأنواع المختلفة من طفيل الايميريا في الجيزة، مصر. و تم دراسة الوصف المورفولوجى و الأعراض السريرية والتغيرات النسيجية المرضية في زغاليل الحمام المصابة بالطفيل. ولإتمام الدراسة تم تجميع عدد ٣٥٠ عينة محتوى معوى. وبفحص العينات أظهرت النتائج أن نسبة الإصابة بطفيل الايميريا هى ٢٧,٤٣%.وكانت أعلى نسبة إصابة فى فصل الشتاء (٣٠,٦٨%) وأقلها فى فصل الصيف (١٥,٦٦%). تم التعرف على خمسة أنواع من الايميريا التي تصيب الحمام وهى كالتالى ايميريا لبيانا(١٨,٧٥ ×١٦,٥ ميكرون)، ايميريا كولمبارم(١٩,٥ × ١٨,٥ ميكرون) ، ايميريا كولمبي(١٦,٢٥ × ١٤ ميكرون)، ايميريا كولمبيني(١٤,٧٥ × ١٣,٢٥ ميكرون) وايميريا شالكوبتري (٢٢,٥× ٢١,٥ ميكرون) .وكان الشكل الخارجي للحويصلات الخاصة بهم هو كروي وشبه كروي وبيضاوي. وأظهرت هذه الدراسة لأول مرة أن ايميريا كولمبيني وايميريا شالكوبتري تصيب الحمام المستأنس في مصر. كما أظهرت الزغاليل المصابة تجريبيا اعراضا مثل انتفاش الريش واسهال ذات لون اخضر مصحوب بمخاط مع ضعف عام وانخفاض وزن الجسم .وكشفت التغيرات النسيجية المرضية في الأمعاء الدقيقة لدى الحمام المصابة تجريبيا عن وجود التهاب معوي منتشر حاد واحتقان الأوعية الدموية وارتشاح كريات الدم البيضاء الشديد مع ظهور الأطوار المختلفة لطفيل الأيميريا.

الكلمات الدالة: الايميريا، الحمام، نسبة الإصابة ، الوصف المورفولوجى ، التشريح المرضي