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PREVALENCE OF HELMINTH PARASITES INFECTING DOMESTIC PIGEONS (*COLUMBA LIVIA DOMESTICA*) FROM AL-QASSIM REGION, SAUDI ARABIA

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Abstract:
This study aimed to identify helminth parasites infecting domestic pigeons in Al- Qassim region, Saudi Arabia, and the biological factors possibly affecting the prevalence of infection. A total of 354 pigeons (*C. L. domestica*) were purchased from four cities in Al-Qassim region; Buraydah, Unaizah, Ar Rass, and Al-Bukairiyah, from January to December 2021. Pigeons were examined to determine the helminths prevalence, and the relationship between the infection and the biological factors; city, season, gender, age, and weight. Overall, our study showed 177 (50%) pigeons were infected with helminth parasites. More precisely, 31.6% of pigeons were infected with cestodes, 13.3% with nematodes, and 5.1% with mixed infection (both cestodes and nematodes). No trematodes were recorded in this study. Cestodes were more common and abundant than nematodes. The correlation between the type of infection and the five biological factors revealed that Buraydah city had a significantly lower rate of cestode infection compared to other cities, while nematode infection was significantly different among the four different seasons. There was no significant difference between the gender factor and a single infection of cestode or nematode, but it had a significant role in mixed infection, this may be due to the fact the sample size was relatively smaller and may be related to males' sex hormones. To our knowledge, this is the first study to shed light on helminths infection in domestic pigeons from Al-Qassim region, Saudi Arabia. This research could aid authorities in taking necessary and preventative measures against pigeon parasitic diseases.

Keywords: Pigeon, Helminths, Prevalence, Biological factors, Saudi Arabia.

Introduction

Pigeons are global birds according to Sari *et al.* [(1)]. They belong to the order *Columbi* sp., and could be found in rural regions and big cities worldwide [(2)]. Domestic pigeons are an important food source (meat and eggs). There are a variety of health issues that might influence pigeons, but parasitic infections play a crucial role [(2)]. They feed on a variety of foods, including seeds, insects, earthworms, and slugs, some of which may carry parasite infection stages [(3-6)]. A broad variety of ectoparasites and endoparasites can infect pigeons [(2,7)]. Helminths and protozoans represent endoparasites [(3)]. Infection

with helminths causes economic losses and serious damage to infected pigeons [5,8]. Little information on helminths fauna in domestic pigeons from Saudi Arabia is available, and no recent data exist for domestic pigeons in Al-Qassim region. Therefore, this study aimed to identify helminth parasites affecting domestic pigeons (*Columba livia domestica*) in Al-Qassim region, Saudi Arabia as well as investigate the biological factors possibly affecting the prevalence of infection.

Materials & Methods

Study area

Al-Qassim Province is one of thirteen provinces of Saudi Arabia. It is situated (between 25° 48′ 22.68″ N and 42° 52′ 23.52 E) in the middle of Saudi Arabia, northwest of the country's capital, Riyadh. Buraydah is the official capital of the region. The climate in Al-Qassim region is typical desert, with cool and rainy winter, and hot summer.

Samples collection

A total of 354 pigeons (*Columba livia domestica*) were bought weekly from bird markets in four cities; Buraydah, Unaizah, Ar Rass, and Al-Bukairiyah, from January to December 2021. Pigeons were divided into two weight classes as follows: class 1 (150-350 gm), and class 2 (351-550 gm). According to their age, they were divided into two groups: the young group (under one year), and the adult group (above one year). The sex of pigeons (male and female) was also determined.

Necropsy

The experiment in this study was conducted at the Department of Biological Sciences at King Abdulaziz University, Jeddah, Saudi Arabia. We followed the guidelines of the Institutional Animal Ethics Committee at the Department of biological sciences in the College of Sciences at the university. The pigeons were not maintained nor fed in the facility. Accordingly, the pigeons used in this study did not require any ethical clearance. Pigeons were humanely anesthetized with an isoflurane-soaked cotton pad and then dissected ethically according to the procedure outlined by Al-Hussaini and Demian [9]. The body cavity of each bird was opened by a longitudinal incision, and the contents of each internal organ were taken out separately in a petri dish with normal saline (0.9%) (37℃). The intestines of pigeons were carefully removed and checked for helminth parasites' presence. Collected parasites from infected pigeons were sorted into nematodes and cestodes. Identification of helminths was carried out under a light microscope using the helminthological keys of Soulsby [10].

Statistical analysis

The statistically significant differences between the prevalence of helminth infections in pigeons and their risk variables were determined using Pearson chi-square and Fisher Exact tests. The level of significance was set at $p \leq 0.05$.

Results

Table (1) showed that the overall prevalence rate of helminths infection was 50 % (177 out of 354 were infected with cestode, nematode, or both). In this study, the cestodes were more prevalent and abundant than nematodes, and single infection was more common than mixed infection. The morphological characterization confirmed that cestodes belong to (*Raillietina* sp.) (Figure 1), and nematodes belong to (*Ascaridia columbae*) (Figure 2). In this study, no trematodes have been found. The prevalence of cestodes, nematodes, and mixed infections was 31.6%, 13.3%, and 5.1%, respectively. Generally, based on host factors; males, adults, and heavy-weight birds recorded a great infection rate with helminth parasites, and based on environmental factors; the autumn season, as well as Unaizah city, recorded high infection rates (Table 1). The correlation between the five biological parameters and cestodes infection was studied in (Table 2). Overall, there was no statistically significant association between gender, age, weight, and season with cestode infection. However, the prevalence of cestode infection was significantly lower in Buraydah city (14.8%) compared to other

cities with a p-value (p=0.003). The infection rate was equally distributed among Al-Bukairiyah (34.8%), Ar-Rass (37.5%), and Unaizah (37.6%). In addition, the correlation between the five biological parameters and nematodes infection was studied in (Table 3). Overall, there was no statistically significant association between gender, age, weight, and city with nematode infection. The prevalence of nematode infection significantly varied among different seasons with a p-value (p=0.004). Among the 67 studied birds, none of them was found infected with nematode in the winter season (0%). The infection rate was equally detected in autumn (17.7%), summer (16.7%), and spring (14.3%). Lastly, the correlation between the five biological parameters and mixed infection was also studied in (Table 4). Generally, the mixed infection rate was very low (5.1%), and there was no statistically significant association between age, weight, city, and season with mixed infection. However, the prevalence of mixed infection was significantly higher among males (7.4%) compared to females (2.4%) with a p-value (p=0.035).

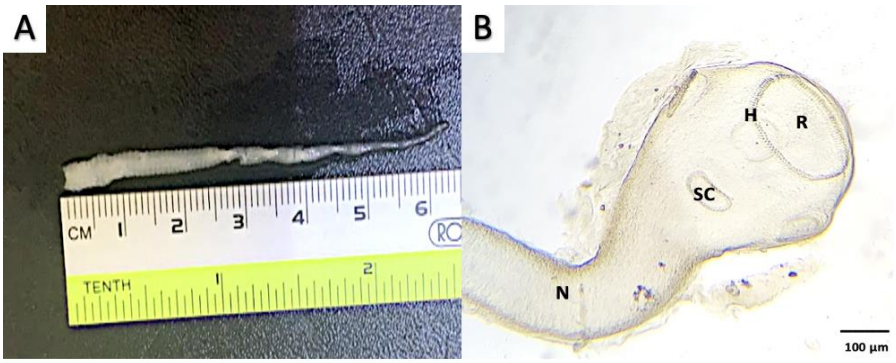

Figure 1. (A) Cestode parasite isolated from the infected pigeon. **(B)** Scolex of *Raillietina* sp. under the light microscope showing rostellum (R) with hooks (H), 4 suckers with hooks (SC), and narrow neck (N) (Scale bar=100 µm)

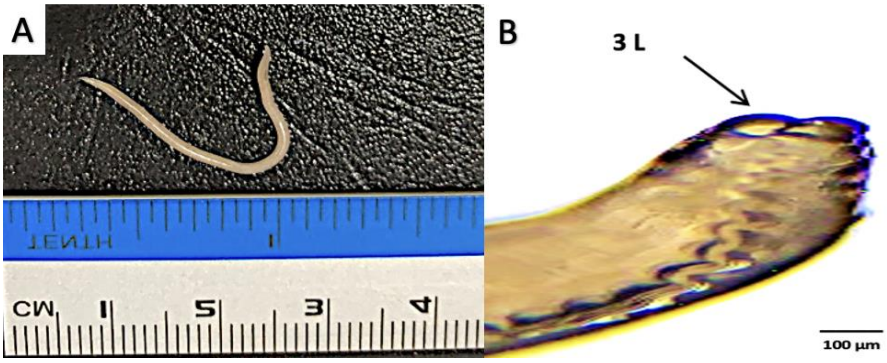

Figure 2. (A) Nematode parasite isolated from the infected pigeon. **(B)** The anterior end of *Ascaridia columbae* under the light microscope showing a mouth with three trilobed lips (L) (Scale bar=100 µm)

Table 1. The overall prevalence of helminth parasites in domestic pigeons *C.L. domestica* (n=354)

General infection rate of helminth parasites			
		Number of examined n (%)	Number of infected n (%)
Helminths infection		354	177 (50%)
Cestode infection (*Raillietina* sp.)		354	112 (31.6%)
Nematode infection (*Ascaridia columbae*)		354	47 (13.3%)
Mixed infection (both cestode and nematode)		354	18 (5.1%)
Gender	Male	190 (53.7%)	109 (30.7%)
	Female	164 (46.3%)	68 (19.2%)
Age	Young	148 (41.8%)	75 (21.1%)
	Adult	206 (58.25)	102 (28.8%)
Weight	Class 1 (150 – 350 g)	156 (44.1%)	84 (23.7%)
	Class 2 (351 – 550 g)	198 (55.9%)	93 (26.2%)
City	Al-Bukairiyah	92 (26.0%)	54 (15.2%)
	Ar Rass	88 (24.9%)	45 (12.7%)
	Buraydah	81 (22.9%)	22 (6.2%)
	Unaizah	93 (26.3%)	56 (15.8%)
Season	Autumn	113 (31.9%)	60 (16.9%)
	Spring	84 (23.7%)	43 (12.1%)
	Summer	90 (25.4%)	51 (14.4%)
	Winter	67 (18.9%)	23 (6.4%)

Table 2. The correlation between the five biological parameters and cestodes infection (n=354)

Factors	**Cestode**			**P-value***
	No. of examined	No. of infected	No. of uninfected	
Gender				0.114
Male	190	67 (35.3%)	123 (64.7%)	
Female	164	45(27.4%)	119 (72.6%)	
Age				0.968
Young (under 1 year)	148	47 (31.8%)	101 (68.2%)	
Adult (above 1 year)	206	65 (31.6%)	141 (68.4%)	
Weight				0.755
Class 1 (150 – 350 g)	156	48 (30.7%)	108 (69.3%)	
Calss 2 (351 – 550 g)	198	64 (32.3%)	134 (67.7%)	
City				0.003**
Al-Bukairiyah	92	32 (34.8%)	60 (65.2%)	
Ar Rass	88	33 (37.5%)	55 (62.5%)	
Buraydah	81	12 (14.8%)	69 (85.2%)	
Unaizah	93	35 (37.6%)	58 (62.4%)	
Season				0.944
Autumn	113	34 (30.1%)	79 (69.9%)	
Spring	84	26 (31.0%)	58 (69.0%)	
Summer	90	29 (32.2%)	61 (67.8%)	
Winter	67	23 (34.3%)	44 (65.7%)	

*Results are expressed as numbers (percentages). Numbers in parenthesis represent row percentages;
*Two-sided P-values based on Pearson chi-square test; ** significant value equals 0.05 or below

Table 3. The correlation between the five biological parameters and nematodes infection (n=354)

Factors	**Nematode**			**P-value***
	No. of examined	No. of infected	No. of uninfected	
Gender				0.384
Male	190	28 (14.7%)	162 (85.3%)	
Female	164	19 (11.6%)	145 (88.4%)	
Age				0.837
Young (under 1 year)	148	19 (12.8%)	129 (87.2%)	
Adult (above 1 year)	206	28 (13.6%)	178 (86.4%)	
Weight				0.176
Class 1 (150 – 350 g)	156	25 (16.1%)	131 (83.8%)	
Calss 2 (351 – 550 g)	198	22 (11.1%)	176 (88.9%)	
City				0.360
Al-Bukairiyah	92	14 (15.2%)	78 (84.8%)	
Ar Rass	88	8 (9.1%)	80 (90.9%)	
Buraydah	81	9 (11.1%)	72 (88.9%)	
Unaizah	93	16 (17.2%)	77 (82.8%)	
Season				0.004**
Autumn	113	20 (17.7%)	93 (82.3%)	
Spring	84	12 (14.3%)	72 (85.7%)	
Summer	90	15 (16.7%)	75 (83.3%)	
Winter	67	0	67 (100%)	

*Results are expressed as numbers (percentages). Numbers in parenthesis represent row percentages; *Two sided P-values based on Pearson chi-square test; ** significant value equals 0.05 or below

Table 4. The correlation between the five biological parameters and mixed infection

Factors	**Mixed infection**			**P-value***
	No. of examined	No. of infected	No. of uninfected	
Gender				0.035**
Male	190	14 (7.4%)	176 (92.6%)	
Female	164	4 (2.4%)	160 (97.6%)	
Age				0.470
Young (under 1 year)	148	9 (6.1%)	139 (93.9%)	
Adult (above 1 year)	206	9 (4.4%)	197 (95.6%)	
Weight				0.135
Class 1 (150 – 350 g)	156	11 (7.0%)	145 (93.0%)	
Calss 2 (351 – 550 g)	198	7 (3.4%)	191 (96.6%)	
City				0.169Ψ
Al-Bukairiyah	92	8 (8.7%)	84 (91.3%)	
Ar Rass	88	4 (4.5%)	84 (95.5%)	
Buraydah	81	1 (1.2%)	80 (98.8%)	
Unaizah	93	5 (5.4%)	88 (94.6%)	
Season				0.102Ψ
Autumn	113	6 (5.3%)	107 (94.7%)	
Spring	84	5 (6.0%)	79 (94.0%)	
Summer	90	7 (7.8%)	83 (92.2%)	
Winter	67	0	67 (100%)	

*Results are expressed as numbers (percentages). Numbers in parenthesis represent row percentages; *Two-sided P-values based on Pearson chi-square test. ΨTwo-sided P-values based on Fisher Exact test; ** significant value equals 0.05 or below.

Discussion

Domestic pigeons play an essential role in the social economy all over the world. In Saudi Arabia, domestic pigeons are considered a supplementary source of meat and eggs. However, the presence of parasite infections such as helminth parasites impedes domestic pigeon production. Parasitic infections are responsible for severe health problems in domestic pigeons. Several factors can influence infectious diseases. These factors include gender, weight, city, age, and season. Overall, our results showed that the whole prevalence of helminth parasites was 50 %. This prevalence rate was in line with previous studies in Egypt (58.3% [11]; 55.79% [12]), Libya (56%[13]), and much higher than those found in Egypt (11.76% [14]; 24.79% [15]), Medina-Saudi Arabia (14.28% [16]). This prevalence rate was lower than the data recorded in Dhaka (100% [17]), Taif-Saudi Arabia (66.1% [18]), and Giza-Egypt (63.1%[19]). Our results revealed that the prevalence of infection with cestode was the highest followed by nematode and mixed infection. These findings are in accordance with those mentioned in Iran [20], Northern Greece [21], Nigeria [22], Iraq [23,24], and Saudi Arabia [16, 25] which found that the infection of cestodes in domestic pigeons is more prevalent than nematode infection. This also was confirmed by Abed *et al.* [26] who reported that cestode infection (*Raillietina* sp.) was the highest parasite infecting domestic pigeons compared to other parasites. In addition, the total number of pigeons that were infected with a single infection was much higher than the number of pigeons that were infected with a mixed infection. This is agreed with Adang *et al.* [5,6] who confirmed that single infections were more common than mixed infections. The low prevalence rate of nematode infection in the current study compared to previous reports is nearly similar to rates recorded in Iran (8.4% [27]; 13.04% [28]), in Egypt (12% [29]; 3.65% [15]), in Nigeria (11.3% [5]), and in Medina-Saudi Arabia (3.57% [16]). It is different from those studies that reported the prevalence of nematodes was high, in Egypt (63.1% [19]), Saudi Arabia (69% [30]), India (75% [31]), Iran (over 96%[32]), Morocco (89.9% [33]), and Ethiopia (91% [34]). These variances in the prevalence rate in the present work compared to other works (even lower or higher) may be attributed to many reasons; poor hygienic measures, host species and their feeding habits, climatic factors in Saudi Arabia such as (humidity and temperature), the presence and abundance of the intermediate host such as (some molluscs, ants, beetles, cockroaches, and earthworms) in the feeding system of pigeons, eggs that are resistant to the disinfectant used, and the existence of polluted premises with a litter of other bird species. No trematodes were recorded in the present study due to their preferable feeding habits lacking the intermediate hosts. The correlation between the five biological parameters with the type of infection revealed that Buraydah had a significantly lower infection rate with cestodes ($p=0.003$), compared to the other cities. This could be attributed to the maintenance of pigeons in the farmers' market, veterinary care, hygiene and sterilization, a healthy feeding system (cereal and seeds), and low exposure to the intermediate host. Also, the season is one of the important factors that can influence infection. It has been reported previously by Yousuf *et al.* [35] that the prevalence of infection had seasonal variability. The change in season significantly influenced the nematode infection. Of note, none of the *C.L. domestica* studied in the winter season was infected with nematodes. This outcome was consistent with that of Moudgil *et al.* [36], who found that the summer season had the highest prevalence rate of nematode infection. This may be related to the favorable environmental conditions (optimal temperature and suitable humidity) needed for the survival and growth of infective parasitic stages[37]. Also, these findings are in agreement with a previous study by Ibrahim *et al.*[11] who examined 120 domestic pigeons (*C. L. domestica*) during one year. They reported the highest prevalence rate of both cestodes and nematodes was in summer (73.3%) and the lowest infection rate was in winter (43.3%). This may be attributed to the abundance of intermediate hosts, a source of food during warm seasons [38]. Oppositely, Salem *et al.* [19] found that prevalence rates of nematode infection (*A.columbae*) were highest in the winter (92.5%), followed by the summer (87.5%), reduced in the spring (55%), and lowest in the autumn (17.5%). Also, this result is in contrast to Begum and Sehrin [17] who reported that *A. columbae* was not present in the spring or summer, and Senlik *et al.*[39] who observed that helminth infections have been more common in the winter and autumn seasons, and came to the conclusion that a plentiful supply of rain combined with a mild winter provides an

environment that is favorable to infestation and production of helminth eggs. Similar to this, a related study showed that nematodes (*Ascaridia* sp.) are quite prevalent in the winter and during the first wet months, which might aid in revealing nematode eggs that are buried beneath the soil's surface to be ingested by birds[5]. Among the other factors, our results showed that gender, age, and weight were not significantly correlated with the prevalence of infection with cestodes or nematodes. The similarities between male and female pigeons in their behavior and nutrition may attribute to the insignificant correlation with the gender factor. This leads to an equal possibility of getting an infection with helminth parasites. These findings were in consensus with previous reports by Sari *et al.*[1]; Begum and Sehrin[17], and Al Quraishy *et al*.[25] who confirmed that gender does not play a role in helminths infection. Interestingly, the prevalence of mixed infection was significantly higher among males compared to females with a p-value (p=0.035), which may be explained by the fact the sample size is rather smaller and may be related to males' sex hormones. This result agreed with the previous studies [39-43] and Tesfaheywet *et al.*[44] who reported that the prevalence rate of intestinal helminth parasites was higher in males than females, and the male sex hormone testosterone is one of the probable causes of male-biased parasitism due to some vertebrates' immunosuppressive effects, which increase their susceptivity to parasite infestations[45].

Conclusion

The current investigation demonstrates that domestic pigeons have cestode and nematode infections, and some biological factors play an essential role in affecting the helminth community. In Saudi Arabia, further research is needed to determine the frequency and biological factors that significantly affect the helminth population. Therefore, reducing the infection rate among domestic pigeons.

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Conflicts of Interest

There are no conflicts of interest reported by the authors.

Fund: Self

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