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Short Communication

Prevalence of Haemoproteus columbae (Apicomplexa: Haemoproteidae) and *Trichomonas gallinae* (Metamonada: Trichomonadidae) infections among pigeons (*Columba livia*) in West Azerbaijan Province, Iran

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ABSTRACT

A cross-sectional survey was performed on domestic pigeons (*Columba liviadomestica*) to evaluate the prevalence of *Haemoproteus columbae* and *Trichomonas gallinae* in West Azerbaijan Province, northwest of Iran between July 2015 and September 2016. Five hundred and sixty oropharyngeal swab smears were examined, 297 (53%) of which were identified to be positive for *T. gallinae.* Also, the results obtained from blood smears examination indicated that 115 (20.5%) cases were found to be infected with *H. columbae.* The rates of *T. gallinae* and *H. columbae* infection in female pigeons (58.3% and 21.3%, respectively) were higher compared to those in males. There were 76 (26.1%) and 210 (72.4%) cases of *H. columbae* and *T. gallinae* infection in adolescent birds, respectively, which were higher than those in other age groups. We found high prevalence rates of *H. columbae* and *T. gallinae* infections in domestic pigeons. Therefore, more attention should be focused on controlling the spread of *T. gallinae* and *H. columbae* infection in domestic pigeons.
Keywords: *Haemoproteus columbae*, *Trichomonas gallinae,* West Azerbaijan, Iran

Prévalence des infections aux *Haemoproteus columba*e (Apicomplexa: Haemoproteidae) et *Trichomonas gallinae* (Metamonada: Trichomonadidae) chez les pigeons (*Columba livia*) dela province de l'Azerbaïdjan occidental (Iran)

Résumé: Une enquête transversale a été réalisée sur des pigeons domestiques (*Columba liviadomestica*) pour évaluer la prévalence de *Haemoproteus columbae* et *Trichomonas gallinae* en Azerbaïdjan occidental, au nord-ouest de l'Iran entre juillet 2015 et septembre 2016. Sur les 560 frottis oropharyngés examinés, 297 (%53) étaient positifs pour *T .Gallinae.* De plus, le résultat de l'examen des frottis sanguins a montré que 115 pigeons (%20/5) étaient infectés par *H .columbae* . Les pigeons femelles ont montré un taux d 'infection plus élevée à *T . gallinae* (%58/3) et *H .Columbae* (%21/3) comparées aux pigeons mâles. Les taux d'infection par *H .columbae* et *T .gallinae* chez les oiseaux adolescents étaient respectivement de 76 (%26/1) et 210 (%72/4) étant les plus élevés parmi les différentsgroupes d'âge .Dans cetteétude ,une forte prévalence desinfections par *H .columbae* et *T .gallinae* a été observée chez les pigeons .Par conséquent, une plus grande attention devrait être accordée à la lutte contre la propagation de *T .gallinae* et *H .columbae* chez les pigeons domestiques.
Mots-clés: *Haemoproteus columbae*, *Trichomonas gallinae*, Azerbaïdjan occidental, Iran

INTRODUCTION

Haemoproteus columbae (Apicomplexa: Haemoproteidae) and *Trichomonas gallinae* (Metamonada: Trichomonadidae) are considered important parasite species, which can infect pigeons. *H. columbae* is an intracellular parasite that infects erythrocytes. Infection with this species is sometimes known as pseudomalaria because of the parasites' similarities to the *Plasmodium* species. Some arthropods including Hypoboscidae and Culicoides mosquitoes transmit *H. columbae.* Birds from several orders are susceptible to the disease; however, pigeons (*Columba liviadomestica*) and doves (*Columbiformes*) are more frequently infected in natural situations (Maharana and Kumar, 2016). Avian trichomonosis, caused by the protozoan *T. gallinae,* has been reported in various parts of the world and is considered the most important disease for mourning doves (*Zenaida macroura*), Mauritian pink pigeons (*Columba mayeri*), and focal populations of Cooper's hawks (*Accipiter cooperii*). Transmission of trichomoniasis occurs directly by pigeon crop milk during courtship and predation by raptors (Nematollahi et al., 2012). Trichomoniasis is characterized by yellowish caseous lesions in the upper digestive region, particularly in the mouth, esophagus, and crop of infected birds, leading to anorexia, emaciation, and asphyxiation (Jiang et al., 2016) Pigeons can be reservoirs for a number of parasitic infections and transmit their parasites to other birds. Concurrent keeping of chickens and other animals with reservoir pigeons in traditional breeding systems develops health and economic problems, as well as sources of infection for industrial poultry, wild birds, and humans (Radfar et al., 2012). Lake Urmia is an important natural habitat for migratory birds that annually travel to this place (Eimanifar and Mohebbi, 2007). Some parasites, such as *H. columbae*, can be transferred from native poultry to migratory birds through biting vectors. Furthermore, Columbidae are known as the parasite's main host, particularly the domestic pigeon, which has been considered responsible for the worldwide spread of *T. gallinae*. Because of the importance of the pigeons as a source of revenue and hobby and limited reports on the prevalence of these parasites in Iran, this study was designed to assess the prevalence of *H. columbae* and *T. gallinae* infection in pigeons (*Columba livia domestica*) in West Azerbaijan Province, northwest of Iran.

MATERIALS AND METHODS

Study area and birds. The present study was conducted in West Azerbaijan Province, situated in northwest of Iran. The rainy winds of the Atlantic Ocean and Mediterranean strongly affect the climate of the area, resulting in abundant rainfall during the year, which can vary from around 900 mm in exposed southern areas to 300 mm in north (Figure 1). There are a large number of pigeon houses in West Azerbaijan Province that are handled traditionally. Five hundred and sixty pigeons consisting of 300 females and 260 males, kept in traditional systems, from different parts of the area were surveyed for the parasites between July 2015 and September 2016. The samples were classified into three age groups, including less than one month (nestling), 1-6 month(s) (adolescent), and more than 6 months (breeding) based on the owners' information.

Figure 1. The map of Iran and location of the study area (the red area)

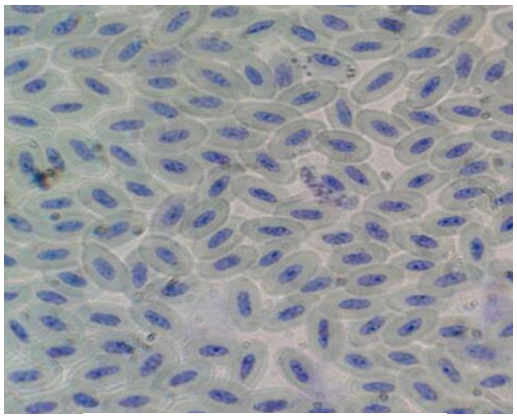

Figure 2. *Haemoproteus columbae*

Collection of samples for *H. columbae*. During the breeding season of 2016, blood samples were collected from 560 pigeons and inspected for blood parasites using the microscopy method. Blood samples were taken from brachial venipuncture of the pigeons using an insulin syringe, and then thin blood smears were separately prepared from each sample (Sol et al., 2003). The smears were fixed with methanol for 5 min, stained with Giemsa, and examined under oil immersion lens of compound binocular microscope (× 100) for the detection of haemoprotozoan parasites.

Collection of samples for *T. gallinae*. Samples were collected from the oral cavity of all the studied pigeons using sterile cotton-tipped applicators, and they were stained with Geimsa. *T. gallinae* diagnosis was performed using a compound binocular microscope under (× 40) and (× 100) magnification.

Statistical analysis. Data analysis was performed using SPSS, version 19.0. Logistic regression test with 95% confidence interval (95% CI) was applied to determine the effect of the hypothesized risk factors such as age and sex on the prevalence of infection. To compare the rates of infection between the two sexes and among the age groups, the Chi-squared (χ^2) test was used. P-value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Prevalence of *H. columbae* in pigeons. From the 560 examined blood samples, 115 (20.5%) were infected with *H. columbae* (Figure 2). *H. columbae* infection was observed in 64 out of 300 (21.3%) female pigeons and 51 out of 260 (19.6%) male pigeons. There was no significant difference in infection status between the two sexes (P=0.616). Logistic regression revealed that the risk of *H. columbae* infection in males was lower than that in females. Also, the highest prevalence rate of *H. columbae* infection was noted in adolescent birds, and the difference between the age groups in terms of *H. columbae* infection was statistically significant (P=0.000). Multivariate logistic regression reflected that adolescent birds were 1.539 times more susceptible to *H. columbae* infection than the other age groups. The relationships of sex and age risk factors with infection are described in Table 1.

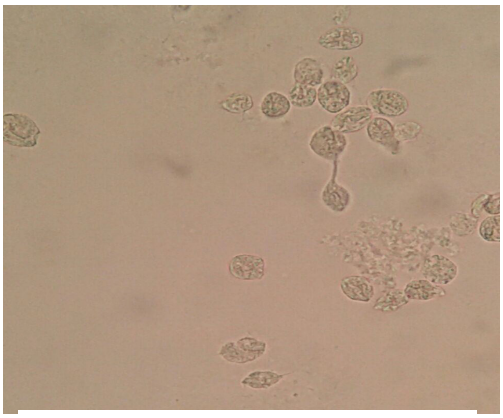

Figure 3. *Trichomonas gallinae*

Prevalence of *T. gallinae* in pigeons. Out of the 560 oropharyngeal swab smears, 297 (53%) were found to be positive for *T. gallinae* (Figure 3). The prevalence of trichomoniasis in different sex and age groups is presented in Table 2. *T. gallinae* infection was detected in 175 (58.3%) and 122 (46.9%) female and male pigeons, respectively. Chi-squared (χ^2) test demonstrated a significant association between infection with *T. gallinae* and sex (*P*=0.007). Based on

the multivariate logistic regression test, male pigeons were at lower risk for *T. gallinae* infection than females (OR=0.631). The highest prevalence rate of this infection was observed in adolescent birds (72.4%). The difference among the age groups with respect to *T. gallinae* infection was statistically significant (*P*=0.000). In addition, the highest risk for *T. gallinae* infection pertained to adolescent birds (OR=3.739).

Table 1. Prevalence of *Haemoproteus columbae* infection in domestic pigeons in West Azerbaijan Province according to different gender and age groups

Risk factors		Prevalence (n/N)[a]		95% CI for OR	Odds ratio
Sex					
	Male	46.9% (122/260)	0.631	0.452 – 0.882	0.007
	Female	58.3% (175/300)	1	-	
Age					
	Nestling [b]	19. % (21/110)	0.336	0.190 – 0.594	0.000
	Adolescent [c]	72.4% (210/290)	3.739	2.489 – 5.615	
	Breeding [d]	41.2% (66/160)	1	-	
Total		53 % (297/560)			

[a]Prevalence (%) = n/N×100 n, number of pigeons infected; N, total number of pigeons examined
[b]Nestling, < one month old [c]Adolescent, one month old to six months old [d]Breeding, > six months old

The infection rate of *H. columbae* in pigeons was found to be 20.5%, which supports the findings of Youssefi and Rahimi (2011) and Bahrami et al. (2012), who reported the prevalence of *H. columbae* in pigeons to be 17.47% and 20.8% in Golestan and Ilam provinces of Iran, respectively. The prevalence of *H. columbae* infection in pigeons has been reported to be 75% in Botswana (Mushi et al., 2000), 37.5% in Nigeria (Orajaka and Nweze, 1990), 29.4% in Italy (Scaglione et al., 2015), and 57% in Turkey (Gicik and Arsalan, 2001). In the current study, the prevalence of *H. columbae* infection in female pigeons was higher than that in males. A plethora of studies have reported a significant negative or positive correlation between haemosporidian infections and different age and sex groups. Numerous endogenous and exogenous factors may have a cumulative impact on the infection status of both sexes of pigeons to these parasites, namely host's hormones, humoral compounds, age, nutritional conditions, behaviors and habits, the season of the year, and ecological and physical features of the regions. Usually, females are more commonly parasitized potentially due to their lower locomotion activity during the nesting period, which increases the probability of their infection with haemosporidians. In addition, occurrence of female bias may be due to longer exposure of females to vectors while sitting on the nest. Our findings indicated higher prevalence and susceptibility to *H. columbae* infection in adolescent birds in comparison to the other age groups. Higher prevalence in younger birds may be caused by their higher exposure to vectors as nestlings and/or lack of immunity (Merino and Potti, 1995; Sol et al., 2003). In this study, the rate of infection with *T. gallinae* in pigeons was 53.03%, which is comparable with the reported prevalence (57.84%) in South Khorasan, Iran (Radfar et al., 2011). The prevalence of trichomoniasis was reported 67.3% in Bangladesh (Begum et al., 2008), 33.9% in China (Qiu et al., 2012), 16% in Iraq (Al-Sadi and Hamodi, 2011), and 44.8% in Spain (Sansano-Maestre et al., 2009). The present study showed a significant association between the prevalence of trichomoniasis and pigeon's sex. Higher prevalence and susceptibility of female pigeons to trichomoniasis were observed. The cause of higher prevalence of trichomoniasis in female pigeons cannot be described precisely, but it is assumed to be due to female sex hormones that make the birds more

susceptible to any infection. In the present study, trichomoniasis was more prevalent among adolescent birds (72.4%), relative to breeding birds (41.25%) and nestlings (19.06%). This result is in agreement with those of studies by Qiu et al. (2012) and Jiang et al. (2016). This difference could be attributed to the fact that as birds grow older, the parents feed them less, hence reduced risk of infection from parasitized food sources. Another possible factor could be enhanced immunity in breeding birds (Estes and Mannan, 2003).

Table 2. Prevalence of Trichomonas gallinae infection in domestic pigeons in West Azerbaijan Province according to different gender and age groups

Risk factors		Prevalence (n/N)[a]	Odds ratio	95% CI for OR	*P-value* (chi-square test)
Sex					
	Male	46.9% (122/260)	0.631	0.452 – 0.882	0.007
	Female	58.3% (175/300)	1	-	
Age					
	Nestling [b]	19. % (21/110)	0.336	0.190 – 0.594	0.000
	Adolescent [c]	72.4% (210/290)	3.739	2.489 – 5.615	
	Breeding [d]	41.2% (66/160)	1	-	
Total		53 % (297/560)			

[a]Prevalence (%) = n/N×100
n, number of pigeons infected; N, total number of pigeons examined
[b]Nestling, < one month old
[c]Adolescent, one month old to six months old
[d]Breeding, > six months old

In conclusion, the prevalence rates of *H. columbae* and *T. gallinae* infections were high among pigeons in West Azerbaijan Province. Pigeons play an undeniable role in the lives of a large number of people living in the area whether bred as a source of income or pastime. Given that parasites such as *H. columbae* and *T. gallinae* can be easily transmitted and severely affect birds, identification and treatment of infected pigeons, as well as taking proper health measures and controlling congestion of birds can be crucial factors for reducing the spread of the infections.

Ethics

I hereby declare all ethical standards have been respected in preparation of the submitted article.

Conflict of Interest

The authors declare that they have no conflict of interest.

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