



Survey of some blood parasites in three species of wild birds in Babylon Province, Iraq

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Abstract. This study is included two species of birds belong to the Columbidae family, i.e., *Columba livia* and *Streptopelia senegalensis*, as well as a species of the family Passeridae, *Passer domesticus*, in Babylon province during the period from December 2020 to December 2021. Blood parasites were examined by microscopic examination of stained blood films prepared from 130 birds of *C. livia*, 122 birds of *S. senegalensis*, and 112 birds of *P. domesticus*. The overall prevalence rate of all species of blood parasites during the study period is 31.59%. Five types of blood parasites were recorded: *Haemoproteus columbae*, *Leucocytozoon marchouxi*, *Haemoproteus passeris*, *Plasmodium* spp., and *Leucocytozoon fringillinarum*. The parasite *H. columbae* is the most prevalent in *C. livia* and *S. senegalensis*, with infection rates of 21.53% and 19.67%, respectively and *H. passeris* in *P. domesticus* with a percentage of 16.96%. Females are more infected than males in the three species of birds, besides, the infection with blood parasites in the center of the province is higher than in the districts and sub-districts. This is the first study for the detection of blood parasites in *P. domesticus* and *S. senegalensis* in Babylon Province.

Keywords: Birds, *Columba livia*, *Passer domesticus*, *Streptopelia senegalensis*, *Haemoproteus*, *Leucocytozoon*, *Plasmodium*, Iraq.

1. Introduction

Presence of blood parasites in birds are very common, as it is estimated that 68% of all bird species are susceptible to infection with blood parasites [1]. Haemosporidia parasites are transmitted by 17 genera of blood-sucking insects such as biting midges, lice flies, black flies and mosquitoes [2]. The avian haemosporidia parasites include approximately 40 morphologically different species of the genus *Plasmodium*, 130 species of the genus *Haemoproteus* and 35 species of the genus *Leucocytozoon* [3]. Among the blood parasites, the most common that infect birds are species of the genus *Trypanosoma* [4]. All species within these genera are potentially pathogenic, as pathogenicity is related to host specificity, age, nutrition, and availability of appropriate vectors [5]. The genus *Haemoproteus* is one of the most haemosporidia that infect birds, as it is found that approximately 68% of bird species are infected with it. It is followed by *Plasmodium* 41% and *Leucocytozoon* 39% [6, 7].

Host families such as the order Passeriformes and the family Columbidae are more susceptible to infection with blood parasites, and they have a high prevalence of infection, while other families, such as Laridae, Scolopacidae and Charadriidae are rarely infected with blood parasites [8].

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Blood parasites play an essential role in the growth and development of birds because they are able to influence the fitness and survival of their hosts [9]. Blood parasites of birds have a negative impact on the reproductive performance of their hosts in some bird species in temperate regions [10], [11]. Birds which are infected with blood parasites also delay reproduction, lay fewer eggs and produce fewer chicks than uninfected birds [12].

Infected birds are more susceptible to predation. Besides, individuals of infected parasite may reduce food consumption and lose body mass [1]. In most cases, pathogenesis of avian blood parasites is low, even very high infection is usually not accompanied by clinical symptoms [13].

The aim of the study is to conduct a survey of blood parasites in three species of birds in the province of Babylon and determine the most prevalent species in addition to determining the difference in infection between males and females and between districts of Babylon province and its center.

2. Materials and Methods

364 birds were collected from the birds found in the districts and center of Babylon Province, including *C. livia* 130 (Fig. 1), *S. senegalensis* 122 (Fig. 2) and *P. domesticus* 112 (Fig. 3), which were caught live by special cages designed by the researcher with sizes that correspond to the size of the birds that are being hunted for the period from December 2020 until the December 2021 (Table 1). The date of hunting and the weight of the hunted birds were recorded, and they were classified according to their basic characteristics based on [14, 15]. Thin blood smears were made directly from each bird by puncturing the brachial vein by micro-needles, air-dried and fixed with absolute methanol, and stained with Giemsa stain at a concentration of 1:10 distilled water at pH 6.8-7.2 for one hour [16]. Parasites were diagnosed based on [6, 8, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27]. Microscopic images were taken with three types of digital cameras connected to a light microscope, Novel (1.3 MP), Hayear (5 MP) and AmScope (18 MP).



Fig. 1. *C. livia* [28].



Fig. 2. *S. senegalensis* [29].



Fig. 3. *P. domesticus*, Right: male, Left: female [30].

Table 1. number of birds examined by months of the year.

Bird species	number of birds examined by months of the year												
	Dec. 2020	Jan. 2021	Feb. 2021	Mar. 2021	Apr. 2021	May 2021	Jun. 2021	Jul. 2021	Aug. 2021	Sep. 2021	Oct. 2021	Nov. 2021	Dec. 2021
<i>C. livia</i>	6	8	6	9	7	15	17	13	11	10	11	8	10
<i>S. senegalensis</i>	10	3	9	10	12	6	8	10	11	11	10	11	11
<i>P. domesticus</i>	5	10	5	6	6	11	9	11	12	9	9	9	10

3. Results

Table 2 summarizes the rates of infection with blood parasites in the three species of birds under study. The highest infection rate was for *H. columbae* in *C. livia* and *S. senegalensis*, which is 21.53% and 19.67%, respectively, and *H. passeris* in *P. domesticus* with an infection rate of 16.96%, while the lowest infection rate in blood parasites is due to the parasite *L. fringillinarum* in *P. domesticus* is 1.78%.

Table 2. rates of infection with blood parasites in the three species of birds under study.

Bird species	number of birds examined	Parasite species and infection rate				
		<i>L. fringillinarum</i>	<i>Plasmodium</i> spp.	<i>H. passeris</i>	<i>L. marchouxi</i>	<i>H. columbae</i>
<i>C. livia</i>	130		12.30		9.23	21.53
<i>S. senegalensis</i>	122		7.37		13.11	19.67
<i>P. domesticus</i>	112	1.78	10.71	16.96		

Table 3 summarizes the results of the peripheral blood test in male and female birds under study. This shows that 115 out of 364 birds (31.59%) are infected with one or more blood parasites belong to the genera: *Haemoproteus*, *Leucocytozoon* and *Plasmodium*, female *C. livia* are more infected than males, which amounted to 40.6% and 31.8%, respectively, as well as females in *S. senegalensis*, are more affected than males, reaching 40.3% and 28.33%, respectively, and with regard to female *P. domesticus*, the infection was 25.39% higher than males 20.4%. The infection in the city center 38.03% higher than in the districts and sub-districts 20% Table 4.

Table 3. Infection rates in males and females of the birds under study.

Bird species	number of birds examined (364)		Infected number (115)			
	males	females	males	%	females	%
<i>C. livia</i>	66	64	21	31.8	26	40.6
<i>S. senegalensis</i>	60	62	17	28.33	25	40.3
<i>P. domesticus</i>	49	63	10	20.4	16	25.39

Table 4. Infection rates in the province center, districts and sub-districts.

Bird collecting areas	number of birds examined	Infected number	percentage
City center	234	89	38.03
Districts and sub-districts	130	26	20

Table 5 summarizes the seasonal appearance of blood parasites, as it shows the presence of parasites: *H. columbae*, *Plasmodium* spp., *H. passeris* throughout the four seasons of the year, while the appearance of the parasite *L. fringillinarum* is limited to November (autumn season) and December (winter season), while the parasite *L. marchouxi* did not appear in July and August (summer season) and September (autumn season).

Table 5. Distribution of infection with blood parasites during the months and seasons of the year.

blood parasites species	Distribution of blood parasite infection by months of the year												
	Dec. 2020	Jan. 2021	Feb. 2021	Mar. 2021	Apr. 2021	May 2021	Jun. 2021	Jul. 2021	Aug. 2021	Sep. 2021	Oct. 2021	Nov. 2021	Dec. 2021
<i>H. columbae</i>	5	4	4	4	4	4	5	5	4	2	4	3	4
<i>Plasmodium</i> spp.	0	1	1	2	4	7	2	5	4	8	2	0	1
<i>L. fringillinarum</i>	1	0	0	0	0	0	0	0	0	0	0	1	0
<i>L. marchouxi</i>	5	2	3	4	1	1	2	0	0	0	2	4	4
<i>H. passeris</i>	3	1	1	1	2	2	2	1	2	2	0	1	1

A. *Haemoproteus columbae* Kruse, 1890

- **Host:** *C. livia* and *S. senegalensis*
- **Description:** Immature gametocytes Fig. 1(a) elongate laterally to the nucleus of erythrocytes, the entire edges of the parasites are rounded or sometimes with pointed ends. Macrogametocytes Fig. 1(b) have darker cytoplasm with randomly dispersed brown pigment granules compared to microgametocytes Fig. 1(c) which have brown pigment granules with a polar distribution. In most cases, immature gametocytes are observed more frequently than mature ones. Mature gametocytes occupy the host cell in a large proportion, the host cell is deformed and the cell nucleus is pushed to one side.

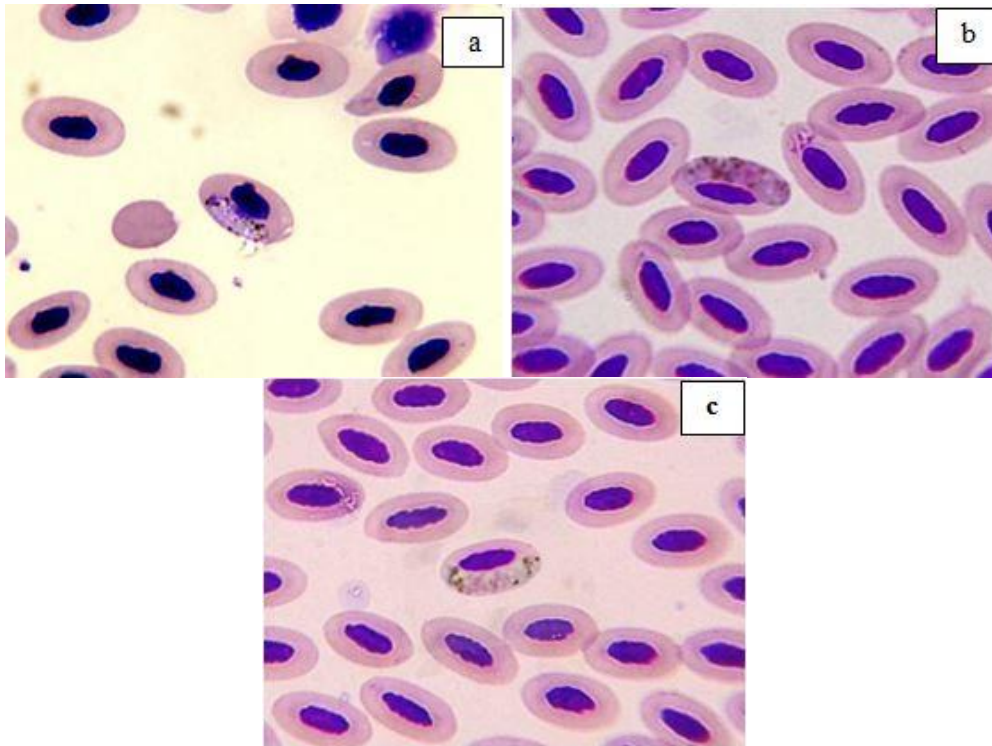


Fig. 1. *H. columbae*, (a) Immature gametocyte, (b) Macrogametocyte , (c) Microgametocyte.

B. Leucocytozoon marchouxi Mathis & Leger, 1910

- **Host:** *C. livia* and *S. senegalensis*
- **Description:** Macrogametocyte Fig. 2(a) of circular shapes show that the parasite is relatively small but occupies 83% of the area of the host-parasite complex, round to broadly ovoid. The nucleus of the host-cell parasite complex is either in the form of a characteristic cap or a thin strip. The cytoplasm is dark blue, while microgametocytes Fig. 2(b) are much more lightly pigmented than macrogametocytes. The cytoplasm is very pale blue, and their nuclei are pale. The nuclei of the host cells of microgametocytes are similar to those of macrogametocytes.

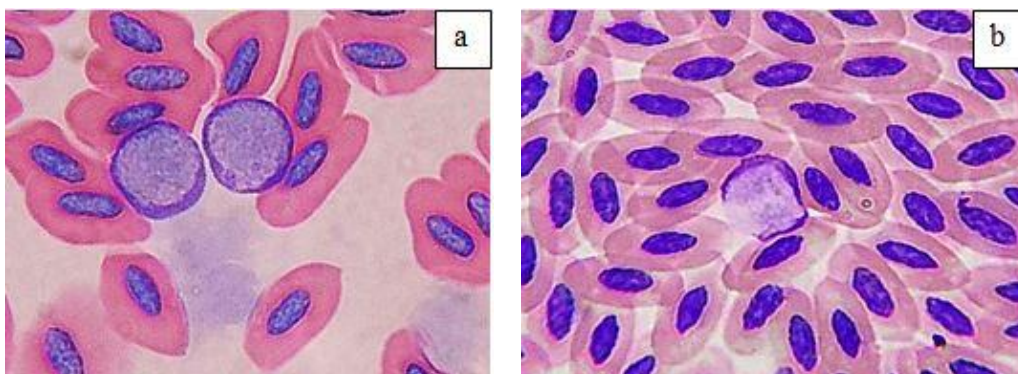


Fig. 2. *L. marchouxi*, (a) Macrogametocyte , (b) Microgametocyte.

C. Plasmodium spp.

- **Host:** *C. livia*, *S. senegalensis* and *P. domesticus*
- **Description:** Trophozoites Fig. 3(a-d) are mainly developed in mature erythrocytes. Older trophozoites are often irregular in shape, often amoebic or indeterminate. Advanced trophozoites

have prominent nuclei and cytoplasm, which are often located close to the nucleus of the host cell, small and few circular pigment granules are usually grouped.

Schizonts Fig. 3(e) in erythrocytes are round and sometimes discolored. Their condensed and spherical nuclei are pushed to the periphery. The schizont's nuclei are 12 to 18 dense, round, and well-defined scattered over the interior of the schizont.

Mature meronts Fig. 3(f-h) produce up to 22 merozoites, which are usually randomly arranged. Growth and maturation significantly displace the affected erythrocyte nuclei.

Many growing gametocytes stick to the nucleus of red blood cells Fig. 3(i-k), the nucleus of the parasite is prominent and irregular in shape, the pigment granules are small or medium in size, black or dark brown, and round or oval, and the nucleus of the parasite is prominent and uneven in shape. The gametocyte cells deform and displace the nuclei of the afflicted red blood cells towards one of the host cell electrodes.

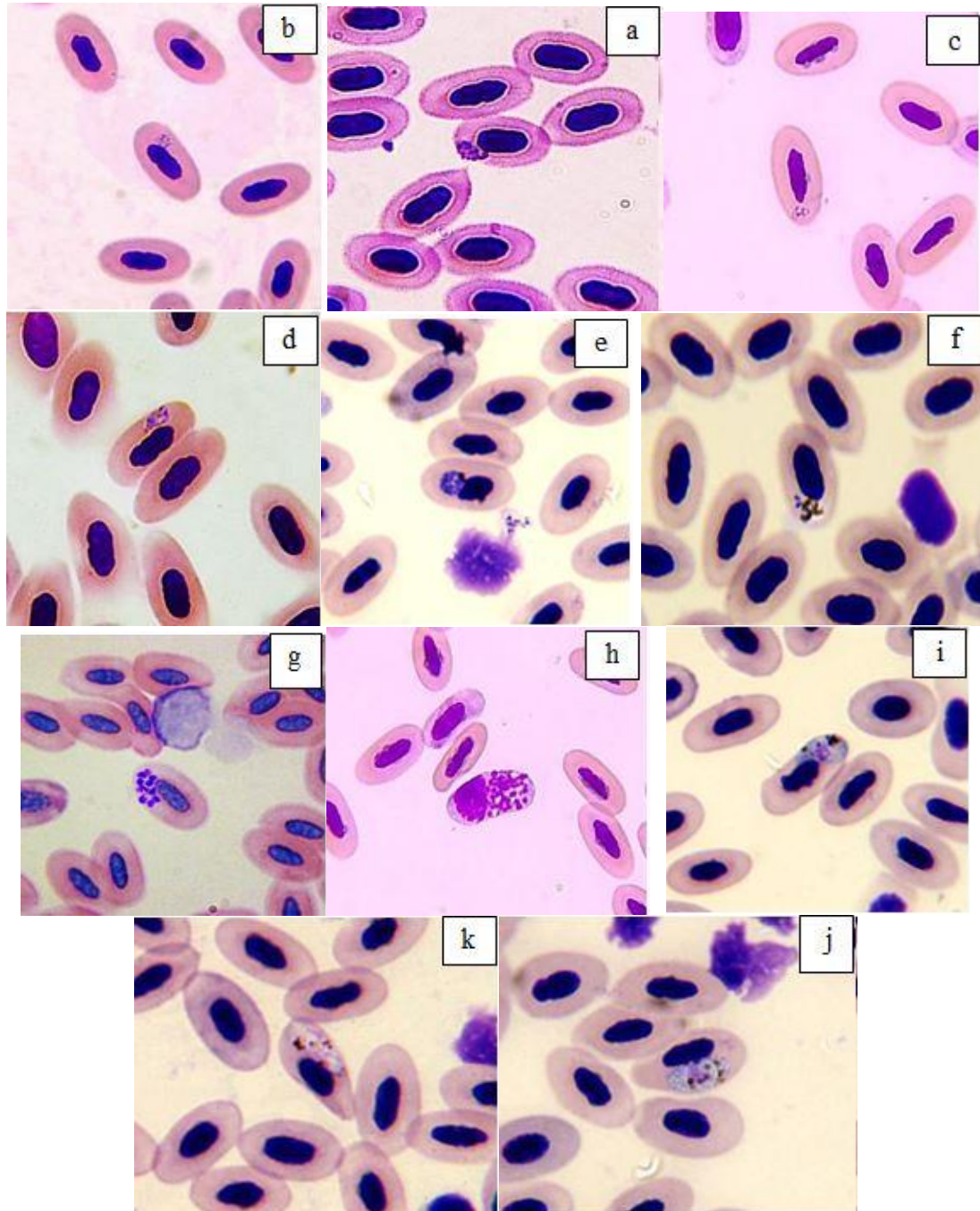


Fig. 3. Plasmodium spp., (a-d) trophozoites , (e) schizont, (f-h) meronts, (i-k) gametocytes.

D. *Haemoproteus passeris* Kruse, 1890

- **Host:** *P. domesticus*
- **Description:** Small trophozoites Fig. 4(a) usually take a lateral position within erythrocytes. The immature gametocytes Fig. 4(b, c) adheres to the nucleus of the host cell and often has round, clear granules of volutin. Small gametocytes contain hyaline cytoplasm, but are often mature gametocyte pigmentation in reddish-purple. The smallest forms seen located in the middle or at the side of the nucleus of the host cell to which they adhere.

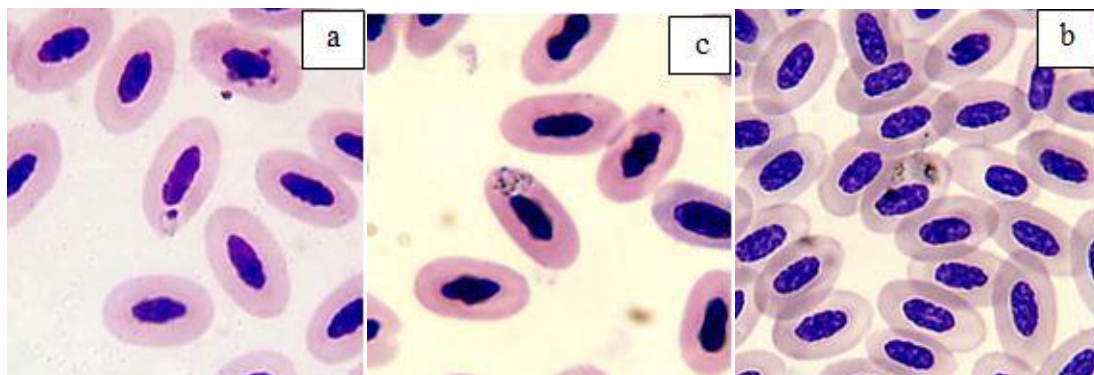


Fig. 4. *H. passeris* (a) trophozoite , (b,c) immature gametocyte.

E. *Leucocytozoon fringillinarum* Woodcock, 1910

- **Host:** *P. domesticus*
- **Description:** Microgametocyte Fig. 5 shows a parasite of only round shape. The parasites are generally small and usually round, occupying 80% of the area of the host cell-parasite complex; The nucleus of the parasite is usually round, with a clear nucleolus. The nucleus of the host cell as a covering (the most common feature of this species).

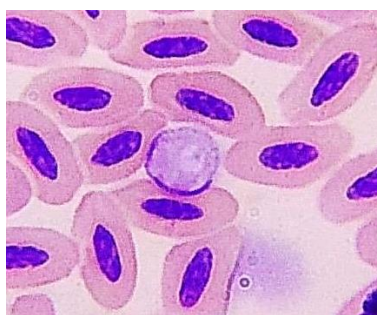


Fig. 5. Microgametocyte of *L. fringillinarum*.

4. Discussion

The results show that the rate of infection with the parasite *H. columbae* in the *C. livia* and *S. senegalensis* is higher than what have been recorded in Iraq before [31] in the *C. livia* in the provinces (Baghdad, Sulaymaniyah, Diwaniyah) with infection rates of 2%, 6.2% and 3.8%, respectively, and in *S. senegalensis* in Baghdad province with a rate of 9.1%. Also, the infection rate was higher than the rates that were recorded in many studies in the world, including [32] parasitoids in wild pigeons in South Africa and [33] in endemic pigeons from Turkey and [34] in the pigeons in northwest Iran with infection rates of 12%, 18.8% and 20.5% respectively. While the infection rates in the current study are lower than the rates recorded before [35] in the pigeons in three different locations (Babul, Lahijan and Firuz Koh) in north of Iran and [36] in the pigeons in Iran, [37] in pigeons in Gaborone,

Botswana, [38] in wild pigeons in Turkey, [39] in adult domestic pigeons in Turkey and [40] in pigeons in Turkey, Additionally southwest of Iran, [41] in wild and domestic pigeons in India, [42] in wild pigeons in four regions in Indonesia, with infection rates of 30%, 23.1%, 80%, 47.5%, 43.2%, 58.9%, 61.33% and (62.5–100%).

Moreover, the rate of infection with the parasite *H. passeris* in *P. domesticus* is lower than the rates recorded in Iraq before [43, 44] in the sparrow, with an infection rate of 19.7% and 22.9%, respectively. The percentage recorded in the current study is less than the percentage that have been recorded before [45] in the sparrow in occupied Palestine amounted to 41%.

The results also show that the infection rate of *L. fringillinarum* is lower than the percentages recorded in Iraq before 44, 18 in Baghdad province and [31] in Baghdad and Diwaniyah provinces with infection rates of 4.8%, 6.3%, (5.6% and 5 %) respectively. Globally the percentage in the current study is also lower than the percentages that have been recorded before [46] in the sparrow in occupied Palestine by 79%. Also, the rate of infection with *L. marchouxi* parasite in *C. livia* and *S. senegalensis* is higher than the rates recorded in Iraq before [31] in *C. livia* in Baghdad province and [47] in *C. livia* in Mosul city with infection rates of 2.2% and 3.08%, respectively. Globally, the percentage in the current study is higher than the rates have been recorded before [48] in pigeons in Colorado, USA and [49] in pigeons in Bangladesh, with infection rates of 1.16% and 2%, respectively, while the percentage was less than the percentage that It was previously recorded [50] in pigeons in Turkey, with a percentage of 31.25%. Also, the infection with *Plasmodium* spp. in *C. livia*, *S. senegalensis* and *P. domesticus* is higher than the percentage recorded in Iraq before [31] in *P. domesticus* in Baghdad with a rate of 1.1%. Globally, the percentage recorded in the current study in pigeons is higher than the rates recorded in many studies, including [51] in India and [52] also in India, with infection rates of 6.76% and 11.18%, respectively. on the other hand, the percentage in the current study is less than the rates recorded before [53] in Uganda, [54] in Nigeria and [55] in Peru with infection rates of 29.4%, 25% and 13.5%, respectively, and the percentage recorded in the current study in *P. domesticus* is less than the percentage that have been registered before [56] in Bulgaria, with a rate of 35.59%.

Variations in blood parasite prevalence and health impact, whether they are sex-related, season-related, or geographical location-related. This, may be influenced by host species susceptibility, ages, and habitats, as well as vector transmission, density, and feeding patterns [57].

5. Conclusion

The results indicate the occurrence of five types of blood parasites in three types of wild birds, female birds are more infected than males, while the infection with blood parasites in the city center is higher than in the districts and sub-districts.

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مسح بعض طفيليات الدم في ثلاثة أنواع من الطيور البرية في محافظة بابل، العراق

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الملخص. تصيب طفيليات الدم أنواعا مختلفة من الفقاريات وتؤثر سلبا على تطور وظهور بعض الأنواع. تعتبر البوغيات الدموية Haemosporidian واحده من أكثر الطفيليات انتشارا من الناحية الجغرافية، ولديها مجموعة واسعة من المضائف، حيث أنها يصيب العديد من الفقاريات مثل الثدييات والطيور والأسماك. تضمنت الدراسة نوعين من الطيور التي تنتمي إلى عائلة الحماميات Columbidae، وهما الحمام الطوراني *Columba livia* و فاختة النخيل *Streptopelia senegalensis*. بالإضافة إلى نوع من عائلة العصفوريات *Passeridae*، هو العصفور الدوري *Passer domesticus*. في محافظة بابل خلال الفترة من كانون الثاني 2020 إلى كانون الثاني 2021. تم فحصها بالفحص المجهرى لافلام الدم المصبغة بصبغة جيمسا والمحضرة من 130 طائرا من الحمام الطوراني *C. livia* و 122 طائرا من فاختة النخيل *S. senegalensis* و 112 طائرا من العصفور الدوري *P. domesticus*. بلغ معدل الانتشار العام لجميع أنواع طفيليات الدم خلال فترة الدراسة 59.31%. سجلت خمسة أنواع من طفيليات الدم: *Haemoproteus columbae*, *Haemoproteus passeris*, *Plasmodium spp.*, *Leucocytozoon marchouxi*. *Leucocytozoon fringillinarum* هو الأكثر انتشارا في الحمام الطوراني *C. livia* و فاختة النخيل *S. senegalensis* بمعدلات إصابة 21.53% و 19.2% على التوالي و *H. passeris* في العصفور الدوري *P. domesticus* بنسبة 16.96%. الإناث أكثر إصابة من الذكور في أنواع الطيور الثلاثة كما ان الإصابة بطفيليات الدم في مركز المحافظة أعلى من الاقضية والنواحي. هذه هي الدراسة الأولى لاكتشاف طفيليات الدم في العصفور الدوري *P. domesticus* و فاختة النخيل *S. senegalensis* في محافظة بابل.

الكلمات الرئيسية: طيور، الحمام الطوراني، العصفور الدوري، فاختة النخيل، المتصورة، العراق.