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ECTOPARASITE DIVERSITY AND ZOONOTIC RISKS IN URBAN BIRDS OF TIZI OUZOU

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Abstract. Increasing urbanization in Algeria, particularly pronounced in northern regions such as Tizi Ouzou, is profoundly altering ecosystems and interactions between species. This study aims to characterize the diversity and dynamics of avian ectoparasites in urban environments through the examination of three model species: the Rock Dove (*Columba livia),* the Yellow-legged Gull *(Larus michahellis*) and the Cattle Egret (*Bubulcus ibis*). Sampling was carried out using captured individuals and nests collected from urban habitats. The results show that Mallophaga lice (*Columbicola columbae, Companulotes compar*) are strictly associated with pigeon, with an abundance of 52.90%. Conversely, nidicolous mites *(Dermanyssus gallinae* and *Ornithonyssus maritimus*) are concentrated in the nests of pigeons and Yellow-legged Gulls at rates of 15.86% and 9.30%, respectively. Cattle Egrets show lower and more sporadic infestations. Furthermore, the three bird species host significantly distinct parasite communities despite sharing parts of their habitat. Finally, the presence of the soft tick *Argas persicus* (0.38%), a known zoonotic vector, underscores the health significance of these results.

INTRODUCTION

According to the World Bank Group data for 2024, the urbanization rate in Algeria was 76%, with urbanization being particularly pronounced in the north of the country, especially in coastal regions and in provinces such as Algiers, Oran, Blida, and Tizi Ouzou. It is one of the major factors driving environmental changes (Grimm et al. 2008). Faced with these changes, ecosystems and species must develop strategies of adaptation, avoidance, or tolerance (Blair 1996; Isaksson 2015).

Several studies suggested that environmental factors associated with urbanization can affect the wildlife health (Sepp et al. 2019). On the other hand, anthropogenic food readily available in urban environments, whether directly or indirectly provided to wildlife by humans, often lacks many essential macro- and micronutrients, which can lead to poor nutrition and cascading effects on oxidative stress, gut microbiome (Sugden et al. 2020), immunity (Watson et al. 2019), and the risk of infection (Murray et al. 2016).

Sites with high food availability are particularly likely to attract both healthy animals and those weakened by disease or injury (Yeakel et al. 2009; Murray and Clair 2017). As a result, diverse species interact with each other and with the human population. These interactions can contribute to the increased rates of conflict and disease emergencies in urban landscapes compared to natural landscapes (Gottdenker et al. 2014).

Avian parasitology is a fundamental area of research in health ecology, given the key role of birds in host-parasite interactions and their influence on ecosystem dynamics (Atkinson et al. 2009). Based on available data, wild birds represent a potentially essential component in the dissemination and propagation of parasites.

Parasites play a major role in host-parasite dynamics, affecting the physiology, body condition, and reproductive success of birds (Clayton and Walther 2001; Møller and Rózsa 2005). However, their importance extends beyond the ecological sphere: they also constitute a direct zoonotic risk to humans. Pigeons, for example, are recognized as reservoirs not only for lice but also for ticks and mites that can transmit pathogens (Haag-Wackernagel and Moch 2004). The Yellow-legged Gull, an opportunistic colonial species, frequently harbours nest mites that can cause gamasoid dermatitis in humans and serve as vectors for infectious diseases (Sparagano et al. 2014; George et al. 2015). The Cattle Egret, which is expanding in agricultural and peri-urban areas, can harbour ticks involved in the transmission of zoonotic pathogens (Hoogstraal 1985; Estrada-Peña and Jongejan 1999).

Located in the centre of Kabylia, the city of Tizi Ouzou is distinguished by its remarkable ecological richness. This region of the Tell Atlas Mountains benefits from a mosaic of habitats (forests, urban areas, agricultural environments), which fosters a diverse avifauna potentially exposed to a wide range of parasites. Despite this biological diversity, parasitological studies on the wild birds of this region remain very rare, if not entirely absent, creating a significant gap in the local scientific literature.

The value of such a study in the Tizi Ouzou region lies not only in characterizing avian parasite diversity, but also in assessing potential health risks for wildlife, domestic animals, and even humans, in a context where parasitic zoonoses represent a growing threat (Tompkins et al. 2011). In addition, a striking observation was made in the field: the partial cohabitation of the Cattle Egret (*Bubulcus ibis*) and the Yellow-legged Gull (*Larus michahellis*) and the Rock Pigeon (*Columba livia*) in several peri-urban sites of Tizi Ouzou. This phenomenon, which is relatively recent in the region and due to the fragmentation of natural habitats, seems to favour the emergence of new ecological dynamics between avian species.

This study aims to examine the external parasites of wild birds captured in different urban localities in Tizi Ouzou, linking parasitological data to the ecological characteristics of the hosts and their environments. It also aims to assess the consequences of this cohabitation on parasite dynamics and the potential zoonotic risk.

MATERIALS AND METHODS

Study area

The present work was carried out in the city of Tizi Ouzou over a period extending from February to July across three consecutive years (2023–2025). Located in northern Algeria in the Kabylia region (Figure 1), the city is situated at an average altitude of about 200 m above sea level, in a valley crossed by the Sebaou River. The region is characterized by a Mediterranean climate belonging to the sub-humid bioclimatic zone with warm to mild winters and average precipitation of 720.1 mm.

Study species

The Rock Dove *(Columba livia),* an emblematic species of Mediterranean and North African cities, is extremely abundant in Tizi Ouzou. Numerous studies confirm that urban pigeon populations have a significant parasite load (Clayton and Walther 2001; Haag-Wackernagel and Moch 2004). As part of this study, the pigeons were captured using the drop box traps.

The Yellow-legged Gull *(Larus michahellis)*, another proliferating urban species, nests on rooftops, artificial cliffs and ports in the Tizi Ouzou region (Moulai and Derradji 2016; Talmat-Chaouchi et al. 2020; Chetibi et al. 2024). Opportunistic and gregarious, it forms dense colonies that promote the proliferation of ectoparasites. The individuals were captured using nets deployed in their nesting areas, allowing for safe handling and subsequent parasitological examination.

The Cattle Egret *(Bubulcus ibis)* is a species expanding in Algeria, gradually colonizing agricultural and peri-urban areas; they are captured using nets set up near their nesting site. In Tizi Ouzou, it sometimes nests near dwellings and feeds in cultivated areas, hosting various ectoparasites.

Collection of ectoparasites

Nests were carefully collected using sterile gloves and plastic bags, labelled (date, site, host species), and transported to the laboratory to extract ectoparasites. All the organic material was sieved and analyzed under a binocular microscope. The birds were carefully handled with gloves to perform a systematic examination of the plumage, wings, head, cloaca, and legs for external parasites. The recovered parasite specimens were preserved in 70% ethanol for subsequent morphological identification. A total of 28 individuals and 16 nests were examined across all the species studied. More specifically, for each species, the pigeon accounted for 12 individuals and 2 nests, the Cattle Egret accounted for 8 individuals and 4 nests, and the Yellow-legged Gull accounted for 8 individuals and 10 nests.

Identification of ectoparasites

The collected ectoparasites were meticulously cleaned, and the specimens were first cleared in a 10% KOH solution for 4 to 7 days. Then they were rinsed with distilled water to neutralize the action of the KOH and mounted

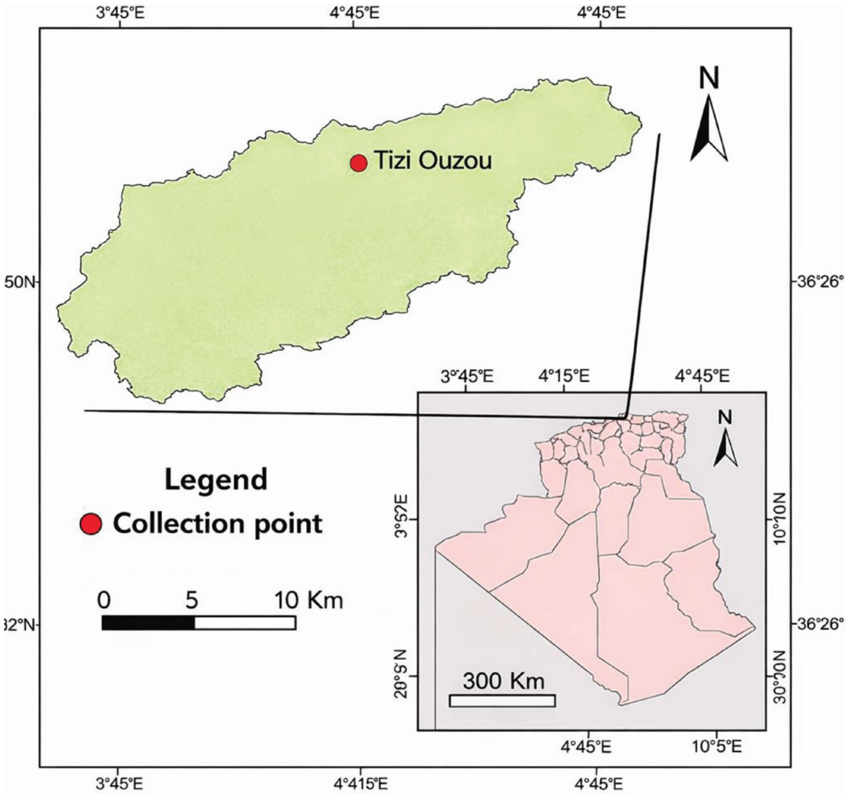

Figure 1. Map of Algeria highlighting the city of Tizi-Ouzou and the collection point of birds.

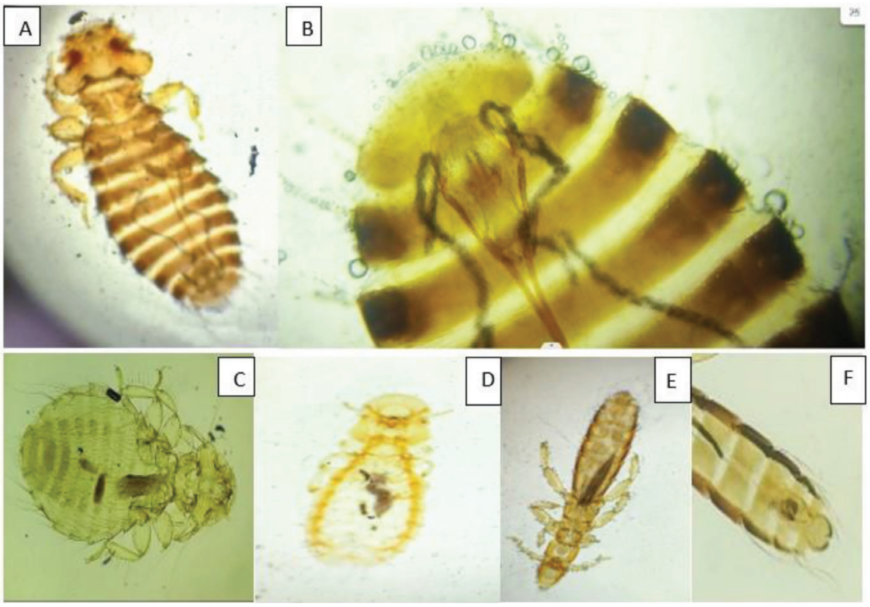

Figure 2. Lice species: A–B – *Ciconiphilus decimfaciatus* (A – whole body, B – male reproductive system), C – *Hohorstiella lata*, D – *Companulotes compar*, F–E – *Columbicola columbae* (E – whole body, F – female reproductive system).

between a slide and coverslip in the laboratory using Canada balsam. Then they were examined under a Leica DM500 microscope at magnifications of 10× and 40×.

The taxonomic keys provided by Timmermann (1952), Price et al. (2003) and Al-Ahmed et al. (2014) were used for the identification of lice. For the identification of mites, the key of Mironov (1989) was used (Figure 2).

Statistical analysis

The prevalence and average intensity of ectoparasites were determined in accordance with the methodology described by Margolis et al. (1982).

In order to assess the distribution of parasites between individuals and nests and to compare parasite loads among host species, all statistical analyses were performed using R software (R Core Team R 4.5.3 2024). Generalized linear models (GLM, Binomial) were used to test differences of parasite abundance between individuals and nests across the three studied species. Differences in parasite loads among species were assessed using the analysis of variance (ANOVA) on parasite prevalence, intensity, and mean abundance. Finally, PERMANOVA was applied to compare parasite community composition and assess differences in co-occurrence patterns among the three host species, using Jaccard distance.

RESULTS

Parametric indicator

The main indicators calculated were prevalence, average intensity, and average abundance (Figures 3 and 4). For *Columba livia*, our results show a very high prevalence of mallophagous lice (*Companulotes compar* and *Columbicola columbae*) reaching 85.7%, with respective mean intensities of 52.9 and 23.5 parasites per infected host. In *Larus michahellis*, the results indicate a clear predominance of nest-dwelling mites, with *Parasitidae*

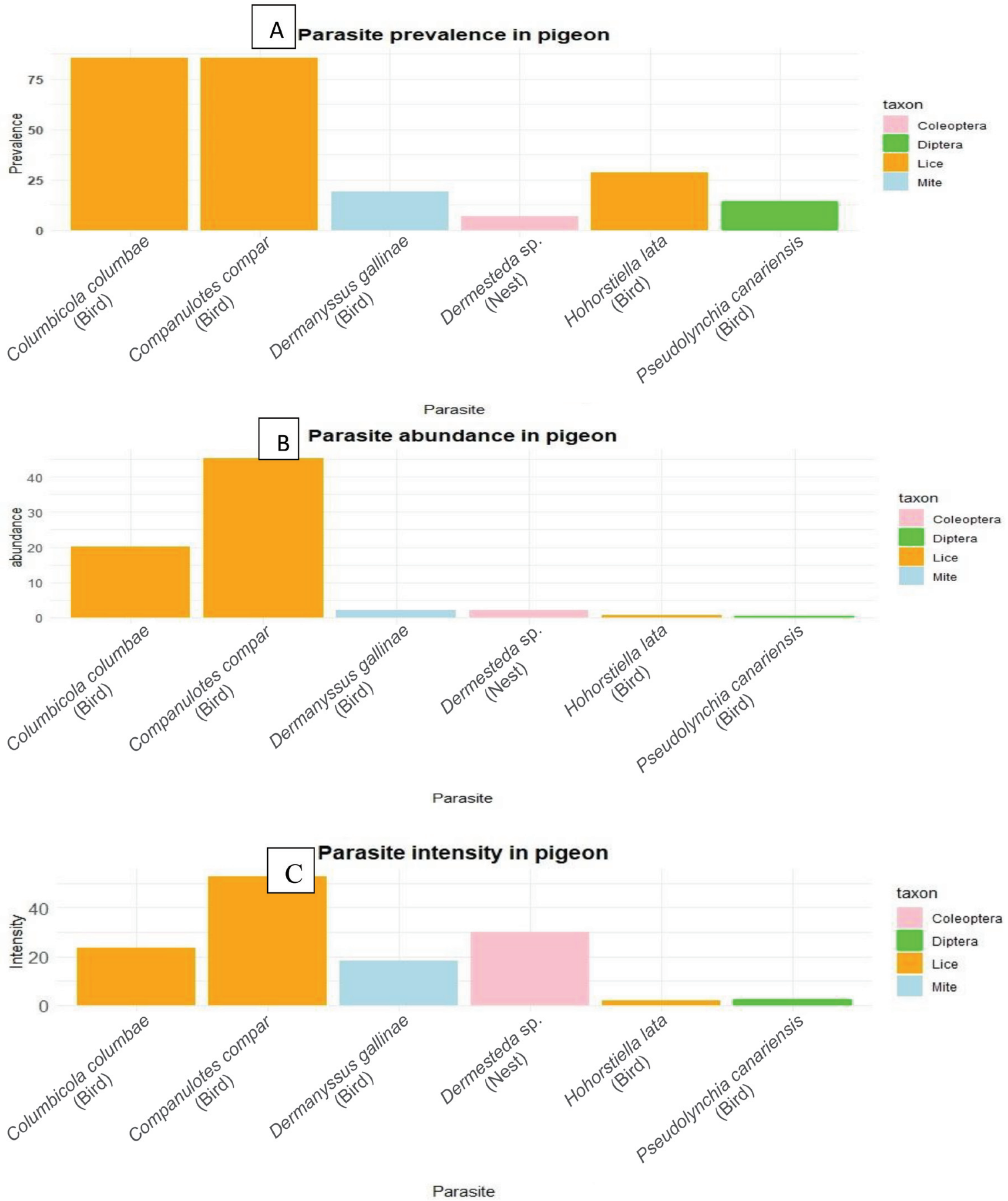

Figure 3. Variation in prevalence, intensity and average abundance of ectoparasites identified in *Columbae livia*: (A) prevalence of infestation, (B) abundance of infestation, (C) intensity of ectoparasites.

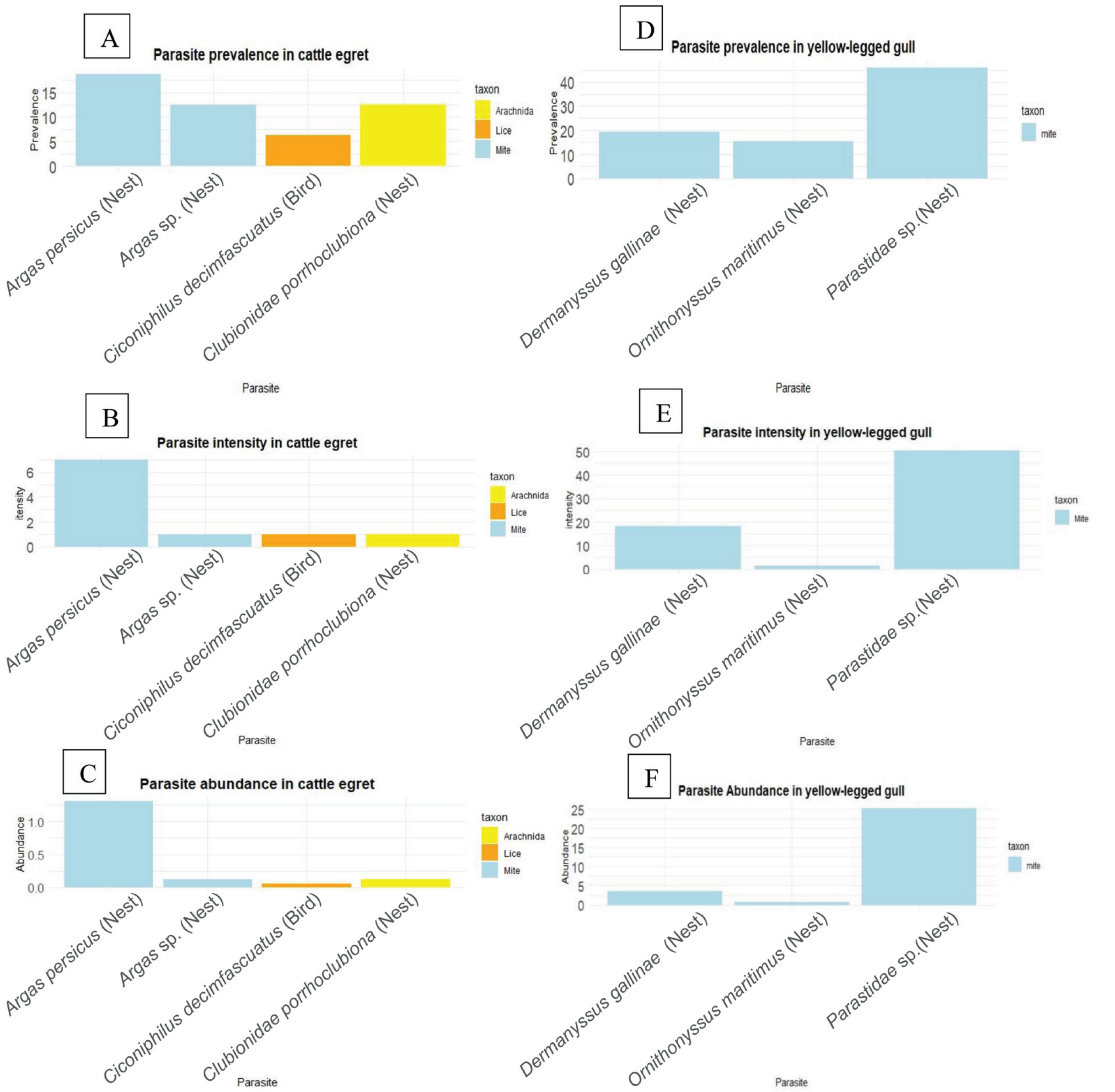

Figure 4. Variation in prevalence, intensity, and mean abundance of ectoparasites identified in *Bubulcus ibis* (A–C) and *Larus michahellis* (D–F).

sp. (prevalence = 46.2%, mean intensity = 50.5) and *Dermanyssus gallinae* (intensity = 18.3). In *Bubulcus ibis*, the observed infestations are significantly lower (prevalence = 6.3% to 18.8%) and of moderate intensity, with the presence of *Argas persicus* in 18.8% of nests (mean intensity = 7.0%).

Parasite distribution among birds and nests

Statistical tests with the generalized linear model (GLM Binomial) were applied to evaluate differences in parasite abundance between individual and nest hosts (Table 1). For the Yellow-legged Gull and Cattle Egret the test indicates that the probability of ectoparasite presence is higher in nests than on individuals. In contrast, in pigeons, the presence of ectoparasites does not differ significantly between nests and birds.

Comparison of parasite loads in species

ANOVA tests (Table 2) revealed significant differences of parasite loads between birds species: for prevalence ($F = 5.72$; $p = 0.019$), the probability of infestation varies across species, with the Rock Dove exhibiting the highest prevalence, followed by the Yellow-legged Gull and then the Cattle Egret. Regarding parasite intensity ($F = 4.95$; $p = 0.029$), the pigeon had the highest intensity, followed by the gull and then the heron. The mean abundance showed a trend close to the significance threshold ($F = 3.84$; $p = 0.056$), indicating a general trend towards higher abundance in pigeons, but this difference was not statistically significant. Post-hoc tests (Tukey HSD) indicate that pigeons are significantly more infested than the Cattle Egret, regardless of the variable studied (prevalence p-value = 0.012,

Table 1. Results of the generalized linear model (GLM).

Variable	Estimate b	SE	Z	P value
Pigeon (individual/nest)	0.248	0.164	–1.513	0.13
Yellow-legged Gull (individual/nest)	4.991	1.002	4.979	1.77×10^{-6}
Cattle Egret (individual/nest)	4.852	1.007	4.816	1.47×10^{-6}

Table 2. ANOVA Test – comparison of parasite loads between birds species.

Variable	F	*p*-value
Prevalence	5.72	0.019
Intensity	4.95	0.029
Abundance	3.84	0.056

Table 3. Post-hoc test (Tukey HSD).

Comparison (birds)	Prevalence	Intensity	Abundance
Pigeon-gull	P = 0.041	P = 0.118	P = 0.092
Pigeon-heron	P = 0.12	P = 0.034	P = 0.047
Gull-heron	P = 0.087	P = 0.049	NS

intensity p-value = 0.034, abundance p-value = 0.047) (Table 3).

Cohabitation

The PERMANOVA performed using Jaccard distance revealed a significant effect of bird species on the composition of ectoparasite communities found on individual birds ($F = 3.92$; $R^2 = 0.67$; $p = 0.031$). The coefficient of determination ($R^2 = 0.67$) indicates that 67% of the observed variation in the composition of ectoparasite communities are explained by bird species, reflecting a strong ecological effect. A relatively high F statistic (3.92) indicates a pronounced separation among groups, confirming that interspecific differences are greater than intraspecific variation. These results suggest that bird species play a major role in structuring ectoparasite communities, potentially due to ecological, behavioural, or physiological differences among host species.

DISCUSSION

Parametric indicator

Lice prevalence in pigeons in our study was slightly higher than that reported in previous observations. Khan et al. (2009) found a prevalence of 80% in domestic pigeons in Pakistan, with a mean intensity of 53 ± 12, while the results of Yamaç et al. (2023) showed that urban birds exhibit significantly higher species richness and lice abundance than rural birds, confirming the major role of dense urban environments in the direct transmission of strictly feather-dwelling lice. These results are also consistent with those of Clayton and Walther (2001), who demonstrated that inter-host transmission is highly dependent on physical contact and grooming behaviour. In Yellow-legged Gulls, our observations are consistent with studies on seabird colonies, where high nest density and the persistence of organic debris promote infestations by nest-dwelling mites and ticks (Sparagano et al. 2014; Vanstreels et al. 2020). A recent study of Mediterranean colonies of *L. michahellis* reported the frequent presence of *D. gallinae* in the nests, highlighting the vulnerability of colonial species to nest-dwelling parasites (Martínez-Abraín et al. 2021). The work of Potti et al. (2007) and Gameiro et al. (2021) also confirms that environmental transmission, rather than direct contact, plays a key role in these colonial hosts. In Cattle Egrets, the observed values are similar to the prevalences reported for the same tick species in domestic birds in North and West Africa, varying between 5% and 15% depending on environmental conditions (Amal et al. 2019; Nahal et al. 2021; Ahmad and Khallil 2025).

Parasite distribution among birds and nests

In pigeons, the absence of significant differences suggests that ectoparasites are distributed relatively evenly among the birds and their nests. This may be explained by pigeon behaviour and the nature of their parasites, some of which are more closely associated with the host than with the nest environment. Furthermore, behaviours such as preening, which is well developed in pigeons, help regulate parasite loads directly on the individual, potentially reducing differences between compartments (Clayton et al. 2010; Bush and Clayton 2018).

In contrast, for the Yellow-legged Gull and the Cattle Egret, highly significant and positive effects ($\beta = 4.991$ and $\beta = 4.852$, respectively; $p < 0.001$) indicate that nests harbour a much higher parasite load than individuals do. This result is consistent with numerous studies showing that nests constitute microhabitats conducive to the accumulation and survival of ectoparasites due to stable conditions (temperature, humidity) and the presence of organic matter (Heeb et al. 2000; Johnson and Clayton 2004). Furthermore, nests can act as long-term parasite reservoirs, allowing ectoparasite populations to persist during the temporary absence of hosts and facilitating their transmission upon the return or replacement of individuals (Tomás et al. 2006). This phenomenon may be accentuated in colonial or semi-colonial species such as gulls and herons, where the proximity of nests and the reuse of breeding sites promote the circulation and accumulation of parasites. Thus, these results confirm that, in certain bird species, nests play a key role in ectoparasite dynamics, whereas in others, such as pigeons, this difference is less pronounced.

Comparison of parasite loads in species

The comparison between *Columba livia* and *Larus michahellis* shows contrasting results depending on the variables analyzed. For prevalence, the difference is significant ($p = 0.041$). In contrast, for intensity ($p = 0.118$) and average abundance ($p = 0.092$), the differences are not statistically significant. This means that the average number of parasites hosted is comparable, suggesting similar parasite pressure in these two urban species sharing similar habitats and ecological conditions. Regarding Yellow-legged Gulls and Cattle Egrets, a significant difference in parasite intensity ($p = 0.049$) was observed, while prevalence ($p = 0.087$) and average abundance did not show statistically significant differences. These results highlight significant differences between the three species studied, emphasizing the major influence of lifestyle, population density, and degree of urbanization on the parasitic dynamics of birds. Strictly urban species, such as pigeons and gulls, benefit from conditions favourable to the transmission of ectoparasites (warmth and artificial shelters). Conversely, the Cattle Egret, less common in urban areas, exhibits a low but not negligible infestation, particularly by *Argas persicus*, a tick with zoonotic potential (Hoogstraal 1985). These observations confirm that urbanization strongly influences host-parasite dynamics and can increase interactions between wildlife and human populations.

Cohabitation

The analysis of variance revealed a significant effect of bird species on the studied variable ($F_2 = 3.92$; $p = 0.031$), explaining 67% of the observed variance ($R^2 = 0.67$). This result indicates that interspecific differences play a major role in structuring the studied variable, potentially reflecting ecological, behavioural, or physiological differences among species. It also suggests that the parasite composition differs significantly among the three species studied, namely the Rock Dove, the Yellow-legged Gull, and the Cattle Egret. These finding confirm that, despite this spatial cohabitation, the parasite composition remains significantly distinct among the species. This suggests that, although they now share some resting or feeding sites, their parasite niches remain differentiated, probably due to their specific behaviours, nesting habitats, and diets.

Health risks

From a health perspective, our results confirm that massive lice infestations can have negative impacts on bird physiology, as demonstrated by Møller and Rózsa (2005). Most importantly, the abundance of *D. gallinae* and the presence of *Argas persicus* pose a risk to human health. Cases of gamasoid dermatitis have been reported in several European cities among residents living near infested pigeon nests (George et al. 2015). Similarly, *A. persicus* is known as a vector of zoonotic pathogens (Hoogstraal 1985; Estrada-Peña and Jongejan 1999), including the transmission of bacteria of the genus Borrelia, which cause avian borreliosis. The increasing proximity between birds, parasites, and human populations in urban environments therefore amplifies the risk of transmission.

Our results thus contribute to a growing body of research showing that urbanization promotes increasing complexity of parasite communities. As Lowther and Cink (2006) suggested in their studies on House Sparrows, the city acts as a self-contained ecosystem, offering new ecological niches for parasites. Comparing our results with these studies reveals that the urban environment plays a dual role: it accentuates the specialization of certain parasites (feather lice) while providing an ecological springboard for others (nesting mites and ticks).

CONCLUSION

This study is one of the first systematic approaches to avian parasitology in an urban environment in Tizi Ouzou, based on three focal species: *Columba livia*, *Larus michahellis* and *Bubulcus ibis*. The results show that the distribution of ectoparasites depends on the type of host (individual or nest), the avian species and the ecology of the parasites. Furthermore, a comparison between host species reveals that pigeons serve as a primary reservoir for lice, while the Yellow-legged Gull and Cattle Egret primarily harbour mites nesting in their nests. This study also demonstrates that spatial proximity alone is insufficient to produce complete convergence of parasite communities. In conclusion, the city of Tizi Ouzou constitutes an ecosystem conducive to the proliferation of parasites, and the presence of *Argas persicus* and *Dermanyssus gallinae* represents a significant health risk for birds and humans.

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