Review

The Population Dynamics of Two Invasive Species in Urban Habitats: The Eurasian Collared Dove (*Streptopelia decaocto* Frivaldszky, 1838) and the Monk Parakeet (*Myiopsitta monachus* Boddaert, 1789)

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Posted Date: 29 October 2025

doi: 10.20944/preprints202510.2243.v1

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The Population Dynamics of Two Invasive Species in Urban Habitats: The Eurasian Collared Dove (Streptopelia Decaocto Frivaldszky, 1838) and the Monk Parakeet (Myiopsitta Monachus Boddaert, 1789)

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Simple Summary

This study has two objectives. First, it analyses the population dynamics of two invasive bird species. Secondly, it focuses on urban habitats, investigating a comparison of the mechanisms whereby invasive birds cope with timely changes. Specific aspects of these mechanisms of population dynamics addressed are climate and habitat effects on occupancy rates, survival rates, carrying capacity, stress responses, resistance, competition between native and invasive species in a scenario of climate and global change, providing a general and complementary approach to understanding the invasion risks of species, which are already being considered as bird pests.

Abstract

The population dynamics of two invasive bird species belonging to two different bird families have been studied, one belonging to the Columbidae family and the other to the Psittacidae family, both phylogenetically distant but jointly occupying some urban habitats in Western Europe. Different information tools were used through bibliographic reference software available on the web. The main conclusions are as follows: the fundamental mechanics of invasion of these two species consist of their genetics, and their environmental resistance predicts that the current patterns of spread are better than the climate, in general habitats and in urban habitats in particular. One of the most fundamental aspects of their invasive processes is of genetic nature.

Keywords: climate; competition; invasive birds; genetics; resilience; resistance; population dynamics; urban habitats

1. Introduction

In a natural world dominated by global change, the effects on the plant and animal kingdom diversity take great importance [1] and future prospects are not optimistic [2]. In birds, in particular (see [3,4] for overall studies) this effect can include changes in (i) phenology (e.g. [5–7]) and the phenology mismatch hypothesis [8] (ii) migration patterns (e.g., time of spring arrival from the wintering grounds: e.g. [9,10], breeding (e.g. [11]) and time of autumn migration to southwards (e.g. [12]), (iii) time migration dates (e.g.. [13]) and its consistency (e.g [14]), (iv) effects on limiting resident birds: e.g [15]), (v) effects on species distribution (e.g., poleward shift of range margins, e.g [16,17]) (vi) gradient variations in morphological components (e.g. body size: [18,19]), (vii) population declines of birds which do not respond to climate change (e.g. [20]), (viii) long-term trends response

 doi:10.20944/preprints202510.2243.v1

of European birds (e.g. [21]) and its analysis and interpretation (e.g. [22]), (ix) impact of bird communities or assemblages ([23]), (x) sex-ratios ([24]).

However, many consequences of climate change as a main cause factor on the changes in the bird's biodiversity have not already been clarified, particularly the population dynamics of invasive birds in certain habitats as urban places in order to set the problem of worldwide expansion. Changes in the distribution of species both geographically and in ecosystems of invasive species, which are more adaptable than native species under this threshold climate effect ([25,26]) and are already proving to be a problem for humans ([27–29]) and for biodiversity ([30–33]).

This research tries to summarize the problem of two invasive bird species by addressing their population dynamics and trying to ascertain why these birds have become to be a bird pest in many urban habitats in Europa. The first step of this research is to clarify the definition of non-native, invasive or alien species because these terms result usually unclear: (i) non-native species are species that have been introduced to an area where they do not naturally occur. This introduction can happen through various means, including human activities such as trade, agriculture, and travel. Non-native species can be benign, beneficial, or harmful to the ecosystems they invade (e.g. [34]), (ii) invasive species are a subset of non-native species, those that spread rapidly and cause significant harm to the environment, economy, or human health. This term according authors could be neutral or ambiguous recalling it as introduced, naturalized, weedy, etc ([35]). They often outcompete native species for resources, disrupt local ecosystems, and can lead to biodiversity loss (e.g. [36]). (iii) alien species: This term is often used interchangeably with non-native species but can also refer to any species that is not indigenous to an ecosystem. Alien species include both non-native and invasive species, emphasizing their introduction from different geographical areas (e.g .[37]). The second step of this research is threefold: (i) to identify the problem, (ii) to set the problem and (iii) to offer possible solutions.

To understand the approach to the dynamics of the expansion of an invasive species, and in particular birds, three hypotheses should be clearly addressed. These are the "*Climate Hypothesis*" (CH, [38]), "*Habitat Hypothesis*" (HH, [39]) and "*Human Activity Hypothesis*" (HA, [40]). In the context of habitat, it is necessary to subdivide the initial two hypotheses into "*microhabitat*" (MIH) and "*macrohabitat*" (MAH). Within the domain of climate, these hypotheses are further categorized as "*microclimate*" (MIC) and "*macroclimate*" (MAC). If deemed appropriate, the MAH and MAC can also be applied at the level of urban areas. The CH suggests that invasive species are more likely to thrive in regions with a similar climate to their native environment, as they can maintain their natural habitat. The HH states that anthropogenic changes render new environments more susceptible to invasion by altering native communities and reducing biotic resistance. The HA assumes that the most effective habitats in biotic terms (i.e. those with the most food and human activity) are more favorable for the establishment of invasive birds. The specific urbans habitats under consideration in this work need a focus on the last four factors, while disregarding the impact of management, which has been demonstrated to be irrelevant in some instances and significant in others [41].

2. Material and Methods

In order to investigate the objectives, set for the two species under study, different search was conducted on Google Scholar (https://scholar.google.es/) from February 2025 to July 2025. Phrases related to the keywords in this article were entered the search engine. Given the large amount of information available on these species, only in those articles containing the most generic and specific information were selected. The output of this selective search resulted in 80 references. With the support of these articles, the framework for this article was constructed.

 doi:10.20944/preprints202510.2243.v1

3. Results

3.1. The Eurasian Collared Dove

3.1.1. Main Features

The Eurasian Collared Dove (*Streptopelia decaocto)* (hereafter, ECD) is a medium-small dove bird of the family *Columbiidae* [42]. Posses a brown rusty body with a feather ring in each side of the posterior part of the neck (more information about plumage features and differentiation with another similar species can be found in [42,43] and [44].

3.1.2. Expansion Mechanisms

The ECD is originated from India and has spread widely over the European continent [43] throughout the last century [45,46]. In Urban habitats of Western Europe this species is stablished, and its complete biology is currently well known [47] and in urban habitats [48]. Its population dynamics is well settled by [49].

One of the most notable characteristics of its expansion is that it has been one of the fastest among known birds [44] and similar to that of the Serin (*Serinus serinus*, [50]), given that Columbiformes have high flight speeds [51] and the cause of its expansion was probably a genetic mutation in the peripheral areas of its original distribution [44,52], which could have caused its innate behaviour towards an adaptive explosion of genetic drift [53] in which the flexibility and innovation of behavioural states of invasive species increases until reaching a state of equilibrium in the so-called *'Adaptive flexibility hypothesis'*[54]. In the USA, expansion is focused on the combined effects of habitat and climate, with grasslands and higher areas being the preferred habitats and warmer and rainier areas being the most suitable climate [55,79]. The population dynamics of this species have already been well studied by [49], who indicate that this expansion dynamic can be perfectly predictable and is governed by two factors: carrying capacity and population growth rates. These, in turn, are related to developed land cover and temperature, while growth rates may also be influenced by dispersal patterns along the invasion front. The multivariate models offered by these authors explained between 35% and 48% and 41% and 46% of the variation in carrying capacity and population growth rates, respectively.

ECD has a dispersal mechanics in Europe called 'jump dispersal' based on a high dispersal rate in the breeding season towards the marginal areas of cities, which determines that the summer reproduction rate in these areas is higher because there is less competition between males [56]. This dispersal causes the expansion rate and survival rate to increase with proximity to less populated rural areas [56]. As [57] point out, and this is a key factor for their metapopulation dynamics in general and in France in particular.

In the USA, ECD's expansion is based on the 'climatic hypothesis', which states that it tends to be absent or occur rarely in areas with very low temperatures. In fact, in areas with minimum temperatures, its occupancy is minimal, and its occurrence is lower the higher the precipitation, as there is an inverse relationship between the two [47,58]. According to the 'anthropogenic hypothesis', ECD increases with proximity to the coastline and appears to follow roads as a dispersal pathway, as observed in Europe [59]. This determines the increased carrying capacity and growth rates of ECD populations in Europe [48].

3.2. The Monk Parakeet

Main Fetaures

The Monk parakeet (Myiopsitta monachus) (herafter, MP) is a bird belonging to *Psytaciidae* Family [60]. MP has a high survival, with a high clutch size and low dispersal. This makes it a r strategist [61] within a communal breeding system not previously recorded in other Psittacines [62].

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In Barcelona, Spain, Sol et al. (1997) [63] did not study the 'climate hypothesis' regarding the distribution of this species, but they did study the 'habitat hypothesis', indicating that the presence of macrohabitat elements, such as Phoenix spp. palms, over successive years, and specifically the taller ones, as microhabitat elements, were key factors in its abundance and presence, due to greater security from human predation. Similarly, in the same city, Rodriguez-Pastor et al (2012) [41] support the anthropogenic hypothesis to explain how this species can successfully become established in a non-native habitat. They emphasise that the limitation of food sources, particularly human-supplied food, is the most important factor to consider in its dynamics.

The MP's preference for nesting in ornamental trees may cause niche displacement in urban areas due to competition with native species [39]. This implies that the range expansion of some invasive psittacine may be due to their ability to exploit urban resources that native species either do not exploit or exploit insufficiently, suggesting an open window of feeding opportunities. Previous observations in Barcelona and other cities showed that approximately 40% of the food ingested by adult MP is of anthropogenic origin. Here we show that this type of food source is also used for feeding nestlings. Since food availability is a major factor regulating population growth, we propose educating the public to reduce the food supply for the species and ultimately limit its population growth [64].

Urbanisation as a major driver of change leads to the extinction of some species while others increase in abundance, especially non-native species. The spatio-temporal distribution patterns of these successful species are likely to be shaped by their response and tolerance to urban features.

4. Discussion

The Problem of Coexistence and/or Competition in Invasive Bird Species

One issue to consider with the species studied is their coexistence in certain highly favourable urban habitats where one species is present but the other is not. For example, ECD exists in scarce colonies aggregated in large gardens and palm groves of western Mediterranean *Phoenix spp* (e.g. Elche city in Alicante province, southeastern Iberia) where MP is totally absent. This is a solving paradox explained because there is competitive superiority of exotic species over native species and opportunistic use of ecological opportunities derived from human activities [65]. Applied to birds, this framework suggests that the possibility that an exotic species ends up associated with human-altered environment is higher if: (1) is more abundant (and hence more available for introduction) in urbanized environments; (2) has a higher chance to be successfully transported, as it is already habituated to humans; and (3) has a higher probability to be introduced in an urbanized environment, where most humans live. If these arguments are true, then the exotic species is likely to successfully establish itself in the new region because the species should already have the traits needed to persist in the novel environment [66]. In Valencia city (eastern Iberia) for example, Murgi & Valentin (2003) [67] study the features of landscape for exotic species. They find that 23 introduced bird species have been recorded in in this city, 56% of them belonging to Psittacidae Family. Most of the records belonged to three breeding species, Ring-necked Parakeet *Psittacula krameri*, Red-masked Parakeet *Aratinga erythrogenys* and Monk Parakeet *Myiopsitta monachus*. These birds were mostly distributed in the built-up area. Despite of the fact that the parks were strongly selected comparing with other landscape features, birds used only 24 out of 130 parks. Parks selected by birds were greater and they were less isolated than the rest. They conclude birds were associated with specific parts of the city. This pattern could be related with the small size of the populations, perhaps because of a low breeding success, with the great quantity of feeding resources near the breeding sites and with the tendency of new escapees to join to the established groups.

Invasive processes have an initial pre-invasive, maladaptive or non-selective framework, followed by a post-invasive, adaptive or natural selective framework [68]. Natural selection acts through phenotypic plasticity, adaptively increasing or accelerating it [69], thereby making invasive species more resilient to the environment than native species once they are established [70]. This is

 doi:10.20944/preprints202510.2243.v1

achieved by increasing additive genetic variance through natural selection processes [77]. Natural selection shapes morphological and behavioural traits, making invasive species more resistant to native species and thus more resilient and flexible in novel environments. This can involve displacing natives through competition and/or opportunism (e.g. [65–68]), or by occupying empty niches not exploited by native species. The impact of human influence on the niche of invasive birds, particularly in urban habitats, has received limited assessment (e.g. [70]).

While most studies consider only the climatic niche, other factors, such as human disturbance, also influence niches. Whether human habitat occupation in the range of exotic species depends on the native tolerance of the species has not yet been explored. We assessed niche conservatism in climatic and human spaces for bird species that exhibit different responses to humans in their native habitats and evaluated the impact of considering anthropogenic niche variables on invasion predictions. In urban environments, the range expansion of the Rose-ringed Parakeet (Psittacula krameri) (39]), like the Psittacidae species in this study, is probably due to its ability to exploit urban resources that native species do not exploit, suggesting an open window of opportunity for feeding, nesting, and resting. These resources are found in parks and in areas with a large population. Exotic vegetation, particularly exotic ornamental trees, and the presence of water are among the main factors regulating the abundance of exotic species (ECD) in urban areas of the eastern Iberian Peninsula [71].

Both species studied exhibit social behaviour in flocks in urban habitats (e.g.,[72]) where such activity is reduced or less frequent in urban areas where predators are present, as evidenced by MP in the city of Buenos Aires, given that it prefers open areas that allow for greater surveillance and defence against them [72], and this may prove to be a key factor in the presence of invasive species in these habitats [73].

The urban habitat poses new challenges for organisms around the world. Numerous effects associated with the urban habitat in birds have been described, including internal and environmental factors. Internal effects mainly consist of elevated levels of the stress hormones corticosterone and cortisol in the blood, which are indicators of the body's response to stress in order to maintain stability, a concept known as allostasis (see [74]). Today, clear and consistent patterns of allostasis are evident in urban birds [75]. For instance, studies of small passerine bird species in urban environments in Northern Europe [78] have revealed a stress gradient measured by nitrogen oxide (NOx) levels in the air, which increase successively with urbanisation. These studies have also shown that the antioxidant capacity of the birds' blood plasma increases in parallel with this gradient. However, the adrenocortical response exhibits all the characteristics of a trait subject to natural selection, including high individual variation, repeatability, and a genetic basis. Furthermore, individuals demonstrate significant phenotypic plasticity, which could facilitate the differential survival of stress-tolerant individuals. However, current evidence suggests that local bird colonization's and extinctions are poorly explained by changes in climatic suitability [80].

5. Conclusions

In some invasive species, a genetic paradox comes into play, whereby some of them enter bottlenecks considered to be genetic sink pools with high genetic diversity due to the immigration of species carrying genetic material from source areas. In the event of high inbreeding in bottlenecks, invasive species enter a process of extinction due to a lack of genetic diversity. To date, there are studies of ECD's and MDP's genetic structure, although is poorly studied (see [47,76]). Without such studies, the keys to its burgeoning expansion cannot be clearly elucidated.

Funding: This research received no external funding.

Acknowledgments: To my recently deceased ancient mother Maria Dolores Peiró Alemán, who allowed me to dedicate to do science.

Conflicts of Interest: The author declares no conflict of interests.

 doi:10.20944/preprints202510.2243.v1

List of Abbreviations

CH = Climate hypothesis.

HA = Human activity hypothesis

MH = Microhabitat hypothesis.

MAH = Macrohabitat hypothesis.

MIC = Microclimate hypothesis.

MAC = Macroclimate hypothesis.

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