FROM CITY TO COUNTRYSIDE: THE CASE OF THE RING-NECKED PARAKEET *Psittacula krameri* IN LAZIO (CENTRAL ITALY)

Fulvio Fraticelli [1] & Alessandro Montemaggiori [2]

Stazione Romana Osservazione e Protezione Uccelli, Piazza Margana 40, 00186 Roma
[1] f_fraticelli@hotmail.com; http://orcid.org/0000-0003-3999-3663
[2] alessandro.montemaggiori@gmail.com; https://orcid.org/0000-0002-3709-2637

Abstract - The Ring-necked Parakeet *Psittacula krameri* is an invasive alien species that can cause damage to native biocenoses and human activities, particularly agriculture. In this study, we analyzed 3,333 observations collected in Latium through the Ornitho.it platform from 2009 to 2024, focusing on the dispersal patterns of individuals from nesting sites. Results show that, although nesting is confined to the urban area of Rome and the adjacent coastal strip, the species regularly moves into rural environments at distances of up to 107 km. Movements vary seasonally, with shorter distances during the breeding period (April-June) and maximum distances during juvenile dispersal (July-August). An inverse correlation was found between distance and flock size, and a preferential dispersal direction toward the Northwest was observed across all periods. Since 2022, the movement of large flocks (up to 350 individuals) has been recorded in the Northwest direction in the Cerveteri area, suggesting the existence of unknown rural roosts. Considering the adaptive capabilities of the species, the presence of potential nesting sites (deteriorating palm trees, Monk Parakeet nests), and the extensive agricultural surface in the region, these dispersal patterns indicate a high risk of expansion as a breeding species into new areas, with potential impacts on agricultural activities and non-synanthropic species.
Key words - Ring-necked Parakeet, Dispersal patterns, Urban-rural movements, Invasive alien species

Riassunto - Dalla città alla campagna: il caso del Parrocchetto dal collare *Psittacula krameri* nel Lazio. Il Parrocchetto dal collare *Psittacula krameri* è una specie aliena invasiva che può arrecare danni alle biocenosi autoctone e alle attività umane, in particolare agricole. In questo studio abbiamo analizzato 3.333 osservazioni raccolte nel Lazio attraverso la piattaforma Ornitho.it dal 2009 al 2024, focalizzandoci sui pattern di dispersione degli individui a partire dai siti di nidificazione. I risultati mostrano che, sebbene la nidificazione sia confinata all›area urbana di Roma e alla fascia litoranea adiacente, la specie si sposta regolarmente in ambiente rurale con distanze fino a 107 km. Gli spostamenti variano stagionalmente, con distanze minori durante il periodo riproduttivo (aprile-giugno) e massime durante la dispersione giovanile (luglio-agosto). È stata rilevata una correlazione inversa tra distanza e dimensione degli stormi, e una direzione preferenziale di dispersione verso Nord-Ovest in tutti i periodi. Dal 2022 è stato inoltre registrato lo spostamento di stormi numerosi (fino a 350 individui) in direzione Nord-Ovest nell›area di Cerveteri, suggerendo l›esistenza di dormitori rurali non conosciuti. Considerando le capacità adattative della specie, la presenza di potenziali siti di nidificazione (palme deperienti, nidi di Parrocchetto monaco) e l'elevata superficie agricola nella regione, questi pattern di dispersione indicano un alto rischio di espansione come nidificante in nuove aree, con potenziali impatti sulle attività agricole e su specie non sinantropiche.
Parole chiave - Parrocchetto dal collare, Pattern di dispersione, Movimenti urbano-rurali, Specie aliena invasiva

INTRODUCTION

The Ring-necked Parakeet *Psittacula krameri* is considered one of the alien invasive species that creates the most significant problems for native biocenoses and human activities (e.g., Menchetti & Mori, 2014; Mack *et al.*, 2000; Jackson, 2011; White *et al.*, 2019). One of the major impacts occurs in relation to agricultural activities (e.g., Dhindsa & Saini, 1994; Khan *et al.*, 2013; Mentil *et al.*, 2018), which is also evident in our country (Battisti & Fanelli, 2022), but, in rural environments, also as a disturbance for birds of prey (Battisti & Fraticelli, 2023).

In Italy, the species is still localized as a breeding bird in urban environments (Mori, 2022), but at the global level, there is evidence of expansion into rural areas as well (Pârâu, *et al.*, 2016). The Italian population was estimated in 2016 at 9,200 individuals (Pârâu, *et al.*, 2016), but an exponential growth capacity has been highlighted in some populations (Fraticelli, 2014) and, in general, it is one of the species with the highest capacity for numerical growth worldwide (Balmer *et al*., 2013; Hernández-Brito *et al.*, 2022a), in some cases managing to double the population in just 3.5 years (Shiels & Kalodimos, 2019).

The availability of cavities for nesting is the main element that can condition the spread and numerical growth of this species (Strubbe & Matthysen, 2007) with competition from other hole nesting species (Dodaro & Battisti, 2014; Fraticelli & Scrocca, 2024). Despite this the structural characteristics of many Italian cities provide availability *ad libitum*, and consequently, this has led in recent years to the Italian population likely increasing by several orders of magnitude compared to the previous estimate.

There are few data available in the literature on the *home range* of this species and none for Italy. In Spain, a home range of 120 ha was found for this species (Batllori & Nos, 1985), while in Belgium between 75 and 85 ha (Strubbe & Matthysen, 2011). The purpose of this work is to verify the movement capabilities in rural environments by this species starting from nesting sites in Lazio, with the consequent increase in the potential for expansion as a breeding species.

STUDY AREA, MATERIALS AND METHODS

We conducted this study considering the entire Lazio region and using data available on the Ornitho.it platform from March 2009 to April 2024. As a first step, we selected all data of probable/certain nesting, Ornitho atlas code greater than 7 (visit to a probable nesting site different from a resting site).

Subsequently, we measured the distance in kilometers from the nearest nesting site for all observations without an atlas code situated beyond 5 km distance, with the aim of excluding from the analysis movements that occur within the normal home range of the species, although precise data on its extent in our context are lacking. The distance thus detected is to be considered cautious since we have no certainty of the site of origin of each individual, which could be more distant than the one considered. For each data point beyond 5 km, the numerical consistency of the flock was also recorded. To evaluate the dispersal directions, we calculated the centroid (41°50’70”N-12°25’19”E)

of the minimum convex polygon that encloses all the nesting sites detected in Lazio (Fig. 1). We preferred to use the centroid and not the barycenter due to the irregular shape of the polygon. We processed the data by dividing them into three distinct phenological periods based on the biology of the species: non-breeding season from September to March, breeding season from April to June, and period of juvenile dispersal from July to August.

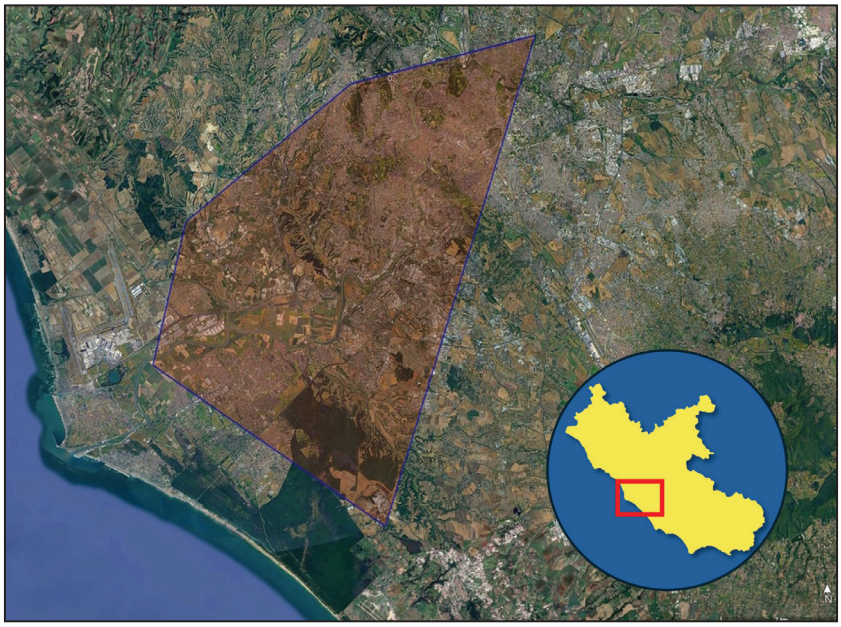

Figure 1. Map of the minimum convex polygon enclosing all nesting sites detected in Lazio.

It should be considered that in the regions adjacent to Lazio, the only data of probable/certain nesting for this species are in Campania in Naples and in Tuscany with an isolated case in Follonica and the others north of Pisa and Florence; there are no data for either Abruzzo or Umbria (source Ornitho.it consulted on August 16, 2024). It is therefore very likely that Lazio observations far from breeding areas refer to local individuals. The data used are probably influenced by the distribution of the surveyors who provided them, but with good approximation can be considered reliable.

For the statistical processing of the data, we used the Kolmogorov-Smirnov normality test, Pearson's correlation test, the χ^2 test, and the G test with a significance level of $\alpha < 0.05$.

RESULTS AND DISCUSSION

We found 66 nesting sites, 78% of which are within the Grande Raccordo Anulare, the ring road that surrounds Rome and hypothetically defines the urban area, and the

remaining 22% in the proximal coastal strip, in the Ostia district and in the municipality of Fiumicino. No probable or certain nesting was detected outside this area.

We measured the distance of all 3,333 observation points from the nearest nest, selecting the 875 that were more than 5 km away. The percentage of use of various distance bands is not uniform, with a marked preference for that between 5 and 10 km and for that between 20 and 30 km (Fig. 2). This could be due to contingent local situations perhaps linked to trophic resources. The record for the greatest distance from the nearest nest was that of an individual at 107 km in the province of Frosinone, while another individual was found at 102 km in the province of Viterbo.

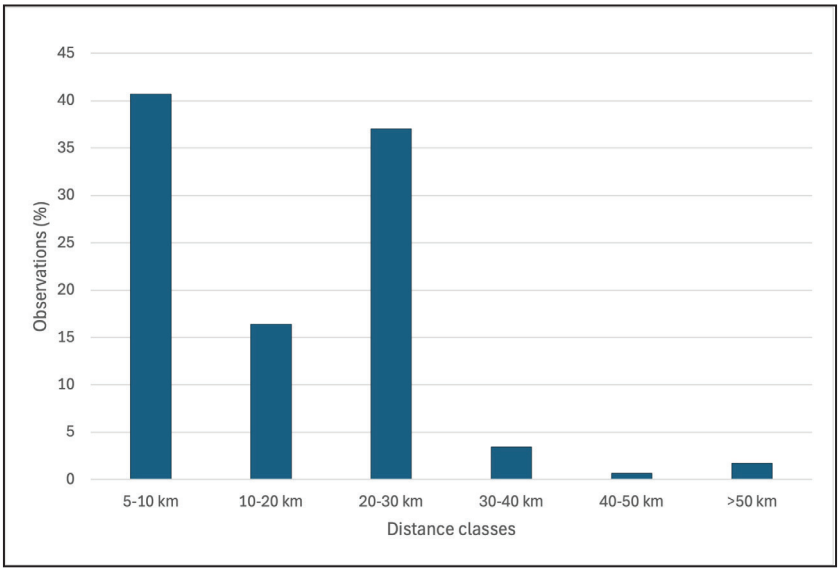

Figure 2. Percentage of observations by distance classes, greater than 5 km, from the nearest nest.

The average distances from the nearest nest divided by month show a decrease during the reproductive period and an evident increase in July and August, probably in relation to the dispersal of young birds (Fig. 3), since it is known that these possess greater mobility compared to adults (Strubbe & Matthysen, 2011). Furthermore, young birds could represent an important fraction of the population in July and August since the fledging rate of juveniles can reach 72% in relation to eggs laid (Shivanarayan *et al.*, 1981).

The flock size in relation to the distance from the nearest nest (Fig. 4) does not show a normal distribution (Kolmogorov-Smirnov test, $D = 0.16$; $P < 0.001$) and shows an inverse correlation between distance and the numerical consistency of the flock (Pearson test, $r = - 0.10$; $P = 0.003$). All 14 data points beyond 54 km from the nearest nest are to be considered outliers. We found flocks composed of the greatest number of individuals in the most frequently used distance bands (Fig. 2), and this could be a confirmation of particular trophic local attraction situations.

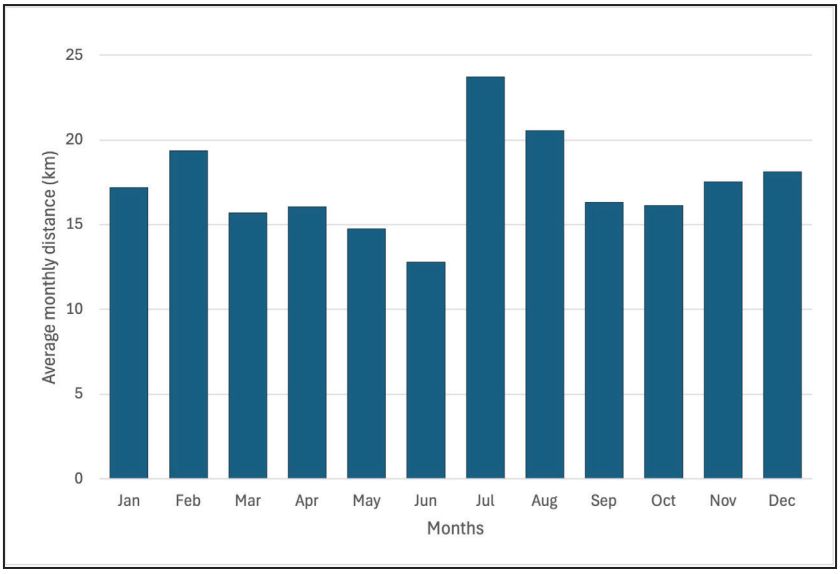

Figure 3. Average distances in km from the nearest nest month by month for observations beyond 5 km.

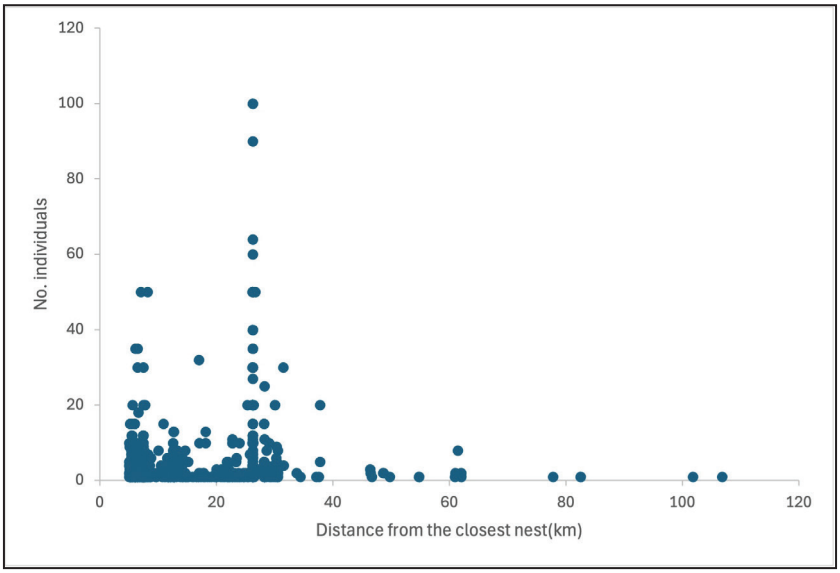

Figure 4. Numerical consistency of flocks in relation to the distance from the nearest nest.

The maximum number of individuals per flock shows the highest values from October to March and the lowest during the breeding season. The values of July and August are probably related to juvenile dispersal (Fig. 5).

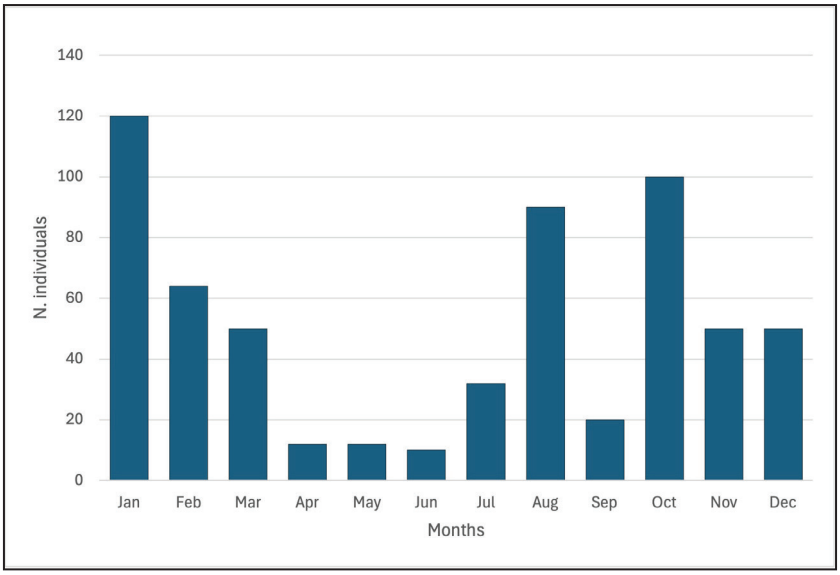

Figure 5. Maximum number of individuals per flock during the year.

Northwest is the dominant dispersal direction from the centroid of the nesting area in all three phenological periods considered (Fig. 6). The directional distribution of individuals with respect to the centroid is highly non-random in all seasons (d.f. = 7; non-breeding season $\chi^2 = 567.5$, $P < 0.001$; breeding season $\chi^2 = 51.6$; $P < 0.001$; juvenile dispersal $\chi^2 = 93.9$, $P < 0.001$). This means that there is a strong directional preference of individuals, with significant variations between the three different periods considered. The statistical comparison of the percentages of dispersal direction does not show a significant difference between non-breeding season vs. breeding season ($G = 8.2$, $P > 0.05$), while it shows a highly significant difference both in the comparison of juvenile dispersal vs. non-breeding season ($G = 27.8$, $P < 0.001$) and in the period of juvenile dispersal vs. breeding season ($G = 29.6$, $P < 0.001$). The significant increase toward the Northwest direction, which is preferred throughout the year, during the juvenile dispersal period could suggest that inexperienced young birds follow adults to feeding sites known to the latter.

The data reported above, which show a considerable frequentation of rural environments by the Ring-necked Parakeet, in our view, increase the probabilities of dispersal of the species also as a breeding bird beyond the area used to date. A further element of concern linked to a possible expansion of the species is given by the ability of the Ring-necked Parakeet, found in Spain, to behave as a primary cavity nester by excavating the nest in the dead tissues of palms or by exploiting, in cohabitation, the nests of the Monk Parakeet *Myiopsitta monachus* (Hernández-Brito *et al.*, 2022b). In the first case, due to the infestation of the Red Palm Weevil *Rynchophorus ferrugine-*

us that has affected our country (Di Domenico, 2013), there are many deteriorating trunks of palms of the genus *Phoenix* throughout the region that lend themselves as potential nesting sites. In the second case, the Monk Parakeet has had a considerable spread as a breeding bird outside the city of Rome in Lazio in recent years, forming various colonies in the coastal strip of the provinces of Rome and Latina (source Ornitho.it consulted on March 23, 2025) and thus creating a further potential element of support for the spread as a breeding bird of the Ring-necked Parakeet. In relation to the preferential directions and distances of dispersal, the main coastal localities north of Rome (Fregene, Ladispoli, Marina di Cerveteri, Santa Severa, Santa Marinella, and Civitavecchia), possessing all the specific structural characteristics (rows of large trees near buildings; Mori, 2022), have good probabilities of becoming nesting sites for this species in the medium term. It is not, however, to be excluded that a local culture could be created that leads to selecting holes in the walls of buildings as nesting sites, as happens for example in Pavia (Grandi *et al.*, 2018).

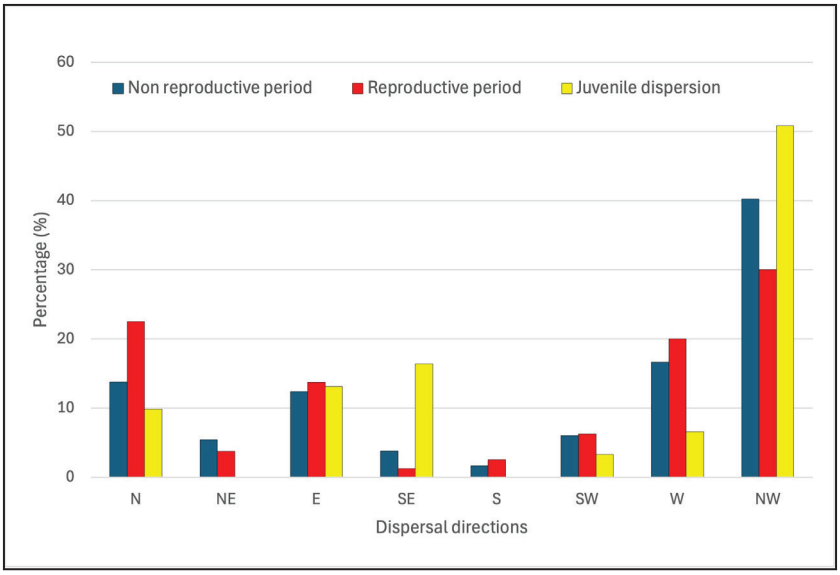

Figure 6. Percentage distribution of dispersal directions with respect to the centroid of the nesting area subdivided into three different phenological periods.

Starting from 2022, we found in an area in the municipality of Cerveteri (42°00'N-12°03'E) the passage at sunset in a Northwest direction, thus parallel to the coast, of significant numbers of Ring-necked Parakeets, even more than 350 individuals in an evening. The area has been monitored almost daily since 2017, but until 2022 this phenomenon had never been noticed. This behavior suggests that not all individuals, once they have completed trophic activities in the countryside, return to the known dormitories within Rome and that there exist important rural dormitories that could

further push this species to colonize new areas as a breeding bird. This is apparently a behavior not known until now because the maximum known distance between the nest and the dormitory for this species is about 10 km (Strubbe & Matthysen, 2011).

Considering that Lazio has 32.8% of its surface used for agricultural activities and that the coastal strip between 10 and 40 m above sea level in the province of Rome is formed by 31.2% agricultural surface (ISTAT, 2024), the frequentation of a high number of Ring-necked Parakeets can potentially cause considerable damage to these economic activities since there are many cultivations of tree species that produce fruits appealing to the species (Battisti & Fanelli, 2022).

Only the particular local situation, represented by nests present only in a very limited area of the region and nesting sites present in neighboring regions that are particularly distant, has allowed all the previous elaborations to be carried out. It is probable that in different environmental situations, the species, thanks to its peculiar cognitive abilities and behavioral flexibility (Auersperg & von Bayern, 2019), applies models of use of areas around nesting sites and, more generally, of dispersal different from those we found in Lazio.

Acknowledgements. We thank the anonymous referee for the useful advice, the Ornitho users who made their data available and Francesca Cosentino for calculating the distances between the database points.

REFERENCES

- Auersperg A.M. & von Bayern A.M., 2019. Who's a clever bird --- now? A brief history of parrot cognition. Behaviour, 156: 391-407.
- Balmer D.E., Gillings S., Caffrey B., Swann R., Downie I. & Fuller R., 2013. Bird Atlas 2007 - 2011: the breeding and wintering birds of Britain and Ireland. BTO Thetford, Norfolk.
- Batllori X. & Nos R., 1985. Presencia de la cotorrita gris (*Myiopsitta monachus*) y de la cotorrita de collar (*Psittacula krameri*) en el área metropolitana de Barcelona. Miscellània Zoològica, 9: 407-411.
- Battisti C. & Fanelli G., 2022. Foraging diet of the two commonest non-native parakeets (Aves, Psittaciformes) in Italy: Assessing their impact on ornamental and commercial plants. Rendiconti Lincei. Scienze Fisiche e Naturali, 33: 431-439.
- Battisti C. & Fraticelli F., 2023. When 'bullies' come out of cities: mobbing among introduced Rose-Ringed Parakeets *Psittacula krameri* and native species of conservation concern in extra-urban habitats with suggestions for a framework of PSIR indicators. *Biodiversity*, 24: 96-101.
- Dhindsa M.S. & Saini H.K., 1994. Agricultural ornithology: an Indian perspective. Journal of BioScience, 19: 391--402.
- Di Domenico M., 2013. Invasioni Biologiche. Il Caso drammatico delle palme e di due specie di insetti, il Punteruolo rosso delle palme (*Rynchophorus ferrugineus*, Coleotteri) e il Castanide delle palme (*Paysandisia archon*, Lepidotteri) in Italia. Altre Modernità, 10: 164-76.
- Dodaro G. & Battisti C., 2014. Rose-ringed parakeet (*Psittacula krameri*) and starling (*Sturnus vulgaris*) syntopics in a Mediterranean urban park: evidence for competition in nest-site selection? *Belgian Journal of Zoology*, *144*: 5-14.
- Fraticelli F., 2014. The rose-ringed parakeet *Psittacula krameri* in a urban park: demographic trend, interspecific relationships and feeding preferences (Roma, central Italy). Avocetta, 38: 23-28.
- Fraticelli F. & Scrocca R., 2024. Some cases of nest usurpation by the ring-necked Parakeet *Psittacula krameri*. Alula, 31: 67-69.

- Grandi G., Menchetti M. & Mori E., 2018. Vertical segregation by ring-necked parakeets *Psittacula krameri* in northern Italy. Urban Ecosystems, 21: 1011-1017.
- Hernández-Brito D., Carrete M. & Tella J.L., 2022°. Annual censuses and citizen science data show rapid population increases and range expansion of invasive rose-ringed and monk parakeets in Seville, Spain. Animals, 12: 677, https://doi.org/10.3390/ani12060677
- Hernández-Brito D., Tella J.L., Blanco G. & Carrete M., 2022b. Nesting innovations allow population growth in an invasive population of rose-ringed parakeets. Current Zoology, 68: 617-626.
- ISTAT, 2024. L'agricoltura nelle regioni italiane 7° Censimento Generale Agricoltura. https://www.istat.it/notizia/lagricoltura-nelle-regioni-italiane/
- Jackson H.A., 2021. Global invasion success of the rose-ringed parakeet: 159—172 In: Pruett-Jones S. (ed.). Naturalized parrots of the world. Princeton University Press, New Jersey, USA.
- Khan H.A., Javed M., Tahir A. & Kanwal M., 2013. Limiting the rose-ringed parakeet (*Psittacula krameri*) damage on guava (*Psidium guajava*) and mango (*Mangifera indica*) with an ultrasonic sound player in a farmland of Faislabad, Pakistan. African Journal of Agricultural Research, 8: 6608—6614.
- Mack R.N., Simberloff D., Lonsdale W.M., Evans H., Clout M. & Bazzaz F.A., 2000. Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications, 10: 689—710.
- Menchetti M. & Mori E., 2014. Worldwide impact of alien parrots (Aves Psittaciformes) on native biodiversity and environment: a review. Ethology Ecology & Evolution, 26: 172-194.
- Mentil L., Battisti C. & Carpaneto G.M., 2018. The impact of *Psittacula krameri* (Scopoli, 1769) on orchards: first quantitative evidence for Southern Europe. Belgian Journal of Zoology, 148: 129—134.
- Mori E., 2022. Parrocchetto dal collare: 342-343. In: Lardelli R., Bogliani G. Brichetti P., Caprio E., Celada C. Conca G., Fraticelli F., Gustin M., Janni O., Pedrini P., Luglisi L. Rubolini D., Ruggieri L., Spina F., Tinarelli R., Calvi G., Brambilla M. (a cura di). Atlante degli uccelli nidificanti in Italia. Edizioni Belvedere, Latina.
- Pârâu L.G., Strubbe D., Mori E., Menchetti M., Ancillotto L., van Kleunen A., White R.L., Hermàndez-Brito D., Le Louarn M., Clergeau P., Albayrak T., Franz D., Braun M.P., Schroeder J. & Wink M., 2016. Rose-ringed parakeet *Psittacula krameri* populations and number in Europe: a complete overview. Open Ornithology Journal, 9: 1-13.
- Shiels A.B. & Kalodimos N.P., 2019. Biology and impacts of Pacific Island Invasive Species. 15. *Psittacula krameri*, the Rose-Ringed Parakeet (Psittaciformes: Psittacidae). Pacific Science 73: 421-449.
- Shivanarayan N., Babu K.S. & Ali M.H., 1981. Breeding biology of rose-ringed parakeet *Psittacula krameri* at Maruteru. Pavo, 19: 92-96.
- Strubbe D. & Matthysen E., 2007. Invasive ring-necked parakeets *Psittacula krameri* in Belgium: habitat selection and impact on native birds. Ecography, 30: 578-588.
- Strubbe D. & Matthysen E., 2011. A radiotelemetry study of habitat use by the exotic Ring-necked Parakeet Psittacula krameri in Belgium. Ibis, 153: 180-184.
- White R.L., Strubbe D., Dallimer M., Davies Z.G., Davis A.J.S., Edelaar P., Groombridge J., Jackson H.A., Menchetti M., Mori E., Nikolov B.P., Pârâu L.G., Pečnikar Ž.F., Pett, T. J., Reino L., Tollington S., Turbé A. & Shwartz A., 2019. Assessing the ecological and societal impacts of alien parrots in Europe using a transparent and inclusive evidence mapping scheme. NeoBiota, 48: 45-69.