Interspecific interactions in nesting and feeding urban sites among introduced Monk Parakeet (*Myiopsitta monachus*) and syntopic bird species

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Monk Parakeet (*Myiopsitta monachus*) is a successful invader of many European urbanised habitats. Here, we report evidence of interspecific interactions between this species and some synanthropic co-occurring birds in three urban parks of Rome (central Italy). In both nesting and feeding sites, we recorded 158 interactions with seven syntopic species in eight colonial focal nests (0.74 events/hr). The number and frequency of interactions significantly differ among nests and species, the Italian Sparrow (*Passer italiae*) being the most interactive species. For this species, the frequency of interactions was normally distributed between different months with a peak in June. We also observed a case of nest cohabitation, as well as predatory attacks carried out by Hooded Crow (*Corvus cornix*). As far as foraging sites are concerned, 11 out of 74 clusters of parakeets (15%) hosted four bird species, mainly Starling, *Sturnus vulgaris*, but we did not observe any interactions. Although Monk Parakeet is a social bird generally tolerant towards other species near their nests and in foraging areas, we observed interspecific interactions in nesting sites as a response to competitive or predatory mechanisms. Italian Sparrows interact because they use parakeet nests as a secondary structure for nesting (cohabitation) and, probably, because of the wide availability of food resources (invertebrates) useful for juvenile recruitment. The interaction of parakeets with Hooded Crow is a response to predatory attacks on eggs or juveniles. However, interspecific interactions seem to be occasional events in nesting sites and are apparently absent in feeding sites, where competitive behaviour is probably reduced due to high availability of plant resources. In urbanised areas, where Monk Parakeets have recently been introduced, the number of competitors and predators might be very reduced (both in number of events and species) in comparison to native areas where competition and predatory mechanisms reflect long-term co-evolutionary dynamics.

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INTRODUCTION

The Monk Parakeet *Myiopsitta monachus* (Boddaert 1783) is a Neotropical bird (Spreyer & Bucher 1998), traded internationally as a pet since the early 1960s (Barthel 2002). It is now widespread with naturalised populations in North America (Hyman & Pruett-Jones 1995; Spreyer & Bucher 1998; Burger & Gochfeld 2009) and in Western and Southern Europe (Spanò & Truffi 1986; Cignini et al. 1996; Pithon 1998; Weiserbs & Jacob 1999; Andreotti et al. 2001; Tala et al. 2005; Garcia-del-Rey 2007; Di Santo et al. 2013).

This parakeet, like other invasive bird species, has peculiar behavioural and ecological traits that make it a highly successful invader, in particular its reproductive strategies result in high population growth rates, effectiveness in colonisation and tolerance to novel habitats (Blackburn et al. 2009). Previous studies have documented various economic, health and environmental problems caused by this species, for example in agriculture (De Grazio 1978; Long 1981; Roll et al. 2008; Conroy & Senar 2009), in power structures (e.g. nesting in electric utility structures causing power outages: Avery et al. 2002; Tillman et al. 2004; Pruett-Jones et al. 2007) and in the avian pet trade (as an agent of epidemic dissemination; Fitzwater 1988).

The behaviour of Monk Parakeet has been identified as both highly aggressive and tolerant towards other syntopic bird species in the invaded areas (Freeland 1973; Davis 1974; Long 1981). Interspecific behaviour between Monk Parakeet and other co-occurring species has not been widely studied (e.g. Lorenzo 1993; MacGregor-Fors et al. 2010), while extensive research is also scarce, at least in the Mediterranean context.

This study sets out to report and discuss further evidence of this introduced species’ interspecific interactions, both at the level of colonial nests and in feeding sites, by reporting results of an intensive survey carried out in three urban parks of Rome (central Italy), where there has been a naturalised patchy population with relative high density for at least two decades (Cignini et al. 1996; Buscemi et al. 1997; Pitzalis et al. 2005; Zocchi et al. 2008; Di Santo et al. 2013).

MATERIALS AND METHODS

This study was carried out in three historical urban parks of Rome (central Italy) where Monk Parakeet was introduced and has been naturalised for about 20 years (Cignini et al. 1996; Pitzalis et al. 2005; Taffon et al. 2008).

Colonial nests (hereafter, ‘nests’) were identified utilising previous original surveys (Di Santo et al. unpub. data), local knowledge and published sources. We consider as a nest the whole structure, which can contain several chambers, actively built from parakeets using twigs and branches. A total of eight focal nests, and their immediately surrounding areas within a 10 m diameter, were studied:

(a) Villa Lazzaroni (coordinates: 41°52.316’N, 12°31.416’E), 5.4 ha-wide, is located in the southern side of Rome [48 m above sea level (a.s.l.)] and is characterised by ornamental and mainly allochthonous plants such as several mature trees of *Robinia pseudoacacia, Paulownia tomentosa, Araucaria araucana, Cupressus sempervirens, Pinus pinea, P. halepensis, Cedrus libanotica, Cercis siliquastrum, Ginkgo biloba, Phoenix canariensis, Washingtonia sp., Quercus ilex, Laurus nobilis, Olea europaea*. Here, we randomly selected
four focal colonial nests (coded NVLC1.1, NVLC5.1, NVLC7.1, NVLP3) from a total of 73
nests built in 25 trees;

(b) Parco Scipioni (coordinates: 41°52.562'N, 12°30.084'E), 1.6 ha wide, is located in the
central-southern side of Rome between Appia and Latina roads (31 m a.s.l.; Cremona
1995). In this area mature ornamental trees occur, mainly Cupressus sempervirens, Pinus
pinea, Cedrus libanotica, Acer campestre, Eucalyptus spp. Here we selected one focal
colonial nest (coded NPS1.1) from a total of 12 nests built in six trees;

(c) Parco della Caffarella (coordinates: 41°51.713'N, 12°31.114'E) is a large valley, 200 ha wide
(ranging from 20 to 30 m a.s.l.), extending in the northwest–southeast direction in the
Appia Antica Regional Park (Taffon et al. 2008). This archaeological area is characterised
by the typical landscape of the "Campagna Romana" (De Rita 1992; Celesti Grapow &
Fanelli 1993), with croplands, Mediterranean maquis and small oak-wood fragments.
Here, we selected three focal colonial nests (coded NCAF1.1, NCAF2.2, NCAF2.3) from a
total of 33 nests built in six trees.

The research was carried out on 71 sampling days from 2 April 2009 to 9 September 2009
(12 sampling sessions for nest: six in the morning and six in the afternoon). Each day we carried
out three consecutive sampling sessions, each 1 hr long, both in the morning and in the afternoon
(see Spreyer & Bucher 1998). Sampling session days were randomly distributed in time from April
to September, each nest being sampled 2 or 3 times per month on different days.

Sampling was carried out by the same observer (MDS) with the use of a video camera Sony
Handycam DCR-HC24E, optical zoom 20× and digital zoom 800× fixed on a lightweight SL-2111
tripod. Each nest was videotaped for 36 hr (33 hr only for NCAF1.1, NCAF2.2, NCAF 2.3). This tool
allowed us to obtain video sessions of 60 min each. We used two battery packs (autonomy: 2 hr
each), so permitting us to cover the whole daily sampling session (3 hr/day). In total we analysed
213 hr of videotape (26.62 hr/focal nest) subdivided in sessions of 10 min each (total = 1238 10-min
sessions). In each 10-min session, we recorded the occurrence of at least one interaction event
between Monk Parakeet and other bird species, independently of their number in each session, in a
 circular area of 10 m diameter. More particularly, we recorded any kind of aggressive behaviour,
i.e. interactions (pecking attacks or going ahead with open wings and vocalisations) by one or more
individuals towards others feeding together. We recorded Monk Parakeets interacting with each
other in a non-specific manner, independently whether it was a breeder in the focal nest or just a
visitor. During each sampling, we waited a few minutes before collecting data to allow the birds
to become acclimated to the observer, and all observations were made from 15 m away. We assumed
that this procedure was adequate to remove observer effects, given that these birds are frequently
exposed to humans and are often unperturbed by people passing within few metres of them (see
Eberhard 1998; South & Pruett-Jones 2000). Hours and sessions have been subdivided into months
as reported in the Supplementary material.

In another location in Parco della Caffarella (41°51.954'N, 12°31.035'E) we also selected a
Monk Parakeet foraging site consisting of a secondary grassland with dominance of Poa sp., and
several individuals of Mullein (Verbascum sp.) and Yellow Thistle (Scolymus hispanicus), often
used for grazing sheep and goats. Here, we recorded (i) the number of feeding clusters (i.e. groups
of clumped co-specific individuals of Monk Parakeet feeding on the ground in the same time
period of sampling) and (ii) any interaction among individuals. For these observations, we used a
binocular Nikon SPRINT IV 10X21.5.

Data analysis

Regarding nesting sites, we analysed the videotape sessions searching for any interspecific
behavioural interaction among individuals, such as any aggressive, threatening or harmful event,
both offensive and defensive, directed towards non co-specific individuals with the aim of
resolving disputes over resources (e.g. territory, food, nesting sites), or of escaping threatening
situations such as predatory events (Collias 1944; Murray 1971; King 1973; Potegal 1979). More
particularly, we defined an ‘interaction’ as any event that includes direct contact between individuals and alarm calls as responses to the presence of non-co-specific individuals in the circular areas surrounding the nests (10 m in diameter). The number of interactions/nest both in total and for each species were recorded. Comparing all the species, we obtained the frequencies of interactions of each species (number of interactions for a species/total no. interactions). The highest number of interactions occurred with Italian Sparrow (Passer italicæ): therefore, for this species we also calculated the frequency of occurrence of interactions in 10-min sessions per month, so obtaining a time pattern of data distribution. The sparrow species is here referred to Passer italicæ (the Italian sparrow) according to Hermansen et al. (2011), who established that it is a stabilised hybrid, living only in Italy.

We performed the one-sample Kolmogorov–Smirnov test for goodness of fit to compare the data distribution of frequency of occurrence of the interactions with Italian Sparrow between months with an expected (normal) distribution (Dytham 2011). Our null hypothesis is that the frequencies of occurrence of interactions were normally distributed between different months, with a modal value in late spring. This hypothesis is supported by some biological aspects such as the fact that during late spring the juveniles fledged from nests and are particularly active, and the highest frequency of interactions occurs during this period. We performed a χ² test (alfa level = 0.05) to compare frequencies of interactions between nests, sites and species. Statistical analyses were processed using the software SPSS 13.0 for Windows.

To check for data reliability, we followed Battisti et al. (2014) and Suen and Ary (2014). We followed Fracasso et al. (2009) for taxonomic nomenclature.

RESULTS

Nest sites

Overall, during 1278 10-min sessions, we recorded 158 interspecific events of interactions of Monk Parakeet with seven syntopic bird species in eight colonial nests and their surroundings (0.74 events/hour; Table 1). The frequency of interactions differs significantly among sites (χ² = 426.1, P < 0.01), nests (χ² = 327.7, P < 0.01) and species (χ² = 455.7, P < 0.01), the Italian Sparrow (Passer italicæ) being the species most widely recorded in terms of frequency (n = 145 individuals during 113 10-min sessions; 91.7% of the total; Table 1).

Considering the occurrences of the interactions with Italian Sparrow during 10-min sessions, we observed that their frequency among months is not significantly different from a normal distribution (Z = 0.361, P = 0.999; Kolmogorov–Smirnov test). Moreover, we observed a significant difference in values either between months (χ² = 26.347, P < 0.01; highest frequency in June) or nests (χ² = 117.098, P < 0.01; Fig. 1 and Supplementary material). We recorded a pair of Italian Sparrows co-habiting in a Monk Parakeet nest (NVLP3, located on a Washingtonia tree).

We recorded three aggressive interactions with Hooded Crow (Corvus cornix); in two cases individuals of this species showing a predatory behaviour inside the parakeet nests were observed. During these attacks, Monk Parakeet always showed an apparent cooperative intraspecific behaviour throughout. This cooperative behaviour took various forms: (i) parakeets on the attacked nest emitted intense alarm calls, followed immediately by all co-specific individuals present in the surroundings (see Martella & Bucher 1990); (ii) when parakeets failed in their attempt to chase away the crows, they moved away from the nest in groups of 3–5 individuals, emitting alarm calls and making circular flights around the nest; (iii) if this social
behaviour also failed and crows continued the attack, parakeets moved away from the nest tree until the crows moved away too. Monk Parakeets obtained the removal of Hooded Crow only in one case out of three.

Feeding sites

Monk Parakeets feed on leaves, flowers and seeds of several species of Fabaceae, Ulmaceae, Poaceae, Rosaceae, Scrophulariaceae and Moraceae, showing a preference for Yellow thistle (*Scolymus hispanicus*), a species of Asteraceae (M. Di Santo pers. obs.).
We sampled 74 feeding clusters of Monk Parakeet. Among them, in 11 clusters (n = 55 individuals, 14.9%) we recorded the co-occurrence of another four bird species (n = 151 individuals) with frequencies of occurrence significantly differing among species ($\chi^2 = 221.8, P < 0.01$): *Sturnus vulgaris* (n = 137; 90.7%); *Passer italiae* (n = 8; 5.3%); *Psittacula krameri* (n = 3; 2%); *Carduelis carduelis* (n = 3; 2%). We never observed interactions with other species, but only among co-specifics.

**DISCUSSION**

In our study, we obtained further evidence of interspecific interactions of Monk Parakeet with syntopic species. All these interactions were observed near the nests, while we observed no interspecific interactions in foraging areas (see Buscemi et al. 1997).

Monk Parakeet is known as a social bird generally tolerant of other birds near their nests and in foraging areas (Moltoni 1945; Lorenzo 1993; Eberhard 1998; Spreyer & Bucher 1998). Nevertheless, this bird showed aggressive behaviour in particular conditions. For example, several studies have focused on Monk Parakeets successfully defending their nests against Speckled Teals (*Anas flavirostris*) (Port & McKinney 2001), Guira Cuckoos (*Guira guira*), Screaming Cowbirds (*Molothrus rufoaxillaris*), Baywings (*Agelaioides* sp.; Martella et al. 1985), Jackdaws (*Corvus monedula*) (Maranini & Galuppo 1994) and Hooded Crows (*Corvus cornix*) (Weiserbs & Jacob 1999). In the United States, introduced Monk Parakeet has been recorded as aggressive defending nesting and feeding territories, even killing Blue Jays (*Cyanocitta cristata*), American Robins (*Turdus migratorius*) and House Sparrows (*Passer domesticus*) in the process (Freeland 1973; Davis 1974; Long 1981).

![Figure 1](image_url)
Interspecific interactions between species typically involve access to resources (space or food competition) or during predatory events. These conflicts occur in many contexts and are frequently expressed in two aggressive forms: (i) defence of a given area (e.g., territory, home range or nest) from predators, nest parasites or competitors and (ii) hierarchies of precedence within multi-specific groups (e.g., when resources are limited; Collias 1944; Murray 1971; Cant et al. 2006).

In our study, the observed interspecific behaviour in nests and their surroundings may be referred to as a defence against: (i) the Italian Sparrow, as a response to the competition for the spatial resource represented by the parakeet’s nests; (ii) the Hooded Crow, as a response to predatory attacks on eggs or juveniles.

The Monk Parakeet is the only species of the Psittacidae family not to nest in existing cavities but to actively build its own nest (Lever 1987). Consequently, secondary cavity nesters such as sparrows (see Glutz von Blotzheim & Bauer 1997; Anderson 2006) may opportunistically utilise these large nest structures as a spatial resource for breeding, also with nest usurpation of the primary nester (sensu Lindell 1996; see also Burger 1976; Gowaty 1984; Earle 1985; Weisheit & Creighton 1989). In our study, we also recorded an event of nest cohabitation between Italian Sparrow and Monk Parakeet. Cohabitation and secondary nest use by other species has already been recorded (e.g., Speckled Teal, Anas flavirostris in the native range, Port & Brewer 2004), including Italian Sparrow (Moltoni 1945) and Spanish Sparrow (Passer hispaniolensis) (Lorenzo 1993).

However, the high frequency of interactions between Monk Parakeets and Italian Sparrows that we reported particularly in late spring might be due to different causes. As well as nest commensalism, another reason may be the presence of invertebrates in the parakeet nests (such as mallophagous parasites, commensal beetles and bugs; see Poggio et al. 2009), sparrows finding these a useful food resource for juvenile recruitment, as already observed in the case of other cohabitations (e.g., with Black Kite, Milvus migrans; Zocchi & Lacroix 2004). This biological hypothesis is supported by the significant difference in frequency of interspecific interactions between months: their hump-shaped distribution shows a peak in June, when parakeet fledglings (as well as their parasites and commensals) are in the nests or in their surroundings, and when, at the same time, sparrows need food resources for juvenile recruitment (Glutz von Blotzheim & Bauer 1997; Arena et al. 2009). At the spatial level, the significant differences observed in frequency of interactions among nests and sites (urban parks) could be due to local external conditions, causal circumstances and other intrinsic and extrinsic environmental factors affecting the Monk Parakeet nest sites.

The predatory attacks were carried out occasionally only by one species (Hooded Crow). Probably, in areas of recent introduction, the number of predators is relatively reduced in terms of species and individuals if compared to native areas where predatory mechanisms are long established. For example, in Argentina, predation on Monk Parakeet is carried out by a large number of mammals (e.g., Didelphis albiventris, Rattus rattus), reptiles (e.g., Phylodryas patagoniensis) and birds (e.g., Spitziapterix circuncincta; Martella & Bucher 1984; Navarro et al. 1992; Peris & Aramburú 1995; Sprenyer & Bucher 1998). Nevertheless, further data are required to confirm this hypothesis.

Although parakeets feed in mixed groups, we observed no interspecific interactions. Starling is the species which mainly occurred in Monk Parakeet clusters, probably because of its local high density (Sorace 2001; Dodaro & Battisti 2014), and its omnivorous diet which includes similar resources used by parakeets (e.g., vegetables and seeds; Feare & McGinnity 1986). However, although Starlings show aggressive
behaviour in the breeding season (Sandell & Smith 1997), we observed no evidence of interactions in feeding areas.

To conclude, despite our research being relatively wide, we observed a low rate of interspecific interactions, mainly focused on Italian Sparrow. Therefore, we hypothesised that interactions in areas of recent parakeet introduction represent only occasional events in nest sites and very rare or absent events in feeding sites where this herbivorous bird's competitive behaviour is reduced due to the high availability of plant resources (see Freeland 1973; Kibbe & Cutright 1973; Davis 1974; Snow & Perrins 1998).

Since it has been previously highlighted that interspecific interactions among syntopic species may vary according to geographical distribution and the history of introductions (Murray 1971), our data can contribute to the understanding of new relationships in areas where non-native parakeets occur.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

SUPPLEMENTARY MATERIAL

Supplemental data for this article can be accessed at http://dx.doi.org/10.1080/03949370.2015.1119761

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