FEEDING ACTIVITY AND SPACE USE OF A NATURALIZED POPULATION OF MONK PARAKEET, *MYIOPSITTA MONACHUS*, IN A MEDITERRANEAN URBAN AREA

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Résumé.— *Activité alimentaire et utilisation de l'espace dans une population naturalisée de* Myiopsitta monachus *dans une zone urbaine méditerranéenne*.— Nous avons étudié une population naturalisée de la perruche *Myiopsitta monachus* dans un parc urbain de Rome en recueillant des données sur les activités diurnes et de recherche de nourriture, de même que l'utilisation de l'espace (*e.g.* préférences pour les reposoirs, hauteur de vol) et les traits comportementaux (*e.g.* taille des regroupements). L'impact écologique potentiel de l'espèce a également été pris en considération. L'activité diurne des perruches ne montre aucune différence entre le matin et l'après-midi. La plupart des individus volent 6-10 m au-dessus du sol et, aux reposoirs ils préfèrent des perchoirs situés à plus de 5 m de hauteur. Les groupes étaient significativement plus grands au sol que dans les reposoirs tandis que leur taille n'était pas liée à la hauteur de vol. Les préférences observées quant aux reposoirs indiquent que la disponibilité de perchoirs dans de hauts arbres est, pour cette espèce, un facteur important du choix de l'habitat: une remise dans les arbres peut accroître les chances d'identifier des sources de nourriture, réduire les risques de prédation au repos et protéger des fortes chaleurs quand les températures diurnes estivales sont très élevées. En matière d'habitudes alimentaires, dans notre site d'étude, cette perruche se nourrissait de diverses espèces végétales tant sur les arbres qu'au sol (e.g. Fabacées, Ulmacées, Poacées, Rosacées), montrant une nette préférence pour quelques espèces quelle que soit leur abondance, *Scolymus hispanicus* (Astéracées) étant de loin la plus exploitée.

Summary.— We studied a naturalized population of monk parakeet breeding in an urban park in Rome, by collecting data on the diurnal and feeding activity, space use (e.g, roosting preferences, flight height) and behavioural traits (e.g., cluster size). Consideration on the potential ecological impact of the species is also made. The diurnal activity of parakeets did not differ between morning and afternoon. Most individuals were observed in flight 6-10 m from the ground, and when at roost, parakeets preferred perches higher than 5 m. The clusters sighted on ground were significantly larger in size than those observed on roosts, while cluster size was not linked to flight height. For this species, the observed roost preference indicates that the availability of perches on high trees seems to be an important factor for habitat selection: standing on trees may increase the chances to identify trophic resources, reduce the risk of predation when at rest, and prevent overheating from high summer temperatures during the day. Regarding to feeding habits, at our study site the monk parakeet fed on different plant species both on the trees and at the ground level (e.g., Fabaceae, Ulmaceae, Poaceae, Rosaceae), showing a clear preference towards some plant species, irrespective to their abundance, and with *Scolymus hispanicus* (Asteraceae) as the most exploited species by far.

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The distribution and abundance of trophic resources, habitat heterogeneity and density of predators are the main factors affecting the space use and the selection of feeding sites in birds (Ganey & Balda, 1988; Nystrom & Perhsson, 1988; Block & Brennan, 1993). Among them, understanding the ecology, demography and behavioural traits of the introduced species is necessary to assess their patterns of expansion and to manage their populations at local scale (Wittenberg and Cock, 2001).

The Monk Parakeet (*Myiopsitta monachus* Boddaert, 1783) is a bird native to the Neotropical region (Bolivia, Paraguay, Uruguay, Southern Brazil and central Argentina; Spreyer & Bucher, 1998) and it fuelled international trade as pet since the early '60s (Barthel, 2002). Considered as an agricultural pest (e.g., damaging tropical fruits; Bucher *et al.*, 1991; Spreyer & Bucher, 1998; Tillman *et al.*, 2000), this parakeet is now widespread with some naturalized populations in the U.S.A. (Hyman & Pruett-Jones, 1995; Spreyer & Bucher, 1998; Burger & Gochfeld, 2009; Johnson & Logue, 2009) and in Western and Southern Europe (Pithon, 1998; Weiserbs & Jacob, 1999; Tala *et al.*, 2005; Garcia-del-Rey, 2007), including Italy (Spanò & Truffi, 1986; Cignini *et al.*, 1996; Andreotti *et al.*, 2001). The first occurrence of free-living individuals in Italy has been recorded by Moltoni (1945) in Milan, but they became extinct in later years. Nowadays naturalized populations are known in many urban areas (Genoa: Galuppo, 1985; Catania: Caruso *et al.*, 1994; Rome and surroundings: Cignini *et al.*, 1996; Buscemi *et al.*, 1997; Pitzalis *et al.*, 2005; Zocchi *et al.*, 2008; Bari: Moschetti *et al.*, 1996; Cagliari: Grussu, 2008).

Although many research notes on their presence in Europe are available, data on space use and feeding activity of introduced Monk Parakeets are still lacking, especially in the Mediterranean area. Therefore, the aim of this paper is to describe some aspect of the ecology and behaviour of an introduced population of Monk Parakeet breeding in a large metropolitan area by investigating the space use (e.g., roosting preferences) and feeding activity.

METHODS

STUDY AREA

The study was conducted in the Caffarella park, a large park located at about 10 km from the city center of Rome (central Italy), in the Appia Antica Regional Park (3,400 ha; 41°51'47.68"N, 12°30'59.37"E). Geologically, this valley derives from the volcanic complex of Colli Albani (De Rita *et al.*, 1992). This area is characterized by patches of Mediterranean forests with Holm Oak (*Quercus ilex*) and Downy Oak (*Quercus pubescens*) and residual disturbed woods of Turkey Oak (*Quercus cerris*). Riparian forests, dominated by the White Willow (*Salix alba*) with scarcity of undergrowth and riparian reed beds dominated by Giant Reed (*Arundo donax*) are also present (Taffon *et al.*, 2008).

PROTOCOL

Cluster size and diurnal activity.- Individuals were observed using the line transect method (Bibby *et al*, 2000). We used four linear transects disposed in order to represent the whole habitat types recorded in the study area (Fig. 1, Tab. I). The area surrounding these transects mainly consisted of a mosaic of grasslands and pastures with dominance of herbaceous species such as Poaceae (16.7%), Yellow Thistle (*Scolymus hispanicus*: 13,3%), and shrubs (*Rubus* sp.: 17,9%; Tab. I). Sampling was carried out during a total of 52 hours and 19 minutes spaced in 14 days between July 28th and September 10th 2009, time corresponding to late breeding season of the parakeets. The sampling protocol was carried out by one observer (MDS). All transects were periodically walked in order to record samples for both individuals and groups (clusters) at different time of the day. Each transect was replicated 24 times for a total of 96 replicates (two replies per day: 8:00 a.m. and 4:30 p.m.). In case of rain or strong wind, when detectability is low, sampling was not carried out (Bibby *et al.*, 2000; Sutherland, 2006). When sampling clusters, if the centre of the identified cluster laid inside the sampled transect belt (0 - 30 m), all individuals of the cluster were counted for estimating cluster size. We considered also cluster composed by a single individual.

Diurnal activity, flight and roost height.- For each record we obtained: (i) the location, as the position at the first sight (on the ground, on perches, in flight); (ii) the type of roost used (natural or artificial) by individuals; (iii) the flight height or perch height, as the height of the individuals or clusters flying or roosting on a perch (ranked in six categories: 0-5, 6-10, 11-15, 16-20, 21-25, 26-30 m). Flight heights of these groups were measured from the points in which they were initially observed. For each detection we also recorded the day-time, i.e. the time of the day when the individual or feeding group was observed.

Perch availability, roost species and food resources.- The availability of perches along the four transects was analysed by creating three roost categories (trees or perches > 5 m, bushes-shrubs and perches < 5 m, and grass)

including all the natural and artificial roosts identified along the transects (Tab. II). We used a scored abundance scale (+, 1, 2, 3, 4),where '+' referred to one sampled record; 1 = 2 to 5 records; 2 = 6 to 10; 3 = 11 to 20; 4 = 21 to 30. Afterwards, we estimated the roost abundance by calculating the percentage of coverage for each roost category. In the same way we calculated the percentage of available roosts species and the percentage of available food resources. Finally, we checked the food plant species, i.e. the plant species eaten by the individuals, if recognized.

DATA ANALYSIS

Parakeet cluster distribution in time and space was analysed by performing Kruskal-Wallis non parametric ANOVA (Fowler & Cohen, 2002). The use of roost and food resource types by Monk Parakeets in respect to their availability were analysed by using the χ^2 test. Statistical analyses, all tests being two-tailed and with alpha set at 5%, were made by Statistica (StatSoft, Inc., 2001 – Version 6).

TABLE I

Characteristics of the four linear transects used in the study. Availability of the roost typologies and the preferred food plant species are reported

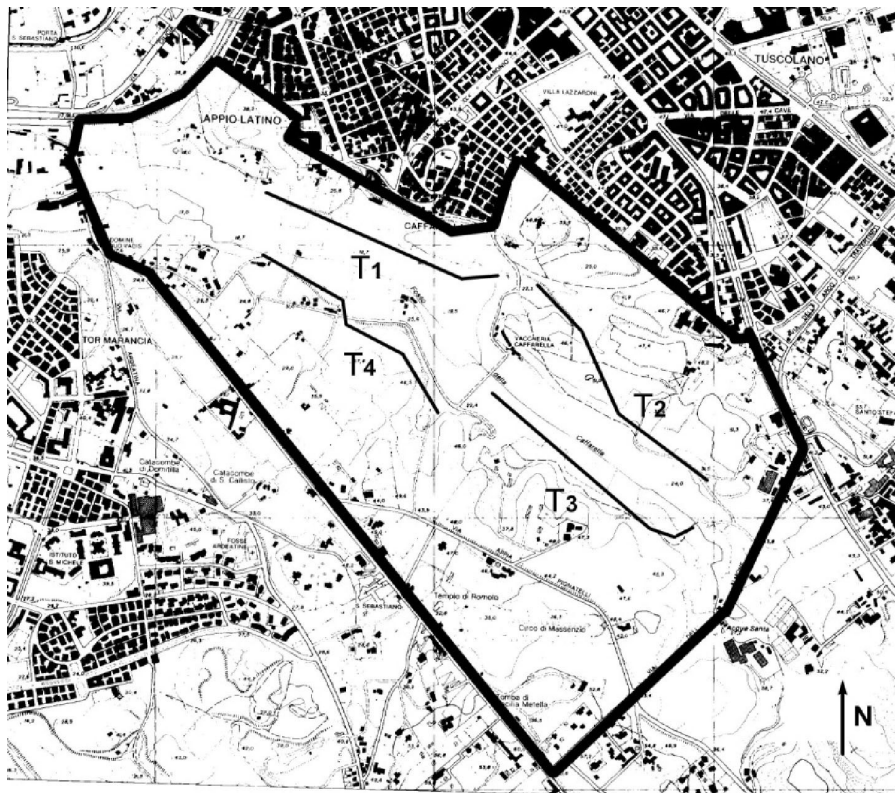| Transect	Length (m)	Roost type availability (%)			Food availability (%)	
		Trees (roosts > 5 m)	Shrubs (roosts < 5m)	Grass	*Scolymus hispanicus*	
1	738	22.7	25.2	52.1	4.3	
2	1,281	54.2	39	6.8	37.8	
3	1,391	62	21.9	16.1	16.7	
4	774	31.9	0	68.1	0	

Figure 1.— Study area in the Caffarella valley (Rome, central Italy) and the location of the four line transects (T1, T2, T3, T4) walked.

TABLE II

Availability of each types of roost (natural or artificial) for monk parakeets, expressed as the relative proportion of roosting places found in the study area

Habitat	Species	% Availability
Trees	*Ailanthus altissima*	2.4
(Roosts > 5 m)	*Celtis australis*	0.6
	Ceratonia siliqua	0.1
	Evonymus europaeus	0.1
	Juglans regia	0.2
	Malus sylvestris	0.3
	Populus sp.	3.2
	Prunus sp.	0.2
	Robinia pseudoacacia	10.3
	Salix sp.	0.6
	Ulmus minor	12.8
Electrical cables (> 5 m)		0.5
Shrubs-Bushes	*Ficus carica*	0,3
(Roosts < 5 m)	*Phytolacca americana*	0.3
	Rubus sp.	17.9
	Sambucus nigra	6.1
	Scolymus hispanicus	13.3
	Spartium junceum	0.5
	Verbascum sp.	7.3
	Cane thicket	3.8
	Ferns	0.5
	Poles	2.4
Ground	Grass (Poaceae)	16.7

RESULTS

In total, 1530 individuals were observed clumped in 355 clusters. Of these, 772 (50.4%) individuals were sighted on perches, 524 (34.3%) in flight and 234 (15.3%) on the ground. The differences in the number of sampled individuals between transects was significant ($\chi^2 = 844.9$, df = 3; $p < 0.01$) and was correlated to the difference in roost and feeding resource availability (roost: r = 1, p = 0; food: r = 1, p = 0. Spearman ranked correlation test). The diurnal activity of parakeets did not differ between morning and afternoon: overall, in the morning we recorded 750 individuals (49%), in the afternoon, 780 (51%; $\chi^2 = 0.54$, df = 1, $p > 0.05$).

Overall, the mean cluster size was 4.31 ± 5.96 individuals (range = $1 - 47$). The clusters of parakeets sighted on ground (mean = 9.75 ± 9.30, n = 24) were significantly larger in size than those observed on roosts (mean = 5.85 ± 7.74, n = 132) or in flight (mean = 2.63 ± 2.40, n = 199) ($H_{2,355} = 57.146$, $p < 0.001$; Kruskal-Wallis test).

The total number of individuals by intervals of flight height significantly differed, with a clear preference (n = 250, 48%) for flying at 6-10 m from the ground ($\chi^2 = 215.2$, df = 3; $p < 0.01$). Mean cluster size (2.63 ± 2.40 individuals, range 1-18) did not differ among ranked heights of flight ($\chi^2_{3,199} = 1.747$, $p= 0.627$; Kruskal-Wallis test).

As concerns the roost preferences, we overall observed 571 individuals (57%) on roosts > 5 m, 201 (20%) on roosts < 5 m and 234 (23%) on grass stems. The parakeets exploited roost typologies irrespective of their availability ($\chi^2 = 436.7$, df = 2, $p < 0.01$) (Fig. 2).

Among 558 individuals observed in feeding activity, 444 (79%) fed on bushy or shrub species, 65 (12%) on trees, 49 (9%) on herbaceous vegetation (Fig. 3), and the difference in the number of individuals observed feeding on these three plant typologies was highly significant (χ^2 = 519.5, df = 2, p < 0.01). As concerns plant species fed by parakeets, there was a clear preference towards some taxa irrespective of their availability in the study area (χ^2 = 1117.02, df = 7, p < 0.01): 434 individuals (77.8%) were observed feeding on shrubs of *Scolymus hispanicus*, 49 (8.8%) on undetermined Poaceae, 42 (7.5%) on *Robinia pseudoacacia*, 19 (3.4%) on *Celtis australis*, 6 (1.1%) on *Verbascum* sp., 2 (0.4%) on *Ulmus minor*, 2 (0.4%) on *Malus sylvestris* (Fig. 4).
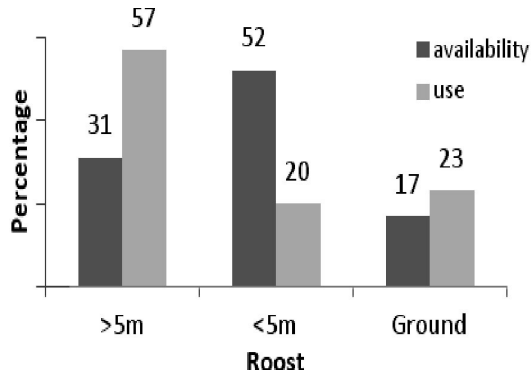

Figure 2.— Availability and use of roosts > 5 m, < 5 m and grass in the transects.
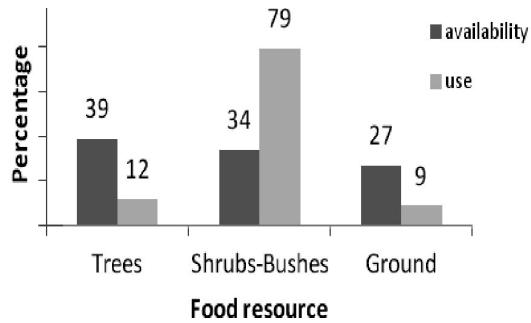

Figure 3.— Percentage of available habitat and percentage of individuals for each food sources (trees, shrubs-bushes, grass).
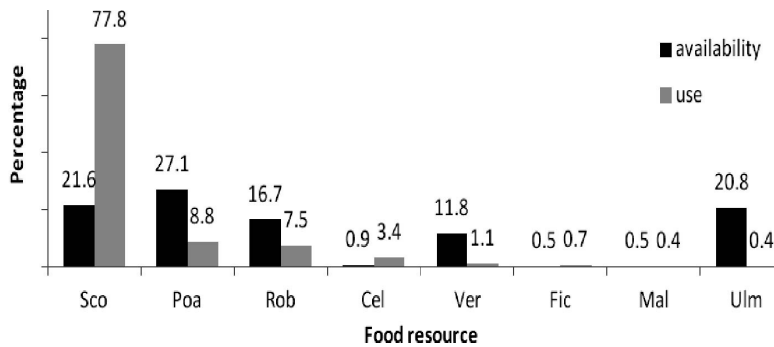

Figure 4.— Percentage of available food resources (availability) and percentage of individuals (use) for each plant species or taxon. Sco, *Scolymus hispanicus*; Poa, *Poaceae*; Rob, *Robinia pseudoacacia*; Cel, *Celtis australis*; Ver, *Verbascum* sp.; Fic, *Ficus carica*; Ulm, *Ulmus minor*; Mal, *Malus sylvestris*.

DISCUSSION

Identifying the traits that make invasive an allochthonous species requires further research for most of the known exotic taxa. In particular, in order to understand the mechanisms underlying the expansion of exotic species at both local and global scales, it is crucial to know their ecological, demographic and behavioural traits (Wittenberg & Cock, 2001). Our study is the one of the few attempts worldwide to investigate the ecology of introduced populations of Monk Parakeets, in Southern Europe and the first in Italy.

As far as the cluster size analysis in concerned, the mean value observed during the breeding period is around four individuals, comparable to that recorded by Bucher *et al.* (1991) in South American native populations. To be part of a cluster, especially of large size, gives individuals the benefit they can dedicate more time in feeding activity while only few of them act as sentinels (Pulliam & Caraco, 1984). This advantage is greater especially if members of the group give the alarm at the sight of predators, increasing the likelihood of escape (Pulliam & Caraco, 1984; Martella & Bucher, 1990; South & Pruett-Jones, 2000). However, in gregarious species, cluster size may be related to other factors such as availability, distribution and quality of trophic resources (Pulliam & Caraco, 1984).

The individuals usually flew between 6 and 10 m high (Bull, 1973) and the flight height did not differ between the morning and the afternoon observations. Monk parakeets usually flied in small clusters of 2-5 individuals, but larger groups were also observed as reported by Bucher *et al.* (1991). This gregarious behaviour increases the chances to identify new trophic resources (Pulliam & Caraco, 1984), especially if learning behavioural events occur (Caraco, 1981). Indeed, in many gregarious species, a member of the group can learn what and where to eat just by looking at the other feeding individuals (Pulliam & Caraco, 1984). Moreover, in our study area monk parakeets preferred to stand on perches than on the ground during day time and the clusters observed on the trees are smaller than those on the ground. Although at the study site there was a large availability of medium height trees, Monk Parakeets preferred the tallest ones (> 5 m). Staying on tree perches provides an adequate defence from predators (locally, e.g. feral cats) due to the foliage protection and may prevent overheating from high summer temperatures during the day, especially in Mediterranean areas; on the ground, where individuals are more vulnerable, the aggregation in larger groups may reduce the risk of predation as well (Stacey, 1986; Sol *et al.*, 1997; Westcott & Cockburn, 1988; South & Pruett-Jones, 2000; Burger & Gochfeld, 2005, 2009).

Monk parakeet is a generalist species regarding its feeding habits (Gochfeld, 1973; Aramburú & Corbalán, 2000; South & Pruett-Jones, 2000). In the native range, this species forages both on trees and on the ground and its diet consists mainly of seeds, fruits, berries, nuts, buds and blossoms of a great variety of plants and in some cases, larvae of insects (Bucher & Martin, 1987; Forshaw, 1989; Martella & Bucher, 1990). At our study site, it feeds both upon the trees and at the ground on different species of Fabaceae, Ulmaceae, Poaceae, Rosaceae, Scrophulariaceae and Moraceae, but it shows a clear preference for the Common Golden Thistle (*Scolymus hispanicus*, Asteraceae): As a consequence of this feeding habit, individuals of Monk Parakeet preferred those areas where the percentage of common golden thistle was the highest. Therefore, it is likely that the density and distribution of clusters could be mainly related to the availability and quality of the preferred trophic resources (Pulliam & Caraco, 1984). The flowers of golden thistle probably offer the intake of energy needed for the nest building and juvenile recruitment during the breeding period. Bucher *et al.* (1991), Aramburú & Corbalán (2000), and Pezzoni *et al.* (2009) reported the same preference towards several Asteraceae showed by Monk Parakeet. In our study, this parakeet did not feed on plant species of agricultural or conservation concerns. Moreover, no vertebrate autochthonous species at the study area is known to use the Common Golden Thistle as the elective food category. Therefore, the impact of the Monk Parakeet on the ecosystem at the study site is not evident even if still far to be exhaustively described.

Further research on the naturalized populations of this species is needed, e.g. feeding activity in the winter period, social interactions among conspecific individuals or with native species (see Chase, & Walsh, 2006), so that we can identify and assess their possible impact and establish adequate management policies.

ACKNOWLEDGMENTS

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