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## Bird feeders may sustain feral Rose-ringed parakeets *Psittacula krameri* in temperate Europe

Philippe Clergeau & Alan Vergnes

The Rose-ringed parakeet *Psittacula krameri*, a bird species of subtropical origin, has established feral populations in temperate Europe. We analysed the feeding habits of Rose-ringed parakeets near Paris, France, in order to assess if food provided by humans might contribute to the success of this invasive bird species. We considered 87 feeding events performed during 2002 - 2007 and 247 feeding events performed during March - November 2008. We recorded the consumption of seeds, buds and fruits from many native and introduced shrubs and trees, and the use of bird feeders in private and public gardens throughout the year. We followed four radio-equipped birds for 150 hours during September - December 2008, which spent about half of their feeding time at bird feeders. This confirmed the importance of bird feeders in the diet of the Rose-ringed parakeet. Our study underlines the opportunistic granivorous-frugivorous character of this parakeet species and the possible role of human food sources in the success of its establishment in many cities across temperate Europe.

*Key words:* alien invasive species, bird feeders, feral parakeet, *Psittacula krameri*, Rose-ringed parakeet, urban avifauna

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Numerous exotic animal and plant species have spread to and settled into new geographical regions after intentional or unintentional release by humans. When alien populations increase in number, they may exert negative pressures on the native ecosystem, especially in terms of predation or competition with native species (Vilà et al. 2010). The mechanisms underlying their success are not well documented. One recurrent human behaviour that may facilitate the establishment of exotic species in temperate regions could be the supplemental provisioning of food (Sol et al. 2002). Clarification of this assumption would be most valuable for management of invasive populations.

The Rose-ringed parakeet *Psittacula krameri* is sold worldwide as a pet, and escapes or releases of these birds have resulted in the establishment of feral populations. This cavity nester is native to

forests of sub-Saharan Africa and rural India. The majority of commercialised birds belong to the Indian subspecies *P. k. manillensis* (Juniper & Parr 1998), and in India, this parakeet is sedentary and very gregarious. It breeds in loose colonies, feeds in groups and roosts in large gatherings (Forshaw 1978). Feral populations of this 'nice bird' in European towns are well accepted (Strubbe & Matthysen 2009a), whereas in India, it is considered an agricultural pest (Reddy 1998, Mukherjee et al. 2000). Recent studies have examined possible impacts of this parakeet on ecosystems and native avifauna in its introduced areas (Strubbe & Matthysen 2007, 2009b, Shwartz & Shirley 2009); however, the mechanisms of its success remain unclear (Butler 2003, Shwartz et al. 2009, Strubbe & Matthysen 2009a). The species' opportunist diet may act as a factor in its success which has been

shown in several similarly opportunistic invasive bird species (Sol et al. 2002, Clergeau & Yésou 2006).

Since the 1970s, the Rose-ringed parakeet has spread across the Ile-de-France region (Clergeau et al. 2009), and is mainly established in the south and northeastern areas around Paris, France. Counts indicate a population size of 1,100 parakeets (Clergeau et al. 2009). In this article, we focus on the food resources exploited by the parakeets using direct observations within the Ile-de-France region, and assess the relative importance of supplemental food supplied by humans among the exploited resources.

## Methods

In our work, we distinguish between three types of landscapes commonly encountered along the rural-urban gradient throughout Europe: the city centre, the suburban area and the periurban area (see Clergeau et al. 2001 for definitions). The Rose-ringed parakeet has been observed mainly in the suburbs of Paris, and rarely in the urban centre or the agricultural landscape. We focused our study on suburban areas and more specifically in Hauts-de-Seine, Essonne and Seine-Saint-Denis, the departments where the parakeet is most common (Clergeau et al. 2009). Suburbs, according to our definition, consist of residential areas of single-family detached houses with gardens, large apartment complexes, parks and cemeteries and large office or supermarket sites with lawns and parking areas. The height and disposition of buildings vary considerably and vegetated areas cover up to 70% of the area.

We used two data sources based on direct observation to assess the diet of the parakeets. The first source was a compilation of feeding behaviours extracted from numerous Rose-ringed parakeet observations: a) punctual observations of feeding behaviours made during 2002 - 2007 in the south of the Ile-de-France region (Essonne and Hauts-de-Seine departments) from which we extracted 87 feeding events, and b) 180 hours of direct observations performed during March - November 2008 in Essonne and Seine-Saint-Denis, from which we extracted 247 feeding events. The observers (including ourselves and the people mentioned in the Acknowledgements) randomly chose parks, public and private gardens, street trees and other sites used

by parakeet, which is a noisy bird making it easy to locate, during different periods of the day. The observers tried to identify the food items eaten, and they collected a sample for identification in the laboratory. In total, we considered 334 feeding events involving 1,246 parakeets. We considered each feeding event as one instantaneous observation whatever the size of the group, but never at the same site and on the same day.

The second source of direct observation data was a study of the behaviours of four radio-equipped birds (with 3-g collar transmitters SOPB 2070 from Wildlife Materials, Inc.). We caught three of the four birds south of Paris (i.e. in Parc de Sceaux and Hauts-de-Seine) in September 2008 and followed them until November 2008. We followed the fourth parakeet in northeastern Paris (Villepinte in Seine-Saint-Denis) from mid-November until mid-December 2008. Since our study goal was to assess the proportional use of different kinds of feeding places, we chose to continuously track the radio-equipped birds during half-day sessions. Each bird was followed for eight half-days, four mornings and four afternoons.

## Results

In the suburb areas of this study, we encountered parakeets in a wide range of locations, all of which contained old trees. The diet of Rose-ringed parakeet (Table 1) was exclusively granivorous-frugivorous with supplemental food items provided by humans (especially seeds and fat balls) in public parks or private gardens. The parakeets consumed seeds, fruits or buds of a wide variety of exotic and native species of trees and shrubs. The same tree was exploited day after day until the resource was exhausted. We observed parakeets feeding on very different types of trees including apple trees *Malus pumila*, yew trees *Taxus baccata* and charms *Carpinus betulus*. Trees with long seed production times, such as plane trees *Platanus* spp., were exploited regularly throughout the studied period.

The proportion of exotic tree species in the parakeet's diet (see Table 1) comprised 33.9% of the feeding events (N = 334) and involved 24.5% of the observed birds (N = 1,246). Feeding events at bird feeders (i.e. food supplemented by humans) represent 21.2% of the observations and 47.8% of the birds.

Following our four radio-equipped birds, we

Table 1. Diet of the Rose-ringed Parakeet in Ile-de-France ranked according to feeding event occurrences (N = 334). We classified the species as exotic (°), native (\*) or fruit-yielding trees or shrubs (+). The number of occurrences are given in brackets.

	Frequent food (> 10% of occurrence)	Irregular food (< 10% of occurrence)
Pulpy fruits and berries	Cherry tree <i>Prunus</i> sp.+ (33)	Apple tree <i>Malus pumila</i> + (18) Plum tree <i>Prunus domestica</i> + (8) Cotoneaster <i>Cotoneaster</i> sp.° (4) Apricot tree <i>Prunus armeniaca</i> + (1) Quince tree <i>Cydonia oblonga</i> + (1) Dogwood <i>Cornus sanguinea</i> ° (1) Woodbine <i>Ampelopsis</i> sp.° (1) Grapevine <i>Vitis vinifera</i> + (1) Blackcurrant <i>Ribes nigrum</i> + (1)
Dry fruits and seeds	Plane tree <i>Platanus</i> spp.° (54)	Locust <i>Robinia pseudoacacia</i> ° (7) Ash <i>Fraxinus excelsior</i> * (5) Maple <i>Acer campestre</i> * (4) Maple <i>A. platanoides</i> ° (4) Yew <i>Taxus baccata</i> * (3) Catalpa <i>Catalpa bignonioides</i> ° (2) Charm <i>Carpinus betulus</i> * (1) Privet <i>Ligustrum vulgare</i> ° (1) Sunflower <i>Helianthus annuus</i> ° (1)
Buds	Birches <i>Betula pendula</i> and <i>B. pubescens</i> * (35)	Chestnuts <i>Aesculus flava</i> and <i>A. hippocastanum</i> ° (18) Plane tree <i>Platanus</i> spp.° (8) Oak <i>Quercus</i> sp.* (11) Lime tree <i>Tilia</i> spp.° (6) Plum tree <i>Prunus domestica</i> + (5) Apple tree <i>Malus pumila</i> + (4) Poplar <i>Populus alba</i> ° (4) Ash <i>Fraxinus excelsior</i> * (3) Hazel <i>Corylus</i> sp.* (3) Walnut <i>Juglans regia</i> + (2) Maple <i>Acer campestre</i> * (2) Maple <i>A. platanoides</i> ° (2) Cherry tree <i>Prunus</i> sp.+ (2) Alder <i>Alnus glutinosa</i> * (1) Apricot tree <i>Prunus armeniaca</i> + (1) Willow <i>Salix alba</i> * (1)
Bird feeders	Fat ball (32) Bird seed and mixed kernels (34)	Apple <i>Malus</i> sp. (2) Peanut (2) Sunflower (1) Banana <i>Musa</i> sp. (1) Bread (1)

collected 150 hours of direct observations of which 39 hours were effective feeding behaviours (Table 2), which all occurred in public parks and domestic gardens. Individuals spent 48.3 (S1), 63.2 (S2), 46.2 (S3) and 58.8% (N6) of their feeding time at bird feeders. This confirms our previous notion that parakeets in the Paris area regularly use food provided by humans. According to our study, the parakeets spent almost half of their total feeding time at bird feeders.

## Discussion

The introduced Rose-ringed parakeet has spread and settled across Ile-de-France (Clergeau et al. 2009), but it has mainly become established in the suburbs of Paris where parks and gardens with large trees are available.

As elsewhere described (Dhindsa & Saina 1994, Pithon & Dytham 1999, Bendjoudi et al. 2005), the species has shown opportunistic granivorous-fru-

Table 2. Feeding behaviour of four (S1-S3 and N6) radio-equipped Rose-ringed parakeets in Ile-de-France showing the importance of the exploitation of bird feeders.

Individual identity	S1	S2	S3	N6	Total (mean)
Period	Sept.-Nov.	Sept.-Nov.	Sept.-Nov.	Nov.-Dec.	
Total number of observations (in hours)	45	45	44	16	150 (37.5)
Total of feeding activities (in hours)	14.5	9.5	6.5	8.5	39 (9.8)
on bird feeders (in hours)	6.5	4.4	4.1	5	20 (5)
on trees and shrubs (in hours)	7.8	5.1	2.4	3.5	18.8 (4.7)
Other (soil. . .) (in hours)	0.2	0	0	0	0
Size of exploited area observed (without roost; in ha)	96	51	34	136	317 (79.3)

givorious feeding habits, which might contribute to its successful establishment in temperate areas (Sol et al. 2002, Clergeau & Yésou 2006). Strubbe & Matthysen (2007) suggested that the great diversity of fruits and seeds, native or exotic, found in towns could explain the bird's occurrence in urban parks rather than in the countryside.

In our study area, supplemental food found in suburban private gardens and public parks appears to be important both in terms of quantity (bird feeders provide food daily the year round) and quality (peanuts, sunflower seeds and fat balls are very nutritious) for the persistence of this exotic bird species. We suggest that the flexible diet of this bird species which allows it to exploit a wide variety of natural, cultivated and supplemental food sources could be a key to its success. The continuous availability of supplemental feeding sites and regular visits by the birds to feeders year-round underline the importance of this feeding source in the urban ecology of the species (Strubbe & Matthysen 2009a).

Potential ecological impacts of the feral parakeet's feeding habits are difficult to assess. Seed abundance seems sufficiently large to avoid potential impacts on tree regeneration by a low number of parakeets or to limit food competition with other birds or mammals such as the hawfinch *Coccothraustes coccothraustes* or red squirrel *Sciurus vulgaris*. However, the impact of this diet could be more problematic for agricultural production (i.e. of sunflower crops, vineyards or orchards) if parakeet populations became as numerous as the populations recorded in England (Gray 2008).

To limit parakeet establishment success, it might be helpful to limit the quantity of food provided by humans. Information about biological invasions and the responsibility of humans who feed feral animals seems urgently needed.

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