Nota Curta / *Short Note*

Records of fatal attacks by Rose-ringed Parakeets *Psittacula krameri* on native avifauna

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Interspecific interactions between invasive and native fauna are poorly studied. Here we report six fatal attacks by Rose-ringed Parakeets *Psittacula krameri*, one of the most successful invasive avian species in Europe, on House Sparrows *Passer domesticus* and Blue Tits *Cyanistes caeruleus* in Barcelona, Catalonia, Spain. Sparrows and tits were attacked through a 1.5-cm mesh whilst trapped inside funnel traps. Attacks were performed by more than one Rose-ringed Parakeets. An osteological examination of the House Sparrow skeletons revealed that most of the injuries were caused by the drilling and crushing of skull bones. Competition for food or nest-site defence do not seem to be plausible causes for such aggressive behaviour by these parakeets.

Key words: Rose-ringed Parakeet, *Psittacula krameri*, alien species, biological invasions, urban ecology, *Passer domesticus*, *Cyanistes caeruleus*.

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Worldwide, the number of invasive species rose during the past century (Hulme 2009) due to an increase in international trade in plant and animal species and globalization (Meyerson *et al.* 2007, Essl *et al.* 2015). Introductions can pose a risk to native species by provoking changes in the structure and composition of ecosystems (Sala 2009, Brenton-Rule *et al.* 2016). Most introductions of birds occurred in the eighteenth and nineteenth centuries during periods of great economic growth and European colonization (Duncan *et al.* 2003). For instance, members of the Psittacidae are popular as pets and commercial benefits are accrued from their sale (Guix *et al.* 1997, Duncan *et al.* 2003, Vall-llosera 2015). One of the most-traded of these species in Europe is the Rose-ringed Parakeet *Psittacula krameri*, a native of Africa and Asia (Strubbe *et al.* 2007).

This parakeet species has successfully established wild populations in Europe (Strubbe *et al.* 2009a, Mori *et al.* 2013, Pârâu *et al.* 2016) and has gradually increased its range thanks to its great ecological tolerance and synanthropy (Strubbe *et al.* 2009a). Rose-ringed Parakeets can cause considerable damage to crops (Ahmad *et al.* 2011, 2012; Menchetti & Mori 2014) and are responsible for negative impacts such as noise in urban areas (Strubbe *et al.* 2009b, Menchetti *et al.* 2016). They can also act as vectors of harmful diseases including *Chlamydophila psittaci*, the etiological agent of psittacosis, which can affect humans and other native species (Menchetti & Mori 2014, Mori *et al.* 2015). Additionally, there are important economic costs associated with the implementation of control measures in places where they act as pests (Vitousek *et al.* 1997, Pimentel *et al.* 2005). From an ecological perspective, their interaction with native species has an impact on native populations and communities (Menchetti & Mori 2014, Menchetti *et al.* 2016), largely in the form of harassment, displacement from nest sites and food competition

(Strubbe & Matthysen 2007, Martin-Albarracin *et al.* 2015). However, direct evidence of such interaction with native species is frequently difficult to obtain and usually anecdotal (Strubbe *et al.* 2011). In this study, however, we describe injuries caused by these parakeets to passerine species in the city of Barcelona, evidence of the seriousness of the impact that Rose-ringed Parakeets have on native fauna.

Case study

The Rose-ringed Parakeet has inhabited the parks of the city of Barcelona since the late 1970s (Batllori *et al.* 1985). One of the largest colonies lives around Parc de la Ciutadella, where there is also a roost of about 200 individuals (Senar *et al.* 2017). In 2002, we started to use funnel traps to capture and mark House Sparrows *Passer domesticus,* and Blue *Cyanistes caeruleus* and Great *Parus major* Tits in this park in winter (January–February) and summer (August–September). These traps are rectangular, with a single opening (Senar *et al.* 1997). The trap is covered by a metal mesh on all the sides except the front, which has a door that can be raised to allow birds to freely use the feeder placed opposite the entrance. When we want to capture birds, we bait the door and leave a hole connected to the entrance so that the birds can only enter the trap through the funnel. Once the birds are in the trap they are unable to find their way out.

In 2014 and 2015, we recorded several fatal attacks by Rose-ringed Parakeets on passerines captured in these traps. The mesh diameter (1.5 cm) impeded parrots or other similar-sized species from entering the traps to feed. Nevertheless, the parrots attacked the trapped passerines from outside through the holes in the mesh. In order to avoid further attacks, we improved the original design of the funnel trap by covering the trap inside with a smaller 0.5-cm mesh.

Four House Sparrows and two Blue Tits were killed in these two years. We found the dead specimens when we visited the traps (every 30 min approximately). The attacks happened both in winter and summer: 14 January 2014, 18 August 2014 and 6 February 2015. After the first fatal attack, we began to observe the funnel traps while they were operational (i.e. capturing birds) to discover the author of the attacks. On three subsequent occasions, we observed a Rose-ringed Parakeet trying to attack a House Sparrow trapped inside the cage (J. Izquierdo & J. Quesada *pers. obs.*), which confirmed our suspicion that parakeets were involved. On one occasion, the parakeet concerned was marked (Senar *et al.* 2012), while on the other two occasions the parakeets were unmarked. Thus, this is evidence that this aggressive behaviour was not confined to just one parakeet.

The dead House Sparrows were deposited in the collection of the Natural History Museum of Barcelona (register numbers: MZB 2014-2039, MZB 2014-2040, MZB 2014-7336 and MZB 2014-7337) and are of interest since to date there are no specimens of bird skeletons with damage caused by Psittacid attacks.

Most of the injuries to the skeletons of the birds were located on the head. Presumably, they were inflicted when sparrows poked their heads through the mesh holes of the funnel trap in an attempt to escape. In one of the three cases the dead bird also had fractures on its hind limbs, above all on the tibiotarsus and tarsometatarsus (MZB 2014-2039). Skull injuries were identified as being the result of drilling between the beak and the cranium (MZB 2014-2040, MZB 2014-2030), with bruising and fracturing of the parietal bone, depression of the cranial cavity MZB 2014-7336, breakage in the less-calcified braincase, a fractured postorbital process (MZB 2014-7337) (Moreno 1985) and a broken lower beak (MZB 2014-2040, MZB 2014-2030) (Figure 1).

Discussion

The attacks described were attributed to Rose-ringed Parakeets, since aggressive behaviour by birds of this species was observed towards captured birds after the first fatal attack. Later, when the skeletons of the dead birds were analysed, we found that all presented two types of injuries: drilling and crushing of the bones. This kind of damages corresponds to the tip and the inside of the bill of the Rose-ringed Parakeet, respectively. One sparrow suffered perimortem fractures to the postcranial skeleton.

The Rose-ringed Parakeet's beak is short but its gape is wide (Kushwaha 2011). With the mandible moves, the quadrate bone turns and

lifts the maxilla. This unique mechanism enables parakeets to open their mouths and attack the area of the skull of birds in the trap (Ares 2007). From an osteological perspective, no birds survived an attack by a parakeet, which implies that such attacks were the direct cause of death (L. Roqué, pers. obs.).

The Rose-ringed Parakeet is not considered a territorial species but may exhibit aggressive antagonistic behaviour towards other birds or animals that approach nests during the breeding season (Fernández-Juricic *et al.* 2007). Rose-ringed Parakeets have been observed to dislodge honey-bee *Apis mellifera* swarms, bats and other birds to take possession of natural nesting cavities (Hernández-Brito *et al.* 2014a, Menchetti *et al.* 2014, 2016). In Europe, deadly attacks on red squirrel *Sciurus vulgaris* and Norwegian rat *Rattus rattus* have been reported since both these mammals are potential predators of Rose-ringed Parakeet chicks (Mori *et al.* 2013, Hernández-Brito *et al.* 2014b). Rose-ringed Parakeets have been also observed calling and physically intimidating birds flying near their nest sites (Menchetti *et al.* 2016). These attacks could therefore be ways of defending their nests and chicks. However, the dates of the recorded attacks do not coincide with the breeding season of the species, so the attacks were presumably not defensive in nature in the cases described.

An alternative hypothesis is a potential inter-specific competition for food, which is especially patent in Mediterranean environments during winter and summer (Estrada *et al.* 2004), the seasons in which the attacks occurred. However, food availability in urban areas is much less seasonal and is not a limiting factor (Candolin & Wong 2012) and so this hypothesis cannot be applied to these deadly inter-specific attacks. We did not capture passerines in other seasons and consequently we cannot use our data to test this resource limited-hypothesis. Interestingly, we have noted for over 10 years how House Sparrows and Rose-ringed Parakeets feed together at open feeders (J.C. Senar & J. Quesada, pers. obs.) without any active displacement or aggressive display by Rose-ringed Parakeets towards House Sparrows. Nevertheless, it is worth remarking that House Sparrows do tend to avoid Rose-ringed Parakeets and other similar-sized species. More evidence is still needed to fully understand the behavioural processes behind the attacks of Rose-ringed Parakeets on passerines in urban environments, which do not seem to be linked to the obtaining of food.

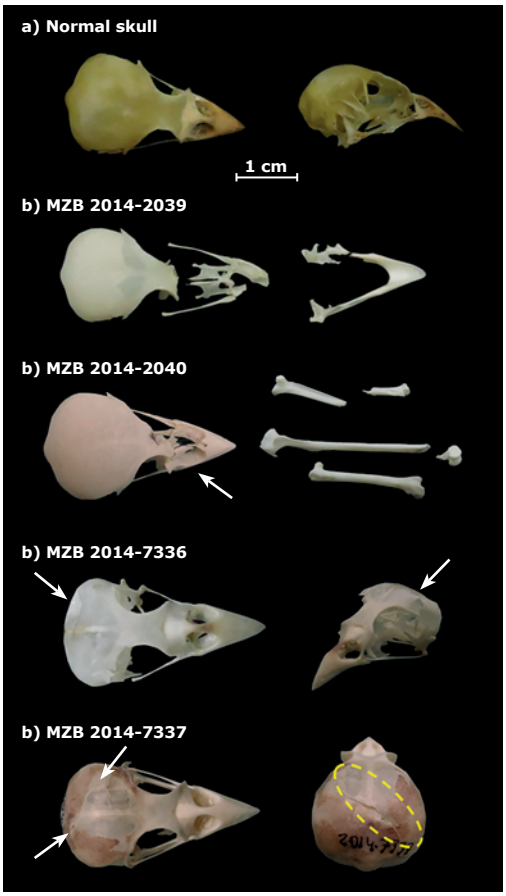

Figure 1. Injuries to the bones of House Sparrows attacked and killed by Rose-ringed Parakeets (b-e). Compare with a normal skull (a).
Ferides en els esquelets dels Pardals comuns atacats i morts per les Cotorres de Kramer (b-e). Compareu amb un crani normal (a).

To sum up, we report here for the first time fatal attacks by Rose-ringed Parakeets on native European bird species, occurrences that highlight the need for further study of the potential impact of invasive species on indigenous bird populations.

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Resum

Registres d'atacs mortals de Cotorra de Kramer *Psittacula krameri* sobre l'avifauna nativa

Les interaccions interespecífiques entre la fauna invasora i la nativa estan poc estudiades. En aquest treball descrivim sis atacs amb resultat de mort per part de la Cotorra de Kramer *Psittacula krameri*, una de les espècies d'aus invasores amb més èxit a Europa, sobre el Pardal comú *Passer domesticus* i la Mallerenga blava *Cyanistes caeruleus* a la ciutat de Barcelona, Catalunya. Els pardals i les mallerengues van ser atacats a través de la malla de 1,5 cm de diàmetre, amb la qual estaven fetes les trampes d'embut on es trobaven atrapats. Els atacs els van realitzar més d'un individu de Cotorra de Kramer. L'examen osteològic dels esquelets dels pardals morts va revelar que la majoria de les lesions es devien a la perforació i aixafament dels ossos del crani. La competència pel menjar o la defensa del lloc de nidificació no semblen causes plausibles per al comportament agressiu de les cotorres.

Resumen

Registros de ataques mortales de Cotorra de Kramer *Psittacula krameri* sobre la avifauna nativa

Las interacciones interespecíficas entre la fauna invasora y la nativa están poco estudiadas. En este trabajo describimos seis ataques con resultado de muerte por parte de la Cotorra de Kramer *Psittacula krameri*, una de las especies de aves invasoras más exitosas en Europa, sobre el Gorrión común *Passer domesticus* y el Herrerillo común *Cyanistes caeruleus* en la ciudad de Barcelona, Cataluña. Los gorriones y herrerillos fueron atacados a través de la malla de 1,5 cm de diámetro con las que estaban hechas las trampas de embudo, en las que se encontraban atrapados. Los ataques fueron realizados por más de un individuo de Cotorra de Kramer. Un examen osteológico de los esqueletos de los gorriones muertos reveló que la mayoría de las lesiones se debían a la perforación y aplastamiento de los huesos del cráneo. La competencia por la comida o la defensa del sitio de nidificación no parecen causas plausibles para el comportamiento agresivo de las cotorras.

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