6

THE ECOLOGICAL IMPACTS OF INTRODUCED PARROTS

Emiliano Mori and **Mattia Menchetti**

INTRODUCTION

Introduced and invasive species are negatively influencing native species at an alarming and increasing rate. Invasive species may alter the structure and the function of ecosystems through hybridization, competition, predation, parasitism, and disease. More than 60 parrot species have established at least one breeding population outside their natural extent of occurrence, thus making Psittaciformes the most introduced bird order throughout the world. Impacts of introduced parrots are known mainly for the two most widespread species, the Rose-ringed Parakeet (*Psittacula krameri*) and the Monk Parakeet (*Myiopsitta monachus*). These impacts may vary across different study sites and population densities. Hybridization occurs in both tropical native areas, where similar species are naturally present, and novel areas where species have been introduced. Behavioral interference by introduced parrots with a number of native species (birds, mammals and insects) sharing the same breeding or feeding areas has been reported. Other types of impacts by introduced parakeets include economic effects (e.g., to agriculture and electrical infrastructures) and human well-being. In this chapter, we summarize the ecological impacts of introduced parrots, updating and improving the review by Menchetti and Mori (2014) and attempting to draw conclusions from a worldwide perspective.

THE GLOBAL INTRODUCTION OF PARROTS

Biological invasions are currently known to shape and modify biodiversity in native communities by means of ecological impacts, health consequences, and economic costs (Mack et al. 2000; Kumschick and Nentwig 2010; Mazza et al. 2014). European Regulation 1143/2014, concerning introduced and invasive species, lists only five bird species among the 49 species on its "blacklist" (cf. Nentwig et al. 2018): Ruddy Duck (*Oxyura jamaicensis*), which is hybridizing with the native White-headed Duck (*Oxyura leucocephala*); Egyptian Goose (*Alopochen aegyptiaca*), an agricultural pest; African Sacred Ibis (*Threskiornis aethiopicus*), which competes with native wading birds and hybridizes with the native African Spoonbill (*Platalea alba*); Indian House Crow (*Corvus splendens*), a predator of native small mammals and birds; and the Common Myna (*Acridotheres tristis*), which competes with natives passerines and is reported to be an agricultural pest. Parrots are the most common bird pets (Drews 2001; Cassey et al. 2004; Dyer et al. 2017; Mori et al. 2017b, 2020a), undoubtedly because of their vividly colored plumages and great synanthropy (Menchetti and Mori 2014). Records and numbers of introduced populations have increased since the late 1970s and are still growing (Mori et al. 2013b; Pârâu et al. 2016; Hobson et al. 2017; Mori et al. 2017b; Falcón and Tremblay 2018; Per 2018; Mori et al. 2020a). Populations of introduced parrots have been recorded in at least 47 countries, on all continents excluding Antarctica (Ancillotto et al. 2015; Menchetti et al. 2016; iNaturalist Alien Parrots

Observatory 2019; see Pruett-Jones, chap. 19 this vol., for updated numbers).

ECOLOGICAL AND BEHAVIORAL IMPACTS

Competitive Exclusion

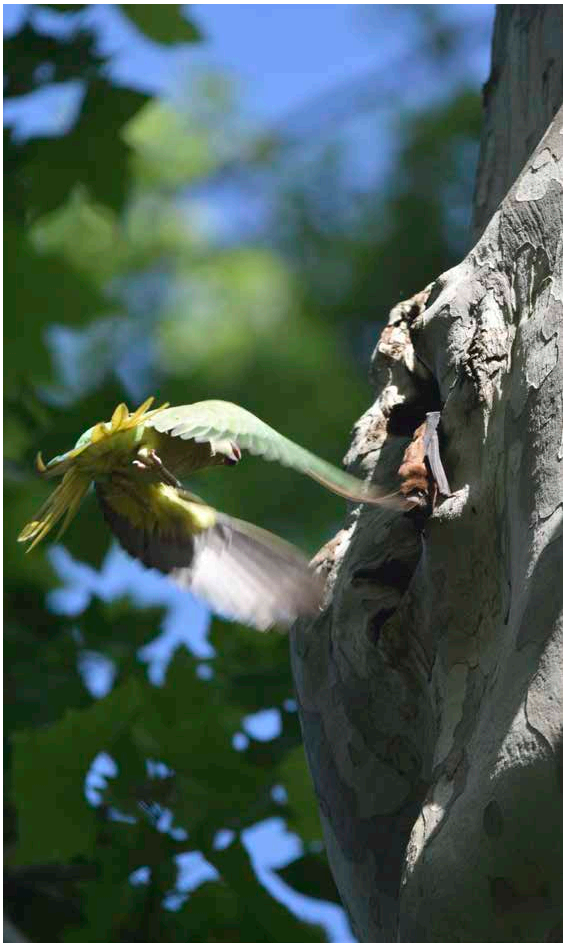
Interspecific competition can include either or both competitive exclusion and behavioral interference. Most parrots rely on cavities for nesting (Cramp 1985; Diamond and Ross 2019). Unlike woodpeckers (Piciformes), which, as primary cavity nesters, directly excavate their nesting cavities, parakeets, as secondary cavity nesters, usually rely upon already existing cavities, sometimes adapting them, e.g., by enlarging their entrances. Competitive exclusion between parrots and woodpeckers may therefore be dependent on the abundance of cavities (Keijl 2001; Menchetti and Mori 2014; Şahin and Arslangündoğdu 2019). Where cavities are a limiting resource (e.g., in urban areas or managed parks), introduced parrots may outcompete native secondary cavity users of comparable body size, including bats and dormice using cavities for resting or roosting (Menchetti and Mori 2014; Diamond and Ross 2019).

To date, no study has confirmed the impact of introduced parakeets on any other species throughout the whole of their range of overlap. Therefore, impacts by parrots are dependent on the geographic context, resource availability, and the complexity of the native community. Competitive exclusion has been observed by the Rose-ringed Parakeet against a number of native cavity-dependent species. The success of the Rose-ringed Parakeet is due, in part, to the fact that it starts breeding early in the season. Therefore, the parakeets may secure the best nest sites before native species begin their breeding process. Strubbe et al. (2010) predicted moderate competition between Rose-ringed Parakeets and the native Eurasian Nuthatch (*Sitta europaea*) in Belgium, putting perhaps one-third of the population of the native species at risk. Conversely, Newson et al. (2011) did not find any significant evidence for competition between Rose-ringed Parakeets and nuthatches in the United Kingdom (UK), however they do not rule out that competitive exclusion may occur where availability of nest cavities is limiting.

Since 1998, the Rose-ringed Parakeet has become one of the most common bird species in Israel (Roll et al. 2008). Before the parakeet introduction, the Eurasian Hoopoe (*Upupa epops*) was a very common and successful species in Israel, as reported by long-term monitoring programs (Yosef et al. 2016). After the establishment of the parakeets, breeding success of the hoopoe dramatically declined. Yosef et al. (2016) claimed that the parakeets were the main factor responsible for hoopoe breeding failures. Rose-ringed Parakeets occupy trunk holes earlier in the season than native hoopoes, and the parakeets can displace hoopoes from occupied holes. In Italy, a comparison of nesting-site occupation before and after the Rose-ringed Parakeet invasion suggested a potential competition with the Eurasian Scops Owl (*Otus scops*). Nesting sites of scops owls overlap with those selected by Rose-ringed Parakeets, and after the parakeets became established the owls were forced to use suboptimal breeding areas (Mori et al. 2017a). Rose-ringed Parakeets are similary forcing Common Swifts (*Apus apus*) to use suboptimal nesting areas in northern Italy (Grandi et al. 2018).

In Seville, Spain, where one of the world's largest colonies of the native Lesser Kestrel (*Falco naumanni*) breeds (Tella et al. 1996), Rose-ringed Parakeets have been observed aggressively attacking the kestrel (Hernández-Brito et al. 2014). In the same city, an urban park hosts the largest European colony of the Greater Noctule Bat (*Nyctalus lasiopterus*), a rare cavity-breeding species (Popa-Lisseanu et al. 2008). Since 2003, the population of Rose-ringed Parakeets has increased in this park, displacing female bats from roosting places, even killing them, and triggering a remarkable population decline of this rare species (Hernández-Brito et al. 2014, 2018). Ivanova and Symes (2019) showed a remarkable decline in native populations of Laughing Doves (*Spilopelia senegalensis*) and Southern Fiscals (*Lanius collaris*) in South Africa coinciding with an increase in Rose-ringed Parakeets.

Competition for nesting sites is particularly concerning on islands, where endemic species may be threatened by the introduction of the Rose-ringed Parakeet. Particularly, in Mauritius (Indian Ocean), the native Echo Parakeet (*Psittacula eques*) may suffer competition with introduced and spreading Rose-ringed Parakeets (Tatayah et al. 2007; Jackson et al. 2015). Displacements by the parakeets have also been recorded with the native Seychelles Black Parrot (*Coracopsis barklyi*) in Mahè Island (Seychelles, Indian Ocean), the Norfolk Parakeet (*Cyanoramphus cookii*) in Norfolk Island (Oceania), and Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) in southwestern Australia (Lever 1994, 2005; Chapman 2005; Jackson et al. 2015; Menchetti et al. 2016).



Rose-ringed Parakeet (*Psittacula krameri*) attacking a Greater Noctule Bat (*Nyctalus lasiopterus*). The bat can be seen clinging to the tree, just above the bird's right wingtip. This bat was later found dead at the base of the tree. Seville, Spain, May 2016. Photo by Dailos Hernández-Brito.

Behavioral Interference

Behavioral interference can be either direct or indirect. Hole-nesting parrots strongly defend cavities they use to breed, sometimes displacing and killing other species (Menchetti and Mori 2014). Fatal attacks against cavity-roosting bats have been observed after the establishment of new parrot colonies or at the start of their spread (Menchetti et al. 2016). For instance, Menchetti et al. (2014) observed a Rose-ringed Parakeet killing and partially consuming a male Lesser Noctule Bat (*Nyctalus leisleri*) in a central Italian site where no breeding population of the parakeet occurred. In northern Italy, four Savi's Pipistrelles (*Hypsugo savii*) are known to have been killed by Rose-ringed Parakeets in early spring 2019.

In the Netherlands, several Common Noctule Bats (*Nyctalus noctula*) were reportedly found under parakeet nests (Haarsma and Van der Graaf 2013). A dead Gould's Wattled Bat (*Chalinolobus gouldii*) was observed under the nest of a Coconut Lorikeet (*Trichoglossus haematodus*), in Perth, Australia, where the lorikeet is invasive (Menchetti and Mori 2014). Gebhardt (1996) reported that Rose-ringed Parakeets displaced a Geoffroy's Bat (*Myotis emarginatus*)—and also two dormouse species (*Glis glis* and *Eliomys quercinus*)—from tree holes in Germany. Most parrot and bat species use tree cavities both for breeding and for roosting, therefore suggesting that behavioral interference may be more frequent than observed or may occur directly within cavities.

In Israel, Rose-ringed Parakeets have often been observed attacking another invasive bird, the Common Myna, around nesting sites (Orchan et al. 2012). Attacks by Rose-ringed Parakeets against Little Owls (*Athene noctua*) around nesting cavities have been observed in Italy and in Algeria, where an individual of this nocturnal raptor was killed by a small group of Rose-ringed Parakeets (Menchetti and Mori 2014). In one case, in Germany, Rose-ringed Parakeets displaced a breeding couple of Common Starlings (*Sturnus vulgaris*) from a nest (Czajka et al. 2011).

Introduced parrots have also been recorded attacking and in some cases killing arboreal mammals, such as squirrels (Clergeau et al. 2009; Mori et al. 2013a). In France and Turkey, groups of Rose-ringed Parakeets were observed attacking and killing Eurasian Red Squirrels (*Sciurus vulgaris*) (Menchetti et al. 2016; Çalışkan 2018). This aggression is likely the result of the fact that the Eurasian Red Squirrel is a known nest predator and has been observed attacking parakeet chicks in Rome (Mori et al. 2013a). Similarly, the introduced Eastern Gray Squirrel (*Sciurus carolinensis*) is reported to be a predator of young Rose-ringed Parakeets in the UK (Shwartz et al. 2008). A total of 21 aggressions by Rose-ringed Parakeets against Black Rats (*Rattus rattus*) have been reported around parakeet nests in Seville and Tenerife (Canary Islands). In the majority of attacks the rats escaped, but two were killed (Hernández-Brito et al. 2015).

Parrot attacks may be due to competition for food resources or may be territorial defense behavior (Covas et al. 2017). In 2013, in Seville, harassment and noise intimidation by nesting Rose-ringed Parakeets were recorded against Spotless Starlings (*Sturnus unicolor*), Rock Doves (*Columba livia* var. *domestica*), House Sparrows (*Passer domesticus*), Western Jackdaws (*Coloeus monedula*), Eurasian Collared Doves (*Streptopelia decaocto*), Eurasian Blue Tits (*Cyanistes caeruleus*), Black Kites (*Milvus migrans*), Great Tits (*Parus major*), and Booted Eagles (*Hieraaetus pennatus*) (Hernández-Brito et al. 2014). Similarly, aggressive interactions were also observed against three other introduced parrot species, the Senegal Parrot (*Poicephalus senegalus*), the Blue-crowned Parakeet (*Thectocercus acuticaudatus*) and the Monk Parakeet (Hernández-Brito et al. 2014).

The presence of Rose-ringed Parakeets significantly increased vigilance among native birds at bird feeders (Peck et al. 2014). Particularly, Le Louarn et al. (2016) found that the most affected species at feeders in northern France is the Common Starling. In turn, breeding Rose-ringed Parakeets are rarely displaced by native species, although this does occasionally occur (Czajka et al. 2011).

Around their colonial nests, introduced Monk Parakeets in the United States (US) may harass and kill Blue Jays (*Cyanocitta cristata*), American Robins (*Turdus migratorius*), and House Sparrows (MacGregor-Fors et al. 2011). In Belgium, this parakeet has been observed harrassing Western Jackdaws and Hooded Crows (*Corvus cornix*) at nesting sites (Dangoisse 2009). Similar observations have been made in central Italy (Menchetti and Mori 2014; Di Santo et al. 2016). Monk Parakeets share feeding sites with the Rock Dove, Common Wood Pigeon (*Columba palumbus*), blackbirds, and other native birds, without competing with them, throughout the introduced range (Dangoisse 2009; Zocchi et al. 2009; Appelt et al. 2016). In Spain, Monk Parakeets occasionally displaced blackbirds from feeding areas (Batllori and Nos 1985). Breeding Turquoise-fronted Amazons (*Amazona aestiva*) have been frequently observed attacking Black Rats, Common Starlings and Western Jackdaws in Italy; and American Crows (*Corvus brachyrhynchos*) in California (Mori et al. 2017b).

At feeding sites in Western Australia, introduced Coconut Lorikeets show aggressive behavior toward Red Wattlebirds (*Anthochaera carunculata*), honeyeaters (Meliphagidae), and corellas (*Cacatua* spp.). During the breeding season, this lorikeet displaces from nesting sites native Galahs (*Eolophus roseicapilla*), Australian Ringnecks (*Barnardius zonarius*), Carnaby's Black Cockatoos *(Calyptorhynchus latirostris*), and Laughing Kookaburras (*Dacelo novaeguineae*) (Chapman 2005). Lamont (1996) reported that introduced lorikeets may also kill the nestlings of Australian Ringnecks before taking over the nest. Nest displacement of native African Palm Swifts (*Cypsiurus parvus*) by introduced Fischer's Lovebirds (*Agapornis fischeri*), Yellow-collared Lovebirds (*A. personatus*), and their hybrids occurs in Kenya (Lever 1994; Mori et al. 2020a), but no data on swift population trends are available (Menchetti and Mori 2014). The Red-breasted Parakeets (*Psittacula alexandri*) introduced to Singapore feed mainly on unripe fruits, thus competing with the native Yellow-vented Bulbul (*Pycnonotus goiavier*), which eats only ripe ones (Neo 2012). In the same area (central Singapore), Red-breasted Parakeets and Tanimbar Corellas (*Cacatua goffiniana*) may affect breeding success of the rare Oriental Pied Hornbill (*Anthracoceros albirostris*) (Peh 2010).

Competition in Singapore between introduced parrots and native Common Flamebacks (*Dinopium javanense*) and Oriental Dollarbirds (*Eurystomus orientalis*) has also been suggested (Neo 2012). Fischer's Lovebirds and House Sparrows may compete in southern France (Dubois 2007). Additionally, Runde et al. (2007) suggested that introduced Mitred Parakeets (*Psittacara mitratus*) may displace native marine birds from their nests in Hawaii.

Mobbing and Harassment

In Singapore, introduced Tanimbar Corellas have been sporadically observed mobbing native Pink-necked Green Pigeons (*Treron vernans*) (Neo 2012). Single Rose-ringed Parakeet individuals have been observed harrasing a Peregrine Falcon (*Falco peregrinus*), a Black Stork (*Ciconia nigra*), a Eurasian Wryneck (*Jynx torquilla*), and a European Green Woodpecker (*Picus viridis*) in Rome (Mori and Menchetti, unpubl. data). Flocks of Rose-ringed Parakeets may occasionally harass larger species; a group of about 60 parakeets was observed mobbing a Booted Eagle in Seville (Hernández-Brito et al. 2014). Single mobbing events or harassments in the surroundings of nesting sites by Rose-ringed Parakeets targeted Hooded Crows, Rock Doves, and Stock Doves (*Columba oenas*) (Menchetti et al. 2016). In Turkey, Per (2018) and Şahin and Arslangündoğdu (2019) reported harassments by Rose-ringed Parakeets of Yellow-Legged Gulls (*Larus michahellis*), Hooded Crows, jackdaws, starlings, nuthatches, Syrian Woodpeckers (*Dendrocopos syriacus*), and Caucasian Squirrels (*Sciurus anomalus*).

OTHER IMPACTS ON FAUNA

Hybridization

Hybridization is common among congeneric species of parrots and may naturally occur in overlapping native ranges (cf. Forshaw 2010). While hybridization between different lovebird species does not alter the individual behavior or invasive success (Mori et al. 2020a), in other cases, hybrids may be better invaders with

Hybrid of Salmon-crested Cockatoo (*Cacatua moluccensis*) × White Cockatoo (*C. alba*). Hybrids between these species show crest coloration intermediate between the parent species. Honolulu, Hawaii, US, August 2017. Photo by Nicholas P. Kalodimos.

than either of the pure species. For instance, hybrids of Rose-ringed Parakeet × Alexandrine Parakeet (*Psittacula eupatria*) are larger and more aggressive than parental Rose-ringed Parakeets (Krause 2004; Ancillotto et al. 2015; Postigo 2016).

Some introduced parrots are endangered in the native range; therefore, self-sustaining introduced populations may represent a source of individuals for reintroduction events (Menchetti and Mori 2014; Kiacz and Brightsmith, chap. 5 this vol.). However, hybridization with other introduced parrot species may represent a problem for the genetic integrity of threatened species. An

example may be represented in Germany by the introduced Yellow-headed Amazon (*Amazona oratrix*), which is endangered in its native range, hybridizing and producing fertile hybrids with the congeneric Turquoise-fronted Amazon (Martens et al. 2013).

Facilitation of Success of Other Introduced Species

The presence of introduced parakeets in an area may help facilitate the establishment success of other non-native species. Ancillotto et al. (2015) stated that the presence of previously established Rose-ringed Parakeets contributes to niche expansion and invasion success of the congeneric Alexandrine Parakeet. In Israel, enlargement of trunk cavities by the Rose-ringed Parakeets may increase the breeding success of the invasive Common Myna by creating more suitable nesting sites (Orchan et al. 2012). The Common Myna is spreading in Israel and affecting the breeding success of many native hole-nesting species (Roll et al. 2008). Colonial nests of Monk Parakeet are used by many other species, including the Italian Sparrow (*Passer italiae*) in its native range (Moltoni 1945) and the White Stork (*Ciconia ciconia*) in Italy (G. Grandi, pers. comm.) and in Spain (Hernández-Brito et al. 2020). In contrast to the White Stork, the introduced African Sacred Ibis in northern Italy uses the nests of Monk Parakeets as a source of material to build its nests elsewhere, sometimes partially destroying the parakeet nest (Castiglioni et al. 2015). The nesting association between Monk Parakeets and White Storks in Spain has been hypothesized to provide the parakeets with protection from potential predators (Hernández-Brito et al. 2020).

Parasite-Mediated Competition

Parasites may have a substantial impact on the success and impact of biological invasions. When a species establishes new populations outside its natural range, it also introduces parasites to the new range (i.e., spillover) and it is subjected to the infection by local parasites (i.e., spillback) (Kelly et al. 2009; Romeo et al. 2014). Two species may thus interact with one another by means of parasites and diseases (Price et al. 1986; McInnes et al. 2013). To date, ectoparasites of introduced parakeets have been examined in Italian and Spanish populations of naturalized parrots (Mori et al. 2015, 2019; Ancillotto et al. 2018). Among introduced species, the Indian lice *Neopsittaconirmus lybartota* and *Echinophilopterus tota* were observed on Rose-ringed Parakeets in Italy; the South American louse *Paragoniocotes fulvofasciatus* and the biting mite *Ornithonyssus bursa* occurred on Monk Parakeets in Italy and Spain. Conversely, several species of native parasite arthropods were detected on parrots introduced to Italy: the squirrel flea (*Tarsopsylla octodecimdentata*), the pigeon soft tick (*Argas reflexus*; responsible for Lyme disease transmission), the chicken mite (*Dermanyssus gallinae*), the buzzard louse (*Laemobothrion maximum*), and the flat fly *Ornithomyia avicularia* on Rose-ringed Parakeets; the pigeon louse (*Columbicola columbae*) and the flat flies *Crataerina pallida* and *Ornithophila metallica* on Monk Parakeets (Mori et al. 2015; Ancillotto et al. 2018). Thus, introduced parakeets may be prone to spillback from coexisting native species with which they interact. Accordingly, in Barcelona, the mite *O. bursa*, introduced with Monk Parakeets, was often recorded on native Rock Doves; conversely, the pigeon louse was rare on Monk Parakeets (Mori et al. 2019).

Introduced parakeets are reservoirs of a high number of bacterial and viral diseases, and therefore, they may affect the fitness of native wild species (Kalodimos 2013; Menchetti and Mori 2014; Mori et al. 2018; Pisanu et al. 2018). Among those, *Chlamydophila psittaci* is reported to be harmful for raptors, including the Bald Eagle (*Haliaeetus leucocephalus*) and the Osprey (*Pandion haliaetus*) (Avery and Shiels 2018).

The role of introduced parrots in spreading avian influenza H5N1 (cf. Fletcher and Askew 2007), potentially harmful to native birds, has been dismissed (D. Brightsmith, pers. comm., 2019). Exotic Newcastle disease, caused by *Paramyxovirus* and carried by Monk Parakeets, increases mortality in wild bird communities (Nelson et al. 1952; Mori et al. 2018). The psittacine beak and feather disease virus (*Circovirus*) has been detected in Rose-ringed Parakeets (Gerlach 1994; Sa et al. 2014; Fogell et al. 2018; Morinha et al. 2020) and is one of the

worst parrot pathologies worldwide. Native to Oceania, this disease is particularly concerning when introduced parrots come into contact with autochthonous parrots (Ha et al. 2007), such as the Seychelles Black Parrot (Jackson et al. 2015). Bites by the mite *O. bursa*, introduced with Monk Parakeets in Italy and Spain, may provoke dermatitis, asthma, irritations, and skin rashes in humans and native animal species (Mori et al. 2018).

PREDATORS OF INTRODUCED PARROTS

Pithon and Dytham (1999) reported that in the United Kingdom, both the Eurasian Sparrowhawk (*Accipiter nisus*) and the Northern Goshawk (*A. gentilis*) regularly prey upon Rose-ringed Parakeets, and Harris (2015) observed that Peregrine Falcons and Eurasian Hobbies (*Falco subbuteo*) occasionally do so. Black Rats were responsible for the extinction of the Monk Parakeet colony in Milan in the 1940s (Scortecci 1953; Menchetti and Mori 2014). Eastern Gray Squirrels and Eurasian Red Squirrels are reported to be occasional predators of Rose-ringed Parakeet chicks (Shwartz et al. 2008; Mori et al. 2013a). Domestic cats have been reported to be effective predators of introduced parakeets; for example, Budgerigars (*Melopsittacus undulatus*) are widely preyed upon by feral cats in Florida (Menchetti and Mori 2014). Remains of a Budgerigar (feathers) have also been recorded in a pellet of a Tawny Owl (*Strix aluco*) in London (Harris 2015). Corvids, such as Western Jackdaw and Carrion Crow (*Corvus corone*) are reported to be predators of parrot chicks in Belgium and Italy (Weiserbs and Jacob 1999). The Rose-ringed Parakeet represented nearly 10% of the total volume of the diet of urban Long-Eared Owls (*Asio otus*) in Follonica, Italy (Mori et al. 2020b).

Human persecution against introduced parakeets is not common, but it has occurred throughout the world. In Italy, two populations of Monk Parakeet have been extirpated by poachers, one in central and one in northern Italy (Mori et al. 2014). Furthermore, a small population of Rose-ringed Parakeets established in the Borromean Islands (Isola Madre, Lake Maggiore, northwestern Italy) was eradicated by the human residents in 1990 (Brichetti and Fracasso 2006). In Israel, where Rose-ringed Parakeets represent an agricultural pest, individuals are commonly killed. In addition to these examples, there are many others in which populations of native or naturalized parrots have been reduced or controlled by humans. Bucher (chap. 8 this vol.) discussed widespread control programs of Monk Parakeets and other species in South America and Pruett-Jones (chap. 19 this vol.) gives other examples of control of naturalized parrots.

IMPACTS ON PLANTS

Apart from the damage parrots cause to cultivated plants (Senar et al. 2016; Mentil et al. 2018; Shiels et al. 2018; Rehman et al. 2019), Tella et al. (2015) recently reported clear evidence of the importance of parrots as potential seed dispersers, a feature that has been long overlooked (Menchetti and Mori 2014). While data on seed dispersion by parrots in their native range are increasingly available (Blanco et al. 2016), there is very little in the literature on the impacts exerted by introduced parakeets on flora and vegetation of local environments (Shiels et al. 2018). Runde et al. (2007) suggested that, given its feeding habits, the invasive Mitred Parakeet may help spread the invasive Velvet Tree (*Miconia calvescens*) in the Hawaiian archipelago. Conversely, if introduced parrots totally remove the seed coat, they may increase the deterioration of the seed, therefore reducing its germination success (Howe 1977; Galetti 1993; Norconk et al. 1998). In turn, parrots may also limit the reproductive success of native plant species, thus potentially threatening endemic plants to native environments. Consumption of flowers and blossoms by Rose-ringed and Monk Parakeets may affect plant reproduction success.

The folivorous diet of introduced Sulphur-crested Cockatoos (*Cacatua galerita*) in New Zealand is currently altering forest dynamics, increasing scrub richness, and triggering the population decline of some tree species (Styche

2008; Menchetti and Mori 2014). Fletcher and Askew (2007) suggested that colonial roosts of Rose-ringed Parakeets may affect the vegetal composition on the ground because of the chemical alteration produced by droppings, but this hypothesis has yet to be verified (Menchetti and Mori 2014).

Monk Parakeets may strip small branches of trees and other plants, both natural and cultivated (e.g., *Vitis vinifera*), to build their nests (Menchetti and Mori 2014).

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

This summary reveals that knowledge on impacts by introduced parrots has increased since the first assessment review (Menchetti and Mori 2014; see Tables 6.1 and 6.2). For Europe, data obtained through ParrotNet, an EU COST (European Cooperation in Science and Technology) Action, allowed us also to draw the impact assessment for the two most widespread parrot species, the Rose-ringed Parakeet and the Monk Parakeet, outside their natural extent of occurrence (Turbé et al. 2017).

Impacts of introduced parrots are context-dependent and vary highly across geography, local resource availability, and the native bird community. Therefore, it is still hard to draw general conclusions and management actions. From a general perspective, native hole-nesting species and cavity-roosting bat species are most affected, and they deserve specific attention, particularly at the start of the invasion process (Hernández-Brito et al. 2014; Menchetti et al. 2014). Conversely, the main gap remains in analyses of effects on the flora (both native and invasive) of the introduced range, which have not been quantitatively assessed yet in any country. Apart from ecological impacts, Menchetti and Mori (2014) reported that introduced parakeets also affect human economy, by impacting agriculture and electrical infrastructures (Reed et al. 2014) and wellness, through noise pollution, disease, and parasite transmission (Avery and Shiels 2018; Mori et al. 2020c).

Prevention and early detection of new invasions are reported to be the most cost-effective strategies (Vall-llosera et al. 2016), which may be obtained also through the help of popular online internet resources (e.g., biodiversity platforms and social networks). Online projects are effective tools for parakeet passive surveillance (Vall-llosera et al. 2016). Once parrots are established, attempts to eradicate or numerically control them may trigger controversy and conflicts (Crowley et al. 2019). Furthermore, eradication and numerical control may be ineffective or, at least, unsustainably expensive (Crowley et al. 2016; Vall-llosera et al. 2016). Where damage to human activity is minimal, parakeets are widely appreciated. For instance, in New Zealand, introduced Eastern Rosellas (*Platycercus eximius*) and Crimson Rosellas (*P. elegans*), both native to Australia, are reported to be efficient predators of a destructive fly species, *Calliphora laemica* (Dipera: Calliphoridae), a perpetrator of fly-strike on domestic sheep (Lever 1994), and therefore are likely appreciated by local shepherds. After educational campaigns, assessment of local behavioral ecology (see Le Louarn et al. 2017; Le Louarn et al. 2018; Postigo et al. 2019) and social impacts may make management actions including eradication and numerical control more democratic and, in turn, much more effective (Crowley et al. 2016).

ACKNOWLEDGMENTS

We would like to thank all the people who helped us in data/paper collection and analysis: Leonardo Ancillotto, Donald Brightsmith, Silvia Giuntini, Gioele Grandi, Lorenzo Mentil, and all the other ParrotNet participants. Jessica Peruzzo, Giuliano Petreri, Mario Monfrini, Alberto Calveri, Milos Di Gregorio, Marco Vicariotto, and Luciano Giacomino kindly provided us with important documentary photos.

TABLE 6.1

Summary of interactions between bird and mammal species and the Rose-ringed Parakeet in its introduced range (Sources: Menchetti and Mori 2014; Menchetti et al. 2016; White et al. 2019; this study). Positive effects refer to those where a species depredates the parakeets; neutral effects refer to harassments or mobbing events by the parakeets; negative effects refer to population/individual effects (i.e., killings, population reduction). Species are listed in alphabetical order by common name.

CLASS	SPECIES	EFFECT ON SPECIES
Experimental Studies:		
Aves	Eurasian Hoopoe (*Upupa epops*)	Negative
Aves	Eurasian Nuthatch (*Sitta europaea*)	Negative
Aves	Eurasian Scops Owl (*Otus scops*)	Negative
Aves	Laughing Dove (*Spilopelia senegalensis*)	Negative
Aves	Screech Owl (*Asio otis*)	Negative
Aves	Southern Fiscal (*Lanius collaris*)	Negative
Mammalia	Greater Noctule (*Nyctalus lasiopterus*)	Negative
Observational Studies and Occasional Observations:		
Aves	Black Kite (*Milvus migrans*)	Neutral
Aves	Booted Eagle (*Aquila pennata*)	Neutral
Aves	Black Stork (*Ciconia nigra*)	Neutral
Aves	Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)	Negative
Aves	Common Blackbird (*Turdus merula*)	Negative
Aves	Common Myna (*Acridotheres tristis*)	Neutral
Aves	Common Starling (*Sturnus vulgaris*)	Negative
Aves	Echo Parakeet (*Psittacula eques*)	Negative
Aves	Eurasian Blue Tit (*Cyanistes caruleus*)	Negative
Aves	Eurasian Green Woodpecker (*Picus viridis*)	Negative
Aves	Eurasian Tree Sparrow (*Passer montanus*)	Negative
Aves	Eurasian Wryneck (*Jynx torquilla*)	Neutral
Aves	Grey Heron (*Ardea cinerea*)	Neutral
Aves	Great Tit (Parus major)	Neutral
Aves	Hooded Crow (*Corvus cornix*)	Negative and Positive
Aves	House Sparrow (*Passer domesticus*)	Neutral
Aves	Italian Sparrow (*Passer italiae*)	Neutral
Aves	Lesser Kestrel (*Falco naumanni*)	Negative
Aves	Lesser Vasa Parrot (*Coracopsis nigra*)	Negative
Aves	Little Owl (*Athene noctua*)	Negative
Aves	Monk Parakeet (*Myiopsitta monachus*)	Neutral
Aves	Norfolk Parakeet (*Cyanoramphus cookii*)	Negative
Aves	Peregrine Falcon (*Falco peregrinus*)	Positive
Aves	Pink-necked Green Pigeon (*Treron vernans*)	Negative
Aves	Rock Dove (*Columba livia*)	Negative

continued overleaf

TABLE 6.1 continued

CLASS	SPECIES	EFFECT ON SPECIES
Aves	Spotless Starling (*Sturnus unicolor*)	Negative
Aves	Stock Dove (*Columba oenas*)	Negative
Aves	Syrian Woodpecker (*Dendrocopos syriacus*)	Negative
Aves	Western Jackdaw (*Coloeus monedula*)	Negative and Positive
Aves	Yellow-legged Gull (*Larus michahellis*)	Neutral
Mammalia	Black Rat (*Rattus rattus*)	Positive
Mammalia	Caucasian Squirrel (*Sciurus anomalus*)	Negative
Mammalia	Common Noctule (*Nyctalus nyctala*)	Negative
Mammalia	Eastern Gray Squirrel (*Sciurus carolinensis*)	Positive
Mammalia	Geoffroy's Bat (*Myotis emarginatus*)	Negative
Mammalia	Lesser Noctule (*Nyctalus leisleri*)	Negative
Mammalia	Red Squirrel (*Sciurus vulgaris*)	Negative and Positive
Mammalia	Savi's Pipistrelle (*Hypsugo savii*)	Negative

TABLE 6.2

Summary of documented behavioral interactions between native species and introduced parrots, except for *Psittacula krameri* (Sources: Menchetti and Mori 2014; White et al. 2019; this study). Species are listed in alphabetical order by common name, and only common names are listed.

	PARROTS													
OTHER SPECIES	Blue-fronted Amazon	Budgerigar	Coconut Lorikeet	Crimson Rosella	Fisher's Lovebird	Little Corella	Long-billed Corella	Mitred Parakeet	Monk Parakeet	Red-breasted Parakeet	Sulphur-crested Cockatoo	Superb Parrot	Tanimbar Corella	Yellow-collared Lovebird
Birds														
African Palm Swift					X									X
American Crow	X													
American Robin									X					
Black Noddy								X						
Blue Jay									X					
Common Blackbird									X					
Common Flameback										X			X	
Common Kestrel									X					
Common Myna			X											
Common Starling	X													
Honeyeater spp.			X											

	PARROTS													
OTHER SPECIES	Blue-fronted Amazon	Budgerigar	Coconut Lorikeet	Crimson Rosella	Fisher's Lovebird	Little Corella	Long-billed Corella	Mitred Parakeet	Monk Parakeet	Red-breasted Parakeet	Sulphur-crested Cockatoo	Superb Parrot	Tanimbar Corella	Yellow-collared Lovebird
Hooded Crow									X					
House Sparrow		X			X				X					
Italian Sparrow	X								X					
Laughing Kookaburra			X											
Little Wattlebird			X											
Mourning Dove		X												
New Holland Honeyeater			X											
Oriental Dollarbird										X			X	
Oriental Pied Hornbill													X	
Petrel spp.								X						
Pied Currawong			X											
Pink-necked Green Pigeon													X	
Purple Martin		X												
Red Wattlebird			X											
Rock Dove									X					
Shearwater spp.								X						
Western Jackdaw	X													
Yellow-vented Bulbul										X				
Other species of native parrots			X	X		X	X						X	
Mammals														
Black Rat	X													
Gould's Wattled Rat			X											
Red Squirel												X		
Native Flora								X	X	X	X			

REFERENCES

Ancillotto, L., Strubbe, D., Menchetti, M., and Mori, E. 2015. An overlooked invader? Ecological niche, invasion success and range dynamics of the Alexandrine parakeet in the invaded range. *Biological Invasions* 18:583–595.

Ancillotto, L., Studer, V., Howard, T., Smith, V. S., McAlister, E., Beccaloni, J., Manzia, F., Renzopaoli, F., Bosso, L., Russo, D., and Mori, E. 2018. Environmental drivers of parasite load and species richness in introduced parakeets in an urban landscape. *Parasitology Research* 117:3591–3599.

Appelt, C. W., Ward, L. C., Bender, C., Fasenella, J., Van Vossen, B. J., and Knight, L. 2016. Examining potential relationships between exotic monk parakeets (*Myiopsitta monachus*) and avian communities in an urban environment. *Wilson Journal of Ornithology* 128:556–566.

Avery, M. L., and Shiels, A. B. 2018. Monk and rose-ringed parakeets. In *Ecology and Management of Terrestrial Vertebrate Invasive Species in the United States*, ed. W. C. Pitt, J. C. Beasley, and G. W. Witmer. Boca Raton, FL: CRC Press.

Batllori, X., and Nos, R. 1985. Presencia de la cotorrita gris (*Myiopsitta monachus*) y de la cotorrita de collar (*Psittacula krameri*) en el Area Metropolitana de Barcelona. *Miscellanea Zoologica* 9:407–411.

Blanco, G., Bravo, C., Pacifico, E. C., Chamorro, D., Speziale, K. L., Lambertucci, S. A., Hiraldo, F., and Tella, J. L. 2016. Internal seed dispersal by parrots: An overview of neglected mutualism. *PeerJ* 4:e1688.

Brichetti, P., and Fracasso, G. 2006. *Ornitologia Italiana*. Vol. 3: *Stercoraridae–Caprimulgidae*. Bologna, Italy: Oasi Alberto Perdisa Editions.

Çalışkan, O. 2018. Rose-ringed parakeets (*Psittacula krameri*) and geographical evaluation of habitats in Turkey. *International Journal of Geography and Geography Education* 38:279–294.

Cassey, P., Blackburn, T. M., Russel, G. J., Jones, K. E., and Lockwood, J. L. 2004. Influences on the transport and establishment of exotic bird species: An analysis of the parrots (Psittaciformes) of the world. *Global Change Biology* 10:417–426.

Castiglioni, R., Azzola, C., Capelli, F., and Biancardi, C. 2015. Aspetti ecologici e riproduttivi del parrocchetto monaco (*Myiopsitta monachus* Boddaert, 1783) in una colonia in provincia di Bergamo. *XVIII Congresso Italiano di Ornitologia*, 17. Caramanico Terme (Pescara), 17–20 Sept. 2015.

Chapman, T. 2005. *The Status and Impact of the Rainbow Lorikeet (*Trichoglossus haematodus moluccanus*) in South-west Western Australia*. Perth, Western Australia: Dept. of Agriculture and Food.

Clergeau, P., Vergnes, A., Delanoue, R. 2009. La perruche à collier *Psittacula krameri* introduite en Ile-de-France: Distribution et régime alimentaire. *Alauda* 77:121–132.

Covas, L., Senar, J. C., Roquè, L., and Quesada, J. 2017. Records of fatal attacks by rose-ringed parakeets *Psittacula krameri* on native avifauna. *Revista Catalana d'Ornitologia* 33:45–49.

Cramp, S. 1985. *Handbook of the Birds of Europe, the Middle East and North Africa: The Birds of the Western Palearctic*. Vol. 4: *Terns to Woodpeckers*. New York: Oxford Univ. Press.

Crowley, S., Hinchliffe, S., and McDonald, R.A. 2016. Invasive species management will benefit from social impact assessment. *Journal of Applied Ecology* 54:351–357.

Crowley, S. L., Hinchliffe, S., and McDonald, R. A. 2019. The parakeet protectors: Understanding opposition to introduced species management. *Journal of Environmental Management* 229:120–132.

Czajka, C., Braun, M., and Wink, M. 2011. Resource use by non-native ring-necked parakeets (*Psittacula krameri*) and native starlings (*Sturnus vulgaris*) in central Europe. *Open Ornithology Journal* 4:17–22.

Dangoisse, G. 2009. Étude de la population de Conures veuves (*Myiopsitta monachus*) de Bruxelles-Capitale. *Aves* 46:57–69.

Diamond, J. M., and Ross, M. S. 2019. Exotic parrots breeding in urban tree cavities: Nesting requirements, geographic distribution, and potential impacts on cavity nesting birds in southeast Florida. *Avian Research* 10:39.

Di Santo, M., Battisti, C., and Bologna, M. A. 2016. Interspecific interactions in nesting and feeding urban sites among introduced monk parakeet (*Myiopsitta monachus*) and syntopic bird species. *Ethology Ecology & Evolution* 29:138–148.

Drews, C. 2001. Wild animals and other pets kept in Costa Rican households: Incidence, species and numbers. *Society & Animals* 9:107–126.

Dubois, P. J. 2007. Les oiseux allochtones en France: Status et interactions avec les espèces indigènes. *Ornithos* 14:329–364.

Dyer, E. E., Cassey, P., Redding, D. W., Collen, B., Franks, V., Gaston, K., Jones, K. E., Kark, S., Orme, C. D. L., and Blackburn, T. M. 2017. The global distribution and drivers of introduced bird species richness. *PLoS Biology* 15:e2000942.

Falcón, W., and Tremblay, R. L. 2018. From the cage to the wild: Introductions of Psittaciformes to Puerto Rico. *PeerJ* 6:e5669.

Fletcher, M., and Askew, N. 2007. *Review of the Status, Ecology and Likely Future Spread of Parakeets in England*. York, UK: Central Science Laboratory.

Fogell, D. J., Martin, R. O., Bunbury, N., Lawson, B., Sells, J., McKeand, A. M., Tatayah, V., Tien Trung, C., and Groombridge, J. J. 2018. Trade and conservation implications of new beak and feather disease virus detection in native and introduced parrots. *Conservation Biology* 32:1325–1335.

Forshaw, J. M. 2010. *Parrots of the World*. London: Helm Field Guides, Christopher Helm Editions.

Galetti, M. 1993. Diet of the scaly-headed parrot (*Pionus maximiliani*) in a semideciduous forest in southeastern Brazil. *Biotropica* 25 419–425.

Gebhardt, H. 1996. Ecological and economics consequences of introductions of exotic wildlife (birds and mammals) in Germany. *Wildlife Biology* 2:205–211.

Gerlach, H. 1994. Viruses. In *Avian Medicine Principles and Application*, ed. B. W. Ritchie, 862–948. 1st ed. Lake Worth, FL: Wingers Publishing.

Grandi, G., Menchetti, M., and Mori, E. 2018. Vertical segregation by ring-necked parakeets *Psittacula krameri* in northern Italy. *Urban Ecosystems* 21:1011–1017.

Ha, H. J., Anderson, I. L., Alley, M. R., Springett, B. P., and Gartrell, B. D. 2007. The prevalence of beak and feather disease virus infection in wild populations of parrots and cockatoos in New Zealand. *New Zealand Veterinary Journal* 55:235–238.

Haarsma, A. J., and Van der Graaf, C. 2013. Halsbandparkieten een bedreiging voor Rosse vleermuizen. *De Levende Natuur* 114:10–13.

Harris, A. 2015. Predation of Rose-ringed parakeets by raptors and owls in Inner London. *British Birds* 108:349–353.

Hernández-Brito, D., Blanco, G., Tella, J. L., and Carrete, M. 2020. A protective nesting association with native species counteracts biotic resistance for the spread of an invasive parakeet from urban into rural habitats. *Frontiers in Zoology* 17:13.

Hernández-Brito, D., Carrete, M., Ibáñez, C., Juste, J., and Tella, J. L. (2018) Nest-site competition and killing by invasive parakeets cause the decline of a threatened bat population. *Royal Society Open Science* 5:172477.

Hernández-Brito, D., Carrete, M., Popa-Lisseanu, A. G., Ibáñez, C., and Tella, J. L. 2014. Crowding in the city: Losing and winning competitors of an invasive bird. *PLoS One* 9:e100593.

Hernández-Brito, D., Luna, A., Carrete, M., and Tella, J. L. 2015. Introduced rose-ringed parakeets (*Psittacula krameri*) attack black rats (*Rattus rattus*) sometimes resulting in death. *Hystrix, the Italian Journal of Mammalogy* 25:121–123.

Hobson, E. A., Smith-Vidaurre, G., and Salinas-Melgoza, A. 2017. History of nonnative monk parakeets in Mexico. *PLoS One* 12:e0184771.

Howe, H. F., 1977. Bird activity and seed dispersal of a tropical wet forest tree. *Ecology* 58:539–550.

iNaturalist Alien Parrots Observatory. 2019. Accessed Dec. 2019. https://www.inaturalist.org/projects/alien-parrots-observatory.

Ivanova, I. M., and Symes, C. T. 2019. Invasion of *Psittacula krameri* in Gauteng, South Africa: Are other birds impacted? *Biodiversity and Conservation* 28:3633–3656.

Jackson, H., Jones, C. G., Agapow, P. M., Tatayah, V., and Groombridge, J. J. 2015 Micro-evolutionary diversification among Indian Ocean parrots: Temporal and spatial changes in phylogenetic diversity as a consequence of extinction and invasion. *Ibis* 157:496–510.

Kalodimos, N. P. 2013. First account of a nesting population of monk parakeets, *Myiopsitta monachus*, with nodule-shaped bill lesions in Katehaki, Athens, Greece. *Bird Populations* 12:1–6.

Keijl, G. O. 2001. Halsbandparkieten *Psittacula krameri* in Amsterdam, 1976–2000. *Limosa* 74:29–31.

Kelly, D. W., Paterson, R. A., Townsend, C. R., Poulin, R., and Tompkins, D. M. 2009. Parasite spillback: A neglected concept in invasion ecology? *Ecology* 90:2047–2056.

Krause, T. 2004. F1-und F2-Hybriden zwischen Alexandersittich *Psittacula eupatria* und Halsbandsittich *P. krameri* im Volksgarten in Dusseldorf. *Charadrius* 40:7–12.

Kumschick, S., and Nentwig, W. 2010. Some introduced birds have as severe an impact as the most effectual introduced mammals in Europe. *Biological Conservation* 143:2757–2762.

Lamont, D. A. 1996. The changing status of the rainbow lorikeet, *Trichoglossus haematodus* (Linnaeus 1771), in southwestern Australia: Its potential for range extension. MS thesis, Univ. of New England, Armadale, Australia.

Le Louarn, M., Clergeau, P., Briche, E., and Deschamps-Cottin, M. 2017. "Kill two birds with one stone": Urban tree species classification using bi-temporal pléiades images to study nesting preferences of an invasive bird. *Remote Sensing* 9:916.

Le Louarn, M., Clergeau, P., Strubbe, D., and Deschamps-Cottin, M. 2018. Dynamic species distribution models reveal spatiotemporal habitat shifts in native range-expanding versus non-native invasive birds in an urban area. *Journal of Avian Biology* 49:jav-01527.

Le Louarn, M., Couillens, B., Deschamps-Cottin, M., and Clergeau, P. 2016. Interference competition between an invasive parakeet and native bird species at feeding sites. *Journal of Ethology* 34:291–298.

Lever, C. 1994. *Naturalized Animals: The Ecology of Successfully Introduced Species*. London: Poyser Natural History.

Lever, C. 2005. *Naturalised Birds of the World*. London: T. & A. D. Poyser.

MacGregor-Fors, I., Calderón-Parra, R., Meléndez-Herrada, A., López-López, S., and Schondube, J. E. 2011. Pretty, but dangerous! Records of non-native monk parakeets (*Myiopsitta monachus*) in Mexico. *Revista Mexicana de Biodiversidad* 82:1053–1056.

Mack, R. N., Simberloff, D., Lonsdale, W. M., Evans, H., Clout, M., and Bazzaz, F. A. 2000. Biotic invasions: Causes, epidemiology, global consequences, and control. *Ecological Appications* 10:689–710.

Martens, J., Hoppe, D., and Woog, F. 2013. Diet and feeding behaviour of naturalised Amazon parrots in a European city. *Ardea* 101:71–76.

Mazza, G., Tricarico, E., Genovesi, P., and Gherardi, F. 2014. Biological invaders are threats to human health: An overview. *Ethology Ecology & Evolution* 26:112–129.

McInnes, C. J., Coulter, L., Dagleish, M., Deane, D., Gilray, J., Percival, A., Willoughby, K., Scantlebury, M., Marks, N., Graham, D., et al. 2013. The emergence of squirrel pox in Ireland. *Animal Conservation* 16:51–59.

Menchetti, M., and Mori, E. 2014. Worldwide impact of introduced parrots (Aves Psittaciformes) on native biodiversity and environment: A review. *Ethology Ecology & Evolution* 26:172–194.

Menchetti, M., Mori, E., and Angelici, F. M. 2016. Effects of the recent world invasion by ring-necked parakeets *Psittacula krameri*. In *Problematic Wildlife: A Cross-Disciplinary Approach*, ed. F. M. Angelici, 253–266. Switzerland and New York: Springer International Publishing.

Menchetti, M., Scalera, R., and Mori, E. 2014. First record of a possibly overlooked impact by introduced parrots on a bat (*Nyctalus leisleri*). *Hystrix, the Italian Journal of Mammalogy* 25:61–62.

Mentil, L., Battisti, L., and 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.

Moltoni, E. 1945. Pappagalli in libertà nei giardini pubblici di Milano e loro nidificazione in colonia in associazione con il passero. *Rivista Italiana di Ornitologia* 15:98–106.

Mori, E., Ancillotto, L., Groombridge, J., Howard, T., Smith, V. S., and Menchetti, M. 2015. Macroparasites of introduced parakeets in Italy: A possible role for parasite-mediated competition. *Parasitology Research* 114:3277–3281.

Mori, E., Ancillotto, L., Menchetti, M., Romeo, C., and Ferrari, N. 2013a. Italian red squirrels and introduced parakeets: Victims or perpetrators? *Hystrix, the Italian Journal of Mammalogy* 24:195–196.

Mori, E., Ancillotto, L., Menchetti, M., and Strubbe, D. 2017a. "The early bird catches the nest": Possible competition between scops owls and ring-necked parakeets. *Animal Conservation* 20:463–470.

Mori, E., Cardador, L., Reino, L., White, R. L., Hernández-Brito, D., Le Louarn, M., Mentil, L., Edelaar, P., Pârâu, L.G., Nikolov, B. P, and Menchetti, M. 2020a. Lovebirds in the air: Trade patterns, establishment success and niche shift of *Agapornis* parrots within their non-native range. *Biological Invasions* 22:421–435.

Mori, E., Di Febbraro, M., Foresta, M., Melis, P., Romanazzi, E., Notari, A., and Boggiano, F. 2013b. Assessment of the current distribution of free-living parrots and parakeets (Aves: Psittaciformes) in Italy: A synthesis of published data and new records. *Italian Journal of Zoology* 80:158–167.

Mori, E., Grandi, G., Menchetti, M., Tella, J. L., Jackson, H. A., Reino, L., van Kleunen, A., Figueira, R., and Ancillotto, L. 2017b. Worldwide distribution of non-native Amazon parrots and temporal trends of their global trade. *Animal Biodiversity and Conservation* 40:49–62.

Mori, E., Malfatti, L., Le Louarn, M., Hernández-Brito, D., ten Cate, B., Ricci, M., and Menchetti, M. 2020b. "Some like it alien": Predation on invasive ring-necked parakeets by the long-eared owl in an urban area. *Animal Biodiversity and Conservation* 43:151–158.

Mori, E., Meini, S., Strubbe, D., Ancillotto, L., Sposimo, P., and Menchetti, M. 2018. Do introduced free-ranging birds affect human health? A global summary of known zoonoses. In *Invasive Species and Human Health*, ed. G. Mazza and E. Tricarico, 120–129. New York: CABI International Edition.

Mori, E., Monaco, A., Sposimo, P., and Genovesi, P. 2014. Low establishment success of introduced non-passerine birds in a central Italy wetland. *Italian Journal of Zoology* 81:593–598.

Mori, E., Onorati, G., and Giuntini, S. 2020c. Loud callings limit human tolerance towards invasive parakeets in urban areas. *Urban Ecosystems* 23:755–760.

Mori, E., Sala, J. P., Fattorini, N., Menchetti, M., Montalvo, T., and Senar, J. C. 2019. Ectoparasite sharing among native and invasive birds in a metropolitan area. *Parasitology Research* 118:399–409.

Morinha, F., Carrete, M., Tella, J. L., and Blanco, G. 2020. High prevalence of novel beak and feather disease virus in sympatric invasive parakeets introduced to Spain from Asia and South America. *Diversity* 12:192.

Nelson, C. B., Pomeroy, B. S., Schrall, K., Park, W. E., and Lindeman, R. J. 1952. An outbreak of conjunctivitis due to Newcastle disease virus (NDV) occurring in poultry workers. *American Journal of Public Health and the Nation Health* 42:672–678.

Nentwig, W., Bacher, S., Kumschick, S., Pyšek, P., and Vilà, M. 2018. More than "100 worst" introduced species in Europe. *Biological Invasions* 20:1611–1621.

Neo, M. L. 2012. A review of three introduced parrots in Singapore. *Nature in Singapore* 5:241–248.

Newson, S. E., Johnston, A., Parrott, D., and Leech, D. I. 2011. Evaluating the population-level impact of an invasive species, ring-necked parakeet *Psittacula krameri*, on native avifauna. *Ibis* 153:509–516.

Norconk, M. A., Grafton, B. W., Conklin-Brittain, N. L. 1998. Seed dispersal by neotropical seed predators. *American Journal of Primatology* 45:103–126.

Orchan, Y., Chiron, F., Shwarts, A., and Kark, S. 2012. The complex interaction among multiple invasive bird species in a cavity-nesting community. *Biological Invasions* 15:429–445.

Pârâu, L. G., Strubbe, D., Mori, E., Menchetti, M., Ancillotto, L., van Kleunen, A., White, R. L., Hernández-Brito, D., Le Louarn, M., Clergeau, P., et al. 2016. Rose-ringed parakeet *Psittacula krameri* populations and numbers in Europe: A complete overview. *Open Ornithology Journal* 9:1–13.

Peck, H. L., Pringle, H. E., Marshall, H. H., Owens, I.P.F., and Lord, A. M. 2014. Experimental evidence of impacts of an invasive parakeet on foraging behavior of native birds. *Behavioral Ecology* 25:582–590.

Peh, K.S.H. 2010. Invasive species in Southeast Asia: The knowledge so far. *Biodiversity and Conservation* 19:1083–1099.

Per, E. 2018. The spread of the rose-ringed parakeet, *Psittacula krameri*, in Turkey between 1975 and 2015 (Aves: Psittacidae). *Zoology in the Middle East* 64:297–303.

Pisanu, B., Laroucau, K., Aaziz, R., Vorimore, F., Le Gros, A., Chapuis, J. L., and Clergeau, P. 2018. *Chlamidya avium* detection from a ring-necked parakeet (*Psittacula krameri*) in France. *Journal of Exotic Pet Medicine* 27:68–74.

Pithon, J. A., and Dytham, C. 1999. Breeding performance of Ring-necked parakeets *Psittacula krameri* in small introduced populations in southeast England. *Bird Study* 46:342–347.

Popa-Lisseanu, A. G., Bontadina, F., Mora, O., and Ibáñez, C. 2008. Highly structured fission–fusion societies in an aerial hawking, carnivorous bat. *Animal Behaviour* 75:471–482.

Postigo, J. L. 2016. New records of invasive parakeet hybrids in Spain: A great opportunity to apply the rapid response mechanism. *European Journal of Ecology* 2:19–22.

Postigo, J. L., Strubbe, D., Mori, E., Ancillotto, L., Carneiro, I., Latsoudis, P., Menchetti, M., Pârâu, L. G., Parrott, D., Reino, L., Weiserbs, A., and Senar, J. C. 2019. Mediterranean versus Atlantic monk parakeets *Myiopsitta monachus*: Towards differentiated management at the European scale. *Pest Management Science* 75:915–922.

Price, P. W., Westoby, M., Rice, B., Atsatt, P. R., Fritz, R. S., Thompson, J. N., and Mobley, K. 1986. Parasite mediation in ecological interactions. *Annual Review of Ecology and Systematics* 17:487–505.

Reed, J. E., McCleery, R. A., Silvy, N. J., Smeins, F. E., and Brightsmith, D. J. 2014. Monk parakeet nest site selection of electric utility structures in Texas. *Landscape and Urban Planning* 129:65–72.

Rehman, Q.S.U., Ali, K. W., Ali, W.S.M., Waqar, M., Muhammad, N., Abdul, S., and Ullah, K. A. 2019. Damage impact of vertebrate pests on different crops and stored food items. *GSC Biological and Pharmaceutical Sciences* 6:16–20.

Roll, U., Dayan, T., and Simberloff, D. 2008. Non-indigenous terrestrial vertebrates in Israel and adjacent areas. *Biological Invasions* 10:659–672.

Romeo, C., Wauters, L. A., Ferrari, N., Lanfranchi, P., Martinoli, A., Pisanu, B., Preatoni, D. G., and Saino, N. 2014. Macroparasite fauna of introduced grey squirrels (*Sciurus carolinensis*): Composition, variability and implications for native species. *PLoS One* 9:e88002.

Runde, D. E., Pitt, W. C., and Foster, J. 2007. Population ecology and some potential impacts of emerging populations of exotic parrots. In *Managing Vertebrate Invasive Species: Proceedings of an International Symposium*, ed. G. W. Witmer, W. C. Pitt, and K. A. Fagerstone, 338–360. Fort Collins, CO: USDA/APHIS Wildlife Services, National Wildlife Research Center.

Sa, R.C.C., Cunningham, A. A., Dagleish, M. P., Wheelhouse, N., Pocknell, A., Borel, N., Peck, H., and Lawson, B. 2014. Psittacine beak and feather disease in a free-living ring-necked parakeet (*Psittacula krameri*) in Great Britain. *European Journal of Wildlife Research* 60:395–398.

Şahin, D., and Arslangündoğdu, Z. 2019. Breeding status and nest characteristics of rose-ringed (*Psittacula krameri*) and Alexandrine parakeets (*Psittacula eupatria*) in Istanbul's city parks. *Applied Ecology and Environmental Research* 17:2461–2471.

Scortecci, G. 1953. Monaco (*Myiopsitta monachus*). In *Animali: Come sono, dove vivono, come vivono*. Milan: Labor Editors.

Senar, J. C., Domènech, J., Arroyo, L., Torre, I., and Gordo, O. 2016. An evaluation of monk parakeet damage to crops in the metropolitan area of Barcelona. *Animal Biodiversity and Conservation* 39:141–145.

Shiels, A. B., Bukoski, W. P., and Siers, S. R. 2018. Diets of Kauai's invasive rose-ringed parakeet (*Psittacula krameri*): Evidence of seed predation and dispersal in a human-altered landscape. *Biological Invasions* 20:1449–1457.

Shwartz, A., Strubbe, D., Butler, C. J., Matthysen, E., and Kark, S. 2008. The effect of enemy-release and climate conditions on invasive birds: A regional test using the ring-necked parakeet (*Psittacula krameri*) as a case study. *Diversity and Distributions* 15:310–318.

Strubbe, D., Matthysen, E., and Graham, C. H. 2010. Assessing the potential impact of invasive ring-necked parakeets *Psittacula krameri* on native nuthatches *Sitta europeae* in Belgium. *Journal of Applied Ecology* 47:549–557.

Styche, A. 2008. Distribution and behavioural ecology of the sulphur-crested cockatoo (*Cacatua galerita* L.) in New Zealand. MS diss., Victoria Univ. of Wellington, New Zealand.

Tatayah, R.V.V., Malham, J., and Haverson, P. 2007. The use of copper strips to exclude invasive African giant land-snails *Achatina* spp. from echo parakeet *Psittacula eques* nest cavities, Black River Gorges National Park, Mauritius. *Conservation Evidence* 4:6–8.

Tella, J. L., Baños-Villalba, A., Hernández-Brito, D., Rojas, A., Pacífico, E., Díaz-Luque, J. A., Carrete, M., Blanco, G., and Hiraldo, F. 2015. Parrots as overlooked seed dispersers. *Frontiers in Ecology and the Environment* 13:338–339.

Tella, J. L., Hiraldo, F., Donazar, J. A., and Negro, J. J. 1996. Costs and benefits of urban nesting in the Lesser Kestrel. In *Raptors in Human Landscapes: Adaptations to Built and Cultivated Environments*, ed. D. Bird, D. Varland, J. J. Negro, 53–60. London: Academic Press.

Turbé, A., Strubbe, D., Mori, E., Carrete, M., Chiron, F., Clergeau, P., Gonzalez-Moreno, P., Le Louarn, M., Luna, A., Menchetti, et al. 2017. Assessing the assessments: Evaluation of four impact assessment protocols for invasive introduced species. *Diversity and Distributions* 23:297–307.

Vall-llosera, M., Woolnough, A. P., Anderson, D., and Cassey, P. 2016. Improved surveillance for early detection of a potential invasive species: The introduced ring-necked parakeet *Psittacula krameri* in Australia. *Biological Invasion* 19:1273–1284.

Weiserbs, A., and Jacob, J. P. 1999. Etude de la population de perriche jeune-veuve *Myiopsitta monachus* à Bruxelles. *Aves* 36:207–223.

White, R., Strubbe, D., Dallimer, M., Davies, Z. G., Davis, A.J.S., Edelaar, P., Groombridge, J., Jackson, H. A., Menchetti, M., Mori, E., et al. 2019. Assessing the ecological and societal impacts of alien parrots in Europe using a transparent and inclusive evidence-mapping scheme. Neobiota 48:45-69.

Yosef, R., Zduniak, P., and Żmihorski, M. 2016. Invasive ring-necked parakeet negatively affects indigenous Eurasian hoopoe. *Annales Zoologici Fennici* 53:281–287.

Zocchi, A., Battisti, C., and Santoro, R. 2009. Note sul pappagallo monaco, *Myiopsitta monachus*, a Roma (Villa Pamphili). *Rivista Italiana di Ornitologia* 78:135–137.