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Short Communication

Nest Usurpation between Mandarin Duck *Aix galericulata* and Coexisting Bird Species in Nest Boxes in a Secondary Forest, Zuojia Nature Reserve, China

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YG and HW conceived and designed the study, collected the data and wrote the article. NB helped in data organization and in writing of the manuscript.

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ABSTRACT

While using artificial nest boxes to protect Mandarin duck *Aix galericulata* in a secondary forest in Northeast China, we found mixed clutches that contained eggs of Mandarin duck and other species over 11 breeding seasons (2004 - 2014). We monitored the frequency of occurrence and the fate of eggs in those nests and recorded fourteen cases of mixed clutches that contained Mandarin duck eggs. Nine cases were classified as successful nest usurpation: in six cases nests of other birds were usurped by Mandarin duck and in three cases nests of Mandarin duck were usurped by other birds. The remaining mixed clutches may be incomplete usurpation. For the nests taken over by Mandarin ducks, all heterospecific eggs were rejected and four clutches were incubated successfully. For the other mixed clutches, none of Mandarin duck eggs were removed, only two eggs were hatched but the ducklings did not survive. Nest usurpation may interfere with normal breeding activities and lead to a reduced breeding success in Mandarin duck and other coexisting bird species, which should be taken into account when providing nest boxes to protect the local population.

Limited cavities may result in interference competition among cavity-nesting birds (Newton 1994). Nest boxes are sometimes provided to alleviate nest-site limitation, especially where cavity-forming trees are lacking (Lõhmus, 2003; Arlettaz *et al*., 2010; Meyrom *et al*., 2011). This may lead to an increase in the reproduction densities of some coexisting cavity-nesting species through supplying with more nest sites (Higuchi, 1978; Savard, 1988; Beissinger and Bucher, 1992) and/or providing well-designed artificial nesting sites preferred by different bird species, not necessarily only the cavity breeding (Petty, 1992). When the birds overlap in similar nest site preferences, interspecific nest competition and usurpation (Favaloro, 1942) are likely to occur (*e.g.,* Heinsohn *et al*., 2003; Frye and Rogers, 2004), which may have negative impacts on breeding performance of the victim (Pribil and Picman, 1991; Ingold, 1998).

Mandarin duck *Aix galericulata* is a secondary cavity-breeding waterfowl that is attracted by nest boxes (Deng *et al*., 2011). The native population of Mandarin duck has greatly declined (Kear, 2005), globally however Mandarin duck is classified as least concern (IUCN 2016). When using artificial nest boxes to protect Mandarin ducks in a secondary forest at the Zuojia Nature Reserve in northeast China, we found mixed clutches with eggs of Mandarin ducks and other birds, which may have been caused by nest usurpation or accidental laying (Fournier, 2000). Nest usurpation is relatively common among birds (Lindell, 1996), however observations of mixed clutches between cavity-nesting waterfowl and other unrelated species are sporadic (*e.g.,* Artuso, 2007). We hereby report the frequency of nest usurpation and the fate of eggs of Mandarin duck in mixed clutches.

Methods

We monitored nest usurpation by collecting data on mixed clutches laid by both Mandarin ducks and other birds during 11 breeding seasons (2004-2014) at Zuojia Nature Reserve. The reserve runs from the eastern Chang Bai Mountains to the western plain (126°1′-127°2′N, 44°6′-45°5′E). For each breeding season from 2004 onward, 52-103 nest boxes were installed in the reserve with the

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objective of conserving the population of Mandarin duck. We initially monitored nest boxes every 5-7 days to identify the ones that were occupied, as evidenced by the presence of at least one egg. Active nest boxes were then checked daily to monitor progress. For mixed clutches that contained eggs of Mandarin duck, laying order of eggs of interspecific individuals was recorded. Cases that a female laid in the active clutch of other interspecific bird and eventually incubated the nest were classified as successful nest usurpation. In this study, nests without mixed clutch were defined as not being usurped. During nest visits to mixed clutches, we recorded the number of eggs laid by different species and the hatching success.

Results

A total of 126 nest boxes containing Mandarin duck eggs were monitored in this study. Among them, 14 nests contained both Mandarin duck and heterospecific eggs of six other bird species (Table I). Nine cases of mixed clutches were classified as successful usurpation: six cases were determined as usurpation by Mandarin ducks at nests of other birds; three cases were determined as usurpation by other birds at nests of Mandarin ducks. Four cases of successful usurpation by Mandarin duck occurred in boxes where Mandarin ducks had nested in the previous year. Mandarin ducks that laid eggs in five nests of other bird species did not incubate them, however the intention or the objective of this laying could not be determined.

During the study period, 52.9% (396 out of 749) of nest boxes remained unoccupied and available to be used. For each coexisting species that also used the nest boxes, the number of mixed clutches that contained Mandarin duck eggs ranged from one to fourteen; the number of successful nest usurpation of different species within those mixed clutches ranged from one to nine (Fig. 1).

In the six nests successfully taken over by Mandarin ducks, all heterospecific eggs were removed: four out of six clutches were incubated successfully. As for the eight other mixed clutches, none of Mandarin duck eggs were removed but they did not hatch in seven out of eight clutches. Two Mandarin duck eggs hatched successfully in a common kestrel (*Falco tinnunculus*) nest, and fledged without parental care.

In two cases of classified successful nest usurpation, the previous nest owners (oriental scops owl *Otus sunia* and collared scops owl *Otus bakkamoena*) had been seen perching among branches near their nests during the first few days since the first duck eggs were laid. In the nest that contained one Mandarin duck egg and three Ural owl S*trix uralensis* eggs, Mandarin duck was found to chase the owl away from nest site before the egg was laid but the nest was eventually incubated by the Ural owl.

Table I.- Fate of eggs in nests containing both Mandarin duck and heterospecific eggs during the 2004–2014 breeding seasons in Zuojia Natural Reserve, northeastern China.

Species	Year	Number of eggs within nest		Incubated by	Fates of egg[1]	
		Mandarin duck	Others[2]		Mandarin duck	Others[2]
Dollar bird (*Eurystomus orientalis*)	2004	2*	4	Dollar bird	Unhatched	Hatched
	2012	2*	4	Dollar bird	Unhatched	Hatched
	2013[S]	3	4*	Dollar bird	Unhatched	Hatched
	2013[S]	7	4*	Dollar bird	Unhatched	Hatched
	2014[S]	15	2*	Dollar bird	Unhatched	Deserted
Common kestrel (*Falco tinnunculus*)	2007[S]	9*	1	Mandarin duck	Hatched	Rejected
	2008	2*	6	Common Kestrel	Hatched	Hatched
Collared scops owl (*Otus lettia*)	2007[S]	11*	4	Mandarin duck	Hatched	Rejected
	2008[S]	23*	1	Mandarin duck	Deserted	Rejected
Oriental scops owl (*Otus sunia*)	2009[S]	16*	2	Mandarin duck	Hatched	Rejected
Ural owl (*Strix uralensis*)	2009[S]	21*	1	Mandarin duck	Unhatched	Unhatched
	2011	1*	3	Ural owl	Unhatched	Hatched
Eurasian jay (*Garrulus glandarius*)	2012	2*	8	Eurasian Jay	Unhatched	Hatched
	2012[S]	13*	1	Mandarin duck	Unhatched	Rejected

[1]Unhatched: eggs did not hatch successfully; hatched: eggs hatched successfully; rejected: eggs were rejected from nests; Deserted: nest was abandoned during incubation period. [2] Other species: Dollar bird, Common Kestrel, Collared scops owl, Oriental scops owl, Ural owl and Eurasian Jay, respectively.* Cases where eggs laid in the clutch of another species. [S] Cases classified as successful usurpation.

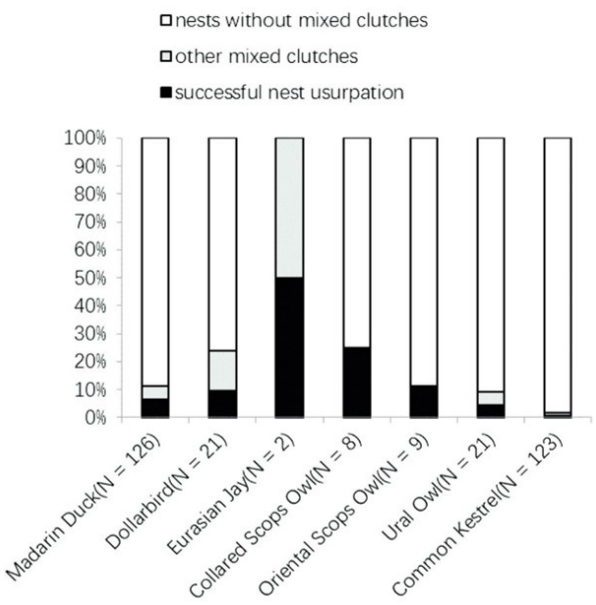

Fig. 1. Frequency of nests with successful usurpation, other mixed clutches and nests without mixed clutches in different bird species nesting in the net box.

Discussion

Mixed clutches of waterfowl and other birds have occasionally been found in nest boxes. For example, Dawson and Bortolotti (1997) reported an American kestrel *Falco sparverius* incubating a bufflehead *Bucephala albeola* egg and four kestrel eggs (the bufflehead and two kestrel chicks fledged); Manlove (1998) found an Eastern screech-owl *Megascops asio* apparently evicting a nesting wood duck or Carolina duck *Aix sponsa*), laying on top of the covered duck eggs, and subsequently hatching at least one owlet and one duckling. However, cases that waterfowl incubated mixed clutch are less documented. Overlap in nest use occurred between Mandarin ducks and six species of birds (Table I), with six cases of Mandarin duck taking over the interspecific nests, and three cases of the Mandarin duck nests successfully usurped by other species.

Laying eggs by female birds in the nests of birds of other bird species is termed as brood parasitism (Lyon and Eadie, 2008; Yang *et al*., 2010, 2016a; Wang *et al*., 2013; Nahid *et al*., 2016). Unlike brood parasites that lay eggs in other birds' nests but provide no parental care, nest usurpers incubate their eggs in the nests of other birds (Lindell, 1996). Successfully usurped nests were incubated by the usurpers, hence this cannot be termed as brood parasitism. However, we found five cases of Mandarin ducks that laid in the nests of other species of birds but did not incubate the mixed clutches. Brood parasites, like Mandarin ducks, commonly make "mistakes" by laying eggs in nests of unsuitable hosts (Kattan, 1997; Yang *et al*., 2016b), thus there is a possibility that the five mixed clutches in our study were caused by accidental laying, where Mandarin ducks failed to recognize that the nests they laid in were not of conspecifics. However, in the study of eiders (genus *Somateria*), the females were observed to usurp the nests of gulls (Laridae family) but sometimes did not continue their occupation of the gull's nest, which may be considered as incomplete nest usurpation (Perry, 1982). This is in line with our study.

Nest usurpation is probably costly for the previous nest owners, because: i) they may have to invest additional energy and time to search for an alternative nest or have to delay reproduction until the nest is vacant again (Heinsohn *et al*., 2003); ii) they may incur a cost of injury while getting involved with aggressive intruders (Michener and McLean, 1996); iii) there could be reduction in reproductive output for individuals who lost their nests (Prokop, 2004); iv) even when intruder did not successfully take over a nest, interspecific interference (*i.e.,* host's incubating behavior is disturbed by intruders for their perching on the nest or at its entrance, peering inside or entering the nest) could also have severe effect on the breeding success of the victim (Eguchi *et al*., 2013).

Actively taking over a nest of another species suggests that value of the resource is high enough and deserves to risk costs (Lindell, 1996). In our study, the number of available nest sites was not likely to limit the reproduction of cavity-nesting birds, as more than half of the nest boxes remained unoccupied. Semel and Sherman (2001) reported that returning female wood ducks usually laid again in the previous year's box, even if another female was already laying there. Similarly, during 2012-2014, two out of 20 banded female Mandarin ducks were found returning to breed in the same nest boxes (unpublished data). This suggests that Mandarin ducks may usurp occupied boxes in which they had nested previously. Four cases of nest usurpation occurred in boxes in which Mandarin ducks had nested during the previous year; however, we could not determine whether the ducks were the same females as these were not banded. Certain desirable quality of a nest site may be preferred by forest birds (e.g. Menaa *et al*., 2016) and therefore affect interspecific nest competition (Dawson and Bortolotti, 1997). We found that 80.2% (101 out of 126) Mandarin duck nests contained old nest materials of Eurasian red squirrel *Sciurus vulgaris*, and 92.9% (13 out of 14) nests involved in mixed clutches contained material, which suggested that nests containing squirrel nest material might be preferred to others.

Our observations of nest usurpation suggest that there existed interspecific competition for nest sites

between Mandarin duck and six bird species. However, the cognitive mechanisms underlying interspecific nest usurpation, such as the assessment cues and decision rules potential usurpers use, remain unclear and should be further investigated to enhance understanding on nest site supplement for Mandarin duck, as well as other coexisting bird species.

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Statement of conflict of interest

Authors have declared no conflict of interest.

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