Species name	RA	Doc	Status
Golden-crested Myna *Ampeliceps coronatus*	R	P	
Hill Myna *Gracula religiosa*	R	S	
Velvet-fronted Nuthatch *Sitta frontalis*	U	P	
Black-crested Bulbul *Pycnonotus melanicterus*	F	C	
Stripe-throated Bulbul *Pycnonotus finlaysoni*	F	C, P	
Yellow-vented Bulbul *Pycnonotus goiavier*	R	S	
Streak-eared Bulbul *Pycnonotus blanfordi*	U	P	
Ochraceous Bulbul *Alophoixus ochraceus*	F	C, P	
Grey-eyed Bulbul *Iole propinqua*	F	C, P	
Rufescent Prinia *Prinia rufescens*	U	V	
Common Tailorbird *Orthotomus sutorius*	F	V	
Dark-necked Tailorbird *Orthotomus atrogularis*	U	V	
Radde's Warbler *Phylloscopus schwarzi*	X	S	m
Greenish Warbler *Phylloscopus trochiloides*	F	C	m
White-crested Laughingthrush *Garrulax leucolophus*	F	C, P	
Lesser Necklaced Laughingthrush *Garrulax monileger*	U	S	
Abbott's Babbler *Malacocincla abbotti*	F	C, P	
Buff-breasted Babbler *Pellorneum tickelli*	F	C	
Puff-throated Babbler *Pellorneum ruficeps*	F	C	
Scaly-crowned Babbler *Malacopteron cinereum*	F	C, P	
Large Scimitar Babbler *Pomatorhinus hypoleucos*	U	P	
Striped Tit Babbler *Macronous gularis*	F	C	
Grey-faced Tit Babbler *Macronous kelleyi*	F	C, P	
Black-browed Fulvetta *Alcippe grotei*	F	C, P	
White-bellied Erpornis *Erpornis zantholeuca*	F	C	
Yellow-vented Flowerpecker *Dicaeum chrysorrheum*	X	S	
Scarlet-backed Flowerpecker *Dicaeum cruentatum*	U	S	
Ruby-cheeked Sunbird *Anthreptes singalensis*	U	C, P	
Purple-naped Sunbird *Hypogramma hypogrammicum*	F	C, P	
Purple-throated Sunbird *Nectarinia sperata*	F	V	
Olive-backed Sunbird *Nectarinia jugularis*	F	V	
Crimson Sunbird *Aethopyga siparaja*	F	P	
Little Spiderhunter *Arachnothera longirostra*	F	C, P	
Richard's Pipit *Anthus richardi*	X	P	

Predation by leopards of Black-necked Cranes *Grus nigricollis* in Bhutan

TSHERING CHOKI, JIGME TSHERING, TSHEWANG NORBU, UTE STENKEWITZ & JAN F. KAMLER

Introduction

The Black-necked Crane *Grus nigricollis* is classified as Vulnerable by IUCN, owing to its single small and declining population (BirdLife International 2009). Population declines are thought to be due to loss of wetland habitat and agricultural changes in both its breeding and wintering grounds (BirdLife International 2009). Breeding grounds occur mainly in the Qinqhai–Tibetan plateau, China, with small populations in adjacent areas. Wintering grounds primarily include southern Tibet and the Yunnan–Guizhou plateau in China, and Bhutan (BirdLife International 2009).

Owing to the high elevation, remoteness and low human population in most of its range, little is known about the ecology of the Black-necked Crane. Although interest and research has increased recently on the species (Lhendup & Webb 2009, Liu *et al*. 2010), virtually nothing is known about its natural predators, especially for adult birds. In Ladakh, India, free-ranging dogs *Canis familiaris* and Common Ravens *Corvus corax* were identified as major predators of eggs and chicks (BirdLife International 2001). Although no predators of Black-necked Cranes have been identified in China, potential predators were thought to be raptors, Common Ravens, domestic dogs, foxes *Vulpes*, Eurasian lynx *Lynx lynx*, wolves *Canis lupus* and bears *Ursus* (Dwyer *et al*. 1992). In Bhutan, natural predators were thought to be jackals *Canis aureus* and red foxes *Vulpes vulpes*, although this was never confirmed (Dorji 1987).

In other crane species, predation on eggs and chicks by a variety of mammal species is commonly reported (Desroberts 1997, Ivey & Scheuering 1997, Bergeson *et al*. 2001), although predation on adult cranes is rarely reported. However, for the Critically Endangered Whooping Crane *Grus americana* predation on juveniles and adults was so severe in some populations that it significantly inhibited recovery efforts (Nesbitt *et al*. 2001). Therefore, identification of predators of adult Black-necked Cranes is important: not only to gain better insights into their ecology, but also to assist conservation efforts that aim to increase long-term populations. In Phobjikha Valley, Bhutan, predation on adult cranes was reported as far back as the 1980s (BirdLife International 2001), although predation seemed to increase in recent years. From 2007 to 2010, ≥5 cranes per winter were killed by mammalian predators, although their identity was not established. Based on previous literature, we thought domestic dogs would be the most likely predator, although several local villagers we interviewed suggested that leopards *Panthera pardus* killed cranes. Our goal was to decrease predation events, but we first needed to identify the predatory species in order to implement preventative measures. Here we provide data that confirmed leopards kill adult Black-necked Cranes in Bhutan, and discuss the implications of this for crane conservation.

Methods

The Phobjikha Valley is located in west-central Bhutan (27°23–30'N 90°10–14'E). Altitude ranges from 2,800 m a.s.l. on the valley floor to 4,000 m on the surrounding mountaintops. Vegetation on the valley floor consists of pastureland dominated by dwarf bamboo *Yushania microphylla*, whereas the surrounding mountains consist of coniferous forests dominated by blue pine *Pinus wallichiana*. The valley contains the largest population (c.300) of wintering Black-necked Cranes in Bhutan, with a large part of the area protected in the Phobjikha Conservation Area (163 km^2). Our research focused in the northern part of the valley floor, which contained a large roosting site of c.100 cranes during the study. The distance from the edge of the roost to the closest forest edge was 100 m.

The Black-necked Cranes were monitored regularly by staff of the Royal Society for Protection of Nature, which manages the conservation area. Cranes were observed using spotting scopes several times per week before they left the roost in the morning. If feathers or carcasses were observed after cranes have left the roost, researchers walked out to the roost to collect remains and record evidence. All dead cranes appeared to have been killed by a

mammalian predator because they had puncture wounds, broken bones, and were almost completely consumed. However, predators could not be identified because prints could not be discerned on the thick mat of dwarf bamboo. Therefore, to determine the predator responsible for killing cranes, six Cuddeback camera traps (Cuddeback Digital, De Pere, WI, USA) were set up in random spots around the roost during the winter of 2008–2009. During the winter of 2009–2010 nine camera traps were used and placed in strategic spots, such as game trails and depressions leading from the nearby forest to the roost.

Results

The minimum numbers of cranes killed in the roost were nine in the winter of 2007–2008, five in 2008–2009 and seven in 2009–2010. Both adult and yearling (<1 yr) cranes were predated, although the age of most cranes killed was unknown due to the nearly complete consumption of carcasses. During the winter of 2008–2009 no predators were photographed by the camera traps, but during the winter of 2009–2010, four photographs of leopards were taken by camera traps. From 4–10 January 2010 one camera trap photographed a leopard heading towards the roost from the nearby forest. On 12 January 2010, another camera trap photographed a leopard dragging a dead crane away from the roost and towards the forest (Plate 1). We could not determine if the photographs were of the same leopard. During the period of these two photographs, remains of at least three cranes were found near the roost closest to where the leopards were photographed. On 9 February 2010 a different leopard (based on pattern of spots) was photographed dragging a dead crane from the roost (Plate 2). On 4 March 2010, another photograph was taken of a leopard dragging a crane away from the roost, although we could not determine if this was one of the leopards from the previous photographs. Interestingly, no remains of other cranes were found near the roost during the period of the last two photographs. Additionally, no remains were found of the three cranes that were dragged away by the leopards, indicating carcasses were probably carried >100 m into the nearby forest before being consumed.

Discussion

Our results showed that leopards can be predators of cranes, and provide the first confirmation of any predator of adult Black-necked Cranes. Previous authors speculated on potential predators of the species, although the leopard was never suggested (Dorji 1987, BirdLife International 2001). However, our results supported claims by several local villagers who stated that leopards killed cranes at night in Phobjikha Valley. Leopards in Africa have been known to prey on medium- to large-sized birds, including Helmeted Guineafowl *Numida meleagris*, korhaans *Eupodotis* and Common Ostrich *Struthio camelus* (Hayward *et al*. 2006); thus it is not too unusual that leopards preyed on cranes in our study.

Among other crane species, Golden Eagles *Aquila chrysaetos* have been reported to prey on adults in flight (Thiollay 1979, Munoz-Pulido *et al*. 1993, Ellis *et al*. 1999), although predation on adults in roosts was rarely reported. An exception was for captive-born Whooping Cranes introduced into several areas of the south-eastern United States. Among these crane populations, predation from bobcats *Lynx rufus* was a major cause of mortality (Nesbitt *et al*. 1997, Urbanek *et al*. 2010, Cole *et al*. 2009). In fact, bobcats killed at least 85 of 208 captive-born Whooping Cranes that were introduced between 1993 and 2000 as a non-migratory population in Florida, causing serious problems for the recovery programme (Nesbitt *et al*. 2001). Bobcats primarily killed naïve captive-born cranes that often roosted in thick vegetation rather than open water (Nesbitt *et al*. 2001); thus others concluded that cranes must roost in water >6 m from shore to be safe from predation by bobcats (Urbanek *et al*. 2010). In our study, all cranes were wild-born and roosted in open water, although the latter did not prevent predation. Leopards entered shallow water to kill cranes in our study, and such evidence can be seen in the photograph which shows mud on the belly and legs of the leopard (Plate 1). However, a defence mechanism for cranes in our study appeared to be the movement of roosts, because we observed that after one or two predation events the large roost would be abandoned for several weeks in favour of several smaller, more scattered roosts.

An alternative explanation is that the crane carcasses were scavenged by leopards in our study site. However, we feel this was unlikely because crane carcasses were not observed in the roosts prior to the leopards being photographed. Also, the only known causes of death for cranes in the roosts during the past five years were from predation, indicating other causes of death (e.g., disease, starvation) were unlikely. It is also unlikely that leopards scavenged cranes that were killed by other predators, because crane carcasses in the photographs appeared intact with no evidence of previous feeding by other predators.

Conservation

Our results showed that predators killed at least 5–9% of cranes from the large roost annually, or c.2–3% of the entire crane population wintering in Phobjikha Valley. However, no remains were found of the three cranes that were dragged away by the leopards, indicating that more predation events occurred than were observed. For example, the photographs indicated almost twice as many cranes were killed than were recorded based on carcass surveys. The leopards probably carried the carcasses into the nearby forest before feeding on them, and consequently we are not sure of the

Plate 1. Camera trap photograph of a leopard dragging a dead Black-necked Crane away from a roost in Phobjikha Valley, Bhutan, on 12 January 2010. Photo copyright Royal Society for Protection of Nature, Thimpu, Bhutan.

Plate 2. Camera trap photograph of a second leopard dragging a dead Black-necked Crane away from a roost in Phobjikha Valley, Bhutan, on 9 February 2010. Photo copyright Royal Society for Protection of Nature, Thimpu, Bhutan.

total extent of leopard predation on cranes that winter in Phobjikha Valley.

Although total deaths from predation could not be determined on our study site, we feel that predation may not be too severe because of the apparent abandonment of roosts after predation events, which probably prevented excessive killing of cranes by leopards. Also, other factors such as habitat loss and suitability probably have a bigger impact on crane populations than predation. If predation by leopards is determined to be excessive for the crane population, preventative measures could include trapping and relocating the offending leopards, as is done with bobcats in Florida to reduce predation on cranes (Urbanek *et al.* 2010).

Predation by leopards might be an important mortality factor for Black-necked Cranes wintering in Phobjikha Valley, and other areas of central Asia, at least where roosts are adjacent to forests containing leopards. We recommend future research that investigates the spatial and temporal extent of predation on wintering cranes in Bhutan, and the behavioural responses of flocks toward predation events. We caution other crane biologists that some predation events are not easily detected if leopards or other predators are killing at night and carrying carcasses far from roosts before feeding on them.

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Nesting notes of the White-browed Tit *Parus superciliosus* in alpine scrub habitats in Qinghai and Tibet, China

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The White-browed Tit *Parus superciliosus* is endemic to alpine scrub and edges of adjacent treeline forest of south-western China. Most of its range falls in the Tibetan plateau, in at least three provinces. The birds were thought to breed in alpine shrub forests at 3,200–4,235 m altitude, placing their nests in rock crevices or old rodent burrows (Harrap & Quinn 1996, Gosler & Clement 2007) based on Martens & Gebauer (1993). This is the only information described in the species account of Gosler & Clement (2007).

For a long time the species was believed to build closed nests with a side entrance, presumed to reflect its occupation of treeless habitat. Although Pleske (1890) had already reported that the Russian explorer N. Przewalski saw birds entering holes in the ground, the view of a free-nest breeder was maintained for about a century. Field researchers of the last century working in central Asia, e.g. Hugo Weigold, Walter Beick and Ernst Schäfer, supported this view (details in Martens & Gebauer 1993). However, an active nest was never found, so the breeding behaviour of *P. superciliosus* remained open to question. Doubts that the species really did build its nests in open *Caragana jubata* or *Berberis* bushes were expressed by Martens & Gebauer (1993), who reported *P. superciliosus* carrying nesting material (sheep wool and feathers) into old small-mammal holes south of Qinghai lake (Koko Nor; east Qinghai). These holes were situated in *loess* cliffs partly opened by erosion. Observed early in the breeding season, these sites were not investigated in detail.

Here we describe the first nests of this species ever found. These were in alpine scrub close to Qinghai lake, east Qinghai, and in the Lhasa mountains, south Tibet: they span nearly the northern- and southernmost parts of the species's range.