

A description of commonly observed behaviors for the kori bustard (*Ardeotis kori*)

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Abstract The kori bustard (*Ardeotis kori*), a large ground-dwelling bird found in southern and eastern Africa, is declining throughout its entire range. We present an ethogram of the kori bustard in which we describe 63 individual behaviors. These behaviors are grouped into ten categories: resting, comfort/maintenance, locomotion, ingestive/excretory, antagonistic, inter-specific response, sexual, maternal, vocalizations and miscellaneous. The precise descriptions of kori bustard behaviors presented here provide a standard that can be used for systematic and quantitative study of kori bustard behavior, both in the wild and in captivity. A greater understanding of kori bustard behavior can help improve breeding success of captive birds and aid future conservation efforts.

Keywords Ethogram · *Ardeotis kori* · Bustard · Individual behavior · Africa

Introduction

Bustards are medium- to large-sized terrestrial birds, chiefly inhabiting open plains in either arid or seasonally dry regions of the old world. The bustard family is

made up of 25 species in 11 genera. Four species are listed by the IUCN (International Union for Conservation of Nature and Natural Resources) red list of threatened animals as endangered, one species is listed as vulnerable and six more are listed as near threatened (del Hoyo et al. 1996). Several species of bustard are poorly known so their true conservation status cannot be determined. Agricultural changes, overgrazing, hunting, trapping, habitat loss, droughts and wars are the main threats to bustards (del Hoyo et al. 1996).

The largest bustard, the kori (*Ardeotis kori*), is indigenous to the grasslands and lightly wooded savannas of southern and eastern Africa. The nominate subspecies *Ardeotis kori kori* occurs in Botswana, Zimbabwe, Namibia, southern Angola, South Africa and Mozambique (Johnsgard 1991), while *Ardeotis kori struthiunculus* occurs in Ethiopia, Kenya and Tanzania. The species is listed in Appendix II of CITES, and the South African Red Data Book lists the status of *A. k. kori* as vulnerable (Brooke 1984). According to Collar (1996), the kori bustard is showing signs of chronic decline and local extinction over its entire range. Causes for this decline include increasing agriculture and development, hunting pressure and a low tolerance for human activity (Dale 1990). Low reproductive rates, observed for kori bustards and found to be only 0.14 chicks per female for great bustards (*Otis tarda*, Morales et al. 2002), make recovery from such decline difficult (Dale 1990). Reduced breeding activity in dry years compounds the problem (T. Osborne, personal communication).

Recently, there has been an increase in the propagation of bustard species in captivity. A breeding program for the kori bustard (*A. kori*) in the United

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States is managed under the auspices of the Association of Zoos and Aquariums as a species survival plan (SSP) species. The United States captive breeding program for kori bustards aims to maintain populations that are genetically and demographically self-sustaining without relying on continued imports from the wild (Hallager and Ballou 2001).

We present a description of observed kori bustard behaviors with the aim of improving the understanding of the species both in captivity and in the wild. This ethogram was developed using observations of captive birds, supplemented by published descriptions of wild birds. Much of what is known about wild kori bustard behavior is descriptive, unsystematic and based on sightings of only one or two individuals, although a long-term study of Namibian kori bustards had been able to provide more detailed information (e.g., Osborne and Osborne 1998, 2002). The precise descriptions and definitions provided by an ethogram aid the quantitative study of behavior (Lehner 1996) and help prevent “drift” in classification of behaviors during the course of a study (Martin and Bateson 2001). This ethogram will provide a valuable basis for further study of both wild and captive kori bustard behavior. A greater understanding of this species’ interactions with conspecifics, other species, humans and the environment is a necessary first step towards development and implementation of effective conservation practices.

Methods

The behaviors reported in this paper were compiled from several sources. Observations of captive kori bustards (*A. k. struthiunculus*) at the Smithsonian National Zoological Park (SNZP), Washington, DC, by Hallager were initiated in 1990 and continued through 2004. Birds were observed informally during daily husbandry sessions inside the enclosure and from outside the enclosure in an area accessible to visitors. Friends of the National Zoo volunteer kori bustard behavior watchers (behavior watchers) logged nearly 1,600 h between 2000 and 2004 recording behaviors exhibited by the birds, space utilization information and crowd levels. Behavior watchers also made note of any new behaviors they observed. Information from the literature was used to supplement descriptions.

The flock composition varied over the years, but was generally comprised of one or two wild caught adult males, three to four wild caught adult females and one

hand-reared captive born female. All birds were individually marked with colored leg bands.

Results

We report 63 behaviors grouped into ten categories: resting, comfort/maintenance, locomotion, ingestive/excretory, antagonistic, inter-specific response, sexual, maternal, vocalizations and miscellaneous.

Resting behavior

Resting behavior is divided into four categories:

Alert

A bird is considered alert when it is stationary, either sitting on the ground or standing, and has its eyes open. Its neck may be tucked against the back, partially extended or fully extended. On rare occasions, one foot is raised slightly off the ground (Fig. 1).

Resting

The bird is stationary, either sitting on the ground or standing, and its eyes are closed. It may be asleep, but generally is awake. Birds probably close their eyes

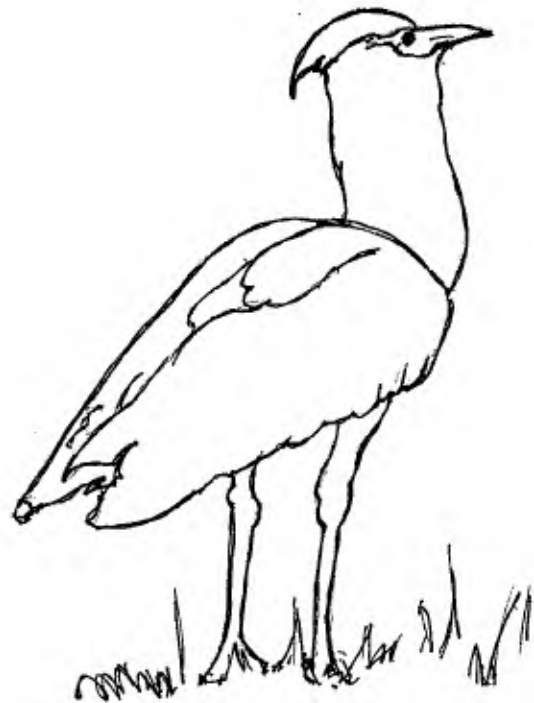


Fig. 1 Alert

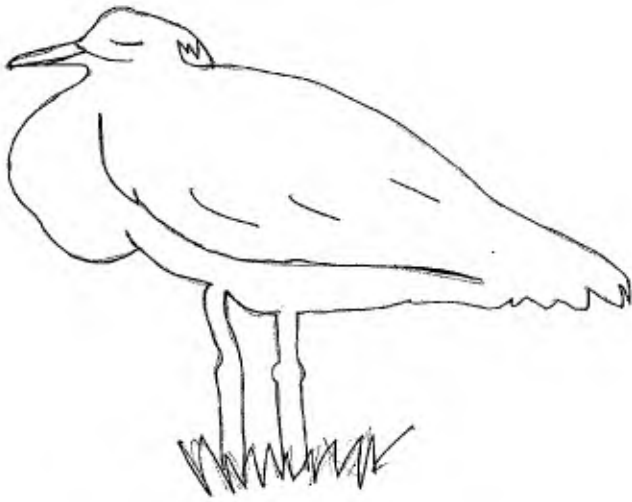


Fig. 2 Resting

only when they feel safe about their surroundings (Fig. 2).

Hock sitting

The bird sits with its tarsi on the ground and tibias vertical, leaving the belly raised off the ground (Fig. 3).

Wet weather standing

During periods of light to heavy rain, the bird tucks its head tightly against the back of its neck, giving it a hunched appearance. The dorsal side of a kori's neck is only lightly feathered, so this posture may help conserve body heat. During inclement weather, birds often stand under a bush for partial protection from the elements (Fig. 4).

Comfort/maintenance behaviors

Personal maintenance and comfort behaviors are:

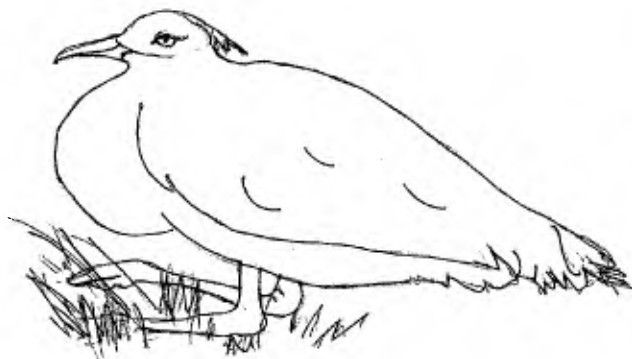


Fig. 3 Hock sitting



Fig. 4 Wet weather standing

Scratching

Generally, the neck and head areas are scratched using a toe (Fig. 5).

Stretching

A kori may stretch its leg, wing or body. The wing and leg on the same side of the body are often stretched together. Bow stretching (Fig. 6; Maozeka 1993) is a full-body stretch in which the neck is extended forward, the body is lowered slightly, and the wings are raised. Stretching often occurs after birds have been resting for an extended period.

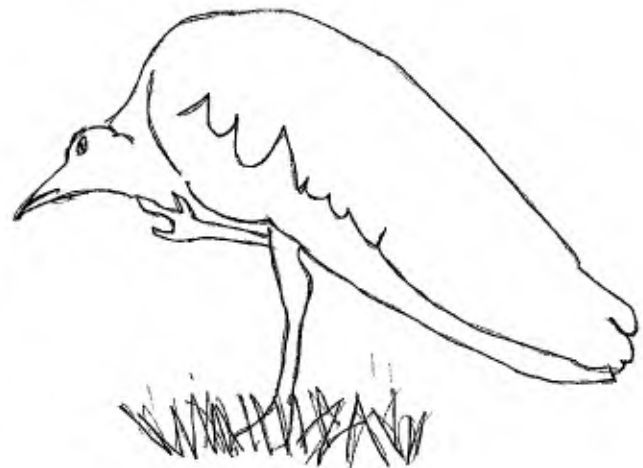


Fig. 5 Scratching



Fig. 6 Bow stretching

Jump stretching

The bird jumps slightly into the air while extending and flapping its wings.

Body fluffing

The feathers on the neck, wings and back are erected and then smoothed down. Body fluffing lasts only for a second or two, and may be followed by a gentle ruffling of the feathers.

Ruffling

The bird shakes its body, with movement passing as a wave from head to tail. The tail feathers are slightly fanned (Fig. 7). This behavior usually occurs after a preening session.

Wing flapping

The bird extends its wings and flaps them several times. Wing flapping often occurs in conjunction with stretching (Fig. 8).

Preening

Kori bustards use their bill to straighten the feathers on their breast, neck, tail, legs or wings (Fig. 9). Dirt and parasites are also removed by the bill. They perform this behavior while sitting or standing. Small feathers preened out are occasionally ingested. Preening birds sometimes close their eyes, and almost always have



Fig. 7 Ruffling

their eyes closed when grooming the legs and underbelly. Preening is often punctuated by moments during which the bird is alert.

Toe picking

While standing on one foot, the bird uses its bill to pull at a toe or nail, presumably to clean it (Fig. 10).

Dust bathing

The bird lies flat and rubs its belly, head, neck and wings on the ground, often in a sandy or dusty

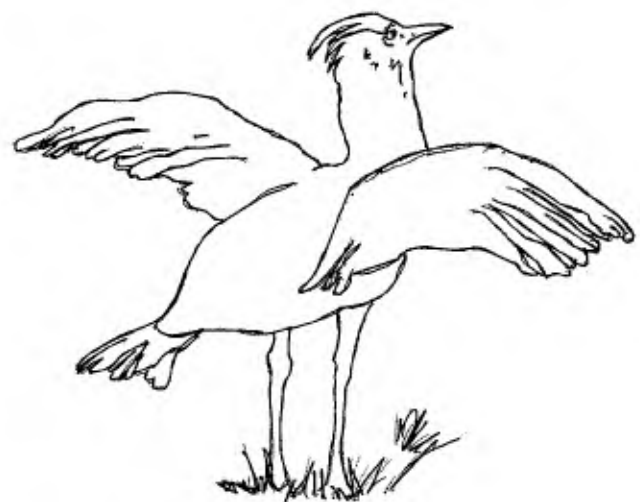


Fig. 8 Wing flapping



Fig. 9 Preening

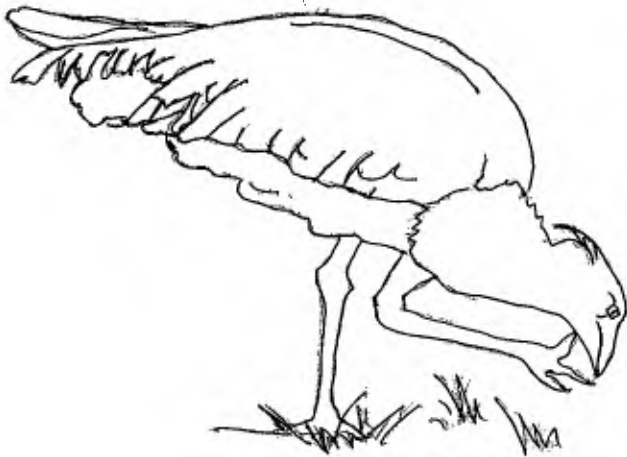


Fig. 10 Toe picking



Fig. 11 Dust bathing

depression. Birds often ruffle their feathers in the material in which they are bathing (Fig. 11). Dust bathing helps keep plumage clean.

Sun bathing

The bird is sitting (usually near a bush or short grass clump) in the sun with one or both of its wings spread horizontal to the ground (Fig. 12). Birds often sun to the point where they are panting heavily, and sun bathing is always followed by extensive preening (see [Preening](#)).

Bill gaping

The mouth is briefly opened wide as if the bird is yawning. Observation of this behavior suggested no specific function.

Bill open

The bill is held partially open for several seconds (Fig. 13). Observation of this behavior suggested no specific function.

Panting

The bill is slightly open, and the gular skin is moving back and forth (Fig. 14). Panting is a cooling mechanism.

Tail erection

Tail erection occurs as soon as 10 min after rain has ended. Birds raise their tails vertically and fan their tail feathers out, potentially in an effort to dry the feathers as quickly as possible (Fig. 15).

Locomotion

Kori bustards move around in the following ways:

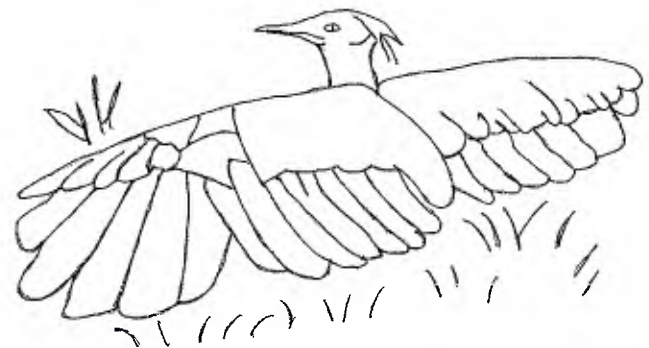


Fig. 12 Sun bathing



Fig. 13 Bill open

Walking

The bird is moving about at a leisurely pace (Fig. 16). The speed of walking for kori bustards can be estimated from the speed measured for great bustards, which are similar in size to kori bustards. Great bustard walking speeds are approximately 1 km per hour (T. Clarke, personal communication). Walking is the primary mode of locomotion for kori bustards.

Running

The bird is moving at a speed similar to or faster than an average human adult runs. Its head may be held high and extended, or low and horizontal to the ground. The wings may be extended or held close to the body (Fig. 17). Kori bustards generally run to escape a perceived threat.

Flying

Like other large bustards, kori bustards prefer walking to flying (Osborne et al. 1984), possibly due to the high energetic costs of flight for such a heavy bird (Mwangi 1988). When they do fly, kori bustards take off into the

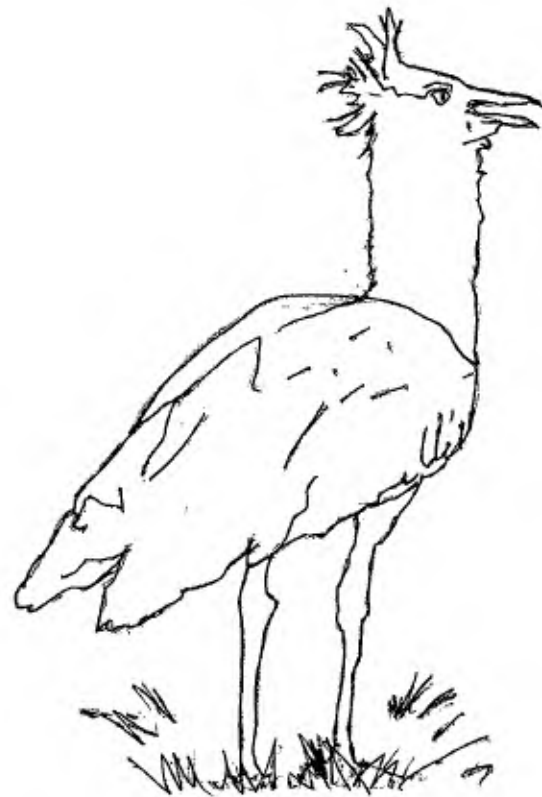


Fig. 14 Panting

wind following a short run (Prozesky 1970). Once in the air, kori bustards are strong fliers and can produce bursts of speed (Osborne et al. 1984). Flight is used to escape from danger, to move from one habitat to



Fig. 15 Tail erection

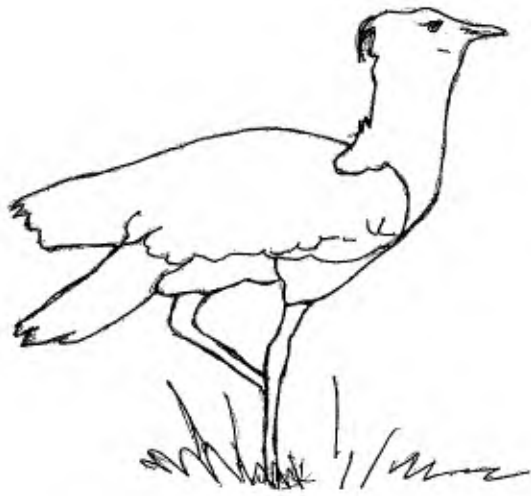


Fig. 16 Walking

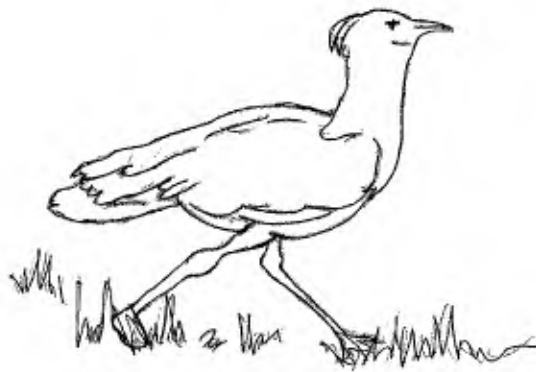


Fig. 17 Running

another or to move to an open resting area (T. Osborne, personal communication) (Fig. 18).

Jumping

Without a running start, a bird will jump into the air (Fig. 19). Flight restricted captive birds can get as high



Fig. 18 Flying



Fig. 19 Jumping

as 2.13 m. Jumping may be a means of evading terrestrial predators, as captive kori bustards sometimes jump while being caught by keepers. Wild birds also jump to obtain food from trees or bushes above their reach (T. Osborne, personal communication) Jumping may be accompanied by barking (see [Barking](#)).

Ingestive/excretory behavior

Kori bustards are opportunistic omnivores, and their gastrointestinal tract is typical of insectivorous birds (Maloiy et al. 1987). The esophagus is not as pronounced as in carnivorous birds, and the ventriculus is thick and muscular, a trait characteristic of birds consuming complex food items such as insects and plant material (Klasing 1998; Stevens 1995). Kori bustards have a large cecum, which is common in omnivorous birds such as ostriches, rheas, cranes and quail (Klasing 1998). Their diet includes insects, plant materials, small lizards, snakes, rodents, birds, bird eggs and nestlings, carrion, (Anonymous 1991; Chiweshe and Dale 1993; Mwangi 1988; Schmidl 1982; Urban et al. 1986) and *Acacia* gum (Skead 1969; Urban et al. 1978). Ingestive and excretory behaviors can be divided into six categories:

Drinking

Kori bustards drink while standing or hock sitting, using a sucking method (Fig. 20; Hallager 1994). This

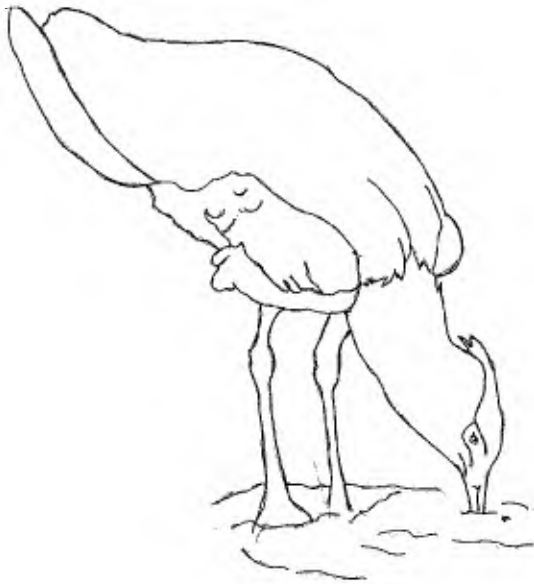


Fig. 20 Drinking

involves submerging the beak in water, using tongue or throat motions to draw in water, and then raising the head to around a 45° angle to gulp down the water (Hallager 1994; Mwangi 1988; Wittman et al. 1993). Wild kori bustards have been observed drinking from rainwater puddles (Mwangi 1988) and at water holes (Urban et al. 1986). These birds are well adapted to the arid environments in which they live and may use alternative water sources such as wild melons (Urban et al. 1986) and insects, especially during the dry season.

Foraging

Kori bustards search for food while walking, looking down at the ground (Fig. 21).

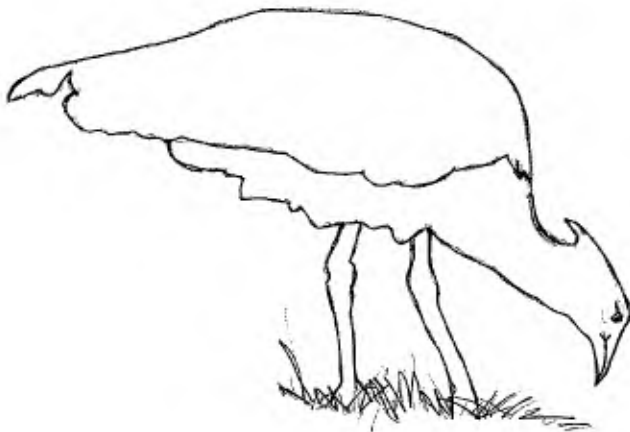


Fig. 21 Foraging

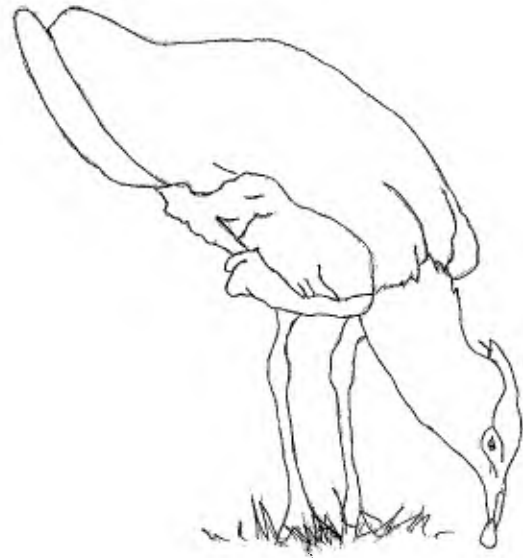


Fig. 22 Feeding

Feeding

Kori bustards peck at food within their reach or chase down jumping or flying prey (Fig. 22). When a prey item is within reach the bird snaps it with its bill, which can exert enough pressure to audibly crack mouse (*Mus musculus*) skulls. Once seized, vertebrates are shaken or struck against the ground before they are finally swallowed whole (Wittman et al. 1993). Smaller items are simply swallowed.

Grit eating

Kori bustards eat grit or small pebbles to aid in digestion (Kok and Van Ee 1989), pecking at and then swallowing these items.

Bill wiping

The bird rubs the sides of its bill along the ground, a tree trunk or other object in order to remove any food attached to the bill (Fig. 23) Bill wiping is only seen after birds have fed.

Defecation

Fecal matter is excreted upon first rising in the morning. Males at the SNZP deposit around 130 g and females deposit 50 g. Smaller amounts are excreted throughout the day. Birds defecate mainly while walking, pausing slightly as feces are excreted



Fig. 23 Bill wiping

(Fig. 24). Birds can also defecate as part of a fear response.

Antagonistic behavior

In the wild kori bustards are generally solitary except for females with chicks, which remain together until the start of the following year's breeding season. Aggregations of kori bustards have also been reported. Mwangi (1988) found in a sample of 258 birds that 68% were alone, 22% were in groups of two, 6% in groups of three, 2% in groups of four and 0.4% in groups of five. Of 610 sightings in Etosha National Park during the non-breeding season, Osborne and Osborne (1998) found adult males alone 66% of the time and adult females alone 15% of the time. Males in this study did

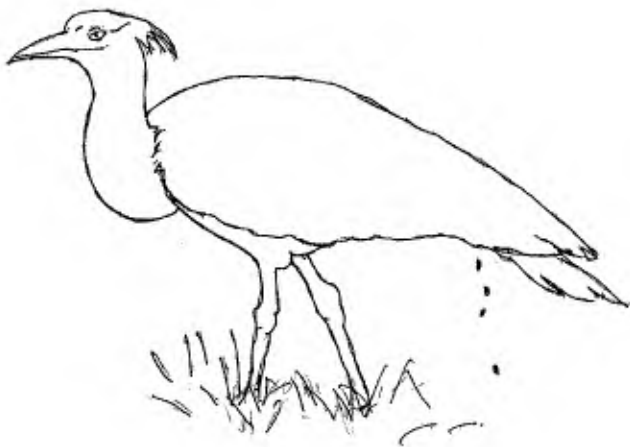


Fig. 24 Defecation

not associate with females other than during the breeding season. Kori bustard antagonistic behavior includes:

Aggressive displacement

Aggressive displacement is shown by both sexes and involves one bird chasing another bird. At the start of this behavior, the aggressor will lower its head, raise its head crest, ruffle its plumage slightly and aim its body towards the other bird. The aggressor will often pursue the other bird until it is out of sight (Webb 1981).

Non-aggressive displacement

One bird walks toward another bird, causing the second bird to vacate its position and move elsewhere. Like aggressive displacement, this behavior can be performed by either sex towards a member of the same or opposite sex, although females do not displace adult males. No special postures are involved in non-aggressive displacement.

Fighting

Allen and Clifton (1972) describe a fight between two male kori bustards where both birds had their feathers fluffed out and tails raised. Grasping each other's beaks, they shoved at each other until one male gave up and flew away (Fig. 25). These contests presumably establish dominance ranks during the breeding season (Osborne et al. 1984). Fights between males can cause physical injuries (Hallager and Boylan 2004). Females have not been reported to engage in such physical contests.

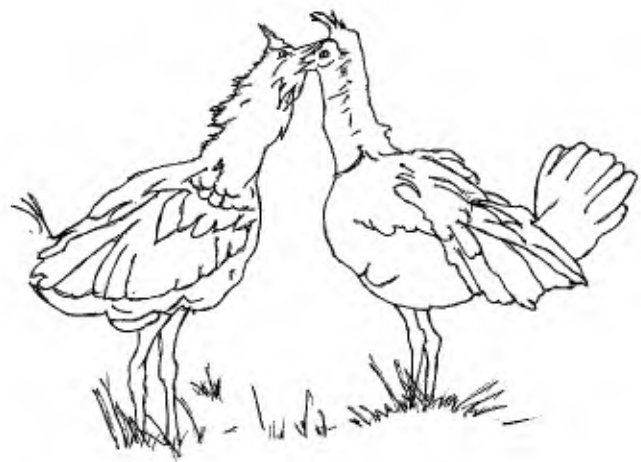


Fig. 25 Fighting

Aggressive head pecking

A dominant bird pecks at the head of a subordinate bird if the subordinate bird does not move when the dominant bird approaches. This rarely results in feather loss and is usually short in duration. Head pecking also occurs during copulation (see [Head pecking](#)).

Tail lifting

The tail is lifted up to a 90° angle and the feathers are fanned, then the tail is lowered (Fig. 26). Tail lifting may be repeated multiple times. It is often performed while the bird is sitting, but can also be shown by a standing individual. Tail lifting occurs when another bird approaches, and may be accompanied by erection of the head crest feathers (see [Crest up](#)). Females may tail lift when approached by a male or a female, but males will not tail lift when approached by a female.

Threat posture

The threat posture is similar to the predator defense posture (see [Predator defense display](#)), but differs in

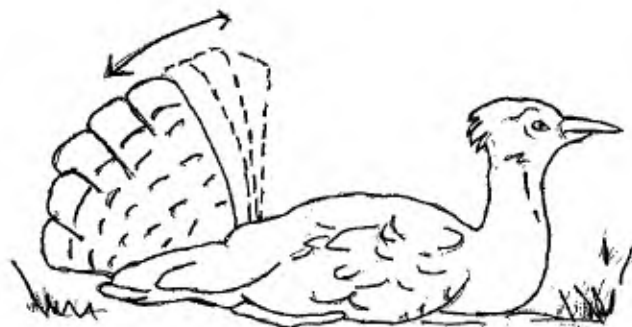


Fig. 26 Tail lifting



Fig. 27 Threat posture

wing and head position. A standing bird has its tail up and fanned, its wings outstretched, its plumage ruffled and its head extended forward (Fig. 27). The wings and tail may be vibrated. This aggressive stance, also called a “shock display” (Hellmich 1988; Johnsgard 1991; Osborne and Osborne 1999), may be directed at conspecifics, other large birds (e.g., Hellmich 1988), humans approaching nests (e.g., Maozeka 1993; Morgan-Davies 1965), springbok (Osborne and Osborne 1999) and presumably other animals to scare them off.

Inter-specific response

Kori bustards have a high rate of predation, thus their ability to detect predators is well developed. Predators of kori bustards include the black-backed jackal (*Canis mesomelas*), spotted hyena (*Crocuta crocuta*), martial eagle (*Polemaetus bellicosus*), tawny eagle (*Aquila rapax*), Verreaux’s eagle (*Aquila verreauxii*), leopard (*Panthera pardus*), lion (*Panthera leo*) and caracal (*Caracal caracal*) (Hallager 2004; Sandler 1992). Kori bustards exhibit the following behaviors in response to perceived predation:

Skyward looking

An alert bird may extend its head and cock it upwards, and may also tilt the head sideways so only one eye is facing upwards (Fig. 28). Grzimek et al. (1972) suggest that elevating the beak increases the kori’s field of view. Kori bustards in this posture are probably more attentive to their surroundings than birds that are simply “alert.”

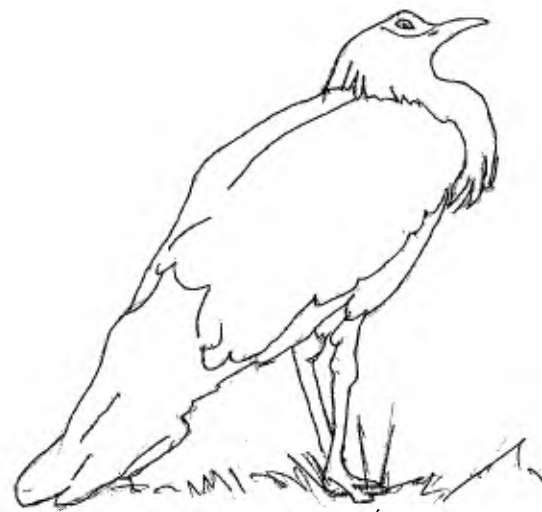


Fig. 28 Skyward looking

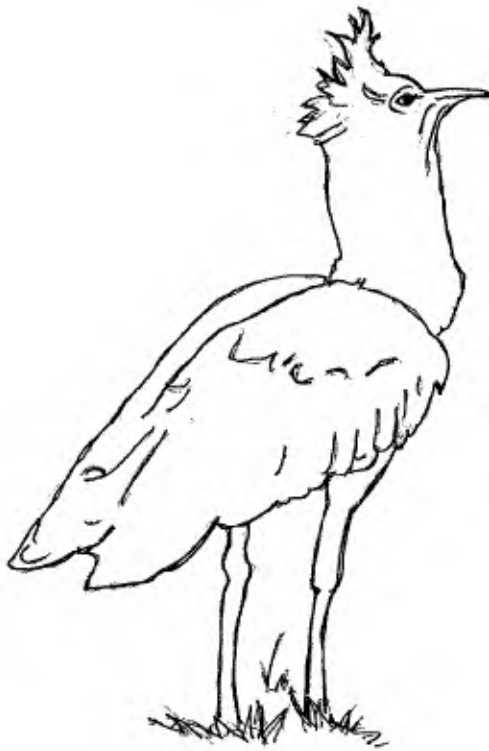


Fig. 29 Crest up

Crest up

The head crest feathers are erected as a response to a potential threat (Fig. 29). Crest up is often preceded by neck fluffing.

Neck fluffing

This reaction to predators or other items of concern increases the bird's apparent size through the erection of the neck feathers and the head crest (Fig. 30). It may be accompanied by skyward looking (see [Skyward looking](#)). Neck fluffing can last for several minutes. Neck fluffing by one bird often results in neck fluffing by other birds in the SNZP flock, suggesting that it is an alarm signal.

Tail spreading

A bird will raise its tail vertically and fan the tail feathers as a defense posture against aerial predators (T. Osborne, personal communication).

Predator defense display

The bird is crouched, its tail is raised and fanned, wings are loosely tucked to the body and the bird's head and neck are extended upwards (Fig. 31). This behavior is usually caused by a potential or perceived predator flying overhead. It is similar to the threat posture display (see [Threat posture](#)), but differs in wing position



Fig. 30 Neck fluffing



Fig. 31 Predator defense display

and head orientation. A kori may also show a partial display in which it raises its tail, but does not crouch (Osborne and Osborne 1999).

Sexual behavior

Kori bustards are polygynous (Johnsgard 1991). Males gather singly or in loose lek-like formations to display to females during the breeding season, which is variable and closely tied to rainfall (Johnsgard 1991; Osborne and Osborne 2000). In the United States, the breeding season of captive birds appears to vary with latitude (Hallager and Boylan 2004), with birds living further south breeding earlier in the year. Captive males at SNZP and St. Catherine's Island Wildlife Survival Center, GA (L. Hudson, personal communication), display at all times of day, with higher levels of display early and late in the day (unpublished data). Wild males may limit displays to the cooler parts of the day (Astley-Maberly 1937; Osborne and Osborne 1998), although Mwangi (1988) noticed males displaying mainly during the middle of the day. Females appear uninterested in courting males, and often deliberately avoid their advances (Hallager 2003).

Females are sexually mature at 3 years in the wild (Osborne and Osborne 2001) and also in captivity. Sexual maturity of wild males has not been documented; in captive males, first reproduction has occurred at 3 years (Hallager 2004).

Male courtship

Males display on open plains and in open areas of lightly scattered shrub lands (Osborne and Osborne 2000). A courting male remains in a particular area, often on a low hilltop (Urban et al. 1986). Male courtship includes the following:

Chasing females With head crest and tail raised, the male will chase after a female. The female often appears disinterested and runs away from the advancing male. Male pursuit will often cease once a female is out of view.

Tail up position With tail raised and fanned, wings held close to the body and head crest erect, a male stands or struts around trying to attract the attention of females. Raising the tail exposes its white under parts, making the male more visible (Fig. 32).

Partial balloon display A male may stand with his neck partially inflated, tail up and head crest erect (Hoesch 1938; Prozesky 1977; Urban et al. 1986) (Fig. 33). This position precedes or follows a full balloon display. Mwangi (1988) reports birds holding this position for up to 1 h.

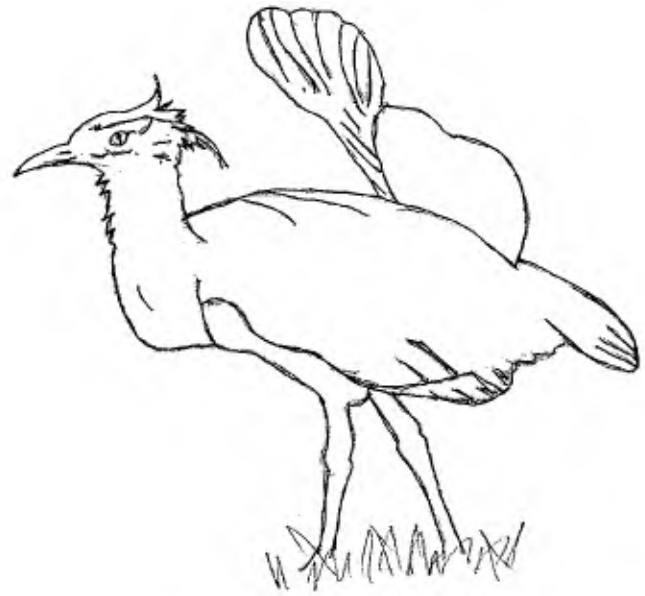


Fig. 32 Tail up position

Balloon display The male extends his neck and fully inflates the esophageal pouch with the bill pointed upward. The tail and wing feathers are pointing downward and the head crest is erect (Fig. 34). The male emits a low-pitched booming sound (see **Booming**) as he snaps his bill open and shut. During

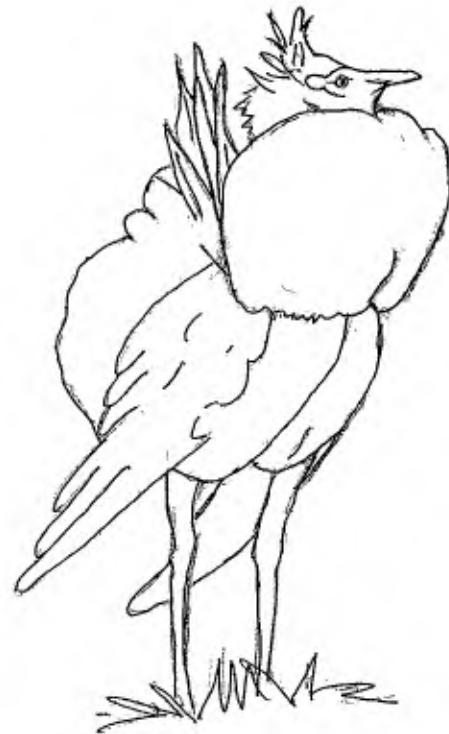


Fig. 33 Partial balloon display

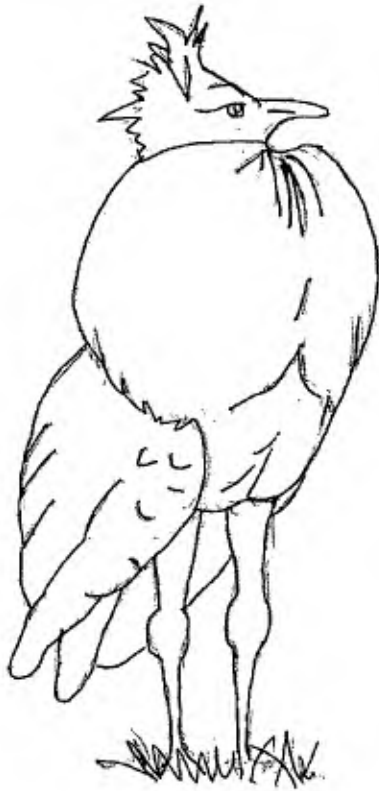


Fig. 34 Balloon display

the height of the male display, the pouch inflates to as much as four times its normal size, and the neck resembles a balloon or giant puffy ball. This action causes the normally gray feathers to reveal their white bases. The balloon display makes the male visible up to 1 km away (Hellmich 1988) and is the most intense form of courtship.

Copulation

Copulation has rarely been observed. It can be broken down into the following behaviors (Hallager 2003):

Copulation initiation A female initiates a copulation event by sitting down near a displaying male. The male then approaches her from behind.

Head pecking After approaching the female, the male gradually begins to peck at the back of her head, stepping from one side of the female to the other. He continues this head pecking for 5 to 10 min. The female remains seated throughout the entire bout of head pecking, recoiling each time the male pecks her. The male's rate of head pecking does not appear to follow any pattern, although further observation of courtship would be required to quantify copulatory head pecking.

Squatting and pecking As the actual copulation event approaches, the male squats down on his hocks

while continuing to peck at the female's head. This generally lasts 5 min.

Mounting The male spreads his wings and climbs onto the back of the seated female. The actual transfer of sperm takes only a few seconds.

Post-copulation feather shaking Immediately after sperm transfer, both birds stand up and vigorously shake their feathers. Some females also bark (see [Barking](#)). Both birds then run off and resume normal activities.

Maternal behavior

Only the female kori bustard incubates and rears the chicks. Like other bustards, females lay their eggs in a shallow scrape on the ground. Nests are usually partially hidden by tall grasses, small trees or bushes (Maozeka 1993; Mwangi 1988; Osborne and Osborne 2002) and are near a natural feature such as a bush (Osborne et al. 1984) or rocks (Maozeka 1993). Both Maozeka (1993) and Osborne and Osborne (2002) estimated that nests they found remained in the shade during the hottest part of the day. Maternal behaviors include:

Pacing

The female walks back and forth in a particular area (approximately 6 m long by 0.25 m wide for SNZP birds), moving faster than when walking (Fig. 35). This may last for just a few minutes or for several hours. Some captive females pace the area where they will eventually lay their egg during the day or two prior to egg laying.

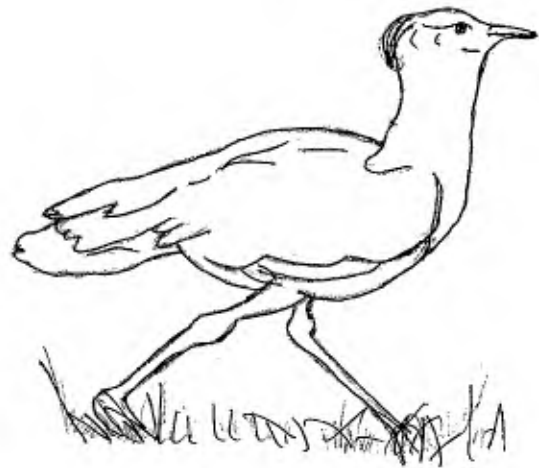


Fig. 35 Pacing

Egg-laying

Eggs in captivity are only found in the morning, indicating that laying occurs after the staff have departed for the day, during the night or early in the morning prior to the staff's arrival. A clutch normally contains one or two eggs, although on occasion three chicks have been observed (Osborne and Osborne 1998). The second egg is usually laid 2 days after the first (Johnsgard 1991; Tarboton 2001). In the wild, the number of chicks raised each year is highly dependent on food availability (Osborne and Osborne 1998).

Incubating

In some captive females, incubation begins with the first egg even if a second egg is laid; most wait until laying the second egg to incubate (Hallager and Boylan 2004). The incubation period is 23 days in captivity. Incubating females rarely leave the nest. Captive females that do leave (e.g., at feeding times or to perform comfort activities such as sun bathing or dust bathing) are very aggressive towards keepers and other birds and return quickly to the nest site. If another bird approaches the incubating female, she will aggressively drive them off (Hallager and Boylan 2004). The posture most commonly observed by incubating females is shown in Fig. 36.

Egg turning

While standing over the nest, females rotate their eggs with their bills several times throughout the day as well as through the night (Fig. 37). Preliminary data obtained using a telemetric egg (Advanced Telemetry Systems, Inc., model R2100) showed that females rotate their eggs between 1 and 26 times per day, with a median turning rate of 8 times per day (unpublished data).



Fig. 36 Incubating

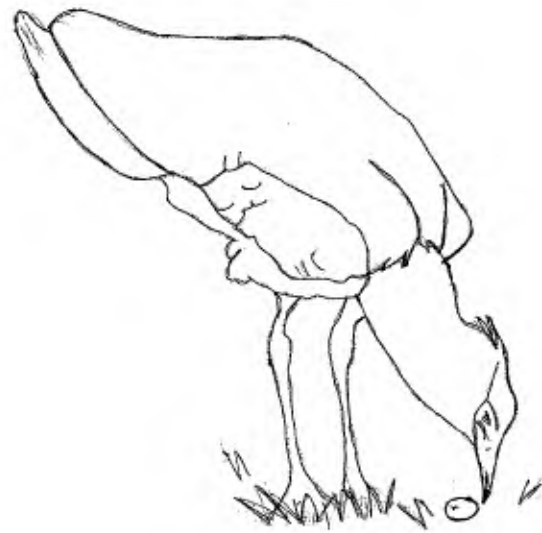


Fig. 37 Egg turning

Debris tossing

The female occasionally throws leaf litter and small sticks onto her back while incubating (Fig. 38). These items are obtained from the area directly around the "nest," and the female remains sitting while engaging in this behavior.

Parental care behavior

Kori bustards exhibit only maternal care. Captive females are highly protective of the chicks and will attack other females and keepers. The female will pick up food and present it to the chicks, bending her head and neck down while holding the food in her bill. Smaller chicks require her to bend farther than do older chicks. When the female is feeding her chicks, she salivates copiously (J. Womack, personal communication). This only occurs with females feeding chicks and is hypothesized to be a source of moisture for the chicks. Chicks begin feeding on their own at approximately 1 week of age. Females have been observed feeding



Fig. 38 Debris tossing

chicks up to 75 days old. The female produces a quiet vocalization when feeding the chicks.

Vocalizations

Kori bustard vocalizations include:

Barking

When nervous or startled, kori bustards produce a soft, gruff “bark,” also called a “gronk” call (e.g., Osborne and Osborne 1998). Birds at SNZP have learned that if two or more people enter their enclosure, capture is most likely imminent, and they will bark when multiple people arrive. A single person entering the enclosure does not provoke barking. Barking birds are generally standing, focused on the cause of concern, and may move away from this object. Other observations of kori bustards barking include females with chicks (Osborne and Osborne 1998; Maozeka 1993; Morgan-Davies 1965), males that had just lost a fight with another male (Allen and Clifton 1972; Hallager and Boylan 2004) and captive birds approaching keepers or food tubs. Chicks bark as young as 2 weeks old (Hallager and Boylan 2004).

Growling

This vocalization consists of a soft “rrrrrr” sound, similar to a cat’s growl. A female may growl when she is defending an egg or chick (e.g., Morgan-Davies 1965) or when handled by keepers.

Booming

Males emit a low-pitched booming vocalization during the breeding season as the bill is snapped open and shut. The boom carries a considerable distance (up to 1 km) and is designed to attract females. Males emit six calls in rapid succession (Hellmich 1988) and may repeat these six-call cycles for several minutes. This sound has been described as a “voomp-voomp-voomp” (Astley-Maberley 1937; Osborne et al. 1984; Urban et al. 1986), as a “wum-wum-wum-wum-wumwum” (Hoesch 1938) and as if someone were kicking a soccer ball in the distance (Astley-Maberley 1937; Hellmich 1988).

Chick chirp

This light chirp or purring sound is produced by chicks that are being fed or brooded.

Chick cry

When upset or stressed, chicks produce a long, sad whistle that can escalate into a loud wailing (Hallager and Boylan 2004). Maozeka (1993) noticed this whistle coming from a chick whose mother had recently flown away. The chick’s cry became more intense when observers whistled back and stopped once the observers found the chick.

Grunting

Females raising chicks make this low- to high-pitched sound to call their chicks, especially when food is available. Chicks will not move until they hear this call (J. Womack, personal communication).

Roaring

Kori bustards are capable of very loud vocalizations similar to a lion’s roar. In captivity, this occurs when birds are initially captured.

Miscellaneous behaviors

Coughing

This is as implied.

Sneezing

This is as implied.

Head jerking

The bird is generally stationary, and the head and neck are moved backwards over the bird’s back (Fig. 39). Running is sometimes preceded by head jerking.

Discussion

Few detailed descriptions of bustard behavior have been published, yet such manuscripts provide a valuable basis for the quantitative study of behavior (Lehner 1996). In addition to providing standardized definitions of behaviors for a species, which help prevent “drift” during the course of a study (Martin and Bateson 2001) and facilitate further research on a species’ behavior, ethograms allow the comparison of behavior between related species (Xiao and Wang 2005). Comparison of kori bustard behavior with that



Fig. 39 Head jerking

of other species can highlight traits potentially shared by all or by specific groups of bustards.

Many of the behaviors we describe are also reported for other bustard species. Resting behaviors appear similar in kori bustards, houbara bustards (*Chlamydotis undulata macqueenii*, Launay and Paillat 1990), great bustards (Hellmich 1987) and black korhaans (*Eupodotis afraoides*, de Swardt 1992). Dust bathing is exhibited by great Indian bustards (*Ardeotis nigriceps*, Ali and Rahmani 1981–1982) and houbara bustards (Hinz and Heiss 1989) and is likely similar for all bustards since all species are birds of open plains in either arid or seasonally dry regions of the old world. de Swardt (1992) suggests that black korhaan jaw stretching, which is similar to kori bustard “bill open” behavior, may help exercise jaw muscles or enhance inhalation and exhalation of air. Neither of these theories has been tested for any bustard. Ingestive behaviors are probably also similar across bustard species, most of which are opportunistic omnivores. Ali and Rahmani (1981–1982) report that, like kori bustards (Hallager 1994), great Indian bustards drink water using a sucking motion of the throat. Fisher et al. (1972) report similar drinking behavior for the Australian bustard (*Ardeotis australis*). Given that bustards occur in arid habitats where water is scarce, drinking behavior probably shows little variation amongst bustard species. Another behavior exhibited by multiple bustard species is head jerking. While the function of this movement is not clear for kori bustards, it may serve some social function for houbara bustards (Launay and Paillat 1990) and indicates aggression in

black korhaans (de Swardt 1992). Other behaviors exhibited by multiple bustard species include tail lifting (little bustard *Tetrax tetrax*, Schulz 1986; houbara bustard, Launay and Paillat 1990), threat posture (little bustard, Cramps and Simmons 1983; great bustard, Hellmich 1987; houbara bustard, Launay and Paillat 1990), predator defense display (houbara bustard, Launay and Paillat 1990), debris tossing (white-bellied bustard *Eupodotis senegalensis*, buff-crested bustard *Eupodotis ruficrista*, houbara bustard, F. Launay, personal communication), tail up and partial balloon display (great bustard, Hidalgo de Trucios and Carranza 1991), balloon display (great bustard, Denham’s bustard *Neotis denhami*, Australian bustard and great Indian bustard, Osborne et al. 1984), booming (Australian bustard, Fitzherbert 1978; great Indian bustard, Osborne et al. 1984) and chasing females (great Indian bustard, Ali and Rahmani 1981–1982; little bustard, Schulz 1986). Chasing females is likely a form of harassment, a phenomenon commonly seen with bird leks (Hoglund and Alatalo 1995).

Analysis of behavioral differences between bustard species can also help highlight trends and suggest behavioral characteristics of under-studied species. Male bustard courtship displays can be grouped into five broad categories (Osborne et al. 1984), with larger species such as the kori bustard showing displays that involve relatively little movement and are entirely terrestrial. Males of smaller species, however, often run, jump or fly during courtship. Dale (1992) suggests that this is the result of sexual selection, which favors small size in males with aerial displays and large size in males with terrestrial displays.

This use of aerial components by smaller, but not larger bustards may also be true for aggressive behaviors. Aggressive encounters are mostly limited to terrestrial movement in kori, houbara (Launay and Paillat 1990) and great Indian bustards (Ali and Rahmani 1981–1982), but usually involve flight in the smaller little bustards (Schulz 1986) and black korhaans (de Swardt 1992). With male kori bustards typically weighing around 14–19 kg and females weight 6–7 kg (Bailey and Hallager 2003), aerial battles would be too cumbersome and energetically costly. Additional information on aggressive interactions for other bustard species will help determine whether body size affects types of aggressive behaviors seen.

While maternal behavior is likely to be similar for all bustards, our study of captive birds highlights several interesting female behaviors. Pacing before laying eggs is not a common bird behavior. Females pace in the area where eggs will eventually be laid and are more aggressive during this pre-laying period, suggesting

that pacing is an expression of territoriality. Pacing may also be an artifact of captivity, since captive females often cannot seek isolated and hidden locations when preparing to lay eggs. Another unusual behavior exhibited by captive incubating female kori bustards is the placement of small sticks and leaves on the back. Since kori bustards do not actually use vegetation to construct their nests, this may be a displacement behavior. Alternatively, it may be a strategy to improve females' camouflage and make them less visible to aerial predators.

The behaviors listed here are the most commonly observed and reported exhibited by kori bustards in the wild and captivity. Additional observations by other researchers, including detailed study of female and chick behavior, are needed. Gaining a better understanding of kori bustard behavior, both in the wild and in captivity, is a necessary first step towards improving the husbandry and management of captive kori bustards and designing future conservation efforts that take into account all aspects of wild kori bustard life history and behavior.

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