

Kori Bustard
Species Survival Plan
(*Ardeotis kori*)
Husbandry Manual



Preface

Habitat loss has led to a major decline in all *Ardeotis* species and kori bustards in the wild now face an uncertain future. Numbers have declined and birds are absent from areas where they used to be found. Reasons for their decline are numerous and include habitat destruction from agriculture and development, bush encroachment, illegal hunting, a low tolerance of human activity, an inherent low reproductive rate and reduced breeding in dry years. As human populations increase and loss of habitat continues, the kori bustard population in Africa can be expected to decline further. If this magnificent bird is to persevere into future generations, action in the form of increased research, public education, captive breeding and the protection of large areas of suitable kori bustard habitat are the only way to safeguard the future of this species.

The kori bustard husbandry manual is a living document written and published by members of the kori bustard Species Survival Plan (SSP) Management Group and its Advisors. The guidelines in this document are intended to improve kori bustard management by better understanding the species both in captivity and in the wild.

Recommendations for future editions of the manual are welcomed, as they will contribute to the improvement of later versions.



Kori Bustard Husbandry Manual

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This manual is dedicated to kori bustards and the people that care for them.

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TABLE OF CONTENTS

Section 1. Natural History and Biology

1. Taxonomy

2. Morphology

- 2.1 Measurements
- 2.2 Physical description
- 2.3 Sexual dimorphism
- 2.4 Vocalizations

3. Longevity

4. Zoogeography and Ecology

- 4.1 Distribution
- 4.2 Habitat
- 4.3 Population
- 4.4 Conservation Status
- 4.5 Threats to survival
- 4.6 Natural predators

5. Diet and Feeding Behavior

6. Reproduction

- 6.1 Sexual maturity and age at first reproduction
- 6.2 Seasonality
- 6.3 Male display
- 6.4 Nesting site
- 6.5 Egg laying and incubation
- 6.6 Hatching
- 6.7 Development and care of young
- 6.8 Dispersal of young

7. Behavior

- 7.1 Activity
- 7.2 Locomotion

- 7.3 Comfort movements
- 7.4 Social behavior
- 7.5 Sexual behavior

Section 2. Management in Captivity

1. Enclosure

- 1.1 Boundary
- 1.2 Substrate
- 1.3 Furnishings
- 1.4 Maintenance
- 1.5 Environment
- 1.6 Predator proofing
- 1.7 Specifications for winter holding stalls
 - 1.7.1 Additional winterizing
- 1.8 Water

2. Population Management

- 2.1 Population status
- 2.2 Individual identification and sexing
 - 2.2.1 Individual identification
 - 2.2.2 Sex determination
- 2.3 General record keeping
- 2.4 Measurements

3. Capture and Transport

- 3.1 Capture methods
- 3.2 Crating methods and crate design
- 3.3 Transport procedures

4. Diet

- 4.1 Executive summary
- 4.2 Feeding ecology and GI morphology
- 4.3 Nutrient content of free-ranging diet
- 4.4 Target nutrient values
- 4.5 Food items available to zoos
- 4.6 Suggested diet composition
- 4.7 Feeding schedule
- 4.8 Food presentation

- 4.9 Health problems associated with diet
- 4.10 Handrearing
- 4.11 References Cited
- 4.12 Appendix I- Nutritionally Compete Feeds
- 4.13 Appendix II- Kori Bustard diet survey

5. Behavior, Social Organization and Group Composition

- 5.1 Basic social structure
- 5.2 Mixed species exhibits
- 5.3 Changing group structure
 - 5.3.1 Introduction of birds to an empty enclosure
 - 5.3.2 Introduction of a male to a female
 - 5.3.3 Introduction of a female to a male
 - 5.3.4 Introduction of a male to a male
 - 5.3.5 Introduction of a female to a female
 - 5.3.6 Introduction of juvenile birds (1-3 years) to a flock of adult birds
- 5.4 Behavioral indicators of stress
- 5.5 Stereotypes
- 5.6 Flock management
 - 5.6.1 Breeding season
 - 5.6.2 Non- breeding season
- 5.7 Winter housing
- 5.8 Non-verbal communication
- 5.9 Auditory vocalizations
- 5.10 Dominance hierarchies
- 5.11 Age of dispersal/removal of young
- 5.12 Management of geriatric birds

6. Reproduction and Contraception

- 6.1 Mating and nestbuilding
 - 6.1.1 Pair formation
 - 6.1.2 Copulation
 - 6.1.3 Nests and incubation behavior
 - 6.1.4 Egg termination
- 6.2 Egg laying and incubation
 - 6.2.1 Egg laying
 - 6.2.2 Natural Incubation
 - 6.2.3 Artificial incubation

- 6.2.4 Management of nesting birds
- 6.3 Physiological measures of the reproductive cycle
 - 6.3.1 Signs of estrus
- 6.4 Average egg measurements
- 6.5 Mean and range of post-partum infertility
- 6.6 Mean and range of copulatory behavior
- 6.7 Age of first reproduction
- 6.8 Reproductive senescence
- 6.9 Artificial insemination
 - 6.9.1 Semen collection methods
- 6.10 Breeding season
- 6.11 Effects of group housing
- 6.12 Fertility
- 6.13 Molt

7. Chicks

General information

- 7.1 Plumage changes
- 7.2 Sex ratio at birth
- 7.3 Mortality first 30 days
- 7.4 Growth rates
- 7.5 Introduction of juvenile birds to flocks

Parent reared chicks

- 7.6 Hatching procedure
- 7.7 Development and parental care of chicks

Handreared chicks

- 7.8 Hatching procedure
- 7.9 Development and handrearing of chicks
- 7.10 Commonly encountered problems handrearing chicks
- 7.11 Imprinting
- 7.12 Introduction of chicks less than 30 days old to other chicks
- 7.13 Chick measurements

8. Veterinary Care

- 8.1 Infectious diseases
- 8.2 Non-infectious diseases
- 8.3 Parasitic diseases
- 8.4 Chemical immobilization
- 8.5 Clinical pathology
- 8.6 Blood chemistry values

- 8.7 Necropsy protocol
- 8.8 Reaction to toxic plants / metals
- 8.9 Normal vs. abnormal fecals

9. Role of Keeper in Animal Management

- 9.1 Communication
- 9.2 Enrichment
- 9.3 Scale Training
- 9.4 Keeper Research
- 9.5 Pest control
- 9.6 Medicating

10. Miscellaneous

- 10.1 Unusual behaviors
- 10.2 Koris in myth and folklore

11. Bibliography

Appendix I. Kori bustard SSP guideline for pinioning

Appendix II. Sample hand-rearing sheet

Appendix III. Necropsy Protocol

Appendix IV. Annual Egg production sheet

Appendix V. *King of the Birds (A Traditional Zulu Story)*

Section 1. Natural History and Biology

1. Taxonomy

Common names	German: Riesentrappe Afrikaans: Gompou French: Outarde de kori Spanish: Avutarda kori
Order	Gruiformes
Family	Otididae
Genus	<i>Ardeotis</i>
Species	<i>Ardeotis kori</i>
Subspecies	<i>Ardeotis kori struthiunculus</i> (eastern Africa) <i>Ardeotis kori kori</i> (southern Africa)

The oldest fossil records of Bustards are from France and date back to the late Eocene and early Oligocene about 38 million years ago (Mourer-Chauviré 1982, Olson 1985). Additional records are known from the Miocene of Bavaria (23 million years ago) and the Pliocene of Asia (5 million years ago, Sanchez Marco 1989-90).

2. Morphology

2.1 Measurements (Johnsgard 1991) (all measurements refer to *A. k. struthiunculus*)

	Male	Female
Weight	10-15 kg	5.5-7.0 kg
Weight*	15-19 kg	
Tail	370-387 mm	280-342 mm
Wingspan	752-767 mm	600-655 mm
Culmen	95-120 mm	81-95 mm
Tarsus	230-247 mm	181-205 mm

* Weights during breeding season

2.2 Physical description (Johnsgard 1991)

Adult male. General color above dark sandy brown, with blackish vermiculations and with a slight grayish shade, some of the feathers of the mantle and upper back rather more blackish; lower back, rump and upper tail-coverts like the back, the latter rather more coarsely freckled; lesser wing coverts like the back; median coverts mostly white, coarsely mottled with black or grey freckles, and having a broad black subterminal bar and a white tip; greater coverts also like the median, but more thickly mottled with black or grey vermiculations; alula like the median or greater coverts, but the subterminal bar not so strongly indicated; primary coverts ashy brown, the inner ones mottled and broadly

tipped with white; remiges brown, the two outer ones scarcely freckled with white on the outer web, but the inner ones becoming more white on the inner web, barred with bluish-gray and tipped with white, some of the inner primaries checkered with sandy buff on the outer webs; secondaries bluish-gray everywhere mottled with white, the feathers tipped white and a subterminal bar of blackish-brown, the innermost secondaries like the back; rectrices ashy brown at the base, crossed by two broad bands of white, which are separated from each other by black bands, one broad and one narrow, the latter followed by an indistinct white band which merges into the sandy-brown ending of the tail, this portion having a narrow band of black, a much broader subterminal band of black, and a white tip; crown strongly crested, black, with a grayish band of feathers down the center, and a black post-ocular stripe (the latter reduced or lacking in *A. k. kori*); the nape and sides of posterior crown grayish white barred with black, exactly like the whole of the neck; sides of face, throat, a streak over the eye, a patch in front of the eye, anterior cheeks and chin all white; on the foreneck, partly concealed by the long barred feathers of the lower throat, is a crescentic band of black, the sides of the upper breast also marked with black; remainder of undersides white, including the axillaries and most under wing-coverts, the lower primary-coverts ashy freckled with white. Iris lemon-yellow to orange-brown; bill light horn color, darker brown above and yellowish below; tarsi and toes light yellowish. Subadult males are similar in size to adult males but have a thinner neck (Osborne 2001). During the breeding season, male kori bustards (*A.k.struthiunculs*) have a darkened throat patch, which becomes less black following post-breeding molt.

Adult female. Smaller, with the black on the crown and eye-stripe somewhat reduced (Urban et al. 1986). Juvenile females have a slighter appearance with a slimmer bill, thinner legs and a brownish back (Osborne and Osborne 2001).

2.3 Sexual dimorphism

Male kori bustards are twice as large as females with males weighing anywhere from 10-18 kg and female from 5-7 kg. Plumage is similar in the sexes with individual birds showing variation in banding patterns.

2.4 Vocalizations

Kori bustards are generally silent. When alarmed however, both sexes produce a barking sound. During capture, loud roaring noises are made. Displaying males produce a low-pitched 6-noted booming noise as part of their mating display. Chicks utter soft cooing noises when contented and during feeding times.

3. Longevity

The life span of kori bustards is unknown in the wild although presumably, they are relatively long-lived given their delayed sexual maturity and low reproduction rate.

4. Zoogeography and Ecology

4.1 Distribution

*Present range of *Ardeotis kori struthiunculus**

The present range of this subspecies is smaller than in previous times. In Ethiopia, the species is now found only south of 9° latitude. From there, the range extends west to the extreme southeastern part of Sudan and south to western Kenya and northeastern Uganda. There are no records of birds in Somalia since 1970. In Tanzania, it is restricted to the northern plains (P. Goriup, pers. comm., and N. Baker, pers. comm.). They are scarce around the coastal lowlands of Tanzania and Kenya (Zimmerman 1996).

*Historical distribution of *Ardeotis kori struthiunculus**

The subspecies historically ranged throughout most of Ethiopia (Ash 1989) and southeastern Sudan (below 9° latitude). From there it ranged southeast to northwestern Somalia and then west and south to northern Uganda, Kenya and the highlands north of the Singida province in Tanzania.

*Present range of *Ardeotis kori kori**

The present range of this subspecies is smaller than in previous times. It is now distributed in the semi-arid areas in the western half of southern Africa to include Namibia, extreme southern Angola (rare visitor), western Zambia, Botswana, western Zimbabwe, South Africa and the Limpopo Valley of Mozambique.

In South Africa, it is found mainly in the Transvaal lowveld and the northern Cape Province, as well as the Kruger and Kalahari Gemsbok National Parks (Kemp 1980) although it is very scarce along the eastern border of Kruger National Park (Barnes, 2000) near Mozambique. It is a vagrant in Lesotho (Goriup, pers. comm.). Allan (1988) reported that the species has declined in the Transvaal, Orange Free State and parts of Cape Province and Parker (1994) noted that this subspecies went extinct in Swaziland prior to 1960.

*Historical distribution of *Ardeotis kori kori**

This southern race historically ranged throughout most of southern Africa including Zimbabwe, Botswana, southern Angola, Namibia, South Africa, southern Mozambique (Johnsgard 1991) and Swaziland (Harrison et al.1997).

4.2 Habitat

The kori bustard (*Ardeotis kori*) is indigenous to the grasslands and lightly wooded savannas of southern and eastern Africa. The nominate subspecies *A. k. kori*

occurs in Botswana, Zimbabwe, Namibia, southern Angola, South Africa and Mozambique (Johnsgard 1991), and prefers wooded grassland areas and dry savannas. In arid grassland areas it is found along dry watercourses where patches of trees offer shade during the heat of the day. In eastern Africa, *A. k. struthiunculus* occurs in Ethiopia, Uganda, Sudan, Kenya and Tanzania in areas of open grasslands including karoo, bushveld, thornveld, scrubland and savanna habitats (del Hoyo 1996). The miombo woodland of Central Africa separates the two populations.

4.3 Population

Throughout its range, the species is uncommon to locally common, but generally declining (Urban et al. 1986). The habitat of both subspecies is under threat from the spread of agriculture, high human densities, illegal hunting, over grazing by livestock and bush encroachment. According to del Hoyo (1996), the kori bustard is showing signs of chronic decline and local extinction over its entire range. Total population size has not been reported for either subspecies.

Status of habitat, total population size and size of population fragments of *Ardeotis kori struthiunculus*

The entire East African region is currently undergoing widespread ecological changes as a result of increased agricultural practices and other forms of land use (Mwangi 1989). Since 1950, the area of land used for agriculture has increased by 26% (Happold 1995). Lado (1996) states that the most serious threat to the future of wildlife in Kenya is habitat destruction and/or alteration. In the Masai Mara for example, the area used for wheat production has grown from 4875 ha in 1975 to over 50,000 ha in 1995. In the nearby Loita plains, (where kori bustards are known to frequent), wheat production continues to expand as the human population grows and farmers realize the agricultural potential of the land. As areas used for agriculture expand in Kenya, it can be expected that the numbers of wildlife, including kori bustards will decline (Ottichilo 2001).

The spread of agriculture, urbanization, pollution, pesticides, (including those that are banned in other countries), and other consequences of an exploding human population are all contributing to a deteriorating situation for many species of wildlife, including kori bustards. Total population size has not been reported in East Africa nor has it been reported for individual countries.

Country	Population size/status
Sudan	Breeding populations exist in the extreme southeastern area of the country, but total population size is unknown. Possibly only a dry season visitor to this country (Nikolaus 1987).
Kenya	Kori bustards are most numerous in the dry grassland areas of northern and western Kenya and the Rift Valley highlands south to Mara Game Reserve, Loita Plains, Nairobi National Park and Amboseli National Park. They are scarce and localized from the Tana River south to Tsavo West and Tsavo East National Park (Zimmerman 1996). Total population size is unknown. Mwangi (1988) estimated 0.3 birds per km ² in Nairobi National Park in 1986/87.

Uganda	Breeding populations exist in Acholi, Lango and Kidepo National Park. Total population size is unknown.
Ethiopia	Kori bustards were formally fairly common in Ethiopia south of 9° latitude, but numbers have declined (Goriup, per. comm.). Total population size is unknown.
Somalia	There are no records of birds in Somalia since 1970.
Tanzania	The Serengeti National Park, Ngorongoro Conservation Area, Tarangire National Park, Maswa Game Reserve, Arusha National Park and Mkomazi Game Reserve offer long term protection and viable numbers of birds can be found in these protected areas. It is still relatively common in the Rift Valley highlands. There is a small and isolated population in central Tanzania, which occupies a small area at low densities (N. Baker, pers. comm.) It is regarded as scarce around the coast (Zimmerman 1996). The birds are hunted around the Lake Eyasi Basin, Lake Natron and in the foothills of Mt. Kilimnjaro Neil Baker (pers. comm.). Total population size is unknown.

Status of habitat, total population size and size of population fragments of *Ardeotis kori kori*

In general, the greatest numbers of kori bustards in southern Africa are to be found in protected areas, for example in Botswana, where birds were 45 times more frequently seen in protected areas than on unprotected areas (Herremans 1998). The species is listed as a vulnerable species in the South African Red Data book (Brooke 1984) and more recently, in the Eskom Red Data book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000).

Country	Population size/status
Botswana	Despite low human densities, kori bustards are under severe pressure from habitat loss. Nonetheless, strongholds for the species include the Kalahari Gemsbok National Park (est. 100-140 birds (Barnes 2000)), Central Kalahari Game Reserve, Nxai Pan National Park and the Chobe National Park where road counts found 1 bird/106 km. However, in unprotected areas, the density level dropped to 1 bird/4356 km (Harrison et al. 1997). Suitable habitat for kori bustards has been lost due to grazing by livestock, which has increased dramatically over the past 100 years. Livestock numbers continue to grow despite reports of overgrazing and forecasts of devastating long-term land degradation since the early 1970's. Grazing pressure has resulted in habitat deterioration of large grassland species such as the kori bustard (Herremans 1998). Total population size is unknown.
Namibia	The stronghold for kori bustards in Namibia and possibly the world is in Etosha National Park where Osborne and Osborne (1998) found 1 bird/16 km. Outside the park boundaries however, birds are hunted.
Zimbabwe	Suitable habitat for kori bustards is deteriorating through overgrazing by livestock and the situation is similar to Botswana. The species has decreased in several areas most noticeably in the Mashonaland plateau (Harrison et al. 1997) where birds are hunted. The decline in this area

	was first noticed in the 1920's (Irwin 1981). Total population size has been variously reported in 1980, when an estimation of 10,700 birds was given by Rockingham-Gill (1983), although Dale (1990) reported 5000 birds and Mundy (1989) estimated 2000 birds and states that Rockingham-Gill's 1983 estimate is vastly over estimated. Total population size is unknown. Matabeleland is the stronghold for the species in Zimbabwe (Rockingham-Gill 1983).
South Africa	Numbers have declined in the 20 th century, but the extent of the decline is unknown (Brooke, 1984). Kruger National Park supports 100-250 individuals (Barnes, 2000). Outside protected areas, kori bustards are found in relatively large numbers only in the Platberg-Karoo Conservancy in South Africa (Barnes, 2000). Allan (1988) reported that the species has declined in the Transvaal, Orange Free State (where it is uncommon to rare) and in parts of Cape Province. Total population size is estimated to be between 2000-5000 birds.
Mozambique	It is locally threatened and probably numbers less than 100 birds (Parker 1999). Hunting is the biggest threat.
Other	Parker (1994) noted that this subspecies went extinct in Swaziland prior to 1960. In Angola, the species is a rare visitor. In Zambia, kori bustards are found only west of the Zambezi River although their status there is unclear. The Sioma Ngwezi National Park may offer protection. It is considered very sparse in Natal with one sighting reported in 1976 (Cyrus and Robson 1980).

4.4 Conservation Status

Kori bustards are listed on Appendix II of CITES. The southern race *Ardeotis kori kori* is listed as Vulnerable in the South African Red Data Book (Brooke 1984) as well as the Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000).

4.5 Threats to survival

The main threats to kori bustards in the form of human-induced factors include habitat destruction through increasing agricultural development (Dale 1990; Ottichilo 2001) and bush encroachment caused by over-grazing from livestock. Poison used to control locusts is toxic to birds and may possibly be affecting kori bustard populations (Barnes 2000). Although the kori bustard is listed as “protected game” it continues to be hunted over much of its range. In Namibia, it is commonly referred to as the “Christmas turkey” (Osborne 2001) and in South Africa it is called the “Kalahari Kentucky” (Barnes 2000). Collisions with overhead power lines are a serious problem as exemplified by one 10-km stretch of overhead powerlines in the Karoo that killed 22 kori bustards during a five-month period (Van Rooyen 2000).

Natural factors affecting the species include an inherent low reproductive rate, and reduced breeding activity in dry years with predation pressure a constant. In addition, favored areas such as tree-lined watercourses are becoming unsuitable for kori bustards because they are being invaded by alien plant material (Barnes 2000).

4.6 Natural predators

Natural predators of kori bustards include 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*).

5. Diet and Feeding Behavior

Kori bustards are omnivorous and their food is likely quite diverse, albeit not well documented. Mwangi (1988) recorded kori bustards in East Africa mainly consuming flowers, seeds, fruits, and pods. Insect prey consisted of Hymenoptera, Orthoptera, Coleoptera, Lepidoptera. Non-insect prey consumed included Chilopoda, Diplopoda, Annelida and Reptilia. In Namibia, Osborne (1998) recorded kori bustards eating insects, lizards, leaves, seeds, acacia gum and flowers.

When drinking, kori bustards use a sucking action (Hallager 1994) to draw up water. This form of drinking is unusual in birds and is believed to be an adaptation to an arid climate where water can be scarce.

In Namibia, Osborne (1998) recorded kori bustards were most active at 0900 and 1700 and rested during the heat of the day (1130 to 1530). He observed that koris arose from their sleeping spot about 30 minutes before sunrise and began to feed. Osborne's observations are similar to data provided by Mwangi and Karanja (1993) in Kenya.

6. Reproduction

6.1 Sexual maturity and age at first reproduction

Osborne and Osborne (2001) documented a female (*Ardeotis kori kori*) banded as a chick with chicks of her own three years later. Age of first reproduction in male *A. k. kori* is unknown. Age of first reproduction in East African populations (*A. k. struthiunculus*) is unknown but likely similar to southern populations.

6.2 Seasonality (Johnsgard 1993)

For both subspecies, breeding is closely tied in with rainfall. Breeding may be greatly reduced or even absent in years with low rainfall.

Region	Breeding Season
South Africa	September to February
Namibia	November to January
Zimbabwe	September to December, April
East Africa region	January to June, with records also from August & November
Ethiopia	March to June
Somalia	March to June

6.3 Male display

During the breeding season, males gather either singly or in loose lek-like formations and perform “balloon” displays to attract females. Displays can occur throughout the day, but are usually most intense in the early morning and late afternoon/evening. During the height of the male display, the esophagus inflates to as much as four times its normal size and resembles a balloon (Fig. 6.1). This display may be seen up to 1 km away. With the neck expanded, the tail and wing feathers pointed downward, and the crest erected, the male emits a low-pitched six-note booming vocalization as he snaps his bill open and shut (Fig 6.2 and 6.3). Prior to copulation, the male spends about five to ten minutes pecking on the head of the recumbent females (see Section 2: Chapter 6.1.2). Actual copulation lasts no more than a few seconds. Once over, the male leaves and resumes displaying to attract another female. He plays no role in incubation or chick rearing.



Fig. 6.1 Debi Talbott©



Fig. 6.2 Debi Talbott©



Fig. 6.3 Debi Talbott©

6.4 Nesting site

Nests are usually partially hidden and usually located near a grass clump or a rock. One nest in Namibia documented by Osborne and Osborne (1999) was in scattered mopane trees 3 – 5 m tall with interspersed mopane scrub. The nest site was under the canopy and 1.55 m west from the trunk of a 2.5 m mopane tree. In all directions, the nest was 2.5 m from 1.2 - 2 m tall mopane bushes. The actual nest was a shallow scrape in the soil. The soil was calcrete with exposed rocks. The topography of the area was flat. Osborne estimated that the nest would be in the shade until 1500 h. A nest found by Mwangi (1988) in Kenya was located in an open area with tall grass up to 1 m in height and 100 m from the nearest bush. The nest was a bare scrape between two grass tufts thinly lined with sticks, grass stems and mammal pellets.

6.5 Egg laying and incubation

The events surrounding egg laying and incubation are largely unknown for birds in the wild. Osborne and Osborne (1998) found the average brood size in Namibia to be 1.52 chicks. Of 70 females with chicks, 35 had single chicks, 22 had twins and 2 had triplets with the number of chicks raised each year highly dependent on food supplies. In Kenya, Mwangi (1988) found two eggs in a nest (nest described in previous paragraph) measuring 81.0mm x 58.0mm and 86.0mm x 61.0mm.

6.6 Hatching

Mwangi (1988) observed a female who left with her newly hatched chicks immediately after they hatched. The only other report in the literature is from Maozeka (1993) who observed a 2 - 3 day old chick with its mother. Faint whistling sounds were heard, which appeared to emanate from the chick. Upon capture of the chick, feces containing fragments of beetles and grasshoppers were produced.

6.7 Development and care of young

There is limited information in the literature on the growth and development of kori bustard chicks in the wild. Reynolds (1973) observed a 2 - 3 week old chick in Kenya being fed large grasshoppers by its mother. When the pair moved, the chick walked under its mother's belly, immediately behind her legs. A 2 1/2-month-old female captured by Osborne and Osborne (1988) was recaptured seven days later and had gained an average of 21.4 g. A second female caught at 1 1/2 months gained an average of 30 g/day over 60 days and a five-month-old male chick gained 5.8 g/day over 164 days. Osborne and Osborne's (1998) observations of a female with two large male offspring note that "the birds appeared to feed on vegetation (*Acacia nebrownii* leaves and flowers) early in the morning and then started eating insects on the plains as the day warmed up. When it got hot, the birds moved into an *Acacia nebrownii* thicket where they ate gumballs while they rested. In the afternoon, the birds fed on insects and vegetation on the plains."

Females with newly hatched young are believed to feed the chicks primarily insects. Offspring remain with the dam until the start of the next years breeding season (Osborne, pers. communication). Osborne and Osborne (2000) report depredation rates as high as 82% in Etosha National Park.

6.8 Dispersal of young

Osborne and Osborne radio-tagged 72 kori bustards and wing-tagged an additional 35 birds in Etosha National Park. Over the course of four years, they discovered that adult and sub-adult males undertook extensive movements, up to 120 km, following the breeding season. Forty percent of all radio-tagged males left the boundaries of the 22,000-km² park (Osborne and Osborne 1998, 1999, 2000). And although females also dispersed, juvenile males dispersed much further from their natal areas. Juvenile females only emigrated 2 - 5 km from their natal areas. Because they have never relocated any of 21 wing-tagged and/or radio-tagged juvenile males, it is suspected that they disperse much farther from their natal areas, beyond the limit that is feasible to radio-track from the ground or that is economical by aerial means.

7. Behavior

7.1 Activity

Observations by Osborne and Osborne (1998) show that kori bustards in Etosha National Park activity feed at 0900 h and again at 1700 h, resting during the heat of the day. Their observations are consistent with reports by Mwangi and Karanja (1993). Osborne reports that near sunset, birds preen for about 30 minutes. About 30 minutes after sunset, birds lay down and settle in for the night.

7.2 Locomotion

Kori bustards generally move about in a slow walk. Running and flying is generally performed to escape from danger (Mwangi 1988). Birds move throughout the day, but generally less so during the early afternoon at which point, resting is the predominant activity (Mwangi 1988). Although the species is not migratory in the true sense, there is much more to learn about the species movements especially in arid environments where rainfall is unpredictable.

7.3 Comfort movements

The literature is scant when describing the types of comfort activities performed by kori bustards let alone the frequency in which they occur. Mwangi (1988) studied the activity budget of kori bustards in Kenya, and found that preening was an activity of low occurrence that could be observed at any time of the day, but was most observed during the middle part of the day when birds rested. Dust bathing was seen on several occasions.

7.4 Social behavior

Kori bustards are generally solitary animals except for females with chicks, which remain as a group until the start of next years breeding season. Aggregations of birds have been reported. In a 1988 report by Mwangi, of 258 birds sighted, they were alone 68% of the time, in groups of two 22% of the time, in groups of three 6% of the time and in groups of four and five 2% and 0.4% respectively.

Of 610 sightings in Etosha National Park during the non-breeding season, Osborne and Osborne (1998) found adult males alone 66% of the time (Fig. 7.1) and adult females alone 15% (Fig. 7.2). Males did not associate with females other than during the breeding season.

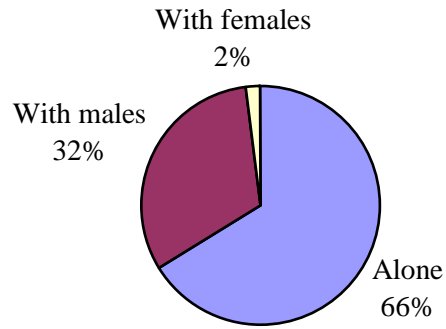


Fig. 7.1. Association of male kori bustards during the dry season, Etosha National Park. Osborne and Osborne 1998

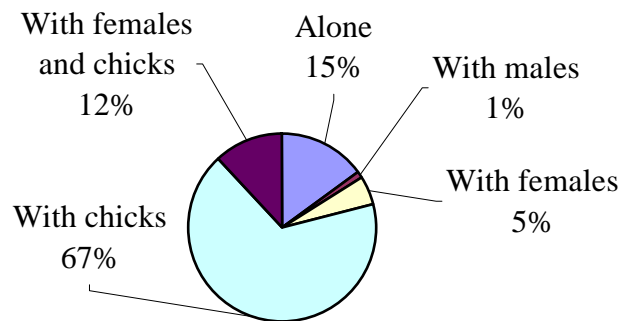


Fig. 7.2. Association of female kori bustards during the dry season, Etosha National Park. Osborne and Osborne 1998

7.5 Sexual behavior

Refer to Section 2 - Chapter 3.3 for sexual behaviors

Section 2: Management in Captivity

1. Enclosure

Kori bustards are terrestrial in nature, (they lack a hind toe with which to perch) therefore large paddock-like enclosures are the most appropriate. However, unless the enclosure is covered, they will need to be flight restrained (pinioned, wing clipped, etc.). Covered enclosures have the added benefit of keeping out unwanted guests. Even though covered enclosures are optimal, they are not necessarily practical or feasible in many captive situations.

Although the number of birds within enclosures varies widely, the minimum enclosure size currently in use is 232 m² (2500 ft²). The maximum enclosure size in use is 4645 m² (50,000 ft²). Obviously, smaller exhibits will be able to hold fewer birds than larger exhibits

Kori bustards do not thrive in climates that are consistently wet, rainy and damp. These conditions lead to poor feather condition and unhealthy birds. Likewise, exhibits that offer no areas of sun are also detrimental to bustard health. Kori bustards need areas of full sun to allow them to dry off damp plumage and to engage in sunning behaviors (see Section 2, Chapter 5.3). If exhibits contain multiple birds, multiple sunning spots are necessary. Additionally, areas of shade need be available, especially in hotter climates.

1.1 Boundary

The preferred boundary for kori bustard enclosures is one-inch chain link mesh. This size mesh reduces the chances of chicks getting out and large rodents getting in. The smaller welded wire also eliminates any chance of a bird getting a leg caught in the fence during a capture. Even though some birds are successfully maintained in exhibits with a 2.4 m (8 ft) high fence the preferable height is 3 - 3.7 m (10 - 12 ft). Kori bustards are powerful flyers and even flight-restrained birds can escape a 2.4 m fence when startled or on a windy day.

Just as care must be taken to avoid housing koris with species that are dangerous to them (see Section 2, Chapter 5.2), consideration must also be made for the species next to whom koris are housed. Species that could injure or kill them should be avoided if the potential exists that a bird could potentially escape the enclosure.

1.2 Substrate

The substrate of enclosures should be natural and non-abrasive for feet and hock joints. A natural soil or grass substrate is most appropriate. As koris are birds of arid environments, marshy areas in the exhibit should be avoided. The exhibit should be as flat as possible to avoid long-term leg and hip problems that may develop if birds are housed in pens with hills. Koris are fond of dust bathing and an area for dust bathing should be provided. This area can be sand, peat moss or coarse oyster shell.

1.3 Furnishings (plants to use/plants to avoid)

Koris can be housed with a variety of plant furnishings although there are some considerations to keep in mind. Plants that have large thorns and/or thick flower stems should not be used as birds can puncture themselves on these kinds of plants. Additionally, ornamental grasses with thick, hard stems and bamboo should be avoided because birds have impaled themselves on these stems. Edible fruits can be planted in the enclosure, but fruit size must be considered because koris tend to eat just about anything that looks interesting. Plants with fruits large enough to cause an impaction must be avoided. Large, soft stemmed grasses and small shrubs scattered throughout an exhibit will give the birds ample cover and provide visual barriers for multiple-bird exhibits. Mature trees, which offer shade as well as limited protection from inclement weather, are also desirable.

1.4 Maintenance

Keepers should check the perimeter of the enclosure daily to ensure that there are no entry holes that may allow predators access. If the exhibit is surrounded by hot wire, this too should be checked and kept in working condition. Any small holes that develop in the soil (either from erosion or rodent activity) should be filled, because bustard feet are small and broken toes and legs can result. Fecal material should be removed from the yard daily to minimize the spread of parasites. Keepers should inspect the grounds where birds have the closest access to the public and immediately remove any foreign material.

1.5 Environment

Koris are not perching birds, so logs and props for perching are dangerous as trip hazards. Avoid all unnecessary obstacles in enclosures.

1.6 Predator proofing

Native/feral predators are dangerous for both adult and young kori bustards. Foxes and/or raccoons have attacked adult birds, sometimes fatally, and small chicks left on exhibit usually disappear. Thus, enclosures must be built to minimize predator access. Digging predators (e.g. dogs, foxes) can be excluded by burying the base of the boundary 0.3m (1-ft) in the ground. Surrounding the enclosure with electrical wire can deter climbing predators (e.g. raccoons). Covered pens are necessary if hens are allowed to raise chicks. In areas where large predators (e.g. coyote, bobcat, cougar) are common, birds may need to be housed indoors at night.

1.7 Dimensions and specifications of winter holding stalls

Zoos in zones where temperatures fall below 0° C (32° F), must have winter holding facilities available for housing birds during inclement weather. Kori bustards are susceptible to frost bite and must not be left outside during periods of freezing rain or snow. Even zoos that do not experience extremely cold weather should have a shelter available. The shelter can be used for times when pen repairs are needed, for medical confinement, to minimize food loss from wild birds or when birds must be caught (see Section 2, Chapter 3: Capture and Transport).

For winter holding of two compatible birds, the minimum recommended space per bird is:

- 2.4 m x 3 m (8 ft x 10 ft) for overnight holding
- 2.4 m x 4.9m (8 ft x 16 ft) for housing up to 7 days
- 3 m x 6.1 m (10 ft x 20 ft) for housing longer than 7 days. Outside holding yards should exist so that birds can be allowed outside access.

The recommended oblong dimensions allow for some exercise space as well as allow the birds to distance themselves from keepers during shelter cleaning. These recommendations are *highly* dependent on the compatibility of cage mates. Larger dimensions or separate shelters may be required for birds that have a lower degree of compatibility.

Sheds should have the capability to be divided in the event that birds are not compatible in small areas. Sheds should be heated to 10° - 15.5° C (50 - 60° F). Heat bulbs, if used, should be encased in protective wiring to prevent bulb breakage in case a bird makes contact with the bulb. Lights should be installed that can be turned on during the day and off at night. Skylights, which allow for natural light in the stalls, may be advantageous for birds that must be housed for extended periods. A small night-light turned on at night will provide some degree of light for the birds. The floor of the shed can be dirt or sand which can be covered with bedding hay (straw). Concrete is not recommended as birds can slip if startled. Sliding doors, operable by ropes outside the shed, are useful for controlling access without having to enter the shelter.

1.7.1 Additional winterizing

Both wild caught and captive born birds will readily utilize heated straw piles in their enclosure when temperatures fall below 4.4° C (40° F). Heated pads (pig warmers) covered with straw will allow birds to remain outside longer. This is especially advantageous when working with wild caught birds, which can be more reluctant to utilize shelters. The straw must be replaced when it becomes wet because kori bustards will not use wet straw piles.

1.8 Water

Kori bustards require only small areas of water from which to drink. They are not heavy drinkers but do drink on a daily basis. Heated water dispensers for northern zones are recommended. Kori bustards do not bathe in water (they dust bathe) so pools are not needed in exhibits (except for aesthetic reasons). If pools are present in enclosures, they should be shallow enough that a bird can walk through the water and the sides should gradually slope to the deepest portion. Pools deeper than 2 feet are not recommended.

2. Population Management

2.1 Population status

Estimates of populations in eastern and southern Africa are provided in Section 1 – Chapter 4.3. Kori bustards are the most numerous bustard species held in North American zoos. As of 1 January 2004, there were 66 birds in 18 zoos.

2.2 Individual identification and sexing

2.2.1 Individual identification

A basic requirement for successful research and captive management of kori bustards is individual identification. Techniques used in kori bustards include leg bands and transponders. Colored, metal leg bands placed above the hock are recommended for those zoos with multiple birds to aid in easy and fast identification. Plastic wrap-around bands are not recommended, as curious birds will remove them and possibly ingest them. Transponders are injected by syringe under the skin where they can be detected and read by an electronic scanner.

2.2.2 Sex determination

As kori bustards are sexually dimorphic with males being twice as large as females, sexing adult birds is easy. Adult weights for males range from 10 to 18 kg. Females typically weigh from 5 to 7 kg. By the time birds reach one-month of age, males are usually distinguishable from females by their larger size. From data on captive-reared individuals, at 65 days of age, individuals greater than 2200 grams were males and less than 2200 grams were usually females. If earlier determination of sex is needed, chicks may be sexed by taking a small amount of blood for DNA sexing. At birth, males tend to have "squarer" heads.

2.3 General record keeping

The need to keep accurate, complete and detailed records cannot be overemphasized. Zoos should enter data in ARKS (Animal Record Keeping System) which is a program developed by ISIS (International Species Information System). Records for the entire life of each bird should be kept and should include:

- A) Diet: Dietary components, amount of food fed and method of feeding
- B) Housing: Dates of when birds are moved indoors, outdoors or to new enclosures
- C) Egg production and reproduction: Yearly onset of egg laying, male display, copulation observations, egg fertility, egg measurements
- D) Weight of adult birds: Weights of adult birds using the scale training method protocol described in Section 2 - Chapter 9.3
- E) Measurements of adult birds: See Section - Chapter 2.4
- F) Behavior: Observations of aggressive behavior including animals involved
- G) Medical problems
- H) Cause of death: A copy of the final pathology report should be sent to the SSP Coordinator
- I) Any other information which a Curator deems pertinent to include in the individuals record and which may improve husbandry standards for the species

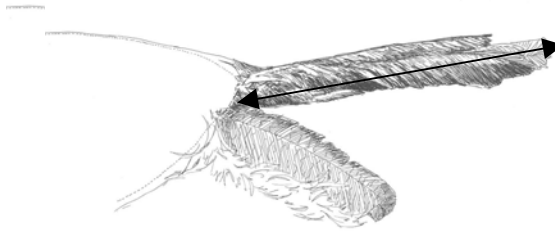
2.4 Measurements of adult birds

It is important to take body measurements on every kori bustard at some point during the animal's life. These measurements are of important use in taxonomy, species characterization, and eco-morphology (the study of the relationship between body form and ecology). In addition to the measurements taken below, also record the sex, age, collection date, sexual condition, weight and collectors name. Please send these measurements to the SSP Coordinator.

Wing length- Measure from the "wrist" to the tip of the longest primary.



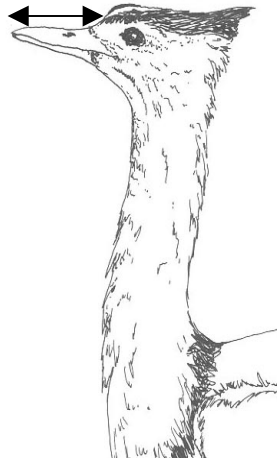
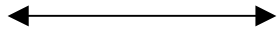
Tail length - Insert a ruler centrally between the longest tail feathers and the under-tail coverts until the ruler stops.



Tarsus-Measure on the front of the leg from the joint of the tibiotarsus with the tarsometatarsus to the lower end at the foot (last scute).

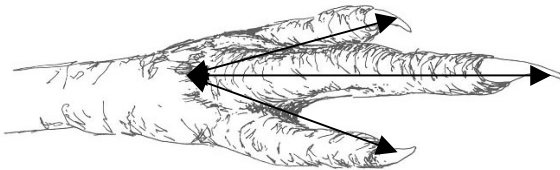


Skull- Maximum length from the rear of the skull to the tip of the bill. Also measure skull width (across the postorbital bones).



Culmen- tip of bill to base of skull

Toe, inner, middle and outer- Measure from the tip of the nail to the joint of the toe with the tarsometatarsus.



3. Capture and Transport

3.1 Capture methods

Koris, especially adult males, are very powerful birds and require somewhat different handling skills from other long-legged birds of similar size. Historically, the species has been prone to leg and wing fractures at the time of capture. They are particularly prone to capture myopathy.

There are three aspects of the birds that demand different handling. 1) The physical strength of the birds, especially adult males, which can weigh as much as 18 kg during breeding season. 2) The thinness of their skin. Bustard skin is very thin and rips easily when a bird is struggling. Torn skin will result in further handling for sutures, etc. This can also lead to maggot infestation. 3) Their inherent nature to shed feathers when captured. Kori feathers are very loosely embedded in the follicles and even the best handling will result in lost feathers. Improper handling can cause major feather loss.

Preparations for Capture:

- a) Two people are needed to capture and handle a bird and, in the case of males, it is absolutely essential to avoid injuries. The initial catch is made single-handed and the second person is there to help bring all limbs under control. Adult males require that a second person be there to take additional control of the legs and wings. A person of small stature (male or female) may be incapable of adequately restraining an adult male kori, regardless of their skill and experience.
- b) The capture team should discuss their plan of operation *before* starting the capture. As with all procedures, begin with a discussion to explain how and why the bird is being caught, where you will be catching the bird, what equipment you need, who will take part in the capture and where you will be releasing the bird. All this should be taken care of away from the catch area as to reduce the stress on the birds, especially if they see nets and/or many people. Captures, which can be done in the early morning hours (especially in southern zones), are recommended to reduce the risk of heat stress to the birds.
- c) Equipment needed for handling birds consists of a dark hood or towel for the bird to reduce stress and struggling (Note: hand-reared birds may prefer to remain unhooded), a net (see below), protective eyewear (if desired or an institutional requirement), gloves (if desired) and a chair for the handler (highly recommended if the bird is to be restrained in the same place for several minutes).
- d) If birds are to be bled (from the leg) when the temperature is below 40° F, it is recommended that birds first be housed in a warm area for a minimum of 30 minutes to allow their legs to warm up. This will allow their blood to clot much quicker following blood collection than if the leg is cold and will reduce the amount of time the bird must be restrained by as much as 10 minutes.

Safety Concerns for the Birds: Because of the physical strength of koris it is recommended that the following checks be done prior to the actual capture:

- a) Choose the preferred capture site. The capture is preferably done in a small, darkened and enclosed area such as a shed or stall with solid walls so that the chance of evasion is greatly reduced. Whenever avoidable, do not corner a bird against chain-link or welded-mesh fences as the birds are more likely to receive trauma to their beaks, heads, carpal joints and feet because they tend to try to “climb” a see-through barrier. If catching a bird in an enclosed area, such as shelter or stall, you may wish to use the shift stall doors to your advantage and capture the bird as it walks through the door into the adjacent area. Again this is potentially dangerous to the bird and will require quick and firm control of the bird as quickly as possible. The bird should be moved away from the walls to reduce injury. Padded walls may be beneficial in a capture area to reduce the chance of trauma. Even fixing corrugated cardboard to the walls can be beneficial though there are plastic alternatives for more permanent use.
- b) If birds are to be captured in their yard, make certain that the fence line at the capture area is at least seven-foot high, preferably more. Even pinioned koris can jump high.

Safety Concerns for the Keeper: The main cause of injury to a keeper from a kori will most likely come from the pushing out of the feet during restraint. Again, they are very strong-legged birds and to tuck them into a position to carry them can be rather difficult. This is why it is necessary to have two keepers present to insure proper safety of the bird as well as the keepers involved. Goggles may be worn as an added safety measure to protect the eyes of the restrainers. It is unusual, but not unheard of, for kori bustards to poke at their holders face.

Capture: The ease of capture will vary widely, depending on exhibit design. If the birds are accustomed to coming into a shed or stall daily for their food, there may be less stress in the capture because the birds can be enticed in with food. In the absence of an indoor capture area, utilize a small area with either trees or brush to assist in directing the animals into the catch area. This can also be created using a funneling system. If there is not an opportunity to funnel, use the boundaries of the exhibit (such as fences or walls) to direct the animal to your catch area. The catch area needs to be such that you can quickly gain control of the bird. Once in the containment area it is very important to catch the bird quickly. The less the bird crashes around to avoid capture the less it will be stressed and the less the chance of resulting injury. (See Safety Concerns for the Birds above.) When cornered against a solid wall, most koris will generally attempt to leap into the air and even a pinioned bird can jump at least six feet into the air. Ideally the bird will be caught before it actually takes the leap. If it does leap upwards try to catch it just as its feet get back onto the ground and before it can leap again. Never grab for the tail or wings, you’ll be left with a handful of feathers and an even more panicked bird.

Nets: *It is strongly recommended that whenever possible, do not catch a kori with a net as the risk of injury to the bird escalates greatly with this capture technique.* Injuries will be greatly reduced if birds are guided into darkened areas (see above) and then caught by hand. However, if a net must be used, the following suggestions are made. To actually catch the bird you may use a long handled flex-head net that has the basket pulled back as not to allow the bird’s entire body to get into the net. This will give you some ability to

cover the bird and move in to gain body control without pushing down too heavily on the bird itself. Great care must be made not to catch the legs or feet within the net. Once the body and legs are controlled it will be necessary to lift or walk the bird to the area of the procedure. If this is at an off-site area, you may wish to crate the bird. Remove the net from the bird quickly after capture.

Restraint: The preferred method of restraint is fairly standard - tuck the body of the bird under one arm with the head at your back. The weight of the bird rests primarily on the holder's forearm while the other hand is used to restrain the legs. Legs are generally not tucked up under the body, as it is possible for a bird to break its leg if it is too tightly restrained this way when it struggles. Restrain the legs at the tarsal joint with at least one finger keeping the legs apart so that they do not abrade the joints against each other. The second handler should immediately cover the eyes of the bird without blocking the nares or holding the beak shut so that the bird can breathe and pant. Once in hand, it is best not to apply pressure to the body from above to make the bird "sit"; as this may cause the bird to resist as well as put undo pressure on the legs. Koris can flap their wings, and since they are large birds it is important to make sure the wings are tucked firmly against the body of the bird. It is not necessary to restrain the head (koris do not poke like cranes), however, it may be in the best interest of the restrainer to have the head under control. When doing this, make sure to not block off the airway for breathing. You may use a towel to cover the eyes in order to calm the bird.

Transporting: For internal transfers, on property, it is better if the bird can be hand-carried as this will reduce the problems associated with recapture once the bird is released from its crate. If there are more birds being caught than can be carried, the use of crates will be necessary. A crate that is padded on top (to protect the head), tall enough for the bird to stand upright and just narrow enough to restrict a large amount of movement is recommended. Crates work very well for transport but removing a kori from a crate so that it can be handled is tricky. If a kori is to be re-captured once released from a crate, it is recommended to release the bird into a small area to let it calm down, and then recapture it again using the technique described above. If a bird is being caught for a procedure that will involve anesthesia, it can be helpful to begin the anesthesia at the exhibit so that the bird is already unconscious when it arrives at the clinic. Use of this technique will of course be up to the discretion of the veterinarian. However, it can greatly reduce the stress on the bird.

Release/Recovery: For the release of a manually restrained kori it is important to be cautious in regard to stabilizing the bird before release. Always release the bird in the direction of a clearing that allows it time to gain its balance and get its bearings. Before releasing the bird, position yourself so that the legs of the bird are touching the ground, keeping in mind they do jump with power. Direct the bird towards your clear area. Once the bird feels stabilized, simply release the bird from your control and slowly step back from the bird. The bird will most likely move away from you, but they can just as easily stand there looking at you. In either case, moving towards the exit in a slow and deliberate manner is the best practice.

When recovering a bird from anesthesia, it will be necessary to restrain for a longer period of time. As expected, individual birds can recover at different rates and some discussion should occur as to what will work best for your team. If you are

manually restraining the bird it will be important to maintain firm and constant pressure/control of the body and legs to restrict any sudden outburst of energy. This is common and using an eye guard (towel) will help in reducing this reaction. Once the animal is fully recovered from anesthesia you may release the bird as described above for a manual release, but be sure that the bird has regained sufficient control of its legs to be released.

When recovering in a crate, it is best to make sure the bird is safe from injury and has recovered completely before release should occur. If you move the crate during recovery, take the time to do this slowly as not to startle the bird. Release is similar to the manual release with the direction of the door to the crate positioned to a clearing that the bird can see. Open the door and step back away so that the bird can step out on its own accord. Once the bird has moved away from the crate, simply move it out of the area while watching the bird for any negative reaction.

3.2 Crating methods and crate design

Shipment: All crates for shipping koris by air must meet IATA recommendations. Your Registrar will have the most recent copy of the IATA recommendations for shipping. Shipping recommendations can also be found on line at www.iata.org.

Crate size will vary according to the sex of the bird being shipped. Crates should not be too large. Koris tend to be highly-strung and relatively close confinement will help them to retain their balance and reduce struggling. It is not necessary for a kori to be able to turn around easily within its crate. The bird should not be able to easily see out of the crate. Darkness reduces stress. However, good ventilation is important. The birds are large and body heat will increase the interior temperature considerably. This is especially significant in summer.

Crate design: Crates can be made specifically for the purpose or it may be possible to use a plastic airline dog kennel of appropriate size for females and juvenile males. Regardless of crate type the following recommendations should be followed:

- 1) Pad the roof of the crate to protect the top of the bird's head.
- 2) The floor should be covered with a non-slip material such as indoor/outdoor carpeting. Hay or straw should not be used because they do not give enough traction when placed on a plywood or plastic floor. Koris have very small feet for the size of their bodies and lose their balance easily.

3.3 Transport procedures

Shipments are preferably carried out early in the day especially during times of extreme heat. Food and water are not needed in the crate unless the bird will be held in the crate for more than 24 hours. When moving the crate, be sure to keep the crate as upright as possible and when the crate is in a vehicle, avoid making sudden stops and sharp turns. Upon arrival at the new destination, let the bird out of the crate as soon as possible. Water should be immediately available. *Wild caught birds, even those previously held in captivity may not eat for several days.* Handreared birds will likely eat within a day of arrival (if not sooner).

4. Diet

Note: This is a DRAFT version of the Nutrition Chapter. The final diet section will be inserted upon review by the Nutrition Advisory Group. September 2004. Mike Maslanka and Ann Ward

4.1 Executive Summary

Kori bustards (*Ardeotis kori*) are reported to be omnivorous, consuming mostly insect and plant material in their grassland habitat. A complete nutrient analysis of these food items and their contribution to the overall diet has not been determined. The gastrointestinal tract of the kori bustard is typical of an insectivorous bird, but to this point they have been fed in captivity as “primarily carnivorous” omnivores. Based on free-ranging ecology and gastrointestinal morphology, the recommended diet is based on nutritionally complete feeds, whole prey (vertebrate and invertebrate), and produce. Recommended crude protein in diets offered to captive koris should range between 16.5-30.0% on dry matter basis. When handrearing kori chicks, diets should contain between 18-22% crude protein on a dry matter basis and growth should not exceed 5% of body weight per day, in an attempt to avoid angel wing.

4.2 Feeding Ecology and GI Morphology

Kori bustards (*Ardeotis kori*) are reported to be omnivorous. Studies have shown that they consume mostly insects and plant material in their grassland habitat (Osborne and Osborne 1998-2002, Mwangi 1988, Arlott 1996). General observations of free-ranging koris indicate that although they consume mainly insects, they also consume lizards, leaves, seeds, acacia gum, and flowers (Osborne and Osborne 1999). Fecal pellet analysis for white-bellied bustards (*Eupodotis senegalensis*) indicated that they consumed items from three main categories – plant matter (68.5%), animal matter (28.1%), and unidentifiable items (3.4%, Mwangi 1988). This finding was not taken to imply an actual preference, as animal matter may have been more completely digested than the plant matter in the fecal samples.

The kori bustard GI tract is typical of an insectivorous bird (Maloiy et al 1987). The esophagus is not as pronounced as that of a carnivorous bird and the ventriculus is thick and muscular (a trait characteristic of birds consuming complex food items such as insects and plant material; Stevens and Hume 1995, Klasing 1998). Additionally, koris have a pronounced cecum, which is common in omnivorous birds such as ostriches, rheas, cranes, and quail (Klasing 1998).

4.3 Nutrient Content of Free-Ranging Diet

Whereas numerous descriptions of free-ranging kori bustard diets have been reported, the nutrient content of those observed diets has not been well described. Two species of acacia gum were analyzed for moisture (8-27.5%), Phosphorus (0.14-0.24% Dry Matter Basis, DMB), Nitrogen (1.4-14.2% DMB), and Total Non-structural Carbohydrates (18.8-23.3% DMB; Osborne and Osborne 1999). It has been suggested that the koris may eat the acacia gum balls due to the insects that are incorporated into them (Hallager 1997), but no insect remains were reported in the acacia gum balls.

4.4 Target Nutrient Values

The target nutrient levels established for koris were derived from several domestic and exotic species (pheasants, quail, geese, and cranes; NRC 1994 and Anderson 1995). In cases where these target values are expressed as ranges, the low end represents a maintenance requirement and the high end (marked by a double asterisk, Table 4.1) represents a breeding requirement (with the growth requirement tending towards the high end of the range). The “target nutrient levels” are listed as “Proposed Nutrient Guidelines 2004” to indicate that they represent the summation of the information available at this time, and will make it easier to re-evaluate them over time, keeping track of the changes, if any.

Of special note, the proposed nutrient guidelines for crude protein include a range from 16.5 – 30.0% on a dry matter basis. Available data indicates that breeding diets for koris that contain 26.4% crude protein on a dry matter basis should be adequate (Hallager et al 2002). Work with Sandhill cranes (Serafin 1982) recommends dietary crude protein levels of no more than 24% on a dry matter basis for growing birds, which also may be appropriate for growing koris. Ways to decrease the dietary crude protein levels are discussed with the suggested diet composition (section 4.6). All of these crude protein values are considerably lower than those of currently offered koris. A target of 30% crude protein in breeding diets represents a starting point.

4.5 Food Items Available to Zoos

To this point, many captive koris have been fed as “primarily carnivorous” omnivores, with whole vertebrate prey comprising large proportions of the diet offered (see survey data reported in Appendix Tables 4.7, 4.8, and Figure 4.1). Reports of free-ranging koris indicate that they are primarily insectivorous omnivores. There is little indication that whole prey should play a prominent role in the captive diet.

Whereas free-ranging insectivores have a myriad of diet choices, the variety of commercially available insects is limited. It is important that the nutrient content of the insects chosen is known. There are excellent references which provide the nutrient content of invertebrate prey (Bernard and Allen 1997). Gut-loading has been shown as the method of choice to improve the nutrient profile of commercially available insects (Bernard and Allen 1997).

Produce items included in kori diets can range from fruits to leafy greens. Numerous species of plants have been observed in fecal samples from free-ranging koris (Mwangi 1988). Determining the nutrient content of the produce offered, and including it in a nutrient analysis of the entire diet, is important. There are several resources available which report nutrient content of readily available produce items (NRC 2003).

The nutritionally complete items included in the diet should provide the nutrient backbone of the diet. Whereas specific nutritionally complete feeds are not recommended, specifications for an appropriate nutritionally complete feed are listed in Table 4.2. It is important to consider that recommendations are made for the nutrient content of the nutritionally complete portion of the diet rather than for specific nutritionally complete diets themselves.

Several diets which fit the nutrient profile suggested are listed in Appendix Table 4.5 (not an inclusive list of all available). Inclusion of a nutritionally complete feed that meets the specifications, in combination with other items, can allow for the formulation of a diet that meets the proposed nutrient guidelines (Table 4.1). Based on the

Kori Bustard Husbandry Manual – Section 2. Management in Captivity

combination of vertebrate and invertebrate prey and produce, nutritionally complete feeds can be included in the diet at levels of 40% or greater to meet the nutrient guidelines for koris (discussed in Section 4.5). The two pellets listed in the last two columns of Appendix Table 4.5 are pellets that were used to successfully maintain koris in captivity (Anderson 1995, Kock 1990).

Table 4.1. Proposed nutrient guidelines for kori bustards on a dry matter basis.*

Nutrient	Proposed Nutrient Guidelines 2004
Protein, %	16.5-30.0**
Fat, %	-
Crude Fiber, %	-
Ca, %	0.66-2.75**
P, %	0.33-1.0**
Ca:P	-
K, %	0.44-0.72
Na, %	0.13-0.18
Mg, %	0.05-0.06
Cu, mg/kg	5.5-8.8
Fe, mg/kg	55-77
Zn, mg/kg	55-70.1
Mn, mg/kg	66-72
Se, mg/kg	0.2
I, mg/kg	0.33-0.44
Vitamin A, IU/g	1.65-5.5
Vitamin D3, IU/g	0.22-1.2
Vitamin E, IU/kg	11.0-27.5
Thiamin, mg/kg	2.2
Riboflavin, mg/kg	2.75-4.4
Pyridoxine, mg/kg	3.3-5.0
Vitamin B12, mg/kg	0.003-0.01
Biotin, mg/kg	0.11-0.25
Choline, mg/kg	990-1650
Folacin, mg/kg	0.8-1.1
Niacin, mg/kg	22-71.5
Pantothenic Acid, mg/kg	10.5-17.6

* Target values based on NRC (1994) and Anderson (1995).

** Values at high end of range for breeding only.

Table 4.2. Suggested specifications for appropriate nutritionally complete feeds for inclusion in kori bustard diets.

Nutrient	Specifications
Protein, %	12.0-25.0
Fat, %	2.0 min
Crude Fiber, %	16.0 max
Ca, %	0.9-4.0*
P, %	0.3-1.9*
K, %	0.6 min
Na, %	0.13 min
Mg, %	0.2 min
Cu, mg/kg	9.5 min
Fe, mg/kg	130.0 min
Zn, mg/kg	55.0 min
Mn, mg/kg	66.0 min
Se, mg/kg	0.2 min
I, mg/kg	0.4 min
Vitamin A, IU/g	6.5 min
Vitamin D3, IU/g	0.5 min
Vitamin E, IU/kg	35.0 min
Thiamin, mg/kg	5.5 min
Riboflavin, mg/kg	3.0 min
Pyridoxine, mg/kg	5.0 min
Vitamin B12, mg/kg	0.003 min
Biotin, mg/kg	0.2 min
Choline, mg/kg	890 min
Folacin, mg/kg	1.1 min
Niacin, mg/kg	68.0 min
Pantothenic Acid, mg/kg	11.0 min

* High end of range is maximum for breeding individuals.

4.6 Suggested Diet Composition

Based on the reported foraging strategy of free ranging kori bustards, proposed diet proportion guidelines are presented in Table 4.3. These guidelines assist with diet formulation by proportion in order to insure that nutrient needs are met (and levels of specific nutrients are not grossly exceeded, i.e. protein). It may work best when formulating a diet using the table to select the desired proportions of items present in smaller amounts (vertebrate prey, invertebrate prey, and produce), and use nutritionally complete food items to round out 100% of the total diet.

When ingredients are combined according to the proportions recommended in Table 4.3, diets can be formulated to meet the proposed nutrient guidelines for koris. Table 4.4 lists five example diets using the proportions listed in table 4.3 and some of the nutritionally complete feeds in Appendix Table 4.5. Please note that when produce is used, the total proportion is split 50% apple and 50% romaine lettuce.

The diets listed in Table 4.4 are not recommended diets, but examples of how the proportions listed in Table 4.3 can be used to formulate diets that meet nutrient

Kori Bustard Husbandry Manual – Section 2. Management in Captivity

guidelines. A variety of ingredients can be chosen based upon availability, palpability and management needs.

Table 4.3. Kori bustard recommended diet proportion guidelines (as fed basis).

Item	Minimum, Percent of Diet	Maximum, Percent of Diet
Vertebrate Prey	0	25
Invertebrate Prey	5	30
Nutritionally Complete Feeds*	40	55**
Produce	10	20

* Nutritionally complete feeds are those designed to meet specific recommended nutrient levels. Specifications are provided in Table 5.1 and examples in Appendix Table 12.1.

** Diets which exceed 55% complete feeds can be considered. A diet comprised of 75% complete feed has maintained captive koris (Anderson 1995).

Table 4.4. Example diets which meet proposed nutrient guidelines (2003) for kori bustards (analysis on a dry matter basis).

Nutrient	Example Diets ¹					Proposed Nutrient Guidelines
	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	
Protein, %	29.1	27.9	24.3	21.2	23.6	16.5-30.0*
Fat, %	7.5	7.6	5.5	4.7	2.8	-
Crude Fiber, %	5.3	5.0	14.4	5.3	4.3	-
Ca, %	1.1	1.2	0.9	0.8	3.6	0.66-2.75*
P, %	0.9	0.8	0.9	0.7	1.8	0.33-1.0*
Ca:P	1.2	1.5	1.0	1.1	2.0	-
K, %	0.6	0.7	1.4	0.7	1.1	0.44-0.72
Na, %	0.1	0.1	0.2	0.1	0.5	0.13-0.18
Mg, %	0.1	0.2	0.3	0.2	0.4	0.05-0.06
Cu, mg/kg	13.1	13.8	25.6	14.2	8.9	5.5-8.8
Fe, mg/kg	187.4	107.7	291.0	264.4	182.0	55-77
Zn, mg/kg	93.2	121.6	194.9	114.7	158.5	55.5-70
Mn, mg/kg	42.7	83.4	183.1	5.3	127.1	66-72
Se, mg/kg	0.3	0.3	0.8	0.4	0.2	0.2
Vitamin A, IU/g	7.9	11.4	5.5	8.8	7.8	1.65-5.5
Vitamin D3, IU/g	0.5	1.8	1.4	2.1	2.7	0.22-1.2
Vitamin E, IU/kg	105.8	96.1	162.3	118.0	203.8	11.1-50
Thiamin, mg/kg	5.1	5.1	11.5	8.5	15.1	2.2
Riboflavin, mg/kg	4.4	2.7	8.9	5.3	13.0	2.75-4.4
Pyridoxine, mg/kg	7.6	4.0	11.9	5.5	12.8	3.3-5.0
Vitamin B12, mg/kg	0.01	0.01	0.02	0.01	0.003	0.003-0.01
Biotin, mg/kg	0.3	0.2	0.4	0.4	1.1	0.11-0.25
Folacin, mg/kg	1.6	1.5	5.4	2.8	0.1	0.8-1.1
Niacin, mg/kg	66.8	63.0	118.7	88.1	88.8	22-71.5
Pantothenic Acid, mg/kg	22.1	14.8	38.8	9.8 [^]	47.3	10.5-17.6

Proportions listed by weight:

¹**Diet 1:** 25% mice, 25% crickets, 35% Zeigler Avian Maintenance (Zeigler Brothers, Gardners, PA 17324), 15% produce.

Diet 2: 15% mice, 25% crickets, 40% Mazuri Waterfowl Maintenance (PMI International, LLC, Brentwood, MO), 20% produce.

Diet 3: 0% mice, 25% crickets, 55% Zeigler Ratite Grower/Maintenance (Zeigler Brothers, Gardners, PA 17324), 20% produce.

Diet 4: 20% mice, 25% crickets, 55% Mazuri Exotic Gamebird Maintenance (PMI International, LLC, Brentwood, MO).

Diet 5: 10% beef, 75% Kock Kori Production Pellets (Breeder; Kock 1990), 15% produce.

² Target nutrient levels established using ranges from domestic poultry (NRC 1994), and Anderson (1995). Breeding values are at the high end of the range and are indicated with an asterisk (*).

[^] Values generated as a result of missing values in database.

4.7 Feeding Schedule

Koris should be fed at least once per day (many zoos feed twice a day), with additional feedings to allow for management and behavioral needs. As long as birds have adequate time to consume the diet, the period of access to diet can range from several hours to all day. Minimizing the presence of pest species and their consumption of the diet may shorten the periods of offering the diet. This should be considered when determining the period of time the koris have access to the diet. The survey information collected indicates that koris are offered diets between 1-3 times per day, and have access to those diets between 1-24 hours each day (Appendix Table 4.6).

4.8 Food Presentation

Food should be offered in such a way as to minimize consumption by non-target (pest) species (See section 9.5) and insure complete consumption of the balanced diet by the birds. Diet can be offered in pans, tubs, buckets, platforms, etc, or hand-fed to individual birds in a group. Kori bustards will consume pelleted foods, so pellet dispensers should be placed in pens to encourage the consumption of dry, nutritionally complete feeds. The survey information indicates that all of these methods are used by holding institutions (Appendix Table 4.6). Fresh, clean water should be available to the birds at all times.

4.9 Health Problems Associated with Diet

Raw Meat Diets and Bacterial Load. Meat is a perishable food item and needs to be handled carefully to prevent spoilage. Spoilage can occur for a variety of reasons, including: (1) growth and activity of microorganisms, often in succession, (2) insects or parasites, (3) action of the enzymes naturally found in meat, (4) purely chemical reactions, and (5) physical changes. The type and number of microorganisms on the meat, in the storage area, in the prep area, on the utensils, or transferred by the handler will determine the type and extent of spoilage (Frazier and Westhoff 1986). Exposure to vertebrate and invertebrate pests may increase the microorganism load or introduce new microorganisms to the meat (Crissey et al 2001). Care should be taken when offering

meat and whole prey to insure that the items are held at appropriate temperatures during the thawing, preparation, and storage periods, and that the items are readily consumed (and do not remain at ambient temperatures capable of sustaining or promoting excessive microbial growth for excessive periods of time).

Growth/Feather Quality. Results of the April 2002 survey indicated that 60% of the survey respondents had problems with breeding and angelwing in their collections. For those who listed “other nutrition-related problems” (33%), they indicated that plumage was the primary issue (50%).

4.10 Handrearing

Few data are available regarding successful hand-rearing of kori bustard chicks (Maslanka and Ward 2003). Nearly 100% of hand-reared chicks prior to 2003 have developed angel wing, a condition linked to high protein diets in waterfowl and cranes (Kear 1986, Serafin 1982). In 2003, consumption data was recorded by weight for two hand-reared chicks. One chick developed angel wing and one chick did not. The chick that developed angel wing consumed a 33% protein diet between days 1-5, compared to 28% for the chick that did not develop angel wing. The growth rate of the chick that developed angel wing was 5.4% of body weight during that period, compared to 5.0% of body weight in the chick that did not. Growth rate of previously hand-reared chicks that developed angel wing ranged from 5.7-8.1% of body weight on a daily basis (mean = 6.8; Hallager et al 2002). Whereas fast growth is important for production birds with significant muscle mass, it is not the goal for captive exotic birds. Angel wing in waterfowl and cranes was successfully “treated” by reducing the crude protein content of the diet offered. For hard-reared koris it may be more appropriate to maintain dietary protein levels that allow normal growth in waterfowl and cranes (18-22%).

When hand-rearing, it is imperative that diets be recorded by weight of each individual food item. This will allow better determination of nutrient content through the early growth period. Growth rates should be restricted to less than 5% of body weight per day.

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Kori Bustard Husbandry Manual – Section 2. Management in Captivity

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4.12 Appendix I – Nutritionally Complete Feeds

When formulating diets, nutritionally complete items should be included as 40-55% of the total diet in order to meet the proposed nutrient guidelines. Nutritionally complete feeds that meet the specification suggested in Table 4.2 can fit into the recommended diet proportion guidelines listed in Table 4.3. Some of these diet items are listed in Appendix Table 4.5.

Table 4.5. Examples of nutritionally complete feeds capable of meeting target nutrient values within the framework provided by the recommended diet proportion guidelines on a dry matter basis (not inclusive of all diets available).

Nutrient	Mazuri		Mazuri WF Maint	Mazuri Ratite	Zeigler Ratite Gr/Mai	Zeigler Crane Breeder	NARC Production Pellet ³	Kock Pellet ⁴
	Exotic Gamebird Maint ¹	Zeigler Avian Maint ²						
Protein, %	13.9	13.9 mi	15.6	16.7	17.8 mi	24.4 mi	24.3	17.8-22.1
Fat, %	3.6	2.2 mi	4.1	4.6	4.4 mi	5.6 mi	-	-
Crude Fiber, %	4.7	5.5 ma	4.6	18.0	15.6 ma	5.6 ma	-	5.0-4.5
Ca, %	0.9	0.9	1.3	1.8	1.0	3.1	3.7	1.4-3.9
P, %	0.3	0.6	0.4	0.9	0.8	0.9	0.9	0.9-1.9
Ca:P	3.0	1.5	3.2	2.1	1.25	7.8	4.6	1.7-2.1
K, %	0.6	0.6	0.6	0.8	1.3	0.8	0.9	0.9-1.0
Na, %	0.1	0.1	0.2	0.3	0.2	0.3	0.2	0.4-0.5
Mg, %	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3-0.4
Cu, mg/kg	10.0	11.5	10.0	20.0	24.4	16.8	16.6	9.6-9.5
Fe, mg/kg	144.4	158.9	155.6	455.6	282.4	348.2	442.9	131.1-191.8
Zn, mg/kg	100.0	49.1	101.1	142.2	175.7	136.9	72.8	69.5-167.2
Mn, mg/kg	111.1	48.5	108.9	122.2	192.1	147.1	80.6	70.7-139.4
Se, mg/kg	0.5	0.4	0.5	0.6	0.6	0.5	0.3	0.2
I, mg/kg	1.2	0.6	1.3	1.2	0.6	0.4	0.9	1.4-2.3
Vitamin A, IU/g	6.7	8.2	10.8	11.3	24.6	19.2	13.8	6.6-7.1
Vitamin D3, IU/g	2.5	0.6	2.5	1.7	1.5	2.1	3.3	1-3
Vitamin E, IU/kg	138.9	140.5	133.3	188.9	173.8	78.6	37.2	75.6-222.0
Thiamin, mg/kg	11.0	6.7	6.9	9.6	12.3	16.3	5.9	12.4-16.2
Riboflavin, mg/kg	6.1	5.7	3.4	11.1	9.4	14.3	8.4	8.6-13.8
Pyridoxine, mg/kg	6.4	10.1	5.4	6.7	126.3	15.2	8.8	9.2-13.7
Vitamin B12, mg/kg	16.7	^	0.01	0.02	^	^	0.02	0.04-0.05
Biotin, mg/kg	0.4	0.4	0.3	0.5	0.5	0.7	0.2	0.3-1.2
Choline, mg/kg	7888.9	1751.7	1133.3	1555.6	1637.6	2188.7	896.4	976-1494
Folacin, mg/kg	3.0	2.0	1.7	6.3	5.4	5.3	1.1	2.5-9.4
Niacin, mg/kg	103.3	88.3	86.7	121.1	126.3	136.2	68.2	75.5-88.4
Pantothenic Acid, mg/kg	11.1	29.1	20.0	28.9	41.1	40.2	25.1	34.7-50.8

¹ PMI Nutrition International, LLC. Brentwood, MO 63144

² Zeigler Brothers, Gardners, PA 17324

³ Production Pellet (Anderson – NARC 1995).

⁴ Richard A. Kock Pelleted Diets (Kock - NARC 1990). Values expressed as a range of maintenance – breeder.

^ Missing values unavailable from manufacturer.

4.13 Appendix II – Kori Bustard Diet Survey

A survey was drafted in April of 2002 in order to collect diet information from holding institutions. The two main issues examined were (1) whether adult koris were being fed as carnivores rather than omnivores, and (2) whether adjustments could be made in the handrearing diet / strategy to minimize the incidence of angelwing. The raw survey is included as Table 4.6. Out of 14 surveys, 13 were returned (93% return rate).

Survey results were used to examine the main issues and propose alterations to nutritional aspects of husbandry for koris (Hallager et al 2002). The results of the survey are summarized in Tables 4.7 – 4.9 and Figure 4.1.

Kori diets currently offered were comprised primarily of whole prey and meat (68%, Figure 4.1). Dry, nutritionally complete feeds were present in the second greatest amount in kori diets (22%). Proportions of diet items in individual institution diets are indicated in Table 4.8. These proportions appeared responsible for the observation that crude protein levels in most diets were well above the target value ($40.4 \pm 9.0\%$, 29.0-56.1% Dry Matter Basis; Table 4.9). Nutrient content of individual institution diets also is listed in Table 4.9. In cases where manufacturers or institutions could not provide complete diet ingredient information, nutrient analysis of the diet could not be performed.

Table 4.6. Kori Bustard Survey (April 2002)

Kori Bustard SSP Nutrition Questionnaire

Date:

Contact person filling out survey:

Phone and fax for contact person:

Circle or fill in answer in appropriate space.

Where are the birds housed?	Inside	Outside	Both		
If outside, access year around?	yes	no			
How long has the bird been on the diet?	_____ years				
Diets changed based on: <small>More than one answer possible</small>	season	breeding	laying	growth	consumption
How does the diet change? (eg. Increase in amount fed, change from maintenance to breeder pellets, etc.)					

How many times per day are the birds fed?

How is the diet presented to the birds?

Does presentation change with different food items?

yes no

If yes, please describe.

How long do birds have access to their diet? _____ hours

Are all items consumed by the birds? yes no

If no, which items are less well consumed?

If some food items are less well consumed, does this vary with individuals or the entire flock?

Would you change the current diet? yes no
If so, how?

Select items that are a problem at your zoo:

obesity shell quality hatch-ability breeding angelwing -
development

Describe problem:

Please note other problems experienced which you believe are diet related:

Do the birds have access to dust pits or grit (oystershell, etc.)? yes no

If yes do the birds consume gravel, dust or grit? yes no

Does your enrichment include in food items? yes no

If so, please include in diet table.
What percentage of the diet is consumed by other animals?

Have you ever observed undigested food items in your birds fecal matter? yes no

If so, which diet items?

Are there any nutritional issues you think should be addressed by the SSP advisors?

Species Data Sheet	1		2		3		4		5	
Bird ISIS #										
M F										
SexUnk										
Weight (kg)										
Date Weight Taken										
Hatch Date										
Check Physiological State										
Adult/maintenance										
Breeding/laying										
Chick rearing										
Chick/growing										
Fledging										
Molting										
Geriatric										

Table 4.7. Summary of Kori Bustard Survey Responses (April 2002)

Question	Percent Yes
Do your birds have access outside at least part of the year?	100%
Is that access year around?	83%
Have your birds been on the current diet for at least 1 year?	100%
Do you base your diet changes on season?	33%
Do you base your diet changes on breeding activity?	8%
Do you base your diet changes on consumption?	58%
Do you base your diet changes on facility changes?	8%
Do regular diet changes involve amount adjustments?	42%
Do regular diet changes involve proportion shifts?	17%
Do regular diet adjustments involve ingredient changes?	17%
Are your birds fed twice daily?	83%
Is your diet offered in a pan?	50%
Is your diet offered by hand to the birds?	25%
Is your diet offered via a different route than those listed?	25%
Does presentation change based on food item?	25%
Do birds have access to their diet for 24 h?	42%
Do birds have access to their diet between 6-18 h?	42%
Table 13.2 (Con't)	
Are all diet items consumed?	67%
If not, is the meat the item not consumed?	75%

Kori Bustard Husbandry Manual – Section 2. Management in Captivity

If not, is the produce the item not consumed?	25%
Would you change the current diet?	58%
If yes, would you change ingredients?	57%
If yes, would you reduce meat or whole prey?	43%
If you have a problem with your collection, is it breeding?	60%
If you have a problem with your collection, is it angelwing?	60%
Do you have other nutrition-related problems?	33%
If yes, are these plumage issues?	50%
Do your birds have access to grit or oystershell?	42%
If they do, do they consume it?	80%
Does enrichment include food items?	75%
Is a portion of the diet consumed by other animals?	83%
If yes, is the proportion 50% or more?	30%
Do you see undigested food in fecal matter?	33%

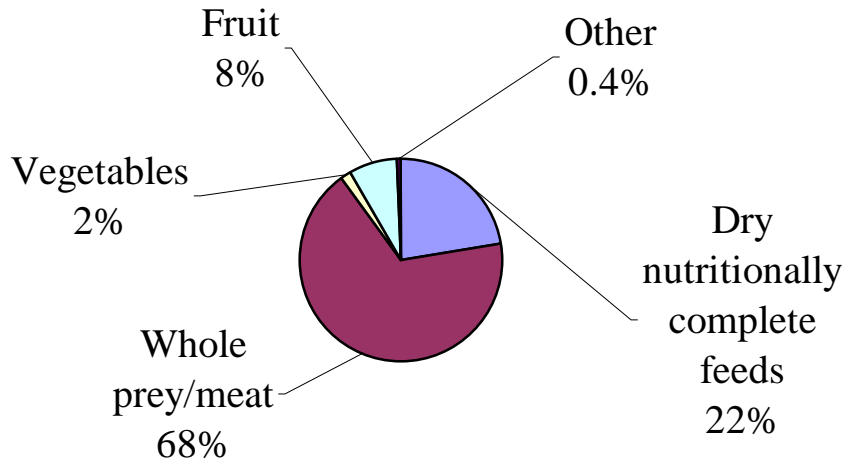


Figure 4.1. Mean Food Group Composition for US Kori Bustard Diets.

Kori Bustard Husbandry Manual – Section 2. Management in Captivity

Table 4.8. Food Group Composition for Kori Diets by Individual Institution.

Food group	Audubon	Baltimore	Cameron Park	Disney	Fort Worth	Jacksonville	National San Diego	WCS	
Dry nutritionally complete feeds	36.5	0	29.2	4	10	15.1	24.7	54.1	27.8
Whole prey/meat	54.1	67	45.3	95.3	78.4	76.3	74.6	45.9	72.2
Vegetables	0	0	2.3	0	5.4	6.8	0.2	0	0
Fruit	7.9	33	23.2	0	6.2	0	0.5	0	0
Other (supplements, nuts, seeds)	1.5	0	0	0.7	0	1.8	0	0	0

Kori Bustard Husbandry Manual. Section2. Management in Captivity

Table 4.9. Summary of Diet Nutrient Content by Individual Institution for Koris compared to Probable Nutrient Requirements (NRC 1994, Anderson 1995).

Nutrient	Range	Mean	SD	Target Value*	AUD	Institution						
						BALT	WACO	DIS	FWZ	JAC	NZP	ZSSD
Crude Protein, %	29-56.1	40.4	9.0	16.5-30.0	29.0	44.5	30.4	56.1	42.9	45.6	40.7	33.9
Crude Fiber, %	1.0-7.0	3.8	2.0	-	4.9	2.6	6.2	2.5	3.4	3.1	7.0	1.0
Fat, %	9.7-22.6	15.6	5.0	-	10.9	18.3	9.7	22.6	17.3	20.9	15.2	10.2
Vitamin A, IU/g	6.0-42.2	14.5	12.6	1.65-5.5	6.3	6.0	23.5	6.3	8.7	42.2	11.7	11.1
Vitamin D3, IU/g	0.6-2.5	1.4	0.7	0.22-1.2	0.5	0.9	1.4	2.5	2.0	1.2	1.7	0.6
Vitamin E, mg/kg	6.0-183.0	85.8	52.0	11-27.5	6.0	183.0	88.6	84.5	52.5	55.4	103.5	112.7
Thiamin, mg/kg	0.6-11.3	7.2	3.2	2.2	1.5	6.2	6.5	0.6**	7.4	11.3	6.7	10.6
Riboflavin, mg/kg	1.0-21.6	13.0	5.7	2.75-4.4	12.6	7.1	12.7	1.0**	18.8	21.6	5.9	12.3
Niacin, mg/kg	5.8-239.0	128.9	61.5	22-71.5	114.4	90.1	115.0	5.8**	239.0	185.3	62.3	96.5
Pyridoxine, mg/kg	0.6-13.3	8.7	3.6	3.3-5	3.7	13.3	9.1	0.6**	10.3	12.4	6.7	5.1
Folacin, mg/kg	0.2-2.4	1.0	1.0	0.8-1.1	0.2	0.5	0.2	0.3**	0.3	2.4	2.4	1.1
Vitamin B12, mg/kg	0.0-0.1	0.1	0.1	0.003-0.01	0.0	0.4	0.0	0.0**	0.1	0.1	0.0	0.0
Pant Acid, mg/kg	1.2-61.7	33.9	21.7	10.5-17.6	35.4	7.3	36.2	1.2**	61.8	61.7	20.1	14.5
Choline, mg/kg	151.4-4536	2212.6	1321.8	990-1650	2837.0	1033.0	2372.0	151.4**	4536.0	2735.0	951.0	1024.0
Biotin, mg/kg	0.0-0.3	0.2	0.1	0.11-0.25	0.0	0.1	0.3	0.1**	0.3	0.2	0.3	0.3
Calcium, %	1.0-3.0	1.6	0.6	0.66-2.75	3.0	1.4	1.6	1.8	1.2	1.4	1.7	1.0
Phosphorus, %	0.7-1.1	0.9	0.2	0.33-1	0.5	1.1	0.7	0.9	0.8	1.0	1.0	0.9
Magnesium, %	0.1-0.3	0.2	0.1	0.05-0.055	0.3	0.1	0.2	0.1	0.1	0.1	0.2	0.2
Potassium, %	0.5-1.0	0.8	0.2	0.44-0.72	0.9	0.5	0.9	0.7	1.0	0.7	0.8	0.5
Sodium, %	0.2-0.5	0.3	0.1	0.13-0.18	0.3	0.2	0.3	0.2	0.5	0.4	0.2	0.2
Iron, mg/kg	145.2-294.4	223.5	50.6	55-77	231.9	160.9	272.4	230.1	213.5	294.4	239.3	145.2
Zinc, mg/kg	92.1-163.0	125.4	25.6	55-70.1	112.6	92.1	105.4	163.0	107.9	127.2	157.8	136.9
Copper, mg/kg	8.8-16.0	11.7	2.6	5.5-8.8	16.0	10.3	13.6	8.8	8.9	9.9	14.0	12.1
Manganese, mg/kg	12.9-137.5	71.8	39.3	66-72	137.5	12.9	100.4	48.0	78.2	65.7	93.1	38.3

Kori Bustard Husbandry Manual – Section 2. Management in Captivity

Selenium, mg/kg	0.0-0.3	0.2	0.1	0.22	0.2	0.2	0.3	0.0	0.2	0.3	0.3	0.3
Iodine, mg/kg	0.1-1.3	0.7	0.4	0.33-0.44	1.3	0.4	1.0	0.1	0.8	1.0	0.3	0.6

* Target values based on NRC (1994) and Anderson (1995).

** Some nutrients appear low due to missing values in the database.

5. Behavior, Social Organization and Group Composition

5.1 Basic social structure

Males: In captivity, it is safest to house adult males separately year round (See Section 5.6. for additional details). Multiple females can be housed with a single male. Although it is recommended that adult males be housed separately at all times, individual bird personalities along with exhibit size/configuration may allow certain males to be housed together during the non-breeding season. If the option is made to allow males physical contact during the breeding season, it is critical that they be monitored closely for any signs of aggression. At the first sign of any aggression, even mild chasing, the males must be separated as it has been demonstrated that mild aggression does lead to higher levels of aggression.

At the San Diego Wild Animal Park (SDWAP), one male and two female adult birds are housed together in one pen while one adult male and one adult female are housed in an adjacent pen. The set-up allows for visual contact but not physical contact. Depending on the dominant male's behavior, visual contact between males may have to be disallowed during the breeding season. On the other hand, allowing the dominant male to see the subordinate male seemed to stimulate the dominant male to display.

At the Smithsonian National Zoological Park (SNZP), both physical and visual barriers had to be employed during the breeding season in order to keep the subordinate male safe from the dominant male. However, a different alpha male was completely compatible with the same subordinate male and did not have to be separated.

Young males (0-3 years) have been housed together as well as with adult males without incident except for some minor eye picking (between the young males) at one institution and it is thought that this was due to a small enclosure.

Females: Aggressive behavior during the breeding season does not apply solely to adult males; adult females exhibit aggressive behaviors as well. Unlike males, aggression between females has never been fatal. Hens aggressively defend their nesting site from other females as well as males. Depending on personality, females may be compatible together if neither is nesting or they may not- it appears to be highly variable.

The Dallas Zoo's dominant female tends to be very aggressive during the breeding season and is allowed to set up her own nesting pen. The other females are blocked from entering this pen. During the non-breeding season however, the females are compatible.

During the non-breeding season at SDWAP, the two females that are housed with one male can be found in close proximity to each other, and they will even eat out of the same food tub. However, when the dominant female is getting close to laying, she does not tolerate the subordinate female in close proximity (The exhibit is large enough for both females to be kept together with the present protocol - eggs are pulled for artificial incubation and chicks are hand-reared.). At times, the male will also chase the subordinate female. Aggressive behaviors observed consist of grabbing/holding on and/or pecking. Male-male aggression during the breeding season has resulted in death when two males shared a pen.

At SNZP, two breeding females have twice nested within 3 m of each other-both were intolerant of each other and other birds when the nest site was approached.

5.2 Mixed species exhibits

Some species have been housed with kori bustards successfully. Before integrating other species with koris, one should contact specific facilities in order to get exhibit parameters in order to keep all species involved safe and comfortable. For zoos with small enclosures, it is recommended that breeding flocks be housed by themselves. Zoos with larger enclosures will likely be able to house their koris with other suitable species of birds and mammals, although even zoos with large pens may opt to house koris by themselves to encourage reproduction.

Kori Bustard Compatibility Survey

In 2003 a survey was sent out to all institutions currently holding kori bustards as well as those zoos which have held koris in the past. A total of 35 institutions were contacted and 21 of these institutions responded with the data contained in the synopsis below. The summary below is designed to be a guide to assist managers in their selection of compatible species. The tables below are provided as a quick reference guide. This is not a complete picture of what is compatible or not compatible with kori bustards and what works at one institution may not work at another.

Summary of Survey:

- 1) Question: Do you exhibit your birds by themselves or with other species?
Answer: Four institutions house their birds by themselves, with two facilities housing them only with other birds. The remaining facilities (71%) housed kori bustards in mixed species exhibits with both birds and mammals.
- 2) Question: What type of habitat are your koris housed in?
Answer: The majority of habitats are large open-air savannah like exhibits with natural foliage for cover and wide areas to roam. This type of enclosure is most beneficial for mixed species exhibits. A total of 13 (waterfowl being one group) other bird species and 15 mammal species were recorded as exhibit mates for koris.
- 3) Question: Describe the interactions that occur in your mixed species exhibit.
Answer: The types of interactions as well as injury were low, with only three reported incidents of aggression resulting in injury. Of those incidences, only one resulted in death. Historically, however, the studbook shows that there have been deaths from exhibit mates including giraffe, zebra, topi, gnu, springbok, eland, hoofstock (species unknown) and pygmy hippo. The majority of interactions in this survey with injuries reported were from zebra with bongo listed second. The question of limited aggressive interaction was asked as well and springbok and giraffe were noted for some interaction as well as ostrich and various crane species. Most of the avian interactions were around a feeding station or during breeding season for either or both of the bird species.

Kori bustards are very curious birds and while great care should be given to the species which may harm them, equal thought should be given to those animals which may be harmed by the koris themselves. For example, at one zoo, pair of koris were overly interested in a newborn dik-dik and until the offspring was located several days later, keepers feared that the koris had injured the baby. Since rodents are a natural prey item for koris, small rodent species are not appropriate exhibit mates. Kori bustards at one zoo prey upon newly hatched mallard chicks. Hence, if breeding waterfowl are kept with koris, ducklings may disappear due to predation from the koris.

Table 5.1. Bird species successfully housed with Kori bustards.

Common name	Facilities / Comments
Crane, Demoiselle	San Diego Wild Animal Park
Egret	Dallas Zoo
Guinea fowl	Baltimore Zoo
Flamingo	Dallas Zoo
Hornbill, Ground	Detroit Zoo, Cheyenne Mt Zoo
Ibis, Sacred	San Diego Wild Animal Park
Secretary bird	Woodland Park Zoo
Spoonbill, African	San Diego Wild Animal Park
Stork, African yellow-billed	San Diego Wild Animal Park
Stork, European white	San Diego Wild Animal Park
Vulture, Egyptian	Dallas Zoo (during nonbreeding season)
Vulture, Hooded	Dallas Zoo (during nonbreeding season)
Vulture, Lappet-faced	Dallas Zoo (during nonbreeding season), Baltimore Zoo
Waterfowl	Dallas Zoo, Woodland Park

Table 5.2. Birds to Avoid. Species where confirmed aggressive encounters have occurred.

Common name	Facilities / Comments
Crane, East-African crowned	Miami Metro Zoo, Woodland Park Zoo
Ostrich	Denver. Never house Ostrich with koris.
Stork, Marabou	No aggressive encounters have been reported, but it is probably not a good combination given the aggressive nature of marabous
Stork, Saddle billed	Not recommended

Table 5.3. Mammal species successfully housed with Kori bustards

Common name	Facilities / Comments
Blesbok	
Dik-dik	Phoenix Zoo, Cameron Park (at Cameron Park, koris were the aggressors)
Duiker	
Eland	
Gazelle	
Gerenuk	Phoenix Zoo
Giraffe	Audubon Zoo, Cheyenne Mt Zoo (Housing giraffe with koris may be specific to the location)
Hartebeest	
Impala	
Kudu	
Nyala	
Rhino	San Diego Wild Animal Park

Table 5.4. Mammals to avoid. Species where aggressive encounters are known to have occurred.

Common name	Comments
Giraffe	Housing giraffe with koris may be specific to the location
Hippo, Pygmy	Have killed koris
Springbok	Have killed koris
Topi	Have killed koris
Waterbuck	Have killed koris
Zebra	Have killed koris. Geriatric females may be ok, but in general, do not house with zebras.

5.3 Changing group structure

Never introduce new birds to an enclosure occupied by other kori bustards during the breeding season. First, introduction of new birds to a breeding flock will negatively impact the breeding members of the flock. Second, levels of aggression are at their highest during the breeding season and new birds will be unduly subjected to abnormal levels of aggression. Breeding season varies throughout the US, with breeding commencing as early as February in southern zones and ending as late as October in northern zones.

The best time for introduction of new birds is during the non-breeding season (this varies throughout the US). In the non-breeding season, birds are calmer and less aggressive and long howdy periods are unnecessary. Ideally, an introduction should consist of housing the new bird next to its intended exhibit mates with a physical barrier that allows for visual contact for at least a few days. However, this is not always possible, and a bird may need to be placed directly into the new situation. It then becomes crucial for the keeper to know individual bird characteristics so that he or she will know which birds will be more likely to aggress upon the new arrival. Enough staff should be present to monitor the initial few days of introduction, as the group's dynamics will change.

5.3.1 Introduction of birds to an empty enclosure

If birds are to be placed in an exhibit that is empty, allow the kori(s) to set up residency first and then slowly introduce other appropriate species if the exhibit is to be a mixed species exhibit.

5.3.2 Introduction of a male to a female

When introducing a new male to a female(s), house the new male in a pen so that he has visual (but not physical) access to the females for at least a few days. Do not introduce a male to an existing flock during the breeding season unless the flock is a non-breeding flock.

5.3.3 Introduction of a female to a male

When introducing a new female to a male(s), house the new female in a pen so that she has visual (but not physical) access to the male(s) for at least a few days. Do not introduce a new female to an existing flock during the breeding season unless the flock is a non-breeding flock.

5.3.4 Introduction of a male to a male

Males should be introduced by visual contact only during the non-breeding season. An extended period (7 - 10 days) of visual contact is recommended. Physical introduction should not be attempted if one male is seen persistently trying to attack the other male during the visual contact period. Some males are compatible during breeding season, but most are not. The safest situation is to house adult males separately even during the non-breeding season. With the absence of females, males are less likely to fight. However, keepers should always watch for signs of aggression and separate males to avoid injury.

5.3.5 Introduction of a female to a female

When introducing a new female to one or more female(s), house the new female in a pen so that she has visual (but not physical) access to the other female(s) for at least a few days. Do not introduce a new female to an existing flock during the breeding season unless the flock is a non-breeding flock.

5.3.6 Introduction of juvenile birds (1-3 years) to a flock of adult birds

When introducing young birds (male or females) to an existing flock, house the birds in a pen so that they have visual (but not physical) access to the other birds at least a few days. Do not introduce young birds to an existing flock during the breeding season unless the flock is a non-breeding flock. Young birds entering an established flock will likely be the most subordinate members of the flock so it is important to monitor these birds closely for overly aggressive actions by other members of the flock. Keepers should expect some form of aggression as the flock sorts out its new hierarchy.

5.4 Behavioral indicators of stress

Auditory indications of stress include vocalizations such as growling and barking. It is important to realize that young birds tend to be more vocal than older birds and are not necessarily stressed. Non-vocal indicators include running/chasing, pacing, hiding, fluffing, tail in up/alert position, and tucking. Tucking (Figure 5.1) often occurs when koris are spooked by native birds flying into the exhibit or when keepers working in the exhibit move too quickly around the birds.

Any one or more of these behaviors can be observed during a stressful situation. Stress behavior inducers include restraining birds, working in the exhibit (especially with loud machinery such as line trimmers), native birds competing for food, introductions, aggressive behavior, breeding season, feeding time and the presence of several keepers in visual range of the birds. High crowd levels (Brostek, Hallager and Powell 2003) have been shown to be stressful to some birds.



Figure 5.1

During feeding sessions, dominant birds may displace subordinate birds from the feed by short chases. The Audubon Zoo reported their dominant male chasing and even biting a subordinate male. The subordinate male ran away barking. During the breeding season, the subordinate female at SDWAP will sometimes bark as she cautiously walks up to the feed tubs. Occasionally, she is displaced by the dominant female and/or the dominant male. There will be a short chase, and both birds end it with fluffing their feathers. The subordinate female will vocalize (bark). The dominant bird will usually growl before chasing her.

The main signal of stress in koris is decreased food consumption. Encouraging birds with favorite food items or food items they like but are not a normal part of the diet may need to temporarily be employed. Decreased food consumption should be monitored very closely as in addition to stress, impaction or illness can cause koris to go off feed. If a bird does not eat for several days, notify a Veterinarian immediately. Other signs of stress are birds finding areas of the exhibit to hide in. Hiding can be induced by high crowd levels, which may cause subordinate birds to seek areas away from visitors.

5.5 Stereotypes

Kori bustards typically do not exhibit many behaviors which would be labeled as stereotypical, although excessive pacing is one behavior which does occur and can be related to stressful situations. It is important to note however, that most females do pace excessively several days prior to egg laying. Excessive preening may be a sign of nervousness.

5.6 Flock management

5.6.1 Breeding season

Adult males must be kept separate during the breeding season because dominant males have killed or severely wounded subordinate males. If multiple males are maintained together, they must be housed in a very large area so that the subordinate male can escape from the dominant male (>4046 m² [Note: this is theory only]). If two males are housed adjacent during the breeding season, a visual barrier may need to be erected to prevent the dominant male from attempting to attack the subordinate male through the physical barrier. The visual barrier will prevent the dominant bird from injuring himself and may enhance the sense of security of the subordinate male. Some subordinate males may be sexually inhibited by the visual presence of the dominant male.

In some cases, however, males may need only a physical barrier. Visual access may act to stimulate one or both males to display/breed. Some subordinate males have bred successfully within sight of the dominant male. The dynamics of each pair of dominant-subordinate males is different and management should be adjusted to minimize aggression while promoting breeding.

Unless the enclosure is very large, females should have an area separate from the male for nesting as breeding males will sometimes chase females from their nesting sites. During nesting/incubation multiple females can remain together as long as no aggression is observed. When chicks hatch, all other birds **MUST** be removed from the enclosure. Adult females (other than the dam) will attack chicks. Because chicks are mobile from the first day, chick-proof mesh (2.5 cm) must be installed around the base of the pen before the chicks hatch - preferably before the start of the breeding season to prevent disturbance to the incubating female. Chicks can be housed with the dam until the start of the next breeding season.

5.6.2 Non-breeding season

Housing during the non-breeding season is dependent upon the age, sex, and personality of individual birds. Multiple females and one male can be housed in the same enclosure. Juvenile males (<3 year) are generally compatible. Males that have grown up together are often compatible year round, although the addition of a female may alter the compatibility of the males once they reach sexual maturity. Some adult males can be allowed physical access to each other during the non-breeding season as their dispositions allow this. Keepers must know the personalities of the males involved very well in order to allow them access to each other.

One month prior to the breeding season, males must be separated from each other. If monthly weights are being monitored (Section 2 - Chapter 9.3), keepers should separate males when the alpha male begins to gain weight.

5.7 Winter housing

Winter housing is usually smaller or more restrictive than regular housing. Thus, housing options are dependent on individual bird personalities. Aggressively dominant females can harm subordinate females, especially when confined in small areas. Adult males should never be housed in the same stall together regardless if they are considered compatible. However, juvenile males may be housed together depending on individual bird personalities. Multiple females can usually be housed with a single male unless the male is overly aggressive. Aggressive males may need to be housed alone. Keepers must rely on their knowledge of each bird's behavior when making housing arrangements.

5.8 Non-verbal communication

Kori bustards have several means of communicating non-verbally. The “tail-up” display (Fig. 5.2) is used to warn an approaching bird to stay away. The threat display (Fig. 5.3) is used by males and females towards anything (another kori, bird, human, predator, also see Section 2 – Chapter 5.4). Dominant birds will displace subordinate birds non-physically as well as physically.

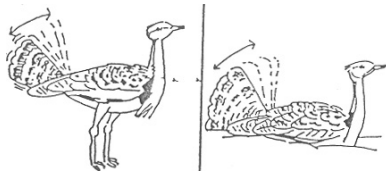


Figure 5.2 Tail lifting



Figure 5.3 Threat display
Debi Talbot©

5.9 Auditory vocalizations

Vocalizations in adult birds include barking, growling, and male breeding vocalizations (booming). Barking tends to occur when a bird is nervous or startled. For example, a bird may bark or growl during capture. Some birds bark as they approach keepers at feeding time and/or as they approach food tubs. Growling tends to occur when a bird is nervous or slightly aggressive. A female may growl when she is defending an egg or chick.

Chicks and birds up to one year are more vocal than adults. When chicks are being fed or brooded, they produce a light chirp or purring sound. When they are upset or stressed, the cry sounds like a long, sad whistle that can escalate into loud whaling cry. Chicks as young as 2 weeks will also bark when alarmed.

Dams raising chicks make a low to high-pitched grunting call to call their chicks especially when food is available. Chicks will not move until they hear this call. Parent-reared chicks tend to be less vocal than hand-reared because they are not separated from the female.

5.10 Dominance hierarchies

Koris create clear dominance hierarchies within genders. Between the sexes, adult males are always dominant over adult females. For males, once established, the dominance hierarchy does not change rapidly if at all. Age is not a good indicator of who will be dominant. In females the hierarchy can change with breeding status and females that are dominant during breeding season, may not be dominant during non-breeding season. A female with a nest becomes more aggressive both to other birds as well as to keepers. Adult birds (male and females) are dominant over juvenile birds.

5.11 Age of dispersal/removal of young

In the wild, chicks separate from their mother at the start of next years breeding season. In captivity, data is limited, but the safest course is to remove the young from the exhibit before the onset of the next years breeding season.

5.12 Management of geriatric birds

The longevity of kori bustards in captivity to date is a wild caught female who has been in captivity 28 years. Kori bustards are probably capable of living much longer however, given their delayed sexual maturity and low reproduction rate.

Females may need to be isolated from breeding males during the breeding season as overly aggressive males may harass them in an attempt to copulate. Older birds may need to be supplied with supplemental heat earlier and later in the season than other birds. When catching or herding older birds, move them slowly as some are arthritic. Some birds may be partially or totally deaf. In this case, keepers should take care not to startle birds. Older birds may need to be housed more often in inclement weather than younger birds.

5.13 Sunning

Sunning is very important to kori bustards for maintaining good feather condition. Data from an ongoing behavior watch at SNZP (Hallager unpublished data) found that on sunny days, kori bustards exhibit sunning behaviors intermittently from 11:00 to 14:00. Sunning is characterized by the spreading of one or both wings in response to direct sunlight. Birds will sun themselves until they are panting heavily. At this point, they cease sunning and move to a shady area of the exhibit. Here, they preen for upwards of 20 minutes. Birds demonstrate preferred sunning areas.

6. Reproduction and Contraception

6.1 Mating and nest building

6.1.1 Pair formation

Although koris are polygynous in the wild, reports of monogamous bonds do exist in captivity. Generally, these reports refer to those birds which have arrived together directly from the wild. Some zoos report males preferring one female to another with preference given to the female with whom the male breeds. Males do not assist with any aspect of reproduction beyond mating.

6.1.2 Copulation

(Observations from one female/3 males at SNZP)

Initiation of copulation: During the SNZP breeding season of April - early October, the male displays nearly continuously in the presence or absence of females. The level of display varies from low (inflated neck and cocked tail) to high (inflated neck, drooped wings and booming). His display intensifies when a female is in view. Increased levels of display are often accompanied by relentless pursuing of a female. A female near to a displaying male appears quite uninterested in the male, outwardly appearing to ignore and even avoid him. The events leading to copulation are initiated by a receptive female who begins the sequence of copulation by laying down near the displaying male.

Pre-copulation: Once the female is seated, the male approaches her from behind. He approaches her either in full display with his neck inflated and wings drooping or in partial display with his neck inflated and his tail feathers raised. He stands over the female and begins to peck at the back and sides of her head in a slow and deliberate way, his tail and crest feathers raised slightly. At each peck, the female recoils slightly. The male stands for 5 - 10 min alternately pecking at the female's head and stepping from side to side behind her before he sits down on his hocks and continues pecking at the back of her head for another 5 min. The female remains seated throughout the entire bout of head pecking.

Copulation: After 10 - 15 min of head pecking, the seated male moves closer towards the sitting female using his hocks to progress forward. As he approaches the female's cloacal area, he spreads his wings and mounts her from behind. Presumably, the female lifts her cloaca so that she could make cloacal contact with the male, but this has not been observed. Actual copulation lasts no more than a few seconds.

Post-copulation: Immediately following copulation, both birds rise and part quickly, violently shaking their feathers. Females often make a 'barking' sound as they move away from the male. Following copulation, both birds resume other activities, with the male often resuming display.

Because copulation involves a lengthy period of head pecking to the female, it is important to monitor females during the breeding season for signs of head injuries. While injuries will likely be minimal (feather plucking, bruising and abrasions), keepers should watch for more serious injuries to the head.

6.1.3 Nests and incubation behavior

Kori bustard females make a small scrape in the ground. Where eggs are eventually laid, females spend increasing amounts of time in the area and are especially protective of the area. In some females, incubation begins with the first egg even when a second egg is to be laid. In other females, incubation begins with the second egg, which generally is laid 2 days after the first egg. Incubating females rarely leave the nest during the 23-day incubation period. When they do (e.g. at feeding times or to perform comfort activities such as sun bathing or dust bathing), they are very aggressive towards keepers and other birds and return very quickly to the nest site. If another bird approaches the incubating female, she will aggressively drive them off.

During incubation, females throw sticks, grasses and leaves onto their back. This behavior may aid in their camouflage.

6.1.4 Egg termination

In the case that the recommendation is made to not breed a female, her eggs should be pulled as soon as they are laid, discarded, and replaced with dummy eggs. The female should be allowed to sit on her nest until she deserts it. Eggs should not be pulled and not replaced with dummies because this will cause the female to lay excessive eggs.

6.2 Egg laying and incubation

6.2.1 Egg laying

Females begin laying in May in northern zones and as early as February in southern zones. Egg laying generally occurs four to six weeks after males begin booming. The average clutch size is 1.4 eggs. Most females lay only one egg per clutch while others lay two eggs per clutch. Three- and four-egg clutches are extremely rare.

Table 6.1. Distribution of clutch size laid by kori bustards in North American Zoos

Clutch size	Number	Percent
1 egg	45	75
2 eggs	9	15
3 eggs	5	8
4 eggs	1	2

Table 6.2. Shortest interclutch intervals for kori bustards in North American Zoos

Dam Studbook Number	Interclutch interval
78	16 days
78	16 days
119	16 days
119	16 days
119	16 days
131	16 days
78	17 days
80	17 days
119	17 days
119	17 days
389	17 days
78	18 days

6.2.2 Natural Incubation

Dallas Zoo protocol

1. Weigh, measure and candle eggs on first day they are laid. Place a dummy egg under the female during the time the egg is removed. Prior to placing the dummy egg under the female, warm the dummy egg in an incubator set at 37.5°C. Return the fresh egg to the female and remove the dummy egg.
2. At day 7, remove the first egg and replace it with a dummy egg for the remainder of the incubation period (avg. incubation 23 days). Weigh and candle the first egg and place it in a Grumbach incubator set at 37.5°C and 55% Relative Humidity. Note that some eggs are heavily pigmented and therefore difficult to candle. If more than one egg has been laid, leave it with the dam for the entire incubation period except for the brief period when it is initially weighed, measured and candled.
3. The target weight loss for kori bustard eggs is 12%. Adjust the humidity in the incubator to produce the target weight loss. Set the incubator to turn the egg on an hourly basis. Candle the egg every five days until the air cell begins to drop down. At that point, increase the humidity in the incubator to 90% and candle the egg daily.
4. At internal pip, place the egg back under the female for hatching. The expected pip to hatching time is 8 - 24 hours. Do not assist the chick in hatching until at least 24 hours following external pipping.
5. Once the chick has hatched, leave the chick(s) with the dam for the first 24 hours so that imprinting and bonding can occur normally. Twenty-four hours after hatching, briefly remove the chick(s) and quickly examine, weigh and clean the umbilicus. Ensure that yolk re-absorption is occurring normally. Return the chick to the dam.

6.2.3 Artificial incubation

Smithsonian National Zoological Park protocol

Place collected eggs immediately inside a Grumbach incubator (temperature = 37.5° C, relative humidity = 50 - 55%). Set the timer to turn the eggs every two hours. Wear gloves at all times when handling eggs. Distilled water only is used for the incubators. Do not clean or dip the eggs before placing them in the incubator. Eggs at SNZP have heavily pigmented which precludes candling. Therefore, fertility is detectable by observing movement in the eggs seven to ten days prior to hatching. Once the chick enters the air cell on Day 21 or Day 22 of incubation, move the egg another Grumbach incubator set up as a hatcher (temperature = 37.4° C, relative humidity = 70-75%). The interval from internal pip to hatch is about 18 - 24 hours. Do not turn eggs once they are moved to the hatcher. If a second chick is expected to hatch, either place it in a different hatcher or thoroughly disinfect the first hatcher.

San Diego Wild Animal Park protocol

Place collected eggs immediately into a Petersime model 1 or Humidaire model 21 incubator (temperature 37.5° C, wet bulb 26.7 – 30° C). (The Petersime incubator turns the egg every hour while the Humidaire turns eggs every two hours.) Additionally, turn eggs by hand 180 degrees twice daily. Do not clean or dip eggs, although a dry sponge may be used to remove dried dirt or fecal matter if needed. Eggs at SDWAP have light pigmentation and are therefore easily candled. Fertility can be confirmed four to five days after being set. Between eight to twelve days, eggs turn dark as circulation is completed. Monitor weight loss to achieve a 15% weight loss by the time of hatching. Once the air cell starts to drop and chicks begin to actively push against the air cell membrane (Day 21 - 22), transfer the eggs to a Leahy hatcher (36.9° C dry / 31.1 – 32.2° C wet bulb). Do not turn eggs once in the hatcher. Check eggs two to four times daily. External pip to hatch is 24 hours or less with total incubation time 23 - 24 days.

6.2.4 Management of nesting birds

During the breeding season and/or when females are on eggs, the flock should be afforded extra privacy. All non-essential yard work should stop and entry into the enclosure should be restricted only to those workers that need to be in the yard. If aggression is seen between birds, then the non-nesting bird should be removed. A dominant female may prevent a subordinate female from incubating her egg(s). Female aggressiveness towards keepers varies between individuals. Some individuals will attack when the keeper is five to ten feet away. Others will let keepers remove the eggs from beneath them (keepers should wear protective eyewear however). Before the eggs are due to hatch cage mates MUST be removed. Breeding females should be given supplemental calcium at least one month prior to the beginning of egg laying.

6.3 Physiological measures of the reproductive cycle

Very little information exists on this subject. At SNZP males increase in body mass during the breeding season (Table 6.3), with the Alpha male increasing significantly more in body weight than the beta male. This phenomenon needs to be confirmed at other institutions. Monitoring weight increase in males is one way to determine when

hormones are beginning to increase. This is important for those zoos that allow their male koris physical contact during the non-breeding season- as weights in the Alpha male begin to rise, it is time to separate the males.

Table 6.3. Breeding and non-breeding weights for male kori bustards at SNZP

Month	Dominant Males						Subordinate Males				
	1999*	2000	2001	2002	2003	Ave.	1999	2000	2001	2002	Ave.
Jan.				14.4		14.4				11.4	11.4
Feb.	10.6			15.0	14.6	13.4	10.3	12.1		11.9	11.4
Mar.	11.1	14.5	14.2	15.1	14.8	13.9	11.3	12.9	12.5	12.5	12.3
Apr.	11.8	14.4	16.3	16.6	15.8	15.0	11.3	12.5	13.4	12.6	12.4
May	14.3	14.4	17.5	17.6	18.6	16.5	11.3	13.5	14.1	11.0	12.5
June	14.1	16.2	18.5	18.0	18.8	17.1	12.1	14.5		11.6	12.7
July	15.1	16.1	18.0	17.4	18.2	16.9	13.0	14.7	14.5	11.8	13.5
Aug.	15.1	17.3	16.3	14.8	18.6	16.4	13.3	12.0		13.2	12.8
Sep.	16.2	14.3	16.7	14.2	18.9	16.0	12.7			13.2	12.9
Oct.	15.3	14.6	15.3	14.2	18.0	15.5	12.3	11.8		13.3	12.4
Nov.	15.2		15.2	15.4	16.0	15.4	12.6		11.5	11.0	11.7
Dec.	13.8		15	15.4	14.8	14.7			11.3	10.4	10.8

* The dominant male in 1999 was different than in the other years.

6.3.1 Signs of estrus

Females become “broody” one to two days before laying the first egg of a clutch. Typically (but not always), this involves repeated pacing in the area where oviposition will occur. The color of eggs varies widely from lightly spotted cream to medium spotted dark green. The latter color is extremely difficult to candle.



6.4 Average egg measurements

Measurement	Average	Range	Sample size
Weight	149.0 g	121.4-177.9 g	165
Width	57.6 mm	52.2-69.4 mm	148
Length	82.2 mm	71.4-100.4 mm	148

Data is limited, but there does not appear to be any statistically significant difference in size or weight between male or female eggs. As more eggs are weighed and measured in the future, this statement may change.

6.5 Mean and range of post-partum infertility

Once chicks hatch, a female usually does not lay again in the same breeding season. On one occasion (at Dallas Zoo) a female laid an egg approximately 2 months

after the chick hatched. Although the hen continued to incubate the egg and get up feed the chick, the egg was removed the same day it was laid to allow the female to properly care for her chick.

6.6 Mean and range of copulatory behavior

Females are usually receptive during the whole breeding season.

6.7 Age of first reproduction (from studbook data)

Youngest dams			Youngest sires		
Studbook Number	Birth Origin	Age (years)	Studbook Number	Birth Origin	Age (years)
371	Captive	3.1	366	Captive	4.0
389	Wild	6.4	370	Captive	4.0
119	Wild	12.8	390	Wild	4.1
131	Wild	13.3	192	Captive	5.8
80	Wild	13.7	69	Wild	12.3
78	Wild	14.7	143	Wild	12.4
57	Wild	16.3	132	Wild	15.4
87	Wild	18.5	94	Wild	15.7
99	Wild	18.6	66	Wild	18.6
			67	Wild	20.5
	Median:	14.7		Median:	12.3
	Mean:	13.0		Mean:	11.3

6.8 Reproductive senescence

Oldest dams			Oldest sires		
Studbook Number	Birth Origin	Age (years)	Studbook Number	Birth Origin	Age (years)
57	Wild	23.3	66	Wild	21.6
57	Wild	22.5	66	Wild	21.6
99	Wild	19.5	66	Wild	21.6
78	Wild	19.5	66	Wild	21.5
99	Wild	19.3	66	Wild	21.5
99	Wild	19.2	66	Wild	21.5
119	Wild	18.6	67	Wild	20.8
99	Wild	18.7	66	Wild	20.8
87	Wild	18.5	66	Wild	20.7
119	Wild	18.5	66	Wild	20.6

6.9 Artificial insemination

6.9.1 Semen collection methods

Artificial insemination has not been done in kori bustards. Houbara bustard semen collection techniques done in the United Arab Emirates might be a good example should this become necessary with kori bustards in the US. (For further information on

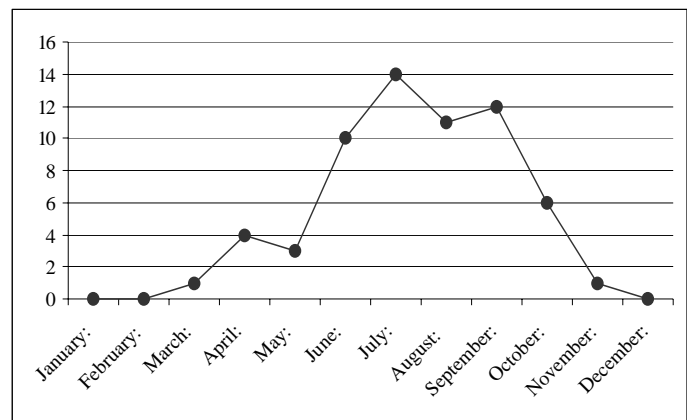
this technique in the houbara bustard see *Propagation of the houbara bustard. edited by M. Saint Jalme and Y.van Heezik. 1995. Published by Kegan Paul International*)

6.10 Breeding season

The breeding season for kori bustards in lower latitudes (e.g. Dallas Zoo, San Diego WAP, Phoenix, St. Catherines WSC) is from February to September, whereas the season for kori bustards at higher latitudes (e.g. National Zoo) is April to late October. Once begun, male reproductive displays reach their maximum several weeks after the initial onset. Females typically begin laying 3-4 weeks after males have begun to lay. Females will lay replacement clutches if previous clutches are pulled.

Hatch seasonality (clutches)

Month	Number	Percent
January	0	0
February	0	0
March	1	2
April	4	6
May	3	5
June	10	16
July	14	23
August	11	18
September	12	19
October	6	10
November	1	2
December	0	0



6.11 Effects of group housing

Female kori bustards do not seem to be influenced by the laying date of other females. Males, however, tend to display synchronously. Previously, it was recommended to keep two males in the breeding flock so that they would stimulate each other into breeding behavior. Recent breeding in flocks of only one male negate that strict recommendation.

6.12 Fertility

Egg Status	Number	Percent
Fertile	86	35.8
Infertile	134	55.8
Unknown	20	8.3
Total	240	

6.13 Molt

The molt cycle of kori bustards has not been closely studied. However, feathers do tend to be shed mainly in the spring (before breeding season) and fall (after breeding season). Males often (but not always) molt out their neck feathers in the spring. Given the visual importance of the throat area in male display, the replacement of new feathers

may be critical to the breeding success of the male.

When feathers are found naturally molted in the yard, they should be picked up and recorded. All primaries (note whether left or right), secondaries, tail, alular quills, greater and secondary coverts, underwing and undertail feathers should be recorded. Smaller feathers such as neck, crest and very small coverts are too numerous to record- they can simply be noted when they are found. Data should be sent to the SSP Coordinator on an annual basis.

7. Chicks

General information for parent and handreared chicks

Kori bustards are precocial and nidifugous at birth. Chick begins to vocalize after internal pip. Hatch occurs about 48 hours after internal pip, 12-24 hours after external pip. For parent-reared birds the eggs are put back under the female at internal pip. Following birth, chicks are usually dry within an hour or two. Eyes are open upon hatch, although they have an opaque appearance to them for the first several days. Chicks are somewhat mobile approximately four to six hours after hatch. They are not fully mobile until they are 24 hours old. Males have "squarer" heads than females.

7.1 Plumage changes



Figure 7.1 One-day old kori chick.
Photo courtesy of Dallas Zoo



Figure 7.2 Eight-day old kori chick.
Photo courtesy of Dallas Zoo



Figure 7.3 Seventeen day old kori chick
Photo courtesy of Jessie Cohen ©



Figure 7.4 Twenty-four day old kori chick.
Photo courtesy of Jessie Cohen ©



Figure 7.5 Thirty-one day old kori chicks.
Photo courtesy of Jessie Cohen ©



Figure 7.6 Two month old kori chicks.
Photo courtesy of Jessie Cohen ©

7.2 Sex ratio at birth

Kori bustards first began breeding in the US in 1992. Since that time, 83 chicks have been born. Of these chicks, 39 (47%) have been male, 28 (34%) have been female and 16 (19%) were of unknown sex (death occurred shortly after birth and could not be determined upon necropsy).

7.3 Mortality

For both sexes, 30-day mortality is 22%. First year mortality is 27% for males and 40% for females. The cause of the higher mortality of females is unknown. It may be a species-specific phenomena or it may be a factor of inappropriate management. More research is needed.

7.4 Growth Rates

Weights from 30 hand-reared males, 20 hand-reared females, 6 parent-reared males, and 3 parent-reared females were used to produce graphs of weight gain and growth rate in kori bustards. It is evident that males gain weight faster than females. Though parent-reared males gain weight faster than hand-reared males, parent-reared and hand-reared females gain weight at similar rates (Figure 7.1).

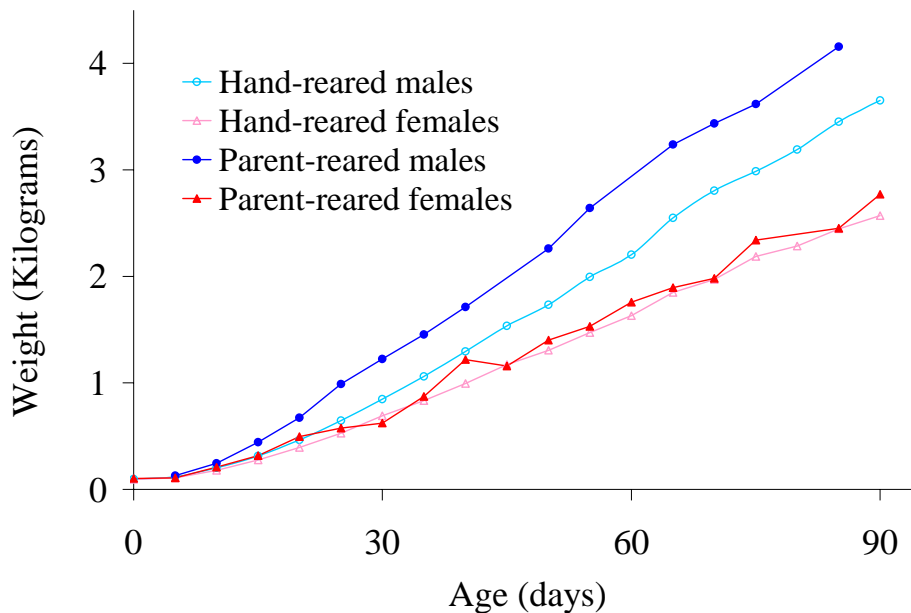


Figure 7.1 Weight gain in kori bustards chicks as a function of age.

At hatch, males are slightly larger than females ($p=0.05$) but much overlap exists. At Day 30, males are larger than females ($p=0.003$) but some overlap exists. By Day 60, males are much larger than females ($p=0.000$) and almost no overlap exists in weights (Figure 7.2).

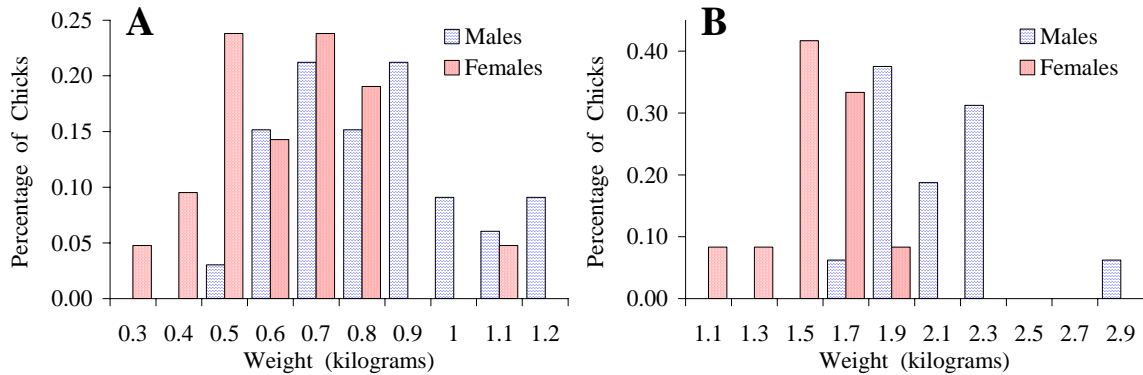


Figure 7.2 Distribution of Chick weights at A) 30 days and B) 60 days of age.

Parent-reared chicks seem to have higher growth rates than hand-reared chicks during the first week of life. The sample size is small so conclusions are not robust. By 30 days of age though, all chicks have similar growth rates.

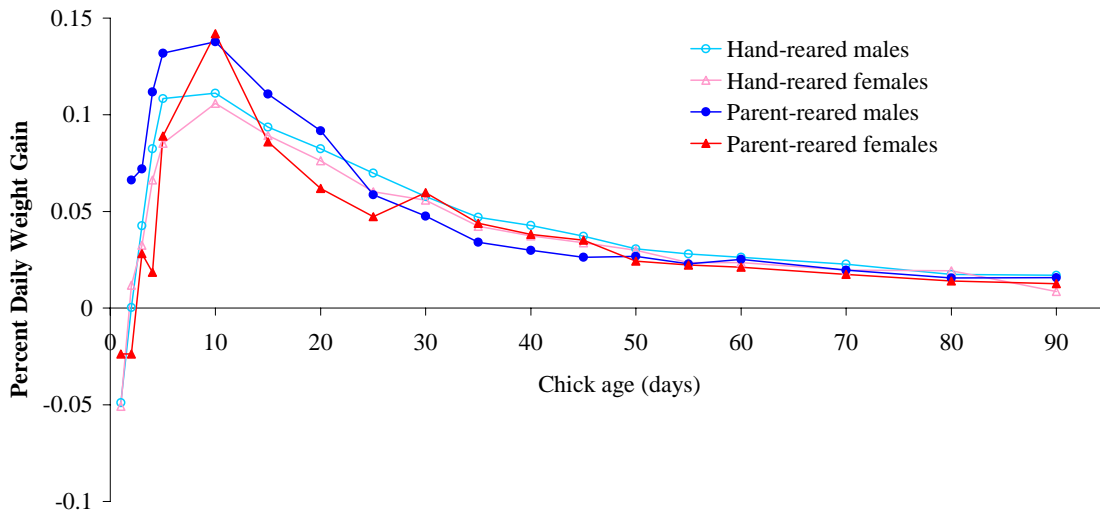


Figure 7.3. Percent daily weight gain versus age of kori bustard chicks

7.5 Introduction of juvenile birds to flocks

See section 5.3 for detail on introductions.

Parent-reared chicks

7.6 Hatching procedure

At internal pip, place the egg back under the female for hatching. The expected pip to hatching time is 8-24 hours. Do not assist the chick in hatching until at least 24 hours following external pipping.

Once the chick has hatched, leave the chick(s) with the dam for the first 24 hours so that imprinting and bonding can occur normally. Twenty-four hours after hatching, briefly remove the chick(s) and quickly examine it, weigh it and clean the umbilicus. Ensure that yolk re-absorption is occurring normally. Return the chick to the dam.

7.7 Development and parental care of chicks

Kori bustards have maternal care only. In the wild the male does not assist in any manner in raising chicks and in captivity the male must be separated from hen and chicks. The establishment of parental care skills seems to be instinctive although to date, no captive born females have raised chicks. Females are highly protective of the chicks and will attack other females and keepers. Females may or may not remove eggshells from nest. On one occasion the female was incubating a dime-sized piece of eggshell and would not leave the nest and attend to the newly hatched chick. Females need time to bond with the chicks and this time may be neglected if the female is incubating.

Behavioral development: Chicks are very active and run around as soon as they are able to leave the nest. Departure from the nest usually occurs on day 2. Parent-reared chicks will follow the dam around. Within a week of hatching chicks are able to pick up food on their own.

Chicks that are separated from their dam or hand-reared chicks left alone will persistently “whine.” This is a high-pitched 2-10 sec long vocalization. Even older chicks that are feeding independently are “stressed” by the initial separation from the dam. Separated chicks will pace and call to the dam. The dam, although initially stressed by the removal of her chicks, does not seem to be unduly stressed once chicks are out of visual and auditory range.

Growth rates: Although parent-reared chicks seem to have higher growth rates than hand-reared chicks during the first week of life, parent reared chicks do not develop angel wing. More research is needed to determine why parent reared chicks do not develop angel wing but handreared chicks do.

Weaning: Chicks can feed on their own after two weeks but the dam will feed them for several months. The dam does not become aggressive toward the chicks. Young are removed before the next breeding season.

Play: Very few of the behaviors of kori bustards would be classified as play. They do jump around, however.

Food acquisition: For young chicks, insects are always the preferred food item, but dams do feed pinkies as well as meatballs to chicks. The female will pick items up in her beak and the chicks will then pick the item from the female's beak. When the female is feeding chicks she salivates copiously. (This only occurs with females feeding chicks and is hypothesized to potentially be a source of water for the chicks.) The chicks begin feeding on forage insects at approximately one week old. Females have been seen still feeding their chicks at 75 days of age even though the chicks are also eating food on their own. The dam produces a quiet vocalization when feeding the chicks.

Participation in rearing/interacting with siblings: For broods with two chicks keepers should ensure that one chick does not out compete the other.

Fratricide: There is no aggression between chicks of similar ages (separated by less than two weeks in age) but a hand-reared chick that is separated in age from a younger chick by more than two to three weeks will severely injure the younger chick. To produce chicks that are as similar in age as possible, first laid eggs should not be incubated until the second egg is laid and then both eggs should be placed in the incubator.

Cross-fostered: This technique has not been tried in captivity, but it remains a potential technique if the timing is appropriate.

Hand-reared chicks

7.8 Hatching procedure

With rare exceptions, hatching occurs on day 23 of incubation. Hatch weights range from 77 – 116 g. Once the chick is hatched, clean the umbilicus with Betadine (100%) solution and weigh the chick. If the chick has had difficulty hatching, 2 cc of half-strength Lactated Ringer's and 2.5% dextrose solution should be provided subcutaneously. After being allowed to rest for several hours in the hatcher, move the chick to an Animal Intensive Care Unit (69.85 x 33 x 35.5 cm deep) at 36.1°C. The floor of the brooder should be carpeted and a feather duster hung in one corner to simulate the mother. A small mirror affixed in the brooder acts as a visual stimulus for the chick.

7.9 Development and handrearing of chicks

Handrearing Protocol for kori bustard chicks

(A sample handrearing sheet is provided in Appendix II)

DAY 1

Brooder/Temp:

- 36.1° C (97 ° F)
- Brooder 69.85 X 33 X 35.5 cm deep
- Floor is carpeted and a feather duster is hung in a corner to simulate the mother. Single chicks are given a mirror.

Number of Feedings: 11

Diet:

- **Each feeding:**
 - 1-2 cricket abdomens (from freshly killed crickets)
 - 1-2 small pieces watermelon
 - 1 green bean
- **Later feedings on Day 1:**

Add soft fruit mix with apple paradise (offer both fruit and pellets) - ***Do not feed more than 5 apple paradise sized pellets.***
- To ensure proper hydration, water is given via a syringe (no needle) at every feeding in addition to the small pieces of watermelon
- Do not feed for the first 12-18 hrs after hatch
- Feed every 60 – 90 minutes (0600 to 1730 h)
- Puffy legs are a good sign of hydration, if skin on the legs appears tight, hydration is poor and chicks must be given SQ fluids. Notify Vets.
- Lightly dust crickets with dicalcium phosphate.

Comments and miscellaneous notes: Healthy chicks will attempt to grab offered food items. Coordination is not always well developed, however, and some chicks may need

to be force-fed for one or two days. Generally, if chicks are not attempting to grab food items, this is a sign they may be dehydrated. Chicks are fed every 60-90 minutes the first day beginning at 0600 and ending at 1730. Chick weights are recorded before the first feeding of the day from Day 1 to Day 30.

Because handreared chicks do not have the constant presence of a mother, they will cry persistently if left alone. To reduce stress and provide comfort, keepers should brood chicks at every feeding and as often as possible during the first 7 days.

DAY 2-3

Brooder/Temp:

- 36.1° C (97 ° F)
- Brooder 69.85 X 33 X 35.5 cm deep
- Floor is carpeted and a feather duster is hung in a corner to simulate the mother. Single chicks are given a mirror.

Number of Feedings: 7

Diet: Total diet for Day 2 and 3 (each)

- 1 pinkie mouse (1- 1.5 g) - chicks can take pinkies whole
- 12-15 cricket abdomens
- 15-20 small watermelon pieces
- Soft fruit mix (including ~ 12 apple paradise pellets)
- Chopped greens
- 3 green beans
- If chicks are well hydrated, they may be offered soaked pheasant starter and soaked dog food on some of the later feedings on day 2 or day 3.

Comments and miscellaneous notes:

- It is important to keep the chick hydrated.
- Chicks are pinioned on Day 3 depending upon their weight, activity, and health status (**See Appendix I for SSP statement on pinioning).
- Chicks are fed at two-hour intervals from 0630 to 1730. Healthy chicks normally lose 3-5g on Day 2, but their weights stabilize on Day 3 and increase thereafter. Chicks can stand and walk on Day 2, and readily accept food items presented by hand.
- Water is given using a syringe (do not use a needle) by drops - Try to train them to drink from dish on their own by using the syringe to lead them to water dish and to get them to peck at the water.
- Do not offer mealworms until chicks are 7 days old.
- Continue to brood chicks.

DAY 4

Brooder/Temp:

- 35° C (95° F)
- Carpeted nursery area (1.8 m x 3.7 m)
- 3 heat bulbs suspended from the ceiling so that three separate sections of the floor are kept at 35°C.
- Several feather dusters are suspended near the heat bulbs.
- Single chicks are given a mirror. Mirrors can be used with multiple chicks but this may cause some chicks to be agitated- if so, remove the mirror.

Number of Feedings: 7

Diet: Total diet for Day 4

- 1 pinkie mouse (1- 1.5 g each) - dusted with Ca₂P.
- 1 - 1.5 g Carnivore meat (rolled into balls). Do not put meat in tub with bird-ration out throughout day. (SNZP does not offer meat until chicks are 30 days old).
- **Offer daily** (proportions will vary with chick. Marion scenic pellets, Zeigler Bird of Paradise pellets, green beans, peas, crickets, watermelon, apple, kale, and banana, crickets, waxworms, small watermelon pieces, soaked pheasant starter, soaked dog food, chopped greens

Comments and miscellaneous notes:

- Feed every 2 hours (0630 to 1830 h). Chicks must be encouraged to exercise in the pen following each feeding to avoid problems such as slipped tendon.
- Chicks should be trained to drink from a dish on their own. Use a syringe or a finger to lead them to water dish and to get them to peck at the water. Floating pieces of greens on the water will encourage them to drink. Use a shallow water bowl and a rock in the bowl to prevent chicks from accidentally falling in and becoming wet.
- Do not over feed chicks with favored food items such as crickets. Emphasis should be on the feeding of fruits and vegetables at each feeding.
- Continue to brood chicks.

DAY 5-6

Brooder/Temp:

- 35° C (95° F)
- Carpeted nursery area (1.8 m x 3.7 m)
- 3 heat bulbs suspended from the ceiling so that three separate sections of the floor are kept at 35°C.
- Several feather dusters are suspended near the heat bulbs.

- Single chicks are given a mirror. Mirrors can be used with multiple chicks but this may cause some chicks to be agitated - if so, remove the mirror.

Number of Feedings: 7

Diet: Total diet for Day 5 and 6 (per day)

- 1 pinkie mouse (1- 1.5 g each) - dusted with Ca₂P.
- 1 - 1.5 g Carnivore meat (rolled into balls). Do not put meat in tub with bird-ration out throughout day. (SNZP does not offer meat until chicks are 30 days old).
- **Offer daily** (proportions will vary with chick.) Marion scenic pellets, Zeigler Bird of Paradise pellets, green beans, peas, crickets, watermelon, apple, kale, and banana, crickets, waxworms, small watermelon pieces, soaked pheasant starter, soaked dog food, chopped greens.

Comments and miscellaneous notes:

- Feed every 2 hours (0630 to 1830 h). Chicks must be encouraged to exercise in the pen following each feeding to avoid problems such as slipped tendon.
- Chicks should be trained to drink from a dish on their own. Use a syringe to lead them to water dish and to get them to peck at the water. Floating pieces of greens on the water will encourage them to drink. Use a shallow water bowl and a rock in the bowl to prevent chicks from accidentally fall in and becoming wet.
- By Day 5, chicks are keen to pick food floating in water, so to encourage self-feeding, some food is left in shallow water bowls during the day.
- Emphasis should be on the feeding of fruits and vegetables at each feeding.
- The need for brooding diminishes around day 6 - chicks will object strongly when brooded.

DAY 7-13

Brooder/Temp:

- 35° C (95° F)
- Carpeted nursery area (1.8 m x 3.7 m)
- 3 heat bulbs suspended from the ceiling so that three separate sections of the floor are kept at 35°C.
- Several feather dusters are suspended near the heat bulbs.
- Single chicks are given a mirror. Mirrors can be used with multiple chicks but this may cause some chicks to be agitated- if so, remove the mirror.

Number of Feedings: 7

Diet:

- Increase to: 2 pinkie mouse (1- 1.5 g) daily

- 2 - 3 g Carnivore meat (rolled into balls)- (SNZP does not offer meat until chicks are 30 days old).
- On Day 7, the amount of pelleted food is increased depending on appetite, with a continued emphasis on fruit and vegetables.
- On Day 13, feedings are reduced to six per day.

Comments and miscellaneous notes:

- Feed every 2 hours (0630 to 1830 h).
- If mealworms are fed, limit the total number fed each day to 10 to reduce the risk of impaction.
- Hand-reared chicks may develop slipped wings (i.e., an outward turning of the manus) anywhere from Day 7-11. Slipped wing is easily and permanently corrected if the primaries of the affected wing(s) are taped to the body in a natural position for 7-10 days at the first sign of the problem.



Figure 7.3 A) Chick displaying “angelwing;” B) Proper taping of wing to correct problem.

Photos courtesy of Jessie Cohen ©

DAY 14

Brooder/Temp:

- 35° C (95° F)
- Carpeted nursery area (1.8 m x 3.7 m)
- 3 heat bulbs suspended from the ceiling so that three separate sections of the floor are kept at 35°C.
- Several feather dusters are suspended near the heat bulbs.
- Single chicks are given a mirror. Mirrors can be used with multiple chicks but this may cause some chicks to be agitated- if so, remove the mirror.

Number of Feedings: 6

Diet: Same as above, but the number of mouse pups (5-6 g) is increased to 4 per day.

Comments and miscellaneous notes:

- Feedings are reduced to 6 per day (0630-1830).
- Chicks are taken outside for the day if the temperature is above 24°C. Once chicks have been given access to outside yards, they are carefully monitored for the ingestion of foreign material that could result in impaction. Watch chicks to be sure they do not consume too many small pebbles. Chicks normally will seek out tiny pebbles as a source of grit. While a few pebbles are acceptable, ensure that chicks do not try and consume stones, which are too large for them. Ensuring that chicks continue to defecate normally is important.

DAY 14-30

Brooder/Temp: Same as above

Number of Feedings: 6

Diet: Same as above

Comments and miscellaneous notes: Move the heat lamps up as the chicks grow so that they do not burn the top of their head. Also, beware of chicks jumping- they can jump very high and if heat lamps are too low, they will hit the bulb and break it.

DAY 30+

Brooder/Temp: When chicks are 30-40 days old, they are moved outside to a covered yard measuring 5 m x 15 m. The young birds spend the day outside and are housed in a heated shed at night.

Number of Feedings: 5

Diet: The number of mouse pups (5-6 g) is increased to 6 per day. The diet at this point is similar to the adult diet - mainly small mice, Toronto meat (mixed with crane and ratite pellets), Marion scenic jungle pellets, chopped kale, eggs, mixed vegetables and fruit.

Comments and miscellaneous notes: If chicks are scale trained, weights may be continued. Otherwise, daily weights are discontinued around Day 30 to minimize the risks associated with repeated handling.

7.10 Commonly encountered problems of hand-reared chicks

Problem	Recommendation
Day 1-13	
Dehydration	Newly hatched chicks can be prone to dehydration for the first 2-3 days of life. Ensure that chicks are properly hydrated by feeding watermelon or dipping food items in water immediately prior to feeding.
Curled toes	Chicks may hatch with inward pointing toes. This condition typically corrects itself. Taping is only necessary in cases where the condition is severe or worsens with time.
Pinioning	Pinioning is recommended when chicks are 2-3 days old. Future fertility will not be compromised as copulation in the species occurs on the ground. Additionally, birds will not need to be routinely captured for feather clipping, reducing capture-related injuries. (See Appendix I)
Exercise	Chicks should be exercised following each feeding session and as often as possible throughout the day. This will minimize problems like slipped tendon. Additionally, chicks should be allowed outside after day 6 for exposure to sunlight.
Housing	If they differ in age by less than 14 days, chicks benefit from being housed together. If they differ in age by more than 14 days, chicks must be housed apart because of aggression from the older chick. Single chicks benefit from a mirror in their pen or a companion (e.g. quail or guinea fowl chick).
Handling	At a young age, chicks are less stressed if handling simulates brooding, such as cupping in one hand and covering with the second hand, keeping it in a “nest” with a feather duster on top, or covering it with a breathable cloth.
Angel wing	This condition typically begins at Day 11 and as early as day 7. Taping the affected primaries in a natural position at the first sign of outward turning will permanently correct the deformity. A definitive cause of the problem has not been determined.
Day 14-29	
Ingestion of foreign material.	Chicks normally eat small pebbles to aid in digestion. When exercising on natural substrates, monitor chicks closely to ensure that they do not consume too many or any large pebbles, which can lead to impaction. Additionally, closely monitor defecation.
Handling	Bustard chicks have very sharp nails. When handling chicks, keep the feet away from the body to avoid injuries (e.g. a ripped neck) to the chick caused by the bird kicking.

Problem	Recommendation
Day 30+	
Eye pecking	One bird may peck at the eyes of another bird. The aggressor must be removed until the eyelid of the injured bird has healed. Providing the birds with food items to pick at (e.g. slices of watermelon, tomatoes etc.) may lessen the behavior.
Weighing	Do not weigh healthy chicks daily. This will reduce injuries caused by frequent handling. If chicks are trained to stand on a scale, then daily weights may be continued.
Housing	Avoid housing in enclosures with barriers (e.g. trees) that the birds may run into, or large-mesh chain-link. These may lead to injured or broken wings. When introducing to a new enclosure, have a familiar keeper acquaint chicks to a new enclosure immediately after releasing them. This entails walking around with the birds and showing them plants, fences, walls, dishes, etc
Capture	Avoid catching birds against a fence. Rather, walk the bird into a dark stall or sectioned-off area of the enclosure. Firmly, but loosely, grab the bird around the body and tighten in when the wings are properly secured. Another person needs to help secure the legs and head. Handreared birds often prefer to remain un-hooded, whereas others are calmer if a breathable cloth is loosely draped over their heads. Some birds are calmer with legs stretched and feet on the ground (still being held securely), whereas, others are calmer sitting on the ground with legs folded. A keeper must constantly monitor and restrain the bird if it jumps up. Most birds are least comfortable when held up off the ground.

7.11 Imprinting

Hand-rearing does not appear to negatively affect future reproduction as several hand-reared birds in the US have bred. An unexpected outcome of hand-rearing chicks has been birds with easygoing temperaments making hand-reared chicks more tractable than wild caught birds.

Chicks reared alone have the highest degree of imprinting on their caretakers. Providing a mirror to a single chick acts as a calming agent as well as serving to reduce the degree of imprinting. Raising hand-reared chicks with a sibling reduces imprinting (see section 7.10 for more information).

Placing the chicks in visual contact with adult kori bustards may also reduce imprinting to some degree. This may negatively impact the breeding flock however, and probably should only be attempted at the end of the breeding season.

7.12 Introduction of chicks less than 30 days old to other chicks

At 5 days, chicks can be placed with other chicks provided that the older chick is less than 2 weeks old. Chicks less than 1 week old must not be placed with other chicks who are 2 weeks or older as the older chick has the capacity to severely (and possibly fatally) wound the younger chick. Chicks can subsequently be placed together when the youngest chick is 3 weeks old. When introducing young chicks together, the older chick will aggress upon the younger chick but the aggression period is generally limited to the

first several hours. Chicks must be observed carefully during the brief introduction period.

7.13 Chick measurements

By day 2, chicks should be measured (using the methods shown below). Measurements should be recorded and sent to the SSP Coordinator for every chick born.



Culmen



Head length



Head width



Total wing length



Tarsus



Middle Toe

8. Veterinary Care **NOTE:** *This section is currently being written by the SSP Veterinary Advisor. The final section will be inserted upon completion.*

8.1 Infectious diseases

8.2 Non-infectious diseases

8.3 Parasitic diseases

8.4 Chemical immobilization

8.5 Clinical pathology

8.6 Blood chemistry values

8.7 Necropsy protocol (See Appendix III)

8.8 Reaction to toxic plants / metals

Koris will readily eat just about anything including nails, batteries, broken glass, and coins. For this reason, it is imperative that keepers check enclosures daily to remove any items that may pose a threat as kori bustard have died from eating the items mentioned above. Plants in enclosures should be carefully selected (see section 2, 1.3) to ensure that they do not have poisonous properties. As an example, a young bird at a zoo would regularly come up with a swollen eyelid. Only after ruling out medical causes, it was determined that barberry (*Berberis sp.*) thorns, which had grown through the enclosure, were causing the swelling as the bird repeatedly and inadvertently brushed up against the bushes.

8.9 Normal vs. abnormal fecals

Kori bustards produce two kinds of fecal matter, both of which are considered normal. The first type is the normal bird type feces produced by all birds, which consists of fecal matter and urates. The second type of fecal produced is a black, tarry, but sometimes runny fecal. Large amounts of stool are normally produced early in the morning within several minutes of the bird rising.

9. Role of the Keeper in Management

9.1 Communication

Like all birds, kori bustards can be very good at hiding an illness. For this reason, keepers need to be especially vigilant and communicate their concerns to a Curator and/or Veterinarian. Familiarity with individual birds is essential when caring for this species. Keepers should report any signs of illness including a reduced appetite to a Veterinarian as soon as possible. Kori bustards have a very good appetite and will take food from keepers on a daily basis. Deviations from this behavior are unusual and should be reported at once. Similarly, any lameness should be reported and checked, as the species is notorious for developing foot and leg problems. If caught early, additional complications can be potentially avoided.

9.2 Enrichment

For kori bustards, which are a curious, intelligent animal, enrichment can be just as much fun for keepers as it is for the birds. Below is a list of food items that are provided to kori bustards at various institutions around the country. Most of the items are scattered around the birds' pens to encourage foraging behavior. Keep in mind that different individuals in a group will respond differently to different items. Some items that one bird will not touch another will consume readily. Be sure to obtain the necessary permission to try these enrichment items first.

Enrichment	Comments
Live Insects	Kori bustards love live insects, in particular super worms, crickets, regular mealworms and waxworms. (SNZP has had mealworms pass through undigested.) Birds that are off of their food for various medical reasons will sometimes start eating if live insects are offered to them.
Chopped fruit/berries	Chopped cantaloupe, watermelon, apple, banana, cooked sweet potato, cherry tomatoes, pomegranate, blueberries, grapes (in bunches or individually scattered), mixed vegetables (especially peas, carrots, and corn)
Whole peanuts in the shell	These are also useful for medicating birds. Remove a small portion of the top of the peanut, remove the nut inside, slip the pill in and put the shell back on. Peanuts work well when birds become suspicious of medicated mice.
Produce	Whole-leaf spinach
Pelleted diets	Marion Scenic Jungle Food, Ziegler Bird of Paradise pellets, or crane pellets
Peanut butter	Spread a few tablespoons of this on the trunks of trees in the wintertime as a source of extra calories. The behavior replicates the bird's behavior in the wild of eating sap from acacia trees.
Knuckle bones	One of the females at the Dallas Zoo helps herself to the knuckle bones that are given to their vultures once a week. She will stand for several minutes, pulling off and consuming any accessible meat.

Live mice	If available, live mice will be relished by koris. Kori bustards are also good at capturing their own enrichment items, consuming small snakes, lizards, toads and small birds that make their way into their pens.
Rope	Young birds have shown some interest in knotted short lengths of rope tied to a fence or bush with a large knot at the end. Youngsters will spend several minutes biting at and pulling on that rope. If the rope is elevated above a bird's head, they will jump up to reach it. Short lengths of rope are prudent here. Longer lengths could potentially wrap around a bird's neck. Keepers should remain present in the yard with this enrichment item to watch for any problems and remove the rope when they leave the yard.
Substrate	A favorite enrichment activity for kori bustards is dust bathing. Birds will bathe in mulch, sand or coarse oyster shell. Dust bathing sessions can last a half an hour or more, well worth the time required obtaining the dust bathing substrate.

9.3 Scale Training

Historically, kori bustards have proven to be a rather "accident prone" species in the US with broken wings and legs occurring mainly when birds are handled. To avoid handling, a 4' x 4' scale (Pennsylvania scale model 7500) can be used to monitor weights on a monthly (or as needed) basis. An added benefit of monthly weighing, is documentation of seasonal weight gains in males (See Chapter 6 - Section 6.3).

Position the scale an area that the birds feel comfortable in- perhaps in front of a feeder. Indoor/outdoor carpet can be placed over the scale so that it completely covers the top and all sides. In addition to hiding the bright silver color of the scale, the carpet also gives the birds good footing when they step on the scale. During the early days of the training process, place mealworms or some other favored food item on the scale to encourage the birds to step onto the scale.

Once the birds feel comfortable stepping onto the scale, routine weighing can begin. An ideal location for the scale is next to a shed. This will allow placement of the scale indicator (which must be kept dry) inside the shed. On days when weighing occurs, the keeper places mealworms on the scale, enters the shed and shuts the door. The keeper identifies the bird on the scale through a small window or slit in the door and records the weight. It is important that the keeper remain out of visual and auditory range of the scale area to allow the birds to feel secure enough to step on the scale. Monthly weighing should be relatively quick especially with a favored food item. Some months, not all birds cooperate and get on the scale, but these birds generally cooperate the following month.

9.4 Keeper research

Keepers are in a great position to contribute to kori bustard management and husbandry advances, as they are the people working with the species on an intimate basis every day. Some areas where keepers can help include:

- Instituting scale training so that birds can be routinely weighed (Section 9.3).

- Documenting physical development of chicks including data collection on weight, morphometrics, and plumage changes (Section 7.1).
- Documenting personalities” of wild versus captive-reared and hand- versus parent-reared individuals.
- When adult birds are handled, recording weight, culmen length, skull length, tibiotarsus length, tail length, wing chord (Section 2.4).
- Weighing and measuring all eggs (fresh weight, length and width of egg).
- Collecting data on activity budgets of adults and chicks.
- Determining food preferences of females feeding chicks.
- Space utilization: what areas and types of areas are preferred by koris, comparing on-exhibit birds with off-exhibit birds.
- Documenting molt patterns (Section 6.13).

If you are interested in additional details regarding any of these areas of research, please contact the SSP Coordinator, Sara Hallager at hallagers@si.edu.

9.5 Pest control

Keepers should check yards daily for signs of rodent activity. Remove any spilled food on a daily basis to aid in rodent control. Poison should not be used inside exhibits. If snap traps need to be set, they should be covered so that the birds are unable to both see and reach the snap trap. Kori bustards are curious and will investigate a trap if they can see it.

Wild birds pose a problem especially at feeding time, as most kori bustards will not aggressively defend their food. Keepers need to compensate for this by providing extra food and/or employing special feeders, which discourage wild birds and squirrels. For pelleted food, feeders which have a platform that closes when a bird (starling, pigeon) lands on it, work very well (Figure 9.1). For dispensing mice, large metal feeders that can hold a food pan and also close when unwanted birds land on the collapsible platform work well.

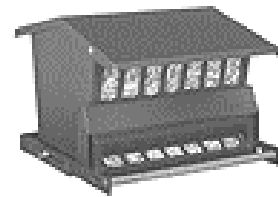


Figure 9.1. Pellet feeder for discouraging feral birds.

9.6 Medicating

Generally, kori bustards are easy to medicate by putting a pill or liquid inside a mouse. There are times however, when birds will refuse the medicated item and at this point, keepers need to get creative. Items such as hopper mice, pinkies, peanuts in the shell, cherry tomatoes, earthworms (works well for thin liquid medications), large mealworms, banana, grape and horsemeat meatballs can all be employed if birds refuse to take a mouse. It is prudent for keepers to become familiar with favored food items before a bird becomes ill so that they will know which food items will be most readily accepted.

10. Miscellaneous

10.1 Unusual behaviors

Sometimes, kori bustards surprise their keepers and deviate from what is considered normal behavior. For example:

- Kori bustards at National Zoo don't like yellow raincoats or red sweatshirts. Chicks especially react negatively to these colors.
- For many years, a female at National Zoo would sit under the wing of a male bird during the winter months. Neither bird ever performed this behavior with any other bird.
- A breeding male at San Diego WAP was observed sitting on an egg on several occasions during his first breeding season.
- A male at Miami MetroZoo was observed allopreening a female.
- Kori bustards do not cast pellets. Findings of casts in exhibits is abnormal (be sure the casts are not raptor in origin!)

10.2 Kori bustards in myth and folklore

Kori bustards figure in dances and songs of the Bushmen of Botswana. Drawings have been found in caves depicting the species. Appendix V is an African tale.

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EVOLUTION/TAXONOMY

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Appendix I: Kori bustard SSP guideline for pinioning

Chicks:

It is the opinion of the kori bustard SSP that kori bustard chicks benefit from being pinioned. The majority of institutions do not have covered pens for their koris and thus, unpinioned birds need to be caught on a regular basis for feather cutting. Kori bustards are very prone to injury during capture and restraint- this has been demonstrated repeatedly at various facilities over the past 50 years. Removing the necessity for feather cutting eliminates the inherent risk involved with catching birds. While each institution will have its own policy on pinioning, in the opinion of the SSP, it is beneficial for the long-term management of the species that pinioning be performed as early as Day 3 but no later than Day 5. The actual procedure will vary between institutions depending upon the veterinarian's preferred method. Kori bustard chicks have very thick wings and if chicks are to be pinioned after day 5, they should be anesthetized for humane reasons. Reproduction is not compromised by this action as copulation in the species occurs on the ground. Kori bustards are terrestrial in nature.

Adults:

It is the opinion of the kori bustard SSP that adult, full winged kori bustards should not be pinioned. Unlike chicks, the procedure in adult birds is very difficult, stressful and can lead to complications such as further injury as the bird learns to adapt to an altered wing as well as complications from the surgery itself. Regular feather clipping is the recommended procedure for rendering the bird flightless. Educating handlers on the proper techniques of catching adult birds is critical to avoid injuries. Recommendations for fence heights which reduce the likelihood that birds will escape can be found in Section 2 Chapter 2.1.1.

Appendix II: Sample hand-rearing sheet - Day 1-14

This is a male kori bustard hatched at the Smithsonian National Zoological Park on 17 August 2003. The sex of this bird was unknown until it was 30 days old.

Date	Time	Food item	Weight (g)	Chick wt
18-Aug	9:30	cricket	0.4	99.2g
		pea	0.3	
	10:30	grape	0.2	
		scenic	0.1	
		waxworm	0.5	
	12:00	scenic	0.1	
		grape	0.3	
		pea	0.3	
	13:00	cricket	0.7	
		bean	0.4	
	15:00	scenic	0.4	
		bean	0.3	
		waxworm	0.5	
	17:30	cricket	0.4	
		bean	0.4	
		waxworm	0.5	
		grape	0.4	
19-Aug	6:30	2 scenic pellet	0.2	100.3g
		2 cricket abs	0.7	
		1 pea	0.3	
		1 bean	0.4	
		3 watermelon	0.2	
		3 waxworm	0.15	
		8:30	2 cricket abs	
	2 watermelon		0.15	
	1 pea		0.3	
	2 waxworm		0.3	
	1 bean		0.4	
	10:30	1 scenic	0.1	
		1 crane	0.3	
		3 watermelon	0.18	
		2 cricket abs	0.9	
		2 bean	0.6	
		1 waxworm	0.2	
	12:30	1 scenic	0.1	
		2 watermelon	1.7	
		1 bean	0.7	
		1 ratite	0.2	
		2 waxworms	0.4	
	14:30	1 pea	0.5	
grape		0.2		
1 scenic		0.1		

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt	
19-Aug	14:30	watermelon	1.7		
		2 waxworm	0.6		
		1 carrot	0.3		
		bean	0.6		
		grape	0.3		
	16:00	1 scenic	0.1		
		waxworm	0.2		
		watermelon	0.5		
	17:30	2 cricket abs	0.8		
		crane	0.1		
		watermelon	0.6		
		1 pea	0.4		
		waxworm	0.2		
	20-Aug	6:30	scenic		0.2
watermelon			1.8		
pea			1.0		
waxworm			0.7		
bean			7		
9:00		cricket	6		
		ratite	0.1		
		bean	0.7		
		watermelon	1.1		
		waxworm	0.8		
		pea	0.4		
		scenic	0.1		
		cricket	0.6		
11:00		egg white	0.8		
		bean	1.0		
		watermelon	0.8		
		scenic	0.1		
		waxworm	0.5		
		13:00	scenic	0.2	
			watermelon	1.3	
pinkie			1.5		
waxworm			0.2		
egg white			0.4		
15:00			scenic	0.1	
			cricket	0.7	
		watermelon	1.6		
		egg white	0.8		
		bean	0.8		
	waxworm	0.6			
	pea	0.5			
	ratite	0.1			
	17:30	pea	3.1		
		scenic	0.2		

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt
20-Aug	17:30	carrot	1.2	
21-Aug	6:30	scenic	0.3	110.3
		cricket	0.8	
		pea	0.7	
		waxworm	0.7	
		bean	1.2	
		watermelon	1.6	
	9:00	egg white	1.2	
		apple	0.6	
		waxworm	0.6	
		bean	0.6	
		scenic	0.2	
		kale	0.1	
		pea	0.4	
		watermelon	0.5	
	11:00	scenic	0.2	
		watermelon	0.8	
		waxworm	0.4	
		apple	0.3	
		bird of paradise	0.1	
		pea	0.9	
		egg white	0.6	
		bean	0.5	
		cricket	0.6	
	13:00	scenic	0.3	
		waxworm	0.7	
		cricket	0.8	
		crane	0.5	
		egg white	0.6	
		apple	0.5	
		kale	0.1	
		watermelon	1.0	
	15:00	cricket	0.9	
		scenic	0.3	
		watermelon	1.1	
		apple	0.4	
		egg white	0.8	
		pea	0.5	
		crane	0.3	
		kale	0.1	
		waxworm	0.2	
		bean	0.4	
		carrot	0.5	
	17:30	pinkie	1.8	
		crane	0.6	
		watermelon	1.7	

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt
21-Aug	17:30	pea	0.6	
		scenic	0.3	
		waxworm	0.4	
		bean	0.4	
		egg white	0.9	
22-Aug	6:30	crane	0.3	122.3
		scenic	0.2	
		cricket	0.8	
		bean	1.0	
		watermelon	2.0	
	9:00	pea	1.8	
		watermelon	1.8	
		crane	0.1	
		egg white	2.4	
		waxworm	0.6	
	11:00	scenic	0.2	
		egg yolk	2.5	
		bird of paradise	0.1	
		bean	0.6	
		papaya	1.6	
		cricket	0.9	
		kale	0.1	
		scenic	0.2	
		pea	0.4	
		13:00	cricket	
	bird of paradise		0.3	
	kale		0.4	
papaya	1.3			
waxworm	0.9			
bird of paradise	0.6			
crane	0.6			
cricket	0.8			
15:00	bean	0.6		
	kale	0.1		
	cricket	0.5		
17:30	apple	0.1		
	waxworm	0.4		
23-Aug	6:30	pinkie	2.8	137.9
		bean	1.3	
		pea	0.9	
		bird of paradise	0.1	
	9:00	cricket	0.7	
		banana	2.7	
		pea	0.9	
	11:00	papaya	2.3	
		waxworm	0.6	

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt
23-Aug	11:00	watermelon	2.1	155
		ratite	0.1	
		bean	1.8	
		bird of paradise	0.1	
		pea	0.9	
	13:00	waxworm	0.9	
		bean	1.3	
		cricket	0.8	
		banana	3.7	
	15:00	pinkie	2.8	
		pea	1.5	
		carrot	4.0	
		bean	1.0	
		scenic	1.5	
	24-Aug	6:30	crane	
bean			1.1	
pea			2.1	
scenic			0.5	
watermelon			0.7	
waxworm			0.8	
9:00			crane	0.6
		pear	1.5	
		bean	3.5	
		scenic	0.6	
		watermelon	1.3	
		carrot	0.5	
		pea	0.6	
		cricket	2.5	
		11:00	egg yolk	2.2
			egg white	0.6
bean			0.8	
bird of paradise			0.3	
crane			0.5	
watermelon			1.2	
carrot			0.5	
scenic			0.5	
pea			0.5	
waxworm			0.3	
13:00		ratite	0.2	
		waxworm	0.8	
		bean	0.9	
	scenic	0.7		
	cricket	1.2		
	crane	0.4		
	spinach	1.8		
15:00	bean	0.8		

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt
24-Aug	15:00	scenic	0.3	
		carrot	1.1	
		pea	1.3	
		spinach	1.8	
		cricket	0.5	
		crane	0.7	
		waxworm	0.4	
	17:30	corn	0.5	
		crane	1.2	
		scenic	0.8	
		pea	1.1	
		bean	0.6	
		cricket	1.0	
		pinkie	1.8	
25-Aug	7:00	waxworm	0.9	171g
		bean	3.5	
		carrot	3.9	
		watermelon	7.0	
		ratite	0.8	
	9:00	bird of paradise	0.6	
		waxworm	0.2	
		ratite	0.3	
		scenic	0.8	
		cricket	0.2	
	11:00	crane	2.0	
		bean	2.1	
		carrot	2.3	
		waxworm	1.4	
		kale	0.1	
	13:00	crane	0.3	
		pea	0.4	
		pear	0.5	
		cricket	0.2	
	15:00	bean	5.2	
pea		0.7		
scenic		1.7		
blueberry		2.01		
17:30	cricket	0.7		
	waxworm	1.3		
	watermelon	2.3		
	crane	0.2		
	bean	1.7		
	pea	3.1		
	pinkie	2.7		
26-Aug	6:30	scenic	0.7	190g
		bean	1.5	

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt	
26-Aug	6:30	pea	1.8		
		crane	0.8		
		cricket	2.5		
		carrot	0.5		
	9:00	scenic	2.5		
		papaya	2.1		
		bean	1.2		
		egg white	3.1		
		pea	1.5		
	11:00	scenic	3.0		
		kale	0.1		
		bean	1.1		
		papaya	2.2		
		cricket	0.8		
		corn	0.4		
		pea	0.8		
		egg white	0.4		
		carrot	0.3		
		13:00	scenic	0.4	
	waxworm		0.8		
	bean		0.6		
	papaya		0.7		
	pea		1.2		
	crane		1.2		
	cricket		0.6		
	carrot		0.6		
	15:00		ratite	1.6	
			crane	0.8	
			carrot	0.5	
		waxworm	0.6		
kale		0.2			
17:30	bean	3.8			
	corn	0.2			
	pinkie	2.1			
	bean	3.3			
	ratite	0.8			
	carrot	3.0			
	crane	0.1			
	bird of paradise	0.1			
	pea	2.4			
	spinach	0.1			
cricket	0.4				
27-Aug	6:30	scenic	0.8	220g	
		pea	2.2		
		crane	1.8		
		bean	4.2		

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt	
27-Aug	6:30	pinkie	1.6		
		cricket	2.1		
	9:00	waxworm	0.2		
		scenic	0.8		
		bean	1.3		
		crane	0.4		
		apple	2.1		
		waxworm	1.1		
		spinach	1.2		
		carrot	0.4		
		pea	1.8		
		11:00	crane	1.4	
	bird of paradise		0.6		
	grape		2.2		
	scenic		0.4		
	bean		1.8		
	carrot		0.8		
	cricket		2.4		
	spinach		1.1		
	13:00		egg white	4.1	
			scenic	0.9	
		waxworm	1.1		
		bean	1.2		
		crane	0.6		
		spinach	0.5		
		cricket	0.8		
		grape	0.8		
		carrot	0.7		
		15:00	scenic	1.5	
	grape		1.8		
	apple		0.5		
	bean		1.3		
waxworm	1.3				
crane	0.6				
pea	0.9				
spinach	0.4				
17:30	pinkie		3.2		
	bean		7.3		
	carrot	4.9			
	waxworm	1.2			
	scenic	3.1			
28-Aug	6:30	scenic	0.8	251g	
		bean	2.3		
		pea	1.5		
		cricket	2.4		
		pinkie	3.1		

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt	
28-Aug	6:30	carrot	0.6		
		9:00	scenic		1.6
			egg yolk		2.8
			egg white		0.5
			bean		2.2
			waxworm		1.3
			carrot		1.1
			pea		0.6
			crane		0.2
		11:00	scenic		2.9
			crane		1.2
			waxworm		1.1
			bean		6.4
			cricket		1.2
		13:00	crane		1.2
			grape		2.1
			bean		0.8
			pea		1.8
			scenic		1.5
		15:00	scenic		1.1
			grape		1.5
			crane		0.2
			bean		0.5
			carrot		1.8
			waxworm		0.8
		17:30	scenic		1.5
			carrot		2.1
		waxworm	0.8		
		pinkie	3.1		
		pea	0.9		
		corn	1.1		
29-Aug	6:30	scenic	0.8	278g	
		bean	2.5		
		pinkie	2.3		
		cricket	2.1		
		carrot	1.3		
		pea	1.2		
	9:00	scenic	3.6		
		bean	2.3		
		cricket	0.8		
		pea	2.4		
		carrot	0.7		
	11:00	scenic	0.4		
		egg white	4.6		
		pea	1.2		
		bean	0.9		

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt
29-Aug	13:00	scenic	0.7	
		waxworm	1.3	
		bean	0.4	
		pea	1.2	
		pinkie	1.3	
	15:00	scenic	0.8	
		apple	1.1	
		crane	1.0	
		bean	2.3	
		carrot	1.7	
		cricket	3.6	
		17:30	scenic	
	banana		7.8	
	bean		4.5	
	pea		4.4	
	carrot		3.5	
	waxworm		0.7	
	cricket		0.9	
	pinkie		3.3	
	kale		1.7	
papaya	3.6			
30-Aug	6:30	scenic	2.8	314g
		bean	3.1	
		waxworm	1.3	
		pea	1.3	
		pinkie	2.8	
		crane	0.6	
		9:00	scenic	
	spinach		0.8	
	egg yolk		2.3	
	pea		1.4	
	crane		1.6	
	egg white		1.8	
	carrot		1.7	
	11:00	scenic	3.6	
		spinach	0.9	
		banana	6.1	
		carrot	0.8	
	13:00	scenic	0.8	
		bean	1.3	
		crane	1.4	
	15:00	scenic	1.2	
		bean	5.1	
		spinach	0.7	
		cricket	.43.4	
		crane	1.1	

Kori Bustard Husbandry Manual - Appendices

Date	Time	Food item	Weight (g)	Chick wt
30-Aug	15:00	bird of paradise	0.2	368g
	17:30	pinkie	2.4	
		bean	2.9	
		crane	0.6	
		cricket	0.5	
31-Aug	6:30	waxworm	0.9	
		scenic	2.8	
		bean	2.3	
		pea	2.4	
		carrot	1.2	
	9:00	pinkie	2.1	
		scenic	2.1	
		bean	6.4	
		crane	0.8	
		pea	1.2	
	11:00	cricket	1.2	
		scenic	0.4	
		grape	2.1	
		egg white	3.1	
		waxworm	0.5	
	13:00	carrot	0.5	
		alpo	1.1	
		scenic	0.8	
		cricket	1.8	
		bean	2.4	
15:00	pea	2.4		
	banana	4.1		
	scenic	0.8		
	bean	0.8		
	waxworm	0.7		
17:30	crane	0.4		
	pinkie	2.3		
	scenic	1.2		
	bean	3.1		
	kale	0.5		

List of manufactured food items:

Scenic- (Marion scenic pellets- jungle and paradise sizes)

Crane (Ziegler crane pellets)

Alpo, canned dog food

Ratite (Ziegler ratite pellets)

Bird of paradise (Ziegler bird of paradise pellets)

Appendix III: Necropsy Protocol

SSP KORI BUSTARD NECROPSY FORM Effective October 2002

INSTITUTION/OWNER _____

ADDRESS _____ COUNTRY _____

ID# _____ ISIS# _____ STUDBOOK# _____ SEX _____

AGE ___Y ___M ___D (Actual or estimate ?) CAPTIVE-BORN OR WILD-CAUGHT ?

WEIGHT (IN GRAMS OR KILOGRAMS) _____

DEATH DATE _____ NECROPSY DATE _____

DEATH-NECROPSY INTERVAL (HRS) _____

DEATH LOCATION _____ NECROPSY LOCATION _____

HISTORY (Include clinical signs, circumstances of death, clinical labwork, diet and housing)

GROSS EXAMINATION

If no abnormalities are noted mark as normal or not examined (NE)

GENERAL EXAM (Physical and nutritional condition, skin, plumage, fat stores, body orifices)

MUSCULOSKELETAL SYSTEM (Bones, marrow, joints, muscle)

RESPIRATORY SYSTEM (Nasal passages, pharynx, larynx, trachea, bronchi, lungs, air sacs)

CARDIOVASCULAR SYSTEM (heart, pericardial sac, great vessels, valves)

DIGESTIVE SYSTEM (mouth, beak, tongue, esophagus, proventriculus gizzard, intestines, cloaca, liver and gallbladder, pancreas)

SPLEEN AND THYMUS

Kori Bustard Husbandry Manual - Appendices

URINARY SYSTEM (kidneys, ureters)

REPRODUCTIVE SYSTEM (gonads, oviduct)

ENDOCRINE SYSTEM (thyroids, parathyroids, adrenals, pituitary)

NERVOUS SYSTEM (nerves, brain, meninges, spinal cord, eyes)

ADDITIONAL COMMENTS OR OBSERVATIONS:

Prosector: _____ Date: _____

SUMMARIZE PRELIMINARY DIAGNOSES:

LABORATORY STUDIES: Results of cytology, fluid analysis, urinalysis, serum chemistries, bacteriology, mycology, virology, parasitology, radiography, etc.

TISSUE CHECK LIST

Where possible freeze 1-3 cm blocks of tissue from major organs (e.g. liver, kidney, spleen) in small plastic bags, preferably to be kept ultrafrozen at -70 degrees Celsius; freezing at conventional temperatures is acceptable if there is no access to an ultrafreezer.

Preserve as many as the following tissues as possible in 10% buffered formalin at a ratio of approximately 1 part tissue to 10 parts solution. Tissues should be no thicker than .5 to 1 cm. Take 2 sets of fixed tissue, one for the Primary pathologist, and the other for the SSP Veterinary Advisor. Send tissues required for diagnosis to Primary pathologist and request a duplicate set of slides for the SSP Veterinary Advisor who should be contacted for further instructions.

NOTE: There is generally no need to fix and label each tissue separately .

Skin	Cecum	Trachea
Muscle	Cloaca	Lung
Nerve (Sciatic)	Liver	Air Sac
Tongue	Gallbladder	Heart
Esophagus	Pancreas	Aorta
Proventriculus	Spleen	Thyroid
Gizzard	Kidney	Parathyroid
Duodenum	Adrenal	Thymus
Jejunum	Testis	Brain
Ileum	Ovary	Pituitary
Colon	Oviduct	Eye
Bone with marrow		

PRIMARY PATHOLOGIST: Name _____
Lab _____
Address _____
Phone _____

Please attach a copy of the final pathology report and send with the duplicate set of fixed tissues to the SSP Veterinary Advisor.

NECROPSY PROTOCOL FOR KORI BUSTARDS

For best results, all dead birds should be necropsied as soon as possible. Carcasses should be refrigerated (**never frozen**) until the time of necropsy.

Post-mortem examinations should be conducted in a routine fashion and all findings should be recorded on the SSP Kori Bustard Necropsy Form (or a comparable form).

The person conducting the necropsy should take **2 complete sets** of tissue samples for formalin fixation. Consult the Tissue Check List to ensure that all samples were collected. For proper tissue preservation, the volume of 10% buffered formalin used must be at least 10 times the volume of the tissue samples.

One set of fixed tissues should be sent to the institution's Primary Pathologist for evaluation. The duplicate set of tissue samples, along with copies of the Necropsy Form and Primary Pathologist's final report and a duplicate set of histology slides (if available), should be sent to the SSP Veterinary Advisor for storage and reference.

If any questions arise regarding this protocol, please attempt to contact the SSP Veterinary Advisor, Dr. Suzan Murray (202-673-7982) before proceeding with the necropsy.

Address of SSP Veterinary Advisor:
Dr. Suzan Murray
Smithsonian National Zoological Park
3001 Connecticut Ave NW
Washington DC 20008
Phone 202-673-7982; Email: murrays@si.edu

Please send a copy of the final pathology report to the SSP Coordinator:

Sara Hallager
Smithsonian National Zoological Park
3001 Connecticut Ave NW
Washington DC 20008
Phone (202-673-4740); Email: hallagers@si.edu

Appendix IV: Annual Egg Report

Kori bustard (<i>Ardeotis kori</i>) Egg Production Annual Update Report																										
Egg number	Sire studbook	Dam studbook	Date egg laid	Incubation					Fertility			Results					result date or hatch date	Rearing			Chick sex					
				Parental	Incubator	Fostered	Combination	Not incubated	fertile	infertile	unknown	hatched	died in shell	broken	missing	unknown		parental	hand	Combination	Chick ID #	male	female	unknown		
Ex.	143	119	25/5/03		x				x			x					17/6/03		x		213964			x		
1																										
2																										
3																										
4																										
5																										
6																										
7																										
8																										
9																										
10																										
If you ARTIFICIALLY incubate any eggs, please provide your incubator settings / Incubator type _____																										
Temperature _____ (F) or (C)										Humidity (wet bulb) _____ OR Relative Humidity _____ %																

Appendix V: “*King of the Birds*” (A Traditional Zulu Story)

"Gogo?" Thobeka was the first to break the silence around the fire this night. Gogo looked at the most inquisitive of her grandchildren with a broad smile. "Yes, my dear one," she answered. "Gogo, I know that the mighty Lion, Bhubesi, is king of all the animals. Is he King also of the birds?" "Ah, that is an interesting question, Thobeka." The children sensed a story coming and drew even closer together. "You are right when you say that Lion is the king of all the animals. And as for the birds, well, I will have to tell you about the time they decided to have a leader of their own. . . Kwasuka sukela. . ."

Some time after the Creator had finished making the beasts of the sea, land and sky, as He was busy putting the finishing touch to His work by creating People, Nkwazi (nkwah'-zee), the great Fish Eagle, called a meeting of all the birds. And they came, from the Flamingo to the Weaver, from the Warbler to the Owl, they came. "Ah-hem," Nkwazi began by clearing his throat. The chatter died down as everyone turned their gaze on the magnificent eagle. "I have asked you all to be here for a very important reason. As you all know, Lion, the great Bhubesi, is the king of all the beast of the land. But he hardly dare speak for us, the great winged creatures of the air! It is my suggestion that we chose from among our number a bird to be our sovereign leader!" A ripple of chattering began again as the birds turned to one another to discuss the idea. "Ah-hem!" Nkwazi cleared his throat once more. He waited until he had the attention of all present. "As I am the most majestic and regal bird present, I suggest that I, Nkwazi, be the King of the birds!"

A great deal of mumbling began from all corners of the gathering. Then one voice rose above the others, demanding attention.

"Yes, Nkwazi, you are indeed majestic." It was the giant Eagle Owl, Khova (koh'-vah) speaking. "However I actually think that it is I who should be the King of the winged animals. You see, I have the largest eyes of any of the birds. I can see everything that happens, and therefore am very wise. It is wisdom we need in a leader more than stateliness."

Again a low murmur went through the crowd until a third voice demanded attention. "I acknowledge Khova's wisdom and Nkwazi's regal bearing, however I would propose that I be King of the birds. " **Kori Bustard, Ngqithi (ngee'-tee)** walked to the centre of the circle as he spoke. "I am the largest of all the winged kingdom. Certainly strength is an important factor in leadership!" All the birds began to speak at once. Some threw their support behind the Eagle, some believed the Owl should be the King, while others liked the Kori Bustard. Finally after a long period of arguing, a little voice was heard rising above the din. "Excuse me. Excuse me, please!" It was Ncedo (n~ay'-day), the tiny Neddicky (a small, quick-moving southern African warbler). He was so small and insignificant looking that he was easily overlooked. Finally the crowd became silent and allowed the little bird his say. "If we are going to elect a King of the birds, well, I think it should me!"

Everyone broke into laughter. Surely this miniature warbler was jesting! Ncedo, King of the birds! Unthinkable! Silly creature for even thinking it! What, the audacity of this little thing! What arrogance! What impudence!

"And what reason would you give for having us elect you as our King?" asked Nkwazi staring into Ncedo's eyes. "Well," began Ncedo, "no real reason, besides to say

that I should be given every bit as much opportunity as anyone else!" While they laughed at Ncede's suggestion, the assembly was impressed with the little fellow's courage! "What we need is a competition!" decided Nkwazi. "We will have a contest to see who is fit to be our King!" Everyone seemed to like this idea. It was agreed that on the first day after the full moon the birds would again gather. They would meet on the open veld when the sun was high in the sky. And when the sun touched the tallest tip of the mountain, the birds would become airborne. The one who could then fly the highest and touch the hand of God would become the King.

On the appointed day the birds assembled. Patiently they watched the sun make her way down from the sky. At the exact moment she touched the tallest peak of the mountain, the birds all rose into the air. It was a magnificent sight to see.

Now, little Ncede was there. He was determined to prove that he had just as much right as anyone else to the kingship. But he knew that his little wings could not lift him very far. He had therefore made a special plan. Just before the birds took off, Ncede silently crept underneath the wing of the mighty Fish Eagle. He carefully pushed his way deep down into the raptor's largest feathers. Nkwazi was so busy concentrating on the descent of the sun, he didn't feel a thing.

Higher and higher the birds soared. The little ones fell out of the race after a short time. Slowly they drifted back down to earth to watch the others. Soon all but three of the birds had dropped out of the competition. Eagle, Owl and **Bustard** fought to see who would claim the prize. They were so tired, but they pushed on, higher and higher. The strain was too much for owl, and with a resigned "Hoo-hoo" he dove back toward firm ground. Now it was Nkwazi and Ngqithi. Up and up they went, closer and closer to the hand of God. But no matter how much he tried, the feat was too much for the heavy Bustard. After a final pull with his mighty wings, he called to Nkwazi. "Ah, my friend, it seems you are the winner. I can go no further."

That confession seemed to temporarily strengthen the almost spent Eagle; he gathered his last bit of strength and climbed beyond the **Bustard**.

"Wheeeee-whee-whee!" The victorious sound of Nkwazi's call filled the sky.

"Not so fast, Nkwazi!" chirped Ncede, and he shot out from under one of the mighty bird's feathers. "You have not won yet!" And with that Ncede rose above Nkwazi to touch the hand of God. No matter how hard he tried, Nkwezi just didn't have the strength left to climb any farther. With a groan he allowed himself to begin gliding down to earth.

Now, all the birds below had watched this and were angered by Ncede's trickery. As Ncede returned to the soil he did not find the kingly welcome he expected. Instead every bird in the kingdom was ready to pluck the feathers from little Ncede's back. But the quick little bird saw their anger and quickly flew into a deserted snake hole. "Come out, Ncede!" snapped the bustard. "Come out and get the prize that you deserve!" "Yes!" echoed all the other birds. "Come on, Ncede! Where's your brave face now?" But Ncede stayed hidden. The birds guarded the hole until long after sunset, waiting for Ncede to show his face. All through the night they waited, thinking that Ncede had to come out for food or water soon. In the morning Ncede had still not appeared. "Listen," said Nkwazi, "I am faint from hunger. We do not all need to guard the hole. I suggest we take turns until the little jokester decides to come out!" Everyone agreed, most of them being terribly tired.

"I am not yet weary or hungry," volunteered the owl. "I do not mind taking the first watch. Just mind that someone comes back in an hour or two to relieve me!" A quick roster was drawn up and everyone but owl went off to sleep or hunt for food. Owl was used to being still and waiting for his prey. He waited and waited it seemed to him forever. Finally he decided to close just one of his eyes. "After all," he thought, "even one of my eyes is bigger and can see better than both eyes on any other bird!" He closed his right eye and peered into the dark hole with his left eye. Several minutes later Owl decided to switch and so he open the right eye and closed the left. This went on for quite a while, until one time Owl forgot to open the right eye when he closed the left. There he was, both eyes closed! And he fell fast asleep.

Now this was the moment for which Ncede had been waiting. Before the opportunity was lost, Ncede shot out of the hole and disappeared into the forest. Eagle, who was on his way to relieve Owl, saw the little creature leave and cried out. He went to owl and found the bird in a deep sleep.

"Wake up, you fool!" he shouted at owl. "You fell asleep and Ncede got away!" Well, Owl was so embarrassed by his mistake, to this day he sleeps during the day and does his hunting at night so that none of the other birds will bother him about having been caught sleeping on the job. And Ncede, he hides out in the forest, flittering from here to there, never stopping anywhere long enough to be caught. "So," Gogo," asked Thobeka when several moments of silence had elapsed, "who then became the king of the birds?"

"That, my child," Gogo looked at her granddaughter with a smile, "no one knows. I think they are arguing to this day about the position!"