COMMONLY ENCOUNTERED HATCHING AND POST-HATCHING PROBLEMS IN BUSTARDS: RADIOGRAPHIC IMAGING, ENDOSCOPY, SURGICAL INTERVENTION AND POST-HATCHING CARE

by Tom Bailey and Susan Anderson

Summary

Selected case reports describe some of the common hatching and post-hatching problems that have been encountered with bustards at the National Avian Research Center in Abu Dhabi. The hatching parameters of bustards along with techniques to assist malpositioned embryos, including radiographic imaging, endoscopy and ovotomy are described. Standard treatments given to chicks with delayed or assisted hatchings and the correction of spraddle leg and umbilical protuberances are discussed.

Introduction

In recent years there has been a surge of interest in the propagation of bustards in captivity, in particular, the Houbara Bustard *Chlamydotis undulata*. Captive breeding and restoration programmes for this species have been established in the Middle East (Bailey et al. 1996). Similar programmes for other threatened species of bustards have been established in Europe (Grummt, 1979; Goriup, 1985, Osborne, 1985), Australia (White, 1985) and the former Soviet Union (Zubko, 1992; Sukhanov, 1992). These programmes aim to produce surplus birds for release into protected areas, to supplement declining wild populations. Larger Houbara Bustard projects plan to release between 500 and 1,000 birds a year. Morbidity and mortality of chicks are potential limiting factors to the success of these projects and maximising the numbers of chicks that hatch is clearly an important goal in the avicultural care of these species.

A variety of techniques can be used to assist an avian embryo that is having problems hatching, these include radiography, endoscopy and ovotomy (Ensley et al. 1994). Selected case reports are presented here to illustrate the range of hatching and post-hatching problems that have been seen in Kori *Ardeotis kori*, Rufous-crested *Eupodotis ruficrista*, Houbara and White-bellied Bustard *E. senegalensis* at the National Avian Research Center and we describe some of the methods that have been used to try to correct these problems. It would be pretentious to say that the way we do things is the right way so we have also included examples of failures as well as the successes. There is still a great deal to learn about the care and management of the bustard paediatric patient.

Materials and Methods

Incubation techniques

The cases described arose from eggs produced between 1994 and 1997 by captive bustards at the National Avian Research Center (NARC), Abu Dhabi, United Arab Emirates. The incubation techniques used at the NARC are fully described in Sleigh and Samour (1996) and Tarr et al. (1996). Forced air incubators (Schumacher VOMO-1SB and Grumbach Compact S-84) were used to incubate the eggs. The standard setting used was 37.7°C (99.9°F) with a turning rate of one cycle per hour. Three machines were run at varying humidities, low (~30%), medium (~60%) and high (~90%). This enabled eggs to be moved between incubators in order to attain an overall weight loss through incubation of 15%-17.5% (Sleigh and Samour, 1996). While eggs were being incubated they were inspected five times a day and relative humidities and temperatures were checked. Eggs were weighed every three days to determine weight loss and deviations from 15%-17.5% resulted in remedial action. Still air incubators (Brinsea Hatchmaker) were used for hatching and the standard setting was 37.7°C (99.9°F) with a relative humidity of 90%. When eggs were in the hatchers they were examined five times daily and temperatures and humidity were checked. Eggs were not turned during this phase. Once a chick had hatched it was transferred to a dryer (set at 35°C-36°C (95°F-96.8°F) and 40%-50% humidity) where it was left for two to four hours depending on the strength of the chick before it was transferred to the rearing unit.

The incubation parameters for Houbara *C. u. macqueenii*, Rufous-crested, Kori and White-bellied Bustards are listed in Tables 1 and 2. If bustard chicks greatly exceeded these pipping intervals, or were weak or not progressing properly radiography, endoscopy and ovotomy were used to determine the position and status of the embryo. Olsen and Duvall (1994) give a full account of the normal hatching process of the avian embryo.

Radiography

Radiographs were taken with portable/mobile X-ray equipment (Sovereign II, PLH Medical, Watford, Hertfordshire, UK) using screen films (SUPER HR-G, Fuji Photo Film Co., Japan). Average egg weights and the exposure settings used for different bustard species are listed in Table 3. Four radiographs were taken of each egg that was positioned with its long axis horizontal (Fig. 1). The egg was rotated through 90 degrees after each radiograph and the eggshell was marked one to four. Radiographs were developed using a manual system. Using this technique it was possible to identify radio-opaque structures including limb bones and the characteristic V-shaped mandible. From each series of radiographs it was possible to

determine in malpositioned embryos the position of the head from identification of the ventro-dorsal profile of the mandible (Fig. 1). Radiography was a particularly useful technique for investigating problems with Kori Bustard eggs which because of the thickness of the shell are harder to candle than other bustard eggs.

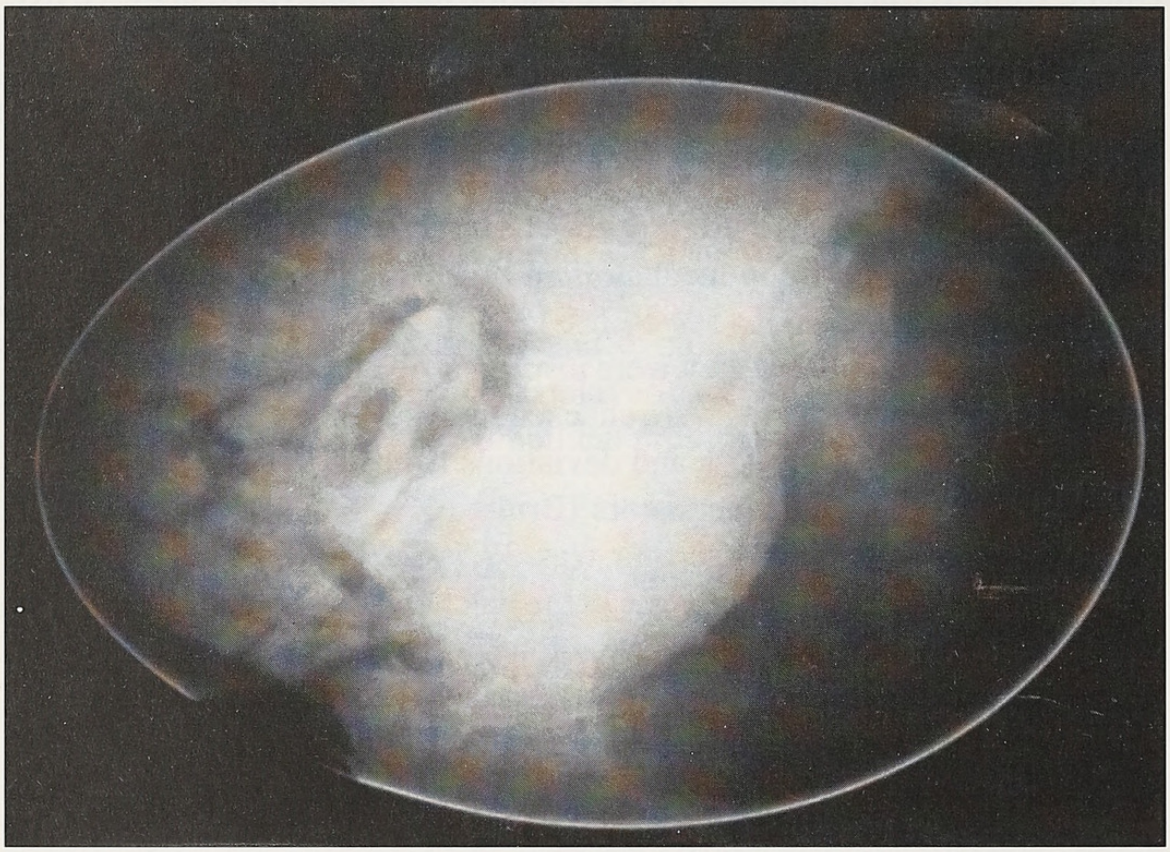

Figure 1. Radiograph of a malpositioned bustard chick (head in the small end of the egg). The outline of the mandible and the structures of the head are visible near to the hole that has been made in the shell

Endoscopy

In the larger eggs of the Kori Bustards it was possible to insert a rigid endoscope (4 mm, Richard Wolf, Mitcham, Surrey) through a hole made in the blunt end of the egg. The membrane was moistened with sterile saline and could be examined to determine embryo viability by monitoring respiratory movements. Use of the endoscope meant that the hole in the eggshell did not have to be made larger than necessary. If the chick was correctly positioned and/or no further immediate intervention was planned the hole in the egg was sealed using micropore tape (3M Medical-Surgical Division, St Paul, MN, USA).

Ovotomy

From examination of radiographs the position of the head and bill was established to determine the entry point for ovotomy. The shell over the entry point was cleaned using dilute iodine (Pevidine antiseidtic solution,

B. K. Veterinary Products, Bury St. Edmunds, UK) and cotton wool moistened with surgical spirit. A small hole was made in the eggshell using the point of a No. 10 scalpel blade and small pieces of eggshell were gently removed using forceps. In the malpositioned embryos, because the entry site was away from the air cell, care had to be taken to examine the membrane for regression of the blood vessels. This was determined by moistening the membrane with sterile saline, which then became translucent. Regressing blood vessels took on a ghost-like appearance and were only partially filled with blood or had no blood in them at all. In all cases of malpositions described in this report there was minimal or no haemorrhage from blood vessels in the membrane. Pieces of eggshell and membrane were progressivelv removed until the head and/or bill were found. Once the chick was provided with a breathing hole it was left and checked every two to four hours when progressively more shell and membrane were removed until the chick was hatched. As more shell was removed the yolk sac was visually examined and chicks were left in the shell until it had fully retracted. Chicks were re-evaluated every two to six hours. lf the yolk sac was still visible dilute iodine was dropped onto it with a moistened cotton bud.

Post-hatching care

All chicks with assisted hatches described in this report were given the following:

Application of 1% iodine solution to the umbilici of chicks promptly after hatching.

Administration of gentamicin (Cidomycin, Roussel Laboratories Ltd, Uxbridge, UK) at a dose of 5 mg/kg sid i.m. for 72 hours and s.c. (Duphalyte, Solvay Duphar Veterinary, Southampton, UK.) or p. o. electrolytes (Pedialyte, Abbott Laboratories, Chicago, USA) for 24-48 hours to chicks that had a delayed or assisted hatch.

Supplementation of the rearing diet with probiotics (Avipro, Vetark. Winchester, UK) from 0-14 days, one week before and after translocations between aviaries, and if birds are given antibiotics.

Case Reports

Hatching problems

Case 1 - White-bellied Bustard id 1178 'head in small end of shell'

This egg had been incubated for the first 18 days in a Shumacher incubator, and in a non-turning Grumbach incubator on days 18-20. The egg was candled on the fourth day and determined to be fertile. The weight loss of this egg had been considered normal (15%) and no problems had

been encountered during incubation (temperature, humidity, rolling).

On the 20th day it was placed in a Hatchmaker incubator. At 7.30am it was candled to determine whether it had internally pipped. No evidence of internal pip was observed by candling and at 10.00am the egg was radiographed to determine the position of the embryo. The radiograph showed that the bill was parallel to the short axis of the egg and midway between the air cell and the small end of the egg. A diagnosis of 'head in the small end' was made. At 11.30am a 10mm hole was made over the bill to enable the chick to breathe. Although blood vessels were not prominent, there was some oozing of blood that rapidly stopped after dabbing with the tip of a dry sterile cotton bud. The chick was alive, but it appeared to be weaker than when it was candled at 7.30pm. At 10.30pm the chick had moved its bill away from the hole and although there were no other changes, vocalisation sounds appeared to be stronger.

On the 21st day at 5.30am the chick had made an external pip crack beside the hole and the chick still sounded strong. At 4.30pm although some blood vessels were still prominent the hole was enlarged and the chick was given two drops of water orally. At 7.30pm examination of the membranes showed that the blood vessels had regressed fully and as the chick had made no progress on its own, more shell was removed and the chick was assisted out of the shell. The yolk sac was fully absorbed. The chick was given the standard post-hatching care. There were no further

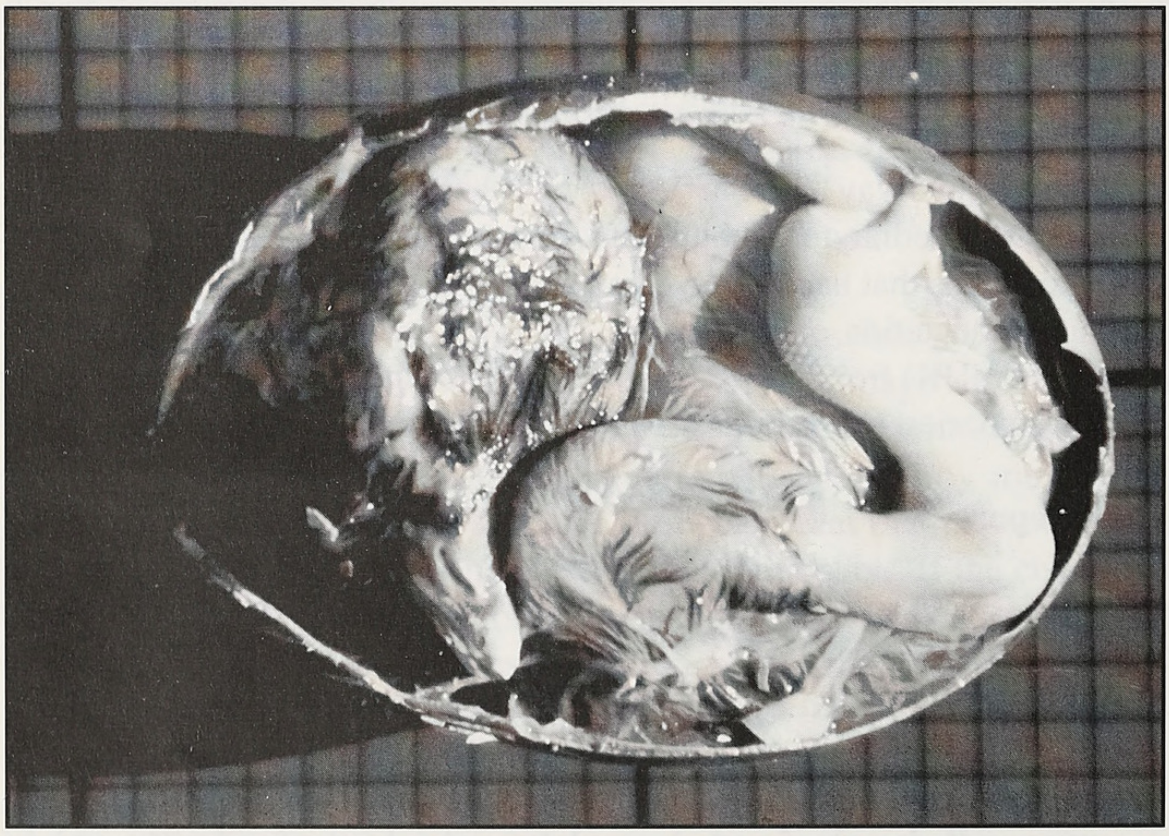

Figure 2. Post-mortem examination of a malpositioned bustard chick (head in the small end of the shell)

problems with this chick which developed normally. Figures I and 2 show the radiographic and post-mortem findings of bustard chicks with this malposition.

Case 2 - Kori Bustard id 795 'foot over head'

This egg had been incubated under a broody bantam for the first 10 days. It was candled on the 10th day and determined to be fertile. From days 11-20 it was artificially incubated in a Shumacher incubator and on the 21st day it was placed in a non-turning Grumbach incubator. The weight loss of this egg had been considered to be normal (13%, low end of normal range) and no problems had been encountered during natural (broody bantam) and artificial incubation (temperature, humidity, rolling).

On the 22nd day there was no evidence that the chick had internally pipped and the chick was estimated to be 24 hours delayed in the hatching process. At 4.00pm radiographs were taken, but it was not possible to visualise any radio-opaque features that would help to establish the position of the head. A hole was made in the large end of the egg and endoscopy was performed which showed that the chick was still breathing and it could be heard vocalising. The hole was enlarged and the air cell membrane was opened. The bill was pointed to the side of the egg below the air cell and one foot was positioned over the head. The breathing was becoming irregular and vocalisations stopped, so more shell was removed and the head was freed. Visualisation of the yolk sac showed that it was not fully absorbed, so the body of the chick was left in the remains of the shell and it was replaced in the hatcher. The chick was checked at 7.00am the following day and the yolk sac was completely reabsorbed, but there was a small 5mm diameter stump of tissue projecting from the umbilicus. In this case the chick received the standard treatments for assisted hatch chicks. The stump was cleaned with dilute iodine and gentamicin ointment (Gental 0.1%, Sulphar, UAE) was applied three times a day. The chick developed normally and there were no further complications.

Case 3 - Kori Bustard egg id KB/AAZ/97/04 'head over right wing'

This egg had been incubated for the first 20 days in a Shumacher incubator, and in a non-turning Grumbach incubator on days 21-23. The egg was candled on the fourth day of incubation and determined to be fertile. The weight loss of this egg had been considered normal (between 13%-17%) and although no problems had been encountered during incubation concerning temperature and humidity, a problem with the turning in one of the incubators was suspected.

On the 24th day it was candled at 7.00am and the membrane at the air cell was observed to be moving and the embryo was thought to have internally

pipped. At 6.00pm the egg was recandled and submitted for radiography. The radiograph showed that the bill was positioned away from the air cell and the shell was opened over the air cell to determine whether the chick was still alive. No movement could be seen and the embryo was declared dead and submitted for post-mortem examination. This revealed that the head was over the right wing. Additional post-mortem findings included an incompletely absorbed yolk sac.

Case 4 - Rufous-crested Bustard egg id AAZ/RCB/97/38 'head between the thighs'

The female incubated this egg for the first three days and it was then placed in a Schumacher incubator for days 4-19, and in a non-turning Grumbach incubator on days 19-20. The egg was candled on the third day of incubation and determined to be fertile. The weight loss of this egg could not be determined because the fresh egg weight had not been recorded. No problems were encountered during incubation (temperature, humidity, rolling).

On the 19th day it was candled at 7.00am and appeared close to internally pipping with the embryo pushing against the internal air cell membrane which was observed to be moving. On the 20th day the egg was recandled because it had still not internally pipped. The air cell was drawn part-way down the length of the egg and it appeared that the body was pushed against the air cell rather than the head. It was submitted for radiography at 6.50pm. The radiograph showed that the head/bill was pointing away from the air cell. At 7.50pm the shell was opened over the air cell to determine whether the chick was still alive. The embryo was making vigorous movements. The radiograph was assessed to determine where to enter the egg and by 8.10pm after the ovotomy was started the chick's head was located but the chick was dead. The egg was submitted for post-mortem examination that revealed that the head was between the legs and the yolk sac was almost completely retracted.

Post-hatching problems

Case 5 - Houbara Bustard id 740 'incompletely absorbed yolk sac'

This chick was malpositioned (head in small end of shell). It had pipped from the small end by itself, but was unable to complete the hatching process on its own. It was successfully assisted without the need for radiography. On hatching the yolk sac was completely absorbed but there was a small remnant stump of umbilical tissue (Fig. 3 illustrates this in a Kori Bustard chick). This was cleaned with dilute iodine and ligated with 4/0 polygalactin 910 (Vicryl, Ethicon Ltd., Edinburgh, UK.) and gentamicin cream was

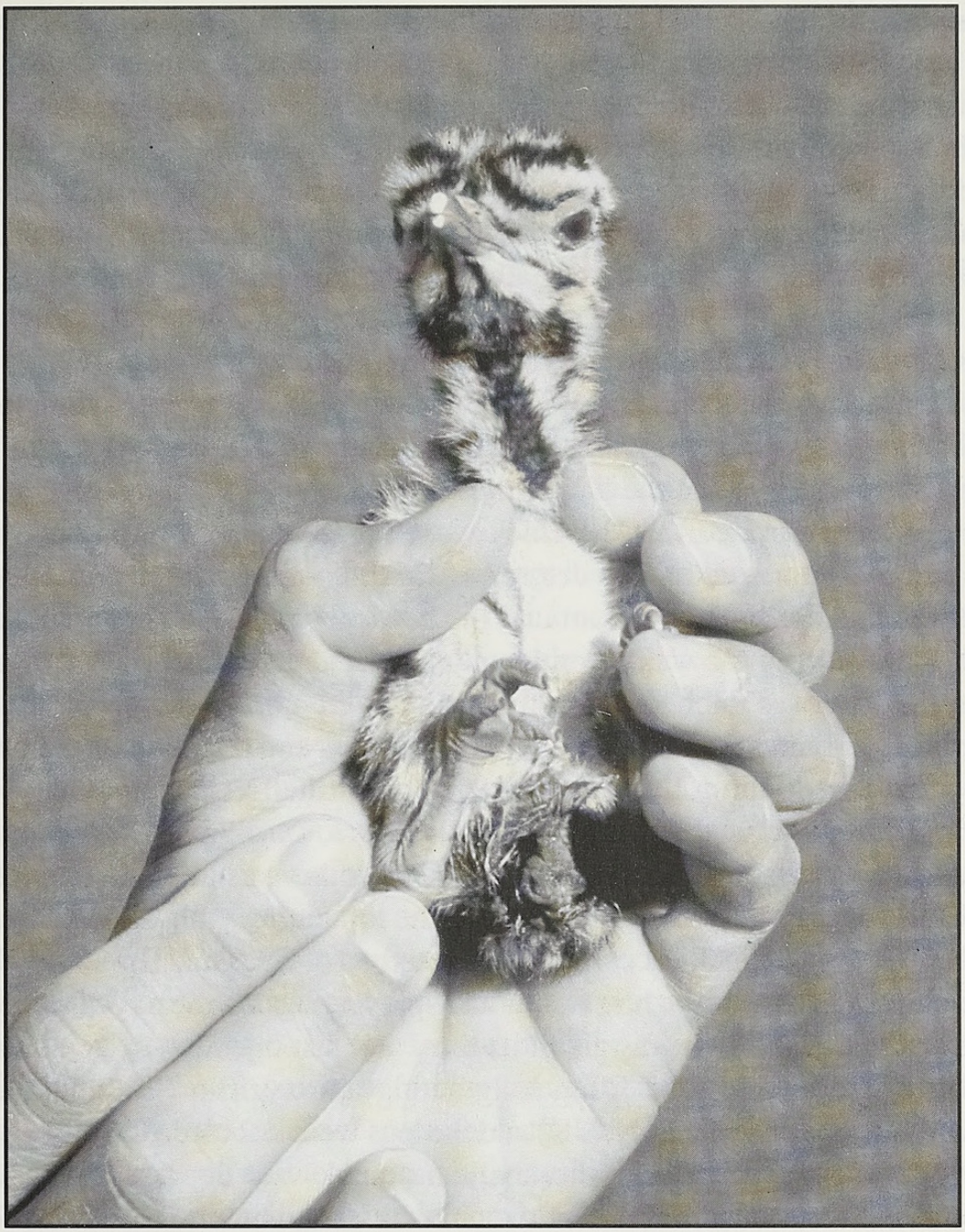

Figure 3. Umbilical stump remnant in a Kori Bustard chick

applied. The other standard treatments for assisted hatch chicks were given. There were no complications and the chick developed normally.

Case 6 - Rufous-crested Bustard id 269 'rolled toes at hatch'

This chick was positioned normally and hatched normally without assistance, but it was noticed to have rolled toes on hatching. The toes were taped with adhesive micropore tape, which was wrapped in such a fashion so that it pulled the toes in the opposite direction until the rotation was corrected. A cut shaft of a cotton bud was incorporated on the plantar surface of the foot. The tape was removed and replaced every two days and after a week no further treatment was necessary.

Case 7 - Rufous-crested Bustard id 650 'splayed legs at hatch'

This chick was positioned normally and hatched normally without assistance, but it was noticed to have splayed legs on hatching. The legs were hobbled with Vetwrap (3M Animal Care products, USA), tied on the middle part of the metatarsus and the chick was kept in a small plastic container padded with paper towels for two days. The chick recovered uneventfully and developed normally with no further complications.

Case 8 - Kori Bustard id 976 'yolk sac infection'

This chick was malpositioned and hatched with assistance. When there was no sign of internal pipping the egg was submitted for radiography. The radiograph showed that the bill of the embryo was away from the air cell. Endoscopy confirmed that the chick was still alive and ovotomy allowed the egg to be entered and to determine that this malposition was a 'head between the legs'. The shell around the head was removed, but it could be seen that the yolk sac was incompletely retracted and the chick was weak. The yolk sac was dabbed with dilute iodine, the chick was given an i.m. injection of gentamicin and s.c. electrolyte fluids and the body of the chick was then taped within the egg to encourage further retraction of the yolk sac. The chick was left in the egg for 24 hours, during which time it was given further fluids and gentamicin. The yolk sac was almost completely reabsorbed and on removal from the egg the remaining yolk sac was ligated with 4/0 polygalactin 910 according to the method of Heck and Konkel (1991). The chick appeared to be bright, but had splayed legs on the day after being freed from the shell. It was given its third and last injection of gentamicin and a single injection of 15mg long-acting amoxycillin (Clamoxyl LA, Smithkline Beecham, Surrey, UK) and the legs were hobbled. On the second day after being freed from the shell the chick was depressed and was dyspnoeic. Treatment with enrofloxacin was started but the chick died four hours later. Post-mortem examination was conducted. The blood vessels lining the yolk sac were congested and the yolk sac was distended with green-yellow contents. The lungs, liver and meningeal blood vessels were congested. A heavy growth of *Staphylococcus* spp. was cultured from yolk sac contents and liver samples.

Discussion

The individual cases described in this report cover a range of hatching and post-hatching problems observed in bustards at the NARC. Cases 3 and 4 demonstrate that although radiography can determine the cause of delayed hatching, intervention may still occur too late, in Case 4 by only a few minutes. Case 8 also demonstrates that malpositioned embryos may be

successfully hatched after radiographic imaging, but the combination of exhaustion and an incompletely absorbed yolk sac makes them susceptible to post-hatching conditions. Despite intensive and early antibacterial therapy this chick succumbed to a yolk sac infection. We have also seen other malpositioned bustard chicks that appear to be 'physically exhausted' by the time intervention has provided a breathing hole or freed them. These chicks have a tendency to fade and die over the first 24-72 hours after hatching. Once a diagnosis of malposition is made in a chick that has failed to internally pip we would recommend immediate but careful ovotomy over the site of the bill to provide a breathing hole for the chick. Assessment of membrane vascularity should determine the speed of further assistance. The use of radiosurgery to cut the membrane in which blood vessels that had not regressed has been described (Olsen and Duvall, 1994) and may be applicable in some circumstances although we have not had any experience with bustard chicks. From our observations chicks that are assisted, but are still strong at the end of the process tend to be more viable compared with chicks that are 'tired' because of delayed intervention. The success of assisted hatching is mainly down to timing, but unfortunately this is easier to determine retrospectively, rather than early in the morning or late in the evening when many of these cases were played out. Case 8 also demonstrates the importance of providing antibacterial therapy to chicks from assisted hatches. It is well known that the survival rate of chicks that hatch with larger umbilical protuberances have a lower survival rate (Joyner, 1993).

Embryo malpositioning is not an uncommon condition, for example, it is estimated that 1%-4% of mature parrot embryos will be in an abnormal position at full development before hatching (Clipsham, 1996). Causes of malpositioning include incorrect turning, abnormal shaped eggs, poor temperature control, careless handling, physical deformities of the embryo, dietary deficiencies and genetic defects in inbred birds (Olsen and Duvall, 1994; Brown et al. 1996). The cause of malpositions described in these case reports was not determined for all but one chick, although temperature control, humidity, turning and weight loss were assessed and did not appear to be abnormal. In Case 3 a problem with the turning of the egg was suspected.

Unlike in parrots (Flammer, 1994), spraddle legs are relatively easy to correct in bustards with most chicks recovering after two to four days of taping. Flammer (1986) reported that this condition is sometimes responsive to injections with vitamin E and selenium in parrots, but in our experience taping the legs has proved successful. The treatment of curled toes has been more problematic because this condition was seen most frequently in Rufous-crested Bustards, which are the smallest bustard species maintained at the NARC. The main problems associated with taping of toes in this species are related to the small size of the chicks which weigh only 20g-25g at hatching.

Radiographic imaging to evaluate chick position in Californian Condor *Gymnogyps californianus* eggs has been shown to be a valid technique in determining whether eggs that are having problems hatching should be assisted (Ensley et al. 1994). Through these case reports we have been able to outline some of the procedures and treatments for some of the common hatching and post-hatching problems seen in bustard aviculture. From our experience with bustards we have found that it is possible to critically evaluate normal versus abnormal embryo position using radiography when there is doubt following conventional candling techniques. Post-mortem examination of a number of chicks provided further information to correlate with radiographic findings. The subjective nature of these case reports illustrates the need for more detailed information on the hatching process in normal and abnormal chicks. Incubation and hatch record and egg post-mortem examination forms are maintained at the NARC. Only with a larger database of information on the hatching sequence and time intervals for bustards can the aetiology of malpositions be determined and the timing for assistance optimised.

Table 1. Incubation parameters (mean, range) in bustard species maintained at NARC (source Anderson, 1998a; 1998b; Anderson and Simpson,1998)

Bustard species	Start of incubation to internal pip (days)	Time to external pip (hrs)	Time to hatch from external pip (hrs)
Houbara	22 (21-22) n=8	9 (2-22) n=8	23 (12-31) n=l 3
Kori	21 (20-22) n-10	13 (3-24)	26 (6-39) n=20
Rufous-crested	19 (17-24 n-15	13 (4-24) n=14	18 (6-44) n=34
White-bellied	19 (19-19) n-3	19 (14-24) n-2	26 (8-38) n-5

Table 2. Average weight loss during artificial incubation of different bustard species (source Anderson, 1998a: 1998b; Anderson and Simpson 1998).

Bustard species	Weight loss %
Kori	14.9
Rufous-crested	12.3
White-bellied	16

Table 3. Radiographic exposure factors and average egg weights of the bustard species described in the case reports (source of egg weights Anderson, 1998a; 1998b; Anderson and Simpson, 1998).

Bustard species	Egg weight(g)	KV	MA	Time (seconds)
Houbara	52	60	20	0.12
Kori	146	60	20	0.2
Rufous-crested	37	60	20	0.12
White-bellied	50	60	20	0.12

Acknowledgments

The authors would like to thank the Crown Prince of Abu Dhabi, H. H. Sheikh Khalifa bin Zayed Al Nahyan, H. H. Sheikh Mohammed bin Zayed Al Nahyan and Mr M. Al Bowardi for their support of this work. We thank Dr J. Naldo, Miss J. Howlett, Mr A. Azur and the staff of the Aviculture Department for their technical assistance.

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A REQUEST FOR HELP FROM FLYCATCHER KEEPERS

Martin Vince is surveying flycatcher keepers on behalf of the Flycatcher Interest Group of the AZA (American Association of Zoological Parks and Aquariums) Passerine TAG. It wants to collect as much husbandry information as possible from public and private collections. The information will be used to compile a husbandry manual and establish a model population of the Verditer Flycatcher *Muscicapa thalassina*. It is hoped that the model population will help refine husbandry and breeding techniques for this species and, in turn, help establish guidelines for keeping and breeding similar species.

If you have experience of keeping flycatchers (including niltavas), you are asked to contact Martin Vince, Assistant Bird Curator, Riverbanks Zoo & Botanical Garden, PO. Box 1060, Columbia, South Carolina 29202-1060, USA. E-mail:martin@riverbanks.org.

ECUADORIAN BIRDS: SOME NESTING RECORDS AND EGG DESCRIPTIONS

by Harold F. Greeney

While visiting Ecuador, one cannot help but be amazed at the diversity and beauty of the avifauna. Of the over 1,600 species of birds recorded from Ecuador, many are among the most flashy and beautiful in the world. At a time when tropical forests are disappearing at an ever increasing rate, the need for detailed ecological and behavioural studies is urgent. Only with a good understanding of species' behaviour and ecological needs can we hope to develop effective methods of conservation. Simple observations of seemingly trivial details such as nest construction and breeding dates, provide enormously valuable data that can be used by conservationists and ornithologists alike. The following nest records represent fairly common species, that are nevertheless threatened by the destruction of their habitat. All observations were made during field work on the natural history of tropical butterflies and other insects, but the excitement of exploring the behaviour of these beautiful birds could not be ignored.

White-sided Flower Piercer *Diglossa albilatera*
San Isidro Ranch, Napo Providence, near Cosanga, elevation 1,700 m (approx. 5,600ft).

On December 18th 1996 a male and female were observed visiting a nest located approximately 10m (approx. 32ft) from the forest edge in a grassy field. The nest was an open grassy cup, about 50cm (almost 1ft 8in) above the ground, built in thick *Paspalum* sp. (Poaceae) grass shaded by ferns (Thelypteridaceae) and blackberries (Rosaceae: *Rubus* sp.). One nestling was found in the nest.

Rufous-collared Sparrow *Zonotrichia capensis*
San Isidro Ranch, Napo Providence, elevation 1,700m (approx. 5,600ft).

On December 10th 1996, a nest, similar to those described by Stiles and Skutch (1989), was discovered in low vegetation in the middle of a cattle pasture. Three eggs were in the nest. When the nest was visited on December 18th 1996, all of the eggs had hatched.

Lemon-rumped Tanager *Ramphocelus icteronotus*
Mindo, Pichincha Providence, elevation 1,400m (approx. 4,600ft).

On December 13th 1996 a lone female was observed building a nest about 4m (approx. 13ft) up in a citrus tree (Rutaceae) in an area of disturbed forest.