

MONITORING OF GROWTH IN HOUBARA BUSTARD *CHLAMYDOTIS [UNDULATA] MACQUEENII* CHICKS

Stiévenart, C., National Wildlife Research Center, Taif, Saudi Arabia.

Introduction

The houbara bustard *Chlamydotis [undulata] macqueenii*, a cursorial medium-sized bird, inhabits undulating, flat arid plains, steppe habitats, and semi-deserts, often with little cover except for open or scattered desert shrubs. Within its range, from the Gobi desert to the Nile Valley, annual rainfall rarely exceeds 200mm. Females differ from males (Figure 1) by their plumage and by their morphology. In adults, body mass (BM) ranges between 1,100g and 1,700g in females and between 1,200g and 2,400g in males (Schulz and Seddon, 1996). Houbara eggs laid in captivity at the National Wildlife Research Center (NWRC, Taif, Saudi Arabia) are similar in size to hen's eggs.

Because of marked population decline of houbara bustards in Arabia related to overhunting, a captive-breeding programme was initiated in 1986 at the NWRC with the purpose of reintroducing this species into its former habitat.

Figure 1. (below left) Female (front) and male (back) adult houbara bustard *C. [u.] macqueenii*. (NWRC Photo Library / C.Tsagarakis).

Figure 2. (below right) Three day-old captive-born houbara *C. [u.] macqueenii* chicks. (Courtesy of Kamaan Photo, Riyadh).



Methodology

I monitored the growth until 45 days of age of two cohorts of 84 and 284 chicks (Figure 2) respectively hatched in 2000 and in 2001 at the NWRC.

Husbandry and Housing of Chicks

We received identified chicks from the hatchery within 24 hours of hatching. We grouped them in flocks of four individuals up to 45 days of age. Each flock consisted of chicks of similar age (± 1 day) up to ten days of age. At ten days of age, we formed flocks of chicks of similar body mass (BM). We usually did not modify the composition of the group later.

Chicks lived indoors for up to three weeks of age and were provided with infra-red heating during their first 25 days of life. During the first ten days of life, they were housed in a nursery room. Each group lived in a small Perspex box (77cm x 52cm) on a sandy ground covered with shade-cloth (Tildernet®). We moved the chicks at the age of ten days to another room into larger Perspex boxes (90cm x 200cm) covered with 5cm thick sand layer. At three weeks of age, we transferred each flock to a room ($\pm 6\text{m}^2$) with an outside paddock ($\pm 20\text{m}^2$) accessible only during the day. The ground was covered with sand. When around one month of age, we transferred them to outdoor facilities.

Water and Food Supplies

During the first 45 days of life, the chick's diet consisted of:

dry pellets (dry matter (DM) 88%, crude protein=22% DM, calcium=1.5% DM, phosphorus=0.8% DM), fresh alfalfa (dry matter 24%, crude protein=4.8% DM (Anderson, 1995)), mealworms (dry matter=42.2%, crude protein=22.3% DM (Jones *et al.*, 1972))

SDS (Special Dietary Services®) pellets (crude protein=23.5% of dry matter) swollen by immersion in water enriched with a vitamin B complex solution and named below as "humid pellets". Humid pellets contained about 75% of water.

We also offered crickets daily (dry matter 31.7%, crude protein=17.8% DM (Anderson, 1995)).

Upon entry to the nursery, chicks received mealworms (one meal every three hours from sunrise to sunset) to stimulate their pecking behaviour. This period of limited food supply ended after the first night spent in the nursery. Then, we hand-fed the chicks with small pieces of humid pellets, mealworms, alfalfa and dry pellets. From one to ten days-old, chicks received six daily meals including these four food items and were progressively accustomed to feed independently. We never force-fed the chicks even when displaying little appetite. From ten days of age, chicks were able to pick up food items independently. We stimulated them to eat dry pellets, whilst fresh food was offered during taming activities at least four times a day. Fresh alfalfa, dry pellets and water were available to the chicks *ad libitum* four days after flocks were formed.

Chick Monitoring and Medical Care

From entry to rearing, we recorded daily for each chick the following data: pecking behaviour, appetite for humid pellets, for mealworms, for crickets and alfalfa, general mobility, abnormal symptoms, and BM. At entry to rearing, chicks could present a yolk sac hernia defined as a protrusion of the yolk sac through the abdominal wall in the umbilicus area. We ligatured yolk sac hernia at entry to rearing and administered these chicks with a preventive five-day long antibiotherapy.

The "long-hatching syndrome" corresponded either to chicks assisted during hatching or to chicks exhausted when hatched as described by Ostrowski *et al.* (1996). We also provided these chicks with a preventive five-day long antibiotherapy. BM was recorded on early morning before the first meal at the same time for all chicks of the same flock. We recorded BM daily during the first ten days of life, and then, at every transfer and every five days from any transfer. We determined the gender of each bird based on the morphology and plumage of the bird at four and at five months of age. We vaccinated the chicks against Newcastle disease virus (NDV) with an inactivated adjuvated vaccine at the end of the first month of life. When mortality occurred, we carried out necropsy within 12 hours.

Data Processing

We used Excel Millenium and Systat 10.0 software. The assumption of normality was based on the trends of four statistical indicators: Skewness, Kurtosis, coefficient of variation and histogram. The chicks we compared hatched from eggs similar in their volume, in their sequential egg number within the clutch and in their sequential clutch number. For the analysis, hatching season was divided into 20 consecutive days hatching periods.

Results

At entry to rearing unit, BM of chicks ranged from 26.7g to 46g in 2000, and from 26.6g to 49.2g in 2001. In healthy individuals, from hatch to about ten days of age, BM increased as:

$$BM_{\text{day } n} = (BM_{\text{day } (n-1)}) \cdot (1 + \text{daily growth rate})$$

Where daily growth rate is the BM gain from day_{n-1} to day_n divided by the BM at day_{n-1}.

The daily growth rate (DGR) is related to the period from the lowest BM (one-way analysis of variance, $P < 0.0001$). The lowest BM was usually achieved one day after entry into the rearing unit when chicks were one day of age. From the lowest BM day up to six days after, daily growth rate increased according to:

$$DGR = 0.029 + 0.016 \text{day}_n \text{ from lowest BM}$$

($F_{1,293} = 211.7$, $r^2 = 0.42$, $P < 0.0001$)

Later, up to 45 days of age, the BM increased linearly versus the age in both sexes ($r^2 = 0.92$, $F_{1,132} = 1587$, $P < 0.0001$ in females; $r^2 = 0.93$; $F_{1,232} = 3231$, $P < 0.0001$ in males) (Figure 3).

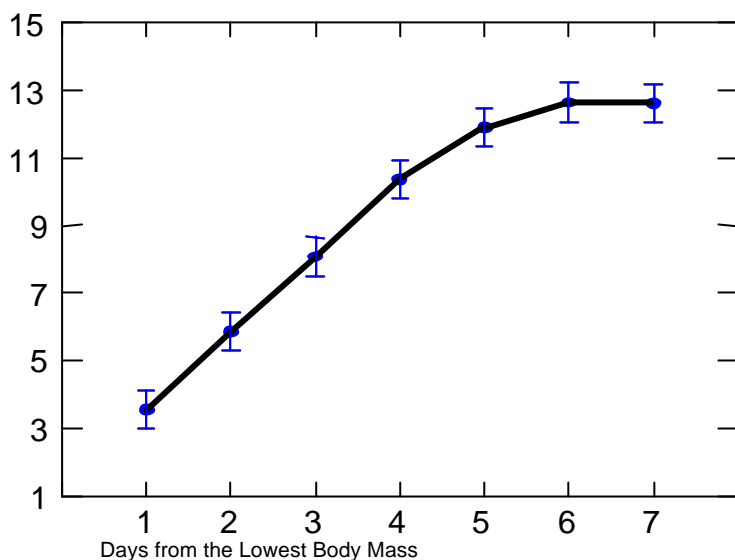


Figure 3. (left) Evolution of the daily growth rate of healthy chicks (DGR in % of the BM of the previous day) during the first seven days after lowest BM of healthy chicks (mean±CI 95%).

The mean daily growth rate during the seven days after the lowest BM (MDGR7) was the daily BM gain during the week from the lowest BM calculated proportionally to the lowest BM based on:

$$\text{BM}_{7 \text{ days after lowest BM}} = (\text{Lowest BM}) \cdot (1 + \text{MDGR7})^7$$

In healthy chicks, the MDGR7 was not significantly affected by the lowest BM ($F_{1,96}=0.773$, $r^2=0.008$, $P=0.38$).

In healthy chicks, within each cohort, I found a significant effect of the hatch period on the MDGR7 and on the BM at 19 days of age despite the lowest BM of the chick was not affected by the hatch period.

I compared the growth of healthy male chicks which had access to drinking water either from the second or from the third day after the lowest BM. When I took into account the hatch period and the time when the chicks were provided drinking water as factors (two-way analysis of variance), I found that chicks with access to drinking water from the second day after the lowest BM displayed a higher growth rate in nursery than chicks with access to drinking water from the third day after the lowest BM ($P=0.015$, for MDGR7, $n=38$).

When I took into account the hatch period within two hatching seasons and the sex as factors (two-way analysis of variance), I found that male and female growth differed after the first week of age. Healthy males ($n=62$) and healthy females ($n=33$) achieved respectively (Figure 4., mean±CI 95%):

from a lowest BM of $36.5 \pm 0.5\text{g}$ and $35.9\text{g} \pm 0.7\text{g}$ ($P=0.625$ for the sex effect),
 a MDGR7 of 0.092 ± 0.002 and 0.084 ± 0.003 ($P=0.046$ for the sex effect),
 a BM at 19 days of age of $206\text{g} \pm 4.3\text{g}$ and $177.7\text{g} \pm 6.2\text{g}$ ($P<0.0001$ for the sex effect),
 at 30 days of age of $371.9\text{g} \pm 6.3\text{g}$ and $315.9\text{g} \pm 9.8\text{g}$ ($P<0.0001$ for the sex effect)
 and at 42 days of age of $581.7\text{g} \pm 7.9\text{g}$ and $479.8\text{g} \pm 12.4\text{g}$ ($P<0.0001$ for the sex effect),
 for a mean daily BM gain (from lowest BM up to 45 days of age) of
 $13.4\text{g} \pm 0.2\text{g}$ and $10.8\text{g} \pm 0.3\text{g}$ ($P<0.0001$ for the sex effect).

In flocks of chicks of different health status (i.e. healthy individuals mixed with unhealthy individuals), I found that: within each sex, the variations of the BM at 19, 30 and 42 days of age were more related to the MDGR7 than to the lowest BM. The BM at these ages increased with the MDGR7 (linear regression, $P<0.0001$, $n=141$ in females, and $P<0.0001$, $n=161$ in males). One percent more in MDGR7 induced on average a BM increase at 30 days of age of 10.2g in females and of 12g in males. Yolk sac hernia and long-hatching syndrome did not affect significantly ($P>0.05$) growth performances provided that veterinary care was administered. In contrast, healthy chicks at hatch which subsequently became unhealthy, showed daily growth rate drop or lower BM gain (Figure 5.) The follow-up based on daily growth rate and clinical symptoms allowed the early detection of troubles and prompt treatments.

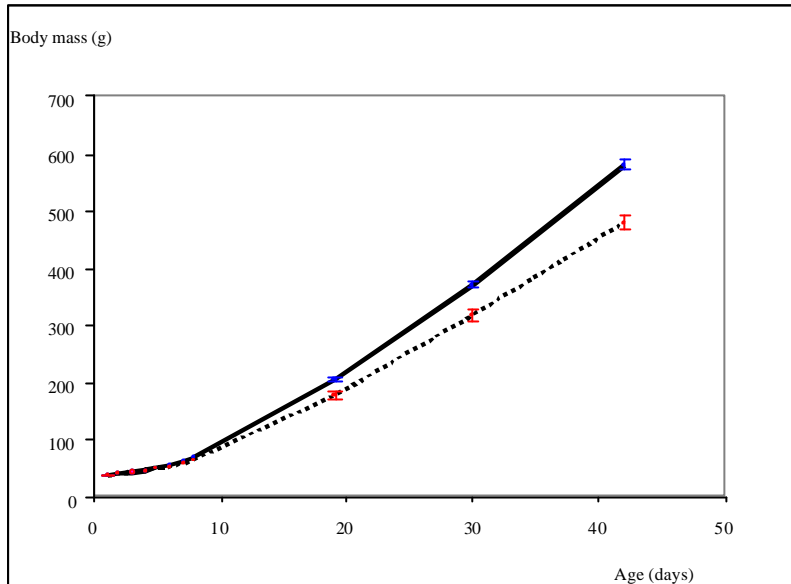


Figure 4. Evolution of BM of healthy female (dotted line, n=33) and male (continuous line, n=62) houbara bustards *C.[u.] macqueenii* during the first six weeks of life (mean±CI 95%).

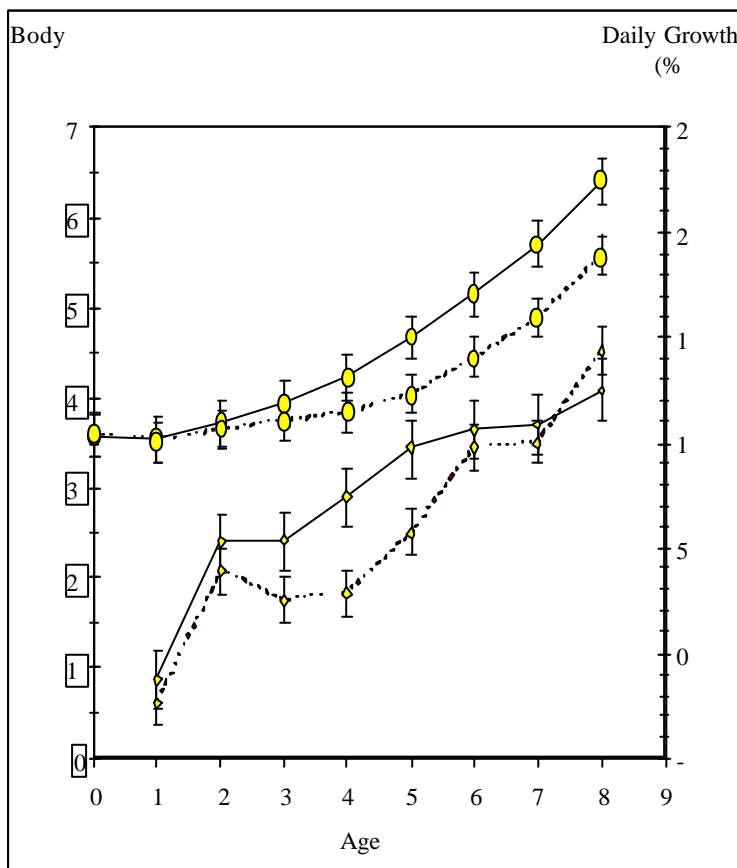


Figure 5. (left) Evolution of the BM (circles) and daily growth rate (losanges) in female houbara bustard chicks (mean±CI 95%). Comparison between healthy females (continuous lines) and females affected with a neonatal infectious disorder (dotted lines).

Discussion

At hatching houbara chicks are nidifugous. The female will intermittently brood chicks during the first 24 hours, and feed them bill-to-bill. When five to six day-old, chicks starts to feed independently (Schulz and Seddon, 1996). At the NWRC, houbara chicks (Figure 2) are raised without the mother assistance and depend only on the care provided by the bird-keeper. Improved early growth induced a higher BM at the age of 30 and 42 days. Growth monitoring helps to detect as early as possible medical disorders.

The present study is the first to document the developmental growth of the houbara bustard during the first ten days of life. Naldo *et al.* (1997 and 2000) described the developmental growth of 7(4.3) houbaras *C.[u.] macqueenii* by measuring long bones serially radiographed and recording BM from two weeks of age until the completion of skeletal development. They did not combine this morphometric data to the BM evolution to monitor the growth in houbara. No attempt was made to differentiate the growth rate of long

bones between males and females. Compared to Naldo *et al.* (1997, 2000), the healthy chicks raised at NWRC were heavier in both genders when 42 day-old. In the osteological study made by Naldo *et al.* (1997, 2000), at six weeks of age, the tibiotarsus and tarso-metatarsus of the houbara reached respectively about 70% and 80% of their final length (at 15 weeks of age).

Theoretically, growth impairment accompanied by abnormally low BM could be detected using a combination of morphometric data and BM data. At the NWRC, morphometric records are not routinely used because skeleton measurement in houbara neonates is time-consuming and can induce traumatic injuries. In contrast, regular BM monitoring is easy to implement and “technically” advisable when managing a large number of chicks at the same time.

Growth in birds is usually described as BM variation versus age (O'Connor, 1984). In houbara bustards, this growth curve from hatch to adult size is sigmoid. The period between hatch and 45 days of age corresponds to the first half of this sigmoid. The sigmoid curve has the convenient property that its log transformation is linear. However, log conversion of BM versus age was not satisfactory to detect abnormally low BM gain because the interpretation of the individual deviation from such linear curve was weak. In contrast, interruption of the daily growth rate increase was easily detected by the technical staff. It allowed us to early detect growth problems from hatch to ten days of age, and, when combined to clinical examination, to diagnose pathology early. In addition, as the MDGR7 is a BM gain proportional to the lowest BM, it allows us to compare hatchlings differing by their size and BM at hatch. MDGR7 could therefore be used throughout the breeding season as a reliable indicator of growth performance.

Interpretation of individual MDRG7 must take into account a number of factors like access to drinking water. Yolk sac hernia and long hatching syndrome did not affect the early growth rate when preventive veterinary care was provided. Our study demonstrates that the gender affects significantly the growth earlier than described by Naldo *et al.* (1997, 2000), i.e. from the second week of life. When gender is not known, confusion exists from the second week of age between healthy females growing well and males affected by growth impairment. Early sexing of chicks possibly by a molecular method was proved effective in houbara bustards (D'Aloia and Griffiths, 1999), and should improve growth monitoring from the age of ten days in this species.

Conclusion

When rearing houbara bustard chicks, monitoring of chicks' growth rates during the first ten days of life and of BM gain from ten days of age proved a helpful tool for early detection of health problems. This monitoring requires gender determination by the age of ten days.

Acknowledgments

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