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## Mate choice, maternal investment and implications for ostrich welfare in a farming environment

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### ABSTRACT

At present, the ostrich industry is inefficient, on account of being characterised by inadequate egg production, high embryo mortality, poor chick survival and suboptimal growth rates. However, as ostrich farming commenced only in the mid 19th century in South Africa, farmed ostriches have had a short period to adapt to the commercial production environment. Hence the poor production results observed could either reflect their failure to adapt to the farming environment, or alternatively, a failure of the ostrich industry to implement proper practices to meet the needs of this species. Limited research has been undertaken to identify and integrate behavioural requirements of ostriches in such environments, in order to reduce potential stress through improving both reproductive performance of the birds and their general welfare. In this paper, we review recent progress in our understanding of ostrich reproductive behaviour both in the wild and in farming environments, with a specific emphasis on female strategies to improve offspring fitness within the context of the ostrich polygynous mating system. In addition, we discuss production and welfare implications of the unusual ostrich communal nesting system, in a farming environment.

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## 1. Introduction

The ostrich is the largest living bird and is a member of a group of flightless birds, the ratites (Bertram, 1992). In the wild, they prefer open habitat (short-grass plains and semi-desert), although ostriches are also found in the hot desert steppes of the Western Sahara and the deserts of Namibia (Deeming, 1999). Ostriches are diurnal, and spend much of the day moving, except when dust bathing, resting or nesting (Bertram, 1992). Although the conservation status of this species is listed as least concerned (Sales, 2009), excessive hunting as well as degradation of their natural habitat, has caused a considerable decrease in ostrich numbers, leading to their disappearance from some areas and the extinction of the subspecies *Struthio camelus syriacus* (Manlius, 2002; Al-Nasser et al., 2003). At present, there are four ostrich sub-species in Africa (*camelus*, *molybdophanes*, *massaicus* and *australis*), which have all been kept in captivity for farming purposes (Bertram, 1992; Deeming, 1999). Ostrich farming initially developed in South Africa in response to the increasing demand for ostrich feathers by the fashion industry during the 19th century (Deeming, 1999). Despite several setbacks in the market due to recurrent threats of avian influenza, the ostrich has remained a valuable animal for farmers as the current industry not only relies on feathers, but also on leather and on the increasing popularity of ostrich meat, which is relatively low in cholesterol (Deeming, 1999; Cloete and Malecki, 2011).

In farmed environments, most ostrich breeders use two main methods for mating adults: they are either kept in breeding groups of 6 females and 4 males, or maintained in camps containing very large groups of birds with approximately the same sex ratio (Deeming, 1999; Cloete and Malecki, 2011). Only occasionally are single pairs of individuals used for mating (Cloete and Malecki, 2011). Farmed conditions are not that different from those in the wild situation (see later), although in most cases, eggs are incubated artificially and chicks reared by farmers, with only few instances where chicks are raised by foster parents (Cloete and Malecki, 2011; Verwoerd et al., 1999). Because of the intensification of ostrich farming conditions and the increase in emphasis on the welfare of farmed animals, commercial ostrich farmers should integrate the behavioural requirements of ostriches into their management programs to ensure an optimal breeding environment (Stewart, 1994; Mohammed et al., 2003). However, only recently has more detailed attention been focused on the social structure and reproductive strategies of free-range and farmed birds as recent studies have highlighted that restricting mate choice in both males and females could lead to stress and subsequent reduced welfare (Cloete and Malecki, 2011). Hence this review focuses on recent developments in the study of ostrich reproductive behaviour, with a specific emphasis on maternal strategies to improve offspring fitness and its implications for ostrich welfare in a captive environment.

## 2. Ostrich reproductive behaviour

### 2.1. The fluff about ostriches

The wild ostrich is sexually mature at 4–5 years, the hen maturing slightly earlier than the male (Sauer and Sauer, 1966; Jarvis et al., 1985; Cooper et al., 2010). They are sexually dimorphic, females developing a dull-brown plumage while males develop a black plumage with some white feathers, as well as a pink bill and legs (Bertram, 1992; Deeming, 1999), the colouration of which changes in intensity during the breeding season and as males become territorial (Bertram, 1992; Lambrechts, 2004). Juvenile birds resemble the females, and can only be sexed (on the basis of plumage characteristics) from the age of 14 months, whereas young chicks are mottled brown, yellow, orange and cream with black quills on the



Fig. 1. Courtship behaviour in the ostrich: (a) Female clucking behaviour (photo – M. Bonato) and (b) Male kantling behaviour (photo – M. Bonato).

back (Deeming, 1999). Families of chicks are combined into crèches and are overseen by a single pair of adult birds (Bertram, 1992).

Both males and females use a repertoire of visual displays, in several of which the wings play a major part, to either control the bird's temperature or protect eggs and young (Bertram, 1992; Bolwig, 1973). Most importantly, they are involved in the courtship displays (Bertram, 1992). Female birds do show pre-nuptial courtship behaviour towards male by spreading, lowering and quivering intermittently her wings while her head is held low and jerked up at intervals (referred to as 'clucking behaviour'; Fig. 1a) (Bertram, 1992; Bolwig, 1973). Males appear to develop courtship behaviours later than females, accompanied by the slow development of a red flush in the beak and legs (Sauer and Sauer, 1966; Bolwig, 1973; Deeming, 1999). The courtship display of males (or 'kantling display'; Fig. 1b) involves the male sitting on his legs, while his wings are held forward, directly exposed to the female, and his neck swings from side to side (Bertram, 1992; Bolwig, 1973). The female usually respond by clucking towards the male and then drops to the ground. The male then gets to his feet, and approaches the female by stamping his feet several times on the ground before mounting the female. Kantling behaviour is also used during antagonistic interactions between males, and in this context is usually performed by a male who is driving a competitor away (Bolwig, 1973).

### 2.2. Seasonality and optimization of the timing of reproduction

Ostrich are seasonal breeders, breeding primarily in spring and early summer (Jarvis et al., 1985). Out of the breeding season, the ostrich is a gregarious species, tending to form groups of mixed gender and age, particularly around water holes (Bertram, 1992; Deeming, 1999; Cooper et al., 2010). The seasonal increase of

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