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Original Investigation

Reproductive biology and life history traits of Arabian oryx (*Oryx leucoryx*) founder females reintroduced to Mahazat as-Sayd, Saudi Arabia

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ABSTRACT

Reproductive and life history data of Arabian oryx founder females reintroduced into Mahazat as-Sayd Protected Area in Saudi Arabia were collected from 1990 to 2007. A General Linear Model revealed a significant effect of both age and reproductive experience prior to release on overall and male birth rates. We also found an effect on the overall birth rate explained by age alone. Our data are in line with theories suggesting that females reaching a stage in their life where they are unlikely to raise further off-spring increase their investment into progeny and skew sex ratio of their off-spring towards males. Inter-calf interval corresponds with findings from reintroductions in Oman and elsewhere in Saudi Arabia but increased with progressing age. Calving occurred throughout the year with no distinct seasonality. Fecundity was higher in experienced founder females, albeit not significantly. Overall fecundity was highest in young females, decreased in middle aged animals, and remained stable throughout the rest of their life span. Our findings may have an influence on future reintroductions of Arabian oryx and confirm theories in behavioural ecology of ungulates.

Introduction

Captive breeding and repatriation programs are widely used as living gene-banks to restock wild populations (Ryder 1986, 1987). A famous example for the reintroduction of an ungulate species extinct in the wild is the Arabian oryx (*Oryx leucoryx*), a species that was once found throughout the Arabian Peninsula, but eradicated in 1972 due to overhunting and poaching (Henderson 1974). Prior to extirpation, several captive-breeding programs were initiated with the intention to re-establish the Arabian oryx to its native habitats (Talbot 1960; Stanley Price 1989). The first reintroduction to the wild was initiated in 1982 in the Arabian Oryx Sanctuary in the Jiddat al-Harasis, a 25,000 km^2 reserve in central Oman (Spalton et al. 1999). In Saudi Arabia, the National Commission for Wildlife Conservation and Development (NCWCD) has engaged in an ambitious reintroduction program with the purpose of re-establishing the Arabian oryx also in the Kingdom. In 1986 a captive breeding program was initiated, intending to eventually release Arabian oryx to protected areas with suitable habitats as determined by the NCWCD system plan (Child and Grainger 1990).

In March 1990 a founder population of 17 Arabian oryx was released into Mahazat as-Sayd, a 2244 km^2 fenced reserve in west-central Saudi Arabia (Ostrowski et al. 1998). With a few subsequent additions from the captive world herd, and from natural births, the population increased significantly until it reached a size of 346 individuals in March 2000 (Seddon and Ismail 2000; Mésochina et al., 2003a, b, c). Currently this population of more than 320 animals is a viable and self-sustaining Arabian oryx population (Cunningham 2008; Strauss 2008).

In the past, many reintroductions were poorly documented (Short et al. 1992), emphasising the fact that repatriation programs should be accompanied by adequate monitoring activities (Beck et al. 1994; Soorae and Seddon 1998; Kock et al. 2007). The main reason for post-release monitoring is to determine the causes of problems experienced by a reintroduced population while establishing itself so that the management of future releases in the same area or elsewhere can be modified in order to improve the chances of success or reduce the financial costs (Stanley Price 1991). Monitoring the survival and reproductive success of founder females are particularly important for this. Parameters of reproductive success and life history of founder females, i.e., life span, life time reproductive success, mean annual birth rate, birth intervals, sex ratio of calves and fecundity in different age classes are presented here for

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the first time for Arabian oryx reintroduced into the wild in Saudi Arabia.

According to Stanley Price (1989), these parameters may differ between females which have already reproduced prior to their release and those which reproduced for the first time in the wild. Moreover, the success of released animals, determined by measurements of reproductive biology and life history traits, depend to a large extent on the age of the of founder females. Theory predicts that fecundity decreases with old age and that older females skew their paternal investment towards male off-spring (Trivers and Willard 1973; Clutton-Brock et al. 1982; Bercovitch et al. 2009). These two factors are not necessarily inter-related since age does not correspond with maternity. In this study we compare experienced founder females, i.e. females that have reproduced in captivity prior to their release, with inexperienced females which reproduced for the first time in the wild in Mahazat as-Sayd using age as a covariate. We asked whether some life history traits of founder females were affected by the age at release and by the breeding experience. Furthermore, we tested the influence of experience on the seasonality of breeding, the fecundity at certain age classes and the birth intervals of founder females. We therefore hypothesise that females which have reproduced in captivity prior to their release are more experienced and better prepared for survival in the wild than animals being released from captivity without having reproductive experience. We further hypothesise that age also has an effect on the reproductive success and the life history of founder females. Subsequently, we present and discuss our findings in the light of other reintroduction attempts of Arabian oryx in Saudi Arabia and elsewhere (e.g., Arabian Oryx Sanctuary, Oman; Stanley Price 1989, and Uruq Bani Ma'arid Protected Area, Saudi Arabia; Strauss 2002). Moreover, we compare our data with observations on captive Arabian oryx before being released into the wild (Vié 1996; Stanley Price 1989).

Material and methods

Study area

The Mahazat as-Sayd Protected Area is located in west-central Saudi Arabia and consists of a gently undulating sand and gravel plain at about 900 m altitude comprising of dwarf scrubland dominated by *Acacia tortilis* trees, other *Acacia* spp. as well as *Maerua crassifolia* trees (Fischer et al. 1998). Perennial grasses, such as *Panicum turgidum*, *Lasiurus scindicus* and *Octhochloa compressa*, which are important oryx forage species (Ostrowski et al. 2002), are abundant on deeper sand and low lying ground. Primary production in Mahazat as-Sayd is low (annual mean rainfall between 1990 and 2005: 7.2 mm; Islam et al. 2010), and rainfall is unpredictable and patchily distributed (Treydte et al. 2001). Ambient temperatures often exceed 45 °C in summer (Treydte et al. 2001; Ostrowski and Williams 2006). Severe droughts occur regularly (i.e., twice in 18 years) and are characterised by two to three consecutive years with no or very little rain, extremely high temperatures and reduced food availability (Islam et al. 2010). Mahazat as-Sayd is completely fenced (2244 m^2) and was gazetted as a reintroduction site for Arabian oryx, Houbara Bustards (*Chlamydotis undulate macqueenii*) and the Arabian Sand gazelle (*Gazella marica*; Child and Grainger 1990). The only predator occurring in Mahazat as-Sayd is the Arabian wolf (*Canis lupus pallipes*; Cunningham and Wronski 2010).

Founder females

The captive breeding of Arabian oryx at NWRC began in April 1986 when 57 animals were transferred from King Khalid Wildlife Research Centre in Thumamah, Saudi Arabia. Those founder animals (A generation) were kept isolated and were bred in individual pens to avoid the risk of transmission of disease. The second, B generation consisted of hand reared oryx which became the main herd for the production of animals suitable for reintroduction (Greth and Schwede 1993). Animals of the third generation were mother reared in breeding pens (300 m^2), or in large enclosures (250,000 m^2) and kept in groups of 1–5 individuals (Vié 1996). They received water and dry hay (Katambora rhodes Grass, 91% dry matter, 14% crude protein) ad libitum; 150 g of dry pellets comprising 18% and 14% protein were given daily to calves and pregnant females, respectively (Vié 1996). At the age of 9–15 months founder females were transported to the release site (Greth and Schwede 1993). Since the release site at Mahazat as-Sayd is 200 km west of the captive breeding site (NWRC), climatic conditions were different. Mean annual rainfall is with 100 mm considerable higher than that of Mahazat as-Sayd while the annual maximum temperature at NWRC (23–35 °C; Vié 1996) does not reach the Mahazat as-Sayd maxima.

Data collection

Between 1990 and 1994 a total of 76 captive-bred oryx were released into the reserve (Ostrowski et al. 1998). The first herd of 17 captive bred oryx was released in March 1990, followed by six animals in January 1991. A third group (14 animals) was released in April 1992, whereas the final release comprised 26 oryx in April 1993 (Greth and Schwede 1993). Thirteen founder females, included in our study, originated from the San Diego Wild Animal Park (SDWAP), USA; three from captive breeding groups in Jordan and Bahrain, and 20 from the breeding stock kept at the National Wildlife Research Centre (NWRC) in Taif, Saudi Arabia. These thirty-six founder females, their age ranging from 0.5 to 8.9 years, were individually identified by collars, ear-tags, or ear notches, until the last female died in March 2007. All individually known females were located at least once every two weeks. We recorded the location, date and time, group composition and the maternal status of focal females. Individual pre-release data, i.e., date of birth in captivity, place of origin, number of calves born in captivity and date of release into Mahazat as-Sayd were obtained from breeding records at NWRC. Based on field observations and pre-release data we established the life span for each female, its age at release, its life time reproductive success, individual birth rates (number of calves/year) and birth intervals, fecundity at different age classes as well as the number of male and female calves born to each female. Male and female births were divided by the total number of births of each female to obtain male and female birth rates.

Data analysis

Reproductive experience, i.e., females which had already reproduced prior to their release *vs* those which reproduced for the first time in the wild, was used as a binomial factor (independent variable) to test for effects on reproductive success and life history of individual founder females (i.e., life span, life time reproductive success [total number of calves], overall birth rate [calves/year], male and female birth rates). These data were analysed using the statistical model of MANCOVA incorporated in a multivariate GLM (SPSS 11.5), in which experience was included as a factor and age at release as a covariate. The data approach normal distribution and meet the requirements for GLM (Tabachnick and Fidell 2001; Quinn and Keough 2002); however, analysis of variance is robust to departures from normality, although the data should be symmetric. The Levene test for homoscedasticity implemented in SPSS 11.5 revealed no violation of the assumption of