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Reproductive performance of the largest captive Asian elephant (*Elephas maximus*) population in Sri Lanka

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ABSTRACT

The Pinnawela Elephant Orphanage (PEO) in Sri Lanka maintains one of the largest captive Asian elephant (*Elephas maximus maximus*) populations in the world, with a total of 79 animals (45 females and 34 males) at present. It was established in 1975 as an orphanage for rescued wild calves, and commenced natural breeding under controlled conditions when they reached breeding age. This study summarizes reproductive data of 65 live births from 38 years of records at PEO. The age at first calving (n = 31) was 14.6 ± 0.7 years, and the numbers of females giving birth two, three, four and five times were 21, 8, 4 and 2, with corresponding inter-birth intervals (IBI) of 4.9 ± 0.3, 4.8 ± 0.5, 7.9 ± 1.9 and 5.7 ± 0.5 years, respectively. Females giving birth to males (5.7 ± 2.2 years) had longer IBIs compared to birthing female calves (4.7 ± 1.1 years). The average gestation for 18 pregnancies with known conception dates was 667 ± 11 days. The average birth weight was similar for male (83.1 ± 4.6 kg; n = 14) and female (82.8 ± 8.4 kg; n = 6) calves. Sex ratio for live births was 36 male:29 female and not different from 1:1; however, more males (10/14) were born after a second parity. Calf mortality and stillbirth rates were low: 7.6% and 4.4%, respectively. This study highlights the successful breeding program at the PEO, providing baseline reproductive data that can aid in improving breeding of other elephants managed under captive conditions.

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1. Introduction

Sri Lanka is a biodiversity hot spot, with the second largest population (5,000–6,000) and highest density of wild elephants among the 13 Asian elephant range countries (Fernando et al., 2011). Habitat loss and fragmentation has resulted in elephants living outside of protected areas, and significant human-elephant conflict (HEC), primarily in the form of crop raiding, occurs throughout many parts of the country. About 200 wild elephants and 71 people are killed annually because of HEC (Fernando et al., 2011), resulting in a number of orphaned calves. This situation prompted the establishment of the Pinnawala Elephant Orphanage (PEO) by the Department of Wildlife Conservation (DWC) in 1975 to serve as a sanctuary for these orphans. Today, there are 363 elephants under human care in Sri Lanka, with PEO having the largest population—79 animals as of December 2013 (45 females and 34 males).

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Until the mid-1990s, the PEO elephant population was expanded mainly by addition of orphaned calves. In 1995, the Elephant Transit Home (ETH) was established at Udawalawe National Park in the southeastern part of Sri Lanka with the objective of raising these orphans with minimal human interaction for release back to the wild. So far, the ETH has released 100 elephant calves, many of which have successfully integrated with wild counterparts (Jayawardana et al., 2010). Today, the PEO no longer sends calves to ETH, but rather its role has changed from being an orphanage to an elephant conservation and captive breeding center. Throughout its existence, the PEO has been open to the public and today averages about 40,000 visitors per month (Dayanada and Weerakoon, 2012).

Globally, few captive Asian elephant populations are self-sustaining due to high mortality and low birth rates, both in Asia (e.g., Thailand, India, Indonesia, Lao and Myanmar) (Thitaram, 2012) and western zoos (Faust and Marti, 2011; Brown, 2014). Asian elephants are protected in most range countries, and exportation or importation of wild born elephants is prohibited under the Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES). As a result, there has been increased interest in captive breeding. Successful captive breeding programs in western zoos generally rely on controlled mating conditions (Schmid, 1998; Prahl, 2009), whereas in range countries, most reports describe unsupervised breeding, such as that in India and Myanmar, where captive females are allowed to forage in the forest and are mated by wild bulls (Sukumar et al., 1997; Leimgruber et al., 2008; Hayward et al., 2014). Breeding at the PEO is controlled and, since the first captive birth that occurred in 1984, more than 60 calves have been successfully produced. Data from the captive breeding program at PEO thus provides a rare opportunity to document and study a number of demographic events, including mortality and birth rates, calf sex ratios, birth weights and heights, and calving intervals over several generations. The main objective of this study was to assess the reproductive performance of captive female Sri Lankan elephants (*Elephas maximus maximus)* at the PEO by analyzing 38 years of breeding records.

2. Materials and methods

2.1. Animals

The PEO is located in the wet-zone, mid-country region of Sri Lanka (92 m elevation) and consists of 11 ha with sheds for night accommodation, a grassland area with water hole, and access to the adjacent Maha Oya River. The elephants are kept under captive conditions as one herd comprising adult females and male/female calves, which are allowed to interact socially throughout the day. Adult females are chained overnight from approximately 1600–0800 h; calves under 5 years of age are untethered and stay in close proximity. Females are not fully tamed and are managed as a group by several mahouts. They are not ridden and do not participate in shows or other tourist activities. All animals except males in musth are walked as a group to the river (<200 m) for bathing twice a day (at 1000 and 1400 h) for 2 h each. Bulls are removed from the female groups at 8–10 years of age and managed separately, with one dedicated mahout per bull. Bulls are trained for basic types of work, such as carrying bundles of fodder, riding by the mahout, and obeying simple commands (e.g. go forward, go back, turn to the side, pick up an object), with the intention of making them more manageable, especially as they age and begin to display musth. Visitors are permitted between 0830 and 1800 h to watch bathing, feeding and grazing activities. Females approaching or in estrus are tested with selected males for receptivity, and mahout-guided, natural mating is allowed with one or more bulls over a period of 2–3 days in an isolated section of the grassland area, or occasionally in the river. Indicators of impending estrus include reduced appetite and increased interest in bulls; for example, when released into the grassland area, a female will approach a male tethered in isolation. Young bulls also will show increased interest in estrous females while at the river, including genital inspection, urine testing, flehmen and mounting.

The diet consists of a mixture of browse [coconut (*Cocos nucifera*); kithul/fish tail palm (*Caryota urens*); jak (*Artocarpus heterophyllus and A. integrifolia*); bo (*Ficus religiosa*); ehatu (*Ficus tsiela*); erabadu (*Erythrina variegats*); ambarella (*Spondias cytherea*); goraka (*Garcinia cambogia*); siyambala (*Tamarindus indica*); nuga (*Ficus benghalensis, F. altissima*)], grasses [guinea grass (*Panicum maxicum*)], and fruits [pineapple (*Ananas sativum*); water melon (*Citrullus lanatus*); banana (*Musa*); cucumber (*Cucumis sativus*); pumpkin (*Cucurbita pepo*)].

A full time veterinarian works onsite, and individual records of health and reproductive events are maintained on all elephants.

2.2. Data collection

We utilized records of female elephants at PEO from its inception in 1975 through the end of 2013 that included: estimated age of orphan calves at arrival; dates of observed matings; dates of calf births; age and parity of dam at calving; and the sex, birth weight and height at withers of the calves. Based on these records, age at first calving and subsequent births, inter-birth interval (IBI) and length of gestation were calculated. Time taken to expulsion of the placenta and placental weights also were recorded. Birth weight of neonates and placental weight were measured using an Avery spring balance scale. Height at the withers on the day of birth was determined using a measuring tape.

2.3. Data analysis

Birth weights and wither heights were compared between male and female calves using two sample *t*-tests, as were differences in gestation lengths and IBIs between females giving birth to male or female calves. Differences in sex ratios based on parity were determined by Chi square analysis. Gestation lengths and IBIs of first, second and third or later births were analyzed by one-way ANOVA followed by post-hoc Tukey's tests. Statistical significance was set at $P < 0.05$. Mean data are expressed as $\pm$ SD.

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