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The use of a 'creep': Zoo animal management to encourage reproductive behaviours in captive Bornean orangutans (*Pongo pygmaeus*)

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Keywords: breeding, preference, primate, proximity

Article history:
Received: 08 Mar 2018
Accepted: 01 Jun 2020
Published online: 31 Jul 2020

Abstract
The number of endangered species held within zoos is increasing; therefore, zoo staff need to be able to understand factors that influence reproduction in captivity, ensuring sustainable populations. However, a variety of factors that are often unknown can cause suitable breeding set-ups to fail. This study aimed to determine whether the use of a 'creep', a partially closed sliding door allowing only smaller female individuals passage into enclosure areas to enhance their control over proximity to a male, has the potential to stimulate copulatory behaviours within zoo-housed orangutans *Pongo pygmaeus*. During observations, when the creep was in use, the male individual spent significantly less time observing people, less time resting and more time feeding and foraging. Female conspecifics also spent less time resting and more time feeding and foraging. However, when given control over their proximity to the male during creep periods, no difference was recorded in their proximity to the male. It is concluded that the use of a creep did not aid in stimulating reproductive related behaviours in this group of orangutans.

Introduction

It is essential that zoo staff monitor factors that may influence reproductive behavioural abnormalities, such as hand rearing and social grouping. Understanding such factors is critical for the sustainable captive management of species classified as Threatened and Endangered under the IUCN Red List of Threatened Species (Saunders et al. 2014). Captive primates often exhibit a range of reproductive behavioural abnormalities that can have a significant impact on the success of ex-situ breeding programmes. For example, captive-born individuals have been found to have lower reproductive outputs than their wild-born counterparts who are housed in similar conditions (western lowland gorillas *Gorilla gorilla gorilla*: Ryan et al. 2002; Tasmanian devils *Sarcophilus harrisii*: Keeley et al. 2012), and various rearing environments have also been shown to alter captive ape reproduction (chimpanzees *Pan troglodytes*: Rogers and Davenport 1969; King and Mellen 1994; gibbons *Hylobates* spp.: Mootnick and Nadler 1997). Behavioural analyses are the logical starting point for discerning the causes of reproductive failure in captive mammals (Lindburg and Fitch-Snyder 1994). These studies can aid in identifying specific individuals within the captive population of the species that have lowered reproductive output, whilst allowing zoo staff to identify the factors suppressing successful breeding.

Bornean orangutans *Pongo pygmaeus* are classified as Critically Endangered under the IUCN Red List of Threatened Species (Ancrenaz et al. 2016). This species is part of the European Endangered Species Programme (EEP), which consists of over 30 zoos in the European Association of Zoos and Aquaria (EAZA), and comprises the most intensive type of population management for a species kept in an EAZA zoo

(EAZA 2020). Bornean orangutans are part of the orangutan Species Survival Plan (SSP), which consists of 52 accredited zoos across the US, Canada and Mexico. The orangutan SSP aims to treat all its member zoos as one population to ensure the long-term survival of the species in captivity (SSP 2017).

Wild and captive sub-adult or prime male orangutan sexual strategies usually consist of consort or combat tactics, where females are sexually coerced or harassed until mating has been achieved (Nadler 1977; Galdikas 1985; Smuts and Smuts 1993; Fox 2002; Atmoko et al. 2009; Kopp and Liebal 2018). Reproductive failures in captivity may result from enforced and continuous proximity between breeding individuals, with pairs bought together only for mating proving successful (Markham 1990). Continuous proximity may induce a chronic level of stress in non-social species, which, along with other factors, interferes with reproduction in primates (Lindburg and Fitch-Snyder 1994; Anestis et al. 2006; Machatschke et al. 2006; Muehlenbein 2006; Thompson et al. 2010; Arlet et al. 2013). Therefore, by allowing female orangutans to control their proximity to males, zoos can allow females to have control over, and cooperation during, mating (Maple et al. 1982; Smuts and Smuts 1993). Moreover, females with control over their proximity to a male can choose to mate mid cycle, when reproductive success is most likely (Nadler 1982). Such control could potentially lower female reproductive costs (Kokko 2005; Knott et al. 2010) whilst combating a loss in the novelty of partners, and the diminishment of libido (Lindburg and Fitch-Snyder 1994). Surprisingly, there have been few published studies on reproductive patterns of the species in captive facilities. Reasons as to why pairings made in captivity may fail, even if the individual's partner is cycling, are often inferred.

This study aims to determine whether limiting male access to three companion females and enhancing female control over proximity to a male has the potential to help combat novelty and familiarity issues, and potentially encourage reproductive behaviours within zoo-housed orangutans.

Methods

Four adult Bornean orangutans were used as subjects for this study; a male of 20 years old and three females aged 33, 21 and 15 years old, housed at Blackpool Zoo's 'Orangutan Outlook'. All females were related, the eldest being the mother of the two younger individuals. The male was previously subject to hand-rearing conditions through his infant and juvenile stages, and as a result, the individual displays social attachment to humans. The eldest female has previously successfully bred with different males. The orangutans were housed in an exhibit comprising two main chambers, each measuring 9.39×6.01 m. The exhibit comprised a deep mulch substrate and various horizontal and vertical beams, ropes, straps and nets. The exhibit could be divided into two separate on-show areas by closing one solid metal sliding door and one heavy-duty mesh panel. The subjects received main feeds at 1100 and 1530 each day, with supplementary feeds occurring throughout the day. Feeds comprised mixed fruit and vegetables as well as a formulated ape pellet. Prior to main afternoon feeds, the individuals were held off-show as part of the husbandry routine.

The 'creep' employed in this study is an entrance that allows

Table 1. Ethogram of orangutan behaviour.

Behaviour	Definition
Travel	Locomotion on the ground
Move	Locomotion above ground
Rest	Sitting, standing or laying in still position
Feeding/foraging	Ingestion and search for food or water
Grooming	Combing through hair with fingers or mouth
Self-directed	Grooming, inspecting, scratching self
Nest	Being in or building a nest (day or night nest)
Play	Playing with a partner or object
Observe	Tracking the movement of conspecific
Observe person	Tracking the movement of a person
Severe aggression	Including contact aggression
Aggression chase	Aggression with movement but without contact, the victim running away
Aggression display	Undirected aggression with movement, display
Aggression threat	Stationary display (hand fling, object shake)
Vocalisation	Kiss-squeak, long-call, other
Successful copulation	Occurrence of copulation
Copulation inspect	Inspecting genitalia
Copulation solicit	Presenting for copulation

Figure 1. Shows the 'creep' as a narrow gap that enables female individuals to pass through into the other half of the enclosure, but not a large male. The sliding door used was always locked securely into place on its runner.

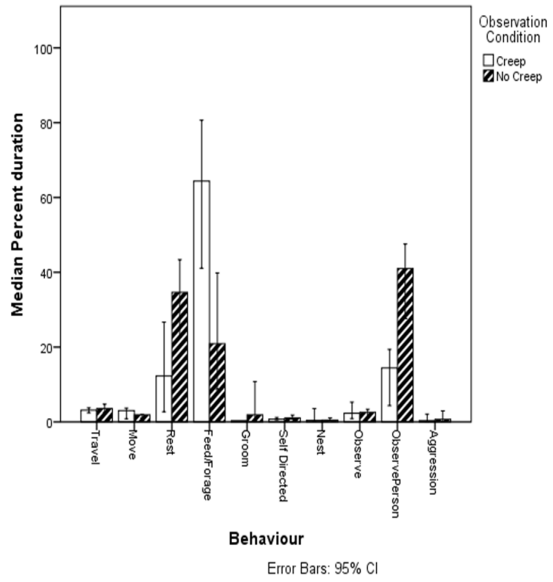

Figure 2. The male's median percent duration of each behaviour during creep and non-creep conditions.

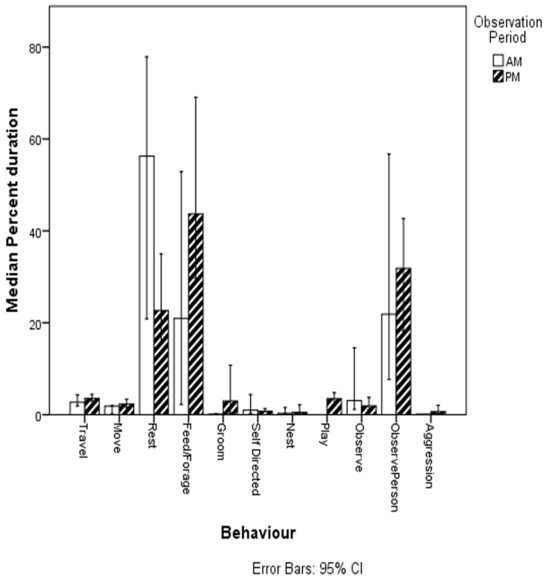

Figure 3. The male's median percent duration of each behaviour during the morning (AM) and afternoon (PM) periods.

females, but not the male, to pass through into a separate part of the enclosure (Figure 1). Keepers closed and secured a metal sliding door into place to allow the smaller female individuals to move freely between the two halves of the enclosure, but to restrict the male to one half of the enclosure due to his size and inability to pass through the gap. The creep was mostly put in place during the afternoon from 1500 as part of the husbandry routine, remaining in place until 0900 at the latest the next morning when the day's husbandry routine began. During 'no creep' conditions, orangutans could always see each other, and the male always had access to the females. During 'creep' conditions, orangutans could see each other, but females could choose to be in a part of the enclosure with or without the male. However, the creep was not always employed by keeping staff. For this reason, fewer observation sessions during the 'creep' condition (28.8%) were made compared to 'no creep' sessions (72.2%).

The study was conducted over a 6-month period from February to July 2017, during which a total of 32.5 hrs of data were collected across the two conditions, when the creep was and was not in use. Data were collected on any six days in a given week, and always between 1000 and 1700 at a time randomly selected to cover the whole day's period (28.8% of observations took place during the morning and 72.2% in the afternoon). Behavioural data for the male were collected via continuous focal observations (Altmann 1974) for 30-minute periods. Female behaviour and proximity to the male in metres was recorded alongside this via 1-minute instantaneous group scan samples (Altmann 1974) for 30 minutes. All data were collected by CH and two research assistants trained by CH using a predefined ethogram (Table 1). Inter-observer reliability was greater than 90%.

Focal sample behavioural data were summarised as percentage durations (duration of behaviour/length of sampling session×100), and scan sample behavioural data were summarised as percentage of frequency of occurrence for each sampling session (frequency of behaviour/number of individuals in group×100). Aggressive behaviours were grouped for analysis due to their rare occurrence. Copulation and vocalisation behaviours were not recorded. The resulting values were calculated for each observational day and used for the analysis. The study comprised a repeated measures design, using the same individuals under two different conditions. Furthermore, there was a distribution of differences between scores that was significantly different to normal for scan sample data ($P<0.001$), and for focal data ($P<0.001$). Therefore, a non-parametric analysis using the Wilcoxon signed-rank test was performed to test for differences in behaviours between creep and non-creep conditions. Exact significance scores were used to account for relatively small sample size, with the value for significance set at 0.05. Additionally, median and interquartile range values are reported due to non-normally distributed data. Proximity data were collected at 1-minute intervals; this made the sampling points dependent on each other, as the previous proximity of the individual would influence the next recorded proximity. For this reason, the mean proximity for each individual, under each condition, was calculated, but statistical tests were not used. All analysis was carried out using the IBM SPSS 22 statistical software package.

Results

Male behaviour change

A significant decrease in time spent performing 'rest' behaviours occurred during creep conditions ($Z=-2.555$, $n=22$, $P=0.009$) (Figure 2), and appears to be replaced by an increase in time spent performing 'feeding and foraging' behaviours, which were significantly higher during creep conditions ($Z=-3.912$, $n=22$, $P<0.001$). This may be due to the husbandry routine, where the main evening feed was placed into the enclosure whilst the orangutans were off-show and prior to the creep being put into place.

There was a significant decrease in time spent performing

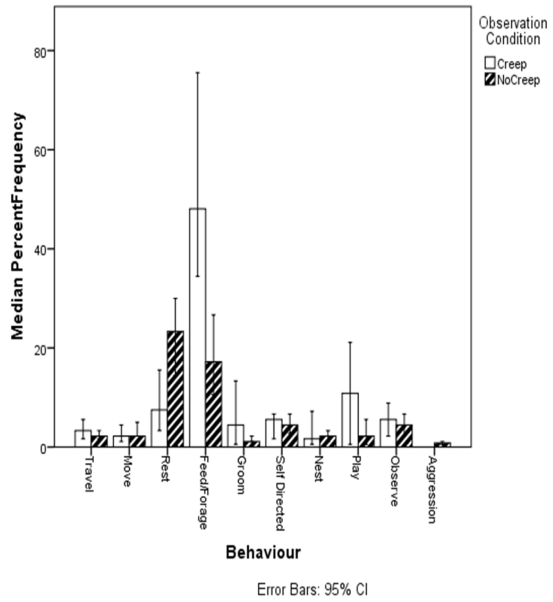

Figure 4. The median percentage frequency of female behaviours recorded during creep and no creep sessions.

'observe person' behaviours during the creep condition (Z=-2.278, n=22, P=0.005) (Figure 2). During 'no creep' observation sessions, the male spent extended periods sat on the ground by viewing windows, following people with his gaze. However, when the creep was in use, he would position himself where he could see the females. On occasions, the male would look directly through the creep at the three females. Despite this, there was no recorded increase in 'observe' behaviours directed towards other orangutans. It is felt this is mainly due to the male eating whilst observing other individuals, and as a result, this has been recorded as 'feeding and foraging' behaviour.

With the creep implemented at around 1500 in the afternoon, fewer visitors may be present in the zoo than throughout the rest of the day, providing fewer people to observe. However, a comparison of morning and afternoon behaviours show a different trend to 'creep' and 'no creep' conditions (Figure 3) with less time spent resting and more observing people during afternoon observations, the opposite to when the creep was in use.

Table 2. The mean proximity in metres for each female orangutan to the male under creep and no creep conditions.

Individual	Proximity to male (m)	
	Creep	No creep
Vicky	5.19	4.55
Cherie	6.99	6.75
Summer	6.21	6.01

Female behaviour change

A significant decrease in the frequency of performing 'rest' behaviours occurred in the three female orangutans during creep conditions (Z=-3.662, n=20, P<0.001) (Figure 4). This appears to be replaced with an increase in the frequency of 'feeding and foraging' behaviours (Z=-3.733, n=20, P<0.001), perhaps due to the husbandry routine. Social behaviours of grooming and play show an increase in frequency during creep conditions; however, this was not significant.

Proximity

There were no large changes in female proximity to the male across 'creep' and 'no creep' conditions (Table 2). However, all female proximities were of a greater distance during creep conditions.

Discussion

The male spent less time observing people when the creep was in use, largely explained by an increase in feed/forage behaviours most probably related to the husbandry routine. Additionally, an increase in observing conspecifics was recorded which may indicate an increased interest. However, this did not lead to copulatory behaviours. The hand-reared background of the male appeared to influence his behaviour, spending large portions of time observing people. It is thought achieving reproduction as an adult, in captive apes, may depend heavily on development and exposure to conspecifics throughout immaturity (Beck and Power 1988). Indeed, it has been noted that play-sex could be an important part of growing up for orangutans (Mackinnon 1974), and young rehabilitated individuals can struggle to grasp the subtle nuances that characterise orangutan relationships and interactions (Galdikas 1995). Therefore, this lack of socialisation at an early age may impact the male's ability to perform mating behaviour and explain the increased interest in people. Various species of gibbon exhibit inadequate sexual behaviour because of inadequate early socialisation (Mootnick and Nadler 1997). Additionally, mother-reared western lowland gorilla males show increased reproductive output compared to hand-reared males (Ryan et al. 2002). Therefore, contact with people during the hand-rearing process may also be a cause for concern within breeding programmes for this species. It is worth noting that wild male orangutans will often be aggressive via chasing, holding and forcing copulation (Nadler 1977; Galdikas 1985; Smuts and Smuts 1993; Fox 2002), behaviour which has also been witnessed in captivity (Kopp and Liebal 2018). Therefore, if this individual had performed more of these behaviours, the creep may have obstructed him in securing a female to mate with.

When the creep was in use, the females would spend time in the side where the male had no access, or sit observing him directly through the heavy-duty mesh panel. This was not observed when the creep was not in use. Additionally, the eldest female 'Vicky' has the closest average proximity to the male in both conditions. Captive females usually appear afraid when introduced to males by attempting to avoid them (Mackinnon 1974; Nadler 1977), as was seen each time the male moved towards the younger females. Following restricted access to the females, an increase in novelty or interest towards them from the male may have been expected, yet this was not recorded during morning sampling periods (Nadler 1982). However, male Bornean orangutans can show no interest when encountering females who are not in a reproductive status, which may have been the case during this study's observations (Mackinnon 1974; Nadler 1977).

Furthermore, whilst the females in this study were provided with control over their proximity to the male, no records of female proceptive behaviours were made. Whilst this is contrary to previous observations (Nadler 1982), it may be due to the short

Journal of Zoo and Aquarium Research 8(3) 2020
https://doi.org/10.19227/jzar.v813.368

study duration. Additionally, the individuals have been housed together previously for several years, enhancing potential novelty and familiarity issues. Orangutans are considered candidates of fission-fusion (Van Schaik, 1999), yet captivity can restrict this movement pattern. When in captivity, they have a lower tendency to socialise compared to other ape species, perhaps enhancing the need for novel partners and the ability to fission (Classen et al. 2016). Social and environmental requirements can be a further factor to consider regarding reproduction in animals, and studies considering different groupings could shed more light on captive breeding in this species (Mellen 1991). A further line of investigation would be to introduce new individuals to each other, as compatibility can be a major factor for breeding failure in other species (Zhang et al. 2004).

This study is one of the first to investigate attempts to increase breeding behaviour in captive orangutans via the reduction of novelty and familiarity issues, as well as by increasing female control over proximity to a male. This study only used one group of orangutans, one of which has a strong hand-rearing background. Additional studies on parent-reared individuals may be of benefit, along with further studies to record the use of this management technique with other great ape species.

Conclusions

The use of a creep did not increase copulatory related behaviours in this group of captive orangutans. However, this management technique may encourage a decreased interest in observing people and resting, promoting more active behaviours and enhanced interest in conspecifics for hand-reared individuals.

Acknowledgements

The authors would like to thank the following voluntary research assistants for helping to collect and code data: C. McIntyre, K. Marklew, E. Gee and K. Brant. Additionally, thanks go to P. Bayliss for helpful comments on an earlier version of this manuscript. The authors are grateful to two anonymous reviewers who provided insightful comments that helped improve the manuscript.

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