JZAR JOURNAL OF ZOO AND AQUARIUM RESEARCH
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Research article

Influence of male presence on female Asian elephants (*Elephas maximus*) behaviour in captivity

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Keywords: Elephant, conservation, zoo, behaviour, welfare, stereotypic

Article history:
Received: 18 Nov 2018
Accepted: 14 Oct 2019
Published online: 31 Jan 2020

Abstract

Maintaining natural behaviour in captivity is important when considering animal welfare and reproductive efficiency. In captivity, few studies have evaluated the influence of male Asian elephants (*Elephas maximus*) on the behaviour of females. This study investigated foraging, standing, elimination, vocalisation, courtship, mating and stereotypic behaviours in four female Asian elephants after the introduction of a dominant male. Elephant activity was video recorded and behavioural data were collected through the transcribing of video footage. In the male´s presence, females spent less time foraging and more time standing. Although not statistically significant, an increased frequency of elimination behaviour was observed when the male was present. Females performed more vocalisations in the male's presence. The females exhibited stereotypic behaviours less frequently when the male was present (5.9%) than when he was absent (26.8%). Therefore, this study has shown that, in captivity, female elephants behave in a male's presence as do their wild conspecifics, which is beneficial for their conservation and well-being. It can be concluded that temporary integration of a male elephant in a female group in captivity has a positive influence on females, leading them to perform less stereotypies and to promote reproductive behaviours. Further studies should be performed to enhance the knowledge of male influence on female elephant welfare in captivity.

Introduction

Wild elephants have been kept in zoos, originally royal menageries, for at least 3,500 years (Crok 1997). There is a range of benefits to keeping elephants in captivity, such as enhancing the knowledge of their biology through research, supporting ex-situ conservation through public education, and raising funds by engaging visitors (Riddle and Stremme 2011). For these reasons, elephants have been extensively studied in zoos (Csuti 2006).

Attaining a self-sustaining zoo elephant population is considered a challenging aim in the modern zoo world (Wiese and Willis 2006), with the main concerns being certain aspects of elephant husbandry: their social structure and social needs (Csuti 2006; Lehnhardt 2006). Even if elephants in captivity do not reflect a kin-based social structure, they display many of the same behaviours as their wild conspecifics (Schulte 2000; Morris-Drake and Mumby 2017; Harvey et al. 2018).

However, zoos do not usually provide opportunities to breed, as most females do not have access to males. Zoos tend to keep only a few or no breeding bulls due to their tendency for aggression and because of a lack of appropriate facilities for males (Ganswindt et al. 2005). Several female reproductive disorders, such as acyclicity, endocrine disorders, infanticide, and continuous ovarian cyclicity of non-breeding females, may have a negative and cumulative effect on reproductive health and on the integrity of the urogenital tract, leading ultimately to infertility (Hildebrandt et al. 2006). Zoo elephants may face captive extinction, if there is not an increase in reproduction (Wiese and Willis 2006; Carlstead et al. 2013).

Therefore, it is necessary to optimise captive conditions to encourage natural behaviours in elephants and thus enhance their well-being and welfare. To this end, elephants must be integrated in an environment that reflects their natural habitat, with the conditions required to manifest their natural behaviours, including social and sexual behaviours. Very few studies have directly investigated this topic (Schulte 2000). Therefore, the purpose of this study was to evaluate the influence of the presence of a male elephant on the behaviour of captive Asian female elephants.

Table 1. Subjects demographics. Elephants are listed individually with gender, age, years in the collection at the time of the study, origin and reproductive status.

Animal	Gender	Age	Years in collection	Origin	Reproductive status
A1	Female	46	1	Captive born	Non pregnant/ Oestrus
A2	Female	25	1	Captive born	Non pregnant
A3	Female	15	11	Captive born	Non pregnant/ Oestrous
A4	Female	15	11	Captive born	Non pregnant/ Lactating
A5	Male	54	51	Wild born	-

Material and methods

Subjects

The elephant group at Copenhagen Zoo consists of seven animals, all Asian elephants (four females, one calf and two males). The youngest male and the calf were excluded from this study because the young male was in a separate facility and calf behaviour was not considered relevant for our study (Table 1).

Housing and management

At Copenhagen Zoo, the elephant exhibit house consists of two large domes, resulting in a great amount of daylight in the stables, and two separated areas for males and females. The two males are not housed together; therefore, they each have their own indoor and outdoor facilities. In the indoor space, the walls and the floor are composed of hard concrete, but for the well-being of the elephants the floors were filled with 50cm of sand. The outdoor facility has sand floors, a deep-water pool, rocks and numerous feeding enrichment devices.

The zoo was intending to introduce the older and more dominant male to the females, so that they could spend more time together and have an enhanced reproductive success. This introduction process started 1 month prior to the beginning of the study. The male spent around 3 hours per day with them (always in the morning), within the females' enclosure. The male was considered "present" when he was sharing the same physical environment with the females. He was considered "out of sight" when he was in the females' complex but in a different physical space, for example, if he was in the indoor space while the females were in the outdoor enclosure. He was considered "absent" when he was in the male's complex.

Data collection

An ethogram was used to evaluate the effect of male presence on the females' foraging, standing, elimination, vocalisation, courtship, mating and stereotypic behaviours (Table 2). Data were collected in November 2013, from 10.00 to 16.00 h (3 hours of data collection per day). For seven consecutive days, a total of 21 hours of data were recorded using a Sony DCR-HC26 MiniDV Digital Handycam. In the morning period (10.00 to 13.00 h) data concerning male presence and out of sight were collected, and in the afternoon (13.00 to 16.00 h) data concerning female behaviour in male absence were collected. Video recordings were divided into 5-min videos (n=252). From these videos, behaviour data were transcribed through continuous sampling methods for each female elephant (Altman 1974). Only if the same female was visible during the whole 5 min would the video be validated. Therefore, 372 validated 5-min videos were obtained (in several videos it was possible to observe more than one female). The number of times each behaviour was performed by each animal in the 5-min period was documented. For feeding and standing behaviours, the number of seconds (0 to 300 sec) spent were also recorded. All videos were reviewed three times by two different observers (AP and BC), to minimise bias.

Statistical analysis

The data collected were statistically analysed using SPSS 25. First, the homogeneity of variances for each variable was tested by a Levene test. To analyse the influence of male presence in foraging and standing behaviours, an Analysis of Variance (ANOVA) was employed, followed by a Bonferroni post-hoc test for multiple comparisons. The column proportions (for each row) were compared using a z-test for analysis of male influence on elimination, vocalisation and stereotypic behaviours. The Pearson product-moment correlation coefficient was used to evaluate the correlation (linear dependence) among courtship and mating. All P-values lower than 0.05 were considered statistically significant.

Table 2. Asian elephant (*Elephas maximus*) ethogram.

Behaviour	Description of behaviour
Foraging	Time spent feeding / drinking and searching for food
Standing	Time spent in standing position without any further activity for at least 2 seconds
Elimination	Urination and / or defaecation
Courtship	Usually involves the bull touching the face, eyes, ears, hind legs and vulva of the cow with his trunk. He may also raise his head and trunk to reach over her shoulder or flank before trying to mount and copulate
Mating	When the male elephant mounts the female
Vocalisation	Vocalisations produced (all audible sounds)
Stereotypic	Unvarying and repetitive behaviours such as body and trunk swaying in forwards and backwards, weaving, head-nodding and pacing

Table 3. Mean (±SD) number of seconds in the 5-min period that females spend feeding and standing with male presence, absence or when he is out of sight.

Male				
	Present (out of 300s)	Absent (out of 300s)	Out of Sight (out of 300s)	Significance
Foraging Behaviour	125±127[a]	163±129[b]	196±123[b]	Present vs. Absent, P=0.033 Present vs. Out of sight, P=0.001 Absent vs. Out of sight, P=0.342
Standing Behaviour	233±54[a]	170±95[b]	192±68[b]	Present vs. Absent, P<0.001 Present vs. Out of sight, P<0.001 Absent vs Out of sight, P=0.171

Results

Clear differences in female behaviours were observed as a consequence of male presence. The occurrence of female foraging and standing behaviours was influenced by male presence. Females spent less time eating/searching for food when the male was present (125±127 out of 300 seconds) than when he was absent (163±129 out of 300 seconds; P=0.033) or out of sight (196±123 out of 300 seconds; P=0.001). Regarding the standing behaviour, it was observed that in male presence, females stood significantly longer (233±54 of 300 seconds) than in his absence (170±95 of 300 seconds; P<0.001) and out of sight (191±68 of 300 seconds; P<0.001) (Table 3).

A higher frequency of elimination behaviour was observed when the male was in the same housing as the females (Table 4); however, these results were not statistically significant. Females vocalised more frequently when the male was present than when he was absent (P<0.001) or out of sight (P=0.0283) (Table 4). Of the four female elephants in this study, only two performed courtship and mating with the male, and a high significant correlation between both behaviours was revealed (r=0.793 and P<0.001).

In the male's presence, the herd also performed fewer stereotypic behaviours. The females less frequently exhibited stereotypic behaviours when the male was present (5.9% of the time) than when he was absent (26.8% of the time) (P<0.001) (Table 4). Analysing each female's behaviour, it can be observed that only female A1 and A2 performed stereotypic behaviours when the male was absent, and that these behaviours reduced drastically in the male's presence and when he was out of sight (Table 5).

Table 4. Association between elimination, vocalisation and stereotypic behaviour with male presence, absence or when he is out of sight. If a pair of values is significantly different, the values have different superscript letters assigned to them. Therefore, different superscript letters denote a subset of variable categories whose column proportions (for each row) do differ significantly from each other at least P<0.05.

Male					
		Present	Absent	Out of Sight	Significance
Elimination Behaviour	Not observed	90.6%[a]	96.4%[a]	96.6%[a]	Present vs. Absent; z=1.9; P=0.0589 Present vs. Out of sight; z=1.5; P=0,139 Absent vs. Out of sight; z=0,1; P=0.9466
	Observed	9.4%[a]	3.6%[a]	3.4%[a]	Present vs. Absent, z=1.9; P=0.0589 Present vs. Out of sight; z=1.5; P=0,139 Absent vs. Out of sight; z=0,1; P=0.9466
Stereotypic Behaviour	Not observed	94.1%[a]	73.2%[b]	86.2%[b]	Present vs. Absent; z=5.2; P<0.001 Present vs. Out of sight; z=2; P=0.0462 Absent vs. Out of sight;z=1.9; P=0.0538
	Observed	5.9%[a]	26.8%[b]	13.8%[b]	Present vs. Absent; z=5.2; P<0.001 Present vs. Out of sight; z=2; P=0.0462 Absent vs. Out of sight; z=1.9; P=0.0538
Vocalisation Behaviour	Not observed	88.6%[a]	99.1%[b]	93.1%[a]	Present vs. Absent; z=3.4; P<0.001 Present vs. Out of sight; z=1; P=0.3223 Absent vs. Out of sight; z=5.2; P=0.0283
	Observed	11.4%[a]	0.9%[b]	6.9%[a]	Present vs. Absent; z=3.4; P<0.001 Present vs. Out of sight; z=1; P=0.3223 Absent vs. Out of sight; z=5.2; P=0.0283

Discussion

This study evaluates the influence of the male on the foraging, standing, elimination, vocalisation, sexual and stereotypic behaviours of female elephants, after his recent introduction to the herd. Although elephants in the wild spend the majority of their day foraging (Mramba et al. 2019), this behaviour is reduced in captive conditions due to the provision of high-quality diets within a shorter time interval (Shepherdson 1999; Posta et al. 2013). The results showed that foraging behaviour was reduced in the presence of the male. This result may be attributable to the fact that females were still acclimatising to his presence and/or that females showed a social or sexual interest in him. As observed by Rasmussen and Schulte (1998), most females remained still when the male approaches them. Therefore, this may explain their standing behaviour in the present study, as females stood for longer when in the male´s presence.

It is well described that urine components represent a chemical signal for reproduction in Asian elephants (Rasmussen et al. 1982; Rasmussen and Schulte 1998). Females urinating after males have come into contact with their urogenital area has also been observed (Rasmussen and Schulte 1998). It was not possible to evaluate separately the values for defaecation and urination in the present study, though this should be assessed in future studies. Nevertheless, it is reasonable that females more frequently exhibited elimination behaviours in the male's presence.

The use of vocalisations in elephant reproductive behaviour has been well described (Leong et al. 2003; Leong et al. 2005). Vocalisations are used in short and long distance contact, conflict, excitement, threat display, nervousness, advertisement for hormonal state in both sexes, group cohesion and coordination and greeting family or bond group members (Langbauer 2000; Soltis 2010). The majority of vocalisations of elephants are in the infrasound range (Leighty et al. 2008). Vocalisations may be observed during or after copulation and are probably produced to attract additional males and instigate competition between them to gan access to high-ranking males (Vidya and Sukumar 2005; Hildebrandt et al. 2011). Therefore, as expected, females vocalised significantly more in the male's presence.

During courtship, the bull was observed to touch the face, eyes, ears, hind legs and vulva of the cows with his trunk. He also raised his head and trunk to reach over her shoulder or flank before trying to mount and copulate. Courtship and mating only occurred with two females, and for both there was positive correlation between these behaviours. Taylor and Poole (1998) suggested that the key to improving conception rates is larger herd groups and continued access between males and females, thus increasing opportunities for mating; the latest management recommendations also suggest periodic health care screening and keeping males and females together in a large enclosure (Kumar et al. 2014).

The male´s presence in the herd reduced stereotypic behaviours in the females. These behaviours are very common in zoos and their occurrence is often used in welfare assessments (Greco et al. 2016). However, one must be very careful when using them to infer well-being as they may indicate past problems and not only current ones (Harris et al. 2008; Mason and Veasey 2010). Nevertheless, the fact that the male's presence helped to reduce stereotypic behaviours in the herd is an indicator of his positive influence. Looking at individual female data, it was observed that stereotypic behaviours were only performed by two herd members, and that these behaviours were drastically reduced in the male´s presence. Overall and during the observation period, the male's introduction to the herd for some hours per day gave the animals the opportunity to increase the diversity of their behavioural patterns, which is an important asset for conservation and well-being. Therefore, male introduction to the herd should be

Table 5. Per female analysis of association between stereotypic behaviour with male presence, absence or when he is out of sight. If a pair of values is significantly different, the values have different superscript letters assigned to them. Therefore, different superscript letters denote a subset of variable categories whose column proportions (for each row) do differ significantly from each other at least P<0.05. N/A: for female A3 and A4, no statistical analysis was performed due to the fact that stereotypic behaviour was not observed.

Male					
		Present	Absent	Out of Sight	Significance
Female 1 (A1)	Not observed	96.5%[a]	50%[b]	92,9%[a]	Present vs. Absent; z=5.2; P<0.0001 Present vs. Out of sight; z=0.6; P=0.548 Absent vs. Out of sight; z=2.7 P=0.0062
	Observed	3,5%[a]	50%[b]	7,1%[a]	Present vs. Absent; z=5.2; P<0.0001 Present vs. Out of sight; z=0.6; P=0.548 Absent vs. Out of sight; z=2.7; P=0.0062
Female 2 (A2)	Not observed	81,1%[a]	42,9%[b]	75%[a]	Present vs. Absent; z=3.5; P=0.0005 Present vs. Out of sight; z=0.6; P=0.5216 Absent vs. Out of sight; z=2.4; P=0.0146
	Observed	18.9%[a]	57,1%[b]	25%[a]	Present vs. Absent; z=3.5; P=0.0005 Present vs. Out of sight; z=0.6; P=0.5216 Absent vs. Out of sight; z=2.4; P=0.0146
Female 3 (A3)	Not observed	100%	100%	100%	N/A
	Observed	0%	0%	0%	N/A
Female 4 (A4)	Not observed	100%	100%	100%	N/A
	Observed	0%	0%	0%	N/A

implemented together with other management strategies (food enrichment, improved housing management, reduced inter-zoo transfers and larger social groups) to reduce elephant stereotypies in captivity (Björk 2011, Greco et al. 2016; Schiffmann et al. 2019).

However, several management problems associated with this approach need to be considered. Applying these management changes could result in an increasing number of breeding captive herds, which will require renovations in facilities and preparations for handling a greater number of males (Taylor and Poole 1998; Wiese and Willis 2006). Nonetheless, this increase in reproduction could constitute an important health factor for females, as they would no longer suffer from continuous cycling, and subsequently would experience fewer reproductive disorders and a better quality of life associated to caring for her calf. As described by Freeman et al. (2004), the focus from now on should be on optimising social and environmental conditions to maximise the reproductive potential of captive elephants with the aim of a self-sustaining zoo population.

This study recommends behavioural evaluations of other elephants and facilities to enhance the knowledge base on male influence on female welfare in captivity. In conclusion, the results showed that the integration of a male elephant into a captive female group positively influenced their behaviour, through reducing stereotypies and promoting reproductive behaviours.

Conflicts of interest

The authors declare that they have no conflict of interests.

Acknowledgements

We would like to thank the scientific committee from Copenhagen Zoo, for making this study possible, especially to Mads Bertelsen who was always supportive during the elaboration of this paper. This work is supported by: European Investment Funds by FEDER/COMPETE/POCI– Operacional Competitiveness and Internacionalization Programme, under Project POCI-01-0145-FEDER-006958 and National Funds by FCT - Portuguese Foundation for Science and Technology, under the project UID/AGR/04033/2013. This work was also supported by the Portuguese Science and Technology Foundation (FCT) under Project PEst-OE/AGR/UI0772/2014.

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