



## Bachelor of Veterinary Medicine Research Project 2

<b>Title</b>	Studies on the development of allomothering behaviours in orphaned juvenile Asian elephants ( <i>Elephas maximus</i> ) in a rehabilitation centre in Sri Lanka
<b>Word count</b>	3971

## ABSTRACT

Both Asian and African elephants live in matriarchal herds where social and physical interaction is commonplace. Within these herds, allo-mothering has been shown to occur and is thought to be an important contributor to infant survival. However, few observations of allo-mothering in captive herds have been recorded. This study examined a group of 37 orphaned, un-related, juvenile Asian elephants in a rehabilitation home in Sri Lanka to determine if allo-mothering behaviours would occur between the youngest calves and the oldest females of the group. 6 females and 6 males >4years were observed for a total of 96 hours and any mothering behaviours; in the form of physical contact or protective behaviour, were recorded. Scan samples were also taken to record how frequently females versus males or calves <2years were found in a 2m radius of the 4 youngest calves. The females observed showed a significant amount of mothering behaviours throughout the study (P:0.002) and were significantly more often in the presence of the youngest calves than older male elephants were (P:0.0243). It was concluded from this study that allo-mothering does occur in a captive group of juvenile elephants in Sri Lanka. This is promising for the goal of releasing the elephants into the wild to raise calves of their own. To support the results of this study it would be recommended to perform a similar study on another captive group of larger size and/or of longer duration.

## INTRODUCTION

A rapid population decline over the past 3 generations has led to the Asian Elephant (*Elephas maximus*) being listed as ‘endangered’ by the IUCN. This is largely due to habitat destruction and human-elephant conflict<sup>1</sup>. There is an estimated 5000 wild elephants currently in Sri Lanka and up to 3 per week are killed due to conflicts with humans, often leaving behind orphan calves (personal communication). The Elephant Transit Home (ETH) in Udawalawe, rescues orphan, often injured calves and returns them to the wild following a period of rehabilitation. This, amongst other projects is helping to maintain an Asian elephant population. However, lower rates of survival and fertility in captivity<sup>2</sup> mean these populations are still at risk of extinction.

In the wild, Asian and African elephants are born and reared in stable family units consisting of 5-20 related older females and calves<sup>3-5</sup>. Aggregating in social groups allows animals to share or respond to information, assisting group members in developing skills<sup>6</sup>, finding resources and being made aware of nearby threats<sup>7,8</sup>. Observations of wild and captive elephants have shown that females in the group will physically interact with and display mothering behaviours towards young calves who are not their own kin<sup>9-12</sup>. This behaviour is deemed to be allo-mothering<sup>13</sup>. Allo-mothering has been defined by Phyllis Lee as “caretaking of infants by animals other than the mother”<sup>12</sup> and has been well described in mammals and birds, although often having markedly different consequences between species<sup>14</sup>. In primates, allo-mothering is considered critical for infant survival in terms of maturation and learning<sup>15</sup> and in bottlenose dolphins and vervet monkeys has been shown to be beneficial to the mother by providing time to focus on other priorities<sup>14,16</sup>. It has additionally been shown to be important in the maintenance of matriarchal societies in elephant herds<sup>3,17</sup>, where females assist others in care-taking duties to increase infant survival. The herd provides vital survival skills and protection and calves remain dependant on older family members for their first few years of life<sup>13</sup>. These adoptive type behaviours are of great importance in countries where human-elephant conflict is present, with calf mortality shown to increase with loss of mother if in the first four years of life<sup>13</sup>. Allo-mothering is also beneficial to the elephant exhibiting the behaviour, as they acquire mothering skills which will result in higher offspring survival rates later in life<sup>10,16</sup>. By the time they give birth to their first calf, allo-

mothers will usually already have several years experience of raising young<sup>18</sup>.

Communication, physical contact and social interaction have been shown to be important in maintaining relationships between elephants<sup>10,19</sup>. Allo-mothering behaviours have been previously described as protective behaviour, comforting behaviour and allo-suckling<sup>11,12</sup> and are vital in minimizing risks to calves who are at their most vulnerable during the first five years of life<sup>13</sup>. Elephants are one of few species who have been shown to respond to each other's distress<sup>19</sup> and these actions often occur between closely bonded individuals such as allo-mothers. Young calves have been observed giving out alarm calls which are immediately responded to by older females in their vicinity<sup>20</sup>. Teaching behaviours however, have not been observed as part of allo-mothering in elephants, unlike primates<sup>15,21</sup>.

In the wild, allo-mothering generally occurs between related elephants<sup>12,22</sup>.

Behaviours exhibited by captive elephants have however been shown to be mainly based on the behavioural characteristics of those involved<sup>23</sup>. As the elephants at the ETH have been found abandoned it is impossible to tell if any are related, but due to the age distribution (all juveniles) they cannot be considered a matriarchal, inter-related herd as typically seen in the wild. It is therefore assumed that any interactions would be based on behavioural characteristics rather than relatedness.

Female elephants reach sexual maturity at 10-14years<sup>1</sup>, although poaching pressures (in African elephants) have led to an increase in females conceiving at younger ages than this<sup>24</sup>. The calves at the ETH are released before they reach sexual maturity and so are all nulli-parous. Nulli-parous females in the wild are in fact the most frequently observed elephants to demonstrate allo-mothering<sup>12</sup>. It is therefore credible to presume that allo-mothering is an innate behaviour that females will instinctively show to animals they deem vulnerable, such as younger calves. However, wild elephants will have been surrounded by mature, multi-parous individuals from birth. They are almost certain to have been mothered themselves and had the influence of older maternal figures as they develop their own behaviour repertoires. The group at the ETH is unique in being a study sample of only nulli-parous, adolescent individuals. All were separated from their mothers at a young age and have only been surrounded by other juveniles since. They will have only had a very limited

experience of being mothered and had no access to older, motherly figures when maturing to learn behaviour types from. As rehabilitation programmes become increasingly important in maintaining an Asian elephant population<sup>25</sup>, this type of juvenile only population is likely to become more and more common.

A 1996 study showed that 15.7% of elephant calves born in European zoos or circuses were killed or rejected by their mothers<sup>22</sup>. These were almost all born to females who were first time mothers and had not had the influence of an older motherly figure during the birthing or early care-taking period. This, compared with evidence of nulliparous females mothering calves in the wild makes it unclear whether it is natural instinct of the female elephant to mother younger calves. If an animal can perform a behaviour irrespective of environmental or rearing conditions it can be considered 'developmentally fixed' or innate<sup>26</sup>; but there are few studies available determining whether 'mothering' is innate or learnt. In many species, particularly humans, an 'empathic responsiveness' towards a child is assumed to evolve naturally with the birthing process<sup>27</sup>. However, Rhesus monkeys who were socially deprived from birth have been shown to struggle to become adequate mothers when raising their first born<sup>28</sup>. It is therefore a concern that calves kept without mothers would similarly be unable to successfully rear their own calves. It is possible that having had no experience of mothering behaviours themselves they would not know how to exhibit the protective, comforting, motherly behaviours necessary for their calf's survival. The purpose of my study is to determine if allo-mothering behaviours do occur amongst an un-related group of captive, juvenile Asian elephants. By studying this I will then be able to determine if 'allo-mothering' is something that these elephant calves can and will do without having been taught or influenced by older, maternal figures.

I hypothesize that allo-mothering does occur amongst a group of captive, juvenile elephant calves in Udawalawe National Park and it is therefore an innate, as opposed to a learnt, behaviour.

## METHODS

A herd of 37 juvenile, orphaned Asian elephants was observed for 15 days (120 hours) at the ETH situated in Udawalawe National Park during the rainy season in April and May 2015. The group ranged in age from 6 months to 7 ½ years and all had been taken in for rehabilitation following injury or being orphaned. The breakdown of age and sex distribution can be seen in table 1.

**Table 1:** Breakdown of herd by age and sex

	<2 year	2-3 year	3-4 year	> 4 year	Total
Female	2	2	1	8	13
Male	3	8	7	6	24
Total	5	10	8	14	37

The ETH is situated on the edge of the National Park in order to raise the calves in their natural environment. They spend the night in an enclosure at the ETH and return there 4 times throughout the day for feeds. For the rest of the day (between 06.30 and 17.30) they have access to roam, bathe and forage in the park where they remain as one herd. The elephants receive minimal physical human contact to prevent imprinting, in order to achieve a smooth introduction back into the wild. The herd was however accustomed to the presence of humans making it possible to move close to and within the group in order to observe individuals.

For two days the elephants were observed as a herd to look at social interactions as a whole. After this, applying the principles of previous studies by Lee<sup>12</sup> and Bates<sup>11</sup>, two categories of allo-mothering were defined; physical contact (in order to comfort the calf) and protective behaviour. These were further categorized into ‘touching calf’s mouth with trunk’, ‘touching calf’s body with trunk’, and ‘allowing calf to touch allo-mothers body with its trunk’ (figure 1) for physical contact, and ‘huddling when signs of danger’ (figure 2), ‘standing over the calf when it is sleeping’ (figure 3) and ‘curled around the calf when both are sleeping’ for protective behaviour (see table 2 for ethogram). Unlike in other studies of allo-mothering in elephants<sup>9,11,12</sup> allo-suckling was not included. All the elephants in the study were adolescent, nulli-parous

individuals who had grown up on milk supplements given via funnels at the ETH, rather than suckling from their mother. For these reasons it was deemed unlikely that any allo-suckling would occur.



**Figure 1:** Photograph showing physical contact behaviour type ‘allowing calf to touch allo-mothers body with its trunk’



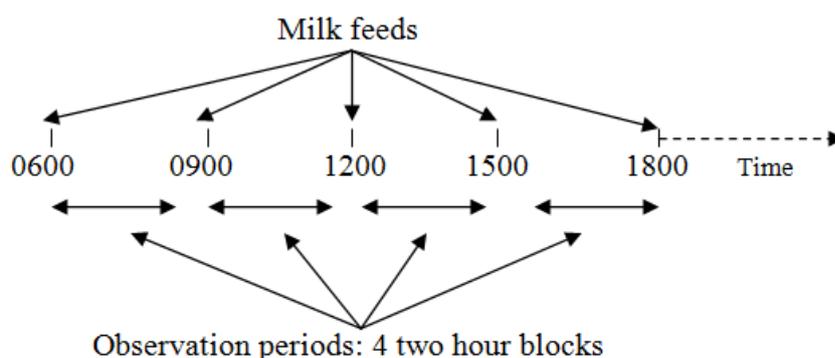
**Figure 2:** Photograph showing protective behaviour type ‘huddling when signs of danger’



**Figure 3:** Photograph showing protective behaviour type ‘standing over the calf when it is sleeping’

Observations:

The herd was observed for 8 hours each day between feeding times when they were in their natural environment of the national park. This was broken into 4 two hour slots; 6.30-8.30, 9.30-11.30, 12.30-14.30 and 15.30-17.30. This is illustrated in figure 4.



**Figure 4:** Observation periods in relation to milk feeds

Each day, for six days, one female of the age group 4+ years was randomly selected to be observed, these will be referred to as F1-F6. A male of the same age group was also selected each day as a control; these will be referred to as M1-M6. They were used as controls as in the wild, males will begin to disassociate themselves from the herd at an adolescent age<sup>1,4,13</sup> so were not expected to exhibit any mothering behaviour. The chosen elephants were clearly identified with spray paint on their rear or forehead. The male and female would each be observed for one hour of each of the

two hour slots, alternating each day whether a male or female was observed first. If any of the behaviours listed were seen they were recorded. The duration of the behaviour in seconds and age and sex of the calf the animal was interacting with was also recorded. The bout interval for all behaviour types was set at five minutes; if the same behaviour was exhibited to the same calf within five minutes of the previous demonstration it was recorded as one bout only. Once 6 of each gender had been recorded the process was repeated, so there was a total of 8 hours data on each of 12 animals. This provided 48 hours of observation per gender. Only 2 elephants were observed each day due to the proposed impact that time of day had on exhibition of behaviour. This meant that each animal was recorded on 2 separate days, 6 days apart.

For the last 11 days of data collection, scan sampling of calves was also done. This was to ensure the maximum amount of data could be gained as occasionally the subject would separate from the herd and not interact with other animals for extended periods of time. The four youngest calves; 2 males and 2 females from the age group <2years were identified; these will be referred to as C1-C4. Twice during each 2 hour block these calves would be found and any elephants within a 2m radius of each calf were recorded. They were recorded as 3 distinct groups; males (>3years), females (>3years) and juveniles (<3years). The sex was determined by visualization of external genitalia and age as an estimate based on size<sup>29</sup>. Any allo-mothering at these times were also recorded. For the final 6 days, the frequency of scans was increased to every ten minutes. Due to the short duration of the study, the scan samples had to be completed during the focal observations of the older elephants. This was achievable as the elephants moved as a herd, making it possible to observe several of the calves in close proximity to the focal male/female. Factors such as the herd splitting, and animals or vegetation blocking vision meant that it was not always possible to observe all 4 calves in each scan without severely impacting the focal male/female observations. No more than 90 seconds during each scan would be spent away from the focal animal looking for calves, if a calf could not be observed in this time it was recorded as 'alone.' As the scan samples were done for the last 11 days of recording, all but F1 and M1 were affected equally so it was not considered likely to skew the results.

Statistical analysis was done using GraphPad6 (<http://www.graphpad.com/scientific->

software/prism/)

**Table 2:** Behavioural ethogram

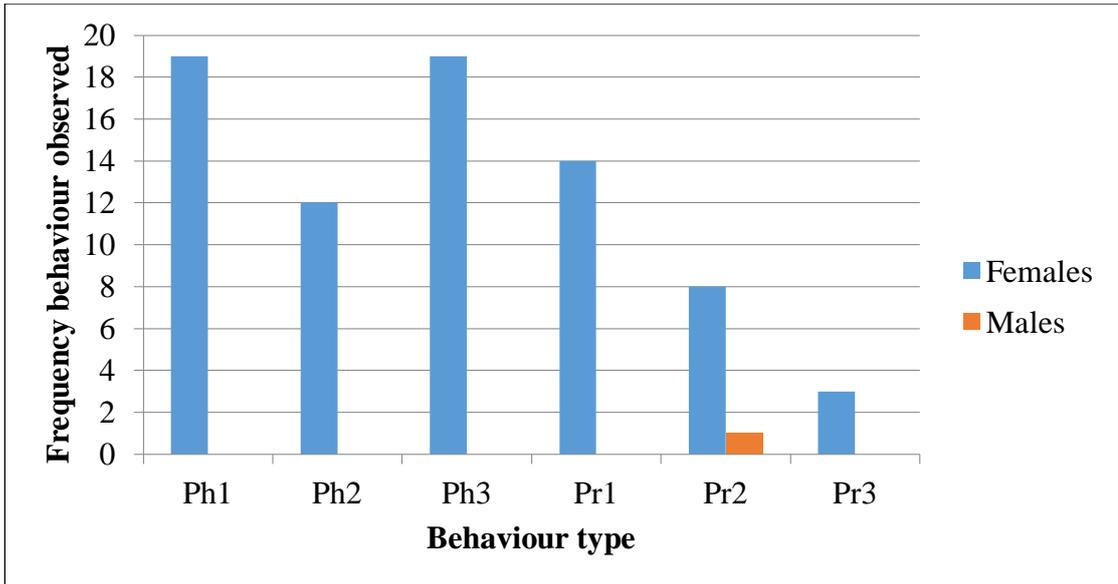
<b>Behaviour type</b>	<b>Description</b>
<b>Touching calf's mouth with trunk</b>	Elephant being observed touches a younger elephant calf's mouth using the end of his/her own trunk. This will be several small movements and does not include when an elephant puts its trunk in another calf's mouth to enquire about food it is eating.
<b>Touching calf's body with trunk</b>	Elephant being observed touches a younger elephant calf's body (anywhere apart from mouth) with the end of his/her own trunk
<b>Allowing calf to touch him/her with its trunk</b>	Elephant being observed stands still while a younger elephant touches his/her body with its trunk
<b>Huddling in signs of danger</b>	When there is a perceived danger e.g. wild elephant, thunder, dogs - groups of elephants will stand close together for protection. Only recorded if animal is clearly positioned in the group in a way to protect a younger calf (i.e. 'allo-mother' is stood on the outside of the group in front of a younger calf)
<b>Standing over calf when it is sleeping</b>	Elephant being observed moves to stand over or next to a younger elephant calf when it is sleeping. The two subjects must be within 1m of each other and the older elephant may or may not rest its trunk of the younger calf's body.
<b>Curled around calf when both are sleeping</b>	Elephant being observed lies down next to a sleeping calf (must be within 1m) with his/her body positioned in a protective manner with his/her legs curled around the calf and his/her face towards the calf

## RESULTS

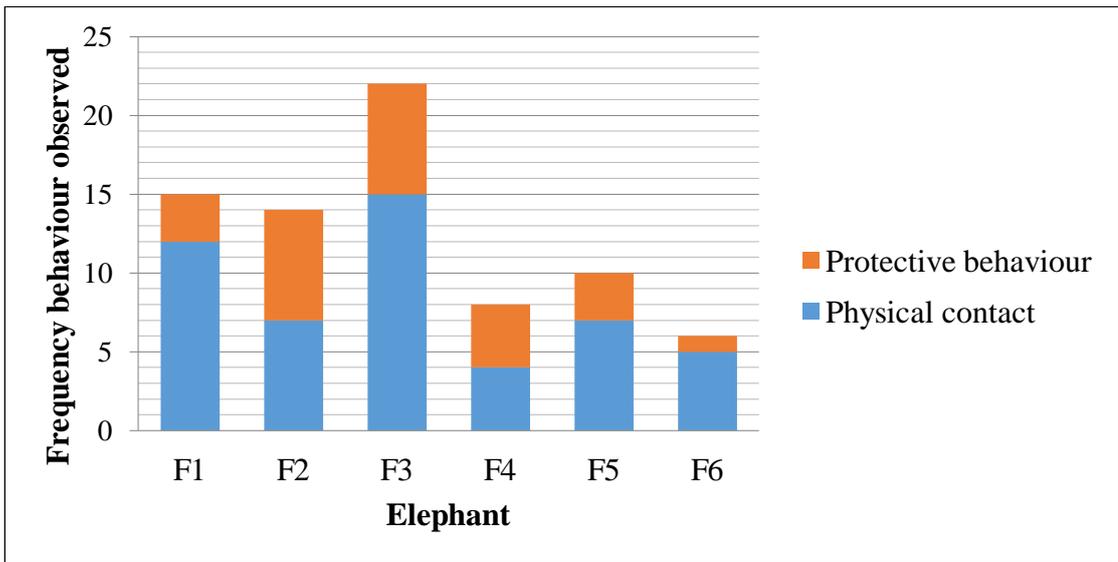
### Male/female comparison:

A total of 76 bouts of allo-mothering were observed during the 96 hour period that the 12 older elephants were studied (figure 5). Only once was a mothering behaviour seen being performed by a male elephant. M1 stood over a calf when it was sleeping for 3 minutes. Otherwise the 6 male elephants made no interactions with younger calves which were considered to be of a protective or comforting motivation. In general, the older males spent much of their time on the outskirts of the group and any interactions with other elephants were more commonly in the form of 'play fighting.' This can confirm their role as controls in the study.

In comparison, all pre-defined types of allo-mothering were seen being performed at least once by the studied females. From this it can be deduced that the 6 females in this group of juvenile, captive elephants can and do exhibit allo-mothering in the form of comforting (as physical contact) and protective behaviours (Mann-Whitney, P: 0.0022 when females considered as a total sum). Physical contact behaviours were seen more frequently (66.7% of total behaviour bouts), but protective behaviours had a longer duration (average bout lasted 3.8 minutes versus 13.6 seconds). 'Touching calf's mouth with trunk' and 'allowing calf to touch her with its trunk' were jointly the most frequently seen behaviour (25.3% each of bouts recorded) and 'curled around calf when both sleeping' was the least seen (4.0%). All 6 females exhibited bouts of allo-mothering behaviours at least once over their eight hour observation period (range: 6-22, mean:12.5). The frequency varied between them (figure 6), but this was not statistically significant (Kruskal-Wallis, P:0.4687). F1 and F3 showed the highest frequency of mothering behaviours over the recording period. These were the 2 oldest females, both having estimated ages of 5 ½ - 6 years. F1 displayed the described behaviours to several different calves <3 years old. F3 directed all of her mothering behaviours to the youngest female in the group. This will be discussed in more detail later.



**Figure 5:** Frequency of each allo-mothering behaviour displayed by females versus males over the total observation period. (Ph1=touching calves mouth with trunk, Ph2=touching calves body with trunk, Ph3=allowing calve to touch him/her with its trunk, Pr1=huddling in danger, Pr2=standing over calf when it is sleeping, Pr3=curled around calf when both sleeping).



**Figure 6:** Breakdown of protective allo-mothering behaviours and physical contact behaviours seen over total recording period per female elephant

### Day and time effect:

After determining that the males could be used as controls, statistical analysis was performed on females only to determine if the time of day or differing recording days had an impact on observations. Weather conditions were similar on the majority of days spent recording and there appeared to be no significant difference between the recordings taken from different days (Mann-Whitney, P: 0.7814). In the early morning, when it was cooler, the elephants were more active and more frequently showed physical contact mothering behaviours (67.9% of behaviour exhibited in time A). In the afternoon the elephants slept more and as a result protective behaviour was observed more frequently than in the mornings (60% of protective behaviour recorded was observed in time C and D). This is displayed in table 3. The time of day influence was not significant enough to alter the behavioural totals (Kruskal-Wallis, P:0.2289).

**Table 3:** Frequency physical contact behaviours and protective behaviours were shown during each time segment. % each frequency of the total behaviours shown over observation period is shown in brackets

	Time A	Time B	Time C	Time D
<b>Physical contact</b>	19 (25.7%)	9 (12.2%)	9 (12.2%)	12 (16.2%)
<b>Protective behaviour</b>	9 (12.2%)	1 (1.3%)	9 (12.2%)	6 (8.1%)

### Calf scan sampling:

The total males (>3y), females (>3y) and juveniles (<3y) recorded in a 2m radius of the 4 youngest calves from the scan samples was calculated (261 total scans, table 4). All calves were more frequently in the presence of females (Kruskal-Wallis, P:0.0066) with 56.8% of total animals recorded within 2m of the calves being female. The calves were invariably found in huddles of several females and juveniles. Allo-mothering was frequently noted during these scan samples and calves were often found following females. On one occasion, C3 was found stuck behind a log. An older female was observed to watch and wait until he could overcome the obstacle. If

the calves were not near females they were in many instances seen with young calves of a similar age and the variance between females or juveniles being in their presence was not statistically significant. If a young calf was sleeping without a nearby female, another young calf could often be found standing over them instead. Males made up only 18.4% of the calves nearest neighbors (range 17.8-21.5%) and if a male did interact with one of the calves they would either engage in playful behaviour such as trunk playing or push the calf out of their way. There was not a significant difference between the presences of juveniles compared with older males near to the younger calves, but males were found in calves' presence significantly less than older females (Kruskal-Wallis, P:0.0243).

C2 and C4 had notably more elephants observed near to them. C2 had a total of 215 females recorded in its presence and C4 220; almost double that of C1 and C3. It is worth noting that C2 was the youngest male of the group at 10 months and C4 the youngest female at 15 months. C2 was the most newly introduced member of the group and had the highest total number of elephants recorded in his vicinity (338). C1, a female of 22 months and C3, a male of 18 months had a higher frequency of juveniles in their vicinity, with a total of 86 and 88 respectively.

**Table 4:** Males (M), Females (F), and elephants <3 years (JUV) recorded within a 2m radius of each of the 4 youngest calves. This is expressed as a % and as a total of the 261 scan samples taken

<b>Calf no:</b>	<b>M Total</b>	<b>F Total</b>	<b>JUV Total</b>
<b>C1</b>	17.7% (43)	47.1% (115)	35.2% (86)
<b>C2</b>	16.6% (56)	63.6% (215)	19.8% (67)
<b>C3</b>	21.5% (55)	44.1% (113)	34.4% (88)
<b>C4</b>	17.8% (54)	72.4% (220)	9.9% (30)
<b>Average</b>	18.4% (52)	56.8% (166)	24.8% (68)

### Specific female-calf bonding:

As discussed in the male/female comparison section, F3 was observed exhibiting her mothering behaviours to one particular calf. Over 8 hours, F3 displayed a total of 22 bouts of mothering behaviour. 100% of these were directed at the same calf; a 15 month old female, one of the calves focused on during the scan sampling (C4). It was also noted during the scan samples that C4 was commonly in the presence of F3. She was often observed following F3 or touching her with her trunk. A total of 32 (84%) of the allo-mothering behaviours observed being directed towards C4 during the scan samples were performed by F3. This number far exceeded that of the behaviours seen being directed to any of the other calves being studied.

## DISCUSSION

Based on the observations made over a 120 hour period, I would argue that allo-mothering does occur in a group of captive, juvenile elephants at the ETH, Udawalawe. From this, I would also conclude that allo-mothering in captive, juvenile, Asian elephants is an innate, as opposed to a learnt, behaviour.

6 females from the age group >4years showed a total of 75 bouts of mothering behaviour over a 48 hour period. The behaviour shown had been pre-defined as 'mothering' behaviours and was directed towards a variety of calves, the majority of whom were below 2 years old. The behaviour observed was significant in comparison to the males studied who only exhibited one bout of behaviour over the same time period. The females exhibited behaviour which comforted the younger calves, allowing the juveniles to touch them and touching the calves with their own trunks. The females would also protect the younger calves in the group if fearful or there was a perceived danger. If the elephants became alert due to a wild male or a dog, older females were observed to stand by or in front of smaller calves. This is similar to protective behaviours seen in mothers and allo-mothers in the wild<sup>12</sup>. As none of the females in the group were mothers to the calves, the behaviour they have displayed

correctly fits the term ‘allo-mothering.’

The females studied were all below six years old, below the age that females are considered ‘sexually mature’<sup>1</sup> but at a similar age to where allo-mothering begins to be seen in the wild<sup>12</sup>. These elephants appear to already have basic mothering abilities without having had their own calves or having previously had a younger sibling to ‘mother’. This is promising for the ultimate goal of releasing them into the wild to repopulate. The behaviours observed in this study indicate that these elephants would have the capacity to comfort and protect young calves of their own. I am hopeful that as the younger females in the group mature they will also begin to develop mothering behaviours, influenced by their current allo-mothers who could be considered to be acting as matriarchs of the group. Eventually, each of these elephants will be released and will be expected to join, or form a matriarchal herd. Infant survival, and consequently the Asian elephant population, will be increased if members of these herds can mother or allo-mother calves.

As previously discussed, the sample group has had little or no exposure to maternal figures. It is therefore assumed that these elephants have never been taught ‘mothering’ behaviours from older elephants. Having had no matriarchal influence, these allo-mothering behaviours were displayed by the females, irrespective of their rearing conditions, correlating with Barnard’s definition of an ‘innate’ behaviour<sup>26</sup>. This, if true for other captive groups would be key for successful breeding programmes; elephants raised as juvenile groups may be able to raise calves of their own without having had to have the influence of matriarchs or older females.

It is clear from the scan calf samples that the youngest members of the group felt most comfortable in the presence of older females. Free-ranging Asian elephant calves of 12 months have been shown to be within 2m of their mother for 50% of their time<sup>20</sup>. In the absence of having access to their birth-mothers, the calves at the ETH appeared to replicate this to some extent by staying in close proximity to older females. Scan samples showed that the youngest calves would frequently be found following older females or in the centre of mixed groups of mainly females and juveniles. It can be surmised from their actions of touching and following the females that they saw them as a source of comfort and protection<sup>19</sup>. They were never observed following males

and never made any attempts to touch them with their trunks.

There are of course drawbacks to the study which need mentioning. Firstly, the sample size was small. Using the herd at the ETH it was impossible to increase the sample size as there were not enough calves in the age group >4years or <2years. It would be useful to repeat a similar study with a larger sample size and if possible, older elephants (for example up to the age of 10 where they generally begin reproducing<sup>13</sup>). Another drawback was the duration of the study; taking place over a total of 15 days, all in the rainy period. A study over several months, including both the dry and rainy period could build up a behaviour repertoire showing the extent of mothering behaviours of each elephant to further confirm what has been discussed here. The study also only looked at behaviours between 06.30 and 17.30, revealing nothing about behaviours from dusk till dawn; periods which elephants have been suggested to be most active in<sup>30</sup>. The elephants at the ETH are kept in an enclosure during this time so behaviours may not be representative. However, observing a free-living herd during these times may be an area for future research. To be able to correlate this to other captive, juvenile groups I would suggest performing a similar, larger study of longer duration on another un-related captive, juvenile Asian population.

Although it is promising that these orphaned elephants have been shown to exhibit allo-mothering to un-related calves, it is not confirmation that they will be able to successfully raise a calf from birth. Follow-up studies of these six females would be recommended to determine if the behaviours shown in this study are transferrable to the wild, and if they will go on to become successful mothers and matriarchs once released from the ETH.

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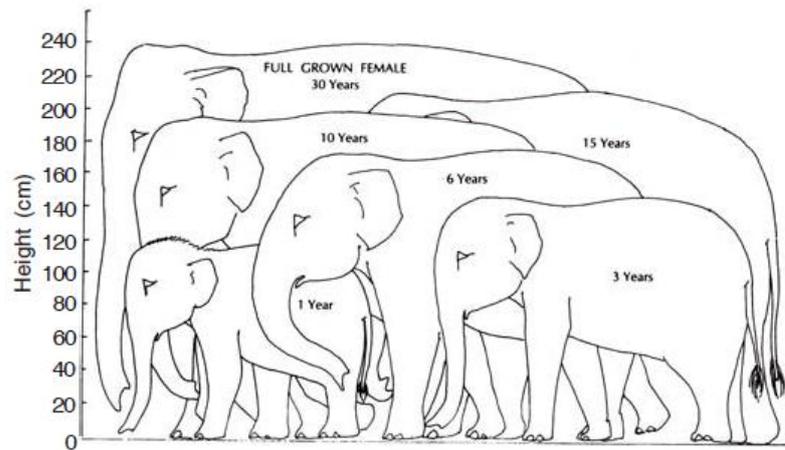
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**Appendix 1** Criteria for determining the relative age of elephant calves (females) based on size (Sukumar, 1994)



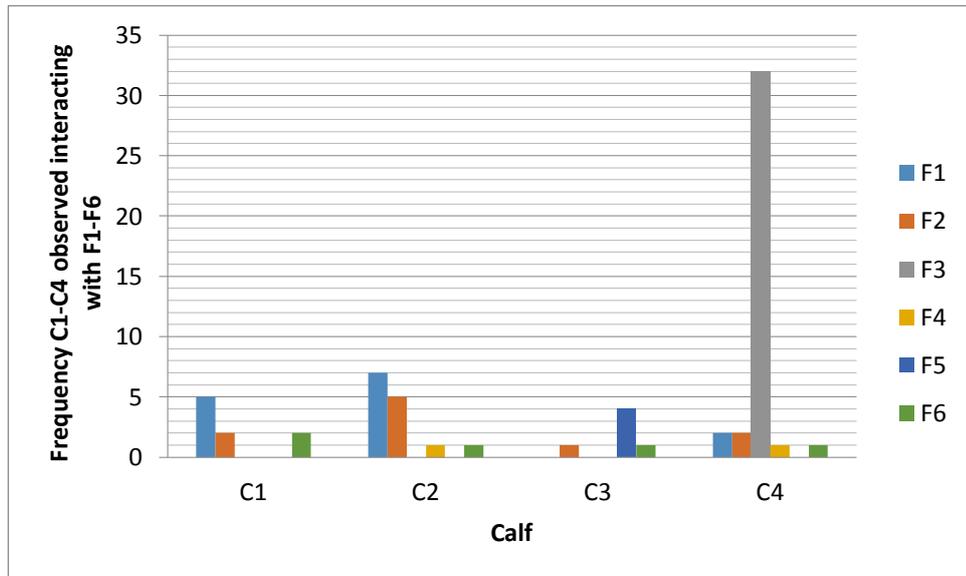
**Appendix 2** Example of how focal animals were identified with spray paint on head or rear



**Appendix 3** Total bouts of each of the 6 behavioural types displayed per time segment per female elephant (Ph1=touching calves mouth with trunk, Ph2=touching calves body with trunk, Ph3=allowing calve to touch him/her with its trunk, Pr1=huddling in danger, Pr2=standing over calf when it is sleeping, Pr3=curled around calf when both sleeping)

		Ph1	Ph2	Ph3	Pr1	Pr2	Pr3
<b>Time A</b>	F1	0	2	3	0	1	1
	F2	0	0	2	1	1	0
	F3	0	2	6	2	0	0
	F4	0	0	0	0	1	0
	F5	2	0	0	1	1	0
	F6	1	1	0	0	0	0
<b>Time B</b>	F1	1	1	1	0	0	0
	F2	0	0	0	0	0	0
	F3	1	0	1	1	0	0
	F4	1	1	0	0	0	0
	F5	1	1	0	0	0	0
	F6	1	0	0	0	0	0
<b>Time C</b>	F1	0	1	1	1	0	0
	F2	0	1	1	1	1	0
	F3	0	0	2	2	0	1
	F4	1	0	0	1	0	0
	F5	1	0	0	0	0	1
	F6	2	0	0	1	0	0
<b>Time D</b>	F1	3	0	0	0	0	0
	F2	1	2	0	3	0	0
	F3	2	0	1	0	1	0
	F4	0	1	0	0	2	0
	F5	1	0	1	0	0	0
	F6	0	0	0	0	0	0

**Appendix 4** Graph displaying frequency that the 4 calves (C1-C4) were found interacting (allo-mothering behaviour or following) with each of the 6 older females (F1-F6) during the scan samples



**Appendix 5** Photograph showing calf (C4) following an older female (F3) during a scan sample

