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Dynamics of Male-Male Asian Elephant Social Structure and Behaviour in Protected and Human Settlement Areas of Sri Lanka

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ABSTRACT

Researchers have long studied the male–social structure of African savanna elephants (Loxodonta africana), but less is known about the male behaviour of Asian elephants (Elephas maximus). The behaviour of male-male elephant interaction was studied in both protected and human settlement areas in Sri Lanka. Data for the present study were collected from 2013-2021. Male elephants were observed with an ethogram that consists of 12 behaviours that are found in male-male elephant interactions. There are three categories into which these interactions can be placed: (i) Behaviour related to greetings or play, (ii) Aggression-based behaviour, (iii) Collaboration behaviour. It was detected that male elephants tend to act more collaboratively with other male elephants in human settlement areas. In human settlement environments, there was a 94.73% chance that male-male elephants would move as a herd, whereas in protected areas, there was only a 5.26% possibility. In protected areas, aggression or intimacy behaviours were highly observed. A hypothesis for this could be that, in human settlement areas, cooperation, just like teamwork, can make them more efficient in their foraging and may make them feel more secure. It was also identified that in human settlement areas; adolescent male elephants will tend to encounter another adult elephant or more. Throughout the research, not a single "adolescent-only" male group was found. A reason for this feature could be that adolescent males may find mature adults to be their mentors. The average social structure of male elephants in the human-settlement range was 4.36 individuals, while in protected areas it was 2.

KEYWORDS *Asian Elephant, Ethology, Human-elephant conflict, Male elephants, Elephant behaviour*

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1 INTRODUCTION

Elephants are intelligent animals with complex behaviours (Rensch 1957; Hart et al. 2001; Viegas 2011). The study of such behaviours can be helpful in the strategic planning for the conservation of elephants and in terms of solving human-elephant conflict. The male social structure of African elephants (Loxodonta africana) has been studied by scientists for decades (Poole 1997; O'Connell 2015) but behaviour research is scarce on male Asian elephants (*Elephas maximus*).

In African males, when not vying with one another for dominance or mates, male elephants may be highly social and will develop long-term bonds (O'Connell 2010). One record describes a male elephant herd at the Galana Ranch in Kenya that consisted of 144 individuals. This was witnessed by Ian Parker, a former game warden in Kenya (Sukumar 2003). Before the 21st century, experts believed that bachelor herds were a rule in African elephants and that such behaviour was absent in Asian elephants (Jayewardene 1994). This view changed when ethological research on male Asian elephants was carried out in various aspects (Fernando 2010). In Sri Lanka, it has been found that the male elephants' social structure was affected by seasonal changes and biological factors (Ranjeewa 2011).

In Sri Lanka, elephants occur over 59.9% of the land, and people are residents in 69.4% of the elephant range (Fernando et al. 2019). This research focuses on male-male elephant interactions inside protected areas (PA) and within the range of human settlements (HS). The elephants studied in the HS range are also subjected to creating human-elephant conflict.

This study's goal was to recognize the male-male social behavior of Asian elephants in protected areas and human settlement areas. Additionally, adolescent male elephants' interactions with adult elephants in protected and human-settlement areas were also evaluated.

2 METHODOLOGY AND EVALUATION

Data were collected from 2013–2021. The elephants were studied relative to an ethogram both day and night. Criteria in the ethogram are based on male-male interaction behaviours. Such interactions could be categorized into three categories:

1. Behaviour related to greetings or play
2. Aggression-based behaviour
3. Collaboration behaviour

Any kind of male-male interaction was considered in this research. The PA and HS observations were compared to understand behavioural differences within those environments. Special attention was given to identifying adolescent (13-20 years) individuals to recognize their behaviours. The total time spent for observation in HS was 49,741 minutes, while in PA it was 38,212 minutes. The variation depended on the chances for observation time. So, all the elephants were observed over variable periods according to their vicinity, observation possibility, and interaction time.

Throughout the research, a total of n = 21 elephant-range PA was targeted, but only n = 16 PA yielded male-male interaction data. Information was extracted in terms of sightings while visiting a PA. The data for PAs come from National Parks such as Kalawewa, Wasgamuwa, Somawathiya, Angammedilla, Minneriya, Yala, Kumana (Yala East), Udawalawa, Kauddulla, Gal Oya, and Wilpattu. Sanctuaries and Forest Reserves consist of Hurulu Eco Park, Mihintale, Buddangala, and Sigiriya.

In HS areas, probable elephant-roaming areas were detected to the Ad libitum sampling method, and to determine areas with high elephant movements, villagers in areas of elephant occupancy range were interviewed. In a questionnaire distributed among the villagers, they were asked whether their residence, neighbourhood, or cropland had an elephant encounter more than once per month. The answers were categorized into two criteria: >1 per month (>1M) and <1 per month (<1M). If there was a location <1M, by using Google Maps, a distance of 3.5 ± 1.5 km was maintained from that location to check the other random location (Figure 1).

This was done to avoid infrequent elephant areas. From the >1M criteria, the villagers were asked to give a spot where they witnessed or experienced elephants frequently. The GPS coordinates of those spots were recorded in a logbook. Using Google Maps, these coordinates were detected, and on a map, a 3 km² (1.2 sq mi) square was drawn, centring each set of coordinates. Those squares were referred to as clusters. Within those clusters, further possible routes were marked according to villagers and freelance journalists. Regular visits were made to those clusters both in the morning and evening hours to detect elephants. About 77.5 ± 34.5 times per 3 months of visitation were made. The morning hours range from 12:00 am -12:00 pm and the night hours range from 6:00 pm – 11:59 pm. Within a range of clusters, all routes were visited where possible. If there was an encounter with two or more male elephants, they were studied.

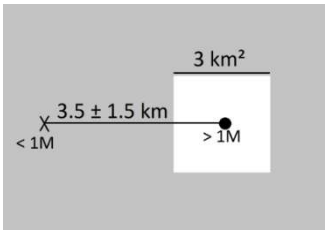

Figure 1. (Cross) marks the <1 M spot that was detected, while the (Dot) marks the >1M spot. The line that transects in between represents the distance. On the map, once a >1M spot was detected, the GSP coordinate were recorded, and a 3 km² square was drawn centring the coordinate.

When an interaction was spotted, it was marked with a number. Then it was checked whether at least one elephant in a couple or group was engaged in a behaviour featured in the ethogram (Table 1). Elephants were observed on average for a duration of 210 ± 150 min. The data for both PAs and HSs were recorded in a logbook, and these were later transferred to a Microsoft Access database. The sightings of two or more elephants were referred to as a "case".

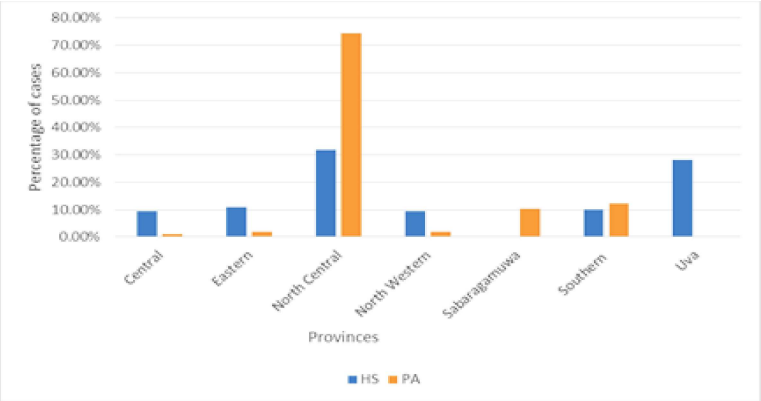

Figure 2. Percentage values to provinces from the total number of cases in human settlements (HS) and protected areas (PA) ranges.

Table 1. Ethogram of male elephant behaviours.

Behaviour	Code	Description
Intensive tactile communication	IT	Deliberately caressing another elephant, especially from the trunk.
Acting as a bachelor herd or moving as one cluster (bull group)	BH	Two or more male elephants would move as one unit for more than 1km. Members of the unit would lead in a mutual direction.
Submerging in the water together	W	Two or more male elephants submerge in the water; frolicking, sparring, tactile communication and chemosensory communication can be common in the water.
Fighting	F	A fight between two male elephants that involves aggression.
Engage in chemosensory communication	CC	Sniffing the temporal glands, genitals, and mouth of other male elephants. Also, by flehmen response using the vomeronasal organ (VNO).
Sparring	S	A play gesture which consists of cues of trunk-twining, pushing, olfactory-chemosensory detections, etc. semi or full extruding of the penis.
Perturbed or altered by the presence of another male elephant but may not associate	R	Rapid ear flapping, semi or full extrusion of the penis, sniffing by pointing the trunk.
Emitting acoustic vocal communication	VC	Communication within the human-audible frequency range.
Dominance cues	D	Trying to intimidate another through aggression.
Superficial tactile communication	ST	Unintentionally touching another elephant.
Penile extrusion (non-urinating)	P	May be semi or full penis extrusion.
More than one elephant's penile extrude (non-urinating)	PN	May be semi or full penis extrusion.

3 RESULTS

3.1 Human Settlement Range-Elephants

A total of 138 cases were detected (Central n=13, Eastern n=15, North Central n=44, North Western n=13, Southern n=14, and Uva n=39). The North Central and Uva provinces had the highest number recorded with an above-average value (Figure 2).

Out of the 12 behaviour criteria in the ethogram, about 10 were detected to be performed by the elephants (Figure 4). Two of the criteria had an above-average value, and those were "Acting as a bachelor herd or moving as one cluster (bull group)" (48.83%) and "Superficial tactile communication" (32.17%). So, this means many of the male elephants did coordinate as one bull group. Even when those elephants are chased by residents or wildlife officers, they tend to move in a mutual direction. From the recorded data, the highest number in the bull group was 15 males. But usually, such large groups are rare, and the average value for male individuals in a group was 4.36 (standard deviation, σ: 2.634).

Only in n=41 cases were adolescent individuals detected, and in all cases, they were associated with one or more adult elephants. In such cases, there was a higher adult number than the adolescents.

The average adolescent number in the male group was 1.902 (standard deviation, σ:1.32) and the number of adults was 3.804 (standard deviation, σ:2.05) (Figure 5).

The percentage occurrence of cases detected to months is as follows: January = 5.79%, February =2.89%, March =8.69%, April =7.24%, May =2.89%, June =1.44%, July =4.34%, August =13.04%, September = 11.59%, October = 10.14%, November = 14.49%, and December = 17.39%.

3.2 Protected Area Range-Elephants

A total of 106 cases were detected (Central n=1, Eastern n=2, North Central n=79, North Western n=2, Sabaragamuwa n=11, Southern n=13). The highest number was recorded in the North-Central Province, with an above-average value (Figure 2). Of this, about 58.22% (n=46) were from Kalawewa National Park, 18.98% (n=15) were from Minneriya National Park, and 13.92% (n=11) were from Kaudulla National Park. Figure 3 below shows two bull elephants sited in North Western Province.

Figure 3. Two bull elephants at North Western Province, Sri Lanka (Photo by Tharindu Muthukumarana)

Five behaviours from the ethogram had an above-average value and those were "Intensive tactile communication" (20.07%), "Engage in chemosensory communication"(19.30%), "Sparring"(35%), "Dominance cues"(8.10%) and "Penile extrusion (non-

urinating)"(11.58%) (Figure 4). These cues usually happen only for a short period, and most of them are linked to the greeting behaviour of elephants.

The majority (n=86) of elephants observed in PAs, generally interacted in pairs (Figure 6). A total of n=15 cases were identified where at least one adolescent interacted. Only in seven cases was there an interaction between adolescent and adult elephants.

The percentage occurrence of cases detected to months is as follows: January = 5.12%, February =7.05%, March =8.97%, April =7.69%, May = 5.76%, June =6.41%, July =7.69%, August =12.17%, September = 10.89%, October = 10.25%, November = 8.33%, and December = 9.61%.

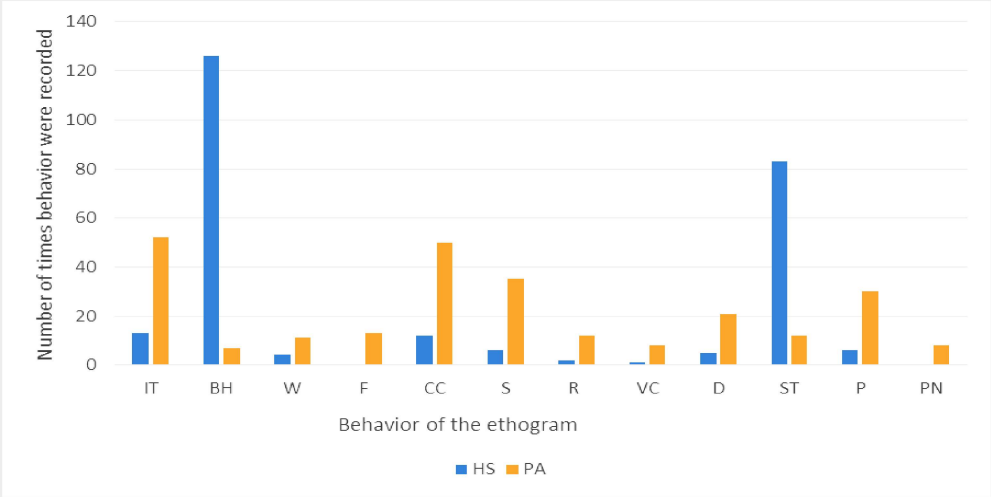

Figure 4. The total number of behaviours from the ethogram recorded in both cases of protected areas (PA) and human settlements (HS) ranges

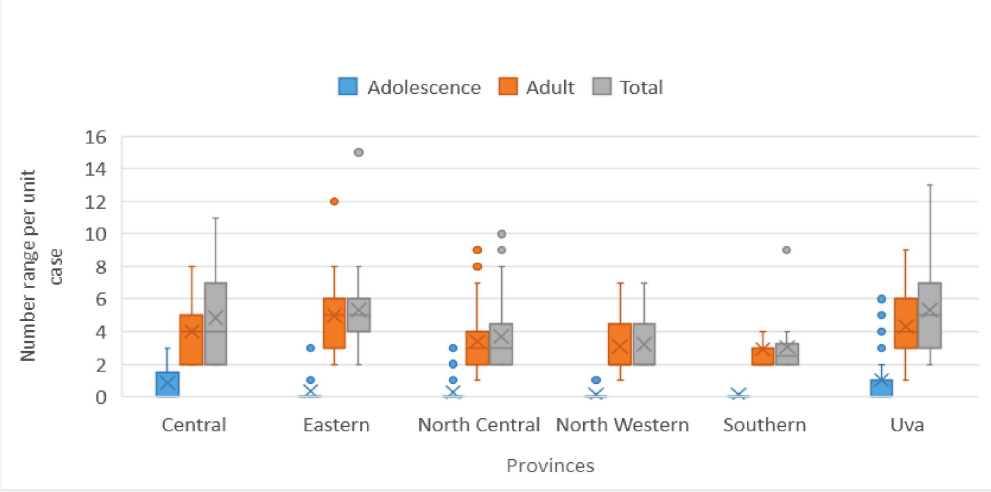

Figure 5. The frequency of the number range of elephants per unit case to provinces in human settlement areas (HS)

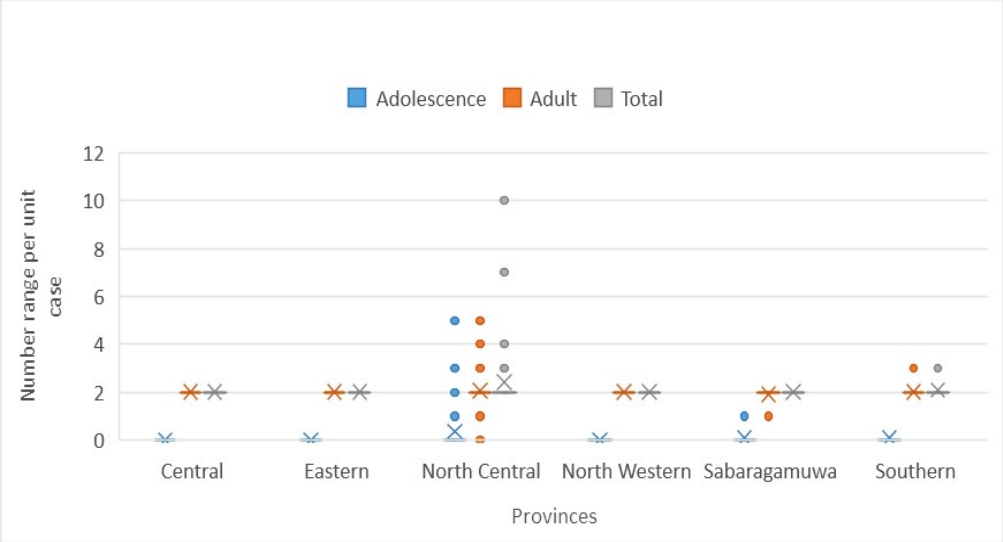

Figure 6. The frequency of the number range of elephants per unit case to provinces in protected areas (PA)

4 DISCUSSION

According to the data presented in this paper, it is understood that elephants' behaviour gets synchronised relative to anthropogenic pressure. "Behaviour related to greetings or play" and "aggression-based behaviour" were the most common in PAs, while "Collaboration behavior" was the most common in HS areas. The BH criteria were 94.73% high in HS areas, while in PAs it was 5.26%. A hypothesis for this feature is that sometimes anthropogenic areas can be risky sites for elephants. Nevertheless, elephants continue to move into human areas to move from one forest patch to another and also to raid crops. There is a high tendency for male elephants to raid crops (Ekanayaka et al. 2011). Therefore, in certain instances, males may cooperate for better security, efficient movement, and foraging. Even though males might crop raid in groups, the present study perceived that they sometimes even come in groups to feed at garbage dumps. Most elephants in musth were detected in PAs (n=21) rather than the HS (n=4). A rationale for this could be that musth elephants feed less compared to their average daily intake (Kurt & Garai 2007). During musth, elephants are engaged in sexual arousal or dominance establishment (LaDue et al. 2021). Hence, this may discourage them from crop raiding.

It was observed that sometimes two or more male-elephant groups in HS areas may get together and form one unit, as in a kinship herd. Adolescent males may find adult males as mentors, which encourages adolescent males to follow up with them. This could be the reason for the absence of "adolescent-only" male groups in HS areas. In research related to African elephants, it has been found that the oldest males were more likely to lead collective movements in male groups (Slotow et al. 2000; O'Connell 2010; Allen et al. 2020). Elephants are animals with high cognition, so they learn a lot from experience rather than knowing their

instincts (Hart et al. 2001; Plotnik & Jacobson 2022).

There seems to be a slight similarity between the demographic data of high human-elephant conflict provinces and the data on male social structure in this study. According to recent records, the highest conflict has shifted from the Northwest to the East and North-Central areas, with the Northwest showing a decline in conflict (Prakash et al. 2020). The results on males in HS areas were also high in the North-Central, Uva, and Eastern provinces. The density of the male groups (the number of individuals per unit group) seems marginally high in high-conflict areas (the average values for provinces ranged from Southern, North Western, North Central, Central, Eastern, and Uva, in increasing order).

It is important to note that even though elephants are deeply affected by the tourism disturbance in PAs (Ranaweerage et al. 2015), it has not induced a high level of male collaborative behaviour as in the HS areas. Though there are numerous water bodies in HS areas, behaviour "W" was still higher in PAs. Certain male groups at HS did cross river streams, but they were not interested in "W" type behaviour. The inducement for such behaviour could be due to a feeling of less agitation in PAs than in HS areas. One common place where male elephants roam in groups is near the Victoria-Randenigala-Rantembe Sanctuary at the banks of the Mahaweil River. They could be seen from the Weragantota Bridge, on the A26 Rd-Mahiyanganya. Even in there, most of them may cross the river, but very few may engage in "W" type behaviour. It was observed that males exhibiting "W" type behaviour submerged in the water at about the same time, and they also tended to come out of the water as a group.

Elephants extrude their penises for 3 reasons: urinating, mating, and emotional reactions. It is also suspected to be a form of display that requires further investigation (Moss, Croze & Lee 2011). In the present study, non-urinating penile extrusion cases were mostly recorded in PAs (n=38) compared to HS areas (n=6).

In HS criteria, behaviour related to greetings/play (50%) and collaboration (50%) had a penile extrusion. While in PA criteria, the highest penile-extrusion was observed in the behaviour of greetings/play (76.31%) and secondarily in aggression-based behaviour (18.42%). The least was collaboration-based behaviour (5.26%).

In a study on African elephants at Etosha National Park during low rainfall, when resources are scarce, certain male elephants formed a group with a defined hierarchy. When the wet season arrives with high resources, it gets repealed. Also, during the wet season, males can be more aggressive, and in the dry season, they are affiliative (O'Connell et al. 2011). In a study done in Sri Lanka at the Udawalawe National Park, it was identified that during the wet season, most of the adult males spent their time as solitary males, but during the dry season, they spent their time in social groups such as male pairs, male-female groups,

and bull groups. In the wet season, frequent contact aggression among pairs of musth males was higher than in the dry season (Ranjeewa; 2011). Both of these researches indicate how males tend to cooperate during the dry season, which is the hard times. They share a similar pattern with the data presented in this paper, indicating how the challenges make some males band together and forage.

Also, when the challenges diminish, it lessens the collaboration and enhances aggression or intimacy behaviours.

A male group comprising 15 individuals recorded in the present study may be the highest number of individuals in a bull group recorded to date. According to previous studies, the largest male group recorded in Sri Lanka comprised seven individuals (Sukumar 2003).

Research done previously elucidated how male Asian elephants' social structure gets affected relatively by seasonal changes and biological factors. This paper corroborates how male social structure changes due to anthropogenic impact. In most literature, it is expressed that once reached puberty male elephants leave their natal herd and become solitary. But proportionately to this research and other previous research, it would be applicable to refer to adolescent or adult male elephants as independent over solitary.

5 CONCLUSION

This research discovered that male elephants' behaviours change when they are in the HS and PA ranges. Male-male elephants' collaboration behaviour, such as moving in groups, increased significantly in HS but decreased significantly in PA. In return, at PA, aggression or intimacy behaviours were high. Furthermore, because most adolescent elephants interact with adults more in HS than in PA, it demonstrates that adolescent elephants seek adult guidance when things become critical.

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