Research Article *Gajah 52 (2020) 30-38*

Demography, Feeding and Keeper Status of Captive Asian Elephants in Eastern Arunachal Pradesh, North-eastern India

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Abstract. To understand the population viability of captive elephants in eastern Arunachal Pradesh, India, we documented the demographic parameters, food and feeding of captive elephants and their keepers' status in private and forest department systems during 2016–2017. The two systems together managed 135 elephants, with 84% being adults and a male bias in younger age-classes. Fecundity was 0.04 calves/adult female/year and mortality was 2.2%, which were lower than in southern India. Given the observed demographic parameters, we recommend, the Arunachal Forest Department to gradually increase its captive stock through effective management and use them in patrolling and eco-tourism for long-term sustainability.

Introduction

The Asian elephant (*Elephas maximus*), listed as an 'endangered' species (IUCN Red List 2017), exists in fragmented populations in south and southeast Asia with 36,000–52,000 distributed among 13 countries (Riddle *et al*. 2010). It is an integral part of the cultural ethos and mythology of Asia. A third of the Asian elephant population is currently in captivity, and so they deserve greater attention both in terms of management and research. In India, captive elephants, numbering 3467–3667, are distributed among 23 states and union territories, including the Andaman and Nicobar Islands (AsESGM 2017), with the majority found in the north-eastern (55%) and southern (25%) states. In the northeast, they are found in larger number in the states of Assam (~1300) and Arunachal Pradesh (560–580) (MoEF 2018). Most studies on captive Asian elephants are from southern India and deal with timber camp elephants (Sukumar *et al*. 1988; Krishnamurthy & Wemmer 1993; Sukumar *et al*. 1997). More recently there have also been studies on captive elephants in private and Hindu temple systems (eg. Vanitha 2007; Vanitha *et al*. 2008, 2009, 2010a, 2010b).

The Asian elephant in spite of its long history in captivity has not been bred sustainably in most captive places. There are hardly any records of captive elephant births in Indian temples, as reproduction in temple premises is considered inauspicious. Private owners do not encourage breeding as maintenance of pregnant and lactating cows is expensive (Krishnamurthy 1998). However, a significant number of privately owned elephants breed in captivity in the north-eastern states of Assam and Arunachal Pradesh, as they are managed close to forested areas, where captive cows come in contact with wild bulls. In north-eastern India interest among private owners for managing elephants is waning due to the loss of demand for them in forestry operations owing to the ban on logging (Bist *et al*. 2002). Thus, in the future captive breeding among privately owned elephants in the north-eastern states could decline. The captive populations of Asian elephants in western zoos (Wiese 2000), Myanmar (Leimgruber *et al*. 2008) and southern Indian timber camps (Vanitha 2007; Vanitha *et al*. 2010a, 2012) are also in reproductive decline. An assessment of the demographic parameters of the captive elephants of north-eastern India may provide insights into their likely future.

Manuscript Editor: Prithiviraj Fernando

Captive elephants in general are not fed in accordance with their nutritional requirements and natural food preferences, which is especially true in relation to elephants managed in zoos (Crandall 1964), Hindu temples (Krishnamurthy 1998; Vanitha 2007; Vanitha *et al*. 2008) and private systems (Vanitha 2007; Vanitha *et al*. 2008). Some captive facilities offer monotonous fodder round the year without seasonal change and in some cases in inadequate quantities (Vanitha 2007; Vanitha *et al*. 2008, 2010a). In contrast wild elephants feed on a wide range of food plants according to seasons (McKay 1973; Olivier 1978; Baskaran 1998; Roy *et al*. 2006). Captive elephants, especially those managed privately and temples, unlike the ones managed by the Forest Department in a semi-wild condition, are totally dependent on the food provided. Hence, there is a need to evaluate the food and feeding practices prevailing in captive facilities.

Elephant-keepers manage the captive elephants on a day-to-day basis, and their living standards and well-being has declined over the years with the dwindling of the importance of the elephant in daily life. This could result in human casualties also, as elephants might attack keepers lacking compassion towards them, while handling or owing to stress due to workload (Vanitha *et al*. 2009).

Methods

Study area

The study was carried out between November 2016 and April 2017 in eastern Arunachal Pradesh, which includes 12 districts (Longding, Tirap, Changlang, Anjaw, Lohit, Namsai, Lower Dibang Valley, Dibang Valley, Upper Siang, Siang, East Siang and West Siang). The state has 62% of its area under forest cover and ranks second highest in India.

The state uses a large number of captive elephants for timber extraction and there was a minimum of 550 elephants in 2002 (Bist *et al*. 2002), which is the third largest captive population in India. The majority (89%) are under private control. Almost all the elephants in the state are used for logging operations in private or community forests, or for work in saw mills. It is the only state to use elephants for agricultural operations (Bist *et al*. 2002). Details about holdings and captive elephants under the forest department are listed in Table 1.

The state's economy is largely agrarian, based on the terraced farming of rice and cultivation of crops, such as maize, millet, wheat, pulses, sugarcane, ginger, oilseeds, cereals, potato, and pineapple (IBEF 2018). A high proportion of

Table 1. Details of captive elephant holdings and elephants in eastern Arunachal Pradesh.

Detail	Private	Forest Department
Facility	Individual owners	Dibang Forest Division & Namdapha National Park
Number of facilities	98	2
Mean number of elephants per facility	1.3 (range 1–4)	4 (range 2–6)
Number of facilities with one elephant	67	None
Nature of work	Logging	Joy ride and patrolling
Duration of work	6 h/day	4 h/day
Time of work	7:00–11:00 & 16:00–8:00	7:00–9:00 & 16:00–18:00
Bathing frequency	Once a week for 2 h	Twice a week for 2 h
Periodic veterinary check-up	Absent	Present (once per year)
Recruitment	Captive birth Purchase from private facilities of other states	Captive birth Confiscation from private Wild orphan rescue
Breeding	Present	Present

the population in the state is below the poverty line (37%) with an average income is Rs. 40/day (equals to US$ ~0.5) (together from urban and rural) and has a relatively low literacy rate (65%) (Konwar 2015).

To assess the population size and structure, a list of captive elephants was prepared using government records and enquiries with private authorities, veterinarians and NGOs. Subsequently, field visits were carried out to each captive elephant location and details verified. The age and sex were recorded for each elephant by enquiring from the keepers, and verified with the stud book/register of records available with each facility. Shoulder height (from dorsal edge of the scapula to the bottom of the front foot) and tusk and tush length and circumference at the lip were measured. Age was verified by shoulder height, and in addition by considering tusk parameters in case of tusked males (Sukumar *et al*. 1988). The age was corrected for one adult female elephant, as its age was not comparable with shoulder height measurements as per Sukumar *et al*. (1988). Elephants were categorized into four age classes, viz. calf (<1-year old; 90–120 cm height), juvenile (≥1 to <5 years; 121–180 cm), subadult (≥5 to 15 years; 181–210 cm for female and 181–240 cm for male), and adult (≥15 years; >210 cm for female and >240 cm for male) based on shoulder height (Sukumar *et al*. 1988).

Natality and mortality

Data on population growth and mortality of elephants during 2013–2017 were obtained from registers of records and by enquiring from keepers. Population growth included births and immigration of individuals through purchase/ confiscation/wild rescues, mostly orphans. Fecundity was calculated by dividing the total number of calves born during the study period by the total number of sexually mature female elephant-years, following Sukumar *et al*. (1997). Elephant-years refer to the summation of all individual elephants multiplied by their number of year(s) representation/survival in a given system for a particular period. For example, if out of 25 different elephants managed in a given system over a two-year period, 20 were there for two years and the remaining five only for one year, the number of elephant-years is 20 x 2 + 5 x 1 = 45. Age-specific mortality was computed by dividing the total number of individuals that died within a given age-class by the total number of elephant-years in that class (Sukumar *et al*. 1997).

Assessment of food and feeding

Food supplied was assessed from November 2016 to April 2017 by inquiring about food items including cooked ration and cut fodder provided to each elephant. Additionally, time and period of supply were obtained from records available at the facilities and enquiry.

Keeper's salary

Salary paid and the number of keepers per elephant was determined from interviews and examining the records of expenses maintained by elephant owners and forest department.

Data analysis

The trend in population size from 2013 to 2017 was tested using linear regression. Differences in supplementary food supplied among age-classes (adult, subadult and juvenile) and between sexes were tested for significance using Kruskal-Wallis and Mann-Whitney U tests, respectively, in SPSS Version 23.

Results

Population size

Private and forest department systems together managed 134 elephants during 2016 and 135 elephants in 2017 (until April). Of the 135 elephants managed during 2017, nine belonged to the forest department. A comparison of data on population size since 2013 shows a negative trend (Fig. 1).

Age structure and sex ratio

Data on age structure has shown that the adult class constituting over two-thirds (84%) of the

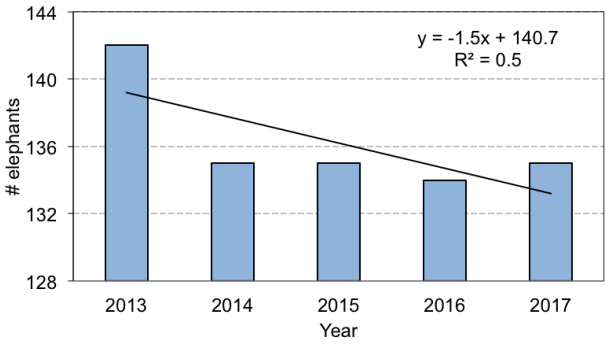

Figure 1. Population size of captive elephants during 2013–2017.

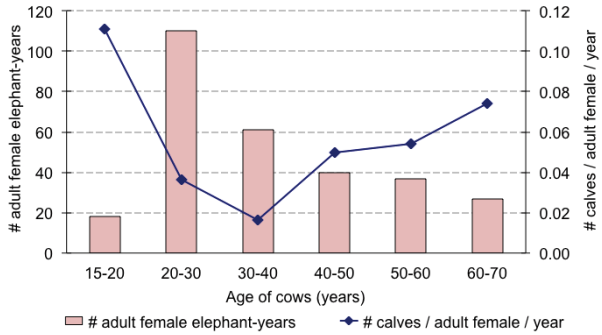

Figure 2. Age-specific fecundity rate of captive elephants during 2013-2017.

total population size in the two captive systems (Table 2) and younger age-classes, such as subadult, juvenile and calf, constitute only 16%. Further, data on age-sex composition during the last five years has shown that the population composed almost of equal number of males and females, both at adult segment and overall. However, at subadult and juvenile segments, it was males biased. The sex ratio has shown female bias at calf level (Table 2).

Natality

There were 61 sexually mature females in the age-class 15–70 years during 2013 to 2017, amounting to 293 female-elephant years. There were 13 births in the period, giving a total of 0.04 calves/adult female/year. Age specific fecundity is given in Figure 2. The age group 30–40, had the lowest fecundity.

Mortality

Of the 141 individual elephants (132 with private owners and nine with the forest department) in 2013–2017 constituting 681 elephant-years over the five-year period, 15 died, 14 in the private system and one in the forest department system, with a mean annual mortality rate of 2.2% for both the systems (Table 3). Of these 15, adults have accounted for 6 individuals or 1%, followed by calves at 9 individuals or 47%. Overall, mortality among females was higher (2.7%; 9/339 elephants) than males (1.8%; 6/342 elephants).

Food and feeding

The elephants' food consisted of: (i) cut fodder - green grass and browse as stall feeding, (ii) supplementary diet of soaked rice and gram inside a bundle of grass and (iii) natural feeding. Quantity of supplementary diet fed were significantly higher for adult class than the younger age-classes (Table 4). Between genders, males were fed a significantly larger quantity of rice and gram compared to females (Table 5).

Status of the keeper: Each elephant above 5 years was managed by two persons, a keeper and an assistant keeper. In the forest department, both keeper and the assistant were employed, whereas in the private system, the owner acted as the keeper and a hired person assisted him. Keepers are paid 111.9 ± 6.09 US$/month by the forest department and 112.4 ± 1.72 US$/month by the private system (Table 6).

Table 2. Age-sex composition of captive elephants in eastern Arunachal Pradesh during 2013–2017.

Age class	Percentage (number in 2017)			Sex ratio (male : female)
	Male	Female	Total	
Adult	41.1 ± 0.55 (57)	43.0 ± 0.41 (60)	84.2 ± 0.74	1.0 : 1.0
Subadult	6.2 ± 0.37 (0)	3.1 ± 0.25 (1)	9.3 ± 0.22	1.0 : 0.5
Juvenile	2.1 ± 0.24 (2)	1.8 ± 0.38 (2)	3.8 ± 0.54	1.0 : 0.9
Calf	0.9 ± 0.37 (10)	1.9 ± 0.84 (3)	2.7 ± 1.08	1.0 : 2.2
Total	50.2 ± 0.63 (69)	49.8 ± 0.63 (66)	100	1.0 : 1.0

Table 3. Age-specific annual mortality of captive elephants during 2013-2017.

Age-class	Female		Male		Overall	
	Mortality rate (%)	n*	Mortality rate (%)	n*	Mortality rate (%)	n*
0–1	23.1	13	100.0	6	47.4	19
1–5	0.0	12	0.0	14	0.0	26
5–10	0.0	8	0.0	22	0.0	30
10–20	0.0	31	0.0	42	0.0	73
20–40	0.0	171	0.0	177	0.0	348
40–60	6.5	77	0.0	71	3.4	148
60–80	3.7	27	0.0	10	2.7	37
Total	2.7	339	1.8	342	2.2	681

n* = number of individuals at risk (of death) expressed as the number of elephant-years over the age-class interval.

Discussion

Population demography

Population size: Of 135 captive elephants we documented, the majority were owned privately. The actual numbers are probably higher as some elephants were not covered due to being away from their holdings during our survey. The central government records show that Arunachal Pradesh has 560–580 captive elephants (Project Elephant 2004), but records of the State Forest Department of Arunachal Pradesh (2001) show that Namsai District alone had 253 captive elephants in 2001 (State Forest Department, Namsai District Captive Elephant Register 2001). Therefore, the Central government records greatly underestimated the elephant numbers. The present estimate of 135 captive elephants for eastern Arunachal, which includes 11 more districts apart from Namsai, indicate that there was a significant decline in elephant numbers in the region. Our study also showed that this decline continued up to 2017.

The adult segment (82.4%) recorded in the captive elephants of eastern Arunachal Pradesh is higher than that of the captive population in Tamil Nadu (76%) (Vanitha *et al*. 2010a, 2012), and wild populations of Mudumalai Wildlife Sanctuary (42%) (Baskaran *et al*. 2010) and Anamalai hill ranges of Western Ghats (45%) (Baskaran *et al*. 2013). Though the captive population in north-eastern India was known for a moderate level of breeding in the past (Krishnamurthy 1998; Bist *et al*. 2002), its current age structure indicates either high mortality or disposal of elephants in subadult and juvenile segments. The male-biased sex ratio at subadult and juvenile segments further supports the above statement. Of the 253 captive elephants in Namsai District, as shown by state government record, 48 were sold to other states of India – three each to Rajasthan and

Table 4. Quantity of food supplied and natural feeding duration (NFD) provided to different age-classes of captive elephants.

Age-class	Supplementary diet		NFD (h)
	Rice (kg)	Gram (kg)	
Adult	6.0 ± 0.22	3.4 ± 0.09	13.7 ± 0.19
Subadult	3.4 ± 0.14	1.6 ± 0.14	13.7 ± 1.24
Juvenile	2.2 ± 0.25	1.00 ± 0.00	14.7 ± 0.25
Kruskal-Wallis χ^2	41.74	48.51	5.81
p value	0.000	0.000	0.055

Table 5. Quantity of food supplied and natural feeding duration (NFD) provided in relation to sex of captive elephants.

Sex	Supplementary diet		NFD (h)
	Rice (kg)	Gram (kg)	
Female	5.1 ± 0.27	2.9 ± 0.13	13.8 ± 0.32
Male	6.1 ± 0.31	3.3 ± 0.15	13.6 ± 0.31
Total	5.6 ± 0.21	3.1 ± 0.10	13.7 ± 0.22
Mann-Whitney U	169.5	143.0	522.5
p value	0.000	0.000	0.670

Table 6. Salary details in US$ (@ Rs.65/US$) of keepers managing different age-classes of elephants.

Age class	N	Salary/month
Adult	113	112 ± 1.8
Subadult	13	114 ± 5.7
Juvenile	4	104 ± 10.6
Overall	131	112 ± 1.7
Kruskal-Wallis χ^2		0.725
p value		0.696

Karnataka, 17 each to Bihar and Kerala, and eight to Uttar Pradesh indicating disposal of elephants from eastern Arunachal Pradesh (State Forest Department, Namsai District Captive Elephant Register 2001). Private and Hindu temple systems in Tamil Nadu, which prefer female elephants, have elephants originating from north-eastern states of Arunachal Pradesh and Assam (Vanitha 2007; Vanitha *et al*. 2010a, 2012). Therefore, the high adult segment observed in eastern Arunachal is likely due to the selective disposal of female elephants to other states of India. Thus, the sex-ratio bias towards males in the subadult and juvenile segments is unusual, as the elephant is a polygynous species, whose population is supposed to be female biased gradually from younger to older age-class (i.e. juvenile to subadult and adult). Given the present scenario of aged population trend with male-biased sex ratio in younger age-classes, the population does not promise a healthy trend of growth or recovery even in the future. The high variation observed in the number of calves between years could be attributed to inter-annual variation in natality. In elephants, the long inter-calving interval results in only a small and varying percentage of females calving in any given year. A high calving rate in any year is usually followed by a lower rate in the subsequent years, as there will be fewer females remaining to calve in the population (Baskaran *et al*. 2010).

Natality: The mean fecundity rate of 0.04 estimated in the present study is considerably lower than that reported for the captive population of southern India (0.155 during 1969–1989, Sukumar *et al*. 1997, and 0.065, during 1996–2005 Vanitha 2007; Vanitha *et al*. 2010a, 2012). Privately owned captive elephants are continuously worked, and owners consider pregnancy and calving as an impediment to work, expensive and a burden (Bist *et al*. 2002) considering the 18–22-month pregnancy period (Sukumar 1989). Age-specific fecundity data shows that middle-aged cows (30–40 age segment) had lower fecundity (0.02 calves/adult female/year) than younger (15–30 years) and older classes (≥0.04 calves/adult female/year), which may be due to the middle age-class bearing a greater workload resulting in lower fecundity.

Mortality: The present study estimated a mean annual mortality of 2.2%, which is comparable to the mortality rate in wild elephants in southern India of 3% (Daniel *et al*. 1995). The present estimate is also comparable with the 1.9% mortality estimated for the timber camp population in Tamil Nadu (Sukumar *et al*. 1997), but lower than the 3.9% reported for the captive populations from private, Hindu temple and forest department systems in Tamil Nadu (Vanitha *et al*. 2010a). The elephant is a polygynous species, in which males experience greater mortality than females (Trivers 1985), the observed higher mortality of females than males in the present study could be ascribed to greater workload. In general, calves are more susceptible to mortality than other age-classes. The observed calf mortality of 47.4% is comparable with that for the captive population in southern India of 39% (Sukumar *et al*. 1997). The lower overall mean annual mortality rate observed in the present study (2.2%) further reveals that sale/gift of elephants is the reason for the aged population and skewed sex ratio trend than higher mortality.

Food and feeding

Asian elephants in the wild feed on a wide variety of food plants (McKay 1973; Olivier 1978; Daniel *et al*. 1995; Baskaran 1998; Roy *et al*. 2006). Their natural diet includes twigs, stems, leaves, bark, fruits and roots of herbs, shrubs and trees, although the main fodder is grass (Baskaran 1998). Since the captive elephants under both private and forest department systems were allowed 13 h a day of natural feeding, their nutritional needs

could be met by shifting from grass consumption during the wet season to browse during the dry season. They could also consume a wide variety of food plants in the natural habitats. Timber camp elephants in southern India also had similar feeding opportunities (Vanitha 2007; Vanitha *et al*. 2008).

The intake rate of food by elephants has been estimated as 5% of their body weight per day on wet-matter (Sukumar 1989). On an average, to consume fresh fodder equalling 5% of body weight, a cow elephant requires as much as 150–175 kg and a bull 200–275 kg per day (Vanitha *et al*. 2008). The present estimate of the mean quantity of supplementary diet supplied per day for adult class (9 kg) is significantly lower than that reported for the timber camp elephants from southern India (Vanitha 2007; Vanitha *et al*. 2008). Although the captive elephants in the study area are let out for 13 h of natural feeding, whether they get the required quantum of green fodder on a day-to-day basis is doubtful, considering that they are let out into the same area throughout the year (JJ and NB pers. obs.), leading to decreased availability of food. The captive elephants in eastern Arunachal Pradesh work mostly in logging, which usually is of longer duration and is more strenuous than other work like eco-tourism, going in processions and patrolling. Thus, an adequate supplementary diet is essential to maintain their health and for sustainable breeding.

Keepers' welfare

Keepers' welfare is related to the elephant's well-being. Our study has shown that elephant-keepers are paid US$ 112/month, which is low compared to the salary prescribed by Project Elephant Experts Committee which is ~US$ 185/month in 2004 (MoEF 2004). Due to low wages, the traditional keepers abandon their jobs (MoEF 2004) and the elephants are left to the care of non-traditional, lesser compassionate and inexperienced keepers. Such situations contribute to attacks by elephants leading to manslaughter and injuries, as reported in southern India (Krishnamurthy 1998; Vanitha *et al*. 2010b). In such cases, the chances of human-elephant conflict with captive elephants are higher; as observed in 2011, when a bull named Dafaa Babu from Namdhapa National Park killed its keeper, and in 2013 Hary Prasad from Namsai District killed its owner.

Conclusions and recommendations

Sustaining the captive elephant population

The present captive population may not be sustainable in the long run considering the (i) aged population, and (ii) low fecundity. To overcome these problems, the private system has to improve captive breeding by providing adequate quantity and quality of supplementary diet. Arunachal State Forest Department in the eastern part of the state is managing very few captive elephants (n = 9) at present, as compared to the private system (n = 125). For captive breeding of elephants, unlike zoos for other species, forested areas like national parks, sanctuaries and territorial forest divisions are ideal locations. Thus, the Arunachal Forest Department should gradually increase its captive stock in forested areas of the eastern parts of the state, through improved captive breeding by better management of existing stocks and with addition of orphans, which could also be used for patrolling and eco-tourism.

Feeding

The study shows that a considerable number of captive elephants in private and forest department systems get a low quantity of supplementary diet compared to captive elephants managed at the timber camps in southern India. Also, the supplementary diet is soaked in water and fed to the elephants inside a bundle of grass. The quantity of supplementary food fed to elephants managed in private and forest department should be based on the veterinarians' prescription as per age, sex, work nature and reproductive status of the elephants, as is practiced in southern India (Krishnamurthy 1998; Vanitha 2007; Vanitha *et al*. 2008). Cooked supplementary diet would enhance the assimilation rate of nutrients (Krishnamurthy & Wemmer 1995; Baskaran *et al*. 2009). As elephants have low digestive efficiency (Benedict 1936), the forest department and the private systems should consider introducing

cooked rice and pulses, as practiced in Tamil Nadu, instead of feeding them only grain soaked in water.

Keepers' status

Unlike in the past, where mohuotry was a proud profession of a specialized class of people, now it has lost its charm due to lack of comparable economic benefits and poor welfare owing to the dwindling importance of captive elephants. Many private facilities cannot afford to pay the right amount of salary (MoEF 2004; Vanitha *et al*. 2010b). Therefore, the art of elephant-keeping is dying at a faster rate and effective steps must be taken urgently to improve the economic status of the keepers and care for their welfare through better pay, risk allowance, insurance and family accommodation, as suggested by Project Elephant Expert Committee, Government of India (MoEF 2004). All facilities should strictly adhere to the norms of the state Forest Department regarding the number of keepers per elephant.

Acknowledgements

We thank the Arunachal Pradesh Forest Department and private elephant owners of the state for permitting this study. We are also thankful to the Principal A.V.C. College (Autonomous) for his support to this work.

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