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A brief review of the status, distribution and biology of wild Asian elephants

Elephas maximus

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The Asian elephant *Elephas maximus* is distributed discontinuously across the Asian continent. The total wild population is 38 500–52 500, with a further *c.* 16 000 in captivity, the majority of which are in range countries. India has 60% of the global population of wild Asian elephants. The species has a multi-tiered social system with ♀♀ living in matriarchal groups of five to 20 individuals that interact with other family units in the area. Adult ♂♂ live alone or in small, temporary groups with weak social bonds. Asian elephants are megaherbivores that spend 12–18 hours per day feeding, and they eat browse and plants depending on availability and season. Home-range size is dependant on the availability of food, water and shelter in the region. Loss and fragmentation of habitat, human–elephant conflicts and poaching are the greatest threats to the species. Asian elephants are managed using traditional and modern methods but progress still needs to be made to improve welfare, training and breeding for these animals.

Key-words: animal care, Asian elephant, biology, captive management, conservation, diet, human–elephant conflict, social system, status in wild, threats

The Asian elephant *Elephas maximus* is the only living species of the genus *Elephas* (Elephantidae) that evolved in Africa *c.* 5–6 million years ago and migrated into Eurasia. The natural range of the Asian elephant is today confined to the Asian continent. *Elephas maximus* is believed to have descended during the later Pleistocene from *Elephas hysudricus,* the fossil remains of which are found in the Siwaliks in the Indian sub-continent (Maglio, 1973).

Historically, zoologists have recognized three subspecies of Asian elephant: *Elephas maximus maximus* from Sri Lanka, *Elephas maximus indicus* from the Asian mainland and *Elephas maximus sumatranus* from Sumatra (Indonesia). Recent evidence from molecular genetic studies does not support the differentiation of the Sri Lankan elephant population from those on the Asian mainland (Fernando & Lande, 2000; Sukumar, 2003). Elephants in Sri Lanka share mitochondrial DNA haplotypes with matrilines found on the mainland and, therefore, should not be considered as distinct subspecies. DNA analysis (Fernando *et al.,* 2003) indicates that elephants in Borneo, on the basis of genetic distinctiveness and evolutionary history, may constitute a separate subspecies *Elephas maximus borneensis,* which has been isolated for over 300 000 years. These studies on elephant genetics add to our understanding of the evolutionary history and population genetic structure of the species across its range, which provides a firmer basis for evaluating conservation priorities and management decisions (Fernando & Lande, 2000; Fernando *et al.,* 2003; Vidya *et al.,* 2005a,b).

STATUS AND DISTRIBUTION

About 6000 years ago the range of the Asian elephant extended from Mesopotamia in the west across the Indian subcontinent to South-east Asia and China and as far north as the Yangtze River (Olivier, 1978). At time of writing the Asian elephant has disappeared from *c.* 95% of its historical range. It is now distributed discontinuously in India, Nepal,

Bhutan, Bangladesh, Myanmar, Thailand, Peninsular Malaysia, Sabah, Kalimantan, Cambodia, Laos, Vietnam, China and the islands of Sumatra (Indonesia) and Sri Lanka (Santiapillai & Jackson, 1990; Sukumar, 2003). A small feral population occurs in the Andaman Islands in India. The Asian elephant is listed as Endangered by IUCN (2004) and appears on Appendix 1 of CITES (Convention on International Trade of Endangered Species of Wild Fauna and Flora).

The total population of Asian elephant in the wild is estimated at 38 500–52 500 individuals (Table 1). Estimates by country vary from <100 in Vietnam to >25 000 in India. There are an additional 16 000 elephants in captivity, mainly in range states, and *c.* 1000 maintained in zoos in western countries.

India has by far the largest numbers of wild elephants, comprising *c.* 60% of the global population. The major populations are in southern and north-eastern India, with fewer in the east-central and north-western regions. Myanmar, Sri Lanka, Malaysia, Thailand and Indonesia also have significant numbers. Owing to the uncertainties of counting elephants in dense tropical forests, it is difficult to quantify accurately changes in animal numbers over time. However, the available figures suggest a substantial reduction in elephant populations in many range states from Myanmar to Vietnam and Sumatra (Sukumar & Santiapillai, 1996; Heffernan & Trinh Viet Cuong, 2004). Increases in several regional elephant populations in India have helped to offset declines occurring elsewhere, with

COUNTRY	ELEPHANT RANGE (km^2)	WILD POPULATION (min–max)	CAPTIVE POPULATION (min–max)
Bangladesh	1800	**196–227**	*c.* **100**
Bhutan	1500	**250–500**	*
Cambodia	*c.* 40 000	**400–600**	**>500**
China	2500	**200–250**	*
India	110 000	**23 900–32 900**	*c.* **3500**
South	(39 500)	(10 300–17 400)	
Central	(23 500)	(2400–2700)	
North-east	(41 000)	(10 300–11 300)	
North-west	(5500)	(900–1500)	
Indonesia	105 000	**1180–1557**	*c.* **350**
Kalimantan	(*c.* 5000)	?–?	
Sumatra	(*c.* 100 000)	(1180–1557)	
Laos	*c.* 20 000	**781–1202**	**1100–1350**
Malaysia	*c.* 45 000	**2351–3066**	*
Peninsular	(*c.* 20 000)	(1251–1466)	
Sabah	(*c.* 25 000)	(1100–1600)	
Myanmar	115 000	**4000–5300**	**>5000**
Nepal	*c.* 2500	**100–170**	*c.* **170**
Sri Lanka	*c.* 15 000	**2100–3000**	**200–250**
Thailand	25 000	**3000–3700**	**3500–4000**
Vietnam	*c.* 3000	**76–94**	*c.* **165**
TOTAL	486 800	38 534–52 566	14 535–15 300

Table 1. Estimated minimum and maximum number of Asian elephants *Elephas maximus* in the wild and in captivity in Asia. Information from Santiapillai & Jackson (1990), Lair (1997), Sukumar (2003) and updated by the IUCN/SSC Asian Elephant Specialist Group in 2004: * there are few elephants in captivity in these countries; bold font indicates the totals for the country; numbers in brackets are regional. In addition to the numbers presented *c.* 1000 Asian elephants are found in zoos outside the range states.

the result that the overall population across Asia has probably not changed much or has only declined slightly during the past 25 years.

BIOLOGY

The Asian elephant is one of the few extant megaherbivores (Owen-Smith, 1988). Neonates of both sexes are *c.* 90 cm in height and 100 kg in mass. Males grow faster than ♀♀ from the age of 2 years onwards (Sukumar *et al.,* 1988). Adult bulls are typically 240–300 cm in height and 3500–6000 kg in body mass compared to 195–240 cm and 2000–3500 kg for adult cows, although there is considerable regional variation with the largest elephants possibly in north-eastern India and the smallest in Borneo.

Elephants are highly intelligent (Rensch, 1957) and have superior cognitive abilities. The basic social unit is the family consisting of an adult cow and her immature offspring. Elephant society is multi-tiered, starting from the mother–calf (or several offspring) unit and moving on to larger joint-family units with several adult cows, the 'kin' or bond group (two to four family units that associate frequently), the clan (a number of family units and bond groups in an area that coordinate their movements), the subpopulation (a number of clans using a particular part of the range) and the whole population (McKay, 1973; Kurt, 1974; Sukumar, 1989; Baskaran *et al.,* 1995)

Females remain in the cow herd of their birth, which is essentially a matriarchy led by the oldest ♀ who is also probably the mother, aunt or grandmother to most of the herd members. Studies of genetic relatedness have confirmed that adult cows within a family unit are closely related to one another (Vidya & Sukumar, 2005). Group size in elephants typically ranges from five to 20 animals and may vary with season. Larger herds with older, more-experienced matriarchs, are more successful in exploiting high-quality habitats and thus ensuring better survival of young. 'Allomothering' is also important in the protection and rearing of calves (Gadgil & Nair, 1984).

Females become sexually mature at 10–14 years of age, cycle every 14–16 weeks and, if they conceive, undergo a gestation of 20–21 months. They produce a calf every *c.* 4–5 years. Males attain maturity around the same age or slightly later and disperse from their natal herds, which avoids inbreeding (Sukumar, 1989). Adult bulls live alone or in small, temporary groups ('bull herds') with weak social bonds. It is possible that social constraints result in ♂♂ mating successfully only a few years after they are sexually mature. A bull elephant attains dominance in the ♂ hierarchy when it comes into musth, a physiological and behavioural phenomenon that usually occurs once a year (Eisenberg *et al.,* 1971). When a bull is in musth the testosterone in the blood increases to high levels, the temporal glands secrete a pungent fluid, the animal shows heightened aggression towards other bulls and it has a better chance of successful mating with an oestrous ♀.

The mechanisms of chemical and auditory communication are highly developed in elephants. The trunk and the vomeronasal organ, located on the roof of the mouth, are the main detectors of chemical signals. Various chemical compounds secreted by the temporal gland, urine, faeces and exhaled breath act as specific biological signals for communication within the family group, with other elephants and between ♂♂ and ♀♀ for reproduction (Rasmussen, 1998). Elephants are extraordinarily vocal and have a rich repertoire of calls; their auditory communication extends to the infrasound range that is not audible to humans (Payne *et al.,* 1986).

Elephants browse and graze on a variety of plants but the time spent foraging and the proportions of the plants consumed vary depending on season and

availability. In tropical dry forest during the dry season over 70% of the diet is browse, while grasses comprise the majority of the diet when they are plentiful during the wet season (Sukumar, 1989). In tropical moist forest, such as rainforest, the diet may be almost entirely browse and fruit. Elephants eat >100 plant species, however, Fabaceae (legumes), Poaceae (grasses), Cyperaceae (sedges), Palmae (palms), Euphorbiaceae (spurges), Rhamnaceae (buckthorn) and Malvales (mallows, sterculias and basswoods) may account for most of their total intake (McKay, 1973; Sukumar, 1989). Elephants may also eat bark, which contains minerals, such as calcium, and provides roughage. The elephant is a hind-gut fermenter and plant cellulose is digested in the large caecum and the colon through symbiotic microbes, with only *c.* 40–50% of the forage being digested. Elephants may spend 12–18 hours a day feeding during which they can consume up to 10% of their body mass as fresh-mass fodder (Vancuylenberg, 1977; Sukumar, 1989). The large quantities of dung generated help nutrient cycling in the ecosystem and also facilitate the dispersal of seeds. Unlike the African savanna elephant *Loxodonta africana,* there seem to be no instances of Asian elephant populations transforming their habitats from woodland to grassland (Sukumar, 2003).

The home ranges of Asian elephants have been estimated from radio-telemetric studies carried out in India (e.g. Baskaran *et al.,* 1995; Williams *et al.,* 2001; Sukumar *et al.,* 2003) and Sri Lanka (e.g. Fernando & Lande, 2000). These indicate home-range sizes of 250–1000 km^2 for family herds in Indian populations but a more restricted 50–150 km^2 in Sri Lanka. The area over which elephants move depends on availability of food and water, which is related to local topography and climate. Regional information on home-range sizes and elephant movement is therefore important for conservation planning.

MAJOR CONSERVATION ISSUES

Loss and fragmentation of habitat Loss and fragmentation of habitat is perhaps the most important factor having a direct impact on elephants in many parts of Asia (Santiapillai & Jackson, 1990). The pressures of an expanding human population, competition for living space and natural resources, and the rapid economic growth of many countries in this region have resulted in a dramatic loss of forest cover and reduced elephant numbers in the wild, and have rendered many of the populations non-viable in the long term (Sukumar, 1995, 2003).

Asian elephants inhabit regions with a high human-population density, which is growing at a rate of 1–3% per year. While the loss of habitat has been a gradual process, it has accelerated in recent decades because of rapid economic growth in countries such as Malaysia and Indonesia, where agriculture, such as oil palm, rubber and sugar cane, is replacing large tracts of tropical rainforest. In many parts of India the expansion of subsistence agriculture, commercial agriculture (tea and coffee plantations) and developmental projects (dams, roads and mineral mines), have also resulted in the loss and fragmentation of habitat. Shifting cultivation on a small scale probably benefited elephants by creating more favourable habitat mosaics but the widespread and intense nature of this practice in north-eastern India and across continental South-east Asia has also resulted in loss of habitat.

Habitat fragmentation is especially acute in east-central India, Laos, Vietnam and Sumatra. In Sumatra the remaining *c.* 3000 elephants are distributed in over 40 distinct populations with none larger than *c.* 500 individuals and several are <50 individuals. Even where large tracts of forest are not directly under threat through deforestation, expanding infrastructure in the form of roads, railway lines and canals in a developing economy will result in habitat fragmentation. The

challenge, therefore, is to maintain the integrity of landscapes in the face of economic development.

Elephant–human conflict Elephant–human conflict has emerged as one of the biggest conservation issues in Asia and presents an urgent challenge for governments and policy makers. Annually, the elephants damage millions of dollars worth of agricultural crops and hundreds of people and elephants are killed as a result of this conflict.

Crops consumed or damaged by elephants include a variety of cereals and millets, sugar cane, palms (e.g. coconut and oil palm), and many vegetables and fruits (Sukumar, 1989). Each year the Indian states of West Bengal (*c.* 5000 wild elephants) and Karnataka (*c.* 6000 wild elephants) pay an average of US$175 000 and US$160 000, respectively, in compensation to farmers cultivating mainly paddy and millets, but these represent only a fraction of the actual losses (Sukumar, 2003). Damage to commercial agriculture, such as oil palm and rubber plantations, can be substantially higher. In Malaysia during the 1970s the annual losses to a single land-development agency ran into several million dollars even though relatively few elephants were involved (Blair *et al.,* 1979).

The problem of the number of humans killed by elephants is greater in Asia than in Africa. In India alone *c.* 200 people are killed each year and a further *c.* 50 people are killed in Sri Lanka. Even in Vietnam and Bangladesh, where there are very few elephants, the conflict can be serious; in Vietnam, for example, small groups of elephants have been in severe conflict with villagers and have been eliminated (Heffernan & Trinh Viet Cuong, 2004). There is a range of causes for this conflict between elephants and people (Sukumar, 2003). Habitat fragmentation increases the contact between elephants and agriculture, and the intensity of conflict is usually higher in more fragmented habitats. Degradation of the natural-habitat resources for elephants is also obvious in some regions. Severe droughts may force the dispersal of elephants into new habitats where conflict may escalate. Cultivated crops are more palatable and nutritious than wild forage (Sukumar, 1989) and some elephants continue to raid crop fields irrespective of the availability of natural forage. There are differences between ♂♂ and ♀♀ in their propensity to raid crops, with subadult and adult ♂♂ showing distinctly greater tendency to do so, which may have its origins in the evolutionary history of polygynous animals (Sukumar & Gadgil, 1988).

Poaching In Asian elephants only some ♂♂ have tusks and there are also tuskless ♂♂. The numbers or proportions of tuskless ♂♂ that occur in a region may reflect the intensity of past hunting for ivory or selective capture of tusked ♂♂ (Sukumar, 1989). The predominantly tuskless bull populations of Sri Lanka, and the considerable numbers or proportions of tuskless bulls in north-eastern India and Myanmar, may reflect this historical process of human selection against tuskers (Tiedemann & Kurt, 1995; Sukumar, 2003).

In recent decades, however, the selective poaching of tuskers for ivory has progressively skewed the sex ratio in several Asian elephant populations. In Southern India a large proportion of ♂♂ have tusks and this region has been hit the hardest by ivory poaching with the adult ♂:♀ ratios being skewed to extreme values, as in the Periyar Tiger Reserve (*c.* 1 adult ♂:100 adult ♀♀) or the Nilgiris (1 adult ♂:25 adult ♀♀) (Ramakrishnan *et al.,* 1998; Sukumar, 2003). If such skewed sex ratios persist, the genetically effective population size will decrease and inbreeding may result. At the same time, large-scale hunting of elephants for not only ivory but also meat, hide and other products, has reduced their populations significantly over a wide area from

Myanmar to Vietnam in South-east Asia (Menon, 2002). The elephant population of Vietnam has plummeted to perhaps <100 individuals and the population in Cambodia is believed to be only a few hundred. There are flourishing local markets for ivory and other elephant products, which contribute to an illegal trade that spans from the Middle East to East Asia (Menon, 2002).

Elephant management in captivity in range countries With almost one in three Asian elephants in captivity (and this proportion is likely to increase), it is imperative that the health care and integrated management of these populations receive adequate attention. This is a difficult task given the dispersed nature of the animals and the differences in management systems under which they are maintained in range states, zoos and other facilities. Elephant welfare, from training to social systems in captivity, is increasingly under public scrutiny. Training methods vary enormously and some of these are clearly outdated and inappropriate. Basic veterinary care is lacking in many countries and numerous elephants are kept alone, a most undesirable state for a highly social animal.

Elephants in captivity in range countries rarely or never breed, and they are kept in temples, zoos or circuses, or by private individuals. Elephants in 'timber' camps, such as in Myanmar, or those maintained under semi-natural conditions in forest areas, such as in India, have a better breeding record largely because cows (captive) are mated by wild bulls (Poole *et al.,* 1997; Sukumar *et al.,* 1997; Taylor & Poole, 1998; Vandebona *et al.,* 2005). Western zoos go to great lengths (and expense) to breed a low but increasing numbers of elephants (see Hildebrandt *et al.,* this volume; Szdzuy *et al.,* this volume). There are several health problems that affect elephants in captivity, many of which are associated with inadequate conditions and opportunities for physical activity, and these may result in higher mortality rates in captive elephants in range states (see also Wiese & Willis, 2004). Overall, captive populations are in decline in the absence of importation from the wild and low breeding rates. Although legal captures from the wild are rare in countries such as India and Thailand, Sumatra still continues to capture significant numbers of elephants. Illegal captures and trading in elephants still occur to some extent over a wide area from north-eastern India to Cambodia (Menon, 2002).

CONCLUSIONS

Changes in land-use patterns across Asia are resulting in continuous contraction of the habitat available to elephants. The natural range has already declined from over 9 million km^2 in the distant past to <0·5 million km^2 at present (Sukumar, 2003), and it is continuing to fragment and isolate elephant populations through the countries in which they still exist. Maintaining the integrity of landscapes is crucial to saving the Asian elephant (Santiapillai & Jackson, 1990). This could be achieved by developing multiple-use areas incorporating protected areas and other forms of land-use, including extraction, grazing, small-scale cultivation and tourism, but with 'corridors' to ensure the free movement of elephants across the landscape. Project Elephant in India is one conservation scheme that incorporates landscape-scale planning for long-term viability of elephant habitats and populations (Bist, 2002).

The management of human–elephant conflict has to be integrated into a long-term land-use policy, which must also recognize elephants as an economic and a cultural asset. Even if the conflict cannot be eliminated altogether, it needs to be reduced to tolerable levels. The rapidly changing socio-economic and cultural contours of South and South-east Asia will also affect the human–animal

relationship and it is imperative that steps are taken to mitigate conflict.

Control of poaching for ivory is tied to not only law enforcement capacity of the range states but also to the international market for illegal ivory and CITES policy.

There has to be greater synergy between different management practices for elephants in captivity and, even if management systems are diverse, it is important to educate elephant trainers and keepers about minimum welfare standards and ensure that countries have appropriate legislation to enforce them. The aim should be to make the elephant population in captivity self-sustaining and this calls for an integrated approach to maintaining wild and captive stocks.

Tamed about 4000 years ago but not yet domesticated, the elephant is still a cultural and religious icon in many Asian countries. It can be a powerful symbol for achieving broader conservation objectives in a biologically rich tropical region.

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