# On *Elephas maximus* Palaeo-Geographical Distribution in China

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## Abstract

From the data given in this paper of the geological and geographical distribution of *Elephas maximus* (110 localities), the writer concludes that they reached once Yangyuan County, Hebei Province, and confirms they declined from north to south in China. And at present, they exist only at few sites of south-west in Yunnan Province.

In addition, the writer discussed the problem of comprehensive causes for the decline of wild *Elephas maximus* in China. Three main points in the discussion are as follows: (1) Climatic change; (2) Mankind disturb; (3) Decline of this species itself.

# Comparative Study of Asiatic Elephant *Elephas maximus* Populations in Gal Oya, Sri Lanka

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## Abstract

Two populations of Asiatic elephants *Elephas maximus* of two different home-ranges of Sri Lanka's Gal Oya area were compared. The group-size-frequency distributions of matriarchal groups belonging to the two populations were significantly different. The population in study site B, in contrast to that in study site A, showed frequent random aggregations, and a higher mean group size. These differences are attributed to excessive range contraction in study site B. The population in the latter area also showed greater dependence on dry grass than that in study site A. Size-class structures, population numbers and adult sex ratios are discussed for the two populations. Seasonality in the birth of elephant calves was evident during the year 1975, in the population using study site A. The need to carry out similar studies over long periods of time is stressed.

# Elephant and Woody-Plant Relationships in Gal Oya, Sri Lanka

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## Abstract

Two sites, having two different elephant populations with non- over-lapping home-ranges, were selected for studies on elephant and woody-plant relationships. Four woody-plant habitats, two within each site, were investigated. Woody-plant utilisation was analysed in relation to type of damage, woody-plant size-clases and species. Preferred woody-plant size-classes and species were identified. These results were used to compare trends in elephant woody-plant relationships in the two populations. The percentage of damaged woody plants, and the preference ratios for size-classes did not differ significantly between the two sites. However, the availability of woody plants in preferred size-classes, as well as in preferred species, was significantly greater in study site 1 than in site 2. The importance of these findings for the conservation and management of elephants in Sri Lanka, is briefly discussed.

# The use of elephant droppings in assessing numbers, occupance and age structure: a refinement of the method

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## Summary

Estimation of elephant numbers by means of dropping counts in the Kasungu National Park, Malawi appeared to be heavily biased in the direction of over-estimation according to a series of aerial surveys. Over-estimation errors in the counting technique were due to the boli of one dropping being spread over a considerable distance and to double counting of one defaecation by scouts counting next to each other. Under-representation of droppings from the youngest calves caused a 4.8% under-estimation in dropping densities while the total correction factor was estimated to be 0.67. A complete decomposition cycle runs from the height of the wet season to the height of the following wet season and consists of three distinct phases each with a characteristic relationship between droppings accumulation and decomposition. The time of year that a survey of this kind can best be carried out and the steps that should be undertaken are briefly discussed. The dry-season defaecation rate for the Kasungu elephants was estimated to be 15.7 droppings per elephant per day with non significant difference between the sexes. The number of elephants present in 1978 was estimated from the dropping counts as being approximately 1189. An alternative method is described for determining the age structure of an elephant population by means of circumference measurements of the individual boli from a sample of droppings. Basic information on the relation between bolus circumference and bolus weight and age was obtained from various zoos. Results were compared with those from a photogrammetric method and, with the exception of calves younger than 1 year, both age structures appeared to be very similar. Slight differences are discussed and a method is given of estimating the true number of males and females in each age class above the age where growth is similar in both sexes.

# Semen of the Ceylon Elephant, *Elephas maximus*

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## Summary

The procedure employed for the collection of semen from a captive male elephant is described. Sperm-rich and sperm-free ejaculates were obtained. Seven sperm-rich ejaculates were evaluated.
Seminal characteristics investigated in the elephant compared favourably with those of other domestic animals of normal fertility. The mean concentration of spermatozoa was $1200 \times 10^6$/ml in the sperm-rich ejaculates. Individual spermatozoa measured $58.5 \mu$ (average) in length.

# Oestrous Cycle of the Asiatic Elephant, *Elephas maximus,* in Captivity

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## Summary

During the course of a programme to breed the Asiatic elephant, *Elephas maximus,* in captivity, the oestrous cycles of eleven adult females were studied. Two methods were used for detecting oestrus: (1) daily testing with a male elephant, and (2) urogenital smear cytology.

Overt signs of oestrus were not observed but 'standing' oestrus was detected in ten animals. The duration of oestrus ranged from 2 to 8 days with a mode of 4 days. Oestrous cycles in six animals ranged from 18 to 27 days with a mean of 22 days.

Urogenital smear cytology failed to indicate accurately the onset of behavioural oestrus but increases in the number of cornified cells may occur before, during and slightly after behavioural oestrus. Considerable mating activity occurred during oestrus. A description of mating behaviour is presented.

The findings are discussed in relation to breeding elephants in captivity and to the phenomenon of temporal gland activity.

# Dental identification and age determination in *Elephas maximus*

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The dentition of an elephant (fossil or extant) can yield clues to the animal's age and species identity, provided the teeth are correctly identified. Identifying the serial category of elephant teeth is difficult because the size, shape and position of each tooth changes throughout life, as the teeth form, erupt, wear and move through the jaw. In the present study, teeth from over 100 museum specimens of the Asian elephant *(Elephas maximus)* were the basis for establishing size ranges for cheek teeth in six serial categories (designated by Roman numerals I to VI).

Although the teeth vary greatly and overlap in their dimensions, reliable identifications (as well as estimates of an individual's age in years) can be obtained using three or more measurements. An appreciation for dental variability in *Elephas maximus* will demand a re-evaluation of frequentlycited examples of macroevolutionary patterns within the Elephantidae.

# Drug Immobilisation of Indian Elephant

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Critical data from the drug immobilisation of six adult wild elephants in U.P. in 1983-84, using Immobilon (etorphine/acepromazine) and Revivon (diprenorphine) are reported. A standard Distinject N60 powder rifle and accessories was used for darting, with the addition of a "radio-dart" in three cases. Complete recumbancy was achieved using doses of 3.0

to 3.5 ml Immobilon (7.4-8.6 mg etorphine, 30-35 mg acepromazine). Induction times varied between 15 and 35 minutes; "down" times between 30 and 324 minutes and revival times between 4 and 41 minutes.

# The elephant populations of India - Strategies for conservation

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## Abstract

Between 17 and 22 thousand elephants are found in 4 distinct regions - the northwest (525), northeast (8725-12130), central (2300) and south India (5750-7150). Elephants largely prefer the deciduous forests where both browse and grass are available. Annual home range size usually varies between 100 and 500 $km^2$. The major threats to the elephant include loss of habitat due to spread of agriculture, degradation of habitat through human impact, developmental projects such as hydroelectric dams and poaching of males for ivory. Suggestions for conservation of the elephant have been made. These include the maintenance of minimum viable populations, habitat integrity, habitat mosaic and reduction in poaching. Measures to reduce crop depredation by elephants such as the use of high-voltage electric fences are recommended.

# Carbon isotopic evidence for different feeding patterns in an Asian elephant population

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## Abstract

Stable carbon isotope ratios ($^{13}C/^{12}C$) in bone collagen of Asian elephants showed a variation in $\delta^{13}C$ value from - 11.1 to - 20.8 per mil. This indicates that individuals within a population vary widely in their dietary intake of $C_4$ plants (grasses) and $C_3$ plants (browse), from a predominance of either of these types through intermediate proportions. The difference in feeding pattern may be related to age, with younger elephants preferentially grazing and adults mainly browsing.

# Growth in the Asian elephant

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## Abstract

Records of captive Asian elephants *(Elephas maximus)* were used to derive parameters of the von Bertalanfly function for growth in height, body weight and circumference of tusks with age. There was some evidence for a post-pubertal secondary growth spurt in both male and female elephants. Domestic elephants which were born in captivity of captured at a young age also showed a reduced growth in height in both the sexes and in body weight in males compared to wild elephants. Aspects of allometric growth such as height-body weight relationship are examined. The height was twice the circumference of front foot throughout the life span, indicating an isometric relationship.

# Ecology of the Asian elephant in southern India.
# I. Movement and habitat utilization patterns

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## Abstract

The movement and habitat utilization patterns were studied in an Asian elephant population during 1981-83 within a 1130 km$^2$ area in southern India (11° 30' N to 12° 0' N and 76° 50' E to 77° 15' E). The study area encompasses a diversity of vegetation types from dry thorn forest (250-400 m) through deciduous forest (400- 1400 m) to stunted evergreen *shola* forest and grassland (1400-1800 m).

Home range sizes of some identified elephants were between 105 and 320 km$^2$. Based on the dry season distribution, five different elephant clans, each consisting of between 50 and 200 individuals and having overlapping home ranges, could be defined within the study area. Seasonal habitat preferences were related to the availability of water and the palatability of food plants. During the dry months (January-April) elephants congregated at high densities of up to five individuals km$^{-2}$ in river valleys where browse plants had a much higher protein content than the coarse tall grasses on hill slopes. With the onset of rains of the first wet season (May-August) they dispersed over a wider area at lower densities, largely into the tall grass forests, to feed on the fresh grasses, which then had a high protein value. During the second wet season (September-December), when the tall grasses became fibrous, they moved into lower elevation short grass open forests.

The normal movement pattern could be upset during years of adverse environmental conditions. However, the movement pattern of elephants in this region has not basically changed for over a century, as inferred from descriptions recorded during the nineteenth century.

# Ecology of the Asian elephant in southern India.
# II. Feeding habits and crop raiding patterns

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## Abstract

The Asian elephant's foraging strategy in its natural habitat and in cultivation was studied in southern India during 1981-83. Though elephants consumed at least 112 plant species in the study area, about 85% of their diet consisted of only 25 species from the order Malvales and the families Leguminosae, Palmae, Cyperaceae and Gramineae. Alteration between a predominantly browse diet during the dry season with a grass diet during the early wet season was related to the seasonally changing protein content of grasses.

Crop raiding, which was sporadic during the dry season, gradually increased with more area being cultivated with the onset of rains. Raiding frequency reached a peak during October-Desember, with some villages being raided almost every night, when finger millet *(Eleusine coracana)* was cultivated by most farmers. The monthly frequency of raiding was related to the seasonal movement of elephant herds and to the size of the enclave. Of their total annual food requirement, adult bull elephants derived an estimated 9.3% and family herds 1.7% in quantity from cultivated land. Cultivated cereal and millet crops provided significantly more protein, calcium and sodium than the wild grasses. Ultimately, crop raiding can be thought of as an extension of the elephant's optimal foraging strategy.

# The Management of Large Mammals in Relation to Male Strategies and Conflict with People

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## Abstract

Many large mammals such as elephant, rhino and tiger often come into conflict with people by destroying agricultural crops and even killing people, thus providing a deterrent to conservation efforts. The males of these polygynous species have a greater variance in reproductive success than females, leading to selection pressures favouring a 'high risk-high gain' strategy for promoting reproductive success. This brings them into greater conflict with people. For instance, adult male elephants are far more prone than a member of a female-led family herd to raid agricultural crops and to kill people. In polygynous species, the removal of a certain proportion of 'surplus' adult males is not likely to affect the fertility and growth rate of the population. Hence, this could be a management tool which would effectively reduce animal-human conflict, and at the same time maintain the viability of the population. Selective removal of males would result in a skewed sex ratio. This would reduce the 'effective population size' (as opposed to the total population or census number), increase the rate of genetic drift and, in small populations, lead to inbreeding depression. Plans for managing destructive mammals through the culling of males will have to ensure that the appropriate minimum size in the populations is being maintained.

# Characteristics of Three Populations of Elephants of the Western Ghats

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## Abstract

Characteristics of 3 elephant populations of Peninsular India are examined and comparisons made with that of other populations. The parameters examined were distribution density sexratio and proportion of individuals in various age classes in the population Out of the 3 localities studied. Bandipur and Perivar had relatively undisturbed habitat while Idukki was disturbed. Largerherds were characteristic of Bandipur and Perivar where the adultmale to adult female ratio was 1:9 and 1.25 respectively. Both populations had a sex ratio of 1:1 in the case of subadults. Although the Perivar population had a lower proportion of adult male elephants in comparison with Bandipur the proportion of young ones was similar. The Idukki population had very few adult males where the proportion of young ones and subadults was also very low. Solitary female elephants were observed at Idukki which is indicative of a disturbed population. The major reason for the disparity in sex ratio between subadults and adults is the poaching of tuskers for ivory. There was extensive continuous forest in Bandipur and Perivar. In the case of Idukki human habitations and construction of a hydroelectric project severely limited habitat continuity and movement.

# Feeding behaviour of the Asiatic elephant in South-East Sri Lanka in relation to conservation

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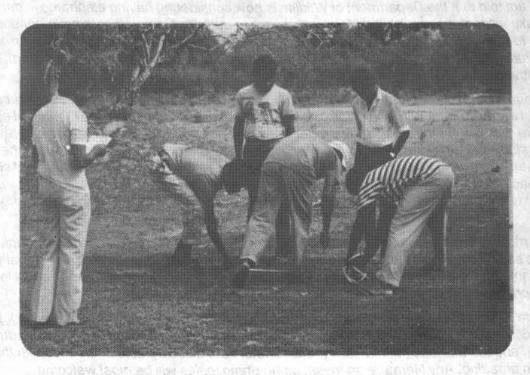
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## Abstract

This paper reports on important behavioural aspects of the Asiatic elephant *(Elephas maximus)* in South-East Sri Lanka (Ceylon), in relation to recommendations for its conservation. The activity cycle of the elephant has been investigated in relation to local or short-range movements which were found to be diurnally rhythmic. The elephant was estimated to spend about 17 to 19 h/day feeding. The feeding cycle is seen to consert of three successive phases, namely (1) rapid movement and low feeding rate, (2) little movement and high feeding rate, and (3) a certain amount of movement and relaxed feeding. During a given feeding cycle an elephant consumes about 150 kg of fresh vegetation and defecates about 80 kg of it per day. The dynamics of grass feeding were worked out for a herd of elephants in the Gal Oya National Park. The outlook for the elephant population in South-East Sri Lanka has been critically analysed with reference to its mode of habitat utilisation. The main constraints introduced into its ecosystem are discussed, namely blocking of migratory routes, burning of grassland, construction of roads, grazing of domestic cattle in its home ranges, felling of trees by villagers, and an over-population of water buffalo *(Bubalus bubalis)*. Measures for conservation are briefly dealt with.

*Staff from the Wildlife Department (Sri Lanka) carrying out studies in Ruhuna National Park. (Photo: Charles Santiapillai)*