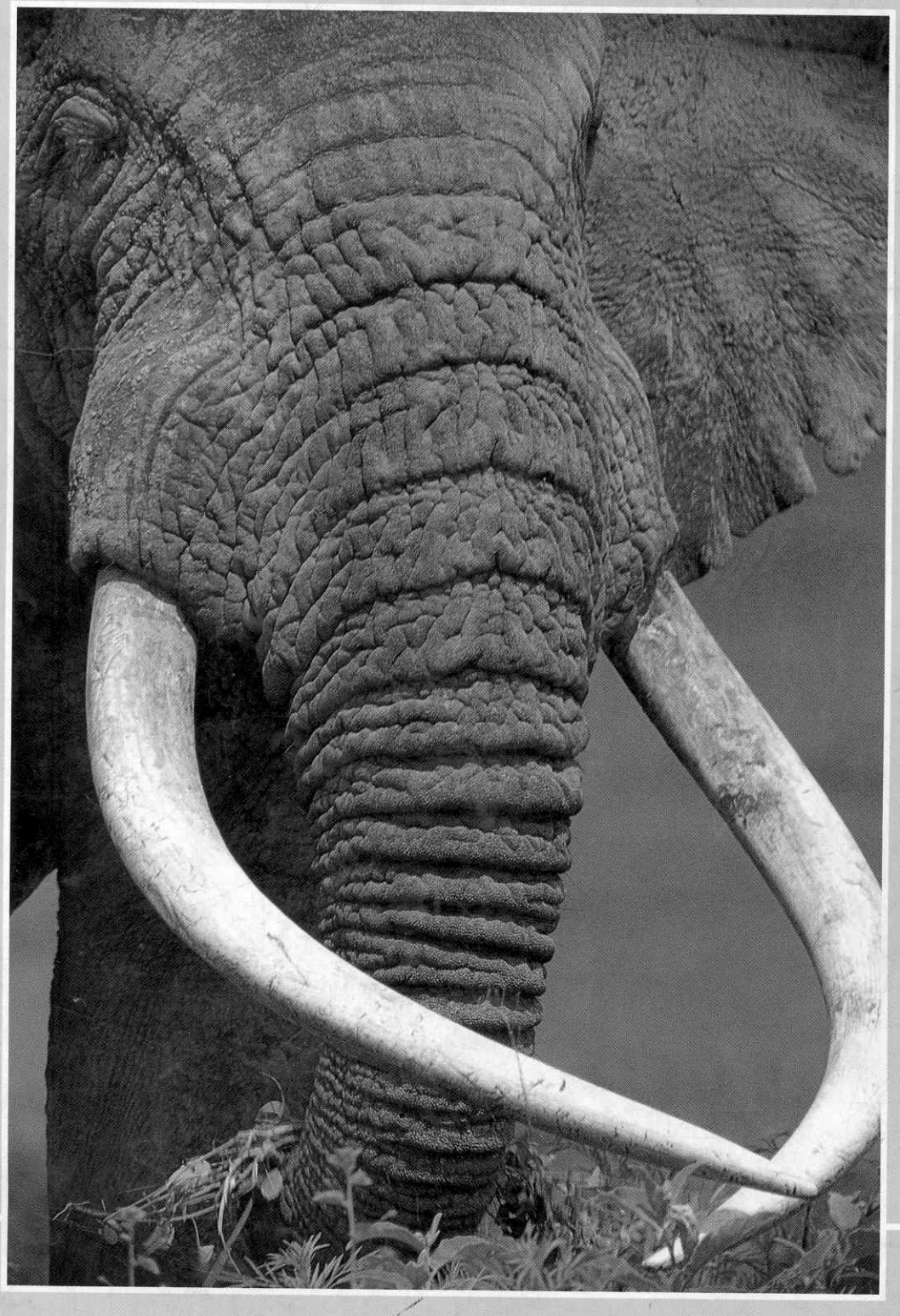
The Illustrated Encyclopedia of

ELEPHANTS

From Their Origins and Evolution to Their Ceremonial and Working Relationship with Man



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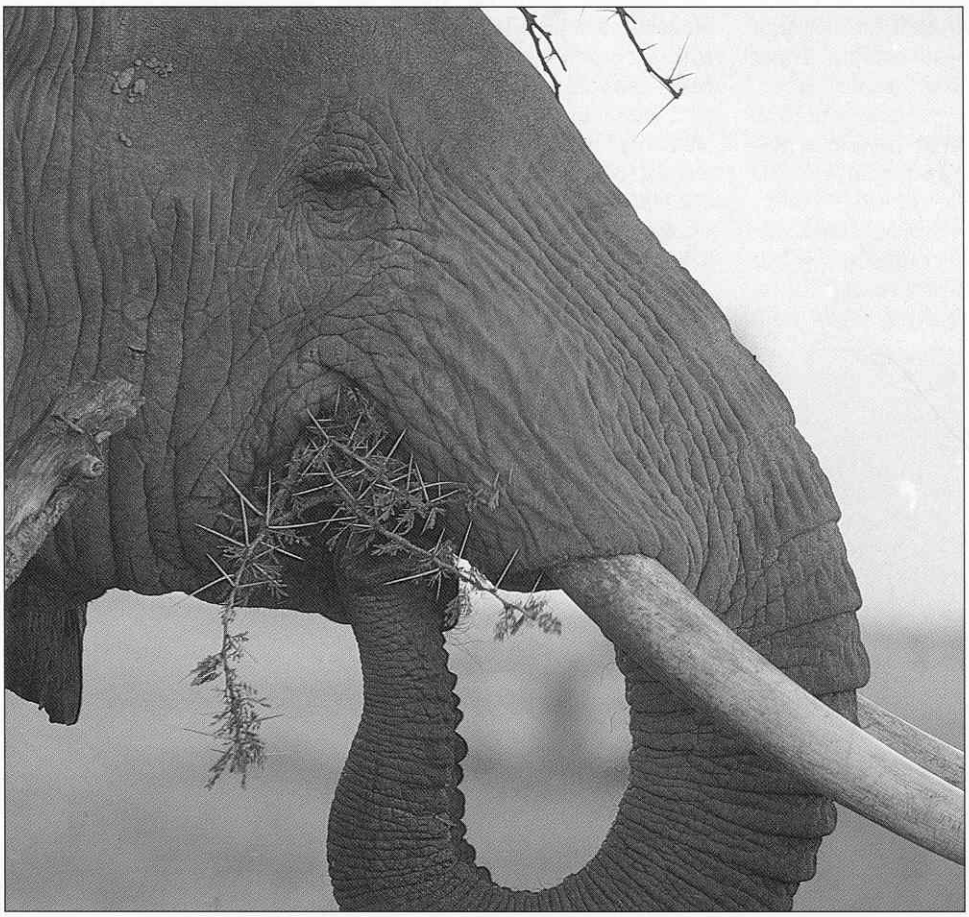


Elephants need enormous quantities of food, which they get from many trees, shrubs and herbs. The acacias are favourite foods, both in Africa and in Asia. They consume not only the leaves – including these vicious-looking spines – but also the bark of acacias.

As individuals, elephants are the largest consumers of plants among the terrestrial animals. They are very adaptable creatures, inhabiting a range of habitats from the hot and dry Kalahari Desert to the humid and wet tropical forests of Malaysia. The menu they can choose from, even within any one region, would be the envy of a chef in most restaurants, so varied can it be. Wherever the feeding habits of elephants have been studied, in Africa or in Asia, it has been found that they may consume anywhere from 100 to 500 plant species. This has been made possible by the organ that, more than any other feature, distinguishes elephants from other mammals – the trunk. The trunk is an elongation of the nose and the upper lip. It has no hard tissue such as bone, but is made up of thousands of tiny muscles that give it incredible flexibility. The amazing versatility of the elephant, to feed on tiny herbs from the ground as well as to rear up on its hind legs and bring down a branch, is unmatched among land animals.

Elephants need a lot of food and cannot afford to be too choosy about what they eat. We begin our exploration of the ecology of elephants, therefore, with a close look at their diet and how they obtain it.

Diet and feeding habits

The elephant's diet comes from a variety of plants – grasses, broadleaved herbaceous plants, shrubs, palms, vines and trees – and from many plant parts – leaves, twigs, bark, fruits and even flowers. However, the bulk of their food may consist of only a few plants, such as grasses and some shrubs and trees. The components of the diet vary with habitat and also change with the seasons. Obviously, the consumption of fruit is seasonal. Elephants are known to gorge themselves with fruits when these are plentiful. For hours on end they may selectively pick up fruits of palm, *Balanites*, tamarind, wood apple or acacia. If the fruits happen to be somewhat overripe and slightly fermenting, as the fallen fruits of the *Borassus* palm often are, an elephant may get quite drunk!

In drier forests and grasslands the grasses predominate in the diet of elephants. In savannas and woodlands the tall grasses are coarse and unpalatable during the dry season, and fires may have reduced them to ashes. Elephants now prefer to feed on the bark, fruits and leaves of many shrubs and trees. If they have access to swamps, they may still be able to get hold of relatively succulent grasses. With the onset of the rains the new flush of grass is both tender and very nutritious. Especially in areas burnt during the dry season, elephants now switch over largely to eating grasses, which give them an adequate supply of protein to make up for whatever weight they may have lost earlier. In the forests of Asia the bamboos are a very important component of the diet of elephants. The bamboos belong to the grass family, although they resemble trees in appearance and are hence known as 'tree-grasses'. They maintain a high level of protein in their leaves even during the dry season, when good-quality food is otherwise scarce.

Studies in African savanna-woodland and in the drier forests of Asia have shown that seasonal dietary patterns in the two regions are remarkably similar. C.R.Field and I.C.Ross found in Kidepo Valley in Uganda that browse constituted 71 percent of the diet of elephants during the dry season, and grasses formed 57 percent of the diet during the rainy months. In southern India I made similar observations on the Asian elephant's dietary habits. Up to 70 percent of the diet was browse during the dry months, and grasses were consumed to the tune of 54 percent during the early wet season. In rain forests the diet is very different. It is very difficult or impossible to observe elephants directly in these dense forests, and therefore one has to rely on indirect methods, such as analyzing the contents of dung or looking for signs of feeding on plants. Jeff Short found that 93 percent of the elephant dung he examined in the rain forests of Ghana contained remains of fruits. Robert Olivier observed that palms are by far the most commonly eaten plants in the rain forests of Malaysia. In addition, elephants feed on a variety of other plants – including

Above: *A bull Asian elephant reaches out for a trunkful of bamboo stems and leaves, standing in water to reach the most succulent growths. Bamboos belong to the grass family and maintain a relatively constant protein value throughout the year. Dozens of bamboo species in Asia are a mainstay of elephants.*

Right: *The grasses are staple food for elephants in all but the dense tropical rain forests. They are nutritious only during the wet season. In areas burnt during the dry spell, the new flush of tender grass that emerges with the rains attracts elephants. Here, an elephant is clearly enjoying the rich crop of new grass after rains in the Yala National Park, Sri Lanka.*

Above: *Elephants are fond of eating soils rich in certain minerals such as sodium, but they will also seek other sources. This cave has been created by elephants eating rocks in the Ngorongoro Conservation Area, Tanzania.*

Below: *In the same cave the tusk marks left by elephants can be clearly seen. The tusks have been used to dig out and remove portions of the mineral-rich rocks. Elephants will even enter dark caves in search of minerals.*

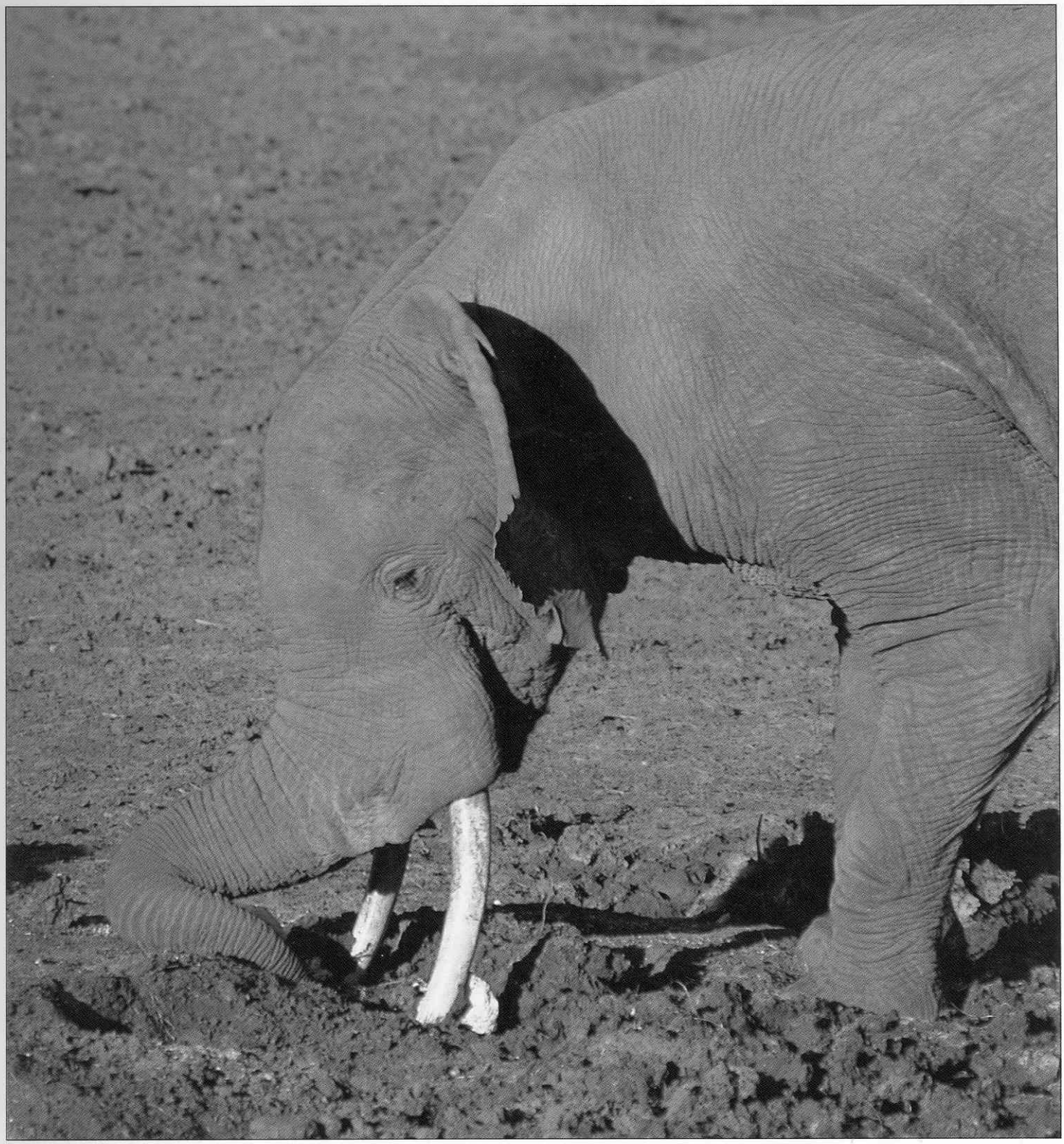
climbers, lianas, herbs and succulents.

The last word has not yet been said on the matter of the elephant's strong liking for the bark of many trees and shrubs. Chemical analyses of the kinds of bark consumed by elephants indicate that these may be a significant source of minerals such as calcium, manganese, iron, boron and copper. However, not everyone agrees that elephants feed on bark for the sake of its minerals. The fibre in bark may be important for elephants to avoid constipation. One of the more interesting explanations for bark eating was given by K.G. McCullagh, who found that African elephants were prone to deficiency in certain essential fatty acids and that bark could satisfy this need.

Whether bark is consumed for its nutrients or not, minerals are so important to elephants that they even eat soils rich in them. Rain forest soils and plant parts are particularly deficient in minerals such as sodium, which elephants need. In these regions elephants may frequent natural salt licks. These are small patches of soil that have a high content of various minerals. Some wildlife parks have taken advantage of this behaviour by artificially supplying common salt at specific locations to attract mammals such as elephants for the benefit of tourists. In the Mount Elgon region along the Kenya-Uganda border, elephants even enter a cave in total darkness to search for rocks that are rich in salts!

Apart from their long-distance seasonal movements, elephants also search for the best possible items on their daily rounds. Where the tall grasses are not very appealing they may search for more tender short grasses that grow in the shade of the coarse swards. They may spend 12-18 hours in feeding each day. The exact time may depend on the availability of suitable forage, the type of plants eaten and the weather. They do not feed at the same rate throughout. There are periods of intense feeding (during the morning and in the late afternoon and evening) and other times when they feed at a more leisurely pace.

Elephants consume a great deal of food. The fresh weight of plants that an elephant consumes each day totals about 6-8 percent of its own body weight. For a



Above: *An elephant uses its tusks to scoop out mineral-rich soil, which it will then consume. The power and leverage exerted by the tusks is very apparent here. The strength and flexibility of the trunk also make this excavation possible.*

big bull elephant weighing about 5 tonnes(10,125lb) this would amount to 400kg(882lb). A full-grown cow elephant would need about 60 percent of this amount, and an average elephant, weighing about 2 tonnes(4,450lb) may need only 160kg(353lb). This may seem an enormous amount, but when we compare elephants with other animals it turns out that elephants eat less food in relation to their body weight than other animals do. The smaller an animal, the more it consumes in proportion to its body weight. For instance, a rat may consume 40 percent of its body weight as food in a day.

A large animal such as the elephant can also tolerate a diet of poorer quality than does a smaller animal; hence its consumption of coarse grasses or even dry twigs at times. To chew the coarse plant material the teeth of elephants have evolved special and complex adaptations. The molar teeth are large and have high crowns (a characteristic known as *hypsodonty*). The grinding surface of the tooth has a complex pattern of transverse ridges, which are diamond- or lozenge-shaped in the African elephant but nearly parallel in the Asian elephant. As the animal chews its food the jaws move from front to back, with hardly any sideways action. The rasplike surface of the molars and the manner in which the upper and lower molars move against each other cause even the toughest plant material to be well sheared.

Digestion and defecation

The elephant is not very efficient at digesting its food. Experiments with captive elephants indicate that the digestive effi-

ciency of protein may be as low as 22 percent of its amount in food. To make up for this lack of efficiency, a large herbivore usually has a greater rate of passage of food, so that more food can be eaten to obtain the required amount of nutrients. The time taken for food to pass through the gut of an elephant may be anywhere from 11 to 46 hours, but an average time of 24 hours seems usual.

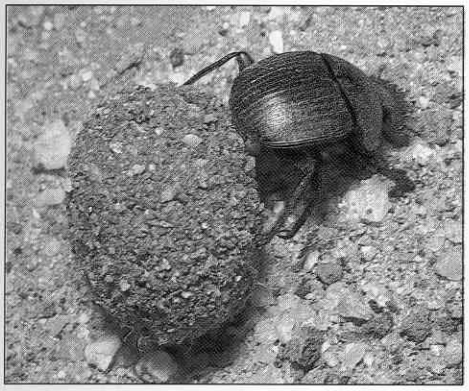
The cud-chewing, or ruminant, animals have stomachs designed to extract energy from cellulose, the complex carbohydrate that predominates in plants. The elephant is not a ruminant but all the fibrous forage that it consumes does not necessarily go to waste. It can obtain a fair amount of energy from the breakdown of cellulose by microorganisms, such as protozoa and bacteria, in the caecum and colon situated after the stomach. An elephant calf that is becoming less dependent on its mother for milk has to be infected with the right microbes for digesting cellulose. It acquires the microbes by eating small quantities of the dung of older elephants, an act known as *coprophagy*.

The large quantities of food eaten by elephants are fairly regularly expelled after digestion. Here again there are varying estimates of the number of times an elephant defecates in a day. Observers who have followed wild and captive elephants, both African and Asian, report between seven and 29 defecations each day. Some of the difference could be due to failure to observe elephants at night, or due to seasonal differences and changes in the nature of the diet. The average rate indicated by many observers is about one defecation every two hours, or 12 defecations daily.

The large quantities of dung deposited by elephants play a major role in the recycling of nutrients in areas where they are numerous. Elephants are generally the dominant species in terms of biomass in many savanna-woodland habitats. If we assume that there is one elephant for every square kilometre of land, and that an average elephant deposits 100kg(220lb) of dung each day, then the landscape is manured with 37 tonnes (74,925lb) of dung per square kilometre in a year. This is a considerable amount when we consider that farmers using organic manure for their millet fields may use about 150 tonnes (303,750lb) over the same area in a year. In some regions the dung of elephants and other animals is quickly removed by dung beetles, which play an important role in the recycling of nutrients.

The dietary habits of elephants also have ecological significance in other ways. Seeds of fruits consumed by them are dispersed away from the parent tree. The seeds of certain plants, such as the acacias, are known to germinate much better if they have passed through the gut of an animal such as the elephant. The enzymes the seeds encounter in the animal's gut soften the tough outer coat and facilitate the germination process. Although there is no firm evidence for this, it is possible that the extinction of large mammals such as the mastodons, close relatives of elephants, severely handicapped the capability of certain plants to disperse and regenerate, and perhaps even led to their extinction.

Whether plants suffered or not, many small mammals seem to have been wiped out in the wake of the disappearance of large mammals such as the proboscids in the Americas. Norman Owen-Smith, a South African zoologist, puts the blame for the extinction of smaller mammals squarely on the extinction of large mammals. In the course of satisfying their prodigious appetites, herbivores such as elephants change the landscape drastically. By pushing over trees they create gaps, which are then invaded by weedy plants. Many smaller mammals use such open habitats. Owen-Smith conjectures that the elimination of the megaherbivores (i.e. mammals over 1,000kg/2,200lb in



Above: *A dung beetle rolls along a ball of dung it has neatly compacted for taking to its nest. In some regions, the dung beetles play an important role in the recycling of nutrients by removing the enormous quantities of dung deposited by elephants and other animals. The beetles scurry out quickly to move fresh dung.*

Left: *An Asian elephant calf, showing the typical hairiness of youth, examines dung with its trunk. All juveniles eat small amounts of the dung of adult elephants. By doing this they pick up the beneficial microorganisms that will remain in the gut to enable them to break down the cellulose in the plants they eat.*

Right: *An olive baboon searches for seeds and insects in elephant droppings in Samburu Nature Reserve, Kenya. Seeds are usually passed out intact and, as well as providing an impromptu snack for other animals, they may also germinate better than those that have not passed through the gut of an animal.*

weight) by human hunters during the Pleistocene, 20,000-10,000 years ago, ultimately led to the transformation of habitats and the extinction of a host of smaller mammals as a result.

Plants on the defensive

Although it may be advantageous for some plants to be eaten by elephants, in that their seeds may be effectively dispersed, it would not be in their interest to be completely at the mercy of these bulldozers. Most plants, in any case, do not have any obvious advantage in being eaten. Plants have evolved their own elaborate defence systems to counter animal consumers; but physical structures such as thorns or spines (as in the acacias) do not prevent elephants from feeding on them. Chemical compounds in plants are a more effective deterrent. These chemical defences are of two main types. Chemicals such as tannins found in the bark of many plants reduce the digestibility of protein in food by binding to it. Yet, elephants still feed on the bark of many acacias that contain fairly high amounts of tannins. The other class of chemical defences are toxins such as alkaloids and cyanogenic compounds. Plants in the evergreen rain forests contain many such chemicals and are consequently avoided by most mammals. (In fact, stinging nettles are reported to give even pachyderms a fright.) The herbivores of such rain forest plants are mostly insects that have evolved mechanisms allowing them to feed on particular plant species. This is the reason why rain forests have very low densities of the large mammalian herbivores, and consequently of carnivores. Even in more hospitable areas the plants contain many toxins. Many perennial grasses can normally afford not to produce chemical defences, because their leaves can regenerate from the base, unlike broadleaved plants; yet even they may produce sufficiently high quantities of cyanogenic compounds, when they are just sprouting, to repel herbivores. Mammals can often deal with these chemical defences of plants, because the liver or microbes in the gut can detoxify many of the chemicals – provided not too much has been consumed. The dietary preference of the elephant is thus a compromise between obtaining sufficient food for its metabolism and growth and avoiding those dangerous chemicals its system cannot deal with.

Below: *African elephants digging for sub-soil water on a dry river bed. The front feet and legs are skilfully coordinated in digging the holes, and the tusks and trunk are indispensable tools for gouging out the dry soil to reach the moisture beneath the surface. As water seeps into the holes from the lower levels of the bed, the elephants suck it up into the trunk and then transfer it – trunkful at a time – to the mouth, swallowing as it trickles down the throat. Here, a youngster drinks at the hole pioneered by its mother. Elephants seem to have a good memory for such watering spots.*

Above: *An Asian bull elephant reaches out for a trunkful of water at a pond in the Biligirirangan Hills, in southern India. Elephants drink daily when water is available, consuming up to 200 litres(52 US gallons) in a day. For drinking and bathing, water is vital for elephants to thrive in all environments.*

Drinking

Elephants drink a lot of water. When water is available they usually drink at least once a day, sometimes several times a day. Each time an adult elephant sucks in water with its trunk it may imbibe 5-10 litres(about 1-2.5 US gallons) of fluid. It may sometimes drink up to 100 litres (26 US gallons) at a time and over 200 litres(52 US gallons) during the day. When water is scarce, elephants dig holes in dry stream beds to get at sub-soil water. Typically the sand is excavated with the front feet and the trunk to create a hole, and the water that seeps into the hole is sucked in with the trunk and consumed. Elephants do not necessarily drink from any waterhole in an area. They clearly prefer waterholes that contain relatively high amounts of mineral salts, particularly sodium. The distribution of elephants can even be correlated with the salt content of waterholes within a region.

It is not true, however, that elephants cannot go without water for more than a few days. In 1973 a herd of 34 elephants accidentally entered a small paddock in the Galana Ranch in Kenya where there was no water. Thirty of these elephants broke out on the fourteenth day, without having drunk any water at all. Of the remaining elephants, two escaped, and two juveniles died (on the fifteenth and seventeenth days). This incident revealed the amazing capacity of such a large mammal to endure without water.

While on the subject of drinking it would be appropriate to mention another drinking habit – their fondness for alcohol! Army camps in forests have been deprived of their stocks of scotch by large, trumpeting night visitors (although the bottles could not be opened by the ransackers), distillers of illicit liquor have found their hidden barrels in the jungle emptied, and policemen in search of outlaws in the forest have been confronted by dancing pachyderms!

Seasonal movement and home range of elephants

To ensure that they get the choicest food items available and adequate water, elephants move long distances. These movements become obvious as the seasons change. During the dry season elephants are largely found where water is available, in river valleys and near swamps. When the rains come and water is found everywhere, it is no longer necessary for them to be confined to such places, and they spread out over a larger area. The distance and area that elephants cover vary from one region to another, depending on rainfall and vegetation types. One of the most detailed studies on elephant movement was carried out in the Tsavo National Park of Kenya by Walter Leuthold. He put radio-collars on a number of male and female elephants and tracked their movements, using an aircraft. He also made aerial transects of the Tsavo population to discover the seasonal distribution patterns. This study showed that elephants were largely confined to belts along rivers such as the Tsavo, Galana and Tiva during the dry season, dispersing from there once the rains came. In this relatively dry region the elephants moved considerable distances. The home ranges of some elephants extended over 100km(62miles) and covered an area of over 3,000km^2(1,172 miles^2). Cynthia Moss observed at the Amboseli National Park in southern Kenya that elephants congregate in the swamps during the dry season and disperse from here during the wet months. There is, however, enormous variation from year to year depending on the environmental conditions.

Studies of the Asian elephant have not been so detailed. Robert Olivier, who

radio-tracked a few elephant herds in the rain forests of Malaysia, found that the home range was only 59km^2(23 miles^2) in secondary forest, whereas it was 167km^2(65 miles^2) in primary forest where food was less abundant. My studies in the deciduous forests of southern India showed that elephants may move 20-50km(12-31miles) and cover a minimum home range of 100-300km^2(36-118 miles^2). Since these figures were obtained only from re-sightings of identified elephants, the actual movement would probably have been greater. Here again, elephants occupied the gallery forests, swamps and moist forests during the dry season, and dispersed over a larger area once the rains began.

From these and other studies it seems clear that the movement of elephants is governed by the availability of water and forage during a particular season.

Crop raiding by elephants

Elephants have the habit of raiding cultivated fields and gardens, much to the consternation of farmers across Asia and Africa. In elephant country it is not uncommon for a farmer to look out of his hut at night and find large dark shapes gorging themselves on jack fruit or systematically harvesting his maize field. Elephants have developed crop raiding into a fine art and no amount of persuasion to leave, except the gun, seems to work with them.

The elephants' taste for cultivated crops must have evolved together with the development of agriculture. It is certainly not a new phenomenon. The *Gajasastra*, an ancient account of elephants that may be 2,500 years old, talks about wild elephants devastating agricultural fields in what is today the state of Bihar in northern India. As human settlements and agriculture spread through the plains, river valleys and hill forests, the conflict between elephants and people would have intensified, leading to the elimination of elephants from many of these areas.

Nevertheless, the elephant has persisted in being a connoisseur of many cultivated plants. Staple food crops grown over much of the globe, the cereals and millets, are also greatly preferred by elephants. Rice fields in Asia and maize or millet fields in Africa are frequently raided by them. In a single night's foray a herd of 20 elephants can eat and trample down 2 hectares(5 acres) of crops. A bull party of four or five animals can cause half this damage during the same period. In fact, crop-raiding elephants can satisfy their entire food requirement for 24 hours by spending just seven or eight hours in a cultivated field at night.

For many farmers in poor countries this means the loss of an entire year's crop and the risk of starvation. They also face the risk of being killed if they attempt to chase away the elephants, especially the large bulls. Adult bulls are more tenacious raiders than are the herds, and frequent the fields far more often. In many countries, farmers have resorted to the gun to protect their crops. In Asian countries such as India, a combination of cultural traditions and conservation laws generally prevents farmers from shooting down elephants outright.

In some regions where agriculture is more commercial, losses due to elephants may run into millions of dollars every year. Oil palm and rubber are two money spinners that are common in Malaysia and increasingly so in Sumatra, and plantations of these are often the targets of attack by elephants. The succulent central rachis, or growing shoot, of the oil palm and the bark of the rubber tree are too tempting to elephants. The losses to these plantations were so high in Malaysia during the 1970s that the country had the reputation of having created the million dollar white elephant!

In spite of the hostility shown to them by farmers, elephants continue to prefer crops, for many reasons. Elephants increasingly encounter cultivated fields as human habitation spreads through their former range. When a sugar cane plantation appears along a traditional migration route, the temptation is too great to resist. As the habitat becomes fragmented, the giants are left with too little room for their comfort and tend to spill over into human habitation. Added to this, the quality of their habitat may also deteriorate. This scenario is all too familiar over much of Asia, where the elephant has lost enormous ground. Equivalent situations apply in many parts of Africa. In the Tana River Valley in Kenya, for example, elephants damage crops when they have to traverse fields on their way to water.

Finally, the crops are much more tasty and nutritious than any similar plants that elephants encounter in the wild. When ripe paddy crop or sugar cane is like cake to them, why should they settle for the common bread of coarse grasses?

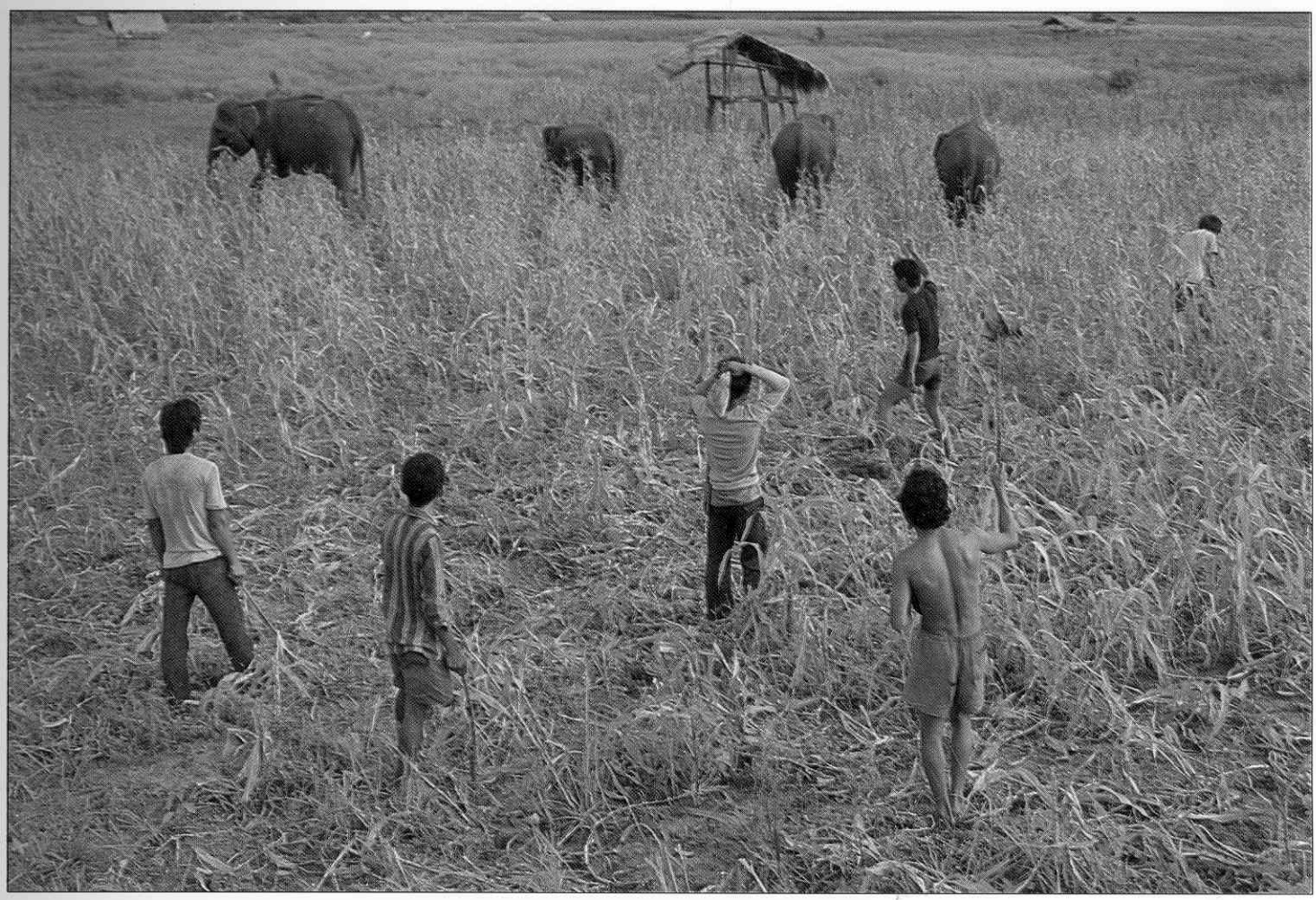
Impact on trees

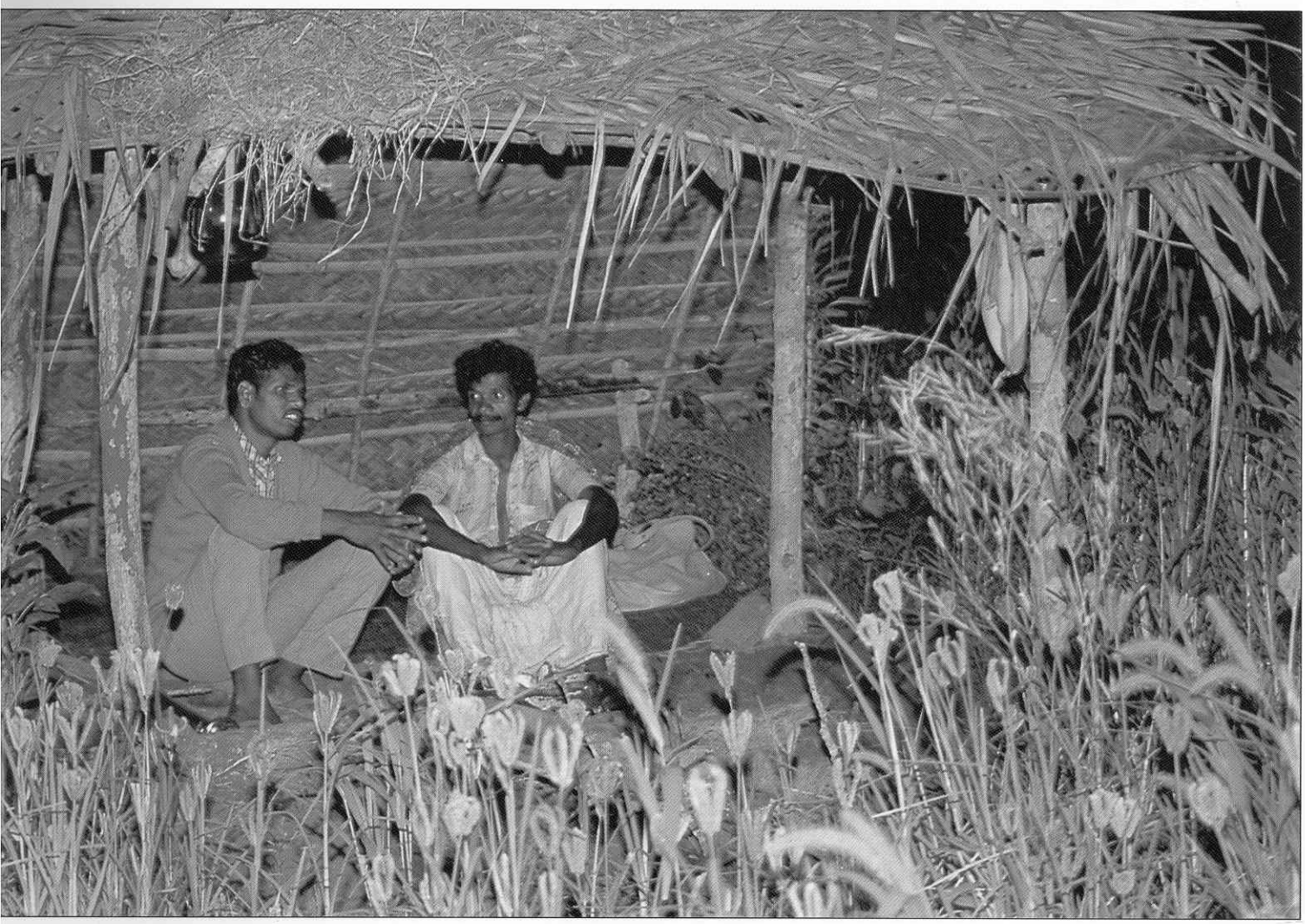
Not only the elephant's habit of demolishing cultivated plants has been of concern to people, but so also has its propensity to debark and push over trees in the wilderness. In the relatively dry savanna-woodland regions of Africa it is not uncommon to come across a landscape that seems as though an army of bulldozers plus a hurricane have passed through the area. Stately baobab trees are reduced to pulp, mature mopane trees flattened or a stand of acacias stripped naked of their life-sustaining bark.

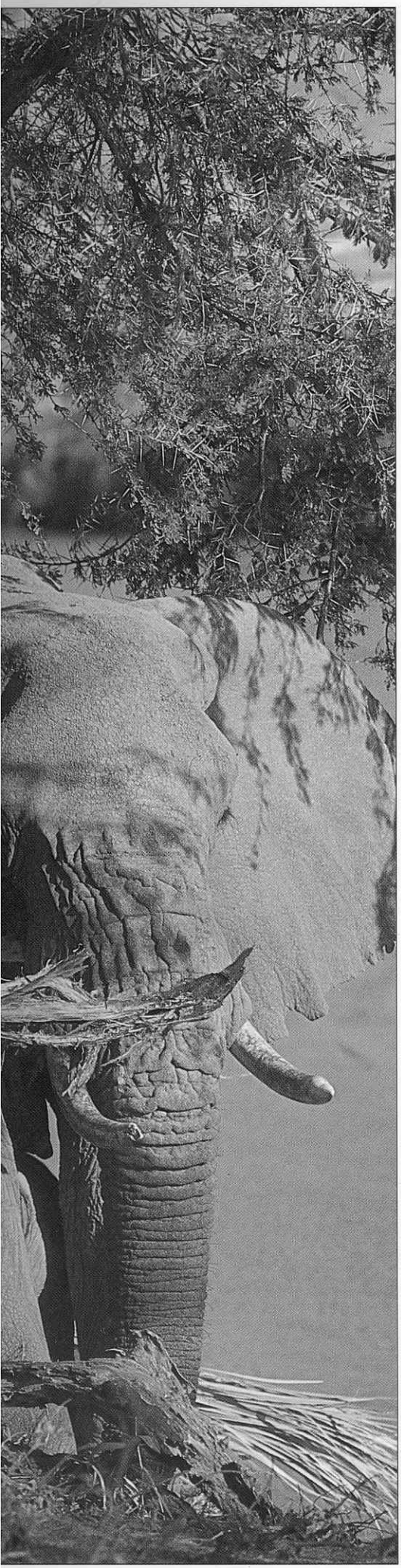
Such scenes of destruction by elephants have led to disagreement between researchers and administrators over solutions to the problem. Some people consider the damage to wood-

Right: *Farmers in the Lampung Province of Sumatra are trying to push out an elephant herd from their maize fields. If they do nothing more than wave their arms, shout and make a noise, there is not much hope that the elephants will depart. A herd can destroy a farmer's entire crop for the season. Raiding of cultivated fields by elephants is a common occurrence in Africa and Asia. Among their favourite crops are rice, maize, millets, sugar cane, palms, banana and many fruit trees. Most of the incursions into crop fields take place at night.*

Below: *In elephant land, farmers must cope with sleepless nights for at least three months of the year. These two men are keeping a nightly vigil over their millet field. The finger millet plants have flowered and, at this stage, the crop is very nutritious and highly attractive to raiding elephants. Keeping guard from a flimsy thatched hut on the ground puts these farmers in great danger of being attacked by elephant raiders. It would be more prudent for them to sit up in a large tree nearby.*







lands and their eventual conversion into grassland by elephants as an unnatural process that is totally unacceptable. In their view the elephant population in such areas has grossly exceeded the carrying capacity of the habitat and therefore elephants have to be killed – or culled, to use a more pleasant euphemism – for the health of both the habitat and the elephants.

Others took a totally different view. Elephants are not destroying the trees or forests, they are merely utilizing them. This is very much a part of nature's inscrutable ways. As the woodlands disappear, the elephants would likewise become reduced in numbers, with a time lag, allowing the trees to regenerate, only to see a resurgence of the elephant population once again. There is no need for man to interfere in nature's affairs by resorting to the culling of elephants.

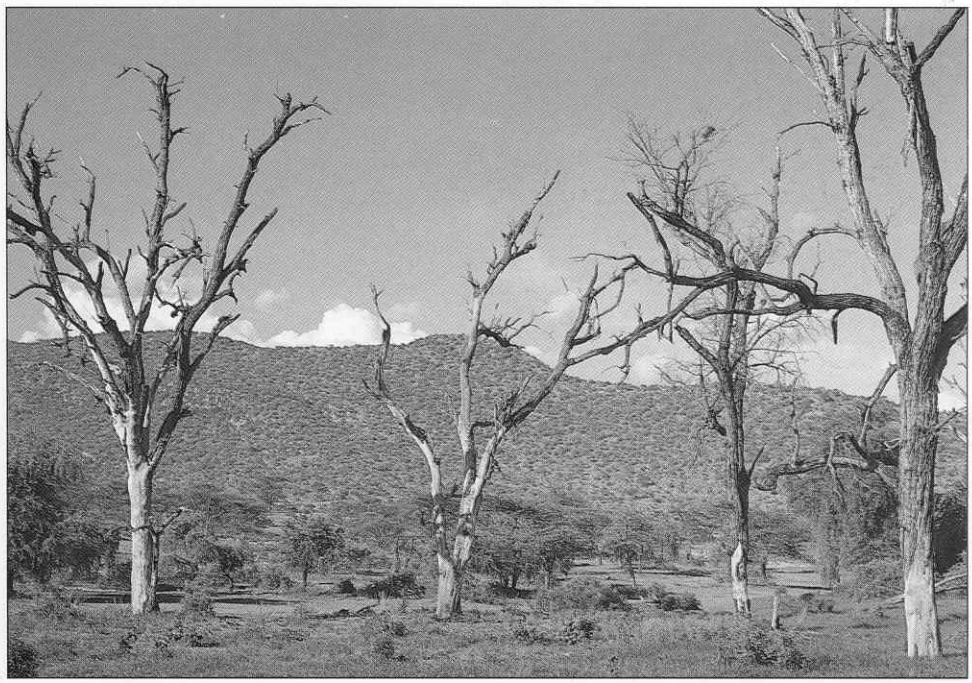
Before going into the merits or demerits of the different points of view, let us first ask why elephants resort to such destructive feeding, and whether this is indeed a threat to tree populations. As we have seen earlier, feeding on the bark of trees may provide nutrients, chiefly minerals and fatty acids, needed for a balanced diet. Stripping of bark or pushing a tree over is not the only way in which it may be killed. The main stem may be broken or all the branches pulled down so that the crown is scanty and distorted in growth. Such trees may never be able to flower and reproduce normally. Even if there is some life left in them, they are as good as dead for practical purposes. Trees damaged by elephants may be susceptible to attack by wood-boring insects or fungi. Such trees fall over more easily when it is windy. A fire may also kill a damaged tree.

Elephants may completely smash up a tree. The wood of the baobab is relatively spongy, and elephants can gouge out the wood with their tusks, or reduce the tree to a pulpy mass. They may feed on the wood in order to obtain some moisture when water is scarce, a possibility that is also true of feeding on sappy bark. Certain trees, such as the mopane, can be pushed over because of their shallow roots; others have weak stems that can be easily broken.

Destruction of woodland has been reported from many semi-arid regions of Africa where elephants are relatively abundant. Early European explorers noticed and commented upon this phenomenon. However, it was not until the 1960s that the particular problem was quantified and scientifically investigated. H.K.Buechner and H.C.Dawkins compared aerial photographs taken in 1932 and 1956 of Murchison (Kabalega) Falls National Park in Uganda. Their study, published in 1961, estimated that during this 24-year period the tree population in the park had roughly halved. Based on later aerial surveys in the park, Richard Laws and his colleagues made the interesting observation that the densities of trees and bushes were low inside the park but much higher outside. Often an abrupt change in vegetation density practically coincided with the park boundary. In areas with the heaviest damage, some 95 percent of *Terminalia glaucescens* trees

Left: *African elephants stripping and feeding on the bark of an acacia tree. The bark may be consumed for its fibre content (to prevent constipation), or for the minerals and other nutrients that it contains. Stripping bark may kill such trees and devastate the landscape.*

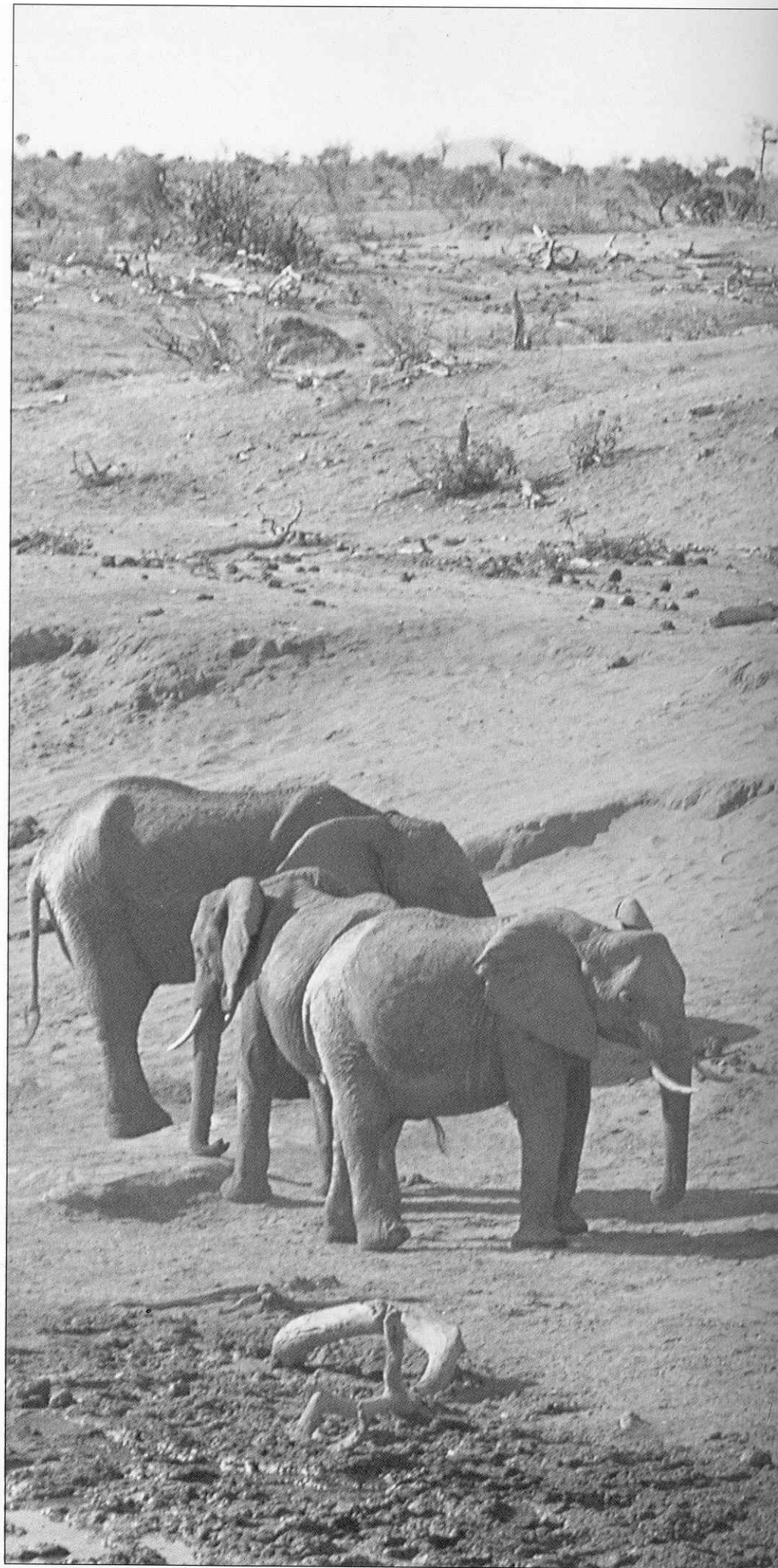
Below: *These acacia trees in the Samburu Nature Reserve, Kenya, have died as a result of being ring-barked by elephants. More 'succulent' trees, such as baobabs, may be smashed by elephants seeking much needed moisture in times of drought.*



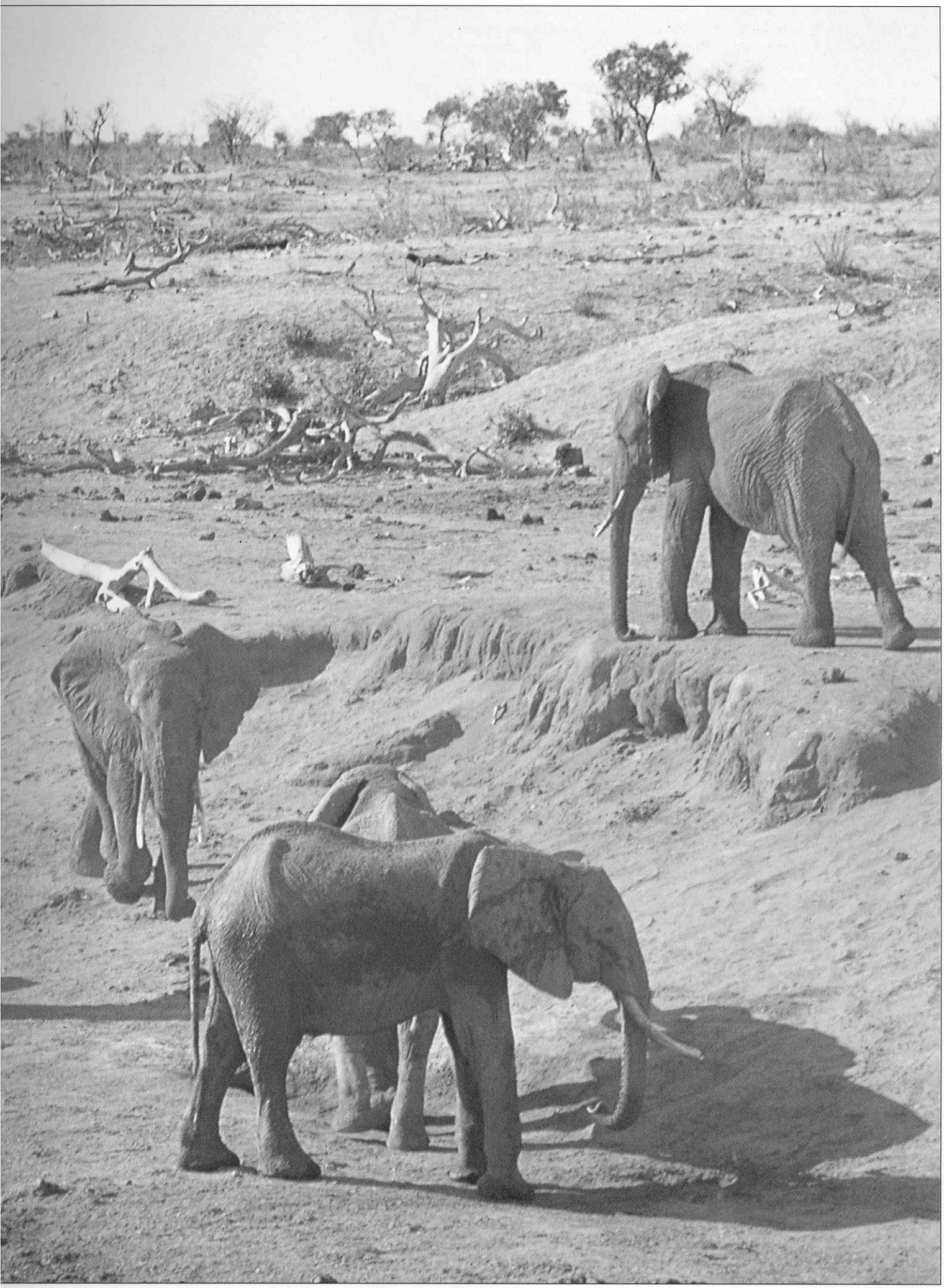
were dead, compared with less than 2 percent dead in areas of low usage. Iain Douglas-Hamilton, working in Lake Manyara Park in Tanzania during the late 1960s, predicted that *Acacia tortilis* would disappear from the park within 10 years due to the heavy damage by elephants. Reports of such damage accumulated from other regions too. In the famous Serengeti National Park there was concern over the disappearance of *Acacia xanthophloea* and other trees. Ruaha in Tanzania, Queen Elizabeth and Kidepo in Uganda, Tsavo in Kenya, Chizarira and Gonarezhou in Zimbabwe, Luangwa Valley in Zambia – all these and more seemed to be plagued by the 'elephant problem'. Although the Asian elephant seemed a gentle cousin by comparison, some reports from Sri Lanka were uncomfortably similar.

Not everyone agreed that elephants were to blame in the matter. R.M.Lawton, studying this phenomenon in Zambia during 1966-70, came to the conclusion that there was no evidence that overfeeding by elephants was responsible for destruction of the habitat. Even plants killed by elephants generally regenerated well through root coppices. He blamed fire for the deterioration of the vegetation. Harvey Croze likewise concluded that the potential of *Acacia tortilis* to regenerate and replace dead trees was being suppressed by fire, not by elephants. Douglas-Hamilton's prediction that *Acacia tortilis* would soon disappear from the Lake Manyara Park did not come true; a decade later, the tree population was very much intact. David Western and C.van Praet found something even more interesting at Amboseli in Kenya. A rising water table was increasing the salinity of the soil and making it difficult for the roots to absorb water. *Acacia xanthophloea* trees were adversely affected by this and were dying in large numbers. For once, the elephant was clearly not the villain.

Different management policies were adopted to deal with the elephant problem. Nature was allowed to take its course in the Tsavo National Park. Following a severe drought during 1970-71, the elephant population here crashed, and at least 6,000 of an estimated 20,000 elephants died of starvation and lack of



Right: *This scene along the Voi River in Tsavo East National Park, Kenya, shows a landscape devastated by elephants and the effects of a prolonged drought. In these desperate conditions, the elephants are gathering near the last-remaining sources of water. Elephants can completely transform their habitat by their 'destructive' feeding habits. An entire woodland may be turned into grassland by elephants breaking and pushing over trees. There has been considerable debate as to whether such transformation is unnatural or a part of natural elephant-vegetation cycles.*



water. Culling programmes were organized in Murchison Falls Park, Luangwa Valley, Chizararia Reserve, Kruger Park (in South Africa) and Hwange Park (in Zimbabwe). In the last two countries mentioned, culling continues as an official management policy. The *status quo* of the original vegetation has been generally maintained in such places. In particular, woodlands have not been converted into grassland.

Judgments on whether to cull or not cannot be made here, but it is pertinent to note that both sides scored points in the debate. In areas where elephants have been virtually eliminated, such as over much of Uganda, the grasslands are in the process of reverting back to woodland. Countries such as Zimbabwe, which regularly cull elephants, have been able to maintain the habitat and the population of elephants in a healthy state of equilibrium. On the other hand, it has not been proved that elephants have caused widespread desertification through destruction of woodland, as feared. Management decisions have to be made by each country's administrators and scientists, based on its own peculiar problems and goals.

Population dynamics

This brings us to the important question of what regulates elephant populations under natural conditions. Is there some self-regulatory mechanism at work that ensures a declining growth rate if there are too many elephants in an area? Otherwise, it is clear that elephant populations would increase to such an extent that they would destroy their food supply and set the stage for a catastrophic decline like that at Tsavo during the early 1970s.

Some of the earliest work on the population dynamics of elephants was carried out by Irven Buss and his associates in Uganda. They found that the number of calves below one year old varied in different populations depending on the population densities. A population with a higher density had a lower rate of reproduction. These findings raised questions about what could be the mechanism for this decline. Could elephants delay the start of reproduction? Could they be reproducing less frequently? Was the decline in birth rate due to changes in behaviour or nutrition?

Detailed studies on elephant populations were clearly needed before these questions could be answered. Soon Richard Laws and his team swung into action in East Africa. Their studies began in the Ugandan parks, and later shifted to Tsavo in Kenya. At this time, Uganda was culling elephants to control the population. This provided the opportunity for scientists to obtain detailed information on reproduction patterns in elephants that otherwise would have been impossible or difficult without long-term studies.

The age of an elephant can be determined from its dentition. Usually the lower jaw is used for this purpose. By examining the reproductive organs of culled elephants, invaluable data could be collected. When a female gives birth a considerable amount of maternal tissue from the uterus lining is also shed, along with the placental tissue. This leaves a permanent scar, which can be easily discerned upon examination. The number of scars in the uterus of a cow elephant is thus the same as the number of pregnancies she has undergone. The ovaries can also be examined, to determine whether an animal has sexually matured. This, together with the presence or absence of uterine scars, indicates the age of first calving. The mean interval between successive calving can be calculated from the number of scars and the age of the elephant.

Richard Laws found that the age of sexual maturity varied greatly from one population to another, but that the males and females within a population matured at roughly the same age. The average age at which a cow matured was 11.7 years at Tsavo but as high as 22.3 years in the Budongo forest of Uganda. The interval between two births similarly varied from 2.9 years at Mkomasi East in Tanzania to

Right: *A radio-collar being fitted by researchers on an elephant in the Hluhluwe Game Reserve, South Africa. The signal from the radio transmitter will enable the elephant to be traced during the study period. The elephant will have been temporarily immobilized with a chemical delivered in a 'dart' syringe.*

Below: *Park staff in Samburu Nature Reserve, Kenya, excavate a hole to provide some water to elephants and other wildlife during an extended period of drought.*

9.1 years at Kabalega Falls Park (North). Clearly, there was enormous flexibility in reproductive parameters that could influence the dynamics of the population.

The age structures of the culled populations also revealed interesting patterns. When these were statistically analyzed they showed a large series of fluctuations with a wavelength of six to eight years. This suggested that there had been cycles of recruitment to the population corresponding to rainfall cycles of similar period in East Africa. The age structures also brought out some disturbing features. In the Murchison (Kabalega) Falls Park the structure for elephants culled in 1966 showed an abnormally low number of elephants up to 20 years of age, suggesting that the birth rate had fallen since 1946. Models of population dynamics indicated that the number of elephants in the park may have declined from 16,000 in 1946 to 9,400 in 1966. This was the first evidence that elephant populations could be regulated if their densities went too high.

John Hanks carried out similar work on elephant reproduction in the Luangwa Valley of Zambia, and G.L.Smuts did so at the Kruger Park in South Africa. All this generated considerable information on elephant reproductive biology and population dynamics.

Studies on the Asian elephant have not been as comprehensive. My own work in southern India showed that female elephants first gave birth between 15 and 20 years of age, but that they reproduced every 4.7 years on average, a rate that was comparable to the productive African populations. The southern Indian population also showed large annual fluctuations in births, similar to those observed in Africa.

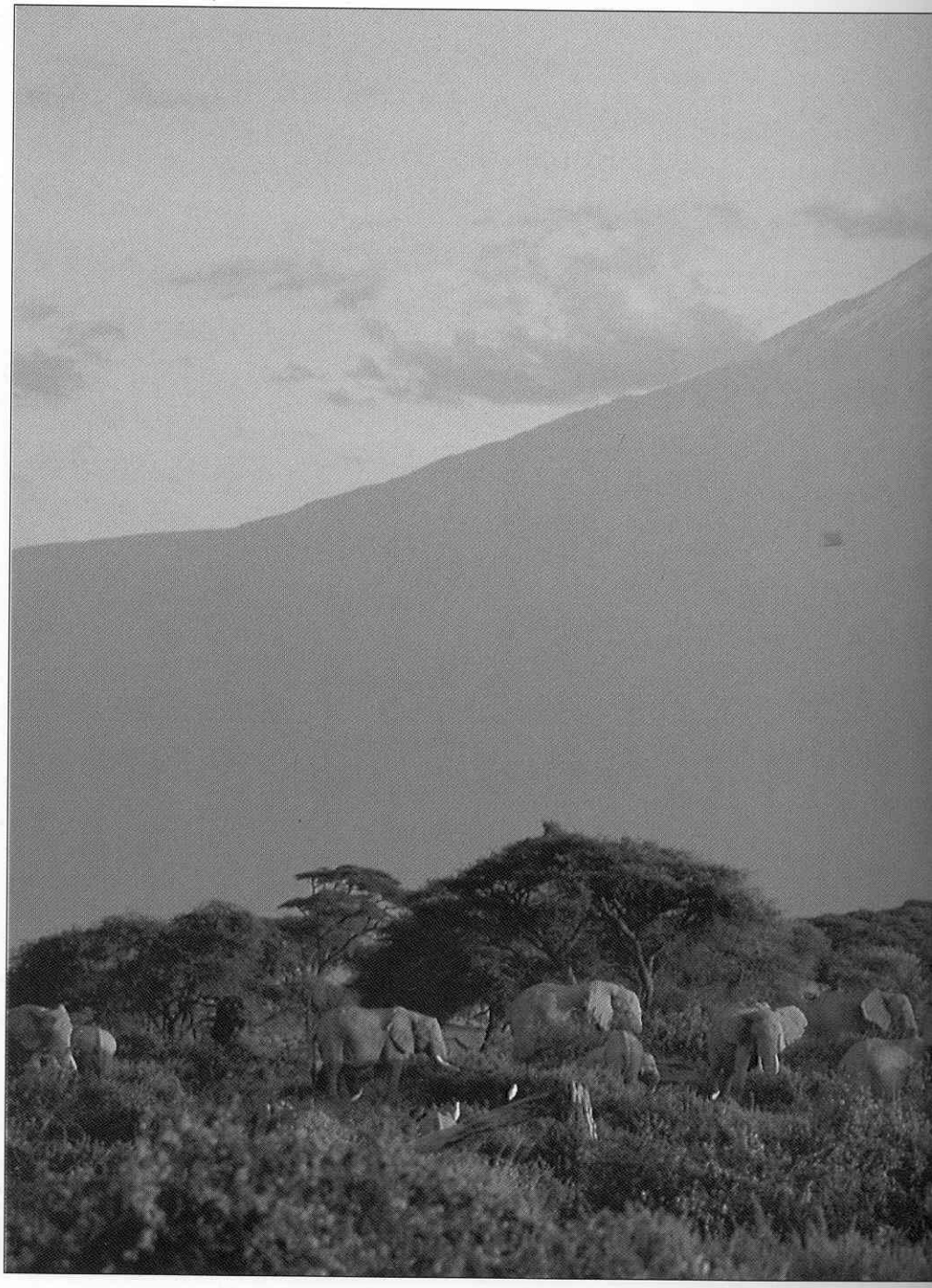
Population ecologist Graeme Caughley came up with an interesting model in 1976 to explain natural regulation in elephant populations. He suggested that elephants and trees do not exist at equilibrium in the East African savannas but that they fluctuate in a manner that is known in mathematical parlance as a 'stable limit cycle'. As the elephant population increases and the tree population declines, the elephants too decline, with a time lag of several decades. This gives a chance for the trees to re-establish and continue the cycle. Based on the age structure of baobab trees in Zambia's Luangwa Valley, Caughley suggested that the interval between successive peaks in the elephant (or tree) population is about 200 years. I argued that in tropical moist forest, elephants and trees would tend to exist at near equilibrium.

If elephant and tree populations were indeed undergoing cycles of such long duration it would be very difficult to prove this with a few years' observation. Elephant populations are usually well buffered against the vicissitudes of the environment. A long-lived mammal such as the elephant has very low mortality rates. Between the ages of 5 and 40 years the annual death rate may be less than 2 percent in most populations. Even juvenile mortality is relatively low and normally does not exceed 10 percent in a year. At the same time, elephants also breed very slowly. With a gestation period of 20-22 months followed by one or two years of anoestrus, an elephant population cannot breed as rapidly as most other mammals could do. (For more information on this, see the chapter on *Reproduction* starting on page 64.)

Computer models have shown that given the best of conditions an elephant population can increase at not more than about 4 percent a year. Real populations probably increase at much lower rates. In regions where they have been known to increase at greater than 4 percent this has been in part due to immigration of elephants from other regions and not solely due to intrinsic increase.

The elephant is adapted to breed slowly but maintain a high population and biomass level. Such species usually live at close to the carrying capacity of the habitat, and are termed *K-selected* (the K signifies carrying capacity, as opposed to *r* signifying rate of increase). The elephant is the best example of an extremely K-selected species.

The population dynamics of a long-lived species such as the elephant can be understood only if long-term studies are carried out on them. The most detailed information on all the individuals in a population is available for the elephants of the Amboseli National Park in Kenya. Research on this population by Cynthia Moss and other biologists has shown how misleading it can be to look at short-term data gathered over a few years. In 1973 the population was estimated to con-



sist of 602 elephants. Over the next six years the numbers declined to 478 in 1978. During one year (1976) alone there was a decline of 49 elephants, or 9 percent of the total population. Seeing this trend, anyone would have concluded that the elephant population was doomed to decline further.

From 1979, however, the Amboseli population began to increase, and reached 674 by 1983. That year witnessed a phenomenal increase of 70 elephants (an 11.6 percent growth), but this should not be seen in isolation. The overall trend was an increasing population between 1973 and 1983. These data showed how year to year fluctuations may occur in births and deaths within an elephant population. This is largely related to the rainfall patterns. The Amboseli study has clearly brought out the need for taking a long-term perspective of elephant population dynamics.

The wave of ivory poaching during the 1970s and 1980s in Africa has, of course, resulted in the total disruption of social structure and population dynamics of its elephants. Large bulls have been shot to a disproportionately greater extent, resulting in unequal sex ratios with fewer males and more females. Shooting of elephants in family herds has caused changes in social behaviour. The impact of these changes on the future dynamics of the populations has yet to be studied.

The Asian elephant has also been poached, but in this species it is only the males that are killed for tusks. In one sense this is a far better situation than in Africa in that the females, which are more important in contributing to future generations, are immune from ivory poaching. In southern India my own studies have shown that a sex ratio of one adult male for every five adult females does not have any negative effect on the fertility of the population. In some regions the sex ratios have since then become even more unequal. It remains to be seen how these populations will respond. One possibility is that the tuskless bulls, which are relatively few in number, could increase in relation to tusked males. Southern India's elephants could then begin to resemble the northeastern population, in which at least half of the males are tuskless or, if poaching is very severe, the Sri Lankan population, where over 90 percent of the males are tuskless.

Below: *An elephant herd in Amboseli, Kenya, crosses the plains at the foot of the snow-capped Mount Kilimanjaro, rising majestically 5,895m(19,340ft) above the surrounding countryside. This is a classic – if well-known – image of animals in harmony with their environment. Understanding the ecology of elephants is a vital step in conserving them where they are threatened.*

DISTRIBUTION OF THE AFRICAN ELEPHANT

Originally the range of the African elephant extended throughout Africa except for the Sahara. Most of the populations in the north of the continent were exterminated in classical times and all had disappeared by the middle ages. The elephants in southern Africa did not long survive the arrival of the settlers but elsewhere, the elephant was still numerous and widely distributed until well after the Second World War. Nevertheless, numbers had probably started to decline in many regions by the 1920s and 1930s as the human population expanded, under the protection of newly acquired firearms, into the elephant's domain.

The true state of affairs did not become apparent until the early 1970s, when a drastic reduction in numbers was recorded in Uganda, where elephant numbers in one national park crashed by 87 percent within two years. Investigation showed that the decline was not confined to that country but was widespread throughout East Africa. Ivory poaching coupled with a breakdown in law and order, or at least in the means to conduct effective anti-poaching operations, seem to be the likely causes of the decline.

An overall view

The first attempt at a comprehensive census of elephants throughout Africa was made in 1979 by Iain Douglas-Hamilton, who produced a figure of 1,343,340 from 35 countries. The only thing that one can be certain about this total is that it is wrong! This is no reflection on the competence of the compiler, for the information was derived from a number of sources, of varying quality, by observers using a variety of methods, ranging from carefully planned and executed aerial counts in open country to rank guesses for the rain forests. It is probably of the right order of magnitude, however, and a figure of about a million may not be far wrong. A further extensive, but not comprehensive, survey was organized by Douglas-Hamilton some eight years later and this revealed a decline, as the total came to only 410,235 in 32 countries.

Although published in 1979 and 1987 respectively, these figures do not refer to specific points in time since the data for both surveys were collected over extended periods. It is unlikely that the decline in numbers has now levelled off; current counts, particularly in East Africa, continue to reveal reductions in numbers. Most losses occurred in East and West Africa and, to a lesser extent in Central Africa. Populations were stable in most southern African countries.

West Africa

West Africa has seen a progressive reduction in numbers throughout the present century, possibly as a result of overexploitation for ivory. Loss of habitat has also played a part and continues to be a threat to the remaining populations.

The West African elephants are now split up into a number of scattered, small groupings, none of which contains more than a few hundred animals and most very many less. These populations are not only small but are also declining, and the prospects for their long-term survival seem bleak.

Central Africa

Although West Africa can be considered a disaster area for elephants, the situation in Central Africa is much brighter because of the still extensive rain forests in the Zaire Basin. Although improved techniques are being developed for estimating numbers in forests (mainly from dung counts), it is still impossible to gauge the numbers present with any great degree of precision. Nonetheless, it can safely be assumed that populations comprise tens, if not hundreds, of thousands, and protection of the central African rain forests represents the best chance for the conservation of elephants because, in the main, forest elephants do not come into conflict with man to the same extent as they do in the savannas. Nevertheless, numbers in Central Africa seem to be following the same downward trend as in other parts of the continent, particularly in those populations outside the protection of forests. The Central African elephants may be reduced in number but they are still very plentiful and the prospects for their survival are not necessarily pessimistic.

East Africa

The elephants of East Africa have received considerable research attention over the years and consequently their numbers in certain areas are known with some precision. The country with the most is Tanzania, whose population was estimated to be 130,369 in 1987. This may seem a lot but it is only about 40 percent of the total reported in 1979, and many of the estimates in the 1987 total were made ten or more years previously. Most of the elephants (55,000) are in the Selous Game Reserve, with another sizeable population of 34,725 in the Ruaha/Rungwa/Kizigo region. Neighbouring Kenya still holds a respectable 34,034, according to the survey, but Uganda is well down with only 2,059; the 1979 estimates for these two countries were 65,000 and 6,000 respectively. The figure for Uganda is probably optimistic; a count in 1991 in all the Ugandan national parks came to only 844 animals. Ethiopia, on the other hand, appears to have shown a marked increase, from an estimated 900 in 1979 to 8,650 in 1985. It is unlikely that numbers have increased that quickly and it is more probable that the earlier counts were inaccurate. Of the other East African countries, elephants have been almost eliminated from Somalia and greatly reduced in the Sudan.

Southern Africa

In southern Africa, Zambia (62,009), Zimbabwe (46,977) and Mozambique (27,150) form a block of contiguous countries with large numbers of elephants, which, in Zimbabwe, are still rising from the 30,000 reported in 1979. Mozambique and Zambia, on the other hand, have suffered massive drops from the previous totals of 150,000 and 54,800 respectively. Elephants are increasing in Botswana, where the total is thought to be of the order of 39,000. Over 5,000 elephants are estimated to live in Namibia and although this is not a high number, half of them are found in the Etosha National Park, where they are secure. The small population of 2,350 in Malawi is also now secure and appears to be stable, after suffering some vicissitudes in the early 1980s. Most of the elephants in South Africa are confined to the Kruger National Park, where their numbers are held at around 7,000 by the culling of any excess. With a total population approaching 200,000 and with excellent management policies in many of the countries, southern Africa is perhaps the most important region for elephant conservation.

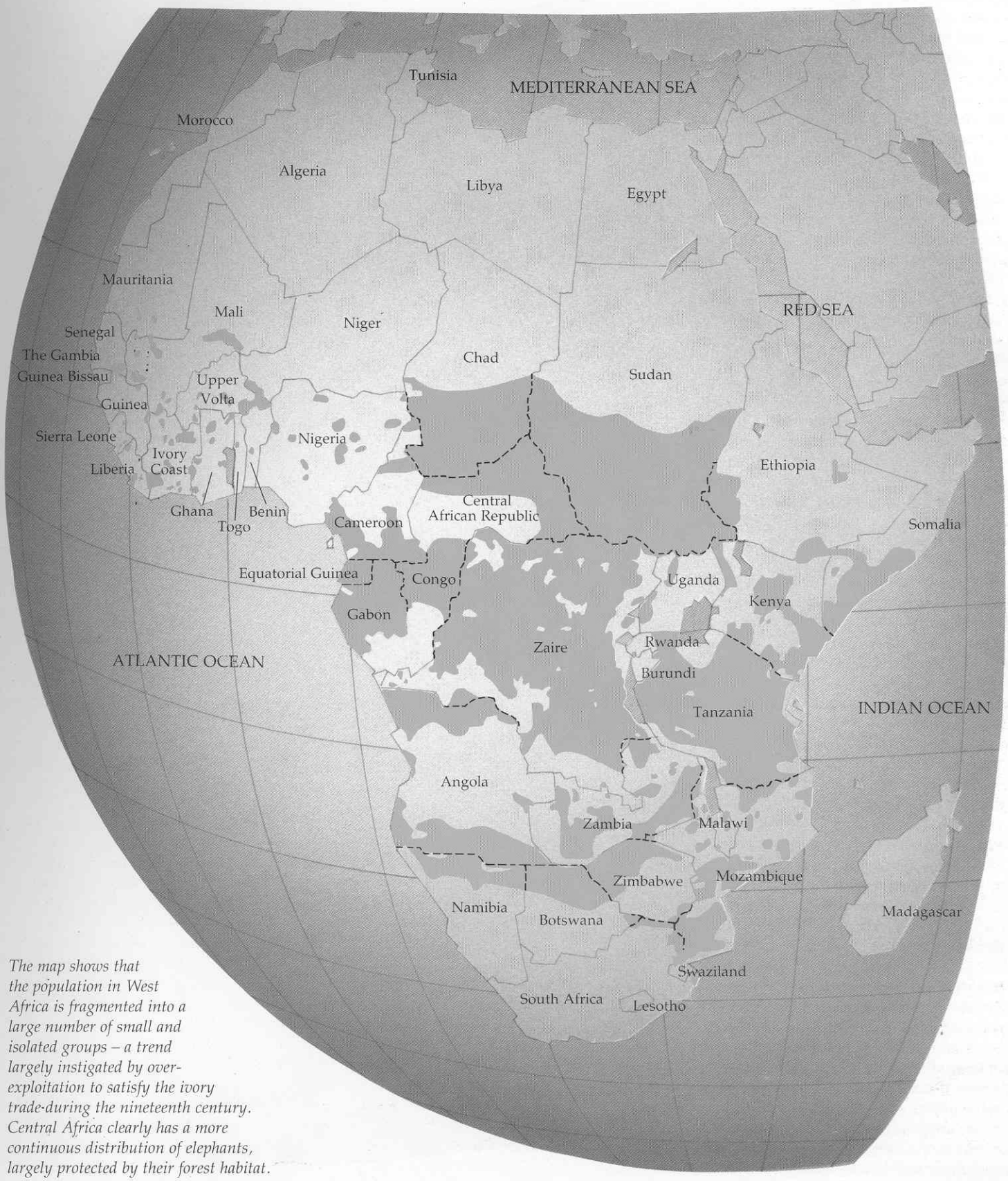
Prospects for the future

In conclusion, it can be said that with a population totalling several hundred thousand, the African elephant is in no immediate danger of extinction. One cannot be complacent, however, in view of the rapid and comprehensive population crashes that have occurred in so many countries. It is likely that numbers will decline still further until a level is reached that is compatible with the increasing demands for land by the burgeoning human population. The African elephant should, however, be conservable as a species provided enlightened management policies are carried out. In the long run, it is conservation of habitat, rather than protection from hunting, that is likely to ensure the elephant's future.

Key

- Distribution of African elephants
- Country borders

This map reflects the current estimated distribution of African elephants. The country borders are dotted in black where they are obscured by the distribution areas.



The map shows that the population in West Africa is fragmented into a large number of small and isolated groups – a trend largely instigated by over-exploitation to satisfy the ivory trade during the nineteenth century. Central Africa clearly has a more continuous distribution of elephants, largely protected by their forest habitat.

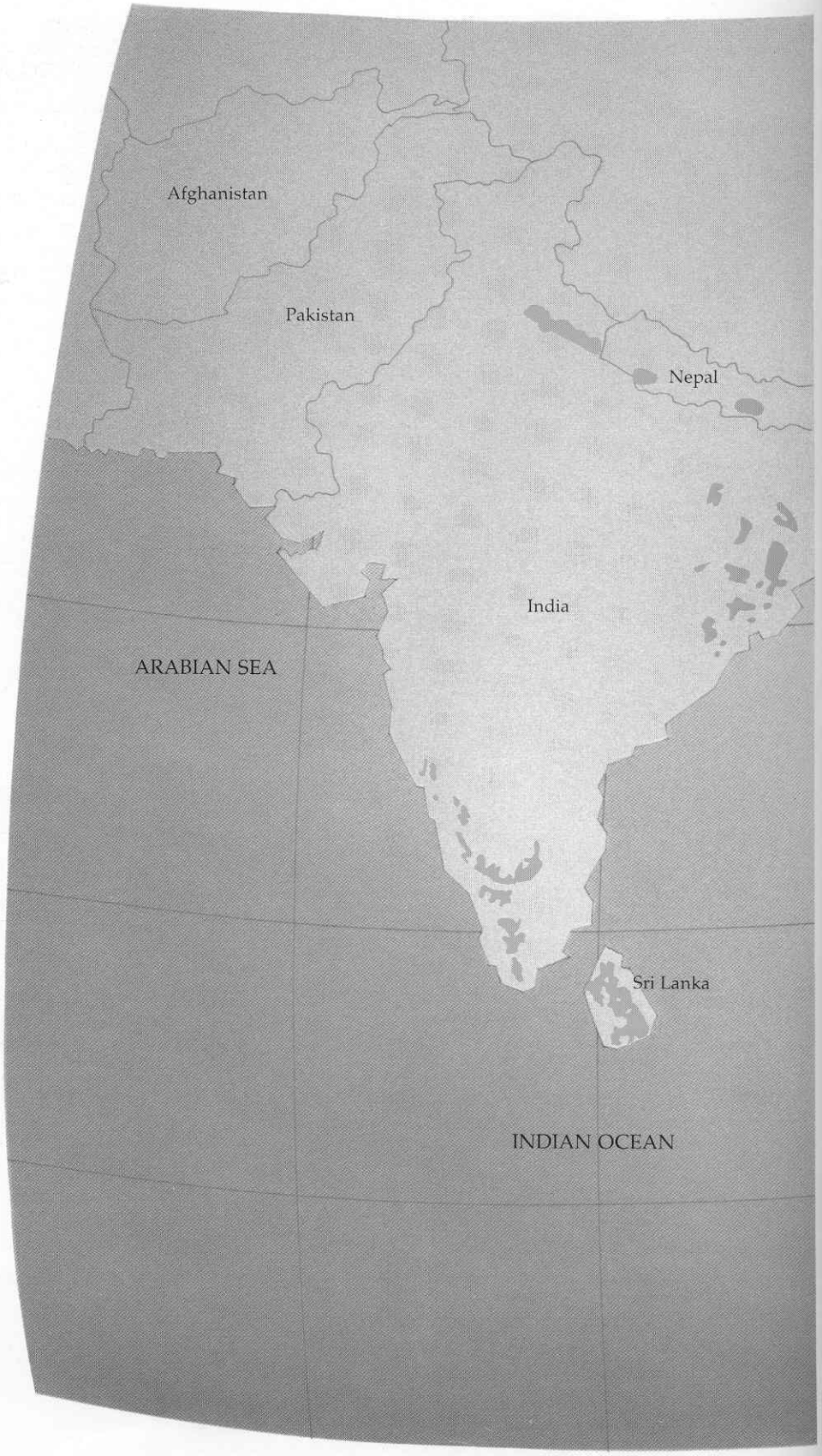
DISTRIBUTION OF THE ASIAN ELEPHANT

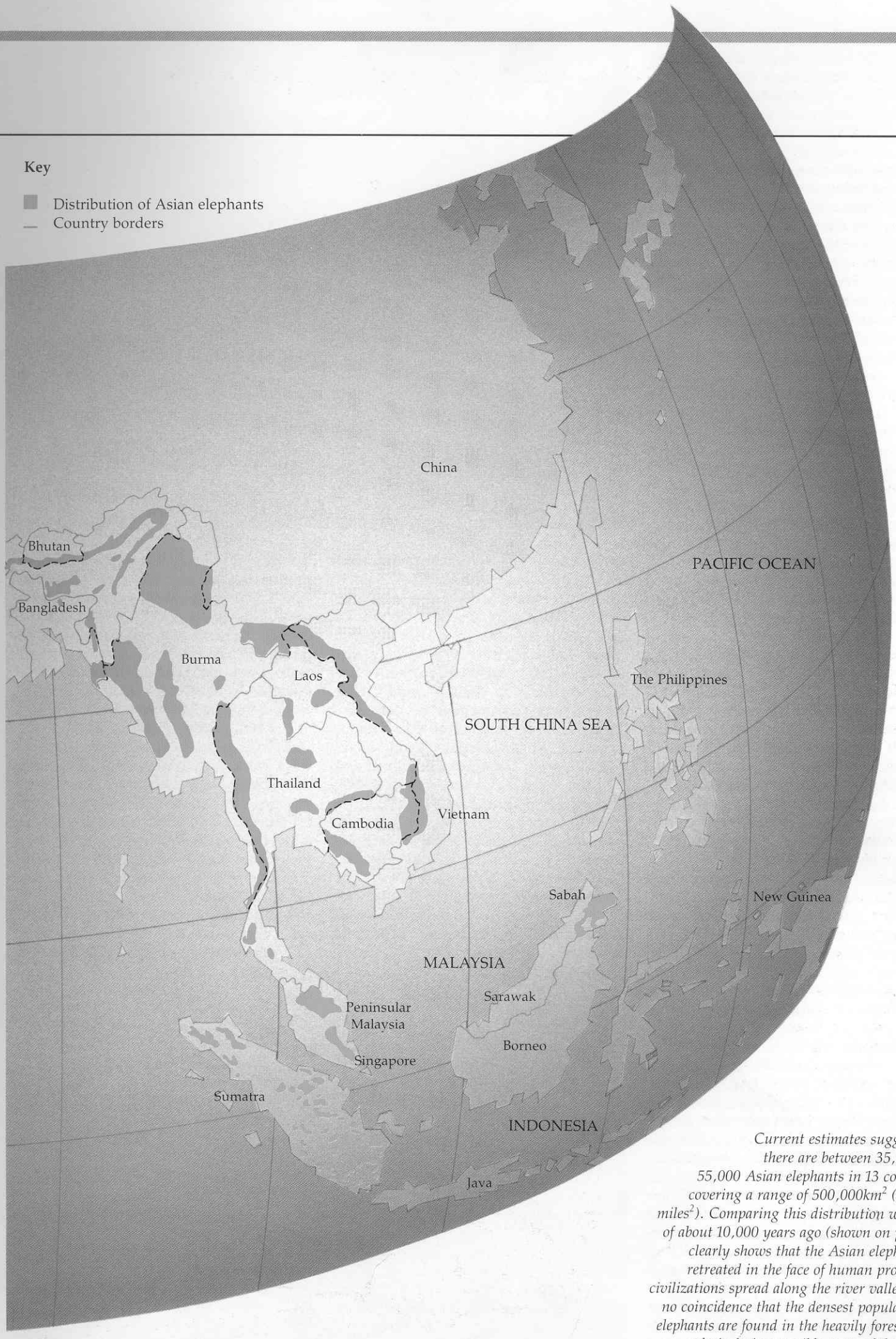
The Asian elephant once had a widespread distribution, from the fertile Tigris-Euphrates crescent in western Asia eastward up to the Yangtze Kiang and perhaps even beyond this in northern China. In the not too distant past *Elephas maximus* may even have met its African cousin in the West Asian/North African cradle of human civilization. Its range covered present-day Iraq and nearby countries, southern Iran, Pakistan, the entire Indian subcontinent and continental Southeast Asia, southern and eastern China, and islands such as Sri Lanka, Sumatra, Borneo and possibly Java. It has been wiped out entirely from western Asia, a major part of the Indian subcontinent, substantial areas of Southeast Asia and almost entirely from China.

The retreat of the Asian elephant can be traced to the spread of human civilization along river valleys and plains. This largely pushed the elephant into the forested hills, which were relatively inaccessible to people. During this century, even these last frontiers have been breached by man in many regions. Hill slopes have been put under the plough and valleys submerged by dams. In Asia, elephants today have their backs to the great wall of human 'progress'.

Estimates of numbers of elephants in forested habitats are largely guesses, sometimes 'educated' guesses, but at other times 'wild' ones. It is extremely difficult to organize a proper census in a forest. It can also be very frustrating, as no elephant may be seen, even after days of wandering in dense rain forest, where elephants are found at very low densities. One does come across elephant dung, however, and the best way of estimating elephant numbers here may be simply by counting dung piles. Objective estimates of Asian elephant numbers are available only from parts of India and Sri Lanka, and from one or two places in Sumatra and Thailand.

The Asian Elephant Specialist Group of the International Union for Conservation of Nature and Natural Resources (IUCN) and World Wide Fund for Nature (WWF) has been mapping the distribution of elephants since the late 1970s. (For more information on the objectives of this group see the text panel on page 177.) With anywhere between 17,000 and 22,000 elephants, India has the largest numbers in the wild among the Asian countries. The elephants are found in four widely separated regions. In southern India, the elephant ranges over the chain of hills known as the Western Ghats and adjoining portions of the Eastern Ghats in the states of Karnataka, Kerala and Tamilnadu. The once continuous distribution has been broken up by developmental projects such as dams, tea and coffee plantations, agriculture, railway lines and roads. About 6,000-8,000 elephants are found here, of which the largest populations inhabit the Nilgiri Hills and Eastern Ghats (4,000-5,000), the Anamalai Hills (800-1,000) and the Periyar





Current estimates suggest that there are between 35,000 and 55,000 Asian elephants in 13 countries, covering a range of 500,000km^2 (193,000 miles^2). Comparing this distribution with that of about 10,000 years ago (shown on page 15) clearly shows that the Asian elephant has retreated in the face of human progress as civilizations spread along the river valleys. It is no coincidence that the densest populations of elephants are found in the heavily forested and relatively inaccessible parts of the region.

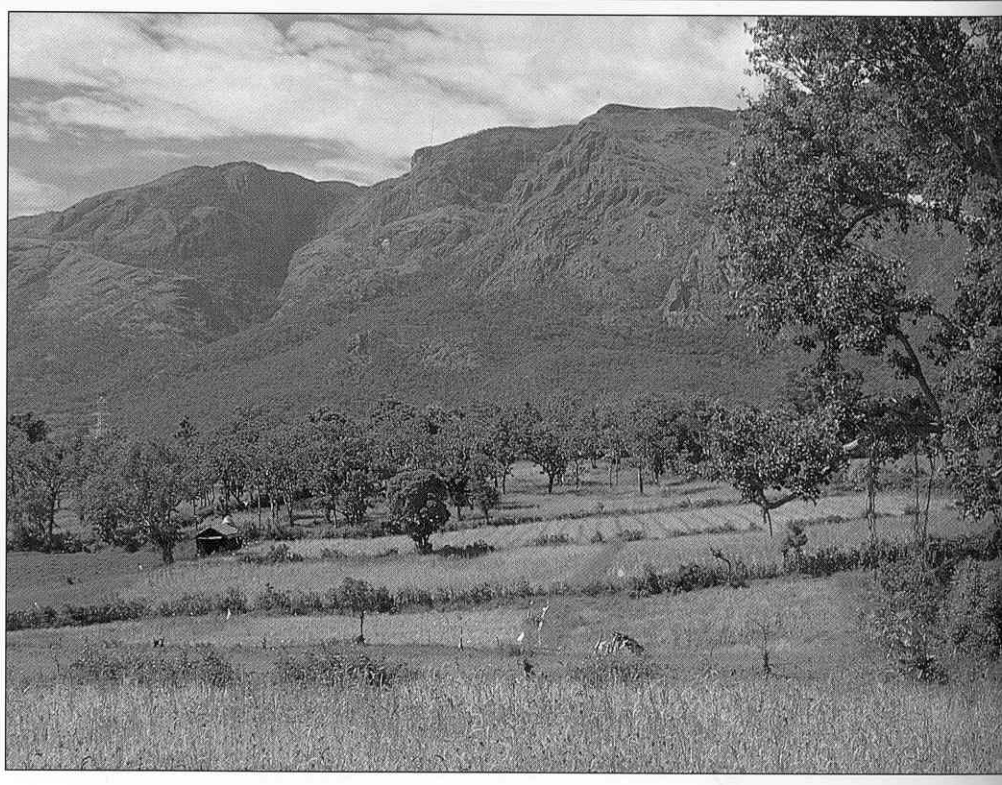
Plateau (700-1,000). Elephant densities in these places are as high as in the well-known African parks. Nagarhole, Bandipur, Mudumalai, and Periyar reserves in southern India are among the best places to see elephants in Asia. The diverse habitats – evergreen forest, deciduous forest and thorn scrub – available to elephants within a relatively small area is no doubt an important factor in supporting these high elephant densities.

Elephants in the east-central states of Bihar and Orissa live in a highly fragmented habitat that is fast degrading under intensive slash-and-burn shifting cultivation. S.P.Shahi and S.Chowdhury estimate that a total of about 1,600 elephants may exist within this region, but these are scattered as numerous small populations. Only the Simlipal Reserve with 375 elephants and the Satkosia Reserve with 300 elephants seem to offer some hope for these beasts.

The narrow belt of moist forest at the foothills of the Himalayas in the north-western state of Uttar Pradesh is home to about 750 elephants according to an estimate by V.B.Singh. Although their habitat is secured in the Rajaji and Corbett reserves, they still have problems of free movement due to irrigation canals and human settlements.

The largest numbers of elephants in India are to be found in the north east. Our knowledge of the elephants there comes mainly from the work of D.K.Lahiri-Choudhury. Here again they are to be seen in a wide range of habitats, from alluvial floodplains of the Brahmaputra River, through semi-tropical rain forests, to the snow line in the Himalayas. One large population of 3,600-5,600 elephants inhabits the lower hills of the Himalayas from northern West Bengal eastward into Arunachal and Assam. The Manas Reserve in Assam is probably one of the finest places in the region for both elephants and a variety of other endangered animals. Another sizeable population of 1,700 elephants or so is found in the Kaziranga Reserve along the south bank of the Brahmaputra and in the nearby hills. A third large population, estimated at 2,500-3,500 elephants, ranges over the Garo Hills and Khasi Hills in the state of Meghalaya. They lead a precarious existence here because their habitat is subject to uncontrolled slash-and-burn shifting cultivation. Although northeastern India has the largest proportion of India's elephants, it is not the region where they necessarily have the best prospects for survival. Large areas of their habitat are not government-owned reserve lands and are fast degrading. Conservation has also generally taken a back seat due to political problems.

Nepal has very few elephants that are resident. Less than 100 seem to exist here and of these, at least half also move into the Indian state of Uttar Pradesh. Bhutan's elephants are similarly partly shared with India across the border with the state of Assam. The Bhutan side of the Manas Reserve is the most important habitat for elephants.



Bangladesh has about 300-350 elephants, mainly in the Chittagong Hills bordering India and Burma. Some of these elephants undoubtedly move across the international borders. Two reserves, one in the Chittagong tract and another in Cox's Bazar, are being planned by the government for the protection of elephants.

Burma may still hold some surprises with regard to its elephant population. Historically, large numbers of elephants have been captured from the forests here, and this still continues to some extent. Elephants are widespread in Burma, because a large proportion of the country is still under forest cover. Teak and bamboo forests, favourite haunts of elephants, are plentiful. Although information on distribution and status is very hazy, it is certain that Burma has the largest number of Asian elephants after India. A conservative estimate of 5,000-10,000 elephants can be made for the wild population. These are distributed in the northern hills, the Arakan Yoma in the west bordering Bangladesh and India, the Pegu Yoma in the central region, the eastern Shan states and the Tenasserim Yoma in the southern part of Burma bordering Thailand. The largest populations seem to be in the northern hills and the Irrawaddy and Chindwin valleys.

All this does not mean that the elephant picture in Burma is rosy. Political rebellion in many regions has made it impossible for anyone to take stock of the true situation. In recent years the Karen people have been poaching elephants on a large scale and smuggling the products, including ivory and skins, into Thailand for sale. Burma is still a closed country to the outside world and, until a proper field assessment can be made, it must be assumed that the elephant is in as much trouble there as elsewhere in Asia.

The last frontier of elephants in China is the southern province of Yunnan along the border with Burma and Laos. Less than 250 elephants seem to survive here, largely in the Xishuangbanna Reserve.

Thailand, the land of the sacred white elephant, has lost its former glory. From a spread covering 80 percent of the country during the 1930s, the forest cover has dwindled to only 30 percent of the land at present. Indiscriminate deforestation for timber and agriculture has been responsible for this attrition. The elephant has also suffered in the process. An estimate of 2,600-4,450 elephants in the wild was made in 1977 by Boonsong Lekagul and Jeff McNeely. Since then, it is certain that the population has been further reduced.

The majority of Thailand's elephants are found in the north and west in the Tennaserim Hill range along its border with Burma. The hills have a diversity of vegetation, including dry forests, which are a favourite habitat of elephants. Two protected area complexes, one in the north comprising Om Koi, Maetuen and Mai Ping reserves, and another in the west including the Huai Kha Khaeng, Thung Yai, Sri Nakarin and Erawan Falls reserves, seem to offer the best hope for elephants here. A significant population also occurs in Peninsular Thailand to the south. The Petchabun Mountains in the north east and the Dangrek Mountains

Left: *Millet fields in a village located within elephant habitat in southern India. The Asian elephant has declined through the centuries, mainly because of the loss of its original habitat to the inexorable expansion of human settlements and their agriculture.*

along the border with Kampuchea (Cambodia) to the south east are other elephant areas. In the Dangreks, the Khao Yai National Park is probably the best place to see elephants in Thailand. Robert Dobias, who has studied the elephant situation in Thailand, estimates that only 500-1,500 elephants are found in the protected area network, which extends over some 25,000km^2(9,655 miles^2).

Laos does not exactly contain a million elephants, as the literal translation of its name implies; in fact, it has only 2,000-3,000 in the wild, according to the most recent estimate. Most of the elephant range occurs along the border with Vietnam to the east. Scattered populations are also found west of the Mekong River in Sayabouri Province and in the highlands along its borders with China to the north and Burma to the west.

Hardly any worthwhile information is available for Kampuchea (Cambodia), where a large proportion of the country is still forested. The stronghold (if one may use this term) of the elephant seems to be along its border with Vietnam to the east, although a considerable number may also be present in the Dangreks to the north west and in the Cardamom and Elephant mountains to the south. Only a 'guesstimate' of 2,000 elephants is available for this country.

With Vietnam gradually recovering from the ravages of war, there is now hope that knowledge about the status of its wildlife will improve. For the present, one has to be content with Le Vu Khoi's recent educated guess of 1,500-2,000 elephants, entirely confined to the east along the border with Laos and Kampuchea. As in the other two neighbouring countries, both elephants and people going in search of them have to contend with unexploded bombs and mines.

Peninsular Malaysia's elephants are confined to its equatorial rain forests, which are now in a fragmented state, largely as a result of the development of rubber and oil-palm plantations. Mohammed Khan bin Momin Khan estimates that less than 1,000 elephants survive in the peninsula. A significant number of these seem to exist as isolated herds that have no hope for the future. A well-organized programme of translocating such small elephant herds to more viable areas is operating here. The most promising area for long-term conservation is Taman Negara (literally 'national park'), with an estimated population of 150-200 elephants.

The island of Sri Lanka has a rich and ancient elephant culture. As in other Asian countries, the elephant population has declined drastically in the wild. Sri Lanka's 3,000 or so elephants, as estimated by A.B.Fernando and more recently by S.K.Kotagama, are found in the drier habitats in the north and the east of the country. Agricultural development has led to the pocketed herd phenomenon in many areas. The Accelerated Mahaweli Development Scheme in the country's largest river basin, involving the construction of numerous dams coupled with agricultural expansion, is expected to make a serious impact on elephants and their habitat. To cope with the anticipated attrition of their habitat, the country has established a network of protected areas linked wherever possible by corridors. (See page 159.) Some of the best-known reserves where elephants can be seen are Wilpattu in the north west, Somawathiya and Maduru Oya in the Mahaweli Basin to the east, and Gal Oya, Ruhuna and Yala in the south east.

The elephant is widespread on the island of Sumatra (Indonesia), the only catch being that it exists as 44 distinct small populations, which have been mapped by Raleigh Blouch and Charles Santiapillai. As in Malaysia, the elephant habitat is almost entirely dense rain forest, often in hilly, inaccessible terrain. Agricultural development, including commercial plantations of rubber and oil-palm, and the transmigration of people from Java have been largely responsible for the reduction in forest cover.

Only 15 populations in Sumatra are believed to consist of over 100 elephants each. The total population on the island is estimated at 2,800-4,800 elephants. The 28 protected areas here have a maximum of 2,500 elephants. According to Charles Santiapillai, the most important of these reserves for elephant conservation are Gunung Leuser, Way Kambas, Kerinci-Seblat and Barisan Selatan.

The origin of elephants on the island of Borneo is not clear. There is fossil evidence that elephants once occurred in Borneo, but no-one is sure whether or not these died out and were replaced by captive elephants brought to the island in 1750 and later set free. Today, elephants are confined to the north east, largely in Sabah (Malaysia) and a small area in Kalimantan (Indonesia). Anywhere from 500 to 2,000 elephants may occur in the dense rain forests in hilly country.

In the final tally, there seem to be between 35,000 and 55,000 Asian elephants left in the wild. Their range covers an area of about 500,000km^2(193,000 miles^2). Even if we consider the 15,000 Asian elephants in captivity, the population numbers and range area of the Asian elephant are less than one tenth of the figures for the African elephant.

Left: *Mother and son enjoy a drink from a lake in a swamp in Mudumalai Wildlife Sanctuary, India. This sanctuary extends over an area of 321km^2(124 miles^2) in southern India and has one of the highest densities of elephants in Asia. Asian elephants are found in a variety of habitats, from dry thorn jungle, and grasslands to deciduous and evergreen forests.*