



THE VANISHING ELEPHANT

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One of the main trends observed in the process of animal evolution is increase in size. This trend reached a culmination in the dinosaurs, or terrible lizards. The same trend is visible in the mammals, as well. The blue whale, an aquatic mammal, is the largest living animal, attaining a length of over 30 meters. On land too there are giants. Some have become extinct like the giant ground sloth, and others are still living like the rhinoceros, giraffe and the elephant. Elephants are an important group of animals. Many reasons can be given for this.

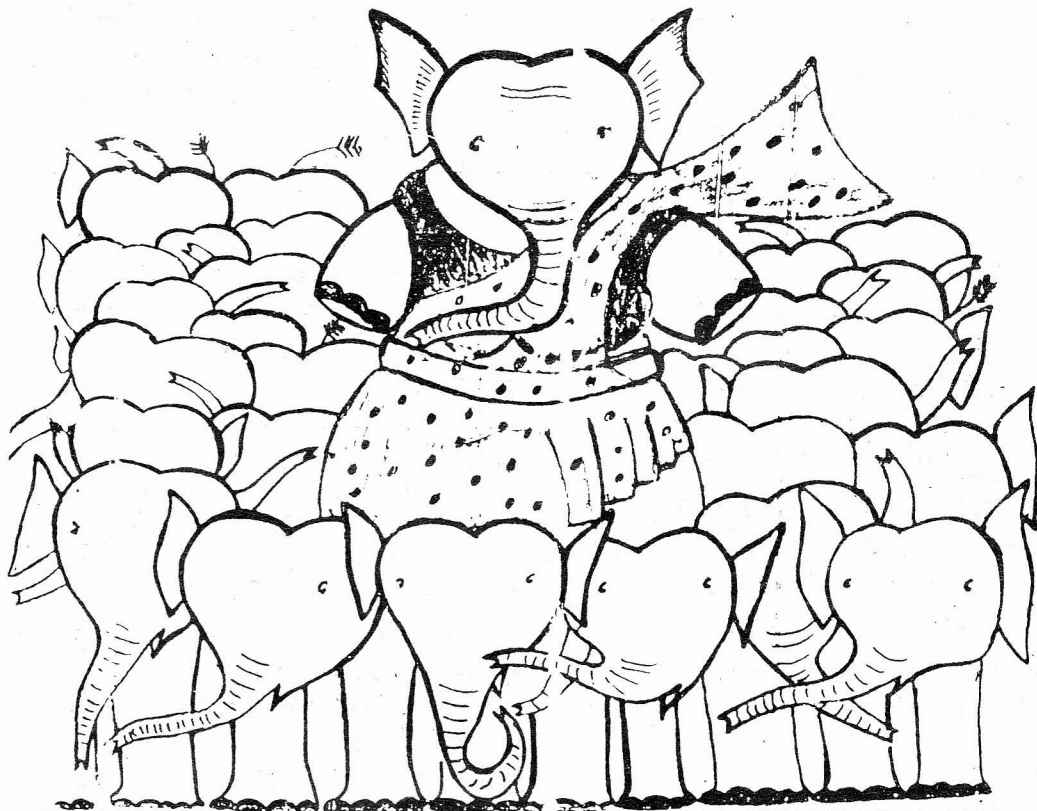
For instance, this animal is almost a national symbol. It is a threatened species and also a charismatic species. Though everyone knows the elephant most persons know very little about it. Main reason for my interest is that for many years I have been working on elephants - their breeding and physiology. Elephants are remarkable for their intelligence, powers of

memory, amenability to training, behavioural patterns and social organization. It is well known that in many Asiatic societies, including our own, elephants have played for centuries prominent roles in the pageants of monarchs, in religious ceremonies, as well as in the theatre of war. Alexander the Great is reputed to have crossed the Alps with them. Our own Maligawa Tusker, Raja which died at the age of about 80 years, played for many years, the star role in the Kandy Perahera carrying the sacred tooth relic. In everyday life in our societies man

and the elephant have been very closely associated for many thousands of years. This close association of man and elephant is one of the contributory factors which impaired their rate of extinction in Sri Lanka. Usually small islands like ours can not sustain large animals like elephants.

In this article, I will refer, briefly first, to their origin, past and present distribution, and to some major features of interest about the life of the elephants. I will also discuss the human/elephant conflicts that are

FIGURE 1: SOCIAL LIFE OF ELEPHANTS



Live in groups or herds
Sri Lanka herds usually consist of 15-40 individuals, Matriarchal, and led by the oldest, largest, reproducing female.

Table : Differences between Asian and African elephants.

	Asian elephant	African elephant
1. Weight	about 5000 Kg	about 6000 Kg
2. Height at shoulder	2.0 - 3.5 m	3.0 - 4.0 m
3. Highest point	at top of head	at top of shoulder
4. Shape	back - convex or level head - has two prominent bulge	back - concave head - has no bulges
5. Ears	smaller and do not exceed height of neck	larger and do exceed height of neck
6. Skin	smoother and depigmentation seen (with aging)	more wrinkled and not depigmented at any age
7. Number of ribs	upto 20 pairs	upto 21 pairs
8. Teeth	narrow plate like loops on chewing surface.	diamond - shaped loops on chewing surface
9. Tusks	only in males	in both males and females
10. Trunk	tip has only one finger like process	tip has two finger like processes
11. Number of nail-like structures in limbs	fore limb - 5 hind limb - 4	fore limb - 4 hind limb - 4
12. Musth	shown only by males	shown by both males and females
13. Domestication	easy	difficult
14. Intelligence	more	less

now eroding the existing population and threatening their future survival. I also propose to devote a part of this article to my own studies on captive breeding in Sri Lanka and to the phenomenon of musth.

The prehistory of the elephant is fairly well documented, from its origin from little modified pig-like mammals, to the mastodonts, wooly mammoths and the present day elephants. Their origin lies in and around Egypt of today.

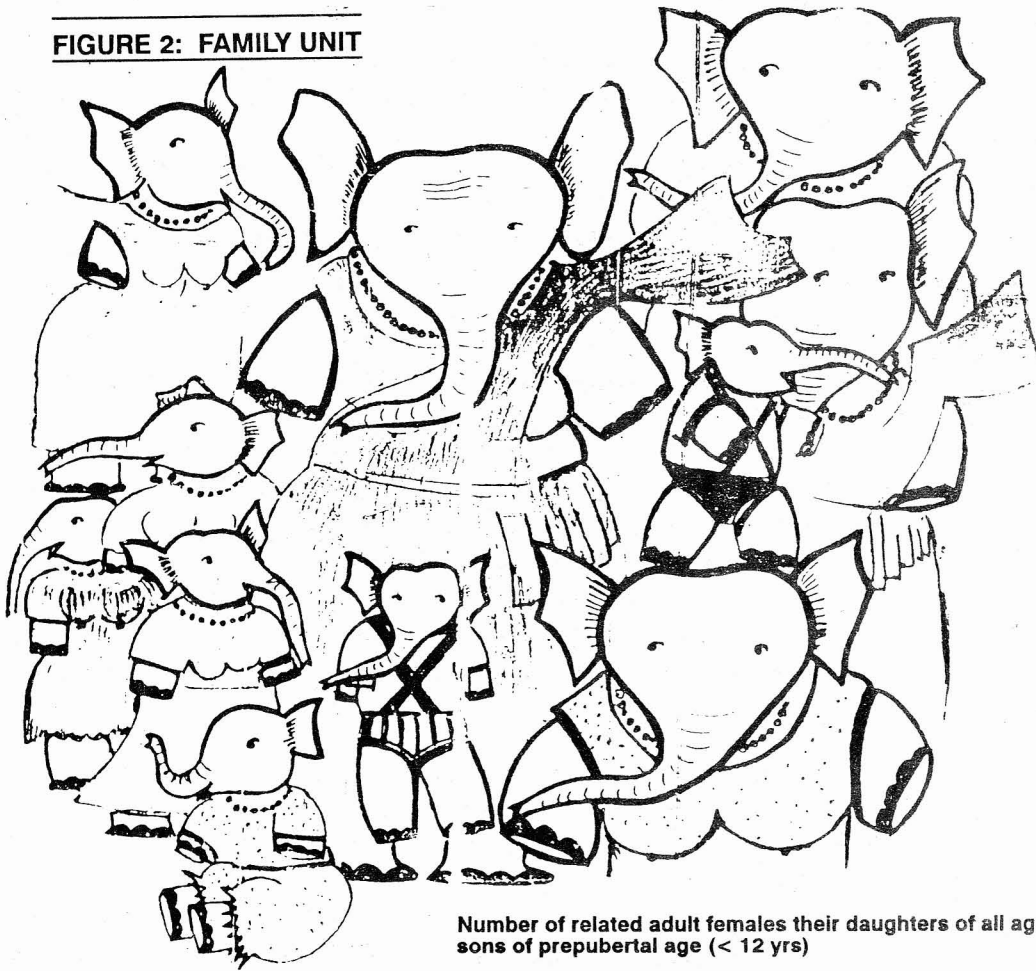
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little modified pig-like mammals, to the mastodonts, wooly mammoths and the present day elephants. Their origin lies in and around Egypt of today. Though they live only in restricted areas today, in the past, elephants were widely distributed through the tropics and sub-tropics of Africa and whole of Asia. They never entered Australia. They have a broad relationship to the herbivorous groups of mammals. However, their closest living relatives are the small, rabbit-like cony living in arid rocky hill sides in Africa and the Middle East and the sea-cows, which are marine. The elephant, the sea-cow and the cony are a good illustration of how the processes of evolution transform a basic animal form in vastly different directions in adaptation to varied environments.

In spite of their long history the animals have not diversified. There are only two genera of elephant living today. *Loxodonta* (the elephant of Africa) and the *Elephas* (the elephant of Asia). There are 2 sub species of African elephant the 'cape' elephant (*Loxodonta africana africana*) and the 'forest or bush' elephant (*Loxodonta africana cyclotis*). On the otherhand, 4 sub speicies of living Asian elephants are recognized:

- *Elephas maximus indicus* (Indian elephant).
- *Elephas maximus maximus* (Sri Lankan elephant).
- *Elephas maximus sumatranus* (Sumatran elephant).
- *Elephas maximus hirsutus* (Malayan elephant).

FIGURE 2: FAMILY UNIT



Number of related adult females their daughters of all ages, sons of prepubertal age (< 12 yrs)

I wish now to turn briefly to some of special and interesting features about the structure and life of the elephant. They are huge [(growing to a height) 3-4 meters at the shoulder and achieving weights of up to 5-6 tons (5000-7500 kg)]. The skeleton is engineered for bearing heavy weight (graviportal) and the limbs are massive pillars. Joints are highly flexible and the soles of the feet are large (flat) and padded. This form enables

In Sri Lankan elephants, 2 races are recognized: The so called, Vil Aliya (Tall and long) and the Gata aliya (short and stout).

There are important differences between the Asian and the African elephant. These differences are indicated in the above table.

Though elephants ranged widely over two large continents, today, their populations have become greatly reduced. It is estimated that the total number of African elephants is around 600,000 and Asian elephant between 30,000 and 40,000. The Sri lankan population is about 2500 in the wild and in addition 550 captive animals. While it is true that in the natural course of evolution the animal species, gradually reach extinction, human activity has increased the rate at which the elephant populations are disappearing. In the case of the African elephant the major threat derives from the demand for ivory. The animals are slaughtered for the ivory. The meat too is consumed as food and favoured for supposed aphrodisiac properties. In the case of the Asiatic elephant the major threat comes from transformation of the natural habitat for agricultural and other developments. In recent times the problem has become very acute. In the absence of adequate corrective measures it is feared that the elephant might finally disappear from the earth in the 21st century.

them to walk on loose sand and in swamps without getting stuck by distributing their weight at about 600 grams per square centimeter. They can climb slopes, swim well and run for short distances at a speed of up to 30 km/H. Another feature of interest is that, inspite of their size they are able to move almost without sound. On the other hand, the same limbs can push down large trees and trample men in to the dust.

The head of the animal is very large but its weight is reduced by the bones being porous. The head has to bear the weight of the tusks as well as that of the trunk and this is anchored to the body by the massive musculature of the neck. The trunk itself is a highly specialized and a unique structure. It is also very ver

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satile in function. It is formed by the union and the extension of the upper lip and the nose. It reaches a length of about 2.5 meters. A group of about 100,000 muscles control its movements ranging from very delicate movements to movements involving immense power. In its versatility it parallels the human hand. Amongst the functions that it performs are breathing, sucking of water, collection and manipulation of food, carrying objects, attacking adversaries, touching and caressing other elephants in play and in sexual behaviour.

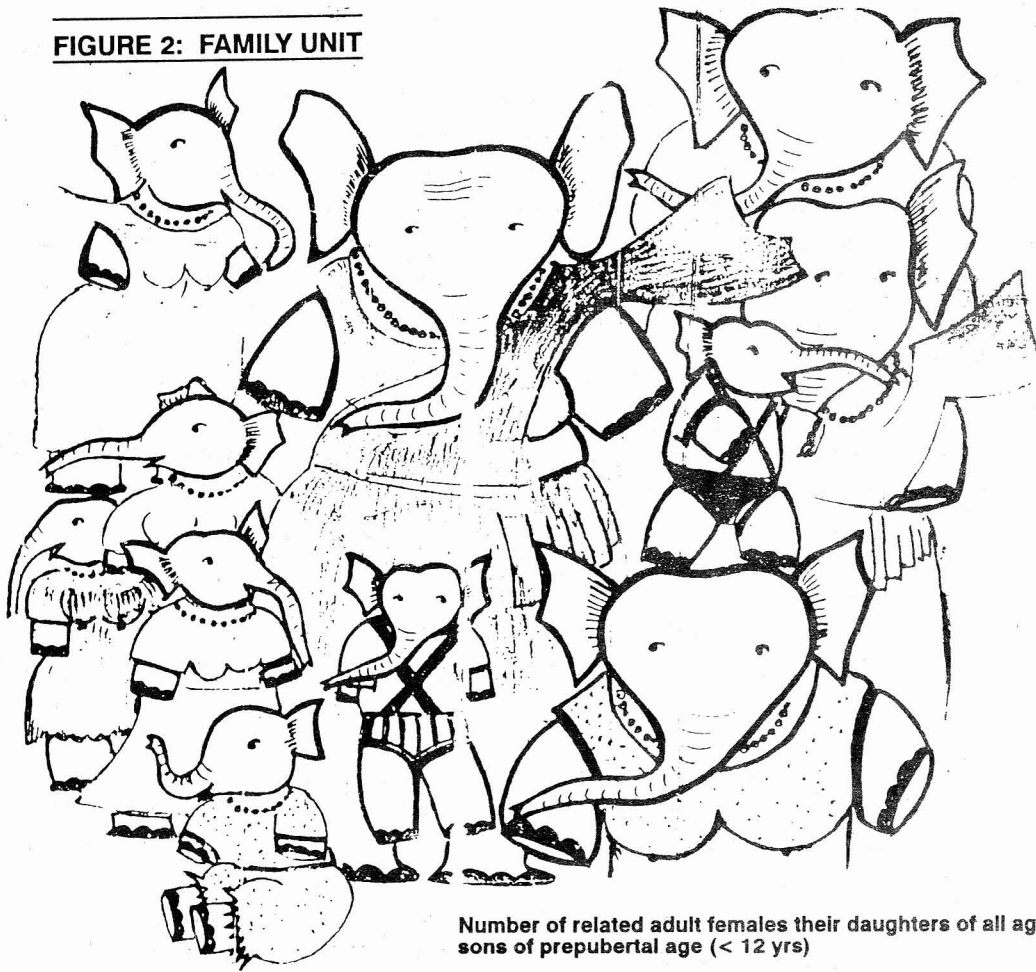
The other well known feature of elephants is their tusks. The tusks are formed by the continuously growing upper incisors. They appear both in males and females of the African elephant but only in males of the Asian elephant. Here too, there is variation: about 90% of the males in the Southern India are tusked. In Sri Lanka, only about 11% are tuskers. Tusked males are called Atha, males with tushes are called Aliya and males without tusk or tushes are called Pussa. Females with tushes are called Athinna and females with out tushes are called Alidena. Some times when foreign materials get into pulp cavity of tusk, dentine is deposited around such material and forms what is traditionally referred to as elephant pearls (Gajamuthu).

The life of the elephant can last only as long as its molar teeth. During its life time an elephant produces 6 sets of massive molars in horizontal succession. At any one time there are only two molars in each jaw. Thus, the elephant chews its food with 4 teeth. As the animal grows the molars produced becomes larger and larger. The number of lophs of ridges on each tooth increase. Therefore, it is possible to estimate the age of an elephant by counting the number of lophs on the teeth currently in use. Once the last of the molars is worn or lost, the animal can no longer grind sufficient food to support life and must gradually die of starvation. Humans are fortunate because they can use dentures.

One consequence of the large size of the animal is the need for very large amounts of food. It is often stated that the life of the elephant is one long meal. Usually, it has to spend up to 20 hrs a day feeding, consuming about 150 kg in the process. Which is about 6-8% of its own body weight. (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. For example, a rat may consume 40% of its body weight as food in a day).

Finding this quantity of food is possible only by ranging over large areas with appropriate vegetal cover. The Sri Lankan female elephant requires about 10 square kilo meters of range in wet season and 17 square kilo meters in dry season. The male requires about 25 square kilo meters in wet season and 60 square kilo meters in dry season. Each herd has its own traditional home range. As seasons change the herds move along regular paths of migration which are traditional.

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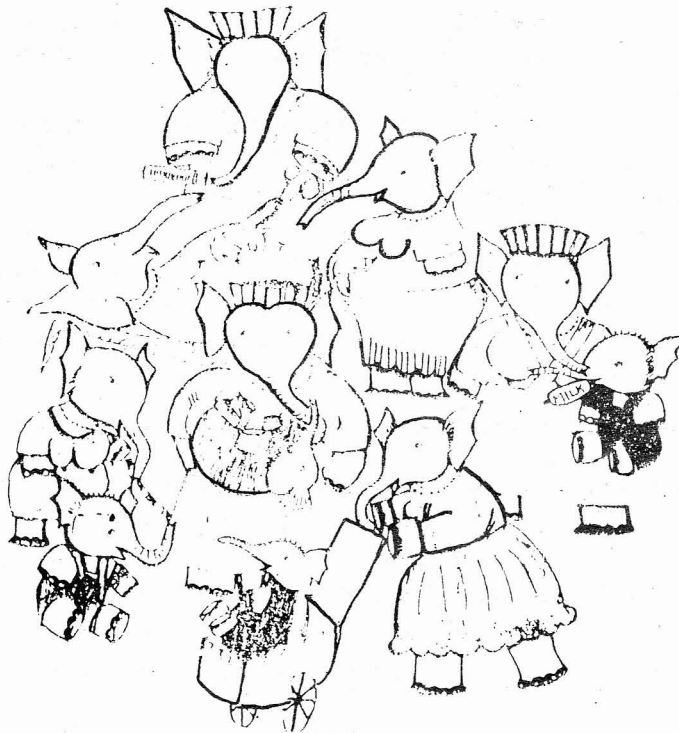
Unlike the other specialized herbivorous mammals such as cattle which have bacteria that help in digestion in the chambers of their stomach, bacteria are present only in the caecum of elephants. Therefore, much of the food intake is wasted. The time taken for food to pass through the gut of an elephant may be any where from 11-46 hours, but an average time of 24 hours seems usual. Large amounts of faeces are voided with undigested matter. About 15 boluses are voided for a day each weighing about 3 kgs. Rabbits too have bacteria only in the caecum, but they are coprophagous (they eat their own faeces) and thus increase the efficiency of digestion. The elephants are mainly grazers (African over 80% and Asian over 50% on grasses), but they also browse, feeding on any green matter that they can lay their trunks on. The Sri Lankan elephant is known to consume about 88 plant species. They are able to detoxify toxic materials such as alkaloids, and cyanogenic glucosides that are found in their food by using special liver enzymes. It is of interest to note that elephants have no gall bladder. They avoid eating certain young plants which contain HCN,

but will eat the mature plants in which this poisonous material is absent. It is known that their habit of consuming the barks of trees is related to their great need for calcium both to support their tusks and teeth and also to support pregnancy. The fibre of the bark, in addition, prevents ab-

liters of water per day and urinates about 10 times per day. Usually, the quality of the water is assessed before drinking by using the trunk. They can smell water at a distance. When a herd is drinking, animals stand in line according to hierarchy. In the dry season, when the water sources dry up, they dig into the river or tank bed for locating water if it is available. However, studies of the African elephant have shown quite clearly that the animals are able to be without water for up to 2 weeks at a time.

Another consequence of size is that, the surface area of the skin is relatively small compared to the volume of the body. Therefore, there is a problem of overheating. An elephant produces about as much heat as 30 men. Moreover, the skin is thick and without sweat glands. They cannot tolerate high temperatures. Special methods have been developed to cool their bodies. The normal body temperature of Sri Lankan elephant is 36.5°C. The development of large ears having high surface to volume ratio is one method. The surface area of the ear is about 20% the total skin surface and is well supplied with a network of

FIGURE 3: NURSING UNIT



Lactating females and their young (< 2 yrs) Expectant mothers Older, experienced, lactating females-Midwives helping at birth and cleaning up the new born babies. Allomothers to babies of young mothers and of orphaned babies by cleaning them, helping to take solid food and even allowing them to suckle.

dominal colics to which the elephants are prone and is a source of essential fatty acids. High fibrous diet may also contribute to the extremely low level of cholesterol in the blood of elephants.

In the life of an elephant water is a critical factor. They drink up to 225

blood vessels. Excess heat of the body is radiated at the ear surface and assisted by constant fanning of the ears (at a rate of 690 flapping/hr). The efficiency of this mechanism is reflected by the fact that the temperature of blood leaving the ear is 16-18 F lower than that entering the ear. Other methods frequently used to cool themselves are: squirting water on to the body; bathing or wallowing in rivers; plastering body with mud packs; powdering body with sand or dust; and in extreme drought conditions spraying their own saliva over their ears.

The lungs of elephants, unlike those of other mammals, are attached to the chest wall. Therefore, they cannot lie on one side for long periods. This could be the reason why elephants rarely lie down to rest or sleep. Rib movements contribute

little to breathing which is diaphragmatic. The heart of elephants are unique in having twin apexes in the ventricle.

Generally, in tall animals venous return to the heart is difficult against gravitational pull. Elephants move their limbs continuously to facilitate venous return. But according to some views such movements are thought to be stress behaviour. There are some special features in the blood profile of elephants. Red blood counts are the lowest among mammals (2-3x10⁶/cu mm vs 5-6x10⁶ cu mm in man). On the other hand, they have the largest red blood cells (diameter greater than 9.2 um vs 7.2 um man and mean corpuscular volume of 138 um vs 110 um in man). Also Elephant haemoglobin has greater affinity for oxygen than human haemoglobin. As a result

elephants could function well even at high altitudes where partial pressure of oxygen is low. A considerable Bohr shift is also seen in elephant haemoglobin. This would restrict them working continuously for long periods. Elephants are also peculiar for showing a platlet serge during early pregnancy.

There is peculiarity in the myoglobin of elephants. This is also an oxygen carrier, but in elephant it also has extremely high affinity to carbon monoxide. This property makes it dangerous to keep elephants for long near garages and other sources of carbon monoxide.

It is noteworthy, that in the elephant society the sole function of the male seems to be that of mating. Beyond that they bear no responsi

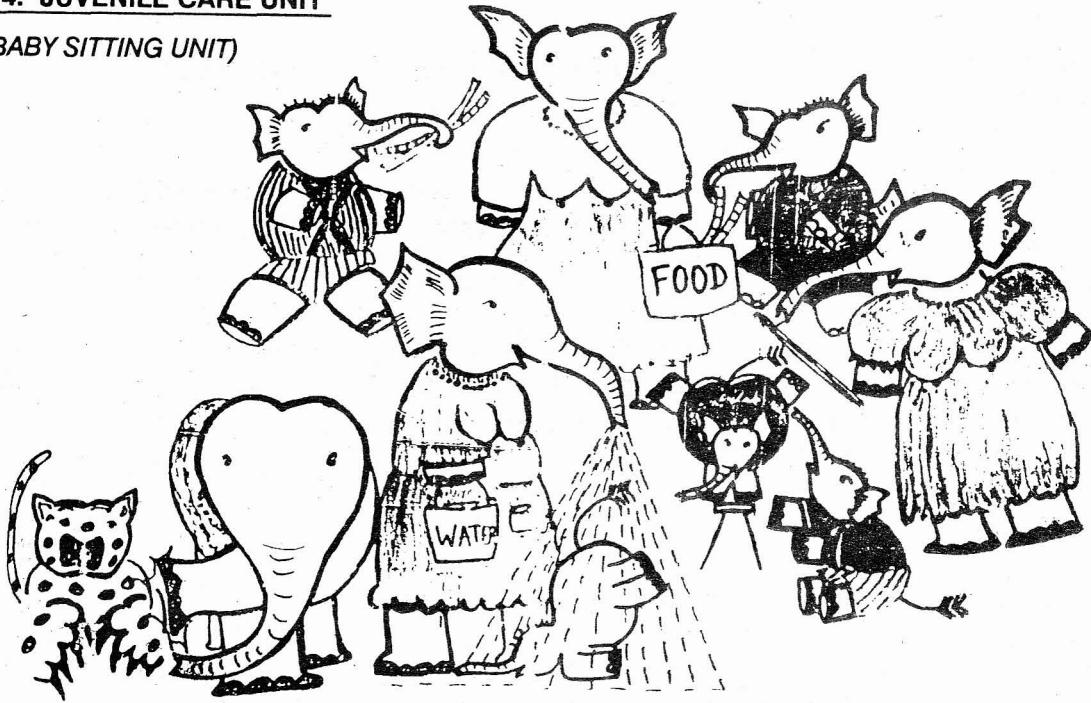
There are many interesting aspects of the social life of elephants. They live in groups or herds which vary in size. In Sri Lanka herds usually consists of 15-40 individuals each. The herd is materiachal and led by the oldest, largest reproducing female, contrary to the popular belief that the male is the leader. The herd is a complex unit, subdivided into functional groups. These parallel in structure and function to human social units. (Figure 1).

- A Family Unit consists of a number of related adult females and their daughters of all ages and sons of prepubertal age. (Figure 2).
- B Nursing Unit of lactating females and their young (under age of 1 year) and expectant mothers. Within this unit the older, experienced, lactating females are midwives, helping at birth and cleaning up the new born baby. They may act as allomothers to babies of young mothers and of orphaned babies by cleaning them, helping to take solid food and even allowing them to suckle. (Figure 3).
- C Juvanile Care Unit or (baby sitting unit) of non lactating females. They look after the playful juveniles (1-5 years) from chewing their food for them and bathing them as well as ensuring that they come to no harm. (Figure 4).

In the elephant society males have a hard time. When they reach puberty (about 12 years) they are chased away from the family unit. Such males usually form bachelor groups. They still live near the main herd, moving in advance of the main herd. The leader of the bachelor group, is usually a large male. Sometimes a bull does not enter a bachelors group but leads a solitary life (Thany aliya). These solitary animals can become aggressive and dangerous. (Figure 5).

FIGURE 4: JUVENILE CARE UNIT

(BABY SITTING UNIT)



Non-lactating females Playful juveniles (1-5 years) finding their food, bathing, ensuring that they come to no harm protection from predators such as leopard.

bility for raising their offspring. They probably do not even know them. In this respect, they are similar in behaviour to some human males.

In Sri Lanka, during the past 200 years the elephant population has declined by over 67%. At the turn of the century, about 12,000 individuals were distributed over most part of the island from the coastal plains to the hill country (up to 2500 meters). Today, we have a captive population of about 550 elephants and a wild population of about 2500. The wild population is found mainly in the low country dry zone in 15 scattered, protected areas constituting about 9.3% of the total land area of the island. Why has the elephant population declined? Human population has increased. There is pressure on land for human settlement, agriculture and development activities. The habitat that elephants have enjoyed for millenia are being transformed by man. Elephants need a home range of 40 - 400 square kilometers. They roam back and forth into their traditional home grounds, as they have done for millenia. Now where there were forests and grasslands they find, instead, paddy, sorgham, kurakkan, sugarcane and banana. From the elephants point of view, these are highly palatable, easily digestible, succulent and nutritious. They turn to these new foods readily leading to human/elephant conflicts.

Elephants destroy crops, homes and may even kill poor farmers and villages. On the other hand, the farmer resorts to protective measures especially to shooting elephants. Individuals of reproductive age may be lost and the elephant population goes into decline. In this process potential breeders are lost.

Elephants reproduce extremely slowly. Reproductive period of females begins at between 10 - 20 years. A calf is produced every 5 years. Males mate effectively at around 24 - 30 years and reach prime breeding state around 40 years.

Secondly, when adult animals die the social structure of the herd is affected. This is known to lead to increase in calf mortality. These are factors that threatened the elephant population.

Survival of the elephants is also threatened by their existence as small isolated populations. The optimum size for a herd is 125 - 150 individuals. However, in more than half of our protected areas the herds have much fewer members. In small isolated populations, such as ours inbreeding depression, lowered fertility, increased juvenile mortality and impaired growth rate results.

Intensification of competition for food is becoming another factor that can affect elephant survival. Populations of water buffalo, axis deer, sambur are large and they all share the same food resource with elephants. As these other animals increase in numbers the pressure on the elephant herds will increase. The problem is compounded by the well known fact that small islands cannot really support large numbers of large mammals and the elephant is the largest of them all.

The life of the elephant can last only as long as its molar teeth. During its life time an elephant produces 6 sets of massive molars in horizontal succession. At any one time there are only two molars in each jaw. Thus, the elephant chews its food with 4 teeth. As the animal grows the molars produced becomes larger and larger. The number of lochs of ridges on each tooth increase. Therefore, it is possible to estimate the age of an elephant by counting the number of lochs on the teeth currently in use.

Hindu mythology relates how an elephant in distress was saved by Lord Vishnu. Today, the elephant is in grave danger but this time there is no guarantee of divine intervention. We ourselves have to act to save them. Can they be bred in captivity? Captive elephants do mate but rarely give birth to babies. It is now understood that herd structure and free ranging are important factors associated with successful breeding. In the captive breeding programme at Pinnawala Elephant Orphanage we simulated wild conditions in a 25 acre coconut plantation. Herd structure was established and animals were allowed to range free. We used the opportunity to study, important aspects of reproduction in the elephant. We were also able to make a systematic study of the musth cycle.

The elephants are allowed to range free and interact as a herd during the daytime at Pinnawala. They are bathe for 2 hours in the morning and 2 hours in the afternoon every day. However, at night they are chained and given additional foliage. The experiment commenced in 1981 with only 5 elephants. At present, the number has grown to 42 by influx of animals.

In a coordinated and continuing study we observed behaviour patterns of the herd, monitored and sampled blood weekly to establish reproductive hormonal profiles and looked for physical changes in females through the oestrous cycle.

Our breeding programme commenced in 1982 and is continuing. The first birth occurred in 1984 and since

then seven calves have been born, 3 males and 4 females. Two births were expected in 1991. This is a remarkable success story by any standard and is not paralleled by in any other country.

Valuable information regarding oestrous cycle has been collected, at the same time. The length of the cycle has been a matter of controversy. However, recent work on African elephant has indicated a period of 16 weeks in those animals. We have established behavioural and hormonal data that indicate the oestrous cycle in our elephants to vary from 12 - 16 weeks. The period when females are sexually receptive lasts for 2 - 3 days. During these days the female will stand and allow the male to mount.

We observed various external signs associated with oestrous (Some of these may be mentioned). The female become more excitable and shows interest in males, rubbing herself on males and even on trees. A white gummy discharge appears from the urinogenital opening. The vaginal folds become swollen and the clitoris becomes visible. The vagina itself becomes reddish in colour. Males introduce the tips of their trunks into the urinogenital sinus of females in oestrous, frequently testing the urine. Usually this behaviour is seen at a rate of 12.0 times/hr but at oestrous it increases to 120 times/hr. We observed a very interesting feature in that some pregnant females showed signs of oestrous, as well.

Intense urine testing, by the male is indicative of attaining full receptive condition in the female. This is followed by precopulatory behaviour. Male and female engage in reciprocal touching behaviour of various parts of the body, especially of the mouth and genital regions. The penis then become fully erected. The male stands on his hind legs with fore limbs and trunk extended on the back of the female. The penis becomes s-shaped and about 1/3rd is inserted into the vagina. About 4 - 9 pelvic thrusts have been observed. However, other workers, working in the wild have not reported pelvic movements. Ejaculation usually occurs about 30 seconds after intromission. Copulation lasts for 1 - 2 minutes. The male dismounts, but the couple remain in close proximity from a few hours upto 3 days, a pattern referred to as consort behaviour. Two-to four copulatory episodes have been observed by us in a single oestrous day. A single female has been observed to mate with two males. Copulation was also observed in the river during bathing. Some females vocalize during mating. The reactions to copulation from other group members range from absence of any reaction to intense excitement including vocalization, flapping of ears, urination and defecation. Our work also suggests that males are selective in their choice of mates. For instance, at Pinnawala, it has been observed that Wijaya prefers to mate with Kumari than with Anusha.

The duration of pregnancy of the Sri Lankan elephant is about 20.8 months, yet another consequence of large sized body. As in other mammals, a rise in progesterone levels was observed but this was lower than in other mammals. A peculiarity noted was that the prolactin levels were elevated during pregnancy (300 - 700 ng/ml). The corresponding levels in non pregnant animals and during lactation were less than 2 ng/ml and 13 - 15 ng/ml respectively. No similar results are known for other mammals and the significance of the differences remain to be understood. Breast enlargement begins from 7 - 9 months into pregnancy. We also noted mating occurring during pregnancy in some females. Except in humans, mating does not occur during pregnancy in other mammals.

All births observed at Pinnawala occurred at night. Pregnant animals, approaching delivery become restless. The female constantly touches the vaginal area with her trunk and vocalises frequently. When this behaviour is observed the female is brought to the shed. As time



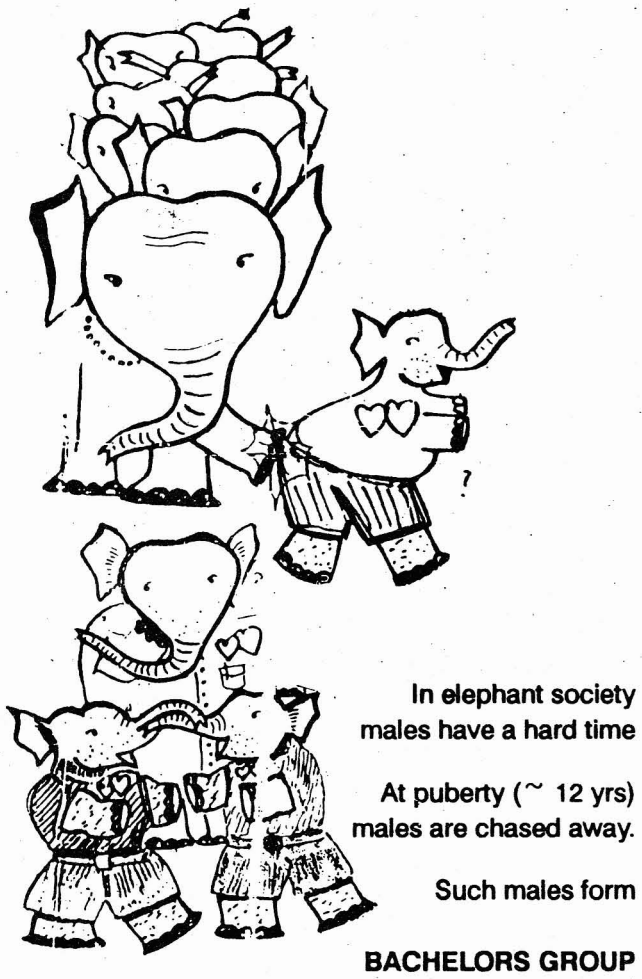
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progresses, irregular contractions of the abdominal region and vaginal folds occur every 4 - 6 minutes followed by discharge of blood and amniotic fluid. Three of the females observed lay on their sides during birth while one female assumed a squatting position. At birth the head of the baby emerged first in all cases and the baby when born was covered fully in the amniotic bag. The process of birth was invariably accompanied by vocalisation by the female. In some instances the water bag burst as it hit the ground. Otherwise the mother removes the bag. The placenta weighing about 12 kg was ejected between 30 minutes to 5.0 hours after birth. The baby was able to stand, between 5 - 15 minutes of birth, but limb coordination was imperfect. The weight of the babies was between 50 - 61 kg height, at shoulder 2'7" to 3' - body length measured from head to anus between 2'4" to 3'7".

Figure 5



In elephant society males have a hard time

At puberty (~ 12 yrs) males are chased away.

Such males form

BACHELORS GROUP

Babies began breast feeding between 8 min to 1 hour, of birth. Each sucking bout lasted 1 - 2 min occurring at about 1/2hr intervals. Alternation of breast sucked usually takes place with each successive sucking. Mothers breast feed their babies upto the age of about 4 years, but time period between feeding intervals increase progressively. Calves were observed to suck from their own mothers and other lactating females. Orphaned babies introduced into Pinnawala are also allowed to suck by lactating mothers but their own baby seems to dislike it. Some workers have reported that certain females in a herd though without babies sometimes lactate and feed calves born to other females. Such females are described as 'aunts'.

Most people have heard of elephants in musth and of the problems they create when in that condition. Musth is a

complex of physical and behavioural features displayed periodically by adult males of the Asian elephant and by both males and females of African elephants.

The most commonly occurring signs of musth observed in captivity are : enlargement of the temporal gland, which are modified sweat lands located midway between the eye and the ear, on both sides, secretion of a sticky smelling liquid containing Phenols and m and p-cresols, dribbling of urine without the penis being extended, as is usual, during urination. The penile sheath showing the "green penis syndrome" (the penile sheath become greenish in colour).

Behaviourally, there is: a decrease in responsiveness to commands of their keepers (especially to the head keeper); deliberate destruction of objects, frequent touching of top of head (4/hr) and temporal gland (4/hr); production of a special kind of infra sound known as musth rumble (low pulsating, low frequency sounds of 14 Hz).

A sharp rise in serum testosterone levels is reported to occur during musth. We have estimated the blood testosterone levels, weekly for about 3 years and observed the same trend but testosterone levels were comparatively low. None of the males at Pinnawala exhibited musth but in the Zoo, 2 males showed musth. Our work also suggests that the threshold level to induce musth appears to be different for different individuals and females who do not show musth, have nearly low levels of testosterone throughout. Most people believe that male elephants can mate only at musth. This is not true. At Pinnawala none of the males exhibited musth but they have mated and fathered young.

Since testosterone levels are implicated with musth, it may be possible to suppress musth by the use of anti-androgens such as cyproterone acetate or GnRH agonist/antagonist. We hope to investigate this possibility and that is why we are monitoring testosterone levels over a long period of time. Currently in captivity, feeding with Una Bada, Ehatu and Budeliya and frequent prodding of a nerve centre in the anal fold with an ankus or burning with hot ankus are used to suppress musth. When tested on rats, Una Bada has been shown by us to possess potent sedative action, thus may be able to calm down the elephants at musth.

In Sri Lanka, musth never appears in males below age of 10 years, appears sporadically between 14 - 20 years and periodically after 20 - 30 years of age upto old age. In contrast, only about 4 - 5% of male African elephants around 30 years show musth. For a given individual, onset of musth is fairly consistent from one year to next. It appears that onset in captive elephants can occur by exposure to large number of females, as during per-aheras.

In the wild however, presence of receptive females does not appear to induce musth. Some claim that high ranking males can suppress musth in low ranking males.

What is the significance of musth? It is claimed to increase an individual's reproductive success because musth helps to achieve dominance status in a herd which helps to overcome other males and aggressive older females thereby enhancing the chance of access to a oestrous female. Furthermore, in African forms, female elephants prefer to mate with a musth male.

The captive breeding programmes if developed further will help to ensure that, elephants will always be a part of the Sri Lankan scene. However, we need to ensure the continued existence of elephants in the wild, as well. In order to achieve this objective the central issue is the resolution of man elephant conflicts. The problem is the extension of agriculture into traditional ranges and migration routes of the elephant.

Agricultural expansion has the effect of fragmenting herds, and I have already pointed out the adverse biological effects of reduction in herd size. Further, they become trapped in small pockets of jungle, surrounded by extensive farm lands with monoculture. Of course, the animals will move into the cropland and inevitably the farmer has to act to protect his own livelihood. Guns are used and often injure the intruders. Wounds fester and the wounded animal undergoes intense suffering. As a result, a normally docile animal becomes an aggressive and dangerous rouge (Hara Aliya). Rouges are usually loners whose behaviour is very different from that of normal elephants. They attack human beings without provocation. Some rouges even go in search of humans to attack them. Others wait patiently hidden in jungles adjoining pathways for humans to pass by and attack

them. Such animals should be captured and treated for wounds, transferred to protected areas, or tamed. Otherwise, they should be eliminated.

A long term approach, is the translocation of pocketed animals by elephant drives. They have to be shifted from critical areas into protected areas where their demand for food, water and range are adequately met. There have been successful drives in the past. For instance, 3 small pocketed herds were successfully driven to Wilpattu National Park from the catchment areas of Kalawewa reservoir. Similar operations were done successfully in other countries like Sumatra.

Another important long term strategy is the establishment of 'jungle corridors'. These function as migration routes hold in forest cover which interconnect the protected areas. Their location and extent must take into account traditional migration patterns as well as the optimum needs of space and food for migrating herds.

Currently, there are two corridors, one connecting Somawathi National Park and Wasgamuwa National park, and the other connecting Wasgamuwa National Park and Maduruoya National park. Another one is proposed connecting Maduruoya National park and Galoya National Park. It is necessary to monitor the use of the herds in existing corridors as a basis for further management of the elephant population.

Finally, there are other methods used for protection of human holdings and are experimentally investigated. These include use of trenches, building of high voltage electric fences, creation of buffer zones, use of high frequency sound beepers use of repellents or attractants (common salt), promotion of public awareness and soliciting community support for elephant conservation and crop and life insurance schemes for settlers at low premium.

Unlike in the past, all development planning, hereafter, must take into account ecological and conservation factors. It must be understood that the elephant cannot change its ways. It is man who has to make the adjustment - Man the Agriculturist, Man the Planner, Man the Politician.

Acknowledgements

I wish to express my thanks to Prof. K.D. Arudpragasam (Chairman, Central Environmental Authority), Mr. Bradly Fernando (Director, National Zoological Gardens of Sri Lanka), Mr. A.M.V.R. Manatunga (National Zoological Gardens of Sri Lanka), Dr. (Mrs.) Y.N.A. Jayatunga (Department of Zoology, University of Colombo), Mr. Nihal Dayawansa (Department of Zoology, University of Colombo), Dr. T.B. Poole (Universities Federation for Animal Welfare, U.K.), Elephant Keepers at Pinnawala and at National Zoological Gardens and Medical Research Council (Edinburgh, U.K.).

