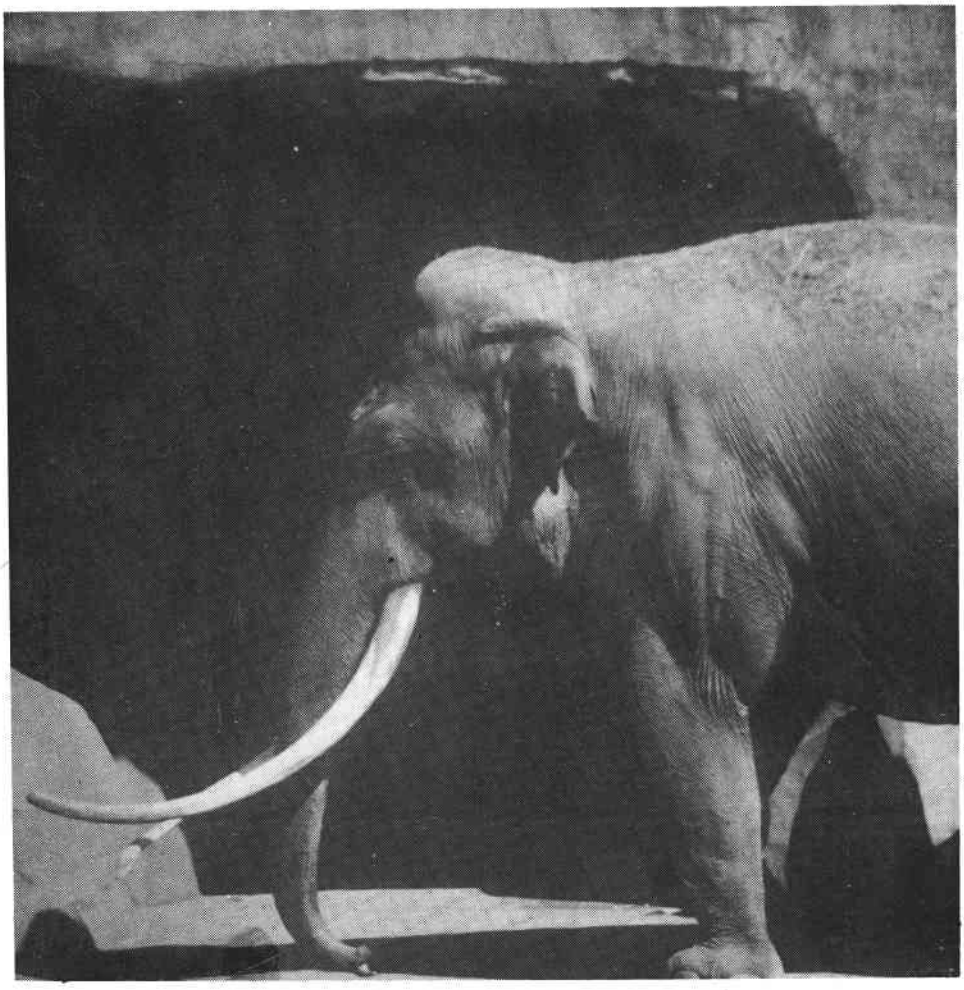
GAJAH

JOURNAL OF THE ASIAN ELEPHANT SPECIALIST GROUP



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1. To highlight the plight of the Asian Elephant.
2. To promote the conservation of the Asian Elephant, and
3. To provide a forum for communication amongst the members of the Asian Elephant Specialist Group.

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COMMENTS ON ELEPHANTS IN BURMA*

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ABSTRACT

This draft is a set of notes rather than a formal report, offering a few suggestions on the population dynamics of wild elephants and timber elephants. The major problem is that the timber elephants do not constitute a self-perpetuating population, that they must be augmented continuously by capture of wild elephants, but that these appear to be declining such that their capacity to provide enough animals is progressively eroded. Demographic analysis suggests that the reason for the timber elephants' inability to maintain numbers has nothing to do with their death rate. This is not high. Burmese veterinary treatment of elephants is of a very high standard. The reason lies instead with the low birth rate. If this could be raised above 8 births per year, per 100 females of breeding age, the population of timber elephants would be self sustaining. Suggestions are offered for how this might be done, but it is best left to the knowledge and experience of the Veterinary Officers. The current capture rate of about 120 elephants per year from the wild population is probably above the maximum sustainable yield. The wild population seems to be declining at about 5% per year. Suggestions are made for determining current numbers, trend, and sustained yield, and for halting the decline of wild elephants.

INTRODUCTION

This draft is more a set of notes than a formal report. The writer is keenly aware of the Burmese expertise on elephants and would not presume to advise men who know much more than he does about this subject. The purpose of these notes is therefore only to give an outline of potential problems as he sees them. Sometimes the perspective of an outsider, however poorly informed, can reveal problems not immediately obvious to men closer to the subject. These notes are offered in that spirit of humility. They will contain mistakes reflecting the writer's lack of detailed knowledge, and for these he asks forgiveness, but they may also contain one or two ideas that can be used.

[* This paper refers to the situation of elephants in Burma in 1980].

PROBLEMS

Burma contains two populations of elephants. The first comprises the timber elephants, a population of known size and demographic characteristics, under intense and skilful veterinary care, which would decline progressively unless captured recruits were added each year. The second comprises the wild elephants, a population whose demographic characteristics are unknown, whose size is not known precisely but is probably in the region of 3,000, and whose rate of increase or decrease is unknown. From this population about 120 elephants are captured each year to add to the timber elephant population.

These questions immediately arise: 1. Why cannot the population of timber elephants maintain itself without artificial recruitment from the wild population? 2. Can the wild population sustain, without declining, an offtake of 120 elephants per year?

DEMOGRAPHY OF TIMBER ELEPHANTS

This section investigates the population dynamics of the timber elephants in an attempt to locate the reason for their inability to hold numbers stable. The data used are not exhaustive and hence the conclusions are only approximations.

Mortality

On p. 78 of his excellent book *"Burmese Timber Elephant"*, U Toke Gale (1979) gives the incidence of death by age-class for 714 timber elephants. These data are used here to investigate the mortality pattern. Table 1. gives U Toke Gale's figures in the second column and rate of mortality per year in the third. The rate of mortality is the percentage of elephants within a stated age-class at the beginning of the year that will die before the end of the year. It is a different statistic from the percentages given by U Toke Gale, which are the deaths in an age-class as a percentage of total deaths recorded.

Table 1. % Mortality Rate in Timber Elephants.

Age-class (years)	Deaths recorded	% mortality rate per year
0 - 9	78	1.2
10 - 17	27	0.5
18 - 35	185	2.0
36 - 54	222	3.8
55 - 70	201	25.0
Total	714	

These figures cast doubt on the commonly expressed opinion that the mortality of timber elephants is excessively high. The mortality pattern revealed above is not much different from that of wild African elephants. The veterinary treatment of elephants is of such a high standard in Burma that little more could be done by chemotherapy to reduce the already low rate of mortality. At present there is one veterinary assistant to about 40 Timber Corporation elephants and one veterinary officer to about every 15 veterinary assistants. Veterinary treatment and training in Burma is modern, highly developed, and backed by an elaborate recording system. Detailed records are kept on the health and treatment of each timber elephant. Burma could teach other countries a lot about veterinary care of elephants but there is little or nothing on this subject that other counties could teach Burma.

Table 2. Life table for timber elephants as approximated from U Toke Gale's data

x	l_x	d_x	q_x
0	1.000	0.109	0.109
1	0.891	0.083	0.093
2	0.808	0.147	0.182
3	0.661	0.160	0.242
4	0.501	0.162	0.323
5	0.339	0.287	0.847
6	0.052	0.051	0.981
7	0.001	0.000	1.000

Notation:

x = Age in decades; l_x = Probability at birth of surviving to age x; d_x = Probability at birth of dying in the decade x of age; q_x = Probability at age x of dying in the next decade of age.

Assumptions: Population has a stationary age distribution and zero rate of increase.

Birth rate

U Toke Gale stated (p. 71) that a healthy female can produce three to five calves in her lifetime at a spacing of five to seven years between births. That approaches the rate of breeding in the wild and represents a maximum that could be hoped for from a captive population. If a female bred at intervals of seven years, and her chances of dying at any age were those given in the previous section, on average she would produce 3.88 calves in her lifetime (Table 3).

The birth rate of timber elephants might reach this level for some females but the average is much lower. The timber elephants in the Prome area produced only 15 calves in 1979 from 283 females of breeding age. That is a birth rate of 5.3 per 100 breeding

females and implies an average calving interval of 18.9 years. Applying again the mortality rates of the previous section we arrive at a figure of 1.44 calves produced in the lifetime of an average female.

Rate of Increase

A rate of increase or decrease can be calculated from the mortality and birth data presented previously. If the timber elephants each bred at intervals of seven years, but the rate of mortality was the same as now, the population of timber elephants would increase at 2.3% per year (Table 3). However, with current mortality rates and the birth rate implied by the 1979 data from the Prome area, the captive population would decrease at 1% per year (Table 4).

This analysis highlights two facts, one obvious, the other less so: (a) the population of timber elephants cannot sustain itself and must be augmented continuously by capture of wild elephants and, (b) the reason seems to lie exclusively in a low birth rate rather than an excessive death rate.

Reasons for the Low Birth Rate

The writer does not have the information necessary to determine precisely why the birth rate of timber elephants is below the replacement rate. The veterinary officers would have a much better idea. However, from the little information available to him he offers the following suggestions:

Although mating is not actively discouraged it is also not greatly encouraged. The attitude is to "let nature take its course". Unfortunately the course of nature is deflected by some of the management practices designed to increase efficiency at elephant camps. The effect of these will now be examined. U Toke Gale's data on p. 67 of his book shows that the commonest period of birth is October-March (average is December-January) which accounts for 68% of total births. Taking the period of pregnancy as 21 months the corresponding peak period of mating is January to June, the average being March-April. That period coincides both with the peak of *musth* and with the annual rest period. Leaving aside the question of whether *musth* is related physiologically to reproduction, we note that the rest period is not conducive to mating. The elephants are widely scattered among rest camps; these camps often contain elephants of only one sex, and males in *musth* are restrained from friendly encounters with females. These practices are designed to increase the peace and efficiency of the elephant camps, but their incidental effect may be to reduce the birth rate. *It is no coincidence that the highest birth rates among timber elephants are in areas where wild elephants are also present.*

Table 3. Rate of increase analysis for a population of timber elephants with a calving interval of 7 years (ideal case)

x	l_x	m_x	$l_x m_x$	$l_x m_x x$
0	1.000	0.000	0.000	0.000
1	0.891	0.286	0.255	0.255
2	0.808	0.714	0.577	1.154
3	0.661	0.714	0.472	1.416
4	0.501	0.714	0.358	1.432
5	0.339	0.714	0.242	1.210
6	0.052	0.714	0.037	0.222
			1.941	5.689

m_x = number of female live births per female of age x, in next 10 years.
Generation length (T) = 2.931 decades;
Instantaneous rate of increase (r) = 0.226 per decade and hence r = 0.0226 per year.
% Finite rate of increase per year = 2.28%

WILD ELEPHANTS

Since the timber elephant population must be augmented continuously from the wild population, knowledge of numbers, trend and permissible offtake of wild elephants is of considerable importance in planning future forestry operations.

Trend

The Forest Department estimated that in the period 1956-60 about 9,000 wild elephants lived in Burma. This figure is quoted in U Toke Gale's book and also in the book by *"Kyaw Gyi"* (U Khin Maung Kyaw) on Wildlife Sanctuaries in Burma. By 1972 the estimate had been reduced to 6,000, and the commonest opinion expressed now is that about 3,000 wild elephants remain. Analysis of these data by linear regression (y transformed to natural logarithms) indicates that between 1960 and 1980 the population of wild elephants decreased at an annual rate of about 5.2%. However, U Toke Gale (p. 87) gives Forest Department estimates of annual increase as 5% between 1956 and 1960, and a figure of 7% is often mentioned as the rate of increase associated with the 1972 estimate of numbers. Obviously the population cannot be *decreasing* at 5% a year, as calculated by the trend in official estimates of numbers, and also be *increasing* by about the same amount as implied by the annual increase estimates.

A brief diversion is needed here to resolve that paradox. Up until about 1974 wildlife managers throughout the world calculated an "annual rate of increase" from the proportion of juveniles in the population. The technique was called the *"surplus production method"* or *"age-ratio method"*. Apparently this was the technique used to calculate the 5% and

7% "rates of increase" for the wild elephants in Burma in 1960 and 1972.

Subsequent work, both theoretical and practical, has proved conclusively that this method is based upon a fundamental error of logic and that the "rate of increase" estimated thereby has no necessary relationship to reality. It has now been shown several times that a declining population will always appear to be increasing according to the surplus production method. Consequently the figures of 5% and 7% rate of increase should now be quietly forgotten - the regression estimate of a 5% rate of *decrease* per year since 1960 is presently the best estimate available.

Table 4. Rate of increase analysis of timber elephants given the birth rate in the Prome area in 1979 (prevailing case)

x	l_x	m_x	$l_x m_x$	$l_x m_x x$
0	1.000	0.000	0.000	0.000
1	0.891	0.106	0.094	0.094
2	0.808	0.265	0.214	0.428
3	0.661	0.265	0.175	0.525
4	0.501	0.265	0.133	0.532
5	0.339	0.265	0.090	0.450
6	0.052	0.265	0.014	0.084
			0.720	2.113

T = 2.935 decades
r = -0.112 on decade basis
= -0.0112 on yearly basis

% Finite rate of increase = 1.0% *decrease* per year

Offtake

The allowable offtake of wild elephants has been set by the Forest Department at 200 per year. (Presumably this is the estimated but erroneous 7% rate of increase multiplied by a population estimate of 3,000). The actual offtake is around 120 per year because not enough elephants can be caught to fill the allowable quota. Hence about 4% of the wild elephants are taken each year.

As mentioned previously, the *"surplus production method"* of estimating rate of increase and allowable offtake has proved to be disastrously wrong. No method using age-ratios alone reveals anything about rate of increase or safe offtake. The appropriate alternative methods call for a monitoring of the dynamics of the population as it is harvested.

The most important statistic is the population's size, or an index of population size, estimated every two or three years.

Without those data no precise estimate of allowable offtake can be made, but it is possible to make a tentative estimate of the maximum sustained yield if a few assumptions are made and statistics from African elephants are used in place of those from Burma. (Note to chief Veterinary Officer: the demography of African elephants is similar to that of Asian elephants, despite their being in different genera. The writer has calculated maximum sustained yield on the assumption that wild elephants have a logistic pattern of population growth, that the intrinsic rate of increase is r_m=0.05 on an annual basis, and numbers are currently stable at half carrying-capacity density). Despite making the assumptions purposely optimistic the calculations lead to a maximum sustainable offtake of only $2^1/_2$% per year, say 75 elephants. The current offtake of 4% per year is almost certainly high enough to cause a continuous decline in the number of wild elephants in Burma.

In fact the problem may be more serious than these calculations imply, for two reasons: Firstly, the wild elephants appear to be declining faster (5% per year) than would be predicted as an effect of excessive offtake. Changes in habitat and food supply, and perhaps some illegal offtake, appear to be implicated. Secondly, although there might be a total population of about 3,000 wild elephants in Burma, these are not all accessible to capture. Most wild elephants are caught in two areas only, and in these areas the rate of offtake must be very much greater than the 4% per year estimated fro Burma as a whole. To work, offtake quotas must be estimated according to the numbers actually available for capture. For this purpose wild elephants in "black" areas do not form part of the catchable population and should not be included in estimates of sustained yield.

Table 5. Rate of increase analysis for a population of timber elephants that is stable. Average calving interval is 12.5 years between conceptions (replacement case)

x	l_x	m_x	l_xm_x	l_xm_xx
0	1.000	0.000	0.000	0.000
1	0.891	0.160	0.143	0.143
2	0.808	0.400	0.323	0.646
3	0.661	0.400	0.264	1.983
4	0.501	0.400	0.200	2.004
5	0.339	0.400	0.136	1.695
6	0.052	0.400	0.021	0.312
			1.087	6.783

T = 6.240 decades; r = 0.013 on a decade basis; = 0.0013 on a yearly basis

% Finite rate of increase = 0.13% per year.

Note that the finite rate of increase is essentially zero. Hence the population is maintaining itself. This is achieved by a birth rate per year of 8 calves per 100 females of breeding age. That estimate can be refined with the help of data on mortality in the period 1970-80.

SUGGESTIONS

The major problem is that the timber elephants do not constitute a self-perpetuating population, that they must be augmented by capture of wild elephants, but that these appear to be declining such that their capacity to provide a sustained offtake of the required size is eroded progressively. Little foresight is needed to predict the future effect on teak extraction if that summary is even approximately true. A major requirement is to find out how closely this provisional conclusion, based as it is upon approximations and assumptions, describes the real position and future trend.

Timber Elephants

A full demographic analysis of timber elephants is needed to refine the estimate of the birth rate that would make the timber elephants a self-sustaining population. It was calculated as 8 births per 100 females of breeding age per year, only a small increase over the prevailing rate of about 5 births per 100 females. But the figure of 8 depends for its accuracy on a mortality rate calculated by approximation from U Toke Gale's figures which, although they give frequency of mortality by age, they do not give the equivalent age distribution of the living elephants needed to complete a valid analysis.

If the calculated replacement birth rate is about right it implies that for little extra trouble or effort the timber elephants could be converted into a self-sustaining population. Only a small change in birth rate is needed and no attempt need be made to lower the prevailing death rate. The Burmese Veterinary Officers are better qualified than the writer to decide how this might be done. Slight changes in the management of resting elephants might be sufficient, or artificial insemination might be considered.

Wild Elephants

The other side of the problem is the trend of the wild elephant population. Unlike the timber elephants, where all the necessary data are already available in the detailed records of the Forest Department, little information is available on the wild elephants.

The priority requirement is for an estimate of numbers in each Forest Division, particularly for those Divisions in which elephants are captured, and a re-survey in three years time to estimate trend. An appropriate first approximation can be obtained by a questionnaire survey of each Division. The writer was impressed by the amount and consistency of local knowledge on wild elephants and considers that a gathering of this

local knowledge would provide a reasonably accurate estimate of wild elephants in each Division.

An initial idea of trend can be gained from a questionnaire survey by asking the respondents whether there are more, fewer or about the same numbers now as three years ago. If the population is declining, the rate of decline, population size and offtake can be analysed to discover whether legal catching alone is responsible. Should this show that other factors are involved there would need to be a survey and upgrading of the wildlife sanctuary system to protect the wild elephants and their habitat.

Capture

U Toke Gale reports a loss rate of around 13% for *kheddah* and *melashikar* operations. It is remarkably low and reflects the expertise of the personnel. Since 1969 an immobilising technique using the drug M99 has been used as well. The writer has no information on the loss rate from this drug in Burma, but his experience of its use in Africa suggests that it would be much higher than 13% even when administered by experts. If this is so the Forest Department might consider using one of the drugs that take longer to act but cause fewer deaths than does M99. Most of these safe drugs take 30-40 minutes to immobilise, and they were not popular because the animal can move far enough away in that time to be lost. That problem has now been solved with radiodarts produced in New Zealand. They contain a small transmitter that can be located with an ordinary transistor radio and loop aerial.

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