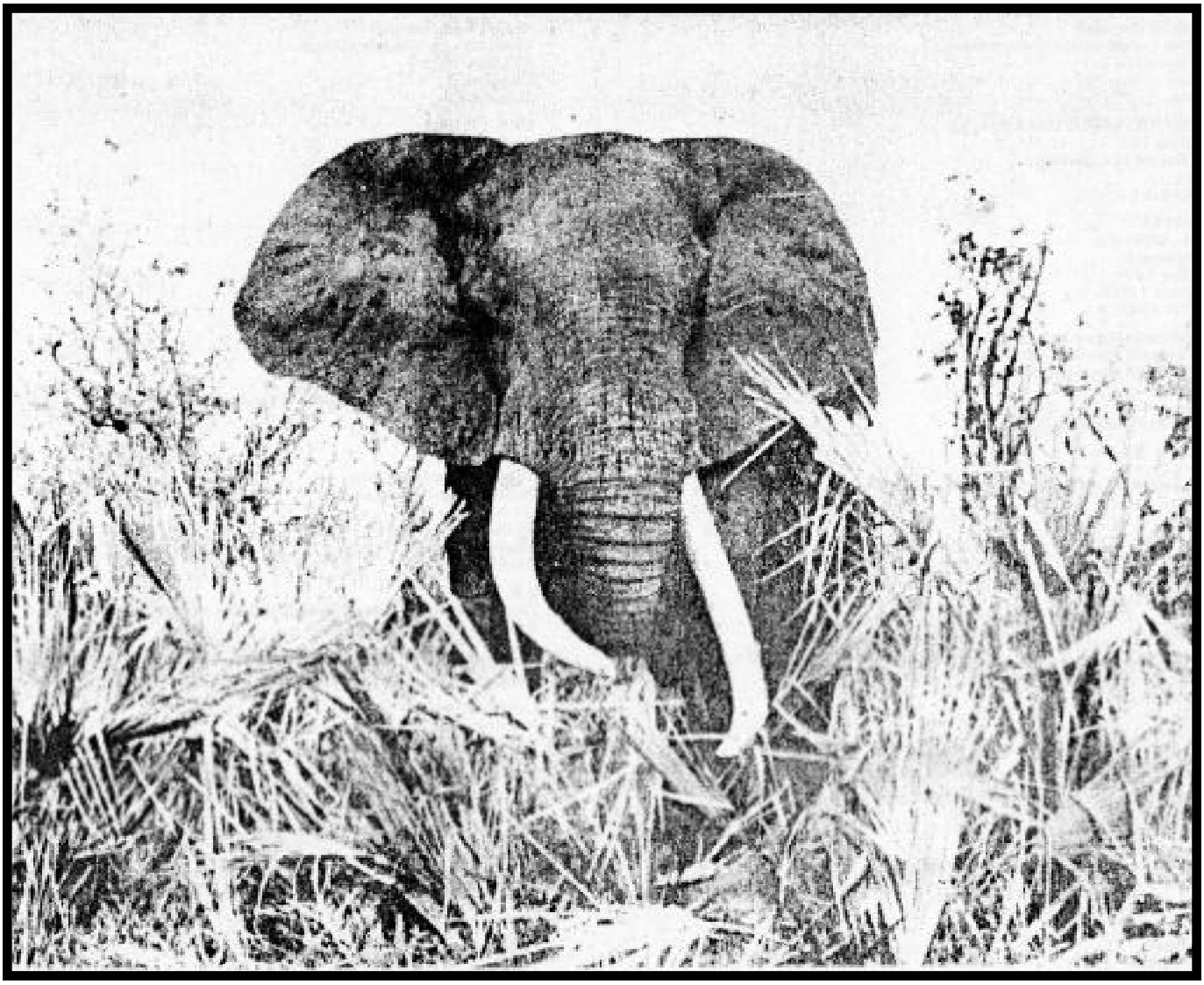
PACHYDERM

NEWSLETTER OF THE AFRICAN ELEPHANT AND RHINO SPECIALIST GROUP



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Chairman's Report

I. CORRUPTION AND CONSERVATION OF PACHYDERMS

Patronage of the corrupt businessman and the corrupt official by corrupt politicians can produce formidable triangular alliances which lead to illegal and devastating exploitation of natural resources. Just as such alliances have destroyed forests in India (Vohra, 1985) so too are they responsible for the recent precipitous decline of black rhino in Africa. These corrupt alliances are undoubtedly a major driving force in the recent over-exploitation of elephant in many parts of Africa and too little attention has been paid to them. We have been too preoccupied with chasing poachers in the field and with changing fashions and trade in lands far removed from the primary area. The core of the problem is corrupt alliances which foster and promote the illegal and uncontrolled (uncontrollable?) exploitation of wildlife resources.

In tackling the rhino and elephant problem wildlife departments have emphasised prevention by going after the man doing the hunting in the field — the poacher. Traditionally, NGO's and aid organisations have similarly concentrated on supporting anti-poaching activities. The other main focus has been the illegal, and sometimes the legal, trade in ivory and horn. Trade bans have been in posed at national and inter-national levels. Much effort and money has been expended on trying to change fashions and reduce demand amongst consumers in Asia or Europe.

International I trade in rhino horn has been banned by all signatories to CITES since the inception of the Convention in 1 976. Producer countries placed a moratorium on the sale of government stocks of horn although Zambia recently (1984) sold a substantial stockpile of horn to North Korea.

If the trend in black rhino in Africa is anything to go by (i.e. from 60 000 plus in 1970, to c. 12 000 in l980 and then to less than 4 000 by the end of 1986) these measures have been a signal failure. The fears that rhino have all hut been eliminated from the Selous Game Reserve (Borner and Severre —Pachyderm No.6) have now been confirmed by recent surveys of the Selous. Black rhino are presently being poached in the Zambezi valley at the rate of one a day despite the capture of 15 Zambian poachers and the deaths of a further 18 in the Zambezi valley over the last two years.

The pivot of illegal and uncontrolled exploitation is the mafia-like alliance which Vohra (1985) identifies, namely, the corrupt politician, the corrupt businessman and the corrupt bureaucrat. It is almost certainly at this pivotal node in the conduit from the field to the end consumer that the greatest profits are to be had, where motivation is highest, and where the ease with which hard currency can he placed in foreign bank accounts is a major part of the spoils. The individuals involved are, through political patronage, effectively above the law in their own countries and they do riot infringe international laws of the sort that lead to arrest, detention and extradition. They are largely immune to the efforts of wildlife agencies — even where these arc' not involved in the corruption That immunity is almost invincible when they establish cross-border poaching operations.

International law enforcement agencies, largely unaware of the value of wildlife products, have shown little interest in involving themselves in this illegal trade and in disentangling the web of corruption which surrounds it.

So what can be done? The first step is to identify the pivotal individuals. The next is to break the alliance, through whatever means are most appropriate, and so stem the strong local, sometimes regional, demand for horn and illegal ivory. These alliances and their demands do not respect national boundaries as Zimbabwe is discovering to its cost. For the most part these apparently simple steps are beyond the means and expertise of conservationists and wildlife department officials. They require the involvement of Heads of State and key professionals at a national and international level. We can merely identify the key problem.

It would be more than tragic if there were to be a repetition of the northern white rhino saga. The time for action is now. For the rhinos in the Zambezi valley another six months maybe too late, The immediate target is perfectly clear and we appeal to those who can take action to do so without delay.

II. FIELD PRIORITIES FOR ACTION ON BLACK RHINO

At the AERSG meeting held in Luangwa in July, 1986, working sessions examined priorities for field action in black rhino populations through out Africa. This exercise was due to follow the development of a continental conservation strategy and completion of the studies on black rhino systematics (see Action Plan). Rapid changes, however, in the status of rhino populations and the urgent need to provide guidance to donors made t necessary to examine priorities now. Priorities were established using the criteria developed at the Hwange meeting in 1981. A working group also drafted a comprehensive conservation strategy for black rhino which has been circulated to members for critical comment. Once these comments are received the document t will be revised and submitted to I UCN for publication.

The field priorities established at the Luangwa meeting for black rhino populations in terms of paragraph 1.3 of the Action Plan follow. The dominant factor in ordering these priority areas was the size of the population. In some cases (Selous and Laikipia) revised estimates received since time Luangwa meeting would place areas at a lower priority than they appear below.

1. ZAMBEZI VALLEY — ZIMBABWE (Population estimate 750)

This area lies downstream from Lake Kariba and includes a number of components of the Zimbabwean parks and wildlife estate. The Mana Pools N.P. and the Chewore and Sapi Safari Areas comprise a World Heritage Site. The Zambezi valley complex carries the largest remaining coherent population of black rhino left in Africa and the only population of more than 500.

Key actions identified were arm increase in anti-poaching forces, infrastructural development for the valley, field research In, and greater co— operation between Zimbabwe and Zambia to stop cross-border poaching. (The perspective on corruption which I have outlined above has developed since the Luangwa meeting.)

2. ETOSHA NATIONAL PAR K — NAMI BIA (Population estimate 350)

Etosha lies within arm incipient war zone and with the second largest coherent population of black rhino on the continent it is vulnerable. No immediate requirement for assistance for the international conservation community was identified.

3. SELOUS GAME RESERVE—— TANZANIA (Population estimate 200?)

This was the top priority for rhino conservation five years ago. In ranking the Selous at the Luangwa meeting we worked on a population of 300 black rhino. Actions considered necessary were a review of the management of Selous, the provision of equipment and the establishment of a monitoring programme. Funding for a survey had already been secured.

4. HWANGE NATIONAL PARK — ZIMBABWE (Population estimate 200?)

Black rhino were re-introduced fun this park inn l960) and more than 100 have been introduced from the Zambezi Valley over the last three years. It is one of the best protected parks in the country and no rhino poaching has been recorded. Immediate assistance is not required.

CHIRISA/CHIZARIRA — ZIMBABWE (Population estimate 350) These contiguous protected areas hold up to 400 black rhino in mostly rugged terrain. Poaching has not been a problem but the present forces are inadequate to counteract commercial poaching. The Zimbabwean authorities were urged to examine the situation carefully and take appropriate action. A small, mobile, well equipped anti-poaching unit established in the district could act as an early antidote to any commercial poaching in the complex comprising Chirisa, Chizarira, Chete and Matusadona (see below).

5. MATUSADONA NATIONAL PARK — ZIMBABWE (Population estimate 150).

The park borders on Lake Kariba and is not under poaching pressure at present. The services of a mobile anti-poaching unit may be needed as indicated above under Chirisa/Chizarira.

TSAVO NATIONAL PARK—— KENYA (Population estimate 200?)

The Kenyan Rhino Conservation Strategy should be supported and law enforcement should be focussed on a priority area within Tsavo so that a wild population can be preserved.

LUANGWA VALLEY — ZAMBIA (Population estimate 120?)

Strong anti-poaching efforts combined with the involvement of local communities were identified as key requirements.

KAOKOLAND/DAMARALAND—NAMIBIA (Population estimate 70)

A population of approximately 70 black rhino live in desert and near desert conditions outside protected areas in Kaokoland and Damaraland. There is a need for additional support for patrols and possibly for the recruitment of additional auxilliaries who, drawn from the local communities, assist the authorities in patrolling the area.

6. KRUGER NATIONAL PARK—SOUTH AFRICA (Population estimate 120)

This growing population is one of the most secure in Africa and no immediate need for assistance is apparent.

MT KENYA NATIONAL PARK — KENYA (Population estimate 50)

There are presently no sound data on numbers and recommendations for action would need ton be put forward once surveys have been completed.

ABERDARES NATIONAL PARK — KENYA (Population estimate 60)

A surveillance unit is operating in the area and no immediate action was identified.

CHETE SAFARI AREA — ZIMBABWE (Population estimate 60) See action under Chizarira/Chirisa above.

7. UMFOLOZI /HLULUWE GAME RESERVE— SOUTH AFRICA (Population estimate 200)

This complex is relatively well protected and requirements for future conservation action will be assessed in the conservation strategy that has recently been initiated in Natal.

8. GONAREZHOU NATIONAL PARK—ZIMBABWE (Population estimate 75)

Rhino were re-introduced to this park of 5 000 sq. km in 1971. The 72 animals introduced increased to over 100 but poaching over the last 18 months has reduced this to less than 75.Anti-poaching efforts are complicated by the Mocambique civil war and the movement of refugees through the park. Equipment and staffing could be improved.

9. MKUZI NATIONAL PARK — SOUTH AFRICA (Populaton estimate 70)

See comment under Umfolozi/Hluluwe above.

BOUBA-NJ IDA NATIONAL PARK

— CAM EROUN (Population estimate 50?)

The major requirement is to find out how many rhino remain in the park. (A recent report — November, 1986 — suggests that there may no longer be any rhino in Bouba-Njida).

SOLIO RANCH—— KENYA (Population estimate 90)

No clear recommendations for action on private ranches in Kenya emerged other than a need to investigate costs of fencing and fence maintenance.

10. LAIKIPIA RANCH — KENYA (Population estimate 40)

See above.

III. AERSG ACTION PLAN

The above recommendations on field action for black rhino constitute elaboration of components of the overall AERSG Action Plan, as outlined below. The priorities of the Action Plan were defined at the Victoria Falls Meeting of the AERSG held on the 21-22 September, 1985, and reviewed at the Luangwa meeting held on the 15-18 July 1986.

FIELD PRIORITIES

1. Develop a Conservation Strategy for the Black Rhino

The continuing rapid decline of black rhino populations in most parts of its range coupled with the fact that many viable populations do still exist in the wild merits the placing of black rhino, in contrast to white rhino, as the top priority for conservation action. The development of a continental conservation strategy for the species involves three major, and preferably concurrent, actions:

1.1 Examine the taxonomic status of presently described subspecies of black rhino so as to provide a sound basis for ordering priorities for action amongst the now geographically separated populations in Africa.

1.2 Develop National Conservation Plans for those countries with more than 100 black rhinos. Priorities for action would need to be examined once the results of the taxonomic studies were available and the national plans had been drafted (however, see above under Field Priorities for Action on Black Rhino).

1.3 Promote the dissemination of information and expertise necessary to implement and support the international and national rhino conservation plans.

2. Northern white rhino

2.1 Encourage efforts to coordinate the breeding of existing captive northern white rhino.

2.2 Examine the taxonomic status of the northern white rhino.

A key issue in deciding on the resources to be invested in the conservation of northern white rhino is the extent to which they have diverged from the southern white rhino populations. Further work on this question was needed.

2.3 Support the rehabilitation of Garamba National Park with northern white rhino as a component of the ecosystem.

3. Desert Elephant

Continue to monitor the status of elephant populations in Mali, Mauritania and Namibia and to urge appropriate conservation action.

4. Forest Elephant

4.1 The second phase of the study of forest elephant numbers and distribution (i.e. the classification and delineation of elephant habitats and land use strata) should be initiated as soon as possible. A sound knowledge of the size of the forest elephant population is crucial to decisions about the management of African elephant and the regulation of the ivory trade.

4.2 Protected areas for forest elephant need to be established.

5. West African Elephant

Convene a regional arm of the AERSG in West Africa and encourage a re-assessment of the status and distribution of elephant within West Africa.

6. Selous Game Reserve

A full census of the rhino and elephant populations of the Selous was needed urgently (this survey was carried out in October, 1986).

7. **Central African Republic**

Continue to support rhino and elephant conservation initiatives in the CAR despite recent major reductions in the populations of these species.

8. Other Surveys

Censuses of elephant and rhino populations are especially needed in Tsavo, Lunangwa, Kafue and Runaha/Rungwa.

TRADE PRIORITIES

1. Rhino Horn

1 .1 North Yemen. Take action to reduce the demand for rhino horn and, if possible, close down the trade.

1.2 East Asia. Take action to reduce the demand for rhino horn and, if possible, stop the trade in horn.

1.3 Investigate the movement of rhino horn within Africa.

1.4 Investigate the discrepancies between reported declines in rhino populations and the amount of horn appearing in the trade.

1.5 Inform Governments of the value, and potential value, of their rhino populations and so encourage the al location of more resources to their conservation.

2. Ivory

2.1 Encourage the formation of a wildlife division within interpol or if this is not feasible the formation of an equivalent organisation linking wildlife law enforcement agencies.

2.2 Investigate the internal trade in ivory and ivory products in central Africa (i.e. Zaire, Cameroun, CAR, Congo and Gabon).

2.3 Investigate the internal trade in ivory and ivory products in West Africa (i.e. from Senegal to Niger and Nigeria).

2.4 Continue the development of ivory and elephant population models as aim aid to the interpretation of ivory trade statistics.

RESOURCE MANAGEMENT

Promote the conservation and management of elephant populations in Africa by providing information and advice on:

1. Monitoring elephant populations
2. Management and harvesting
3. Legal and administrative frameworks
4. Law enforcement
5. Ivory trade

The main focus of conservation action for elephants in Africa has been on anti-poaching and on attempts to halt the ivory trade. While these may be the most appropriate actions in some cases there are many circumstances where positive management of elephant, as a valuable aesthetic and economic resource, may be more successful. African Governments and wildlife agencies need to be made more aware of the options available to them.

David Cumming

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RHINO POACHING IN THE ZAMBEZI VALLEY

Rhino poaching in the Zambezi Valley of Zimbabwe continues at a serious level, with staff of the Zimbabwean Department of National Parks and Wildlife Management (assisted by units of the Police Support Unit) waging what amounts to counter-insurgency warfare against commercial rhino poachers. These poachers enter Zimbabwe from Zambia in groups of 4-6 men, armed with AK47 assault rifles and .375 hunting rifles, with their prime objective being the acquisition of rhino horn. They use sophisticated tactics to avoid capture by the Zimbabwean forces: e.g. anti-tracking, fire-and-movement drill, and co-ordinated operations along the Zambezi river frontage. Since June 1985,19 poachers have been killed (the inmost recent death occurring in early December, T 986), and a further Tb have been captured. The latter have confirmed, during interrogations, that they carry military type weapons specifically to resist capture.

It is estimated that over 200) rhino have been slaughtered on the Zimbabwean side of the Zambezi since July 1984, and although the rate of loss has decreased in recent months (due partly to reduced densities of rhino along the river frontage), t is likely that poaching activity will increase during the rainy season. Officials of the Zimbabwean Department of National Parks and Wildlife Management are attempting to develop liaison with Zambian officials over the matter (the Zambian Commissioner of Police was recently fully briefed on the problem during a visit to Zimbabwe).

The Zambezi situation provides clear evidence of the high degree of criminal motivation associated with rhino poaching. Weak law-enforcement, mild penalties for poaching, adherence to traditional game-scouting approaches, and lack of attention to systematic intelligence work must be corrected if there is to be any hope for the survival of rhino in African wildlife areas.

Glen Tatham

COVER PHOTOGRAPH (by A. Hall-Martin): Joao, a famous tusker of Kruger National Park. His left tusk measured 191 cm from lip to tip, and his right 165 cm; lip circumference of the left was 54 cm, and the right 55 cm. His shoulder height was 348 cm.

AFRICAN RHINO WORKSHOP IN CINCINNATI, OCTOBER 1986

The American Association of Zoological Parks and Aquaria convened a 4-day meeting of rhino specialists (including a number of members of AERSG) in Cincinnati, to discuss the management of small populations of rhino in captive or semi-captive situations. Information was presented on a range of relevant topics, including rhino systematics, genetics, decision analysis, reproductive physiology and health problems. It is intended that the proceedings wilt be published as a special issue of Pachyderm.

The aim of *Pachyderm.* the AERSG Newsletter. is to offer members of the group. and those who share its concerns. brief research papers. news items and opinions on issues directly related to the conservation and management of elephant and rhino in Africa. All readers are invited to submit articles (up to 3 000 words), black and white photographs and graphics for publication; articles may be edited. Material published in *Pachyderm* does not necessarily reflect the views of AERSG, SSC, UCN or any organisation supporting AERSG.

Editors: Raoul du Toit and David Cumming.

The Pygmy Elephant: A Myth and a Mystery

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INTRODUCTION

For decades a debate has flourished over whether or riot there is a pygmy elephant (Morrison-Scott, T 947; Offerman, 195 T; Pfeffer, T 960; Biancou, 1962), a race sympatric with yet smaller than the forest elephant. Noack first described the 200 cm-tall race with tong straight tusks and small rounded ears in 1906. Reports of its existence, but no definite proof, are as perennial as ever. That proof one way or another is lacking is testimony to our biological ignorance of forest elephants.

In the course of a forest elephant survey in January and February 1986,1 had arm opportunity to hook into reports of the pygmy elephant.

The survey combined 12000 km of aerial reconniasance over Zaire, Central African Republic, Cameroun, Gabon, Congo Republic and western Uganda, with more detailed ground work at five locations in three countries — CAR., Gabon and Zaire. Peter Matthiessen accompanied me on the entire trip, and Richard Barnes, who is conducting a detailed study of forest elephant for New York Zoological Society, joined us in C.A.R. and Gabon.

PYGMY ELEPHANT

I did riot expect to see many elephants, and certainly not clearly, knowing the difficulty of seeing them in demise forests. As t was, we were fortunate in getting a clear view of about a hundred and twenty elephants in three different locations in C.A.R. and Gabon.

At Dzhanga, am open pan in the Bayanga Forest of south-western C.A.R., we observed a number of herds on two afternoons. A few individuals fitted Noack's (1906) description of **Loxodonta africana pumillio** and later accounts, including that of Haltenorth and Diller (1980). The pygmy elephants had small round ears, straight to slightly bowed backs, sloping foreheads and long tusks projecting vertically from the jaw. Shoulder height varied from around 140cm to 180 cm. In keeping with their reputation for aggressiveness one pygmy elephant trying to take over a small salt lick gave aggressive head threats to a savanna bull nearly twice his height.

Our observations gave us every reason to believe these were genuine pygmy elephants. However, aside from mature tusk development, I felt sure these were juvenile elephants. None had young of their own. This was confirmed when several adult females entering the clearing were joined by the pygmy elephants, which showed affiliate behaviour. I saw this happen on three separate occasions. Each juvenile stayed with its respective female as t left the clearing.

Our direct observations confirm what several authors (Morrison-Scott, 1947; Pfetter, 1958; Pfeffer,1960) have conjectured without first-hand observations — the pygmy elephant is a juvenile forest elephant.

But why should tusk development be so precocial in these "pygmy" elephants, and why should they leave their mothers so early?

Spinage (1959) has already noted that precocial tusk development may confuse age determination and explain the myth of the pygmy elephant.

A juvenile bush elephant he photographed shows much less tusk advancement than juvenile forest elephants at Bayanga, where 5-to 7-year-olds (based on estimated back height and Pfeffer's (1960) growth curve), with tusks almost to the ground, can easily be mistaken for adults. Tusk development is undoubtedly far faster in some forest elephants than in the bush race. Why is unclear. The answer may lie in the calf's early detachment from the mother.

I observed tiny calves, some no more than 3 years old, some alone, some in herds, quite detached from adult females. Why the partial independence at a far younger age than in savannas is unclear. Perhaps there is more incentive to separate and less risk in doing so in forests. Food scarcity may provide the incentive, and lack of predators the freedom of risk.

Tropical rain forests are no more productive than moist savannas (Whittaker and Likens, 1973). The production available to large mammals is far less, both because a large proportion is indigestible wood, and because so little is within reach of ground-hiving herbivores. Secondary compounds may further limit digestible forage. Elephant densities in forests are consequently far lower than in moist savannas (Short, 1983; Mertz, 1986). The small herds typical of forest elephants (Mertz, 1982) suggest that food competition is high. Food spacing would therefore be advantageous. That being so, weaned infants with sufficient foraging skills would benefit from extended feeding forays from their parent herd.

Despite their separation, immatures may well remain in contact with their mothers if, as Katy Payne (pers. comm.) has shown recently, elephants are capable of infrasound (how frequency) communication over considerable distances.

The absence of lions and hyenas in central African rainforests must make the early separation of elephant calves relatively safe. At Bayanga we watched a number of three- to four-year-old bush elephant calves, which would be vulnerable to predators in the savannas, wandering alone or in juvenile groups.

In conclusion, I can well see why young forest elephants can be regarded as a race different from and smaller than **cyclotis**. The confusion contributes in part to the belief in a pygmy elephant. It is revealing that both the type specimen of **pumillio** — an animal imported to the Bronx Zoo in 1904—— and every other elephant imported to zoos as the supposed pygmy race, subsequently continued to grow to normal forest elephant stature (Pfeffer, 1960; Crandall, 1964; Bridges, 1966).

BUT TWO RACES DO EXIST IN FORESTS

Pygmy elephant reports do not rest solely, or even mainly on mistaken age identity of forest elephants. After direct observations of elephants in C.A.R., Gabon and Zaire, in discussion with field biologists, indigenous forest peoples and hunters, and after reviewing the literature and looking at photos taken of elephants throughout these countries, I believe there is a far more compelling reason for the belief in a pygmy elephant: there are genuinely two races of elephant in the forest.

Two elephants, a big one and a small one, are recognised by almost all indigenous hunters throughout the central African forests. The names may vary in different locations. In Gabon and C.A.R. the big one is Ie gros, the small one assala. Assala is, according to naturalists and hunters in the region, the pygmy elephant.

At Bayanga we observed both Ie gros and assala, as pointed out to us by our Babinga Pygmy guides. Yet the bigger form was the regular bush elephant, the smaller one the forest elephant. I suspected at first that Bayanga's bush elephants were recent refugees from the savannas 200 km or so north, where poaching has been heavy, and that our guides were confused. Later, however, scrutiny of 70 or so animals showed otherwise; adults 40 years or more old, showed hybrid characters of both races. Hybrids showed variations in tusk, head, and ear shape, and in size.

The sympathy was not, as it turned out, an edge effect. In Gabon, as far removed from the savannas as one can get, bush elephant traits and a considerable size variation are still evident. Some el-

ephants have thin vertical tusks, others thicker and horizontal. Through cyclotis characters dominate, variation in ear, back and head shape can be seen.

Offerman (1935) reports, and his photos show that both large, predominantly bush forms and small forest elephants co-exist in eastern Zaire.

The sympatry of two forest-dwelling races is most surprising and quite unexpected. It raises a number of questions and has several conservation implications.

DISCUSSION

The Pygmy peoples are correct about there being a big and small race of elephants in the forest. It is the naturalists who have wrongly deduced that two sympatric races of elephant in the forest must mean that there are two races of forest elephant. That assumption logically leads to the conclusion that the two forms must be the regular forest elephant and a smaller pygmy race, rather than the bush and forest elephant and their hybrid forms. No doubt the precocial forest elephant calves have done much to foster the myth. But, if there were a pygmy elephant, the pygmies would report three, not two, races.

The intriguing question is why bush elephants occur so deep in the forest. Either the incursion is relatively recent, induced perhaps by hunting in the last several hundred years, or it is more ancient and the result of past habitat changes.

The nature of bush and forest elephant overlap belies the hunting hypothesis. The overlap is very broad, with forest elephants occurring along the savanna margins and in the thin gallery forests which run well into it in C.A.R. and Zaire. Forest elephants would be unlikely to expand in the direction of bush elephant retreat from hunting. Furthermore, bush elephant traits occur deep in the forest, not merely at the periphery, as one might expect in a forced retreat from the savannas. Finally, from evidence gathered at almost every location we visited, it became clear that poaching was quite as severe in remote forests as in the savannas. Remoteness from humanity gives no immunity from hunting.

Bush elephant influence declines from forest periphery to centre, but unevenly, with hybrid traits occurring throughout. Two non-exclusive explanations are possible. First, one can postulate a broach hybrid zone between a deep-forest, pure **cyclotis** race and a pure bush race in the savannas remote from the forest edge. Second, a mosaic of the two races and their hybrids may occur throughout the forest, a mosaic formed in drier times when the forest was interspersed with savanna. If an exclusive cyclotis zone exists, it can only do so in a small region of eastern Zaire and western Congo Republic. All other regions show both traits. My guess is that the present mosaic of both races stems from a former dry phase when the forest was fragmented much as the 1.5 million km2 savanna—forest mosaic stretching from eastern Zaire to West Africa is today. Here **cyclotis** predominate in gallery forests and **africana in the open** savannas. A wetter climate would induce rapid forest advancement and the envelopment of bush elephants. This may well have occurred over much of the central African forest in the last few thousand years. John and Terrese H hart (pers. comm.) have identified extensive 2 000-year-old charcoal deposits under the Ituri Forest, indicating woodland or savanna conditions.

Such climatic and habitat oscillations are not exceptional. Vanzolini (1973) believes that there is no time in the last 10000 years when Africa's equatorial vegetation has been stable for more than a thousand years. Climatically induced fragmentation and re-afforestation would account for bush elephant traits in forests. Assortative mating might show down the rate of hybridization and bush trait disappearance.

THE IMPLICATIONS

The sympatry and hybridization of cyclotis and africana in central African forests and forest-savanna mosaic (a combined area of over 3.5 million km2), has numerous implications for elephant biology and conservation. I will touch on a few.

First, detailed surveys are needed to sort out the complicated distribution and hybridization mosaic of bush and forest elephants, and to look at their habitat, feeding and mating patterns.

Second, **cyclotis** and **africana** tusk and body growth curves are different, so one cannot infer age of the former from tusks of the latter. Separate tusk growth-curves for forest elephant are needed. Furthermore, because many small forest elephants have **africana rather** than **cyclotis** tusk shape, tusk-inferred age is dubious for bush elephant tusks originating in central Africa, whether from forest or forest-savanna.

Third, with such extensive hybridization, t is difficult to know which growth curve applies to a given tusk. Tooth eruption times are also likely to differ between the two races, which will further complicate age estimates.

Finally, the **cyclotis** and **africana** distribution mosaic and extensive hybridization throughout central Africa invalidates tusk shape as a method of estimating the proportion of forest-origin elephants entering the trade.

CONCLUSION

There is no reason to believe that a pygmy elephant exists. The origins of such a belief — the developmental and tusk precocity of forest elephants and the sympatry of both **cyclotis** and **africana** races in the forest — are, however, fascinating and puzzling phenomena in need of detailed study. A clear geographic and morphological distinction between the two races can no longer be upheld. Rather, we need to focus on why the overlap is so extensive, whether the two races coexist in equilibrium due to a degree of ecological separation and assortative mating, or whether the genetic balance is shifting due to climatic and habitat changes over the last few thousand years.

The forest—savanna mosaic, which is so extensive that ot should be viewed as a biome rather than arm ecological transition zone, is, and perhaps has been evolutionarily important in explaining species fragmentation and hybridization patterns in the equatorial region. A study of the ecology and behaviour of both elephant races in the northern forest savanna mosaic would give valuable insights on these questions, and on the impact of future deforestation on forest ecosystems.

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Reference are continued on P.10.

Recruitment in a Small Black Rhino Population

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INTRODUCTION

A population of black rhino of the Kenyan **subspecies Diceros bicornis michaeli occurs** in the Addo Elephant National Park of South Africa. Times. animals (now a population of 17) are descended from four wild-caught Kenyan animals which were translocated in 1961 and 1962. The details of their introduction and initial management can be found in Hall-Martin and Penzhorn (1977). In late 1977 the park area available to these black rhino was enlarged to the present 8 596 ha. The rhino are free-ranging in this area which also supports populations of other large mammals (Table 1).

The population dynamics of this rhino group have been monitored and the observations are summarized below, since they have direct relevance to initiatives to build deli small rhino populations elsewhere.

MANAGEMENT

The animals are not handled in anyway. Routine management consists only of maintaining perennial water supplies and protection within the fenced area of the Park.

INTERFERENCE

During September 1977 a regrettable introduction of three bulls from Natal, of the subspecies D. b. minor, was made. One of these bulls had only one external ear. As this was thought to be due to a genetic condition (known from elsewhere in Africa — Goddard, 1969; Hitchins, this issue) the bull was immobilised and castrated in 1979. Later observations of the castrated bull attempting to mate with cows, and keeping other bul Is anway from them, led to him being shot. The other two D. **b.** minor bulls were removed in May 1981, im compliance with a resolu-tion of the African Rhino Specialist Group of IUCN/SSC taken at its Kilaguni, Kenya meeting in 1980.

A further consequence of the decision of the National Parks Board of Trustees of South Africato implement the SSC resolution was that three calves, possibly sired by Natal bulls, were removed from the Park in May 1983. These three animals were exchanged with the National Zoological Gardens in Pretoria for an adult cow of the subspecies D. b. michaeli. The transfer of this cow from a zoo to the wild was not successful and she died after three months at Addo.

The remaining animals, all pure **D. b. michaeli**, have been undisturbed since 198 I and their prospects for the future are good.

MONITORING

Because of the nature of the vegetation at Addo — which is a dense thicket of mainly evergreen and succulent shrubs and small trees (Hall-Martin, et al. 1982), in which visibility is limited, and access restricted to a few roads and elephant paths — it is difficult to keep records of the rhino. All animals were, therefore, darted in May1977 when they were still held in a relatively small fenced paddock, and were marked by ear tags ('Lone Star' type) and had notches cut in their ears.

The tags lasted a few years and then fell out. The notches, however, have allowed observations of known individuals to continue. A helicopter census of the Park (now carried out annually) during which all rhino are identified and photographed, is the major means of recording data on the reproductive performance of the populations. When calves reach the age of 2-3 years, before they leave their mothers, they are darted and marked by ear notches. Three young animals were caught and marked in 1986 and more will be marked in 1987. The ultimate objective is to have all animals marked.

Figure 1. Map showing location of Addo Elephant National Park.

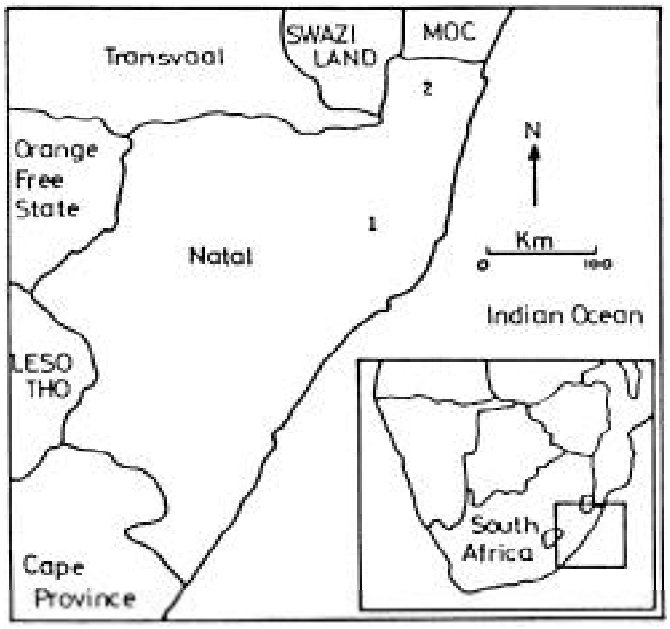

Table 1. The large mammals of the Addo Elephant N.P.

Species	Numbers					
	1978	1979	1981	1983	1985	1986
Elephant	92	102	108	116	117	118
Buffalo	247	269	75	120	42	52
BlackRhino	9	11	16	19	16	17
Kudu	152	203	192	493	361	361
Bushpig	22	38	26	23	11	3
Bushbuck	80	81	109	206	123	137
Duiker	193	384	392	489	194	238
Eland	119	138	52	37	49	54
Red Hartebeest	26	27	27	24	23	26

REPRODUCTIVE PERFORMANCE

From the records which have been kept some data can be derived to assess the reproductive performance of the population:

a. Age at first calving

Six cows born in the Park have calved and the ages of first conception and calving are shown in Table 2.

Table 2. Ages of cows at first conception and calving

Cow	Age Conception	First Calving
Lucky Star	7 years 2 months	8 years 5 months
Doreen	6 years 9 months	8 years
Blom	9 years 1 month	10 years 4 months
Slattery	3 years 10 months	5 years 1 month
Ida	6 years 3 months	7 years 6 months
Vega	4 years 10 months	6 years 1 month

The ages at first calving are higher than those given in the literature for wild black rhino (Goddard, 1970) but of the order reported for captives (Mentis, 1 972). The records for the first three cows given above (mean age at first calving 8 years 11 months) were derived from the period when the animals were living at an unnaturally high density and when only one adult bull, or no adult bull was available. The age at first calving for the second group of three cows is 6 years 3 months. Four adult bulls were available at the time when the first two of these cows conceived, and three when the third conceived. These latter records are, therefore, more likely to be representative of what may be expected from this population in the future.

b. Calving intervals

Intervals between successive calves have been recorded on 16 occasions. Records exist for seven cows (Table 3).

Table 3. Recorded calving intervals for cows in Addo Elephant N.P.

Cow	Calving interval (months)	Mean (months)
Brunni	27+32+52+34	36
Ida (Snr)	46+24	35
Doreen	33+28+33+58	38
LuckyStar	114 + 36	(75)
Blom	48	
Slattery	35	
Ida (Jnr)	39+28	33

Three of the four longest calving intervals (46,52 and 114 months) were associated with the initial period of poor conditions at Addo. The mean of the remaining 1 3 intervals is 35 months. If the two longest of these are regarded as unusually long, then the mean for the remaining 11 intervals is32 months. This mean is closer to others recorded in the literature (Mentis, 1972) but nevertheless somewhat longer than the 27 months suggested for wild black rhinoceros (Goddard, 1 967; Joubert and Eloff, 1971).

c. Sexual maturity of bulls

There is little evidence of the age of bulls at full 'sexual' maturity and first mating. One bull was killed by an older bull at the age of 8 years 5 months which suggests that he was regarded as a rival at that age. One successful mating, according to strong circumstantial evidence, occurred when another bull was 6 years old.

d. Observed rate of increase

For the purpose of this calculation the performance of the population at Addo from 1977 to 1986 was assessed. The hybrid animals (removed in 1983) were considered to be part of the population in the model, but the Natal bulls not. The population growth over the 9 years is described by the equation:

Log_e population = 2.11 +0.09 1 7t (where t is years)

This observed rate of increase r=0.091 7 (giving a finite rate of increase of 9.6% per annum) is slightly higher than the rate of 9.00/ 0 calculated for the Kruger National Park population (Hall-Martin, 1982), and is considerably higher than that of Hluhluwe Game Reserve in Natal (5.3%) (Hitchins and Anderson, 1983), or, historically, the 7.0% at Ngorongoro and 7.2% at Olduvai in Tanzania (Goddard, 1 967). Other Natal populations such as Umfolozi have a higher rate of increase of 11.0% (Hitchins and Anderson, 1983).

e. Seasonality of conception

The records of 28 conceptions at Addo are shown diagramatically relative to long term rainfall (Figure 3). There appears to be a clear spring to mid-summer peak in conception time.

FUTURE PROSPECTS

With the improvement in their circumstances t can be expected that the Addo black rhino population will increase at about 10% per annum. The carrying capacity for Addo has not yet been calculated. However, it would seem that a case could be made for the translocation of surplus black rhino from Addo within the next decade.

No firm decision has yet been taken on what could become of surplus animals from Addo. The demand for animals to found other populations in protected areas would most likely be regarded as sufficient justifi-

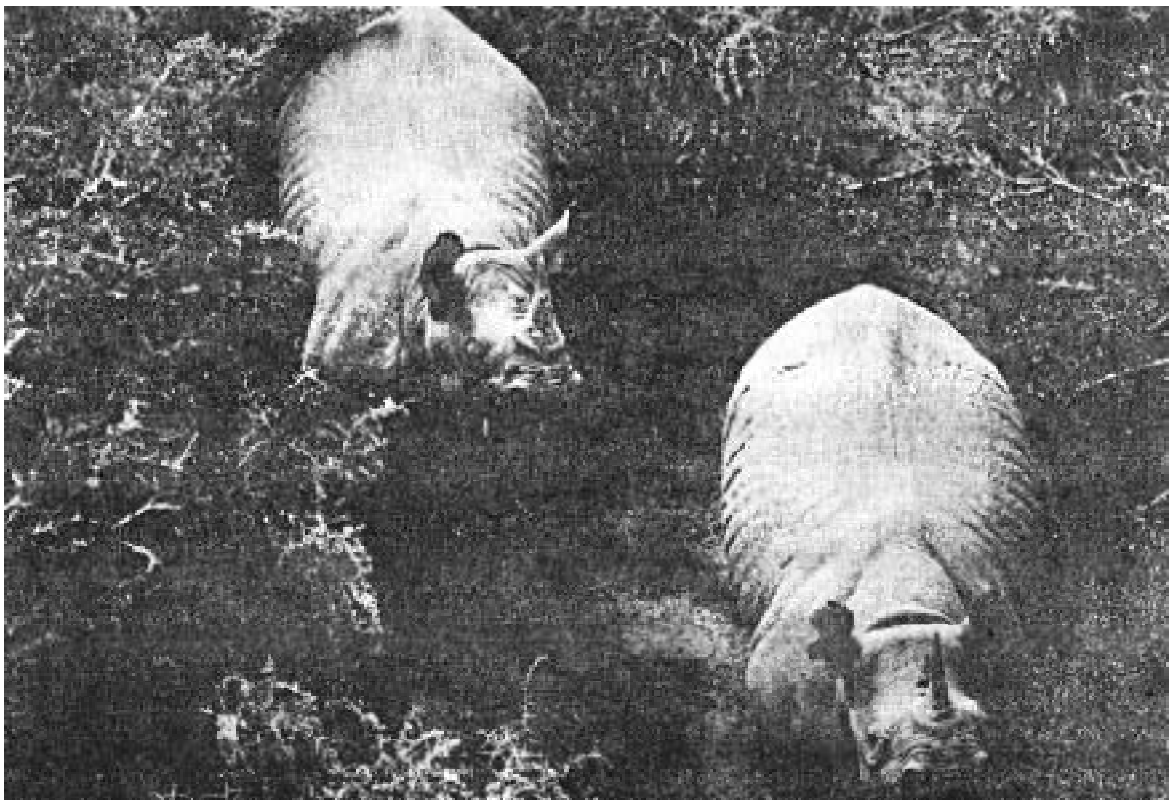

Figure 2. D.b.michaeli in Addo Elephant N.P. The skin on the sides of these animals appears more currugated than in Southern African sub-species.

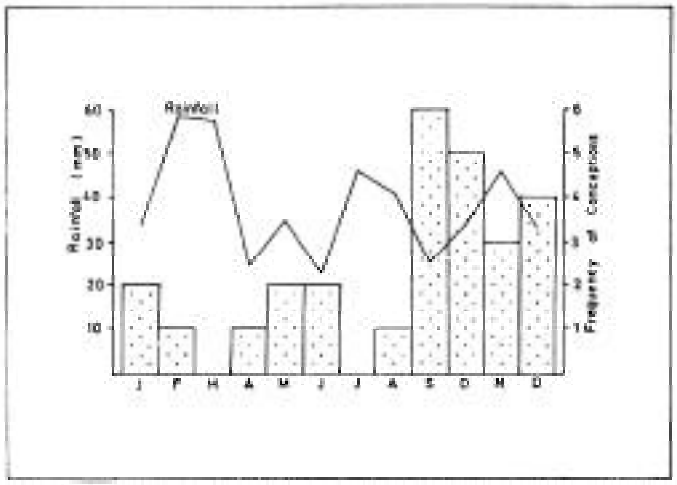

Figure 3. Frequency of conceptions of black rhino in the Addo Elephant National Park (1962-1984).

cation for removing black rhino from Addo. Enlargements to Addo, by the purchase of surrounding land, could ensure that a larger population, ultimately delivering more animals for translocation, could be maintained.

The National Parks Board of South Africa is now fully committed to an extensive black rhino conservation program me. It may be the only organisation controlling viable populations of more than one subspecies of black rhino. It has the Addo population (**D. b. michaeli**) which currently numbers 1 7 animals, a population of 1 .35 **D. b. minor** in the Kruger National Park and 5 **D. b. bicornis** in the Augrabies Falls National Park (this assumes that these animals are recognised as belonging to this subspecies as suggested by Hall-Martin, 1985). During 1987 a further group of 7 **D.b. bicornisare** due to be introduced to the Vaalbos National Park.

Any other available black rhino habitat in South African national parks will be stocked with either **D. b. bicornis** from Namibia or **D.b. minor** from Natal or Kruger. The options of establishing a second **D. b. michaeli** population in a suitable protected area, or returning the surplus animals from Addo to Kenya and Tanzania at some future time remain to be explored.

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Earlessness in the Black Rhinoceros — A Warning

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Unilateral or bilateral earlessness (i.e. lack of pinnae) in the black rhinocerous has been recorded from a number of populations in eastern and southern Africa (Goddard, 1969; Hitchins and Anderson, 1983). These authors have attributed the condition to predation on black rhinoceros calves by spotted hyaena **Crocuta crocuta** whilst Goddard (1969) suggests that a genetic character, a sex influenced or sex—linked gene could also be responsible for a congenital deformity.

The black rhinoceros population in the Hluhluwe/Corridor/Umfolozi Game Reserve complex, has been monitored at various intervals between 1961 and 1985 by the author. Physical characteristics of all individuals seen were recorded over this period, which resulted in comprehensive data on missing ears and/or tails or parts of tails of various individuals. Prior to 1961 earlessness was first observed in early 1955 (N. Deare, pers. comm.) in the north of Hluhluwe Game Reserve: an adult female with its left pinna missing. Later during 1955 a male calf was born with both pinnae missing and with no external openings.

From 1955 to 1985 a total of 23 individuals in Hluhluwe Game Reserve amid Corridor showed the earless condition (one or both pinnae absent) and an additional 15 individuals had either a portion of the tail or the whole tail missing (Table 1; Figures 1, 2 and 3).

In the earless condition (n = 23), 21 animals were examined in the

Table 1. Number of black rhinoceros with missing ears and/or tails or portions of tails in Hluhluwe Game Reserve amid Corridor, 1955-1985.

Sex	One pinna absent	Both pinnae absent	One amid tail absent	One and portion of tail absent	Tail absent	Portion of tail absent
H LU H LUW E:						
Male	7	1	1	2	—	7
Female	3	2	—	—	3	3
Unsexed	1	—	1	—	—	—
CORRIDOR:						
Male	—	1	—	—	—	—
Female	2	1	—	1	—	2
TOTAL	13	5	2	3	3	12

38

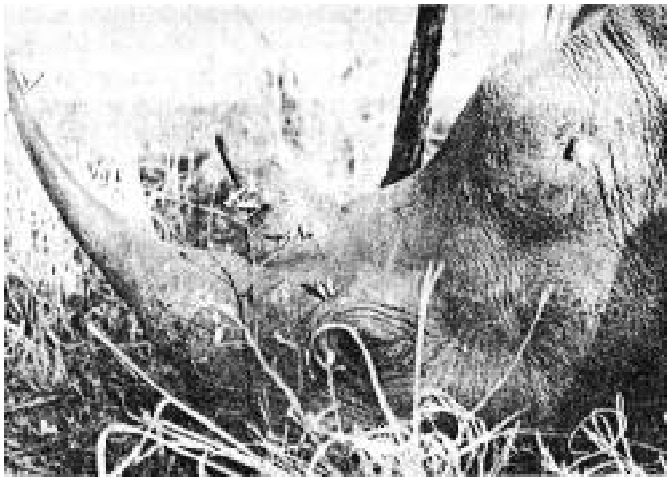

Figure 1. Black rhinoceros male with left pinna absent; note scars.

Figure 2. Detail of ear opening of black rhinoceros male showing prominent scars.

field in detail and showed the following characteristics:

both pinnae absent with no external opening: 1 (no scars);
both pinnae absent with external opening: 3 (scars present);
one pinna absent with no external opening: 1 (scar present);
one pinna absent with external opening: 16 (scars present).

Where tails were missing or damaged (n = 1 5) obvious scars were always visible.

Of the 36 animals examined with missing ears and/or damaged tails, only one showed a congenital deformity. If one considers this single case in relation to the whole black rhinoceros population in the Hluhluwe/Corridor/ Umfolozi Game Reserve complex over a 30-year period (1955 to 1985) the incidence of a genetic character being responsible for earlessness is indeed rare. The impact of hyaena predation on the black rhinoceros population is unknown but is considered to be fairly high in Hluhluwe, low in the Corridor and very low in Umfolozi. Kruuk (1972) observed hyaenas grabbling black rhinoceros calves preferentially by the ears and tail ,at Serengeti which supports the observations inn Table 1.

It is of interest to note that in the square-lipped rhinoceros **Ceratotherium simum simum** there has been no record of any ear or tail losses in the reserve complex from thousands of observations made by the author. There is little doubt that the reason for this is related to predation by spotted hyaenas on black and not square-lipped rhinoceros. This preference is in turn related to the mother-calf relationship when the animals are disturbed: with the square-lipped rhinoceros, a calf always runs in front of the mother

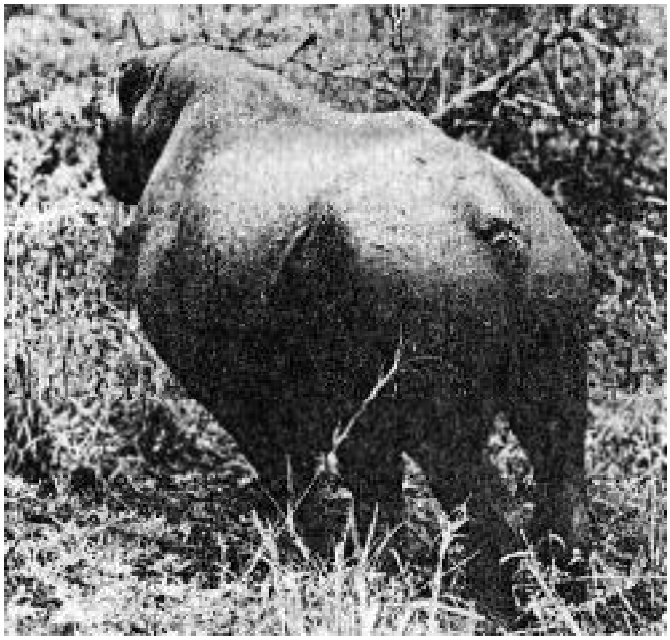

Figure 3. Young black rhinoceros male with tail (note scar) and left pinna missing.

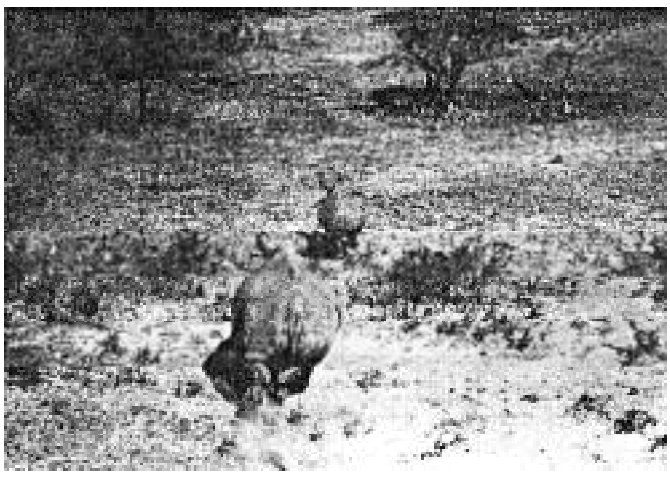

Figure 4. Disturbed square-lipped rhinoceros, mother and calf in flight.

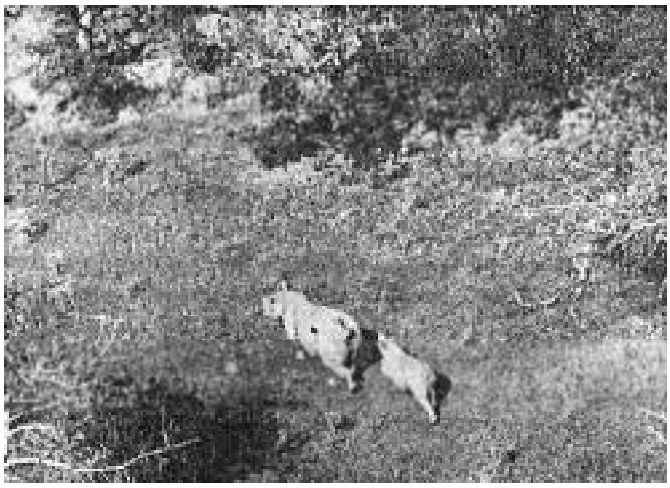

Figure 5. Disturbed black rhinoceros, mother and calf in flight.

(Figure4) which has total contact with its calf, whereas the black rhinoceros calf follows the mother with very little contact and therefore less protection (Figure 5). Both these relationships are related to the different habitat requirements of these two species.

THE WARNING:

In 1977 a black rhinoceros male lacking one pinna was introduced to the Addo Elephant National Park from Hluhluwe Game Reserve. It was later successfully castrated to prevent the possibility of an earless inducing gene being introduced into the Addo population (de Vos and Braack, 1980). Subsequently it has been destroyed as it no longer served a reproductive function in the park (J. Flamand, pers. comm.). The animal had been a familiar resident of Hluhluwe Game Reserve prior to its translocation and was known to have been born with both pinnae. Scars that were subsequently seen around its ear opening indicated that the animal was no exception to the general rule that earlessness in the Natal black rhinoceros is due to hyaena predation. The castration exercise was clearly ill-considered and the presumption that rhinoceros earlessness is necessarily a genetic condition is to be avoided in future.

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Re-Establishment of Elephant in the Hluhluwe and Umfolozi Game Reserves, Natal, South Africa

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Prior to the advent of European influence in Southern Africa, elephant were widely distributed throughout Natal and Zululand. The elephant populations in this area were decimated during the "Great White Hunter" era and the last elephant in the Hlabisa district of Zululand was reputedly shot in 1890. It is only in the unspoilt Mozi swamps and Sihangwane forests in the very northern part of Zululand that a remnant population of elephant survives. This population numbers between 75-150 and moves back amid forth across the international boundary between Mocambique and South Africa. Fortunately, the elephants are now protected on the South African side of the border with the recent proclamation of the Tembe Elephant Reserve, which falls under the control of the KwaZulu Legislative Assembly.

Tine Natal Parks, Game and Fish Preservation Board (henceforth termed the Board) controls a number of conservation areas in Zululand, the largest being the Hluhluwe and Umfolozi Game Reserves; these are joined by a corridor of state land (the whole area being approximately 900 square kilometres). The Board's primary objectives for these areas are to conserve a wide variety of habitat types and their associated indigenous species and to allow ecological processes to operate without interference (except where these processes have been impaired in some way). In line with these objectives it is the Board's policy to re-establish species in conservation areas where they have been eradicated.

Three major factors motivated the Board to re-establish elephant in the Hluhluwe and Umfolozi Game Reserves. (1) Elephant occurred naturally in the reserves and have been locally extinct for just under 100 years. (2) Since the reserves were proclaimed in 1985, the tree and shrub component of the vegetation has increased to the extent that the thicket, woodland and forest habitats are encroaching severely upon the more open savanna, grassland and wetland habitats. One of the major ecological factors that was removed from the area is the destructive feeding habit of elephant, and it is thought that the increased woody component is due, at least im part, to their absence. (3) Since elephant are classified asa special caseof threatened species by IUCN, the establishment of two interlinked populations of elephant in Natal would improve the status of this species in Africa. Furthermore, this would add considerably to the biological and conservation status of the reserves.

POTENTIAL PROBLEMS

During the planning of the re-establishment programme three potential problems were identified:

1. Would elephant break through die reserves' boundary fence?
   In some parts of Africa elephants move over large distances. If the re-introduced elephant were to exhibit this type of movement pattern and break through the fence they might cause socio-political problems by: (i) damaging the property of the adjacent subsistence farming community, or (ii) allowing other animals (particularly large carnivores such as lion, leopard, hyaena and cheetah) to leave the reserves.
2. Would the elephant damage the reserves' vegetation to an unacceptable level?
   This question may seem contradictory to one of the motivations for re-establishing elephant in the reserve, but it refers specifically to the possibility of the elephant selecting strongly for endangered or endemnic plant species which have higher priority for conservation than elephant.

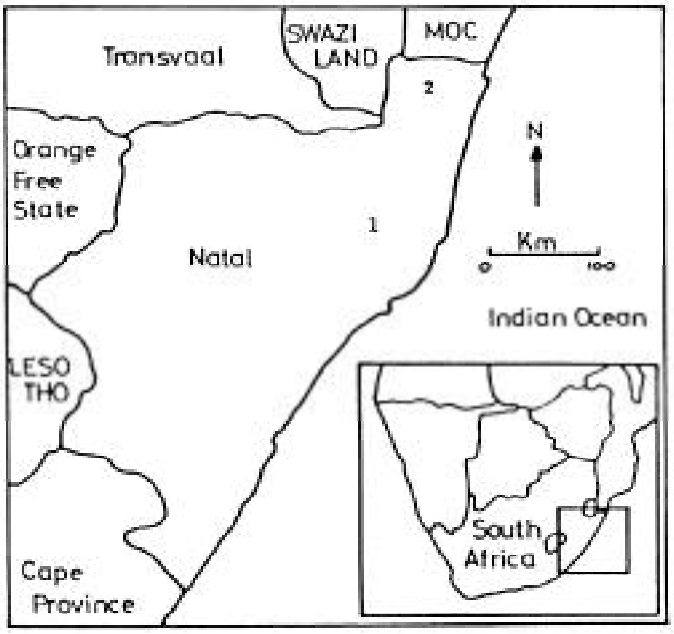

Figure 1. Location of Hlabisa District (1) within which Hluhluwe and Umfolozi Game Reserves lie; and the Sihangwane Forest and Mozi Swamps (2), now proclaimed as the Tembe Elephant Reserve.

3. Would the elephant survive the translocation exercise?
   This question arose from the fact that only juveniles (approximately 3-4 years old) could be translocated, due to the difficulties in handling and transporting wild adult elephant. At the commencement of the elephant re-establishment programme in 1981 all previous attempts to translocate juvenile elephant in Southern Africa had experienced extremely high mortality rates. Reasons put forward for this were based on the fact that young elephant spend most of their formative years learning which plants are palatable and where food and water may be found at different times of the year, from older members of the herd. Therefore, a high mortality rate is to be expected as the translocated juveniles have not had the opportunity to complete their education and are consequently ill-equipped to survive on their own in a new environment.

In order to establish whether or not these potential problems would present insurmountable obstacles an experimental phase was initiated, with a limit of 20 animals being set for each reserve.

MONITORING THE INITIAL PHASE OF THE PROGRAMME

Initially the Board resolved to monitor the movement patterns, feeding behaviour and mortality rate of the juvenile elephant re-introduced into Hluhluwe Game Reserve. Only when preliminary results from Hluhluwe indicated that translocation could be successful would the experimental phase be extended to Umfolozi Game Reserve.

1. Movement patterns

Two groups of 8 and one group of l0 juvenile elephant have been translocated from Kruger National Park to Hluhluwe Game Reserve since September 1981. Each group had radio collars fitted on at least two of the largest animals so that their movement patterns over time could be established. On translocation, there was an initial period of one to two weeks during which the elephant were highly disturbed and agitated. During this stage a loose group structure was formed, with the larger animals establishing leadership. Sometimes the groups split up, re-formed and /or one or two elephant would join up with an older group of elephant (which had already been established). Thereafter, they settled into a small home-range (between 25-50 ha) which gradually expanded and stabilized. At present, the three groups have home-ranges which overlap considerably, with a combined area of approximately 6 000 ha (about 20% of Hluhluwe Game Reserve).

Since the elephant in Hluhluwe Game Reserve did not attempt to break out of the reserve over the four year period from 1981-1985, two groups of elephant were released into Umfolozi Game Reserve in 1985. No radio collars were fitted on these animals (as experience from Hluhluwe showed that whenever their collars had to be changed they became highly disturbed causing the group structure to break down). Therefore movement patterns could not be monitored as closely as those in Hluhluwe. However, from sightings of these elephant they appeared to exhibit the same pattern of movement as the Hluhluwe elephant, being initially disturbed, then settling down in a small home-range which gradually expanded. Their home-range at present appears to be approximately 3% of Umfolozi Game Reserve.

2. Feeding behaviour

Feeding behaviour of the first group of young elephant released in Hluhluwe was studied intensively before and after they were released. This study tailed off after a few months as these young elephant were very susceptible to disturbance by humans on foot. Feeding behaviour since then has been monitored by analysing their faeces periodically (using a scanning electron microscope). The composition of their diet to date has been approximately 50% grass (particularly Durban grass **Dactyloctenium australe)** and 50% browse, which is the same ratio as has been recorded for elephant in the Kruger National Park. It was interesting to find that while the elephant were held in pens and their diet was supplemented with high protein cubes, they did not appear to be specific in their choice of plant species to eat. But after the elephant were released they showed positive selection for some of the more palatable woody plant species and rejected unpalatable species.

Despite this selection, the elephant have shown no particular preference for any endangered or endemic plant species and to date the possibility that the elephant may damage plant species which have been identified for special protection has not materialised.

3. Mortality rates

Of the 26 animals introduced to the Hluhluwe Game Reserve, eight have died which represents a 31% mortality rate. Of the 30 elephant released in Umfolozi there have been four confirmed deaths and possibly more (as only 20 animals cam be accounted for at present). However, this mortality rate is quite low compared to the levels experienced in translocations elsewhere in Southern Africa prior to 1981; the Board regards a mortality rate of up to 33% as unavoidable.

IN CONCLUSION

To date, the re-establishment of elephant into Hluhluwe and Umfolozi Game Reserves has been a success and the Natal Parks Board is mow considering detailed plans for the second phase of the operation. These plans revolve around, firstly, the question of how many animals would have to be introduced to form baseline breeding populations which will be genetically viable in the long term; secondly, what time intervals should elapse between the release of groups of juvenile elephant to produce a demographically stable baseline population; and thirdly, what is the maximum number of elephant that the reserves can support over the long term?

It is only with bold moves, such as this exercise to re-establish elephant into parts of their former range, that conservationists will be able to achieve their ideals.

The Ivory Carving Industry of Zambia

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Commercial ivory carving in Zambia did not begin until the early 1970's, the same decade as for Zambia's southern neighbours: Zimbabwe, Botswana and South Africa. Prior to then, ivory was, however, carved in small quantities. For example, in some parts of Zambia chiefs wore ivory bangles as a symbol of their status and authority, and the Lozi people were known to make bangles as ornaments for both men and women; but in no way could the carving be considered an ivory industry, anditis unlikely that there were any carvers who worked full-time with ivory.

The early 1970's were prosperous times for Zambia, and the relatively strong economy, based on copper exports, attracted many foreigners, including traders from West Africa, Kenya and Somalia, some of whom had little respect for the law. This was when many Zairois were also lured to Zambia, including ivory carvers who had a tradition in their own country of working ivory for several hundred years.

Since raw ivory was easily obtainable in Zambia in the early 1970's and its value was starting to increase substantially on the world market,itwas not surprising that the foreign traders along with Zambians began to exploit it in a major way. For a person to trade legally in ivory, whether worked or raw, he required a trophy dealer's licence, which was granted by the National Parks and Wildlife Service (NPWS). From 1971 to 1978 the number of trophy dealers increased from 66 to 224 (see Table 1). Over 90% of them handled ivory as there was much money to be made from selling ivory carvings and in exporting raw ivory.

One of the first persons to set up an ivory carving business in Lusaka was an Italian businessman in 1971. He hired four Zairois carvers who worked with only hand tools in the beginning, but once the business began to prosper, the owner purchased electrically powered machines. The raw ivory was bought from NPWS at 2 kwacha per kg (about US$3) in 1974, and from hunters who shot elephants legally. By the mid-1979's the firm was consuming between 500 kg and 600 kg of raw ivory a year, which was processed into many types of items: carved tusks, chess sets, pendants, bangles, necklaces, sculptures of human heads, animals and fruit.

The Italian's company, however, was not the biggest in the late 1970's. The largest one in the country was then owned by an Indian who had a retail shop in the middle of Lusaka, where he sold all types of tourist souvenirs and gifts. Also in Lusaka, he started his ivory factory in 1977; he hired two carvers and two machinists to produce items for his shop. The business quickly grew, and at its peak, around 1980, there were 28 ivory workers: seven carvers, nine machinists and twelve ivory scrapers. All the carvers were Zairois, and they were paid for what they made, rather than given a regular salary. In the early 1980's the Indian's best carvers were earning about $650 a month, and the factory was consuming on average eight to ten tusks per month weighing 12-16kg each. In a year, about 1,5 tonnes of raw ivory were processed into ivory goods, with a 25% wastage. Tine raw ivory, purchased from NPWS at a total cost of $37 500, was converted into about $330 000 worth of ivory commodities (at retail prices). Thus, each ivory worker converted on average 53,5 kg of raw ivory into carvings that retailed for about $11 800. For comparison, in 1982 in Zimbabwe, the average ivory craftsman consumed 75 kg of raw ivory (E. Martin, 1984).

Zambia's period of economic growth was shortlived, however; in the latter past of 1976 the economy began to decline and has continued to fall ever since; between 1976 and 1984 the per capita national income in kwacha (at 1970 proces) fell by 25%, according to official data published by the Central Statistical Office in Lusaka

Table 1. Licensed trophy dealers in Zambia

Year	Number
1971	66
1973	96
1974	130
1975	186
1977	222
1978	224
1979	216
1980	205
1981	167
1982	62
1983	25

Source: Unpublished statistics from the National Parks and Wildlife Service.

(Republic of Zambia, 1984; 1985). With the decline, many of the European and Asian residents began to leave the country, and the government brought in stricter controls on foreign exchange. Therefore, these foreigners began to look around for items they could purchase which would have some value outside the country. Ivory carvings were au obvious choice, although the quality of the workmanship was not upitthe standard prevailing in most of southern Africa.

Large quantities of ivory carvings were bought in the late 1970's, but many of them lacked proper documentation. In 1978 some of Zambia's honorary rangers searched every passenger and crew member flying to Europe during a six-week period to ascertain how much ivory was being taken out of the country illegally, and the discovered that vast amounts of worked ivory were being taken, but only one raw tusk was found. During these six weeks, $41 260 worth worked ivory was confiscated. There were two incidents when the crews of a European carrier were caught smuggling ivory carving. Flights going to London carried very little illegal ivory, but those going the European continent carried large amounts. The honorary rangers learned that almost all the people smuggling ivory were residents of Zambia, not tourists.

As the economy of Zambia declined, the value of the kwacha, com pared with the maim European and American currencies, also fell. From 1975 to June 1985 the official value of the kwacha went from on kwacha equalling US$1 ,55 to just 42c — a 73% drop. Many traders in Zambia illegally exported goods in order to externalize their assets. The West Africans and Zairois were especially active; they smuggled out emeralds, amethysts and malachite as well as ivory.

By the early 1980's thee traders realised that because Zambian ivor carvings were relatively crude there were difficulties in selling ther abroad. They then put their efforts into moving large quantities of raw ivory out of the country, which produced disastrous results to the elephant populations.

In 1973 an aerial census was carried out in the Luangwa Valley, which had the largest number of elephants in the country. Graham Caughley and John Goddard estimated a total of 56 000 in North Luangwa, Souti Luangwa and in the corridor between (Caughley and Goddard, 197 5) Some six and a half years later, in 1979, lain Douglas-Hamilton estimated a population of 33 510 in the same areas; this meant a 40% decline (Douglas-Hamilton et al. 1979). A third census was

carried out and analysed by Dale Lewis and Gilson Kaweche during the wet season, in January 1985. This showed a further decline of **³0%** to **400/n** since 1979 (Kaweche and Lewis, 1985). Iain Douglas-Hamilton, who made the first continental estimate of elephant numbers in 1979 for the World Wildlife Fund and the New York Zoological Society, believed there were then about 150 000 elephants in all of Zambia (Douglas-Hamilton, 1979). tin mid-1985, NPWS estimated only 41 000 (personal communication with George Mubanga, Senior Wildlife Research Officer), indicating a decline of 73% over the past six years.

The illegal killing of elephants throughout most of Zambia escalated due not only to the deteriorating economy but also to the sharp increase in the world market price for raw ivory and the ineffectiveness of the anti-poaching units of NPWS which suffered from a lack of adequate funding, a shortage of manpower and low morale. The illegal trade in raw ivory increased so much during the 1970's that several members of NPWS believed that the trade was totally out of control. Some trophy dealers were buying a single ivory tusk from N PWS only for the purpose of using the official ownership certificate they received withitfor other ivory they illegally purchased from villagers.

According to information supplied to me by senior members of NPWS, much of the ivory smuggled out of the country since the 1970's came from elephants poached in the Luangwa Valley. The normal practice is for a trader (who may be Zairois, Senegalese, Somali or Zambian), to lend to an illegal hunter a rifle with a good supply of cartridges. The hunter then descends the Muchinga escarpment, probably with a porter or two from a nearby village to carry provisions down, and raw ivory back. Often a group of hunters and porters will work together in a gang, staying in the Valley for a week or two. On the western side of the Valley, the gangs are large, averaging about ten men, but on the eastern side they rarely consist of more than seven and these are less sophisticated hunters, generally without automatic rifles. The gangs move their camp from time to time during their stay in the Valley and they search for rhinos as well as elephants. When they leave, they go back up the escarpment by foot, usually to the western side or due north; the eastern and southern sides of the Valley are more protected by tourist development and Game Management Areas. On the western side of the Valley most of the poachers are Bisa and Lala peoples; in the north the Bemba are involved, and in the east the Kunda, Chewa, Nsenga and Tumbuka take part.

In 1992, according to information supplied to me by Phil Berry (then Warden of the Save tine Rhino Trust Luangwa Anti-Poaching Unit), hunters on the western side of the Valley were paid 20 kwacha ($2 1,50) per kg for the raw ivory by middlemen, while on the eastern side of the Valley Zambian and Malawian poachers received only half that amount, or just under $11 per kg. The ivory on the eastern side went into neighbouring Malawi whereitwas used in tine domestic ivory carving industry (Martin, 1985), and the ivory transported to the northern and western ends of the Valley was mostly exported out of tine country to Burundi and other places where the markets were bigger and more lucrative. The price paid to the poachers on the western side of the Valley in 1982 was about half the world market price, based on the official value of the kwacha. In fact, in 1982 and 1983 the black market rate for the kwacha was twice as high for foreign convertible exchange as the bank rate soon the western side of the Valley poachers were receiving only 25% of the international price for raw ivory, and 12,5% on the eastern side.

According to more recent information supplied to me by the Chief Ranger of N PWS, D.C. Eldred, the traders in rural areas paid about 65 kwacha ($37) per kg for raw ivory in 1984 while the price in the cities was 95 kwacha ($53) per kg. Time prices in rural areas are now almost exactly half time world market price, based on official exchange rates, but, using the unofficial kwacha rate, are one-quarter of the world market price (as was the case in 1982).

Once the middlemen purchase the illicit raw ivory, they organise its shipment out of the country. According to information given tome by two honorary rangers in Zambia, the majority ends up in Burundi, sometimes moving via the Zambian port of Mpulungu on Lake Tanganyika. Much cement is exported to Burundi from this port, anditis likely that considerable quantities of ivory are hidden in the cement bags. One of Zambia's better-informed honorary rangers told me that the pace of loading cement bags on to ships at Mpulungu becomes almost frantic during the lunch period when customs officers are either not on duty or are not inspecting as thoroughly as during the regular working hours. Whether this has been true for some years, I do not know, but there is no doubt whatsoever that large amounts of raw ivory from Zambia are illegally taken out of the country and sent to Burundi. Since tine late 1970's, Burundi has been one of the major exporters of raw ivory in Africa, although the country has only one live elephant; most of Burundi's ivory originates from Tanzania, Zaire and Zambia (R. Martin, 1985).

Zambia's raw ivory is also illegally moved overland by lorry into Zaire and Malawi, and southwards into Botswana and South Africa. Statistics on this illicit trade are few, but occasionally large hauls are intercepted by the government authorities. In 1981 a Greek businessman in Lusaka concealed 476kg of raw ivory in a false bottom of his lorry and illegally tookitinto South Africa. He was arrested, and pleaded guilty in the South African court, but in mitigation he stated that time reason he moved ivory out of Zambia without a permit was because the Zambian government would not give him enough convertible exchange to take out of the country.

In the 1970's there were three sources from which trophy dealers obtained ivory: N PWS headquarters at Chilanga (which obtained most of its supplies from confiscations), the legal elephant hunters and the dishonest businessmen. Quantifying amounts from these sources is impossible, but general estimates cam be made. Unfortunately, even figures from NPWS are incomplete. From 1971 to 1976 one set of official statistics shows that on average each year NPWS gave export permits for 2 041 tusks, but no weights are listed for these. It appears from other ivory export permits supplied to me by NPWS that from 1975 to 1978, 58 745 kg of raw ivory were legally exported, or an annual average of 14 686 kg. These figures give some idea of the minimum quantity of raw ivory legally available.

For 1978 and 1979 am annual average of 363 elephants were legally shot by resident hunters and 78 byoverseas safari clients (see Table 2).

Table 2. Numbers of elephants shot on licence in Zambia from 1978 to 1981.

Year	Resident Hunters	Safari Clients	Total
1978	365	82	447
1979	361	74	435
1980	293	101	394
1981	159	47	206

Source: Unpublished statistics from the National Parks and Wildlife Service.

Most of the ivory obtained by safari clients was exported by them and thus was not usually available to the Zambian trophy dealers. NPWS annual report for 1978 gives the average tusk weight of elephants shot by safari clients from 1973 to 1978 —over which time it dropped from 22 kg to 17 kg. If we assume that the average tusk weight continued to decline to 15 kg, them in the late 1970's the resident elephant hunters produced a maximum of 10 tonnes of ivory per year.

Regarding the third source, the illicit dealers, one can only guess the amounts. However, it is not unreasonable to propose that at least

2 000 elephants were illegally killed each year during the 1970's, which would provide a gross potential of at least 20 tonnes of ivory a year; although not all of t would be picked up, probably more than half would be.

Whatever the total amount of ivory available in Zambia in the 1970's, it was a very great quantity, and the majority of it was illegally obtained by traders. This was confirmed to me not only by members of NPWS but also by honorary game rangers and trophy dealers themselves. Moreover, the ivory carving industry was based mainly on illegal supplies. Consequently, the government began phasing out licences to trophy dealers in 1979. From 216 in that year, there were only 25 licences issued in 1983.

On account of the illegality of the ivory trade in the 1970's, it is not possible either to determine how much raw ivory was consumed by the ivory carving industry of to know how many ivory craftsmen there were. However, from information supplied by N PWS staff, honorary rangers, former owners of ivory workshops and from the estimated demand for worked ivory (partly based on today's requirements), it is probable that the amount of raw ivory consumed in the ivory industry from 1974 to 1979 was between 6-10 tonnes per year, and that there were about 10 full-time ivory craftsmen and perhaps another 100 part-time. This conforms with the figure derived from the annual average consumption of 53,5 kg per carver.

In the 1970's the staff at Chilanga, NPWS headquarters, outside Lusaka, sold ivory on a "first come first served" basis. However, charges of favouritism towards some of time trophy dealers were made, and the Chief Warden also believed that the system was unfair since certain dealers were privileged to inside information about the times when the ivory store was full. With the phasing out of the local trophy dealers and tine private ivory carving industry, N PWS changed the method of selling raw ivory. In 1979 a tender system started, and only locally registered trophy dealers were invited to submit bids. The raw ivory was divided into three grades, based on weight and quality: Grade 1 was whole tusks in excess of 15 kg; Grade 2 was whole tusks of 5-15 kg; Grade 3 was scrap, broken tusks and pieces of ivory weighing less than 5 kg. (Recently, thee minimum weight of Grade 1 was reduced to 13 kg and Grade 2 to 4 kg). On 11th November1979 NPWS sold 10 358 kg of raw ivory to six local companies for the following prices: Grade 1 at 30 kwacha ($37,82) per kg; Grade 2 at 26 kwacha ($32.78) per kg and Grade 3 at 10 kwacha ($1 2,61) per kg. These prices were about half those of the world market price at the time and thus N PWS lost about $340 000 on this sale.

Within the private ivory carving industry being purposely wound down by the government and with N PWS trying to discourage exports of raw ivory by Zambian trophy dealers, NPWS began to invite overseas buyers to purchase their stocks of raw ivory, a policy which should have been introduced earlier. In February, 1982, two well — known foreign firms won tenders for 12 437 kg in a consignment within an average tusk weight of 5,68 kg. Only Grades 1 and 2 were sold, at 53,19 kwacha ($57,30) and 51,14 kwacha ($55,09) per kg. This time, because foreign buyers were approached, NPWS received approximately the world market price.

The third major tender took place in July1983, when 8 831 kg of ivory (average tusk weight 7,96 kg) sold for an average price of $37,83 kwacha, or $30,25 per kg — which is low — but no ivory of Grade 1 was offered. The consignment was purchased by a European company which of course exported it. The fourth and most recent sale was 8 108 kg offered by tender for US dollars, and t was secured by the same European company. The three grades of ivory were sold at $87,10, $69,05 and a remarkable $59,09 per kg respectively. In early 1985 the world price for raw ivory reached an all-time high because of tremendous demand for it in Hong Kong and Japan, due to the fact that a significant decrease in supply would occur in 1986 with the introduction of the new CITES quota system.

In a further attempt to control Zambia's ivory trade, the government outlawed all hunting of elephants in early 1982 by Presidential decree. Moreover, a year and a half later, all licences to trade in worked ivory were withdrawn; but a few trophy dealers were allowed to continue to sell their old stocks of ivory commodities if they registered them with NPWS. In July 1985 there were several shops in the centre of Lusaka, mostly on Cairo Road, and some at thee airport, still selling various ivory items: chess sets, heads, necklaces, earrings, pendants, animal figurines, chokers, bangles and hair pins, even though all private carvers were supposed to have ceased working in ivory by June 1984. And, there were also illegal hawkers of ivory in the back streets of Lusaka and outside the Pamodzi Hotel, a few kilometers from the city centre. They claimed that their small selection of ivory carvings were made on the Copper Belt. Since N PWS does not have staff or transport available to patrol urban areas adequately this illegal trade has not stopped.

Under the provisions of the Wildlife Conservation Fund, which began in January1983, NPWS set up its own ivory carving business. The Fund permits NPWS to enter into a variety of businesses in order to earn money to purchase equipment for anti-poaching work, to improve conservation activities and to aid staff welfare. In setting up am ivory factory, NPWS hoped to create stronger controls on the sale of ivory carvings and to create a monopoly on the ivory carving industry, as well as increasing revenues.

The ivory factory, officially called the Zambia ivory and Trophy Centre, was established in August 1983 in Chilanga, shortly before all private ivory craftsmen were to cease work. NPWS bad no previous experience In running such an enterprise and therefore wisely went into partnership with private businessmen, giving them a 40% share in return for the equipment and management expertise they would provide. N PWS also supplied a building, electricity and water; the raw ivory was provided a heavily subsidised price.

In July 1985 the factory employed one manager (am expatriate lndian mechanical engineer), one accountant, five carvers and three ivory scrapers (all male). The ivory carvers were born in Zaire and speak French; they receive a monthly salary which varies between 200 kwacha ($91) and 315 kwacha ($143), plus a bonus of one kwacha (45c) for each kilogram of ivory worked. Thus, they average between $107 and $163 a month.

The factory purchases raw ivory (mostly Grade 3) from NPWS at very advantageous prices: for Grades 1, 2 and 3 the prices are $22,73 (50 kwacha), $18 and $11,36 per kg respectively. Such prices are between one-quarter and one-third of those on the world market.

Since September 1984 the factory has been consuming an average of 300 kg of raw ivory each month. From this, 225kg of polished tusks and carved items such as bridges, human heads, flower vases, monkeys and jewellery are made. The wastage is no more than that of the largest private factory and this is comparatively little. The eight ivory craftsmen consume a phenomenal 450 kg of raw ivory a year per person, but they are polishing many tusks and this takes little time or effort.

The carving is still of a lower quality than that found in Zimbabwe, Malawi or South Africa (E. Martin, 1985). One indication of the poor craftsmanship is that the finished goods are sold by weight. In July1985 the price for an ivory item weighing between 1 g and 50 g was calculated on the basis of a kilogram of raw ivory costing $9 1,50-100 g at $88 per kg, 101-200 g at $84 per kg, 201-300 g at $81 per kg, and items over 300 g at $75 per kg. Thus, all 300 g ivory items, no matter what their differences in carving, are priced at $22,50 retail.

Despite the poor quality of the carving, the factory is highly profitable. For the first half of 1985, the running expenses averaged about $2 275 a month, while the gross revenue from sales (almost all ivory) was around $20 000.

Although perhaps an additional 0,5-1 tonne of ivory is still being carved by private traders illegally, the Zambia Ivory and Trophy Centre has no problems in disposing of all its output within days of production. Moreover, people often come to Chilanga in the morning, order a piece of ivory, and come to collect it the following afternoon. The factory sells all its output dt Chilanga and clues not wholesale or retail it elsewhere. At present production levels, it is unnecessary for the factory either to advertise or sell its ivory items in other shops. Demand is so great that production could even be doubled.

One of the main reasons why business is so brisk is that residents still want to buy ivory for the purpose of converting t into hard currency abroad. By far the most potentially profitable item for people who wish to externalise their money is polished or slightly carved tusks. The price for these is actually lower at the factory than raw ivory on the international market.

Oddly, tourists also have to pay for their purchases at the ivory factory with kwacha; it does not accept foreign exchange or international credit cards. The processed ivory, inexpensive as it is at the official kwacha rate, is ludicrously cheap when the black market rate for dollars or sterling is used. Since this is three times the bank rate, it obviously tempts diplomats as well as tourists.

The government of Zambia is now actively encouraging foreign tourism. According to the Central Statistical Office, in 1984 only 10 491 tourists came to Zambia specifically on holiday, with the largest numbers from Zimbabwe (2 037), the United Kingdom (2 012) and the USA (995). These numbers are very low, especially in comparison to earlier ones; twice as many tourists (22 167) came to Zambia in 1965 (Game and Fisheries Annual Report for the year 1966). Tourism is, in fact, going up this year and, as elsewhere in Africa and Asia, demand for ivory items will probably become greater with increased tourism.

In order to take advantage of the present market and a likely higher demand in the future, NPWS should initiate some changes in the ivory factory. Prices for the worked ivory should be raised; payment should be accepted in hard currencies from tourists, and considerable improvement in the quality should be made. The factory should also open a few retail shops in Lusaka, the Luangwa Valley, Livingstone and at the international airport. These would make it much less competitive for the illegal carvers and hawkers to sell their products, and if the factory increased its own output, there would be still less incentive for illegal sales. In addition, N PWS should set a deadline for stopping all sales of ivory in private shops which are still allowed to market their "old" stocks, in order to maintain the monopoly on the ivory carving industry. There are about 200 honorary rangers in Zambia, and NPWS should make greater use of these people. With their assistance, N PWS could easily crack down on those hawkers and shops that persist in selling ivory goods illegally. Some honorary rangers could also help with the policing of the new retail outlets for the government-owned ivory factory.

Furthermore, NPWS should make some changes in its sales of raw ivory. In the past, prices well below those of the international market have been accepted, and ivory stocks have also been held in storage too long at a time, losing revenue. NPWS should consider selling ivory on regular, open auctions, advertising these well in advance, particularly in Europe, Japan and Hong Kong. Even if the government prefers to retain its practice of selling raw ivory by tender, t should not accept a bid of less than 10% below the prevailing international price. And, of course, all sales should be paid for in convertible foreign exchange, a policy only recently introduced.

Under present conditions, the government-owned ivory factory in Chilanga is annually consuming 3,6 tonnes and grossing $240 000 a year (approximately 87% of the total ivory carving business in Zambia), with a net profit of around $213 000. From the one sale of raw ivory in early 1985 the government grossed $542 151. However, as has been shown above, these revenues could be substantially increased. The senior staff of N PWS are well aware of the problems affecting the management of ivory in Zambia and they are extremely concerned about the country's 60% elephant population loss between 1974 and 1984. They sincerely want to improve the situation, and with more money accrued from a properly managed ivory trade, they could do so.

Table 3. Ivory stocks held at the National Parks and Wildlife Service headquarters.

Year	No. of Pieces	Weight in kg	Average Tusk Weight (kg)
1979	1605	8824	5,5
1980	486	7465	15,4
1981	3489	15659	4,5
1982	2717	9968	3,7
1983	2197	6865	3,1
1984	3393	10515	3,1

Source: Unpublished statistics from the National Parks and Wildlife Service.

Table 4. Retail prices for ivory commodities sold in shops in Lusaka and at the capital's international airport, July 1985.

Item	Size	Average price in US$
Sculptures of heads	5 cm	43
Bangles	small to medium	29 – 54
Chokers	medium	20
Crocodiles	10 cm	16
Lions	5 cm	16
Necklaces	medium	10 –20
Lady's hairpins	medium	9
Earrings	small	*7* –– 10
Pendants	small to medium	5 — 10
Crosses	small	2

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Letters to the Editor

ELEPHANTS AND WOODLANDS—WHAT ARE THE ISSUES?

When we decided to respond to the article on elephant/woodland interactions by Jachmann and Bell (1984), Rob Olivier and I recognized a number of separate issues which we felt deserved comment. We hoped to stimulate discussion, rather than 'lecture" the authors, but because we were limited to a small space for our letters (Lindsay and Olivier, 1984), we were able to deal with only a single point each, and perhaps neither particularly well. Bell's (1985) reply continued the dialogue and answered some of our concerns. However, a few contentious points remained, and this "reply to Bell's reply" discusses more fully the issues we considered important.

Bell (1985) suggested that what we were "really worried about" was the issue of culling. This is accurate in so far as we feel that management interventions, such as culling (and burning, water development, and translocation), have impacts on ecological processes, and should be cautiously applied or avoided for valid reasons. What concerned us about the Jachmann and Bell article was the authors' use of ecological and evolutionary arguments mixed with opinion to support an apparent preference for short term stability (versus "dynamic" fluctuation) in savanna community structure, and for management intervention to preserve a given status quo. This position surprised us, in view of Bell's (1983) earlier commitment to a separation between "aesthetic" opinions and "technical" facts in the decision-making process. The questions posed for scientific study and the application of research results to management may incorporate value judgements, but we agree with Bell in the view that ecologists ought to be philosophically neutral when they discuss the scientific aspects of elephant biology. To do otherwise is to bias the decision-making process from the outset. An ecologist might properly say""Elephants alter woodland to grassland", leaving t to the manager (or to his own manage*r persona*. if he wears two hats) to say "Elephants destroy roan antelope habitat" or "Elephants create wildebeest habitat" and to judge this process as desirable or riot. Similarly, while the term "maladaptation" has an objective, scientific meaning, t can also be subtly persuasive when t addresses our attitudes towards management: can our sympathy for a "maladapted" organism be as great as for its""well-adapted" cousins? Bell's reply clarified the technical and aesthetic issues, and was more generous in its attitude towards ecological change. We find ourselves in closer agreement with this approach.

Technical questions were covered more extensively in the reply than in the original, but further discussion might still prove useful. One of these concerns elephants' dietary requirements. Can we really say that all elephants **need** a diet with a substantial browse fraction, simply because that is what they have been seen to eat in certain places and times? Olivier has suggested that elephants primarily need large quantities of plant material containing digestible energy, with supplements for specific amino acids or minerals if they are not found in the bulk diet. Grass is a good food source for large herbivores because its cell wall is not highly lignified (and is therefore fairly fermentable) and toxin levels are generally low. Woody browse may have larger amounts of soluble nutrients in its leaves and bark, but also contains more lignin and secondary compounds. Greater feeding selectivity, high turnover rates, and/or detoxification mechanisms may be needed by herbivores ingesting large amounts of browse. The relative abundance of grass v browse in a habitat will influence its inclusion in the diet. It seems that where and when grass is abundant, t supplies much of the dietary bulk for elephants. In dry seasons, or in habitats where woody vegetation is dense and grass sparse, browse will **necessarily** form a larger part of the total diet. In certain Asian forests, palm leaves are a major food of elephants technically palm leaves might be called "browse" since they come from trees, but as monocots, they more closely resemble grass in their chemical structure. Where marshes are found, as in Amboseli, swamp sedges are prominent even in dry season diets. The categorization of elephants as primarily grazers or browsers is clearly an oversimplification. They are generalist""mixed feeders" with large absolute requirements for nutrients (because of their size) and they make opportunisitic use of locally available resources. Indeed, nobody disputes that browse is important as a seasonally or regionally abundant food source; equally, few should disagree that grasses (or other monocots) are also important and are actively chosen when available.

A second technical issue concerns the development of equilibria in interactions between elephants and woody plant communities. Bell's research into the factors favouring coppice equilibrium demonstrates that some relatively unpalatable tree species, under certain environmental conditions, can grow back after elephant feeding and produce stable equilibrium communities. Absence of elephants appears to result in a community dominated by different woody species. The effects of herbivory on plant community structure have also been observed in grassland communities under the influence of grazing ——is this process qualitatively different from the elephant/tree interaction? There may be greater potential for instability in arid eutrophic systems, because higher nutrient density in woody plants may promote higher herbivore biomass and lower rainfall can limit compensatory plant growth, as Bell (1984) noted. Greater yearly variation in arid zone plant production and time lags in elephant and tree population responses could increase the instability, contributing to cyclic or irregular fluctuations. Bell (1985) also suggests how other ecological factors, such as fire, could contribute to the dynamics of arid zone communities. Our understanding of the factors affecting persistence and stability in elephant/woodland systems is developing slowly but steadily as more exstensive, longer term data on both plants and elephants accumulate. However, the Manyara example shows that "damaged" woodlands can regenerate under favourable conditions ——similar regrowth appears to be underway now in parts of Tsavo. There seems no reason to assume that all fluctuations must be catastrophic or irreversible, or that stability is never possible in arid eutrophic ecosystems.

In view of the foregoing, the suggestion that stable equilibria must occur by "husbandry" of woodlands by elephants seems unnecessarily complicated. It shares the theoretical difficulties of resource husbandy models, which require that discounting of short term benefits against longer term advantage be favoured by natural selection. In the case of elephants' use of trees, two hypothetical traits, tree damaging (TD) and non-damaging (ND) must be defined. Given the same local conditions, we will assume that both traits satisfy nutrient requirements in diets with the same grass/browse ratio; but TD animals break most of the trees they feed on while NDs do not (R. Bell, pers. comm.). ND individuals should take care not to damage trees, if necessary by visiting a greater number of trees over a larger area, and feeding less intensively on each single one. A "true N D" should do this even when ts immediate foraging needs (and perhaps short term survival chances) would be better served by feeding intensively on palatable, localized trees. Additionally TDs might be expected to make an extra effort to damage trees, not just when necessary to get a food source such as twig tips, leaves, or fruits, but simply to stimulate coppicing for future feeding. According to the husbandry model, TD should be selected for in moist oligothrophic areas where damage leads to coppicing, while N D should be favoured in arid eutrophic areas where trees are apparently more likely to die when broken or debarked (Bell, 1985)..

It remains difficult to see how such traits could spread through populations by natural selection. In moist oligotrophic woodlands, if a TD elephant coppices a tree and an ND neighbour does not, ND and its offspring will still get the long term benefit from increased browse abundance. On the other hand, in arid eutrophic areas, if TD kills a tree, its ND neighbour will also suffer. Assuming the energy costs of damaging or avoiding damaging trees are small or balance out, the TD and N D traits would not confer any relative advantage to their possessors over individuals carrying the opposite traits. It also seems that "cheaters" seeking short term gains could easily invade and disrupt the system. For this type of resource husbandry to work, individuals or closely bonded social groups must have long term exclusive control over their foraging ranges. Does resource monpolisation occur in elephants? Details of elephant social organisation are still under study in Addo, Amboseli, Hwange, and elsewhere, and any conclusions must be tentative. From the work done thus far, t appears that while putative elephant "clans" may have "relatively" exclusive use of the core area of a shared range, the number of individuals included may be large (over 100) and social relationships beyond the level of family unit may be fairly diffuse. Social bonding in mammals is often based on kinship, and elephants in family units maybe as closely related as mother-offspring pairs or full sibs (r = 1/2). However, kin relations may more often be half-sibs (1/4), half-aunts (1/8), half-cousins (1/16), or more distant. Clan areas appear to include a number of overlapping family unit ranges, making average relatedness lower still. Reciprocal relationships between non-kin have been found in some primate groups, but such groups with exclusive home ranges are generally sedentary and small in size. The inclusion of bulls further complicates the picture. There is often some overlap of bull areas with those of presumably unrelated females; among bulls sharing the same area, the relatedness of most individuals may be lower than within female clans. With our present understanding, it appears that the level of control over plant resources possible under the social system of elephants would be insufficient to allow the development of husbandry traits by individual, kin, or non-kin group selection.

It may, therefore, be inappropriate to describe elephants as maladapted when they do not appear to husband tree populations (or well-adapted when they do). It seems more likely that neither the TD or ND extremes are accurate descriptions of elephant feeding behaviour. Instead, elephants appear to feed on the parts of woody plants which they need to satisfy immediate nutritional needs. Damage may thus be an inevitable cosequence of efficient foraging in the short term. However, future studies of elephant feeding behaviour could examine more closely the context and relative inicidence of damage to woody plants, to further examine this question.

Despite these difficulties, many of the ideas proposed by Bell, especially in his reply letter, are stimulating amid suggest some priorities for research. For me, an important additional point was the policy statement recommending no culling in part of the Kasungu system. Although this recommendation was made for practical reasons — a massive culling programme would be required to reverse the elephant impact at this point, and further vegetation change appears unlikely (R. Bell, pers. comm.) — t also represents an opportunity to test the coppice equilibrium hypothesis. While such an experimental approach may be deemed undesirable for human social reasons in many areas, t is valuable whenever possible to gain knowledge about the biological principles underlying elephant/tree interactions and management options.

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Comment by R. du Toit (Co-Editor)

Sikes (1968) found that elephant hiving in lowland East African parks that were comprised largely of degraded scrubland or grassland had a high incidence of arterial diseases (median sclerosis and atheroma) and many had abnormally-shaped hearts, while elephant in montane forest areas were virtually free of these problems. This study did not establish whether these diseases were primarily due to dietary deficiencies, or to postulated stress factors (such as overpopulation, frustration of migratory habit, and excessive exposure to sunlight). McCullagh amid Lewis (1967) also found arterial lesions in most elephant sampled during population reduction exercises in Murchison Falls National Park amid Tsavo National Park, and ascribed the lesions to a lack of dietary lipid. McCullagh (1973) suggested that excessive tree damage by elephant may be a natural response to an inadequate fatty acid intake, since trees such as baobabs and **Terminalia** species which were particularly sought after by elephant in Tsavo and Murchison Falls have relatively high concentrations of linoleic acid (which was found to be particularly deficient in the elephants' diets).

White and Brown (1978) sampled elephant in a grassland habitat of the Kabalega National Park, which had an apparent overpopulation of elephant; they found a number of animals that showed polycythaemia (not found in elephant in the forested Ruwenzori National Park) and postulated that this was related to cardiovascular disease. Cmelik and Ley (1977) found that elephant in the Wankie (Hwange) National Park— where woody browse is readily available— — had relatively high levels of chohesteryl linoheate, even in the dry season, indicating that they must be receiving sufficient linoleic acid in their diet.

In view of these observations, t is surprising that Keith Lindsay asks: "Can we really say that all elephants NEED a diet with a substantial browse fraction, simply because that is what they have been seen to eat in certain places and times?" Richard Bell (pens. comm.) says that knowledge of the possible relationship between the incidence of arterial disease in elephant amid the proportion of woody browse in their diets is taken for granted in his letters. The above review of relevant literature is incomplete, and t would be useful if someone with a sound knowledge of these physiological aspects contributed some comments to the debate on elephant and woodlands.

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ELEPHANT TAXONOMY

Colin Groves and Peter Grubb are attempting a taxonomic revision of hiving elephants, using mainly characters of the skull, and would appreciate information from anyone who has measured even parts of an elephant skull of KNOWN LOCALITY (and, preferably, known sex and known age — dental eruption stage). Required measurements are given below; the figures indicate the position in which each measurement is, in our experience, most conveniently taken.

So far, we fiave between us nieasured all skulls in all the major collections of Europe and the United States (and in many minor collections too). Some very preliminary observations are as follows.

(a) Among African elephants, **cyclotis** is very distinct indeed from ordinary **africana**. Among the differences are the shorter, broader rostrum, the lesser degree of mastoid inflation, the longer mandibular syniphysis, the smaller teeth, and the fact that measurements (3) and (4) are usually identical (whereas number (3) is always greater, by several centimetres, in ordinary africana). We have, however, indications from a few skulls in the Brussels Museum that interbreeding occurs in the Virunga National Park, Zaire; and we would hike to hear from anybody who has evidence that the two interbreed anywhere else, or conversely approach each other without apparently interbreeding.

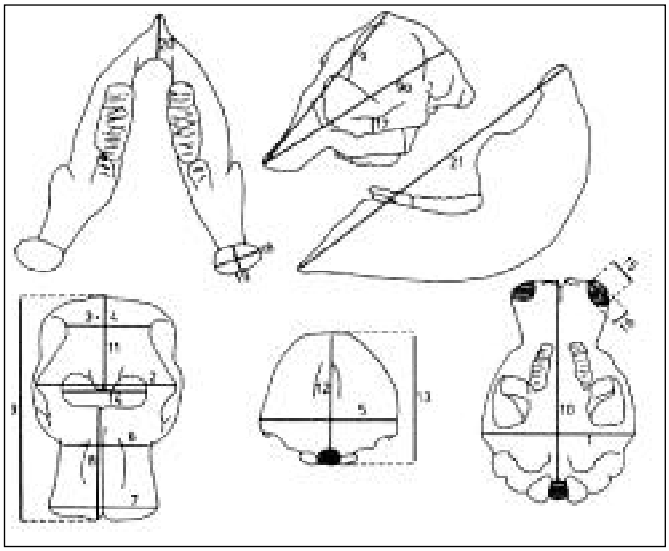
(b) Among Asian elephants, there seem to be two basic divisions: a "mainland" group (also in Sri Lanka), and a smaller "insular" group (also Malaya). The degree and amount of depigmentation seems to differentiate these two groups. Within the first group, t seems to us in possible so far to distinguish a Sri Lankan race, unless at the same time the big Mahavili elephants (vilaliya) are distinguished from the smaller mountain forest or general Sri Lankan form. Within the second group, the elephants of Borneo do seem distinguishable from those of Sumatra and Malaya: we incline to think they are indigenous, not introduced.

REQUIRED SKULL MEASUREMENTS:

1. Bizygomatic breadth;
2. Width across postorbital processes;
3. Width across postorbital constriction (least);
4. Width between temporal lines (least); this may be the same as (3) or t may be somewhat less;
5. Greatest breadth of occiput;
6. Least width of rostrum;
7. Greatest width of rostrum;
8. Length of rostrum;
9. Greatest skull length in midline;

9.a Greatest skull length, if occipital inflation is great enough to make a measurement taken from occipital surface exceed (9);

10. Basal length;
11. Occipitonasal length;
12. Occipital height, from opisthion;
13. Occipital height. fronm basion;
14. Width of external naris, taken between the ridges bounding t laterally;
15. Width of incisor alveolus: mesiodistal;
16. Width of incisor alveolus: buccoligual;
17. Least depth of zygoniatic arch;



18. Greatest diameter of mandibular condyle;
19. Diameter of condyle at right angles to (18);
20. Length of mandibular syniphysis;

AND

Breadths of all teeth present, arid state of eruption;
Lengths of all teeth present ——if erupting, then length that is in wear; if being shied, then length that still remains;
Number of lamellae (a) visible and (b) in wear on each tooth;
State of following sutures: (a) internasal, (b) bordering naris, (c) naxillo-premaxillary;
Length of humerus; radius; femur; tibia;
Numbers of vertebrae in each spinal segment;
Any external measurements available.

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CITES DEVELOPMENTS

Singapore has been a trade centre for rhino horn in eastern Asia, since the country did riot adopt CITES trade restrictions concurrently with other trading countries. However, as of 24 October 1986, the import and export of rhino horn has been prohibited by the Singapore Government and thus there is hope for some reduction in the trade in Eastern Asia.

An extremely significant development is the agreement by the Government of Burundi to enforce C ITES procedures for the control of trade in ivory. As of 1 September 1986 all imports and re-exports of ivory from Burundi have become subject to complete CIT ES controls. The Burundi Government has registered stocks of raw ivory totalling 89 502 kg.

Senegal has adopted new legislation on ivory trade, which makes the export of raw ivory illegal, except in the case of illegal hunting trophies.